AirIceOcean Interaction: Turbulent Ocean Boundary Layer Exchange Processes

Miles McPhee and MaryLouise Timmermans

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either quantum physics or undergraduate mathematics. He does so with an informal, study-guide approach that involves a large number of worked examples and exercises. A research consultant at Sandia National Laboratories, McMahon is a practiced hand at this approach; he has written more than 10 teach-yourself texts on diverse areas of science and engineering. As he explains in his preface, the goal for his book is to open up and introduce quantum computation to nonspecialist readers from a wide variety of backgrounds.

Does it work? The book has some very attractive features, including a broad range of topics for an elementary text, some derivations of important results, and many examples worked in great detail. It is a good text for technically trained nonexperts who can follow simple mathematics and who wish to learn something of the intellectual content and context of quantum computation. On the whole, the book's style is very pedagogical. For instance, before readers tackle the more advanced exercises, they are guided through many worked examples that illustrate the ideas upon which quantum computation is based. Those worked examples will be helpful for undergraduates in fields other than physics and computer science, the primary fields that contribute to quantum information science.

The text may also be helpful as a study guide for undergraduate physics students. That audience, however, is likely to be less satisfied overall, because a large proportion of the text is devoted to the basics of quantum mechanics. Even physics students who have not yet encountered the notion of generalized measurements or discussions of entanglement in their quantum mechanics classes will likely not be challenged by the relatively elementary first 170 pages of the book.

A more significant drawback for physics students and others with a serious interest in the subject is the book's inconsistent approach to providing derivations of key results—some are given in detail while others are glossed over. Another drawback is the lack of references that could have provided further guidance, particularly for those topics that received only a cursory nod in the text. Expanded references would have been consistent with the author's goal to provide a foundation that can be built upon by consulting more advanced texts. A further lacuna is the absence of discussions of quantum information demonstrations—for example, the physical realization of a qubit—or experiments that relate to quantum computation. Granted, the field is moving very quickly on the experimental side, but a short overview of physical implementations would be precisely the kind of thing that an educated nonexpert would welcome. Experimental discussions and references are better handled in *Quantum Computing for Computer Scientists* (Cambridge University Press, 2008) by Noson Yanofsky and Mirco Mannucci, a recent text that aims to provide computer science undergraduates with a similarly gentle introduction to the topic.

However, as noted above, it is easier to write for a specific audience than for one with diverse interests and expertise. McMahon's text certainly conveys the excitement and some of the intellectual content of quantum computation to the nonphysicist who is prepared to invest some effort to understand both the theoretical framework and the conceptual underpinnings of the field.

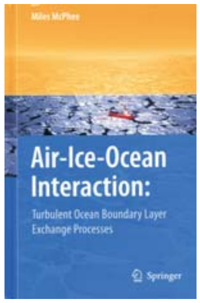
K. Birgitta Whaley
University of California, Berkeley

Air-Ice-Ocean Interaction
Turbulent Ocean Boundary Layer Exchange Processes

Miles McPhee
Springer, New York, 2008. $119.00 (215 pp.). ISBN 978-0-387-78334-5

The immensely complex interactions between the atmosphere, sea ice, and ocean limit the ability of scientists to understand recent change to polar climates. Exchanges of momentum, heat, and salt between the ocean and overlying sea ice are critical to the evolution of the sea ice; as a consequence, they influence the regional and global climate systems. Miles McPhee's descriptively titled monograph, *Air-Ice-Ocean Interaction: Turbulent Ocean Boundary Layer Exchange Processes*, is a timely contribution, given the recent attention being paid to the climate of the polar regions. As the author succinctly states: "Rapid and apparently accelerating changes in the state of the Arctic ice pack lend a sense of urgency: essentially, it seems that Nature is solving the equations a lot faster than we are."

McPhee is an acknowledged expert on the important ocean boundary layer beneath sea ice. His book, which ties together almost four decades of research, details the current understanding of how the shallowest water layers and wind-forced sea ice interact and how that interaction can be modeled numerically. The range of topics covered in the first six chapters includes the use of ice-based measurements for estimating turbulent fluxes in the ice–ocean boundary layer and the influence of wind stress on the structure of that layer. In the remaining three chapters, McPhee introduces approaches for numerically modeling the ice–ocean boundary layer. He demonstrates, through comparison of model output and field data, how numerical models can serve as a tool to interpret measurements and explore the boundary layer's evolution.



McPhee's monograph, a window onto his career as a polar oceanographer, is interspersed with personal stories about his field experiences. Those accounts add color, depth, and historical perspective to the analyses. For example, in explaining the unstable conditions in the upper ocean caused by rapidly freezing ice, he engages the reader with a personal account of waiting with colleagues at an ice camp for the ice to fracture and expose a lead, or channel of open water. The research team, poised to transport equipment and shelters to the lead in helicopters, would have limited time to deploy instruments and take measurements in the critical period when the lead remained open. The anecdote gives the reader a glimpse into the effort behind every laborious measurement. In that and other examples, McPhee accentuates how sea ice is an ideal platform from which to measure boundary-layer processes. Indeed, sea-ice-based measurements form the basis for most of the field programs carried out by the author and his colleagues.

Air-Ice-Ocean Interaction will be a valuable reference for Arctic and Antarctic researchers—be they observers, numerical modelers, or theoreticians. It will also be an excellent resource for Earth sciences graduate students. In fact, McPhee developed the book partly from lecture notes he used to teach an air-sea-ice interaction course in Svalbard, Norway. His monograph would make a fine graduate-level companion text with *The Geophysics of Sea Ice* (Plenum Press, 1986) edited by Norbert Untersteiner. That now out-of-print, hefty book, which includes a chapter entitled "The Upper Ocean" by McPhee, presents a broad overview of sea ice and polar oceanography. The more topic-specific *Air-Ice-Ocean Interaction* gives an up-to-date exposition of present knowledge of the ice–ocean interaction.

As a researcher in the field, I could open McPhee's practical text and refer to a specific chapter without needing to read the book from cover to cover. In that regard, the nomenclature definitions at the end of each chapter and the chapter abstracts are particularly helpful. However, one is occasionally left hunting through a chapter for variable or acronym definitions that were introduced several chapters earlier. The nomenclature definitions could be more inclusive, and a table of acronyms would be an effective appendix. Further, more meticulous editing would have improved the text. Despite those minor shortcomings, *Air-Ice-Ocean Interaction* will provide students and researchers alike with the theoretical principles needed for rigorous investigations of ongoing and future polar climate processes and change.

Mary-Louise Timmermans
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

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energy and environment

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