use among European Union (EU) member states, particularly in the context of the EU's water framework directive. The CD-ROM contents are listed in German only, however. Even so, the contents of the CD were relatively easy to navigate for a non-German speaker. Moreover, the CD contains software specifically developed for viewing the maps and text, a convenient addition. Several of the files on the CD were opened using ArcView 3.1 without difficulty, so users interested in pursuing GIS applications of the atlas contents should have no problem doing so.

The price of the atlas is a hefty $310. Obviously, this is not a document that most hydrologists would add to their personal library. However, given the substantial amount of information contained within the atlas, the price represents a good value, and university libraries and research institutions should find it a useful, and beautiful, addition to their collections.

The Austrian government has provided a clear blueprint for the design of a modern atlas. It is a pleasure to see a nation's hydrology treated with the care that it deserves.

—HARRY LINS, U.S. Geological Survey, Reston, Va.

THE BOOKSHELF

Earth's Climate: The Ocean-Atmosphere Interaction

A new AGU book, Earth's Climate: The Ocean-Atmosphere Interaction, *edited by Chunzai Wang, Shang-Ping Xie, and James A. Carton, presents current observations, theories, and models of ocean-atmosphere interaction that help shape climate and its variations over the global ocean.*

The book represents the climate community's first effort to summarize the modern science of ocean-atmosphere interaction and the roles that the interaction play in climate variability in the Pacific, Atlantic, and Indian Oceans as well as interactions across basins and between the tropics and extratropics. In this issue, Eos *talks with lead editor Chunzai Wang. Wang is a research oceanographer at the Physical Oceanography Division of the National Oceanic and Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratory, in Miami, Florida.*

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Eos: The book highlights the importance of ocean-atmosphere interaction in Earth's climate. How can ocean-atmosphere interaction produce climate change and why do we need to study it?

Wang: For historical reasons, the ocean and atmosphere have traditionally been studied separately and independently, assuming that the state of the other fluid is a specified boundary condition. That changed in the 1960s when Jacob Bjerknes at the University of California, Los Angeles, recognized the connection between El Niño, which refers to extended episodes of anomalous warming of the ocean off the coast of Peru, and the Southern Oscillation, a sea level pressure swing between Darwin, Australia, and the island of Tahiti in the central tropical Pacific.

He realized that ocean-atmosphere interaction or feedback is at the heart of the El Niño-Southern Oscillation (ENSO) phenomenon, and described how an initial change in the ocean could affect the atmosphere in a manner that altered the atmospheric conditions and induced oceanic changes that reinforce the initial change. For example, if at some initial time sea surface temperatures in the equatorial eastern Pacific are anomalously warm, then the east-west gradient in sea surface temperatures will be reduced. The atmosphere will respond by reducing the east-west gradient of sea level pressure, and consequently relaxing the strength of the easterly trade winds. The relaxation of the easterly winds causes an eastward surge of warm water along the equator, positively reinforcing the initial warm sea surface temperature anomalies. Thus, this positive ocean-atmosphere feedback amplifies small initial perturbations into large observable amplitudes, i.e., a warm El Niño state.

The ocean and atmosphere interact with each other and create phenomena that are responsible for climatic extremes on the regional to global scale. They are attracting increasing attention from the scientific community, the general public, and policy makers owing to their great social and economic impacts as well as scientific interests. The study of climate demands that we treat climate phenomena as a coupled ocean-atmosphere problem. This paradigm of ocean-atmosphere interaction has enabled us to unlock the mysteries of ENSO and other climate phenomena, which will eventually lead to skillful and useful climate prediction with the assistance of an adequate observing system.

Eos: Ocean-atmosphere interaction has emerged as a major topic for climate research. What is the current state of understanding ocean-atmosphere interaction and climate variability, and how does this monograph contribute to the research in the field?

Wang: Although the Pacific El Niño has become the "poster boy" of climate, we must also focus on the advances in observing and understanding other climate phenomena. Recent studies show that the importance of ocean-atmosphere interaction goes far beyond the Pacific El Niño, including variability from seasonal to decadal timescales over the globe.

The Bjerknes positive ocean-atmosphere interaction also operates in the equatorial Atlantic and Indian oceans for producing the Atlantic Niño (a counterpart of the Pacific El Niño) and the Indian Ocean dipole. In addition to the Bjerknes dynamic feedback mechanism, thermodynamic ocean-atmosphere interaction mechanisms have been identified to produce the tropical meridional gradient ("dipole") variability observed in the Atlantic, with some evidence of its existence in the Pacific and Indian oceans. In the extratropics, the atmosphere is stably stratified and the direct effect of sea surface temperature changes is limited to a shallow atmospheric boundary layer. This limitation, along with high levels of weather noise, has made it difficult to make a robust identification of mechanisms by which the ocean can induce positive feedback in the coupled ocean-atmosphere system, except near narrow ocean fronts. It has been suggested that ocean-atmosphere interaction modulates extratropical modes such as the North Atlantic Oscillation and Pacific Decadal Oscillation. This monograph summarizes the current understanding of all these climate phenomena and how ocean-atmosphere interaction helps produce these climate phenomena. It also addresses issues of various atmospheric and oceanic bridges that link different ocean basins and connect the tropics and extratropics, along with their implications for paleoclimate changes and the current global warming.

Eos: How has global warming affected ocean-atmosphere interaction and climate variability? What are some of the long-term consequences of global warming on climate?

Wang: Anthropogenic climate changes pose a great challenge for the climate research community as well as for mankind in general. On the global scale, exchange of carbon dioxide and heat between the atmosphere and ocean has likely slowed down the rate of temperature rise so that its effects are just beginning to be observed. On the regional scale, the temperature rise is unevenly distributed, with the greatest rise over continents but some cooling over the North Pacific and North Atlantic oceans during the second half of the past century.

Human-induced climate change may have some further surprises in store. Some model projections suggest a slowdown of the Atlantic meridional overturning circulation in a warmer climate due to increased sea surface evaporation, as well as increased rainfall in the mid/high latitudes as a result of a more intense hydrological cycle. This slowdown would reduce the northward transport of warm surface water, and may send the North Atlantic and Europe into a colder climate. Such abrupt climate changes are believed to have happened before as the climate warmed at the end of the last ice age. What causes such a rapid spread of North Atlantic cooling is unclear. Tropical ocean-atmosphere interaction may have played an important role in transferring this regional cooling into a global event.

Eos: What are the unique features of this book and how do they help to advance research in the field?

Wang: This book presents the state-of-the-art in research on ocean-atmosphere interaction and climate variations. For the first time, it brings together our current understanding of climate variations over the three major oceans in a single volume. The presentation consists of a combination of overview and research articles, many by leading scientists in the field. The book opens with an overview chapter that provides a global survey of ocean-atmosphere interaction and climate variability, including a discussion of similarities and differences among the tropical ocean basins, and influences and interactions among different ocean basins and between the tropics and extratropics. It is organized into five themes: Pacific climate variability, tropical Atlantic climate variability, Indian Ocean climate variability, tropical-extratropical interaction, and cross-basin issues.

Scientists, researchers, and students of climate, oceanography, and atmospheric sciences—in fact anyone interested in how and why climate varies in space and time—will find this book a significant resource now and in the future.

AGU Geophysical Monograph Series Volume 147; 414 pp. hardbound; 2004; ISBN 0-87590-412-2; AGU Code GM1474122; List Price: $70.00, AGU Member Price: $49.00.

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—JONATHAN LIFLAND, AGU Science Writer