

WORLD METEOROLOGICAL ORGANIZATION

**POLAR SPACE TASK GROUP
(PSTG)**

SECOND SESSION

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FINAL REPORT



WMO General Regulations

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 on 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)

M. Drinkwater as Chair welcomed the attendees to the Second Meeting of the Polar Space Task Group (PSTG). Apologies had been received from P. Zhang (CMA), and S. Hosford (CNES). Meanwhile, R. de Buss Sousa (INPE) was understood to be en-route and arriving late.

2. INTRODUCTIONS (ALL PARTICIPANTS)

The invited meeting participants introduced themselves to the Members of PSTG (see attendance list in Appendix I).

3. APPROVAL OF AGENDA (M. DRINKWATER)

The provisional agenda and work schedule (Appendix II) was approved with minor changes – with WCRP Agenda item 11 to be taken if possible at the end of day 1. The work schedule was adopted for the meeting. 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.

4. ACTION ITEMS FROM PSTG-1 (B. RYAN)

The Action items list from the last meeting was discussed, with the following status update;

- **Action 1.1:** Edward Sarukhanian, as part of the WMO Secretariat, to investigate hosting the IPY-STG materials - **CLOSED**

All reports and documentation collected by Ed Sarukhanian have been posted online on the WMO website, with unique identifiers, at http://www.wmo.int/pages/prog/sat/pstg_en.php.

- **Action 1.2:** PSTG Members to identify a list of data sets and routinely generated products for preparation of an inventory of satellite products for the cryosphere – **OPEN**, with intent for Agencies to report specifically, and address at PSTG-2 under Global Cryosphere Watch (GCW) Agenda item. The table will be circulated for inputs from each Agency.
- **Action 1.3:** PSTG Members to review the IGOS-P Cryosphere Theme Report for an inventory of needs and observational requirements - **CLOSED**

The Report was provided to PSTG with link to document. WCRP CliC drove the preparation of the document. The GCW Observing System sub-group is most likely to be the community of practice driving the update of the document.

- **Action 1.4:** PSTG Members to review the cryosphere application area in the WMO Database of Observation Requirements (<http://www.wmo-sat.info/oscar/observingrequirements>), particularly in regard to the threshold, breakthrough and goal values – **OPEN and ONGOING**

The Rolling Review of Requirements (RRR) of WMO is an ongoing action. The RRR weblink was circulated to members. PSTG should use the link to consider to what extent the Group can fulfil the requirement. WMO just launched a survey about how satellite data are being used (both Operational satellites and R&D satellites). The Secretariat will create a cryosphere-related theme in the online Database.

- **Action 1.5:** WMO Secretariat to invite a SCAR/IASC representative to the next PSTG meeting – **CLOSED** (Invited to this meeting)

- **Action 1.6:** PSTG Chair to distribute a list of the Potential Areas of Focus for development of a Strategic Implementation Plan – **CLOSED**
Report of PSTG-1 distributed and online at http://www.wmo.int/pages/prog/sat/pstg_en.php
- **Action 1.7:** WMO Secretariat to contact Argentina, China, India, Korea and the Russian Federation regarding their interest/participation in PSTG – **OPEN**
CONAE contacted but unable to come. Secretariat need to follow-up with/confirm:
 - ISRO – formal invitation sent
 - KMA – did not nominate a representative (no response)
 - PLANETA – Vasily Asmus (Concern expressed about the status of Arktika)
 - USGS – recovery actions required (new nomination)
 - NASA – Craig Dobson

A summary of remaining Action items is to be found in Appendix III.

5. OUTCOMES FROM IPY MONTREAL CONFERENCE

[Background information](#) on this item has been prepared and distributed by M. Drinkwater. To this, Y. Crevier added that he had made a presentation on behalf of PSTG at the IPY Conference. J. Key presented GCW at the meeting.

The Conference had a very good turn-out (>2000 participants), especially in view of its overlap with the EGU meeting in Vienna. It consisted of a mix of scientific sessions and societal events. Scientists viewed the Conference as a science meeting, with sometimes not sufficient attention, beyond case studies, devoted to the continental and global implications of the issues confronting the Polar Regions.

One key message from the Action Forum on Space Infrastructure came from Steve MacLean (President CSA): “If we are interrupting continuous observations of Polar Regions, we are creating a gap in world history”.

V. Ryabinin noted the “Momentum series” Action Forum comprising four discussion fora: requirements of science (with 20 yrs perspective); data; prediction systems for Polar Regions; and how to wrap everything together.

6. EC-PORS UPDATE (M. ONDRAS)

M. Ondras presented an update from EC-PORS-3 meeting ([presentation](#) and [meeting report](#)). The expanded mandate of the Panel includes the “Third Pole” (Himalaya, Tibetan Plateau) including the Karakoram-Pamir mountain regions. He noted the three sub-groups within EC-PORS on observations, research, and services. PSTG provides reports within the observations sub-group and receives feedback from all groups. There is a strong link to the WMO priority areas WIGOS, WMO Information system (interoperability), and Global Framework for Climate Services.

The EC-PORS polar agenda is to establish the Antarctic Observing Network (AntON), GCW and a Global Integrated Polar Prediction System (GIPPS), along with enhancement of weather and climate services. An initial governance structure for GCW has been provided by EC-PORS. PSTG should aim at responding to space-related requirements of all these initiatives. Further, strategic priorities for PSTG should consider

- new products and datasets;
- sustaining critical datasets for operational services;
- climate services;
- addressing Third Pole issues.

A number of other discussion items were covered at EC-PORS. An interface is being established with Sustained Arctic Observing Networks (SAON), and Antarctic Treaty Consultative Meetings (ATCM) to enable them to understand what is required by PSTG in terms of consolidated requirements for space observing system.

A presentation on SAON should be arranged at the next session of PSTG.

7. POLAR/CRYOSPHERE SATELLITE OBSERVATION REQUIREMENTS

a) SCAR/IASC: ISMASS, SOOS, SAON Needs

The time conflict with ATCM dates in Australia had meant that the invited SCAR representatives C. Kennicut and M. Sparrow (SCAR Secretariat) were unable attend the PSTG-2 meeting. Instead the [SOOS Implementation Plan](#) was distributed to the meeting participants as a source of observation requirements.

b) Ice Sheet Monitoring Needs (B. SCHEUCHL - IMBIE)

The [presentation](#) by B. Scheuchl identified the motivation and background of ice sheet monitoring for ice sheet dynamics, mass balance and relation to sea-level change. He identified necessary steps and related challenges in engaging the Space Agencies in addressing and responding to SAR data requirements for ice sheet studies.

It was noted that perhaps some of the requirements can be fulfilled by optical missions. However, the judgement in the scientific community is that speckle tracking in all-weather SAR images outperforms optical satellites. This is an issue that will require further investigation via intercomparisons of IPY datasets. High-resolution optical sensors may be able to address some of the issues, albeit with limitations due to weather disturbances and the need for solar illumination.

c) Glacier Monitoring and Future Needs (F. PAUL - WGMS)

Frank Paul [presented](#) current work on EO-based glacier monitoring and outlined the required datasets and processing steps to achieve effective monitoring. Requirements for new data come from the fact that most of the original data sources are no longer available. One of the primary data sources was Landsat TM.

International glacier monitoring and basic observations of glaciers was initiated in 1894. Today there is a combination of activities under GTN-G. Important components today are GLIMS, WGMS and NSIDC. The overarching goal to integrate ground data with remote sensing and modelling is to achieve global coverage. Globally around 600-700 glaciers are monitored using remote sensing data. Glacier inventories are established using remote sensing data.

The one-stop portal is www.gtn-g.org, with links to the following Earth Observation (EO)-based products for glacier monitoring:

- Area
- Elevation Change (requires DEMs as basis for mass change)
- Snow-covered area
- Velocity fields (InSAR dismissed for small glaciers – and only feature tracking or speckle tracking retained).

It was noted that there are consolidated requirements documents developed as part of the ESA Climate Change Initiative (CCI) Glacier project. The User Requirements Document, Data Access Requirements document, and the Product Specifications document are all online at the ESA CCI website for each ECV (including ice sheets, glaciers, and sea ice), at: <http://www.esa-cci.org/>.

E. Sarukhanian thanked the group for all the presentations of the day, and for the direct interactions that were being stimulated with the science community.

8. ENVISAT LOSS - IMPLICATIONS FOR POLAR ATMOSPHERIC COMPOSITION (M. GOTTWALD)

A [presentation](#) was provided by M. Gottwald, with H. Laur (ESA) joining remotely by teleconference. It was noted that an Envisat failure board report will be issued in July 2012.

The end of mission was declared on 9 May 2012, although efforts continue to try to recover the satellite. There is only an estimated 2% probability for re-establishing contact with the satellite. Commands will be sent once a day until end of year, to maintain efforts. Mission-related activities are being phased out, though data processing and dissemination continue. The 10 year dataset is a very important resource.

Current efforts focus on filling the data gap until the GMES Sentinels become available. There are a number of potential third-party missions that could help to mitigate the data gap caused by the loss of Envisat instrument data. It is planned to process the data and place the archive in an easily accessible location for the polar community.

For ocean altimetry, Jason-1 is no longer providing nominal flow, and thus, given the loss of Envisat RA-2, ocean satellite altimetry coverage is presently in difficulties. CryoSat is helping to mitigate the situation. Altika could also help, along with HY-2A. To mitigate the gap in SAR coverage, RISAT-1/-2 and Korean KompSat-5 SAR would be of high priority. For ocean colour coverage, data from the FY-3A MERIS (Medium Resolution Spectral Imager) are received by EUMETSAT.

The group noted that despite the loss, Envisat was a big success.

H. Laur emphasized Envisat's success including in terms of data provision to users. Serious efforts had gone into making the data available, and they continue.

Envisat was a significant contribution through the ASAR, SCIAMACHY, MERIS and MIPAS instruments. There has been operational flow of ASAR data in support of the GMES sea ice monitoring service. During IPY, coverage of large ice sheets was achieved. From 2014 onwards, Sentinel-1 shall resume data provision for these user communities, including coverage of ice sheets.

Until then, an alternative to ensure ice sheet coverage is required, and PSTG should take this on board, for example by using the data from ASI, DLR, and CSA. H. Laur proposed to reinvigorate the SAR Coordination Working Group to find methods for mitigating the current challenges related to large area SAR image data acquisition and access.

9. AGENCY PERSPECTIVES ON STRATEGIC PRIORITIES (AGENCY MEMBERS)

The Chair asked Member Agencies to focus in their respective presentations on the strategic focus areas for PSTG, and the status of the respective missions.

9.1 ASI – F. Battazza

F. Battazza presented a status report on ASI EO missions – microwave (Cosmo-Skymed) and UV/VIS missions (PRISMA – scheduled for launch in 2014). The first two Cosmo-Skymed satellites were launched in 2007, and the current constellation is composed of four satellites. Nominal satellite lifetime is 5 years with goal for 7 years (i.e. 5+2 years). Cosmo-Skymed has a repeat cycle of 16 days, with 1, 4, and 8 days revisits possible using capabilities of the total constellation. Total cost of four satellites is estimated at 1.4 BEuro.

ROSA (Radio Occultation for Sounding of the Atmosphere) is embarked on OceanSat-2 and Aquarius SAC-D. A third will be launched on the Megha-Tropiques ISRO/CNES mission.

PRISMA – only Hyperion has been launched on a free-flyer with similar hyperspectral imaging capability. The mission will be pre-operational with a demonstration intention. Characteristics are 10nm spectral resolution between 400-2500nm spectral range, a panchromatic band from 400-700nm, 5m ground sampling distance (and 30km swath). PRISMA is currently at Critical Design Review stage at end of Phase C.

Cosmo Skymed (CSK) Second Generation is conceived as a follow-on to Cosmo-Skymed 1st generation, and comprised of two satellites. First launch is scheduled in 2015.

F. Battazza reported on science and research activities for Polar Regions conducted in 2010-2012 using the CSK-AO. He showed examples of snow detection from X-band satellites, sea ice in the Baltic Sea, and outlet glaciers. Examples of rapid changes in glacier outflow require the rapid revisit offered by CSK.

He also showed spectacular examples of a Petermann glacier ice calving event as well as North Pole monitoring using huge region mode (beam 5 – 100m res. with 200km swath) at around 53-39° incidence angle. The CSK data will be used to monitor this routinely.

He also pointed out that ASI activities in Polar Regions are ongoing, and that future calls for tender will invite investigations using CSK data. The use of multisensor data is considered very valuable. Y. Crevier questioned whether the calls would be thematic – F. Battazza responded that there is some scope for defining the areas covered by the calls.

9.2 CSA – Y. Crevier

RADARSAT is a hybrid mission. RADARSAT-1 (R-1) is still functioning, but only via direct downlink. Canadian government can use and distribute data to community. RADARSAT-2 (R-2) is owned and operated by the private sector, and there is a government data allocation which is the primary way to respond with these data. Uniquely RADARSAT-2 is the only C-band mission capable to observe the South Pole.

The future Radarsat Constellation Mission (RCM) has an anticipated launch of unit A in 2016, with B/C units on dual launch in 2017. Full commissioning of the constellation is planned in 2018. The intent is to have an open data policy, though a decision to be taken in a Remote Sensing Systems data Act (RSSSA). Phase C is to be completed by the end of the year 2012. Pressure should be applied on the Canadian government to make best use of the RCM mission, and negotiations are ongoing with the goal to make data widely useable which are viewed to be of commercial value. There is a focus on the Northern Hemisphere for operational and commercial applications. RCM is likely to have standard coverage planning for different communities of users. PSTG could help influence how this standard acquisitions/operations plan is configured to meet needs.

For the Polar Communications and Weather (PCW) satellite (2 satellite constellation in HEO), Phase A has been completed. Financial support is yet to be established for subsequent phases.

Y. Crevier proposed ways to coordinate/tie existing Canadian activities to PSTG interests.

9.3 DLR – M. Gottwald

M. Gottwald provided an update on DLR interests in past, present and future missions. He noted that EnMAP slipped to a planned launch date in 2015. He further noted that the interest for Sciamachy data does not go away, both in terms of reprocessing of the data and providing a long-term dataset. ESA continues to support this reprocessing effort.

The meeting recognized the critical contribution of GOME, Sciamachy, and GOME-2 to polar ozone monitoring. M. Drinkwater noted the ESA CCI effort to ensure the long term perspective on combination of GOME, Sciamachy and GOME-2 data for monitoring the ozone hole and polar ozone in general.

9.4 DLR - D. Floricioiu

D. Floricioiu complemented M. Gottwald's presentation with SAR aspects.

TerraSAR-X has in particular been acquiring data to cover the Antarctic peninsula and Pine Island/Thwaites outlet glaciers. The PI Angelika Humbert is acquiring and processing data in these locations via an Announcement of Opportunity (AO) project. Using TerraSAR-X, she noted that 22 Greenland outlet glaciers were also covered by special monitoring plan – covered by the AO project of I. Joughin.

It was reminded that there are periodically Open TerraSAR AOs for thematic areas – with the current AO involving the use of archival material (open 1 June – 31 Dec 2012; <http://sss.terasarsar-x.dlr.de>).

TanDEM-X acquisitions completed a global mapping phase, although the whole Antarctic is not yet covered. It is planned to cover Antarctica, but a robust plan is needed to develop the DEM, as well as to provide data for ice sheet mapping. There are different DEM products which renders modes and operations difficult. Not all DEM acquisitions are good due to low coherence. Thus, additional acquisitions are planned with a reduced baseline to achieve better coherence.

Results were shown from high-resolution velocity fields from glaciers through Trans-Antarctic mountains, along with grounding line indication from DInSAR. Other differencing of DInSAR-generated DEMs shows great promise for locations with significant mass balance changes.

DLR responded to the GMES Sentinel Collaborative Ground Segment questionnaire. DLR would propose to contribute value-added high-level geophysical products for the coastal areas of Greenland and Antarctica. This would exploit TOPSAR or wide-swath mode. For outlet glaciers, stripmap mode needs to be used. Sentinel-1 coverage is limited to 78 deg S with no left looking mode.

A 5-year preparatory project has started within the German Helmholtz Association for TanDEM-L, including a cryosphere team.

9.5 ESA – M. Drinkwater

Notable points raised by M. Drinkwater are that CryoSat-2 products are available in reprocessed form by Sept 2012 back to the start of mission. New SMOS products provide some insight in relation to growth cycle in thin ice, and thermodynamic growth in seasonal sea ice regions. A summary of cryosphere-relevant global product time series was provided (global snow cover, GlobSnow, GlobIce, GlobGlacier, CCI). Elements of prototype polar services were also presented.

M. Drinkwater pointed out the forthcoming ESA-CliC-EGU Cryosphere Conference (www.eo4cryosphere.info) on 13-16 November 2012 at ESA-ESRIN, in Frascati, Italy. This meeting would provide an opportunity to assess the state of the art after the paper deadline for IPCC AR5 reporting, and a chance to collect requirements for acquisition plans for the polar regions and the cryosphere in general.

9.6 EUMETSAT – K. Holmlund

K. Holmlund presented the status of current and planned EUMETSAT satellites. MetOp-A is now beyond its five-year nominal design lifetime, and degradation of GOME-2 and MHS instruments has been noted. The orbit of MetOp-A unit could be changed to extend its lifetime until the C unit

is launched in 2016. This would provide back-up to MetOp-B when launched. The launch of MetOp-B has been delayed until launch drop zone agreement negotiated [it was launched successfully on 17 September 2012].

Key decisions for the programme are taking place in the EUMETSAT Council and at the ESA Ministerial Council (for equivalent MetOp-Second Generation programme) in November 2012.

The next generation of Meteosat geostationary satellites (Meteosat Third Generation - MTG) is also in preparation with two platforms comprising an imaging and sounding platform, respectively. The meeting noted that the Sentinel-4 instrument would be on MTG with UVN providing continuity in products from GOME, Sciamachy, OMI etc. (albeit from geostationary orbit).

K. Holmlund noted that EUMETSAT is establishing third-party agreements for operational data delivery. For NASA this includes OCO-2, Aquarius/SAC-D, SMAP and GPM. For ESA this includes SMOS, ADM/Aeolus, EarthCARE, and Sentinel-5 precursor. Priority is assigned for redistribution of some of these 3rd party data, such that EUMETSAT is able (through formal agreements) to redistribute certain products.

With respect to NPP, EUMETSAT has a baseline service for European operational users. Until now, only ATMS and CrIS are available globally, and the VIIRS data were only available regionally. Discussions are ongoing regarding mitigating the loss of Envisat data streams. European users have made a strong case for access to VIIRS and other similar such replacement data.

9.7 NOAA (NESDIS) – J. Key

J.Key presented the status of NOAA/NESDIS products and plans for Polar Regions, including relevant missions. This complements the Ice Services perspective previously presented by P. Clemente-Colon.

GOES-R provides information all the way to the pole, though products are somewhat limited in geographic range due to viewing geometry. Important products include snow cover and ice concentration over great lakes (with advantage over SSM/I for spatial resolution).

NPP provides inter alia snow cover, ice characterization (ice age/concentration), ice surface temperature. Algorithms were developed by Northrop Grumman, though now need to be updated or replaced.

VIIRS provides ice cover in the Arctic. There are some issues limiting the use of the products: ice surface temperature looks pretty good, although with a cold bias compared to MODIS (mean difference is about 2K). Ice concentration is an intermediate product en route to ice characterization, which is an interesting product containing new/young ice, all other ice, and ice free zones. An energy budget approach is used which seems to work in a variable manner depending on the diurnal cycle.

Snow cover extent products seem to indicate that the VIIRS misses some snow that MODIS sees, whilst also putting snow in locations where there should be none. New product developments at NESDIS include sea-ice lead orientation and size distribution.

The main atmospheric product at NESDIS specific to Polar Regions is the polar wind product, derived from Aqua and Terra MODIS data combined with AVHRR polar winds. AVHRR on Metop provides 1km global coverage. The LEO+geostationary data are combined for deriving polar winds products. VIIRS polar winds should be operational in early 2013.

VIIRS is also equipped with a night-time visible band which allows imaging of aurora at times with no moonlight.

He also mentioned the snow and ice product suite for the GCOM-W1 AMSR-2 (launched 18 May 2012).

10. GLOBAL CRYOSPHERE WATCH IMPLEMENTATION (J. KEY / B. GOODISON)

J. Key [reported](#) on implementation of the Global Cryosphere Watch (GCW) which was approved in May 2011 by the World Meteorological Congress. A meeting was held in November 2011 to define the organization, with participants from 17 countries and 18 agency institutions and international bodies. Points of contact were defined for GCW in each country.

J. Key highlighted what is unique about the GCW initiative by comparison to NSIDC and GCOS in terms of observations, requirements, assessments, data management and distribution, setting of standards and best practices. GCW is a legacy of IPY, a component of WIGOS and a contribution to the GEOSS.

One of the challenges for GCW is putting together an in-situ network of supersites, which are mostly national contributions. J. Key presented several other challenges (e.g., standards, partnerships), among which is the selection of consistent, robust, error-characterized products meeting user requirements.

He asked for PSTG involvement in product selection and review of requirements etc. A demonstration site has been developed to prototype a GCW portal: <http://gcwdemo.met.no>.

A number of working groups are involved in GCW: the Observing Systems Working Group (includes a CryoNet team), the Requirements and Capabilities team, and the Infrastructure and Practices team. CryoNet is important because of the opportunity to use supersites. The Products and Services Working Group consists of a Products team, a Portal team and an Outreach team.

GCW was recognized as needed to develop a community of practice, and to build the interface from which to source requirements. Later it will be possible to use the requirements articulated by this community for implementation by space agencies.

11. POLAR INITIATIVES AND WCRP PERSPECTIVES (V. RYABININ)

V. Ryabinin [presented](#) consolidated outcomes of the October 2011 WCRP Open Science Conference in Denver, CO, USA, in the context of the development of Global Framework for Climate Services. An implementation plan is being developed for GFCS.

The ICSU visioning exercise is developing a new approach under the banner “Future Earth”, comprising a 10-year initiative, involving scientific collaboration on Earth System research. It involves “innovating, observing and forecasting” as keywords. WCRP activities will interlock with the ICSU initiative, and will have a reorganized structure. Within this, the CliC will follow a number of “grand challenges” for cryosphere: provision of regional climate information; regional sea-level rise; cryosphere in a changing climate; changes in water availability; aerosol, precipitation and cloud systems; and climate extremes.

There will be a joint task group with IOC for the sea level rise grand challenge.

A WCRP modelling council will be set up to coordinate the multitude of different modelling activities, such as CMIP efforts. The regional downscaling efforts which are needed to meet the demand for regional climate information will be coordinated by a working group on downscaling and regional climate. Reanalysis is also considering the assimilation of all types of data into a contemporary climate. CMIP5 is planning on using the reanalysis data. A WCRP data advisory council is being set up which will be concerned with data being used in CMIP, and this is probably the most important body with which PSTG needs to establish links.

The polar predictability initiative will be focusing on how to use the existing observing system data to find key areas of predictability of the system. Eurasian snow cover impact on Northern Hemisphere weather anomalies is recognized to be one key issue. The other would be sea ice impact on global climate.

The International Polar (Decade) Initiative is proposed as a modified framework under the original polar decade banner to provide a number of key initiatives. A number of key focal points have been identified which need to be addressed as a continuing legacy of IPY. V. Ryabinin identified the International Polar Initiative (IPI) plan to combine these elements and to preserve the legacy of IPY. The concept was initially presented at the IPY Conference in Montreal. It will be distributed to the PSTG.

Action 2.1: V. Ryabinin to distribute IPI Concept Note to the PSTG for reflection when the Concept is consolidated amongst the IPI Steering Group.

Action 2.2: PSTG to establish links with the WCRP Data Advisory Council, through a representative of the WCRP Joint Planning Staff on PSTG.

12. WWRP/THORPEX POLAR PREDICTION PROJECT (T. JUNG)

T. Jung [presented](#) the World Weather Research Project (WWRP) Polar Prediction Project (PPP) initiative to promote research enabling the development of improved prediction services for the Polar Regions on timescales from hourly to seasonal. Research areas involve forecasting system development, underpinning research and ultimately services.

The WWRP-PPP is developing verification methods to establish the accuracy of forecasts in the Polar Regions. Understanding teleconnections is an important component. Model improvements are an important context with the goal to improve representation of key processes in models of the polar atmosphere, land and ocean.

The modelling community is pushing for coupled models to be included in NWP systems. Currently the ice is forced to be persistent over assimilation timesteps. The coupled approach allows the evolution of the system. Ensemble forecasting is also a focus.

Data assimilation is a goal for accounting for unique aspects of the polar system. Observations are necessary and to be provided for use in assimilation experiments. The ultimate goal is to do Observing System Experiments (OSE) and data denial experiments, as well as Observing System Simulation Experiments (OSSE).

T. Jung introduced the proposal of the Year of Polar Prediction (YOPP) – with a period of intensive observations and modelling in 2017 and 2018. This involves numerical experiments and interest in observing system design. He stressed the intent to establish linkages with Space Agencies and other data providers. The intention is to send out a draft Implementation Plan in July 2012, for comments.

The ensuing discussion addressed linkage of EC-PORS to the YOPP Project. T. Jung asked whether PSTG could establish a focal point. PSTG was positive about an active link of WWRP/YOPP with members in the PSTG.

Action 2.3: Chair to distribute Polar Prediction Project Implementation Plan, once available, for comment by PSTG by 1 Nov 2012 deadline.

Action 2.4: PSTG to nominate focal point for the Year of Polar Prediction (YOPP).

N. Gordon (EC-PORS collaborator on the WWRP-PPP) noted that the WWRP-PPP is a user of data. It was noted that the models would ultimately reach sufficient maturity to allow for OSSEs. This would imply the models reached a sufficient degree of maturity to inform the satellite agencies where a particular measurement may, in the future, be justifiable in terms of proving greatest impact.

The participation of users such as WWRP at PSTG was considered essential, and the Team agreed to have a standing invitation to the modelling community, with T. Jung as interface.

13. FINALIZING PSTG TERMS OF REFERENCE

The PSTG Terms of Reference (ToR) were discussed by the members and comments were made to finalize the text of the ToR which had been discussed at PSTG-1. Some suggestions were made to move the Key Functional Requirements of the PSTG into an Annex, and to rename the heading on Governance to Policy Framework.

It was noted that CEOS had spun off IGOS-P – and thus it was suggested that the reference to the Theme Team should be changed to read “Theme Report”. Meanwhile GEO has not necessarily provided the logical connection in terms of a community of practice for continuity in Theme activities. Thus it was felt that there is no need to explicitly link to GEO in the ToR. Global Cryosphere Watch on the other hand can ultimately provide the PSTG with a requirements interface. It was felt that the PSTG should remain open to ad-hoc sources of requirements via workshops.

Members noted that it should remain a priority to define an implementation plan with goals and objectives to guide future activities of the group. If possible, quarterly teleconferences of PSTG members would be an important mechanism to follow up on actions, and to discuss the status of ongoing activities.

PSTG affirmed the current chairmanship role.

Action 2.5: PSTG members are requested to look at PSTG Terms of Reference once more before finalising.

Action 2.6: Secretariat to set up a teleconference with Tim Stryker (CEOS CEO), Barbara, Mark and Yves to discuss best way to interface with CEOS, and to establish a regular reporting opportunity.

Members reiterated that strong and active Secretariat is required to follow up on Action items and to remind/push PSTG members. In respect to the departure of B. Ryan to GEO Secretariat, it was felt important to clarify the Secretariat position in the future in order to properly fulfil the PSTG role vis-à-vis EC-PORS and otherwise. It needs to be ensured that the WMO Space Programme office (Stephan Bojinski) has the tools and the sustained resources to provide an active Secretariat role to the PSTG. Similarly, Team members need to support WMO in the interval between meetings to ensure progress.

Action 2.7: M. Drinkwater to consult with David Grimes (President of WMO) about the situation regarding Secretariat support, and future prospects.

14. NEXT STEPS FOR STRATEGIC IMPLEMENTATION

The Agencies expressed concerns that the Team first needed sets of consolidated observation requirements before starting implementation. Some strategic priorities need to be identified, before collecting the observational requirements. Requirements sets will have to be assembled on the basis of these strategic priorities. Many of the observation requirements already exist in the IGOS

Cryosphere Theme document, and thus, a starting point exists in respect to physical aspects of the cryosphere. With these in hand, the work of the PSTG can be initiated with community-endorsed sets of requirements.

14.1 [SAR Working Group \(Y. Crevier\)](#)

Y. Crevier pointed to the [IPY-STG SAR Coordination Group document](#) which summarizes the important aspects of the process by which the Working Group addressed thematically organised user and observation requirements. A subset of these were chosen, and the lessons learned from this process were outlined:

- Space Agencies are willing to respond as a group to satisfy EO data needs for science objectives;
- A high level policy framework is important for securing agency commitments;
- Clearly articulated science requirements give Space Agencies realistic targets and ensure the value of the resulting data;
- Commercial sector sensor operators are important participants and contributors;
- Matching the observational requirements to available agency resources is important;
- Defining the duration of agency commitments is important for committing resources.

Based on the successful work of the IPY-SAR Coordination Group, Y. Crevier then recommended establishing a “standing committee” rather than an ad hoc working group for future coordination of SAR-related Agency action in support of observing the polar regions and the cryosphere. Such a standing group would serve as an anchor to new initiatives and areas of mutual and worthwhile interest.

The following ingredients were identified for a “coordination recipe”:

- Identification and prioritization of user needs (identify low hanging fruits – in terms of addressing science gaps and priorities);
- Entertain constant dialogue with science community;
- Pool resources of individual Space Agencies;
- Use of internal programme resources.

Action 2.8: B. Scheuchl to consolidate the user and observation requirements document for ice sheet SAR for ice sheet mass balance.

Action 2.9: PSTG members and WCRP to identify community points of contact (PoCs) to review and endorse SAR-related acquisition plans in their respective national science communities.

PSTG members agreed in the near-term to establish a SAR Coordination Working Group, to begin to address the more urgent ice sheet and sea ice requirements. In view of the recent losses of missions like ALOS, ERS-1 and Envisat, it was recognized that the SAR agencies have to coordinate tasking of the operating SAR missions and to plan strategically for the future, when new SAR missions come online. Meanwhile, there are specific short-term needs which favour establishment of this working group, as had been outlined in the presentation by B. Scheuchl.

Action 2.10: Y. Crevier (CSA) and F. Battazza (ASI) to work on framework and charter for a SAR Coordination Working Group.

PSTG can respond to the ice sheet requirements developed by Bernd Scheuchl (on behalf of the IMBIE group of scientists) since these were recognized as a short-term strategic priority.

Action 2.11: M. Drinkwater to draft a letter on behalf of PSTG with a request to S. MacLean (President of CSA) in response to the community need for large scale SAR acquisition planning from Radarsat.

It was noted that some agencies like ASI cannot take action without guiding requirements endorsed by Italian researchers.

14.2 Other Working Groups (Instrument/Thematic)

It was noted that in the past there had been less interest expressed in a working group comprising Agencies with optical sensors. This is because, for the most part, the instruments do not require tasking. It was noted that the recently-launched Pleiades provides a critical new stereo capability, which could deliver key scientific benefits.

A near-term priority is to address the basics for setting up a dedicated working group. After that, the Agencies concerned with managing optical missions should evaluate the need for similar coordination as that foreseen for the SAR Coordination Working Group.

14.3 Reporting

A discussion was held on how reporting could be made most effective. Members noted that reporting should be focused primarily on achieving visibility in CEOS, CGMS and GEO forums.

Notably, in the interim since PSTG-1, a report of last meeting had been prepared and presented at CEOS SIT (by Y.Crevier, CSA), and a CGMS report had similarly been presented by B. Ryan (WMO Space Programme). E. Sarukhian reiterated the importance of the link to the High Level Consultative Meetings (comprising heads of Space Agencies) – which now take place only every other year. A high-level report was presented previously in this forum, but any report must be strategically tuned to contain only the priority, high-level recommendations.

Y. Qiu noted that GEO now recognized a high-level water task in its Work Plan which requires cryospheric information. Although there is nothing explicit in the Plan, he reiterated that the cryosphere is currently being captured in GEO under the Water Societal Benefit Area. Any information service for Polar Regions, and particularly the Third Pole, could logically be channelled via this aspect of GEO. Additional visibility could potentially be made via the GEO Work Plan for PSTG activities. It was recognised that some agencies may need GEO as a way to justify aspects of what they do. CEOS explicitly responds to the societal benefit areas of GEO.

For the operational agencies, such as NOAA, CMA, and EUMETSAT, the blessing of CEOS/CGMS is likely to be more important.

15. REVIEW OF ACTION ITEMS

The review of Action items will occur through dissemination of meeting minutes. Periodic checks will be made in conjunction with the Secretariat regarding the status of each Action item. A summary is provided in Appendix III.

16. PLAN FOR NEXT MEETING

The general consensus amongst the members was that, if meetings were held at annual intervals as a general rule, there needs to be more dialogue during the intersessional period – via Secretariat to the members. This would need to comprise tracking and reminders of Action items requiring completion, as well as regular circulation of information relevant to the group. The challenge remains to keep members sufficiently engaged, if they are not otherwise involved in other relevant meetings in the interim.

In retrospect, after the experiment to have a meeting spanning 3 days (including two half days), it was decided that it was better to try to limit the agenda to a 1.5-2 days' meeting. It was agreed that Agency presentations need to be limited to 15 minutes, with other invited presentations forming the basis for discussion amongst the group.

Member agencies reiterated that since they must travel on their own resources, it has to be convenient. Moving the meetings periodically outside Geneva may help with accommodation and cost to the participants, though it was noted that a willing host would need to be established.

Action 2.12: PSTG Secretariat to send invitation to complete a Doodle Poll for members to attend a 3rd PSTG in mid-late April or June 2013 timeframe (Priority for mid-late April)

17. ADJOURN MEETING

The meeting was adjourned at 12:30 on 14 June 2012.

LIST OF PARTICIPANTS**Participating Members
of PSTG**

ASI	Battazza, Fabrizio	fabrizio.battazza@asi.it
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Invited Participants

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Secretariat

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APPENDIX II

FINAL AGENDA AND WORK SCHEDULE

TUESDAY, 12 JUNE 2012

- 12:30 *Registration (Salle 7 LAKE)*
- 13:00 1. Opening and Welcoming Remarks (Mark Drinkwater)
- 13:05 2. Introductions (All Participants)
- 13:15 3. Approval of Agenda (Mark Drinkwater)
- 13:30 4. Action Items from PSTG-1 (Barbara Ryan)
- 14:00 5. Outcomes from IPY Montreal Conference (TBC)
- 15:00 6. EC-PORS Update (Miroslav Ondras)
http://www.wmo.int/pages/prog/www/WIGOS_6_EC_PORS/Final_Report2012.pdf
- 15:30 *Coffee Break*
- 16:00 7. Polar/Cryosphere Satellite Observation Requirements:
a. SCAR/IASC:ISMALSS, SOOS, SAON Needs (TBD)
b. Ice sheet Monitoring Needs (Bernd Scheuchl - IMBIE)
c. Glacier Monitoring and Future Needs (Frank Paul - WGMS)
- 17:30 *Adjourn Day 1*

WEDNESDAY, 13 JUNE 2012

- 09:00 8. Envisat Loss - Implications for Polar Atmospheric Composition (Manfred Gottwald)
- 09:30 9. Agency Perspectives on Strategic Priorities (Agency Members)
a. Key Contributions in relation to Strategic Focus Areas
b. Status of Relevant Missions
- 11:00 *Coffee Break*
- 11:30 9. Continue Agency Report-Outs
- 13:00 *Lunch Break*
- 14:30 10. Global Cryosphere Watch Implementation (Jeff Key)
- 15:00 11. Polar Initiatives and WCRP Activities (Vladimir Ryabinin)
- 15:30 12. WWRP/THORPEX Polar Prediction Project (Thomas Jung)
- 16:00 *Coffee Break*
- 16:30 13. Finalizing PSTG ToR
- 17:30 *Adjourn Day 2*

APPENDIX II

THURSDAY, 14 JUNE 2012

- 09:00 14. Next Steps for Strategic Implementation
- a. SAR Working Group (Crevier)
 - b. Other Working Groups (Instrument/Thematic)
- 11:15 15. Review of Action Items (PSTG-2)
- 11:45 16. Plans for Next Meeting
- 12:00 *Adjourn Meeting*

APPENDIX III

ACTION ITEMS FOR PSTG

I. Actions from PSTG-2, and Status	
Action 2.1: V. Ryabinin to distribute IPI Concept Note to the PSTG for reflection when the Concept is consolidated amongst the IPI Steering Group.	DONE; Chair distributed IPI Concept to PSTG on 29 Aug 2012.
Action 2.2: PSTG to establish links with the WCRP Data Advisory Council, through a representative of the WCRP Joint Planning Staff on PSTG.	OPEN; Invite WCRP representative to PSTG-3.
Action 2.3: Chair to distribute Polar Prediction Project Implementation Plan, once available, for comment by PSTG by 1 Nov 2012 deadline.	DONE; Chair distributed PPP IP to PSTG for comment by 1 Nov 2012 deadline, on 16 Oct 2012.
Action 2.4: PSTG to nominate focal point for the Year of Polar Prediction (YOPP).	OPEN
Action 2.5: PSTG members are requested to look at PSTG Terms of Reference once more before finalising.	DONE; Comments from PSTG members requested on 15 Jun 2012, by deadline 14 Jul 2012.
Action 2.6: Secretariat to set up a teleconference with Tim Stryker (CEOS CEO), Barbara, Mark and Yves to discuss best way to interface with CEOS, and to establish a regular reporting opportunity.	DONE; Teleconference held 24 Aug 2012.
Action 2.7: M. Drinkwater to consult with David Grimes (President of WMO) about the situation regarding Secretariat support, and future prospects.	OPEN
Action 2.8: B. Scheuchl to consolidate the user and observation requirements document for ice sheet SAR for ice sheet mass balance.	DONE; Consolidated request presented at 1 st SAR Coordination Working Group meeting in Nov 2012.
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
Action 2.10: Y. Crevier (CSA) and F. Battazza (ASI) to work on framework and charter for a SAR Coordination Working Group.	DONE; Draft presented to 1 st SAR Coordination Working Group meeting in Nov 2012.
Action 2.11: M. Drinkwater to draft a letter on behalf of PSTG with a request to S. MacLean (President of CSA) in response to the community need for large scale SAR acquisition planning from Radarsat.	DONE; Letter sent by Chair on 29 June 2012
Action 2.12: PSTG Secretariat to send invitation to complete a Doodle Poll for members to attend a 3 rd PSTG in mid-late April or June 2013 timeframe (Priority for mid-late April).	DONE; Date for PSTG-3 24-25 April 2013; Location: TBD (Options: WMO Geneva, CSA Montreal, CNES Paris)

APPENDIX III

II. Actions from PSTG-1	
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.	OPEN; Dataset and product template to be circulated to PSTG by Secretariat, in conjunction with further development of Product Access Guide.
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; Secretariat to create a cryosphere-related theme in the online database of user requirements.
Action 1.7: WMO Secretariat to contact Argentina, China, India, Korea and the Russian Federation regarding their interest/participation in PSTG	OPEN; Need to follow up in Secretariat on CONAE, ISRO, USGS participation; [Results of direct discussion at CGMS-40, Nov 2012: KMA: Recommendation made to join PSTG; PLANETA: Valery Asmus confirmed to be representative; NASA: nomination of Craig Dobson confirmed by Jack Kaye, with Thomas Wagner as observer (thomas.wagner@nasa.gov)]

Terms of Reference¹

WMO Polar Space Task Group (PSTG)

(October 2012)

The Polar Space Task Group (PSTG) has been established under the auspices of the World Meteorological Organization's (WMO) Executive Council Panel of Experts on Polar Observations Research and Services (EC-PORS). The group's mandate is to provide coordination across Space Agencies to facilitate acquisition and distribution of fundamental satellite datasets, and to contribute to or support development of specific derived products in support of cryospheric and polar scientific research and applications.

The PSTG shall actively seek realisation of benefits from the growing constellation of polar orbiting satellites by mobilising the unique and complementary capabilities of each of the respective participating Agencies, whether research and development or operationally oriented. In the case of the latter, the role is to support the scientific activities that may lead to improved numerical weather and climate forecasting, or development of improved operational polar products and services, to the extent that these activities fall within each Agency's mandate.

The PSTG is a successor of the successful International Polar Year Space Task Group (IPY-STG), established for the purpose of Space Agency planning, processing and archiving of the IPY Earth Observation legacy dataset. This new group shall be an independent working group which reports to the EC-PORS via common membership of its Observational Task Team. A suitable reporting mechanism shall be established to inform CEOS, CGMS and WMO Consultative Meetings on High-Level Policy on Satellite Matters on relevant PSTG progress and issues.

Membership of the PSTG has been established by invitation from the WMO Secretary General and nomination by the respective Space Agency. Following the successful IPY-STG, the re-establishment of the PSTG coincides with the four year interval bridging the WMO Congresses in 2011 and 2015 (i.e. Cg-XVI and Cg-XVII). Thus, the initial working term of PSTG foresees a 3 year interval of activities between 2011 and 2014, with the goal to review progress and working mandate prior to the deadline for inputs to the WMO Congress in 2015.

Objectives

1. The group shall review cryosphere and polar scientific requirements, including user needs and observational requirements stemming from, but not limited to GCOS, the IGOS-P Cryosphere Theme Report, the WMO Expert Team on Satellite Utilization and Products (ET-SUP), and the specific needs of the WMO Global Cryosphere Watch (GCW), the World Climate Research Programme (WCRP), SCAR/IASC and the Group on Earth Observations (GEO);
2. The group shall develop a mechanism to source these requirements, through workshops, meetings, etc.;
3. The group shall develop a set of key strategic goals to meet user needs and observational requirements and prioritize them considering existing Agency-specific programmes (in collaboration with the WMO Expert Team on Satellite Systems (ET-SAT)), or international project frameworks;
4. The group shall develop a short-, mid- and long-term implementation strategy covering atmosphere, ocean and terrestrial domains, based on the strategic goals and requirements;
5. Members shall establish commitments on behalf of their Agency to support data acquisition, and support for product development and establishment of relevant accompanying scientific studies, as appropriate for the Agency;
6. Members shall participate in the joint development and coordination of mission acquisition plans with consideration of:
 - existing *in-situ* observing system infrastructure;

¹ V5, 31 Oct 2012

APPENDIX IV

- individual agency mandates and resources, including space-segment and ground-segment assets;
 - time-space distribution of planned in-situ and air-/ship- borne campaign activities;
7. The group shall develop and coordinate plans for satellite data product distribution and archiving;
 8. The group shall develop indicators or metrics of success of data use;
 9. PSTG meetings shall be held at least once each year, with:
 - Intermediate Working Group meetings as needed;
 - Quarterly teleconferences as needed;
 - Standing invitation to Members for hosting meetings at their respective premises or suitable local venues.

Membership

- Members of PSTG shall be nominated by Heads of Space Agencies, upon invitation by the WMO Secretary General;
- Positions of Chair and Vice-Chair of PSTG shall be established:
 - The Chair and Vice-Chair are nominated by PSTG members as needed,
 - The Chair and Vice-Chair rotate amongst Member Agencies.

Policy Framework

The EC-PORS Panel of Experts reports annually, via the WMO Secretariat, to the Executive Council (EC) of WMO. The EC consists of 37 Members, including the President, three vice-Presidents and the presidents of the six regional associations (each ex-officio members). The Executive reports to WMO Congress every four years (2011, 2015, etc.), on which all members of WMO are represented.

Reporting Framework

The PSTG shall informally report to WMO via the EC-PORS in the context of its Observations Framework. EC-PORS will take responsibility for establishing the scientific needs of its research framework and identify observation gaps or specific science and data requirements originating from the GCW which are relevant to PSTG.

Observational requirements assembled by PSTG shall be provided as an input to the Rolling Review of Requirements (RRR) process of the WMO Inter-Programme Expert Team on the Observing System Design and Evolution (IPET-OSDE).

Representatives of GCOS and WCRP (particularly, the Climate and Cryosphere (CliC) Project) will be invited to participate in the PSTG meetings to facilitate coordination. Other groups with polar interests may also be invited to participate, as appropriate.

The PSTG (through an agency liaison) shall provide a report on an annual basis to the Committee on Earth Observation Satellites (CEOS), particularly at their Strategic Implementation Team (SIT) meetings, and the Coordination Group for Meteorological Satellites (CGMS) (through WMO), as well as to the WMO Consultative Meetings on High-level Policy on Satellite Matters, where Actions and Recommendations can be brought to the attention of the Space Agency members.

Secretariat

The group's Secretariat shall be provided by the WMO Space Programme (SAT) within the Observing and Information Systems (OBS) Department of the WMO Secretariat.

The Secretariat will prepare meeting invitations, assemble, post and/or distribute documents, convene intersessional teleconferences, prepare, review and distribute meeting minutes, ensure

action items are communicated to members and followed up, and necessary mail and email exchanges with members, and hosting of meetings.

ANNEX to PSTG Terms of Reference

Key Functional Requirements

The PSTG activity shall enable to:

- a) Assemble disciplinary science requirements for polar and cryospheric research to be addressed with spaceborne systems through regular and broad interaction with the science community;
- b) Through iteration amongst the planning and processing arms of the participating international Space Agencies, including their representatives within ET-SAT, develop a concise, prioritized list of observational objectives based on:
 - i) Efficient use of the international constellation of satellites;
 - ii) Operating mandates of each Space Agency;
 - iii) Satisfying science objectives best served by coordinating agency activities;
- c) Regularly assess and revise observation acquisitions and acquisition plans;
- d) Redirect observation priorities over time;
- e) Develop plans to use shared resources for processing and distributing data and data products;
- f) Establish subgroups addressing instrument specific issues; and
- g) Encourage active participation by all interested Space Agencies.

Members may be requested to contribute to meeting presentations or periodic reports to EC-PORS or WMO Consultative Meetings on High-Level Policy on Satellite Matters, identifying progress and successes, or key Actions and Recommendations.

ACRONYMS

AnTON	Antarctic Observing Network
AO	Announcement of Opportunity
ATCM	Antarctic Treaty Consultative Meeting
ASI	Agenzia Spaziale Italiana
CCI	Climate Change Initiative
CEOS	Committee for Earth Observing Satellites
CGMS	Coordination Group for Meteorological Satellites
CliC	Climate and Cryosphere Project
CMA	China Meteorological Administration
CMIP	Coupled Model Intercomparison Project
CONAE	Comisión Nacional de Actividades Espaciales (Argentina)
CNES	Centre National d'Etudes Spatiales (France)
CSA	Canadian Space Agency
DEM	Digital Elevation Model
DInSAR	Differential Interferometric SAR
DLR	Deutsches Zentrum für Luft- und Raumfahrt
EC-PORS	WMO Executive Council Panel of Experts on Polar Observations, Research and Services
ECV	Essential Climate Variable
EGU	European Geophysical Union
EO	Earth Observation
EPS-SG	EUMETSAT Polar System – Second Generation
ESA	European Space Agency
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
GCOS	Global Climate Observing System
GCW	Global Cryosphere Watch
GEO	Group on Earth Observation
GEOS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GIPPS	Global Integrated Polar Prediction System
GLIMS	Global Land Ice Measurements from Space
GMES	Global Monitoring for Environment and Security
GTN-G	Global Terrestrial Network - Glaciers
HEO	Highly Elliptical Orbit
IASC	International Arctic Science Committee
ICSU	International Council for Science
IGOS-P	Integrated Global Observing System Partnership
IMBIE	Ice Sheet Mass Balance Intercomparison Exercise
InSAR	Interferometric SAR
INPE	Instituto Nacional de Pesquisas Espaciais (Brazil)
IPI	International Polar Initiative
IOC	Intergovernmental Oceanographic Commission
ISMAS	Ice Sheet Mass Balance and Sea Level
ISRO	Indian Space Research Organization
IPY	International Polar Year
KMA	Korea Meteorological Administration
LEO	Low-Earth Orbit
NASA	National Aeronautics and Space Administration (USA)
NESDIS	National Environmental Satellite, Data, and Information Service (USA)
NOAA	National Oceanic and Atmospheric Administration (USA)
NSIDC	National Snow and Ice Data Center (USA)
OSE	Observing System Experiment

APPENDIX IV

OSSE	Observing System Simulation Experiment
PSTG	Polar Space Task Group
RRR	Rolling Review of Requirements
SAON	Sustaining Arctic Observing Networks
SAR	Synthetic Aperture Radar
SCAR	Scientific Committee on Antarctic Research
SOOS	Southern Ocean Observing System
STG	Space Task Group
USGS	United States Geological Survey
WCRP	World Climate Research Programme
WGMS	World Glacier Monitoring Service
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WWRP	World Weather Research Project
YOPP	Year of Polar Prediction