

## POLAR ENVIRONMENTS AND GLOBAL CHANGE.

By ROGER G. BARRY and EILEEN A. HALL-McKIM.  
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978-1-108-42316-8. 418 p., maps, b&w and colour illus.,  
bib., glossary. Hardbound. Cdn\$22.24.

*Polar Environments and Global Change* is an excellent compendium of pertinent information highlighting the unprecedented changes in environmental conditions facing three of the world's most significant cold regions.

The volume is divided into nine chapters and approximately 400 pages of text. Barry and Hall-McKim strategically incorporate an overview of historical information into the book's first chapter, which focuses on past climatic conditions complemented by sections detailing polar exploration and technological advances that have facilitated recent research detailing cryospheric interactions with the ocean, land, and atmosphere. Chapter 1 is highlighted by an extremely pleasant synthesis that compares the geographical and climatic characteristics of the two major polar regions (Arctic and Antarctic), while also highlighting the importance of the "third polar region" in Central Asia where altitude is the principal climatic factor.

The second chapter offers a thorough outline of climatic history from the Eocene to recent times (Holocene-Anthropocene). The authors do a masterful job of clearly defining the primary drivers of long-term global climate change (e.g., increased greenhouse gas concentrations and changes in Earth's orbital cycles) while highlighting the environmental conditions that characterized various geological epochs.

Chapter 3 provides a refreshing synthesis of the array of observing networks that have enabled contemporary insights into polar regions. This section is well structured in its layout and details the importance of in situ measurements complemented by community-based observations and traditional knowledge. The chapter ends with a summary of the multiple benefits of employing satellite imagery (e.g., Landsat, Radar) to observe and monitor environmental changes (e.g., snow cover extent, global sea ice concentration, landscape changes) in the polar regions. While emphasizing the distinct advantages of incorporating data obtained from optical remote sensing imagery to quantify change in the polar regions, the authors also provide an unbiased perspective of some of the limitations of remote sensing technology (e.g., costs associated with obtaining data, errors due to un-calibrated instruments).

Chapter 4 summarizes the geographical differences and environmental forcings between the Arctic and Antarctic regions, while describing the atmospheric and oceanic circulations of both areas. The importance of circulation modes in the Northern Hemisphere (e.g., Arctic Oscillation) and Southern Hemisphere (e.g., Southern Annular Mode) are linked to the effects on global weather patterns, as well as historic and recent trends observed in

sea ice regimes. This chapter lays out the conceptual basis for the subsequent book sections on polar landscapes and ice sheets. Chapters 5 and 6 are enlivened by the fact that Barry and Hall-McKim have presented recently referenced scholarly information on the environmental conditions of the many differing surface types of the polar regions (e.g., desert, tundra, permafrost, lakes, rivers, ice sheets) as a result of the effects of climate variability. The information covered in chapters 5 and 6 is well complemented by the adequate use of contemporary photographs that present the reader with exhaustive information on the environmental characteristics of various polar terrestrial environments. The authors conclude that accelerated rates of permafrost thaw, glacial retreat, coastal erosion, and loss of ice sheet mass are likely due to increases in global temperature.

Chapter 7 is a welcome reminder of the major factors that act as catalysts to global sea level fluctuations. The authors reiterate the importance of thermal expansion due to ocean warming and the mass loss of land ice in contributing to eustatic sea level variations. Comprehensive descriptions of the characteristics of the Arctic and Southern Oceans in chapter 7 are supplemented by wide-ranging narratives of the hydrography of the diverse seas adjacent to the Arctic and Antarctic Oceans. The penultimate chapter presents the concept of the "third pole," an often-ignored storehouse of snow, ice, and frozen ground that comprises the northern mountain ranges of Central Asia, the Tibetan Plateau, and the Himalayan region to the south (Fig. 8.1, p. 34, <https://nsidc.org/charis/project-summary/>). The authors should be complimented for devoting an entire chapter of this book to informing the reader about the unique characteristics of the third polar region (e.g., climate, permafrost, and biota) and the amplified signals of environmental change in this locale. Throughout the text, Barry and Hall-McKim drive home the narrative that continued warming will facilitate further landscape changes—retreating glaciers and ice caps, decreasing summer sea ice extent, and increasing depth of soil thawing—through the end of this century. The final chapter emphasizes the latter point while easing into a welcome discussion of expected future changes based largely on computer modeling simulations.

An especially appealing feature of this book is the presence of summary sections at the end of each chapter. These summaries are concise subsets of the wealth of information expanded on earlier in the chapter. The discussion questions at the conclusion of every section allow the reader to reflect on the salient points of the chapter. If this book is used for teaching, these enquiries can facilitate peer discussion to amplify students' comprehension of the material. Further, the exhaustive reference sections at the end of each chapter save the budding researcher some time as Barry and Hall-McKim have provided a wealth of scholarly sources to complement the chapter themes. In my opinion, this well written and engaging book provides a fundamental and necessary background in polar regions and will serve as a valuable learning tool suitable for both undergraduate and graduate students interested in polar

studies. The theoretical material will also be of great interest to environmental scientists, as well as the wider public interested in obtaining auxiliary knowledge about the significant role that polar regions play in the global climate system. I highly recommend this book to anyone interested in building their knowledge capacity on polar regions.

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**BRAVE NEW ARCTIC: THE UNTOLD STORY OF THE MELTING NORTH.** By MARK C. SERREZE. Princeton, New Jersey: Princeton University Press, 2018. ISBN 9780691173993. 264 p., maps, b&w and colour illus., index, endnotes. Hardbound. US\$24.95.

For around a decade it has been a generally accepted scientific fact that the world's climate is changing, and that the cause is man-made carbon dioxide. These effects are magnified in the Arctic (so-called "Arctic amplification"), and steady reductions in the amount of sea ice have been one of the most visible results. In this sparsely populated region, this is a trend of concern not only for polar bears. Without its year-round ice cover, the reduced albedo of the Arctic Ocean has been blamed for changing weather systems throughout the Northern Hemisphere, resulting in more severe winters in the northern United States, earlier forest fires in Canada, and flooding in Europe. The eroding wave action resulting from the absence of sea ice has washed away coastal settlements in Alaska and the Canadian Arctic. The Arctic is at the front line of the global climate crisis.

What makes Mark Serreze's book interesting and different is that it does not merely document the changes we already know about, but tells the story of how the American scientific community came to the realization that Arctic climate change was real and man-made—and happening far quicker than models had predicted. Serreze himself admits to initially being skeptical that there was a link between CO<sub>2</sub> and Arctic warming, so the journey is also a personal one as the mounting evidence gradually persuades him to change his mind.

Climate models had long predicted that the consequence of increasing global CO<sub>2</sub> levels would be raised temperatures and reduced summer sea-ice cover, but for a long time this was simply not observed. Between 1979 and 2000 there were several years when new minima were observed, but these were followed by years in which the sea-ice extent returned to "normal" levels. Separating the anticipated downward trend from natural variability was surprisingly complicated.

For example, the eruption of Mount Pinatubo in the Philippines in June 1991 caused a drop in summer temperatures in the Canadian Arctic the following year, abruptly reversing several years of shrinking summer sea-ice extent and obscuring the expected CO<sub>2</sub>-induced warming. It was not until 2003 that Serreze was finally convinced that a new trend had been established. This trend was confirmed beyond doubt in 2007, when there was a further dramatic drop in summer sea-ice cover. At a press conference the following year, Serreze said that he believed the Arctic cryosystem had probably now reached a tipping point and coined the term "death spiral" to describe the ever-shrinking summer sea-ice cover.

Another interesting example of the pitfalls to befall the scientific community as they tried to determine whether CO<sub>2</sub> levels were actually having an impact on the Arctic climate was what Serreze describes as a "mania" in the 1990s for invoking the Arctic Oscillation (AO), a large-scale atmospheric phenomenon, as a cause for observed changes. In fact, he claims that for a while the joke was that it was impossible to get a paper published or proposal funded unless it had a link to the AO. But ultimately the AO turned out to be a red herring as the underlying cause of Arctic climate change.

The difficulty of determining cause and effect in the Arctic climate was not merely a matter of science though. Perhaps the most remarkable part of the book is his detailed account of how political interference by the U.S. government of the day (the Republicans of the Bush administration) attempted to suppress data and harass and intimidate prominent scientists working in the field, on several occasions successfully shutting down or misdirecting the science programs they were employed on.

My main criticism of the book is that this story is viewed from a purely American perspective. Serreze rarely mentions contributions by non-U.S. scientists or the considerable international progress in unravelling the Arctic climate puzzle. He mentions that the major international Arctic climate research program, MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate), which is billed as the "largest polar expedition in history" with over 600 participants from 17 countries (<https://www.mosaic-expedition.org/>), is much larger than the U.S. one, but then tantalizingly says nothing about its objectives. Perhaps the biggest future Arctic climate threat of all, the thawing of the vast reserves of frozen methane hydrates offshore Siberia (already observed to be bubbling to the surface), again receives barely a mention. So, one is left wondering how much of "the untold story of the melting north" from the book's title has actually been told.

Overall though, this is an enlightening and often fascinating read and well worth the money. In terms of technical level, since the book necessarily focuses on the subtleties of how the academic debate has evolved over the decades, it does require a good grasp of climate science on behalf of the reader. Despite its often chatty style, the book