STATUS OF THEMATIC AREAS 1 & 2

TA-1: *Polarimetric and multi-frequency SAR applications*

TA-2: *Interferometric SAR applications*

TA-1: Ake Rosenqvist (JAXA/soloEO), Klaus Scipal (ESA ESRIN)

TA-2: Cathleen E. Jones (NASA JPL), Björn Rommen (ESA ESTEC)

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Int'l SAR Coordination: Thematic Areas

Thematic Areas created to support the Working Groups with cross-cutting issues concerning science & application requirements and observation planning.

- Thematic Area 1: *Polarimetric and multi-frequency SAR applications*
- Thematic Area 2: *Interferometric SAR applications*
- Thematic Area 3: *Program and mission coordination*

Int'l SAR Mission Coordination	WG 1 Present & Near-Future Systems	WG 2 (Far) Future Imaging Systems	WG 3 Data Exploration
TA 1 Polarimetric & Multi-Frequency SAR Applications			
TA 2 Interferometric SAR Applications			
TA 3 Programme & Mission Coordination			

Present & Near-Future SAR systems (2020s)

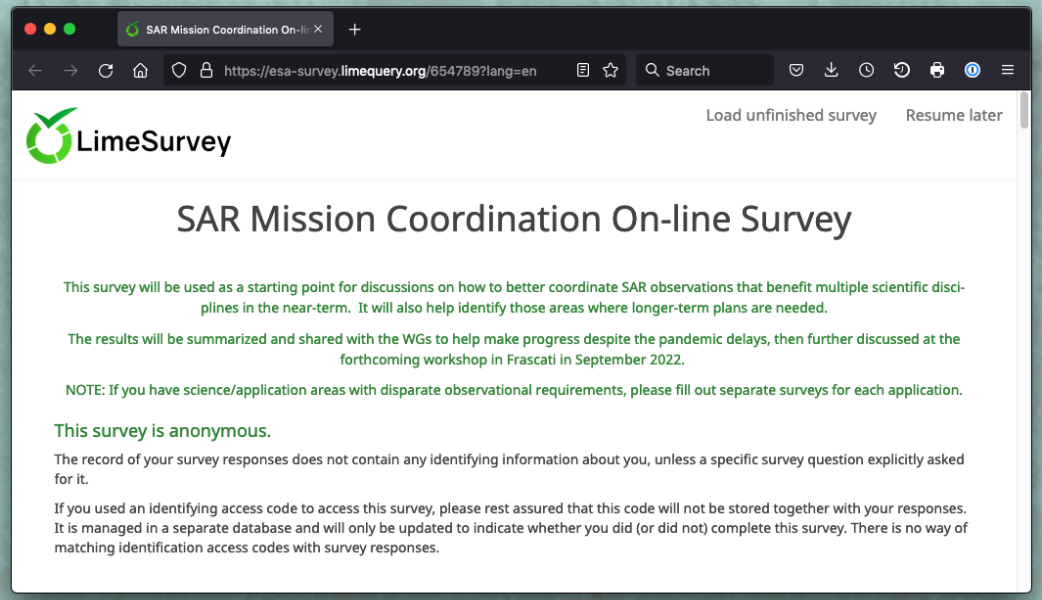
- Task: Identify SAR coordination actions that could be taken in the near/mid-term that will improve science/applications overall

Future SAR Imaging Systems (2030+)

- Task: Identify and prioritize the long-term (2030+) goals and objectives for SAR coordination – the 'Game Changers' for the respective science disciplines.
- Consider novel trends, e.g. bistatic constellations – tandem or companion satellites; micro-SAR systems, etc.

TA activities 2021/2022

- Bi-monthly TA-1/2 coordination calls
- Pres @ LPS22, IGARSS'22, IGARSS'21
- Short **Review Paper** on SAR obs req for IGARSS'21
  → **White Paper** (peer rev.) planned for 2023
- Online Survey launched in October 2021
  - 78(?) responses / 12 science areas thus far
  - Survey still open – please contribute!



https://esa-survey.limequery.org/654789?lang=en

A REVIEW OF SAR OBSERVATION REQUIREMENTS FOR GLOBAL AND TARGETED SCIENCE APPLICATIONS

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Abstract – **In this paper we provide a brief review of the Earth observation requirements for a number key science applications for which spaceborne Synthetic Aperture Radar sensors can contribute with critical measurements. We outline the current state of the science and identify information gaps associated with each application, and subsequently, provide recommendations on how these gaps can be mitigated in the 2020's time-frame by coordination of current and already planned missions, and for the next decade, with a vision for a comprehensive constellation system that would address the outstanding scientific requirements.**

Index Terms — SAR coordination, Next-Generation SAR missions, Interferometry, Polarimetry, satellite constellations, Climate Change.

1. INTRODUCTION

Since the birth of SAR interferometry in the 1990's with the ERS missions, and the introduction of global systematic SAR observation strategies by ALOS PALSAR in 2000's, we are now at the beginning of a golden era for Synthetic Aperture Radar applications, with a multitude of operational SAR missions in orbit, and with a number of novel next generation missions to be launched within the next 2-3 years.

In this small study we assess the SAR information requirements for six key applications, namely: Glaciers and Ice Caps; Solid Earth Science; Hazards; Forest and Biomass; Wetlands; Agriculture and Soil Moisture. It is duly acknowledged that the selection is not comprehensive and that several important applications, such as e.g. sea ice, ocean winds and ship detection, are not covered here.

The findings are summarised in section 3 followed by recommendations in section 4.

2. SAR APPLICATION REQUIREMENTS

2.1. Glaciers and Ice Caps

SAR data in interferometric mode have revolutionized the study of ice sheets and glaciers. These data have provided the first comprehensive coverage of ice velocity of the large ice sheets in Greenland and Antarctica and in combination with optical data the first comprehensive coverage of the velocity of glaciers and ice caps (GIC). For the ice sheets, this achievement resulted not from one but multiple SAR missions: ESA's Earth Remote Sensing (ERS-1/2), Envisat SAR and Sentinel-1A/1B, JAXA's PALSAR-1/2, CSA's RADARSAT-1/2, and ASI's COSMO-SkyMed (CSK). In addition to ice velocity, SAR data have been used to sample the grounding line positions, where ice detaches from the glacier bed and becomes afloat in the ocean waters, with high precision, in North Greenland and the entire Antarctic periphery for the first time, thereby resolving major uncertainties in ice fluxes into the ocean and rates of ice melt in the ocean.

As a result of these advances, the community has obtained comprehensive information on ice flow, ice discharge, ice mass balance and contribution to sea level rise; areas of rapid change contributing to sea level due to changes in glacier speed; and insights about the role of ice dynamics in ice sheet mass balance and the role of the ocean in driving these changes. Ice dynamics also holds the largest potential for rapid sea level rise in the future, hence the need to continue and improve our monitoring.

At present, the scientific community has migrated from multi-year comprehensive maps to annual maps and now moving to sub-monthly maps. Grounding line mapping is now conducted at the monthly scale to reveal important dynamics not previously known.

While these achievements are spectacular, much remains to be done. We need to extend high data quality at daily and sub-daily time-scale along, reduce data noise in the vast interior, and map velocity in three dimensions. Current methods assume surface parallel flow, which is acceptable in most areas except in the vast interior and over rapidly melting mountain glaciers. Current repeat cycles of weeks do not help understand the processes of iceberg calving which operate at sub-daily time scales. Another limitation is that we do not maintain fringe visibility over fast-flowing ice. Speckle tracking has alleviated that problem, however reducing data precision by a factor ten and not allowing grounding line mapping. It is essential in the future to design an observation system capable of phase observations everywhere. In order to achieve 3D mapping, we will need more than one satellite. We can count on Sentinel-1a/b 6 day repeat over the ice sheets, limited coverage at 1-day repeat with CSK, and 12-day repeat with upcoming NISAR,

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Thematic Area 1 Splinter

Polarimetric & multi-frequency SAR applications

Session organisers:

Ake Rosenqvist (JAXA)

Klaus Scipal (ESA)

Thursday Sept 29; 14:45-17:45

Room: James Cook

Time	Topic	Speaker
14:45 – 14:55	Welcome & session objectives.	Ake Rosenqvist & Klaus Scipal
14:55 – 15:10	**PolSAR/Multi-*f* Theme 1:** Forest, Wetlands & Biomass	Maurizio Santoro (Gamma RS)
15:10 – 15:40	Theme 1 open floor discussions	Moderators: AR & KS
15:40 – 15:55	**PolSAR/Multi-*f* Theme 2:** Agriculture & Soil Moisture	Heather McNairn (AAFC)
15:55 – 16:25	Theme 2 open floor discussions	Moderators: AR & KS
16:25 – 16:40	**PolSAR/Multi-*f* Theme 3**: Ocean & Sea Ice	Malin Johansson (U. Tromsø)
16:40 – 17:10	Theme 3 open floor discussions	Moderators: AR & KS
17:10 – 17:45	**TA discussions** - Coordination across disciplines Summary & Conclusions	AR & KS

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Thematic Area 2 Splinter

Interferometric SAR applications

Session organisers:
Cathleen Jones (NASA JPL)
Björn Rommen(ESA)

Thursday Sept 29; 14:45-17:45
Room: ***Magellan***

Time	Topic	Speaker
14:45 – 14:55	Welcome & session objectives.	Cathleen Jones & Björn Rommen
14:55 – 15:10	**InSAR Theme 1:** Glaciers & Ice Sheets	Eric Rignot (UC Irvine)
15:10 – 15:40	Theme 1 open floor discussions	Moderators: CJ & BR
15:40 – 15:55	**InSAR Theme 2:** Dynamic events (e.g. cascading events, rapid landslides, eruptions)	Eric Fielding (JPL)
15:55 – 16:25	Theme 2 open floor discussions	Moderators: CJ & BR
16:25 – 16:40	**InSAR Theme 3:** Slow processes (e.g. subsidence, aseismic slips)	Andy Hooper (Univ of Leeds)
16:40 – 17:10	Theme 3 open floor discussions	Moderators: CJ & BR
17:10 – 17:45	**TA discussions** - Coordination across science disciplines Summary & Conclusions	CJ & BR

TA-1 & TA-2 Seed Questions for the splinter sessions:

1. *Identify one to three SAR coordination actions that could be taken in the near/mid-term (current and near future SAR missions) that would improve science/applications for your field overall.*
   - *What science communities/application areas in your field are presently well served? How/why?*
   - *What science communities/application areas are not well served? For them, what are the missing critical elements?*

2. *Identify and prioritize the long-term (2030+ / not yet defined missions) goals and objectives for SAR coordination that would significantly improve your science discipline.*
   - *Mission parameters*
   - *Data / products*