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POLAR SPACE TASK GROUP: UPDATE ON ACTIVITIES

This paper provides an update on Polar Space Task Group (PSTG) activities and plans, including on snow product validation and intercomparison, a snow mission concept workshop tentatively scheduled for 2018, consideration of Year of Polar Prediction (YOPP) science needs for dedicated satellite data acquisitions and products, continued response by agencies to ice sheet and permafrost community needs, and addition of new members to the Group in 2016 (CONAE Argentina, ISRO India).

At its 7th session in March 2017, the WMO Executive Council Panel of Experts on Polar and High-Mountain Observations, Research and Services (EC-PHORS), the parent body of PSTG within WMO, added the focus of observing high-mountain regions to the PSTG terms of reference.

REFERENCES:
1. PSTG: http://www.wmo.int/pages/prog/sat/pstg_en.php

Action/Recommendation proposed:
CGMS Members are invited to take note.

CGMS

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1. PSTG Activity

The Polar Space Task Group (PSTG) made significant progress in the interval between PSTG-5 and PSTG-6, particularly with the expansion of Group membership to 15 Agencies, and the breadth of activities. Cg-17 had endorsed the Terms of Reference and strategic plan, and the membership term was extended through 2019. Representatives of the two new PSTG agency members - the Indian Space Agency (ISRO) and Argentinian Space Agency (CONAE) - were on hand for the first time at the PSTG-6 meeting hosted by ESA on 13-15 September at ESA-ESTEC, Noordwijk, The Netherlands.

Details of the 6th session of PSTG, and the 5th session of the PSTG SAR Coordination Working Group can be found in the Sections below, and in

PSTG-6: http://www.wmo.int/pages/prog/sat/documents/PSTG-6_Final-Report.pdf
PSTG SAR-CWG-5: http://www.wmo.int/pages/prog/sat/documents/PSTG-SARCWG-5_Final-Report.pdf

Recent accomplishments by the PSTG include:

- Snow Product Intercomparison Exercise (SnowPEx) and accompanying Satellite Snow Product Intercomparison and Evaluation Experiment (iSSPI) workshops have recently concluded a landmark activity to intercompare and assess snow product accuracy and quality. The successfully completed ESA-funded project "Snow Product Intercomparison Exercise" (http://snowpex.enveo.at/) has met its objectives to inter-compare and evaluate pre-operational global/hemispheric snow products (snow extent and water equivalent) derived from different Earth Observation sensors, and to evaluate and inter-compare temporal trends of seasonal snow parameters from the various products. The SnowPEx activity has both benefited the validation of satellite-based snow algorithms with reference to independent station data and reference datasets, and identified weaknesses in snow algorithms which result in differences between the products.

- Given the value of product intercomparisons to assess uncertainties and to provide guidance to users, PSTG identified the need for a framework to organise intercomparisons of other satellite-based product suites, such as on sea-ice thickness. PSTG stressed the necessity to mobilise dedicated resources for carrying out intercomparisons. Further discussions on a potential sea ice thickness intercomparison activity will be considered at the CryoSat 2017 user workshop

- Snow activities remain ongoing with the NASA SnowEx campaign, and in various snow satellite mission concept studies being run by CSA and ESA. To further develop such concepts in dialogue with the user community, a GCW-PSTG Snow satellite mission concepts workshop is proposed (see section 6 below).

- Further coordination and planning discussions took place with Year of Polar Prediction (YOPP; kicked off on 15 May 2017) and Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) representatives. The MOSAiC ship drift experiment provides a strategic opportunity for support from PSTG member agencies, with opportunities for coordinated airborne and satellite acquisitions and in-situ satellite validation. A call for contributions by PSTG agencies to the priority requirements of YOPP scientists is currently ongoing (deadline 30 June 2017). YOPP runs from 15 May 2017 until mid-2019.

- The ice sheet and snow community have opened a snow, glaciers and ice sheet products and services portal based on PSTG agency datasets (http://cryoportal.enveo.at/), with a combination of support from Austrian FFG/BMVIT, the ESA Climate Change Initiative and EC FP7 CryoLand project. The site enables near real time Arctic and Antarctic ice stream/glacier velocity and ice shelf calving front locations to be plotted using the online data resources.

- Under the lead of TU Dresden, Gravimetric Mass Balance (GMB) products are provided in the frame of the Antarctic Ice Sheet CCI project (see: https://data1.geo.tu-dresden.de/ais_gmb/) based on NASA/DLR GRACE mission data. The GMB products are based on the monthly GRACE solutions ITSG-Grace2016 produced by Technische Universität Graz, Austria. GMB products comprise mass change time series for different Antarctic drainage basins and a time series of mass change grids covering the entire ice sheet. Both products are available for download (GMB Product Download).

- In response to initial Permafrost user requirements gathered at the request of PSTG, a new international project GlobPermafrost has been initiated to develop, validate and implement Earth Observation (EO) products to support research communities and international organisations in their work on better understanding permafrost characteristics and dynamics. The project will extend local process and permafrost monitoring to broader spatial domains, support permafrost distribution modelling, help implementing permafrost landscape and feature mapping in a GIS framework, and will complement active layer and thermal observing networks. Lowland and mountain permafrost issues will be addressed. Information regarding project status and events are available from www.globpermafrost.info

- PSTG satellite data were used in supporting the emergency relocation of the Halley Station upon discovery of a large new fracture in the vicinity of the station (http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Sentinels_warn_of_dangerous_ice_crack). The decision was subsequently taken by BAS to withdraw personnel from the station and not to inhabit the base over-winter. Satellite data are being used to monitor the extension of the fractures in the Brunt Ice shelf.

The 7th session of PSTG is planned on 12-14 December 2017 in Innsbruck, Austria.

2. PSTG SAR Coordination Working Group

The PSTG SAR Coordination Working Group met on 12-13 September 2016, at ESA-ESTEC in Noordwijk, NL. This group continues to perform an important role in coordination of complementary Synthetic Aperture Radar (SAR) data acquisition, and for sharing the workload amongst the PSTG members operating SAR missions. Progress made by SAR CWG since last year includes (i) continued SAR data contribution and collective acquisitions in response to science requirements of PSTG, (ii) updated coordinated space agency acquisition plan.

Ice Sheets

SAR coverage of Greenland and Antarctica ice sheets, including coastal areas, Antarctic Peninsula and the Pine Island/Thwaites Glacier area, has significantly improved following the joint CSA-DLR-ASI-ESA acquisition plan developed under PSTG SAR CWG auspices. With combined availability of data from the EC/ESA Sentinel-1A and -1B satellite, Greenland will see six-day continuous monitoring in 6 identified priority zones, and annual ice sheet-wide coverage. Over Antarctica, at least 12-daily monitoring of margins will be possible, and an

ice-sheet wide acquisition campaign is to be performed every 3 years for coverage of the visible interior.
Demonstrable benefits were also illustrated from the use of summer Landsat and Sentinel-2 optical data in summer for tracking ice sheet surface velocity in conjunction with SAR. This is particularly beneficial for locations of surface melting or snowfall, for which radar coherence can be lost at 6 day exact revisit intervals. Consequently, a full Sentinel-2 Antarctic mapping campaign was planned in October 2016, with further overage for repeat mapping the ice sheet margins every other cycle until Feb/Mar 2017 for monitoring dynamic regions such as ice streams and ice shelves.

Permafrost

The permafrost community is planning a minor update to its requirements, by the end of 2017. Suggested goals for GCW CryoNet regarding permafrost in the "Primer to the GCW CryoNet" recognise the use of remote sensing techniques. The ESA GlobPermafrost project (www.globpermafrost.info) addresses many of the requirements formulated in the PSTG context (with focus on 10 sites out of the 49 "cold spots") and using Sentinel-1 and Sentinel-2 data. Within this project, users identified physical subsurface properties as the most required parameter, with preferences for horizontal resolution of 10-30m, and bi-weekly temporal resolution. Due to the fragmented nature of tundra, mixed pixel effects strongly affect accuracy of land cover classification, therefore high-resolution datasets are necessary. So far, the community purchases high-resolution optical data on a case-by-case basis.
Optical imagery help in surveying thaw slumps. Quicklooks from Cosmo-SkyMed were also used. Only very few scenes over "cold spots" were cloud-free over the summer of 2016 (on the order of 5 out of 100).

High Mountains, Glaciers and Ice Caps

Routine monitoring of mountain regions, including glaciers, and ice caps is planned from the combination of Copernicus Sentinel-1A and B, Sentinel-2A and B and Sentinel-3A, ASTER and Landsat. Meanwhile, these data are complemented by acquisitions from MODIS, TerraSAR-X and TanDEM-X, SPOT, Pléiades, PALSAR and CryoSat. The new PSTG members ISRO and CONAE considerably augment these satellite capabilities with ResourceSat-1 / 2, RISAT-1/2 and CartoSAT (with NISAR planned in the future), and the planned SAOCOM SAR satellite series, respectively.

SAR Data Compendium

The document[1] contains a compendium of comprehensive satellite radar data sets collected over polar regions during the past two decades as a result of well-planned and coordinated efforts of representatives from space agencies, international organisations and the science community.

The document describes the synthetic aperture radar (SAR) data sets that have been acquired, both prior to and during the mandate of PSTG SAR CWG, and those data sets which are planned for the coming years. The data is intended to be openly available for scientific purposes, and should lead to a wealth of new observations, analyses and conclusions. The value of coordinating SAR data collection is based on sharing the load

[1] WMO Polar Space Task Group SAR Coordination Working Group (2016). Data Compendium: SAR Coordination Working Group, Update for 2015 and Plans for 2016, Summary Documentation of SAR Satellite Data Collections, Plans and Activities, Version 3.2, March 4, 2016, 41 pp.
http://www.wmo.int/pages/prog/sat/documents/SAT-GEN_PSTG-SAR-CWG-DataCompendium-Apr2016.pdf

between like sensors (e.g. between the C-band sensors or between the X-band sensors), and also on combining data from dissimilar sensors to extract richer information.
The scientific community has provided data requirements to the PSTG in four themes: ice sheets, floating ice, permafrost, wet snow. The science leads have provided the SAR CWG with science requirements tailored to SAR data. In addition to the SAR data sets that have been acquired in a coordinated fashion over polar regions during the past two decades, the document also describes planned acquisitions that have been coordinated to exploit the particular strengths of each sensor and share the load.

Through the coordinated efforts of representatives from space agencies, international organizations and the scientific community, several thousand images were collected from over two decades. This coherent and extensive compilation is one of the richest and most diverse datasets ever composed and it contributes to our understanding of the impact of climate change on the Polar Regions.

3. PSTG Interface to CEOS

At the CGMS-44 meeting held in 2016, IOC raised the question of coordination of satellite observations of sea ice in the polar regions, and whether current arrangements were adequate. An Action was taken by the CEOS SIT Chair to investigate this through the CEOS channels.

The issue was then discussed among CEOS Agencies at the SIT Technical Workshop in September 2016 and at CEOS Plenary in November. It was agreed at the 2016 CEOS SIT Technical Workshop on 14th-15th September 2016 in Oxford, UK that the WMO Polar Space Task Group (PSTG) covers polar sea-ice observations well, but that an increase in SAR observation coordination may be of benefit.

CEOS considered that the PSTG represented a competent body for the coordination of polar space observations and that the creation of a Virtual Constellation or similar body within CEOS to conduct the same function would be an unnecessary duplication. The view was that indeed the PSTG was already functioning very well in this task, that no further body was necessary and the PSTG was reconfirmed as the primary body for this work.

A significant number of PSTG Space Agency Members are represented on the Committee of Earth Observing Satellites (CEOS). Since there is no other group responsible for coordinating satellite observations in the polar regions and cryosphere, and in order to encourage information flow, PSTG periodically will continue to periodically submit reports to the CEOS Strategic Implementation Team (SIT) meetings.

4. Third Pole – Himalayan Glaciers

In September 2016, ISRO was welcomed as a new participating member of PSTG and declared a strong interest in high mountain cryosphere. ISRO provided a report on Monitoring Snow and Glaciers of Himalayan Region, using a broad combination of space agency datasets from this region. Further work is planned in the Himalaya in 2016-17 under a new Project entitled: “Integrated studies of Himalayan Cryosphere using space based inputs and impact assessment due to climate change”.

5. Andean Glaciers, Patagonia Ice Fields

CONAE, the space agency of Argentina, joined PSTG in 2016. In preparing for its SAOCOM mission with two L-band SAR satellites, the acquisition scenario is based on maritime surveillance of Argentine waters including Antarctica and Antarctic waters (resolution 100m azimuth and 10m), swath width is 200km. The mission has no commercial basis, and data should in principle be available for science. An Announcement of Opportunity is planned for next year. Regions of Interest (ROI) have been defined for “snow and ice” and “glaciers” along the Andean Cordillera, the latter including the Patagonian ice fields. These regions have been determined based on the statistics of user requests for other data. Two observations of these areas per year are the baseline. PSTG is currently providing feedback to the planned SAOCOM acquisition scenario, recognising its complementary value to other SAR missions.

6. Snow satellite mission concept workshop

Significant interest exists in preparing future mission to fill the important observation gap in retrieval of snow-water equivalent at the desired spatial scale for operational use by national meteorological and hydrological services and the scientific community. Currently, a number of PSTG member agency studies and campaigns are being conducted in support of snow retrievals and snow mission concepts. It is proposed to consider organising a small GCW / PSTG Snow satellite mission concepts workshop to take place in Geneva, with invitation to the space Agencies and the stakeholder community (with not more than 50 to 60 participants).

Rather than just focusing on space agency’s collaboration and coordination using current assets, this workshop would explore the coordination up-stream space agency activities in the early phases of a mission definition, with potential future users (scientific and operational).

Regarding the format of such a workshop – a mix of presentation and discussion sessions could be envisaged culminating in a set of recommendations for the next scientific, operational and technological challenges to be addressed. WMO/EC-PHORS/PSTG would forward the results of this consultation to Heads of space agencies for further coordination and actions.

Proposed goals of Workshop:

- To compile results and state of art of from the various remote sensing studies on terrestrial snow conducted over the last few years
- To review and reconfirm priority snow observation requirements
- To reflect on the next scientific questions to be addressed by the global science community
- To establish and agree on the recommendations and actions (programmatic and scientific) to be explore in a near finite horizon (3-5 years)

Tentatively, the workshop is scheduled for Q1/2018.

7. EC-PHORS-7

At its seventh session, WMO Executive Council Panel of Experts on Polar and High-Mountain Observations, Research and Services (EC-PHORS), the parent body of PSTG within WMO, added monitoring of high-mountain regions to the PSTG terms of reference. In this context,

"high mountains" are alpine areas where seasonal or perennial cryosphere is present and poses potential and serious risks to society related to water security and disaster resilience.