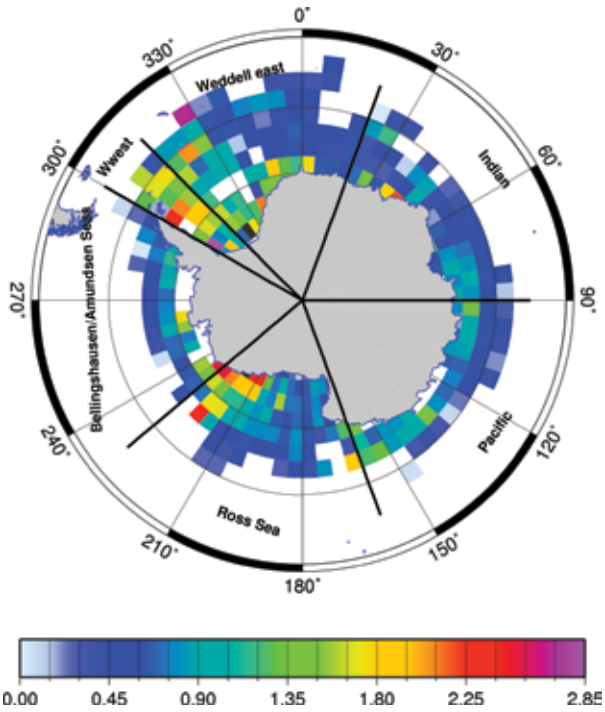
# Antarctic Sea Ice Thickness

## ... the way forward

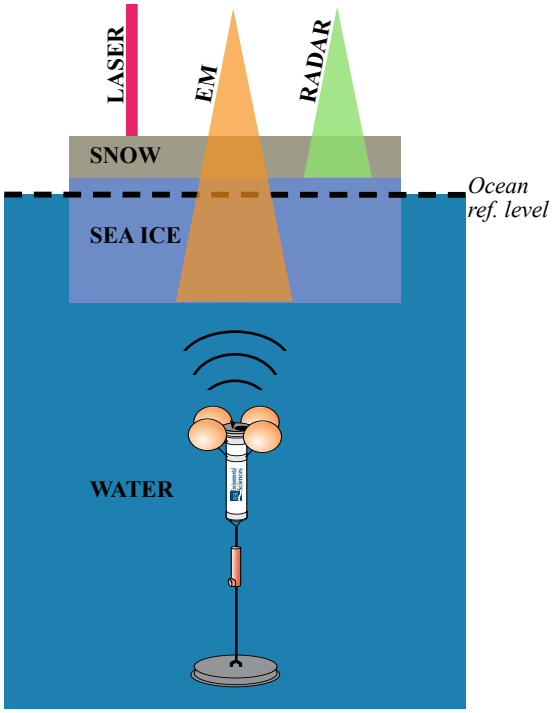
The *International Workshop on Antarctic Sea Ice Thickness* was held in Hobart, Australia on July 5-7, 2006. The workshop assessed the state of knowledge of Antarctic sea ice thickness and discussed both existing and emerging technology for future research. Sixty participants from 13 countries presented results from remote sensing, field observations and modelling.

### Workshop Statement

There has never been a greater demand for climate data, yet **sea ice thickness remains arguably the largest single gap in our knowledge of the climate system.** The workshop concluded that there has been encouraging progress towards obtaining circumpolar Antarctic sea ice thickness information through efforts like the ASPeCt ship observations program and the validation of National Ice Centre (NIC) ice charts. There has also been **successful use of airborne and ship-based electromagnetic induction (EMI) techniques** that provide information on the combined ice and snow thickness distribution. Upward-looking sonars have also provided valuable records of ice draft from moored instruments and Autonomous Underwater Vehicles, but over extremely limited areas. However, the goal of a circumpolar **high resolution** data set of Antarctic sea ice and snow thickness distributions has not yet been achieved and must remain an overarching priority of the international sea ice community over the coming decade. In particular, future research must take a coordinated approach that synthesizes the strengths of these different techniques with **the goal of a consistent sea ice thickness data set**. The urgent need for this record is driven by observed Arctic change, as well as model predictions that **reductions in sea ice thickness have already begun,** and that significant further change is likely under increased greenhouse gas scenarios. The data will be crucial for future validation of satellite observations, climate models, and for assimilation into forecast models. While the recent development of satellite laser and radar altimetry holds the promise of future routine global sea ice and snow thickness products, this remains an elusive goal and is significantly more complicated for the relatively thin Antarctic sea ice compared to the Arctic. Field studies must remain a high priority in order to improve our understanding of Antarctic sea ice processes and their role in the climate system.




The Antarctic sea ice processes and climate (ASPeCt) program has compiled ship observations from 1980 – 2005 into a gridded circumpolar map of mean ice thickness (in m), shown here. The values include the ridged component of the pack ice but are not weighted for open water. The ASPeCt data archive is available at http://www.aspect.aq. (© AGU. Further reproduction or electronic transmission not permitted.)




This schematic shows **a number of techniques used to determine sea ice and snow cover thickness**. Upward-looking sonar instruments measure sea ice draft (from which thickness is inferred) and may be moored or mounted on Autonomous Underwater Vehicles ULS). Laser altimeters measure total freeboard elevation including any snow cover, while radar altimeters penetrate dry snow to return a signal from the ice/snow interface. The difference between laser and radar signals provides information on snow cover thickness. However, layers of different snow density, in particular icy layers, may complicate the radar returns. Electromagnetic induction techniques provide an estimate of total ice and snow thickness (ULS, courtesy *ASL Environmental Sciences, Inc.*)

## Background

In the polar oceans, sea ice and its associated snow cover is a major regulator of the heat, mass and momentum between the atmosphere and the ocean. Although ice extent and concentration are routinely measured from space, sea ice and snow thickness, particularly in the Antarctic, are not well measured and are highly uncertain. In climate change scenarios, model results indicate that Antarctic sea ice thickness decreases more rapidly than ice extent, suggesting that **thickness may be a better climate change indicator**. In both the Arctic and Antarctic, these changes are predicted to have started already. Obtaining **circumpolar observations of Antarctic sea ice thickness is critical for both monitoring and predicting climate.**

## The Way Forward

### *Single data archive*

The value and use of historical *in situ* observations (from all data sources) would be vastly improved if they were coordinated into a single data archive. A new effort to establish an Antarctic Sea Ice data portal will be coordinated through the Australian Antarctic Data Centre (http://aadc-maps.aad.gov.au), and a working group has been established to oversee the development of data protocols and the compilation of data. This will be closely coordinated with similar, Arctic data. Because satellite altimetry retrievals of sea ice thickness rely on large-scale assumptions of sea ice and snow-cover properties (including density), the synthesis of historical data is of particular importance for algorithm development.

### *Sea ice observations*

The Antarctic sea ice research community must take a **leading role in the future development of a Southern Ocean Observing System (SOOS), and in CryOS (Cryosphere Observing System)**, to ensure that sea ice observations for monitoring, research, and operational use are **coordinated and sustained**. Observations must include ship-based (ASPeCt) observations, fast ice monitoring and *in situ* drilling. Comprehensive and sophisticated programs, such as coordinated circumpolar AUV transects and aircraft-based EM surveying and radar and laser altimetry programs, must be promoted. The US National Ice Centre is encouraged to **reinstate comprehensive ice charting** for the Antarctic sea ice zone and explore opportunities for the establishment of an internationally funded Antarctic desk. The establishment of **an internationally accessible instrument pool** (including EM bird, Autosub, snow thickness radar, *in situ* drilling equipment) would provide a mechanism to involve nations who have not traditionally participated in Antarctic sea ice research activities.

An open forum / evening session will be held during the Fall **AGU meeting in San Francisco in December, 2007** to discuss the implementation of these recommendations. Details advised via the CliC website (http://clic.npolar.no) closer to the meeting. All welcome.

Antarctic sea ice and snow cover thickness can vary from a thin, smooth sheet of ice with no snow to ridges several meters thick with variable snow cover.

## SOPHOCLES: Southern Ocean Physical Oceanography and Cryospheric Linkages

As a result of this workshop, SOPHOCLES was formed to improve our understanding of how Southern Ocean ice processes are represented in models, with time scales ranging from daily sea ice forecasting to decadal climate change. SOPHOCLES will engage the observational community to take full advantage of new satellite data and *in situ* data. All components of the cryosphere - including sea ice, glaciers, ice-shelves, and icebergs and their associated freshwater and heat fluxes to the ocean - will eventually be addressed. The project lead is Siobhan O'Farrell (Siobhan.OFarrell@csiro.au).

## International Polar Year

Two major Antarctic sea ice research voyages are taking place in September - October 2007. SIMBA (Sea Ice Mass Balance of the Antarctic; www.utsa.edu/lrsg/Antarctica/SIMBA) and SIPEX (Sea Ice Physics and Ecosystem eXperiment; www.acecrc.sipex.aq) are both taking steps towards implementing the recommendations of the workshop.

## Marine Cryosphere and CliC

The Climate and Cryosphere (CliC) project (http://clic.npolar.no) stimulates, supports, and coordinates research into the processes by which the cryosphere interacts with the rest of the climate system. CliC has a theme dedicated to *Marine Cryosphere and Climate (MarC)* led by Dr Tony Worby (a.worby@utas.edu.au). The focus of this theme is on the response of sea ice to climate change and the interactions of the ocean and atmosphere with sea ice, ice shelves and icebergs, in the Arctic and the Antarctic. CliC supports the need to strengthen national and international structures for recovering and archiving cryospheric data. Cryospheric data are being lost rapidly and the scientific community needs to collectively work towards preventing further losses.

Workshop conveners: Tony Worby (a.worby@utas.edu.au)
Steve Ackley (sackley@pol.net)

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Layout: Victoria Lytle, Angélique Prick
Content: Steve Ackley, Christian Haas, Tony Worby
CliC International Project Office
The Polar Environmental Centre
Norwegian Polar Institute - NO-9296 Tromsø, Norway
Tel: +47 77 75 01 50 - Fax: +47 77 75 05 01
clic@npolar.no - http://clic.npolar.no

More information and full report: www.aspect.aq/workshop2006.html