

WMO POLAR SPACE TASK GROUP

SAR COORDINATION WORKING GROUP

FOURTH SESSION

**DLR (German Aerospace Centre)
OBERPFAFFENHOFEN, Germany, 8-9 OCTOBER 2015**

FINAL REPORT

(9 October 2015)

1. Welcome and Opening Remarks

1.1. Yves Crevier, the Chair of SAR CWG, welcomed participants to the meeting of the SAR Working Group. Dana Floricioiu (DLR), the local host, also welcomed participants and provided needed logistical information.

2. Introductions

2.1 During the round table participants introduced themselves, see the list of participants in Annex I.

3. Meeting Objectives and Approval of Agenda

3.1 Y. Crevier explained the objectives for the meeting, namely: (a) Review of achievements; (b) Consolidate response activities and agree on an actionable Coordinated Imaging Strategy, (c) Adoption of a 3-year Implementation Plan, and (d) Discussion of Communications, Compendium and Data Access.

3.2 The Chair acknowledged the work done by the consultant team of Don Ball, Dirk Werle and Dennis Nazarenko in preparing for this meeting.

3.3 Y. Crevier proposed changes in the agenda based on the successful outcome of the PSTG-5. Therefore, the thematic areas will be taken in the same order as during PST-5, with each thematic area immediately followed by activities of the respective agencies.

3.4 The Chair informed that SAR CWG should provide an update of the work done and coordination activities since the last meeting. There would be a presentation addressing management of the SAR CWG, including a discussion on how SAR CWG is integrated within the PSTG.

3.5 He recalled that communication had been an integral part of SAR CWG, therefore there is a need to make sure that what the Group is doing is communicated as broadly as possible. The Group, in going through aspects of communication, should discuss how to address those challenges.

3.6 During the first day a generic discussion took place, while during the second day the group discussed further many details and finalized remaining elements.

3.7 Updated Agenda was approved as presented in Annex II.

4. Review of Action Items

4.1 Don Ball introduced SAR CWG Action Items from previous meetings. All of them were closed. Annex III(a) shows the status of these actions at the end of the meeting.

5. SAR Coordination Working Group – Management, Communication and Coordination Business

5.1 Three Year Implementation Plan

5.1.1 Don Ball presented a draft of the Three Year Implementation Plan, focusing on the mandate, objectives, communications, activities and resources. The activities cover four science themes: permafrost, wet snow, floating ice and ice sheets. For each activity there are deliverables for the next three years. These deliverables need to stay at high level but should be SMART (specific, measurable, achievable, realistic and time-related). Communications planning is covered in an appendix of the Implementation Plan. Comments were presented and their inclusion in the Plan was discussed, such as the right level of inclusion of SAR activities in support of YOPP into the Plan. The Chair proposed that the Plan would be revised yearly, as appropriate.

5.1.2 **ACTION 5.1.1: Pablo-Clemente Colon to provide a text on YOPP for the inclusion into the Three Year Implementation Plan. Deadline mid-December**

5.1.3 **ACTION 5.1.2: The three year implementation plan will be reviewed by all members by end October**

5.2 Data Compendium

5.2.1 Don Ball explained reasons behind the Data Compendium and suggested a process of completion of this important document. After a short discussion, it was agreed that this document will be finalized by correspondence.

5.2.2 **ACTION 5.2.1: The PSTG Chair to provide inspiring words on behalf of PSTG for inclusion into the Compendium.**

5.2.3 **ACTION 5.2.2: Bernd Scheuchl to provide information on the SeaSat data set.**

5.2.4 **ACTION 5.2.3 Members of SAR CWG to provide shape files or KLM files for data sets that would be included in the Compendium.**

5.2.5 **ACTION 5.2.4: Members of SAR CWG to provide comments on the Data Compendium by mid-December 2016.**

5.2.6 **ACTION 5.2.5: Pablo-Clemente Colon to follow up on the PSTG letter to IICWG on data acquired to be accessible by science users.**

5.3 SAR CWG Brochure

5.3.1 Don Ball explained the proposed format and content of the next issue of the SAR CWG Brochure and a process of its completion. Preferably, it should be ready for outreach during the ArcticNet Scientific Meeting, 7 – 11 December 2015. This brochure will make reference to the Three Year Implementation Plan and the Data Compendium and should summarize recent achievements in the four thematic areas, i.e., floating ice, permafrost, snow and ice sheets. This brochure should demonstrate an effort of bridging the gap between the science and space agencies. Brief articles about each science theme and specific accomplishments should be provided by the scientific community. This brochure is the second in a series; the first brochure was issued in 2013. Mark Drinkwater stressed that the first brochure was well used in several fora, such as CEOS, GEO and conferences.

5.3.2 **ACTION 5.3.1: Members of SAR CWG to provide scientific articles/graphics/images for the SAR CWG Brochure by 2 November 2015. Specifically: (a) Bernd Scheuchl for ice sheets; (b) Dana**

Floricioiu for the Recovery Glacier; (c) Annett Bartsch for permafrost; (d) Steve Howell for floating ice; and (e) David Small and Thomas Nagler for snow.

5.3.3 ACTION 5.3.2: Members of SAR CWG to provide bullets for the achievements section of the Brochure by 2 November 2015.

5.3.4 ACTION 5.3.3: The PSTG Chair to provide inspiring words on behalf of PSTG for inclusion into the Brochure.

5.3.5 ACTION 5.3.4: An overarching review of the Brochure should be completed by all members by 2 November 2015.

5.4 Timeline Poster 2015

5.4.1 The Timeline Poster will provide an overview of two decades of coordinated satellite SAR acquisitions over the Polar Regions. It should be a standalone document but could be also included in the Compendium and the Brochure. The Poster should cover the four agreed themes but there could be one separate poster for each theme, if time permits.

5.4.2 There is a need for inputs based on scientific results. Inputs could be in various forms, such as graphics, imagery, and products. The practical approach would be to look in the scientific presentations made at PSTG-5 and SAR CWG meetings and identify those that are most suitable.

5.4.3 ACTION 5.4.1: Members of SAR CWG to provide input to the Poster, namely the science results in a form of graphic/imagery/product for the Poster by mid-November 2016.

5.4.4 ACTION 5.4.2: Mark Drinkwater and the Secretariat to provide historical IPY STG archive material as a potential source for the Poster by end of October.

5.5 Social Media

5.5.1 SAR CWG should use social media to disseminate information. Don Ball presented some examples of SAR CWG presentations in media, such as on Twitter and Facebook. This would, however, require regular attention and sustainability would be critical. It was agreed to go for a try and come back to this issue in the next meeting of the SAR CWG. The Chair proposed to develop a mock-up for comments by the Group and test it before going online.

5.6 Data Access

5.6.1 The group discussed what kind of a concept could be agreed upon by agencies for access to their data. There are several options, such as the thematic announcements and opportunities; open portals, and open data policies for science. It was noted that the open data policies for science is generally not acceptable for some commercial data providers. It was agreed that there is a need to develop a common preamble, understanding even if there are differences among agencies, each agency has a different mechanism to make the data accessible to users. The Data Compendium will be useful for documenting all the data sets. The GFOI (Global Forest Observations Initiative) is proceeding to tackle this problem, and several members of the SAR CWG are also members of GFOI. The SAR CWG will watch the progress of GFOI and follow their lead.

6 NISAR Mission and Science Plan

6.1 Paul Rosen (Jet Propulsion Laboratory, USA) presented NISAR concept and history that goes back to 2011 when NASA started working closely with the Indian Space Research Organization

(ISRO). NISAR is a science driven mission and has Baseline Science requirements for several attributes, such as for sea ice velocity, for ice sheets and glacier displacement.

6.2 The Key NISAR Characteristics to Capture the Earth in Motion are: (a) Dense temporal and spatial sampling; (b) Comprehensive global measurements; and (c) Targeted new science observations. AS for the NISAR Imaging and Orbit Geometry, it uses wide swath in all modes for global coverage at 12 day repeat, with 2-5 passes over a site depending upon latitude, Data acquired ascending and descending, and Left/Right Pointing Capability (Right nominal).

6.3 NISAR Science Observing/Operations Modes Blanket Land and Ice coverage is every 12 Days and the Observation strategy employs a small subset of possible modes, among others: land ice, Sea ice dynamics and types and Himalayas.

6.4 There are 5 years remaining before the launch and there may be additional requirements based on which the science plan could be updated. PSTG SAR CWG may provide additional requirements such as the complete scan of Polar Regions (e.g. filling the hole over the Antarctic) that might be considered. A lot of options are on the table and will be discussed over the next years to finalize the plan.

6.5 NISAR is interested in the international SAR constellation. It seeks to understand and potentially participate in international commitments to polar observations to optimize science. The nature of these plans and commitments could influence NISAR observation strategy. The Chair of the SAR CWR will collaborate with NISAR on a potential NISAR – SAR international coordination.

7. Thematic Science Session – Review of SAR Requirements, Achievements and Expected Data and Agencies Imaging Activities over Polar Regions

7.1 Ice Sheets

7.1.1 Bernd Scheuchl explained the motivation, goal and role of remote sensing in monitoring of ice sheets. Ice sheets are acknowledged by WMO and UNFCCC as Essential Climate Variable (ECV) and there is a needed to make progress in the generation of global climate products and derived information. The challenge is that none of the current SAR missions are science missions and science campaigns need to be carefully planned and compete for resources.

7.1.2 The goal is to better understand the earth's ice sheets, how they react to a changing climate, and how they contribute to global sea level rise. Directly observable parameters (ice velocity, grounding line and calving front) can be determined from SAR. Surface Elevation Change requires other missions (e.g. altimeters - though TanDEM-X is suitable). Indirectly observable parameters (from the above) are ice flux, ice shelf melting, calving rate, and mass balance. Model output (using observation-based boundary conditions) can provide backstress, damage, rigidity, to name a few, but most importantly provides projections.

7.1.3 Based on literature review and an ESA Ice SHEET CCI User Survey for Greenland, the user requirements were revisited and presented to PSTG. Similarly, user requirements were revisited for Antarctica based on a user survey undertaken for Antarctica.

7.1.4 Based on previous experience and discussions, the following general recommendations are: (a) HH Polarization; (b) Stripmap acquisition mode; (c) 25 to 45 degrees incidence angle range (with the use the same range of incidence angles where possible); and (d) coast to coast i.e. rock to rock long tracks.

7.1.5 General observation requirements for Antarctica: (a) Annual coverage of all of Antarctica with at least 4 consecutive cycles for winter observations (more cycles are considered an asset); (b) More frequent observations of critical areas with every possible acquisition of selected tracks (Pine Island / Thwaites Glacier region; Antarctic Peninsula; Totten Glacier). Note: there is also a proposal for the reduced observations if sensor capacities require scale down.

7.1.6 Science Mission Requirements: (a) Ongoing coverage of the visible area with coast-to-coast tracks (right looking: coastal areas; left looking: Central Antarctica); (b) Acquisition of additional tracks covering large outlet glaciers with higher resolution modes; and (c) Switch left looking from ascending to descending every year (or acquire long tracks asc +dsc).

7.1.7 General observation requirements for Greenland: (a) Annual coverage of all of Greenland with at least 4 consecutive cycles – winter observations (more cycles are considered an asset) for December to March period; (b) A secondary full coverage each year would be an asset; (c) More coverages in winter would also be an important science contribution that would reduce errors; and (d) Higher frequent observations of critical areas with every possible acquisition of selected tracks with ascending and descending coverages. This would improve accuracy in the interior where the InSAR phase could be used in both directions. Note: there is also a proposal for the reduced observations if sensor capacities require scale down.

7.1.8 Science Mission Requirements: (a) Ongoing coverage of the entire area; (b) Acquisition of additional tracks covering large outlet glaciers with higher resolution modes (e.g. Jakobshavn, Helheim, and Kanger – more desired).

7.1.9 Requirements document: Draft requirements were presented to PSTG in Geneva in June 2012 and to the SAR CWG in November 2012. SAR Science Requirements for Ice Sheet v.1.0 was available in May 2013. There was ongoing communication with space agencies directly regarding sensor specific recommendations. It is proposed to update the requirements document to reflect recent specific recommendations made to space agencies.

7.1.10 Thomas Nagler presented acquisition requirements used for Sentinel-1, Greenland Ice Sheets Velocity Map annual campaign 2015 and Ice Sheet Wide Coverage campaign 2015 for Antarctica by S-1. Similarly, Bernd Scheuchl made a presentation related to Radarsat-2 Greenland and Antarctica approach.

7.1.11 **ACTION 7.1.1: The Ice Sheets Requirements Document will be updated by Bernd Scheuchl and Thomas Nagler by the end March 2016.**

7.1.12 Johannes Roeder presented Sentinel-1 imaging activities of ESA over Polar Regions, explaining mission status, data volume evolution, data processed at SLC level over land that are made available for download, S-1A coverage density map (from Oct 2014 to 31 May 2015), and thematic spotlight for both Greenland and Antarctica, e.g., S-1A – IW SLC Products 16.1.2015 to 9.3.2015 ice sheet campaign over Greenland and S-1A – IW SLC Products 23.5.2014 to 1.10.2015 ice sheet campaign over Antarctica.

7.1.13 Yves Crevier presented CSA contribution to ice sheet science, which included: (a) InSAR Coverage of Ice Sheets in both Greenland and Antarctica; (b) Radarsat-1 “Greenland 2000/2001 and 2005-2008” (full interferometric coverage of Greenland Ice Sheet with multiple (4) repeats); (c) Radarsat-1 “Greenland 2013” (post IPY data coverage of the Greenland Ice Sheet with full interferometric coverage of the ice sheet with multiple (min 3) repeats); (d) RADARSAT-2 “Greenland 2014/2015” (post IPY data coverage of the Greenland Ice Sheet with full interferometric coverage of the ice sheet with multiple (min 3) repeats); (e) RADARSAT-2 “Antarctica 2009 to 2011” (Coverage of Central Antarctica, with ~ 78 deg south to South Pole, with interferometric SAR data (3 repeats));

(f) RADARSAT-2 “Antarctica 2013” (Post IPY coverage of coastal Antarctica with interferometric SAR data (min. 3 repeats)); (g) RADARSAT-2 “Antarctica 2014 to 2017” (augmented Sentinel-1a C-band data acquisition scenarios with ongoing right looking acquisitions in key coastal areas (fine wide stripmap mode)); (h) RADARSAT-2 “Central Antarctica 2015 to 2017” (with annual focus on ice shelf regions (grounding line), the highest scientific value ascending orbits used (to be combined with 2009 descending orbits). In summary the preliminary mosaic of Radarsat-2 for Antarctica includes: (a) RADARSAT-2 InSAR- based ice velocity map; (b) 2009 IPY campaign for South Pole; (c) about 90% of Post IPY data to date (standard mode); (d) Data gap in East Antarctica from a systematic conflict; (e) West Antarctica suffers from low correlation; and (f) Ongoing conflicts on the Antarctic Peninsula.

7.1.14 ACTION 7.1.2: Frank Paul will provide a Glacier Requirements Document.

7.1.15 Glacier requirements will be left in the document of Bernd Scheuchl and Thomas Nagler.

7.2 Permafrost

7.2.1 Annett Bartsch presented developments since SAR CWR-3, including requirements review. This covered (a) ECV parameters (Permafrost extent, Soil temperature profiles, Active layer thickness and Ground ice condition); (b) What satellite data should be utilized (to identify hot spots of surface change and thus advice on extension of in-situ monitoring networks, support modelling of sub-surface conditions, provide higher resolution (spatial and temporal) measurements in the proximity of long-term in-situ monitoring sites; and place the in-situ measurements into a wider spatial and temporal context); (c) Features of interest for Earth observation (Coastal erosion, Thaw lakes (summer extent, winter ice; time stamp missing on land cover products) and wetlands (circumpolar account for flux studies required) and Subsidence; and (d) Needs (circumpolar accounts, baseline for future monitoring, and temporally and spatially consistent acquisitions of optical, thermal and microwave).

7.2.2 A. Bartsch presented specific recommendation and comments for several parameters, such as subsidence, rock glaciers, surface status, wetlands and lakes, coastal erosion, lake depth thawed zone characteristics. It was recommended that the requirements be presented in a way of “thresholds” and “goals” to see whether agencies have existing capabilities to address those requirements.

7.2.3 ACTION 7.2.1: Annette Bartsch to update Requirements Document by the end of 2015.

7.2.4 Achim Roth presented DLR status of TerraSAR-X and TanDEM-X data acquisition over polar areas. TerraSAR-X “Cold Spot” monitoring covers 10 sites that are routinely observed (2012-2015 - ongoing), having a total of 1621 data, with HH/VV, HH/HV polarizations in Stripmap and HH/VV in spotlight modes. It was noted that combination of HH/HV is more suitable for permafrost study. He explained objectives of TerraSAR-X Greenland outlet glaciers (2009-2015) and TerraSAR-X Antarctica monitoring. The objective of TandDEM-X super sites is to acquire as many as possible data over some specific areas over Greenland and Antarctica, as from 1 June 2011. He also presented TanDEM-X operational data acquisition over Greenland (2 complete coverages in 2011 and 2012, ascending orbits) and Antarctica (2 complete coverages 2013 and 2014 right & left looking).

7.2.5 Johannes Roeder presented Sentinel-1 thematic spotlight, e.g. S-1: EW GRDM Products: 1-10.2014 - 1.10.2015, with the sea ice mask extended to cover coastal erosion zone over Asia and North America as per commitment taken at PSTG #3 to contribute to the permafrost.

7.2.6 ACTION 7.2.2: Johannes Roeder (ESA) to provide S-1 planning zones to Annett Bartsch by the end of October.

7.3 Floating Ice

7.3.1 Stephen Howell focused on scientific gaps over the Northern Hemisphere (NH), especially the Arctic and Southern Hemisphere (SH), especially the Antarctic. He showed examples of Sentinel-1 and Radarsat-2 to document those gaps.

7.3.2 In the Southern Hemisphere there is a need: (a) to combine ascending and descending passes to get day to day overlap areas and be able to detect ice drift and deformation; (b) for more than two satellites to give SH similar coverage to the NH; (c) for automatic methods to process the 1000s of Sentinel-1 scenes into more user friendly products; and (d) for an automatic SAR classification.

7.3.3 There are also requirements from operational community for S-1 to improve coverage over the Antarctic. These should eventually be reflected in the Requirements document. S-1 could consider providing monitoring of areas for resupply ships to the Antarctic.

7.3.4 **ACTION 7.3.1: Pablo-Clement Colon to provide Johannes Roeder with logistic information for the Antarctica re-supply activities, such as location and time.**

7.4 Snow

7.4.1 David Small presented key general recommendations of WMO White Paper on SAR Acquisition Planning for Terrestrial Snow Monitoring. He provided examples of S-1 C-band Backscatter and Radarsat-2 SCN & SCW images over Alps, British Columbia and Ellesmere Island, explained wet snow classification and brought to the attention of the Group the mutual interference of S-1 and R-2.

7.4.2 As a conclusion, for composite backscatter mosaics there is a need for: (a) Wide area potentially seamless coverage; (b) "Tighter" time window with multi-sensor integration (e.g. Sentinel-1 / Radarsat, or TerraSAR-X / Cosmo-Skymed; Harmonised acquisition strategies ensuring e.g. asc./desc. coverage within tight time window; and avoidance of mutual RFI of S-1 and R-2). This depends on: (a) Availability of DEM (also north of 60 deg N); and (b) A high standard of geometric and radiometric calibration.

8. Definition and Coordination of an Actionable Imaging Strategy

8.1 Building on the development made during PSTG-5 on plans, actions and gaps, and taking into account thematic scientific discussions and respective contributions from space agencies during the first day of the meeting, a draft Space Agency Acquisition Plan was developed, see [Annex IV](#). This Acquisition Plan provides for each of the four scientific themes, the strategic priorities (taken from the PSTG Strategic Plan 2015-18) that are relevant to SAR, and for each of these, the space agency involved; respective location, plan for 2015-16, and comments on status and/or gaps. The Plan will be finalized by correspondence after SAR CWG meeting.

8.2 **ACTION 8.1: Bern Scheuchl to provide airborne SAR acquisition from NASA.**

8.3 **ACTION 8.2: SAR CWG Members should provide their comments on the draft Space Agency Acquisition Plan by end of October.**

9. Meeting Wrap-up

9.1 The Group reviewed newly proposed actions, list of which is in [Annex III\(b\)](#). The participants greatly appreciated how the meeting was conducted and pay tribute to the Chair of the SAR CWG for his work. The importance of scientific contributions was highlighted and that credit for this is needed.

9.2 **ACTION 9.1: The chair of PSTG to develop credit statements for scientific papers/contributions to PSTG.**

9.3 Members of the SAR CWG expressed their view on how to organize their work. It was felt that while electronic communication (emails, WebEx) is a working tool, face-to-face meetings are important. The preference is to have SAR CWG back-to-back with PSTG and possibly shorten it to one day.

9.4 The meeting was adjourned on 9 October 2015 at 12:15 hours.

List of Participants

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Agenda

1. Welcome and Opening Remarks
2. Introductions
3. Meeting Objectives and Approval of Agenda
4. Review of Action Items
5. SAR Coordination Working Group – Management, Communication and Coordination Business
 - 5.1 Three Year Implementation Plan
 - 5.2 Data Compendium
 - 5.3 SAR CWG Brochure
 - 5.4 Timeline Poster 2015
 - 5.5 Social Media
 - 5.6 Data Access
- 6 NISAR Mission and Science Plan
- 7 Thematic Science Session – Review of SAR Requirements, Achievements and Expected Data and Agencies Imaging Activities over Polar Regions
 - 7.1 Ice Sheets
 - 7.2 Permafrost
 - 7.3 Floating Ice
 - 7.4 Snow
- 8 Definition and Coordination of an Actionable Imaging Strategy
- 9 Meeting Wrap-up

Actions from previous meetings

ACTION	COMMENTS
<p>ACTION SAR CWG-2.8: Draft a compendium paper describing collective datasets available (such an activity is ongoing within the Geohazard supersites concept, which then could be duplicated for a Polar Ice Sheet exploitation portal) (Lead: Y. Crevier and H. Laur); CNES (S. Hosford) to contribute concepts related to common access and licensing (deadline: 31 December 2013)</p>	<p>CLOSED. The draft Data Compendium was sent to members for review prior to the PSTG SAR CWG-4 meeting.</p>
<p>ACTION SAR CWG-2.9: Y. Crevier to draft a 3-year work plan for the Group (deadline: next PSTG SAR CWG meeting)</p>	<p>CLOSED. The draft Three Year Implementation Plan was sent to the members for review prior to the PSTG SAR CWG-4 meeting.</p>
<p>ACTION SAR CWG-3.7: DLR and ASI will work together to assess their joint capability to monitor the prioritized list of cold spots and transects proposed by A. Bartsch. (cf. PSTG-4 Action 4.8) Deadline: PSTG SAR-CWG-4.</p>	<p>CLOSED. DLR reported on their coverage of the cold spots during the PSTG-5 meeting. ASI was not present to report on their cold spot work.</p>

Actions from SAR CWG-4

ACTION 5.1.1: Pablo-Clemente Colon to provide a text on YOPP for the inclusion into the Three Year Implementation Plan. Deadline mid-December

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ACTION 7.2.2: Johannes Roeder (ESA) to provide S-1 planning zones to Annett Bartsch by the end of October.

ACTION 7.3.1: Pablo-Clement Colon to provide Johannes Roeder with logistic information for the Antarctica re-supply activities, such as location and time.

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POLAR SPACE TASK GROUP - SAR COORDINATION WORKING GROUP

TABLE OF COORDINATED SPACE AGENCY ACQUISITION PLANS (draft)

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
Permafrost	Routine high-resolution circumpolar coverage for monitoring variability in carbon pools				S-1 routine coverage not yet assured. Zonal mapping running, 2 – 3 revisits /year. RS-2 can be supported when the Nat. Mon. Framework will be in place for Canadian portion.
	Multi-sensor monitoring around key research locations where GTN-P and in-situ measurements are made (“cold spots”) (supplement existing T-SAR-X acquisitions; Bi-weekly InSAR for permafrost modeling)	DLR	10 cold spot sites	Routinely monitored by T-SARX In stripmap HH and HH/VV and spotlight HH/VV	Other cold spot sites not covered (ASI?)
		ESA	Sample of cold spots and 5 mountain permafrost areas (with focus on rock glaciers) (TBC)	Glob Permafrost ITT	
	Quantify rates of pan Arctic coastal erosion (Annual circumpolar Arctic coastline mapping at < 10m optical resolution; InSAR estimates of	DLR	Limited areas	Demonstrations using TSAR-X	Not yet comprehensive coverage to observe changes over time

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
	erosion/degradation)				
	Establish SAR monitoring of Arctic permafrost transects on routine basis to supplement existing 30-300m pan-Arctic multispectral imaging (Antarctic Peninsula covered by sea ice requirements)	ESA	Transects as defined in Reqt Doc	TBC by Pierre/Johannes	
		CSA	Coverage of ABOVE transect in N America	NTEMS implementation TBC	
	Derive SAR DEM and land surface classification map suitable for permafrost community	ESA		CCi Land cover TBC	
		CSA		Point Annett to Can. Interferometric data set (RS-1) processed and available on Polar Data Catalogue	
Floating Ice	Acquire contiguous (seamless) six days repeat pan-Arctic and Southern Ocean SAR imaging at consistent polarization combination (with view to expanding to an intermediate goal of less than three days repeat in future with right-looking Sentinel-1 (S-1), RCM, etc.; and subsequently sub-daily data with C-, X-, S-, L-band SAR combined data sources)	CSA		Contribute Can Ice Service data set during operational monitoring period (July – late Oct). During non-operational period, Steve Howell will program coverage of the western Arctic to complement S-1 data set. Distribution will be via a MURF sponsored by EC. Backdated to July 2015. RADARSAT support to ice thickness and snow surveys during OIB	Some risk of non-approval by MDA.

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
				(NASA) when applicable.	
		DLR		<p>Ice support in NRT for ships operating in ice (demonstration). Includes for example:</p> <ul style="list-style-type: none"> • Combination of sea ice parameters and meteo (conc/winds) from T-SAR-X • Unique HH/VV combination for floe-size distribution. • Wind/wave interaction in marginal ice zone. (SWH and peak wavelength). • Iceberg tracking- for IIP but insufficient repeat to track icebergs. 	
		NOAA		<p>NOAA operational processing of any available SAR dataset. For metocean and sea ice analyses. Demonstration of capability to fill pole hole with CSK background data for sea ice analysis. Pilot project to test CSK multi sat data to support IIP flights. NOAA test request for</p>	A need for routine sea ice information over North Pole.

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
				TanDEM-X, CSK and other SAR acquisitions support for resupply/ science cruise to McMurdo.	
		ESA	<p>¾ of Arctic Basin with high frequency plus background coverage of western Arctic</p> <p>Southern Ocean</p>	<p>Sentinel-1 routine monitoring following CMEMS reqts (3 days + revisits).</p> <p>Acquisition goal of coverage of Southern Ocean in one cycle. (Confirm frequency.) Slightly higher frequency in waters around Antarctic Peninsula.</p>	Southern Hemisphere SAR coverage needs some attention. Clearly not close to addressing the needs in terms of coverage and repeat.
	Establish tundra lakes and river monitoring sites	CSA	Canadian lakes	CSA will provide info on winter lake monitoring program to permafrost and floating ice communities and assess the value.	
		DLR	The 10 DLR cold spots	<p>TSAR-X classification of river and lake ice – in tundra regions</p> <p>Water; frozen to ground; consolidated ice ; frazil ice.</p> <p>Classification of Sentinel-1 data using Kennaugh elements.</p> <p>All of the above are demonstrations.</p>	

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
Ice sheets, Ice caps and Glaciers	Follow coordinated ice sheet observation plan				<p>(General statement) Update to User requirements needed to refresh the requirements document – based on user survey for Antarctic and based on currently implemented acquisition plans.</p> <p>L-band SAR summer InSAR pairs/coherence needed for debris glacier mapping</p> <p>L-band SAR ice sheet coverage over the margins of Greenland and Antarctica in BOS Insufficient to meet user requirements.</p>
		CSA		To be filled in by Bernd	
		DLR		<p>April 2015 – DLR joined Antarctic CCI with TerraSAR-X. The data will support the GLL and IV. TerraSAR-X coverage of 27 outlet glaciers of Greenland on-going.</p> <p>Regular TanDEM-X</p>	

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
				<p>coverage of supersites, including Greenland and Antarctica</p> <p>TanDEM-X – 90m pixel spacing DEM planned to be available by 2016. A call for data will be established.</p>	
		ESA	<p>Greenland</p> <p>Antarctica</p> <p>Arctic Ice Caps</p>	<p>Annual winter campaign (TBD (4+) consecutive acquisitions)</p> <p>Continuous monitoring of Greenland margins. (6 tracks)</p> <p>Annual winter campaign (4 consecutive acquisitions as a goal).</p> <p>Selected margin areas (e.g. Antarctic Peninsula & Amundsen Sea Embayment) and others TBD continued coverage.</p> <p>Canadian Icecaps associated with the Greenland Campaign. Iceland and Svalbard covered under the European coverage. Russian ice caps covered</p>	

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
				under zonal mapping.	
Snow	Plan SAR data as complement to passive microwave and 300m optical data for continental scale snow extent/SWE – and in Alpine regions and rugged topography where other methods fail	CSA	BC and Alps Ellesmere Is.	Routine RADARSAT-2 coverage to test methods EC to provide CIS archive data	Comprehensive coverage of Mountain snow in unified dual pol strategy over BC.
		ESA		Sentinel-1 routine coverage over European Alps, British Columbia (IW mode) and Ellesmere Island (EW) (planned)	European coverage extended eastwards to Caucasus TBC.
	Establish less than three day repeat SAR monitoring (ascending/descending combinations) of European Alpine region and other selected mountain regions (Scandinavia, Canadian Pacific mountains) during seasonally-limited snow melt time window	ESA		S-1 alpine monitoring of European Alps With S-1B in 2016 the monitoring will be more complete. S1 acquisitions over British Columbia And Ellesmere Island, Canada HH/HV Offers subdaily coverage. Tighter time series will allow demonstration (D. Small to refine)	DEM required to demonstrate capability in Scandinavia TBC
	Establish common polarization/mode observation strategy between SAR missions	CSA		RADARSAT-2 unified VV/VH over Alps (D. Small to refine)	More complete Asc/Desc coverage in B.C.

Science Theme	Strategic Priority	Agency	Location	Plan for 2015-16	Status/ Gaps
		ESA		Unified S-1 and R2 VV/VH acquisitions (D. Small to refine)	