

Thermohaline circulation



Ocean Circulation And Climate

Carl Wunsch, Patrick Heimbach



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Ocean Circulation and Climate Carl Wunsch, Patrick Heimbach, 2013-10-22 The World Ocean Circulation Experiment drove the development of estimates of the decadal scale time evolving general circulation that are dynamically and kinematically consistent. A long timescale and a goal of estimation rather than prediction preclude the use of meteorological methods called data assimilation. DA Instead state estimation methods are reviewed here and distinguished from DA. Results from the dynamically consistent family of solutions from the project Estimating the Circulation and Climate of the Ocean based upon least squares Lagrange multipliers adjoints are used to discuss the determination of the dominant elements of the circulation in the period since 1992 which marked the beginning of the satellite altimetric record. Significant changes documented in the Arctic in recent decades now mandate consideration of the coupled ocean cryospheric state. *Ocean Circulation and Climate* Gerold Siedler, John Church, John Gould, William John Gould, 2001-04-11 This book presents the views of leading scientists on the knowledge of the global ocean circulation following the completion of the observational phase of the World Ocean Circulation Experiment WOCE. In situ physical and chemical measurements together with satellite altimetry have produced a data set which provides for development of ocean and coupled ocean atmosphere circulation models used for understanding ocean and climate variability and projecting climate change. This book guides the reader through the analysis interpretation modelling and synthesis of this data. *Ocean Circulation and Climate* Shiro Imawaki, Amy S. Bower, Lisa Beal, Bo Qiu, 2013-10-22 Strong persistent currents along the western boundaries of the world's major ocean basins are called western boundary currents WBCs. This chapter describes the structure and dynamics of WBCs, their roles in basin scale circulation, regional variability and their influence on atmosphere and climate. WBCs are largely a manifestation of wind driven circulation; they compensate the meridional Sverdrup transport induced by the winds over the ocean interior. Some WBCs also play a role in the global thermohaline circulation through inter gyre and inter basin water exchanges. After separation from the boundary, most WBCs have zonal extensions which exhibit high eddy kinetic energy due to flow instabilities and large surface fluxes of heat and carbon dioxide. The WBCs described here in detail are the Gulf Stream, Brazil and Malvinas Currents in the Atlantic, the Somali and Agulhas Currents in the Indian and the Kuroshio and East Australian Current in the Pacific Ocean. *Ocean Circulation and Climate*, 2013-10-22 The book represents all the knowledge we currently have on ocean circulation. It presents an up to date summary of the state of the science relating to the role of the oceans in the physical climate system. The book is structured to guide the reader through the wide range of world ocean circulation experiment WOCE science in a consistent way. Cross references between contributors have been added and the book has a comprehensive index and unified reference list. The book is simple to read at the undergraduate level. It was written by the best scientists in the world who have collaborated to carry out years of experiments to better understand ocean circulation. Presents in situ and remote observations with worldwide coverage. Provides theoretical

understanding of processes within the ocean and at its boundaries to other Earth System components Allows for simulating ocean and climate processes in the past present and future using a hierarchy of physical biogeochemical models Ice Drift, Ocean Circulation and Climate Change Jens Bischof,2000-11 The issue of global warming and climate change is of continuous concern Since the 1970s it has been shown that the pack ice around the Arctic Ocean is thinning the margin of permafrost is moving north and the vegetation in the high northern parts of the world is changing the greening of the Arctic But are these changes the result of human activity or simply regular variations of the Earth s climate system Over thousands of years a continuous archive of iceberg and sea ice drift has formed in the deep sea sediments revealing the place of the ice s origin and allowing a reconstruction of the surface currents and the climate of the past However the drift of floating ice from one place to another is not just a passive record of past ocean circulation It actively influences and changes the surface ocean circulation thus having a profound effect on climate change Ice Drift Ocean Circulation and Climate Change is the first book to focus on the interactions between ice the ocean and the atmosphere and to describe how these three components of the climate system influence each other It makes clear the positive contribution of paleoclimatology and paleoceanography and should be read by anyone concerned with global warming and climate change Ocean Circulation and Climate Swadhin Behera,Peter Brandt,Gilles Reverdin,2013-10-22 The tropical oceans play important roles in the global climate system through ocean transports of heat and freshwater as well as ocean atmosphere interactions The developments in observational networks during recent decades have helped us to quantify the strength and variability of most of the ocean general circulations responsible for the transports Those are discussed in detail in individual sections covering each tropical basin separately with a special emphasis on recent research results Shallow overturning cells observed in all three tropical basins as well as the deep Atlantic meridional overturning circulation are such examples that are linked to ocean and climate variations on multiple timescales In addition tropical ocean atmosphere interactions associated with oceanic planetary waves cause large scale climate variations such as El Ni o Southern Oscillation ENSO Indian Ocean Dipole Atlantic Ni o and ENSO Modoki Recent advances in numerical modeling augmented by in situ and satellite observations are helping the research community to understand ocean process and to predict associated climate variations on seasonal to longer timescales

Ocean Circulation and Climate Stephen R. Rintoul,Alberto C. Naveira Garabato,2013-10-22 The Southern Ocean circulation connects the ocean basins as well as the upper and deep layers of the ocean As a result the region has a profound influence on the global ocean circulation and climate The Antarctic Circumpolar Current and the overturning circulation are dynamically linked through interactions between the mean flow eddies topography air sea forcing and mixing and stirring by small and mesoscale processes A new dynamical paradigm is emerging that emphasizes the fully three dimensional nature of the circulation including the localization of meridional and vertical exchange of momentum vorticity and tracers by interactions between the flow and topography Changes observed in the Southern Ocean in recent decades have implications

for global climate and provide insight into the response of the Southern Ocean circulation to changes in forcing

Ocean Circulation Andreas Schmittner, John C. H. Chiang, Sidney R. Hemming, 2013-05-02 Published by the American Geophysical Union as part of the Geophysical Monograph Series Volume 173 The ocean's meridional overturning circulation MOC is a key factor in climate change The Atlantic MOC in particular is believed to play an active role in the regional and global climate variability It is associated with the recent debate on rapid climate change the Atlantic Multi Decadal Oscillation AMO global warming and Atlantic hurricanes This is the first book to deal with all aspects of the ocean's large scale meridional overturning circulation and is a coherent presentation from a mechanistic point of view of our current understanding of paleo present day and future variability and change It presents the current state of the science by bringing together the world's leading experts in physical chemical and biological oceanography marine geology geochemistry paleoceanography and climate modeling A mix of overview and research papers makes this volume suitable not only for experts in the field but also for students and anyone interested in climate change and the oceans

Ocean Circulation and Climate Sybren S. Drijfhout, David P. Marshall, Henk A. Dijkstra, 2013-10-22 Conceptual models are a vital tool for understanding the processes that maintain the global ocean circulation both in nature and in complex numerical ocean models In this chapter we provide a broad overview of our conceptual understanding of the wind driven circulation the thermohaline circulation and their transient behavior While our conceptual understanding of the time mean wind driven circulation is now fairly mature basic questions remain regarding the thermohaline circulation for example surrounding its overall strength and stability Similarly basic questions remain regarding the transient adjustment and internal variability of the ocean circulation

Ocean circulation and climate change, 1990

Ocean Circulation and Climate Peter R. Gent, 2013-10-22 Coupled climate models consist of atmosphere ocean land and sea ice components Most climate models now do not need to use flux adjustments to maintain the present day climate in a control run when the forcings have a repeating annual cycle or are constant in time A control run must simulate well known important large scale phenomena such as the El Nino Southern Oscillation and the North Atlantic overturning circulation Climate models are used to simulate the climate of the twentieth century and to make projections of the future climate The uses and limitations of climate models are then described and several cutting edge issues are discussed

Ocean Circulation Rui Xin Huang, 2010 The interaction between ocean circulation and climate change has been an active research frontier in Earth sciences in recent years Ocean circulation and its related geophysical fluid dynamical principles are now taught at graduate level in many Earth and atmospheric science departments This is the first advanced textbook to discuss both wind driven and thermohaline driven processes two important aspects of large scale ocean circulation It provides a concise introduction to the dynamics and thermodynamics of oceanic general circulation This includes sea water thermodynamics and the energetics of the ocean circulation an exhaustive theory of wind driven circulation thermohaline circulation with discussions on water mass formation erosion deep

circulation and the hydrological cycle and interactions between wind driven and thermohaline circulation Highly illustrated to help the reader establish a clear mental picture of the physical principles involved the book is invaluable for advanced courses in ocean circulation and as a reference for oceanographers and Earth scientists Ocean Circulation Rui Xin Huang, 2010 The interaction between ocean circulation and climate change has been an active research frontier in Earth sciences in recent years Ocean circulation and its related geophysical fluid dynamical principles are now taught at graduate level in many Earth and atmospheric science departments This is the first advanced textbook to discuss both wind driven and thermohaline driven processes two important aspects of large scale ocean circulation It provides a concise introduction to the dynamics and thermodynamics of oceanic general circulation This includes sea water thermodynamics and the energetics of the ocean circulation an exhaustive theory of wind driven circulation thermohaline circulation with discussions on water mass formation erosion deep circulation and the hydrological cycle and interactions between wind driven and thermohaline circulation Highly illustrated to help the reader establish a clear mental picture of the physical principles involved the book is invaluable for advanced courses in ocean circulation and as a reference for oceanographers and Earth scientists *The Oceanic Thermohaline Circulation* Hendrik M. van Aken, 2007-03-12 This book presents a global hydrographic description of the thermohaline circulation an introduction to the theoretical aspects of this phenomenon and observational evidence for the theory The hydrographic description and the observational evidence are based on data sources available via internet mainly from the World Oceanographic Experiment WOCE The book also offers an introduction to hydrographic analysis and interpretation *Marine Geochemistry* Matthieu Roy-Barman, Catherine Jeandel, 2016-11-03 Marine geochemistry uses chemical elements and their isotopes to study how the ocean works in terms of ocean circulation chemical composition biological activity and atmospheric CO₂ regulation This rapidly growing field is at a crossroad for many disciplines physical chemical and biological oceanography geology climatology ecology etc It provides important quantitative answers to questions such as What is the deep ocean mixing rate How much atmospheric CO₂ is pumped by the ocean How fast are pollutants removed from the ocean How do ecosystems react to anthropogenic pressure This text gives a simple introduction to the concepts the methods and the applications of marine geochemistry with a particular emphasis on isotopic tracers Overall introducing a very large number of topics physical oceanography ocean chemistry isotopes gas exchange modelling biogeochemical cycles with a balance of didactic and indepth information it provides an outline and a complete course in marine geochemistry Throughout the book uses a hands on approach with worked out exercises and problems with answers provided at the end of the book to help the students work through the concepts presented A broad scale approach is taken including ocean physics marine biology ocean climate relations remote sensing pollutions and ecology so that the reader acquires a global perspective of the ocean It also includes new topics arising from ongoing research programs This textbook is essential reading for students scholars researchers and other professionals **The Theory of Large-Scale Ocean**

Circulation R. M. Samelson, 2018-03-01 Mounting evidence that human activities are substantially modifying the Earth's climate brings a new imperative to the study of the ocean's large scale circulation This textbook provides a concise but comprehensive introduction to the theory of large scale ocean circulation as it is currently understood and established Students and instructors will benefit from the carefully chosen chapter by chapter exercises This advanced textbook is invaluable for graduate students and researchers in the fields of oceanic atmospheric and climate sciences and other geophysical scientists as well as physicists and mathematicians with a quantitative interest in the planetary fluid environment

Global Warming Could Have a Chilling Effect on the Military Richard F. Pittenger, Robert B. Gagosian, 2003 Most debates and studies addressing potential climate change have focused on the buildup of industrial greenhouse gases in the atmosphere and a gradual increase in global temperatures But this slow ramp climate change scenario ignores recent and rapidly advancing evidence that Earth's climate repeatedly has become much colder warmer wetter or drier in time spans as short as three to 10 years Earth's climate system appears to have sensitive thresholds the crossing of which shifts the system into different modes of operation and triggers rapid non linear and not necessarily global changes This new paradigm of abrupt climate change does not appear to be on the radar screens of military planners who treat climate change as a long term low level threat with mostly sociological not national security implications But intense and abrupt climate changes could escalate environmental issues into unanticipated security threats and could compromise an unprepared military The global ocean circulation system often called the Ocean Conveyor can change rapidly and shift the distribution patterns of heat and rainfall over large areas of the globe The North Atlantic region is particularly vulnerable to abrupt regional coolings linked to ocean circulation changes Global warming and ocean circulation changes also threaten the Arctic Ocean's sea ice cover Beyond the abrupt climatic impacts fundamental changes in ocean circulation also have immediate naval implications Recent evidence suggests that the oceans already may be experiencing large scale changes that could affect Earth's climate Military planners should begin to consider potential abrupt climate change scenarios and their impacts on national defense

Ocean Circulation Andreas Schmittner, John C. H. Chiang, Sidney R. Hemming, 2007-01-09 Published by the American Geophysical Union as part of the Geophysical Monograph Series Volume 173 The ocean's meridional overturning circulation MOC is a key factor in climate change The Atlantic MOC in particular is believed to play an active role in the regional and global climate variability It is associated with the recent debate on rapid climate change the Atlantic Multi Decadal Oscillation AMO global warming and Atlantic hurricanes This is the first book to deal with all aspects of the ocean's large scale meridional overturning circulation and is a coherent presentation from a mechanistic point of view of our current understanding of paleo present day and future variability and change It presents the current state of the science by bringing together the world's leading experts in physical chemical and biological oceanography marine geology geochemistry paleoceanography and climate modeling A mix of overview and research papers makes this volume suitable not only for

experts in the field but also for students and anyone interested in climate change and the oceans **Ocean Currents**

Robert Marsh, Erik van Sebille, 2021-06-30 *Ocean Currents Physical Drivers in a Changing World* opens with a general introduction to the character measurement and simulation of ocean currents leading to a physical and dynamical framework for understanding the wide variety of flows encountered in the oceans. The book comprises chapters covering distinct aspects of contrasting ocean currents: broad and slow, deep and shallow, narrow and swift, large scale and small scale, low latitudes and high latitudes, and moving in horizontal and vertical planes. Through this approach, the authors cover a wide range of applications from local to global with considerable geographical context. Provides analyses of ocean observations and numerical model simulations highlighting the pathways and drift associated with ocean currents around the World Ocean, linked to online exercises for instructors and students that extend this perspective. Presents applications to natural phenomena showing how ocean currents shape marine ecosystems, helping researchers understand the distribution and adaptation of life in the oceans. Addresses societal challenges specifically how ocean currents disperse pollutants e.g. plastic from coastal sources and how the global ocean circulation is central to our changing climate, helping students and researchers develop an interdisciplinary approach to global environmental change. **The Ocean's Role in Global Change**

National Research Council, Division on Earth and Life Studies, Commission on Geosciences, Environment and Resources, Ocean Studies Board, 1994-02-01 What role does the ocean play in global climate change? Although not fully understood, there is general agreement that it is significant. Therefore, the scientific community has initiated large scale research programs based on studies of the ocean and its relation to global climate and climate related processes. This volume provides brief summaries and reports on the progress of the major oceanographic research programs. It looks at both programs that study processes that occur over periods ranging from days to hundreds of years, the contemporary system, and those that seek to understand long term variations ranging from thousands to millions of years, the geological perspective.

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