

## **International Coordination for Spaceborne Synthetic Aperture Radar – A Personal Impression –**

Marwan Younis

I arrived late on a warm autumn night in Frascati – a city near Rome and well known to remote sensing scientist and engineers being the place-to-stay when visiting the European Space Agency (ESA/ESRIN) in Italy. Although it was not my first visit to the ESA ESRIN center, I was particularly excited to be there as I was going to attend the *Second Workshop on International Coordination for Spaceborne Synthetic Aperture Radar* [1] on the following day, which was my first “real”, i.e., in person, events after most of the corona restrictions had been lifted. Actually, this second *Workshop* (I called it in my mind “Elachi Workshop” – see explanation below) was originally scheduled for May 2020, but had been postponed three times due to COVID-19. As the organizers realized that an in-person participation was crucial to achieve the aims of the workshop, they decided to wait until this was possible.

The underlying articles introduces the activities and effort of the SAR coordination group and my personal impressions from the workshop where I want to emphasize the necessity of this kind of coordination and possibly motivating similar activities.

It was the former director of NASA’s Jet Propulsions Laboratory (JPL), Charles Elachi, who recognized the need and importance of coordination and cooperation between space agencies. Being committed to remote sensing with Synthetic Aperture Radar (SAR) he had the ingenious idea of establishing a workshop as a means to facilitate a regular contact and cross-fertilization between space agencies.

The key elements of the workshop objectives were to identify:

- new trends in spaceborne SAR missions,
- areas where coordination of data acquisitions can lead to improved science processing efficiency,

- organizational challenges in achieving coordination among agencies,
- recommendations needed to acquire spatially and temporally dense SAR data sets.

And further to discuss:

- how to maximize scientific/user exploitation of present and planned SAR missions,
- interest and value in having common test sites for calibration & validation,
- optimized systems approach to the overall constellation of planned and proposed missions,
- the desirability of coordinating future missions and the role of the commercial and New Space sector to achieve future scientific and user objectives
- Develop a roadmap for addressing the above challenges and development areas
- Further promote the international coordination for spaceborne SAR.

Three Working Groups (WG) that include radar systems experts, users, and scientists from various organizations have started their activities following the first workshop in 2018. The preparation of the Second Workshop included adding three thematic areas (TA) to further deepen the collaboration across the WG topics.

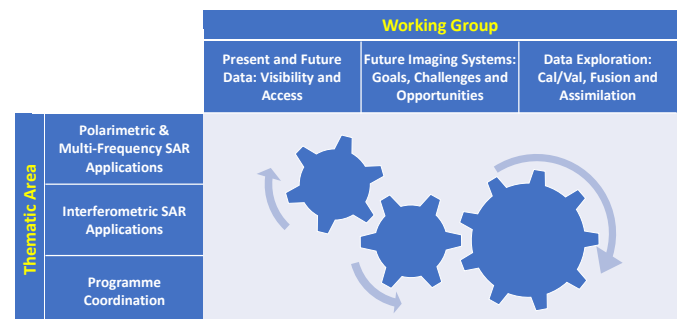


Fig. 1: The workshop includes different Working Groups (WG) and Thematic Areas (TA)

I had been aware of the first workshop held at Caltech, Pasadena [2] in 2018, but at the time I did not have the chance to participate. Attending the

workshop was by invitation only in order to limit the number of participants and to ensure an efficient process with committed attendees.

I am an active member of the Geoscience and Remote Sensing Society (GRSS) [3] and engaged in its Technical Committee (TC) [4a] on Instrumentation and Future Technologies (IFT). The IFT is a global, multi-disciplinary network of engineers and scientists with emphasis on remote sensing instruments. One of IFT aims is [4b]:

*To foster international cooperation in advancing the state-of-the-art in geoscience remote sensing instrumentation and technologies.*

Which is in-line with the workshop added to this the GRSS seeks to cooperate with space agencies. The allure of the GRSS is that it supports the engagement of members, which motivated me to seek being invited to the workshop representing the GRSS. Getting the approval from the TC was straight forward, unbureaucratic, and fast.

Organizing a workshop to be attended by nearly 100 scientists and engineers from almost all countries and space agencies flying spaceborne SAR sensors in addition to participants from the commercial sector is a big piece of work. Moreover, there is no guarantee for success or even fulfillment of its intended purpose. Having been involved in the organized of workshops and conferences myself I know that there is more than one possible pitfall such as: not reaching any (or, even worse, superficial) decisions, unengaged and bored participants, too many (possibly, irrelevant) talks, diverging off-topic discussions, the participants not getting enough chance to interact, just to name a few.

As I expected the workshop co-chairs were experienced and very successfully managed to avoid the mentioned pitfalls. I am convinced that one of the key elements to the success of the workshop is its agenda, which was constructed to guide and engage the participants to reach practical and useful recommendations.

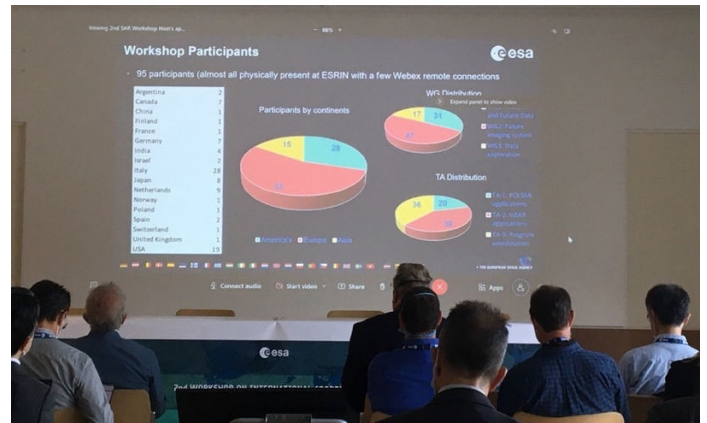


Fig. 2: Maurice Borgeaud introduced the workshop and presented the statistics of the participants

After Maurice Borgeaud welcomed the participants and introduced the workshop, the overall progress since the first workshop was presented by Charles Elachi. To give an example, the 1<sup>st</sup> workshop formulated four recommendations concerning easy SAR data accessibility, coordinate data acquisition and processing, optimized constellation system approach, sharing calibration and test sites; the overall progress is evaluated by the degree these recommendations have been addressed or implemented for mutual benefit. The workshop program and the presentations are available on [1] and providing detailed information. Then, the status of each working group (WG) was presented:

- WG-1 Present and Future Data by Shin-Ichi Sobue (JAXA) ;
- WG-2 Future Imaging Systems by Paul Rosen (NASA/JPL); and
- WG-3 Data Exploration by Bruce Chapman (NASA/JPL) and Heather McNairn (Agri-food Canada).

This was followed by the presentation on the Thematic Areas 1 and 2 by Cathleen Jones (NASA/JPL) and Åke Rosenqvist (JAXA) just before an extensive coffee break. The keynote talks that followed were titled “Future applications of SAR missions in Cryosphere Science” by Eric Rignot, “Future SAR technologies and mission concepts” by Alberto Moreira and “New space for SAR” by Darren Muff. The three talks were to be understood as an appetizer presenting the general and new trends in the SAR. Later representatives of the individual space agencies (see Fig. 3 for the list of space agencies represented at the workshop) presented on their SAR activities and future plans, followed by a general discussion including all participants. The first day was concluded by an icebreaker gathering and visit to ESRIN’s Phi-Experience [5].

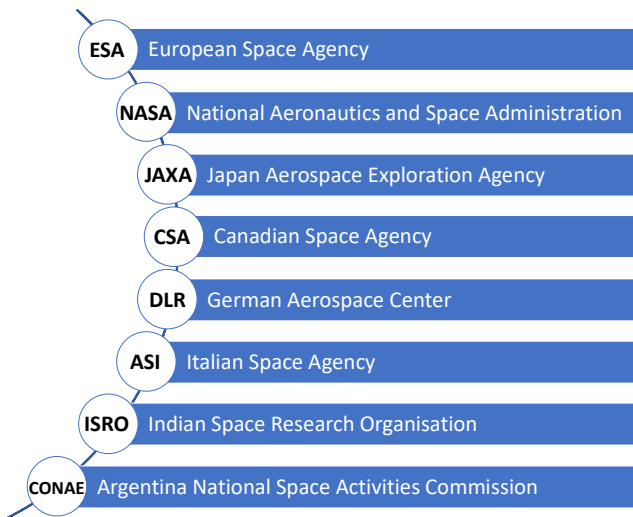


Fig. 3: Space agencies represented at the workshop

One of the most common mistakes when scheduling the agenda for workshops or meetings is that not enough time is given for the exchange between the participants. Instead, most often the schedule is packed with presentations without giving the audience to deepen nor discuss the content. This was different in this 2<sup>nd</sup> Workshop on International Coordination for Spaceborne SAR. People were gathered in groups and talking, walking around and ear dropping I noticed that most of the discussions where within the context of the workshop. In my opinion this by its own manifests the success of the workshop.



Fig. 4: Participants discussing after the talk from JAXA.

The last years has witnessed several new emerging commercial companies investing and developing their own SAR satellites. The cost of these small instruments is a fraction of that of big and complex SAR systems build and contracted by space agencies. A question (concern) is, if and how NewSpace activities are competing with the SAR activities of space agencies. To answer this question

the first hour of the second workshop day was dedicated to presentations from NewSpace companies followed by a panel discussion. In short, it was concluded that NewSpace and Space Agencies are complementary as the former have a commercial orientation and serve a different market with (mostly local) products, whereas the latter have a stronger scientific orientation aiming for global well calibrated SAR products.

An effective engineering approach is to divide big “problems” into sub-topics which can be solved more easily. Following this reasoning the main part of the second day was dedicated to splinter meetings, first for each of the working groups and then for the thematic areas. A dedicated program was set up for each splinter group giving the discussion a framework leading to tangible recommendations, which were then presented on the third and last day of the workshop.

It is often not easy to comprehend space agencies, which, when viewed from outside seem to be obscure and diverse constructs. Moreover, their higher-level strategies are often influenced by politics and other external factors. Thus, if participants were too high in the hierarchy, they would not be able to understand the technical challenges associated with establishing a real cooperation. Engineers and scientist deeply involved into radar instrument or remote sensing data evaluation don’t necessarily have sufficient impact. The optimum for achieving the workshop’s aims is (as always) to carefully choosing the participants. Knowing the trends in application, technologies and industry is crucial to understanding and planning for a successful coordination between space agencies.



Fig. 5: The conference dinner provided an excellent opportunity for discussion and exchange of ideas

Individual workshops, even if carried out at regular intervals, are not the only place/time where the actual coordination occurs. The engagement between space agencies is a continuous process on a multitude of levels which is mainly initiated by the workshops. The long term aim of the initiative is to maintain the coordination and keep the partners engaged. The presentation reports on [1] shows that after the first workshop several organization and coordination meetings were held in addition to sessions at conferences including various gatherings and networking (by the way, networking is one of the main purposes of IEEE GRSS conferences). One of the activities after the second meeting was organizing a session on *Coordination and Cooperation of International Spaceborne SAR Missions* at the IGARSS 2024 in Pasadena [6].

The question to be asked is whether and what the International Coordination for Spaceborne SAR has achieved? To answer this question, it should be mentioned the type of achievements may often be subtle and are not necessarily intended of bigger visibility, which is due to the complex nature of international coordination and cooperation mentioned before. Nevertheless, for the sake of completeness a few examples are mentioned in the following:

Examples from WG-1 on Data Access is the Disaster Observation Planning Platform (OPTEMIS) which synergizes different user and operator information layers to support timely disaster response and perform collaborative operations effectively. Further, this working group is working on joint sea ice and oil spill observation by C-band and L-band and subsequent analysis of satellite imagery by different space agencies.

Next an example is given for specific possibilities and achievements for planned and proposed SAR missions (WG-2). Here an optimized systems approach to explore mutual benefit for SAR missions of different space agencies is envisaged. Despite the fact that each organization, understandably, optimizes its SAR system for its own needs, there are opportunities for enhanced or new capabilities such as

- Better continuity of observations over a long (multi decadal) period of time.
- New multi-system capabilities such as bistatic and multi-interferometric observations
- Left / right imaging coordination to overcome shadowing

This has, for example, been successfully implemented for the NASA/ISRO NISAR [7] to and Sentinel-1 [8] missions, which are coordinated to achieve mutual full coverage of the Arctica and Antarctica.

An activity of WG-3 is SARCalNet, which, once implemented will provide reliable, pre-defined, information about SAR calibration targets, both natural and artificial, thus facilitating joint calibration and performance evaluations. SARCalNet will assist post-launch Calibration/Validation of SAR sensor data, and, when possible, also provide access to the data sets used to calibrate and monitor the performance of specific sensors. Currently, the CEOS WGCV SAR subgroup hosts a SAR target database [9].

To conclude, I can definitely say that the cooperation between the space agencies on synthetic aperture radar has been successfully established. The steps taken are already fruitful and encouraging. The task is to maintain and develop this cooperation. We are already looking forward to the next 3<sup>rd</sup> workshop which is scheduled for the first week of November 2024 and will be hosted by JAXA.



Fig. 6: Group photo of the workshop participants at ESA/ESRIN.

- Better filling of imaging gaps and higher repeat coverage by slight adjustment of orbit, node crossings or local crossing time.
- Quick response for time critical applications.

## Links

[1] <https://nikal.eventsair.com/NikalWebsitePortal/second-workshop-on-international-coordination-for-spaceborne-synthetic-aperture-radar/esa>

[2] <https://www.workshop.caltech.edu/SpaceborneSAR/index.html>

[3] <https://www.grss-ieee.org>

[4a] <https://www.grss-ieee.org/technical-committees/>

[4b] <https://www.grss-ieee.org/technical-committees/instrumentation-and-future-technologies/>

[5] [https://www.esa.int/About\\_Us/Earth\\_observation\\_multimedia\\_centre](https://www.esa.int/About_Us/Earth_observation_multimedia_centre)

[6] [https://2023.ieeeigarss.org/view\\_session.php?SessionID=1513](https://2023.ieeeigarss.org/view_session.php?SessionID=1513)

[7] <https://nisar.jpl.nasa.gov>

[8] <https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/overview>

[9] <http://calvalportal.ceos.org/point-distributed-targets-db>