ANTARCTIC CLIMATE & ECOSYSTEMS
COOPERATIVE RESEARCH CENTRE

ACE CRC Intern Project 2018-18

Supervisors: Dr Alex Fraser (ACE CRC), Dr Rob Massom (ACE CRC; AAD)

ACE CRC Project (RP): 1.3

Project Title: Radar backscatter as a proxy for Antarctic sea ice thickness

Background/context of project:

Despite excellent knowledge of sea ice extent from satellite sensors, we know much less about sea ice thickness. This is due to the technical difficulty associated with remotely sensing sea ice thickness directly. Spaceborne radar and laser altimeters can detect the ice and snow surface "freeboard" (height above the waterline), and these techniques work well in the Arctic. However, these measurements are confounded by heavy snowfall and typically small freeboard of sea ice in the Antarctic.

Antarctic sea ice extent has, until the recent sudden decline, shown a slightly positive long-term trend overall. This stands in stark contrast to Arctic sea ice, which has been significantly declining since satellite records began in the late 1970s. The mechanisms behind the apparent resilience of Antarctic sea ice are still being debated in the scientific literature. However, without knowledge of Antarctic sea ice thickness change, our ability to comment on the change in sea ice volume is limited. Thus, sea ice thickness/volume is a fundamental climate parameter which has yet to be sufficiently quantified in the Antarctic.

While direct measurement of sea ice thickness remains challenging, alternative techniques exist which may contribute to knowledge of Antarctic sea ice thickness. Previous work by collaborators in the Sea of Okhotsk (northern Japan) has shown that L-band (1.27 GHz) microwave backscatter is a useful proxy for sea ice thickness there (on small spatial scales). Such a relationship has yet to be exploited as a proxy for Antarctic sea ice.

Project outline:

A limited large-scale satellite-derived dataset of sea ice thickness/freeboard exists in the Weddell Sea (from the ICESat laser altimeter, 2003 to 2009). This dataset gives a reliable estimate of sea ice thickness in this region, but is limited to brief campaigns when the satellite was operational. The successful applicant will investigate C-band (5.255 GHz) scatterometer data from the Advanced Scatterometer (ASCAT) as a proxy for sea ice thickness in the Weddell Sea, using the ICESat-derived record for validation.

If time permits, the successful applicant will examine imagery from other satellites, or sea ice motion fields which may influence sea ice roughness.

Key deliverables:

- A rigorous comparison between ASCAT-derived backscatter and ICESat-derived sea ice freeboard/thickness in the Weddell Sea during periods of data overlap, including assessment as to its use as a large-scale proxy for sea ice thickness.
- Significant progress towards production of a manuscript for submission to a high quality, peer-reviewed scientific journal.

Any specific skills required:

- This project is aimed at final year or honour level students with a physical sciences or mathematics background although other applicants will be considered on merit. Tertiary-level study of electromagnetics and thermodynamics is an advantage.
- Well-developed computing skills, with familiarity of the Linux computing environment and use of IDL, are an advantage.
- Familiarity with large scientific datasets is an advantage.

Reference:

Toyota, T., S. Ono, K. Cho & K. I. Ohshima (2011). Retrieval of sea ice thickness distribution in the Sea of Okhotsk from ALOS/PALSAR backscatter data. Annals of Glaciology 57 (52). Available from https://www.igsoc.org/annals/52/57/a57A118.pdf

Zwally, H.J., Yi, D., Kwok, R. & Zhao, Y. (2008). ICESat measurements of sea ice freeboard and estimates of sea-ice thickness in the Weddell Sea. *J. Geophys. Res.* **2008**, *113*.

Yi, D., Zwally, H.J. and Robbins, J.W. (2011). ICESat observations of seasonal and interannual variations of sea-ice freeboard and estimated thickness in the Weddell Sea, Antarctica (2003–2009). *Ann. Glaciol. 52*, 43–51.

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