The Polar Oceans and Global Climate Change

Ph.D. Course

Lecturer:

Prof. Peter Wadhams

Bio

Peter Wadhams ScD is Emeritus Professor of Ocean Physics at the Department of Applied Mathematics and Theoretical Physics, University of Cambridge, and was formerly Director of the Scott Polar Research Institute. He is also Professor at the Università Politecnica delle Marche and, since October 2019, Visiting Professor at Politecnico di Torino. Since 1976 he has run a research group concerned with sea ice physics and climate change, with extensive field work done using submarines, AUVs, icebreakers, aircraft and ice camps.

Abstract

The course is designed to give a complete background on the physics of sea ice and its role in the climate system, also including ice mechanics, icebergs and the physics of oil-ice interaction.
Climate risks associated with sea ice changes are specially described and analysed.

Programme

1. (23/10 14.00-17.00) The physics of sea ice and ice formation
2. (24/10 10.00-13.00) Ice growth and decay
3. (30/10 14.00-17.00) Ice dynamics
4. (31/10 10.00-13.00) The ice thickness distribution
5. (6/11 14.00-17.00) The marginal ice zone
6. (7/11 10.00-13.00) Icebergs and ice islands
7. (13/11 14.00-17.00) Oil spills under ice
8. (14/11 10.00-13.00) Two important ice regions – Greenland Sea and Beaufort Sea
9. (20/11 14.00-17.00) Thinning and retreat of sea ice in response to global change
10. (21/11 10.00-13.00) Arctic feedbacks and acceleration of global change
11. (27/11 14.00-17.00) Saving planet Earth from climate change
12. (28/11 10.00-13.00) The need for direct air capture

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Lectures will take place in the Meeting Room at First Floor of DIATI Entrance 3

Download the full programme

Course programme:

Module 1 (23/10 14.00-17.00) The physics of sea ice and ice formation
Oceanographic background – Arctic and Antarctic
What happens when sea water cools
Growth of ice crystals
Brine cells and brine rejection
Salinity structure
Summer melt processes
First- and multi-year ice

2. (24/10 10.00-13.00) Ice growth and decay
Thermodynamic model
Equilibrium thickness
Sensitivity of thickness to changes in forcing
Sensitivity to albedo.

3. (30/10 14.00-17.00) Ice dynamics
Ice motion - driving forces
Free drift solution
Ice interaction
The dynamics of polynyas

4.(31/10 10.00-13.00) The ice thickness distribution
Ridge and lead formation
Geometry of pressure ridges
The probability density of ice thickness and its evolution
Mathematical form of ridges and leads distributions
The ridging and rafting process
Ridge evolution and decay
Ice interaction with structures
Ice interaction with the seabed

5. (6/11 14.00-17.00) The marginal ice zone
Ice floes
Waves in ice
Modelling development of floe size distribution
Eddies

6. (7/11 10.00-13.00) Icebergs and ice islands
Sources
Distribution in Arctic and Antarctic
Physical properties
Dynamics
Decay and breakup
Role in the oceans and in sediment transport
Iceberg scouring – depths, incidence, seabed interaction
Mechanics of iceberg and ice island interaction with structures
Upstream detection of ice islands
Towing icebergs - a source of fresh water?

7. (13/11 14.00-17.00) Oil spills under ice
Scope of the under ice blowout problem
Other sources of spills under and in ice
Physical behaviour of crude oil in very cold water
Dynamics of a rising oil-infested bubble plume
Incorporation of oil in rough sea ice – containment factors
Ice growth under an oil layer
Oil penetration into brine drainage channels
Oil transport by ice
The melt process and mode of final oil release
Oil behaviour in pancake ice and the marginal ice zone

8. (14/11 10.00-13.00) Two important ice regions – Greenland Sea and Beaufort Sea
East Greenland waters
Greenland Sea convection zone
South Greenland and the Storis
Baffin Bay and Nares Strait ice conditions
The Lincoln Sea and waters north of Greenland
The Beaufort Gyre and its variability
Changes in ice conditions in central Beaufort Sea
The Beaufort Sea coastal zone
The summer Beaufort Sea as a new MIZ
Methane release from seabed

9. (20/11 14.00-17.00) Thinning and retreat of sea ice in response to global change
Satellite data on retreat
Parkinson - retreat in sectors, Arctic and Antarctic
What is found in Antarctic
Thinning - the submarine and other evidence
Model predictions of a future seasonal Arctic ice cover

10. (21/11 10.00-13.00) Arctic feedbacks and acceleration of global change
Albedo change and snowline retreat
Greenland ice sheet melt and global sea level rise
Offshore methane release and its threat to climate
Changes in thermohaline circulation
Extreme weather events and the jet stream

11. (27/11 14.00-17.00) Saving planet Earth from climate change
Ice ages and their causes
The coming of the anthropocene
Exponential growth of greenhouse gases
Geoengineering as a way of delaying warming
Marine cloud brightening and other techniques

12. (28/11 10.00-13.00) The need for direct air capture
Paris climate agreement and its defects
Need for CO_2 removal
Possible techniques
Direct air capture methods currently in use