

# SEA ICE

An Introduction to its  
**PHYSICS, CHEMISTRY,  
BIOLOGY AND GEOLOGY**

Edited by  
David N. Thomas &  
Gerhard S. Dieckmann



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# Sea Ice An Introduction To Its Physics Chemistry Biology And Geology

**John Orcutt**



## **Sea Ice An Introduction To Its Physics Chemistry Biology And Geology:**

**Sea Ice** David N. Thomas, Gerhard S. Dieckmann, 2008-04-15 Sea ice which covers up to 7% of the planet's surface is a major component of the world's oceans partly driving ocean circulation and global climate patterns. It provides a habitat for a rich diversity of marine organisms and is an extremely valuable source of information in studies of global climate change and the evolution of present-day life forms. Increasingly, sea ice is being used as a proxy for extraterrestrial ice-covered systems. Sea Ice provides a comprehensive review of our current available knowledge of polar pack ice, the study of which is severely constrained by the logistic difficulties of working in such harsh and remote regions of the earth. The book's editors, Drs Thomas and Dieckmann, have drawn together an impressive group of international contributing authors providing a well edited and integrated volume which will stand for many years as the standard work on the subject. Contents of the book include details of the growth, microstructure and properties of sea ice; large-scale variations in thickness and characteristics; its primary production; micro and macrobiology; sea ice as a habitat for birds and mammals; sea ice biogeochemistry; particulate flux; and the distribution and significance of palaeo sea ice. Sea Ice is an essential purchase for oceanographers and marine scientists, environmental scientists, biologists, geochemists, and geologists. All those involved in the study of global climate change will find this book to contain a wealth of important information. All libraries in universities and research establishments where these subjects are studied and taught will need multiple copies on their shelves. David Thomas is at the School of Ocean Sciences, University of Wales Bangor, UK. Gerhard Dieckmann is at the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany.

**Sea Ice** David N. Thomas, 2016-12-27 Over the past 20 years, the study of the frozen Arctic and Southern Oceans and sub-arctic seas has progressed at a remarkable pace. This third edition of Sea Ice gives insight into the very latest understanding of how sea ice is formed, how we measure and model its extent, the biology that lives within and associated with sea ice, and the effect of climate change on its distribution. How sea ice influences the oceanography of underlying waters and the influences that sea ice has on humans living in Arctic regions are also discussed. Featuring twelve new chapters, this edition follows two previous editions (2001 and 2010) and the need for this latest update exhibits just how rapidly the science of sea ice is developing. The 27 chapters are written by a team of more than 50 of the world's leading experts in their fields. These combine to make the book the most comprehensive introduction to the physics, chemistry, biology, and geology of sea ice that there is. This third edition of Sea Ice will be a key resource for all policy makers, researchers, and students who work with the frozen oceans and seas.

**Encyclopedia of Snow, Ice and Glaciers** Vijay P. Singh, Pratap Singh, Umesh K. Haritashya, 2011-06-29 The earth's cryosphere, which includes snow, glaciers, ice caps, ice sheets, ice shelves, sea ice, river and lake ice, and permafrost, contains about 75% of the earth's fresh water. It exists at almost all latitudes, from the tropics to the poles, and plays a vital role in controlling the global climate system. It also provides direct, visible evidence of the effect of climate change and therefore requires proper understanding of its complex dynamics. This

encyclopedia mainly focuses on the various aspects of snow ice and glaciers but also covers other cryospheric branches and provides up to date information and basic concepts on relevant topics It includes alphabetically arranged and professionally written comprehensive and authoritative academic articles by well known international experts in individual fields The encyclopedia contains a broad spectrum of topics ranging from the atmospheric processes responsible for snow formation transformation of snow to ice and changes in their properties classification of ice and glaciers and their worldwide distribution glaciation and ice ages glacier dynamics glacier surface and subsurface characteristics geomorphic processes and landscape formation hydrology and sedimentary systems permafrost degradation hazards caused by cryospheric changes and trends of glacier retreat on the global scale along with the impact of climate change This book can serve as a source of reference at the undergraduate and graduate level and help to better understand snow ice and glaciers It will also be an indispensable tool containing specialized literature for geologists geographers climatologists hydrologists and water resources engineers as well as for those who are engaged in the practice of agricultural and civil engineering earth sciences environmental sciences and engineering ecosystem management and other relevant subjects

**Field Techniques for Sea-Ice Research** Hajo Eicken, Maya Salganek, 2010-03-15 As much as one tenth of the world's oceans are covered with sea ice or frozen ocean water at some point during the annual cycle Sea ice thus plays an important often defining role in the natural environment and the global climate system This book is a global look at the changes in sea ice and the tools and techniques used to measure and record those changes The first comprehensive research done on sea ice field techniques this volume will be indispensable for the study of northern sea ice and a must have for scientists in the field of climate change research

**Sea Ice** David N. Thomas, Gerhard S. Dieckmann, 2009-11-06 As the Arctic perennial sea ice continues to disappear at an alarming rate a full understanding of sea ice as a crucial global ecosystem and the effects of its loss is vital for all those working with and studying global climate change Building on the success of the previous edition the second edition of Sea Ice now much expanded and in full colour throughout includes six completely new chapters with complete revisions of all the chapters included from the first edition The Editors Professor David Thomas and Dr Gerhard Dieckmann have once again drawn together an extremely impressive group of internationally respected contributing authors ensuring a comprehensive worldwide coverage of this incredibly important topic Sea Ice second edition is an essential purchase for oceanographers and marine scientists environmental scientists biologists geochemists and geologists All those involved in the study of global climate change will find this book to contain a wealth of important information All libraries in universities and research establishments where these subjects are studied and taught will need multiple copies of this book on their shelves truly multidisciplinary approach world leading authors and editors international in scope covering both Arctic and Antarctic work of vital interest to all those involved in global warming and climate change research highly illustrated full colour book with colour images throughout

**Polar Microbiology** Robert V. Miller, Lyle Whyte, 2011-12-29 Sheds new light

on the microbial ecology and physiology of the Earth's polar regions Examines the microbial investigations during the International Polar Year of 2008 focusing on the Arctic and Antarctic along with earlier investigations on critical environmental issues such as climate change ozone depletion and elemental cycling Offers a survey of what is known and unknown about the microbial inhabitants of polar environments addresses the adaptations and physiology of cold adapted microorganisms and explores the ecological role that polar microbial communities play in biogeochemical cycling Presents the challenges that polar and subpolar microorganisms face and describes the lowest temperatures in which microbial life can exist and the prospects for life on other planets Recommended for a general microbiology audience as well as for scientists and students in all areas of biology and geomicrobiology **Earth System Monitoring** John Orcutt, 2012-12-12

Modern Earth System Monitoring represents a fundamental change in the way scientists study the Earth System In Oceanography for the past two centuries ships have provided the platforms for observing Expeditions on the continents and Earth's poles are land based analogues Fundamental understanding of current systems climate natural hazards and ecosystems has been greatly advanced While these approaches have been remarkably successful the need to establish measurements over time can only be made using Earth observations and observatories with exacting standards and continuous data The 19 peer reviewed contributions in this volume provide early insights into this emerging view of Earth in both space and time in which change is a critical component of our growing understanding **Proceedings of the 8th Pacific Rim International Conference on Advanced Materials and Processing (PRICM-8)** Fern D.S.

Marquis, 2017-03-21 PRICM 8 features the most prominent and largest scale interactions in advanced materials and processing in the Pacific Rim region The conference is unique in its intrinsic nature and architecture which crosses many traditional discipline and cultural boundaries This is a comprehensive collection of papers from the 15 symposia presented at this event *The Routledge Handbook of the Polar Regions* Mark Nuttall, Torben R Christensen, Martin Siegert, 2018-07-18 The Routledge Handbook of the Polar Regions is an authoritative guide to the Arctic and the Antarctic through an exploration of key areas of research in the physical and natural sciences and the social sciences and humanities It presents 38 new and original contributions from leading figures and voices in polar research policy and practice as well as work from emerging scholars This handbook aims to approach and understand the Polar Regions as places that are at the forefront of global conversations about some of the most pressing contemporary issues and research questions of our age The volume provides a discussion of the similarities and differences between the two regions to help deepen understanding and knowledge Major themes and issues are integrated in the comprehensive introduction chapter by the editors who are top researchers in their respective fields The contributions show how polar researchers engage with contemporary debates and use interdisciplinary and multidisciplinary approaches to address new developments as well as map out exciting trajectories for future work in the Arctic and the Antarctic The handbook provides an easy access to key items of scholarly literature and material otherwise

inaccessible or scattered throughout a variety of specialist journals and books A unique one stop research resource for researchers and policymakers with an interest in the Arctic and Antarctic it is also a comprehensive reference work for graduate and advanced undergraduate students

**MARGO** M. Kucera, R. Schneider, M. Weinelt, 2006-04-10 MARGO Multiproxy Approach for the Reconstruction of the Glacial Ocean surface summarizes the results of the MARGO international working group with the aim to develop an updated and harmonised reconstruction of sea surface temperatures and sea ice extent of the Last Glacial Maximum oceans The MARGO approach differs from previous efforts by developing and consistently applying measures of various aspects of reconstruction reliability and by combining faunal and geochemical proxies In 14 papers the volume provides a comprehensive review of earlier work and a series of new proxy specific reconstructions based on census counts of planktonic foraminifera diatoms radiolaria and dinoflagellate cysts as well as on Mg Ca measurements in planktonic foraminifera The approach of harmonising the calibration and application of different proxies is described in detail various paleothermometry techniques and their results are compared and the challenge of treating sparsely sampled data as the basis for ocean circulation models is addressed The use of stable oxygen isotope composition of foraminiferal shells as a proxy for past sea water composition is comprehensively reassessed and a new approach to the transfer function paleothermometer is presented This volume represents a landmark contribution to the understanding of ice age oceanography as well as the proxies used to reconstruct past ocean states The results will form the basis for forcing and validation of ocean circulation models New regional reconstructions of Last Glacial Maximum ocean temperatures and sea ice cover Compilation of new calibration and fossil datasets as well as documentation of techniques and approaches to paleoenvironmental reconstructions Comparison of techniques proxies and modelling approaches

**Oceanography and Marine Biology** S. J. Hawkins, A. J. Evans, A. C. Dale, L. B. Firth, I. P. Smith, 2018-09-03 Chapters 3 and 5 of this book are freely available as a downloadable Open Access PDF under a Creative Commons Attribution Non Commercial No Derivatives 4.0 license <https://www.taylorfrancis.com/books/oceanography-marine-biology-hawkins-evans-dale-firth-smith> e 10.1201/9780429454455 Oceanography and Marine Biology An Annual Review remains one of the most cited sources in marine science and oceanography The ever increasing interest in work in oceanography and marine biology and its relevance to global environmental issues especially global climate change and its impacts creates a demand for authoritative reviews summarizing the results of recent research OMBAR has catered to this demand since its foundation more than 50 years ago Following the favourable reception and complimentary reviews accorded to all the volumes Volume 56 continues to regard the marine sciences with all their various aspects as a unity Physical chemical and biological aspects of marine science are dealt with by experts actively engaged in these fields and every chapter is peer reviewed by other experts working actively in the specific areas of interest The series is an essential reference text for researchers and students in all fields of marine science and related subjects and it finds a place in libraries of universities marine laboratories research

institutes and government departments      *Climate Change in North America* George Ohring, 2014-02-12 This book describes thoroughly the North American Climate of the past 65 million years with special emphasis on the last 21 000 years as revealed by paleoclimatic observations and climate models It analyzes weather observations over the past century and satellite measurements of the last few decades to develop a picture of more recent climatic trends It explains how global climate models are used to simulate and project climate and presents the application of these models to reproduce recent climate variations and predict future North American climate It answers the critical question of whether observed climate change is due to natural variations or human activity      **Polar Microbiology: Recent Advances and Future Perspectives**

Pabulo H. Rampelotto, 2018-10-01 This book is a printed edition of the Special Issue Polar Microbiology Recent Advances and Future Perspectives that was published in Biology      **Polar Remote Sensing** Dan Lubin, Robert Massom, 2006-08-31 The

polar regions perhaps more than any other places on Earth give the geophysical scientist a sense of exploration This sensibility is genuine for not only is high latitude eldwork arduous with many locations seldom or never visited but there remains much fundamental knowledge yet to be discovered about how the polar regions interact with the global climate system The range of opportunities for new discovery becomes strikingly clear when we realize that the high latitudes are not one region but are really two vastly different worlds The high Arctic is a frozen ocean surrounded by land and is home to fragile ecosystems and unique modes of human habitation The Antarctic is a frozen continent without regular human habitation covered by ice sheets taller than many mountain ranges and surrounded by the Earth's most forbidding ocean When we consider global change as applied to the Arctic we discuss impacts to a region whose surface and lower atmospheric temperatures are near the triple point of water throughout much of the year The most consistent signatures of climate warming have occurred at northern high latitudes IPCC 2001 and the potential impacts of a few degrees increase in surface temperature include a reduction in sea ice extent a positive feedback to climate warming due to lowering of surface albedo and changes to surface runoff that might affect the Arctic Ocean's salinity and circulation      **Living and Working**

**With Snow, Ice and Seasons in the Modern Arctic** Hannah Strauss-Mazzullo, Monica Tennberg, 2023-08-31 This book describes everyday practices of life in changing Arctic winter conditions The authors explore the contemporary and situated outdoor practices in different work settings in Finnish Lapland and investigate how for example tourism reindeer herding cattle breeding and urban snow management adapt to the physically limiting or enabling features of cold temperatures snow and ice The book also highlights individual and societal adjustments to such harsh conditions and their seasonal changes in mobility including winter cycling use of snow mobiles and walking with studded shoes The impact of a warming climate is a great concern for those utilising the enabling qualities of winter weather The need then for continuous adaptation in everyday practices of work and mobility will increase in the future      **Water in North American Environmental History**

Martin V. Melosi, 2022-06-07 *Water in North American Environmental History* offers 25 case studies that explore the range

of uses and perceptions of water throughout Canadian Mexican and United States history Water has served a myriad of purposes historically as human sustenance agricultural irrigation sanitation fire protection military defense power generation transportation and much more Water and its uses provide an excellent entrance into the study of humans and the environment not only because water is a vital resource for life but also because water as a medium is so intimately woven into the everyday experiences of humans and into society's economic political and social fabric A North American perspective is not representative of the world's water use but it is an area with a linked history and many overlapping human and environmental features and concerns With a continental perspective the book explores many disparate topics without being confined to the history and experiences of just one country The chapters are short but descriptive and departure points for what they tell us about the human experience in dealing with water and the environmental implications of water use The text leads students to consider water in relation to society and to the past The book will be of interest to students of environmental history geography and the environmental sciences

Life in the World's Oceans Alasdair McIntyre, 2011-06-09 Life in the World's Oceans Diversity Abundance and Distribution is a true landmark publication Comprising the synthesis and analysis of the results of the Census of Marine Life this most important book brings together the work of around 2000 scientists from 80 nations around the globe The book is broadly divided into four sections covering oceans past oceans present oceans future and a final section covering the utilisation of the data which has been gathered and the coordination and communication of the results Edited by Professor Alasdair McIntyre Marine Life is a book which should find a place on the shelves of all marine scientists ecologists conservation biologists oceanographers fisheries scientists and environmental biologists All universities and research establishments where biological earth and fisheries science are studied and taught should have copies of this essential book on their shelves A true landmark publication One of the most important marine science books ever published Contributions from many world leading researchers Synthesis of a huge amount of important data Represents the culmination of 10 years research by 2000 scientists from 80 countries

**Spatial and Temporal Dynamics of Primary Production in Antarctic Sea Ice** Benjamin Lundquist Saenz, 2011 Sea ice is an important driver of climate patterns and polar marine ecosystem dynamics In particular primary production by microalgae in sea ice has been postulated as a sink for anthropogenic CO<sub>2</sub> and as a critical resource in the life cycle of Antarctic krill *Euphausia superba* a keystone species Study of the sea ice ecosystem is difficult at regional and global scales however because of the expense and logistical difficulties in accessing such a remote and hostile environment Consequently models remain valuable tools for investigations of the spatial and temporal dynamics of sea ice and associated ecology and biogeochemistry Recent advances in model representations of sea ice have called into question the accuracy of previous studies and allow the creation of new tools to perform mechanistic simulations of sea ice physics and biogeochemistry To address spatial and temporal variability in Antarctic sea ice algal production and to establish the bounds and sensitivities of

the sea ice ecosystem a new coupled sea ice ecosystem model was developed In the vertical dimension the model resolves incorporated saline brine macronutrients concentrations spectral shortwave radiation and the sea ice algae community at high resolution A novel method for thermodynamics desalination and fluid transfer in slushy high brine fraction sea ice was developed to simulate regions of high algal productivity The processes of desalination fluid transfer snow ice creation and superimposed ice formation allowed the evolution of realistic vertical profiles of sea ice salinity and algal growth The model replicated time series observations of ice temperature salinity algal biomass and estimated fluid flux from the Ice Station Weddell experiment In the horizontal dimension sub grid scale parameterizations of snow and ice thickness allow more realistic simulation of the ice thickness distribution and consequently sea ice algal habitat The model is forced from above by atmospheric reanalysis climatologies and from below by climatological ocean heat flux and deep water ocean characteristics Areal sea ice concentration and motion are specified according to SSM I passive microwave satellite estimates of these parameters Sensitivity testing of different snow and ice parameterizations showed that without a sub grid scale ice thickness distribution mean ice and snow thickness is lower and bottom sea ice algal production is elevated Atmospheric forcing from different reanalysis data sets cause mean and regional shifts in sea ice production and associated ecology even when sea ice extent and motion is controlled Snow cover represents a first order control over ice algal production by limiting the light available to bottom ice algal communities and changes to the regional rather than mean snow thickness due to the use of different ice and snow representations are responsible for large differences in the magnitude and distribution of sea ice algal production Improved convective nutrient exchange in high brine fraction slush sea ice is responsible for up to 18% of total sea ice algal production A continuous 10 year model run using climatological years 1996 2005 produced a time series of sea ice algal primary production that varied between 15.5 and 18.0 Tg C yr<sup>-1</sup> This study represents the first interannual estimate of Antarctic sea ice algal production that dynamically considers the light temperature salinity and nutrient conditions that control algal growth On average 64% of algal production occurred in the bottom 0.2 m of the ice pack Production was spatially heterogeneous with little consistency between years when examined at regional scales however at basin or hemispheric scales annual production was fairly consistent in magnitude At a mean of 0.9 g C m<sup>-2</sup> yr<sup>-1</sup> the magnitude of carbon uptake by sea ice algae will not significantly affect the Southern Ocean carbon cycle Light availability was the dominant control on sea ice algae growth over the majority of the year however severe nutrient limitation that occurred annually during late spring and summer proved to be the largest control over sea ice algal productivity

*The Impact of Environmental Variability on Ecological Systems* D.A. Vasseur, K.S. McCann, 2007-05-08 Fluctuations in the environmental conditions impacting life are ubiquitous These fluctuations induce changes in the vital processes occurring within individual organisms such as cellular metabolism and the ecological processes occurring among individuals such as competition mutualism and predation ultimately leading to observable fluctuations in the commonly measured characteristics of

ecological systems From a very simple perspective these processes are all modulators of environmental variability We might best be able to understand the final form of this modulation the impact of environmental variability on ecological systems by building from an understanding of the responses of these life processes in isolation to an understanding of their responses in harmony The impact of environmental variability on ecological systems is an issue that has been at the forefront of ecological research for many years Research is taking place on many fronts including theoretical mathematical based analyses natural ecosystem observation and experimentation This book brings together contributions from these three fronts to provide readers with a comprehensive look at the challenges for ecological systems and ecological research alike     *Glaciers, Sea Ice, and Ice Formation* John P. Rafferty Associate Editor, Earth Sciences, 2010-08-15 Explores the frozen tundra of the Arctic and Antarctic as the complexities of water are revealed

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