

# **ISSI Team Meeting Report: Monitoring of Antarctic Sea Ice during IPY**

## **Objectives**

Knowledge of Antarctic ice kinematics, ice thickness, fast ice and their spatio-temporal variability is fundamental to evaluate the state of sea ice within the global climate system. Sea-ice motion and deformation as well as sea-ice thickness respond rapidly to environmental changes. Hence, information on their baseline and variability is crucial in assessing the state of the climate system.

SAR imagery provide regular information on the ice drift and deformation at high spatial resolution over large regions. Our proposed ISSI activity will focus on the Antarctic sea-ice zone, a previously sparsely sampled region (i.e. by RADARSAT). Two of the linked proposals (ESA AO4114 and ESA AO4123) will provide baseline snapshots of circum Antarctic sea-ice properties including ice motion, deformation and thickness (for the pack ice). Thickness information will be derived from coincident ICESat laser altimetry. Project AO4123 aims to produce maps of circumpolar fast-ice extent. Data will be acquired during three important stages of the seasonal ice evolution: February (minimum extent while capturing perennial ice regions), June (early winter) and October (maximum ice extent). SAR imagery collected for ESA project AO4007 will provide a regional extension to in-situ sea-ice drift, deformation and growth measurements obtained during three Antarctic cruises (two during austral spring 2007, one during austral autumn 2008) and from drifting sea-ice buoys. The satellite data analysis will make a significant contribution to the overall success of these field campaigns. In addition, ESA project AO4046 addresses high-frequency (sub-daily), high-resolution processes in the Antarctic sea-ice zone, knowledge of which is crucial to derive an estimate of open water within the pack (i.e. cracks or polynyas). The latter, in turn, is crucial to accurately estimate the net regional ice production, which itself is an important parameter within the polar climate system.

## **Location**

International Space Science Institute  
Hallerstr. 6  
Bern, 3012 Switzerland

## **Date**

30.06.2008 – 04.07.2008

## Participants

- Cathy Geiger (University of Delaware, USA)
- Christian Haas (University of Alberta, Canada)
- Petra Heil (Australian Antarctic Division & ACE CRC, Australia, coordinator)
- Ron Kwok (Jet Propulsion Laboratory, USA)
- Edward Maksym (British Antarctic Survey, UK)
- Rob Massom (Australian Antarctic Division & ACE CRC, Australia)
- Takenobu Toyota (Hokkaido University, Japan)
- Roberto Saldo (DTU, Denmark)

## Student participants

- Sandra Krutzky (Alfred-Wegener Institut, Germany)
- Burcu Ozsoy-Cicek (University of Texas, USA)

## Meeting summary

DAILY COVERAGE OF SAR IN THE SOUTHERN OCEAN BASED ON EXPERIENCE FROM FIRST YEAR IPY MAPPING OF ANTARCTIC SEA ICE

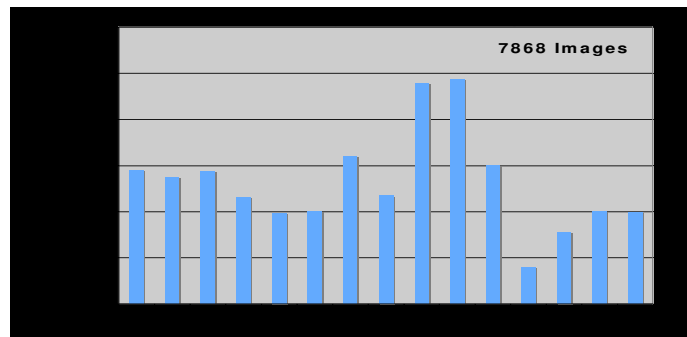


Figure 1: Monthly distribution of WSM acquisitions over Antarctic ice sheets and sea ice highlighting the variable spatial and temporal coverage totalling about 1 Tb of data.

Experiences:

- Typical strain-rates for Antarctic sea ice ( $10^{-6}$  to  $10^{-5}$   $s^{-1}$ ) are one to two orders of magnitude higher than in the Arctic ( $10^{-7}$   $s^{-1}$ ). Daily temporal resolution is therefore a higher critical need in the Southern Ocean relative to the Arctic.
- Observing sea ice in large-gradient regions across a band of narrow ice extent requires high spatio-temporal resolution data. This is the case for the entire East Antarctic sector. Daily high resolution coverage is needed in this region in particular as current coverage is inadequate for determination of ice dynamics (Figure 1).
- Temporal variability in radar backscatter heavily impacts ice tracking capability using ASAR imagery. In the Antarctic sea ice zone, episodic warming and high moisture events occur year-round, to significantly influence ice backscatter signatures (Figure 2). Hence, key issues remain with regard to the interpretation and understanding of sea ice backscatter signatures and characteristics in the region, as they affect ice motion algorithm performance, fast ice detection and sea ice classification.

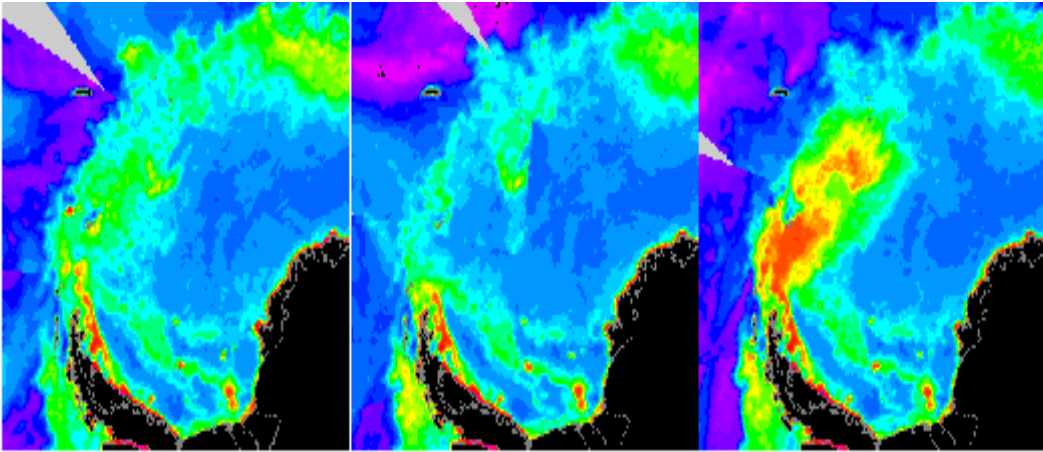


Figure 2: Radar backscatter maps of the Weddell Sea on 28.09.2006 (left), 29.09.2006 (middle), and 30.09.2006 (right), showing strong short-term backscatter variations due to the passage of a low pressure system with the temporary advection of warm air and even rain. Green to red indicate high backscatter, blue is low backscatter (Quickscat Ku-band data, courtesy L. Toudal/R. Saldo, Danish Technical University).

Data available from the first phase of IPY 2007/08 exhibit a lower coverage of the Antarctic sea-ice zone compared to the ice sheet (Figure 3). In general, there is poor coverage of the East Antarctic sea ice. The repeat coverage provided so far is not suitable to ice-motion retrieval or fast-ice detection. Hence the background mission has so far not been optimized for our scientific objectives.

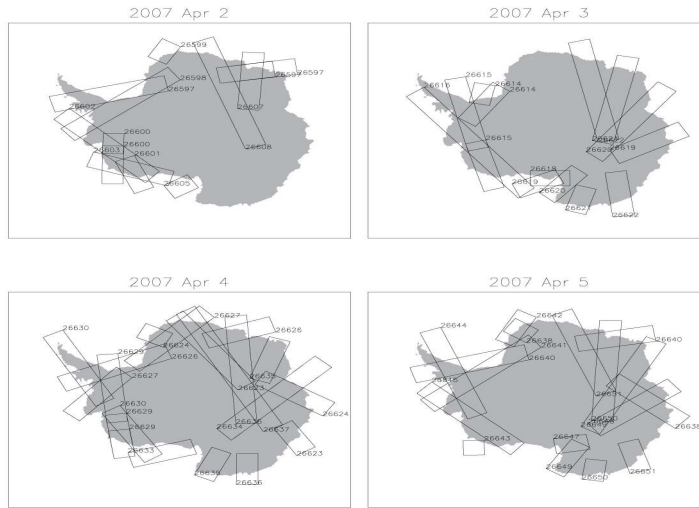


Figure 3: Daily maps of WSM acquisitions over the Antarctic cryosphere (02.04.2007 – 05.04.2007).

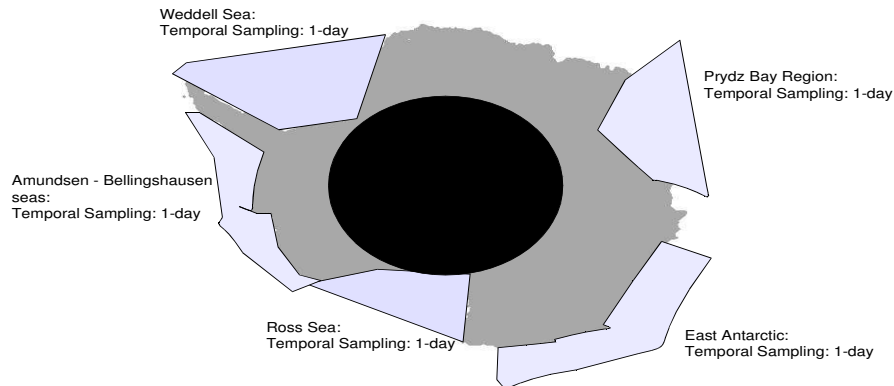
## Conclusions & further steps

Our recommendations to ESA from collective lessons learned during the first phase of our IPY projects are:

- We request support to implement a dedicated remote sensing experiment with twice-daily Envisat WSM ASAR imagery over a 100km x 100km area of the East Antarctic sea ice zone within a target area off Adlie and George V Land. Even though improved coverage of the Southern Ocean occurred during the first phase of IPY, it is still not sufficiently systematic (Figure 3) to carry out the science needed for the regional-scale sea ice dynamics and associated fast ice research.

## Recommendation for Systematic WSM Mapping

- Perform dedicated 1-month remote sensing experiment (100 km square) to assess feasibility of near-daily acquisitions.
- Instead of coverage of entire sea ice zone, focus on daily acquisitions within key regions.



- In addition, for circumpolar fast ice: Temporal sampling: 1-day throughout Feb, Jun, and Oct.

Figure 4: Recommended WSM acquisitions for systematic sampling over the Antarctic sea-ice zone.

- Based on examination of current image acquisitions, we strongly suggest a change in the background mission to acquire systematic, reliable, and continuous WSM image coverage over key regions of the Antarctic sea ice zone - to better enable the project aims to be met (Figure 4). Our recommendation is to include flexibility to adapt the background mission coverage to better meet the needs and requirements of upcoming sea ice field programs and buoy deployment campaigns, e.g. in the Bellingshausen and Amundsen seas in January 2009 or off East Antarctica in Oct 2009.
- We further request circumpolar daily WSM ASAR coverage of the coastal fast-ice zone throughout the months of February, June, and October. Daily repeat coverage is necessary to resolve synoptic-scale variability in fast-ice extent (the fast ice detection technique is based on an ice-motion tracking technique applied to co-registered image pairs).

## Attachment

### Agenda

Monday,	30.06.2008:	
0900 - 0930	Heil	Welcome, Introduction, and workshop goals (incl. EOS/CLIC report).
0930 - 1020	Haas	Background: current status of remotely sensing of Antarctic sea ice
1020 - 1100	Break	
1100 - 1230	D: Kwok/ Heil	Antarctic SAR data for 2007/08 IPY. ASAR data coverage in the region of interest. SAR data availability & accessibility. SAR product availability: What are our general analysis strategies? Availability of open source analysis tools? How would we want to extend those? What are the (project) time lines?
1230 - 1330	Lunch	
1330 - 1335	Heil	Overview of funded ESA IPY proposals liased here at ISSI.
1335 - 1355	Haas	Sea-ice motion, deformation, thickness and lead dynamics in the Antarctic
1355 - 1415	Heil	Complete mapping of Antarctic sea-ice dynamics.
1415 - 1435	Kwok	Southern Ocean sea-ice cover: kinematics, thickness, polynyas, & export
1435 - 1455	Massom	Mapping and Monitoring of Circum-Antarctic fast ice.
1455 - 1525	Break	
1525 - 1700	D: All	Discussion and roadmap of the science drivers: Produce work roadmap. Summary of key science questions. List of key deliverables. Identification of routine output products. Synergies. Future investigations.
Tuesday,	01.07.2008:	
0900 - 0910	Heil	Review workshop roadmap. Status of the analysis of the Antarctic sea-ice Envisat ASAR data
0910 - 0950	Kwok	Defining science requirements for Antarctic ice motion.
0950 - 1030	Geiger	Regional high-resolution sea-ice motion tracking.
1030 - 1110	Haas	Update on the GlobIce project.
1110 - 1130	Break	
1130 - 1210	Massom	Fast-ice deliniation and ice-motion tracking using IMCORR.
1210 - 1250	Toyota	Retrieval of sea-ice thickness distribution from L-band SAR.
1250 - 1400	Lunch	
1400 - 1510	D: Massom/ Kwok	Discussion What tools are missing? Are there other tools and techniques that we want to harness? Towards the Antarctic RGPS? Need for (A)SAR working group?
1510 - 1530	Break	
1530 - 1600	Heil/Massom	Update on IPY field projects on Antarctic sea ice incl. drifting buoys SIPEX 2007
1600 - 1630	Geiger/Cicek	BeARS 2007 & 2009/10 Odden cruises
1630 - 1700	Maksym	FOCAS 2007 and the 2009 BAS cruise
1700 - 1730	D: All	Discussion & update workshop roadmap.

Wednesday,	02.07.2008:	
0820 - 0830	Heil	Review workshop roadmap. Note: Highlight key science questions posed for ESA IPY projects. Recent science results: Sea-ice processes.
0830 - 0900	Kwok	Antarctic polynyas
0900 - 0930	Massom	Fast ice
0930 - 1000	Geiger	Buoy/ASAR analysis
1000 - 1030	Heil	East Antartic sea-ice drift
1030 - 1050	Break	
1050 - 1120	Maksym	Demonstration of Antarctic Polarview
1120 - 1150	Massom	Use of SeaIceView during SIPEX and beyond.
1150 - 1300	D:Geiger/ Haas	Identify requirements for ship/experimental support data accessibility.
1300 - 1410	Lunch	
1410 - 1440	Haas	Overview of IPAB drifting buoy activities during IPY.
1440 - 1530	D:Heil/ Toyota	Field related issues: Options and a forward strategy for Antarctic buoy experiments. What parameters are not sampled for at all? Gaps (spatial or temporally) in in situ sampling?
1530 - 1550	Break	
1550 - 1645	D:Kwok	Future ASAR data requests: Gaps in (A)SAR data? (Temporal or spatial scale, coverage). Target for future (A)SAR data requests.
1645 - 1700	D: All	Update workshop roadmap.
Thursday,	03.07.2008:	
0850 - 0900	Heil	Review workshop roadmap. Applications using ASAR data
0900 - 0930	Krutzky	Drift and ice production in the Larsen Region, Weddell Sea.
0930 - 1000	Haas	Sea-ice dynamics in the Laptev Sea using ASAR data.
1000 - 1030	Cicek	Remote Sensing of Sea Ice during SIMBA 07.
1030 - 1100	Break	
1100 - 1300	D: Kwok/ Massom	What answers can we provide? What new science questions have arisen from this meeting?
1300 - 1400	Lunch	
1400 - 1500	D: Heil/Haas	Summarize workshop discussions, final workshop roadmap, and input to workshop white paper (EOS/CliC?).
1500 - 1520	Break	
1520 - 1630	D: Heil/Haas	Summarize workshop discussions. Cont.
1630 - 1700	Heil	Closing remarks and map towards next workshop.
Friday,	04.07.2008:	
0900 - 1230	Heil/Geiger/ Massom	Finalize draft report and workshop summary.
1330 - 1800	Heil/Massom	Determine data request for targeted 1month acquisition.