

Book Reviews

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Remote Sensing of Snow and Ice

W. Gareth Rees
Taylor & Francis, 2006
ISBN 0 41529831 8, 312 pages, £56.99

Since most texts on remote sensing techniques are biased toward lower latitudes this book's aim of providing an overview of their application to the cryosphere is a good one. The author has largely succeeded in hitting his target of both researchers and master's degree level in a comprehensive account of the current state of the art with sufficient background information on available sensors, methods, and the cryosphere.

Chapter 1 provides a succinct and very useful background to the significance of the cryosphere. Chapters 2 and 3 provide comprehensive reviews of remote sensing systems, techniques and digital image analysis. Given the title these chapters could be considered unnecessary. There are certainly other volumes on remote sensing that cover these topics in more detail (e.g. Rees (2001) and Lillesand & Kiefer (2003)). Whilst all examples are from the cryosphere, omission might have allowed expansion of the subsequent chapters that deal with remote sensing application to the individual components of the cryosphere. Chapter 4 describes the physical properties of snow and ice and their relation to remote sensing observations. It provides an excellent and well-referenced description of the physical characteristics and electromagnetic properties of snow and ice, introducing the following treatment of each element of the. There follows in Chapters 5 to 9 more in-depth discussion of the application of remote sensing to the study of snow (Chapter 5), sea ice (Chapter 6), freshwater ice (Chapter 7), glaciers, ice sheets and ice shelves (Chapter 8), and icebergs (Chapter 9). Each provides a comprehensive account of the current state of the science, techniques and observations applicable to each of these components. Again they are well referenced and allow the reader to read more widely if necessary.

Some topics, in particular the sections addressing snow in Chapters 4 & 5, are approached from a very mathematical perspective. The addition of more descriptive explanations would be beneficial to those who do not immediately approach things from a numerical point of view.

The final chapter usefully reviews the benefits from remote sensing to the study of snow and ice. Any detractors of remote sensing techniques would do well to read the first section of this chapter in particular. For balance the difficulties involved in remote sensing observations are considered, but also the scope for development of future instrumentation and techniques that promise to deliver much more quantitative information about the cryosphere.

The book succeeds in providing a comprehensive account of the current use of remote sensing to study the cryosphere. It is also recommended for its good structure and extensive

referencing. The detail in some of the black and white photographs is difficult to discern but this detracts only slightly. Overall, it is an excellent text that will serve its target audience well as an easily accessible, manageable and well-referenced summary of current remote sensing application to snow and ice.

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A century of *Discovery*: Antarctic Exploration and the Southern Ocean

G. Griffiths & D.W.H. Walton (eds.) (2005).
Archives of Natural History, 32(2), 129–401.

These seventeen papers, and two abstracts, were presented at an international symposium, celebrating the centenary of *Discovery's* return after a highly successful voyage of scientific exploration. They are a mix of historical and modern achievements of Antarctic science, mostly presented in pairs of chapters covering old and new. The volume is well written, edited and produced. Three papers - on ships called *Discovery*, an account of life at sea on *Discovery*, and a discussion on artistic perceptions of Antarctica are not discussed here.

The first paper "A century of Antarctic science; planning and serendipity" by the late G.E. (Tony) Fogg is a fine last tribute to his scholarship, providing an excellent introduction to the remaining more specialist material.

Marsden describes the inception of the *Discovery* Investigations at South Georgia, from the various committees, starting in 1913, to the establishment of the marine station in 1926. Whale biology was prominent in the early work, and the studies of Mackintosh & Wheeler were seminal to much later work in the Southern Ocean. It is therefore regrettable that the recent remarkable work on sea mammals using electronic instruments to track movements, and also to collect oceanographic data at little cost, is not included!

Headland usefully summarises exploration and research in both polar regions from 1600 to the present, setting the scene for the third International Polar Year in 2007.

Rainbow discusses the *Discovery* collections, begun in 1904 and now comprising more than 70 000 glass jars with more than five million specimens of marine animals. Surprisingly, Helene Bargmann, curator from 1928 to 1964, is not mentioned. She produced papers on krill and was involved in editing the *Discovery* Reports from 1929 onwards. During the bombing of London in WW II she transferred 25 000 jars from the museum to safety. The current cost of creating such a collection would approach £100 million, if indeed it were possible. The collections still have great potential for studies on phylogeny, biodiversity and ecology.

Cameron introduces the foundations of Antarctic glaciology starting with the Heroic Age. Three significant milestones were Wright & Priestley's Glaciology memoir (1910–1913) on the McMurdo Dry Valleys, the Norwegian–British–Swedish Expedition (1949–52) subice topography discoveries, and the development of glaciology during the International Geophysical Year (1957–58). Cameron provides personal recollections and stories of the IGY. Vaughan's account (abstract) of modern glaciology notes the key developments of deep ice–cores to bedrock and the subice data from the airborne radio–echo sounding begun in 1961. Since then the Antarctic ice sheet has been recognised as the single most important control on global sea level.

Mills covers the history of the hydrology of the Southern Ocean from 1885 to 1937. He shows what George Deacon's discoveries owed to the investigations of his predecessors and makes the case that Deacon's work transcended theirs providing a first global view of oceanic circulation. Cunningham follows this with a modern account of the Southern Ocean circulation, describing the global three-dimensional circulation that plays a central role in regulating the Earth's climate. He describes the interactions of the different main water masses within the circum–Antarctic ocean and how three choke points can be used to measure water transport – the Drake Passage, South Africa/Antarctica and Australia/Antarctica. Unfortunately the annual cycle of expansion and contraction of the Antarctic pack ice is neglected in this account.

Next Angel runs through a range of topics concerning Southern Ocean pelagic ecosystems including the studies of primary production stimulated by Hart's (1942) reports of the sharp contrast between high standing crops around South Georgia and contrastingly low values in the offshore waters of the Southern Ocean and his hypothesis that extremely small amounts of organics, iron and manganese enhance phytoplankton production. Studies on krill are considered and the distribution patterns of zooplankton species, exemplified by Marr's classic work *Euphausia superba*. He briefly discusses the importance of the volatile gas dimethyl sulphide (DMS), produced by certain phytoplankton, and its role in atmospheric precipitation and then moves to human impacts on the system. One omission in this paper is any reference to the international BIOMASS Programme (1976–1991) organized by SCAR/SCOR.

Everson discusses the origin and operation of CCAMLR. As the populations of great whales declined interest turned to fish and krill in the Southern Ocean. There were major concerns about overfishing of krill and the possible fate of those species dependent on it. BIOMASS was set up in response to a request from the Antarctic Treaty Parties to obtain a deeper understanding of the structure and dynamic functioning of the ecosystem. The ecosystem approach of CCAMLR was the first to be included in any fisheries convention and it has been remarkably successful.

Walker covers the early voyages of discovery and the dawn of scientific meteorology. James Clark Ross recorded the first systematic observations from 1839 to 1843, but the first land station was only established in 1899. Practical descriptions of the difficulties of making observations in the Antarctic are described. Bruce set up the first permanent

meteorological station in the South Orkneys in 1903, which is still operational today. Byrd's three expeditions, 1928–41, produced important new information on the vertical structure of the atmosphere.

Turner carries the story forward into modern meteorology and climatology. We now know that the climate is affected by tropical atmospheric and oceanic cycles such as the El Niño–Southern Oscillation (ENSO), but the picture is complex. By the end of this century near-surface temperatures across much of the continent are expected to increase and increased precipitation is expected. Computer modelling is a valuable tool for prediction of atmosphere–ocean interactions, but the challenges are greater than in non-polar regions.

McConnell's paper describes how charts showing the lines of magnetic variation have been published over the last three centuries and extended southwards as instruments were improved. With the establishment of Antarctic stations, continuous monitoring became possible, explorers reached the South Magnetic Pole, and new techniques became available. Rodger (abstract), referring to the last half century, reminds us that the Southern Hemisphere is unique in that the magnetic pole is much further displaced from the geographic pole allowing effects controlled by the magnetic field to be separated from those caused by solar radiation. Solar wind energy is guided by the Earth's magnetic field into the upper atmosphere of the polar regions. High speed thermospheric winds could be determined for the first time and the ionosphere is undergoing cooling due to increasing concentrations of carbon dioxide. Data from the south are likely to be very important in establishing links between solar variability and climate change.

Thomson & Vaughan discuss the evolution of Gondwana and Antarctica, covering historical and modern research. In the last century knowledge of Antarctic geology increased from near zero to centre stage in the development of plate tectonics, confirming the supercontinent, continental break up and evolution of global climate. This paper traces the origins and initial slow development of geological descriptions of Antarctica over the last century, considering the seminal works by Wegener and DuToit, and the rapid progress during and after IGY. The Deep Sea Drilling Program made a huge contribution, and it was shown that West Antarctica was a mosaic of five microplates. New techniques revealed the 'superplume' phenomenon, and subglacial lakes, notably Lake Vostok, were revealed by radio-echo sounding. For the future there is increasing interest in earthquakes, the origin of Cenozoic Antarctic glaciation and investigating the hydrothermal vents.

Finally Walton pulls the diverse threads together and shows how the scientific backwater has now become central to integrated global models of our world. Ending up with five questions for the future he shows how we can still learn useful lessons from the past. This collection of papers is both thought provoking and a most useful reference to many of the key events in Antarctic science. I hope it will be widely read.

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