Review of FRINGE 2011 recommendations related to Sentinel-1

Review of FRINGE 2011 Recommendations

Recommendation	From Session	Status	Comment
ESA should make simulated S-1 products available in order to familiarize the user community with the new formats.	Earthquakes & Tectonics	Implemented	Available since Fall 2013
ESA should provide the community with TOPS SAR data, either simulated data or preferably actual TOPS SAR acquisitions from TerraSAR-X and/or Radarsat-2. This will help the community to prepare for the new type of SAR data and to solve possible issues related to required TOPS azimuth- coregistration over moving terrain.	Earthquakes & Tectonics, Ice & Snow, Volcanoes, Methods General, DInSAR & PSI, InSAR Methods	Implemented	Radarsat-2 TOPS products were made available fall 2013
ESA should disseminate detailed information about the new TOPS imaging modes including the processing recommendations and requirements for azimuth coregistration accuracy.	Methods General, DInSAR & PSI	Implemented	DPM is in the Sentinel-1 handbook. Two technical notes exist on TOPS deramping and RAW data decoding
S-1 TOPS coregistration issues over moving terrain should be studied.	Ice & Snow, Volcanoes, Summary Session	Partly implemented	INSARAP workshop in Dec 2014. A lot of discussions on the matter are expected at Fringe 2015 !
Additional studies are needed to assess how the 6/12 day repeat-cycle of S-1 affects Ice Velocity tracking, and what is the trade-off between IWS and SM modes.	Ice & Snow	Not implemented	Acquisitions in SM are today not encouraged. First results with IW acquisitions are expected at FRINGE 2015. The possibility to perform campaigns in SM could be assessed if required in the future. Other SAR missions provide higher resolution (CSK, TX, RS-2) in particular in the framework of the Polar Space Task Group
The potential of S-1 for absolute positioning techniques should be studied.	InSAR Methods	Implemented	See presentation on S1 Instrument and Product Performance Status (Nuno Miranda)

Review of FRINGE 2011 Recommendations (cont'd)

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There is a need for an increased orbital tube to allow for better relative height estimation of Persistent Scatterers (The current 50 m tube will not allow for this, and as a result the achievable PS height precision will be limited). It should be investigated whether an increased orbital tube should be used for only a limited period of the mission (say, during commissioning) or continuously. In other words, the width of the orbital tube needs to be revisited.	DInSAR & PSI	Implemented	Since 7 August 2014, and upon decision taken during the In-orbit commissioning phase, the orbit ground track is being maintained with a dead band of +/-120m at the equator and at the maximum latitudes (spec was +/-60 m). Recently, mainly due to the uncertainty in predicting the solar and geomagnetic activity, a violation of the dead band of up to +/-200 m at equator has occurred (satellite orbit control operations are based on weekly in-plane maneuvers. ***ESA is seeking feedback from FRINGE 2015 on the suitability of a dead-band control of +/-120 m, with a max. violation of +/-200 m under certain conditions.***
For S-1 operations it is recommended to collect large baselines by periodically shifting the platform trajectory off the nominal 50m orbital tube to tomographically staggered baselines. This could be done during dedicated mission phases, for example the Commissioning Phase. This modality would allow collecting packs of small baselines for DInSAR while allowing few larger baselines for InSAR and Tomography.	Methods General, InSAR Methods	Not planned	See above – Note: it is not planned to implement specific mission phases to support Tomography. Opportunity tomographic data sets could be collected during the mission.
Investigate the possibilities of allotting part of the S-1 observation time to experimenting with new modes, for example the concept of squinted or split beam antenna operations.	InSAR Methods	Not planned	This is not foreseen.

Review of FRINGE 2011 Recommendations (cont'd)

Recommendation	From Session	Status	Comment
Over critical areas requiring frequent observations (tectonic, subsidence, landslides, volcanoes), the capability of the short repeat-cycle of S-1 should be fully exploited, and acquisitions in both ascending and descending orbits should be performed regularly.	Sentinel-1, Earthquakes & Tectonics, Terrain Subsidence & Landslides, Volcanoes	Implemented	See observation scenario. Substantial discussions took place with various relevant user communities. The baseline today is to do both ascending and descending in Europe every repeat cycle (12 days) and over global tectonic areas ascending every other repeat cycle (24 days), alternating with descending every other repeat cycle (24 days)
If a choice between single or dual polarization needs to be taken due to mission resources limitations, the mapping extent in single polarization should be prioritized vs. the use of dual polarization.	Sentinel-1	Implemented	This is considered. The dual pol doubles the data volume. Over tectonic areas (quite a large extent at global level), single pol is used, but where land cover applications are used (e.g. agriculture or forest monitoring), the dual-pol is used. Dual-pol is systematically used over Europe.
The S-1 observation strategy should consist of one main mode with as frequent acquisitions over tectonically active areas as possible (with regular acquisitions in other areas), with a priority on two look directions, small baselines, single polarization and long data-takes.	Earthquakes & Tectonics	Implemented	This concept is followed, using the IW mode
Consider using higher resolution modes over active tectonic regions to enable along-track deformation measurements with multiple-aperture interferometry or sub-pixel correlation techniques	Earthquakes & Tectonics	Not Implemented	This is not planned. However, if SM would be better suited than IW for an isolated AOI without disturbing other needs (e.g. a volcano in the middle of the ocean), the use of the SM can be envisaged.

Review of FRINGE 2011 Recommendations (cont'd)

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Ideally operate at HH-polarization and IWS-mode with ascending/descending passes for full coverage of ice every cycle.	Ice & Snow	Implemented	For sea-ice operational monitoring the mode / polarisation is either EW HH+HV or EW HH. For ice sheets campaigns, the mode / polarisation is IW HH.
For ice sheet wide mapping, once a year is probably sufficient because large changes in the interior regions are not expected. Yet you need sufficient data stacking to tackle motion of less than 1 m/yr (e.g. a couple of months of data).		Implemented	Requirements for ice sheets have been dealt with as part of the PSTG SAR WG. Two campaigns are foreseen per year for both Greenland and Antartica. For Antarctica, Sentinel-1 is not able to map the interior due to the right looking.
Do not forget the smaller glaciated areas: Sentinel-1 systematic mapping of ALL ice sheets and glaciers (Patagonia, Alaska, Himalaya, Alps, Svalbard, Canadian ice caps, etc.) decided a-priori, every cycle if possible, at the minimum by series of 4 consecutive cycles (3 for grounding line mapping, 4 in case of gaps), with coast-to-coast tracks.		Implemented	Requirements for ice sheets are discussed as part of the PSTG SAR WG. These other areas are covered. The campaigns assume 3 consecutive cycles. Such campaigns affect in some cases the Copernicus operational sea-ice monitoring for which EW is preferred.
Be careful about assuming too much a priori which area matters and which does not --> focus on all coastal regions as a threshold mission with a set of predefined tracks.		Implemented	Mission / system technical constraints must be taken into account. Observation requirements specifying AOIs should be provided…
Select "supersites" for systematic acquisitions - maybe following the TanDEM-X supersites definition (5 main outlet glaciers in Greenland; PIG, Thwaites, Totten and the Peninsula in Antarctica + Mountain glaciers in Himalaya, Patagonia, Alaska).	Ice & Snow	Implemented	All implemented with systematic acquisitions, except Totten Glacier (covered however by ice sheet campaigns). Requirements discussed as part of PSTG SAR WG

Review of FRINGE 2011 Recommendations (cont'd)

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ESA should set up a web-based system to collect, in a transparent way, the priorities of the potential S-1 users. The users should clearly identify the 'minimum requirements' for their proposed application.	Terrain Subsidence & Landslides, DInSAR & PSI	Not implemented	S-1 Observation scenario is built in a different manner. A process to gather S1 observation requirements is in place and is going to be reinforced, involving Copernicus services, Member States, and key scientific and application communities.
High revisit frequency with homogeneous acquisitions is desired over volcanic regions (e.g. the whole volcanic arcs). Both ascending and descending acquisitions are needed due to steep slopes (layover etc.) and the nature of volcanic deformation (unknown source type, & geometry). When signs of a possible future eruption, such as an increase in seismicity, are detected (users are partly responsible for this), the planned acquisitions should be acquired with the highest priority and acquisitions additional to the standard mission are desired.	Volcanoes	Implemented	Implemented / planned. Specific actions were (already) taken in the case of volcanic eruption.
ESA should investigate adding Atmospheric Phase Screens routinely to S-1 products to benefit geo-location and interferometry. This information could be produced from global weather & ionospheric models and/or data from future sensors.	Earthquakes & Tectonics, DInSAR & PSI, InSAR Methods	Not implemented	Not planned.
ESA should provide estimates of fine offsets between TOPS SAR scenes to avoid phase ramps from small mis-registration in TOPS interferograms.	Earthquakes & Tectonics	Partly implemented	Issue addressed at INSARAP workshop December 2014, to be further discussed at FRINGE 2015
ESA should make RAW auxiliary data for S-1 available once the mission starts, e.g. raw GPS data for orbit determination.	Earthquakes & Tectonics	Implemented	Access to precise (21-day delay) and restituted (few hours delay) orbit products is available to all users
ESA should seriously consider S-1 data-delivery in Level-0 format as this would entail enormous savings in bandwidth (factor of ~5) for both the users and ESA.	Summary Session	Implemented	Level 0 products are part of the core products available to users

Review of FRINGE 2011 Recommendations (cont'd)

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ESA should ensure timeliness of S-1 data availability and ease of downloading as these are of vital importance for successful global monitoring.	Volcanoes	Implemented	S1 products are made available within 1 day from sensing . Scripting is possible to automatically download products related to user defined areas.
ESA should consider delivering geocoded interferograms, perhaps using a "processing on demand" approach.	Earthquakes & Tectonics	Partly implemented	Exploitation platforms will be the place to give possibility for generating such products
Coordinate with Radarsat-2 and Radarsat Constellation Mission for coverage of the South Pole.	Ice & Snow	Implemented	This is foreseen, these aspects are discussed as part of the PSTG
Coordinate with other space agencies for continuity measurements on specific "supersites" (rapidly changing areas), now that three InSAR missions are being phased out in 2011.	Ice & Snow	Implemented	This is foreseen, these aspects are discussed as part of the PSTG
Space agencies should coordinate and guarantee acquisitions over active volcanoes.	Volcanoes	Implemented	Sentinel-1 will regularly cover most active volcanoes, coordination with other space agencies should indeed also be done