Reviews

MICROWAVE REMOTE SENSING OF SEA ICE. Frank D. Carsey (Editor). 1992. Washington, DC: American Geophysical Union (Geophysical Monograph 68). 478 p, illustrated, hard cover. ISBN 0-87590-033-X. US$68.00.

The value of remote-sensing techniques for the study of sea ice, especially when they are used from satellites, has long been recognised. Such methods can substantially reduce the need for expensive and difficult *in situ* measurements from ship-based campaigns, or, alternatively, can augment such measurements by allowing them to be extrapolated over very large areas using data obtained during periods as short as a few days. The use of microwave wavelengths (1 mm to 1 m) is especially attractive for the polar regions, as techniques operating at these wavelengths are, unlike most other remote-sensing techniques, largely unaffected by the presence of haze, cloud, precipitation, and ionospheric disturbances, and entirely independent of the presence of sunlight. These methods are now routinely used to measure ice concentration, type, and dynamics, and interest in them, considerable for many years, has recently been boosted by the launch in 1991 of the European Space Agency's ERS-1 satellite.

This book covers the subject of microwave remote sensing of sea ice in considerable, although variable, depth. It is divided into 26 chapters, with contributions from more than 60 authors. As one might expect of a publication from an American institution, the list of contributors provides excellent representation of workers in the field from the USA, although other groups are less well-represented, both in terms of authorship and in the awareness shown by the contributors of their work. Nevertheless, this book represents a major contribution to a field the literature of which has tended to be rather dispersed, and I believe it will be warmly welcomed both by sea-ice specialists with interests in remote-sensing methods and by remote-sensing specialists who are developing new methods for the study of sea ice.

The first three chapters provide a general introduction to the significance, development, and physical and electromagnetic properties of sea ice, and to the current status of relevant satellite technology. Chapters 4 and 5 discuss at a fairly general level the signatures of sea ice observed by the two principal types of microwave sensor, namely, passive microwave radiometers (PMRs) and synthetic aperture radars (SARs). Chapter 6 provides a very brief introduction to the complex and rather counter-intuitive process of SAR image formation, and sits rather uncomfortably with the rest of the book, since none of the other chapters really need this level of technical development. I would prefer to have seen here a discussion of the technical limitations imposed by the SAR imaging process as they relate specifically to the imaging of sea ice, and perhaps a chapter earlier in the book describing and comparing the principles of operation of the main microwave sensors. Chapter 7 provides an excellent summary of the use of radar altimetry (RA) methods for the study of sea ice. This is a topic that had been largely neglected until the Mullard Space Science Laboratory, University College London, began to demonstrate its potential in the late 1980s, and it is good to see it well represented here.

From this point onwards the editorial selection of material for inclusion, and the order in which it appears, become necessarily somewhat more subjective. Subsequent chapters discuss the modelling and laboratory simulation of sea-ice properties, characterisation of thin ice, polynyas, snow cover, low-salinity ice and freezing and melting processes, the nature and performance of specific algorithms for extracting ice concentration and type from PMR and SAR data (including a chapter on the use of polarimetric SAR), techniques for determining ice motion from time series of SAR images, the current status of attempts to determine ice thickness using airborne or spaceborne microwave techniques, case studies from various parts of the world, and the assimilation and fusing of data sets, especially for climatological studies. Finally, there is a short chapter summarising the current status and future directions of microwave remote sensing of sea ice. There are also two appendices. The first provides a useful glossary of sea-ice terms. The second is a very incomplete list of archived satellite data from various types of sensor, not just microwave sensors. It is not clear on what basis this list has been compiled, and I do not believe it is particularly useful, since more complete lists are readily available elsewhere.

I have two general criticisms of the book. The first applies to any edited, multiple-author, publication. Despite the best endeavours of the editor, the book will inevitably be to some extent a collection of separate papers, with the consequence of overlapping and occasionally inconsistent treatment of the same topics in different chapters. The obvious way of avoiding this problem is in a single-author work, although, as the editor rightly points out in his preface, the field is not yet mature enough for this to be a feasible undertaking. However, I must say that more comprehensive indexing and cross-referencing between chapters would be of great assistance. Another way round the problem of drawing together the material presented in 26 separate articles is to provide a substantial review of the subject, ideally linked to the later chapters. To a limited extent this is accomplished in the early chapters of the book, but again the comprehensive overview of the subject is never quite apparent.

My second criticism can, I think, be more fairly lev-

elled at some of the authors of individual chapters, and it relates to the general lack of consolidation and intercomparison of experimental results. Experimental data on almost any relevant physical parameter (for example, the PMR emissivity of a particular ice type at a certain frequency and viewing angle) can be found in different places in various chapters of the book. Such data will, of course, reflect the local conditions prevailing at the time and location of the particular experiment, but, if they are to be useful to the rest of us, we need to appreciate to what extent they are characteristic of conditions in general. To the extent that the authors have not felt able to provide this contextual information (and there are some who have succeeded notably), the book can be regarded more as a sourcebook than as a textbook. But as a sourcebook it does collect many of the relevant data in one place, and provides plenty of references to the recent literature, so that specialised researchers may begin to carry out the task of review and consolidation for themselves.

In summary, then, this book is not perfect, and maybe other editors would have constructed it differently. But I believe it represents just about the best coverage of an important and rapidly developing field that is currently possible. It is well produced, and the price should put it within the reach of individual researchers as well as institutions. (Gareth Rees, Scott Polar Research Institute, University of Cambridge, Lensfield Road, Cambridge CB2 1ER.)

INTERNATIONAL LAW AND THE ANTARCTIC TREATY SYSTEM. Arthur Watts. 1992. Cambridge: Grotius Publications (Hersch Lauterpacht Memorial Lecture Series 11). xiii + 469 p, hard cover. ISBN 1-85701-007-8. £58.00; US$120.00.

An expanded version of a series of three lectures delivered in February 1992 at the University of Cambridge in memory of Sir Hersch Lauterpacht, this book provides a wide survey of the legal framework that governs human activities in Antarctica. The aim of the author, whose involvement in Antarctic affairs goes back to 1961, is to explore ways in which the Antarctic legal regime contributes to the development of certain areas of international law.

Before starting his analysis, the author rightly points out the unique physical characteristics of Antarctica that, in many cases, are the determining factor in the application of the relevant legal rules. Unlike the great amount of literature that contemplates the Antarctic Treaty System in a historical perspective, this work is divided into 11 chapters covering the main legal questions arising out of the Antarctic Treaty regime. Chapters 2 and 3 deal with the constitutional evolution of the system: the author gives an accurate description of the institutional structure that has been established under the different elements of the Antarctic Treaty System. He ends these two chapters by showing that the emergence of a full-scale organisation has an impact on the position of the states claiming sovereignty over parts of Antarctica, even if their legal positions remain protected by Article IV of the Antarctic Treaty. Chapter 4 concerns dispute settlement and describes the particular procedures adopted to cover disputes arising under each convention. Chapter 5 examines the territorial question, a topic related to the diverging positions of the states over sovereignty, and that underlies all that is done in this region. The 'non-solution' of this issue provided by Article IV of the Antarctic Treaty, and the similar provisions found in the other parts of the Treaty System, is well known. The author examines the many questions related to the problem and comes to the conclusion that these provisions 'have afforded all the States concerned an unparalleled opportunity, despite deep-seated differences about a matter so politically sensitive as territorial sovereignty, to cooperate closely in Antarctica in (as the preamble to the Antarctic Treaty puts it) the "interest of all mankind"' (page 140).

The different views on territorial sovereignty have their implications at sea as well as on land. In chapter 6 the author surveys the main questions related to the Antarctic seas: the first concerns their landward limits and the difficulties created by ice shelves and sea ice in identifying these limits; the second deals with the outer limits of these seas. The requirement of an ecologically sound marine living-resource conservation regime and the necessity to make the mineral regime established in 1988 by the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA) applicable to activities taking place on the continental shelf of Antarctica have considerably complicated the setting of these limits. The third major question discussed in this chapter relates to the connection between the Antarctic Treaty areas and the Convention on the Law of the Sea (1982).

Jurisdiction, enforcement, and liability remain the Achilles' heels of the Antarctic Treaty System. Each part of the Treaty System other than CRAMRA requires its parties to take appropriate measures within their competence, including the adoption of laws, regulations, and administrative actions to ensure its implementation. This formula, dictated by the sovereignty issue, allows states to take measures on either a territorial or a nationality basis. The provisions on liability are weak: except the detailed and technical provisions contained in CRAMRA, no satisfactory solution has been found on this topic. The Protocol on Environmental Protection (1991) only contains a commitment for the Parties to elaborate a liability regime.

Chapter 8 reminds the reader of the importance of one of the Antarctic Treaty's main achievements: the provisions on non-militarisation and non-nuclearisation. They have ensured the use of Antarctica for exclusively peaceful purposes. The management of Antarctic natural resources and the protection of the continent's environment form the bases of chapters 9 and 10. The author describes the different regulations adopted on these matters, since the Antarctic Treaty does not directly address these issues.

At the end of this invaluable review, the author concludes that the various legal instruments adopted to regulate human activities in the Antarctic have given rise to a single coherent system. The main consequence of this