ELSEVIER

Atmospheric Research 62 (2002) 171–173

ATMOSPHERIC RESEARCH

www.elsevier.com/locate/atmos

Book review

Wind Stress over the Ocean

Ian S. F. Jones and Yoshiaki Toba, Cambridge University Press, 2001, 307 pages, ISBN 0 521 66243 5 (hardcover US$80.00)

By the 1930s, turbulence researchers had reliable observations and a workable theory for describing the drag or surface stress over solid surfaces. Subsequent observations over water surfaces, however, yielded drag measurements that were surprisingly small in light of how large the apparent roughness elements (i.e., the waves) were when compared to those that support the drag over solid surfaces. This mystery—still not fully solved—is the subject of this book.

This book is the final report of Working Group 101, commissioned by the Scientific Committee on Oceanic Research in 1993 to survey the "influence of sea state on the atmospheric drag coefficient." The volume thus consists of 15 chapters written either individually or jointly by experts on various aspects of air–sea momentum exchange.

The editors group these chapters into two parts. After an overview in Chapter 1, Chapters 2–7 make up Part 1, which reviews the basics of dynamical coupling between air and ocean. Topics include atmospheric and oceanic boundary layers, ocean wave spectra, mechanisms that generate drag, and measurement techniques. Chapters 8–15 make up Part 2 and identify phenomena that are not well understood but are presumed to contribute to the uncertainty in measured drag coefficients or roughness lengths documented earlier in the book. Topics include the influence of swell, surfactants, wave age, unsteadiness in the wind, mesoscale atmospheric processes, ocean fronts and current boundaries, and basin boundaries such as the edges and the bottom. Here, we also find evidence that, because of the waves, the mean wind and the wind stress are not always aligned—contrary to the fundamental assumption in almost all drag relations.

Chapter 2 shows the breadth of the problem this volume is dealing with. The chapter reviews published expressions for the neutral-stability drag coefficient appropriate at a reference height of 10 m, C_{DN10}, and for the roughness length for wind speed, z_0. Two sets of figures here highlight the wide disparity in observational results and in their interpretation. Figs. 2.1 and 2.2 both show C_{DN10} as a function of the neutral-stability, 10-m wind speed U_{10}, with wave age, c_p/U_{10}, as a parameter. Here c_p is the phase speed of the dominant waves. Fig. 2.1, from Donelan et al., shows C_{DN10} increasing with U_{10} and with c_p/U_{10}. Fig. 2.2, from Toba et al., shows C_{DN10} increasing with U_{10} but *decreasing* with c_p/U_{10}. Likewise, Figs. 2.3b and 2.4b in this chapter show 16 different parameterizations for the nondimensional roughness length as a function of wave age. Here, the predictions for nondimensional roughness range over three orders of magnitude for some values of

PII: S0169-8095(02)00009-1

the wave age. The remainder of the volume reviews processes and phenomena that are presumed to explain these discrepancies.

The editors advertise this book as a companion to the one by Komen et al. (1994), *Dynamics and Modelling of Ocean Waves*. Though that book reviews the theoretical and observational basis for wave modeling, its main purpose is to serve as a manual for implementing the WAM wave model. In contrast, though reviewing the state of the art and presenting a variety of parameterizations for C_{DN10} and z_0, the current volume reaches no consensus on a general method for modeling wind stress over the ocean but, instead, documents the continuing uncertainty and, thus, is a call for more research.

One of the inherent problems in analyzing wind stress over the ocean that, I feel, contributes to the range of results summarized in Chapter 2 and evident elsewhere in the book is that, often, too few independent variables are available to scale observations. For example, I mentioned plots of C_{DN10} versus U_{10}. Because C_{DN10} actually has U_{10}^{-2} in its definition, plots of C_{DN10} versus U_{10} are subject to fictitious correlation. Likewise, plots of the nondimensional roughness length $z_0 g/u_*^2$ versus wave age c_p/u_*, where g is the acceleration of gravity and u_* is the friction velocity, are common in this business (e.g., Figs. 2.3a, 7.4a, 10.4, and 10.5). Again, u_* appears in both nondimensional variables; consequently, such plots have built-in correlations because u_* is always uncertain by 10–20%. Despite the possible importance of this issue, the book does not mention it until page 50; and only Chapter 7 contains any meaningful discussion. Ways exist to mitigate or evaluate such fictitious correlations. Because sharing variables to nondimensionalize data is such an essential part of the analyses described here, the consequences merit a dedicated chapter.

The production quality of this book—by which I mean design, layout, and editing—is uneven. The cover, which is a color photograph of the Floating Instrument Platform (FLIP), deployed for profile measurements during the 1995 Marine Boundary Layer Project, is the best I have seen on a scholarly book. The text is laid out well; it is pleasing and easy to read. Ample white space leads the reader from section to section. The figures are crisp and generally well designed; low-quality, computer-generated figures that are proliferating in modern scientific publications are rare. Some figures, however, would benefit from more descriptive captions, better legends or call-outs, and consistency between text and plot nomenclature. Figures in Chapters 1 and 4, in particular, suffer from these shortcomings. The index, which is less than 2 1/2 pages long, is rudimentary.

The punctuation throughout the volume is poor. For example, the text contains very few semicolons; and too often, introductory clauses and phrases are not set off from the rest of the sentence with a comma. To demonstrate that this grammatical error is ubiquitous, I cite this example from Chapter 1, "When air flows over a steeply deformed water surface it is not able to follow the surface but instead separates," and this one from Chapter 15, "As we have noted in other chapters more than one relevant measure of the wave field changes at the same time." It is hard for me to imagine that so many authors simultaneously decided to disregard the same grammatical rule. Rather, it seems that the editors themselves or Cambridge has a minimalist punctuation philosophy and, therefore, arbitrarily removed commas and semicolons from the authors' submitted text. The result is unfortunate. Presumably, the target audience for this book is the worldwide community of scientists interested in turbulent air–sea exchange. But for many of these readers, English is not their first language: They deserve to see all the clues that English has to offer to help them understand this material. Minimizing commas and shunning the powerful semicolon in scientific writing is like requiring experimentalists to measure the wind stress over the ocean without using three-axis sonic anemometers.

One of the main benefits of a review such as Jones and Toba's is the collection of references to previous work that will help guide novices in the field to the key publications. Each chapter in this book includes bibliographic information at the bottom of the first page. Apparently, Cambridge anticipated that some readers will copy only selected chapters from their library's copy of the book and, therefore, wanted to make sure that each such copy included complete bibliographic information. Unfortunately, all the references are collected alphabetically in 27 pages at the end of the book. Thus, to have a stand-alone copy of a chapter, a user must also copy 27 pages of references, most not cited in the chapter being copied. While having all the references collected in one place is valuable, a better organizational scheme might be to group them at the end of the book, as here, but by chapter.

In summary, though this book has numerous flaws in copy editing, Jones and Toba have assembled a valuable collection of papers on air−sea momentum exchange. Their treatment of our current understanding of wind stress over the ocean is broad and balanced, with both sides of some controversial issues represented. Rather than reaching a consensus on how to explain the variability in wind stress over the ocean, however, and thereby retarding future work, this book documents the uncertainties and ambiguities and should, thus, serve to focus future research on this fascinating subject.

Edgar L Andreas
U.S. Army Cold Regions Research and Engineering Laboratory,
72 Lyme Road,
Hanover, NH 03755-1290, USA
E-mail address: eandreas@crrel.usace.army.mil
Tel.: +1-603-646-4436; fax: +1-603-646-4644