W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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POLAR SPACE TASK GROUP

(PSTG)

THIRD SESSION

PARIS, FRANCE

22-23 MAY 2013

FINAL REPORT

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation of behalf of the constituent body when the matter is, in his opinion, urgent and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

MEETING SUMMARY

1. OPENING AND WELCOMING REMARKS

M. Drinkwater as Chair welcomed the attendees to the Third Meeting of the Polar Space Task Group (PSTG). The Chair appreciated everyone's presence despite restrictions in some institutions on travel, since broad engagement by agencies was critical for advancing the mission of PSTG. Apologies had been received from the following Members of PSTG for not being able to attend this time: P. Zhang (CMA), F. Battazza (ASI), J. Key (NOAA and PSTG Vice-Chair), M. Gottwald (DLR) and C. Dobson (NASA) (C. Dobson and J. Key joined parts of the session by telephone).

Pascale Ultré-Guérard (CNES) welcomed PSTG at CNES premises. CNES has a long history in supporting the polar/cryospheric communities. The Institut Emile Victor is charged with maintaining French and European research in Antarctica including the French/Italian Concordia stations, and the French/German Spitsbergen station in Ny Alesund. Optical data from SPOT-5 has shown high value for polar research through the SPIRIT project, which is currently under review for continuation. Based on an initiative by the French scientific community, a new satellite mission is under study for generating a DEM with precision of <1m.

P. Ultré-Guérard stressed that CNES welcomed the work undertaken by PSTG and expressed her thanks to WMO for providing an appropriate framework to PSTG. She noted that CEOS agreed at SIT-28 to see PSTG continue its work in the existing framework and confirmed that CNES as incoming Chair of CEOS SIT will maintain this position, with ad-hoc reporting by PSTG to CEOS as appropriate.

S. Hosford informed participants about logistics for the meeting.

2. INTRODUCTIONS (ALL PARTICIPANTS)

In a tour-de-table, participants introduced themselves (see attendance list in Appendix I). The Chair particularly welcomed participation by representatives from the permafrost and snow communities (A. Bartsch and K. Luojus, respectively) and the World Weather Research Programme (P. Bauer) who were invited to introduce their requirements for satellite datasets and acquisitions, for consideration by PSTG. In addition, ice sheet community requirements were represented by B. Scheuchl. Some participants in the 2nd meeting of the PSTG SAR Coordination Working Group, held the previous day, also took part in the session (A. Roth, E. Herland).

3. APPROVAL OF AGENDA (M. DRINKWATER)

M. Drinkwater explained the logic of the agenda which was subsequently approved (Appendix II), with a main objective that scientists understand how requirements should be framed and formulated such that space agencies on PSTG can respond effectively. All working documents used to inform agenda items and the session in general are available at http://www.wmo.int/pages/prog/sat/pstg_en.php.

For improved communication on PSTG, the session identified the need for a set of generic overview slides describing PSTG, its mission, objectives and achievements.

All meeting documents are available at http://www.wmo.int/pages/prog/sat/meetings/PSTG-3.php, with references in Appendix II.

ACTION 3.1: M. Drinkwater and Secretariat to distribute generic PSTG overview slides to all participants and Members of PSTG. Deadline: 1 Oct 2013

4. ACTION ITEMS FROM PSTG-2

The Action items list from the last meeting was discussed, with the following status update on open items:

Action 1.4: WMO RRR Observation Requirements – REMAINS OPEN; participants are encouraged to review requirements stated in the RRR database by application area (http://www.wmo-sat.info/oscar/applicationareas).

Action 2.4: PSTG to nominate focal point for the Year of Polar Prediction (YOPP) – DONE; K. Holmlund (tentatively) accepted; discussion with P. Bauer needed

Action 2.9: PSTG members and WCRP to provide community points of contact (PoCs) to review and endorse SAR-related acquisition plans in their respective national science communities. – REMAINS OPEN; community PoCs are: Chris Derksen (snow), Birgit Heim and Hugues Lantuit (permafrost), and John Falkingham (sea ice).

A summary of all Action items is stated in Appendix III.

5. CNES PRIORITIES IN POLAR AND CRYOSPHERE RESEARCH

Juliette Lambin (CNES) introduced CNES missions with relevance to polar/cryosphere observations. Although there is no dedicated cryosphere mission, in all ocean missions operated with CNES involvement (Jason series, CryoSat, Saral/AltiKa), some polar/cryosphere objectives are of relevance. She recalled derivation of sea ice and iceberg information from inversion of altimeter waveforms over large areas and using the historical record, and showed some first results from Saral/AltiKa, a joint ISRO/CNES mission flying in the Envisat orbit with high inclination (thus well covering Greenland and Antarctica). The Ka band used by the AltiKa altimeter has an ice penetration depth of 2-10 cm and a beam of 0.55°, allowing more precise retrieval of ice topography than Ku band (1-5 m; 1.22°) and thus being of potentially high value for ice sheet mapping.

J. Lambin also introduced the CNES/CNSA (China) CFOSAT oceanography mission, planned for launch at the end of 2014, mainly aiming at measuring the directional wave spectrum in the range 70-500m, through the French SWIM radar instrument and a new scatterometer using a rotating fan-beam. There is potential use of this mission for ice sheet and land monitoring (e.g., roughness). Use of the planned NASA/CNES SWOT mission (2020 timeframe) for cryospheric applications is to be determined.

She confirmed that access to data from all the above-mentioned missions was in line with past practice, with distributed processing responsibilities and planned open access.

S. Hosford introduced the SPIRIT programme, aimed at facilitating data access by scientists. The programme started during IPY with a SPOT-5 based stereoscopic survey of polar ice (reference imagery and digital elevation models, with 2 600 000 km2 currently covered). He showed the publication record as a result of SPIRIT (61, with a peak in 2012), including on Antarctica, Greenland, Svalbard, Alaska, Canadian Arctic, and the Russian Arctic. Target areas for the proposed SPIRIT2 project (2013/2014, with PSTG support letter) are glaciers around the Arctic Ocean and Alaska, and outlet glaciers of Greenland and Antarctica. If evaluated positively by CNES, the project should start in autumn 2013 with an aggressive schedule since the EOL of SPOT5 (2.5m HR) is expected for 2014. The database from the first project phase is not yet openly

available (still residing under control of Astrium Geospatial – however this issue should be resolved within the coming weeks).

He further gave an update on Pleiades (50cm HR, 1m VR, with 20x20 km^2 footprint), a commercially-operated satellite system with a tri-stereo functionality which is crucial in areas of high relief. 12 bit radiometric resolution means less saturation and better contrast, resulting in higher accuracy of DEM products. The system is currently acquiring data in the Tibetan Plateau and Antarctica. Large-scale (continent-wide) coverage is more problematic to achieve with this system given the amount of processing involved. S. Hosford stressed the usefulness of Pleiades for targeted, repeated mapping of glaciers (100 target glaciers with repeat acquisition every 5 years). He also mentioned the CNES Z-Earth mission concept consisting of a lidar and a stereo image mapper, aiming at achieving a global dynamic topography for scientific monitoring of natural hazards and global warming; in response to IGOS GeoHazard & IGOS Cryosphere). The concept is currently in its phase 0 and undergoing feasibility analysis.

As for data access, the Pleiades data policy should use the same provisions as used in SPIRIT, and CNES plan to facilitate this process for the benefit of scientists. The ISIS data acquisition and distribution system (http://www.isis-cnes.fr) should be generalized for this purpose, to organize scientific data acquisition, distribution, and licensing for the benefit of scientists based in Europe. It was noted that for mapping glaciers, the GTN-G priority list maintained by the World Glacier Monitoring Service should serve as an important source of requirements for Pleiades acquisition.

ACTION 3.2: S. Hosford to provide further details on ISIS to PSTG and participants. Deadline: 1 Oct 2013

6. EC-PORS UPDATE (M. DRINKWATER)

M. Drinkwater presented an update from the EC-PORS-4 meeting (Lanzhou, China, 13-15 March 2013), based on the presentation made by P. Zhang to the Panel on behalf of PSTG. He recalled the mandate and objectives of PSTG, described the manner in which the Group works and sources its requirements, and gave a brief report on achievements of the SAR Coordination Working Group. The EC-PORS meeting confirmed the formalized link to PSTG.

The Chair recalled the recent bereavement of two outstanding scientists who made major contributions to the evaluation of CryoSat-2 datasets. He summarized the successful launch of relevant missions since PSTG-2 (GCOM-W, Metop-B, Landsat Data Continuity Mission) and forthcoming launches of FY-3C, Sentinel-1A and ALOS-2.

Considerations for EC-PORS were to reflect on the progress in engaging PSTG Members and to emphasize priorities. Metrics on the utilization of datasets provide an important basis for justifying PSTG action. EC-PORS-4 agreed in its Action 2 that support for experts to participate in PSTG meetings could be considered on a case-by-case basis, by the co-chairs of EC-PORS and the Director of Observing and Information Systems at WMO.

PSTG-relevant actions agreed at EC-PORS-4 are that PSTG should:

- Finalize its action plan [i.e., draft implementation plan]
- Tailor the plan toward GIPPS and GCW and determine where to obtain consolidated sources of requirements
- Liaise with IICWG.

ACTION 3.3: PSTG Members to provide input, comments and suggest actions addressing the ToR of the Group as given by PSTG-3/Doc.11-03-02, including concrete steps to "develop a short-, mid-, and long-term implementation strategy". Deadline: 1 Nov 2013 *[see also item 11.3]*

Y. Crevier pointed out that New Zealand had issued a post stamp series ("2012 Definitive Stamp Issue – Ross Dependency") including first day covers and stamp presentation pack featuring satellite-based results achieved during IPY, with image acknowledgements to CSA, ESA, and NASA.

E. Herland raised the point whether the Group should put more emphasis on responding to ECVs. The Chair recognized the importance of the ECVs, noting the PSTG has the task to respond to GCOS requirements among others. He stressed that with a view to clearly separating the work between the CEOS WG Climate and PSTG, coordinated generation of cryosphere (and other) ECV climate data records was covered by the WG Climate, whereas PSTG would focus more on targeted data acquisition-related scientific requirements in the cryosphere. Good coordination between the Chairs of the two Groups should ensure unnecessary overlap. M. Drinkwater noted that M. Dowell, Chair of the CEOS WG Climate had previously been invited to attend PSTG-2 to engage on this particular issue, and further efforts would be needed in view of the recent CEOS discussions.

7. POLAR/CRYOSPHERE SATELLITE OBSERVATION REQUIREMENTS

7.1 SWE and Snow Cover (K. Luojus)

K. Luojus informed the Group about high-level observation requirements coming from GCOS-107 the IGOS Cryosphere Report and European projects related to snow (extent, snow water equivalent). He stressed the distinction between climate-related requirements (aiming at long, well-characterized time series) and near-real time applications and described currently available Northern Hemisphere snow extent and snow-water equivalent (SWE) datasets. These include:

<u>SWE</u>
- ESA GlobSnow daily Hemispherical SWE (1980-present)
- NASA AMSR-E/Aqua daily L3 Global SWE (2002-present)
- NSIDC Global monthly SWE Climatology (monthly: 1978-2007, SMMR/SSM/I)

<u>Snow Extent/Fractional Snow Cover</u>
- ESA GlobSnow daily Hemispherical FSC/SE (1995-present)
- NASA MODIS snow products: FSC/SE (2000-present)

<u>Snow cover (binary)</u>
- NOAA/NESDIS IMS daily NRT product (since 1966; 1997 introduction of multi-sensor data)
- NOAA snow chart CDR – (Rutgers Univ.) SE (1967-present)

plus a large array of other regional datasets and initiatives.

Related to passive microwave-based SWE monitoring, the main retrieval issues are coarse resolution, algorithm performance for shallow and deep snow packs, disturbance due to vegetation, and that regional tuning of retrievals is not applicable at global scales. Studies using the GlobSnow dataset showed that data assimilation including satellite and ground-based data improved overall consistency.

As for optical monitoring of snow extent and fractional snow cover, the existing record provides a long time series, and is impacted by forested areas and the presence of clouds. The longest records for climate studies are available for binary snow cover.

Some examples were shown for comparing models and observations using Arctic snow cover datasets in the WCRP Coupled Model Intercomparison Project Phase 5 (CMIP5) and in comparing snow cover and sea ice extent reduction trends and their influence on radiative forcing.

He showed a view on the GCW Snow Tracker featured on GCW website, with 2010 and 2013 NH snow mass status reports based on passive MW (Figure 1).

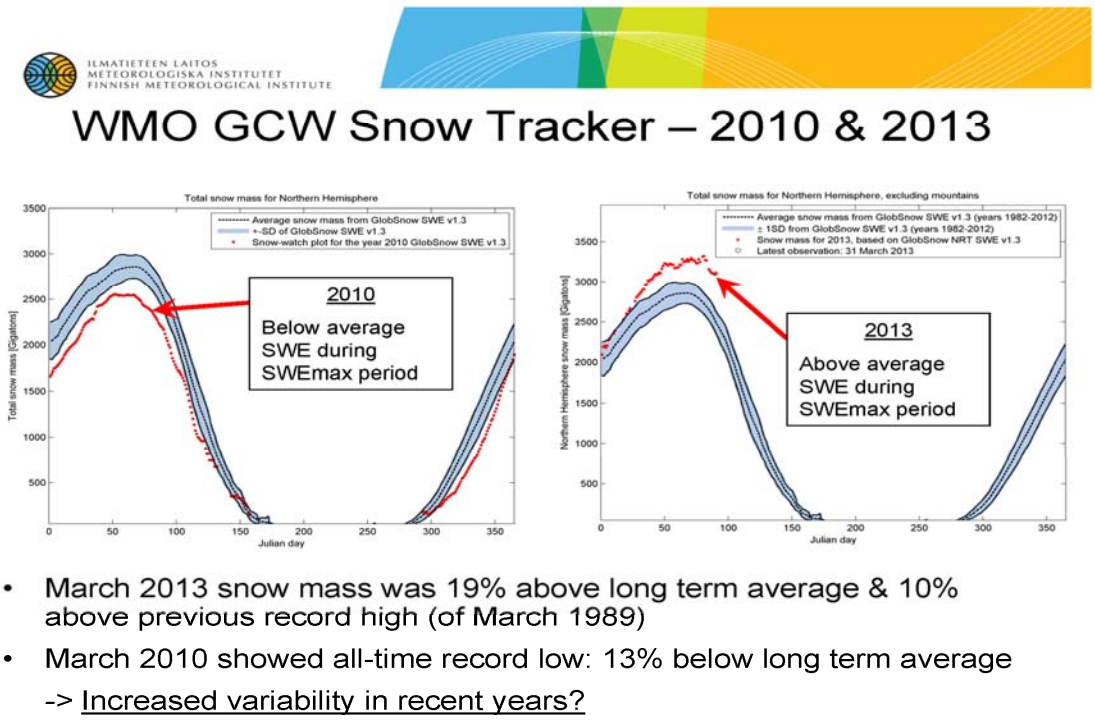

Figure 1: GCW Snow Watch SWE Tracker (http://www.globalcryospherewatch.org/state_of_cryo/snow/)

Current mission plans are expected to allow for the continuation of current snow cover/extent and SWE products. He reviewed future satellite capabilities relevant to snow, including plans for Sentinel-1, and the HEO missions PCW and the Russian Arktika, and compared these to current and future product requirements.

Some of the key current gaps are:

- Snow/SWE on sea ice
- High resolution and high topography SWE retrieval (also in view of CoReH$_2$O not being selected as ESA's seventh Earth Explorer mission)

Information on calibration/validation requirements and capabilities was provided focusing on the Northern Hemisphere. Field campaigns using airborne snow SAR and lidar should be commissioned to provide evidence that these techniques can provide high-resolution information with constrained uncertainty. It was noted that financial pressure posed a risk to the continued operation of ground-based networks, such as snow transects. The WMO Solid Precipitation InterComparison Experiment (SPICE) was noted which investigates methods of observing solid precipitation using ground-based systems. A NASA Snow Remote Sensing Workshop is planned for 14-16 August 2014 in Boulder CO, USA.

The Chair noted that the snow community was quite mature and many needs were covered by ongoing and operational activities. The data policy attached to Sentinel-1 will be important in this context. He raised the question whether large-scale routine C-band SAR coverage was a priority to the snow community.

Similarly, on the question of using Chinese multi-frequency MW radiometry data, their value is recognized and EUMETSAT are in dialogue with CMA to facilitate access to these data.

In summary, observation requirements for SWE and snow cover need refinement and update.

ACTION 3.4: K. Luojus to initiate a discussion within the snow remote sensing community addressing the need for a consensus user requirement document on terrestrial snow cover, and for the community PoC to report on results to PSTG. Deadline: PSTG-4

7.2 Permafrost (A. Bartsch)

On requirements for observing permafrost parameters, A. Bartsch discussed requirements identified in the 2007 IGOS Cryosphere Theme Report, the ESA Data User Element (DUE) Permafrost project, and the May 2013 Global Terrestrial Network-Permafrost/International Permafrost Association (GTN-P/IPA) workshop. She also described some current EO issues related to studying permafrost.

A number of projects were identified as contributing to improve high-latitude Earth observations and having expressed requirements, such as PAGE21 (EU FP7), MONARCH-A, GRENE-TEA (led by Hokkaido University); these are coherent with the implementation phases suggested in the IGOS Cryosphere report. The MONARCH-A project involves the digitization of historical permafrost maps in view of developing an ECV permafrost dataset; it is led by the Nansen Centre and has involvement by Russian scientists.

A. Bartsch discussed the summary table of EO requirements identified by users involved in the ESA DUE Permafrost project, which took into consideration the GCOS requirement for observing permafrost extent (see Figure 2). It includes the following parameters: land surface temperature, soil moisture, vegetation (land cover/phenology), snow cover extent, SWE, water bodies, DEM, elevation change (subsidence/heave), runoff, methane emissions. Requirements were specified at a range of scales (pan-Arctic, regional, local) and for multiple permafrost-related areas of interest. All parameters are indirect indicators for presence and changes in permafrost – direct measurements of permafrost (e.g., depth and thickness of active layer) can only be measured at boreholes. User organizations are distributed around the world, mostly from academia.

Some key issues with EO of permafrost were discussed: user often require land cover at high spatial resolution (10-30m), e.g., in order to properly estimate the extent and water volume of small lake ponds (thermokarst lakes). Temporal dynamics of permafrost-related phenomena is also important (seasonal and long-term), and adequate sampling of areas of interest is required, e.g. several measurements throughout a season. Land cover classification schemes (such as ECOCLIMAP, GLC2000, GlobCover2009) often poorly represented tundra areas (e.g., in correctly mapping vegetation cover) since they are mostly not adapted for high latitudes.

Mapping of snow patches on permafrost, e.g., on the Antarctica peninsula, is important for geo-ecological studies and requires very high-resolution imagery (QuickBird-type, 1-2m horizontal resolution).

Studies are ongoing to explore the potential of InSAR to infer on seasonal changes in surface height, and on the relation of subsidence to ice content (frost heave). It may thus serve as an indicator of active layer thickness. She noted that doing so was difficult especially when long repeat cycles were at hand. Although demonstrations indicating frost heave have been made using ALOS and ERS-Envisat tandem data, no published and validated transfer function exists in practice to derive frost heave to active layer thickness.

The PAGE21 project (www.page21.eu) focuses on primary and secondary sites for studying changes in permafrost (e.g., Lena Delta, Tiksi, Herschel island); some of these sites overlap with

DLR TerraSAR-X long-term monitoring sites, which again are some of the “cold spots” at which well-focused multi-scale imaging acquisition plans from complementary instruments are desirable.

A review of the 2009 permafrost EO requirements is currently in progress, e.g. within activities such as Reklim and PAGE21 and also from GCW CryoNet, with regard to climate modelling, upscaling of carbon pools, and site-based monitoring. In summary, the parameter permafrost is characterized *inter alia* by temperature, coastal processes, mass movements, and carbon pools.

Table 9: Standardised requirements on panboreal / -arctic scale

Pan–boreal / arctic scale			
EO Product	User application/ interest	requirements temporal resolution	requirements spatial resolution
Land Surface Temperature LST	near-surface air temperature soil temperature seasonal range of air temperature variations monthly near-surface air temperature mean annual air temperature	optima: hourly medium weekly to bi-weekly monthly range of amplitude minimum annually mean air temp. in July	optima 1km for upscaling medium 10 km minimum 25 km, 0.1°
Surface Soil Moisture SSM (incl. re-freeze/ thaw)	soil moisture moisture content at different depths freeze/ thaw-degree days solid-liquid ratio	weekly information	optima 1km for upscaling medium 10 km minimum 25 km, 0.1°
Land Cover LC CAVM upgraded using GlobCover + peatland incl. disturbance incl. phenology	Land Cover area percentage of water body area percentage of vegetation physiognomy area percentage of bare soil disturbances 'fire' 'storm' 'Insects' 'cutting' '(thermo)erosion' 'thermokarst' albedo in red and NIR leaf area index LAI or another volumetric index of total vegetation or an index of height of vegetation cover	annually: phenological products -> does this mean seasonal phenology? further clarification required	Optimal Medium minimum
Water bodies	water bodies all lentic and lotic systems water body ratio	annually: summer state July to August	water/ body ratio
Digital Elevation Model DEM Global ASTER DEM	elevation topography (variance and aspect)		optimal < 300 m medium < 1 km Minimum 25 km, 0.1° ,fine data for variance & north-south aspect.

Figure 2: Pan-boreal/Arctic-scale EO requirements related to permafrost identified in the 2009 ESA DUE Permafrost project [Ref: PSTG-3/Doc. 7-2-2, Table 9, http://www.wmo.int/pages/prog/sat/meetings/documents/PSTG-3_Doc_07-02-02_ESA-DUE2009.pdf]. The same document also identifies regional and local-scale requirements.

Main messages from the discussion are:

- Some continuous products relevant for permafrost community are available
- Scale-dependent information is required for priority sites (e.g. in GTN-P)
- Further iteration on community requirements, and on availability of products (not only data) is necessary.
- Consolidation of these requirements is needed at circumpolar, regional, and local/site levels.

There are plans to prepare a permafrost outlook (similar to the one for sea ice cover).

ACTION 3.5: PSTG Members to read Permafrost User Requirements document (*http://www.wmo.int/pages/prog/sat/meetings/documents/PSTG-3_Doc_07-02-02_ESA-DUE2009.pdf*), and provide first response at next meeting of PSTG. Deadline: PSTG-4

ACTION 3.6: Engage USGS and other agencies with strong optical high-resolution imagery acquisition capability in a coordinated response by PSTG to permafrost requirements. Deadline: PSTG-4

7.3 Atmosphere - YOPP (P. Bauer)

P. Bauer informed the Group on the WWRP/THORPEX Polar Prediction Project. The programmatic context for the Project is the Global Integrated Polar Prediction Project (GIPPS), where coordination and synergy between hourly/seasonal and longer-term prediction capabilities is envisaged. The Polar Prediction Project focuses on the hourly/seasonal timeframe; it includes coupling of chemical models and numerical weather models for environmental predictions. Research areas encompassed by the Project are predictability, the influence of the analysis (initial conditions) on forecasts, observations, models, algorithms, and metrics development.

He showed the improvements in NWP performance (rms error in 500hPa geopotential height forecast) over time for six operational systems over the Arctic (60-90N). Improvement is partly due to availability of conventional observations, and possibly related to IPY observing activities in 2007/2008. Predictability is scale-dependent, with forecast skill with longer lead times improve at larger spatial scales.

P. Bauer explained some issues with model skill over polar and high-latitude regions. Differences between model analysis and observations for various meteorological parameters are largest in Polar Regions and over the Tibetan Plateau, based on model analyses available in TIGGE. There are issues in data assimilation over the Arctic and Antarctic, e.g., of microwave sounder data, mainly due to inadequate assumptions on ground emissivity. Also, the eminent role of sea ice extent for weather forecasting was explained, noting that model forecast skill in the Arctic also affects mid-latitude skill. He explained issues in estimating analysis uncertainty and, as a consequence, forecast uncertainty.

Overall, the use of observations from Polar Regions in the ECMWF model is relatively poorly understood, giving rise to artificially low analysis uncertainties. As for sea ice, the effects are largest during times with high gradient of sea ice cover change. Updates of orographic datasets (soil types, roughness, topography) in the ECMWF model occurs only every 5-10 years.

Solutions would be to focus on better observations (of sea ice, snow cover, for example) and associated uncertainty estimates, to better understand how to use them in forecast models.

NWP data requirements are geared towards:

- Model development for improved process representation (list of variables available; complex issues to deal with in NWP – low-level clouds, snow cover, melting ponds, sea ice all

combined). Observations types at level 2 (distinguish retrieval errors and sampling errors when stating product uncertainty)
- Data assimilation for improved initial conditions: wind profiles are very important; level 1 datasets required
- Near-real time availability (<3h delay)

The Year of Polar Prediction (YOPP) 2017-2018 foresees a dedicated concerted observation and modelling period, for data assimilation development (e.g., coupling). It is expected to establish data priorities and observation requirements (NRT data transmission; special observation modes on demand for selected Intensive Observation Periods; observing system design). The dialogue continues with a YOPP workshop in June 2013; detailed observation requirements are to be developed approximately over the course of the next year.

The Chair noted that PSTG was to support specific projects and science questions in support of ECMWF and YOPP, to prepare for operational uptake of satellite observations by NWP.

ACTION 3.7: Chair to participate in the ECMWF-THORPEX workshop on polar prediction to further iterate the dialogue with this community. Deadline: 15 June 2013

ACTION 3.8: PSTG Members to provide examples on the use of remote sensing products in data assimilation for improved polar prediction. Deadline: PSTG-4

7.4 GEO Cold Regions

The Group recognized that the explicit link that existed between PSTG predecessor and GEO Work Plan during IPY was now through the task WA-01-C3 ("Information for Cold Regions services"). PSTG is linked to GEO through this task and any specific satellite observation requirements developed within GEO Cold Regions initiative, for example from ecosystem and biodiversity communities of practice, should be brought to the attention of PSTG. Requirements related to the Third Pole may be a subset of these.

8. COORDINATING A RESPONSE TO SCIENCE REQUIREMENTS

8.1 SAR Coordination WG Status Update (Y. Crevier)

Y. Crevier recalled mandate, membership and current activities of the SAR Coordination Working Group operating under PSTG auspices. It has been established to provide coordination across space agencies with SAR missions, to facilitate acquisition and distribution of fundamental SAR satellite datasets, and to support the development of products in support of cryospheric scientific research and applications. The Group has good links with the private sector in order to provide the best possible service to users. There is an open invitation to other space agencies with relevant assets to join the Group. Engagement of CONAE and ISRO should be strengthened in the future.

He provided the Group with a synthesis of the coordinated response by agencies in the Group to ice sheet monitoring needs for the Arctic and Antarctic regions (see item 8.2).

8.2 Ice Sheet Monitoring – Acquisition Plans & Status (B. Scheuchl, D. Floricioiu)

In opening, B. Scheuchl noted that it is relatively straightforward for PSTG agencies to respond to ice sheet monitoring requirements relying on basically a single source of all-weather data (SAR) than designing acquisition plans relying on multiple sources of data (such as needed for permafrost, snow monitoring). He then recalled the motivation and background for the request to PSTG, including their recognition as a GCOS Essential Climate Variable. He mentioned the ESA

and NASA large-scale ice sheet monitoring projects (Climate Change Initiative and MEaSUREs, respectively), informed on products collected during IPY, and showed statistics on the use of products, and noted that some (single) users serve large downstream user communities (e.g., ECMWF), and that there is significant interest including from users in Italy and China. Four SAR missions (ALOS PALSAR, Envisat ASAR, RADARSAT-1, ERS-1/2) saw the end of their mission lifetime since the end of IPY, posing a significant gap in coverage.

For the benefit of the other user representatives present, he described the iterative process of preparing and presenting the requirements to PSTG, which consisted of:

- Presentation of draft requirements to PSTG-2 in Geneva (June 2012) and to the SAR Coordination Working Group in Frascati (Nov 2012);
- Ongoing communications with space agencies directly regarding sensor specific recommendations;
- A draft requirements document sent out to the science community for input and public review (posting on CryoList etc.);
- Development of a document SAR Science Requirements for Ice Sheets V1.0, May 2013, distributed in preparation for this session.

A summary of the agreed science requirements, general acquisition recommendations, and sensor-specific recommendations followed. The resulting acquisitions plans for Greenland, Svalbard and the Canadian Ice Caps, and Antarctica are as follows:

Greenland, Svalbard and Canadian Ice Caps: coverage occurred from Jan to March 2013 using RADASAT-1 (F1 mode, right-looking; see Figure 3) – to be repeated for 2-3 consecutives years with an increasing number of missions;

Plan: 2013-2015
Sensors: RADARSAT-1, TerraSAR-X, Cosmo-SkyMED, ALOS2*, Sentinel1*
Goals:

- Full interferometric coverage of Greenland – Jan to April and Nov to March
  (RADARSAT-1 F1 mode, 3-4 consecutive coverages)
- Full interferometric coverage of Svalbard – March to May and Nov to March
  (RADARSAT-1 F1 mode, 4 consecutive coverages)
- Regions included in science TanDEM-X first and second global DEM acquisitions
- Dense time series over Greenland and Antarctica fast flowing glaciers using X-band missions

NSC/KSAT provides the reception of the RADARSAT-1 data using the Tromso receiving station. NASA provides support to processing and generation of scientific products through the MEaSUREs Program.

(*according to ALOS2 Basic Observation Scenario and initial Sentinel-1 High-Level Operations Plan when these missions will have been commissioned)

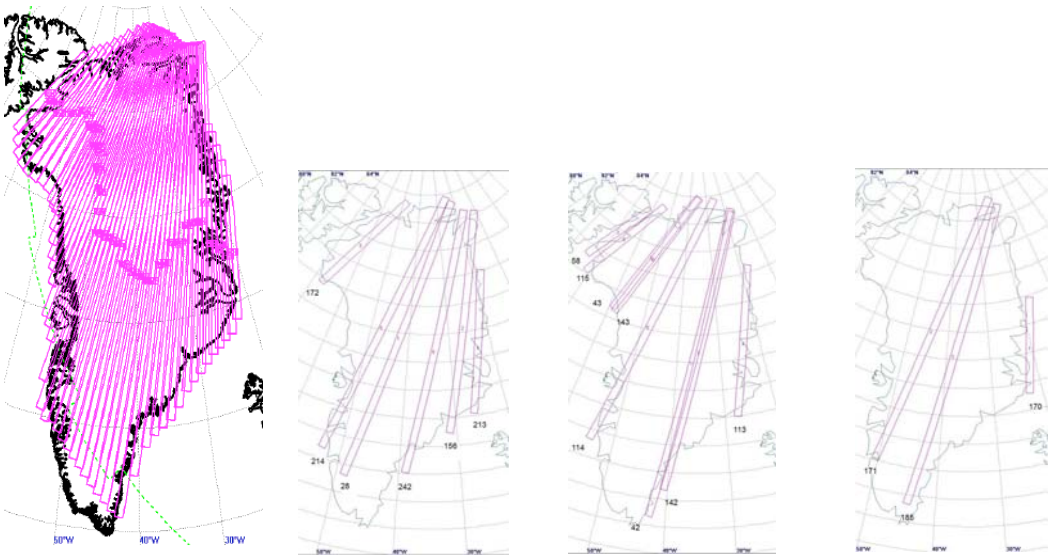

Figure 3: RADARSAT-1 SAR coverage of Greenland (F1 mode) Jan-March 2013; 32 triplets acquired, 6 24-day pairs and 8 48-day pairs, for interferometric processing.

Antarctica:

Phased implementation approach taking into account the availability of Sentinel 1 and ALOS 2 in the coming years. As of May 2013, acquisition using RADARSAT-2 (standard S1 mode, mostly right-looking) is shown in:

Plan: 2013
Sensors: RADARSAT-2, TerraSAR-X, Cosmo-SkyMED
Goals:

- Interferometric Coverage of Antarctica – April to Sept (visible area for right looking acquisitions) (RADARSAT-2 Standard mode, 3 consecutive coverages)
- Dense time series over Greenland and Antarctica fast flowing glaciers using X-Band missions
- TanDEM-X Antarctica acquisitions campaign starting with April 2013

NASA to provide support for the generation of scientific products through the MEaSUREs Program.

Plan: 2014 -2016
Sensors: ALOS 2, Sentinel 1, RADARSAT-2, TerraSAR-X, Cosmo-SkyMED
Goals:

- Interferometric Coverage of Antarctica – ALOS2 coverage as defined in the Basic Observation Scenario, Sentinel-1 coverage as defined in the High-Level Operations Plan, RADARSAT-2 three consecutive coverage in left looking mode to cover the region south of 80 degrees
- Dense time series over Greenland and Antarctica fast flowing glaciers using X-band missions

NASA to provide support to the generation of scientific products through the MEaSUREs Program.

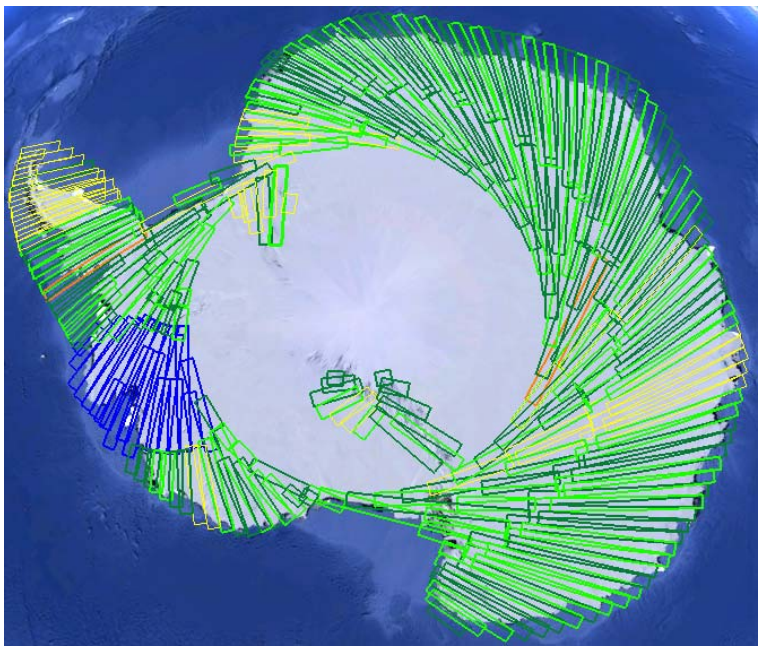

Figure 4: RADARSAT-2 SAR coverage of Antarctica (S1 mode) Jan-May 2013; acquisitions are colour-coded as dark green (3 consecutive acquisitions), light green (2), orange (one 48-day pair), blue (ongoing observation campaign), yellow (no InSAR pair available).

For all campaigns, data access arrangements are sensor-dependent. Agreements for broad access are under consideration.

D. Floricioiu gave an update on TerraSAR-X and TanDEM-X satellite missions and data acquisition over the ice sheets of Greenland and Antarctica. She gave details on new TerraSAR-X modes that may also be of interest in serving permafrost or snow-related requirements. Targeted acquisition campaigns cover the Antarctic Peninsula and Pine Island Glacier are planned, with AWI in scientific lead. She described details of TerraSAR-X support to aircraft campaigns to investigate the Recovery glacier system (Polar5/6 of AWI) and the grounding line along the Transantarctic mountain range (Operation IceBridge).

As for TanDEM-X, since Feb 2012, co-registered SAR experimental data are delivered to science users. An Antarctica campaign started on 29 April 2013, in order to complete a global DEM. Expected vertical accuracy of the derived DEM is around 3m (specification: 10m). Land coherence maps of single-baseline processed TanDEM-X acquisitions show low coherence in sand desert areas and complex terrain. The super sites important to glaciology covered by TanDEM-X can also be used for other scientific applications.

8.3 Permafrost (A. Roth)

A. Roth presented time series of routine TerraSAR-X acquisitions, in response to lists of key permafrost test sites provided by AWI, with circumpolar distribution and associated with GTN-P and borehole measurements. Using various acquisition modes (in HH, VV, stripmap modes), TerraSAR-X acquisitions cover the Lena Delta, Svalbard, Yukon/Herschel island (12 day repeat cycle), Alaska Barrow, Kytalyk, Bolshoi Lyakhovsky, Anzhu, Abisko (N Sweden), Nuuk, Zackenberg, Marre Sale.

He also showed a preliminary DEM based on TanDEM-X for the (flat) Mackenzie delta – currently the baseline for any DEM especially in high latitudes.

ACTION 3.9: Global permafrost community to validate the list of current focus sites ("cold spots"), and send feedback to Y. Crevier. Deadline: 1 Nov 2013.

ACTION 3.10: A. Roth to provide current TerraSAR-X permafrost acquisition sites in .kmz format to Chair of SAR Coordination Working Group (Y. Crevier), for distribution to the community. Deadline: 1 Nov 2013

Recognizing the value of the TanDEM-X DEM, C. Dobson asked about access to the DEMs for scientific purposes – even if degraded. A. Roth stated that the distribution policy is based on a proposal for the full resolution. A 3 arcsecond model can be made available for larger areas (e.g., Greenland). The current acquisition phase focuses on Antarctica, and the processing strategy foresees that areas where two acquisitions are sufficient have priority.

M. Drinkwater (in PSTG-3/Doc.07-02-03) showed a short summary of generic permafrost requirements for Earth observation, complementing the information presented by A. Bartsch. Since permafrost terrain is very dynamic, time series of data are required (SAR more useful since all-weather; optical important for baseline). He showed various data types (high-resolution optical, all weather SAR, all weather scatterometry and passive microwave, coarse resolution high temporal resolution circumpolar datasets, experimental hyperspectral) that could be useful in responding to permafrost needs.

M. Drinkwater showed one use of permafrost mapping in support of methane emission data assimilation into Earth system models (JULES and HadGEM3).

8.4 Other existing acquisition plans (Sentinel Operations Plan)

On behalf of P. Potin, B. Scheuchl showed acquisition plans for Sentinel-1 in response to requirements of the GMES Services, and potential additional acquisitions of the ice sheets that can be added to the planned acquisitions.

M. Drinkwater drew attention to the Sentinel High Level Operations Plan (HLOP - PSTG-3/Doc.08-04-02) covering all Sentinel missions. There are planned acquisitions of e.g. Sentinel-2 over the Tibetan plateau. Additional user / scientific requirements vis-à-vis the Sentinels should be articulated through the national focal points to the GMES User Forum. There will be regular iterations to the HLOP, such as including SAR altimetry over the global oceans.

9. WMO MATTERS

S. Bojinski briefed participants on three items:

- Key results of the WMO 2012 Survey on the Use of Satellite Data
- WMO Product Access Guide
- Rolling Review of Requirements

The WMO survey carried out in 2012[1] provided some information relevant to polar and cryosphere communities. Based on 227 responses from 95 countries, the survey provided information on how many users were utilizing products on snow, ice sheets, glacier and ice caps, and sea ice, as well as DEMs (in use by 20-40% of all respondents). It also provided details on the institutions using such products, and impediments to their use. For example, fourteen respondents expressed a desire to use satellite-based glacier information, but were currently unable to do so (these were the national meteorological services of Argentina, Azerbaijan, Bosnia-Herzegovina, Chile, India, Iran, Kenya, Netherlands, Kuwait, Republic of Korea, Russian Federation, and Uzbekistan). In

[1] http://www.wmo.int/pages/prog/sat/documents/SAT-PUB_SP-9-Survey-Report-2012.pdf

summary, the detailed survey responses can be used by PSTG to identify a wide range of actual or potential users of polar/cryosphere datasets.

The Product Access Guide under development by WMO has the following objectives:

- To provide a simple, user-friendly guidance to online EO satellite product collections
- To enhance visibility and access to EO products (including polar/cryosphere)
- To respond to a demand identified by many WMO Members
- Products maintenance, QC and documentation resides with providers
- Not to duplicate online catalogues of providers
- Not to duplicate GEO Portal, GCMD, search engines
- In support of an Action from PSTG-1:
    - "PSTG Members to identify a list of datasets and routinely generated products for preparation of an inventory of satellite products for the cryosphere"

A revised Product Access Guide concept document and an online mock-up are available, to which PSTG Chair and Vice-Chair provided positive feedback. Step-by-step implementation in the course of 2013 is planned, and requires satellite provider support mainly in that unique, stable URLs are required to link to online product collections of satellite providers (e.g., a URL to JMA Snow Products). Coordination with the development of the GCW website "Cryosphere Now" is needed and ongoing.

S. Bojinski then explored the similarity between the WMO Rolling Review of Requirements (RRR) process which essentially matches community observation requirements with observing system capabilities on a regular basis, and the PSTG mechanism responding to user requirements for satellite data. Requirements in the "RRR database" are stated, by application area (e.g., global numerical weather prediction) in terms of geophysical variables and their technology-free sampling attributes (e.g., spatial and temporal resolution, maximum delay between observation and availability, uncertainty etc.). More background to the RRR is given here. Since the design of the database has its roots in numerical weather prediction, requirements stated therein sometimes lack contextual information since they are given for observations, not products or datasets. Nevertheless, it is important for WMO and global planning of the space-based Global Observing System (through CGMS and CEOS) to base its work on a well-defined, up-to-date RRR database.

ACTION 3.11: A. Bartsch, K. Luojus and P. Bauer to review the polar/cryosphere-related requirements specified in the WMO RRR database (http://www.wmo-sat.info/oscar/observingrequirements), and to provide feedback to the application area focal points and WMO. Deadline: 1 Dec 2013

10. GLOBAL CRYOSPHERE WATCH IMPLEMENTATION (J. KEY)

J. Key quoted Aristotle with "The whole is greater than the sum of its parts," explaining the value of coordination through GCW, and formal links to PSTG. Elements of integration and coordination ("forcing") were mentioned, such as measurement standards and best practices, setting of requirements, quality control and maturity assessments, observing system coordination, broad country participation, and increased funding opportunities. He informed on planned GCW Working Groups on Observing Systems (addressing CryoNet, requirements and capabilities, infrastructure and practices) and Products and Services (addressing products, website, and outreach).

As for measurement standards, the WMO Regulation 49 is being revised with input from snow and ice communities; observation requirements should be revisited and fed into the WMO RRR database (see item 9); scientific guidance on generation and distribution (through the GCW website) of "authoritative" products is needed. He recalled that PSTG members should assist in identifying datasets and products for an inventory of satellite products for the cryosphere (Action 1.2).

The GCW IP 1.0 is available, due for modification and shall be formally approved by WMO EC-66 in 2014 – there is an ongoing discussion related to funding and approval of GCW as a WMO Programme. Currently, locations and measurements for CryoNet are being identified, building on current multipurpose sites. He mentioned the GCW Website and suggestions for product attributes for use in a product inventory. The Website provides snapshots on recent developments in polar/cryospheric regions, whereas the met.no-maintained portal also links to past datasets.

10B. UPDATE ON SAON

S. Bojinski, on behalf of Miroslav Ondras and Etienne Charpentier (WMO), briefed participants on recent developments in the SAON initiative. SAON was established by the Arctic Council in 2012 to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environmental, social, economic and cultural issues.

The third meeting of the SAON Board was held in Vancouver in April 2013 in preparation for the Arctic Observing Summit in May 2013. Among other things, the Board reviewed the SAON strategy focusing on (1) Coordination, (2) Outreach, (3) Access to free open & high quality data, (4) Community Based Monitoring, and (5) Securing platforms and access to these. The Board agreed on the need for establishing an inventory of Arctic Observing System, and nominated an associated member from a WMO Commission for Basic Systems Expert Team (IPET OSDE).

PSTG should be recognized by SAON in the task (4) on the role of remote sensing in Arctic monitoring. Both Canada and WMO are represented in SAON to ensure this.

11. IMPLEMENTATION STRATEGY DISCUSSION

11.1 Status of relevant missions

M. Drinkwater pointed out that there is a need to communicate what is and will be available in terms of polar/cryosphere-related satellite missions. Based on an overall view on cryospheric missions, he showed the missions relevant to various sea ice parameters. Some discussion emerged whether the CEOS Missions, Instruments, and Measurements (MIM) database allows generation of informed mission timeline charts based on filtering of primary cryosphere-related missions. WMO informed on the OSCAR tool containing satellite mission information and allowing generation of timeline charts. PSTG could serve in a similar role as the CEOS Virtual Constellation to provide vetted polar/cryosphere-related mission charts.

ACTION 3.12: All PSTG members are invited to provide feedback to the mission overview charts and recommended content in PSTG-3/Doc.11-1-1. Deadline: 1 Dec 2013

11.2 Key strategic drivers

Policy and science drivers for PSTG activities should be firmly understood, given that different member agencies have different mandates. M. Drinkwater raised the issue of a strategic implementation plan for PSTG. Information sources for doing so are: cost-benefit analysis provided by EUMETSAT to justify EPS/Metop Second Generation [PSTG-3/Doc.11-04]; policy drivers documented in the contribution of space technologies in support of Arctic policy priorities [PSTG-3/Doc.11-05] and results of the Space and the Arctic 2012 conference which included EU policymakers [PSTG-3/Doc.11-06] (recently the EU, Japan, Korea were accepted as observers on the Arctic Council). Recently identified cryosphere science drivers are summarized in PSTG-3/Doc. 11-07. The recent publication of a U.S. Arctic Policy was noted.

M. Drinkwater summarized these sources based on PSTG-3/Doc.11-05, “The Contribution of Space Technologies to Arctic Policy Priorities”: policy areas are safety (marine transport [MDSS zones], search and rescue), environment (pollution, environmental protection, climate change),

sustainable economic development, sovereignty and security, indigenous people and social development. He showed a mapping of applications of data and application areas against societal benefit areas, exploring the impact of transport options opening up through the Northwest passage and the Northern sea route. Preconditions for any effective services in the Arctic are broadband communication and reliable navigation.

He briefly discussed socio-economic benefits of ice information and pointed out EO-related ice charting requirements as given in PSTG-3/Doc.11-03 (IICWG). He illustrated some of the sometimes competing service and science requirements for acquisitions (resulting in mode conflicts) using the example of S-1 [final section of PSTG-3/Doc.08-02-01] in the Arctic and in the Southern Ocean around Antarctica.

He showed assessed relevance of various sensor types for measuring sea ice, as provided in PSTG-3/Doc.11-02-01 (Howell, Derksen, and Haas).

Y. Crevier was in favour of identifying policy drivers in a PSTG implementation strategy document without being too specific since these drivers may change. While the framework provides direction and visibility, however, a key measure of success for PSTG are concrete outcomes; key scientific questions should be posed that could be answered (through output) within a finite timeframe. User communities PSTG interacts with should be identified in a generic sense.

ACTION 3.13: Draft a strategic implementation plan, with Lead by PSTG Chair and Vice-Chair. Deadline: 1 Jan 2014

ACTION 3.14: Y. Crevier to develop a proposal toward how to address sea ice observing requirements focussing on scientific service drivers, and pure scientific drivers. Deadline: 1 Dec 2013

11.3 Consistency of current plans with PSTG Terms of Reference

The Group went through the PSTG Terms of Reference, was invited to provide comments on current and planned activities in response to the Terms. This could provide first input to the strategic implementation plan discussed in item 11.2.

12. AGENCY REPORTS

12.1 CMA

On behalf of P. Zhang, M. Drinkwater provided an overview of CMA contributions to polar/cryospheric satellite observations, with the list of past and currently operating polar and geostationary satellites. CMA GEO satellites are relevant for possible monitoring of the “Third Pole”. The MERSI imager and the MWRI were highlighted as being particularly valuable for mapping polar/cryospheric regions (Greenland shown as an example). Snow cover and snow depth are being monitored over the Tibetan Plateau with these capabilities. The broad value of the FY series was recognized, and many of these datasets are now operationally used (e.g., by ECMWF) and available. Strong participation by CMA in PSTG is encouraged.

12.2 INPE

Ronald de Buss Souza introduced the Brazilian Antarctic Programme 2013-2022 and noted that Brazil has been active in Antarctica for 30 years. Five main fields of investigation are proposed that comprehensive cover ice processes and ice-ocean-atmosphere interactions, to foster leadership of Brazil in the Southern Hemisphere. A new research base in the Antarctic is going to be built.

Scientific objectives comprise better understanding of oceanic and atmospheric variability modes of the coupled system, and to understand the influence of ocean-atmosphere interaction on synoptic scales. He explained the areas of high scientific interest in the SH oceans addressed by oceanographic research in Brazil, for example the Brazil-Malvinas confluence region where large differences in water temperature modulating the atmospheric boundary layer. He elaborated on deployment of novel observing instruments on research vessels and SH islands, for example for validating ocean colour and SST measurements.

He showed some capabilities of the CBERS sensor, with new satellite from CBERS-3 covering most of South America; a ground receiving station is required in the south of Argentina or of Chile.

ACTION 3.15: R. de Buss Souza to contact DLR (through D. Floricioiu) to explore possibility of using the Bernardo O'Higgins Chilean base (where DLR maintains a receiving station) to use for CBERS-3. Deadline: 1 Oct 2013

ACTION 3.16: Chair to formulate a letter to D/INPE (Perondi) with CC R. de Buss Souza to encourage consideration of INPE the extension of CBERS data acquisition capability over Southern Andes and Patagonian and Terra del Fuego icefields, and potentially Antarctic peninsula Deadline: 1 Nov 2013

Further observations are needed, for example instruments on moored buoys, to support scientific studies in the regions of interest for Brazil.

12.3 CSA

Y. Crevier described the achievements of RADARSAT-1. He elaborated on the details of the anomaly on the system that led to its end of lifetime, and on results of an investigation addressing the event. Most of the archived data will be processed and made openly available to the scientific community. The loss of RADARSAT-1 occurred during the 2013 PSTG monitoring campaign of Greenland and Svalbard.

A presentation on the RADARSAT Continuity Mission constellation is available, for reference; this programme is approved, and planned launch date is July 2018. Six minutes per satellite per orbit are reserved for Canadian government purposes (hence 18 minutes per orbit), hence there are large free capacities for PSTG-related acquisitions.

ACTION 3.17: PSTG Chair to send a letter of appreciation to CSA on R-1 accomplishments and contributions. Deadline: 1 Nov 2013

12.4 EUMETSAT

K. Holmlund briefed the Group on EUMETSAT programme development, with Metop-B being fully online now. Metop-A and –B tandem operations allow for improved sampling for example by the GOME-2 instrument, with operations using broader swath width. Problems with the HIRS instrument are compensated for with IASI-simulated HIRS data. Timeliness of data delivery has improved in Polar Regions (to roughly 49 minutes) through the Antarctic Data Acquisition (ADA) system, with benefits for NWP. He showed the planned mission schedule of the Metop series. The Hydrology SAF generates a soil moisture product of interest to ECMWF, and a snow product. Sea ice products are derived from SSM/I and SSM/iS by the OSI SAF. Other H-SAF products such as on precipitation are only regional.

C. Dobson (NASA) confirmed that NASA has the task to develop the concept for observations to be covered by JPSS within the Presidential FY2014 budget. J. Key (NOAA) expected that products from JPSS should be available that are superior to NPP products.

12.5 NSC

E. Herland introduced the Svalbard Integrated Arctic Earth Observing System (SIOS), which is part of the European Strategy Forum on Research Infrastructures, aimed to establish a research capability in the Arctic and with funding from the European Commission. It should serve in the future as a node for the SAON. Svalbard is focus for testing the concept since large changes in the region are expected with climate change, and coupling processes can be studied, building on a large heritage and a substantial research infrastructure (Longyearbyen university, research sites, broadband undersea cables, airport, research vessels, marine observation platform). SIOS is intended to provide "glue funds" for establishing institutional relationships, maintaining infrastructure ("SIOS Knowledge Centre"), and enable scientific activities by the international community present on Svalbard. A report on priorities research applications using EO has been prepared (to be made available on http://sios-svalbard.org).

Y. Crevier informed on the resources going into the CHARS (Canadian High Arctic Research Station) site, and potential collaboration with SIOS should be explored.

13. CEOS SIT-28 DEBRIEF

S. Hosford recalled the dialogue between PSTG and CEOS over the past three years, and results of the discussions held at the 28th meeting of the CEOS Strategic Implementation Team (SIT). The value of a constructive dialogue among agencies on polar/cryosphere matters was recognized. Agency leadership has recognized the effectiveness the PSTG serving the purpose, and that this should continue in the existing framework ("if it's not broken, do not fix it"). The Secretariat agreed to inform the CEOS Executive Officer on PSTG matters by copying her on the distribution of PSTG and related reports.

14. STATUS OF INVITATIONS TO NEW MEMBERS

An update to the list of Members and invitees was provided.

15. SUMMARY OF PSTG ACTIONS

Participants agreed to finalize PSTG Actions by email after the meeting.

16. PLAN FOR NEXT MEETING

The Chair proposed to hold the next session of PSTG in the spring timeframe of 2014. C. Dobson (NASA) offered hosting PSTG-4 in Washington D.C., USA, possibly in May 2014. R. de Buss Souza proposed hosting PSTG at INPE premises in Brazil. WMO is always a fall-back option.

DLR tentatively agreed to host the next meeting of the PSTG SAR-CWG in October 2013.

Any other business:
Regarding Vice-Chairmanship of PSTG, the current Vice-Chair J. Key noted that he wished to direct his primary effort to implementing GCW. He plans to remain on PSTG and EC-PORS, and to be the link to GCW, but encourages that a different individual would volunteer for the position of Vice-Chair.

17. ADJOURN MEETING

The meeting was adjourned at 16:30 on 23 May.

APPENDIX I

LIST OF PARTICIPANTS

Members of PSTG

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APPENDIX II

PROVISIONAL AGENDA AND WORK SCHEDULE

WEDNESDAY, 22 MAY 2013

8:30 ***Registration***

9:00 **1. Opening and Welcoming Remarks**
Pascale Ultré-Guérard (CNES)
Mark Drinkwater (Chair)
Steven Hosford (local host logistics, etc)

9:15 **2. Introductions (All Participants)**

9:30 **3. Approval of Agenda (M. Drinkwater)**

9:40 **4. Action Items from PSTG-2 (Secretariat)**

10:00 **5. CNES Priorities in Polar and Cryosphere Research (P. Ultré-Guérard)**

10:30 *Coffee Break*

10:45 **6. EC-PORS-4 Update (M. Drinkwater)** [doc. 06-02]

11:00 **7. Polar/Cryosphere Satellite Observation Requirements**
7.1 SWE and snow cover (K. Luojus)
7.2 Permafrost (A. Bartsch) [doc. 07-02-02]

12:15 *Lunch Break*

13:30 **8. Coordinating a Response to Science Requirements**
8.1 SAR Coordination WG Status Update (Y. Crevier)
8.2 Ice Sheet Monitoring – Acquisition Plans & Status (B. Scheuchl) [doc. 08-02-02]
8.3 Permafrost Acquisition Plans & Status (A. Roth)
8.4 Other existing acquisition plans (e.g., ESA Sentinel Operations Plan) (P. Potin) [doc. 08-04-02]

16:30 **9. WMO Global Survey on Use of Satellite Products; Product Access Guide; Rolling Review of Requirements (Secretariat)**

17:00 **10. Global Cryosphere Watch (J. Key)**
Satellite products, data product intercomparisons, GCW portal [doc. 10-02]

17:25 **10b. Update on SAON (Sustained Arctic Observing Networks) (Secretariat)**

17:30 ***Adjourn Day 1***

THURSDAY, 23 MAY 2013

9:00 **7. Polar/Cryosphere Satellite Observation Requirements (cont'd)**
7.3 Atmosphere - Year of Polar Prediction (P. Bauer) [doc. 07-03-02]
7.4 Requirements development under the GEO Cold Regions initiative (Y. Qiu)

9:45 11. Implementation Strategy Discussion [doc. 11-02, 11-03, 11-04, 11-05, 11-06, 11-07]

11.1 Status of relevant missions (M. Drinkwater)

10:30 Coffee Break

10:45

11.2 Key strategic drivers (M. Drinkwater; All)

i. Socio-economic benefits, e.g., transportation in the Arctic

ii. Example: Coordinating a response to sea ice requirements (including IICWG) [doc. 11-02-01]

11.3 Consistency of current plans with PSTG ToR (M. Drinkwater; Secretariat) [doc. 11-03-02]

11:45 12. Agency-Specific Reports (10 min each)

12.1 CMA (M. Drinkwater, on behalf of P. Zhang)

12.2 INPE (R. Buss de Souza)

12.3 CSA – Radarsat-1 and Radarsat Constellation Mission (Y. Crevier)

12:15 Lunch Break

14:00

12.4 EUMETSAT – Status of Metop-B and cryosphere products (K. Holmlund)

12.5 NSC – Development of Svalbard Integrated Observing System (E. Herland) [doc. 12-05-02]

14:20 13. CEOS SIT-28 debrief (Y. Crevier & S. Hosford)

14:45 14. Status of invitations to new Members

15:00 15. Summary of PSTG-3 Actions

16:00 *Adjourn Session*

Reference documents

Meeting URL: http://www.wmo.int/pages/prog/sat/meetings/PSTG-3.php

Item	Doc.	Title
6	06-02	EC-PORS-4 Final Report
7.2	07-02-02	ESA DUE URD: User Requirements for Permafrost Monitoring
7.3	07-03-02	WWRP Polar Prediction Project Implementation Plan
8.4	08-04-02	ESA Sentinel High Level Operations Plan
10	10-02	Global Cryosphere Watch Implementation Plan v1.0
11	11-02	Meredith et al. (2012): *The vision for a Southern Ocean Observing System.* Current opinion in Environmental Sustainability 5, 1-8
11	11-03	International Ice Charting Working Group (IICWG) Requirements
11	11-04	The Case for EPS/Metop Second Generation: Cost Benefit Analysis
11	11-05	The Contribution of Space Technologies to Arctic Policy Priorities
11	11-06	Space and the Arctic 2012 Conference
11	11-07	Fernandez et al. (2012): Earth Observation and Cryosphere Science: The Way Forward
12.5	12-05-02	The Svalbard Integrated Earth Observing System: A regional initiative to build observing capacity for an Arctic Observing System

APPENDIX III

ACTION ITEMS FOR PSTG

I. Actions from PSTG-3	
ACTION 3.1: M. Drinkwater and Secretariat to distribute generic PSTG overview slides to all participants and Members of PSTG. Deadline: 1 Oct 2013	**OPEN**
ACTION 3.2: S. Hosford to provide information on ISIS to PSTG and participants. Deadline: 1 Oct 2013	**OPEN**
ACTION 3.3: PSTG Members to provide input, comments and suggest actions addressing the ToR of the Group as given by PSTG-3/Doc.11-03-02, including concrete steps to "develop a short-, mid-, and long-term implementation strategy". Deadline: 1 Nov 2013 Deadline: 1 Nov 2013	**OPEN**
ACTION 3.4: K. Luojus to initiate a discussion within the snow remote sensing community addressing the need for a consensus user requirement document on terrestrial snow cover, and for the community PoC to report on results to PSTG. Deadline: PSTG-4	**OPEN**
ACTION 3.5: PSTG Members to read Permafrost User Requirements document (*http://www.wmo.int/pages/prog/sat/meetings/documents/PSTG-3_Doc_07-02-02_ESA-DUE2009.pdf*), and provide first response at next meeting of PSTG. Deadline: PSTG-4	**OPEN**
ACTION 3.6: Engage USGS and other agencies with strong optical high-resolution imagery acquisition capability in a coordinated response by PSTG to permafrost requirements. Deadline: PSTG-4	**OPEN**
ACTION 3.7: Chair to participate in the ECMWF-THORPEX workshop on polar prediction to further iterate the dialogue with this community. Deadline: 15 June 2013	**OPEN**
ACTION 3.8: PSTG Members to provide examples on the use of remote sensing products in data assimilation for improved polar prediction. Deadline: PSTG-4	**OPEN**
ACTION 3.9: Global permafrost community to validate the list of current focus sites ("cold spots"), and send feedback to Y. Crevier. Deadline: 1 Nov 2013	**OPEN**
ACTION 3.10: A. Roth to provide current TerraSAR-X permafrost acquisition sites in .kmz format to Chair of SAR Coordination Working Group (Y. Crevier), for distribution to the community. Deadline: 1 Nov 2013	**OPEN**
ACTION 3.11: A. Bartsch, K. Luojus and P. Bauer to review the polar/cryosphere-	**OPEN**

related requirements specified in the WMO RRR database (http://www.wmo-sat.info/oscar/observingrequirements), and to provide feedback to the application area focal points and WMO. Deadline: 1 Dec 2013	
ACTION 3.12: All PSTG members are invited to provide feedback to the mission overview charts and recommended content in PSTG-3/Doc.11-1-1. Deadline: 1 Dec 2013	**OPEN**
ACTION 3.13: Draft a strategic implementation plan, with Lead by PSTG Chair and Vice-Chair. Deadline: 1 Jan 2014	**OPEN**
ACTION 3.14: Y. Crevier to develop a proposal toward how to address sea ice observing requirements focussing on scientific service drivers, and pure scientific drivers. Deadline: 1 Dec 2013	**OPEN**
ACTION 3.15: R. de Buss Souza to contact DLR (through D. Floricioiu) to explore possibility of using the Bernardo O'Higgins Chilean base (where DLR maintains a receiving station) to use for CBERS-3. Deadline: 1 Oct 2013	**OPEN**
ACTION 3.16: Chair to formulate a letter to D/INPE (Perondi) with CC R. de Buss Souza to encourage consideration of INPE the extension of CBERS data acquisition capability over Southern Andes and Patagonian and Terra del Fuego icefields, and potentially Antarctic peninsula. Deadline: 1 Nov 2013	**OPEN**
ACTION 3.17: PSTG Chair to send a letter of appreciation to CSA on R-1 accomplishments and contribution. Deadline: 1 Nov 2013	**OPEN**
II. Actions from PSTG-2, and Status	
Action 2.4: PSTG to nominate focal point for the Year of Polar Prediction (YOPP).	**DONE;** K. Holmlund tentatively accepted to be focal point; discussion with P. Bauer needed
Action 2.9: PSTG members and WCRP to provide community points of contact (PoCs) to review and endorse SAR-related acquisition plans in their respective national science communities.	**OPEN;** community PoCs are: Chris Derksen (snow), Birgit Heim and Hugues Lantuit (permafrost), and John Falkingham (sea ice); Vladimir Ryabinin (WCRP Joint Planning Staff) serves as point of contact and liaison to CliC community
III. Actions from PSTG-1, and Status	

Action 1.2: PSTG Members to identify a list of datasets and routinely generated products for preparation of an inventory of satellite products for the cryosphere.	**DONE; ONGOING**; Dataset and product template to be circulated to PSTG by Secretariat, in conjunction with further development of Product Access Guide. Chair provided comments on updated concept for online Product Access Guide in Mar/Apr 2013. GCW website www.globalcryospherewatch.org launched
Action 1.4: PSTG Members to review the cryosphere application area in the WMO online Database of Observing Requirements (http://www.wmo-sat.info/oscar/observingrequirements), particularly in regard to the threshold, breakthrough and goal values	**OPEN**; participants are encouraged to review requirements stated in the RRR database by application area (http://www.wmo-sat.info/oscar/applicationareas); Secretariat has not yet created a cryosphere-related theme in the online database of user requirements due to website restructuring (allowing multiple "tags" per variable); check http://www.wmo-sat.info/oscar/observingrequirements for preferred representation of cryosphere-related requirements.