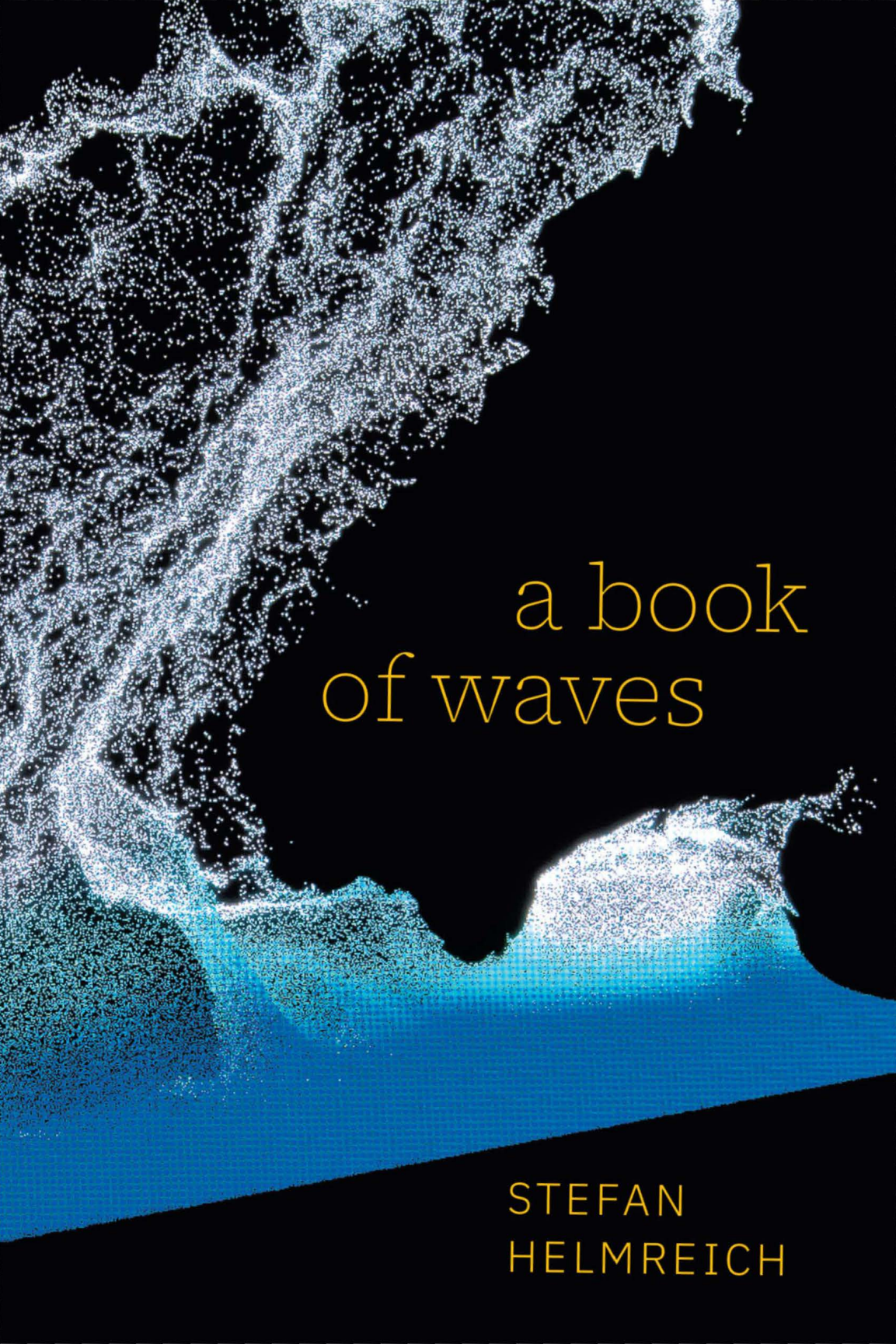

a book
of waves
STEFAN
HELMREICH

A BOOK OF WAVES

The Lewis Henry Morgan Lectures
Robert J. Foster and Daniel R. Reichman,
Co-directors

A BOOK OF WAVES

Stefan Helmreich

DUKE UNIVERSITY PRESS
Durham and London
2023

publication supported by a grant from
The Community Foundation for Greater New Haven
as part of the **Urban Haven Project**

Printed in the United States of America on acid-free paper ∞
Project Editor: Ihsan Taylor
Designed by A. Mattson Gallagher
Typeset in Source Serif 4 and IBM Plex Sans
by Westchester Publishing Services

Library of Congress Cataloging-in-Publication Data
Names: Helmreich, Stefan, [date] author.
Title: A book of waves / Stefan Helmreich.
Other titles: Lewis Henry Morgan lectures.
Description: Durham : Duke University Press, 2023. | Series: The Lewis Henry Morgan lectures | Includes bibliographical references and index.
Identifiers: LCCN 2022044728 (print)
LCCN 2022044729 (ebook)
ISBN 9781478020417 (paperback)
ISBN 9781478019947 (hardcover)
ISBN 9781478024538 (ebook)
Subjects: LCSH: Human ecology. | Ocean and civilization. | Ocean waves—Climatic factors. | Sea level—Social aspects. | Ocean—Philosophy. | BISAC: SOCIAL SCIENCE / Anthropology / Cultural & Social
Classification: LCC GF65 .H45 2023 (print) | LCC GF65 (ebook) | DDC 304.209162—dc23/eng20230407
LC record available at https://lccn.loc.gov/2022044728
LC ebook record available at https://lccn.loc.gov/2022044729

Cover art: Clifford Ross, *Digital Wave* (still, detail), 2017.
Courtesy of the artist.

CONTENTS

This page intentionally left blank

FOREWORD

The Lewis Henry Morgan Lectures at the University of Rochester were inaugurated in 1962 and have been presented annually ever since, with the exception of 2020, when they were postponed due to the COVID-19 pandemic. The lectures commemorate the contributions of Morgan (1818–81) to the University of Rochester, his support for the founding of a women's college, and his legacy in anthropology, as reflected in the topics of the first three lectures, which focused on kinship (Meyer Fortes, 1963), Native North Americans (Fred Eggan, 1964), and the origins of the state (Robert M. Adams, 1965).

As the oldest and longest-running anthropology lecture series in North America, the Morgan Lectures have produced some of the most influential texts in modern anthropology. To name but a few: Victor Turner's *The Ritual Process: Structure and Anti-Structure* (1966), Marilyn Strathern's *After Nature: Kinship in the Late Twentieth Century* (1992), and Marisol de la Cadena's *Earth Beings: Ecologies of Practice across Andean Worlds* (2015). A view of the lectures after sixty years illustrates the ways that anthropologists have moved well beyond Morgan's Enlightenment roots and how they have expanded on and reconsidered the topics that preoccupied him: kinship

and social organization, political economy, Indigenous peoples, and cross-cultural comparison.

Stefan Helmreich presented the Morgan Lectures over three days in October 2014. His public lecture was followed by a daylong workshop during which members of the Department of Anthropology, along with invited scholars, discussed several draft chapters of the manuscript that became this book. Formal discussants included Michael Fortun (University of California, Irvine), Anand Pandian (Johns Hopkins University), Daniel Reichman (University of Rochester), Nicole Starosielski (New York University), and Holly Watkins (Eastman School of Music).

Helmreich's lectures track the figure of the wave across various sociocultural domains, including oceanography, climate modeling, maritime infrastructure, statistics, music, sports, and art. His work brilliantly queries the relationship between waves' material dimensions and the myriad formalizations meant to capture them, which, he argues, express as well as format different understandings of time, nature, and culture. Waves can be rhythmic, regular processes that point toward a knowable future or unruly, destructive forces that portend an unknowable, unpredictable set of threats. For populations facing the imminent dangers of rising seas due to climate change, the material, representational, predictable, and unpredictable meanings of waves all interact to orient how people think about what is to come on a planet in precarity. In this regard, the wave serves as a key symbol to think about human responses to climate change.

The reality of climate change has led to a paradigm shift in anthropology, transforming our understandings of temporality, nature, and culture in the Anthropocene. Lewis Henry Morgan lived through another paradigm shift in anthropological notions of time, during which the biblical account of human origins was challenged by recognition of the Earth's long history (Trautmann 1992). Morgan's sometime interest in the intelligence of nonhuman species, particularly the American beavers he studied in Michigan's Upper Peninsula, was thus shaped by a scientific and cultural reassessment of the place of humanity in the natural world, and it gave a Darwinian charge to his questions: What separated humans from other animals? Did nonhuman animals possess intelligence, sociality, and culture? In the beavers Morgan found nonhumans that transformed their landscape to adapt to changing water levels. It was their architectural skill—their ability to construct sophisticated canals, dams, channels, and embankments—that convinced Morgan of their humanlike intelligence. In 1868, he even described an event in which a beaver dam was cut in half

by newly laid railroad track, lowering the water to its original level, after which the beavers "immediately repaired the breach" (Morgan 1868, 102), restoring the water to a suitable level for them—which, of course, was unsuitable for the railroad engineers (Cheng 2006; Feeley-Harnik 2021, 21). Although Morgan famously referred to the beavers as "mutes," we might also think of them as nonhuman hydroengineers.

Morgan worked as an attorney for a railroad company that developed Michigan's Upper Peninsula for iron mining, and he personally profited from the endeavor. The railroads and mines were built on land that had been unjustly ceded by Chippewa bands only a decade before the railroad work began. And Rochester, where Morgan resided, then, as now, sits on the unjustly occupied land of the sovereign Onöndowa'ga:' (Seneca) Nation of the Haudenosaunee (Iroquois) Confederacy, vital to acknowledge since Morgan's anthropological career depended on a mix of advocacy for and racializing and assimilationist views of Indigenous peoples in what settlers, in the ongoing wake of colonialism, call North America. The very processes of industrialization and extractivism in which Morgan participated, and that he heralded as "progress," have had long legacies, contributing, now, to the climate disaster. The coastal engineers whom Helmreich describes in segments in this work are seeking to undo—or live amid—the damage. How the waves with which they, as well as their oceanographer colleagues, reckon may themselves act or be enlisted as agents of hydroengineering—amplifying, damping, or rescripting sea level rise on a climate-changed planet—remains to be seen.

DANIEL R. REICHMAN
ROBERT J. FOSTER
Department of Anthropology
University of Rochester
May 2022

This page intentionally left blank

PRELIMINARY

FORWARD AND BACK

The coronavirus arrived in waves. Rolling graphs of case and death rates from COVID-19 came chronicled and projected in uneven lulls and surges. I finished writing this book during the pandemic, and as I revised my stories of ocean wave science—accounts I had gathered throughout the 2010s—they seemed to slip into another era, even as I knew that one of the tales I wanted to tell, of sea level rise and climate calamity, was still being written, inexorably, in and by the waves. Like many sequestered at home, I read. The edition of Albert Camus's *The Plague* that I obtained was fronted by a photo, taken as if from a sea cliff, showing a span of spray-crested waves, at once repeating and sporadic (plate 1). What were we meant to see? Epidemic waves? The dissolution of individual fortune in the stir of aggregation? A vaguely sinister postcard image of the kind of watery pathway that brought French colonialism to *The Plague*'s North African setting, the waves legible as a medium of politics? I took the image (which turned out to be from Australia's Bondi Beach, famous for surfing and known to its Aboriginal traditional owners, the Gadigal people of the Eora Nation, as an early site of British imperial incursion) to be about the riddle of reading itself, that puzzle in pattern recognition, in discerning meaning, that preoccupies me and the wave

scientists and publics who are the subjects of this book. The question of how to interpret the roil of the world—moving nowadays through a surge of syndemic crisis, ascendant authoritarianism, and renewed nuclear threat—requires, like wave forecasting, looking backward to look ahead, orienting to how the wakes of history tell on the present. But it also demands attention to the unforeseen; to that which, like suddenly breaking waves, may overwhelm expectation. Waves, this book proposes, may be oracular forms and forces through which to apprehend today's climatological and political sea changes, as oceanic and social processes increasingly churn into one another, running forward and back.

PREFACE

WAVE CLUTTER

Imagine a rippling sea. Imagine, next, the invisible waviness of a radio transmission skittering along the surface. As radio waves propagate over ocean waves, where seawater and atmosphere meet, oscillations of multiple sorts materialize. Often, the waves, both watery and electromagnetic, interfere with one another, appearing on ship radar readouts as a mess of squiggles.

One day in 2017, finding my feet on a research vessel operated out of the Scripps Institution of Oceanography, in La Jolla, California, I was directed by a sea scientist to a sensor display of this scribbly disorder. I already knew what this chaos was called: wave clutter. I had first heard the phrase a few years back from the poet Paul Muldoon on a seagoing study abroad program on which he was leading writing classes and I was teaching cultural anthropology (on leave from my usual post, at the Massachusetts Institute of Technology). Muldoon had just returned from a tour of the bridge, and, taking me aside, asked, in a conspiratorial voice, "Have you heard of this? Wave clutter?" Muldoon, a Pulitzer Prize–winning poet, had a way of making ordinary words sound like dispatches from a secret history of the English language. *Wave clutter*. I turned the phrase over in my head: *wave* suggesting a rising and diving flow; *clutter*, a crosscutting

confusion. The term came back to me as I swayed slowly before the Scripps ship's radar screen, which was visualizing waves in the waters around us, thirty-five miles off Malibu.

Waves of many sorts had at that time been scrolling steadily through news headlines, and this book, *A Book of Waves*, arose in the wake of the multifarious, dramatic waves that had been capturing wide, sometimes world, attention since around the turn of the millennium. A partial list:

- The first officially measured instance of a "rogue wave," an eighty-four-foot wave that hit an oil platform in the North Sea in 1995 and established the real, not mythical, status of such "freak waves," now defined as twice the size of their immediate neighbors
- The 2003 foundation of Wavestar, a Danish company dedicated to generating fossil-free electricity from the energy of ocean waves arriving at the shores of the Jutland Peninsula
- The 2004 Indian Ocean tsunami, which killed some 227,000 people
- The 2005 storm surges of Hurricane Katrina, which devastated New Orleans and claimed the lives of more than 1,800 souls
- The 2008 and 2014 waves that flooded the Marshall Islands, leading to declarations of a state of emergency and ongoing anticipation of a sea level rise that could inundate the archipelagic republic
- The 2009 Green Wave postelection protests in Iran, followed by what the anthropologist David Graeber (2013, 64) called "a wave of resistance sweeping the planet" that he named as beginning in Tunisia in January 2011, moving from Egypt to Libya to Yemen to manifest as the Arab Spring and traveling on to the Occupy protests that materialized later that year across the United States. In 2016, the election of Donald Trump to the US presidency ushered in a counterwave, a courier of a worldwide tide of populism and authoritarianism, whose full effect is yet unknown
- The Tōhoku tsunami of 2011, which hit the east coast of Japan, killing some twenty thousand people and causing a level 7 meltdown at the Fukushima Daiichi Nuclear Power Plant
- The 2011 surfing of a record-breaking 23.8 meter wave in Nazaré, Portugal
- The 2012 approval by the US Food and Drug Administration of a Wi-Fi enabled implantable cardioverter defibrillator, which administers shocks to the human heart to keep its ventricular waves on pace, but which can also be jammed by ambient electromagnetic waves

The 2012 waves of Hurricane Sandy, which hit the Caribbean and then left New York and other East Coast cities in the dark, an Atlantic calamity superseded by 2017's Hurricane Maria, which killed thousands in Puerto Rico

The gravitational waves detected by cosmologists in 2016, a burst consequent upon the collision of two black holes in a distant galaxy

The 2017 opening of the surfer Kelly Slater's artificial wave pool in inland California

Finally, to flip the script into a future I could not in 2017 see: the waves of coronavirus infection that began in 2020

Such a list may seem unaccountably cluttered—joining different orders of things; fusing the disastrous, the mundane, and the recreational; collapsing diverse modes of description; breaking across various planes of analysis, and including not just the oceanographic, but also the social, biological, and cosmological. All of these waves, however, manifest as energies that in some way gather up or substantiate anxieties, terrors, and, sometimes, optimisms about the shape of history and of the future.

In the years I have spent thinking about waves—motivated, initially (full disclosure) by enthusiasm for the sport of bodysurfing, later by an interest in ocean environmentalism, and still later by an anthropological commitment to examining the cultural and political making of natural-science knowledge—I have been fascinated time and again by how waves have been considered both abundantly material and abstractly formal and by how they have been described as phenomena that can unfurl in diverse media (electromagnetic, sonic, oceanic), even as water waves remain the reference example. As I researched this book, in the context of a world in growing turbulence and uncertainty, I came to see something more. I came to understand waves as objects through which people seek to apprehend time, to foretell futures: ecological, scientific, political, local, planetary.

Waves are forms, patterns, and material carriers of change, sometimes regular and periodic, sometimes abrupt and irreversible. The futures waves bring may unfold with slow inexorability (sea level rise) or disastrous speed (storm surges, tsunamis), in synchrony with infrastructural transformation (the shoring up or falling apart of coastal defenses), and in uneven resonance with the churn of collective social process (including intensified currents, these days, of protest, migration, and pandemic relay). If the coming decades on our superheating planet will see increased ice melt, urban flooding, redrawn coast lines, and accompanying courses of

social rearrangement, waves will be heralds of those dynamics, symbols and forces of future sea changes.[1]

This book centers an anthropological attention on wave science—and primarily, though not exclusively, ocean wave science, a science that has been organized around projects of maritime, civil, military, recreational, and infrastructural planning. Other books offer more traditional institutional, disciplinarily internal histories of the science, as well as more technical primers on how waves are known in oceanography, hydrodynamics, and mathematics (see, e.g., Parker 2012; Pretor-Pinney 2010; Zirker 2013). My account is based on ethnographic research I conducted among oceanographers, coastal engineers, programmers, surfers, and others, mostly in Europe and North America, though also with scientists in Australia, Japan, and Bangladesh. I followed them as they worked to understand the Earth's wavescape through fieldwork at sea, wave modeling in the lab, and, increasingly, computational simulation. I examine how scientific portraits of waves have transformed over the past century or so in calibration with shifting methods of technoscientific representation, as well as with changing sociopolitical concerns and demands, and I argue that waves should be approached not only as natural phenomena but also as culturally significant entities.

A Book of Waves understands waves to be not only material processes of energy propagation across space or of vibration at some frequency. Waves are also made manifest through abstractions crafted by scientists who decide what will count as wave activity, whether in a passive medium (as with water waves, sound waves), an excitable medium (as with waves in biological tissue), or a vacuum. Waves are empirical and conceptual phenomena both. Empirical: there they are. Conceptual: discerning that *there they are* requires abstraction, whether accomplished by an electronic transducer visualizing radar returns at sea, a gravitational wave detector listening for sounds of the early cosmos, an electrocardiogram mapping heartbeats, a watercolor painter seeking to capture the evanescence of a cresting wave, a network of coastal buoys detecting incoming storm surges, a surfer judging potential rides, or a social theorist seeking to make a claim about epochal political change.

In her review of Paul Muldoon's *To Ireland, I* (1998), Clair Wills (2000, 6) suggests that, for Muldoon, "the political dimension of literature . . . is not to be found in public position-taking, nor purely in a willful disruption of linguistic codes, but in a kind of interference of wavebands." The chapters here, some growing from Lewis Henry Morgan Lectures I delivered in the

Department of Anthropology at the University of Rochester in 2014, are very much tuned to the interference of wavebands, to worldly clutter, though the reader will also find sharp moments of position-taking and willful disruption in the service of understanding wave science, like any science, as fully immersed in the disputations of human life and politics. I treat wave clutter not as confusion fully to be cleared up or as always a generator of unwelcome artifacts but, rather, as indicative of the inextricability of the world and its representation.

A Book of Waves presses a bit against the coherence of the "book," against the singular form of the monograph. Ethnographic chapters on ocean wave science move from the Netherlands to San Diego, then to Oregon and Japan, to Washington, DC, and to the Bay of Bengal (by ricocheting way of Australia), and are interleaved with shorter, interstitial pieces I have gathered into *sets*. A *set*—a term of art from surfing—is a group of waves of like speed that travel together, entrained by a common wavelength. In this book, each set contains three essays that reapproach, from varied angles, themes in the ethnographic chapters they follow. They reflect on waves in folklore, surf culture, music, movies, painting, forensics, environmental disaster, and more. Some (typically the final entry in a set) consider waves other than ocean waves—gravitational, cardiac, social—examining the rippling exchange of analogy among natural, cultural, and social domains.[2] These essay sets offer thematic refractions—or, better, diffractions, interferences of wavebands, constructive clutter.[3]

As I set to writing this book, I had already spent a lot of time with ocean scientists in work toward *Alien Ocean: Anthropological Voyages in Microbial Seas* (Helmreich 2009). In that book, I examined how research on marine microbes in the early 2000s was reshaping how marine biologists viewed the ocean, coming to see the sea as not just populated by microorganisms but as, to some extent, made of them—made, that is, of life evolutionarily enduring, but also of life damaged and at risk. The global state of the sea, I came to see, may be illuminated through tracking the making of knowledge about its composing parts. Just so, the waves of wave science—whitecaps, swells, breakers, surges, rogues—may have much to reveal about the social, cultural, and political state of this beleaguered ocean planet and its future.

This page intentionally left blank

PLATE 1 Ocean waves on the cover of the Penguin Classics edition of Albert Camus's *The Plague*. Photograph © 2003 Rankin. Reproduced with permission of Rankin/ Trunk Archive.

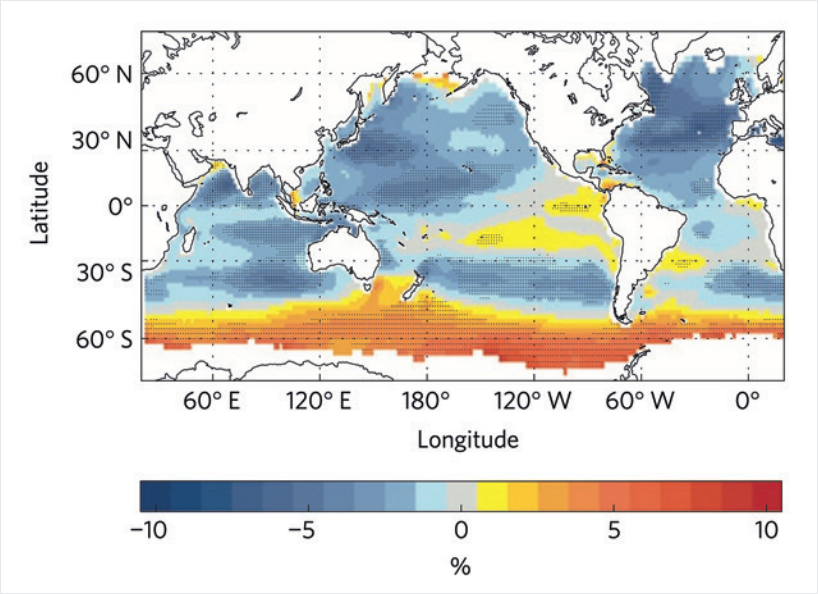


PLATE 2 Projected changes, by percentage, in annual mean significant wave height for a future time slice (ca. 2070–2100) relative to a present climate time slice (ca. 1979–2009). From Hemer et al. 2013, fig. 2b.

PLATE 3 Inaugural wave in Delta Flume, Deltares Research Institute, Delft, Netherlands, October 20, 2015.

PLATE 4 Ivan Aivazovsky, *The Ninth Wave*, 1850, oil on canvas, State Russian Museum, Saint Petersburg.

PLATE 5 Raden Saleh, *A Flood on Java*, ca. 1865–76, lithograph, Royal Netherlands Institute of Southeast Asian and Caribbean Studies, Leiden, Netherlands.

PLATE 6 FLIP upright, at sea, at 33.689°N, 118.989°W, October 2017. Photograph by the author.

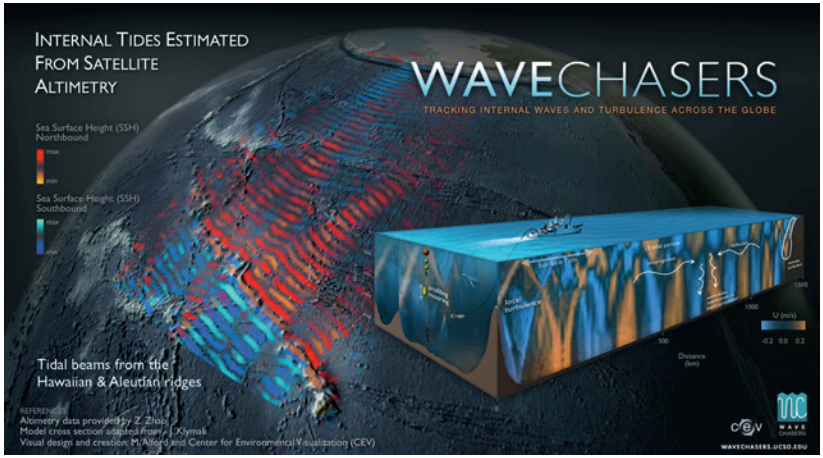


PLATE 7 Internal wave crests, detected from space, travel north (red) and south (blue), away from the Hawaiian and Aleutian ridges. Right: cross-section volume depicting propagation of internal waves. Image design by Matthew Alford, using altimetry data from Zhongxiang Zhao and simulation work by Jody Klymak, in collaboration with the Center for Environmental Visualization, University of Washington, Seattle.

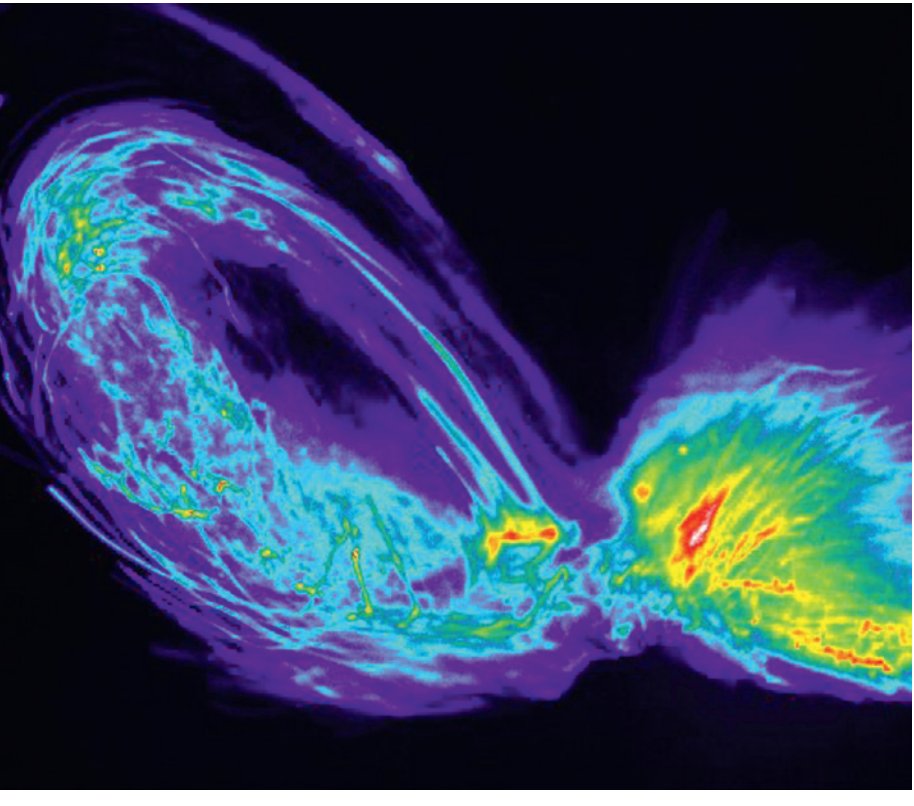
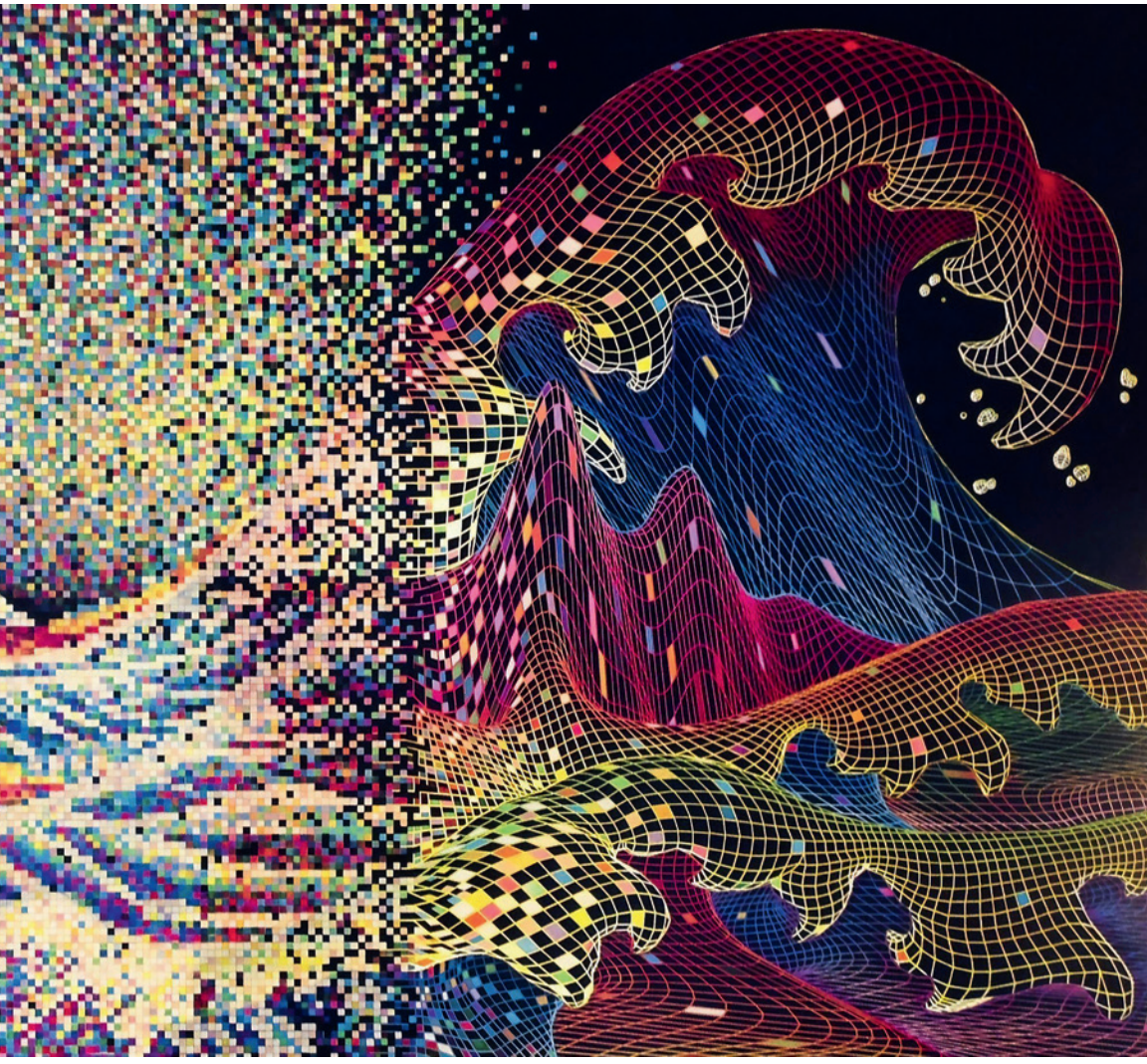


PLATE 8 False color side view image of a breaking wave (left to right), with warm colors indicating bioluminescence from dinoflagellates, used as a proxy for shear stress, a measure of turbulent energy dissipation. From Deane et al. 2016, fig. 2.

PLATE 9 Ken Charon, *Obama Rides the Big Wave*, 2008, acrylic on hemp canvas board.

PLATE 10 Judy Kirpich and Alex Berry, *The Wave of the Future*, 1981, lithograph.



DUKE
UNIVERSITY
PRESS

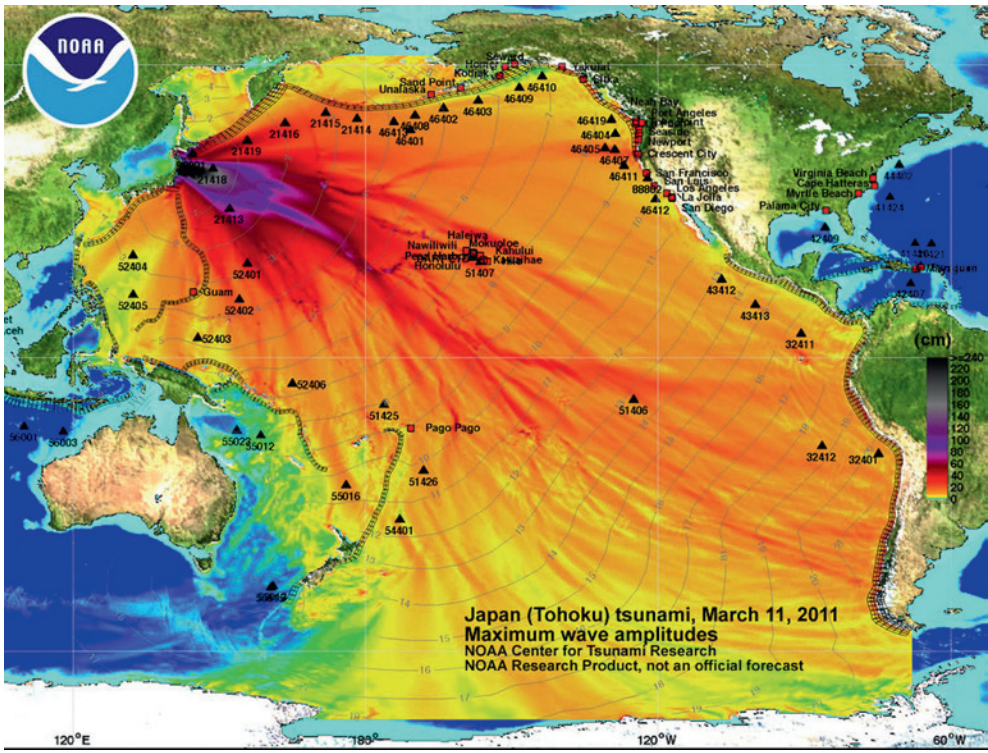


PLATE 11 "Japan (Tohoku) tsunami, March 11, 2011. Maximum wave amplitudes, NOAA Center for Tsunami Research, NOAA Research Product, not an official forecast." http://nctr.pmel.noaa.gov/honshu20110311/Energy_Polot20110311=1000_ok.jpg.

PLATE 12 Illustration from Maekawa Monzo's 大水海 (Large Water Sea), an account of the tsunami of 1896, published in 1903.

PLATE 13 Bonnie Monteleone, *Plastic Ocean: In Honor of Captain Charles Moore*. From the *What Goes Around Comes Around* collection, 2011, trash, after Katsushika Hokusai, *Under the Wave off Kanagawa*, ca. 1829, woodblock print. Copyright Bonnie Monteleone.

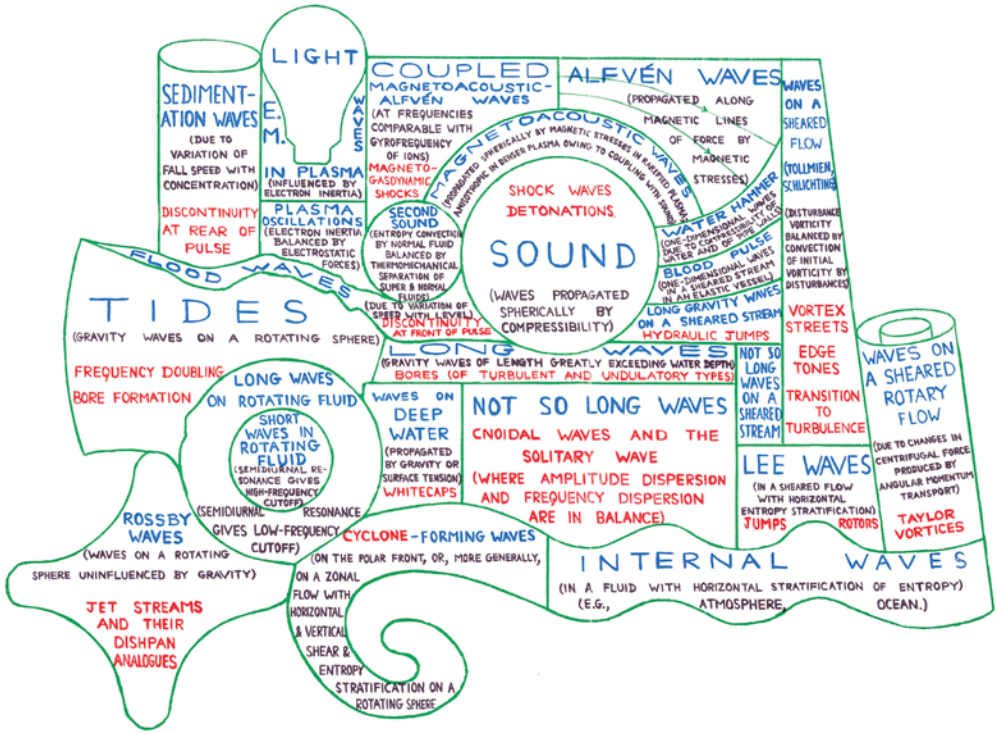


PLATE 14 Diagram. From Lighthill 1967, 269–70.

PLATE 15 Edgar Arceneaux, *The Slave Ship Zong*, 2011, acrylic, graphite on paper. Courtesy of the artist and Vielmetter Los Angeles. Photograph by Robert Wedemeyer.

Introduction

Significant Waves

THE SUN HAD NOT YET SET. Overlooking the Pacific Ocean from the chalky cliffs of La Jolla, California, I was talking with the ninety-seven-year-old oceanographer Walter Munk at his house, a mid-century modern perched just north of the Scripps Institution of Oceanography. Munk, born in Vienna in 1917, arrived at Scripps in 1939—the same year he became an American citizen; the same year the Nazis annexed his native Austria—and was soon recruited into projects of ocean wave prediction for World War II. Working with colleagues from California to Cornwall, he made models used to forecast the forms and forces of waves breaking on the beaches of Normandy, providing critical information for the amphibious landing of Allied troops in northern France on June 6, 1944—D-Day. When the Cold War heated up, he was tapped by the US Navy to undertake measurements of wave action in the western Pacific, calculating the terrible wake of experimental detonations of nuclear bombs in Micronesia. In the 1960s, he led a team tracing the storm-born Southern Hemispheric origin of the swells that hit California, knowledge still relied on by weather forecasters and the surfing faithful. A few months before our conversation, Munk had joined in a public tête-à-tête with the Dalai Lama,

the Tibetan Buddhist monk and spiritual leader, on a matter of common concern: climate change and sea level rise. And the day before we spoke, in August 2015, the *New York Times* published a biographical profile, calling Munk the "Einstein of the Oceans" (Galbraith 2015), a designation that, in an age when the sea's ecological health is under siege from anthropogenic insult, summoned up the significance of the ocean as a problem space for physics, with the Einstein comparison suggesting pioneering genius, a historical implication in deadly technological enterprise, and, perhaps, a weathered arrival at worldly wisdom (see also Munk and Wunsch 2019).

Munk's house was called "the Seiche" (Swiss French for "undulating wave"), a name proffered by his late first wife's mother in 1954, designating a form of wave—one that oscillates back and forth in a bounded space—that stands for a contained dynamism. I had found Munk in a contemplative mood. As he adjusted his hearing aid to tune me in, I scouted for a way to ask about the relation, for him, among waves; science; and the politics of war, peace, and everyday life. I started with a technical question, asking him about the difference between studying waves in the ocean and in the controlled environment of the laboratory, or even, these days, on a computer. He declared that he had always been "on the field side," then said something remarkable:

> I've often asked this question: if we met somebody from another planet who had never seen waves, could he dream about what it's like when a wave becomes unstable in shallow water? About what it would do? I don't think so. It's a complicated problem. If you asked the best mathematicians who have worked with waves—who have never been in a lake or in an ocean—what happens to waves when they come to the coast, I doubt they could calculate it.[1]

No mathematical abstraction alone, Munk urged, could properly predict a wave's breaking. Thinking about wave dynamics requires conceptual work, to be sure, but there is something empirical, irreducible, about waves in the wild. Putting on his glasses to look out over the dusking Pacific, Munk directed my attention to bands of waves arriving from the horizon, heading toward us in neat lines, and continued:

> I've never gotten tired of watching waves. And that's the amazing thing. There's sufficient variability. I've been in certain bathhouses where they make waves by plungers. The ones that I saw were single-frequency—terribly dull, one wave like the other. The interesting thing is waves

> that are not either so stochastic that they have no predictability associated with them nor so regular that one is like the other. In between, you get the most interesting things. Some degree of predictability, but certainly no certainty.

"What appeals to you about that?" I asked. Munk leaned forward. "That's a question for *you*, the anthropologist."

Munk's flipping of the interview script set me reorienting. I looked down at the La Jolla waves, recalling my young adult years as a bodysurfer trying to read them, seeing in them, from my vantage as an East Coast transplant, some Pacific promise of an open, unfurling future, unaware then of their historical and ongoing roles as watery supports for colonial adventure and war, as elements in calculations around coastline development, and as media in the sea changes of climate transformation—all matters that now, as an anthropologist studying the culture and politics of science, shape my seeing of the sea. Munk's rejoinder, pointing to the matter of how wave scientists assign cultural value to the boundaries between predictability and unpredictability, unlocked for me a set of social questions. At stake in ocean wave science and its dedication to forecasting are orientations to time and to the future—futures to do with coastal infrastructure, beach and sea recreation, the logistics and ongoing projection of military power (US and otherwise), disaster preparedness, atmospheric transmutation, the seaborne trajectories of plastic and other pollutants, human and multispecies pathways of shipping and migration, marine insurance bureaucracies, the harnessing of ocean energy, and much more.[2] Scientific accounts of waves not only offer modes of analyzing oceanic process; they are also conditioned by the frames of anticipation and value—national, regional, hemispheric—within which such reading takes place.

Such frames, for wave science, build on a scaffold put together, in one canonical outline, by European, Enlightenment, and colonial preoccupations. Roll back to the Italian polymath Leonardo da Vinci, who, writing in his journal at the turn of the sixteenth century about "the numberless waves of the sea" (see Baskins 2010), delivered a cosmologically expansive vision of the sea as an immeasurable force, one of which he was famously terrified, inking toward the end of his life image after image of the world ending in swirling deluge (figure I.1).

Western mariners and scientists later strove to bring this realm into the sphere of the accountable, though they were hardly the first, or alone.[3] From 1405 to 1433, the Ming dynasty mariner Zheng He created sailing charts

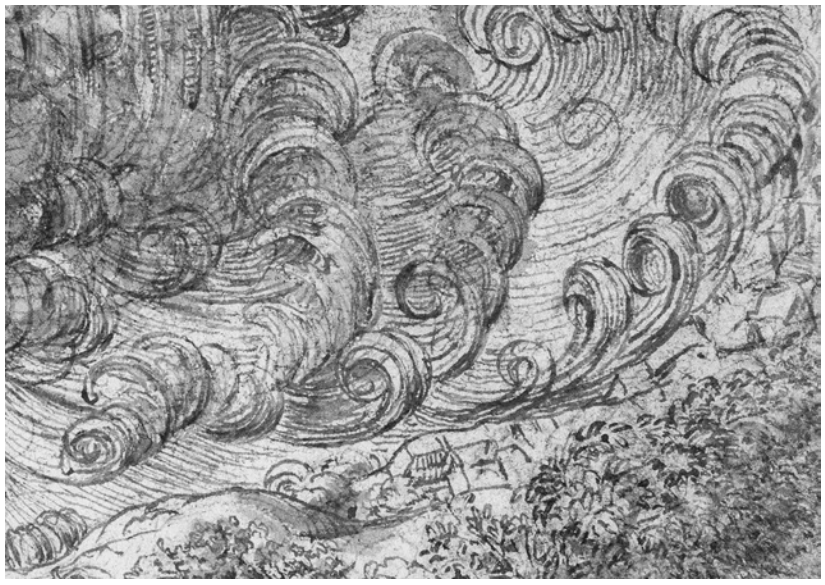


FIGURE I.1 Detail of Leonardo da Vinci, *A Deluge*, ca. 1517–18, pen and black ink with wash on paper. Royal Collection Trust, London.

that outlined ocean winds between South India and East Africa (Pereira 2012). The fifteenth-century Arab navigator and cartographer Ahmad ibn Mājid wrote works on the currents, tides, and winds of the Indian Ocean, naming breaking waves (*ouqod al-ma*) "sea signs" (*isharat*) of close-by coasts and describing a phenomenon later translated as the "wave of the Cross (Southern Cross)," which enabled trade across the monsoon ocean ([1490] 1971, see also Aleem 1967; Al Hosani 2005). Sixteenth-century fishers on the West African coast of what is now Ghana designed dugout surf canoes (*ali lele* in the Fanti language) to ride waves safely in to shore (Dawson 2018). And wayfinders and surfers in the Pacific developed techniques of navigation and surf riding (*he'e nalu* in Hawaiian) pitched to a range of wave configurations (see Genz 2016; Walker 2011).

Well before the rise of oceanography, back in Europe, researchers in fluid mechanics had been describing waves as moving patterns of crests and troughs—patterns that could be characterized by their wavelength (horizontal distance from crest to crest), height (vertical measure from crest to trough), and period (the time it took for a crest to advance one wavelength).[4] A roll call of European mathematicians including Isaac Newton, Leonhard Euler, Joseph-Louis Lagrange, Baron Augustin-Louis

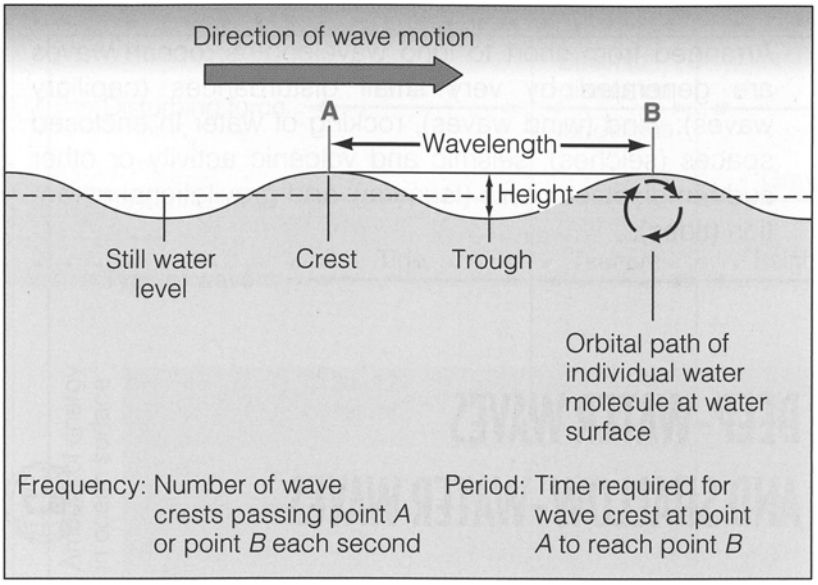


FIGURE I.2 "The Anatomy of a Progressive Wave." From T. Garrison 2005, 230, fig. 10.2.

Cauchy, Heinrich Martin Weber, and Lord Kelvin made formal models of wave action—from field observations, in glass wave tanks, and using calculus (with infinitesimals a tool for bounding Leonardo's "numberless waves" [Craik 2004]). Water in waves, they emphasized, did not hurtle itself forward but, rather, relayed a kinetic form. Water particles looped up and down, back and forth, beneath a traveling, progressive oscillation. With the rise of wave theories of light and sound, ocean waves came to be understood as a specific genre of energy transmission, working through processes of compression and rarefaction and prone to reflection, refraction, and diffraction.[5] But while sound and light waves moved every which way, ocean waves were bound by gravity and atmospheric pressure, organized around that wriggling, horizontally oriented boundary that divides the realm above (air, mostly) from the world below (water).

A now standard water wave diagram is a side-view line drawing of a full cycle of an individual wave (figure I.2) in deep water, in forward motion, not yet breaking (see figure 4.2). The diagram emphasizes that it is the pattern, not the water, that is the wave. That pattern unfurls a sine wave: a description that results from treating the line traced out by wave motion as graphing the travel of a point around a circle—an abstraction that renders

the wave a kind of nonhuman inscription, making water the author of an automatic nature writing.[6] But the canonical wave formalism also bears traces of cultural technique. Beneath the wave, the coiling motion of water under curvy crests in circular motions is called an "orbit," a concept derived from work in celestial mechanics by the nineteenth-century astronomer George Biddell Airy. Pointing to origins for wave idioms inspired by clockwork mechanics, the physicist J. B. Zirker (2013, 16) offers, "Under the surface, a traveling water wave looks like the inside of a fine clock, filled with carefully synchronized 'gears.'" (The analogy is inexact. An orbiting water particle never returns *exactly* to a previous point but slowly edges forward in a wave dynamic called "Stokes drift," a process described in 1847 by the University of Cambridge mathematician George Stokes.) And the correlation between the wavelength of the wave and the period it takes for a crest to travel that distance was worked out using pendulums as a model (where the length of a cord supporting a pendulum weight was analogous to wavelength). Wave science is stocked with comparisons to mechanistic process, posing waves as kinds of mechanisms, even machines. The individuality of the "wave," meanwhile, has been an important conceptual fiction, a way to keep comprehension uncluttered. It has also been a building block for an account of waves as traveling in trains and groups and as belonging to populations, underwriting a statistical framing elaborated in the mid-twentieth century and central for wave science since.

Here is a quick primer on the maritime histories that prepare the wave science elaborated by people such as Munk: in the eighteenth century, the British Parliament sought methods for finding longitude at sea. In recognizing John Harrison's marine chronometer as the solution, it came to envisage the gridded globe as a kind of clock face (Sobel 1995). In 1835, the Cambridge natural philosopher William Whewell—who coined the word *scientist*—led a "great tide experiment," organizing seven hundred "associate laborers, including dockyard officials, harbormasters, expert calculators, tide table makers, and professional military men associated with the trigonometric and coastal surveys of the British Navy" in a project that "measured, tabulated, graphed, and charted the tides around the world at exactly the same time." It was a project that enabled the extension of British colonial enterprise, calibrating ocean temporality—time and tide (with tide a kind of giant, Earth-hugging wave)—to imperial objectives (Reidy 2008, 8–9). The United States in the 1840s saw the naval officer Matthew Fontaine Maury (1860, 343) leading projects to map the oceans' currents and winds, seeking to create "mile-posts . . . set up on the waves" to make ocean

currents and winds into infrastructure for extending national commerce—and, notably, for Maury himself, who defected to the Confederacy in 1861, the institution of slavery, which he advocated exporting to South America (Hardy and Rozwadowski 2020; Hearn 2002). What the geographer Philip Steinberg (2001) has described as a European model of the ocean as a "great void" between nations acquired ever sharper surface textures. Shipbuilders had been paying close attention. "From at least the sixteenth century onward," writes Christina Sharpe (2016, 40), "a major part of the ocean engineering of ships has been to minimize the bow wave and therefore to minimize the wake," meaning that wave science emerged in calibration with merchant, military, and colonial desires for seafaring speed, particularly in the Atlantic. In the 1860s, knowledge of waves became crucial for the laying of the submarine transatlantic telegraph cable (see Starosielski 2015). By the time of the publication of Sir Horace Lamb's *Hydrodynamics* in 1879, the study of water waves had become an established science, and by 1934, with Vaughn Cornish's *Ocean Waves and Kindred Geophysical Phenomena*, oceanography had its still more specific enunciation. And just as longitude and oceanic wind tracks became thinkable through techniques of their time (clocks, railroads), so would ocean waves become readable to scientists using conceptual schemes made available by twentieth-century technologies and media (photography, film, computing).

In response to Munk's extraterrestrial thought experiment—his provocation on mathematically minded aliens—I told him I sought to understand how wave scientists, from the mid-twentieth century to now, navigated the fit between abstraction and the world, the relation of formal knowledge to the phenomenology of ocean experience. I wanted to know how scientists had ushered waves, as material forces and as icons, indexes, and symbols of watery process, into technical representation. What historical, political, and cultural conditions had been bound up with rendering ocean waves systematically knowable, countable, legible—where, for whom, and to what ends? How, in turn, did the waves of wave science, mathematically and diagrammatically apprehended, curl back into different communities' intuitions about and encounters with ocean worlds, politics, and futures?

My questions, I continued, were about the *significance* of waves—which I fully intended to resonate, I told Munk, with a term of art he had early introduced to wave science: *significant wave height*. Munk's coinage of that phrase, in 1944, emerged from his work with Marine Corps steersmen, whose eyeballed (and, he thought, exaggerated) estimates of wave height he hoped

to square with scientific measure. Munk told me about his conversations with Marine coxswains training off the coast of Oceanside, California, as they prepared for their invasion of Normandy:

> We'd ride in their boats, and we would ask them, "What do you call the wave height today?" Now, statisticians talk about the *root mean square* of . . . but it was clear that a marine wouldn't give you a number that was *higher* than the root mean square of. I made the policy decision that it would be easier to accept their statistics than to try and teach them mathematics. So I invented using *significant wave height* to accommodate the community that works with waves. And for some reason that has taken tremendous hold.[7]

Significance, of course, is about meaningfulness, and I am concerned in this book with how, for whom, and at what scales, from personal to planetary, waves become meaningful. I am interested in how scientific measurement, monitoring, and modeling have informed that meaningfulness, and I am curious about how scientific research into waves has been shaped by and, in turn, has shaped culturally contoured accounts of waves as unceasing, wild, ephemeral, meditative, useful, inexorable, sublime, terrifying.

I argue this: oceanographers' and coastal engineers' apprehensions of waves encode ideas about—orientations toward—time, nature, and culture. These might bespeak a vision of the past as a horizon of eternal and recurring cycles, which may be used as a template for prediction. They might pose waves as disorderly entities to be tamed by shore and maritime structures crafted in coordination with judgments of wave height probabilities and risks over year-, decade-, or century-long spans of time. One generation of scientists might see waves as belonging fully to the order of nature, a ready-made matrix for seafaring activity, while a next comes to see them as a medium carrying the historical, material freight of anthropogenic ocean harm (radiation, pollution). Engineers may treat waves as amenable to abstractions that can be scale modeled and time stepped in the lab, or *in silico*, only to find waves in real time unfold faster, slower, or more nonlinearly than anticipated. The dynamics of wave-land interactions in one part of the world—due to sea level rise or planetary warming—may be construed as heralds of what is coming elsewhere. Waves broker negotiations between the foreseen and unforeseen, with their breaking the symbol of that uncertain arbitration, which may carry the heaviness of storms, hazards to human construction, and, these days, a future of climate transmutation.

Waves may also carry memory. I take lessons from the Black studies scholar Christina Sharpe's *In the Wake*, which presses readers to remember "the transverse waves of the wake" (2016, 57) of Atlantic slave ships. For Sharpe, following the Saint Lucian poet Derek Walcott, *the sea is history*—an archive of imperial violence, an unmarked grave—and waves, particularly ship-made waves, may be read as its haunting inscriptions.[8] Living "in the wake" is to recall the tracks of oceanic and human damage and to bear witness, to mourn. Waves, in repetition, may keep recollection, even trauma, alive. They may also mix with unexpected futures. The Barbadian poet Kamau Brathwaite (1999) captures this doubleness with his notion of "tidalectics," which refuses the resolution of the dialectic (thesis, antithesis, synthesis), turning instead to the back-and-forths of watery flux, pasts and futures stirring into one another (see also Hessler 2018).[9]

In remembrance, in hope, in fear, in anticipation, waves are significant.

Such significance, to adapt Munk's phrasing, takes a particular form in the practices of "the community that works with waves"—and there exist these days, as ever there have been, many such communities. Meteorologists, fishers, shippers, surfers, coastal engineers, climate activists, maritime human rights advocates, and many others take waves (their shapes, frequencies, powers, material effects) as matters of concern and, in so doing, read waves through measures and abstractions developed by scientists.

Let me introduce today's wave science community, then, through an account of a conference where I first met many of its members and from which I set out for anthropological fieldwork in the Netherlands, the United States, Australia, and, through videoconferencing, with scientists in Japan and Bangladesh. I follow this orientation with a first-pass account of how wave scientists think about the effects of human action on the ocean, a topic that leads me to ask what the uneven changes associated with the lately proposed geological epoch of the Anthropocene (ancient Greek *anthropos*, "human," plus *cene*, "new") look like from the sea. I deliver, next, an explication of what it means (for scientists, for me) to *read waves*—to interpret something that is not written. Scientific readings unfold at sea, in labs, online—in watery and communications media, mobilizing abstractions that have real-world consequences and that sometimes come to be read into the nature of the wavy world itself. Those readings carry concepts of time—recurring, irreversible, momentary, planetary—as well as loyalties to particular framings and schedules (e.g., national, global, market-based, humanitarian), all of which implicate visions of the future as a time of coherence and continuity, though also, increasingly today, of rupture, breaking.[10]

Forecasting Dangerous Sea States, the Thirteenth International Workshop on Wave Hindcasting and Forecasting, was held in Alberta, British Columbia, in October 2013.[11] Oceanographers, mathematicians, coastal engineers, ship and platform designers, and meteorologists gathered in the châteauesque halls of the Banff Springs Hotel, a UNESCO National Heritage Site, to present results on monitoring, modeling, and managing hazardous wave activity, particularly the sort on the rise with climate change, including storm surges consequent on hurricanes.

When I arrived, some eighty or so participants were circulating through the hallways; they had come mainly from Australia, Canada, France, Germany, Japan, the Netherlands, the United Kingdom, and the United States, with a handful from elsewhere (Italy, Malaysia, Mexico, Portugal, Russia). The organizers opened the workshop by observing that its first day fell on the one-year anniversary of Hurricane Sandy, the 2012 superstorm that brought so much devastation to the Caribbean and Atlantic United States. The meteorological past was invoked as a charter for conversation about the future, underscoring how *hindcasting*—retrospective, model-checking prediction using past data—prepares the way for forecasting. Possible futures become visible to scientists when they think backward, when they frame what they call *inverse problems*, scenarios about *what will have had to have been the case* for particular outcomes to materialize.

Over the next days, dozens of talks offered angles on capturing global wave climate, long-term trends in wave weather. Wind is the force that initiates waves, transferring energy from air to sea (with energy imparted to air, in the earlier instance, by the sun). A light wind will give rise to capillary waves, what sailors call "cat's-paws." A more intense wind will lead to larger, traveling (and lengthening) waves, impelled by both wind and the force of gravity.[12] Persistent wind across an area of water, known as a "fetch" of "windsea," generates waves with a predictable range of heights. Out from under the influence of wind, waves are called "swells," packets of energy that continue to travel on their own. As trains of swells of different wavelengths run into each other, variously reinforcing or canceling one other out (interfering, as they move in and out of phase), they gather into groups (*sets* to surfers). These groups then move at half the speed of their constituent waves. (Think of people moving briskly along an airport conveyer belt: people are waves; the belt is the group.) When waves arrive to shoal and shore (defined as when water is shallower than half a wave-

length), they begin to "feel" the bottom, which slows their bases, causing their crests to steepen. When the ratio of wave height to wavelength hits about 1:7, waves begin to break—as spillers (which sloppily collapse on themselves), plungers (which pitch over themselves to create the "barrels" beloved of surfers), and surgers (which slosh onto shore without generating whitewater), all of which next create "swash," a turbulent layer of moving water that marks the end of a wave. The story of waves is a tale about energy moving across space.

To track such motion, waves these days are largely measured by floating buoys and orbiting satellites, owned and operated by a collage of governments, companies, and other agencies. Buoys have their own internet protocol addresses, used to transmit information to computers that work the data into forecasts for meteorological organizations, shipping companies, coastal planners, fishers, boaters, and surfers. Wave prediction is all about infrastructure, and it starts with buoys.

Buoys were a big workshop topic. Val Swail, manager of the Climate Data and Analysis Section of Environment Canada, offered an overflowing inventory of wave-measuring buoys in a talk entitled, "Are Wave Measurements Actually Ground Truth?" (Jensen et al. 2013). Showing us photos of buoys hewing to a bevy of standards, he asked: "How to 'ground truth' the 'ground truth'?" (figure I.3). With good-humored world-weariness, Swail advised us: "You need to define what a wave *is* before you can measure it. Is your device measuring whitecaps, foam, green water, blue water? And in which *direction* are you measuring? Given that a typical buoy costs around $60,000, it's worth some thought." Swail's question—a mixed-sea-and-land metaphor—made clear what practitioners were after: a level reference plane in the ocean, bringing into this technology histories of trying to fix, in practical, world-spanning abstraction, the notion of *sea level* (see Hardenberg 2020; Sammler 2019).[13] Models of wave dynamics start with a stationary sea, and a lot of work goes into factoring out the pitch, yaw, and roll of buoys so wave data can be presented as oscillation against a fixed baseline.[14]

Knowledge about waves, Swail was acknowledging, is not just an *empirical* matter but also an *epistemological* one—to do with how wave scientists warrant what they know. The mathematical physicist Elzbieta Bitner-Gregersen, working for Extreme Seas, a European university consortium dedicated to ship safety, underscored this point. In her talk, she named two kinds of uncertainty in wave measurements: *physical* and *epistemic*. *Physical uncertainty* includes the randomness of waves in the world, whereas *epistemic uncertainty* points to uncertainties in data sets, statistical analyses,

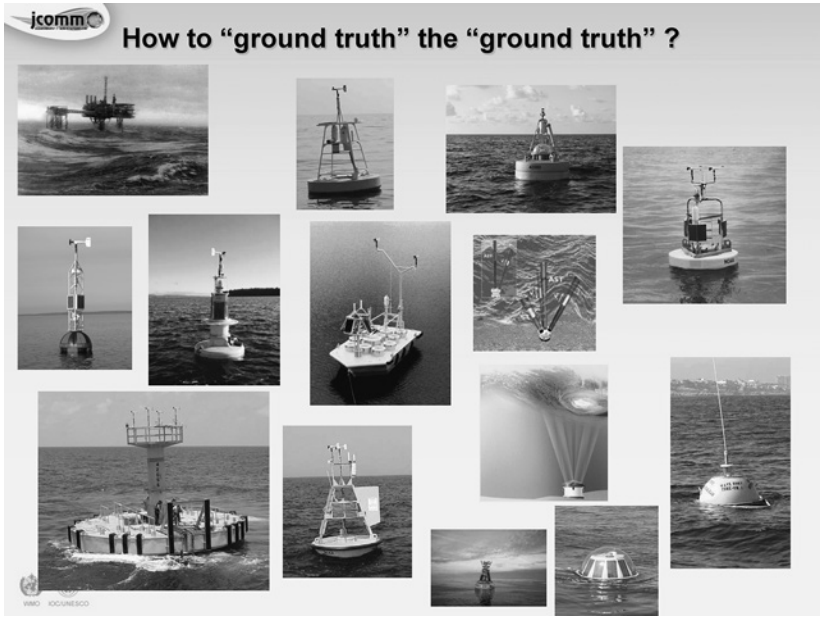


FIGURE I.3 Various wave-measuring buoys. From Jensen et al. 2013.

and models of waves (Bitner-Gregersen and Magnusson 2013). Waves as scientific objects flicker between reality and representation. Waves are mash-ups, amalgams of watery events, instrumented captures of those events, and mathematical portraits of those happenings, often described statistically rather than singularly.

The statistical view came into focus in the mid-twentieth century, when oceanographers found that water waves, like light or radio stations, might be sorted by magnitude (frequencies) into a *spectrum*.[15] Instead of using oscillating lines to visualize the simple rise and fall of water, oceanographers turned to a representation that broke down a large wave into the smaller, diversely sized waves of which it might be composed. (Math aficionados will know this as Fourier analysis.) Waves came to be known not as individuals but as collections of superimposed waves, little and big, with different generating origins and histories. In the “wave spectrum” model, waves were rendered as collisions of bell curves; these might index the many time scales and processes that come together in any “wave” (figure I.4).

A “wave” might be made up of energy generated a month earlier on some faraway shore, by a hurricane a week earlier, and by fresh energy

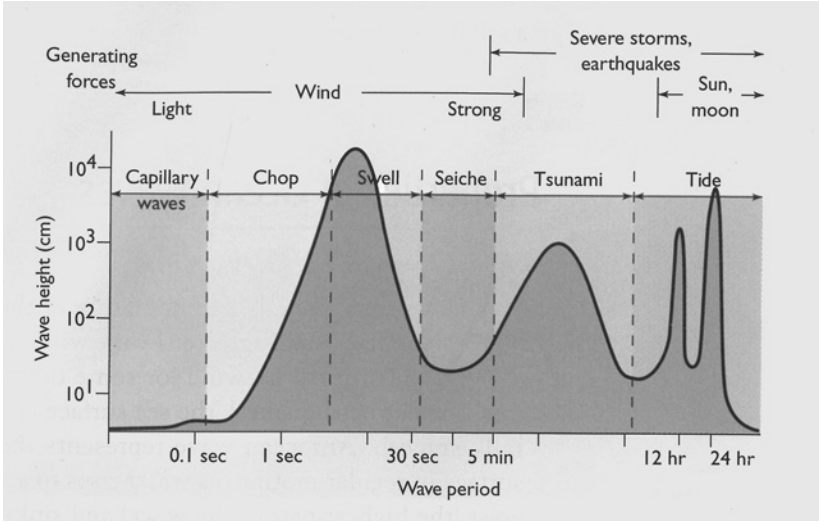


FIGURE I.4 "Idealized Wave Spectrum." From Pinet 2009, 232, fig. 7.1b.

from wind-swept ripples (figure I.5). As the historian of oceanography David Irvine (2002, 382) writes about wave spectra, however, "'Observed' spectra are not really observed; they are the finished products of a sophisticated mathematical analysis. . . . Spectra [stand] midway between raw observation and fundamental theory."[16] Swail's talk made that clear—and the days are long gone when such epistemic hybrids made scientists balk. Munk once wrote, "Inasmuch as these terms—'fetches,' 'finite durations'—are really great idealizations of the wind field over the sea, to try and write spectra for given fetches and finite durations is to endow these meteorological notions with more claim to reality than they deserve" (quoted in Irvine 2002, 380). The reality of waves nowadays, however, is known through precisely such idealizations, through instruments of mechanical objectivity (Daston and Galison 2007), a representational idiom putatively free of human judgment.

Where are buoy data sent? The computer wave modeling framework WAVEWATCH is employed in more than eighty countries and operated by the US National Weather Service, under the National Oceanic and Atmospheric Administration (NOAA). The designer of the system, Hendrik Tolman, who began the model as a master's thesis project in the 1980s at the Delft University of Technology, in his native Netherlands, gave a passionate update. The WAVEWATCH framework is built on millions of lines

FIGURE I.5 US Coast Guard, GAPA 05-05-71, *Rough Sea Swells in Mid-ocean, Far from Shore: The Texture of a Great Wave*, Willard Bascom Papers, SMC 62, Special Collections and Archives, University of California, San Diego, Library, box 12, folder 6.

of the FORTRAN computer programming language and, he announced, would eventually be integrated into the General Circulation Models on which the Intergovernmental Panel on Climate Change (IPCC) depends. This simulation framework offers a digital double for the ocean, crafted for anticipatory governance (see Lehman 2016; see also Gabrys 2016). When I caught up with Tolman at the conference banquet, he told me that he had lately been traveling around the world leading WAVEWATCH workshops, engaging in a kind of scientific missionary work. He also told me that if I wanted to learn the deep history of wave modeling I would need to do fieldwork in the Netherlands, where his teachers framed some of the earliest models in wave science (see chapter 1). He invited me to learn more about WAVEWATCH by visiting the offices of NOAA (chapter 4).

Wave models run on an armada of supercomputers that require huge amounts of air conditioning, contributing, scientists at the conference wryly remarked, to the very weather transformations they track (see Gonzalez Monserrate 2022). As computationally intensive as they are, wave models often demand *more* data points than there are buoys. To fill the gaps, models conjure proxy data, creating virtual buoys by interpolating between known points. Such phantom buoys speed up prediction. Waves can also be simulated in real water—either through using theoretical models to generate oscillations in wave flumes and basins or through reincarnating real, historical waves in scale-model form. Such work can be useful for ship and port design, the results of which may be delivered to logistics planners (Gray 2020; see also chapter 3 in this volume).

The centrality of prediction to wave science means that waves are vehicles—media—for scientists to orient to the shape of things to come, whether imminent, medium range, or emergent from the epochal climate-changing modulations of human activity. Wave futures are usually imagined against the grid of a uniform, metered, secular, homogeneous time—the tick-tock clock time of modernity (and of state and market bureaucracies [see Bear 2014; Munn 1992])—which invites researchers to pose cycle and succession in a stream of time whose material correlate is something like the unspooling rolls of graph paper scientists once used to gather wave records (see figure 2.6). To employ a term from the philosopher Mikhail Bakhtin (1982), wave science has operated within a *chronotope*—a representation of time in space—in which time and space are abstract.[17] If the figure of the wave offers what the literary theorist Nathalie Roelens (2019) describes as "revolving movement as the unveiling of a latency," this is always "implicit against Euclidian geometry." The futures believed to be prefigured by waves express *orientations*—"anticipation, expectation, speculation, potentiality, hope, and destiny" (Bryant and Knight 2019, 2)—to possible worlds. Think, then, of wave knowledge, drawing on Donna Haraway's (1991b) notion of "situated knowledges," as *oriented knowledge*, knowledge for and toward specific aims. The forward aims of oriented wave knowledge depend on the steady work of hindcasting, of past reference—though waves, as Munk reminded me, also *break*, a capacity that can upend their predictability, that may clutter, disorient, fracture, or overtop the neat models or infrastructures prepared to meet them.

It was during the Banff workshop that I first began to accumulate a sense of waves as all at once physical, epistemic, computational, and virtual. And political. Waves, captured by buoys and computer programs, may

exist inside jurisdictions. In the United States, waves have been officially considered part of the weather since 1973, when the United Nations ratified the Convention for the Safety of Life at Sea, which tasked national meteorological rather than oceanographic agencies with wave measurement. If you want to get US data about waves, consult the National Weather Service, not the National Ocean Service—though neither will do you much good if there's a government shutdown, as there was just before Banff, which meant US waves were . . . closed.

Waves have lives as commodities, too. For European polities, wave data are stewarded by the European Center for Medium-Range Weather Forecasts (ECMWF), an intergovernmental organization that hosts the world's largest store of numerical weather-prediction information.[18] Data are available to "national meteorological and hydrological services and research institutions," and countries that are members of the ECMWF have custom subscription arrangements.[19] Such instrumented measures of wave phenomenology become purchasable products.[20] And WAVEWATCH is a model that, while open source, may not, because of US trade embargoes, be distributed to countries such as North Korea and Iran. Waves, then, can be read as political-economic texts, formatted by national, military, and corporate infrastructures. They also have legal lives; one speaker in Banff reported that, for the World Meteorological Organization, "only windsea and two swells are regulated in ship reports"—that is, only part of the wave spectrum. Waves, then, are *phenomenological-technical-mathematical-political-legal objects*. Sometimes their ghosts are carried into legal gray areas, as when pirates pillage buoys for parts. One conferee reported that, while reading wave data from a buoy off the coast of Somalia, he realized it was on land, perhaps being ferried in the back of someone's truck.

When I signed up for Forecasting Dangerous Sea States, I imagined the event would be mostly math and modeling. But the gathering was full of stories about people. There was an anthropology inside wave science.

Wakes, Breaks, and Churns in the Chronic Ocean

The figure of humanity—individual, corporate, regional, global—loomed over the gathering. That became visceral as news streamed into the conference of Saint Jude, an extratropical cyclone that arrived in northern Europe on October 27, 2013, and killed seventeen people. Just hours into the workshop, a presenter showed the day's headline from *The Mail*: England was being "lashed by 25 f[oo]t waves." Participants from the ECMWF were

gratified that their models seemed to be predicting the path, though they were upset about people heading into the waves anyway. "We can't save everyone," one participant exclaimed at a picture of a kite surfer. Talk of probability becomes talk of *risk* when human elements are introduced, one speaker remarked.

Such attention to individual humans contrasted with talks about populations of coastal dwellers. Conversation turned to storm surges, what one speaker called "the stupid big brothers of waves." Here, differences among nation-states differently positioned geopolitically—in the Global North and Global South—emerged as a topic. The UK scientist Matt Lewis spoke about the World Meteorological Organization's Coastal Inundation Forecasting Demonstration Project, aimed at improving predictions for such places as Bangladesh, a low-lying country with a history of monsoon-inflected, cyclone-activated storm surges that have killed hundreds of thousands of people (see chapter 5). He commented that it is hard to "get data into a model" for such settings because they are "data poor"—that is, not dotted with measuring instruments. More, surge models imported from elsewhere do not always work; the mangrove forests and coastal villages of Bangladesh are not written into off-the-shelf models. Facts on the ground vary and change.

Open-ocean and hemispheric dynamics do not stay still, either. I encountered a dramatic, global picture on a conference poster. Lured in by lustrously colored maps of world seas, I found the Portuguese oceanographer Alvaro Semedo explaining future wave climate. His team had taken global data about significant wave heights from the present, defined as 1979–2009, and then, assuming a steady increase of carbon dioxide into the atmosphere—the Intergovernmental Panel on Climate Change's anthropogenic scenario—projected significant wave heights into the future, 2070–2100 (see plate 2; see also Semedo et al. 2013). His prognosis? Climate change will generate ever larger significant wave heights in southern oceans, which will correlate with more extreme weather—storms, droughts—and an accelerated breaking up, by wave action, of Antarctic ice.[21] This was a claim I would hear again and again, suggesting that thinking about climate change from Southern Hemisphere oceans might unsettle dominant perspectives from the North (see chapter 5). As I stood in front of Semedo's map—also a kind of graph, using saturated colors to underscore its message—an Australian wave scientist joined the conversation around the poster. He jumped up and down. *Homo sapiens* are driving the planet toward disaster: heat waves and fires in Australia, floods in South Asia, collapsing agricultural infrastructure in Africa, and waves, he said, of climate refugees.

The ocean and atmospheric scientists around me spoke animatedly about how humans were agents and destinations for thinking about global climate. As a wave scientist from Oregon State University put it to me:

> Changing climate means changing the wave climate—and that's a relation with *people*. We're producing too much carbon dioxide. So part of the destruction of our houses is because we're doing something wrong with the environment. So we should be interested in waves not only because we have fun in the waves or we have to protect ourselves from the waves, but also because what happens now with the waves is partly *because of us*. The loop closes that way with wind waves.

Ocean waves have become legible as materializations of social process. Against a vision of their forms as pertaining merely to the order of an endlessly cycling nature, enacting a steady beat of physical time, they have been brought into history.

Back in 2013, the term *Anthropocene*, though coined at the turn of the millennium, was just beginning to gain public traction. The atmospheric chemist Paul Crutzen and the ecologist Eugene Stoermer (2000) proposed the word to designate the contemporary geological epoch, during which human activity began to have planetary effects—effects now layered into a geological record marked with evidence of coal extraction, atomic testing, plastic and other pollutants, and accompanying species extinction.[22] Semedo's poster mapped a world in the wake of those processes, an Anthropocene sea.

The analytic of the Anthropocene has gathered copious commentary pointing out the historically specific human practices that initiated it, which come not from humans in general, but from economic, political, and military forms animated by large-scale resource extraction under colonialism and industrial enterprise, mostly inaugurated in the Global North. A raft of possible renamings has surfaced, prominently the *Capitalocene*, since so many recent geophysical transformations have followed from capital-intensive generation of fossil fuels, and the *Plantationocene,* pointing to how the transoceanic slave trade and the plantation complex shifted world ecologies toward a tipping point (Haraway 2015; Moore 2016; Jobson 2021; McKittrick 2013).[23]

What about the oceans? "What would it mean to take the Anthropocene out to sea?" asks the ocean humanities scholar Stacy Alaimo (2017, 153).[24] For one thing, it would usher the analytic away from thoroughly geological time, mixing temporalities deep and shallow (think ocean circulation, upwelling,

freshwater flux) in different cadences from what happens in the layering realm of the stratigraphic (neither itself always linear [see Roosth 2022]).[25] Such "a possible oceanic turn," offers the literary theorist Steve Mentz (2015, xviii, xix), might suggest the frame of the *Thalassocene* (*thalasso*, "sea," plus *cene*, "new"), naming "a recurrent material counterforce, a pressure the inhuman ocean exerts on all histories."[26] If such recurrence also folds in the *old*, call that the *Thalassochronic: thalasso*, "sea," plus *chronic*, "old," "long lasting"—or perhaps, simply, the *chronic ocean*. The repetition and churn of such a sea is unevenly distributed, socially intensified, and felt. It is choppy, subject, like waves, to cluttered, broken motion.[27] It conjoins, unsteadies—and, sometimes, breaks—scales of analysis and experience. Sea level rise, the continued growth of trash vortexes, acidification-driven extinction and coral bleaching, the legacy of nuclear weapons detonations—these pressures churn together natural, cultural, colonial, imperial, postcolonial, and climate histories.[28] The historian Dipesh Chakrabarty (2021, 26) writes, "Anthropogenic explanations of climate change spell the collapse of the age-old humanist distinction between . . . natural history and human history." For wave scientists at Semedo's poster, humans operated as a kind of doubled figure—as an embodied (and unequally positioned and impacted) collectivity and as a scaled-up actor with inhuman capacities, activating the powers of a geophysical force.[29]

Emblematizing conference conversations on futurity, the problem of predictability, and the constant interruption of clutter and chop was the figure of the *rogue wave*, the statistically unexpected wave, twice the significant wave height of its surroundings.[30] Bigger storms in contemporary oceans might lead, some wave scientists held, to increases in numbers of rogue waves (see Bitner-Gregersen and Toffoli 2013; Rosenthal and Lehner 2008). Conferees were divided on that claim, though all believed such waves existed. Although rogue waves were, once upon a time, considered mythical, conjured by credulous mariners, they are now accepted as real.[31] Such waves may emerge from the superimposition of waves in "crossing seas," from wave-current interactions (Africa's Cape of Good Hope is notorious), or from resonance events in which one wave sucks energy from another.[32] One speaker said, "We can expect that in some ocean areas, where the wind severity increases and we get more 'crossing seas,' we will see more rogue waves."[33] The phrase *rogue waves* not only echoes terms such as *rogue elephant* and *rogue shark* (used by naturalists to refer to anomalous, wild, individual animals that depart from the dominant socialities of their species); it also resonates with the "rogue state" idiom forwarded by political

scientists in the 1990s, entities that disturb geopolitical business as usual (Hoyt 2000). Rogue waves appear as newly cast characters in an Anthropocene drama, materializations of the inhuman human—manifestations of, to lean into the workshop's title phrase, "Dangerous Sea States." Storm surges, tsunamis, and rogue waves have become consequential forms in the twenty-first century, avatars of an ocean encroaching in an age of climate change, rearranging maritime globalization, and breaking down infrastructure at world coasts. The tidalectic ocean, bearing as well as breaking Anthropocene analysis, carries waves that exist in the stream of history and at the edge of a future difficult for institutions to keep calibrated to their routines and rhythms. This chronic ocean is an ocean made of churning time and, these days, too often—think chronic illness—of recurring conditions of compromised health.

This is the ocean of *the wake*, that "region of disturbed flow" in which, as Sharpe (2016, 3, 9) writes, "the past that is not past appears, always, to rupture the present." It is also the ocean of *the break*, "a broken or disturbed portion on the surface of water," according to the *Oxford English Dictionary* (*OED*), that brokers "an interruption of continuity." Recall Munk's assertion that wave breaking is best understood empirically, not theoretically (it is always, to some extent, a complex surprise) and torque this into dialogue with Sharpe's *wake*, drawing on the poet Fred Moten's *In the Break* (2003, 99), an analysis of the aesthetics of interruption (particularly in the Black radical tradition, from the jazz break to the breaking of language in poetry) in which he argues that a *break* is a "temporal-spatial discontinuity" that requires of those who experience it a "fundamental reorientation." Contemporary wave science, I suggest, operates, especially in a time of climate uncertainty and its unequal social effects, *in the wake* and *in the break*.

I left Forecasting Dangerous Sea States, then, with a set of questions, as well as a sense of where to travel to learn more. I conducted anthropological fieldwork in the Netherlands in 2016, a country below sea level where many wave modeling practices originated and from which many models have been globally exported. I worked at the Scripps Institution of Oceanography over several summers, from 2015 to 2019, learning—through archival work, interviews, and a trip to sea on the singular "FLIP ship"—about the outsize influence of field research on waves undertaken at this site, largely in calibration with US Navy priorities. I spent a month in 2015 at the world's largest water wave modeling basin, at Oregon State University, permitting me to contrast Scripps's field approach with wave science in the lab—and to learn about scale-model studies of tsunamis,

which had intensified at this laboratory since Japan's disaster in 2011, as well as fresh news about the possibility of a similar event, soon, in the US Pacific Northwest. In 2017, I enrolled in a summer school on WAVEWATCH, led by scientists and engineers at NOAA. I visited Australia to understand how wave science looked from the Southern Hemisphere, moving from there to think from the Indian Ocean about the shape of waves to come, forms that may look, worldwide, more and more like those strong waves spinning off from southern seas (waves that cannot be understood as made of water alone but must be understood as also composed of silt and sand, demanding a rethinking of land-and-sea distinctions). In 2020, I conducted online fieldwork with wave scientists in Bangladesh, interviewing and attending events by videoconference after the COVID-19 pandemic made travel impossible. All of this work required examining the many ways wave scientists read waves and how I might, in turn, read these readings in anticipation of writing this, *A Book of Waves*.

Reading Waves

In Italo Calvino's short story "Reading a Wave," an eccentric amateur philosopher called Mr. Palomar stands on a beach, seeking to follow with his eye the arrival, passage, and decoalescence of a single ocean wave. Hoping to achieve a calming reverie, Palomar endeavors to "carry out an inventory of all the wave movements that are repeated with varying frequency within a given time interval" (Calvino [1983] 1985, 6). He finds that any single "wave" is crosscut by others, interrupted by "many dynasties of oblique waves" (7). But if Calvino, as he later explained, meant "Reading a Wave" as an inquiry into how to "read something that is not written" (quoted in Lucente 1985, 248), Palomar already comes to the sea with highly tutored reading habits, parsing what he sees in terms of "frequencies" and "intervals." These measures make sense to him because of the mathematical grammar that has formatted wave research, a grid of interpretation that patterns water waves as abstract arcs of energy to be regarded with a passionate dispassion, as texts to be read in the stillness of scientific meditation.[34]

Contrast Palomar's reading with early attempts by one of Munk's colleagues, Willard Bascom, to take wave readings near shore. One question before Bascom, who began work in the 1940s, was, "Did large waves in the ocean do the same things as those in a model tank?" In his memoir, *The Crest of the Wave*, he writes about an encounter with the sea in Humboldt Bay: "The surf roared at us, which is to say that the wide spectrum

of frequencies created by all the waves crashing, colliding, swashing, and releasing bubbles produced a high volume of white noise—a hiss of astonishing proportions broken only by the occasional crack of a single breaker" (Bascom 1988, 7, 5). He recalls trying to bring waves into measure from an amphibious truck (repurposed versions of which are now known to American tourists as "duck boats" [figure I.6]) about to be swamped by a wave: "While balancing under this incipient waterfall, I would estimate the height of the wave that was about to come crashing down, add one third of that . . . to the trough depth, call the answer into the microphone, and duck. Then the reaching crest of the plunging wave would collapse on us, not quite capsizing the DUKW (Bascom 1988, 9)."[35]

A narrative entanglement of observation, audition, olfaction, and theory was a signature of Bascom's rhetoric. (Think of his shouting out wave heights as reading waves *aloud*.) He writes in *Waves and Beaches: The Dynamics of the Ocean Surface* (1964, 40–41):

> Now, full of confidence that we understand waves both in theory and by actual test, we fling open the laboratory door, stride to the edge of the cliff and look to the sea. Good grief! The real waves look and act nothing like the neat ones . . . that march across the blackboard in orderly equations. These waves are disheveled, irregular, and moving in many directions. Should we slink back inside to our reliable equations and brood over the inconsistencies of nature? Never! Instead, we must become outdoor wave researchers. It means being wet, salty, cold—and confused.[36]

This is an expression of scientific affect at home simultaneously at the blackboard and outdoors. Bascom's biography can be situated in a history that has seen American natural science researchers, mostly white men, conducting work in lands and seascapes imagined as rugged zones of uncontaminated nature, a vision institutionalized in such famous US work-vacation sites as Woods Hole, Cold Spring Harbor, Los Alamos, and Monterey Bay (see Kohler 2002; Pauly 2000), all places, too, with significant and too often effaced Indigenous histories and presents. This early data point on scientific readings of waves is at the same time a reminder of an embodied, sensory method that nowadays has been fractionated and mostly delegated to machines (which do not, in the same way, listen, smell, taste, swim, or gasp for air).[37]

Wave scientists now read waves through fieldwork at sea, research in laboratories, and computational modeling, as well as through mathemati-

FIGURE I.6 *Willard Bascom Standing on Duck Boat with Wave Ruler, 1940s*. Willard Bascom Papers, SMC 62, Special Collections and Archives, University of California, San Diego, Library, box 11.

cal formalisms, techniques of visual recording and replay, and networked information technologies. *A Book of Waves* asks how wave researchers craft their knowledge within historically shifting technical, social, and political settings—*contexts* within which waves as *texts* come to significance. I take *reading*, here, to be not only about interpreting formal properties—think of the morphologies of languages, images, music—but also about the sensory impressions on which such activity relies (Gandorfer 2016). As Karin Littau (2006, 3) writes, reading is "not only about sense-making but also about sensation." Therefore, particularly in the sciences, it is also about distributed anatomies of perception, nowadays often a hybrid of human and machine-meditated interpretation (see also Gabrys and Pritchard 2018).

The reading tools wave scientists have to hand include eyes and ears, measuring devices such as buoys (consider Swail's question, "How to 'ground truth' the 'ground truth'?," as cautioning against what literary scholars would call a "surface reading," taking wave readouts from buoys at face value [see Best and Marcus 2009]), underwater pressure sensors, beachside and floating labs, radar, water basins for scale model wave reenactment, video cameras, mathematical approximations, and computer simulations (with WAVEWATCH permitting the kind of "distant reading" advocated by practitioners of digital humanities, scanning swaths of big-data results, discerning large-scale patterns of significance in a corpus of texts [see Jänicke et al. 2015]). The range of practices bundled under this ecumenical definition of reading—taking readings, enumerating, calculating, watching, even, sometimes, machine-aided hydrophonic listening—underscores an additional claim I make, which is that waves emerge in these reading relations as *media*, or material forms that convey meaning (oceanic, climatic, anthropogenic) to wave researchers and their publics. This may not be a surprise, since the ocean, especially its farther reaches, for humans often requires access through the mediation of technology.

Media technologies (e.g., radio, photography, buoys) have enabled and guided how scientists understand ocean waves. More, waves have, in the process, become understood and experienced as media themselves.[38] The literary theorists John Durham Peters (2015) and Melody Jue (2020) approach the elemental properties of water, atmosphere, and weather as media, both in the environmental sense (think of seawater as that medium in which dolphins swim, methane hydrate bubbles, and waves uncoil) and in the sense of communication infrastructure (think of *sonar* as that medium that channels information through the propagation of echoing underwater acoustic signals).[39] Waves *as media* carry signals about where they come from, what they are made of, and where they are going.

In the early twentieth century, the Swiss linguist Ferdinand de Saussure used a wave analogy to describe how humans make meaning through language. He illustrated the relation between thinking and speaking with a diagram to be read from left to right as a wavy flow of time (figure I.7). For Saussure, (A) "the indefinite plane of jumbled ideas" and (B) "the equally vague plane of sounds" mutually inform one another, creating units—divided, in the diagram, by dotted lines—which he called *signs*, composed of *signifieds* (ideas) and *signifiers* (sounds, or, more broadly, articulations). Extending the analogy with a meteorologically inspired reading of his illustration, Saussure ([1915] 1959, 112–13) offered this guid-

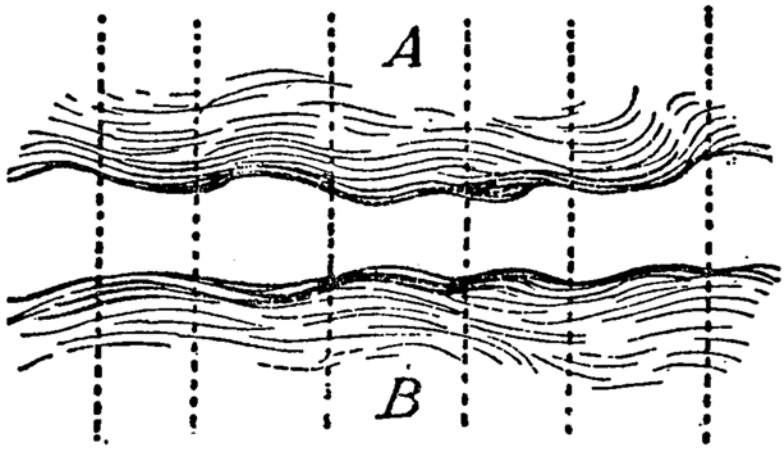


FIGURE I.7 Diagram of language as a wave-like meeting of signifieds (A) with signifiers (B). From Saussure [1915] 1959, 112.

ance: "Visualize the air in contact with a sheet of water; if the atmospheric pressure changes, the surface of the water will be broken up into a series of divisions, waves; the waves resemble the union or coupling of thought with phonic substance." In the "borderland where the elements of sound and thought combine," Saussure argued, "their combination produces a form, not a substance."[40] Such forms may be multiple, overlapping, and, if one speaks sign language, of many textures, and they may generate interference, clutter. Saussure, who thought signs emerged as socially conventional (or, as he put it, arbitrary) links between ideas and sounds, was here using the wave as an analogy for the sign. Over in the realm of the literal, oceanographers who study waves do indeed study them just so: as forms that emerge at the interface of atmosphere and water. If they treat these as signs less arbitrary than Saussure's—waves carry quasi-indexical impressions of recent pressure changes, of distant and coming storms, of oceanic displacements—scientists do sometimes, even simultaneously, understand them through stacks of abstractions that have more to do with conventions of mathematics than with one-to-one mappings onto the world. Waves may be reformalized many times over (see esp. chapter 4) as they are represented on paper, in equations, in wave tanks, and in computer simulation. Think of these hybrid mimetic and nonfigurative representations, forgive the pun, as *sign waves*.

Waves, then, are material forces that are apprehensible, simultaneously, only through abstract formalisms (whether these are curvilinear simplifications or nonfigurative mathematical descriptions). In *Phenomenon of Life*, the philosopher Hans Jonas (1966, 77) wrote that a "'wave' . . . has its own distinct unity, its own history, and its own laws, and these can become independent objects of mathematical analysis, in abstraction from the more immediate identities of the substratum." In the essay *Précisions sur les vagues* (*Waves in Detail*), Marie Darrieussecq (2008, 36) writes, "The wave is by its essence a formal modification of matter, creating froth, vapor, sprays, breaks and shocks" (my translation). Waves enter signification—in prose, philosophy, music, film, oceanography—as forces of generation, as sorts of quasi-agents that, while empty of intentionality, are full of animate action, lapping, running, roaring, their forms, as I occasionally discuss in this book, sometimes compared to those of horses, dolphins, wolves, lovers, monsters.[41]

Waves are therefore also useful entities to think with and against recent demands in cultural theory to attend to *materiality*, to a physical world beyond or before signification. The political theorist Jane Bennett (2010, 349) calls for recognizing the vital agencies inherent in materials such as trash, metal, and oil, naming "materiality as a protean flow of matter-energy." Scholars in the "blue humanities"—literary and media theory concerned with oceans—have also turned to materialities, or what the geographers Phil Steinberg and Kimberly Peters (2015) call a "wet ontology." They argue for conceptualizing oceans as "open, immanent, and ever-becoming" and, more, as elemental volumes (elemental: watery and molecular; volumes: not merely horizontal surfaces or vertical depths) in turbulent motion.[42] Such a view facilitates tracking the multiplicitous entities that assemble ocean space, matter, and time.[43] Equally important to keep in mind, however, is the role of concept work in formatting what scientists take to be material in the first instance (a demand with a reflexive charge; scholars in the critical humanities should also think about the historical origins of their own theories of materiality, which often come from classical physics). Waves must be read as things material *and* formal, concrete *and* conceptual.[44]

A Book of Waves

If the scientifically described ocean is a kind of text, and its waves are like pages in a modern, published book—reproduced in many identical, standardized copies, bound by law to represent the agency of a consistent,

knowable author (here, physical nature [see Johns 1998])—my hope is to survey some of the ways this book has been, and might yet be, read, even as scientists have also rendered it into a flip-book movie, transduced its sounds into audio data, and, of course, in the age of the e-book, reformalized it in computer models. I argue against the political theorist Carl Schmitt, who, writing about the sea as a blank space between nations, dismissed waves this way: "The sea has no *character*, in the original sense of the word, which comes from the Greek *charassein*, meaning to engrave, to scratch, to imprint. . . . On the waves there is nothing but waves" (Schmitt [1950] 2003, 42–43).[45] This is a modern, disenchanted reading of the ocean as an empty chaos (Corbin [1988] 1995). It construes ocean expanse as timeless horizon (see Rozwadowski 2019), a vision reinforced, argues the historian of oceanography Eric Mills (2009, 82, 43), by the way nineteenth-century physical sciences, working at "making the ocean mathematical," approached it "ahistorically and atemporally" (in contrast to nineteenth-century geology and fossil-grounded evolutionary biology, which depended on deep, layered time).[46] In Schmitt's picture, waves become guardians of the ocean's secrets, orderly scriveners ever overwriting the matter of seawater, erasers unmaking their own inscriptions. This is only one way to see the sea. In this book, I track how waves may be and may become texts, agents, heralds, and, indeed, *characters*.

The first chapter, "From the Waterwolf to the Sand Motor: Domesticating Waves in the Netherlands," offers an ethnographic itinerary around the Netherlands, a country shaped by centuries-old endeavors to hold waves back from a land below sea level. Waves, long interpreted as forces of a wild, enemy nature, have come to be read as entities that might be rewritten, domesticated, allies in sculpting resilient environmental infrastructure. The chapter introduces, in miniature, themes that recur in this book—to do with the historical matrices out of which wave science arrives, with folklore, record keeping, physical scale models, computer simulations, remote sensing instruments, field measurement campaigns, and visions of waves as natural objects yoked to projects of cultural control.

Essays in my "Set" sections, similarly to the interludes in Virginia Woolf's novel *The Waves* (1931), break away from the book's throughline story, offering reflections, refractions, and diffractions on topics in the chapters that they follow. Chapter 1's theme of zoomorphic or anthropomorphic waves finds an alternative angle in "Set One, First Wave: The Genders of Waves." "Set One, Second Wave: Venice Hologram," elaborates on visions of waves as infrastructure, revisiting a narrative Walter and Judith Munk

wrote about their stay in Venice in the 1970s, during which they imagined unorthodox ways to save the city from drowning. "Set One, Third Wave: Wave Navigation, Sea of Islands," sets out from an account a Dutch scientist relayed to me about a trip he took to Micronesia, where he sought to place computational wave models in dialogue with Marshallese wave navigation. I read his story in diffraction with postcolonial and decolonial discussions of Indigenous wave piloting in Oceania.

"Flipping the Ship: Oriented Knowledge, Media, and Waves in the Field, Scripps Institution of Oceanography," the second ethnographic chapter, recounts fieldwork at the Scripps Institution of Oceanography, in La Jolla, California. I am concerned with science *in the field*—at shore and on the sea—and organize my account around my stay on one of oceanography's most storied vessels: the FLoating Instrument Platform (FLIP), a craft able to "flip" itself vertically to become a live-aboard buoy that stays stationary amid rolling wave fields. Scientists, seeking fixed positions for observation, try to hold still frames within which they read waves, flipping between orientations to science as objective and as a source of wonder and between visions of science as pure or applied, civil or military. I offer a history of Scripps scientists reading waves through analogies to media (sonic, filmic, infrared, biotic), a history that also tracks generational shifts among physical oceanographers from military motivations to concerns with climate and contamination.

"Set Two, First Wave: Being the Wave," the first essay in Set Two, dives into the sea off San Diego, documenting my entry into the Thirty-sixth Annual World Bodysurfing Championship. It argues that surfing techniques, contoured by gender, race, and class, shape what surfers take waves to be. "Set Two, Second Wave: Radio Ocean" picks up on wave sound, in poetry and music. And "Set Two, Third Wave: Gravitational Waves, Sounded," listens to how the detection in 2016 of gravitational waves from the distant collision of two black holes 1.3 billion years ago was made audible through media that, similar to oceanographic formalisms, modeled the profiles of waves in advance of their arrival.

Staying with the theme of models, the third ethnographic chapter, "Waves to Order and Disorder: Making and Breaking Scale Models inside and outside the Lab, from Oregon to Japan," recounts fieldwork at the O. H. Hinsdale Wave Research Laboratory at Oregon State University, home of the world's largest tsunami simulation basin. I am concerned with what wave science looks like *in the lab*, as scientists make scaled-down replicas of real-world waves. Wave tanks, using water as a modeling medium, turn

textbook waves into liquid movies, offering *theory, animated*. The chapter also reports on how Oregon-based scientists, living on the Cascadia fault line, grapple with Japan's 2011 tsunami as a premonition of their own possible Pacific future. Wave scientists' experiences in Japan itself, meanwhile, lead them to speculate on what happens when the very notion of *scale fails*, when lab time cannot prophecy real time.

"Set Three, First Wave: Massive Movie Waves" examines how waves in cinema deliver their effects. "Set Three, Second Wave: Hokusai Now" contemplates the world's most iconic representation of waves, the Japanese woodcut "Under the Wave off Kanagawa" (1829), examining how it has lately been used to speak about sociogenic ocean damage. The theme of health opens into "Set Three, Third Wave: Blood, Waves," which examines the electrocardiogram—the formalism that treats the heartbeat as a wave that can be managed by devices implanted into heart patients and that can be monitored remotely, like wave buoys, for signs of future danger.

The fourth ethnographic chapter, "World Wide Waves, *In Silico*: Computer Memory, Ocean Memory, and Version Control in the Global Data Stack," draws on fieldwork at NOAA, where, since the 1980s, the WAVEWATCH computer model has organized national wave prediction in coordination with a global infrastructure of buoys and satellites. Interested in what wave science looks like in *computer models*, I enrolled in a summer school on WAVEWATCH, meeting an international collection of wave scientists from countries that included Bangladesh, Brazil, China, Iraq, Korea, Mexico, and Turkey. Culminating in an account of how we learned to model 2005's Hurricane Katrina, the chapter argues that, as computer models of waves work with the time of waves at sea, the retrodictive time required to generate predictions, the speedy time of simulation, the reshuffling "version" time of computing in the data stack, and the staggered time of global wave science, they both depend on and create idiosyncratic, biographical, and political memories of all the waves yet to be included.

The first essay in Set Four, "First Wave: Middle Passages," examines the work of organizations repurposing surveillance data to reconstruct human rights violations in today's Mediterranean, which has seen thousands of migrants drown as they escape war in the Middle East and Africa, a tragedy that Sharpe (2016) has read alongside and through the Middle Passage. Drawing next, in "Set Four, Second Wave: Wave Power," on a field visit I made to Denmark to learn about experiments in wave energy, I consider utopian dreams of human sovereignty over waves. "Set Four, Third Wave: Wave Theory ~ Social Theory" then considers how waves have become

figures in describing and predicting social change, from waves of opinion, immigration, and protest to waves of fascism and pandemic.

The final ethnographic chapter, "Wave Theory, Southern Theory: Disorienting Planetary Oceanic Futures, Indian Ocean," reports on wave science in the Southern Hemisphere, drawing from a conference I attended in Australia, as well as from Zoom fieldwork with scientists in Bangladesh, on the Bay of Bengal, where legacies of colonialism mix with future-facing projects to refashion land, sea, and siltscapes to meet rising seas. Thinking from the Indian Ocean may re- and de-orient knowledges about how to read oceans and their waves.

The postface, "The Ends of Waves," turns to where I live, Massachusetts, to glance at preparations for sea level rise in Boston, reading those preparations against Indigenous calls to remember histories of Nipmuc relocation and death on the Harbor Islands, modes of reckoning with pasts and futures of waves and the stories they carry.

A Book of Waves offers readings of wave science—readings of scientists reading waves—that spell out histories and present states of this cultural knowledge. We must think of waves, following Munk, not from the point of view of an alien, but from an Earth Ocean vantage. The historian Paul Gilroy (2018) argues that our time of planetary crisis calls for "sea level theory." Sea level, of course, is always oscillating and locally uneven, as June Pattullo, one of Munk's early graduate students, argued in foundational research she conducted in the 1950s (Pattullo et al. 1955; and see Baker-Yeboah et al. 2009 for recent work on sea surface height variability). Nowadays, sea level is also rising, overtopping any steady-state vision of fixed future horizon.

This book offers an anthropology of waves and wave science. It participates in what scholars in the humanities and social sciences have called an "oceanic turn"—where that turn is not just toward marine topics, but also toward anticipations, expectations, and anxieties about the shape of maritime worlds to come. Mindful of the heterochronic time of the ocean, however, it may be better to call this reorientation an *oceanic churn*, where to churn, according to the *OED*, is "to agitate, stir, and intermix any liquid, or mixture of liquid and solid matter; to produce (froth, etc.) by this process." The waves discussed in this book are forces of agitation and intermixture, of churn. They are media whose significance stirs together the wakes and breaks of ocean history and futurity.

NOTES

Preface

1 Writing in 2022, the Intergovernmental Panel on Climate Change notes that "the largest observed changes in coastal ecosystems are being caused by the concurrence of human activities, waves, current-induced sediment transport, and extreme storm events" (500).

2 Surf lore often has the third—sometimes the seventh or ninth—wave as the largest in a set, but there is no universal trend; much depends on locality (Deacon 1984).

3 I am inspired by analytics of diffractive reading offered by Donna Haraway (1997) and Karen Barad (2014), which tune to how texts generate multiple, superimposed meanings.

Introduction

1 This quotation and others from Munk are from my interview with him on August 25, 2015. I reproduce these words, as I do others from interviews with scientists I name, with permission. Munk died in 2019.

2 There is a thick historical literature on the shaping of oceanographic knowledge about fisheries, tides, currents, circulation, atmospheric carbon dioxide, radioactivity, and more by nation-state patronage and

international initiatives (see Benson and Rehbock 2002; Deacon 1971; Deacon et al. 2001; Hamblin 2005; Höhler 2017; Mills 1989, 2009; Oreskes 2020; Rehbock 1979; Rozwadowski 2002, 2005; Schlee 1973).

3 Ancient Greek investigations into waves are part of an Occidental tradition. Plato (429?–347 BCE), discussing social change in *The Republic*, organized key transformations into "three waves," which, classicists suggest, called on then contemporary knowledge about wave groups in the Mediterranean (Sedley 2005). Aristotle (384–22 BCE) and Plutarch (ca. 44–120 CE) pondered how wind generates waves. Still earlier, and more impressionistically, *The Iliad* (ca. 1260–1180 BCE) offered the word κύμα for wave. Jamie Morton (2001, 32) suggests that this drew on an image of the sea as procreatively female: "derived from κύω, to conceive or be pregnant, κύμα denotes something swollen."

4 Much early wave science centered attention on waves in canals rather than at sea, keying to the port logistics of imperial powers such as France, Britain, and the Netherlands (see, e.g., Green 1839; see also Darrigol 2003; Mukerji 2009).

5 Analogies of the travel of sound to the travel of waves themselves have a long history (Kilgour 1963).

6 Or not. The twentieth-century Anatolian author Cevat Sakir Kabaağaçlı scolds writers for thinking that the materiality of writing shares anything with sea substance. "If that blue is the sea's own," he dares storytellers, "then dip your pen into it and write blue" (quoted in Opperman 2019, 444). On "Self-Recording Seas," see Burnett 2011. On "wavewriting," see Philippopoulos-Mihalopoulos 2022.

7 One of Munk's colleagues, Carl Wunsch (personal communication, February 7, 2019), told me the term has caused confusion, since the word *significant* does not point to a measure such as statistical significance, as some might surmise.

8 The vision forwarded by Walcott (1978) grew out of postcolonial contestations of the sea as *aqua nullius*—the figuration offered by the Dutch jurist Hugo Grotius in *Mare Liberum* (1609)—as well as contestations of the sea grabs of powers such as the United States, which, with the Truman Proclamation of 1945–46, arrogated to itself an exclusive economic zone of two hundred miles around its coasts, tripling the country's area. This was followed by other nations that, in so doing, both enclosed territory and rendered "the high seas" outside national sovereignty and history (DeLoughrey 2017).

9 Drawing on the work of the Martinican poet Édouard Glissant, Elizabeth DeLoughrey (2017, 33) describes sea history as pointing to "a submarine temporality in which linear models of time are distorted and ruptured."

10 On the "shape" of time keyed to "loyalties of various kinds: to God, land, descent group, king, nation, employer, one's children, and so on," see Greenhouse 1989, 1632.

11 For a record of this series back to 1986, see the website of the International Workshop on Waves, Storm Surges and Coastal Hazards, http://www.waveworkshop.org.

12 Lord Kelvin postulated that winds that were strong enough could overcome the surface tension of water and raise ripples. In 1924, Sir Harold Jeffreys "proposed that the wind, moving in the same direction as a wave but somewhat faster, would tend to separate from the water surface as it flowed over a crest. In effect, the wind would leap from crest to crest, avoiding the troughs. The back side of the crest would then *shelter* the front side of the crest, so that the pressure on the front side would be lower" (Zirker 2013, 32–33). That idea turned out to be not quite right; the pressure differential was not big enough. The fluid dynamicist Owen Phillips, who studied turbulence over airplane wings, posited in the 1950s that "turbulent pressure fluctuations in the wind might generate ripples" if such fluctuations fell into resonance with water waves; *that* might generate and amplify waves. Meanwhile, the engineer John Miles, at the University of California, Los Angeles, also had his eyes on pressure, positing that "once weak waves appear, they modify the airflow and therefore the pressure distribution near the water surface, in such a way as to amplify themselves" (Zirker 2013, 35, 37). For more recent views, see Pizzo et al. 2021.

13 On fixed versus mobile reference points for ocean space, see Steinberg 2013.

14 As Paul Edwards (2010, 109) argues in *A Vast Machine*, his history of climate modeling, "Data are never an abstraction, never just 'out there.' . . . Data remain a human creation, and they are always material; they always exist in a medium. Every interface between one data process and another—collecting, recording, transmitting, receiving, correcting, storing—has a cost in time, effort, and potential error: data friction."

15 In a wave spectrum, "wave records [are] represented as a weighted sum of sine waves; the relative weightings constitute . . . the spectrum" (Irvine 2002, 379). See Kinsman 1965 for an early, authoritative rendering.

16 Spectra have something in common with computer simulations—theoretically animated models within which scientists perform virtual experimental operations (Galison 1997).

17 See Cohen 2006 on "chronotopes of the sea," which she uses to classify the ways novels stage the time-space of the ocean in tales of the open sea, the shore, and the deep.

18 The ECMWF's headquarters are in Reading, UK; Bologna, Italy; and Bonn, Germany. See also Janssen 2000.

19 Commercial users can also employ wave-prediction products by paying licensing fees, the amounts of which will depend on whether they need medium-, extended-, or long-range forecasts (ECMWF n.d.).

20 On oil and gas licensing in the 1970s enabled by maps of extreme wave heights generated by the United Kingdom's National Institute of Oceanography, see Draper 1996.

21 The Arctic is at risk, too. As the political theorist William Connolly (2017, 104) reports, as "melting ice enlarges the space of open seas during the Arctic summer, the combination of more open water and more intense winds produces larger waves than heretofore experienced."

22 Early discussions pegged the beginning of the Anthropocene to the industrial revolution, but recent deliberations—by the Anthropocene Working Group of the Subcommission on Quaternary Stratigraphy of the International Commission on Stratigraphy—date it to the beginning of the atomic age, which released bomb carbon into the atmosphere and oceans, a process that has left a definitive geological marker (see Masco 2018).

23 Donna Haraway (2015) proposes that ecopolitical messes—oceanic dead zones filled with mucilage communities, populations of jellies and slime—have muddied bright lines between evolutionary pasts and futures, between the putatively natural and the cultural. Stealing a page from the fantasist H. P. Lovecraft, Haraway suggests that eco-theory might remake, as a refigured mascot, *Cthulhu*, the tentacled monster of a repressed, abject but potent Earth. Re-spelling as *Chthulu* to call back a chthonic multiplicity against Lovecraft's racist vision, she suggests the *Chthulucene*, a heterochronic time in which the boundary between the ancient and contemporary is mucked up (see Hetherington 2019; Lorimer 2017). For a catalog of *-cenes*, see Mentz 2019a. On "Indigenizing the Anthropocene," see Todd 2015.

24 See also Zalasiewicz and Williams 2011, which notes that much knowledge about Anthropocene stratigraphy comes, in fact, from the deep sea.

25 Take the case of chemical weapons (e.g., mustard gas) dumped by Allied powers into the Baltic Sea after World War II, detritus now leaking waste upward into the sea, making military pasts into damaging presents and futures (see Neimanis et al. 2017).

26 Mentz (2015, xxii, xii) also suggests the *Naufragocene*, the age of shipwrecks, whose "contours present themselves whenever and wherever keels plough waves" as "the sudden shock and pressure of immersion fractures ships, systems, and alliances."

27 Consider something like the "choppy Anthropocene," a riff on the "patchy Anthropocene" of Tsing et al. 2019.

28 These do not leave the geological behind. Kathryn Yusoff (2018) argues that the field of geology is suffused by histories of extractivism that have called foundationally on unfree Black labor (in mining, shipping), extractivisms that, bound up with the Middle Passage, have an oceanic component.

29 Chakrabarty's work on climate builds on earlier writing (see Chakrabarty 2000) on different kinds of history—what he calls History 1 (normative, secular, Enlightenment history, told by the West) and History 2 (subaltern,

postcolonial, sometimes supernatural accounts). The literary theorist Ian Baucom (2020) proposes that climate change might require a new history, History 3—*naturalhistorical*—that, in a future-facing idiom, he calls "History 4° Celsius," keyed to an extreme but possible temperature rise over the next century. Maybe Semedo's image is one visual aid for that.

30 Wave statistics inform maritime insurance since the shipping industry embeds its financial planning within the calculus of sea-travel risk.

31 Ferdinand Lane (1947, 65) reported the scold: "Scientists, critical of untrained observers, discount such tales [of larger-than-expected waves], since gravity, they remind us, works steadily to prevent waves from vaulting above a certain height." In 1995 came the first measured instance, at a North Sea Norwegian gas pipeline-monitoring platform, the Draupner. In a field that treats waves as statistics, this one—in a sea of thirty-nine-foot waves this wave was eighty-four feet—was given an individual name: the Draupner wave. (Other waves, particularly those beloved by surfers, have names—Pipeline in Hawai'i, Mavericks in California—though those designations pick out recurring events, not once-in-a-lifetime happenings.)

32 "Waves forming out at sea off the Cape of Storms can grow almost 100ft tall from trough to crest, about the same as a ten-story building" (Pretor-Pinney 2010, 148).

33 Climate change also means warming water—which is expanding water, which can connect to intensifying wind, which can generate higher waves. Sergey Gulev and Vika Grigorieva (2004) suggest that waves in the North Atlantic have been rising fourteen centimeters each decade since the 1950s, while the Pacific has seen increases of eight to ten centimeters.

34 Reading a Kipling story in which a lighthouse keeper goes mad from hallucinating the markings of his maritime maps projected into the sea around him, Stephen Donovan (2013, 396) suggests that the late nineteenth century ushers in "a new mode of seeing in which maritime phenomena are considered primarily as artefacts of consciousness." Such seeing may also operate as distracted reading; Michel de Certeau argues that reading entails "detours and drifts across the page, imaginary or meditative flights taking off from a few words, overlapping paragraph on paragraph, page on page" (quoted in Dening 2002, 4).

35 "DUKW is a manufacturer's code based on D indicating the model year, 1942; U referring to the body style, utility (amphibious); K for all-wheel drive; and W for dual rear axles": Michael Ray, "DUKW Amphibious Vehicle," *Encyclopedia Britannica*, online ed., https://www.britannica.com/technology/DUKW.

36 Compare Sverdrup et al. (1942), in which the authors write, "In physics the general picture of surface waves is that of sequences of rhythmic rise and fall which appear to progress along the surface. . . . The actual appearance of the sea surface of the open sea, however, is mostly in the sharpest

contrast to that of rhythmic regularity . . . from the point of view of physics [these real seas] can be termed 'waves' only by stretching the definition" (quoted in Irvine 2002, 378).

37 In *We, the Navigators: The Ancient Art of Landfinding in the Pacific* (1994), David Lewis reports on one Micronesian navigator: "Kaho is said to have dipped his hand into the sea, tasted the spray and bade his son tell him the directions of certain stars. He then averred that the water was Fijian and the waves from the Lau group where they duly arrived the next day" (quoted in Mack 2011, 128). For a critical view of this tradition's representation in Western ethnography, see "Set One, Third Wave: Wave Navigation, Sea of Islands."

38 In the late nineteenth century, the physicists Albert Michelson and Edward Morley tested (and found mistaken) the then prevalent belief that light required a "luminiferous aether" as a medium in which to propagate (Holton 1969). My use of the word *media* here rather emphasizes the message-carrying qualities of signals themselves.

39 Eva Hayward's work examines how sea species know the ocean as compounds of bodies, senses, sexualities, impressions, transductions, and mediations (see, e.g., Hayward 2005).

40 See also Komel 2019, which points out the biblical quality of this moment in Saussure, who founds his linguistics in the same way God, in the book of Genesis, "moved over the face of the waters."

41 Waves are kinds of *nonhuman actors*—a term employed in recent anthropological studies of human entanglements with other creatures (including such customarily significant others as apes, dogs, and whales, but also insects, fungi, and microbes), as well as other efficacious entities (including computers, glaciers, and volcanoes). For a survey of early work in "multispecies ethnography," see Kirksey and Helmreich 2010; see also Tall-Bear 2011. Waves, in this idiom, might be *non-animal-plant-microbe-mineral*, though, since water waves teem with organic and chemical happenings of many kinds, *more-than-animal-plant-microbe-mineral* might also fit, an amalgam that could also upend the life/nonlife distinction (Povinelli 2016), making waves—not unlike, say, electricity, light, or oil slicks—patterned processes unfolding in the zone of the animate inanimate (see Chen 2012).

42 For work in the blue humanities, see Anderson and Peters 2014; Blum 2010; Bolster 2008; Cohen 2017; Cusack 2014; DeLoughrey 2019; De Wolff et al. 2021; Gillis 2013; Gilroy 1993; Lewis and Wigen 1999; Shewry 2015.

43 Anthropologists have multiplied accounts of maritime materiality, too. Studies of fisheries, maritime governance, transoceanic migration and diaspora, ports and logistics, and piracy see the ocean not merely as a stage, but also as a place whose form and physicality matters for life at sea (see Ben-Yehoyada 2017; Chalfin 2015; Dua 2013; Ho 2006; Kahn 2019; Lien 2015;

Markkula 2011; Pauwelussen and Verschoor 2017; Subramanian 2009; ten Bos 2009).

44 On "epistemic things" in science—things not quite known, that generate questions—cf. Rheinberger 1997. Hans-Jörg Rheinberger contrasts these with "technical objects," things known well enough to be operationalized in the search for other things.

45 Helen Rozwadowski (2010a, 162) summarizes how the sea has been rhetorically posted outside human history: "Most glimpses out to sea reveal endless waves reaching to the horizon rather than any lasting evidence of human presence." Steve Mentz (2015, 48) quotes Joseph Conrad on waves as signs of the ocean's oldness: "If you would know the age of the earth, look upon the sea in a storm. The greyness of the whole immense surface, the wind furrows upon the faces of the waves, the great masses of foam, tossed about and waving, like matted white locks, give to the sea in a gale the appearance of hoary age."

46 On the "temporalization of nature," see Porter 1980.

Chapter One. From the Waterwolf to the Sand Motor

1 See Bosscher and Maljaars 2017; Nederlands Instituut voor Beeld en Geluid, *De "nieuwe waterweg" in Noordoost polder*, film, Polygoon-Profilti, 1956; Steenhuis et al. 2015. See also Abe Hoekstra's *History of Waterloopbos* website, http://waterloopbos.net. The site has been used as a stage for environmental art (see van der Molen 2012; cf. Keiner 2004).

2 He continued, "We would have wave data from the physical model in the woods, and later, we had a colleague mathematician who would put that into programs in FORTRAN. But we had no computer! So, he would travel to Groningen, bringing data with him and then typing that onto punch cards."

3 I worry I was meant to see the photo through a white European gaze, one that poses racial others as subject peoples while disavowing it is doing so (see Wekker 2016). The primary source I find on the Bangkok project—Frijlink 1963—does not name Thai participants. On the transnational travel of Thai engineers, see Morita 2013.

4 In late 2019, van Vledder died unexpectedly, from a respiratory infection. A memory of his life by Giordano Lipari is posted on the LinkedIn social media site under the title, "In Memoriam: Gerbrant van Vledder (1957–2019): A Soft-Spoken Gentleman in Permanent Discovery Mode," December 5, 2019, https://www.linkedin.com/pulse/memoriam-gerbrant-van-vledder-1957-2019-soft-spoken-gentleman-lipari/.

5 For a computational contribution, see van Vledder 2006. For a philosophical meditation, see van Vledder 2017.

6 On the domestication of "air" in colonial South Africa, cf. Flikke 2018.

7 For a satiric reading of this claim, see van Boxsel 2004, 36, which quotes the English poet Andrew Marvell in the 1650s wisecracking, "Holland, that scarce deserves the name of land/ As but the off-scouring of the British sand, . . . / This ingested vomit of the sea/ Fell to the Dutch by just propriety."

8 Shore-close seascapes show how the "new sea power of the Netherlands took form not [only] on the high seas but in coastal waters, estuaries, channels" (Siegert 2014, 10).

9 The translation is by Clemens Driessen.

10 The hydraulic engineer Eco Bijker (1996) has suggested that practices of cooperation and compromise were always suffused by dynamics of inequality, even if folk narrative has them as embodying frictionless democracy.

11 Bruno Latour (1987, 230–31) saw something similar during a visit to Bijker's father: "When Professor Bijker and his colleagues enter the Delft Hydraulics Laboratory in Holland they are preoccupied by the shape that a new dam to be built in Rotterdam harbour—the biggest port in the world—should take. . . . The engineers build a dam, measure the inflow of salt and fresh water for a few years for different weather and tide conditions; then they destroy the dam and build another one . . . [but] the years, the rivers . . . the wharfs, and the tides have been scaled down in a huge garage that Professor Bijker, like a modern Gulliver, can cross in a few strides."

12 Intriguingly, Dutch "rewilding" projects aimed, for example, at introducing Heck cattle in Flevoland so they might "de-domesticate" (Lorimer and Driessen 2013) have occasionally (and controversially) been accompanied by desires to reintroduce wolves as predators.

13 It shows up, for example, in literature that links Dutch water engineering across centuries (see de Groot 1987; Kelly 2012; Rooijendijk 2009; TeBrake 2002).

14 See also Kraijo 2016. On evacuation simulations in the Netherlands, see Traufetter 2008.

15 Children were guided by the artist Rob Cerneus. For photographs of the event, see the website at http://schoutenenterprises.com/MarkerNieuws/2016/9121.htm. See also Rijser 2016. The burning practice may have drawn on a Dutch tradition of burning Christmas trees on Epiphany, which fell close to the 1916 Marken flood.

16 For an earlier, German, book of waves, see Thorade 1931.

17 Christopher Connery (1995, 56) calls the ocean "capital's favored myth-element," imagined as "free" to exploit.

18 Battjes also developed a model for energy dissipation in random waves over gently sloping bottoms, offering a mathematical term now incorpo-

rated, the world over, in numerical models for the generation, propagation, and dissipation of coastal wind waves (Battjes and Janssen 1978).

19 This work led to savings in construction cost. Battjes, with his student Martijn de Jong, was also central to discovering the process of seiche generation in the Port of Rotterdam, creating a model for operational prediction, which aided ships in traveling smoothly into the harbor (de Jong and Battjes 2004).

20 Quoted in the museum copy for an exhibition on Ivan Aivazovsky at the Tretyakov Gallery, Moscow, July 29–November 20, 2016.

21 The Waverider became widespread after a 1972 meeting at the National Institute of Oceanography in the United Kingdom that set enduring, world buoy standards (Joosten 2013, 76).

22 This is distinct from Datawell's purchasing, research and development, and management office, in Haarlem.

23 Integrating twice: acceleration → velocity → position.

24 This enables not just the *becoming environmental of computation*, but also a baseline for the *becoming computable of environment* (see Gabrys 2016).

25 Because, in the initial design, "plastics intended for the design of the accelerometer and the platform were all heavier than water" (Joosten 2013, 50), an early Datawell inventor experimented with adding sugar to the water to increase its density (inspired, the lore goes, by the inventor having spent a childhood keeping bees). Company literature records that, in early days, "dissolving enormous amounts of sugar in hot water . . . gave Datawell to the surprised passer-by the appearance of an illegal distillery" (Datawell BV 2001, 2).

26 The central polystyrene sphere in which the Datawell sensor sits is nestled loosely within another polystyrene sphere. That permits the inner sphere to stay "still" and the outer to move with waves, preventing "the transfer of the buoy's pitch and roll motion to the [inner] sphere" (Joosten 2013, 56).

27 In its earliest manifestation this double-sphere was able to measure height, but not direction. The *Directional* Waverider, introduced in 1988, added another accelerometer, in the perpendicular, coupled with a compass to convert to a North-West coordinate system, adding *magnetoception*, a sensory mode on beyond human (present, for example, in homing pigeons). This introduced another puzzle: controlling for magnetic properties of the Datawell buoy's metal casing (Joosten 2013, 148).

28 On materials that make up undersea cables, cf. Starosielski 2015.

29 On "signal traffic," see Parks and Starosielski 2015.

30 De Bakker is now a researcher in coastal morphodynamics at Deltares.

31 Schiermonnikoog is not far from Terschelling, another Wadden island, where the New York–based artist Sarah Cameron Sunde showed video works in June 2016 based on enactments of her *36.5: A Durational Performance with the Sea*, a piece in which Sunde stands in seawater at sites

around the world for periods of thirteen hours, letting the tide rise and fall around her (https://www.365waterproject.org). Sunde's immersion (wearing street-clothes over a wetsuit) in a slowly rising and falling sea at locales in the United States, the Netherlands, and Bangladesh, is shadowed by a sense that one day the sea may rise up for good.

32 For pointers to discussions that led to the Zandmotor, see Adviescommissie voor de Zuid-Hollandse Kust 2006. See also van Dijk 2012. On the early changing morphology of the Sand Motor, see de Schipper et al. 2016.

33 On genres of "soft" sand coastal infrastructure in New Zealand/Aotearoa, see also Gesing 2021.

34 For more about how waves shape beaches, see Warren Brown, dir., *The Beach: A River of Sand*, Encyclopedia Britannica Films, 1965. For specifics of the Dutch case, see Groeneweg et al. 2006.

35 Rewilding and ecological engineering fit within recent European Union advocacies for "nature-based solutions" (see Calliari et al. 2019).

36 Lotte Bontje and Jill Slinger (2017) do this work in a cultural, folkloric register, examining how Dutch residents weave the Sand Motor into personal narratives.

37 On environmental infrastructure, see Ballestero 2019; Carse 2012; Jensen 2015; Scaramelli 2019. See also Pritchard 2011.

Set One, First Wave. The Genders of Waves

1 On "vibrant matter," see Bennett 2010. On "new materialisms," see Coole and Frost 2010.

2 I am inspired here by Anthropocene feminism (Alaimo 2016; Gibson-Graham 2011) and queer critical race accounts of the animacies of metals and toxins (Chen 2012).

3 See also Ortberg 2016.

4 Consider also the wave of Octavio Paz's 1949 short story "Mi vida con la ola" (My Life with the Wave), a wave the protagonist takes home, a tempestuous seductress that might be tamed, and finally dissolved, in a mermasculine heterosexual conquest.

Set One, Second Wave. Venice Hologram

1 For more about Judith Munk, see Sterman and Gullette 2005.

Set One, Third Wave. Wave Navigation, Sea of Islands

1 Mention of vanishing brings to mind projects to generate infrastructures to *hide* islands from waves, which are at the center of investigations into *cloaking*, a technique naval engineers have explored to make ships that can

hide their wakes and with which coastal engineers have been experimenting to generate surface calm around buoys (Cho 2012; Newman 2014). See also Alam 2012, which suggests a mode of canceling water waves beneath buoys by sculpting portions of the ocean floor so they realize shapes that attenuate underwater wave action.

2 See also Simon Penny's "Orthogonal Project" (http://simonpenny.net/orthogonal), which "combin[es] design and pedagogy with indigenous knowledge systems and with the embodied intelligences of sailing and of skilled making and tool use."

3 Beware, however, claims that one place is the future of another. Carol Farbotko (2010, 54) observes that treating Pacific Islands as "a mere sign of the destiny of the planet as a whole" may serve to contain and displace the worries of the privileged.

Chapter Two. Flipping the Ship

1 The "Is It a Duck or Is It a Rabbit?" illusion first appears in a German humor magazine, the *Fliegende Blätter*, in 1892. It was adopted by the psychologist Joseph Jastrow in 1900 to demonstrate the underdetermination of interpretation by visual stimulus and was then made famous by Wittgenstein in *Philosophical Investigations* to describe the difference between "seeing that" and "seeing as." It is picked up by in Kuhn 1962 to illustrate the notion of a paradigm shift.

2 On FLIP, see "History of FLIP," Scripps Institution of Oceanography, n.d., https://scripps.ucsd.edu/ships/flip/history. On *Alvin*, see Helmreich 2007.

3 On how *contexts of motivation* shape questions asked even before what the philosopher Hans Reichenbach once called scientists' *contexts of discovery* (which may be serendipitous) and eventual *contexts of justification* (which name how results are shored up logically), see Oreskes 2003.

4 The *Oxford English Dictionary* (*OED*) points to the hip-hop song "Mecca and the Soul Brother" (1991), by Pete Rock and CL Smooth, as the origin of the phrase. My definitions of *flip* are adapted from both Merriam-Webster and the *OED*.

5 The contrast between "matters of fact" and "matters of concern" is from Latour 2004.

6 For an account of Chinese women in science in the United States, attending to how the range of women who come to the country is inflected by histories of regional difference in China, see Gu 2016.

7 Oreskes (2003, 730), writing about Scripps and the Navy, notes: "As scientists trained students, the interests of the next generation remained weighted towards issues originally driven by Cold War concerns, even after military funding and decreased . . . Military concerns were naturalized, and the extrinsically motivated became the intrinsically interesting."

8 Non-Navy funds—from the NSF, the National Oceanic and Atmospheric Administration, and the US Department of Energy—also become dominant after the late 1970s.

9 On the history of Japanese Pacific Empire before World War II, see Tsutsui 2013.

10 On British initiatives, see Cartwright 2010; Tucker 2010. On American ones, Inman 2003; Ross 2014; Shor 1978; Sverdrup and Munk 1943.

11 On the Steere Surf Code, see Bates 1949. On the ca. 1805 Beaufort Wind Force scale, which offered descriptors for local, not global conditions (e.g., "wind felt on exposed skin"), see Huler 2005.

12 "Height of Breakers and Depth at Breaking, Preliminary Report on Results Obtained at La Jolla and Comparison with South Beach State and B.E.B. Tank Results," SIO Wave Project, report no. 8, March 11, 1944, Walter Heinrich Munk Papers, 1944–2002, accession no. 87–35, Scientific Papers, Manuscripts and Talks, Scripps Institution of Oceanography Archives, (hereafter, Munk Papers), box 23, Special Collections and Archives, UCSD, La Jolla, CA.

13 The pressure sensors were called "brass boxes"—though, as they were neither made of brass nor were shaped like boxes, a later report by Munk and colleagues offered that "brass box is a hell of a name for a bronze cylinder": "Brass Box Records," SIO Wave Project, report no. 157B, Munk Papers.

14 "Effect of Bottom Slope on Breaker Characteristics as Observed along the Scripps Institution Pier," SIO Wave Project, report no. 24, October 23, 1944, Munk Papers.

15 SIO Subject Files, 1890–1982, "Waves in Shallow Water," 1944 Woods Hole Oceanographic Institution, US Navy Bureau of Ships, box 50, folder 6 (hereafter, "Waves in Shallow Water"), Special Collections and Archives, UCSD, La Jolla, CA.

16 "An Agreement between the Woods Hole Oceanographic Institution and the Regents of the University of California," January 10, 1944, and Harald Sverdrup to John C. Hammond, letter of introduction, February 16, 1944, both in "Waves in Shallow Water."

17 John C. Hammond to Harald Sverdrup, memorandum, April 16, 1944, "Waves in Shallow Water."

18 "Proposed Uniform Procedure for Observing Waves and Interpreting Instrument Records," Munk Papers. And see, later, Bigelow and Edmondson 1947.

19 "Overtly using the islands as laboratories and spaces of radiological experiment, British, American, and French militaries configured those spaces deemed by Euro-American travelers as isolated and utopian into a constitutive locus of a dystopian nuclear modernity"; "nuclear annihilation is not a threat looming in the future, but an experience of the past" (DeLoughrey

2019, 67). "The myth of the island isolate perpetuated by the US Atomic Energy Commission (AEC) and adopted by ecologists and anthropologists alike, helped to justify the detonation of hundreds of thermonuclear weapons in the Marshall Islands (Micronesia) and French Polynesia" (171). This would "figure the Pacific island as a 'natural' laboratory devoid of human history, subject to the 'god's eye' view of the ubiquitous cameras of the AEC" (172).

20 Rainger notes that Scripps oceanographers' willingness to collaborate with Miyake's students was part of an effort to internationalize ocean science, but also may have worked to mute or co-opt Japanese radiation research.

21 Though with imperialism and war such drivers of pollution and fuel use—which extend beyond capitalist countries (it's not *just* the Capitalocene)—it might also be named the *Militari-ocene*.

22 On Munk and Bascom's privileged "nuclear sensorium," see Shiga 2019.

23 See also Dennis O'Rourke, dir., *Half Life: A Parable for the Nuclear Age*, documentary film, Camerawork Pty, Cairns, Australia, 1985.

24 "Endless Holiday," by John Knauss, with lyrics by Ellen Revelle and Helen Raitt, 1952, Constance Mullin Papers 1962, 1986–2003, accession no. 2003–02, SIO Centennial Show, 2003, Scripps Institution of Oceanography Archives, box 1, folder 13. Rozwadowski (2010a, 170) observes that, "In naval parlance, a holiday is an area in which work has been left undone, but oceanographer-planners relished the double meaning."

25 It also risks obscuring the work of women scientists and technicians at Scripps such as Margaret Robinson, whose shoreside work on the relation between subsurface sea temperature provided accountings of the movements of water mass that were vital to underwater acoustics. As Oreskes (2000, 385) notes, "men went 'out' into the field to collect geophysical data; women stayed 'home' to process it."

26 On demographics and labor relations in oceanography, see Steinhardt 2018. For more about #BlackInMarineScience, follow #BIMSRollCall on Twitter.

27 Ortiz-Suslow is now assistant research professor in meteorology at the Naval Postgraduate School.

28 The spectral model appeared earlier, in 1938, in "The Spectrum of Turbulence," in which G. I. Taylor starts with an analogy to light and prisms. The Corps of Engineers sought in the 1950s to record spectra on magnetic tape (Beach Erosion Board 1955).

29 Robert Dierbeck, dir., *Waves across the Pacific*, film, McGraw-Hill Text-Films, 1967.

30 Summary of *Waves Across the Pacific* from American Archive of Public Broadcasting, http://americanarchive.org/catalog/cpb-aacip_75–9995xh8c. See also Dierbeck, *Waves across the Water*.

31 On an explicit Scripps policy enacted in 1949 (and overturned in 1960) that forbade women from taking passage on overnight cruises, see Day 1999.

32 Rozwadowski (2010a, 170) underscores the significance of play for these men: "While at sea and stationed on Pacific islands, Scripps oceanographers integrated into their scientific work diving for pleasure, enjoying sunsets, and collecting art and objects from natives."

33 See the biography of Helen Hill Raitt (Day 1997), wife of the geophysicist Russell Raitt, who cofounded UCSD's International Center and who in 1952 flew to meet her husband during a Pacific voyage, after which she developed a career of advocating for Tongan-language library infrastructure. See also letters from Judith Horton Munk (Walter Munk's wife) to her parents, Winter Davis Horton, and Edith Kendall Horton, written in 1963 from Tutuila, in Judith Horton Munk Papers, 1962–1968, accession no. 93–18, Scripps Institution of Oceanography Archives, box1, folder 3.

34 On anthropology and wonder, see Srinivas 2018. On wonder in sea science, see Adamowsky 2015.

35 The idea of the "turn" has been used to describe shifts of attention in the humanities and social sciences. The "linguistic turn" in philosophy (pivoting to questions of naming rather than being), the "global turn" in art history (moving from national to transnational contexts), and the "practice turn" in anthropology (looking to in-the-world activity rather than idealized cultural schemes) are examples. As Tom Boellstorff (2016, 390) points out, however, one "entailment of the turn metaphor is that turning takes place around an axis, a still center held constant."

36 See Oceanography: The Making of a Science, People, Institutions and Discovery Collection, 2000 (SMC 0087), box 1, folder 3: Douglas Inman—Interview by Ronald Rainger, February 16, 2000.

37 There were some in-place formal speculations, notably from Munk who with colleague Christopher Garrett forwarded a possible spectrum for internal waves, one they believed might be universal (Garrett and Munk 1972, 1979). Munk's first publication, in 1939, was on internal waves.

38 Oceanography: The Making of a Science, People, Institutions and Discovery Collection, 2000 (SMC 0087), box 1, folder 3: Douglas Inman—Interview by Ronald Rainger, February 16, 2000.

39 Oceanography: The Making of a Science, People, Institutions and Discovery Collection, 2000 (SMC 0087), box 1, folder 4: Walter Munk—Interview by Naomi Oreskes and Ron Rainger, February 16, 2000.

40 While internal waves are no longer ghostly state secrets, knowledge about them can permit scientists to peek into volumes that cross ocean governance regimes. Nation-states have rights over the waters of their exclusive economic zones [EEZs], as well as over the seabed located on their adjacent continental shelves; the International Seabed Authority has jurisdiction over the seabed outside EEZs; and the High Seas, the water column outside

EEZs, are subject to no such authority. US- and Taiwan-based researchers, for example, funded by the Taiwan National Science Council, in collaboration with the United States Office of Naval Research, often gather data at sites in the South China Sea controlled and claimed by Taiwan—and are then able to reconstruct internal wave processes unfolding within Chinese-claimed waters. On "volumetric sovereignty," see Billé 2017.

41 When I met the biological oceanographer Drew Lucas, I took note of a tattoo on his leg, one that summarized this coming together of the physical and biological: an equation from vector calculus inked against a flowing rendering of kelp.

42 Franks tested—and confirmed—his vision of internal waves as mechanisms to form dense plankton aggregation in a project called "Spontaneous Patch Formation in Robotic Plankton," deploying a swarm of autonomous underwater explorers (AUEs) to stand as proxies for phytoplankton (Jaffe et al. 2017).

43 In California, off the coast of Palos Verdes Peninsula, an undersea location the *Los Angeles Times* once designated as "the nation's largest ocean dumping ground of DDT," internal waves have been found to stir up sedimented DDT as well as PCB contamination, the legacy of DDT manufacture and dumping from 1947 to 1983 by the Montrose Chemical Corporation (Ferrel 1992; see also Ferré et al. 2010). DDT and PCBs have worked their way through microbes, fish, seabirds, and marine mammals—and in ways facilitated by internal waves off the Palos Verdes Shelf, which have suspended such toxic elementalities higher in the water than they might otherwise be.

44 Questions about open-ocean wave breaking have been in the asking for a long time. The head of Scripps's Air-Sea Interaction Lab, the late physical oceanographer Ken Melville, recalled to me that the Cambridge University physicist George Stokes in 1847 had posited that the shape of stable, propagating waves could be described as "a trochoid, the curve traced in space by a point on the rim of a rolling wheel" (Zirker 2013, 52). One property of such waves is that the orbitals of water beneath the crests do not stay stationary, but get carried forward a bit, opening into elongating spirals (imagine stretching a spring), an effect known as "Stokes drift." In 1967, mathematicians Brooke Benjamin and Jim Feir, trying artificially to generate Stokes waves in a wave tank, discovered that these waves were *unstable*, that, as Melville put it, "if you had a theoretically uniform wave train, of all the waves exactly the same, that after enough time, the wave field would become modulated—just like an AM/FM radio uses modulated waves to send a signal."

Melville took me to Scripps's indoor wave tank, and asked a student to generate Stokes waves down the tank. The waves marched forward regularly. But as the train of waves began to wobble, there started to appear "parasitic capillary waves," little ripples growing on the forward faces of pointy waves. These were the result of those carrier waves produced by

the Benjamin-Feir instability developing a curvature at their crests large enough for surface tension to become important. Such parasitic waves are dissipative of the wave energy associated with the longer waves on which they ride, dissipation that may lead to open ocean wave breaking.

The question of how to think about air flow over waves—inspired by thinking of ocean waves, like airplane wings, as interfaces between the aero- and hydrodynamic—was one that came to occupy Melville. He wanted to know whether breaking waves "could lead to the separation of the airflow," and did experiments in a wave tank with wind blowing over it, even adding a smoke generator "to visualize the flow; we saw indeed that there was separation in the air when you had breaking" (Banner and Melville 1976; see also Melville 1983). "The breaking of surface waves," he told me, "is probably the primary way of generating currents in the ocean, so oceanographers talk about wind-generated currents, but really the waves come between the wind and the water column. The momentum from the wind goes into the waves, the waves break, and then goes out through the currents" (see Melville and Rapp 1985).

45 This work seeks to add a field case to lab work reported in Buckley and Veron 2019.

46 On attuning to atmosphere, see Choy 2012; McCormack 2018; Stewart 2011.

47 For an early summary of work in science studies on this topic, see Smit 1995.

48 While most oceanographic work was not classified starting in the 1990s, this was not true in the 1940s and '50s. And most Scripps oceanographers from the 1930s to 1960s were aware of, and usually approving of, military uses of their work (Oreskes 2020).

49 On high-energy physicists' calibration of their scientific, biographical career times to the "beamtime" they are able to secure on particle detectors, cf. Traweek 1988.

50 After COVID-19 became a matter of concern in the United States, Prather turned her expertise on aerosols to study how to reduce person-to-person transmission of SARS-CoV-2.

51 Just after I finished writing this chapter, UCSD founded the Institute for Indigenous Futures, part of the charge of which was the revitalization of Kumeyaay seafaring technologies (see Rodriguez et al. 2021). The foreclosed future imagined in apocalyptic science fiction about the ruins of FLIP is only one possible prospect for where oceanography around Scripps might head.

Set Two, First Wave. Being the Wave

1 Duane 2019 tracks the rise of "surf Nazis," mostly white California kids who, seeking confrontationally to protect their "local" spots in the 1980s, spray painted swastikas on their boards. This protectionism was entangled with histories of white supremacy and beach segregation in California.

2 Keith Malloy, dir., *Come Hell or High Water: A Body Surfing Film Documenting the Plight of the Torpedo People* (Santa Monica, CA: Woodshed Films, 2011).

3 Nemani 2015 contests dismissive judgments of bodyboarding, cataloging the ways they calibrate to gendered and racialized hierarchies that persist in posting white male board- and bodysurfers at the top.

Set Two, Second Wave. Radio Ocean

An audio companion to this essay—a sample-based composition by Wayne Marshall and Stefan Helmreich entitled "Wave Count," is available online at https://www.thewire.co.uk/audio/tracks/wire-mix-wave-count-a-montage-by-wayne-marshall-and-stefan-helmreich.

1 Seismometers employed to detect earthquakes picked up crashing waves heralding the arrival of Hurricane Irma (Wilts 2017).

2 Compare John Luther Adams's Pulitzer Prize–winning *Become Ocean* (2013), a single-movement orchestral composition made of rising swells of strings, woodwinds, and brass, played over a bed of rippling piano, meant to put listeners in mind of sea level rise and of ice melting at the poles.

3 Compare "Sound-Wave" (2012), a composition by Alexis Kirke in which Kirke wired a conductor's baton to wave-generating paddles in a research tank at Plymouth University in England.

4 Also in an experimental register, listen to Luigi Nono's 1976 ". . . Sofferte onde serene . . ." (. . . Suffering Serene Waves . . .) for piano and tape, crafted, in part, from the recorded sound of bells reflected off of the fog and waves of the canals of Venice.

5 Tristan Murail, "*Le partage des eaux*: Note," Works, n.d., http://www.tristanmurail.com/en/oeuvre-fiche.php?cotage=27533.

6 For a collection of eighty-four pieces of hydrophonic sound art, variously tuned to different underwater frequencies, listen to *freq_wave*, curated by the Thyssen-Bornemisza Art Contemporary Academy: https://ocean-archive.org/collection/72.

7 Michelle Dougherty and Daniel Hinerfeld, dirs., *Sonic Sea*, Natural Resources Defense Council, New York, 2016.

Chapter Three. Waves to Order and Disorder

1 The logging industry arrived in the 1880s, along with white American settler colonialism, which displaced Oregon Indians to reservations such as Grand Ronde, Siletz, Warm Springs, and Klamath. The Oregonian businessman O. H. Hinsdale, for whom the OSU lab is named, hailed from a family that once owned the Umpqua River Steam Navigation Company, involved in the timber business (with the name "Umpqua" lifted from Native inhabitants). The Hinsdale webpage features a poem about him, written by

a friend, Peggy Hoecker, part of which reads: "A generous philanthropist, O. H. Hinsdale had a dream, Of recreating ocean waves by the use of a machine" (https://wave.oregonstate.edu/history).

2 On "derangements of scale," see Clark 2012.

3 For a report on the experiment, see Rueben et al. 2011.

4 On the substitution of computer simulations for physical experiments, see Winsberg 2010.

5 A lot of the work is automated; in fact, the lab itself has only four permanent staff—the director, a research associate (managing lab software, hardware, and infrastructure), an education outreach coordinator, and a maintenance person.

6 Interestingly, this poster is a 1981 ad for a software company, and the pixel images in its middle were rendered by hand, in pencil.

7 One of the artificial features of these spectra is that, while waves in the ocean acquire their energy largely from *wind*, in this lab *there is no wind*; spectral parameters in a model fold wind effects into an artificially generated wave. (Other wave labs do use wind, introducing additional variables.)

8 The printing idiom may be fitting, since Corvallis, Oregon, is the home of the segment of the Hewlett-Packard company that invented the ink jet printer.

9 On "real time," see Riles 2004; Weston 2002.

10 "An algorithm was developed to detect the landward-most statistically significant bright point and then a polynomial curve was fitted to the raw edge, producing an initial estimate of the wave edge" (Rueben et al. 2011, 235).

11 See Ludwin et al. 2005, which documents the work of Indigenous scholars, anthropologists, and geologists to gather historical examples of Indigenous and First Nations narratives about Pacific waves and floods during this period. See also Finkbeiner 2015.

12 On political rhetoric of invasive species, see Subramaniam 2001.

13 For more ethnographic accounts of the 3.11 event, see Gill et al. 2013.

14 Good (2016, 146) notes, "After 3.11, the National General Association for Stone Shops in Japan began to erect 500 coastal stone monuments similar to past *tsunamihi* but modernized to include English translation and QR (Quick Response) codes linking to images and video of the disaster."

15 Ryo Morimoto, personal communication, August 6, 2019.

16 Lori Tobias in the *Oregonian*, quoted in Carr and Fisher 2016, 133.

17 Available through links in Read 2015.

18 Echoing wartime propaganda maps from the West that have Japan represented as an octopus reaching into Pacific territory. See Meier 2017, which reproduces a stark Dutch version from 1944.

19 On how the tsunami put linear models of time into crisis, see Morimoto 2012. As he writes in a later argument, "The wave of semiosis repeatedly goes from remembering to forgetting and vice versa" (Morimoto 2015, 560).

20 Nao considers herself a wave, reflecting on her position as a student who has not yet graduated (*ronin*): "The way you write ronin is 浪人 with the character for wave and the character for person, which is pretty much how I feel, like a little wave person, floating around on the stormy sea of life" (Ozeki 2013, 42).

21 When I was writing *Alien Ocean*, I attended a deep-sea conference in India weeks after the 2004 tsunami, and the questions on the minds of scientists were, indeed, about how fast they could understand what had happened and how they could calibrate different kinds of time—geological, oceanic, bureaucratic. Some held the tsunami and victims at a distance—available by speaking in terms of long, geological time frames—and, if they did not themselves know anyone present at the event, placed victims (craft fishers, people in coastal poverty) in what Johannes Fabian (1983, 104) once called "the Time and the Other," a "time" that metropolitans use to deny the coevalness of usually far-away and marginalized communities. Other scientists found themselves transformed by the disaster, eager to find some way to calibrate geological, oceanic, and social time.

22 See the online Tsunami Digital Library, at http://tsunami-dl.jp.

23 And, in fact, they do not always necessarily suggest waves. As Parry (2017, 74, 144) writes, "Rather than comprising a single wave, the tsunami had consisted of repeated pulses of water, washing in and washing out again, weaving over, under, and across one another. . . . The one thing it did not resemble in the least was a conventional ocean wave. . . . [T]he tsunami was a thing of a different order, darker, stranger, massively more powerful and violent, without kindness or cruelty, beauty or ugliness, wholly alien."

24 For an account of living through the 2004 tsunami, which killed her parents, husband, and two children, see Deraniyagala 2013. See also Goldman 2011.

25 As Greg Siegel (2014, 18) writes, "Modern reason secularizes the accident, disenchants it, casts out its primeval ghosts and goblins, while modern technology effectively humanizes it, brands it as anthropogenic failure rather than a 'natural disaster.'" Precisely this partitioning—natural versus anthropogenic—was at stake in framings of 3.11.

26 See also Fisch 2022.

27 Michael Fisch, personal communication, September 12, 2019.

Set Three, First Wave. Massive Movie Waves

1 On life, animation, and film, cf. Kelty and Landecker 2004.

2 The original Japanese version was *Japan Sinks* (日本沈没 [1973]), by Shiro Moritani.

3 Franklin, in "Inside *Interstellar*," bonus feature included with, *Interstellar*, directed by Christopher Nolan (2014, Paramount Pictures; 2015), DVD.

4 Nicole Starosielski (2013) suggests that underwater settings in 1950s films portray the deep as monstrous and in the 1960s move to narratives about the sea as a place to colonize. In disaster movies, crashing waves confuse the realms of above and below.

5 Compare *Hereafter* and *The Impossible* to Indian tsunami films such as Prabhu Solomon's 2014 *Kayal*, a Tamil romantic comedy that features the tsunami as a backdrop. The events around the 2011 *Tōhoku* tsunami in Japan have only started entering fiction film, and most (see Sion Sono's *Land of Hope* [希望の国] [2012]) focus on Fukushima rather than the wave (see Schilling 2015).

6 The blog *Mana Moana* describes itself as an online "home for indigenous critique of Disney's *Moana*": "Nau Mai," *Mana Moana*, n.d., https://manamoana.wordpress.com. In *Surf's Up*, a cartoon about surfing penguins, animators hoped to render waves in the film using computer simulation, but, finding that such virtual waves do not pack enough emotion, they worried that they wouldn't look "real." Eventually, animators produced a virtual wave "puppet," so that waves could be, as they put it, "characters."

7 On the algorithms behind *Moana*'s waves, see Lafrance 2017.

Set Three, Second Wave. Hokusai Now

1 Ocean scientists have been adamant that Hokusai's wave *not* be mistaken for a tsunami (Cartwright and Nakamura 2009). As Christine Guth (2015, 200) remarks, "It is a measure of the celebrity of 'Under the Wave off Kanagawa' that what kind of wave it represents is a question that has been taken up by geophysicists." Some have claimed the Great Wave may represent a *rogue wave*. The physicist and optics theorist John M. Dudley, science writer and diver Véronique Sarano, and mathematician Frédéric Dias postulate just this in "On Hokusai's *Great Wave off Kanagawa*: Localization, Linearity and a Rogue Wave in Sub-Antarctic Waters" (2013).

2 See Yuko Shimizu, "Climate Change and the City," *Yuko Shimizu* (blog), February 11, 2013, https://yukoart.com/blog/climate-change-and-the-city.

3 Guth (2015, 197) writes, "Waves are widely understood to connote the precariousness of human existence, but this one has translated the consequences of human actions into the workings of nature." On modernity as foam, see Sloterdijk [2004] 2016.

4 Turner's studies were aesthetic, not scientific: "Turner . . . was friends with scientists of his day and he was certainly interested in theory, particularly of colour. But it is hard to see him driven by the theories of science. What he set out to do, from his early days of embracing the romantic theories of

the 'sublime' in nature, was to depict sensation—the sensations experienced at sunrise and sunlight, in storm and dead calm, in rain and mist" (Hamilton 2012). The artist is a medium, and Turner went to extremes to gather experience, even having himself "tied to a mast of a boat so that he could draw waves smashing onto the deck" (Knight 2006, 66). Evocations take a sharper cast in the vivid red waves of Turner's *Slave Ship* (1840 [see "Set Four, First Wave: Middle Passages"]).

5 For an ethnography of the trash vortex and scientists and activists arrayed around it, see De Wolff 2017. See also Decker 2014.

Set Three, Third Wave. Blood, Waves

1 Unless the blood has been spilled in war or violence—mixing up the order of things—in which case the trope of the "sea of blood" often emerges. One notable appearance of a wave of blood in popular culture is in Stanley Kubrick's film adaptation of Stephen King's novel *The Shining* (1980). Bill Blakemore (1987), noting that Kubrick marketed the film in Europe, after its success in America, with the line, "The wave of terror which swept across America," argues that a key scene in the movie, in which a wave of blood floods out of a hotel elevator, symbolizes the blood spilled by European settlers in the genocide of Native Americans. He notes the Calumet, Navajo, and Apache symbols that decorate the movie's Overlook Hotel and writes, "The blood squeezes out in spite of the fact that the red doors are kept firmly shut within their surrounding Indian artwork embellished frames. We never hear the rushing blood. It is a mute nightmare. It is the blood upon which this nation, like most nations, was built, as was the Overlook Hotel."

2 "This is true even when the researchers compared people with the same medical conditions, the same age, and the same insurance coverage" (DeNoon 2007, summarizing Hernandez et al. 2007). See also Pollock 2008.

Chapter Four. World Wide Waves, *In Silico*

1 HOK Design, "A Breath of Fresh Air for NOAA's New Home," n.d., https://www.hok.com/design/type/science-technology/noaa-national-center-for-weather-and-climate-prediction.

2 Think of this as a descendant of the United States' Cold War–era Semi-Automatic Ground Environment (SAGE) computer network, which coordinated radar data to create representations of airspace (Edwards 1996).

3 On fire prediction, cf. Neale and May 2020. On sea-ice melt forecasting, cf. Vardy 2020.

4 On how mapping in the twentieth century came to couple God's-eye vantages with smaller-scale, sometimes embedded GPS views, see Rankin 2016.

5 Hans Blumenberg ([1979] 1997, 7) explores the history of keeping seas at observational distance, a view from "the lamenting but uninvolved spectator" who may (or not) accept their implication in the larger scene. Blumenberg quotes the nineteenth-century historian Jacob Burckhardt, reflecting in 1869 on the French revolutions of his day: "As soon as we rub our eyes, we clearly see that we are on a more or less fragile ship, borne along on one of the million waves that were put in motion by the revolution. We are ourselves these waves. Objective knowledge is not made easy for us" (Blumenberg [1979] 1997, 69–70).

6 For the notion of "ocean memory," I am indebted to the Ocean Memory Project, a science-art-humanities collaboration funded by the National Academies Keck Futures Initiative dedicated to multidisciplinary work on apprehending Earth's seas as a space of recollection (https://oceanmemoryproject.com/).

7 Ubuntu itself is not embargoed, however, and users of Linux have been keen to keep the operating system free of US embargoes (see Marti 2003). Adrian Mackenzie (2008b, 156) writes that Ubuntu, through enlisting programmers in Europe, North America, India, and East Asia, "introduces a multinational dimension to the internationalization of software, but the software itself remains universal in its aims and expectations because code and software themselves are presumed to be universal as text and practice. . . . [S]oftware now garners universality from that other universal, 'human beings,' free individuals." Chun (2011, 21) writes,

> Free software does not mean escaping from power, but rather engaging it differently, for free and open software profoundly privatizes the public domain: GNU copyleft—which allows one to use, modify, and redistribute source code and derived programs, but only if the original distribution terms are maintained—seeks to fight copyright by spreading licenses everywhere. More subtly, the free software movement, by linking freedom and freely available source code, amplifies the power of source code both politically and technically. It erases the vicissitudes of execution and the institutional and technical structures needed to ensure the coincidence of source code and its execution.

8 Mackenzie (2006, 169) writes that, in software, "relations are assembled, dismantled, bundled and dispersed within and across contexts."

9 In the novel *The Man without Qualities*, by Robert Musil ([1930–43] 1996, 76), the mathematician protagonist Ulrich struggles with the oddness of logical descriptions of water:

> And there now was water, a colourless liquid, blue only in dense layers, odourless and tasteless (as one had repeated in school so often that one could never forget it again), although physiologically it also included bacteria, vegetable matter, air, iron, calcium sulphate and calcium bicarbonate, and this archetype of all liquids was, physically speaking,

fundamentally not a liquid at all but, according to circumstances, a solid body, a liquid or a gas. Ultimately the whole thing dissolved into systems of formulae that were all somehow connected with each other, and in the whole wide world there were only a few dozen people who thought alike about even as simple a thing as water; all the rest talked about it in languages that were at home somewhere between today and several thousands of years ago.

10 One approach to tuning surprised me—one animated by a "genetic algorithm," an optimization technique based on an analogy to artificial selection (see Tolman and Grumbine 2013). For analysis of genetic algorithms, see Helmreich 1998.

11 Chun (2011, 19) writes, "Software . . . turns process in time into process in (text) space." On computers as infrastructures that fabricate what counts as "real time" (e.g., through the use of "Unix epoch" time stamps keyed to the number of seconds elapsed since January 1, 1970), see Cox and Lund 2021.

12 Here, perhaps, is code as "source, code as the true representation of action, indeed code as conflated with, and substituting for, action" (Chun 2011, 19).

13 For an Indigenous critique of the universality of the stack, see Lewis 2019.

14 This was before Trump, in September 2019, defended a map of the path of a hurricane that had been doctored with a Sharpie pen in order to align with his erroneous claims about its path, which contradicted National Weather Service predictions (Sobczyk 2020).

Set Four, First Wave. Middle Passages

1 On rhetoric describing these people as moving in "swarms," see Sanyal 2021.

2 Del Valle also reports that some thirty-five thousand people have died crossing the Mediterranean since 2000. See, for further statistics, the website of the Missing Migrants Project, organized by the International Organization for Migration (IOM): https://missingmigrants.iom.int/. See also the Search and Rescue information page of Doctors without Borders: http://searchandrescue.msf.org.

3 In the nine-screen art installation *Ten Thousand Waves*, which ran at Victoria Miro Gallery in London from October 7 to November 13, 2010, Isaac Julien (2010) took as a subject the drowning of twenty-three Chinese migrant cockleshell pickers in 2004 in Morecambe Bay, in northwestern England. The pickers' work leader was misinformed about the direction in which the tide would rise. Julien weaves this event together with a tale of the Chinese goddess of the sea, Mazu, from Fujian, the province from which the cockle pickers began their migration to the United Kingdom. Julien juxtaposes an aestheticized mythspace of wave goddess with the emergency media of grainy police helicopter footage, telling of the closely

coupled apparatuses of surveillance and neglect that track global maritime work in and around waves.

4 In an audio recording of the poem, which begins with the word *water* broken up, Philip "multiplies the phoneme 'wa' and enunciates it with increasing speed as if to both underscore its significance and to mimic the sound of an echo, a reverberation from which we can no longer trace an origin. . . . Water in the poem resists graphic and aural cohesion while demanding repetition. . . . [The poem] aurally and graphically represents waves by breaking lines and words" (Fehskens 2012, 408).

Set Four, Second Wave. Wave Power

1 And which is not in dialogue with Native Hawaiian notions of place or sea.

2 See the Save the Waves website, at https://savethewaves.org.

3 On coproduction, see Jasanoff 2004. For a reflection on coproduction that points to how resistance, opposition, and friction characterize science-society relations as much as collaborative coproduction, *see* Filipe et al. 2017.

Set Four, Third Wave. Wave Theory ~ Social Theory

1 This idea got an update in 1960, when Elias Canetti ([1960] 1962, 80) wrote, "The sea is multiple, it moves, and it is dense and cohesive. Its multiplicity lies in its waves. . . . The dense coherence of the waves is something which men in a crowd know well." See also Cody 2020.

2 Accounts of waves as forces to "surf" can reach toward a beachy sublime. As the midcentury psychedelic drug advocate Timothy Leary told *Surfer* magazine, "Everything is made of waves. At the level of electrons and neutrons . . . it's part of a wave theory. Historical waves—cultural waves . . . sequential, cyclical, moving, ever-changing forms" (quoted in Pezman 1978).

3 "Insurrectionary wave" first appears in accounts of the European revolutions of 1848 (Knight 1855, 217). In *Waves of Decolonization*, David Luis-Brown (2008) calls for a recognition of the power of waves of mid-twentieth-century decolonization and their concomitant movements of immigrants. Picking up on an essay by W. E. B. Du Bois, "The Souls of White Folk" (1920, 31), in which Du Bois wrote, "Wave on wave, each with increasing virulence, is dashing this new religion of whiteness on the shore of our time," Luis-Brown calls for a rescripting of waves of (non-white) immigration as waves of liberation from whiteness.

Chapter Five. Wave Theory, Southern Theory

1 The North-South dichotomy was early articulated by the Italian Marxist Antonio Gramsci to describe exploitation by northern Italian capitalists of southern Italian peasantry (see Dados and Connell 2012).

2 Boaventura de Sousa Santos (2018) points to concepts such as *ubuntu* and *ahimsa* as alternative optics through which to make social relations. On science from the South, see also Kervran et al. 2018.

3 In the usual projection, "Europe hovers over the lands below, from a position of scopic and epistemological privilege" (Wenzel 2014, 20). For the inverted map in figure 5.1, see "The Revolutionary AuthaGraph Projection" 2017.

4 "The common logic is that a system of categories is created by metropolitan intellectuals and read outwards to societies on the periphery, where the categories are filled in empirically" (Connell 2007, 66).

5 Another term to add is *tropical*, which emerges from European matrices to name hot equatorial climates and, when brought into descriptions of Indian Ocean worlds, sometimes mixes with the figure of the "Orient" (Arnold 2006).

6 See also Dasgupta and Pearson 1987.

7 Isabel Hofmeyr (2010) updates the "cradle of globalization" argument to suggest that today's Indian Ocean gathers up trends of global transformation—postnational (and post-American) politics, amplified oil extraction, the rise of Chinese capital, and the emergence of new African transnationalism.

8 *Waves across the South* opens with reproductions of nineteenth-century European paintings of Indian boats battling waves as they are tasked with carrying colonial cargo. Think of such boats and their hydrodynamics as a kind of wave theory—as many colonialists did, making close study of, for example, Burmese boats of war.

9 Sivasundaram (2020, 248, 245) documents an earlier technoscientific making of the Indian Ocean, managed by the British East India Company starting in 1792 at the Madras Observatory. The observatory's "central nautical aim, given its location at the heart of the Indian Ocean, was as a calibration point for ships across this vast ocean." It generated "calculations of longitude, tidal determinations and coastal marking points"—and did so by both drawing on and erasing local contributions. Part of what proceeded from the observatory's work was a representational smoothing of the irregularity of the Earth's equatorial bulge, a result that made "the Earth more like a spherical globe."

10 See also the listing "International Indian Ocean Expedition: Collected Reprints, VI," United Nations Educational, Scientific, and Cultural Organization, UNESDOC Digital Library, https://unesdoc.unesco.org/ark:/48223/pf0000148948.

11 See also Shanti S. Varma, dir., *Indian Ocean Expedition*, Films Division, Bombay, 1963. The Bandung conference, convened in Indonesia in 1955, aimed at fostering Afro-Asian resistance to neocolonialism (see Hofmeyr 2010).

12 "This unsuitability [was] the result of modeling the embankments after Dutch dikes (polders) in the Rhine delta, which sees only 1 percent of the sediment in the Ganges-Brahmaputra delta" (Dewan 2021, 59).

13 On how COVID-19 complicated the delivery of post-Amphan aid to coastal villages, see Mehtta 2020.

14 On JICA, see Leheny and Warren 2010. The appeal of Japan as a place for Bangladeshis to study increased after 9/11, when the United States became restrictive in issuing visas to people from Muslim-majority countries.

15 See *Tropical Storms: Bangladesh's Cyclone Aila* (Pumpkin TV, Bristol, UK, 2010), film.

16 On "hydronets," or "neural network models designed to exploit both basin specific rainfall-runoff signals, and upstream network dynamics, which can lead to improved predictions at longer horizons," see Moshe et al. 2020. Zach Moshe and his colleagues have tested their models on data sets from the Ganga and Brahmaputra.

17 More, as Jason Cons (2018, 267, 270) argues, discourses that stage the Bangladesh delta region as a "laboratory" for "resilience" (and for adapting "in place") are often formatted by a Northern—and sometimes an Indian—"development-security nexus" that worries about Bangladeshi outmigration, about people in this part of the delta becoming climate refugees, framing "particular spaces at once as sites of experimental management for future crisis and as representational zones that enact spectacles of containment."

18 For a Netherlands-based research project to compare Dutch with Bangladeshi deltas, see the Hydro Social Deltas website, at https://hydro-social-deltas.un-ihe.org.

19 On toxins in the Bay of Bengal, see the work of Ravi Agarwal, founding director of the nongovernmental organization Toxics Link (https://toxicslink.org) of New Delhi.

20 On "braided sciences," see also Mukharji 2016. On river time, see Gearey 2018. On a Sundarban river's "whirlpools, braids, striations, and many sorts of ripples," see also Ghosh 2019, 104; Jue 2017b.

21 The "regularity of bourgeois life" phrase is from the literary theorist Franco Moretti (2013, 81).

22 The work is badly needed; as I finished copyediting this chapter, in summer 2022, Pakistan was suffering from a supercharged monsoon disaster—a consequence of legacies of development- and nationalist-driven dam construction, of global warming, and more—leaving some ten percent of the country flooded. On the question of what science is *for*, see Fortun 2023.

23 Other books that bear mention might be "The Book of Sand," imagined by the Argentine writer Jorge Luis Borges (1976), a text that never shows the

same page twice, and "the book of silt," conjured by the Scottish poet John Burnside (2002), his meditation on finding shore-side signs of worn-away life. In "Of Sea Changes and Other Futurisms," Ayesha Hameed (2022) asks, referring to the Indian Ocean, "What would a book be if it was invented at sea in the context of indentured and enslaved labour, following trade winds, navigating mangroves, and the sound of the co-mingling of languages and ecosystems?"

Postface

1 See also Sarah Kanouse and Nicholas Brown, dirs., *Ecologies of Acknowledgment,* video, 2019, https://www.nicholasanthonybrown.net/projects#/ecologies-of-acknowledgement. Listen also to Kristen Wyman, "Remembering Deer Island." Thanks to Elizabeth Solomon and Faries Grey, members of the Massachusett Tribe at Ponkapoag who in 2019 started leading an Indigenous Boston Harbor Tour, and whose 2022 tour was vital to my account here.

2 In a famous meditation on time, Walter Benjamin ([1940] 1968, 257–58) imagines the angel of history: "His face is turned toward the past. Where we perceive a chain of events, he sees one single catastrophe which keeps piling wreckage upon wreckage and hurls it in front of his feet." The wind of history, blowing from the past "propels him into the future to which his back is turned, while the pile of debris before him grows skyward." Contrast this with the figure of a wave coming toward us, the face of a wave that, erasing and forgetting, *also* gathers up that which was and will shape what will be.

This page intentionally left blank

REFERENCES

Abbott, B. P. et al. (LIGO Scientific Collaboration and Virgo Collaboration). 2016. "Observation of Gravitational Waves from a Binary Black Hole Merger." *Physical Review Letters* 116, no. 6. https://journals.aps.org/prl/pdf/10.1103/PhysRevLett.116.061102.

Abrams, Sarah. 2019. "The Power of Fear." *Radcliffe Magazine*, Winter, 30–35.

Adamowsky, Natascha. 2015. *The Mysterious Science of the Sea, 1775–1943*. London: Routledge.

Adams, Allan, and Sasha Chapman. 2016. "What Gravitational Waves Sound Like." *The Atlantic*, February 11. https://www.theatlantic.com/science/archive/2016/02/what-gravitational-waves-sound-like/462357.

Adler, Antony. 2019. *Neptune's Laboratory: Fantasy, Fear, and Science at Sea*. Cambridge, MA: Harvard University Press.

Adviescommissie voor de Zuid-Hollandse Kust. 2006. *Kustboekje: Groeien naar Kwaliteit*. The Hague: Hoogheemraadschap van Delfland.

Agostinho, Daniela. 2015. "Flooded with Memories: Risk Cultures, the Big Flood of 1953 and the Visual Resonance of World War Two." In *Hazardous Future: Disaster, Representation and the Assessment of Risk*, edited by Isabel Capeloa Gil and Christoph Wulf, 265–86. Berlin: Walter de Gruyter.

Aguilera, Mario. 2007. "Research Highlight: Saving Venice." *Scripps Institution of Oceanography News*, March 2. https://scripps.ucsd.edu/news/research-highlight-saving-venice.

Ah-King, Malin, and Eva Hayward. 2014. "Toxic Sexes: Perverting Pollution and Queering Hormone Disruption." *O-Zone* 1: 1–12.

Ahmad, Aalya. 2015. "Feminism beyond the Waves." *Briarpatch*, July–August. https://briarpatchmagazine.com/articles/view/feminism-beyond-the-waves.

Ahmed, Sara. 2006. *Queer Phenomenology: Orientations, Objects, Others*. Durham, NC: Duke University Press.

Ahsan, Reazul, Hajime Nakagawa, Kenji Kawaike, Masakazu Hashimoto, et al. 2019. "Informing and Involving the Flood Exposed Community in Fulcharri Upazila at Ghaibandha District Bangladesh on Flood Risks and Mitigation." *Disaster Prevention Research Institute Annual*, no. 62B. https://www.dpri.kyoto-u.ac.jp/nenpo/no62/ronbunB/a62b0p30.pdf.

Aiyar, Sana. 2020. "Colonialism's Afterlives and Invocations of Oceanic History." In *Indian Ocean Current: Six Artistic Narratives*, edited by Prasannan Parthasarathi, 75–83. Boston: McMullen Museum of Art, Boston College.

Alaimo, Stacy. 2016. *Exposed: Environmental Politics and Pleasures in Posthuman Times*. Minneapolis: University of Minnesota Press.

Alaimo, Stacy. 2017. "The Anthropocene at Sea: Temporality, Paradox, Compression." In *The Routledge Companion to the Environmental Humanities*, edited by Ursula K. Heise, Jon Christensen, and Michelle Niemann, 153–61. London: Routledge.

Alam, Mohammad-Reza. 2012. "Broadband Cloaking in Stratified Seas." *Physical Review Letters* 108: 084502.

Alarcon, Francisco, 2019. "Water Games: An Archaeology of the Representation of Water in Video Games." https://watercgi.com/.

Alarcon, Francisco, and Stefan Helmreich. 2020. "Ocean Amplification: Rising Waves and North-South Asymmetries." *Strelka*, June 30. https://strelkamag.com/en/article/ocean-amplification-rising-waves-and-north-south-asymmetries. Reposted at https://mail.archiecho.com/ocean-amplification-rising-waves-and-north-south-asymmetries after Russian invasion of Ukraine.

Aleem, A. A. 1967. "Concepts of Currents, Tides and Winds among Medieval Arab Geographers in the Indian Ocean." *Deep-Sea Research* 14, no. 4: 459–63.

Alexander, Meena. 2018. "Fragment in Praise of the Book." In *Atmospheric Embroidery*, by Meena Alexander, 42. Evanston: Northwestern University Press.

Alford, Matthew H., Jennifer A. MacKinnon, Zhongxiang Zhao, Robert Pinkel, et al. 2007. "Internal Waves across the Pacific." *Geophysical Research Letters* 34, no. 24. https://doi.org/10.1029/2007GL031566.

Alford, Matthew H., Thomas Peacock, Jennifer A. MacKinnon, Jonathan D. Nash, et al. 2015. "The Formation and Fate of Internal Waves in the South China Sea." *Nature* 521: 65–69.

Al Hosani, Naeema. 2005. "Arab Wayfinding on Land and at Sea: An Historical Comparison of Traditional Navigation Techniques." Master of arts thesis in geography, University of Kansas, Lawrence.

Alpers, Edward A. 2014. *The Indian Ocean in World History*. Oxford: Oxford University Press.

Alves, José Henrique. 1992. "O encanto e a fúria das ondas bizarras." *O Globo*, August 30, 38.
Amrith, Sunil. 2018. *Unruly Waters: How Rains, Rivers, Coasts, and Seas Have Shaped Asia's History.* New York: Basic Books.
Amrith, Sunil. 2020. "Climate Change and the Future of the Indian Ocean." In *Indian Ocean Current: Six Artistic Narratives*, edited by Prasannan Parthasarathi, 141–50. Boston: McMullen Museum of Art, Boston College.
Anand, Nikhil. 2020. "Before the Next Disaster: What Mumbai Needs to Learn from Cyclone Nisarga." *Indian Express*, June 4. https://indianexpress.com/article/opinion/mumbai-cyclone-nisarga-lessons-6441869.
Anderson, Jon, and Kimberly Peters, eds. 2014. *Water Worlds: Human Geographies of the Ocean*. Farnham, UK: Ashgate.
Anderson, Warwick, Miranda Johnson, and Barbara Brookes, eds. 2018. *Pacific Futures: Past and Present*. Honolulu: University of Hawai'i Press.
Andrews, Tamra. 2000. *A Dictionary of Nature Myths: Legends of the Earth, Sea, and Sky*. Oxford: Oxford University Press.
Anidjar, Gil. 2011. "The Blood of Freedom." In *Experiences of Freedom in Postcolonial Literatures and Cultures*, edited by Annalisa Oboe and Shaul Bassi, 122–31. London: Routledge.
Antonello, Alessandro. 2017. "The Southern Ocean." In *Oceanic Histories*, edited by David Armitage, Alison Bashford, and Sujit Sivasundaram, 296–318. Cambridge: Cambridge University Press.
Arasaratnam, Sinnappah. 1994. *Maritime India in the Seventeenth Century*. New York: Oxford University Press.
Arnold, David. 2006. *The Tropics and the Traveling Gaze: India, Landscape, and Science, 1800–1856*. Seattle: University of Washington Press.
Asscher, Maarten. 2009. *H2Olland: Op zoek naar de bronnen van Nederland*. Amsterdam: Amsterdam University Press.
Athens, Elizabeth, Brandon K. Ruud, and Martha Tedeschi. 2017. *Coming Away: Winslow Homer and England*. New Haven, CT: Yale University Press.
Atwater, Brian F., Satoko Musumi-Rokkaku, Kenji Satake, Yoshinobu Tsuji, et al. 2005. *The Orphan Tsunami of 1700: Japanese Clues to a Parent Earthquake in North America*. Seattle: University of Washington Press.
Babanin, Alexander. 2011. *Breaking and Dissipation of Ocean Surface Waves*. Cambridge: Cambridge University Press.
Bachelard, Gaston. (1942) 1983. *Water and Dreams: An Essay on the Imagination of Matter*. Translated from the French by Edith Farrell. Dallas: Dallas Institute of Humanities and Culture.
Bachelard, Gaston. (1934) 1984. *The New Scientific Spirit*. Translated from the French by Arthur Goldhammer. Boston: Beacon.
Baehr, Leslie G. 2014. "The Waves within the Waves." *Oceanus*, December 18. https://www.whoi.edu/oceanus/feature/the-waves-within-the-waves.
Bahng, Aimee. 2019. "Pacific Pessimisms: Decolonizing Transpacific Optimism." Paper presented at the Association for Asian American Studies Annual Conference, April 25–27, Madison, WI.

Bailey, Cathryn. 1997. "Making Waves and Drawing Lines: The Politics of Defining the Vicissitudes of Feminism." *Hypatia* 12, no. 3: 17–28.

Baker-Yeboah, Sheekela, D. Randolph Watts, and Deirdre A. Byrne. 2009. "Measurements of Sea Surface Height Variability in the Eastern South Atlantic from Pressure Sensor-Equipped Inverted Echo Sounders: Baroclinic and Barotropic Components." *Journal of Atmospheric and Oceanic Technology* 26, no. 12: 2593–609.

Bakhtin, Mikhail M. 1982. *The Dialogic Imagination: Four Essays*. Translated from the Russian by Caryl Emerson and Michael Holquist. Austin: University of Texas Press.

Bakker, Maarten, Satoko Kishimoto, and Christa Nooy. 2017. *Social Justice at Bay: The Dutch Role in Jakarta's Coastal Defence and Land Reclamation*. Report, Transnational Institute, April 21. https://www.tni.org/en/publication/social-justice-at-bay.

Ballestero, Andrea. 2019. *A Future History of Water*. Durham, NC: Duke University Press.

Banner, M. L., and W. K. Melville. 1976. "Separation of Air-Flow over Water-Waves." *Journal of Fluid Mechanics* 77: 825–42.

Barad, Karen. 2008. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham, NC: Duke University Press.

Barad, Karen. 2014. "Diffracting Diffraction: Cutting Together-Apart." *Parallax* 20, no. 3: 168–87.

Barad, Karen. 2019. "After the End of the World: Entangled Nuclear Colonialisms, Matters of Force, and the Material Force of Justice." *Theory & Event* 22, no. 3: 524–50.

Barber, N. F., F. Ursell, J. Darbyshire, and M. J. Tucker. 1946. "A Frequency Analyser Used in the Study of Ocean Waves." *Nature*, no. 4010: 329–32.

Barclay, David R., Fernando Simonet, and Michael J. Buckingham. 2009. "Deep Sound: A Free-falling Sensor Platform for Depth-profiling Ambient Noise in the Deep Ocean." *Marine Technology Society Journal* 43, no. 5: 144–50.

Barker, Holly M. 2004. *Bravo for the Marshallese: Regaining Control in a Post-nuclear, Post-colonial World*. Belmont, CA: Wadsworth Learning.

Barras, Colin. 2019. "The Ocean's Tallest Waves Are Getting Taller." *Science*, April 25, www.sciencemag.org/news/2019/04/ocean-s-tallest-waves-are-getting-taller.

Barthes, Roland. (1970) 1974. *S/Z*. Translated from the French by Richard Howard. New York: Hill and Wang.

Bartusiak, Marcia. 2000. *Einstein's Unfinished Symphony: Listening to the Sounds of Space-Time*. New York: Berkley.

Bascom, Willard. 1964. *Waves and Beaches: The Dynamics of the Ocean Surface*. Garden City, NY: Anchor.

Bascom, Willard. 1988. *The Crest of the Wave: Adventures in Oceanography*. New York: Harper and Row.

Baskins, Wade, trans. and comp. 2010. *The Wisdom of Leonardo da Vinci*. New York: Philosophical Library.

Bates, Charles. 1949. "Utilization of Wave Forecasting in the Invasions of Normandy, Burma, and Japan." *Annals of the New York Academy of Sciences* 51, no. 3: 545–72.
Battaglia, Debbora. 2012. "Coming in at an Unusual Angle: Exo-surprise and the Fieldworking Cosmonaut." *Anthropological Quarterly* 85, no. 4: 1089–106.
Battjes, Jurjen. 1972. "Long-term Wave Height Distribution at Seven Stations around the British Isles." *Deutsche Hydrographische Zeitschrift* 25, no. 4: 179–89.
Battjes, Jurjen. 1974. "Surf Similarity." *Proceedings of 14th Conference on Coastal Engineering, Copenhagen, Denmark*, edited by Morrough P. O'Brien, 466–80. New York: American Society of Civil Engineers.
Battjes, Jurjen. 1982. "Effects of Short-Crestedness on Wave Loads on Long Structures." *Applied Ocean Research* 4, no. 3: 165–72.
Battjes, Jurjen, and J. P. F. M. Janssen. 1978. "Energy Loss and Set-up due to Breaking of Random Waves." *Proceedings of 16th Conference on Coastal Engineering, Hamburg, Germany*, 569–87. New York: American Society of Civil Engineers.
Baucom, Ian. 2020. *History 4° Celsius: Search for a Method in the Age of the Anthropocene*. Durham, NC: Duke University Press.
Beach Erosion Board, Corps of Engineers. 1955. "A Magnetic Tape Wave Recorder and Energy Spectrum Analyzer for the Analysis of Ocean Wave Records." Technical Memorandum No. 58.
Bear, Laura. 2014. *Doubt, Conflict, Mediation: The Anthropology of Modern Time*. Chichester, West Sussex: John Wiley and Sons.
Beauregard. Guy. 2015. "On Not Knowing: *A Tale for the Time Being* and the Politics of Imagining Lives After March 11." *Canadian Literature* 227: 96–112.
Beck, Ulrich, Anthony Giddens, and Scott Lash. 1994. *Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order*. Stanford, CA: Stanford University Press.
Becker, J. M., M. A. Merrifield, and M. Ford. 2014. "Water Level Effects on Breaking Wave Setup for Pacific Island Fringing Reefs." *Journal of Geophysical Research: Oceans* 119, no. 2: 914–32.
Beer, Gillian. 1996. "Wave Theory and the Rise of Literary Modernism." In *Open Fields: Science in Cultural Encounter*, by Gillian Beer, 295–318. Oxford: Oxford University Press.
Beer, Gillian. 2014. "On Virginia Woolf 's *The Waves*." *Daedalus* 143, no. 1: 54–63.
Bell, K. L., H. L. Van Trees, B. R. Osborn, and R. E. Zarnich. 2011. "A Range-coherent Model for Discriminating Targets and Wave Clutter in High Range Resolution Surface Radar." *2011 IEEE Radar Conference: In the Eye of the Storm* (May 23–27): 740–45.
Beltrán, Héctor. Forthcoming. *Code Work: Hacking across the US/México Techno-Borderlands*. Princeton, NJ: Princeton University Press.
Benford, Gregory. 1980. *Timescape*. New York: Simon and Schuster.
Benjamin, Walter. (1940) 1968. "Theses on the Philosophy of History." In *Illuminations*, edited and with an introduction by Hannah Arendt. Translated from the German by Harry Zohn, 253–64. New York: Harcourt, Brace and World.

Bennett, Jane. 2010. *Vibrant Matter: A Political Ecology of Things*. Durham, NC: Duke University Press.

Benson, Keith R., and Philip F. Rehbock, eds. 2002. *Oceanographic History: The Pacific and Beyond*. Seattle: University of Washington Press.

Ben-Yehoyada, Naor. 2017. *The Mediterranean Incarnate: Region Formation between Sicily and Tunisia since World War II*. Chicago: University of Chicago Press.

Bergson, Henri. (1907) 1911. *Creative Evolution*. Translated from the French by Arthur Mitchell. New York: Henry Holt.

Bergson, Henri. (1934) 1946. *The Creative Mind: An Introduction to Metaphysics*. Translated from the French by Mabelle L. Andison. New York: Philosophical Library.

Best, Stephen, and Sharon Marcus. 2009. "Surface Reading: An Introduction." *Representations* 108, no. 1: 1–21.

Bezgodov, Alexey, and Dmitrii Esin. 2014. "Complex Network Modeling for Maritime Search and Rescue Operations." *Procedia Computer Science* 29: 2325–35.

Bhattacharyya, Debjani. 2021. "A River Is Not a Pendulum: Sediments of Science in the World of Tides." *Isis* 112, no. 1: 141–49.

Bigelow, Henry B., and W. T. Edmondson. 1947. *Wind Waves at Sea, Breakers and Surf*. Washington, DC: US Government Printing Office.

Bijker, Eco W. 1996. "History and Heritage in Coastal Engineering in the Netherlands." In *History and Heritage of Coastal Engineering*, edited by Nicholas C. Kraus, 390–412. New York: American Society of Civil Engineers.

Bijker, Wiebe. 2002. "The Oosterschelde Storm Surge Barrier: A Test Case for Dutch Water Technology, Management, and Politics." *Technology and Culture* 43, no. 3: 569–84.

Billé, Franck. 2017. "Introduction: Speaking Volumes." Theorizing the Contemporary, *Fieldsights*, October 24. https://culanth.org/fieldsights/introduction-speaking-volumes.

Bitner-Gregersen, Elzbieta M., and Anne Karin Magnusson. 2013. "Intrinsic Variability on Wave Parameters and Effect on Wave Statistics." Paper presented at Forecasting Dangerous Sea States, the Thirteenth International Workshop on Wave Hindcasting and Forecasting, Banff, AB, October 27–November 1.

Bitner-Gregersen, Elzbieta M., and Alesandro Toffoli. 2013. "Probability of Occurrence of Rogue Sea States and Consequences for Design." Paper presented at Forecasting Dangerous Sea States, the Thirteenth International Workshop on Wave Hindcasting and Forecasting, Banff, AB, October 27–November 1.

Blakemore, Bill. 1987. "Kubrick's 'Shining' Secret: Film's Hidden Horror Is the Murder of the Indian." *Washington Post*, July 12.

Bloomfield, Leonard. 1933. *Language*. New York: Henry Holt.

Blum, Hester. 2010. "The Prospect of Oceanic Studies." *Proceedings of the Modern Language Association* 125, no. 3: 670–77.

Blumenberg, Hans. (1979) 1997. *Shipwreck with Spectator: Paradigm of a Metaphor for Existence*. Translated from the German by Steven Rendall. Cambridge, MA: MIT Press.

Bock, Y., S. Wdowinski, A. Ferreti, F. Novali, and A. Fumagalli. 2012. "Recent Subsidence of the Venice Lagoon from Continuous GPS and Interferometric Syn-

thetic Aperture Radar." *Geochemistry, Geophysics, Geosystems* 13, no. 3. https://doi.org/10.1029/2011GC003976.
Boellstorff, Tom. 2016. "For Whom the Ontology Turns: Theorizing the Digital Real." *Current Anthropology* 57, no. 4: 387–98.
Bolster, W. Jeffrey. 2008. "Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500–1800." *American Historical Review* 113: 19–47.
Bolter, Jay, and Richard Grusin. 1999. *Remediation: Understanding New Media*. Cambridge, MA: MIT Press.
Bontje, Lotte E., and Jill H. Slinger. 2017. "A Narrative Method for Learning from Innovative Coastal Projects: Biographies of the Sand Engine." *Ocean and Coastal Management* 142: 186–97.
Booth, Douglas. 1999. "Surfing: The Cultural and Technological Determinants of a Dance." *Culture, Sport, Society* 2, no. 1: 36–55.
Borges, Jorge Luis. 1976. "The Book of Sand." Translated from the Spanish by Norman Thomas di Giovanni. *New Yorker*, October 25, 38–39.
Borovoy, Amy. 2016. "Robert Bellah's Search for Community and Ethical Modernity in Japan Studies." *Journal of Asian Studies* 75, no. 2: 467–94.
Bose, Sugata. 2006. *A Hundred Horizons: The Indian Ocean in the Age of Global Empire*. Cambridge, MA: Harvard University Press.
Bosscher, Frans, and Margot Maljaars. 2017. *Het Waterloopbos*. Wageningen, Netherlands: Blauwdruck.
Bould, Mark. 2021. *The Anthropocene Unconscious: Climate Catastrophe Culture*. London: Verso.
Bowen, David. n.d. "Telepresent Water." David Bowen artist website: https://www.dwbowen.com/telepresentwater.
Bowker, Geoffrey. 2005. *Memory Practices in the Sciences*. Cambridge, MA: MIT Press.
boyd, danah, and Kate Crawford. 2012. "Critical Questions for Big Data." *Information, Communication and Society* 15, no. 5: 662–79.
Braidotti, Rosi. 2013. *The Posthuman*. Cambridge: Polity.
Brathwaite, Kamau. 1999. *Conversations with Nathaniel Mackey*. Staten Island, NY: We.
Bratton, Benjamin. 2015. *The Stack: On Software and Sovereignty*. Cambridge, MA: MIT Press.
Braverman, Irus. 2018. *Coral Whisperers: Scientists on the Brink*. Berkeley: University of California Press.
Bremner, Lindsay, ed. 2018. *Monsoon [+ other] Waters*. London: Monsoon Assemblages.
Briggs, John, and Joanne Sharp. 2004. "Indigenous Knowledges and Development: A Postcolonial Caution." *Third World Quarterly* 25, no. 4: 661–76.
Briggs, M. J., H. Yeh, and D. T. Cox. 2010. "Physical Modeling of Tsunami Waves." In *Handbook of Coastal and Ocean Engineering*, edited by Y. C. Kim, 1073–1105. Singapore: World Scientific.
Brinkema, Eugenie. 2014. *The Forms of the Affects*. Durham, NC: Duke University Press.

Bronson, Earl D., and Larry Glosten. 1985. "FLIP: FLoating Instrument Platform." Scripps Institution of Oceanography Reference 85–21. Office of Naval Research and Naval Sea Systems Command, October.

Brøvig-Hanssen, Ragnhild, and Anne Danielsen. 2016. *Digital Signatures: The Impact of Digitization on Popular Music Sound*. Cambridge, MA: MIT Press.

Brown, Able. 2011. "BS'N All the Time." *Surfer's Journal*, online journal entry, October 13, www.surfersjournal.com/journal_entry/bs%E2%80%99n-all-time, available via Internet Archive Wayback Machine; last snapshotted December 16, 2011.

Brown, William. 2013. *Supercinema: Film-Philosophy for the Digital Age*. New York: Berghahn.

Brugidou, Jeremie, and Clouette Fabien. 2018. "'AnthropOcean': Oceanic Perspectives and Cephalopodic Imaginaries Moving beyond Land-centric Ecologies." *Social Science Information* 57, no. 3: 359–85.

Bryant, Rebecca. 2016. "On Critical Times: Return, Repetition, and the Uncanny Present." *History and Anthropology* 27, no. 1: 19–31.

Bryant, Rebecca, and Daniel M. Knight. 2019. *The Anthropology of the Future*. Cambridge: Cambridge University Press.

Bryld, Mette. 1996. "Dialogues with Dolphins and Other Extraterrestrials: Displacements in Gendered Space." In *Between Monsters, Goddesses, and Cyborgs: Feminist Confrontations with Science, Medicine, and Cyberspace*, edited by Nina Lykke and Rosi Braidotti, 47–71. London: Zed.

Buckley, Marc P., and Fabrice Veron. 2019. "The Turbulent Airflow over Wind Generated Surface Waves." *European Journal of Mechanics-B/Fluids* 73 (January): 132–43.

Bulkens, Maartje, Hamzah Muzaini, and Claudio Minca. 2016. "Dutch New Nature: (Re)landscaping the Millingerwaard." *Journal of Environmental Planning and Management* 59, no. 5: 808–25.

Burnett, D. Graham. 2011. "Self-Recording Seas." In *Oceanomania: Souvenirs of Mysterious Seas from the Expedition to the Aquarium: A Mark Dion Project*, 134–45. Monaco: Nouveau Musée National.

Burnside, John. 2002. "History." In *The Light Trap*, by John Burnside, 40–42. London: Jonathan Cape.

Butler, Judith. 1993. *Bodies That Matter: On the Discursive Limits of "Sex."* New York: Routledge.

Bystrom, Kerry, and Isabel Hofmeyr. 2017. "Oceanic Routes: (Post-It) Notes on Hydro-Colonialism." *Comparative Literature* 69, no. 1: 1–6.

Calliari, Elisa, Andrea Staccione, and Jaroslav Mysiak. 2019. "An Assessment Framework for Climate-proof Nature-based Solutions." *Science of the Total Environment* 656: 691–700.

Calvino, Italo. (1983) 1985. *Mr. Palomar*. Translated from the Italian by William Weaver. Orlando, FL: Harcourt.

Calvino, Italo. (1967) 1969. "Blood, Sea." In *t zero*, by Italo Calvino, 39–51. Translated from the Italian by William Weaver. Orlando, FL: Harcourt.

Canetti, Elias. (1960) 1962. *Crowds and Power*. Translated from the German by Carol Stewart. London: Gollancz.

Carr, E. Summerson, and Brooke Fisher. 2016. "Interscaling Awe, De-escalating Disaster." In *Scale: Discourse and Dimensions of Social Life*, edited by E. Summerson Carr and Michael Lempert, 133–56. Berkeley: University of California Press.

Carse, Ashley. 2012. "Nature as Infrastructure: Making and Managing the Panama Canal Watershed." *Social Studies of Science* 42, no. 4: 539–63.

Carson Rachel. 1951. *The Sea around Us*. Oxford: Oxford University Press.

Cartwright, David. 2010. "Waves, Surges and Tides." In *Of Seas and Ships and Scientists: The Remarkable Story of the UK's National Institute of Oceanography*, edited by Anthony Laughton, John Gould, 'Tom' Tucker, and Howard Roe, 171–80. Cambridge: Lutterworth.

Cartwright, Julyan H. E., and Hisami Nakamura. 2009. "What Kind of a Wave Is Hokusai's *Great Wave off Kanagawa*?" *Notes and Records of the Royal Society* 63, no. 2: 119–35.

Casper, Drew. 2011. *Hollywood Film 1963–1976: Years of Revolution and Reaction*. Oxford: Wiley-Blackwell.

Cassidy, Rebecca, and Molly Mullin, eds. 2007. *Where the Wild Things Are Now: Domestication Reconsidered*. Oxford: Berg.

Cassanelli, Lee, Brian Spooner, and Robert Nichols. 2002. "Cover Letter." Indian Ocean: Cradle of Globalization Summer Institute, University of Pennsylvania. http://ccat.sas.upenn.edu/indianocean/index.html.

Cavaleri, Luigi. 2000. "The Oceanographic Tower *Acqua Alta*—Activity and Prediction of Sea States at Venice." *Coastal Engineering* 39, no. 1: 29–70.

Chakrabarty, Dipesh. 2000. *Provincializing Europe: Postcolonial Thought and Historical Difference*. Princeton, NJ: Princeton University Press.

Chakrabarty, Dipesh. 2021. *The Climate of History in a Planetary Age*. Chicago: University of Chicago Press.

Chalfin, Brenda. 2015. "Governing Offshore Oil: Mapping Maritime Political Space in Ghana and the Western Gulf of Guinea." *South Atlantic Quarterly* 114, no. 1: 101–18.

Chao, Sophie, Karin Bolender, and Eben Kirksey, eds. 2022. *The Promise of Multispecies Justice*. Durham, NC: Duke University Press.

Chari, Sharad. 2019. "Subaltern Sea? Indian Ocean Errantry against Subalternization." In *Subaltern Geographies*, edited by Tariq Jazeel and Stephen Legg, 191–209. Athens: University of Georgia Press.

Chaudhuri, Ashawari. 2019. "The Kernel of Doubt: Agricultural Biotechnology, Braided Temporalities, and Agrarian Environments in India." PhD diss., Massachusetts Institute of Technology, Cambridge, MA.

Chen, Mel Y. 2012. *Animacies: Biopolitics, Racial Mattering, and Queer Affect*. Durham, NC: Duke University Press.

Cheng, Irene. 2006. "The Beavers and the Bees: Intelligent Design and the Marvelous Architecture of Animals." *Cabinet* 23. https://www.cabinetmagazine.org/issues/23/cheng.php.

Chin, Andrea. 2015. "Daan Roosegaarde Floods Amsterdam's Museumplein with Waterlicht." *Designboom*, May 13. https://www.designboom.com/art/daan-roosegaarde-waterlicht-05-13-2015.

Cho, Adrian. 2012. "Proposed Cloaking Device for Water Waves Could Protect Ships at Sea." *Science*, March 2. https://www.sciencemag.org/news/2012/03/proposed-cloaking-device-water-waves-could-protect-ships-sea.

Choi, Vivian. 2020. "Exploring the 'Unknown': Indian Ocean Materiality as Method." In *Reimagining Indian Ocean Worlds*, edited by Smriti Srinivas, Bettina Ng'weno, and Neelima Jeychandran, 227–42. London: Routledge.

Chowdhury, Piyali, Manasa Ranjan Behera, and Dominic E. Reeve. 2019. "Wave Climate Projections along the Indian Coast." *International Journal of Climatology* 39: 4531–42.

Choy, Timothy. 2011. *Ecologies of Comparison: An Ethnography of Endangerment in Hong Kong*. Durham, NC: Duke University Press.

Choy, Timothy. 2012. "Air's Substantiations." In *Lively Capital: Biotechnologies, Ethics, and Governance in Global Markets*, edited by Kaushik Sunder Rajan, 121–53. Durham, NC: Duke University Press.

Chun, Wendy Hui Kyong. 2011. *Programmed Visions: Software and Memory*. Cambridge, MA: MIT Press.

Clark, Timothy. 2012. "Scale." In *Telemorphosis: Theory in the Era of Climate Change*, vol. 1, edited by Tom Cohen, 148–66. Ann Arbor, MI: Open Humanities.

Cochran, William G., Frederick Mosteller, and John W. Tukey. 1953. "Statistical Problems of the Kinsey Report." *Journal of the American Statistical Association* 48, no. 264: 673–716.

Cody, Francis. 2020. "Wave Theory: Cash, Crowds, and Caste in Indian Elections." *American Ethnologist* 47, no. 4: 402–16.

Coen, Deborah R. 2018. *Climate in Motion: Science, Empire, and the Problem of Scale*. Chicago: University of Chicago Press.

Cohen, Ashley L. 2017. "The Global Indies: Historicizing Oceanic Metageographies." *Comparative Literature* 69, no. 1: 7–15.

Cohen, Jeffrey Jerome. 2015. *Stone: An Ecology of the Inhuman*. Minneapolis: University of Minnesota Press.

Cohen, Margaret. 2006. "Chronotopes of the Sea." In *The Novel v. 2*, edited by Franco Moretti, 647–66. Princeton, NJ: Princeton University Press.

Comer, Krista. 2010. *Surfer Girls in the New World Order*. Durham, NC: Duke University Press.

Connell, Raewyn. 2007. *Southern Theory: The Global Dynamics of Knowledge in Social Science*. Sydney: Allen and Unwin.

Connery, Christopher L. 1995. "Pacific Rim Discourse: The U.S. Global Imaginary in the Late Cold War Years." In *Asia/Pacific as Space of Cultural Production*, edited by Rob Wilson and Arif Dirlik, 30–56. Durham, NC: Duke University Press.

Connolly, William. 2017. *Facing the Planetary: Entangled Humanism and the Politics of Swarming*. Durham, NC: Duke University Press.

Cons, Jason. 2018. "Staging Climate Security: Resilience and Heterodystopia in the Bangladesh Borderlands." *Cultural Anthropology* 33, no. 2: 266–94.

Consolandi, Pietro. 2020. "Our Wooden Shelter: Mangrove Forests along the Coasts of India." Ocean-Archive.org. https://ocean-archive.org/collection/119.
Coole, Diana, and Samantha Frost, eds. 2010. *New Materialisms: Ontology, Agency, and Politics*. Durham, NC: Duke University Press.
Corbin, Alain. (1988) 1995. *The Lure of the Sea: The Discovery of the Seaside in the Western World 1750–1840*. Translated from the French by Jocelyn Phelps. Harmondsworth, UK: Penguin.
Cornish, Vaughn. 1934. *Ocean Waves and Kindred Geophysical Phenomena.* Cambridge: Cambridge University Press.
Cornwall, Warren. 2018. "As Sea Levels Rise, Bangladeshi Islanders Must Decide between Keeping the Water Out—or Letting It In." *Science*, March 1. https://www.sciencemag.org/news/2018/03/sea-levels-rise-bangladeshi-islanders-must-decide-between-keeping-water-out-or-letting.
Cox, Geoff, and Jacob Lund. 2021. "Time.now." In *Uncertain Archives: Critical Keywords for Big Data*, edited by Nanna Bonde Thylstrup, Daniela Agostinho, Annie Ring, Catherine D'Ignazio, and Kristin Veel, 523–31. Cambridge, MA: MIT Press.
Craik, Alex D. D. 2004. "The Origins of Water Wave Theory." *Annual Review of Fluid Mechanics* 36: 1–28.
Crary, Jonathan. 2001. *Suspensions of Perception: Attention, Spectacle, and Modern Culture*. Cambridge, MA: MIT Press.
Creado, Eliana Santos Junqueira, and Stefan Helmreich. 2018. "A Wave of Mud: The Travel of Toxic Water, from Bento Rodrigues to the Brazilian Atlantic." *Revista do Instituto de Estudos Brasileiros* 69: 33–51.
Crucefix, Martyn, and Amel Alzakout. 2019. *Cargo of Limbs*. London: Hercules.
Crutzen, Paul J., and Eugene F. Stoermer. 2000. "The 'Anthropocene.'" *Global Change Newsletter* 41: 17–18.
Cullen, Beth, and Christina Leigh Geros. 2020. "Constructing the Monsoon: Colonial Meteorological Cartography, 1844–1944." *History of Meteorology* 9: 1–26.
Cusack, Tricia. 2014. *Framing the Ocean, 1700 to the Present: Envisaging the Sea as Social Space*. London: Routledge.
Dabydeen, David. 1995. *Turner: New and Selected Poems*. London: Jonathan Cape.
Dados, Nour, and Raewyn Connell. 2012. "The Global South." *Contexts* 11, no. 1: 12–13.
Darrieussecq, Marie. 2008. *Précisions sur les vagues*. Paris: P.O.L.
Darrigol, Olivier. 2003. "The Spirited Horse, the Engineer, and the Mathematician: Water Waves in Nineteenth-Century Hydrodynamics." *Archive for History of the Exact Sciences* 58: 21–95.
Dasgupta, Ashin, and Michael Pearson, eds. 1987. *India and the Indian Ocean*. Calcutta: Oxford University Press.
Daston, Lorraine. 1992. "Objectivity and the Escape from Perspective." *Social Studies of Science* 22, no. 4: 597–618.
Daston, Lorraine, and Peter Galison. 2007. *Objectivity*. New York: Zone Books.
Datawell BV. 2001. "History of Datawell." Brochure, Datawell BV website, n.d. Accessed June 16, 2022. http://www.datawell.nl/Portals/0/Documents/Brochures/datawell_brochure_history_b-13-01.pdf.

Davenant, Charles. (1698) 1771. "Discourses on the Public Revenue and on the Trade of England." In *The Political and Commercial Works of That Celebrated Writer Charles D'avenant, Collected and Revised by Sir Charles Whitworth*, vol. 1, 127–459. London: R. Horsfield.

Davies, Sarah R. 2021. "Atmospheres of Science: Experiencing Scientific Mobility." *Social Studies of Science* 5, no. 2: 214–32.

Davis, Adam. 2014. "Never Quite the Right Size: Scaling the Digital in CG Cinema." *Animation* 9, no. 2: 124–37.

Davis, Heather. 2022. *Plastic Matter*. Durham, NC: Duke University Press.

Davis, Heather, and Etienne Turpin, eds. 2015. *Art in the Anthropocene: Encounters among Aesthetics, Politics, Environments, and Epistemologies*. London: Open Humanities.

Davis, Mike. 2017. *Late Victorian Holocausts: El Niño Famines and the Making of the Third World*. New York: Verso.

Davis, Robert, and Garry R. Marvin. 2004. *Venice, the Tourist Maze: A Cultural Critique of the World's Most Touristed City*. Berkeley: University of California Press.

Dawson, Kevin. 2018. *Undercurrents of Power: Aquatic Culture in the African Diaspora*. Philadelphia: University of Pennsylvania Press.

Day, Deborah. 1997. "Helen Hill Raitt Biography." La Jolla, CA: University of California, San Diego, Libraries. https://library.ucsd.edu/scilib/biogr/Raitt_Helen_Biogr.pdf.

Day, Deborah. 1999. "Overview of the History of Women at Scripps Institution of Oceanography." *UC San Diego: Library—Scripps Digital Collection*. https://escholarship.org/uc/item/85t1s746.

Deacon, Margaret. 1971. *Scientists and the Sea, 1650–1900*. Aldershot, UK: Ashgate.

Deacon, Margaret. 1984. "The Biggest Wave." *Folklore* 95, no. 2: 254–55.

Deacon, Margaret, Tony Rice, and Colin Summerhayes, eds. 2001. *Understanding the Oceans*. London: UCL Press.

Dean, Robert G., and Robert A. Dalrymple. 1991. *Water Wave Mechanics for Engineers and Scientists*. Singapore: World Scientific.

Deane, Grant B., Dale Stokes, and Adrian H. Callaghan. 2016. "Turbulence in Breaking Waves." *Physics Today* 69, no. 10: 86–87.

de Bakker, A. T. M., J. A. Brinkkemper, F. van der Steen, M. F. S. Tissier, and B. G. Ruessink. 2016. "Cross-shore Sand Transport by Infragravity Waves as a Function of Beach Steepness." *Journal of Geophysical Research: Earth Surface* 121, no. 10: 1786–99.

Decker, Julie, ed. 2014. *Gyre: The Plastic Ocean*. London: Booth-Clibborn.

De Frees, Madeline. 1983. "The Book of Sediments." *Paris Review* 89: 136–37.

de Groot, Wouter T. 1987. "Van Waterwolf tot partner: Het culturele aspect van het niuewe waterbeleid." *Milieu* 2, no. 3: 84–86.

de Jong, Martijn P. C., and Jurjen Battjes. 2004. "Analysis and Prediction of Seiches in Rotterdam Harbor Basins." *Proceedings of 29th Conference on Coastal Engineering, Lisbon, Portugal*, edited by Jane McKee Smith, 1238–50. Singapore: World Scientific.

de la Cadena, Marisol. 2015. *Earth Beings: Ecologies of Practice across Andean Worlds.* Durham, NC: Duke University Press.
Delap, Lucy. 2011. "*The Woman's Dreadnought*: Maritime Symbolism in Edwardian Gender Politics." In *The* Dreadnought *and the Edwardian Age*, edited by Robert Blythe, Andrew Lambert, and Jan Rüger, 95–108. Farnham, UK: Ashgate.
Deleuze, Gilles (1985) 1995. "Mediators." In *Negotiations: 1972–1990*. Translated from the French by Martin Joughin, 121–34. New York: Columbia University Press.
Deleuze, Gilles. (1983) 1986. *Cinema 1: The Movement-Image*. Translated from the French by Hugh Tomlinson and Barbara Habberjam. Minneapolis: University of Minnesota Press.
Deleuze, Gilles. (1985) 1989. *Cinema 2: The Time-Image*. Translated from the French by Hugh Tomlinson and Robert Galeta. Minneapolis: University of Minnesota Press.
Deleuze, Gilles, and Félix Guattari. (1980) 1987. *A Thousand Plateaus: Capitalism and Schizophrenia*. Translated from the French by Brian Massumi. Minneapolis: University of Minnesota Press.
DeLoughrey, Elizabeth. 2017. "The Oceanic Turn: Submarine Futures of the Anthropocene." *Comparative Literature* 69, no. 1: 32–44.
DeLoughrey, Elizabeth. 2019. *Allegories of the Anthropocene*. Durham, NC: Duke University Press.
Dening, Greg. 2002. "Performing on the Beaches of the Mind." *History and Theory* 41, no. 1: 1–24.
DeNoon, Daniel J. 2007. "ICD Gap for Women, African-Americans," *WebMD*, posted October 2. https://www.webmd.com/heart-disease/news/20071002/icd-gap-for-women-and-african-americans.
Deraniyagala, Sonali. 2013. *Wave*. New York: Knopf.
Desrosières, Alain. 2002. *The Politics of Large Numbers: A History of Statistical Reasoning*. Translated from the French by Camille Naish. Cambridge, MA: Harvard University Press.
de Vriend, Huib J., and Mark van Koningsveld. 2012. *Building with Nature: Thinking, Acting and Interacting Differently*. Dordrecht: Ecoshape.
Dewan, Camelia. 2020. "Living with Toxic Development." *Anthropology Today* 36, no. 6: 9–12.
Dewan, Camelia. 2021. *Misreading the Bengal Delta: Climate Change, Development, and Livelihoods in Coastal Bangladesh*. Seattle: University of Washington Press.
Dewan, Camelia. 2022. "'Climate Change as a Spice': Brokering Environmental Knowledge in Bangladesh's Development Industry." *Ethnos* 87, no. 3: 538–59.
Dewan, Camelia, Aditi Mukherji, and Marie-Charlotte Buisson. 2015. "Evolution of Water Management in Coastal Bangladesh: From Temporary Earthen Embankments to Depoliticized Community-Managed Polders." *Water International* 40, no. 3: 401–16.
De Wolff, Kim. 2017. "Plastic Naturecultures: Multispecies Ethnography and the Dangers of Separating Living from Nonliving Bodies." *Body & Society* 23, no. 3: 23–47.

De Wolff, Kim, Rina C. Faletti, and Ignacio López-Calvo, eds. 2021. *Hydrohumanities: Water Discourse and Environmental Futures.* Berkeley: University of California Press.

Dick, Stephanie. 2020. "Coded Conduct: Making MACSYMA Users and the Automation of Mathematics." *British Journal for the History of Science Themes* 5: 205–24.

Di Maio, Alessandra 2013. "The Mediterranean, or Where Africa Does (Not) Meet Italy: Andrea Segre's *A Sud di Lampedusa* (2006)." In *The Cinemas of Italian Migration: European and Transatlantic Narratives*, edited by Sabine Schrader and Daniel Winkler, 41–52. Newcastle upon Tyne: Cambridge Scholars.

DiNitto, Rachel. 2014. "Narrating the Cultural Trauma of 3/11: The Debris of Post-Fukushima Literature and Film." *Japan Forum* 26, no. 3: 340–60.

Disco, Cornelis. 2002. "Remaking 'Nature': The Ecological Turn in Dutch Water Management." *Science, Technology, & Human Values* 27, no. 2: 206–35.

Donovan, Stephen. 2013. "Shockwaves: The Interrupted Sea-Journeys of Rudyard Kipling and Morgan Robertson." *Forum for Modern Language Studies* 49, no. 4: 393–405.

Draper, Laurence. 1996. "The History of Wave Research at Wormley, a Personal View." *Ocean Challenge* 6, no. 2: 24–27.

Drenthen, Martin. 2009. "Developing Nature along Dutch Rivers: Place or Non-place." In *New Visions of Nature: Complexity and Authenticity,* edited by Martin Drenthen, Jozef Keulartz, and James Proctor, 205–28. Dordrecht: Springer Netherlands.

Dua, Jatin. 2013. "A Sea of Trade and a Sea of Fish: Piracy and Protection in the Western Indian Ocean." *Journal of East African Studies* 7, no. 2: 353–70.

Duane, Daniel. 2019. "The Long, Strange Tale of California's Surf Nazis." *New York Times*, September 28. https://www.nytimes.com/2019/09/28/opinion/sunday/surf-racism.html.

Du Bois, W. E. B. 1903. *The Souls of Black Folk*. Chicago: A. C. McClurg.

Du Bois, W. E. B. 1920. "The Souls of White Folk." In *Darkwater: Voices from Within the Veil*, by W. E. B. Du Bois, 29–52. New York: Harcourt, Brace and Howe.

Dudley, John M., Véronique Sarano, and Frédéric Dias. 2013. "On Hokusai's *Great Wave off Kanagawa*: Localization, Linearity and a Rogue Wave in Sub-Antarctic Waters." *Notes and Records of the Royal Society* 67, no. 2: 159–64.

Dupuy, Jean-Pierre. 2005 (2015). *A Short Treatise on the Metaphysics of Tsunamis*. Translated from the French by Malcolm B. DeBevoise. East Lansing: Michigan State University Press.

Durkheim, Émile. (1897) 1951. *Suicide: A Study in Sociology*. Translated from the French by John A. Spaulding and George Simpson. New York: Free Press.

Eckstein, Lars, and Anja Schwarz. 2019. "The Making of Tupaia's Map: A Story of the Extent and Mastery of Polynesian Navigation, Competing Systems of Wayfinding on James Cook's *Endeavour*, and the Invention of an Ingenious Cartographic System." *Journal of Pacific History* 54, no. 1: 1–95.

ECMWF (European Center for Medium-Range Weather Forecasts). n.d. "Ocean Wave Model High Resolution 10-Day Forecast (Set II—HRES-WAM), https://www.ecmwf.int/en/forecasts/datasets/set-ii.

Edwards, Paul. 1996. *The Closed World: Computers and the Politics of Discourse in the Cold War America*. Cambridge, MA: MIT Press.

Edwards, Paul. 2010. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge, MA: MIT Press.

Eeltink, D., H. Branger, C. Luneau, and Y. He et al. 2022. "Nonlinear Wave Evolution with Data-driven Breaking." *Nature Communications* 13. https://doi.org/10.1038/s41467-022-30025-z.

Ehrenreich, Barbara. 1987. "Foreword." In *Male Fantasies, Volume 1: Women, Floods, Bodies, History*, by Klaus Theweleit, ix–xvii. Minneapolis: University of Minnesota Press.

Elliott, Ralph Nelson. (1938) 1994. *The Wave Principle*, reprinted in *R.N. Elliott's Masterworks: The Definitive Collection*, edited by Robert R. Prechter Jr., 85–151. Gainesville, GA: New Classics Library.

Emmelhainz, Irmgard. 2015. "Conditions of Visuality under the Anthropocene and Images of the Anthropocene to Come." *e-flux*, no. 63. https://www.e-flux.com/journal/63/60882/conditions-of-visuality-under-the-anthropocene-and-images-of-the-anthropocene-to-come/.

Engelstad, A., B. G. Ruessink, D. Wesselman, P. Hoekstra, et al. 2017. "Observations of Waves and Currents during Barrier Island Inundation." *Journal of Geophysical Research: Oceans* 122, no. 4: 3152–69.

Environmental Solutions Initiative. 2020. "'The Emerald Tutu' Wins NSF Grant for Design to Protect Boston's Coastline." *MIT News*, September 2. https://news.mit.edu/2020/emerald-tutu-design-wins-nsf-grant-protect-boston-coastline-0903.

Eshun, Kodwo. 1998. *More Brilliant Than the Sun: Adventures in Sonic Fiction*. London: Quartet.

Evers, Clifton. 2009. "'The Point': Surfing, Geography and a Sensual Life of Men and Masculinity on the Gold Coast, Australia." *Social & Cultural Geography* 10, no. 8: 893–908.

Fabian, Johannes. 1983. *Time and the Other: How Anthropology Makes Its Object*. New York: Columbia University Press.

Farbotko, Carol. 2010. "Wishful Sinking: Disappearing Islands, Climate Refugees and Cosmopolitan Experimentation." *Asia Pacific Viewpoint* 51, no. 1: 47–60.

Farmer, Ricky J. 1992. "Surfing: Motivations, Values, and Culture." *Journal of Sport Behaviour* 15, no. 3: 241–57.

Fay, Jennifer. 2018. *Inhospitable World: Cinema in the Time of the Anthropocene*. Oxford: Oxford University Press.

Feeley-Harnik, Gillian. 2021. "Lewis Henry Morgan: American Beavers and Their Works." *Ethnos* 86, no. 1: 21–43.

Fehskens, Erin M. 2012. "Accounts Unpaid, Accounts Untold: M. NourbeSe Philip's *Zong!* and the Catalog." *Callaloo* 35, no. 2: 407–24.

Felkin, Robert. 1889. *On the Geographical Distribution of Some Tropical Diseases*. Edinburgh: Young J. Pentland.

Fenton, John. 1985. "A Fifth-Order Stokes Theory for Steady Waves." *Journal of Waterway, Port, Coastal, and Ocean Engineering* 111, no. 2: 216–34.

Ferrel, David. 1992. "Off Palos Verdes, a DDT Dumping Ground Lingers." *Los Angeles Times*, September 9. http://articles.latimes.com/1992-09-09/news/mn-117_1_palos-verdes.

Ferré, Bénédicte, Christopher R. Sherwood, and Patricia L. Wiberg. 2010. "Sediment Transport on the Palos Verdes Shelf, California." *Continental Shelf Research* 30: 761–80.

Filipe, Angela, Alicia Renedo, and Cicely Marston. 2017. "The Co-production of What? Knowledge, Values, and Social Relations in Health Care." *PLOS Biology* 15, no. 5: e2001403.

Finkbeiner, Ann. 2015. "The Great Quake and the Great Drowning." *Hakai Magazine*, September 14. http://www.hakaimagazine.com/article-long/great-quake-and-great-drowning.

Finney, Ben. 2003. *Sailing in the Wake of the Ancestors: Reviving Polynesian Voyaging*. Honolulu: Bishop Museum Press.

Finney, Ben, and James D. Houston. 1996. *Surfing: A History of the Ancient Hawaiian Sport*. Rohnert Park, CA: Pomegranate Artbooks.

Fisch, Michael. 2021. "Staging Encounters with the End in Pre-Apocalyptic-Post-3.11 Japan." *Ethnos* (May). https://doi.org/10.1080/00141844.2020.1867608.

Fisch, Michael. 2022. "Japan's Extreme Infrastructure: Fortress-ification, Resilience, and Extreme Nature." *Social Science Japan Journal* 25, no. 2: 331–52.

Fisher, Fred H., and Fred Spiess. 1963. "Flip—FLoating Instrument Platform." *Journal of the Acoustical Society of America* 35, no. 10: 1633–44.

Fisher, R. A. 1937. "The Wave of Advance of Advantageous Genes." *Annals of Eugenics* 7: 355–69.

Fletcher, C. A., and T. Spencer, eds. 2005. *Flooding and Environmental Challenges for Venice and Its Lagoon: State of Knowledge*. Cambridge: Cambridge University Press.

Flikke, Rune. 2018. "Domestication of Air, Scent, and Disease." In *Domestication Gone Wild: Politics and Practices of Multispecies Relations*, edited by Heather Anne Swanson, Marianne Elisabeth Lien, and Gro B. Ween, 176–95. Durham, NC: Duke University Press.

Forbes, Vivian L. 1995. *The Maritime Boundaries of the Indian Ocean Region*. Chicago: University of Chicago Press.

Ford, Nick, and David Brown. 2006. *Surfing and Social Theory: Experience, Embodiment, and Narrative of the Dream Glide*. New York: Routledge.

Forensic Architecture. 2020. "Shipwreck at the Threshold of Europe, Lesvos, Aegean Sea," February 19. https://forensic-architecture.org/investigation/shipwreck-at-the-threshold-of-europe.

Fortun, Mike. 2023. *Genomics with Care: Minding the Double Binds of Science*. Durham, NC: Duke University Press.

Fortun, Mike, and Herbert J. Bernstein. 1998. *Muddling Through: Pursuing Science and Truths in the Twenty-first Century*. Washington, DC: Counterpoint.

Fortun, Mike, and Kim Fortun. 2005. "Scientific Imaginaries and Ethical Plateaus in Contemporary US Toxicology." *American Anthropologist* 107, no. 1: 43–54.

Frake, Charles. 1995. "A Reinterpretation of the Micronesian 'Star Compass.'" *Journal of the Polynesian Society* 104, no. 2: 147–58.
Frich, Morten, and Sille Veilmark. 2017. "Manden i bølgerne." *Information*. https://www.information.dk/mofo/manden-boelgerne.
Frijlink, H. C. 1963. "Activities of Dutch Engineers Abroad." In *Selected Aspects of Hydraulic Engineering*, edited by A. A. Van Douwen, 71–95. Delft, Netherlands: Technological University of Delft.
Fritz, Angela. 2019. "The National Weather Service Is 'Open,' but Your Forecast Is Worse Because of the Shutdown." *Washington Post*, January 7. https://www.washingtonpost.com/weather/2019/01/07/national-weather-service-is-open-your-forecast-is-worse-because-shutdown/.
Fritz, Hermann M., David A. Phillips, Akio Okayasu, Takenori Shimozono, et al. 2012. "The 2011 Japan Tsunami Current Velocity Measurements from Survivor Videos at Kesennuma Bay Using LiDAR." *Geophysical Research Letters* 39, no. 7. https://doi.org/10.1029/2011GL050686
Frost, Mark. 2010. "'The Guilty Ship': Ruskin, Turner and Dabydeen." *Journal of Commonwealth Literature* 45, no. 3: 371–88.
Frost, Mark Ravinder. 2010. "'That Great Ocean of Idealism': Calcutta, the Tagore Circle, and the Idea of Asia, 1900–1920." In *Indian Ocean Studies: Cultural, Social, and Political Perspectives*, edited by Shanti Moorthy and Ashraf Jamal, 251–79. London: Routledge.
Gabrys, Jennifer. 2016. *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet*. Minneapolis: University of Minnesota Press.
Gabrys, Jennifer, and Helen Pritchard. 2018. "Sensing Practices." In *Posthuman Glossary*, edited by Rosi Braidotti and Maria Hlavajova, 394–95. London: Bloomsbury.
Galbraith, Kate. 2015. "Walter Munk, the 'Einstein of the Oceans.'" *New York Times*, August 24. https://www.nytimes.com/2015/08/25/science/walter-munk-einstein-of-the-oceans-at-97.html.
Galison, Peter. 1997. *Image and Logic: A Material Culture of Microphysics*. Chicago: University of Chicago Press.
Gandorfer, Daniela. 2016. "Deleuze & Guattari's *A Thousand Plateaus*, Law, and Synesthesia." *Nietzsche 13/13* (blog), November 5. http://blogs.law.columbia.edu/nietzsche1313/daniela-gandorfer-deleuze-guatarris-a-thousand-plateaus-law-and-synesthesia.
Gandorfer, Daniela. 2019. "Reading Law: A Beginner's Guide to the Manual of How to Read the Book of Law Yet to Come." In *Law and New Media: West of Everything*, edited by Christian Delage, Peter Goodrich, and Marco Wan, 222–45. Edinburgh: Edinburgh University Press.
Gardner, Robert. 1972. *The Art of Body Surfing.* New York: Chilton.
Garrett, Christopher, and Walter Munk. 1972. "Space-Time Scales of Internal Waves." *Geophysical Fluid Dynamics* 2: 225–64.
Garrett, Christopher, and Walter Munk. 1979. "Internal Waves in the Ocean." *Annual Review of Fluid Mechanics* 11: 339–69.

Garrison, Ednie Kaeh. 2005. "Are We on a Wavelength Yet? On Feminist Oceanography, Radios, and Third Wave Feminism." In *Different Wavelengths: Studies of the Contemporary Women's Movement*, edited by Jo Reger, 237–56. New York: Routledge.

Garrison, Tom. 2005. *Oceanography: An Invitation to Marine Science*, 5th ed. Belmont, CA: Thomson Brooks/Cole.

Gearey, Mary. 2018. "Chronos and Kairos: Time, Water, Memory and the Wayfaring Riverbank." In *Monsoon [+ other] Waters*, edited by Lindsay Bremner, 155–66. London: Monsoon Assemblages.

Gell, Alfred. 1996. "Vogel's Net: Traps as Artworks and Artworks as Traps." *Journal of Material Culture* 1, no. 1: 15–38.

Genz, Joseph. 2016. "Resolving Ambivalence in Marshallese Navigation: Relearning, Reinterpreting, and Reviving the 'Stick Chart' Wave Models." *Structure and Dynamics* 9, no. 1: 8–40.

Genz, Joseph. 2017. "Without Precedent: Shifting Protocols in the Use of Rongelapese Navigational Knowledge." *Journal of the Polynesian Society* 126, no. 2: 209–32.

Genz, Joseph, Jerome Aucan, Mark Merrifield, and Ben Finney et al. 2009. "Wave Navigation in the Marshall Islands: Comparing Indigenous and Western Scientific Knowledge of the Ocean." *Oceanography* 22, no. 2: 234–45.

Gerstner, Franz. 1804. *Theorie der Wellen*. Prague: Gottlieb Haase.

Gesing, Friederike. 2021. "Towards a More-than-Human Political Ecology of Coastal Protection: Coast Care Practices in Aotearoa New Zealand." *Environment and Planning E: Nature and Space* 4, no. 2: 208–29.

Ghosh, Amitav. 2004. *The Hungry Tide.* Delhi: Ravi Dayal.

Ghosh, Amitav. 2005. "Overlapping Faults." *The Hindu*, January 11, 11.

Ghosh, Amitav. 2008. "Of Fanás and Forecastles: The Indian Ocean and Some Lost Languages of the Age of Sail." *Economic and Political Weekly*, June 21, 56–62.

Ghosh, Amitav. 2016. *The Great Derangement: Climate Change and the Unthinkable*. Chicago: University of Chicago Press.

Ghosh, Amitav. 2019. *Gun Island*. New York: Farrar, Straus and Giroux.

Gibson-Graham, J. K. 2011. "A Feminist Project of Belonging for the Anthropocene." *Gender, Place & Culture* 18, no. 1: 1–21.

Gill, Tom, Brigitte Steger, and David H. Slater, eds. 2013. *Japan Copes with Calamity: Ethnographies of the Earthquake, Tsunami, and Nuclear Disasters of March 2011*. Bern: Peter Lang.

Gillis, John. 2013. "The Blue Humanities." *Humanities* 34, no. 3. https://www.neh.gov/humanities/2013/mayjune/feature/the-blue-humanities.

Gilroy, Paul. 1993. *The Black Atlantic: Modernity and Double Consciousness*. Cambridge, MA: Harvard University Press.

Gilroy, Paul. 2018. "'Where Every Breeze Speaks of Courage and Liberty': Offshore Humanism and Marine Xenology, or, Racism and the Problem of Critique at Sea Level." *Antipode* 50, no. 1: 3–22.

Glassie, Alison, 2020. "Ruth Ozeki's Floating World: *A Tale for the Time Being*'s Spiritual Oceanography." *Novel: A Forum on Fiction* 53, no. 3: 452–71.

Goldman, Francisco. 2011. "The Wave." *New Yorker*, February 7, 54–60, 62–65.
Gonzalez Monserrate, Steven. 2022. "The Cloud Is Material: On the Environmental Impacts of Computation and Data Storage." *MIT Case Studies in Social and Ethical Responsibilities of Computing* (Winter [January]). https://doi.org/10.21428/2c646de5.031d4553.
Goode, Lauren. 2018. "Kelly Slater's Artificial Surf Pool Is Really Making Waves." *Wired*, September 5. https://www.wired.com/story/kelly-slaters-artificial-surf-pool-is-really-making-waves/
Good, Megan. 2016. "Shaping Japan's Disaster Heritage." In *Reconsidering Cultural Heritage in East Asia*, edited by Akira Matsuda and Luisa Elena Mengoni, 139–61. London: Ubiquity.
Goodwin, Charles. 1995. "Seeing in Depth." *Social Studies of Science* 25, no. 2: 237–74.
Gorodé, Déwé. 2004. "Wave-Song." In *Sharing as Custom Provides*, edited and translated from the French and Païci by Raylene Ramsay and Deborah Walker, 42–43. Canberra: Pandanus.
Graeber, David. 2013. *The Democracy Project: A History, a Crisis, a Movement*. New York: Spiegel and Grau.
Graff, Agnieszka, 2003. "Lost between the Waves? The Paradoxes of Feminist Chronology and Activism in Contemporary Poland." *Journal of International Women's Studies* 4, no. 2: 100–16.
Grasseni, Cristina. 2004. "Skilled Vision: An Apprenticeship in Breeding Aesthetics." *Social Anthropology* 12, no. 1: 41–55.
Gray, Ian. 2020. "Damage Functions." *e-flux Architecture*, September 2. https://www.e-flux.com/architecture/accumulation/337972/damage-functions.
Green, George. 1839. "Note on the Motion of Waves in Canals." *Transactions of the Cambridge Philosophical Society* 7: 87–96.
Greenhouse, Carol. 1989. "Just in Time: Temporality and the Cultural Legitimation of Law." *Yale Law Journal* 98, no. 8: 1631–51.
Gregory, Alice. 2013. "Mavericks: Life and Death Surfing." *n+1*, no. 17 (Fall). https://nplusonemag.com/issue-17/essays/mavericks-surf.
Groen, Pier 1949. *Zeegolven*. Netherlands: Staatsdrukkerij.
Groeneweg, Jacco, Mathijs van Ledden, and Marcel Zijlema. 2006. "Wave Transformation in Front of the Dutch Coast." *Proceedings of 30th Conference on Coastal Engineering, San Diego, California*, edited by Jane McKee Smith, 552–64. Singapore: World Scientific.
Grosz, Elizabeth. 1994. *Volatile Bodies: Toward a Corporeal Feminism*. Bloomington: Indiana University Press.
Grotius, Hugo. 1609. *Mare Liberum*. Leiden: Elzevier.
Grusin, Richard, ed. 2015. *The Nonhuman Turn*. Minneapolis: University of Minnesota Press.
Gu, Diane Yu. 2016. *Chinese Dreams? American Dreams? The Lives of Chinese Women Scientists and Engineers in the United States*. Rotterdam: Sense.
Gulev, Sergey, and Vika Grigorieva. 2004. "Last Century Changes in Ocean Wind Wave Height from Global Visual Wave Data." *Geophysical Research Letters* 31: L24302. https://doi.org/10.1029/2004GL021040.

Gullander-Drolet, Claire. 2018. "Translational Form in Ruth Ozeki's *A Tale for the Time Being*." *Journal of Transnational American Studies* 9, no. 1: 293–314.
Guth, Christine M. E. 2015. *Hokusai's Great Wave: Biography of a Global Icon*. Honolulu: University of Hawai'i Press.
Hacking, Ian. 1982. "Biopower and the Avalanche of Printed Numbers." *Humanities in Society* 5: 279–95.
Hackett, Robin. 2004. *Sapphic Primitivism: Productions of Race, Class, and Sexuality in Key Works of Modern Fiction*. New Brunswick, NJ: Rutgers University Press.
Hadjioannou, Markos. 2008. "Into Great Stillness, Again and Again: Gilles Deleuze's Time and the Constructions of Digital Cinema." *Rhizomes: Cultural Studies in Emerging Knowledge* 16. http://www.rhizomes.net/issue16/hadji.
Hage, Ghassan. 2017. *Is Racism an Environmental Threat*? Cambridge: Polity.
Hamblin, Jacob Darwin. 2005. *Oceanographers and the Cold War: Disciples of Marine Science*. Seattle: University of Washington Press.
Hameed, Ayesha. 2014. "Black Atlantis: Three Songs." In *Forensis: The Architecture of Public Truth*, edited by Forensic Architecture, 712–19. Berlin: Sternberg.
Hameed, Ayesha. 2022. "Of Sea Changes and Other Futurisms." Ioan Davies Memorial Lecture, delivered via Zoom at York University, March 21. https://www.torontomu.ca/graduate/programs/comcult/news-events/2022/03/2022-ioan-davies-memorial-lecture/.
Hamilton, Adrian. 2012. "Turner: On the Crest of a Wave." *Independent*, February 6. http://www.independent.co.uk/arts-entertainment/art/features/turner-on-the-crest-of-a-wave-6534511.html.
Hamilton, Kevin, and Ned O'Gorman. 2021. "Seeing Experimental Imperialism in the Nuclear Pacific." *Media+Environment* 3, no. 1. https://doi.org/10.1525/001c.18496.
Hamilton-Paterson, James. 2007. *Seven-Tenths: The Sea and Its Thresholds*. London: Faber and Faber.
Hance, Susan. 2014. "Tackling Ocean Trash: Turning Plastic Pollution into Art for Awareness." *Wilma: Wilmington's Successful Woman*, April. https://www.wilmamag.com/tackling-ocean-trash/.
Hansen, Mark B. N. 2004. *New Philosophy for New Media*. Cambridge, MA: MIT Press.
Haram, Linsey, James T. Carlton, Gregory M. Ruiz, and Nikolai A. Maximenko. 2020. "A Plasticene Lexicon." *Marine Pollution Bulletin* 150: 110714.
Haraway, Donna J. 1991a. "'Gender' for a Marxist Dictionary." In *Simians, Cyborgs, and Women: The Reinvention of Nature*, by Donna J. Haraway, 127–48. New York: Routledge.
Haraway, Donna J. 1991b. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective." In *Simians, Cyborgs, and Women: The Reinvention of Nature*, by Donna J. Haraway, 183–202. New York: Routledge.
Haraway, Donna J. 1992. "The Promises of Monsters: A Regenerative Politics for Inappropriate/d Others." In *Cultural Studies*, edited by Lawrence Grossberg, Cary Nelson, and Paula Treichler, 295–336. New York: Routledge.

Haraway, Donna J. 1997. *Modest_Witness@Second_Millennium.FemaleMan©_Meets_OncoMouse™: Feminism and Technoscience*. New York: Routledge.
Haraway, Donna J. 2015. "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin." *Environmental Humanities* 6: 159–65.
Hardenberg, Wilko Graf von. 2020. "Measuring Zero at Sea: On the Delocalization and Abstraction of the Geodetic Framework." *Journal of Historical Geography* 68: 11–20.
Hardy, Penelope K., and Helen M. Rozwadowski. 2020. "Maury for Modern Times: Navigating a Racist Legacy in Ocean Science." *Oceanography* 33, no. 3: 10–15.
Hasselmann, D. E., Dunckel, M., and Ewing, J. A. 1980. "Directional Wave Spectra Observed during JONSWAP 1973." *Journal of Physical Oceanography* 10: 1264–80.
Hasselmann, Klaus. 1962. "On the Nonlinear Energy Transfer in a Gravity-Wave Spectrum, Part 1: General Theory." *Journal of Fluid Mechanics* 12: 481–500.
Hasselmann, K., T. P. Barnett, E. Bouws, H. Carlson, et al. 1973. *Measurements of Wind-Wave Growth and Swell Decay during the Joint North Sea Wave Project (JONSWAP)*. Hamburg: Deutsches Hydrographisches Institut.
Hastrup, Kirsten. 2018. "Water Literacy: Challenges of Living with Troubled Waters." In *Monsoon [+ other] Waters*, edited by Lindsay Bremner, 167–84. London: Monsoon Assemblages.
Hau'ofa, Epeli. 1994. "Our Sea of Islands." *Contemporary Pacific* 6, no. 1: 148–61.
Hawkes, R. 2014. "Interstellar: Behind the VFX." *The Telegraph*, December 5. http://www.telegraph.co.uk/culture/film/film-news/11274246/Interstellar-behind-the-VFX.html.
Hayashi, Michio. 2015. "Reframing the Tragedy: Lessons from Post-3/11 Japan. In *In the Wake: Japanese Photographers Respond to 3/11*, curated by Anne Nishimura Morse and Anne Havinga, 166–79. Boston: Museum of Fine Arts Publications.
Hayward, Eva. 2005. "Enfolded Vision: Refracting the Love Life of the Octopus." *Octopus* 1: 29–44.
Hayward, Eva. 2014. "Transxenoestrogenesis." *TSQ: Transgender Studies Quarterly* 1, no. 1: 255–58.
Hearn, Chester G. 2002. *Tracks in the Sea: Matthew Fontaine Maury and the Mapping of the Oceans*. Camden, ME: International Marine and McGraw Hill.
Heller, Charles, and Lorenzo Pezzani. 2012. "The Left-to-Die Boat: The Deadly Drift of a Migrants' Boat in the Central Mediterranean." Forensic Architecture, Goldsmiths, University of London. http://www.forensic-architecture.org/case/left-die-boat.
Heller, Charles, and Lorenzo Pezzani. 2014. "Liquid Traces: Investigating the Deaths of Migrants at the EU's Maritime Frontier." In *Forensis: The Architecture of Public Truth*, edited by Forensic Architecture, 657–84. Berlin: Sternberg.
Helmreich, Stefan. 1998. "Recombination, Rationality, Reductionism, and Romantic Reactions: Culture, Computers, and the Genetic Algorithm." *Social Studies of Science* 28, no. 1: 39–71.
Helmreich, Stefan. 2007. "An Anthropologist Underwater: Immersive Soundscapes, Submarine Cyborgs, and Transductive Ethnography." *American Ethnologist* 34, no. 4: 621–41.

Helmreich, Stefan. 2009. *Alien Ocean: Anthropological Voyages in Microbial Seas*. Berkeley: University of California Press.
Hemer, Mark A., Yalin Fan, Nobuhito Mori, Alvaro Semedo, and Xiaolan L. Wang. 2013. "Projected Changes in Wave Climate from a Multi-model Ensemble." *Nature Climate Change* 3: 471–76.
Henderson, Bonnie. 2014. *The Next Tsunami: Living on a Restless Coast*. Corvallis: Oregon State University Press.
Henderson, Caspar. 2014. "Why Light Inspires Ritual." *Nautilus* 11. https://nautil.us/why-light-inspires-ritual-234840/.
Henderson, Margaret. 2001. "A Shifting Line Up: Men, Women, and *Tracks* Surfing Magazine." *Continuum* 15, no. 3: 319–32.
Henriques, Julian. 2003. "Sonic Dominance and the Reggae Sound System Session." In *The Auditory Culture Reader*, edited by Michael Bull and Les Back, 451–80. Oxford: Berg.
Henry, Archdeacon of Huntingdon. (1133–55) 1996. *Historia Anglorum: The History of the English People*. Edited and translated from the Anglo-Saxon and Latin by Diana Greenway. Oxford: Clarendon.
Hereniko, Vilsoni. 1999. "Representations of Pacific Islanders in Film and Video." *Documentary Box* 14. https://www.yidff.jp/docbox/14/box14-3-e.html.
Hernandez, Adrian F., Gregg C. Fonarow, and Li Liang et al. 2007. "Sex and Racial Differences in the Use of Implantable Cardioverter-Defibrillators among Patients Hospitalized with Heart Failure." *Journal of the American Medical Association* 298, no. 13: 1525–32.
Herzog, Lena. 2014. *Strandbeest: The Dream Machines of Theo Jansen*. Cologne, Germany: Taschen.
Hessler, Stefanie, ed. 2018. *Tidalectics: Imagining an Oceanic Worldview through Art and Science*. Cambridge, MA: MIT Press.
Hetherington, Kregg, ed. 2019. *Infrastructure, Environment, and Life in the Anthropocene*. Durham, NC: Duke University Press.
Hewitt, Nancy, ed. 2010. *No Permanent Waves: Recasting Histories of U.S. Feminism*. New Brunswick, NJ: Rutgers University Press.
Hiltzik, Michael. 2017. "Trump's EPA Has Started to Scrub Climate Change Data from Its Website." *Los Angeles Times*, May 1. http://www.latimes.com/business/hiltzik/la-fi-hiltzik-epa-climate-20170501-story.html.
Hlebica, Joe, and Steve Cook. 1993. *Legacy of Exploration: Scripps Institution of Oceanography since 1903*. San Diego, CA: Scripps Institution of Oceanography.
Ho, Enseng. 2006. *The Graves of Tarim: Genealogy and Mobility across the Indian Ocean*. Berkeley: University of California Press.
Hodder, Ian. 1990. *The Domestication of Europe*. Oxford: Basil Blackwell.
Hoeksema, Robert. 2006. *Designed for Dry Feet: Flood Protection and Land Reclamation in the Netherlands*. Reston, VA: American Society of Civil Engineers.
Hofmeyr, Isabel. 2007. "The Black Atlantic Meets the Indian Ocean: Forging New Paradigms of Transnationalism for the Global South—Literary and Cultural Perspectives." *Social Dynamics* 33, no. 2: 3–32.
Hofmeyr, Isabel. 2010. "Universalizing the Indian Ocean." *PMLA* 125, no. 3: 721–29.

Hofmeyr, Isabel, and Charne Lavery. 2020. "Exploring the Indian Ocean as a Rich Archive of History." *The Conversation*, June 7. https://theconversation.com/exploring-the-indian-ocean-as-a-rich-archive-of-history-above-and-below-the-water-line-133817.

Höhler, Sabine. 2017. "Local Disruption or Global Condition? El Niño as Weather and as Climate Phenomenon." *Geo: Geography and Environment* 4, no. 1: e00034.

Holthuijsen, Leo H. 2007. *Waves in Oceanic and Coastal Waters*. Cambridge: Cambridge University Press.

Holton, Gerald. 1969. "Einstein, Michelson, and the 'Crucial' Experiment." *Isis* 60, no. 2: 132–97.

Horton, Sarah Bronwen. 2021. " On Pandemic Privilege: Reflections on a 'Home-Bound Pandemic Ethnography.'" *Journal for the Anthropology of North America* 24, no. 2: 98–107

Hoyt, P. D. 2000. "'Rogue States' and International Relations Theory." *Journal of Conflict Studies* 20, no. 1: 69–79.

Hughes, J. Donald. 2009. "Ripples in Clio's Pond: Holland against the Sea." *Capitalism Nature Socialism* 20, no. 3: 96–103.

Huler, Scott. 2005. *Defining the Wind: The Beaufort Scale and How a 19th-Century Admiral Turned Science into Poetry*. New York: Three Rivers.

Hutchins, Edwin. 1995. *Cognition in the Wild*. Cambridge, MA: MIT Press.

ibn Mājid, Ahmad (1490) 1971. *Arab Navigation in the Indian Ocean before the Coming of the Portuguese*, being a translation from the Arabic of *Kitab al-Fawa'id fi usul al-bahr wa'l-qawa'id* by Gerald Randall Tibbets. London: Royal Asiatic Society of Great Britain and Ireland.

Idhe, Don. 1991. *Instrumental Realism: The Interface between the Philosophy of Science and the Philosophy of Technology*. Bloomington: Indiana University Press.

Igo, Sarah. 2007. *The Averaged American: Surveys, Citizens, and the Making of a Mass Public*. Cambridge, MA: Harvard University Press.

Ingersoll, Karin Amimoto. 2016. *Waves of Knowing: A Seascape Epistemology*. Durham, NC: Duke University Press.

Inman, Douglas L. 2003. "Scripps in the 1940s: The Sverdrup Era." *Oceanography* 16, no. 3: 20–28.

Intergovernmental Panel on Climate Change. 2022: *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, edited by H.-O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, et al. Cambridge: Cambridge University Press.

Irigaray, Luce. (1977) 1985. *This Sex Which Is Not One*. Translated from the French by Catherine Porter with Carolyn Burke. Ithaca, NY: Cornell University Press.

Irvine, David. 2002. "The Role of Spectra in Ocean Wave Physics." In *Oceanographic History: The Pacific and Beyond*, edited by Keith R. Benson and Philip F. Rehbock, 378–86. Seattle: University of Washington Press.

Ishiwata, Eric. 2002. "Local Motions: Surfing and the Politics of Wave Sliding." *Cultural Values* 6, no. 3: 257–72.

Ivakhiv, Adrian. 2013. "An Ecophilosophy of the Moving Image: Cinema as Anthro-biogeomorphic Machine." In *Ecocinema Theory and Practice*, edited by Stephen Rust, Salma Monani, and Sean Cubitt, 87–105. New York: Routledge.

Jaffe, Jules S., Peter J. S. Franks, Paul L. D. Roberts, Diba Mirza, et al. 2017. "A Swarm of Autonomous Miniature Underwater Robot Drifters for Exploring Submesoscale Ocean Dynamics." *Nature Communications* 8, 14189. https://doi.org/10.1038/ncomms14189.

Jänicke, Stefan, Greta Franzini, Muhammad Faisal Cheema, and Gerik Scheuermann. 2015. "On Close and Distant Reading in Digital Humanities: A Survey and Future Challenges." Paper presented at the Eurographics Conference on Visualization, Cagliari, Italy, May 25–29. http://www.informatik.uni-leipzig.de/~stjaenicke/Survey.pdf.

Janssen, Peter. 2000. "ECMWF Wave Modeling and Satellite Altimeter Wave Data." In *Satellites, Oceanography, and Society*, edited by David Halpern, Elsevier Oceanography Series 63, 35–56. Amsterdam: Elsevier.

Jasanoff, Sheila, ed. 2004. *States of Knowledge: The Co-production of Science and Social Order*. London: Routledge.

Jauss, Hans Robert. 1970. "Literary History as a Challenge to Literary Theory." *New Literary History* 2, no. 1: 7–37.

Jensen, Casper Bruun. 2015. "Experimenting with Political Materials: Environmental Infrastructures and Ontological Transformations." *Distinktion* 16, no. 1: 17–30.

Jensen, Casper Bruun. 2020. "A Flood of Models: Mekong Ecologies of Comparison." *Social Studies of Science* 20, no. 1: 76–93.

Jensen, Robert E., Val Swail, Tyler J. Hesser, and Boram Lee. 2013. "Are Wave Measurements Actually Ground Truth?" Paper presented at Forecasting Dangerous Sea States, the Thirteenth International Workshop on Wave Hindcasting and Forecasting, Banff, AB, October 27–November 1.

Jetñil-Kijiner, Kathy. 2017. "Two Degrees." In *Iep Jaltok: Poems from a Marshallese Daughter*, by Kathy Jetñil-Kijiner, 76–79. Tucson: University of Arizona Press.

Joas, Christian, and Christoph Lehner. 2009. "The Classical Roots of Wave Mechanics: Schrödinger's Transformations of the Optical-Mechanical Analogy." *Studies in History and Philosophy of Modern Physics* 40, no. 4: 338–51.

Jobson, Ryan Cecil. 2021. "Dead Labor: On Racial Capital and Fossil Capital." In *Histories of Racial Capitalism*, edited by Destin Jenkins and Justin Leroy, 215–30. New York: Columbia University Press.

Johns, Adrian. 1998. *The Nature of the Book: Print and Knowledge in the Making*. Chicago: University of Chicago Press.

Johnson, Richard H., and Robert A. Houze Jr. 1987. "Precipitating Cloud Systems of the Asian Monsoon." In *Monsoon Meteorology*, edited by C.-P. Chang and T. N. Krishnamurty, 298–353. New York: Oxford University Press.

Jonas, Hans. 1966. *The Phenomenon of Life: Toward a Philosophical Biology*. New York: Harper and Row.

Jones, David, and Stefan Helmreich. 2020. "The Shape of Epidemics." *Boston Review*, June 26. http://bostonreview.net/science-nature/david-s-jones-stefan-helmreich-shape-epidemics.

Jones, Madison, Aaron Beveridge, Julian R. Garrison, Abbey Greene, Hannah MacDonald. 2022. "Tracking Memes in the Wild: Visual Rhetoric and Image Circulation in Environmental Communication." *Frontiers in Communication* 7. https://www.frontiersin.org/articles/10.3389/fcomm.2022.883278/full.

Jones, Mike. 2007. "Vanishing Point: Spatial Composition and the Virtual Camera." *Animation* 2, no. 3: 225–43.

Jones, Owain. 2019. "Monsoon plus Tide." Paper presented at the third Monsoon Assemblages Symposium, University of Westminster, London, March 21–22. Video available at https://www.oceanichumanities.com/post/conference-paper-permeability-ocean-concrete.

Jones, Ron. 1981. "The Third Wave." In *No Substitute for Madness: A Teacher, His Kids, and Lessons of Real Life*, by Ron Jones, 1–24. Covelo, CA: Island.

Joosten, H. P. 2013. *Datawell, 1961–2011: Riding the Waves for 50 Years*. Translated by L. M. Ruitenberg-van Meersbergen. Heemstede, Netherlands: Gravé.

Jue, Melody. 2017a. "Intimate Objectivity: On Nnedi Okorafor's Oceanic Afrofuturism." *Women's Studies Quarterly* 45, nos. 1–2: 171–88.

Jue, Melody. 2017b. "From the Goddess Ganga to a Teacup: On Amitav Ghosh's Novel, *The Hungry Tide*." In *Scale in Literature and Culture*, edited by Michael Tavel Clarke and David Wittenberg, 203–24. New York: Routledge.

Jue, Melody. 2020. *Wild Blue Media: Thinking through Seawater*. Durham, NC: Duke University Press.

Julien, Claude. 2006. "The Enigma of Mayer Waves: Facts and Models." *Cardiovascular Research* 70, no. 1: 12–21.

Julien, Isaac. 2010. *Ten Thousand Waves*. London: Isaac Julien Studio and Victoria Miro Gallery.

Kahn, Jeffrey S. 2019. *Islands of Sovereignty: Haitian Migration and the Borders of Empire*. Chicago: University of Chicago Press.

Kajiura, Kinjiro. 1963. "The Leading Waves of a Tsunami." *Bulletin of the Earthquake Research Institute* 41: 535–71.

Kaplan, Caren. 2018. *Aerial Aftermaths: Wartime from Above*. Durham, NC: Duke University Press.

Karatzis, Emmanouil, Theodore G. Papaioannou, and Konstantinos Aznaouridis et al. 2005. "Acute Effects of Caffeine on Blood Pressure and Wave Reflections in Healthy Subjects: Should We Consider Monitoring Central Blood Pressure?" *International Journal of Cardiology* 98, no. 3: 425–30.

Keane, Stephen. 2006. *Disaster Movies: The Cinema of Catastrophe*, 2nd ed. London: Wallflower.

Keiner, Christine. 2004. "Modeling Neptune's Garden: The Chesapeake Bay Hydraulic Model, 1965–1984." In *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, edited by Helen M. Rozwadowski and David K. van Keuren, 273–314. Sagamore Beach, MA: Science History.

Keisling, Benjamin, Isabella La Bras, and Bonnie Ludka. 2021. "A Conversation on Building Safe Spaces for the LGBTQ+ Community in the Geosciences." *Nature Communications* 12. https://doi.org/10.1038/s41467-021-24020-z.

Keller, Catherine. 2003. *The Face of the Deep: A Theology of Becoming*. London: Routledge.
Keller, Sarah, and Jason N. Paul, eds. 2012. *Jean Epstein: Critical Essays and New Translations*. Amsterdam: Amsterdam University Press.
Kelley, Lindsay. 2014. "Tranimals." *TSQ: Transgender Studies Quarterly* 1, no. 1: 226–28.
Kelly, Shannon. 2012. "Dancing with the Water Wolf and Choreographing Urban Ecologies." In *Strootman: Strategies for the Sublime*, edited by Uje Lee, René van der Velde, and Véronique Hoedemakers, 154–71. Seoul: C3.
Kelty, Christopher, and Hannah Landecker. 2004. "A Theory of Animation: Cells, L-systems, and Film." *Grey Room* 17: 30–63.
Keown, Michelle. 2018. "Waves of Destruction: Nuclear Imperialism and Anti-nuclear Protest in the Indigenous Literatures of the Pacific." *Journal of Postcolonial Writing* 54, no. 5: 585–600.
Kervran, David Dumoulin, Mina Kleiche-Dray, and Mathieu Quet. 2018. "Going South: How STS Could Think Science in and with the South?" *Tapuya* 1, no. 1: 280–305.
Keulartz, Jozef. 1999. "Engineering the Environment: The Politics of 'Nature Development.'" In *Living with Nature: Environmental Politics as Cultural Discourse*, edited by Frank Fischer and Maarten Hajer, 83–102. Oxford: Oxford University Press.
Khan, Naveeda. 2019. "At Play with the Giants: Between the Patchy Anthropocene and Romantic Geology." *Current Anthropology* 60 (Supplement 20): S333–41.
Kilgour, Frederick G. 1963. "Vitruvius and the Early History of Wave Theory." *Technology and Culture* 4, no. 3: 282–86.
Kimura, Shuhei. 2016. "When a Seawall Is Visible: Infrastructure and Obstruction in Post-tsunami Reconstruction in Japan." *Science as Culture* 25, no. 1: 23–43.
King, Tiffany Lethabo. 2019. *The Black Shoals: Offshore Formations of Black and Native Studies*. Durham, NC: Duke University Press.
Kinsman, Blair. 1965. *Wind Waves: Their Generation and Propagation on the Ocean Surface*. Englewood Cliffs, NJ: Prentice-Hall.
Kipling, Rudyard. 1896. "The Bell Buoy." *Saturday Review*, Christmas supp., 1.
Kirksey, S. Eben, and Stefan Helmreich. 2010. "The Emergence of Multispecies Ethnography." *Cultural Anthropology* 25, no. 4: 545–76.
Kirsch, Stuart. 2020. "Why Pacific Islanders Stopped Worrying about the Apocalypse and Started Fighting Climate Change." *American Anthropologist* 122, no. 4: 827–39.
Kittler, Friedrich A. (1986) 1999. *Gramophone, Film, Typewriter*. Translated from the German by Geoffrey Winthrop-Young and Michael Wutz. Stanford, CA: Stanford University Press.
Klauder, J. R., A. C. Price, S. Darlington, and W. J. Albersheim. 1960. "Theory and Design of Chirp Radars." *Bell System Technical Journal* 39, no. 4: 745–808.
Klaver, Irene, Jozef Keulartz, Henk van den Belt, and Bart Gremmen. 2002. "Born to Be Wild: A Pluralistic Ethics Concerning Introduced Large Herbivores in the Netherlands." *Environmental Ethics* 24, no. 1: 3–21.

Kluzek, Zygmunt, and Alaiksandr Lisimenka. 2013. "Acoustic Noise Generation under Plunging Breaking Waves." *Oceanologia* 55, no. 4: 809–36.

Knight, Charles. 1855. *The English Cyclopedia: A New Dictionary of Universal Knowledge, Geography*, vol. 4. London: Bradbury and Evans.

Knight, David B. 2006. *Landscapes in Music: Space, Place, and Time in the World's Great Music*. Lanham, MD: Rowman and Littlefield.

Knorr Cetina, Karin. 1995. "Laboratory Studies: The Cultural Approach to the Study of Science." In *Handbook of Science and Technology Studies*, edited by Sheila Jasanoff, Gerald E. Markle, James C. Petersen, and Trevor Pinch, 140–66. Thousand Oaks, CA: Sage.

Knox, Hannah. 2018. "Not Flying: Steps toward a Post-carbon Anthropology." *Hannah Knox* (blog), March 24. https://hannahknox.wordpress.com/2018/03/24/not-flying-steps-towards-a-post-carbon-anthropology.

Kohler, Robert E. 2002. *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology*. Chicago: University of Chicago Press.

Komel, Mirt. 2019. "The Wave of the Sign: Pyramidal Sign, Haptic Hieroglyphs, and the Touch of Language." In *The Language of Touch: Philosophical Examinations in Linguistics and Haptic Studies*, edited by Mirt Komel, 5–18. London: Bloomsbury Academic.

Komen, G. J., L. Cavaleri, M. Donelan, and K. Hasselmann et al. 1994. *Dynamics and Modeling of Ocean Waves*. Cambridge: Cambridge University Press.

Kondratieff, Nikolai. (1922) 2004. *The World Economy and Its Conjunctures during and after the War*. Translated from the Russian by V. Wolfson. Moscow: International Kondratieff Foundation.

Kraijo, Ineke. 2016. *Vechten tegen de golven*. Heerenveen, Netherlands: Royal Jongbloed.

Kraus, Werner. 2005. "Raden Saleh's Interpretation of the *Arrest of Diponegoro*: An Example of Indonesian 'Proto-nationalist' Modernism." *Archipel* 69: 259–94.

Kuhn, Thomas. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

LaDuke, Winona. 1983. "Native America: The Economics of Radioactive Colonialism." *Review of Radical Political Economics* (Fall): 9–19.

Lafrance, Adrienne. 2017. "The Algorithms behind *Moana*'s Gorgeously Animated Ocean." *The Atlantic*, May 31. https://www.theatlantic.com/technology/archive/2017/05/the-algorithms-behind-moanas-gorgeously-animated-pacific-ocean/528645.

Lamarre, Eric, and W. K. Melville. 1994. "Void-Fraction Measurements and Sound-Speed Fields in Bubble Plumes Generated by Breaking Waves." *Journal of the Acoustical Society of America* 95, no. 3: 1317–28.

Lamb, Horace. (1879) 1895. *Hydrodynamics*. Cambridge: Cambridge University Press.

Lanagan, David. 2003. "Dropping In: Surfing, Identity, Community and Commodity." In *Some Like It Hot: The Beach as a Cultural Dimension*, edited by James Skinner, Keith Gilbert, and Allan Edwards, 169–84. Oxford: Meyer and Meyer Sport.

Lane, Ferdinand C. 1947. *The Mysterious Sea*. New York: Doubleday.
Latour, Bruno. 1987. *Science in Action: How to Follow Engineers and Scientists through Society*. Cambridge, MA: Harvard University Press.
Latour, Bruno. 2004. "Why Has Critique Run Out of Steam? From Matters of Fact to Matters of Concern." *Critical Inquiry* 30, no 2: 225–48.
Latour, Bruno, and Steve Woolgar. 1986. *Laboratory Life: The Construction of Scientific Facts*. Princeton, NJ: Princeton University Press.
Lavery, Charne. 2020. "Thinking from the Southern Ocean." In *Sustaining Seas: Oceanic Space and the Politics of Care*, edited by Elspeth Probyn, Kate Johnston, and Nancy Lee, 307–18. London: Rowman and Littlefield.
Le Bon, Gustave. (1895) 1896. *The Crowd: A Study of the Popular Mind*. Translated from the French. New York: Macmillan.
Lee, Jia Hui. 2021. "Rat Tech: Transforming Rodents into Technology in Tanzania." Environment and Society Portal, *Arcadia* 5. http://doi:10.5282/rcc/9214.
Leenaers, Henk, comp. 2013. *Water Atlas of the Netherlands*. Groningen, Netherlands: Noordhoff Uitgevers B.V.
"Legacy of Genocide Resurfaces in Boston as Construction Is Planned on Burial Site." 2019. *Cultural Survival*, July 27. https://www.culturalsurvival.org/news/legacy-genocide-resurfaces-boston-construction-planned-burial-site-0.
Leheny, David, and Kay Warren. 2010. *Japanese Aid and the Construction of Global Development: Inescapable Solutions*. London: Routledge.
Lehman, Jessica. 2016. "A Sea of Potential: The Politics of Global Ocean Observations." *Political Geography* 55: 113–23.
Lehman, Jessica. 2021. "Sea Change: The World Ocean Circulation Experiment and the Productive Limits of Ocean Variability." *Science, Technology, & Human Values* 46, no. 4: 839–62.
Leibniz, Gottfried Wilhelm. (1765) 1982. *New Essays on Human Understanding*. Translated from the German by Peter Remnant and Jonathan Bennett. Cambridge: Cambridge University Press.
Leighton, Timothy G. 2014. "Bubble Acoustics." Paper presented at the Twelfth Particle Technology Forum 2014, Manchester, UK, September 16–17. https://eprints.soton.ac.uk/415945/1/2014_Leighton_2014_Particles_conference_Manchester_.pdf.
Lennert-Cody, Cleridy E., and Peter J. S. Franks. 2002. "Fluorescence Patches in High-frequency Internal Waves." *Marine Ecology-Progress Series* 235: 29–42.
Lentjes, Rebecca. 2017. "Surreal Conjunctions: An Interview with Annea Lockwood." *VAN Magazine*, July 26. https://van-magazine.com/mag/annea-lockwood/.
Leonelli, Sabina, Brian Rappert, and Gail Davies. 2017. "Data Shadows: Knowledge, Openness, and Absence." *Science, Technology, & Human Values* 42, no. 2: 191–202.
Lepore, Jill. 1998. *The Name of War: King Philip's War and the Origins of American Identity*. New York: Vintage.
Lewis, David. 1972. *We, the Navigators: The Ancient Art of Landfinding in the Pacific.* Canberra: Australian National University Press.

Lewis, Jason Edward. 2019 "An Orderly Assemblage of Biases: Troubling the Monocultural Stack." In *Afterlives of Indigenous Archives*, edited by Ivy Schweitzer and Gordon Henry Jr., 218–31. Hanover, NH: Dartmouth College Press.

Lewis, Martin W., and Kären Wigen. 1999. "A Maritime Response to the Crisis in Area Studies." *Geographical Review* 89, no. 2: 161–68.

Ley, Lukas. 2021. *Building on Borrowed Time: Rising Seas and Failing Infrastructure in Semarang*. Minneapolis: University of Minnesota Press.

Leya, Rabeya Sultana, Debanjali Saha, Sujit Kumar Bala, and Hamidul Huq. 2020. "Gender Vulnerability Assessment due to Flood in Northern Part of Bangladesh." In *Water, Flood Management and Water Security under a Changing Climate*, edited by Anisul Haque and Ahmed Ishtiaque Amin, 235–49. Cham, Switzerland: Springer International.

Liboiron, Max 2021. *Pollution Is Colonialism*. Durham, NC: Duke University Press.

Lien, Marianne. 2015. *Becoming Salmon: Aquaculture and the Domestication of a Fish*. Berkeley: University of California Press.

Lighthill, M. J. 1967. "Waves in Fluids." *Communications on Pure and Applied Mathematics* 20: 267–93.

Lindow, John. 2001. *Norse Mythology: A Guide to Gods, Heroes, Rituals, and Beliefs*. Oxford: Oxford University Press.

Lippit, Akira Mizuta. 2015. "Between Disaster, Medium 3.11." *Mechademia* 10: 3–15.

Littau, Karin. 2006. *Theories of Reading: Books, Bodies, and Bibliomania*. Cambridge: Polity.

Littlejohn, Andrew. 2021. "Ruins for the Future: Critical Allegory and Disaster Governance in Post-Tsunami Japan." *American Ethnologist* 48, no. 1: 7–21.

Longfellow, Henry Wadsworth. 1885. *The Poetical Works of Henry Wadsworth Longfellow*. Boston: Houghton Mifflin.

Longuet-Higgins, Michael, comp. 2010. "Group W at the Admiralty Research Laboratory." In *Of Seas and Ships and Scientists: The Remarkable Story of the UK's National Institute of Oceanography*, edited by Anthony Laughton, John Gould, 'Tom' Tucker, and Howard Roe, 41–66. Cambridge: Lutterworth.

Lorimer, Jamie. 2017. "The Anthropo-scene: A Guide for the Perplexed." *Social Studies of Science* 47, no. 1: 117–42.

Lorimer, Jamie, and Clemens Driessen. 2013. "Bovine Biopolitics and the Promise of Monsters in the Rewilding of Heck Cattle." *Geoforum* 48: 249–59.

Lotan, Gilad, Erhardt Graeff, Mike Ananny, and Devin Gaffney et al. 2011. "The Revolutions Were Tweeted: Information Flows During the 2011 Tunisian and Egyptian Revolutions." *International Journal of Communication* 5: 1375–405.

Lucente, Gregory. 1985. "An Interview with Italo Calvino." *Contemporary Literature* 26, no. 3: 245–53.

Luciano, Dana, and Mel Y. Chen. 2015. "Has the Queer Ever Been Human?" *GLQ* 21: 2–3.

Ludwin, Ruth S., Robert Dennis, Deborah Carver, and Alan D. McMillan et al. 2005. "Dating the 1700 Cascadia Earthquake: Great Coastal Earthquakes in Native Stories." *Seismological Research Letters* 76, no. 2: 140–48.

Luis-Brown, David. 2008. *Waves of Decolonization: Discourses of Race and Hemispheric Citizenship in Cuba, Mexico, and the United States*. Durham, NC: Duke University Press.

Lynteris, Christos. 2017. "Zoonotic Diagrams: Mastering and Unsettling Human-Animal Relations." *Journal of the Royal Anthropological Institute* 23, no. 3: 463–85.

Mack, John. 2011. *The Sea: A Cultural History*. London: Reaktion.

Mackenzie, Adrian. 2006. *Cutting Code: Software and Sociality*. New York: Peter Lang.

Mackenzie, Adrian. 2008a. "Codec." In *Software Studies: A Lexicon*, edited by Matthew Fuller, 48–55. Cambridge, MA: MIT Press.

Mackenzie, Adrian. 2008b. "Internationalization." In *Software Studies: A Lexicon*, edited by Matthew Fuller, 153–61. Cambridge, MA: MIT Press.

MacKinnon, Jennifer A. 2014. "Autobiographical Sketch. Women in Oceanography: A Decade Later." *Oceanography* 27, no. 4 (supp.): 164.

MacKinnon, Jennifer A., Zhongxiang Zhao, Caitlin B. Whalen, Amy F. Waterhouse, et al. 2017. "Climate Process Team on Internal Wave-Driven Ocean Mixing." *Bulletin of the American Meteorological Society* 98, no. 11: 2429–54.

Maleuvre, Didier. 2011. *The Horizon: A History of Our Infinite Longing*. Berkeley: University of California Press.

Mangolte, Babette. 2003. "Afterwards: A Matter of Time: Analog versus Digital, the Perennial Question of Shifting Technology and Its Implications for an Experimental Filmmaker's Odyssey." In *Camera Obscura, Camera Lucida: Essays in Honor of Annette Michelson*, edited by Richard Allen and Malcolm Turvey, 261–74. Amsterdam: Amsterdam University Press.

Manovich, Lev. 2001. *The Language of New Media*. Cambridge, MA: MIT Press.

Marcus, Adam. 2020. "Buoyant Ecologies: Interspecies Cooperation for Sea Level Rise Adaptation." In *Sustaining Seas: Oceanic Space and the Politics of Care*, edited by Elspeth Probyn, Kate Johnston, and Nancy Lee, 253–60. London: Rowman and Littlefield.

Markkula, Joanna. 2011. "'Any Port in a Storm': Responding to Crisis in the World of Shipping." *Social Anthropology* 19, no. 3: 297–304.

Marti, Don. 2003. "Letter to the US Department of Commerce on Exporting Linux to Iraq." *Linux Journal*, December 16. https://www.linuxjournal.com/article/7318.

Marx, Leo. 1964. *The Machine in the Garden: Technology and the Pastoral Ideal in America.* Oxford: Oxford University Press.

Masco, Joseph. 2014. *The Theater of Operations: National Security Affect from the Cold War to the War on Terror*. Durham, NC: Duke University Press.

Masco, Joseph. 2018. "The Six Extinctions: Visualizing Planetary Ecological Crisis Today." In *After Extinction*, edited by Richard Grusin, 71–106. Minneapolis: University of Minnesota Press.

Maury, Matthew Fontaine. 1860. *The Physical Geography of the Sea, Being a Reconstruction and Enlargement of the Eighth Edition of "The Physical Geography of the Sea."* London: Sampson Low, Son & Co.

Mauss, Marcel. (1934) 1973. "Techniques of the Body." *Economy and Society* 2, no. 1: 70–88.

McCormack, Derek P. 2018. *Atmospheric Things: The Allure of Elemental Envelopment*. Durham, NC: Duke University Press.
McCosker, Anthony. 2013. "De-framing Disaster: Affective Encounters with Raw and Autonomous Media." *Continuum* 27, no. 3: 382–96.
McKittrick, Katherine. 2013. "Plantation Futures." *Small Axe* 17, no. 3: 1–15.
McPhee-Shaw, Erika. 2006. "Boundary-Interior Exchange: Reviewing the Idea that Internal-wave Mixing Enhances Lateral Dispersal Near Continental Margins." *Deep Sea Research Part II: Topical Studies in Oceanography* 53, nos. 1–2: 42–59.
McTighe, Laura, and Megan Raschig. 2019. "Introduction: An Otherwise Anthropology." Theorizing the Contemporary, *Fieldsights*, July 31. https://culanth.org/fieldsights/introduction-an-otherwise-anthropology.
Meier, Allison. 2017. "The Octopus, a Motif of Evil in Historical Propaganda Maps." *Hyperallergic*, May 8. https://hyperallergic.com/375900/the-map-octopus-a-propaganda-motif-of-spreading-evil.
Melillo, John. 2016. "Breaking Waves and Aurality." Paper presented at Periods and Waves: A Conference on Sound and History, Stony Brook University, Stony Brook, NY, April 29–30.
Melville, W. K. 1983. "Wave Modulation and Breakdown." *Journal of Fluid Mechanics* 128: 489–506.
Melville, W. K., and R. J. Rapp. 1985. "Momentum Flux in Breaking Waves." *Nature* 317: 514–16.
Mentz, Steve. 2015. *Shipwreck Modernity: Ecologies of Globalization, 1550–1719*. Minneapolis: University of Minnesota Press.
Mentz, Steve. 2019a. *Break Up the Anthropocene*. Minneapolis: University of Minnesota Press.
Mentz, Steve. 2019b. "Experience Is Better than Knowledge: Premodern Ocean Science and the Blue Humanities." *Configurations* 27, no. 4: 433–42.
Metz, Tracy, and Maartje van den Heuvel. 2012. *Sweet and Salt: Water and the Dutch*. Rotterdam: NAi.
Mehtta, Megnaa. 2018. "Unembanking Habitations and Imaginations: The Politics of Life amidst the Ebbs and Flows of the Sundarbans Forests of West Bengal." In *Monsoon [+ other] Waters*, edited by Lindsay Bremner, 29–43. London: Monsoon Assemblages.
Mehtta, Megnaa. 2020. "The Sundarban after Cyclone Amphan." Interview by Raisa Wickrematunge. *Himal Southasian*, June 11. https://www.himalmag.com/what-the-sundarban-tells-us-podcast-2020.
Middleton, Fiona. 2020. "Brown Clouds." Ocean-Archive.org, n.d. https://ocean-archive.org/collection/119.
Mignolo, Walter D. 2011. *The Darker Side of Western Modernity: Global Futures, Decolonial Options*. Durham, NC: Duke University Press.
Mills, Eric. 1989. *Biological Oceanography: An Early History, 1870–1960*. Ithaca, NY: Cornell University Press.
Mills, Eric. 2009. *The Fluid Envelope of Our Planet: How the Study of Ocean Currents Became a Science*. Toronto: University of Toronto Press.

Mills, Mara. 2016. "Beyond Recognition: What Machines Don't Read." *American Foundation for the Blind* (blog), September 15. https://www.afb.org/blog/entry/beyond-recognition-what-machines-dont-read.

Minsberg, Talya. 2017. "On a California Ranch, Perfect Conditions for Pro Surfing." *New York Times*, September 20, https://www.nytimes.com/2017/09/20/sports/world-surf-league-kelly-slater-test.html?_r=0.

Mitman, Gregg. 1999. *Reel Nature: America's Romance with Wildlife on Film*. Cambridge, MA: Harvard University Press.

Mitsuyasu, Hisashi. 2009. *Looking Closely at Ocean Waves: From Their Birth to Their Death*. Tokyo: Terrapub.

Mirzoeff, Nicholas D. 2015. "The Drowned and the Sacred: To See the Unspeakable." *How to See the World*, August 29. https://wp.nyu.edu/howtoseetheworld/2015/08/29/auto-draft-73.

Moore, Jason W., ed. 2016. *Anthropocene or Capitalocene? Nature, History, and the Crisis of Capitalism*. Oakland, CA: PM Press.

Moorthy, Shanti, and Ashraf Jamal. 2010. "Introduction: New Conjunctures in Maritime Imaginaries." In *Indian Ocean Studies: Cultural, Social, and Political Perspectives*, edited by Shanti Moorthy and Ashraf Jamal, 1–31. London: Routledge.

Moretti, Franco. 2013. *The Bourgeois: Between History and Literature*. New York: Verso.

Morgan, Lewis Henry. 1868. *The American Beaver and His Works*. Philadelphia: J. B. Lippincott.

Morimoto, Ryo. 2012. "Shaking Grounds, Unearthing Palimpsests: Semiotic Anthropology of Disaster." *Semiotica* 192: 263–74.

Morimoto, Ryo. 2014. "Message without a Coda: On the Rhetoric of Photographic Records." *Signs and Society* 2, no. 2: 284–313.

Morimoto, Ryo. 2015. "Waves of Semiosis: Is It about Time? On the Semiotic Anthropology of Change." In *International Handbook of Semiotics*, vol. 1, edited by Peter Pericles Trifonas, 547–64. Dordrecht: Springer.

Morita, Atsuro. 2013. "Traveling Engineers, Machines, and Comparisons: Intersecting Imaginations and Journeys in the Thai Local Engineering Industry." *East Asian Science, Technology, and Society* 7, no. 2: 221–41.

Morita, Atsuro, and Wakana Suzuki. 2019. "Being Affected by Sinking Deltas: Changing Landscapes, Resilience, and Complex Adaptive Systems in the Scientific Story of the Anthropocene." *Current Anthropology* 60 (Supplement 20): 286–95.

Morton, Jamie. 2001. *The Role of the Physical Environment in Ancient Greek Seafaring*. Leiden: E. J. Brill.

Morton, Timothy. 2013. *Hyperobjects: Philosophy and Ecology after the End of the World*. Minneapolis: University of Minnesota Press.

Moshe, Zach, Asher Metzger, Gal Elidan, Frederik Kratzert, et al. 2020. "HydroNets: Leveraging River Structure for Hydrological Modeling." Paper presented at the International Conference on Learning Representations, April 26–May 1. https://ai4earthscience.github.io/iclr-2020-workshop/papers/ai4earth04.pdf.

Moten, Fred. 2003. *In the Break: The Aesthetics of the Black Radical Tradition*. Minneapolis: University of Minnesota Press.
Mouw, Colleen B., Sarah Clem, Sonya Legg, and Jean Stockard. 2018 "Meeting Mentoring Needs in Physical Oceanography: An Evaluation of the Impact of MPOWIR." *Oceanography* 31, no. 4: 171–79.
Mrázek, Rudolf. 2002. *Engineers of Happy Land: Technology and Nationalism in a Colony*. Princeton, NJ: Princeton University Press.
Mukerji, Chandra. 1989. *A Fragile Power: Scientists and the State*. Princeton, NJ: Princeton University Press.
Mukerji, Chandra. 2009. *Impossible Engineering: Technology and Territoriality on the Canal du Midi*. Princeton, NJ: Princeton University Press.
Mukharji, Projit Bihari. 2016. *Doctoring Traditions: Ayurveda, Small Technologies, and Braided Sciences*. Chicago: University of Chicago Press.
Mukherjee, Jenia. 2020. *Blue Infrastructures: Natural History, Political Ecology and Urban Development in Kolkata*. Singapore: Springer.
Munk, Judith, and Walter Munk. 1972. "Venice Hologram." *Proceedings of the American Philosophical Society* 116, no. 5: 415–42.
Munk, Walter. 1939. "Internal Waves in the Gulf of California." *Journal of Marine Research* 4, no. 1: 81–91.
Munk, Walter, and Carl Wunsch. 2019. "A Conversation with Walter Munk." *Annual Review of Marine Science* 11: 15–25.
Munn, Nancy D. 1992. "The Cultural Anthropology of Time: A Critical Essay." *Annual Review of Anthropology* 21: 93–123.
Musil, Robert. (1930–43) 1996. *The Man Without Qualities*, vol. 1. Translated from the German by Sophie Wilkins and Burton Pike. New York: Vintage.
Muto, Ichiyo. 2013. "The Buildup of a Nuclear Armament Capability and the Postwar Statehood of Japan: Fukushima and the Genealogy of Nuclear Bombs and Power Plants." *Inter-Asia Cultural Studies* 14, no. 2: 171–212.
Narayan, Siddharth, Michael W. Beck, Borja G. Reguero, and Iñigo J. Losada et al. 2016. "The Effectiveness, Costs and Coastal Protection Benefits of Natural and Nature-Based Defences." *PLOS ONE* 11, no. 5: 4.
National Resilience Program. 2019a. *Annual Programme Narrative Progress Report, Bangladesh, Reporting Period: 1 January–31 December 2019*, United Nations Development Programme, UN Women, and United Nations Office for Project Services. https://info.undp.org/docs/pdc/Documents/BGD/2.%20Annual%20Progress%20Report%202019-v4-30-04-2020.pdf.
National Resilience Program. 2019b. *Report on Gender Review of Development Project Proposal*. https://drive.google.com/file/d/17FUozWNdor5bks9BXNK8r1irjUdNejoU/view.
National Science Foundation (NSF). 1967. *International Indian Ocean Expedition* film. Washington DC: Screen Presentations, Inc.
National Science Foundation (NSF). 2016. "LIGO Detects Gravitational Waves." Press conference, National Press Club, Washington, DC, February 11.
Neale, Timothy, and Daniel May. 2020. "Fuzzy Boundaries: Simulation and Expertise in Bushfire Prediction." *Social Studies of Science* 50, no. 6: 837–59.

Neimanis, Astrida. 2012. "Hydrofeminism: Or, On Becoming a Body of Water." In *Undutiful Daughters: New Directions in Feminist Thought and Practice*, edited by Henriette Gunkel, Chrysanthi Nigianni, and Fanny Söderbäck, 85–99. New York: Palgrave Macmillan.

Neimanis, Astrida, Aleksija Neimanis, and Cecilia Åsberg. 2017. "Fathoming Chemical Weapons in the Gotland Deep." *Cultural Geographies* 24, no. 4: 631–38.

Nelson, Diane M. 2019. "Water as Genre." Roundtable on Form, Genre and Ethnographic Imaginations, 118th Annual Meeting of the American Anthropological Association, Vancouver, BC, November 20–23.

Nemani, Mihi. 2015. "Being a Brown Bodyboarder." In *Seascapes: Shaped by the Sea*, edited by Mike Brown and Barbara Humberstone, 83–100. Farnham, UK: Ashgate.

Newman, J. N. 1977. *Marine Hydrodynamics*. Cambridge, MA: MIT Press.

Newman, J. N. 2014. "Cloaking a Circular Cylinder in Water Waves." *European Journal of Mechanics-B/Fluids* 47: 145–50.

Nietzsche, Friedrich. (1882) 1974. *The Gay Science*. Translated by Walter Kaufmann. New York: Vintage.

Nixon, Rob. 2013. *Slow Violence and the Environmentalism of the Poor*. Cambridge, MA: Harvard University Press.

Nolan, Bruce. 2009. "Stacy Head Has Rubbed Some People the Wrong Way, but Supporters Say Her Brash Style Is Misunderstood." *Times-Picayune*, April 8. http://www.nola.com/news/index.ssf/2009/04/stacy_head_photo_for_terry.html.

Novak, David. 2013. *Japanoise: Music at the Edge of Circulation*. Durham, NC: Duke University Press.

Obama, Barack. 1995. *Dreams from My Father: A Story of Race and Inheritance*. New York: Times.

Oguma, Eiji. 2013. "Era." In *To See Once More the Stars: Living in a Post-Fukushima World*, edited by Daisuke Naito, Ryan Sayre, Heather Swanson, and Satsuki Takahashi, 240–43. Santa Cruz, CA: New Pacific.

Okorafor, Nnedi. 2014. *Lagoon*. London: Hodder and Stoughton.

Oldenziel, Ruth. 2011. "Islands: The United States as a Networked Empire." In *Entangled Geographies: Empire and Technopolitics in the Global Cold War*, edited by Gabrielle Hecht, 13–42. Cambridge, MA: MIT Press.

"On Creeds." 1809. Editorial. *Panoplist, and Missionary Magazine United*, 298–305.

O'Neill, Kevin Lewis. 2018. "On the Importance of Wolves." *Cultural Anthropology* 33, no. 3: 499–520.

Onneweer, Maarten. 2006. "An Ecology of Prospects: Time and Nature in Dutch Landscapes." *Etnofoor* 19, no. 2: 23–46.

Open University Course Team. 1994. *Waves, Tides, and Shallow-Water Processes*. Oxford: Butterworth-Heinemann.

Opperman, Serpil. 2019. "Storied Seas and Living Metaphors in the Blue Humanities." *Configurations* 27, no. 4: 443–61.

Oreskes, Naomi. 1996. "Objectivity or Heroism? On the Invisibility of Women in Science." *Osiris* 11: 87–113.

Oreskes, Naomi. 2000. "'*Laissez-tomber*': Military Patronage and Women's Work in Mid-20th-Century Oceanography." *Historical Studies in the Physical and Biological Sciences* 30, no. 2: 373–92.

Oreskes, Naomi. 2003. "A Context of Motivation: U.S. Navy Oceanographic Research and the Discovery of Sea-Floor Hydrothermal Vents." *Social Studies of Science* 33, no. 5: 697–742.

Oreskes, Naomi. 2020. *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean.* Chicago: University of Chicago Press.

Ortberg, Daniel Mallory. 2016. "Women Inexplicably Aroused by Waves in Art." *Toast*, January 25. http://the-toast.net/2016/01/25/women-inexplicably-aroused-by-waves-in-art.

Ortiz-Suslow, David G., Brian K. Haus, Sanchit Mehta, and Nathan J. M. Laxague. 2016. "Sea Spray Generation in Very High Winds." *Journal of Atmospheric Sciences* 73, no. 10: 3975–95.

Ozeki, Ruth. 2013. *A Tale for the Time Being*. New York: Penguin.

Palmer, Dexter. 2017. *Version Control*. New York: Vintage.

Pandian, Anand. 2015. *Reel World: An Anthropology of Creation*. Durham, NC: Duke University Press.

Pantti, Mervi. 2013. "Getting Closer? Encounters of the National Media with Global Images." *Journalism Studies* 14, no. 2: 201–18.

Parker, Bruce. 2012. *The Power of the Sea: Tsunamis, Storm Surges, Rogue Waves, and Our Quest to Predict Disasters*. New York: St. Martin's Griffin.

Parks, Lisa. 2014. "Drones, Infrared Imagery, and Body Heat." *International Journal of Communication* 8: 2518–21.

Parks, Lisa, and Nicole Starosielski, eds. 2015. *Signal Traffic: Critical Studies of Media Infrastructures*. Urbana: University of Illinois Press.

Parikka, Jussi. 2014. *The Anthrobscene*. Minneapolis: University of Minnesota Press.

Parry, Richard Lloyd. 2017. *Ghosts of the Tsunami: Death and Life in Japan's Disaster Zone*. New York: MCD.

Parsons, Keith, and Robert Zaballa. 2017. *Bombing the Marshall Islands: A Cold War Tragedy*. Cambridge: Cambridge University Press.

Parvin, Nassim, and Anne Pollock. 2020. "Unintended by Design: On the Political Uses of 'Unintended Consequences.'" *Engaging Science, Technology, and Society* 6: 320–27.

Patton, Kimberly C. 2007. *The Sea Can Wash Away All Evils: Modern Marine Pollution and the Ancient Cathartic Ocean*. New York: Columbia University Press.

Pattullo, June, Walter Munk, Roger Revelle, and Elizabeth Strong. 1955. "The Seasonal Oscillation in Sea Level." *Journal of Maritime Research* 14, no. 1: 88–155.

Pauly, Philip J. 2000. *Biologists and the Promise of American Life: From Meriwether Lewis to Alfred Kinsey*. Princeton, NJ: Princeton University Press.

Pauwelussen, Annet, and G. M. Verschoor. 2017. "Amphibious Encounters: Coral and People in Conservation Outreach in Indonesia." *Engaging Science, Technology, and Society* 3: 292–314.

Paz, Octavio. (1949) 1976. "Mi vida con la ola/My Life with the Wave" In *Eagle or Sun?* by Octavio Paz. Translated from the Spanish by Eliot Weinberger, 44–53. New York: J. Laughlin.

Pearson, Kent. 1979. *Surfing Subcultures of Australia and New Zealand*. St. Lucia, Australia: University of Queensland Press.

Pearson, Michael. 2003. *The Indian Ocean.* London: Routledge.

Pearson, Michael. 2006. "Littoral Society: The Concept and the Problems." *Journal of World History* 17, no. 4: 353–73.

Pearson, Michael, ed. 2015. *Trade, Circulation, and Flow in the Indian Ocean World*. New York: Palgrave.

Pereira, Clifford J. 2012. "Zheng He and the African Horizon: An Investigative Study into the Chinese Geography of Early Fifteenth-Century Eastern Africa." In *Zheng He and the Afro-Asian World*, edited by Chia Lin Sien and Sally K. Church, 248–79. Melaka, Malaysia: Perbadanan Muzium.

Peters, John Durham. 2015. *The Marvelous Clouds: Towards a Philosophy of Elemental Media.* Chicago: University of Chicago Press.

Petryna, Adrianna. 2022. *Horizon Work: At the Edges of Knowledge in an Age of Runaway Climate Change*. Princeton, NJ: Princeton University Press.

Pezman, Steve. 1978. "Interview: Dr. Timothy Leary: The Evolutionary Surfer." *Surfer*, no. 5, January, 100–103.

Philip, M. NourbeSe, as told to the author by Setaey Adamu Boateng. 2008. *Zong!* Middletown, CT: Wesleyan University Press.

Philippopoulos-Mihalopoulos, Andreas. 2022. "We Are All Complicit: Performing Law through Wavewriting." In *Laws of the Sea: Interdisciplinary Currents*, edited by Irus Braverman, 283–93. London:Routledge.

Pierson, Ryan. 2015. "Whole-Screen Metamorphosis and the Imagined Camera (Notes on Perspectival Movement in Animation)." *Animation* 10, no. 1: 6–21.

Pierson, Willard J., and Wilbur Marks. 1952. "The Power-Spectrum Analysis of Ocean-Wave Records." *Transactions of the American Geophysical Union* 33, no. 6: 834–44.

Pinet, Paul. 2009. *Invitation to Oceanography*. 5th ed. Sudbury, MA: Jones and Bartlett.

Pinkel, Robert. 1975. "Upper Ocean Internal Wave Observations from Flip." *Journal of Geophysical Research-Oceans and Atmospheres* 80, no. 27: 3892–3910.

Pinkel, Robert. 2016. "A Brief Review of Doppler Sonar Development at Scripps." *Methods in Oceanography* 17: 252–63.

Pinkel, Robert, Matthew Alford, Andrew J. Lucas, and Shaun Johnston et al. 2015. "Breaking Internal Tides Keep the Ocean in Balance." *Eos* (November 17). https://eos.org/project-updates/breaking-internal-tides-keep-the-ocean-in-balance.

Pinkel, Robert, Albert Plueddemann, and Robin Williams. 1987. "Internal Wave Observations from FLIP in MILDEX." *Journal of Physical Oceanography* 17, no. 10: 1737–57.

Pirie, David. 1996. "Wave Theory." *Sight and Sound* 6, no. 9: 26–27.

Pizzo, Nick. 2017. "Surfing Surface Gravity Waves." *Journal of Fluid Mechanics* 823: 316–28.

Pizzo, Nick, Luc Deike, and Alex Ayet. 2021. "How Does the Wind Generate Waves?" *Physics Today* 74, no. 11: 38–43.

Pollock, Anne. 2008. "The Internal Cardiac Defibrillator." In *The Inner History of Devices*, edited by Sherry Turkle, 98–111. Cambridge, MA: MIT Press.

Pombo, Pedro. 2018. "Soaking Cartographies: Of Waters, Landscapes and Materialities." In *Monsoon [+ other] Waters*, edited by Lindsay Bremner, 127–38. London: Monsoon Assemblages.

Porter, Roy. 1980. "The Terraqueous Globe." In *The Ferment of Knowledge*: *Studies in the Historiography of Eighteenth-Century Science*, edited by George Sebastian Rousseau and Roy Porter, 285–324. Cambridge: Cambridge University Press.

Povinelli, Elizabeth A. 2016. *Geontologies: A Requiem to Late Liberalism*. Durham, NC: Duke University Press.

Pretor-Pinney, Gavin. 2010. *The Wave Watcher's Companion: From Ocean Waves to Light Waves via Shock Waves, Stadium Waves, and All the Rest of Life's Undulations.* New York: Perigee.

Prince, Stephen. 1996. "True Lies: Perceptual Realism, Digital Images, and Film Theory." *Film Quarterly* 49, no. 3: 27–37.

Pritchard, Sara B. 2011. *Confluence: The Nature of Technology and the Remaking of the Rhône*. Cambridge, MA: Harvard University Press.

Probyn, Elspeth. 2021. "Doing Cultural Studies in Rough Seas: the COVID-19 Ocean Multiple." *Cultural Studies* 35, nos. 2–3: 557–71.

Prodanovich, Todd. 2020. "Whose Coast Are You Surfing in San Diego? A Look at the Indigenous History of One of California's Most Iconic Surf Zones." *Surfer Magazine*, August 17. https://www.surfer.com/features/whose-coast-are-you-surfing-in-san-diego/.

Quinn, Judy. 2014. "Mythologizing the Sea: The Nordic Sea-Deity Rán." In *Nordic Mythologies: Interpretations, Intersections, and Institutions*, edited by Timothy R. Tangherlini, 71–99. Berkeley, CA: North Pinehurst.

Raban, Jonathan. 2010. "The Waves." In *Driving Home: An American Journey*, by Jonathan Raban, 159–64. New York: Pantheon.

Raffles, Hugh. 2002. *In Amazonia: A Natural History*. Princeton, NJ: Princeton University Press.

Lord Raglan. 1960. "Canute and the Waves." *Man* 60, no. 4: 7–8.

Rahman, Ashiqur, Munsur Rahman, Shampa, and Anisul Haque et al. 2020. "Performance Evaluation of Bandal-like Structures for Sediment Management in Braided Jamuna River." *Proceedings of the 22nd IAHR-APD Congress 2020, Sapporo, Japan*, September 15–16. https://iahr-apd2020.eng.hokudai.ac.jp/htdocs/static/mirror/proceedings/pdf/1-1-7.pdf.

Rahman, Munsur, Tuhin Ghosh, Mashfiqus Salehin, and Amit Ghosh et al. 2020. "Ganges-Brahmaputra-Meghna Delta, Bangladesh and India: A Transnational Mega-Delta." In *Deltas in the Anthropocene*, edited by Robert J. Nicholls, W. Neil Adger, Craig W. Hutton, and Susan E. Hanson, 23–50. Cham, Switzerland: Springer Nature.

Rainger, Ronald. 2004. "'A Wonderful Oceanographic Tool': The Atomic Bomb, Radioactivity and the Development of American Oceanography." In *The*

Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment, edited by Helen Rozwadowski and David K. van Keuren, 96–132. Sagamore Beach, MA: Science History.
Raitt, Helen. 1956. *Exploring the Deep Pacific*. New York. W. W. Norton.
Raitt, Helen, and Beatrice Moulton. 1967. *Scripps Institution of Oceanography: First Fifty Years*. Los Angeles: Ward Ritchie Press.
Rankin, Bill. 2016. *After the Map: Cartography, Navigation, and the Transformation of Territory in the Twentieth Century*. Chicago: University of Chicago Press.
Rao, R. Prasada and Eugene C. LaFond. 1958. "The End of a Wave." *Current Science* 27, no. 11: 431–32.
Ray, T. K. 1986. "Ocean Waves and Their Response to Monsoon." *Mausum (मौसम)* 37, no. 2: 203–6.
Read, Richard. 2015. "*The New Yorker* Earthquake Article Unleashes Tsunami of Social Media: 8 Takeaways." *Oregon Live/The Oregonian*, July 15. https://www.oregonlive.com/pacific-northwest-news/2015/07/the_new_yorker_lets_cascadia_r.html.
Reguero, Borja G., Iñigo J. Losada, and Fernando J. Méndez. 2019. "A Recent Increase in Global Wave Power as a Consequence of Oceanic Warming." *Nature Communications* 10. https://doi.org/10.1038.
Rehbock, Philip F. 1979. "The Early Dredgers: 'Naturalizing' in British Seas, 1830–1850." *Journal of the History of Biology* 12, no. 2: 293–368.
Reidy, Michael S. 2008. *Tides of History: Ocean Science and Her Majesty's Navy*. Chicago: University of Chicago Press.
Reidy, Michael S., and Helen M. Rozwadowski. 2014. "The Spaces in Between: Science, Ocean, Empire." *Isis* 105, no. 2: 338–51.
"Remembering Deer Island: A Cause Worthy of Nipmuc Support." 1994. Editorial, *Nipmucspohke Newsletter*, vol. 1, no. 2, 3.
"The Revolutionary AuthaGraph Projection." 2017. *Decolonial Atlas* (blog), March 11. https://decolonialatlas.wordpress.com/2017/03/11/authagraph-world-maps.
Rezaie, Ali Mohammad, Celso Moller Ferreira, and Mohammad Rezaur Rahman. 2019. "Storm Surge and Sea Level Rise: Threat to the Coastal Areas of Bangladesh." In *Extreme Hydroclimatic Events and Multivariate Hazards in a Changing Environment*, edited by Viviana Maggioni and Christian Massari, 317–42. Amsterdam: Elsevier.
Rheinberger, Hans-Jörg. 1997. *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*. Stanford, CA: Stanford University Press.
Rhodan, Maya. 2016. "Donald Trump Calls Climate Change a Hoax, but Worries It Could Hurt His Golf Course." *Time*, May 23. http://time.com/4345367/donald-trump-climate-change-golf-course.
Rijser, Christy. 2016. "De Waterwolf is verslagen." *Die Uitkomst*, January 19.
Riles, Annelise. 2004. "Real Time: Unwinding Technocratic and Anthropological Knowledge." *American Ethnologist* 31, no. 3: 392–405.
Robinson, Kim Stanley. 2017. *New York 2140*. New York: Orbit.
Rodgers, Tara. 2016. "Toward a Feminist Epistemology of Sound: Refiguring Waves in Audio-technological Discourse." In *Engaging the World: Thinking after Iriga-*

ray, edited by Mary Rawlinson, 195–214. Albany: State University of New York Press.
Rodriguez, Stanley, Martha Rodriguez, and Elizabeth Newsome. 2021. "Kelp Road: Kumeyaay Oceanways." *Oceanographic Art and Science: Navigating the Pacific*. https://www.graphicocean.org/work-1/kelp-road.
Roelens, Nathalie. 2019. "The Wave as an Epistemological Challenge Today." Paper presented at Water Logics, Tulane University, New Orleans, April 11–12.
Rogers, W. Erick, and K. Todd Holland. 2009. "A Study of Dissipation of Wind-waves by Mud at Cassino Beach, Brazil: Prediction and Inversion." *Continental Shelf Research* 29, no. 3: 676–90.
Rooijendijk, Cordula. 2009. *Waterwolven: Een geschiedenis van stormvloeden, dijkenbouwers en droogmakers*. Amsterdam: L. J. Veen.
Roosth, Sophia. 2022. "The Sultan and the Golden Spike; or, What Stratigraphers Can Teach Us about Temporality." *Critical Inquiry* 48, no. 4: 697–720.
Rosenthal, Wolfgang, and Susan Lehner. 2008. "Rogue Waves: Results of the MaxWave Project." *Journal of Offshore Mechanical and Architectural Engineering* 130, no. 2: 21006–13.
Ross, John. 2014. *The Forecast for D-Day and the Weatherman behind Ike's Greatest Gamble*. Guilford, CT: Lyons.
Ross, Nancy Wilson. 1943. *The WAVES: The Story of the Girls in Blue*. New York: Henry Holt.
Rotman, Brian. 2000. *Mathematics as Sign: Writing, Imagining, Counting*. Stanford, CA: Stanford University Press.
Rozwadowski, Helen. 2002. *The Sea Knows No Boundaries: A Century of Marine Science under ICES*. Seattle: University of Washington Press.
Rozwadowski, Helen. 2004. "Turning Heads: FLIP and the Technological Imagination in Postwar Oceanography." Paper presented at the annual meetings of the History of Science Society, Austin, November 18–21.
Rozwadowksi, Helen. 2005. *Fathoming the Ocean: The Discovery and Exploration of the Deep Sea*. Cambridge, MA: Harvard University Press.
Rozwadowski, Helen. 2010a. "Playing by—and on and under—the Sea: The Importance of Play for Knowing the Ocean." In *Knowing Global Environments: New Historical Perspectives on the Field Sciences*, edited by Jeremy Vetter, 162–89. New Brunswick, NJ: Rutgers University Press.
Rozwadowksi, Helen. 2010b. "Ocean's Depths." *Environmental History* 15: 520–525.
Rozwadowksi, Helen. 2019. *Vast Expanses: A History of the Oceans*. London: Reaktion.
Rozwadowski, Helen M., and David K. van Keuren, eds. 2004. *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*. Sagamore Beach, MA: Science History.
Rueben, M., R. Holman, D. Cox, S. Shin, et al. 2011. "Optical Measurements of Tsunami Inundation through an Urban Waterfront Modeled in a Large-Scale Laboratory Basin." *Coastal Engineering* 58, no. 3: 229–38.
Ruskin, John. 1851. *The Stones of Venice. Volume the First*. London: Smith, Elder & Co.

Russi, Daniela, Patrick ten Brink, Andrew Farmer, Tomas Badura, et al. 2013. *The Economics of Ecosystems and Biodiversity for Water and Wetlands*. London: Institute for European Environmental Policy.

Rust, Stephen. 2013. "Hollywood and Climate Change." In *Ecocinema Theory and Practice*, edited by Stephen Rust, Salma Monani, and Sean Cubitt, 191–211. New York: Routledge.

Saket, Arvin. 2014. "Evaluation of ECMWF Wind Data for Wave Hindcast in Chabahar Zone." Presented at KOZWaves: Kiwi-Oz Waves Conference: First International Australasian Conference on Wave Science, Newcastle, Australia, February 17–19.

Saldanha, Arun. 2007. *Psychedelic White: Goa Trance and the Viscosity of Race*. Minneapolis: University of Minnesota Press.

Sammler, Katherine G. 2019. "The Rising Politics of Sea Level: Demarcating Territory in a Vertically Relative World." *Territory, Politics, Governance* 8, no. 5: 606–20.

Samuels, Richard J. 2013. *3.11: Disaster and Change in Japan*. Ithaca, NY: Cornell University Press.

Samuelson, Meg, and Charne Lavery. 2019. "The Oceanic South." *English Language Notes* 57, no. 1: 37–50.

Santiago-Fandiño, Vicente, Yevgeniy Kontar, and Yoshiyuki Kaneda, eds. 2015. *Post-Tsunami Hazard: Reconstruction and Restoration*. Dordrecht: Springer.

Santos, Boaventura de Sousa. 2018. *The End of the Cognitive Empire: The Coming of Age of Epistemologies of the South*. Durham, NC: Duke University Press.

Sanyal, Debarati. 2021. "Race, Migration, and Security at the Euro-African Border." *Theory & Event* 24, no. 1: 324–55.

Saussure, Ferdinand de. (1915) 1959. *Course in General Linguistics*. Translated from the French by Wade Baskin. New York: Philosophical Library.

Save the Waves. 2016. "#NatureTrumpsWalls: Stop Trump's Irish Wall." Save the Waves. https://www.savethewaves.org/nature-trumps-walls/.

Savelyev, Ivan, and Julian Fuchs. 2018. "Stereo Thermal Marking Velocimetry." *Frontiers in Mechanical Engineering* 4 (February). https://doi.org/10.3389/fmech.2018.00001.

Scammacca, Pietro, and Daniela Zyman. 2020. "The Indian Ocean Contact Zone." Ocean-Archive.org. https://ocean-archive.org/collection/119.

Scanlan, Emma, and Janet Wilson. 2018. "Pacific Waves: Reverberations from Oceania." *Journal of Postcolonial Writing* 54, no. 5: 577–84.

Scaramelli, Caterina. 2019. "The Delta Is Dead: Moral Ecologies of Infrastructure in Turkey." *Cultural Anthropology* 34, no. 3: 388–416.

Scaramelli, Caterina. 2023. "Swamps and Dragons." In *Swamps and the New Imagination: On the Future of Cohabitation in Art, Architecture, and Philosophy*, edited by Nomeda Urbonas, Gediminas Urbonas, and Kristupas Sabolius. Cambridge, MA: MIT Press.

Schama, Simon. 1987. *An Embarrassment of Riches: An Interpretation of Dutch Culture in the Golden Age*. New York: Alfred A. Knopf.

Schild, Jan. 2015. *Leven met het water*. Marken, Netherlands: Stichting Mooi Marken.

Schlee, Susan. 1973. *The Edge of an Unfamiliar World: A History of Oceanography*. New York: E. P. Dutton.

Schilling, Mark. 2015. "In the Cinematic Wake of the Fukushima Nuclear Disaster." *Japan Times*, March 4. https://www.japantimes.co.jp/culture/2015/03/04/films/cinematic-wake-fukushima-nuclear-disaster.

de Schipper, Matthieu A., Sierd de Vries, Gerben Ruessink, and Roeland C. de Zeeuw et al. 2016. "Initial Spreading of a Mega Feeder Nourishment: Observations of the Sand Engine Pilot Project." *Coastal Engineering* 111: 23–38.

Schlangher, Zoë. 2017. "Rogue Scientists Race to Save Climate Data from Trump." *Wired*, January 19. https://www.wired.com/2017/01/rogue-scientists-race-save-climate-data-trump.

Schmitt, Carl. (1950) 2003. *The* Nomos *of the Earth in the International Law of the* Jus Publicum Europaeum. Translated from the German by G. L. Ulmen. New York: Telos.

Schulz, Kathryn. 2015. "The Really Big One." *New Yorker*, July 20, http://www.newyorker.com/magazine/2015/07/20/the-really-big-one.

Schwartz, Hillel. 2011. *Making Noise: From Babel to the Big Bang & Beyond*. New York: Zone Books.

Schweitzer, Albert. 1911. *J. S. Bach*. Translated from the German by Ernest Newman. Leipzig: Breitkopf and Härtel.

Scott, Michael. 2017. "Getting More Real with Wonder: An Afterword." *Journal of Religious and Political Practice* 3, no. 3: 212–29.

Seaver, Nick. 2015. "Bastard Algebra." In *Data, Now Bigger and Better*, edited by Tom Boellstorff and Bill Maurer, 27–46. Chicago: Prickly Paradigm.

Sedley, David. 2005. "Plato's Tsunami." *Hyperboreus* 11: 205–14.

Semedo, Alvaro, Ralf Weisse, Arno Behrens, Andreas Sterl, et al. 2013. "Projection of Global Wave Climate Change toward the End of the Twenty-First Century." *Journal of Climate* 26, no. 21: 8269–88.

Shange, Savannah. 2020. "Comments at *The Case for Letting Anthropology Burn? Race, Racism, and Its Reckoning in American Anthropology*." Webinar sponsored by the Wenner-Gren Foundation for Anthropological Research and the Department of Anthropology, University of California, Los Angeles September 23. https://vimeo.com/461947530.

Sharpe, Christina. 2016. *In the Wake: On Blackness and Being*. Durham, NC: Duke University Press.

Shaw, Rosalind. 1992. "'Nature,' 'Culture' and Disasters: Floods and Gender in Bangladesh." In *Bush Base, Forest Farm: Culture, Environment and Development*, edited by Elisabeth Croll and David Parkin, 200–17. London: Routledge.

Sheen, Ivonne. 2020. "Visions du Réel 2020: Purple Sea de Amel Alzakout y Khaled Abdulwahed." *Desistfilm*, September 5. https://desistfilm.com/visions-du-reel-2020-purple-sea-de-amel-alzakout-y-khaled-abdulwahed.

Shepard, Jim. 2009. "The Netherlands Lives with Water." In *McSweeney's 32: 2024 AD*, edited by Dave Eggers, 189–212. San Francisco: McSweeney's Quarterly Concern.

Sherrif, Abdul. 2010. *Dhow Cultures of the Indian Ocean: Cosmopolitanism, Commerce and Islam*. Oxford: Oxford University Press.

Shewry, Teresa. 2015. *Hope at Sea: Possible Ecologies in Oceanic Literature*. Minneapolis: University of Minnesota Press.

Shiga, John. 2019. "The Nuclear Sensorium: Cold War Nuclear Imperialism and Sensory Violence." *Canadian Journal of Law and Society/Revue Canadienne Droit et Société* 34, no. 2: 281–306.

Shockley, Evie. 2006. *A Half-Red Sea*. Durham, NC: Carolina Wren.

Shockley, Evie. 2011. "African American Poetic Innovation and the Middle Passage." *Contemporary Literature* 52, no. 4: 791–817.

Shor, Elizabeth Noble. 1978. *Scripps Institution of Oceanography: Probing the Oceans, 1936–1976*. San Diego, CA: Tofua.

Shuto, Nobuo, and Koji Fujima. 2009. "A Short History of Tsunami Research and Countermeasures in Japan." *Proceedings of the Japanese Academy, Series B: Physical and Biological Sciences* 85, no. 8: 267–75.

Siegel, Deborah L. 1997. "The Legacy of the Personal: Generating Theory in Feminism's Third Wave." *Hypatia* 12, no. 3: 46–75.

Siegel, Greg. 2014. *Forensic Media: Reconstructing Accidents in Accelerated Modernity*. Durham, NC: Duke University Press.

Siegert, Bernhard. 2014. "The *Chorein* of the Pirate: On the Origin of the Dutch Seascape." *Grey Room* 57: 6–23.

Sinnett, Gregory, and Falk Feddersen. 2014. "The Surf Zone Heat Budget: The Effect of Wave Heating." *Geophysical Research Letters* 41, no. 20: 7217–26.

Sivasundaram, Sujit. 2020. *Waves across the South: A New History of Revolution and Empire*. London: William Collins.

Sloterdijk, Peter. (2004) 2016. *Foams: Spheres, Volume 3: Plural Spherology*. Translated from the German by Wieland Hoban. Cambridge, MA: MIT Press.

Slovic, Scott. 2016. "Seasick among the Waves of Ecocriticism: An Inquiry into Alternative Historiographic Metaphors." In *Environmental Humanities: Voices from the Anthropocene*, edited by Serpil Oppermann and Serenella Iovino, 99–111. Lanham, MD: Rowman and Littlefield.

Smit, Wim A. 1995. "Science, Technology, and the Military: Relations in Transition." In *Handbook of Science and Technology Studies*, edited by Sheila Jasanoff, Gerald E. Markle, James C. Peterson, and Trevor Pinch, 598–626. Thousand Oaks, CA: Sage.

Snider, Robert G. 1961. "The International Indian Ocean Expedition 1959–1964." *Discovery* (March): 114–17.

Snodgrass, F. E., G. W. Groves, K. F. Hasselmann, and G. R. Miller et al. 1966. "Propagation of Ocean Swell across the Pacific." *Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences* 259, no. 1103: 431–97.

Sobchack, Vivian, ed. 2000. *Meta-morphing: Visual Transformation and the Culture of Quick-Change*. Minneapolis: University of Minnesota Press.

Sobczyk, Nick. 2020. "NOAA Watchdog Chides Agency for How It Handled Hurricane Dorian's 'Sharpiegate.'" *Science Insider*, July 10. https://www.science.org/content/article/noaa-watchdog-chides-agency-how-it-handled-hurricane-dorian-s-sharpiegate.

Sobel, Dava. 1995. *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time*. New York: Walker.

Søland, Birgitte. 2000. *Becoming Modern: Young Women and the Reconstruction of Womanhood in the 1920s*. Princeton, NJ: Princeton University Press.

Spencer, Jane. 2007. "Afterword: Feminist Waves." In *Third Wave Feminism: A Critical Exploration*, 2d ed., edited by Stacy Gillis, Gillian Howie, and Rebecca Munford, 298–303. New York: Palgrave Macmillan.

Spigel, Lynn. 2004. "Theorizing the Bachelorette: 'Waves' of Feminist Media Studies." *Signs* 30, no. 1: 1209–21.

Spillers, Hortense J. 1987. "Mama's Baby, Papa's Maybe: An American Grammar Book." *Diacritics* 17, no. 2: 64–81.

Spitz, Julia. 2010. "Nipmucs Add History to Memorial to Deer Island Internment." *Metro West Daily News*, October 24.

Spivak, Gayatri Chakravorty. 2003. *Death of a Discipline*. New York: Columbia University Press.

Srinivas, Tulasi. 2018. *The Cow in the Elevator: An Anthropology of Wonder*. Durham, NC: Duke University Press.

Starosielski, Nicole. 2013. "Beyond Fluidity: A Cultural History of Cinema under Water." In *Ecocinema Theory and Practice*, edited by Stephen Rust, Salma Monani, and Sean Cubitt, 149–68.

Starosielski, Nicole. 2015. *The Undersea Network*. Durham, NC: Duke University Press.

Starosielski, Nicole. 2019. "Infrared." *Environmental Planning D: Society and Space*. https://www.societyandspace.org/articles/infrared.

Steenhuis, Marinke, Lara Voerman, Marlies Noyes, and Joost Emmerik. 2015. *Waterloopkundig Laboratorium: Cultuurhistorische duiding, ruimtelijke analyse en essentiële principes*. Schiedam, Netherlands: SteenhuisMeurs.

Steinberg, Philip E. 2001. *The Social Construction of the Ocean*. Cambridge: Cambridge University Press.

Steinberg, Philip E. 2013. "Of Other Seas: Metaphors and Materialities in Maritime Regions." *Atlantic Studies* 10, no. 2: 156–69.

Steinberg, Philip E., and Kimberly Peters. 2015. "Wet Ontologies, Fluid Spaces: Giving Depth to Volume through Oceanic Thinking." *Environment and Planning D: Society and Space* 33, no. 2: 247–64.

Steinhardt, Stephanie. 2018. "The Instrumented Ocean: How Sensors, Satellites, and Seafloor-Walking Robots Changed What It Means to Study the Sea." PhD diss., Cornell University, Ithaca, NY.

Sterman, Nan, and Will Gullette. 2005. "Munks' Folly: Celebrated Couple's Garden and Sunken Treasure." *San Diego Home/Garden Lifestyles*, August, 62–65, 86–90.

Stewart, Kathleen. 2011. "Atmospheric Attunements." *Environment and Planning D: Society and Space* 29, no. 3: 445–53.

Stoler, Ann Laura. 2001. "Tense and Tender Ties: The Politics of Comparison in North American History and (Post) Colonial Studies." *Journal of American History* 88, no. 3: 829–65.
Stoker, Bram. 1897. *Dracula*. Westminster, UK: Archibald Constable.
Stokes, George. 1847. "On the Theory of Oscillatory Waves." *Transactions of the Cambridge Philosophical Society* 8, no. 287: 441–55.
Stokes, M. D., G. B. Deane, K. Prather, and T. H. Bertram, et al. 2013. "A Marine Aerosol Reference Tank System as a Breaking Wave Analogue for the Production of Foam and Sea-Spray Aerosols." *Atmospheric Measurement Techniques* 6: 1085–94.
Stranger, Mark. 1999. "The Aesthetics of Risk: A Study of Surfing." *International Review for the Sociology of Sport* 34, no. 3: 265–76.
Strathern, Marilyn. 1992. *After Nature: Kinship in the Late Twentieth Century*. Cambridge: Cambridge University Press.
Sturken, Marita, and Simon Leung. 2005. "Displaced Bodies in Residual Spaces." *Public Culture* 17, no. 1: 129–52.
Sturluson, Snorri. (ca. 1200) 1916. *The Prose Edda*. Translated from the Icelandic by Arthur Gilchrist Brodeur. New York: American-Scandinavian Foundation.
Subramaniam, Banu. 2001. "The Aliens Have Landed! Reflections on the Rhetoric of Biological Invasions." *Meridians: Feminism, Race, Transnationalism* 21, no. 1: 26–40.
Subramanian, Ajantha. 2009. *Shorelines: Space and Rights in South India*. Stanford, CA: Stanford University Press.
Subramanian, Lakshmi. 2010. "Commerce, Circulation, and Consumption: Indian Ocean Communities in Historical Perspective." In *Indian Ocean Studies: Cultural, Social, and Political Perspectives*, edited by Shanti Moorthy and Ashraf Jamal, 136–57. London: Routledge.
Sugden, Edward. 2018. *Emergent Worlds: Alternative States in Nineteenth-Century American Culture*. New York: New York University Press.
Supper, Alexandra. 2015. "Data Karaoke: Sensory and Bodily Skills in Conference Presentations." *Science as Culture* 24, no. 4: 436–57.
Sutherland, P., and W. K. Melville. 2013. "Field Measurements and Scaling of Ocean Surface Wave-Breaking Statistics." *Geophysical Research Letters* 40: 3074–79.
Sverdrup, Harald, Martin W. Johnson, and Richard H. Fleming. 1942. *The Oceans: Their Physics, Chemistry, and General Biology*. New York: Prentice-Hall.
Sverdrup, Harald, and Walter Munk. 1943. *Wind, Waves and Swell: A Basic Theory for Forecasting*. La Jolla, CA: Scripps Institution of Oceanography.
SWAMP Group. 1985. *Ocean Wave Modeling*. New York: Plenum.
Swapna, P., J. Jyoti, R. Krisgnan, N. Sandeep, and S. M. Griffies. 2017. "Multidecadal Weakening of Indian Summer Monsoon Circulation Induces an Increasing Northern Indian Ocean Sea Level." *Geophysical Research Letters* 44, no. 20: 10560–72.
TallBear, Kim. 2011. "Why Interspecies Thinking Needs Indigenous Standpoints." *Fieldsights*, November 18. https://culanth.org/fieldsights/why-interspecies-thinking-needs-indigenous-standpoints.
Taussig, Karen-Sue. 2009. *Ordinary Genomes: Science, Citizenship, and Genetic Identities*. Durham, NC: Duke University Press.

Taylor, Ula Y. 1998. "Making Waves: The Theory and Practice of Black Feminism." *Black Scholar* 28, no. 2: 18–28.

Taylor, G. I. 1938. "The Spectrum of Turbulence." *Proceedings of the Royal Society of London, Series A: Mathematical and Physical Sciences* 164: 476–90.

TeBrake, William H. 2002. "Taming the Waterwolf: Hydraulic Engineering and Water Management in the Netherlands during the Middle Ages." *Technology and Culture* 43, no. 3: 475–99.

Temmerman, Stijn, Patrick Meire, Tjeerd J. Bouma, Peter M. J. Herman, et al. 2013. "Ecosystem-based Coastal Defence in the Face of Global Change." *Nature* 504: 79–83.

ten Bos, René. 2009. "Towards an Amphibious Anthropology: Water and Peter Sloterdijk." *Environment and Planning D: Society and Space* 27, no. 9: 73–86.

Theweleit, Klaus. 1987. *Male Fantasies, Volume 1: Women, Floods, Bodies, History*. Minneapolis: University of Minnesota Press.

Thompson, Rachel. 2018. "A Dutch Garuda to Save Jakarta? Excavating the NCICD Master Plan's Socio-environmental Conditions of Possibility." In *Jakarta: Claiming Spaces and Rights in the City*, edited by Jörgen Hellman, Marie Thynell, and Roanne van Voorst, 138–56. London: Routledge.

Thorade, Henri. 1931. *Probleme der Wasserwellen*. Hamburg: Henri Grand.

Thornberry-Ehrlich, Trista L. 2017. *Boston Harbor Islands National Recreation Area: Geologic Resources Inventory Report*. Natural Resource Report NPS/NRSS/GRD/NRR—2017/1404. Fort Collins, CO: National Park Service, US Department of the Interior.

Thorpe, Steve. 2010. "Internal Waves and All That." In *Of Seas and Ships and Scientists: The Remarkable Story of the UK's National Institute of Oceanography*, edited by Anthony Laughton, John Gould, 'Tom' Tucker, and Howard Roe, 140–47. Cambridge: Lutterworth.

Tierney Kathleen, Christine Bevc, and Erica Kuligowski. 2006. "Metaphors Matter: Disaster Myths, Media Frames, and Their Consequences in Hurricane Katrina." *Annals of the American Academy of Political and Social Science* 604, no. 1: 57–81.

Tingley, Kim. 2016. "The Secrets of the Wave Pilots." *New York Times*, March 17. https://www.nytimes.com/2016/03/20/magazine/the-secrets-of-the-wave-pilots.html.

Todd, Zoe. 2015. "Indigenizing the Anthropocene." In *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies*, edited by Heather Davis and Etienne Turpin, 241–54. London: Open Humanities Press.

Toffler, Alvin. 1980. *The Third Wave*. New York: William Morrow.

Tolman, Hendrik L. 1989. "The Numerical Model WAVEWATCH: A Third Generation Model for Hindcasting of Wind Waves on Tides in Shelf Seas." Communications on Hydraulic and Geotechnical Engineering, report no. 89–2. Department of Civil Engineering Group, Delft University of Technology, Netherlands.

Tolman, Hendrik L., and Robert W. Grumbine. 2013. "Holistic Genetic Optimization of a Generalized Multiple Discrete Interaction Approximation for Wind Waves." *Ocean Modelling* 70: 25–37.

Tompkins, Dave. 2017. "*Moonlight*'s Forgotten Frequencies: How Miami Bass, Ocean Waves, and Pirate Radio Shaped the Film." *MTV News*, February 23. https://www.mtv.com/news/mbfohf/moonlight-forgotten-frequencies.

Toop, David. 1995. *Ocean of Sound: Aether Talk, Ambient Sound and Imaginary Worlds*. London: Serpent's Tail.

Traufetter, Gerald. 2008. "The Dutch Simulate Their Demise." Translated by Christopher Sultan. *Der Spiegel*, November 14. http://m.spiegel.de/international/europe/a-590489.html.

Trautmann, Thomas R. 1992. "The Revolution in Ethnological Time." *Man* 27, no. 2: 379–97.

Traweek, Sharon. 1988. *Beamtimes and Lifetimes: The World of High Energy Physicists*. Cambridge, MA: Harvard University Press.

Trower, Shelly. 2019. "Peripheral Vibrations." In *Unsound: Undead*, edited by Steve Goodman, Toby Heys, and Eleni Ikoniadou, 19–22. Falmouth, UK: Urbanomic.

Tsing, Anna. 2012. "On Nonscalability: The Living World Is Not Amenable to Precision-Nested Scales." *Common Knowledge* 18, no. 3: 505–24.

Tsing, Anna, Andrew Mathews, and Nils Bubandt. 2019. "Patchy Anthropocene: Landscape Structure, Multispecies History, and the Retooling of Anthropology." *Current Anthropology* 60 (Supplement 20): S186–97.

Tsutsui, William M. 2013. "The Pelagic Empire: Reconsidering Japanese Expansion." In *Japan at Nature's Edge: The Environmental Context of a Global Power*, edited by Ian Jared Miller, Julia Adeney Thomas, and Brett L. Walker, 21–38. Honolulu: University of Hawai'i Press.

Tucker, Tom. 2010. "Applied Wave Research." In *Of Seas and Ships and Scientists: The Remarkable Story of the UK's National Institute of Oceanography*, edited by Anthony Laughton, John Gould, 'Tom' Tucker, and Howard Roe, 182–90. Cambridge: Lutterworth.

Tukey, John W., and Richard W. Hamming. 1949. "Measuring Noise Color 1." *Memorandum MM-49–110–119*. Murray Hill, NJ: Bell Telephone Laboratory.

Turner, Sharon. 1820. *History of the Anglo-Saxons from the Earliest Period to the Norman Conquest*, 3d ed. London: Longman, Hurst, Rees, Orme, and Brown.

Turner, Victor. 1966. *The Ritual Process: Structure and Anti-Structure*. Ithaca, NY: Cornell University Press.

Valentine, David. 2017. "Gravity Fixes: Habituating to the Human on Mars and Island Three." *HAU: Journal of Ethnographic Theory* 7, no. 3: 185–209.

van Boxsel, Matthijs. 2004. "Birth of the Water Wolf." *De Gids* 167, nos. 5–6: 30–36.

van den Vondel, Joost. 1641. "Aan den Leeuw van Holland." In *Provisionneel Concept Ontwerp ende Voorslach dienende tot de bedyckinge van de groote Water Meeren*. Amsterdam.

van der Cammen, Hans, and Len de Klerk. 2012. *The Selfmade Land: Culture and Evolution of Urban and Regional Planning in the Netherlands*. Antwerp: Spectrum.

van der Heiden, Henri J. L. 2019. "Modelling Viscous Effects in Offshore Flow Problems: A Numerical Study." PhD diss., University of Groningen, Groningen, Netherlands.

van der Molen, Karin, ed. 2012. *Drift: Art in Nature Laboratory*. Blankenham, Netherlands: Stichting ReRun Producties.
van de Stadt, Leontine. 2013. *Nederland in 7 Overstromingen*. Zuphen, Netherlands: Walburg Pers.
van Dijk, Tomas. 2012. "Sand Engine Quells the Coast's Hunger for Sand." *Delft Outlook* 1: 6–9.
van Gent, Marcel R. A. 2015. "The New Delta Flume for Large-Scale Testing." *Proceedings of the 36th IAHR World Congress (The Hague)*: 2811–20.
van Keuren, David K. 2000. "Building a New Foundation for the Ocean Sciences: The National Science Foundation and Oceanography, 1951–1965." *Earth Sciences History* 19, no. 1: 90–109.
van Looy, Rein. 1955. *Sijtje en het Klompenland*. Gorssel, Netherlands: Terra Nostra.
van Veen, Johan. 1962. *Dredge Drain Reclaim! The Art of a Nation*. The Hague: Martinus Nijhoff.
van Vledder, Gerbrant. 2006. "The WRT Method for the Computation of Non-linear Four-Wave Interactions in Discrete Spectral Wave Models." *Coastal Engineering* 53, no. 2-3: 223–42.
van Vledder, Gerbrant. 2017. "The Book of Waves by Dolph Kessler." In *The Wave: Crossing the Atlantic*, by Dolph Kessler, 97–101. Oentsjerk, Netherlands: Mauritsheech.
Vardy, Mark. 2020. "Relational Agility: Visualizing Near-Real-Time Arctic Sea Ice Data as a Proxy for Climate Change." *Social Studies of Science* 50, no. 5: 802–20.
Vaughn, Sarah E. 2017. "Disappearing Mangroves: The Epistemic Politics of Climate Adaptation in Guyana." *Cultural Anthropology* 32, no. 2: 242–68.
Vierlingh, Andries. (1579) 1920. *Tractaet van Dyckagie.* Den Haag and Rotterdam: Martinus Nijhoff, Nederlandse Vereniging Kust en Oeverwerken.
Vigoureux, P., and J. B. Hersey. (1962) 2005. "Sound in the Sea." In *The Sea: Ideas and Observations on Progress in the Study of the Seas, Volume 1: Physical Oceanography*, edited by M. N. Hill, 476–97. Cambridge, MA: Harvard University Press.
Vink, Markus P. M. 2007. "Indian Ocean Studies and the 'New Thalassology.'" *Journal of Global History* 2: 41–62.
Vissering, G. 1916. *De watervloed van 13–14 Januari 1916*. Leiden: E. J. Brill.
von Storch, Hans, and Klaus Hasselmann. 2010. *Seventy Years of Exploration in Oceanography: A Prolonged Weekend Discussion with Walter Munk*. Berlin: Springer.
Wagner, Roy. 2001. *An Anthropology of the Subject: Holographic Worldview in New Guinea and Its Meaning and Significance for the World of Anthropology*. Berkeley: University of California Press.
Waitt, Gordon. 2008. "Killing Waves: Surfing, Space, and Gender." *Social and Cultural Geography* 9, no. 1: 75–94.
Walcott, Derek. 1978. "The Sea Is History." *Paris Review* 74. https://www.theparisreview.org/poetry/7020/the-sea-is-history-derek-walcott.
Walker, Isaiah Helelkunihi. 2011. *Waves of Resistance: Surfing and History in Twentieth-Century Hawai'i*. Honolulu: University of Hawai'i Press.
Wang, Chunzai, Liping Zhang, Sang-Ki Lee, Lixin Wu, and Carlos R. Mechoso. 2014. "A Global Perspective on CMIP5 Climate Model Biases." *Nature Climate Change* 4: 201–5.

Wang, Qing, Denny P. Alappattu, Stephanie Billingsley, Byron Blomquist, et al. 2018. "CASPER: Coupled Air-Sea Processes and Electromagnetic Ducting Research." *Bulletin of the American Meteorological Society* 99, no. 7 (July): 1449–71.

Wang, Qing, Robert J. Burkholder, Caglar Yardim, and Denny P. Alappattu, et al. 2019. "Sampling Spatial-Temporal Variability of Electromagnetic Propagation in CASPER-West." Keynote talk at the Thirteenth European Conference on Antennas and Propagation, March 31–April 5, Krakow, Poland.

Waterhouse, Amy F., Jennifer A. MacKinnon, Ruth C. Musgrave, and Samuel M. Kelly, et al. 2017. "Internal Tide Convergence and Mixing in a Submarine Canyon." *Journal of Physical Oceanography* 47, no. 2: 303–22.

Waters, Hannah. 2012. "FLIP: The FLoating Instrument Platform." *Smithsonian Ocean*, https://ocean.si.edu/human-connections/exploration/flip-floating-instrument-platform.

Watts, Laura. 2018. *Energy at the End of the World: An Orkney Islands Saga*. Cambridge, MA: MIT Press.

Watts, Laura, and Brit Ross Winthereik. 2018. "Ocean Energy at the Edge." In *Ocean Energy: Governance Challenges for Wave and Tidal Stream Technologies*, edited by Glen Wright, Sandy Kerr, and Kate Johnson, 229–46. New York: Routledge.

Weiner, Melissa F., and Antonio Carmona Báez, eds. 2018. *Smash the Pillars: Decoloniality and the Imaginary of Color in the Dutch Kingdom*. Lanham, MD: Lexington.

Wekker, Gloria. 2016. *White Innocence: Paradoxes of Colonialism and Race*. Durham, NC: Duke University Press.

Wenzel, Jennifer. 2014. "Planet vs Globe." *English Language Notes* 52, no. 1: 19–30.

Wesselink, Anna J., Wiebe E. Bijker, Huib J. de Vriend, and Maarten S. Krol. 2007. "Dutch Dealings with the Delta." *Nature and Culture* 2, no. 2: 188–209.

Westcott, Kathryn. 2011. "Is King Canute Misunderstood?" *BBC News Magazine*, 26 May, http://www.bbc.com/news/magazine-13524677.

Weston, Kath. 2002. *Gender in Real Time: Power and Transience in a Visual Age*. New York: Routledge.

Weston, Kath. 2017. *Animate Planet: Making Visceral Sense of Living in a High-Tech, Ecologically Damaged World*. Durham, NC: Duke University Press.

Whissel, Kristen. 2014. *Spectacular Digital Effects: CGI and Contemporary Cinema*. Durham, NC: Duke University Press.

White, Richard. 1995. *The Organic Machine: The Remaking of the Columbia River*. New York: Hill and Wang.

Wielenga, Friso. (2012) 2015. *A History of the Netherlands: From the Sixteenth Century to the Present Day*. Translated by Lynne Richards. London: Bloomsbury.

Wilensky, Hiroko. 2012. "Disaster Symbols and Cultural Responses." *International Reports on Socio-Informatics* 9, no. 2: 67–73.

Willet, Julie A. 2000. *Permanent Waves: The Making of the American Beauty Shop*. New York: New York University Press.

Wills, Clair. 2000. "Let Eriny Remember." *Times Literary Supplement*, no. 5070, June 2, 6.

Wilts, Alexandra. 2017. "Hurricane Irma Has Become So Strong It's Showing Up on Seismometers Used to Detect Earthquakes." *Independent*, September 5. https://www.independent.co.uk/news/world/americas/irma-hurricane-strength-category-earthquake-measurement-seismometer-a7931286.html.

Winkler, Raimund. 1901. "On Sea Charts Formerly Used in the Marshall Islands, with Notices on the Navigation of these Islanders in General." In *Annual Report of the Smithsonian Institution for the Year Ending June 30, 1899* 54: 487–508.

Winsberg, Eric. 2010. *Science in the Age of Computer Simulation*. Chicago: University of Chicago Press.

Winthereik, Brit Ross. 2019. "Is ANT's Radical Empiricism Ethnographic?" In *The Routledge Companion to Actor-Network Theory*, edited by Anders Blok, Ignacio Farias, and Celia Roberts, 24–33. London: Routledge.

Wittgenstein, Ludwig. 1953. *Philosophical Investigations*. Translated from the German by G. E. M. Anscombe. New York: Macmillan.

Wolfe, Cary. 2009. *What Is Posthumanism?* Minneapolis: University of Minnesota Press.

Wolfenstein, Eugene Victor. 2000. *Inside/Outside Nietzsche: Psychoanalytic Explorations*. Ithaca, NY: Cornell University Press.

Wood, Marcus. 2000. *Blind Memory: Visual Representations of Slavery in England and America 1780–1865.* Manchester: Manchester University Press.

Woods, Austin. 2006. *Medium-range Weather Prediction: The European Approach*. New York: Springer Science and Business Media.

Woolf, Virginia. 1931. *The Waves*. London: Hogarth.

Wooster, Warren S. 1965. "Indian Ocean Expedition." *Science* 150: 290–92.

Woznik, Bear, with Lou Aronica. 2012. *Deep in the Wave: A Surfing Guide to the Soul.* New York: Hachette.

Wylie, Alison. 2006. "Afterword: On Waves." In *Feminist Anthropology: Past, Present, and Future*, edited by Pamela L. Geller and Miranda K. Stockett, 167–76. Philadelphia: University of Pennsylvania Press.

Wyman, Kristen. 2010. "Remembering Deer Island." Interviewed by J. Kēhaulani Kauanui, *Indigenous Politics: From Native New England and Beyond* radio show, http://www.indigenouspolitics.com.

Yeh, Harry, Shinji Sato, and Yoshimitsu Tajima. 2011. "Waveform Evolution of the 2011 East Japan Tsunami." In *Proceedings of the Sixth International Conference on Asian and Pacific Coasts*, edited by Joseph Hun-Wei Lee and Chiu-On Ng, 131–138. Singapore: World Scientific.

Yuill, Simon. 2008. "Concurrent Version System." In *Software Studies: A Lexicon*, edited by Matthew Fuller, 64–69. Cambridge, MA: MIT Press.

Yusoff, Kathryn. 2018. *A Billion Black Anthropocenes or None*. Minneapolis: University of Minnesota Press.

Zalasiewicz, Jan, and Mark Williams. 2011. "The Anthropocene Ocean in Its Deep Time Context." In *The World Ocean in Globalisation: Climate Change, Sustainable Fisheries, Biodiversity, Shipping, Regional Issues*, edited by Davor Vidas and Peter Johan Schei, 19–35. Leiden: Martinus Nijhoff.

Zee, Jerry C. 2017. "Holding Patterns: Sand and Political Time at China's Desert Shores." *Cultural Anthropology* 32, no. 2: 215–41.
Zirker, J. B. 2013. *The Science of Ocean Waves: Ripples, Tsunamis, and Stormy Seas*. Baltimore, MD: Johns Hopkins University Press.
Zylinska, Joanna. 2014. *Minimal Ethics in the Anthropocene*. Ann Arbor, MI: Open Humanities Press.

INDEX

Page locators in italics refer to figures.

This page intentionally left blank