

CONTENTS

List of Illustrations xi

Preface to the 2026 Paperback Edition xv

Note on Measurements xix

INTRODUCTION

Frankenstein's Weather 1

ONE

The Pompeii of the East 12

TWO

The Little (Volcanic) Ice Age 33

THREE

"This End of the World Weather" 45

FOUR

Blue Death in Bengal 72

FIVE

The Seven Sorrows of Yunnan 97

SIX

The Polar Garden 121

SEVEN

Ice Tsunami in the Alps 150

EIGHT

The Other Irish Famine 171

NINE

Hard Times at Monticello 199

EPILOGUE

Et in Extremis Ego 229

Acknowledgments 235

Notes 237

Bibliography 259

Index 281

INTRODUCTION

FRANKENSTEIN'S WEATHER

The War of Independence between Britain and America provisionally ended with the Treaty of Paris in December 1783. But official ratification of the peace accord was delayed for months by a mix of political logistics and persistent bad weather. The makeshift U.S. capital in Annapolis, Maryland, was snowbound, preventing assembly of congressional delegates to ratify the treaty, while storms and ice across the Atlantic slowed communications between the two governments. At last, on May 13, 1784, Benjamin Franklin, wrangling matters in Paris, was able to send the treaty, signed by King George himself, to the Congress.

Even while scrambling to bring the warring parties to terms, Franklin—tireless and mercurial—found time to reflect on the altered climate of 1783–84 that had played such a complicating role in recent events. “There seems to be a region high in the air over all countries where it is always winter,” he wrote. But perhaps the “universal fog” and cold that had descended from the atmosphere to blanket all Europe might be attributed to volcanic activity, specifically an eruption in nearby Iceland.¹

Franklin’s “Meteorological Imaginations and Conjectures” amounts to no more than a few pages of disconnected thoughts, scribbled amid a high-stakes diplomatic drama. The paper’s unlikely fame as a scientific document rests on its being the first published speculation on the link between volcanism and extreme weather. Franklin hastily sent his

2 INTRODUCTION

paper on meteorology to Manchester, where the local Philosophical Society had awarded him honorary membership. On December 22, 1784, the president of the society rose to speak on Franklin's behalf. No doubt dismayed at the paper's thinness, he had no choice but to read the "conjectures" of the society's celebrated new member to the crowded assembly. There, in a freezing Manchester public hall, the theory that volcanic eruptions are capable of wreaking climate havoc was given its first public utterance.

No one believed it for a moment. Even as the hall emptied, Franklin's idea had entered the long oblivion of prematurely announced truths. But, of course, he was right. The eruption of the Iceland volcano Laki in June 1783 brought abrupt cooling, crop failures, and misery to Europe the following year, and created dangerously icy conditions for Atlantic shipping. Even so, Laki did not go global. Latitude is critical to the relation between volcanic eruptions and climate. As a high northern volcano, Laki's ejecta did not penetrate the trans-hemispheric currents of the planet's climate system, and its meteorological impacts were confined to the North Atlantic and Europe.

Two hundred years ago, no one—not even Benjamin Franklin—had grasped the potential global impact of volcanic emissions from the *tropics*, where, two decades after Laki, planet Earth's greatest eruption of the millennium took place. When Mount Tambora—located on Sumbawa Island in the East Indies—blew itself up with apocalyptic force in April 1815, no one linked that single, barely reported geological event with the cascading worldwide weather disasters in its three-year wake.

Within weeks, Tambora's stratospheric ash cloud had circled the planet at the equator, from where it embarked on a slow-moving sabotage of the global climate system at all latitudes. Five months after the eruption, in September 1815, meteorological enthusiast Thomas Forster observed strange, spectacular sunsets over Tunbridge Wells near London. "Fair dry day," he wrote in his weather diary—but "at sunset a fine red blush marked by diverging red and blue bars."² Artists across Europe took note of the changed atmosphere. William Turner drew vivid red skylscapes that, in their coloristic abstraction, seem like an advertise-

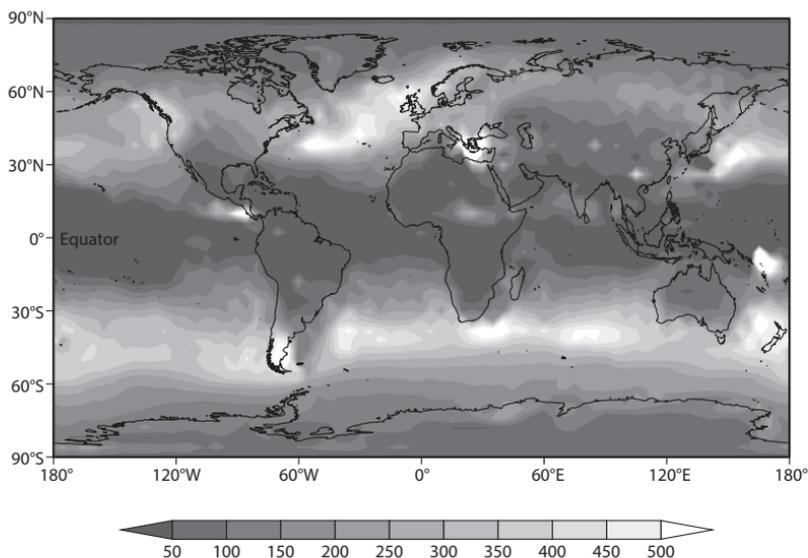


FIGURE 0.1. This 2007 model of Tambora's sulfate cloud shows its global reach, with a band of high aerosol concentration at mid- to high latitudes in both hemispheres, notably over the North Atlantic and Western Europe. This model situates the volcanic cloud in the stratosphere, 24–32 kilometers above the Earth. (Chaochao Gao, "Atmospheric Volcanic Loading Derived from Bipolar Ice Cores: Accounting for the Spatial Distribution of Volcanic Deposition," *Journal of Geophysical Research* 112 [2007]: D09109; © American Geophysical Union).

ment for the future of art. Meanwhile, from his studio on Greifswald Harbor in Germany, Caspar David Friedrich painted a sky with a chromic density that—one scientific study has found—corresponds to the "optical aerosol depth" of the colossal volcanic eruption that year.³

Forster, Turner, and Friedrich—all committed skywatchers—saw the imprint of major atmospheric changes in the North Atlantic. But neither Forster's London sky "on fire" in September 1815 nor the nearly three years of destructive global cooling that ensued inspired anyone to the realization that a faraway volcanic eruption had caused it all. Not until the Cold War—and the development of meteorological instruments to measure nuclear fallout—did scientists begin study of the atmospheric residency of volcanic aerosols. The sun-blocking dust veil



FIGURE 0.2. Caspar David Friedrich, *Ships in the Harbor* (1816). Sanssouci Palace, Potsdam. (© Erich Lessing/Art Resource, NY).

of a major eruption, it was concluded, might linger above the earth for up to three years. Two centuries after Franklin's first tentative speculations, the geophysical chain linking volcanism and climate could at last be proven.

I dwell on this point for good reason. The formidable, occasionally mind-bending challenge in writing this book has been to trace cataclysmic world events the cause of which the historical actors themselves were ignorant. Generations of historians since have done little better. The Tamboran climate emergency followed hard upon the devastations of the Napoleonic Wars and has always remained in the shadows of that epochal conflict. Out of sight and out of mind, Tambora was the volcanic stealth bomber of the early nineteenth-century. Be it the retching cholera victim in Calcutta, the starving peasant children of Yunnan or County Tyrone, the hopeful explorer of a Northwest Passage through the Arctic Ocean, or the bankrupt land speculator in Baltimore, the world's residents were oblivious to the volcanic drivings of their fate. Equally challenging for me as an environmental historian has been to capture the physically remote relation between cause and effect in measuring Tambora's impact on the global commons of the nineteenth century. Volcanic strife traveled great distances and via obscure agents. But it is only by tracing such "teleconnections"—a guiding principle of today's climate and ecological sciences—that the *worldwide* tragedy of Tambora can be rescued from its two-century oblivion.

Climate change is hard to see and no less difficult to imagine. After a day's climb through the dense forests of Sumbawa Island, drenched in tropical rains, I almost didn't succeed in seeing at firsthand the great Tambora's evacuated peak. Then, at daybreak on the second morning, the clouds suddenly lifted, and we were able to complete our ascent along the treeless ridges. Nearing the summit, we clambered over flat pool tables of tan, serrated rock and left our boot prints in the black volcanic sand. Almost without warning, we found ourselves at the rim of a great inverted dome of earth, with sheer rock walls leading down to a pearl-green lake a kilometer below. My camera whirred as puff-clouds of sulfur performed lazy inversions in the still, separate universe



FIGURE 0.3. Tambora's caldera. The morning this photograph was taken (March 3, 2011), the mountain rumbled and the odor of sulfur was palpable. A few weeks later, the volcano began belching ash and smoke. By September that year, Indonesian seismologists had ordered evacuation of the surrounding area. Volcanologists do not expect an imminent eruption, however, on account of the geologically recent 1815 event. (Author photo).

of Tambora's yawning caldera. Its six-kilometer diameter might as well have been a thousand. My swimming eyes performed no better than my camera in taking measure of the volcano's unhealed intestinal canyon, let alone in imagining its once pristine peak a mile above me in what was now open sky. Sleepless and damp in our tents the night before, we had felt rumblings from deep in the earth. Now, we smelled the distinct odor of sulfur in the morning air. Looking down for a moment to recover my senses, I realized I was standing on a sponge-like rock that, but a blink before in geological time, had been adrift among the brewing magma of Tambora's subterranean chamber.

Gazing out across that dizzying crater, I felt no better equipped than pioneer meteorologist Thomas Forster in 1815 to grasp the catastrophic

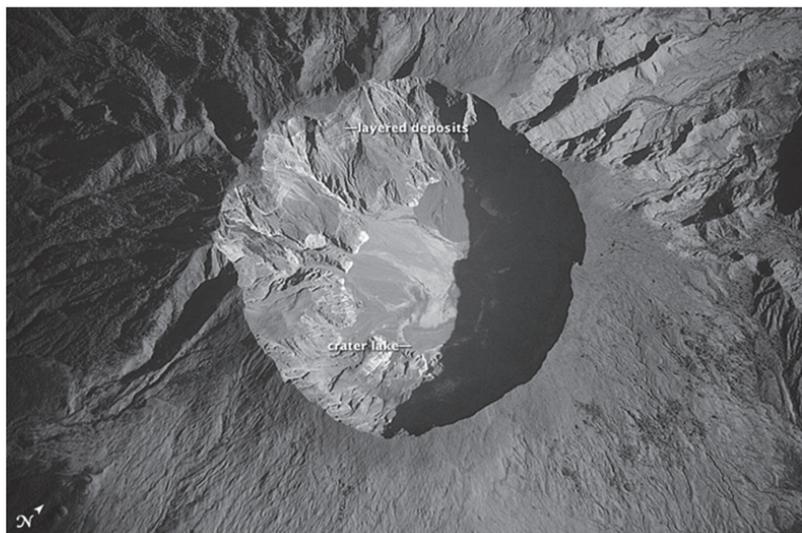


FIGURE 0.4. An aerial view of Tambora's caldera taken from the International Space Station shows its terrific, lunar-like dimensions. (NASA).

impact of a single mountain's explosion on the history of the modern world. It was a calm sunrise. The straits of Teluk Saleh to the south came into view over the treetops, its postcard blue waters dotted with islands in the milky sunlight. Stretching behind us, the forests of the Sanggar peninsula appeared at perfect peace. Did an event of world-changing violence truly happen here? Like the shivering audience in that Manchester hall two centuries ago, trying to make sense of Franklin's ramblings about cold weather and an Iceland volcano, I could hardly believe in Tambora's global reach.

It has taken five years of research into the science of volcanism and climate, collaboration with scholars across many disciplines, and much dogged detective work to remake that morning's ascent of Tambora in my imagination: to articulate, in book-length form, the years-long impact of the massive 1815 eruption on the world in the critical period after the Napoleonic Wars. Unlike Benjamin Franklin and Thomas Forster, I have had the advantage of modern scientific instruments and data through which to "see" the otherwise invisible teleconnections linking

tropical eruptions, climate change, and human affairs. Climbing Tambora, by this route, one could not mistake its greatness.

Tambora belongs to a dense volcanic cluster along the Sunda arc of the Indonesian archipelago. This east-west ridge of volcanoes is a segment, in turn, of the much larger Ring of Fire, a hemisphere-girdling string of volcanic mountains bordering the Pacific Ocean from the southern tip of Chile, to Mount St. Helens in Washington State, to picturesque Mount Fuji in Japan, to Tambora's near neighbor Krakatau, due to explode into global fame in 1883. Along its almost 40,000 kilometers length, the Ring of Fire boasts lofty, cone-topped volcanoes located exclusively on coastlines and islands. Tambora sits some 330 kilometers north of a tectonic ridge in the trans-Pacific Ring of Fire known as the Java Trench, which marks a curvilinear course south of the islands of Sumbawa and its neighbors Lombok and Sumba.

After perhaps a thousand years' dormancy, Tambora's devastating evacuation and collapse in April 1815 required only a few days. It was the concentrated energy of this event that was to have the greatest human impact. By shooting its contents into the stratosphere with such biblical force, Tambora ensured its volcanic gases reached sufficient height to seriously disable the seasonal rhythms of the global climate system, throwing human communities worldwide into chaos. The sun-dimming stratospheric aerosols produced by Tambora's eruption in 1815 spawned the most devastating, sustained period of extreme weather seen on our planet in perhaps thousands of years.

A dramatic story unto itself. But a more urgent motivation has driven my history of Tambora. The great Sumbawan volcano is the *most recent* volcanic eruption to have had a dramatic impact on global climate. Considered on a geological timescale, Tambora stands almost insistently near to us, begging to be studied. On the eve of Tambora's bicentenary and facing multiplying extreme weather crises of our own, its eruption looms as the richest case study we have for understanding how abrupt shifts in climate affect human societies on global scales and decadal time frames. The Tambora climate emergency of 1815–18 offers us a rare, clear window onto a world convulsed by weather extremes, with human communities everywhere struggling to adapt to sudden,

radical shifts in temperatures and rainfall, and a flow-on tsunami of famine, disease, dislocation, and unrest.

For three years following Tambora's explosion, to be alive, almost anywhere in the world, meant to be hungry. In New England, 1816 was nicknamed the "Year without a Summer" or "Eighteen-Hundred-and-Froze-to-Death." Germans called 1817 the "Year of the Beggar." Across the globe, harvests perished in frost and drought or were washed away by flooding rains. Villagers in Vermont survived on porcupine and boiled nettles, while the peasants of Yunnan in China sucked on white clay. Summer tourists traveling in France mistook beggars crowding the roads for armies on the march.

One such group of English tourists, at their lakeside villa near Geneva, passed the cold, crop-killing days by the fire exchanging ghost stories. Mary Shelley's storm-lashed novel *Frankenstein* bears the imprint of the Tambora summer of 1816, and her literary coterie—which included the poets Percy Shelley and Lord Byron—will serve as our occasional tour guides through the suffering worldscape of 1815–18. As one literary historian has observed, "there was never a more documented group of people" than Mary Shelley's circle of friends and lovers. The paper trail of impressions they left of the late 1810s will lead us back again and again to Tambora.⁴

In the early nineteenth century, the overwhelming majority of the world's population were subject (unlike Dr. Frankenstein) to the unforgiving regime of nature: most people depended on subsistence agriculture, living precariously from harvest to harvest. When crops worldwide failed in 1816, and again the next year, starving rural legions from Indonesia to Ireland swarmed out of the countryside to market towns to beg for alms or sell their children in exchange for food. Famine-friendly diseases, cholera and typhus, stalked the globe from India to Italy, while the price of bread and rice, the world's staple foods, skyrocketed with no relief in sight.

Across a European continent ravaged by the Napoleonic Wars, tens of thousands of demobilized veterans found themselves unable to feed their families. They gave vent to their desperation in town-square riots

10 INTRODUCTION

and military-style campaigns of arson, while governments everywhere feared revolution. Human tragedies rarely unfold without blessings to some. During this prolonged global dearth that ended only with the bumper harvests of 1818, farmers in Russia and the American western frontier flourished as never before, selling their grain at stratospheric prices to desperate buyers in the Atlantic trade zone. But for most people, worldwide, this was “the worst of times.”

Tambora’s aftermath, particularly the “Year without a Summer,” 1816, is rich in folklore and continues to be the subject of popular histories. But these accounts are confined to 1816 and to Tambora’s impacts in Europe and North America.⁵ None has engaged seriously with the robust and ever-increasing scientific literature on Tambora, volcanism, and global climate change. I learned about Mount Tambora in an atmospheric science seminar, not from a history book, and my first exhilarated thought was it was high time historians caught up with the climatologists on Tambora. This book, through all the byways of its creation, remains the product of that initial inspiration. *Tambora* is the first study of this iconic period to marry a volcanological account of the 1815 eruption with both the folklore of the “Year without a Summer” and the full range of biophysical sciences relevant to climate change. It is the first to treat the Tambora event not as the natural disaster of a single year, 1816, but as a three-year episode of drastic climate change whose downstream effects can be traced long into the nineteenth century.

I focus here on the human story of Tambora’s aftermath, while my engagement with the detailed discussion of the volcano to be found in recent scientific literature allows me to tell that story on multiple spatial scales, from the molecular to the global. My emphasis, from the point of view of method, is less on nature’s impact on history—far less a crude environmental determinism—but on Tambora as a case study in the fragile interdependence of human and natural systems. Put another way, this book considers the disparate human communities of 1815–18—and the climatic zones to which they were adapted—as a single, anthro-ecological world system on which Tambora acted as a massive, traumatic perturbation. After April 1815, many human societies were “changed, changed utterly”—to borrow from the poet

W. B. Yeats—altered, in radical ways, from their pre-eruption state. I have not traveled, in my fieldwork and research, to all continents. In some areas of the globe—notably Africa, Australia, and Latin America—the contemporary data are thin or archives nonexistent. But *Tambora* offers a rich and unique travelogue nonetheless, traversing the hemispheres to trace this epochal eruption's shaping hand on human history.

Across Asia, for example—whose Tambora story has never been told—the volcano's effects were arguably the most devastating of all. A celebrated ancient genre of Chinese verse is called Poetry of the Seven Sorrows. In a Seven Sorrows poem, the poet dramatizes the five bodily senses under assault, overlaid with the twin mental afflictions of injustice and bitterness: seven sorrows in all. The original work in the genre, from the third century, tells of a man forced by civil war from his home, a kind of Chinese Dante. The sorrowful poet, Wang Can, sees lines of corpses from the road and encounters an anguished woman who has abandoned her child in the barren fields. She cannot feed it, but she loiters nearby, listening to its cries. As we will see in chapter 5, the ancient poetic mode of Seven Sorrows enjoyed a renaissance in China in the Tambora period of 1815–18 because it captured so well the human suffering wrought by three successive years of climatic breakdown. A forgotten Chinese poet named Li Yuyang, it turns out, spoke as movingly as anyone for the weather-devastated world of the late 1810s.

The accounts of environmental breakdown and human tragedy left by survivors such as Li Yuyang must stand in for countless histories of individual and community trauma from the Tambora period that are lost forever. In the aftermath of a mega-disaster such as Tambora, the paucity of victim narratives itself tells us something both of the scale of the cataclysm and who bore the brunt of it: the poor and illiterate peasant millions of the early nineteenth-century world. Just as my vision failed me confronted by the dizzying vortices of Tambora's vast caldera, so a complete panoramic view of the human crises it spawned lies out of reach. But with an eye committed to a twenty-first-century way of seeing—to tracing the complex teleconnections between earth, sky, and the fate of human beings—the haywire story of a two-centuries-old global climate crisis may at last be properly told and with it our own fate, in cautionary ways, foretold.

INDEX

- Account of the Arctic Regions, An* (Scoresby), 126, 135, 136
- Adams, John Quincy, 224
- Agassiz, Louis, 161, 167–68
- agriculture, 29, 156; Alps and, 156, 164; ameliorative effects on climate of, 215; America and, 203–6, 213–17, 221–28; barley, 61, 102, 113, 181; beans, 13, 102, 105, 115, 119; buckwheat, 113; Buffon and, 214; Byron and, 68; climate change and, 216, 232; coffee, 13, 27, 81; corn, 13, 61, 176, 180, 203, 205–6; cotton, 13, 205, 221; droughts and, 9, 24, 39, 54, 57, 82–83, 87, 89–90, 102, 113, 139–40, 203, 205–6, 227–28; Dustbowl and, 257n63; famine and, 62 (*see also* famine); Ireland and, 179–80; Jefferson and, 203, 205–6, 213–17, 221, 225–28; Little Ice Age and, 39; Liverpool and, 62; Monticello and, 203, 206, 217, 221, 223, 224; oats, 61, 176, 178, 203, 206; pepper, 13, 27; potatoes, 61, 176, 180–81, 192, 194–95; prices and, 179–80 (*see also* prices); rice, 9–10, 13–14, 16–20, 23–24, 31, 71, 82, 90, 99, 101–5, 107–11, 113, 119; rye, 203, 222; scientific progress in, 230; Russia and, 10, 63, 198; subsistence, 9, 179; sugar, 27; Sumbawa and, 13; Switzerland and, 62, 64; wheat, 99, 102, 105, 110, 113, 115, 119, 164, 176, 203, 205–6, 214, 221, 222, 226; Williams and, 215; Yunnan and, 99–103, 107–8, 117–20
- AIDS, 93
- algae, 89
- Alps: Agassiz and, 161, 167–68; agriculture and, 156, 164; aquatic submersion and, 162; avalanches and, 46, 152; Chamonix and, 152–56; Charpentier and, 161–62, 167–68, 251n24; erratics and, 166; glaciers of, 129, 150–70; global warming and, 156; Ice Age theory and, 155–60, 162, 166, 168–69; ice dams and, 158, 159–60, 162–64, 166–67; *jökulflaups* and, 159, 162, 170; Mount Le Pleureur and, 159, 161; Perraudin and, 160–62, 164, 166–68; River Dranse and, 159–67; Shelleys and, 45–46, 151–59, 169–70, 206; Swiss Society of Natural Sciences and, 157, 162, 166–67; Tambora's effects on, 45–66, 150–51, 155–56, 159, 162–63, 165, 168–70; Val de Bagnes and, 159–68, 170; Venetz and, 157–58, 160–68, 170; wheat and, 164; storms of, 45–46
- America: agriculture and, 203–6, 213–17, 221–28; Annsville snowstorm and, 200–201; Buffon's theories on, 206–16; climate change and, 206–17, 227–28; climate optimism and, 126–27, 199–200, 212; climate pessimism and, 206, 210–11, 226–28; Cumberland Pike and, 225; drought and, 20–23, 205–6, 227–28; Dustbowl of, 257n63; “Eighteen-Hundred-and-Froze-to-Death” and, 9, 128, 200–206, 217; Era of Good Feelings and, 224; Erie Canal and, 225; famine and, 205, 217, 224–25; Great Depression and, 225; Great Lakes and, 203; Hamiltonian economics and, 225; immigration to, 214, 218–19, 224; as inhospitable continent, 210; Jefferson and, 200, 203, 205–7, 211–28; June 1816 weather in, 203, 215–16; meteorology and, 199, 203, 211, 216–17, 227; Monticello and, 203, 206, 217, 221, 223, 224; panic of 1819 and, 216–26; poverty and, 218, 226; as Promised Land, 217; starvation and, 138, 205, 226; storms and, 200–205, 227; Tambora's effect on, 71, 199–203, 204, 216–27; War of Independence

- America (*cont.*)
and, 1; wheat and, 203, 205–6, 214, 221, 222,
226; Year without a Summer and, 199–200,
203, 225
- American Indians, 212, 219
- Andes, 34
- animal mortality, 18, 178, 229
- Annsville snowstorm, 200–201
- Antarctica, 149
- Anthropocene Period, 232–33, 258n4
- Antoinette, Marie, 35
- Arabian Sea, 78
- Arabs, 26–27, 79, 86
- Arctic: Atlantic Meridional Overturning Circulation (AMOC) and, 137–38, 140, 249n25; Baffin Bay and, 132, 141; Banks and, 121–22, 127–28, 135, 142; Barrow and, 122–34, 141–51; Bering Strait and, 128; British politics and, 121, 131, 148; Buchan and, 126, 131, 133, 141, 144; Canada and, 40, 125, 133, 140–41, 144, 147; climate change and, 121–23, 130–31; Davis Strait and, 132; Denmark and, 128–29; *Frankenstein* and, 146–49, 250n31; Franklin and, 131–32, 144–49, 233; glaciers and, 129; global warming and, 122–31, 133, 146, 150, 258n5; Holocene Period and, 233; icebergs and, 127, 130, 151; Lancaster Sound and, 132, 141–42, 144; Little Ice Age and, 129, 131; Marine Diver and, 135–38; melting ice and, 121, 127, 129–33, 138, 140, 233, 258n5; Melville Bay and, 132; northeast passage and, 128; North Pole and, 48, 134, 137, 140, 147, 168; northwest passage and, 5, 123, 125, 127–29, 132–34, 142–49; Norway and, 129, 149; O'Reilly and, 131–34; Parry and, 131–32, 142–48; Ross and, 126, 131–33, 141–42, 148, 233; Royal Navy and, 121–34, 141–51, 233; Royal Society and, 121, 128, 132; Scoresby and, 125–28, 131–38, 258n5; Tambora's effect on, 121–23, 132, 135, 138–41, 146, 149; von Kotzebue and, 128, 131, 141; whaling and, 125, 127, 135; wind and, 140
- “Arctic Expeditions, The” (Porden), 144
- Arctic Oscillation, 50–51
- ash: Arabian Sea coast studies and, 78; blocked sun and, 3, 5, 22–23, 66–69; Crawford on, 15; fluorine and, 24, 48; P. B. Shelley and, 33; rain and, 12, 16–20, 22–25, 30, 48, 52; sulfate aerosols and, 3, 37, 38, 48, 78–79, 81, 121, 123, 141, 230; sulfur and, 5, 6, 43, 48, 52, 79; Sumbawa and, 12, 15–25, 30; sunsets and, 2, 97; *zaman hujan au* (time of the ash rain) and, 24–25
- Association for the Suppression of Mendicity, 191–92
- Atlantic Meridional Overturning Circulation (AMOC), 137–38, 140, 249n25
- Atlantic Ocean, 1–3, 10; Arctic Oscillation and, 50–51; Arctic studies and, 127, 130, 132, 135, 137–38, 140, 146; eastern U.S. and, 9, 42, 82, 98, 128, 138, 199–205, 210, 215–18, 220, 224, 226, 228; icebergs and, 127, 130, 132; Ireland and, 176; New England seaboard and, 9, 42, 82, 98, 128, 138, 199, 202–5, 215–16, 218, 224; transatlantic trade and, 64, 138, 210, 217, 222, 224, 226, 228, 237n5; zones of, 15, 71, 79, 116, 226
- atmosphere: circulation patterns in, 48–50, 82, 89, 130, 137–40, 249n25; National Center for Atmospheric Research (NCAR) and, 50–51, 81; precipitation patterns and, 49, 217; pressure variables and, 49–51, 80, 99, 140, 177, 202–3; tropopause and, 50; wind and, 49 (*see also* wind)
- atmospheric pressure, 49–51, 80, 99, 140, 177, 202–3
- Austen, Jane, 95, 142, 242n1
- Australia, 11, 42, 134
- automobiles, 229
- avalanches, 46, 152, 218
- bacteria, 88–90, 184
- Baffin Bay, 132, 141
- Bali, 14, 19, 22–24
- Banks, Joseph, 121–22, 127–28, 135, 142
- Barker, Francis, 178, 191–92
- barley, 61, 102, 113, 181
- Barrow, John: Arctic and, 122–34, 141–51; bureaucratic achievements of, 133; *Frankenstein* and, 146–48; global warming and, 123–25, 127, 129–31, 133, 146; journalistic propaganda and, 124; Little Ice Age and, 131; meteorology and, 129–31; northwest passage and, 123, 125, 127–29, 132–34, 142, 144–46, 148–49; Parry and, 142–44; *Quarterly Review* and, 124–25, 129–30, 133, 142, 146–47; Ross and, 141; snubs O'Reilly, 133–34; snubs Ross, 141–42; snubs Scoresby, 126
- Bay of Bengal, 71, 78, 83, 89–91, 99
- Bay of Naples, 35
- beans, 13, 102, 105, 115, 119
- beggars: Association for the Suppression of Mendicity and, 191–92; children and, 63, 172; poverty and, 9, 59, 61, 63–65, 172, 188–93, 225

- Benares* (ship), 21
- Bengal: Calcutta, 5, 73, 81, 83–84, 86–87, 91, 96, 239n21; cholera and, 72–78, 81, 83–96, 123, 178; famine and, 83; Ganges River and, 80–84, 88, 96; *ghauts* and, 81, 83–86; Hastings and, 74; monsoons and, 78–84, 88–91; Ola Bibi and, 83; rice and, 82, 90; *sharif* crop and, 81–82; storms and, 80–83, 99; Tambora's effects on, 71–72, 78–83, 90–91, 96
- Bering Strait, 128
- Betwah (River), 73, 76
- Bible, 44, 49, 53, 57, 68, 121, 162, 165, 178
- bicycles, 229
- Birkbeck, Morris, 218
- "Bitter Famine" (Li Yuyang), 113–14
- Black Death, 94
- black frost, 203
- Black Prophet, The: A Tale of Irish Famine* (Carleton), 173–74, 175, 178, 180, 196
- Bologna Prophecy, 69–71
- Borneo, 22
- Bossons glacier, 153–55, 169
- Brady, David M., 256n35
- Brandes, Heinrich, 59
- bread, 9, 61–62, 112, 176
- Brockedon, William, 164
- Buchan, David, 126, 131, 133, 141, 144
- buckwheat, 113
- Buffon, Comte de (Georges Louis Leclerc): American Indians and, 212; background of, 209; climate change and, 155, 206–16, 226–28; climate pessimism and, 226–28; earth science of, 130–31, 155, 206–16; Enlightenment and, 226; geo-engineering and, 226; "Great Climate Compromise" and, 215; *Histoire Naturelle* and, 208, 213; Jefferson and, 206–7, 211–16, 226–28; New World theories of, 206–16; temperature observations of, 209, 214
- Burma, 91, 98, 119
- Burns, Robert, 172
- Burundi, 183
- Byron, George Gordon, 9, 116; apocalyptic poetry of, 68–69; Arctic and, 148; *Childe Harold's Pilgrimage* and, 46–47, 54, 125; Clairmont and, 45, 51; "Darkness" and, vii, 67–69; death by malaria of, 76–77; famine and, 69; ghost story contest and, 51, 57, 156; global warming and, 156; Polidori and, 51; storms and, 68, 77; Switzerland and, 45–47, 51, 65–67, 69; Tambora and, 47; vampires and, 52–53; Villa Diodati and, 46, 51, 67, 68
- calderas, 5–6, 7, 11, 21
- Cambodia, 14
- Canada: Arctic and, 40, 125, 133, 140–41, 144, 147; cold fronts of, 217; Hudson Bay and, 140–41, 147; immigrants and, 219; snowstorm of 1816 and, 202; Tambora's effects on, 202, 232
- Carleton, William: *The Black Prophet* and, 173–74, 175, 178, 180, 196; despair over countrymen, 173–75, 178; Irish famine and, 173–74, 175, 178, 180, 184, 186, 188, 190, 192, 194–95, 196; typhus and, 184, 186, 188, 190, 192
- Casa Galetti, 76
- Celebes. *See Sulawesi*
- Charpentier, Jean de, 161–62, 167–68, 251n24
- Childe Harold's Pilgrimage* (Byron), 46–47, 54, 125
- children: Annsville storm and, 200–201; beggar, 63, 172; disease and, 74, 188; famine and, 5, 9, 23, 25, 63–65, 98, 109–14, 198
- China, 14, 138, 199; "century of humiliation" of, 106; cholera and, 91; Confucianism and, 98, 106–7, 109–10, 114, 120; Han Chinese and, 100–101, 103; Himalayan plateau and, 82, 99, 102, 115; northwest passage and, 125; opium and, 115–20, 123; Qing dynasty and, 100, 101, 105–13, 117, 120; Yunnan and, 9, 11, 97–120
- cholera, 5; actions of, 77; bacteria and, 88–90; Bengal and, 72–78, 81, 83–96, 123, 178; Calcutta Medical Board and, 87; climate change and, 86–91, 94; Colwell and, 89–90; deities of, 74–5, 83; etiology for, 183; famine and, 9; fecal matter and, 88; Ganges River and, 80–84, 88, 96; global epidemic of, 71, 91–95, 123, 230, 233, 236; Grand Army and, 72–76; great fear of, 75–76, 85–86, 92, 94; International Sanitary Conference and, 93; Jameson and, 87–88, 91, 95, 178; Koch and, 87–88; Medwin on, 76–77; meteorology and, 87–91; nineteenth-century literature on, 72; Pascual and, 89–90; pathogens of, 87–90; plankton and, 88–90; recent research on, 246n25; superstition and, 74–75; temperature and, 90
- Christmas Carol, A* (Dickens), 40
- circulation patterns: atmospheric, 48–50, 82, 89, 130, 137–40; meridional, 48–50, 82, 137–38, 249n25; ocean, 130, 140, 146; thermohaline, 137, 140
- Clairmont, Claire, 45, 51, 76, 115
- climate: ash and, 67 (*see also* ash); Atlantic Meridional Overturning Circulation

climate (*cont.*)

- (AMOC) and, 137–38, 140, 249n25; atmospheric pressure and, 49–51, 80, 99, 119, 136, 140, 177, 202–3; Calcutta Medical Board and, 87, 91; circulation patterns and, 48–50, 82, 89, 130, 137–40, 146, 249n25; coldness of 1810s and, 36–42; droughts and, 9, 24, 39, 54, 57, 82–83, 87, 89–90, 102, 113, 139–40, 203, 205–6, 227–28; Earth's tilt and, 49, 80; El Niño and, 82, 90; eruption of 1258 and, 41, 43–44, 216; eruption of 1809 and, 37–39, 41–43, 58, 216, 241n12; floods and, 9, 20, 39, 46, 54, 56–57, 59–60, 83, 89–90, 102, 105, 107–8, 121, 159–60, 162, 164–67, 169–70, 218, 227–28; “Frankenstein weather” and, 91, 107, 174, 227–28; Franklin’s observation of altered, 1–2; frost and, 9, 37, 39, 58, 60, 98, 102, 105, 127, 130, 142, 147–48, 155, 200–206, 210, 233; glaciers and, 37, 55, 129, 150–70; heat transfer and, 49, 50, 137–38, 140, 249n25; Himalayan, 82, 99, 102, 115; Holocene Period and, 42, 44, 232–33, 241n12; ice core analysis and, 37, 43, 48, 241n12; jet streams and, 50, 203; latitude and, 2, 3, 43, 49–50, 56, 79–80, 91, 98, 101, 122, 130, 137, 139, 150, 203, 209, 234; moderate, 42, 49, 100, 102, 137, 212, 215, 226, 228, 230; optimism and, 126–27, 199–200, 212; pessimism and, 206, 210–11, 226–28; precipitation patterns and, 49, 217; snow and, 1, 37, 42, 45–46, 56–58, 60–61, 67, 98, 102, 105, 115, 130, 144, 147, 151–52, 154, 157, 163, 200–203, 205, 210, 215; solar radiation irregularity and, 40–41; stratospheric effects and, 3, 8, 19, 43, 48, 50, 52, 67, 79, 90, 115, 230; sulfate aerosols and, 3, 37, 38, 48, 78–79, 81, 121, 123, 141, 230; sunspots and, 40–41, 70; Tambora’s effects on, 8 (*see also* Tambora); trade winds and, 19, 23, 78, 82, 99; tree-ring studies and, 24, 43, 82–83, 217, 248n19; volcanism and, 6, 10, 26, 33–34, 43, 235, 238n10 (*see also* volcanoes); weather patterns and, 37, 43, 55, 59, 67, 102, 226; wind and, 49–51, 150, 173, 178; Yunnan and, 98–105; zones of, 10, 15, 71, 79, 82, 91, 99, 138, 216
- climate change: agriculture and, 216, 232; America and, 206–17, 227–28; Arctic and, 121–31, 133, 146, 150, 258n5; Buffon and, 226–28; cholera and, 86–91, 94; Crutzen and, 230, 232; fossil fuels and, 123, 226, 232; geo-engineering solutions to, 230–31; glaciers and, 152, 158, 165–70; global warming and, 123–31, 133, 146, 150, 156, 228, 231, 258n5; “Great Climate Compromise” and, 215; human affairs and, 5–6, 8, 10; Intergovernmental Panel on Climate Change (IPCC) and, 235; Ireland and, 180–81, 184, 195; Little Ice Age and, 41; Medieval Warming Period and, 40; melting ice and, 121, 127, 129–31, 138, 140, 233, 258n5; modern concerns of, 230–35; Pinatubo and, 138–39; refugees and, 216, 218; Royal Society and, 121; scale of threat of, 233; social consequences of, 24, 36, 41, 61–62, 64, 67–69, 71, 86–87, 95, 98, 110, 112, 117, 120, 171, 180, 182, 194–95, 197, 199–200; Sumbawa and, 24; Swiss Society for Natural Science and, 157; trauma from, 59–60, 67, 71, 230–31; Venetz and, 157–58, 160–68, 170; volcanism and, 6, 10, 26, 33–34, 43, 235, 238n10; Yunnan and, 119–20
- climate models, 40, 81
- Climate of London, The* (Howard), 55, 58–59
- coffee, 13, 27, 81
- Cold War, 3
- Coleridge, Samuel Taylor, 39, 51, 60, 70, 99
- colonialism: America and, 205, 209–10, 212; Bengal and, 85, 87, 93–94; Ireland and, 172, 191; Sumbawa and, 17, 27, 29–30; typhus and, 183
- Colwell, Rita R., 89–90
- Committee on Manufactures, 225
- Confucianism, 98, 106–7, 109–10, 114, 120
- Constable, John, 40, 50–51, 60, 174
- Cook, James, 128
- Corbyn, Frederick, 74
- Corinne* (de Staël), 34
- corn, 13, 61, 176, 180, 203, 205–6
- Cortez, Hernán, 128
- Cotopaxi, 34
- cotton, 13, 205, 221, 233
- County Tyrone, 5, 173, 181, 186, 190, 193
- Crater Lake, 21
- Crawford, John, 15
- Croker’s Mountains, 142, 144
- Crutzen, Paul, 230, 232
- Cuvier, Georges, 130
- cyclones, 50, 80
- “Darkness” (Byron), vii, 67–69
- Darwin, Charles, 135, 232
- Davis Strait, 132
- Davy, Humphry, 34
- Day of Judgment, 70
- deforestation, 24–25, 214, 234

- Denmark, 128–29
de Staël, Madame, 34
Dickens, Charles, 40
disease: bacterial, 88–90, 184; Black Death, 94;
children and, 188; cholera, 9, 72–78, 81, 83–96,
123, 178, 183, 230, 233, 236, 246n24, 246n25; ep-
idemics, 71–75, 81, 84–96, 123, 181–97, 230, 233,
236; fecal matter and, 88; Great Famine and,
173, 194, 198 (*see also* famine); International
Sanitary Conference and, 93; lice and, 176,
179, 181–83; malaria, 76–77; pathogens and,
87–90, 180, 183–84; plagues, 44, 78, 92, 95, 183,
190–91; riots and, 94; syphilis, 183; tubercu-
losis, 77, 221; typhus, 9, 66, 69–70, 176, 179,
181–93, 198; yellow fever, 183
Dranse (River), 159–67
Drayton, Michael, 212
drinking water, 7
droughts, 9; America and, 203, 205–6, 227–28;
Bengal and, 82–83, 87, 89–90; Howard and,
57; Java and, 24; Little Ice Age and, 39;
Masters and, 54; Pinatubo and, 139–40;
Scandinavia and, 57; Yunnan and, 102, 113
dry season, 13, 79, 80, 86
Dublin Evening Post newspaper, 190
Dublin Royal Society, 132
Duke of Wellington, 12
Dupre, Daniel, 223
Dustbowl, 257n63
Dutch: Bengal and, 79; cholera and, 86; Sum-
bawa and, 13–15, 20, 24–25, 27, 29–30, 62
earthquakes, 22; Byron and, 47; New Madrid,
34; Shelley and, 33
earth science: Buffon and, 130–31, 155, 206–16;
Cuvier and, 130; Humboldt and, 33
East India Company, 21, 27, 29
Ecuador, 231
Egypt, 44
“Eighteen-Hundred-and-Froze-to-Death,” 9,
128, 200–206, 217
Elizabeth, Queen of England, 128
El Niño, 82, 90
England: Act of Union and, 188 (*see also*
Ireland); Arctic region and, 127, 129–30,
141; cholera and, 92; famine riots and, 61;
Grand Army and, 72–76; Howard’s climate
observations and, 55–57, 59; Little Ice Age
and, 34, 37, 40; opium and, 115–20; Pentrich
Revolution and, 61–62; Royal Navy and, 20,
121–34, 141–51; storms and, 60; Tambora’s
effect on, 57–60; typhus and, 253n43; Water-
loo and, 70, 116, 148, 180; welfare politics in,
197; Weymouth Bay, 50
Era of Good Feelings, 224
Essay on the Modification of Clouds (Howard), 55
evacuations, 5, 6, 8, 163
Evening Post newspaper, 190
famine, 230; America and, 205, 217, 224–25; Ben-
gal and, 83; *The Black Prophet* and, 173–74,
175, 178, 180, 196; “Bread or Blood” slogan
and, 61; Byron on, 69; Carleton’s writings
and, 173–74, 175, 178, 180, 184, 186, 188, 190, 192,
194–95, 196; children and, 5, 9, 23, 25, 63–65,
98, 109–14, 198; cholera and, 9; Europe’s
last, 60–64; Great Famine (Ireland), 173,
194, 198; Ireland and, 171–74, 176, 179–81, 182,
184–90, 193–98; Lord Liverpool’s response
to, 62; media and, 190; opium and, 115–20;
Pentrich Revolution and, 61–62; poetry on,
106–15; Raffles and, 30–31; refugees and,
63–64, 98, 185, 187–89; riots and, 9–10, 61–62,
193–94; Russell and, 174; starvation and,
5, 9, 19, 23–24, 61–64, 69–70, 105, 112, 113–14,
138, 144–45, 148, 155, 172–73, 181, 187, 189, 194,
198, 205, 226, 233–34, 239n14; Sumbawa and,
24, 30; supply and demand effects on, 112;
Switzerland and, 62–66, 69; Trevelyan and,
174; typhus and, 9, 70; Yunnan and, 102–20
fecal matter, 88
floods, 9; Alps and, 159–67, 169–70; America
and, 227–28; Bengal and, 83; cholera and,
89–90; dykes and, 59; Howard and, 56–57,
60; *jökulflaups* and, 159, 162, 170; Little Ice
Age and, 39; Masters and, 54; River Dranse
and, 159–67; Sumbawa and, 20; Switzerland
and, 46; Val de Bagnes and, 159–68, 170;
“Year of the Beggar” and, 59; Yunnan and,
102, 105, 107–8, 121
Flores island, 14, 18, 23
fluorine, 24, 48
Forster, Thomas, 2–3, 6–7, 55
fossil fuels, 123, 226, 232
France, 9, 12, 58–59, 62–63, 211
Frankenstein (Mary Shelley): Arctic and,
146–49, 250n31; Barrow and, 146–48; as
cautionary tale, 234; cultural significance
of, 146; refugees and, 64–66; Shelley’s inspi-
ration for, 9, 45, 53–54, 59, 65–67, 95–96, 125,
142, 146–49, 156–57, 170, 195, 197, 210, 234
“Frankenstein weather,” 91, 107, 174, 227–28

- Franklin, Benjamin, 1–2, 5, 7
Franklin, John: Arctic explorations and, 131–32, 144–49, 233; books on, 259n28; death of, 145–46; as “The Man Who Ate His Boots,” 144
free trade, 30
French Revolution, 35–36
Friedrich, Caspar David, 3
frost: 9, 37, 39, 58, 60, 98, 102, 105, 127, 130, 142, 147–48, 155, 200–206, 210, 233; black, 203; early, 60; late, 37
Fuji, Mount, 8
- Gallatin, Albert, 205
Gamble, John, 186–87
Ganges (River), 80–84, 88, 96
Gaulleux, Eusèbe–Henri, 64
George III, King of England, 1
Germany, 3, 59, 61, 197
ghauts (stone steps), 81, 83–86
Giétro glacier, 158, 159–61, 163–65, 170
glaciers: advancement of, 151–55, 157, 159, 162, 169; Agassiz and, 161, 167–68; Alps and, 129, 150–70; Arctic and, 129; Bossons, 153–55, 169; Charpentier and, 161–62, 167–68, 251n24; climate and, 37, 55, 129, 150–70; Giétro and, 158, 159–61, 163–65, 170; Ice Age theory and, 155–60, 162, 166, 168–69; ice dams and, 158, 159–60, 162–64, 166–67; *jökulblaups* and, 159, 162, 170; Mer de Glace and, 154, 156; Mont Blanc, 152–57, 159, 169–71; Perraudin and, 160–62, 164, 166–68; starvation and, 155; Swiss Society of Natural Sciences and, 157, 162, 166–67; temperature and, 152, 157, 159–60; Venetz and, 157–58, 160–68, 170
- Global Volcanism Program, 42
global warming. *See* climate change
Godwin, Fanny, 45–46, 115–16
Godwin, Mary. *See* Shelley, Mary
Godwin, William, 96
Goethe, Johann Wolfgang von, 55
Grand Army (India), 72–76
Grand Banks, 127
Grand Tour, 34
Grant, Charles, 192–94, 197
“Great Climate Compromise,” 215
Great Depression, 225
Great Famine (Ireland), 173, 194, 218
Great Lakes, 203
Greenland, 40, 202, 232; Arctic exploration and, 125, 127, 129, 132–34, 137–38, 140–42; Baffin Bay, 132, 141; Davis Strait, 132; Godthaab (Nuuk), 138; ice core studies and, 37; Lancaster Sound, 132, 141–42, 144; Spitsbergen and, 138; sulfate deposits in, 38; whaling and, 125
Greenland (O’Reilly), 133–34
- hail, 58–59, 83, 163, 179, 203, 236
Hamilton, William, 34
Hamlet (Shakespeare), 123
Hamlin, Christopher, 93
Hampstead Heath, 60
Han Chinese, 100–101, 103
Hardaul Lala, 74–75
Harty, William, 186, 190–91
Hastings, Lord, 72–76, 77
Heine, Heinrich, 92
Himalayas, 82, 99, 102, 115
Hinduism, 28, 82
Histoire Naturelle (Buffon), 208, 213
History of Java (Raffles), 29, 31, 32
Holocaust, 24
Holocene Period, 42, 44, 232–33, 241n12
homelessness, 66, 171, 182, 189, 234
Homer, 72
horses, 14, 18, 20–24, 58, 61, 178, 211, 229
Howard, Luke, 55–60, 174, 243n17
Huaynaputina, 44
Hudson Bay, 140–41, 147
Humboldt, Alexander von, 33
Hunt, Leigh, 124–25
hurricanes, 32, 58
Hutton, James, 168
- Ice Age theory, 230; Alps and, 155–60, 162, 166, 168–69; Little Ice Age and, 33–44, 129, 131
icebergs, 127, 130, 151
ice core analysis, 37, 43–44, 48, 241n12
Ice-Core Volcano Index (IVI), 43–44
ice dams, 158, 159–60, 162–64, 166–67
ice floes: Alps and, 150–70; Arctic and, 130
Iceland, 1–2, 7, 34, 40, 43, 50–51, 159
Iliad (Homer), 72
India: Calcutta, 5, 73, 81, 83–84, 86–87, 91, 96, 239n21; cholera and, 72–78, 81, 83–96, 123, 178; Ganges River and, 80–84, 88, 96; *ghauts* and, 81, 83–86; Hastings and, 72–76, 77; Hinduism and, 28, 82; monsoons and, 78–84, 88–91; Ola Bibi and, 83; opium and, 115–20; *sharif* crop and, 81–82; Tambora’s effects on, 71–72, 78–83, 90–91, 96
Indian Ocean, 22, 78, 80, 82, 89, 98, 102
Indonesia, 6, 8–9, 92, 199, 231

- insects, 89, 170, 183
- Intergovernmental Panel on Climate Change (IPCC), 235
- International Sanitary Conference (1851), 93
- Ireland: Act of Union and, 188; agriculture and, 179–80; Association for the Suppression of Mendicity and, 191–92; Board of Health and, 197; Carleton and, 173–74, 175, 178, 180, 184, 186, 188, 190, 192, 194–95, 196; climate change and, 180–81, 184, 195; conditions of 1817 in, 179–81, 185–94, 197–98; Cork, 180, 185–86, 189, 194; County Tyrone, 5, 173, 181, 186, 190, 193; Dublin, 132, 150–51, 173, 176, 178–79, 189–94; famine and, 171–74, 176, 179–81, 182, 184–90, 193–98; Gamble and, 186–87; homelessness and, 171, 182, 189; Irish character and, 187–98; Keats and, 171–73; landlords and, 173, 185; lice and, 176, 179, 181–87; Limerick, 188, 194; meteorology in, 150–51, 180, 190, 192, 196; Poor Employment Act and, 197; potatoes and, 176, 180–81, 192, 194–95; poverty and, 172, 176, 179–80, 186–87, 191; riots and, 193–94; storms and, 176, 177, 179; Tambora's effect on, 71, 171–74, 178–81, 186, 189–90, 193–95, 197–98; typhus and, 66, 176, 179, 181–93, 198; wheat and, 176; winds of, 178; "Year without a Summer" and, 174, 176, 177
- Israelites, 44
- Israel (official), 17
- Jackson, Andrew, 225
- Jacobins, 35, 191
- Jameson, James, 87–88, 91, 95, 178
- Jameson, Robert, 135
- Japan, 8, 91
- Java, 8, 134, 239n15; cholera and, 91; Raffles and, 27–32, 62, 240n33; Sumbawa and, 13–14, 16, 19, 22–24, 27–32
- Java Trench, 8
- Jefferson, Thomas: agriculture and, 205–6, 213–17, 221, 225–28; American Indians and, 212; Buffon and, 206–7, 211–16, 226–28; climate pessimism and, 226–28; drought and, 205; "Eighteen-Hundred-and-Froze-to-Death" and, 205–6, 217; Gallatin and, 205; "Great Climate Compromise" and, 215; Hamiltonian economics and, 225; meteorological studies of, 201, 211, 216–17, 227; Monticello and, 203, 206, 217, 221, 223, 224; *Notes on the State of Virginia* and, 211–13, 215; panic of 1819 and, 216–26
- jet streams, 50, 203
- Jews, 24
- Jiaqing, Emperor, 109–10
- jökulhlaups* (glacier-floods), 159, 162, 170
- jugement dernier des rois, Le (Day of Judgement for the Kings)* (Maréchal), 36
- Jura mountains, 46
- Katmai, Mount, 42
- Keats, George, 221
- Keats, John, 39, 60, 76–77, 171–73, 221
- Keats, Tom, 172
- Kilkenny Moderator* newspaper, 190
- Klingaman, Nicholas P., 237n5
- Klingaman, William K., 237n5
- Koch, Robert, 87–88
- Krakatau, 8, 37, 41–42, 44, 53
- "Kubla Khan" (Coleridge), 99
- Kun Hua Five, 107
- Kuwae, 37, 44
- Lake Geneva, 46, 53, 55, 67, 164
- Laki (Lakagfirar), 2, 43
- Lamb, H. H. (Hubert), 50, 177
- Lancaster Sound, 132, 141–42, 144
- landlords, 173, 185
- Laos, 98, 119
- Last Man, The* (Mary Shelley), 95–96
- latitude: Atlantic Meridional Overturning Circulation (AMOC) and, 137–38, 140, 249n25; climate and, 2, 3, 43, 49–50, 56, 79–80, 91, 98, 101, 122, 130, 137, 139, 150, 203, 209, 234; Earth's tilt and, 80; high, 3, 43, 56, 122, 139; mid-, 3, 49, 203; northern, 122; southern, 130, 150; temperature and, 137, 209; tropical, 2, 79, 98 (see also tropics); Volcanic Explosivity Index (VEI) and, 43
- leeches, 20, 26
- Le Pleureur, Mount, 159, 161
- Letters from an American Farmer* (St. John Crèvecoeur), 212
- lice: host–parasite relationship and, 181, 183; propagation of, 181, 183; typhus and, 176, 179, 181–87
- lightning, 53–54, 57–59, 115, 179
- Little Ice Age: agriculture and, 39; Arctic and, 129, 131; Barrow and, 131; climate change and, 41; coldness of 1810s and, 36–42; Ice–Core Volcano Index (IVI) and, 43–44; intermittent nature of, 40; northwest passage and, 129; poetry and, 34, 39; Robock and, 40–41; tropics and, 37, 39; volcanic causes of, 40–41

- Li Yuyang: "Bitter Famine" and, 113–14; famine poetry of, 11, 106–15, 120; official biography of, 247n11; "A Sigh for Summer Rain" and, 107–8; tax collectors and, 108–10; translations of, 236, 248n12
- Lombok, 8, 14, 22–23, 25, 236
- Mackenzie, George Steuart, 34
- Mackenzie, George, 39
- magma, 6, 17–21, 43
- Maison Chappuis, 45–46, 115–16
- malaria, 76–77
- Manchester Philosophical Society, 2
- Mansfield, Calvin, 205
- Maratha War (1817–18), 73, 74, 77
- Maréchal, Sylvain, 36
- Marine Diver, 135–38
- Masters, Jeff, 54–55
- McClure, Robert, 146
- Medieval Warming Period, 40
- Medwin, Thomas, 76–77, 245n7
- Mekong delta, 98, 102, 119
- melting ice, 121, 127, 129–33, 138, 140, 233, 258n5
- Melville, Lord, 128
- Melville Bay, 132
- merchants, 27, 79, 86, 94, 96, 189, 194
- Mer de Glace glacier, 154, 156
- meridional circulation patterns, 48–50, 82, 137–38, 249n25
- "Meteorological Imaginations and Conjectures" (Franklin), 1–2
- Meteorological Register*, 227
- meteorology, 67, 80, 96, 230; America and, 199, 203, 211, 216–17, 227; Barker and, 190, 192; Barrow and, 129–31; Brandes and, 59; Carleton and, 196; cholera and, 87; Colwell and, 89–90; El Niño and, 82, 90; Forster and, 2–3, 6–7, 55; Franklin and, 1–2; Grant and, 192; Howard and, 55–60, 174; Ireland and, 150–51, 180, 190, 192; Jameson and, 87–88, 91, 95, 178; Jefferson and, 203, 211, 216–17, 227; Krakatau and, 53; Laki and, 2; Mackenzie and, 39; Masters and, 54–55; Milham and, 199; NASA and, 40; Pascual and, 89–90; Yunnan and, 97–99, 104–5, 109
- Milham, Willis, 199
- Minoans, 44
- monsoons: China and, 99, 102; India and, 78–84, 88–91; *sharif* crop and, 81–82; Sumbawa and, 22; Yunnan and, 99, 102
- Mont Blanc, 152–57, 159, 169–71
- "Mont Blanc" (P. B. Shelley), 153–55, 157, 169–71
- Monticello, 203, 206, 217, 221, 223, 224
- Montserrat, 231
- Morning Chronicle* newspaper, 150–1
- mortality rates, 63, 233, 254n45
- Napoleon Bonaparte, 64, 124–25, 151; Alps and, 152; Napoleonic Wars and, 5, 7, 9, 56, 179; typhus and, 183; Waterloo and, 70, 116, 148, 180
- NASA, 40
- National Center for Atmospheric Research (NCAR), 50–51, 81
- Natural and Civil History of Vermont* (Williams), 215–16
- natural selection, 232
- Nelson, Horatio, 128–29, 144
- New England, 9, 42, 82, 98, 128, 138, 199, 202–5, 215–16, 218, 224
- New Hampshire Patriot* newspaper, 205
- New Madrid earthquakes, 34
- northeasters, 46
- northeast passage, 128
- North Pole, 48, 134, 137, 140, 147, 168
- northwest passage, 5, 123, 125, 127–29, 132–34, 142–49
- Norway, 129, 149
- Notes on the State of Virginia* (Jefferson), 211–13, 215
- oats, 61, 176, 178, 203, 206
- ocean circulation, 130, 140, 146
- Ola Bibi, 83
- opium, 51, 99, 115–20, 123, 230
- Oppenheimer, Clive, 238n10, 239n14
- O'Reilly, Bernard, 131–34
- Pacific Ocean, 8, 125, 132, 141–42, 146
- paleoclimatology: Canadian Arctic and, 40; ice core analysis and, 37, 43, 48, 241n12; Iceland and, 40; Volcanic Explosivity Index (VEI) and, 43
- Panic of 1819, 216–26
- Papua New Guinea, 231
- Parker, William, 185
- Parry, William Edward, 131–32, 142–48
- Pascual, Mercedes, 89–90
- pathogens, 87–90, 180, 183–84
- Peacock, Thomas Love, 33, 153
- Peel, Robert, 176, 197
- Pentrich Revolution, 61–62
- pepper, 13, 27
- Perraudin, Jean-Pierre, 160–62, 164, 166–68
- Pfister, Christian, 155

- Philippines, 42, 48, 52, 91, 138–39, 241n22
Phillips, Owen, 20, 31
Pierre à Bot, 166
Pinatubo, Mount, 42, 48, 52, 138–39, 241n22
pirates, 15–16, 21
Place de la Révolution, 35
plankton, 88–90
plinian eruptions, 18–20, 22, 23
Pliny the Younger, 18
poetry: Byron and, 9 (*see also* Byron, George Gordon); Coleridge and, 39, 51, 60, 70, 99; Confucian, 120; famine and, 11, 106–15, 120, 236; Goethe and, 55; Homer and, 72; Keats and, 39, 60, 76–77, 171–73, 221; Little Ice Age and, 34, 39; Li Yuyang and, 11, 106–15, 120, 236; Porden and, 144; Qing-era, 105–13, 120; Romantic Age and, 34; of Seven Sorrows, 11, 120, 234; Shakespeare and, 72; Shelley and, 9 (*see also* Shelley, Percy Bysshe); Sumbawa and, 17, 37; Tennyson and, 146; Wang Can and, 11; Yunnan and, 106–15
polar bears, 135, 233
Polidori, John William, 51–52
Polo, Marco, 99
Pompeii, 18, 33, 37, 44
Poor Employment Act, 197
Porden, Eleanor, 144
Portuguese, 27, 79
Post, John, 62
potatoes, 61, 176, 180–81, 192, 194–95
Poussin, Nicolas, 232–33
poverty: America and, 218, 226; Association for the Suppression of Mendicity and, 191–92; beggars and, 9, 59, 61, 63–65, 172, 188–93, 225; Carleton's writings and, 173–74, 175, 178, 180, 184, 186, 188, 190, 192, 194–95, 196; homelessness and, 66, 171, 182, 189, 234; Ireland and, 172, 176, 179–80, 186–87, 191; Irish landlords and, 173, 185; panic of 1819 and, 216–26; Poor Employment Act and, 197; Sumbawa and, 25; Yunnan and, 107
precipitation patterns, 49, 217
prices, 27; bread, 9, 61–62; carbon waste and, 226; commodity, 179, 227; cotton, 221; flour, 220–21; grain, 10, 63, 110, 155, 179–80, 197–98, 221, 222, 224; land, 219; rice, 9, 105, 111; slavery and, 23; transatlantic trade and, 64, 138, 210, 217, 222, 224, 226, 228, 237n5
Pride and Prejudice (Austen), 95
Prussia, 197
pumice, 17, 21–22, 33
pyroclastic flows, 18–20, 22, 170
Qing dynasty, 100, 101, 105–13, 117, 120
Quarterly Review, 124–25, 129–30, 133, 142, 146–47
Queen Mab (P. B. Shelley), 130, 210
Raffles, Stamford, 37, 63, 239n11; as colonial anthropologist, 29; East India Company and, 29–30; famine aid and, 30–31; Java and, 27–32, 62, 240n33; as “philosopher king,” 27–32; Singapore and, 24; slavery and, 23–24, 239n21
Raffles, Thomas, 62
railroads, 229
raja of Sanggar, 13–20
refugees: climate change and, 216, 218; famine and, 63–64, 98, 185, 187–89; *Frankenstein* and, 64–66
Reign of Terror, 35
Rhône (River), 164
rice, 9–10; Bengal and, 82, 90; selling humans for, 23; Yunnan and, 71, 99, 101–5, 107–11, 113, 119
Ring of Fire, 8
Riot Act, 61
riots: disease and, 94; famine and, 9–10, 61–62, 193–94; in Ireland, 193; Lord Liverpool's response to, 62; Pentrich Revolution and, 61–62
Robertson, William, 210
Robespierre, 35
Robock, Alan, 40–41
Romanticism, 33–34, 35, 76–77, 95, 156, 169
Ross, John, 126, 131–33, 141–42, 148, 233
Royal Navy, 20; Arctic and, 121–34, 141–51; Barrow and, 121–34, 141–51; Buchan and, 126, 131, 133, 141, 144; Franklin and, 131–32, 144–49, 233; Lord Melville and, 128; Nelson and, 128–29, 144; northwest passage and, 123, 125, 127–29, 132–34, 142, 144–46, 148–49; O'Reilly and, 134; Parry and, 131–32, 142–48; Ross and, 126, 131–33, 141–42, 148, 233
Royal Society, 121, 128, 132
Russell, Lord John, 173–74
Russell, Ken, 51
Russia, 48; agriculture and, 10, 63, 198; Arctic and, 128, 232; Bering Strait and, 128; cholera and, 86, 92; grain and, 63, 198; immigrants and, 64; northeast passage and, 128; typhus and, 183; von Kotzebue and, 128, 131, 141, 183
rye, 203, 222
Saint Helens, Mount, 8, 43
St. John Crèvecoeur, 212

- St. John's Chapel, 51
Sanggar Peninsula, 7, 13–24, 170; raja of, 13–20
Santorini, 44
Schoolcraft, Henry, 219
Scoresby, William: *An Account of the Arctic Regions* and, 126, 135, 136; Arctic and, 125, 126, 127–28, 131–38, 258n5; Marine Diver of, 135–38; polar ice treatise of, 125; snubbed by Barrow, 126; whaling and, 125, 127, 135
Scotland, 37, 56, 62, 88, 172
Scott, Robert, 149
Sen, Amartya, 190
Shakespeare, William, 72, 123
sharif crop, 81
Shelley, Mary, 47; Alps tour and, 45–46, 151–59, 169–70, 206; Arctic and, 124–25, 131, 134, 146–48; Barrow and, 124–25, 131, 146–47; Bath and, 116; biographers' depictions of, 65; Byron and, 46, 52, 54, 66, 69; de Staël and, 34; *Frankenstein* and, 9, 45, 52–55, 59, 65–67, 95–96, 125, 142, 146–49, 156–57, 170, 195, 197, 210, 234; ghost story contest and, 51, 57, 156; Hunt and, 124–25; *The Last Man* and, 95–96; literary friends of, 9, 51, 55; Pompeii and, 33–34, 37; reading Buffon, 210; sisters of, 115; Switzerland and, 45–46, 51–52, 54–55, 57, 62, 151; Walton character and, 147
Shelley, Percy Bysshe, 9, 47; Alps tour and, 45–46, 151–59, 169–70, 206; beggar children and, 65; Byron and, 9; death of, 77, 95; de Staël and, 34; Fanny Godwin and, 116; ghost story contest and, 51, 57, 156; global warming and, 130; Medwin and, 76; “Mont Blanc” and, 153–55, 157, 169–71; near drowning of, 53; Peacock and, 33, 153; poetry of as “satanic,” 139; Pompeii and, 33; *Queen Mab* and, 130, 210; Switzerland and, 45, 51–52, 65
Shelley Circle, 51, 65–66, 77, 152, 171, 243n12
“Sigh for Autumn Rain, A” (Li Yuyang), 107–8
Simond, Louis, 154, 154–55
Sinde (River), 73–76
Singapore, 24
Slave Felony Act, 239n21
slavery, 15–16, 23–24, 79, 95, 111, 129, 211, 223, 239n21, 240n33
Smith, Adam, 30
Smithsonian Institution, 42–43
snow, 1; agriculture and, 60–61; Alps and, 151–52, 154, 157, 163; America and, 200–203, 205, 210, 215; Arctic and, 130, 144, 147; Howard and, 56–58; ice core analysis and, 37, 43–44, 48, 241n12; Pinatubo and, 42; red, 67; summer, 98; Switzerland and, 45–46; Yunnan and, 98, 102, 105, 115
South Pole, 38, 48
starvation, 70, 148, 233–34, 239n14; America and, 138, 205, 226; “Bread or Blood” slogan and, 61; Byron on, 69; children and, 5, 9, 23, 25, 63–65; eating boots and, 144; Franklin and, 144–45; glaciers and, 155; Germany and, 61; Ireland and, 172–73, 181, 187, 189, 194, 198; Lord Liverpool's response to, 62; Pentrich Revolution and, 61–62; refugees and, 63–64, 98, 185, 187–89; Sumbawa and, 19, 23–24; Swiss bakers and, 62; Switzerland and, 61–64; Yunnan and, 105, 112, 113–14
Statham, James, 84–85
Stommel, Elizabeth, 237n5
Stommel, Henry, 237n5
storms, 1; America and, 200–205, 227; Annsville and, 200–201; Arctic Oscillation and, 50–51; Bengal and, 80–83, 99; Byron and, 68, 77; coldness of 1810s and, 39; Coleridge and, 70; cyclones, 50, 80; floods and, 56 (*see also* floods); *Frankenstein* and, 9, 45, 52–55, 59, 91, 107, 174, 227–28; hail and, 58–59, 83, 163, 179, 203, 236; heat and moisture transfer and, 50; Howard and, 55–59; hurricanes, 18, 32, 58; Iceland and, 50–51; Ireland and, 176, 177, 179; lightning and, 53–54, 57–59, 115, 179; London and, 60; Masters and, 54; meteorology and, 54 (*see also* meteorology); monsoons, 22, 78–84, 88–91, 99, 102; northeasters, 46; Plymouth tree and, 59–60; Scotland and, 51; Shelleys and, 9, 45, 52–55, 59, 77, 130; Switzerland and, 46–47, 51–53; Tambora-driven, 50–51, 55–56; thunderstorms, 50–51, 54, 59, 203; Yunnan and, 115
stratosphere, 3, 8, 19, 38, 43, 48–50, 52, 67, 78–79, 82, 90, 115, 230
sugar, 27
Sulawesi (Celebes), 14, 23
sulfate aerosols, 3, 37, 38, 48, 78–79, 81, 121, 123, 141, 230–31, 230
sulfur, 5, 6, 43–44, 48, 52, 79
sulfuric acid, 52, 79
Sumbawa, 5, 37; agriculture and, 13, 29; ash and, 12, 15–25, 30; Bali and, 14, 19, 22–24; climate change and, 24; deforestation of, 24–25; dry season of, 13; Dutch and, 13–15, 20, 24–25, 27, 29–30, 62; economic devastation of, 23–25; famine and, 24, 30; Flores and, 14, 18, 23; horse breeders of, 14; Java Trench and, 8;

- Koteh and, 13, 17–19; Lombok and, 8, 14, 22–23, 25; pirates and, 15; poetry and, 17, 37; poverty and, 25; rice and, 13–14, 16–20, 23–24, 31; Sanggar Peninsula and, 7, 13–24, 170; settlement of, 14–15; Sulawesi (Celebes) and, 14, 23; Sumba and, 8; Tambora's death toll on, 17, 19–20, 30; tsunamis and, 18–19, 22; vassal system of, 14–15; *zaman hujan au* (time of the ash rain) and, 24–25
- summer of 1816: as "Year of the Beggar," 9, 59, 61; "Eighteen-Hundred-and-Froze-to-Death" and, 9, 128, 200–206, 217; "Frankenstein weather" and, 91, 107, 174, 227–28; June 6 storm and, 200–203; as "Year without a Summer," 9–10, 32, 39, 41, 55, 58, 60, 127, 174, 176, 177, 199–200, 203, 225
- Sunda arc, 8
- sunsets, 2, 97
- sunspots, 40–41, 70
- superstition, 16, 25–26, 55, 74–75, 161
- Surrey Gardens, 35, 230
- Swiss Society of Natural Sciences, 157, 162, 166–67
- Switzerland: agriculture and, 62, 64; Alps and, 151 (*see also* Alps); avalanches and, 46, 152; famine and, 62–66, 69; floods in, 58; Shelleys and, 45–46, 51–55, 57, 62, 65, 151; storms and, 46–47, 51–53; Swiss Society of Natural Sciences and, 157, 162, 166–67; Tambora's effect on, 48, 50–51, 57, 61–67; Villa Diodati and, 46, 51, 67, 68
- syphilis, 183
- Tambora: Alpine effects of, 45–46, 150–51, 155–56, 159, 162–63, 165, 168–70; American effects of, 71, 199–203, 204, 216–27; Arctic effects of, 121–23, 132, 135, 138–41, 146, 149; ash and, 48 (*see also* ash); background climate for, 39; caldera of, 5–7, 11, 21; as cautionary tale, 234; climate change and, 233 (*see also* climate change); Crawford on, 15; England effects of, 57–60; evacuations and, 5, 6, 8; first rumblings of, 16–17; first victim of, 17; flora/fauna effects of, 229; "Frankenstein weather" resulting from, 91, 107, 174, 227–28; German effects of, 61; hydrologic cycle disrupted by, 139–40; immediate deaths from, 17, 19–20; implosion of, 21; Indian effects of, 71–72, 78–83, 90–91, 96; Irish effects of, 71, 171–74, 178–81, 186, 189–90, 193–95, 197–98; Koteh and, 13, 17–19; lost kingdom of, 25; monsoon effects of, 78–84, 88–91; panic of 1819 and, 216–26; pumice hail of, 17, 21–22; pyroclastic flows and, 18–20, 22, 170; Sanggar Peninsula and, 7, 13–24, 170; scale of eruption of, 42–44; sound of, 21–22; storms and, 50–51, 55–56 (*see also* storms); stratospheric effects and, 48, 78, 82, 90; sulfate aerosols and, 3, 37, 38, 48, 78–79, 81, 121, 123, 141, 230–31 230; Sumbawan deaths from, 17, 19–20, 30; Sunda arc and, 8; superstition and, 16, 55; Swiss effects of, 48, 50–51, 57, 61–67; Teluk Saleh and, 7; wind and, 17–19, 22, 48, 55, 61, 78–79, 83, 87, 107–8, 111; Yunnan effects of, 98, 102–8, 111–13, 115, 117–20
- Teluk Saleh, 7
- temperature, 9; atmospheric pressure and, 49; average, 39, 178, 205, 209, 217; Buffon on, 209, 214; cholera and, 90; cycles of, 166; febrile body, 184; glaciers and, 152, 157, 159–60; gradient of, 50, 80, 81, 203; higher, 18, 88, 89, 138, 140; Holocene Period and, 42, 44, 232–33, 241n12; Howard's observations and, 58; jet streams and, 50, 203; Land Office records and, 227; latitude and, 137, 209; lower, 38, 39, 41, 50, 55–56, 58, 78, 79, 89, 98, 103–5, 115, 127, 129, 131, 141, 150–51, 178, 200–203, 205, 216; measuring seawater, 135–37; meridional currents and, 48–50, 82, 137–38, 249n25; moderate, 42, 49, 100, 102, 137, 212, 215, 226, 228, 230; ocean, 135–38; raw, 49, 79; regional, 207; rice crops and, 105; sulfate aerosols and, 230; wind and, 49 (*see also* wind)
- Tenerife, 34
- Tennyson, 146
- Thailand, 91, 119
- Theatre de la République, 35–36
- thunderstorms, 50–51, 54, 59, 203
- Times* newspaper, 194
- "To Autumn" (Keats), 39
- trade winds, 19, 23, 78, 82, 99
- transatlantic trade, 64, 138, 210, 217, 222, 224, 226, 228, 237n5
- Treaty of Paris, 1
- tree-ring studies, 24, 43, 82–83, 217, 248n19
- Trevelyan, Charles, 174
- tropics, 2, 8, 127, 151, 232; air pressure differentials and, 49; Atlantic Meridional Overturning Circulation (AMOC) and, 137–38, 140, 249n25; disease and, 94; eruption of 1258 and, 41, 43–44, 216; eruption of 1809 and, 37–39, 41–43, 58, 216, 241n12; forests of, 17; heat transfer and, 137–38, 140, 249n25; Little Ice Age and, 37, 39; monsoons and, 22, 78–84, 88–91, 99, 102; rain in, 5, 15; raw

- tropics (*cont.*)
surface temperature and, 79; rice and, 103;
summer snows and, 98; Volcanic Explosivity Index (VEI) and, 43; volcanoes located in, 2, 41, 43–44 (*see also* volcanoes); wind-based heat transport and, 49
- tropopause, 50
- Trotter, John, 185
- tsunamis: Alpine ice floods compared to, 150–70; Sumbawa and, 18–19, 22
- tuberculosis, 77, 221
- Turner, J. M. W. (William), 2–3, 35, 58, 156, 174
- typhus, 69; Burundi and, 183; Carleton's writings and, 184, 188, 190, 192; clergy and, 190; doctors and, 181, 186, 189–92; etiology for, 183; famine and, 9, 70; Gamble and, 186–87; Harty and, 186, 190–91; Ireland and, 66, 176, 179, 181–93, 198; lice and, 176, 179, 181–87; Napoleon's army and, 183; newspaper media and, 190; pathogen source of, 183; rural population and, 188–89; treatises on, 187, 253n43
- unknown volcanic eruptions: of 1258, 41, 43–44, 216; of 1809, 37–39, 41–43, 58, 216, 241n12
- Val de Bagnes: Agassiz and, 161, 167–68; Charpentier and, 161–62, 167–68, 251n24; Perraudin and, 160–62, 164, 166–68; Venetz and, 159–68, 170
- vampires, 52, 52–53, 66
- Vanautu, 37
- Venetz, Ignace: climate change and, 166–67; engineering talents of, 157, 158, 161–62, 164, 167; Giéтро and, 158, 159–61, 163–65, 170; glacier studies of, 157–58, 160–68, 170; Swiss Society paper of, 166–67; Val de Bagnes and, 159–68, 170
- Vesuvius, Mount, 18, 33–36, 44, 153
- Vietnam, 14, 98, 117
- Villa Diodati, 46, 51, 67, 68
- Volcanic Explosivity Index (VEI), 43
- volcanoes: ash and, 2 (*see also* ash); calderas and, 5–7, 11, 21; climate change and, 5 (*see also* climate change); climate impacts of recent, 231; coldness of 1810s and, 36–42; ejecta of, 2, 48; eruption of 1258 and, 41, 43–44, 216; eruption of 1809 and, 37–39, 41–43, 58, 216, 241n12; evacuations and, 5, 6, 8, 163; fluorine and, 24, 48; Fuji, 8; Huaynaputina, 44; Ice–Core Volcano Index (IVI) and, 43–44; Iceland and, 1–2, 7, 34, 40, 43; Katmai, 42; Krakatau, 8, 37, 41–42, 44, 53; Kuwae, 37, 44; Laki, 2, 43; magma and, 6, 17–21, 43; Pinatubo, 42, 48, 52, 138–39, 241n22; impacts on precipitation, 49, 217; pumice and, 17, 21–22, 33; pyroclastic flows and, 18–20, 22, 170; Ring of Fire and, 8; St. Helens, 8, 43; Santorini, 44; stratospheric effects of, 3, 8, 19, 43, 48, 50, 52, 67, 79, 90, 115, 230; sulfate aerosols and, 3, 37, 38, 48, 78–79, 81, 121, 123, 141, 230; sulfur and, 5, 6, 43, 48, 52, 79; symbolism of, 35–36; Tambora and, 2 (*see also* Tambora); Tenerife, 34; unknown eruptions of, 37–39, 41–44, 58, 216, 241n12; Vesuvius, 18, 33–36, 44, 153; visual entertainment and, 34–35; Volcanic Explosivity Index (VEI) and, 43
- volcanologists, 6, 10, 26, 33–34, 43, 235, 238n10
- Volney, Constantin-François, 215
- von Clausewitz, Carl, 61
- von Drais, Karl, 229
- von Kotzebue, Otto, 128, 131, 141
- Wales, 62, 116
- Wang Can, 11
- War of Independence, 1
- Waterloo, 70, 116, 148, 180
- Weymouth Bay (Constable), 50
- whaling, 125, 127, 135
- wheat: Alps and, 164; America and, 203, 205–6, 214, 221, 222, 226; Ireland and, 176; Yunnan and, 99, 102, 105, 110, 115, 119
- Williams, Samuel, 215, 215–16
- wind: Alps and, 45–46; Arctic and, 140; America and, 203, 215–16; Bengal and, 78–79, 83, 87, 89; climate and, 49–51, 150, 173, 178; dark, 104; hurricane-strength, 17–18, 58; Ireland and, 173, 178; Switzerland and, 53; Tambora and, 17–19, 22, 48, 55, 61, 78–79, 83, 87, 107–8, 111; trade, 19, 23, 78, 82, 99; Yunnan and, 99–100, 102, 104, 107–8, 111
- World War I, 149
- Yang Yuda, 247n3
- “Year of the Beggar,” 9, 59, 61
- “Year without a Summer,” 9–10, 60; America and, 199–200, 203, 225; Banks and, 127; Howard and, 58 Ireland and, 174, 176, 177; legends of, 55; Little Ice Age and, 41; Mackenzie and, 39; Sumbawa and, 32

- Yeats, W. B., 11
- yellow fever, 183
- Yunnan, 5; agriculture and, 99–103, 107–8, 117–20; climate change and, 119–20; climate of, 98–101, 102–5; Confucianism and, 98, 106–7, 109–10, 114, 120; famine and, 102–20; Han Chinese expansion and, 100–201, 103; Himalayan plateau and, 99, 102, 115; Jiaqing and, 109–10; as “Land of Eternal Spring,” 100–1; Li Yuyang and, 11, 106–15, 120, 236; meaning of name, 100; Mekong delta and, 98, 102, 119; meteorology and, 97–99, 104–5, 109; monsoons and, 99, 102; opium and, 115–20; poetry and, 11, 106–15, 120; poverty and, 107; Qing dynasty and, 100, 101, 105–13, 117, 120; rice and, 71, 99, 101–5, 107–11, 113, 119; storms and, 115; Tambora’s effects on, 98, 102–8, 111–13, 115, 117–20; wheat and, 99, 102, 105, 110, 115, 119; winds of, 99–100, 102, 104, 107–8, 111
- zaman hujan au* (time of the ash rain), 24–25