climatic change, as well as a neat scientific detective story. It should expand the horizons of Baker's more traditionally oriented colleagues.

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Accounts of an Ash Fall

The Time of Darkness. Local Legends and Volcanic Reality in Papua New Guinea. R. J. BLONG. University of Washington Press, Seattle, 1982. xii, 258 pp., illus. $25.

The recent eruptions of Mount St. Helens and El Chichón have drawn attention once again to the power and influence of volcanoes in human affairs. These recent eruptions, however, were smaller than many others that people have seen, and the frequency of big eruptions is greater than many of us imagine. More than 10 eruptions in the past 200 years have exceeded the 1980 eruption of Mount St. Helens in the volume of material erupted. The biggest recorded eruption, at Tambora in 1815, was 100 times larger, and much greater cataclysms have been obscured by the mists of time, known now only from the natural traces they left behind. The record of such eruptions is far from complete, and we have much to learn before we can assess confidently their real frequency and their hazards.

Even so, it is disconcerting to learn of an eruption several times larger than the one of Mount St. Helens—and similar to the Krakatau eruption of 1883—that occurred only 300 years ago and yet went completely unrecorded at that time by the Western world. This book deals with such an eruption, one that occurred on Long Island in the Bismarck Sea and distributed ash over a large area of Papua New Guinea. Although it was not described in written literature, the eruption was abundantly recorded in the oral traditions of the region, which refer to its ash fall as "the time of darkness." A truly remarkable feature of the event is its preservation among more than 30 different language groups. It thus provides a splendid opportunity to investigate not only the event but the precision with which it was recorded.

The Time of Darkness is an admirable and far-ranging account of interdisciplinary sleuthing that should be of equal interest to geologists, anthropologists, and oral historians. It should interest many general readers as well, despite some technical jargon and diagrams and cryptic descriptions of some analytical methods. An appended glossary of volcanic terms should be helpful for the nongeologist.

Blong is a geomorphologist and devotes almost half of the book to a description of the eruption and its deposits. He shows how a widespread ash layer of mainland New Guinea, the Tibito Tephra, can be identified and correlated with the Matapun beds on Long Island by various physical and chemical criteria. Comparing these deposits with those of well-recorded eruptions, he then reconstructs the probable history of the eruption, including its magnitude and duration, and the spreading of its ash cloud.

Blong turns next to the legends about the time of darkness, as recorded by a large number of field observers who questioned local informants. He compares these descriptions with geologic evidence in an attempt to evaluate the accuracy of the traditions. The comparison shows that in most respects the legends seem to give a realistic portrayal of the expected physical characteristics and consequences of such an ash fall. Blong argues that although these accounts were not written down they appear to be as accurate as most European accounts of ash falls (some "scientific" descriptions have been grossly inaccurate) and should therefore be regarded as history and not as myth.

In one important respect, however, the legends do differ significantly from the geologic reconstruction. They appear to err in recording time. Temporal inaccuracy is expressed in two ways. First, the duration of the tephra fall appears to have been exaggerated in almost all versions of the legend, in some cases by more than an order of magnitude. This circumstance could have arisen from stress and from an absence of clocks when the diurnal movement of the sun was not available to mark the passage of time. Second, and of much greater importance to oral historians, the legends severely underestimate the interval since the eruption occurred. Whereas most geologic and historical evidence indicates that the eruption occurred about 300 years ago, the evidence from genealogies points to its having occurred only about 100 to 150 years ago. If the genealogies really do err by this amount, we must question once again the reliability of such evidence. For this reason alone, Blong's work deserves close attention.

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A Weather Anomaly

Volcano Weather. The Story of 1816, the Year Without a Summer. HENRY STOMMEL and ELIZABETH STOMMEL. Seven Seas Press, Newport, R.I., 1983. xii, 178 pp., illus. $15.

This is a pleasant small book. An impressive amount of study and scholarship is evident from the very first chapter, which starts off with a brief account of the political situation in the Sunda Islands (modern Indonesia) after the end of the Napoleonic wars, with reports requested by the temporary British administration about a major eruption of Mount Tambora on the island of Sumbawa in 1815, and with the history of subsequent ascents of that volcano. The story is nicely illustrated with pictures of Thomas Stanford Raffles, naturalist and founder of Singapore, who was then lieutenant governor of Java, and with drawings of the volcano. Of particular interest is a diagram that compares the volume reduction of Tambora with that produced by the recent eruption of Mount St. Helens.

The following eight chapters describe the weather during the exceptionally cold summer of 1816 in New England and in western Europe and relate the social consequences of the resulting food shortage. The reader gains a strong impression of the resilience of New England's scrabble farm economy, but also of the impetus that the disaster gave to westward migration into the Great Plains and beyond. The whole development is profusely and interestingly documented with quotations from contemporary journals, diaries, accounts of academic and legislative meetings, lists of wheat prices, and so on. The narrative is enlivened by many illustrations of historical interest.

The last third of the book seems less informative. Chapter 10 considers a possible connection between the climate anomalies of 1816 and a subsequent widespread cholera epidemic, which reached New York in 1832. This connection is at best tenuous. The beginning of the scourge is associated with a famine in Bengal in 1816, which in turn is attributed to the peculiar weather conditions of that year. This contradicts an earlier statement that "it would appear . . . that the truly exceptional character of 1816 weather was limited to a small portion of northeastern America, Canada and the extreme western parts of Europe." It is a pity that the Indian lead was not followed up, because I believe that there were some British records available from Bengal at that time and the connection

"This aquatint, by Rudolf Tanner, shows Swiss gourmandizers in the famine of 1817 about to be led to hell." [From *Volcano Weather*; photo courtesy Kunsthaus, Zurich]

between excessive atmospheric turbidity and monsoon failure would not seem physically implausible.

The final three chapters deal rather cursorily with various explanations of the weather anomaly. Volcanoes can inject aerosols into the stratosphere, and the resultant turbidity can affect the surface radiation balance. The associated temperature change is different on land and sea surfaces and also depends on the latitude. It therefore affects the atmospheric circulation pattern. The authors could have given the general reader more insight into these physical relations without making the book much longer or more ponderous. I found it intriguing that the atmospheric turbidity theory of anomalous weather conditions was apparently first suggested by Benjamin Franklin almost exactly two centuries ago. Altogether, readers are likely to enjoy this book, particularly as a historical climate-impact study and as a delightful vignette of some aspects of New England life in the early 1800's.

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Coastal Dynamics

Circulation in the Coastal Ocean. G. T. CSANADY. Reidel, Boston, 1982 (distributor, Kluwer Boston, Hingham, Mass.). xii, 280 pp., illus. $52.50. Environmental Fluid Mechanics.

Blue-water physical oceanographers often refer disparagingly to continental-shelf seas as "the rim of the bath tub." The coastal ocean may indeed appear dirty, in more ways than one. There are practical problems involving fisheries, other resources, and pollution (requiring the physicist to collaborate with, or even serve, strange people like biologists or engineers), and the physics itself appears very messy, with forcing by wind, tide, surface heating or cooling, and freshwater input and with further complications introduced by irregularities of the coastline or sea floor. It is no wonder that physical oceanography departments at many major institutions have, until rather recently, placed greater emphasis on studies of the deep ocean.

However, as the dust jacket of this book states, "knowledge of coastal physics has developed explosively during the past two decades," and one welcomes a monograph by Csanady, who has himself generated quite a few of the explosions, providing in his papers a quantitative framework for many dynamical features of shallow seas.

The book is largely made up of mathematical solutions, and physical reasoning, associated with idealized models of circulation patterns with time scales greater than a few hours. Many of the results will seem strange at first to the newcomer. He or she will learn, for example, that the flow in the center of a long lake generally opposes the wind and that sea level at the coast is far more sensitive to winds parallel to the shore than to winds at right angles.

The professional will discern from a quick glance at the book that it is dominated by Csanady's own substantial contributions. The first half discusses transient currents, mainly as generated by an impulsively applied wind. The response of a homogeneous ocean is considered first, with the effects of stratification and topography being added later. Results, such as those mentioned above, and including some of the key effects for coastal upwelling regions, are derived and shown to account qualitatively for a variety of observations.

Bottom friction is added to the models in the second half of the book, in which low-frequency, quasi-steady circulation patterns are discussed. A variety of forcing functions are considered: onshore and offshore wind with different spatial patterns, a longshore pressure gradient (possibly imposed by the deep ocean), and horizontal density differences due, for example, to freshwater input at the coast. One particularly interesting consequence of forcing, by both longshore wind and a longshore pressure gradient, can be a convergence or divergence of cross-shelf bottom flow at a particular isobath. As reported by Csanady in his final chapter (and in his classic 1976 paper) this theory accounts for the observation that, in the mid-Atlantic Bight, bottom waters move slowly onshore in water less than 60 meters deep, offshore outside this isobath.

The final chapter contains other comparisons of low-frequency features of shelf circulation with theoretical models. Remarkable agreement is found, for example, between observed changes in sea level and simple models for the response to a spatially varying longshore wind. However, here, as in the earlier part of the book, the data on variable winds, currents, and sea level are largely presented as time series for "eyeball" comparison. Results of some statistical studies are mentioned, but no power spectra or cross spectra are shown. This is disappointing, given the extensive amount of time-series analysis that has been done, often showing clearly the transition from transient to quasi-steady response and