Trends in Antarctic sea ice volume from satellite observations

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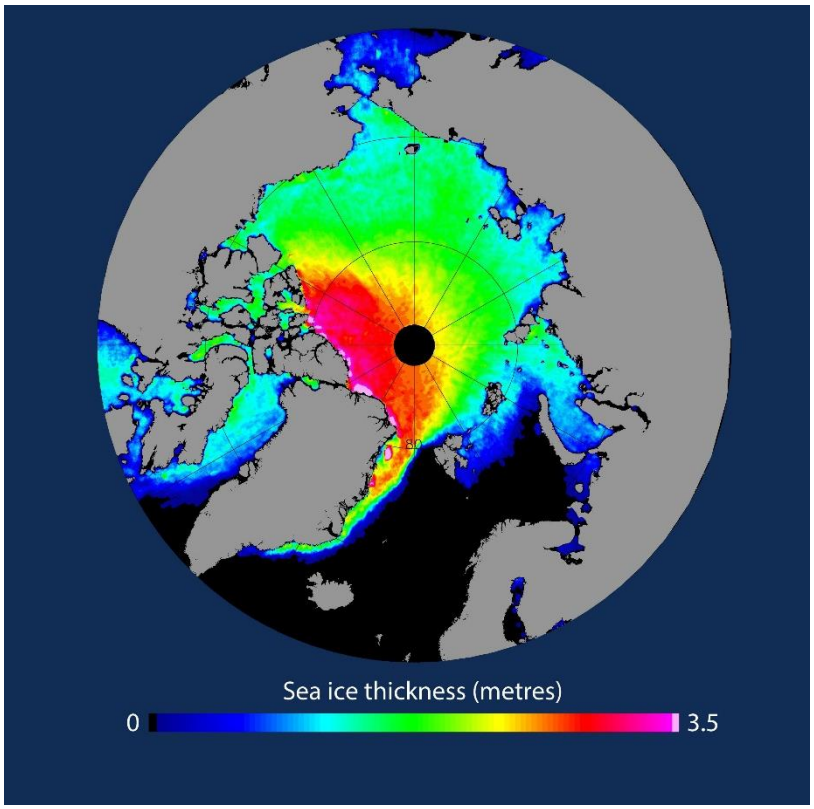
This project offers an exciting opportunity to work at the forefront of polar science, with a focus on monitoring Antarctic sea ice using satellite measurements, in collaboration with the British Antarctic Survey.

Sea ice is a key component of the global climate system, because it plays a significant role in Earth's heat and freshwater balance, and because it is a sensitive indicator of environmental change.

The launch of the European Space Agency (ESA) CryoSat-2 satellite in 2010 began a new era of high resolution, Synthetic Aperture Radar (SAR) altimetry which has transformed our ability to monitor Arctic sea ice thickness, as well as its spatial extent, to give a measure of total volume; and to track its response to changes in climate [Tilling *et al*., 2015, 2016].



Average thickness of Arctic sea ice in spring as measured by CryoSat-2 between 2010 and 2015

Despite these advances, we still know little about Antarctic sea ice because heavy snowfall in the southern hemisphere complicates our ability to measure its thickness from space. The aim of this PhD is therefore to produce the first continental-scale measurements of Antarctic sea ice volume, and to explore this dataset to provide the first understanding of spatial and temporal trends which may impact on the region's climate, natural habitat, and maritime activity.

Antarctic sea ice thickness will be determined from a combination of CryoSat-2 satellite altimetry, a model of dynamic snow loading, and a physical model of the sea ice buoyancy and radar scattering informed by ship-based measurements. These estimates will be combined with passive microwave

satellite measurements of sea ice concentration to determine changes in sea ice volume. There may be opportunities to participate in polar field campaigns.

The successful applicant will therefore have the opportunity to (1) work with state-of-the-art satellite data, (2) develop expertise in the most recent instrument and processing techniques, and (3) address globally-significant questions relating to climate science.

Sampling Antarctic sea ice thickness from PolarStern (Courtesy S. Hendricks)

The PhD is based within the Centre for Polar Observation and Modelling (CPOM), in partnership with the British Antarctic Survey (BAS) and ESA. CPOM provides the UK with core strategic expertise in the exploitation of satellite measurements to study the Earth's cryosphere, using state-of-the-art Earth observation techniques and numerical models to study and predict changes in the polar ice sheets and sea ice cover. CPOM also develops and maintains near real time measurements of Arctic sea ice thickness in partnership with the European Space Agency (http://www.cpom.ucl.ac.uk/csopr/seaice.html).

The project will be supervised by Professor Andy Shepherd and Professor Ian Brooks at Leeds, with input from Dr Paul Holland at BAS and collaborators at ESA. Andy is the Principal Scientific Advisor for ESA's CryoSat-2 mission, Ian is an expert in polar climate processes, and Paul is an expert in Antarctic sea ice.

The project would suit a numerate candidate with a degree in a discipline such as Physics, Mathematics, Earth Sciences, Computer Sciences or Geography.

Objectives

This PhD will establish the first continental-scale measurements of, and spatial and temporal trends in, Antarctic sea ice thickness using high resolution SAR altimetry data. The precise objectives will depend upon the successful candidate's specific expertise and interests, but may include:

- Developing novel approaches to Antarctic sea ice freeboard retrieval from SAR altimetry

- Improving the certainty of SAR altimetry estimates of Antarctic sea ice thickness through advances in processing techniques
- Testing alternative estimates of sea ice snow load

Potential for high impact outcome

Establishing and monitoring changes to Antarctica's sea ice is of global significance because these trends affect not only the Antarctic region itself but also the global climate system.

The ability to map and predict sea ice trends is, for example, highly valuable for tourist and research expeditions in the area whilst helping to understand changes to marine life beneath the ice, and global weather patterns.

The project also provides the opportunity to be at the forefront of advances in SAR altimetry observation of Antarctic sea ice, an emerging area of polar science.

We therefore anticipate that the work will lead to several publications, with at least one submission to a high impact journal.

Training

The successful candidate will work under the supervision of Prof Andrew Shepherd and Prof Ian Brooks within the ICAS Polar Earth Observation group. The group, which currently includes 3 PhD students and 2 postdoctoral researchers, offers a supportive and collaborative environment for training as a polar Earth Observation scientist. The project will provide specialist training in geodetic Earth Observation techniques, algorithm development and data processing. The student will also benefit from being a member of CPOM, with opportunities to participate in ESA workshops and meetings. There will also be access to a broad spectrum of training workshops provided by the Faculty, including computer programming, degree management and communication (http://www.emeskillstraining.leeds.ac.uk/).

References

Near-real-time Arctic sea ice thickness and volume from CryoSat-2. Tilling, R.L., Ridout, A., Shepherd, A. (2016), *Cryosphere* doi:10.5194/tc-10-2003-2016

Increased Arctic sea ice volume after anomalously low melting in 2013. Tilling, R.L., Ridout, A., Shepherd, A., Wingham, D.J. (2015), *Nature Geoscience* doi:10.1038/ngeo2489

Holland, P. R. (2014), The seasonality of Antarctic sea ice trends, Geophys. Res. Lett., 41, 4230–4237, doi:10.1002/2014GL060172.

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