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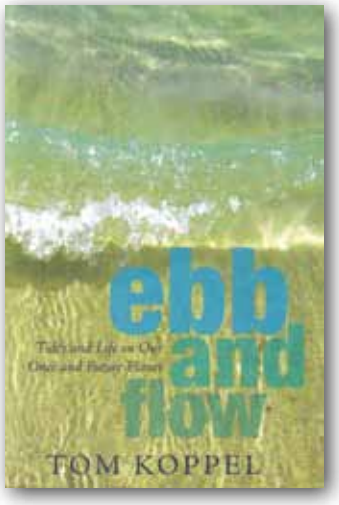
Ebb and Flow

Tides and Life on Our Once and Future Planet

By Tom Koppel, The Dundurn Group, 2007, 296 pages, ISBN 9781550027266, Paperback, $26.99 US

REVIEWED BY JOHN L. LUICK



Ebb and Flow: Tides and Life on Our Once and Future Planet is well titled. It tells the story of tides, why they matter, what causes them, and how they have changed over time. The author, Tom Koppel, is not an analyst or theoretician of tides but a man of inquisitive mind and substantial beachcombing and sailing experience. He tells his stories in an engaging style, be they of gathering clams on tidal flats or harrowing escapes from tidal races. They are woven into a well-paced and thoughtful narrative, never straying far from the tidal theme.

Most of the chapters combine two elements—typically, a story of how tides have played a defining role in the lives of a coastal people, and a discussion of the related natural history. For example, Chapter 9 begins with the story of how certain coastal Native Americans harvest a small fish (eulachon), describes the involvement of tides, and then broadens the discussion to include tides in coastal ecosystems generally. This format suits the topic well, successfully drawing in the reader and maintaining interest.

Koppel ranges over many historical, scientific, and practical aspects of tides: what the "ancients" thought of them, the advances in understanding from the 1600s to the present, the effect on the morphology of shorelines, various disasters attributable to tides (not the least of which is the loss of much of the fleet of Alexander the Great due to a tidal bore), coastal ecosystems, modern analysis, and extracting energy from tides. Chapter 1 contains an account of the ancient tidal dockyards at Lothal, India—surely a candidate for "Engineering Wonders of the Ancient World." The most ambitious and original chapter is the final one, whose three subheadings are *Sea Level Change Causes Intertidal Zones to Migrate*; *Giant Ancient Tides and Earth's Rotation*; and *The Origin, Evolution, and Future of Life on Earth*. The subject of the first section may seem self-evident, but Koppel does a great job of developing it, beginning with an anecdote concerning dieback among trees he found on the shores of British Columbia. Clearly, the trees had grown to maturity at a time when the local relative sea level was at least a meter lower. This story provides a nice lead-in to a discussion of local tectonics, and from there to how macrotidal embayments like the Bay of Fundy became tuned to resonate with external tidal forcing as global mean sea level changed since the last ice age. The second subheading considers how tides have evolved over millennia from a time when the moon was much closer and days much shorter. As Koppel poetically put it, "the record of these changes is written in limestones, corals, and seashells" (rhythmites, rugose corals, and nautaloid cephalopods, as he goes on to explain). The third subheading takes us back to the origin of life. A well-known speculation of Charles Darwin sets the stage: "[perhaps life started in] some warm little pond with all sorts of ammonia and phosphoric salts." Again, tides are shown to play a crucial role in both the origin and the evolution of life on earth, with polymerization made possible by repeated cycles of tidal-pool drying.

I have seen many nonmathematical attempts to explain how the moon and sun combine to cause tides on earth, and have yet to find a satisfactory one. (Most of the mathematical ones are equally unenlightening.) Without the simplifying power of potential theory and Legendre polynomials, one inevitably must resort to counterintuitive devices such as "revolution without rotation," confusing diagrams with lots of circles and arrows, and a balance between gravitational and centrifugal forces in a rotating reference frame. No wonder, then, that the subject has a well-deserved reputation for being arcane—especially if the derivation (quite unnecessarily) employs "fictitious stars" (two each for the moon and sun, to account for their diurnal and semidiurnal effects) and the individual frequencies, like M_2, are given names like, well, "M_2." Koppel makes a brave attempt, but he probably would have done better to have simply stated

a few of the fundamental results, such as that the tide-generating forces on Earth's surface are inversely proportional to the cube of the distance from either the moon or sun, and then referred the interested reader to a Web site such as NOAA's "Our Restless Tides," which at least has some nice graphics. Actually, the only mention of an inverse cube relationship (page 276) is incorrectly stated (it would be correct if the words "tide-generating forces" were substituted for "gravity"). The inverse cube relationship is always surprising when first encountered by anyone with basic physics training, in which one is taught that the gravitational attraction between two bodies varies as the inverse square.

In Chapters 8 and 12, much is made of the shortcomings and ultimate failure of the "progressive wave theory." This emphasis is a bit misleading because Laplace's progressive wave theory and dynamics remain the foundation of modern tidal hydrodynamic modeling. It was really only the highly simplified version (for which Laplace found analytic solutions) that turned out to be unrealistic.

My few remaining negatives are minor. First, the reproductions of photographs mostly look like poor scans of color prints. Second, I am allergic to the "National Geographic School of Writing" (the tale begins with a dramatic state of affairs, then reverts back to tell how it came to pass, and finally reveals the finale). Luckily, Koppel did not overuse the formula and my allergic rash disappeared quickly. Third, although in several places the book discusses phenomena that are in fact circadian rhythms, the term itself is not used, which seemed like a missed opportunity in terms of organizing things. Fourth, the book would have benefited from an index. Fifth, showing the sense of rotation around the amphidromes in Figure 12 would have helped elucidate the text. Finally, I noticed a couple of typos.

This book will be of interest to those with affinities for natural history, seafaring, and tides in general—and even tidal scientists will learn a few things about their science.

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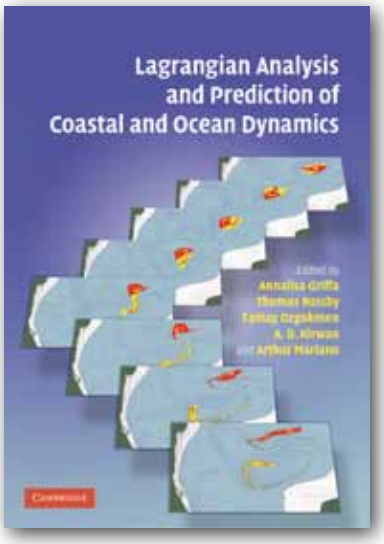
Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics

Edited by Annalisa Griffa, A.D. Kirwan Jr., Arthur J. Mariano, Tamay Özgökmen, and H. Thomas Rossby, Cambridge University Press, 2007, 487 pages, ISBN 9780521870184, Hardcover, $160 US

REVIEWED BY JOSEPH H. LaCASCE



During a colloquium on Lagrangian dynamics in Liège, Belgium, in 1999, several participants discussed convening a meeting devoted to Lagrangian studies in the ocean and atmosphere. The European Science Foundation program TAO (Transport in the Ocean and Atmosphere) had previously sponsored similar meetings, which mostly involved European researchers; the proposed LAPCOD (Lagrangian Analysis and Prediction of Coastal and Ocean Dynamics) would offer greater participation by American scientists. Several of the organizers were from Miami and Italy, and thus there have been meetings in Ischia, Italy (2000); Key Largo, Florida (2002); and Lerici, Italy (2005). (I recall thinking, while enjoying several outstanding fish dishes near the harbor in Lerici, that having an Italian as one of the organizers was a good choice.)

Lagrangian studies have always had an eclectic flavor. Although current meters produce fairly straightforward data (e.g., a time series of velocity at a fixed location and depth), floats and drifters move about, providing the drifter posi-