

WORLD METEOROLOGICAL ORGANIZATION GLOBAL CRYOSPHERE WATCH

REPORT No. 10

FINAL REPORT OF THE JOINT FOURTH CRYONET TEAM AND THIRD PORTAL & WEBSITE TEAMS MEETINGS

Boulder, Colorado, USA
7-9 December, 2015



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Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box 2300
CH-1211 Geneva 2, Switzerland

Tel.: +41 (0) 22 730 8403
Fax: +41 (0) 22 730 8040
E-mail: Publications@wmo.int

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EXECUTIVE SUMMARY

The Fourth Session of the CryoNet Team and the Third Session of the Portal and Website and Outreach Teams were held at the University of Colorado (Boulder, Colorado, USA), 7-9th December 2015. This joint meeting was hosted by the US National Snow and Ice Data Center (NSIDC).

The meeting began with a discussion on CryoNet issues, namely the need to finalize the concept of station/site and to start the procedure for site selection. It was recognized that GCW and WIGOS have different structures but GCW could complement WIGOS on interdisciplinary issues and acts as a bridge between WMO and the scientific community. Also discussed was the engagement of GCW to the broader scientific community in particular that of the International Network for Alpine Research Catchment Hydrology which was seen as a good opportunity to enhance EC-PHORS's arctic hydrology experience. Another point raised was the inclusion of CryoNet sites/stations metadata in OSCAR/Surface which is a requirement. The appropriate mechanism by which this will be done is yet to be determined.

The report on the CryoNet South America activities was presented. Twelve regional CryoNet and contributing stations have been proposed and approved by GCW, it was also recognized that increased co-operation with partner organizations, such as UNESCO IHP, is crucial. As for the 3rd Pole activities, engagement with the operational agencies will be strengthened.

Regarding the status of CryoNet, the joint session: (a) Reviewed the list of existing sites, see Annex 5; (b) Reviewed pre-operational testing by means of exploring data accessibility and procedure to access the data; (c) Revised the minimum site/station requirements in a version similar to WIGOS, see Annex 7; (d) Discussed the minimum program for CryoNet stations and sites aiming to identify the set of variables which would be measured at each site/station; (e) Reviewed the GCW design principles, which is broadly consistent with WIGOS OSND guidelines but deviates from these in the "designing through a tiered approach" which is currently an implicit concept in CryoNet; (f) Revised definitions and structure of the CryoNet as given in Annex 8; (g) Looked into a process for assessment of new sites/stations into GCW, see Annex 9; (h) Assessed the selection of newly proposed sites; (i) Discussed data policy, namely the use what has been accepted by operational and research communities and drafting a policy document which should include existing WMO policies; (j) Reviewed the development of a GCW Guide and Manual, see Annex 12; (k) Agreed on Work Plans of CryoNet Team; and (l) Updated the CryoNet related action sheets.

The meeting followed with a review of the status of the GCW Data Portal. Currently metadata is harvested twice daily from six data centers and testing is ongoing or planned for a number of other data centres. One issue requiring attention is the use of controlled vocabularies and the development of structured data management. The Norwegian Meteorological Institute has started to plan the establishment of the GCW Data Portal as a WIS DCPC following GSG request. This is expected to be completed within 2016. The first draft versions of the GCW Portal Interoperability Guidelines and the GCW Portal Operations Manual have been developed.

The integration of data from CryoNet sites into the GCW portal has begun. The implementation of interfaces to metadata for SLF-Davos is currently being tested. Further work is required to achieve interoperability at the data level and data segmentation for real time exchange. The availability of data from stations approved for pre-operational testing has also begun. It was also noted that GCW operates with stations outside the WMO hence real-time exchange may be on the internet and must take into account the user community's needs. GCW Portal Interoperability Guidelines and GCW Portal Operations Manual have been developed with the intention to guide

CryoNet sites in the dialogue with the GCW Portal Team. GCW Data Portal actions were reviewed and updated.

The session considered GCW website and outreach related issues, starting with actions from previous meetings that were being reviewed and updated. A webpage to show surface network sites by category and a database table and search tool for the Snow Watch inventory were completed. Significant changes were made to the station/site questionnaire after the Copenhagen meeting. An updated work plan for the next two years was prepared which includes further revision of the station/site questionnaire based on the new CryoNet structure, adding additional ice products, finalizing and adding some new trackers. A GCW Newsletter was suggested to add visibility as an outreach mechanism - to be considered when the GCW Project Office is established. Another point raised was how survey(s) of user needs might be conducted. Examples of products provided by NWS Alaska for "cryosphere and climate monitoring" were presented as an example of the user driven products GCW could develop.

An inventory of the Snow Watch products developed by the Snow Watch Team was made available on the GCW website and is intended to be updated on an ongoing basis. The inventory provides users with some guidance about the suitability of snow information products and datasets for various applications.

There currently exist three GCW trackers which provide a quick look at the current state of cryosphere relative to the mean state of the last 2-3 decades. Other trackers are under development. A point left to be considered by all teams is the policy/procedure for including products on the website.

The GCW Terminology Team has been activated and a three phase work-plan developed. To implement such a "pan-cryospheric" glossary will require collaboration from the cryosphere community at-large and also ideally the endorsement of all relevant cryosphere organizations.

The meeting finished with an open discussion on the need to engage scientists, students and institutes/agencies in GCW ensued. This linked into discussing funding from programs external to NMHSs and projects supported by Foreign Affairs Ministries or State Departments.

After the official closure an open session was organized at NSIDC to interact with local scientists to share perspectives on issues such as observing the cryosphere, developing/delivering cryospheric products and relevant data issues.



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MEETING REPORT

1. ORGANIZATION OF THE MEETING

1.1 The Fourth Session of the CryoNet Team and the Third Session of the Portal Team and the Website and Outreach Team were held at the National Snow and Ice Data Center (NSIDC), Boulder, Colorado, USA from 7 to 9 December 2015. The meeting was organized by the leads of the three teams, Dr. Wolfgang Schöner, Dr. Øystein Godøy, Dr. Jeff Key, respectively. The sessions were chaired by Wolfgang Schöner and Dr. Árni Snorrason (Chair of the Global Cryosphere Watch Steering Group). Dr. Mark Serreze, Director, NSIDC welcomed the participants to NSIDC and the University of Colorado. Dr. Wenjian Zhang welcomed the teams on behalf of the World Meteorological Organization. He emphasized that GCW is a new WMO priority and links strongly to other priority issues e.g. WIGOS/WIS and the Global Framework for Climate Services (GFCS).

1.2 The programme (**ANNEX 1**) for the meeting was adopted with minor amendments. Item 2.4, Report on the CryoNet Asia 3rd Pole activities could not be discussed as Xiao Cunde was unable to participate and no written submission was provided.

1.3 Participants are listed in **ANNEX 2**.

1.4 All documents prepared for, or given at, the meeting are available online at <https://sites.google.com/a/wmo.int/gcw-cnt-pt-wt/>. Presentations are available at "[CryoNet presentations Boulder](#)".

2. CRYONET ISSUES

2.1 **Review of Actions from previous meetings:** The CryoNet Action sheets from previous meetings are given in **ANNEX 3**. All have been updated as of the current meeting, except an update for actions from the first Asia CryoNet meeting is required from Xiao Cunde. Most other actions are now closed.

The establishment of regional working groups was discussed at Cg-17, acknowledging that the cryosphere is global with important high mountain aspects. Engagement of countries at Congress should lead to development of regional WGs. The Regional Association meetings will offer an opportunity to pursue the development of a regional GCW group as appropriate, recognizing the need to connect with RAs on technical issues. It was recognized that CryoNet is in line with Members' interests and Members relate to CryoNet.

ACTION: The Secretariat will take the lead in co-ordinating the establishment of regional working groups, as appropriate, with support from regional experts.

Keeping track of progress between meetings is important and Øystein Godøy suggested setting up an "issue tracking" system.

ACTION: The Secretariat will discuss this further with Øystein Godøy for implementation.

2.2 **Review of the 2015 CryoNet Team Work Plan:** CryoNet chair, Wolfgang Schöner presented and led the discussion on the key items in the work plan (**ANNEX 4**) for the Boulder meeting, including the need to finalize station/site concept v1.0 and to start the procedure for site selection using the list of stations/sites approved for pre-operational testing by Cg-17. The questionnaire is the basis for leading to approval, but the details of assessing the submissions for final approval needs to be worked out. Other key items, which are discussed below included the

CryoNet Primer, agreed observing practices, and the minimum observing programme for CryoNet sites.

There was considerable discussion on GCW in the context of WIGOS. Dr. Godøy (chair of the Portal Team) noted that GCW and WIGOS use different terminology for station and sites and that GCW and WIGOS must recognize this. Dr. Zhang (Director of Observing and Information Systems Department) agreed that WIGOS has to recognize that CryoNet is different in its structure. As well, the GSG Chair, Dr. Snorrason, noted the broader aspect, that WMO has to recognize the differences between communities, that GCW can help WIGOS on interdisciplinary issues and that GCW bridges between WMO and the scientific community. Dr. Godøy noted that this latter point is also a main message for WIS, especially in the context of how data are routed.

There was discussion on engagement of the broader scientific community. In Europe HarmoSnow (a COST action, www.harmosnow.eu/), IASC, EU-PolarNet (www.eu-polarnet.eu) and the Joint Programming Initiatives for the European Area are particularly relevant.

ACTION: Wolfgang Schöner, with the support of GCW experts, will continue building interactions and partnerships with communities such as HarmoSnow, IASC, EU-PolarNet and the EU JPI, both within Europe and globally.

There was specific discussion about INARCH (the International Network for Alpine Research Catchment Hydrology). Partnering with INARCH is seen as a very good opportunity and important for GCW and EC-PHORS. GCW needs to establish a connection and determine how to extend this into EC-PHORS to enhance its arctic hydrology experience.

ACTION: Wolfgang Schöner and Barry Goodison will contact John Pomeroy, who is INARCH chair, to discuss appropriate linkages for GCW and for CryoNet as several INARCH sites could be CryoNet station/sites (and vice versa).

The Secretariat informed the Team that having CryoNet sites/stations metadata in OSCAR/Surface is a requirement. It was suggested that the Team discuss practical options, such as building a separate GCW database which will feed WIGOS metadata automatically into OSCAR/Surface through machine to machine interface, or using OSCAR/Surface directly for manually inserting the CryoNet metadata in OSCAR/Surface using its web interface. The appropriate mechanism is yet to be determined.

ACTION: The Secretariat will work with the CryoNet and Portal Teams to assess the appropriate approach. (Secretariat, Wolfgang Schöner, Øystein Godøy)

2.3 **Report on the CryoNet South America activities:** Gino Casassa provided an [update](#) on activities since the first CryoNet South America workshop. Twelve regional CryoNet and Contributing stations have been proposed and approved by GCW, which represents 30% of the 40 approved CryoNet and Contributing Stations at the global level. Eleven lie in South America (Ecuador, Bolivia, Peru, Argentina and Chile) and one in Mexico. This is a major outcome from the first CryoNet workshop and demonstrates the importance of establishing a regional GCW/CryoNet Team.

A two-day Coordination Meeting on glaciers and adaptation strategies was held in Santiago, Chile, on 3-4 September 2015, sponsored by a UNESCO IHP project “The Impact of Glacier Retreat in the Andes: International Multidisciplinary Network for Adaptation Strategies”. This led to discussion on how GCW (and WMO) can work more effectively with UNESCO IHP on alpine/glacier initiatives. UNESCO IHP has established a Central Asian Regional Glaciological Centre in Kazakhstan and a similar centre was being considered for South America. As well, a joint South American meeting on glacier research is being proposed for 2016 to UNESCO IHP and GCW WMO. Support from both agencies would be sought. Casassa emphasized that there is a synergy with UNESCO which GCW

needs to exploit. This workshop would offer the opportunity to merge operational and research activities. The group was reminded that Barry Goodison and Jeff Key met with UNESCO (IHP and IOC) to discuss GCW and potential cooperation in 2012. Unfortunately, this meeting occurred just as US funding to UNESCO was being cut. UNESCO IHP has been invited to GCW meetings but has been unable to attend.

ACTION: The Secretariat is asked to review the WMO mission report of the meeting with UNESCO (Meeting File/Meeting Form No: S-OME 187-2011) and to provide an update and follow-up on actions/activities and recommendations since the meeting.

ACTION: GSG and Secretariat are requested to include funds in their 2016 budget proposal to support one participant from each Andean country to participate in the 2016 joint WMO/UNESCO workshop. (UNESCO would be asked for the same support) (Chair, Vice-chair GSG, D/OBS)

ACTION: Director of WMO/OBS Department will contact WMO Education and Training Programme about possible support of this workshop activity and to identify opportunities for collaboration and funding for GCW to provide training sessions to build capacity. (Wenjia Zhang)

2.4 **Report on the CryoNet Asia 3rd Pole activities:** A report was not available in advance of the meeting. A [presentation](#) (Asia CryoNet 2015) was forwarded by Xiao Cunde to D/OBS at the meeting. A [presentation](#) on the Third Tibetan Plateau Atmospheric Scientific Experiment (TIPEX III) was also made available. An update of outstanding actions from the first Asia CryoNet meeting is needed, including progress on establishing a Regional WG. The very limited engagement of the operational agencies, notably the NMHSs, was identified as a weakness. D/OBS will discuss further with CMA.

ACTION: The Chair of the GCW Steering Group will contact Xiao Cunde requesting a written update on the open and ongoing action items from the 1st Asia CryoNet meeting (Annex 3). The report is required by January 15 (before the Salekhard meeting)

ACTION: Given the size and diversity of the Asia CryoNet region, the CryoNet Team felt there was a need for need more representation from Asia CryoNet and that a second representative to work with Xiao Cunde would be beneficial. The Chair of the CryoNet Team will discuss this further at the Salekhard meeting. (Wenjia Zhang)

ACTION: Noting the need for a stronger link between CAS, CMA and GCW, D/OBS will discuss with CMA about its involvement and potential contributions to GCW. Qin Dahe will also be consulted on this issue. (Wenjia Zhang)

2.5 **Status of CryoNet:** The discussion was led by the Chair of the CryoNet Team, Wolfgang Schöner. Several issues were raised which helped set the context for more in-depth discussion of the topics to follow, including:

- What are the requirements for the “Watch”? This sets the tone for what is needed and ultimately creates the value-chain.
- The chair of the GSG noted that it is important not to make the CryoNet process an elite approach; GCW is trying to operationalize monitoring of the cryosphere and it needs to be inclusive, not exclusive.
- CryoNet sites offer a mechanism for people to work together. One of the original attributes for sites was to measure as many elements of the cryosphere that may occur at the site as possible – an integrated cryosphere site.
- What are critical variables to be measured at CryoNet stations and sites?

- GCW needs to be clear on how synoptic and climate stations fit into the GCW observing system and how they can contribute to GCW and CryoNet.
- What does GCW mean by “cryosphere representativeness”?
- How can the GCOS reference network contribute to GCW?

The document describing the GCW Surface Observing Network was presented and revised during the workshop for submission to the GSG. Most significantly it updated and clarified the properties of GCW stations and sites. The document was revisited during the discussion of agenda 2.5.6 Review of Design Principles.

2.5.1 **List of existing sites:** The list of existing CryoNet, contributing and candidate sites are given in **ANNEX 4**. Given the new CryoNet structure, the last column of the table defining “Type” will need to be eliminated or revised.

ACTION: The Table in ANNEX 5, and on the website, needs to be updated to reflect the new CryoNet structure for stations and sites. (Wolfgang Schöner; Michele Citterio, Charles Fierz, Jeff Key)

2.5.2 **Pre-operational testing:** Pre-operational testing is an essential step in the development of CryoNet. A sub-group (see 2.5 above) will conduct this evaluation phase and it is in the process of developing the procedure to be followed. As a first step, the CryoNet chair prepared a “data sample” from the CryoNet sites (see [Document 2.5.2\(2\) Rev 1](#)). This provides insight on data available (non-exhaustive list of parameters currently being measured at each station/site in the CryoNet pre-operational phase), the date when the latest data are available from each station/site and a brief description of how to access the data, and a data sample.

Stations/sites identified and approved for the pre-operational testing phase will be assessed according to their capability to share metadata and data. This process has started, led by the Secretariat (Clément Hutin). Each station has been requested to provide WMO with information on the location and procedure to access the data for that particular station. This may be through ftp, website, email or other means, but it should allow WMO to download data for virtually all measurements (elements and variable) specified in the station’s CryoNet Questionnaire. The following information is being considered in the selection process of sites to be included in CryoNet:

- a. The means through which data are accessible (website, email, ftp, other);
- b. The types of measurements performed at that station/site (meteorological, glaciological...);
- c. Link to data or other information (e.g., data manager email) through which the data are available;
- d. Procedure to download data;
- e. Parameters measured at that station;
- f. File type (Excel, Text...) and data format (csv, tsv...);
- g. The date of the latest data available.

The results of the data availability study up to the time of the meeting are presented in [Document 2.5.2\(1\)&3.3.5\(1\), Rev 2](#).

A schedule for conducting the pre-operational testing phase and completing the review process for presentation to the next CBS meeting in November 2016 was prepared during the meeting for approval by the GSG (see **ANNEX 6**). The sub-group needs to develop templates to compile what different sites are doing, including information on the time step of observations.

ACTION: A sub-group was established to evaluate the stations that have been approved for pre-operational testing: Wolfgang Schöner, V. Smolyanitsky, Michele Citterio, Charles Fierz, permafrost rep (from GTN-P steering community), and lake ice (possibly a SWIPA author).

ACTION: Rick Thoman will ask Vladimir Romanovsky to help evaluate permafrost and the Alaska NWS River Forecast Center for a river/lake ice expert as they still do operational measurements.

ACTION: The CryoNet document and the selection process should be forwarded to GCW partners to assess if requirements are clear (e.g. WIGOS, WIS, WGMS, GTN-P, GTN-G, IPA, GCOS, GAW, IACS, and IHP)

ACTION: GSG Vice-chairperson contacted Secretariat seeking the continuing assistance of Clément Hutin the CryoNet Team in completing templates from questionnaires and getting information on time steps of observations and Specific tasks can be identified for appropriate action by Secretariat. Chair of CryoNet will follow-up.

2.5.3 Review of (minimum) Site/Station Requirements: The minimum station requirements were again reviewed in the context of the revised GCW structure. **ANNEX 7** provides a proposed revised version developed by Wenjian Zhang (D/OBS) which is presented in a manner similar to WIGOS.

ACTION: CryoNet Team, in consultation with the Secretariat, is to finalize the revised minimum requirements for a CryoNet station/site (CryoNet Team, Secretariat) and ensure these are included in the relevant GCW documents.

2.5.4 Review of minimum program for CryoNet Sites: The CryoNet Team has started the process to determine a viable minimum program of cryosphere observations at CryoNet stations and sites using manual and automatic observing methods and remote sensing information. This task has just started and the Team shared their initial effort ([GCW-CryoNet-minimum-requirement-of-sites_2015-12-07.xlsx](#)) to identify the variables which could be measured. All participants were invited to provide their feedback on the tables.

2.5.5 Review of Site Questionnaire: The questionnaire ([Doc.2.5.5](#)) will be reviewed when changes are required. No action was deemed necessary at this time.

2.5.6 Review of Design Principles: Michele Citterio has been leading this important task for GCW and has been representing GCW on the WIGOS Programme Expert Team on the Observing System Design and Evolution (IPET-OSDE). [Document 2.5.6](#) and the presentation ([CryoNet Design Principles](#)) on this topic provide an excellent summary on GCW Network Design and how it currently fits into the broader WIGOS design. The overall GCW design is broadly consistent with Technical Regulations (WMO-No. 49) and the Manual on the WMO Integrated Global Observing System as per v. 0.11 (2015 edition), in particular section 2.2.2.1 and Appendix 2.1 on Observing System Network Design (OSND) Principles. In order to facilitate a direct reference to the twelve WIGOS OSND Principles, each one of them is given in Doc. 2.5.6, followed by the relevant CryoNet-specific details.

CryoNet structure deviates the most from WIGOS OSND guidelines on “designing through a tiered approach”. WIGOS states that observing network design should use a tiered structure, through which information from reference observations of high quality can be transferred to and used to improve the quality and utility of other observations. While the word ‘tier’ is not used, the GCW and CryoNet Station and Site concept describe in effect a tiered structure, with CryoNet Sites and Stations providing the higher quality observations (‘reference observations’ in the language of the WIGOS OSND guidelines). Subsequent discussion decided that GCW should respond to WIGOS that they need to recognize that CryoNet operates in a different manner; we do operate in the general framework recommended by WIGOS. It was also noted that the GCW observing system includes all sources of information, including from satellite and a variety of ground based sources in addition to CryoNet.

ACTION: The “GCW surface observing network” is comprised of CryoNet and contributing stations. This is a type of tiered network. This wording has to be rationalized to ensure consistency in all GCW documents.

ACTION: GCW needs to have a representative at the next WIGOS design team meeting. This should be Michele Citterio, if he is available.

ACTION: The updated version of the CryoNet Network Design document will be sent to all CryoNet Team members for comment by January 8, 2016.

ACTION: GCW is included in the Manual on WIGOS; hence changes are submitted to ICG-WIGOS which in turn reports to Executive Council (EC). This document should not be rushed for the April meeting. The GSG Chair recommended that GCW submit what is available at the 2016 ICG-WIGOS meeting, and if the document still needs work, then it be submitted to the November meeting of CBS-16 for review and then to ICG-WIGOS in early 2017. (Secretariat to co-ordinate with Chair and vice-chair of Observations WG)

The CryoNet Network Design must align with that of the GCW Surface Observing Network. The latter document received considerable discussion and the updated version is given in **ANNEX 8**. The properties of stations and sites were updated to clarify and simplify their description. This major change has to be incorporated into all GCW documents, including the design document. There was a proposed update of the minimum station requirements as described above and given in **ANNEX 7**. Once these are approved by the CryoNet Team, they will be incorporated as a further revision to the GCW surface observing network document. The question of the size of a site was briefly discussed and it was suggested that it could be 400-500km². For reference, the nominal grid cell size of the gridded SSMI/S sea ice products is 25 km x 25 km and for cal/val the satellite product may help define the area of a CryoNet site over which measurements are made. Øystein Godøy reminded the CryoNet Team that GCW is an observing component system under WIGOS, and hence GCW should adopt the overall structure of WIGOS metadata in order to help GCW participants. Also in the WIGOS context, it is feasible that CryoNet stations could become part of the Regional Basic Observing Network (RBON) and GCW should consider the strategy of regional networks in its planning.

ACTION: The CryoNet Team is to finalize **ANNEX 8**, revising as appropriate (e.g. minimum requirements) and with Secretariat support, ensure that all GCW documents reflect the revised structure of the surface observing network.

2.5.7 Review of the Process for Assessment of Sites: Sandy Starkweather led a discussion on developing the process for assessment of sites proposed to CryoNet, including a summary review ([Doc 2 5 7 CryoNet.pptx](#)) of the process used by other relevant global programs. As noted at the first GCW CryoNet meeting, GCW has many similarities to the GAW network. It was suggested that a closer look of the GAW procedures for acceptance was warranted.

Several related issues/suggestions were raised, some of which will require further action by the team and/or Secretariat, including:

- The process used by different networks relates to the requirements of the stations/networks: this may be based on station’s location, on the technology being used, on protocol or quality based practices implemented, or policy based.
- If GCW is to meet the “Watch aspect”, then some data will be needed in real-time (e.g. snow depth); GCW needs to identify which variables are needed in real-time, near-real-time (and define) and later and this depends on the variable and user need.
- For a station to be accepted, the “Watch” group has to define the time frame for data submission and the station has to agree to submit in a timely manner.
- There is a need to develop a minimum set of measurements at a CryoNet station.

- GCW needs to develop as a global network, which is an evolving network of established stations and stations which GCW may wish to be established.
- Stations/sites need to be assessed against GCW minimum requirements; experts with knowledge of the different cryosphere variables need to be part of the process.
- The current formal procedure requires a letter from the PR supporting a station to be a CryoNet station; an extra step may be required as the PR may have to have an agreement/understanding with another agency which is the station operator before submitting the letter.

ACTION – Secretariat to check for letters received to date.

- A key step for approval is data accessibility and quality control; Charles Fierz noted that at Davos they are developing interfaces to be interoperable with the GCW Portal and rather than others duplicating such an effort, they offered to share what has been developed with other data centres and providers of CryoNet data.

ACTION: Godøy and Fierz, with Secretariat support, to determine a procedure for sharing with other centres.

This discussion led to a draft procedure for acceptance of new stations into GCW (**ANNEX 9**), which was accepted by the CryoNet Team for submission to the GSG.

ACTION: Draft procedure is to be finalized, with support from Secretariat, by January 31, 2016

2.5.8 **Selection of newly proposed sites:** Drafts are online for the Davos site, and for stations in Columbia and Spain. It was understood that the candidate site, Formigal in Spain, was submitted by the proponent, but it appears that its questionnaire is still in draft form. This will need to be followed up with the proponent.

ACTION: A response to those with draft submissions is required noting that we are updating our documents and procedures, including some changes to the questionnaire, which they would be asked to address.

ACTION: Jeff Key is requested to follow up on the submission of the Formigal questionnaire (contact Samuel Buisan).

2.5.9 **Data Policy:** There was no action on data policy since the last meeting. The chair of the GSG recommended that GCW should use what been accepted by operational and research communities. GCW does need a policy document. Policies from IPY, IASC, GEO and the EU would offer guidance suitable to GCW. It should not be too restrictive. Existing WMO policies (Resolutions 25 and 40) and the climate data policy discussed at Cg-17 (Resolution 60) should be included in the review. A small group is needed to review policies and recommend a draft data policy for GCW. It was noted that the satellite community was aiming for free and open access for everyone. It was noted that for cal/val that there needs to be a working agreement with those who wish to exploit CryoNet site data. There also needs to be special access to products to assess quality in real-time. The policies used in South America and Asia need to be determined and reviewed.

ACTION: A small data policy group (Øystein Godøy, Þorsteinn Þorsteinsson, Thomas Johanneson) was established to review data policies and prepare a draft GCW data policy for review before the next meeting. Þorsteinn and Thomas will take the lead.

ACTION: The issue of data exchange and hence data policy will need to be discussed at the Salekhard CryoNet meeting. The outcome of the discussion is to be provided to the data policy group.

2.6 **Draft list of CryoNet stations for consideration by GSG and EC-68, including draft Resolution on CryoNet:** This task cannot be completed until the selection procedure is in place and the selection completed. The team established to do the selection will use remote discussion. The Secretariat can set up WebEx communication for these discussions. The PSTG noted that they are imaging selected permafrost sites and these should be cross-referenced with GCW CryoNet sites to ensure co-ordination wherever possible. ESA has funded PAGE21 continuation to ensure sites are continued for this study.

ACTION: The list and associated resolution should be available by the end of September 2016 to allow for translation into all WMO languages before the CBS meeting. Secretariat will coordinate with the CryoNet chair to facilitate this process.

2.7 **Review of Best Practices for CryoNet:**

2.7.1/2 **WMO Technical Regulations and WIGOS Regulatory Material:** Information on WMO Technical Regulations ([Doc. 2.7.1](#)) and WIGOS Regulatory Material ([Doc. 2.7.2](#)) were provided to participants before the meeting for their review. Dr. Zhang gave [a summary presentation](#) on both topics, emphasizing the outcome of Cg-17 in the context of GCW. An important issue is to determine the best approach and mechanism for GCW to manage the revision of WMO TR and Manual on WIGOS with respect to GCW and CryoNet. The process of changes for GCW depends on their nature: editorial changes can be approved by the President, non-critical decisions by Executive Council and critical changes by Congress. Changes in the documents, as discussed at this meeting, have to be incorporated as recommended changes in the Manual: CBS can make the recommendation on the changes. Hence, draft revisions should be submitted to CBS-16 in November and subsequently to EC-69 in 2017; a brief to the next EC-PHORS would also be necessary as it oversees GCW implementation.

W. Zhang also provided an overview of the Secretariat role to support GCW development ([GCW role of Secretariat DOBS Dec 2015 final.ppt](#)). He also noted the importance of workshops and meetings of regional associations and technical commissions which could be used by GCW to engage regional and national support. This will require preparation of appropriate documents, but will be fundamental in coordinating GCW within WMO (see **ANNEX 10** for calendar of known meetings). Although GCW works at the global level, WIGOS can help GCW in pushing to get coordination and commitment at the national level. GCW needs to continue working with partners and national entities to encourage expansion of met stations for cryosphere measurements. Monitoring of data reporting will be important for GCW and at the moment it will have to do its own monitoring. It has the added challenge that it works with the research community whose culture is not operational so GCW will have to work to promote reporting in a timely manner. Eventually GCW will become part of the regional monitoring centres' responsibility, so it will have to engage these centres as they are established. The Portal Team chair also noted that WIS is also very important for GCW, particularly since WIS and WIGOS look at different aspects of metadata. For the exchange of data, the new resolution 60 could help promote exchange of cryosphere data in a timely manner (see **ANNEX 11**).

2.7.3 **Status of the development of Primer:** The primer needs to be updated with the new text developed by the Team. Also some terminology needs to be included as an annex in the Primer so that the GCW teams, the cryosphere community at-large and WMO programmes are working with the same understanding of terms used. It was noted that a person is needed to develop the section for lake ice. Perhaps the person involved in the pre-testing sub-group could be engaged, or a co-author of the SWIPA report (e.g. Claude Duguay).

ACTION: The Primer should be ready for the CBS-16. The document will need to be translated so it should be ready by end of September. Wolfgang Schöner will lead completion of the

document which must be reviewed by the CryoNet Team and Observations WG before submission to CBS-16.

ACTION: Engage a person to prepare the lake ice section. (Rick Thoman will ask the Alaska NWS River Forecast Center for expert to join the CryoNet Team).

2.7.4 **Review of available and proposed GCW agreed practices:** Þorsteinn Þorsteinsson provided a summary of the progress to date on compiling best practices ([GCW-Guide-Manual-Workplan1st draft.docx](#)) and provided an outline and timeline for preparing a 30-40 page GCW Guide to Cryospheric Practices and then a more comprehensive Manual of Best Practices (see **ANNEX 12**). In-situ and satellite based observations would be included. Engagement of experts from different countries and regions will be essential. Experts will be drawn from GCW teams and working groups and nominees through national focal points and partner organizations. A separate best practices team should be established to focus on this task; small sub-groups may be established to work on individual components. Existing links on the website must be checked. New manuals, guides, best practices need to be added, including national guides which may have to be translated so the material can be incorporated as appropriate. Existing WMO practices included in WMO Guides (e.g. CIMO, Climate, Hydrology, AgMet) would be included. Ongoing regional efforts should be incorporated whenever possible (e.g. HarmoSnow in Europe). The guide and manual will include best practices suitable for research and operational purposes. It was noted that IICWG is working on preparing a list of available guides and manuals from which it would select the best manual. Their starting point is WMO-No.574; their timeline is JCOMM 2017. IACS could possibly create a WG to bring together scientists on best practices.

The CBS representative (Sue Barrell) noted the GCW documents have to be aligned with Manual and Guide on WIGOS as well as with other WMO Guides. D/OBS saw the task being done over the next 3 years ultimately producing a guide and manual that would be translated, so the task has to be started immediately, as per the timeline proposed in **ANNEX 12**. It is recognized that components could proceed as individual tasks over different timelines. It was recommended that drafts of the components be posted on the GCW website as “Draft for Comments” seeking community feedback. Then the documents would go to CBS-16 and CIMO-17 as they are part of WIGOS. An essential step is to ensure community consultation and feedback so there is global acceptance.

ACTION: Recommend to the GSG the creation of a Best Practices Task Team under the Observations Working Group.

ACTION: Secretariat will help to guide where there should be consultation and to manage the internal WMO process.

ACTION: Best Practices Team and the Secretariat must ensure community consultation and feedback so there is global acceptance of the Guides and Manual.

3. PORTAL ISSUES

3.1 **Review of Actions from previous meetings:** Actions were reviewed and updated (see **ANNEX 3**).

3.2 **Review of the Portal Team Work Plan:** Øystein Godøy, Chair of the Portal Team, led the discussion on progress of the team’s work plan (**ANNEX 13**). Items 1.1 to 1.12 relate to 3.3 below.

3.3 **Status of GCW Data Portal:** The Chair of the Portal Team presented a very useful update ([gcw-201512-dmstatus-joint.pdf](#)) of the status and plans for the GCW Portal Data Catalogue and the issues which need to be addressed by the Team, as well as [Doc. 3.3](#) submitted prior to the meeting.

3.3.1 **Dataset inventory:** Currently metadata are routinely harvested from the following data centres: British Antarctic Survey; CryoClim; Chinese National Arctic and Antarctic Data Center; National Institute of Polar Research (Japan) – Arctic Data Archive System; Norwegian Polar Institute; and National Snow and Ice Data Center. These data centres are now harvested twice daily. In addition, testing is either ongoing or planned towards a number of other data centres, including:

- Canadian Cryospheric Information Network (CCIN) – the main issue being translation of controlled vocabularies for mapping to search model, metadata are routinely harvested.
- International Arctic Systems for Observing the Atmosphere (IASOA) – the main issue is translation of controlled vocabularies for mapping to search model.
- World Glacier Monitoring Service (WGMS) – the main issue is the availability of metadata in a proper form.
- Arctic and Antarctic Research Institute (AARI) – testing is ongoing, but progress is slow due to man power.
- Global Terrestrial Network – Permafrost (GTN-P) – discussions on metadata end points, no end point received so far.
- EUMETSAT – Updated discussions on end points as interfaces has changed slightly. The main issue used to be mapping of controlled vocabularies, but this is potentially solved.

All the datasets referred to above are hosted by contributing data centres and not by the GCW Portal. Only metadata is harvested and stored in a searchable catalogue. A schematic of the current configuration is presented in **ANNEX 14**. Further information on the status of interfaces etc. and associated issues were provided in the session presentation.

One issue requiring attention is the use of controlled vocabularies and the development of structured data management. WMO uses controlled vocabularies, but there are issues with their consistency as codes.wmo.int is not yet populated enough. There needs to be discussion on development, propagation and utilization of controlled vocabularies. ICSU has significant experience with archived data while WMO's experience is primarily with operational data; WIS "lost momentum" to ICSU WDS after IPY on these issues and there is an opportunity to cooperate with ICSU on such matters.

ACTION: Recommend that the GSG ask WMO, through the Secretariat, to engage with ICSU on data management issues.¹

3.3.2 **WIS DCPC status:** Following GSG requests to establish the GCW Data Portal as a WIS DCPC, the Norwegian Meteorological Institute has started to plan this. The Norwegian Meteorological Institute has already been through the approval process for a WIS DCPC earlier (Arctic Data Centre) and will base the new DCPC proposal on this experience. However, in order to reduce development and maintenance costs creating a sustainable framework for operation of two DCPCs, the WIS implementation plan at the Norwegian Meteorological Institute is under revision and the revised version will cover GCW requirements as well. This work is expected to be completed within 2016.

3.3.3 **GCW Portal Interoperability guidelines:** A first draft version of the GCW Portal Interoperability Guidelines has been developed ([Doc. 3.3.3](#)). The purpose of the guidelines is to inform contributing data centres and CryoNet sites on the interoperability requirements of the GCW Portal. Part of the intention of the guidelines is to reduce the number of interfaces the GCW Portal has to maintain towards contributing data centres. If the number of interfaces is too large or complicated, development and maintenance costs are too high and the portal is not sustainable.

ACTION: The GSG, CryoNet Team, WIS, and data centres should be asked for their advice and feedback on the guidelines proposed.

¹ Post meeting note: Data Week 2016 will take place in Denver, organised by RDA, ICSU-CODATA and ICSU-WDS.

3.3.4 **GCW Portal Operations Manual:** A first draft version of the GCW Portal Operations Manual has been developed ([Doc. 3.3.4](#)). The purpose of the Manual is to specify some rules for operation of data centres contributing to the GCW Portal in order to avoid changes at data centres which break the functionality of the GCW Portal. Among the issues identified in the Operations Manual are identification of Points of Contacts, change procedures etc.

ACTION: The GSG, CryoNet Team, WIS, and data centres should be asked for their advice and feedback on the proposed manual.

3.3.5 **Accessibility of data from CryoNet sites:** It had been decided to start the work on integration of data from CryoNet sites with the stations at Davos, Sonnblick and Sodankylä. Discussions and interaction with the SLF-Davos station have been most efficient. This has resulted in the implementation of interfaces to metadata for SLF-Davos. These interfaces are currently being tested; initial testing has been successful and metadata will be integrated in the searchable catalogue if tests are successful. However, the integration currently is only at the metadata level. Further work is required to achieve interoperability at the data level and data segmentation for real time exchange. For Sonnblick the primary data flow comes through Pangaea. The datasets that were available at the time when this interface was set up are currently being harvested, but the interface has to be operationalised as it currently is a test interface. The main challenge of integrating these data is establishing a real time data stream through Pangaea. This is currently not supported by Pangaea, but the issue is discussed. This needs to be discussed in more detail with Sonnblick operators. Cryospheric information for Sodankylä from FMI is available through an Apollo ERDAS CSW server. Testing is ongoing, but has not succeeded yet. Challenges are related to understanding end points functionality and usage of controlled vocabularies when mapping to the search model used in the GCW Portal.

The Secretariat has also been testing the availability of data as part of the pre-operational testing phase of CryoNet (see [Doc. 3.3.5\(1\) Rev2](#)) and also 2.5.2 above). One of the requirements for stations to be considered in CryoNet is that “data and metadata, including changes in instrumentation, traceability, and observation procedures, are submitted in a timely manner to a data centre that is interoperable with the GCW portal”. This is now being checked for stations approved for pre-operational testing. The procedure established is described in Doc.3.3.5(1). The data contact for each station has been emailed and asked to provide WMO with information on the location and procedure to access the data for that particular station. The results of the data availability study to-date are presented in the appendix of the document. It must be remembered that GCW operates with stations outside the WMO and the exchange of data may be too difficult using BUFR code tables and the GTS; real-time exchange may be on the internet. The user community’s needs must be considered in data exchange.

ACTION: The chair and vice-chair of the GSG commended the Secretariat, and especially Clément Hutin, for initiating this work and requested their continuing support for this task.

3.3.6 **Plan to develop interfaces with CryoNet Sites, including bilateral agreements:** Based on the experience from working with the stations above, preliminary versions of the GCW Portal Interoperability Guidelines and GCW Portal Operations Manual have been developed. The intention of these documents is to guide CryoNet sites in the dialogue with the GCW Portal Team as it is expected that many sites do not have interoperable data management systems. In this context, the experience from the dialogue with SLF-Davos is invaluable and encouraging. The plan is to distribute the two manuals to CryoNet sites once they have been discussed properly at the joint Portal and CryoNet Teams meeting and GSG and modified accordingly.

ACTION: The current drafts should be sent to Steve Foreman to review and submit to the WIS OPAG as documents for ultimate approval by CBS-16

ACTION: The following experts are recommended to be members of the Portal Team: Hironori Yabuki, Julie Friddell, Peter Pulsifer, and Lynn Yarmey; the GSG is requested to approve.

ACTION: The Team is asked to consider the need for a data management expert for high mountain regions.

ACTION: The Portal Team chair was asked to prepare a workplan for the next 2 years; this has been completed and is included in ANNEX 13.

4. WEBSITE ISSUES

4.1 Review of Actions from previous meetings: Actions were reviewed and updated (see ANNEX 3).

4.2 Review of the Website Team Work Plan: Jeff Key, Chair of the Website and Outreach Team, provided a review ([gcw_website_update_1215.pptx](#)) on progress of the team's work plan. Team members include Rick Thoman and Jenny Baeseman. A webpage to show surface network sites by category and a database table and search tool for the Snow Watch inventory were completed. Progress on new trackers and the glossary are noted below. The station/site questionnaire underwent some significant changes after the Copenhagen meeting as can be seen online. The code for the "Cryosphere in the News" news feed had to be completely rewritten due to the termination of Yahoo Pipes, which was used to gather relevant articles from a variety of news feeds and journals. A few products have been added to "Cryosphere Now". As part of the outreach effort, the GCW handouts and poster were updated for distribution at Cg-17 and are available for download from the website.

Based on discussions at the CryoNet Team meeting, an updated plan for the next 2 years was prepared (see ANNEX 13). Plans include further revision of the station/site questionnaire based on the new CryoNet structure defined at this meeting, adding additional ice products suggested by M. Drinkwater, and finalizing and adding some new trackers. In the longer term making the GCW more mobile friendly is envisioned. The Website and Outreach Team Chair also suggested that a GCW Newsletter could add visibility as an outreach mechanism; this should be considered when the GCW Project Office is established. GCW refers routinely to "meeting user needs" and it should discuss how survey(s) of user needs might be conducted, such as ones done by IICWG and the EU Project CryoLand.

The Website and Outreach Team needs to be enlarged to meet the growing needs and complexities of GCW. Contributors of assessments are needed. It would be useful to include more pictures and videos and to have some more graphics for glaciers, permafrost and South American activities.

ACTION: Gino Casassa will provide information to add real-time data for the Southern Hemisphere.

ACTION: Glaciers at CryoNet sites could be added to glacier sections (CryoNet Team).

ACTION: Further discussion is required to identify how GCW can get both human and financial resources to conduct specific tasks such as data processing and development of products for the GCW Website.

Rick Thoman provided a very informative overview ([Alaska monitoring.pptx](#)) of the products provided by NWS Alaska for "cryosphere and climate monitoring". There were many good examples of products they prepare, including some on impacts. Although regional, GCW should consider including these on the website. These are the type of value-added products that GCW could develop,

in cooperation with Members, on a pan-Arctic basis as cryospheric products available through the Polar Regional Climate Centre. They have several lake/river ice products, an area where GCW is currently weak. They have also incorporated traditional knowledge in producing user driven products.

ACTION: The Website Team will initiate inclusion of these regional products on the website.

ACTION: Rick Thoman, through the US PRCC team, will promote the development of such cryospheric products as a regional pan-Arctic cryosphere product for the PRCC.

4.3 **Documented practices on GCW Website:** An initial inventory of existing documents describing practices for cryospheric measurements can be accessed from GCW Website and is summarized in [Doc.4.3](#). This task will be the responsibility of the new Best Practices Task Team (see 2.7.4 above).

4.4 **Snow Watch Product Inventory:** [Document 4.4](#) provides an initial inventory of the Snow Watch products developed by the Snow Watch Team and available on the GCW Website. The Snow Watch Team is assessing the maturity and accuracy of snow products through an intercomparison project. With this perspective in mind, it has developed an initial inventory of snow products that is available on the GCW website and is reproduced in Annexes 1 to 3 of Doc 4.4. The inventory is provided in three categories: (1) Satellite-derived snow products and datasets, (2) Analyses, reanalyses and reanalysis-driven snow products and datasets, and (3) In-situ snow products and datasets. It is an important source of information and is meant as a living document with updates and additions incorporated on an ongoing basis. GCW's mandate is to be an authoritative source of cryospheric information for many users, among others the Polar Regional Climate Centres. Therefore the inventory provides users with some guidance about the suitability of snow information products and datasets for various applications that can be found under "comments". Further information is available on the website.

4.5 **GCW Trackers:** [Document 4.5](#) provides information on GCW "trackers" currently available on GCW website and plans for the future. GCW and its partners are developing "trackers" for the cryosphere. Most will be based on satellite data. The trackers will provide a quick look at the current state of cryosphere relative to the mean state of the last 2-3 decades. The existing trackers for the cryosphere include: (a) The FMI/GCW SWE Tracker, based on GlobSnow snow water equivalent (SWE); (b) EC/GCW Snow Cover Extent; and (c) The EC/GCW Snow Water Equivalent; see: <http://globalcryospherewatch.org/satellites/trackers.html>. Other trackers that are currently under development include surface albedo, sea ice thickness, and cloud cover. Mark Drinkwater noted additional sea ice products which have been identified in the Website workplan for inclusion. A pertinent question, applicable to the trackers and to products, is what is the policy or procedure for including products on the website. All teams need to consider this issue, as it relates directly to the provision of authoritative information.

ACTION: The Snow Watch Team was asked to address how GCW trackers can be included in WMO's Annual Climate Statement. The Secretariat will discuss with Omar Baddour who is responsible for producing the statement.

4.6 **GCW Glossary:** [Document 4.6](#) provides information on the GCW Cryosphere Glossary currently available on the website and plans for expanding the effort. GCW has now incorporated 19 existing snow & ice glossaries (<http://globalcryospherewatch.org/reference/glossary.php>) including some 2500 cryospheric terms, 1500 of which are unique (see ANNEX 15). The glossary covers ten cryospheric and/or related elements, namely: snow, sea ice, freshwater ice, glaciers, ice sheets, permafrost, precipitation, ice in general, miscellaneous, and atmosphere. The GCW Terminology Team, led by Gino Casassa, has been activated and a workplan developed. ANNEX 15 provides the concept to be implemented in three phases. The support of Clément Hutin, an intern in the Secretariat, is greatly appreciated. To implement such a "pan-cryospheric" glossary will require

collaboration from the cryosphere community at-large and also ideally the endorsement of all relevant cryosphere organizations.

The GCW glossary terms will ultimately be included in WMO's METEOTERM.

5. FUTURE ACTIVITIES

5.1 **Next meetings and/or workshops:** The following meetings/tasks of the Observations, Information and Services WGs were identified for the next 15 months:

- CryoNet Station/site selection working meeting, Graz, Austria, July 2016 (3 days).
- Student to provide analytical support, and CryoNet document preparation (4months @50%).
- CryoNet Team Meeting (3 days, consecutive with GSG), Dec 2016 - Jan 2017 (site TBD).
- UNESCO-GCW-WMO Latin America glacier workshop, 2ndQ 2016, (Santiago, date TBC).
- Best Practices Team Meeting, Tentative- March 2017, Reykjavik, Iceland.
- Portal Team Meeting, TBD.
- Terminology Team meeting, TBD.

All planned meetings/tasks are subject to budget approval. Additional meetings should be identified as soon as possible to add them to the planning cycle. In addition there are the WMO meetings identified in **ANNEX 10**, at which GCW presence may be requested and documents required. WebEx calls can be arranged by the Secretariat to facilitate a virtual meeting. These are effectively used by other WMO projects and teams.

6. REPORT TO GCW STEERING GROUP

6.1 **Draft report to GSG:** All teams updated their presentations and documents as necessary for submission/presentation to the GCW Steering Group for their consideration.

7. ANY OTHER BUSINESS

An open discussion on the need to engage scientists, students and institutes/agencies in GCW ensued. This logically links to the availability of financial resources. Several people noted that accessing resources to support GCW activities at the national level will involve reaching out to programs and departments external to NMHSs and that GCW might be “packaged” with other larger initiatives which need cryosphere products, observations, or data and information services. In some countries, there may be projects supported by Foreign Affairs Ministries or State Departments which may offer opportunities in regions of interest and need of GCW activities. Mark Drinkwater brought [several opportunities](#) to the attention of the meeting. These include EU Horizon 2020 opportunities, including a space component and a transatlantic partnership mechanism between the EU-USA-Canada on Arctic-Atlantic connections, especially for oceanography. Such opportunities have been used in the past for activities which supported GCW objectives. The EU-COST project funded a snow initiative (HarmoSnow) whose outcomes should be useful for the Best Practices team. Other components, e.g. glaciers could try using the COST mechanism. In all such initiatives the link to GCW can be identified. At the national level it was suggested that data management aspects should be included in proposals as appropriate and hence take advantage of other programs for funding GCW interests. Such opportunities were identified for Norway, Canada, Japan and the EU. D/OBS briefed the team on the status of the Project Office, which hopefully will be filled in 2016.

ACTION: Team leads are requested to share funding opportunities with other team leads and with team members.

ACTION: It is recognized that Team leads and members are very busy and students or interns could help with writing proposals as well as providing support to team leads. Secretariat and Team leads should identify opportunities to support the project in this manner.

ACTION: The session was informed that ECMWF will run a Climate Change Service, for which validation of models will require long-term observations. Wolfgang Schöner will follow up with Gianpaolo Balsamo on this potential link.

ACTION: Sue Barrell will keep GCW informed of Australian opportunities which may evolve from a review of their Antarctic program.

ACTION: Mark Drinkwater will keep GCW informed of potential opportunities related to the validation of Copernicus.

ACTION: It was noted that funding for ETSI was in doubt and they asked whether GCW could help, although GCW has no funding allocated for this activity. Secretariat is asked to investigate the situation and advise the GSG Chair and vice-chair on this situation.

ACTION: There needs to be a concerted effort to engage young scientists in GCW, drawing on the accomplishments of APECS. An invitation should be extended to a representative of APECS, or someone like Jenny Baeseman with a strong background in engaging young scientists, to participate in next year's GSG meeting.

8. CLOSURE OF MEETING

The meeting officially ended at 14h15 to allow time to rearrange the room for the open session.

8.1 The list of action items arising from the Meeting is provided in **Annex 16**.

9. OPEN SCIENCE SESSION

After the CryoNet meeting and before the GCW Steering Group Meeting, an open session was organized at NSIDC to interact with local scientists. The objective was to share perspectives on issues such as observing the cryosphere, developing/delivering cryospheric products, or any relevant data issues of relevance to the global community. The following talks were [presented](#).

Overviews

Mark Serreze (NSIDC overview)
Árni Snorrason (GCW overview)
Wolfgang Schöner (CryoNet overview)
Øystein Godøy (GCW Data Portal overview)

Series Talks

Florence Fetterer (Sea Ice Products)
Lynn Yarmey (Cryospheric Data Management)
Roy Rasmussen (SPICE)
Matt Shupe (MOSAIC)
Bruce Raup (GLIMS)
Ted Scambos (Mapping Glacier Flow Speed with Landsat)

The GCW Steering Committee on behalf of all GCW participants expressed their appreciation for the opportunity to meet with the local community, and particularly NSIDC who hosted the session.

GLOBAL CRYOSPHERE WATCH (GCW)
Joint Meeting of CryoNet Team and Portal & Website Team
Third Session

AGENDA

VENUE: University of Colorado, NSIDC, Boulder, Colorado, USA

DATE/TIME: 7 December 2015 09.00 to 9 December 2015 18.00

1. ORGANIZATION OF THE MEETING (Chair W. Schöner)

- 1.1 Welcome and Opening of the meeting (W. Schöner/W. Zhang)
- 1.2 Adoption of the Agenda (W. Schöner)
- 1.3 Working Arrangements (W. Schöner/S. Starkweather)
- 1.4 Introductions of participants (participants)

2. CRYONET ISSUES

- 2.1 Review of Actions from previous meetings (WMO Secretariat)
- 2.2 Review of the CryoNet Team Work Plan (W. Schöner)
- 2.3 Report on the CryoNet South America activities (G. Casassa)
- 2.4 Report on the CryoNet Asia 3rd Pole activities (C. Xiao)
- 2.5 Status of CryoNet (W. Schöner)
 - 2.5.1 List of existing sites (W. Schöner/WMO Secretariat)
 - 2.5.2 Pre-operational testing (W. Schöner/WMO Secretariat)
 - 2.5.3 Review of (minimum) Site Requirements (W. Schöner with help from C. Fierz, M. Citterio, C. Genthon, V. Smolyanitsky)
 - 2.5.4 Review of minimum program for CryoNet Sites (W. Schöner with help from C. Fierz, M. Citterio, C. Genthon, V. Smolyanitsky)
 - 2.5.5 Review of Sites Questionnaire (J. Key, W. Schöner)
 - 2.5.6 Review of Design principles (M. Citterio)
 - 2.5.7 Review of the Process for assessment of Sites (S. Starkweather)
 - 2.5.8 Selection of newly proposed sites (W. Schöner)
 - 2.5.9 Data Policy (W. Schöner/ Þ. Þorsteinsson)
- 2.6 Draft list of CryoNet stations for consideration by GSG and EC-68, including draft Resolution on CryoNet (W. Schöner)
- 2.7 Review of Best Practices for CryoNet
 - 2.7.1 WMO Technical Regulations (WMO Secretariat)
 - 2.7.2 WIGOS Regulatory Material (WMO Secretariat)
 - 2.7.3 Status of the development of Primer (W. Schöner)
 - 2.7.4 Review of available and proposed GCW agreed practices (Þ. Þorsteinsson/C. Fierz)

3. PORTAL ISSUES (Ø. Godøy)

- 3.1 Review of Actions from previous meetings (WMO Secretariat)
- 3.2 Review of the Portal Team Work Plan
- 3.3 Status of GCW Data Portal
 - 3.3.1 Dataset inventory
 - 3.3.2 WIS DCPC status
 - 3.3.3 GCW Portal Interoperability guidelines
 - 3.3.4 GCW Portal Operations Manual
 - 3.3.5 Accessibility of data from CryoNet sites
 - 3.3.6 Plan to develop interfaces with CryoNet Sites, including bilateral agreements

4. WEBSITE ISSUES (J. Key)

- 4.1 Review of Actions from previous meetings (WMO Secretariat)
- 4.2 Review of the Website Team Work Plan
- 4.3 Documented practices on GCW Website
- 4.4 Snow Watch Product Inventory
- 4.5 GCW Trackers
- 4.6 GCW Glossary

5. FUTURE ACTIVITIES

- 5.1 Next meetings and/or workshops (W. Schöner/J. Key/Ø. Godøy/WMO Secretariat)

6. REPORT TO GCW STEERING GROUP

- 6.1 Draft report to GSG (W. Schöner/J. Key/ Ø. Godøy/WMO Secretariat)

7. ANY OTHER BUSINESS (W. Schöner/J. Key/ Ø. Godøy/WMO Secretariat)

8. CLOSURE OF MEETING (15h00) (W. Schöner/J. Key/ Ø. Godøy/WMO Secretariat)

9. OPEN SCIENCE SESSION (1500-1745)

Overviews:

- Mark Serreze (NSIDC overview)
- Árni Snorrason (GCW overview)
- Wolfgang Schöner (CryoNet overview)
- Øystein Godøy (GCW Data Portal overview)
- Mark Drinkwater (Polar Space Task Group)

Series Talks:

- Florence Fetterer (Sea Ice Products)
 - Lynn Yarmey (Cryospheric Data Management)
 - Roy Rasmussen (SPICE)
 - Matt Shupe (MOSAIC)
 - Bruce Raup (GLIMS)
 - Ted Scambos (Mapping Glacier Flow Speed with Landsat)
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GLOBAL CRYOSPHERE WATCH (GCW)
Joint Fourth CryoNet Team and Third Portal and Website Teams Meeting
 Boulder, Colorado, USA,
 7-9 December 2015

LIST OF PARTICIPANTS

Name	Institution/Affiliation	E-mail
Arni Snorrason	Icelandic Meteorological Office, Bustadavegur 7-9, IS-108 Reykjavik, Iceland	Arni.snorrason@vedur.is
Sue Barrell	Bureau of Meteorology, G.P.O. Box 1289, Melbourne, 3001 VIC, Australia	s.barrell@bom.gov.au
Gino Casassa	Geoestudios, San Jose de Maipo, Chile; and, University of Magallanes, Punta Arenas, Chile	gino.casassa@gmail.com
Michele Citterio	GEUS - Geological Survey of Denmark and Greenland, Copenhagen, Denmark	mcit@geus.dk
Mark Drinkwater	Mission Science Division (EOP-SM), European Space Agency (ESA), ESTEC, Keplerlaan 1, NL-2201 AZ Noordwijk, The Netherlands	mark.drinkwater@esa.int
Charles Fierz (remote participation)	WSL Institute for Snow and Avalanche Research SLF, and International Association of Cryospheric Sciences (IACS), Davos, Switzerland	fierz@slf.ch
Øystein Godøy	Norwegian Meteorological Institute, Oslo, Norway	o.godoy@met.no
Barry Goodison	Vice-Chair, GSG 4 Vezina Pl., Kanata, Ontario K2K 3G9, Canada	barrygo@rogers.com

Jeff Key	Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison, 1225 West Dayton Street, Madison WI 53562, USA	jkey@ssec.wisc.edu
Kari Luojus	Finnish Meteorological Institute (FMI), Helsinki, Finland	kari.luojus@fmi.fi
Vasily Smolyanitsky	Arctic and Antarctic Research Institute, St. Petersburg, Russian Federation	vms@aari.aq
Sandy Starkweather	University of Colorado, Boulder, Colorado, USA	sandy.starkweather@noaa.gov
Wolfgang Schoener	University of Graz Dept. of Geography Heinrichstrasse., 36 8010 Graz Austria	wolfgang.schoener@uni-graz.at
Þorsteinn Þorsteinsson	Icelandic Meteorological Office, Reykjavík, Iceland	thor@vedur.is
Hironori Yabuki	Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan	yabuki@jamstec.go.jp
Rick Thoman	NOAA-National Weather Service P.O. Box 757345 Fairbanks, Alaska, 99775 USA	richard.thoman@noaa.gov
Wenjian Zhang	WMO Secretariat, 7bis, avenue de la Paix, CH 1211 Geneva, Switzerland	wzhang@wmo.int

ACTION SHEET – STATUS December 2015
First CryoNet Asia Workshop, Geneva (3-5 December 2013)

N°	Action	By	Deadline	Status/ Comments
CryoNet structure				
1	Establish Regional Working Groups (GCW-R-WG) (according to WMO Regions), i.e., membership, work plans, etc.	Secretariat, with leading regional experts	Ongoing	OPEN
2	Within GCW-R-WG in RA II, establish a Working Group on Practices, i.e., membership, work plan.	Jeff Key & Cunde Xiao (with help from Secretariat)	Jun.2014	CLOSED
3	Define a formal procedure to nominate experts to GCW-R-WG	Cunde Xiao (with help from Secretariat)	Ongoing (associated with RA sessions)	OPEN
4	Compile information on proposed stations of CryoNet Asia.	Secretariat	Mar.2014	Request has been sent to managers of stations
5	Write a letter to countries' Permanent Representative for WMO to reaffirm the GCW focal point and to seek support for GCW and CryoNet.	Secretariat	Mar.2014	CLOSED
6	Include AWS in the CryoNet Asia.	Members of GCW-R-WG	Sep.2014	OPEN
7	Update GCW-IP to better define role of the Third Pole in GCW	Jeff Key	Jan.2014	CLOSED
8	Update GCW-IP to include Himalaya, Pamir and Tien Shan in the Third Pole definition of CryoNet Asia (wider than it is now).	Jeff Key	Jan.2014	CLOSED
9	Update GCW-IP to include a mechanism within GCW to coordinate work of GCW Working Groups and GCW-R-WGs.	Jeff Key	Jan.2014	CLOSED
10	Update GCW-IP by replacing the term "Supersite" by "Integrated Site".	Jeff Key	Jan.2014	CLOSED
Data policy				
11	Develop data policy for Baseline, Reference and Integrated sites.	GCW-R-WGs	Dec.2014	Draft version
12	Provide metadata for Baseline, Reference and Integrated sites.	Site operators	Dec.2014	Continuous
13	Provide recommendations on data sharing principles to the Draft Resolution under discussions for GFCS.	GCW-R-WGs	Sep.2014	CLOSED
14	Define data quality requirements within CryoNet-Asia.	GCW-R-WG	Sep.2014	OPEN
15	Encourage free data exchange.	GCW-R-WG	ongoing	
16	Clearly cite the data provider when including data in GCW products (who's the provider, data originator, publication reference...).	GCW community	ongoing	
Other issues				
17	Strengthen the collaboration between observing network operators, observers and modellers to create an integrated network.	GCW-R-WG	ongoing	
18	Create a link to the main research publications on the GCW website.	Jeff Key	Mar.2014	CLOSED
19	Organize the next meeting of GCW-R-WG-RA-II in 2014.	Jeff Key (with help from Secretariat)	Oct/Nov. 2015	Will be held in Salekhard, RF, 2-5 Feb 2016

First CryoNet Team Meeting, Reykjavik (20-22 January 2014)

N°	Task	Deliverable / Activity	Due	Responsible	Status/Comments
1	Primer to CryoNet	Technical report	April 2014	W. Schöner and CryoNet Team (with help from secretariat)	OPEN - Draft version available
2	Text for WIGOS section for WMO TR 49	Document	May 2014	W. Schöner, J. Key, B. Goodison	CLOSED
3	Chapter 6 for WIGOS Manual	Document	May 2014	W. Schöner, J. Key, B. Goodison	CLOSED
4	Minimum requirements for site inclusion in CryoNet	Document	Feb. 2014	W. Schöner	CLOSED
5	Site questionnaire (metadata information)	Document	Feb. 2014	J. Key, S. Starkweather	CLOSED
6	TOR for CryoNet	Document	Jan. 2014	B. Goodison	CLOSED
7	List of CryoNet candidate sites (including metadata)	Document	Jan. 2014	J. Key	CLOSED
8	List of initial CryoNet sites	Document	Jan. 2014	J. Key	CLOSED
9	Draft CryoNet Data Policies	Document	Feb. 2014	W. Schöner, T. Johannesson, T. Thorsteinsson	OPEN
10	South America CryoNet Meeting	Workshop	Oct. 2014	G. Casassa	CLOSED
11	Design Principles of CryoNet	Document	May 2014	M. Citterio, V. Smolyanisky, T. Ohata	Draft available
12	CryoNet Portal Team Meeting (including data management)	Meeting	June 2014	J. Key, C. Fierz	CLOSED
13	Review of Best Practices	Document	2015	C. Fierz, M. Citterio,	OPEN

Joint Second CryoNet and First Portal & Website Teams Meeting, Davos (11-13 June 2014)

N°	Action	Responsible	Deadline	Status /Comments
1	Add citation information to metadata – It is already done in WIS discovery metadata under UML classes (CI).	J. Key	Continuous	This is done when a new questionnaire is filled out.
2	Invite GCW to metadata meetings – ICG WIGOS TT on Metadata – invite Øystein Godøy (back-up Michele Citterio).	Secretariat	Continuous	For each ICG WIGOS TT on Metadata meetings
3	Scientific Data Conference Nov. 2014 – There is a need for WMO to participate.	Secretariat	CLOSED	
4	Inform Øystein Godøy who can help him to establish controlled vocabularies.	Secretariat	CLOSED	CLOSED
5	Inform every data provider that they should implement one of the agreed protocols for the metadata interoperability with the GCW Portal, such as: OAI-PMH, OGC CSW, ISO23950/Z39.50, HTTP (FTP), SMTP.	Secretariat (after information provided by Ø. Godøy)	December 2014	OPEN
6	Add into the CryoNet Site Questionnaire, questions on data and metadata formats and interfaces and then decide what should be the preferred formats.	J. Key Ø. Godøy	CLOSED	Preferred formats remain to be defined
7	Some data and products should be endorsed by GCW, therefore, criteria should be establish to define “GCW endorsed data”	J. Key Ø. Godøy	January 2015	OPEN
8	CryoNet Team should assess what kind of data should be exchanged in real-time, time critical data.	W. Schöner	January 2015	OPEN
9	GCW Portal should become operational soonest possible to make GCW visible. Øystein Godøy will prepare a road map.	Ø. Godøy	January 2015	OPEN

First CryoNet South America Workshop, Santiago (27-29 October 2014)

N°	Action	Responsible	Deadline	Status /Comments
1	Select National Representatives of CryoNet South America among the participants invited to CryoNet South America Workshop, in coordination with the national IACS correspondents.	Gino Casassa	Mid-November 2014	DONE
2	Each National Representative will contact the respective agencies, institutions and colleagues to remind them to complete the site questionnaire	Each National Representative	25 November 2014.	DONE
3	Form a Regional Group by consensus from the National Representatives	Each National Representative	April 2015	OPEN
4	Include Mexico in the group, and the name CryoNet Latin America will be proposed.	Regional Group	April 2015	OPEN
5	Potential collaboration with the Latin America and the Caribbean (LAC) regional section of the International Hydrological Programme (IHP) of UNESCO will be proposed to the Snow and Ice Working Group of LAC.	Gino Casassa, Regional Group (with support from WMO Secretariat)	June 2016	OPEN
6	Preparation of the Second CryoNet Latin America meeting	Gino Casassa with Secretariat	2 nd Q of 2016	OPEN

**Joint Third CryoNet and Second Website & Portal Teams Meeting,
Copenhagen (19-20 January 2015)**

N°	Action	Responsible	Deadline	Status/Deadline
1	Organize a joint UNESCO & Second CryoNet Latin America, City?, Country?, 2Q 2016.	Secretariat	On-going	Postponed until late 2016, possibly Santiago
2	Contact Xiao Cunde to seek its collaboration to nominate GCW focal points, national representatives and experts in order to establish the Regional Asia Group.	Secretariat	May 2015	OPEN
3	Present the new CryoNet structure to the GSG members during the following meeting to seek their consideration.	CryoNet team		DONE
4	M. Citterio, as CryoNet representative, will attend the WIGOS meeting related to observing network design issues.	M. Citterio	On-going	
5	GCW members are requested to provide cryospheric assessments (e.g. glaciers).	GCW members	On-going	
6	Submit the list of sites/stations identified for the pre-operation testing phase to GSG for consideration and approval.	CryoNet team		DONE
7	Update the GCW website accordingly to both the new CryoNet structure and the agreed list of site/station.	GCW website team		DONE
8	Re-design the questionnaire so that applicants will have to select one of the two categories (core or contributing sites).	GCW website team		DONE
9	Send a letter to PRs to seek approval with their sites to be included in the pre-operational testing phase.	Secretariat		DONE
10	Contact Sandra Barreira (Argentina) and ask her to specify the categories of the proposed sites/stations.	GCW website and CryoNet teams	May 2015	DONE
11	Organize teleconference to follow-up with identified actions.	Secretariat	On-going	

CRYONET TEAM WORK PLAN 2015

Activity	Deliverable	Deadline	Responsible	Members	Comment
Update documents for Cg17		2015-01	Secretary		
Update GCW regularly material		ongoing until 2016-01	Secretary		
Editing of questionnaires by expert	Questionnaire update	2015-02-08	Gino Casassa, Jeff Key		
Update CryoNet Primer	CryoNet Primer	03-2015	Wolfgang Schöner	CryoNet team	Integrate new site types structure and contributing sites
Review available and propose GCW agreed observing practices	GCW agreed practices	11-2015	Porsteinn Porsteinsson, Charles Fierz	Gino Casassa, Michele Citterio, Wolfgang Schöner, Vasily Smolyanitsky, additional experts for cryo-components tbd	Table with experts for various cryo-components to be invited for the group, entire group structured into sub-groups for cryo-components To be established as a new task team
Developing the process for assessment of sites proposed to CryoNet	Document on procedure for assessment of CryoNet sites	2015-11	Sandy Starkweather	CryoNet team	
Consider defining minimum program for CryoNet sites	Document on minimum program for CryoNet sites	2015-11	Wolfgang Schöner	Charles Fierz, Michele Citterio, Christophe Genthon, Vasily Smolyanitsky, lake ice	List of variables measured for each cryo-component
Selection of CryoNet sites	List of CryoNet sites for EC	2015-12	Wolfgang Schöner	CryoNet team	To be approved by ECPORS (first info go to ECPORS in 09-2015, final approval by email)
CryoNet team meeting	Report	3days in 12-2015	Wolfgang Schöner	Secretary	suggested location: Boulder, suggested date: week before AGU2015
Joint CryoNet-Portal team meeting	Report	1day in 12-2015	Wolfgang Schöner, Øystein Godøy	Secretary	Topic for meeting (beside others): How will CryoNet (meta)data be integrated into GCW portal?
2nd CryoNet Asia workshop	Report	3 days 02-2016	Vasily Smolyanitsky	Secretary, Wolfgang Schöner	
Joint UNESCO-GCW-CryoNet meeting in SA	Report	10-2015	Gino Casassa		Join activities of GCW and UNESCO

LIST OF EXISTING GCW AND CRYONET STATIONS AND SITES

Existing CryoNet Sites

Station/Site	Operating Country	Location	Type
1 SIGMA-A	Japan	Greenland	Basic
2 PROMICE Greenland Ice Sheet Monitoring Network	Denmark	Greenland	Basic
3 Sonnblick	Austria	Austria	Integrated
4 Qilianshan Station of Glaciology and Ecologic Environment	China	China	Basic
5 Sodankylä-Pallas	Finland	Finland	Integrated
6 Qilian	China	China	Integrated
7 Tanggula Cryosphere and Environment Observation Station	China	China	Basic
8 Eureka	Canada	Canada	Basic
9 Hofsjökull	Iceland	Iceland	Basic
10 Antisana 15 alfa	Equador	Equador	Basic
11 Zongo Glacier	France	Bolivia	Integrated
12 Morenas Coloradas Rockglacier	Argentina	Argentina	Basic
13 Quelccaya Ice Cap	USA	Peru	Basic
14 Weissfluhjoch - Davos	Switzerland	Switzerland	Integrated
15 Glaciar Norte	Mexico	Mexico	Basic
16 Saint-Sorlin Glacier	France	France	Integrated
17 Argentiere Glacier	France	France	Integrated
18 Mer de Glace Glacier	France	France	Basic
19 Gebroulaz Glacier	France	France	Basic
20 Xidatan	China	China	Integrated
21 Tanggula	China	China	Integrated
22 Tiksi	Russia	Russia	Integrated
23 Ice Base Cape Baranova	Russia	Russia	Integrated
24 Vuriloches	Argentina	Argentina	Basic
25 Aonikenk	Argentina	Argentina	Basic
26 Barrow Baseline Observatory	USA	USA	Integrated
27 Tianshan	China	China	Basic

Station/Site	Operating Country	Location	Type
28 Zackenberg	Denmark	Greenland	Integrated
29 The Koxkar Glacier Camp (KGC)	China	China	Integrated
30 Syowa	Japan	Antarctica	Integrated
31 SIGMA-B	Japan	Greenland	Basic
32 Dome-C	France-Italy	Antarctica	Basic
33 Spasskaya Pad (Yakutsk)	Japan	Russia	Integrated
34 Forni Glacier	Italy	Italy (Europe)	Basic
35 Valle Nevado	Chile	Chile	Basic
36 Col de Porte	France	France	Integrated

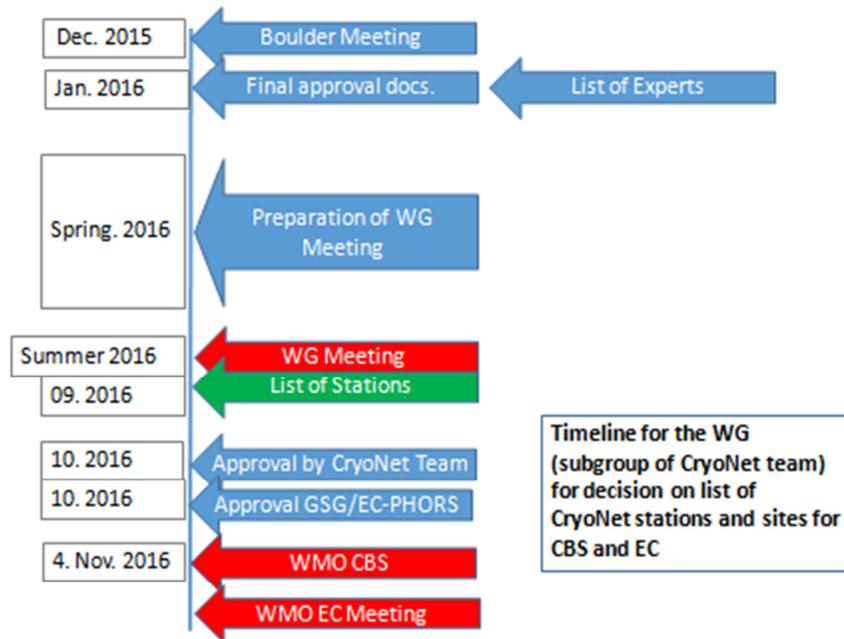
Existing Contributing Sites

Station/Site	Operating Country	Location	Type
1 Yanamarey	Peru	Peru	n/a
2 Gueshque	Peru	Peru	n/a
3 Artesonraju	Peru	Peru	n/a
4 Mocho-Choshuenco Volcano	Chile	Chile	n/a

Existing Candidate Sites

Station/Site	Operating Country	Location	Category	Type
1 Glaciar Conejeras	Colombia	Colombia	Core	Basic

**TIMELINE FOR DECISION OF WORKING GROUP
ON ACCEPTANCE OF CRYONET STATIONS/SITES**



CRYONET STATION REQUIREMENTS – Proposed Revisions

In order for a surface station to be included in the core part of the GCW network, CryoNet, it must meet certain criteria. The current minimum requirements are posted on the GCW Website. If a station meets these requirements, additional information can be provided for further evaluation through the GCW Station/Site Questionnaire. Contributing stations, which are part of the GCW surface network, but not part of CryoNet, only need to meet the data sharing requirement, although they would be encouraged to meet as many of the requirements as possible.

Discussion at the CryoNet meeting resulted in a suggested revision and update to the minimum requirements, as given below. When finalized by the CryoNet Team, and approved by the GSG, these will become the minimum requirements for a CryoNet station.

Revised Minimum requirements of CryoNet Station (to be finalized by CryoNet Team)

1. Meeting Core CryoNet Measurement Requirements

The station shall measure at least one of the major cryosphere components and variables (i.e. snow, solid precipitation, lake and river ice, sea ice, glaciers and ice caps, ice sheets, permafrost and frozen ground). The station location is chosen such that cryospheric measurements are representative of the surrounding area, and such representativeness needs to be clearly described by the applicant.

2. Commitment of Operational Continuity

The station must be active. The responsible agencies are committed, to the extent reasonable, to sustaining long-term observations of at least one cryosphere component. There must be a commitment to continue measurements for a minimum of four (4) years.

3. Metadata Up-to-Date and Available

The station metadata (including all needed metadata describing the station characteristics and observational programme information) are kept up-to-date and available in the GCW station information database, and through the GCW Portal, the WIGOS Information Resource (WIR).

4. Compliance with Agreed Regulatory Practice

The station observational procedures, the instruments and method of observations, quality control practices, etc., should follow GCW endorsed regulations, manuals, guides and to the extent possible the recommended GCW best practices.

5. Data and Ancillary Data Freely Availability

Data shall be made freely available, whenever possible in (near-) real time, or otherwise for the agreed timelines (for some special observations which have no real or near real time nature); in-situ ancillary meteorological observations, as required in the CryoNet best practices, should also be available with documented quality.

6. Competency of Staff

Personnel must be trained in the operation and maintenance of the station.

GCW SURFACE OBSERVING NETWORK

The GCW surface observing network builds on existing cryosphere observing programmes and promotes the addition of standardized cryospheric observations to existing facilities in order to create more robust environmental observatories. The basic component of the GCW network, including its core network called *CryoNet*, is the *station*. A station measures one or more components of the cryosphere and one or more variables of each component, for example depth and density of the component snow.

All types of GCW stations need to make their data, metadata, and observation procedures available in a timely manner, preferably to a data centre that is interoperable with the GCW portal. Observations are made and quality controlled according to CryoNet best practices.

A *CryoNet station* must meet the minimum set of requirements, which includes providing ancillary meteorological measurements. Potential attributes of CryoNet stations are given below. All stations will be either Primary or Reference, and may have one or more additional attributes.

- *Primary* - Have a target (intent) of long-term operation and have at least a 4-year initial commitment.
- *Reference* - Have a long-term operational commitment and long-term (more than 10 years) data records.
- *Cal/val* - In addition, the station is being used for calibration and/or validation of satellite products and/or (earth system) models, or it has been used for such purposes in the past and it still provides the needed facilities.
- *Research* - In addition, the station has a broader research focus related to the cryosphere.

The minimum requirements (subject to revision as per (ANNEX 7) of a CryoNet station are:

1. Stations must be active. Observations are made and quality controlled according to CryoNet best practices.
2. The responsible agencies are committed, to the extent reasonable, to sustaining long-term observations of at least one cryosphere component. There must be a commitment to continue measurements for a minimum of four (4) years.
3. The station location is chosen such that cryospheric measurements are representative of the surrounding region, and such representativeness needs to be clearly described.
4. User needs have been considered in the observation design process.
5. Personnel must be trained in the operation and maintenance of the station.
6. In situ ancillary meteorological observations, as required in the CryoNet best practices, are made with documented quality.
7. The station characteristics and observational programme information are kept up-to-date in the GCW station information database. Station metadata are also provided to the WIGOS Information Resource (WIR) and updated regularly.
8. Data are made freely available, and whenever possible in (near) real-time.

A *CryoNet site* generally encompasses an area greater than a conventional observing station and is comprised of two or more active GCW stations with varying capabilities that are operated as a coordinated unit. At least one station has to be a CryoNet station. A site may encompass several micro-climatological regions or extend over larger altitudinal gradients. Thus, further ancillary meteorological stations are part of a site. Different partners may operate the stations, but they are co-ordinated through one agency or institute. Each CryoNet site has to provide a concept describing the research approach and the site management (e.g. cooperation between different partners).

Typically, sites have a broader research focus related to the cryosphere compared to stations. Whereas simple sites investigate the cryosphere only, integrated sites aim to provide a better understanding of the cryosphere and/or its linkages to other components of the earth system, for example, the atmosphere, the hydrosphere, the biosphere, the oceans, soil, vegetation, etc. Potential attributes of CryoNet sites are:

- *Basic* - Monitor single or multiple components of the cryosphere.
- *Integrated* - Monitor at least two components of cryosphere or at least one cryosphere component and one other component of the earth system. Integrated sites are particularly important for the study of feedbacks and complex interactions between these components.

Requirements for CryoNet sites are:

1. A site comprises at least one CryoNet station.
2. Integrated sites have technical supporting staff.
3. Integrated sites have training capability.
4. There is a long-term financial commitment.
5. Data are made freely available, and whenever possible in (near) real-time.

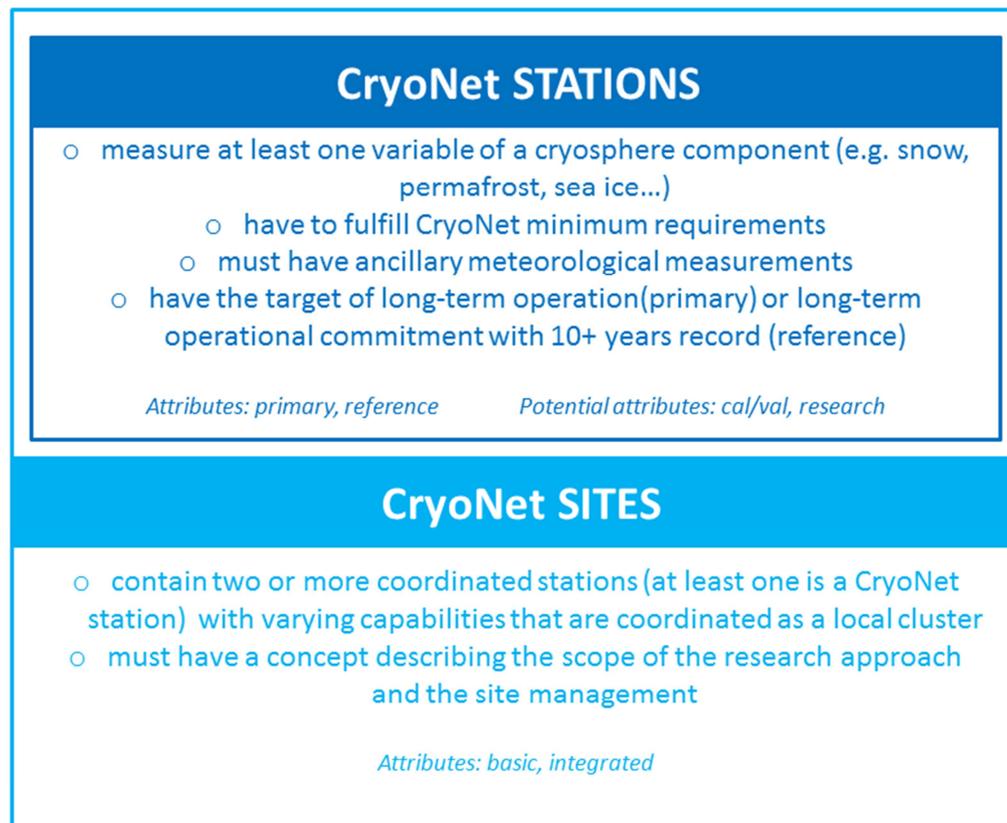


Figure 1: Properties of GCW and CryoNet Stations as well as CryoNet Sites.

A GCW contributing station is required to measure at least one variable of at least one cryosphere component (e.g. snow, permafrost, sea ice, etc.). Contributing stations are those that provide useful measurements of the cryosphere but do not fulfil CryoNet minimum requirements, or in some other way do not provide the quality and/or consistency of data required by CryoNet stations; for example, where data records may be short or with large gaps. These stations may be in remote, hard to access regions where cryospheric observations are scarce or in regions where they complement other cryospheric measurements. Mobile platforms such as ships, drifting stations and buoys may also be contributing stations. Contributing stations may have this attribute:

- Reference - Have a long-term operational commitment and/or long-term (more than 10 years) data records.

Synoptic/climate stations of the NMHSs measuring cryospheric variables to WMO standards, and providing their metadata and data via WIS and WIGOS, could fulfill the necessary requirements in order to contribute to GCW and to be accepted as stations in the GCW surface network.

As encouraged by GCOS, GCW will facilitate the establishment of high-latitude stations with co-located measurements of key variables, especially permafrost and snow cover, thus enhancing GCOS/GTOS Networks for Permafrost (GTN-P), Glaciers (-G) and Hydrology (-H) and including the measurements of solid precipitation. In addition, aerosol contamination of surface snow (dust, black carbon, heavy metals, etc.) will also be monitored to link with existing atmospheric measurements from the GAW network. GAW stations and WCRP/Coordinated Energy and Water Cycle Observations Project (CEOP) reference sites in cold climates are potential candidates. Community monitoring also offers new network opportunities for GCW.

Members, through their GCW focal points, and participants in CryoNet workshops have recommended potential stations and sites. Many Members have proposed contributing to GCW through their sites in Europe, Asia, North America, and South America. For example, China has established sites in the “Third Pole” region where the High Asian cryosphere (HAC) serves as the Asian “water tower” for over a billion people. Finland has the Sodankylä-Pallas site in the boreal forest. Its infrastructure is designed for integrated monitoring of soil-snow-vegetation-atmosphere interaction and provides reference measurements for satellite sensors and model development on a continuous basis. Some of the atmospheric observatory sites operated by the International Arctic Systems for Observing the Atmosphere (IASOA) program are being expanded to include measurements of surface properties, including permafrost, making them ideal for inclusion in CryoNet. Current IASOA member observatories include Barrow-USA, Eureka and Alert-Canada, Summit-Greenland, Ny-Alesund-Norway, Abisko-Sweden, Pallas and Sodankylä-Finland, Tiksi and Cherski-Russia, and the Arctic Drifting Station-Russia. Various countries in South America have proposed glacier stations.

GCW will drive performance and provide motivation for high quality observations. Being a GCW station or CryoNet site means being part of an international, operational, global observing system and thus providing observations of known quality for research and knowledge beyond a site’s local region.

The process of selecting initial CryoNet stations and sites for the GCW network is in its “pre-operational” phase (see <http://globalcryospherewatch.org/cryonet/stations.php>). It will be completed in 2016.

Space agencies, particularly through the WMO Polar Space Task Group (PSTG), and modelling groups such as ECMWF will provide guidance in the development of the surface observing network, given the importance of in situ observations for the validation of satellite products and model parameterization.

DRAFT PROCEDURE FOR ACCEPTANCE OF NEW STATIONS INTO GCW

GCW is open to any station that makes measurements of the cryosphere, but seeks to design a network that advances WMO's scientific and operational objectives. The process of evaluating a station or site for inclusion in the GCW surface network is described below. It is the same for stations and sites, core (CryoNet) and contributing, unless indicated otherwise.

1. A representative of the station or site (hereafter, the "applicant" and the "station") completes and submits the station questionnaire (the "application") on the GCW website (globalcryospherewatch.org/cryonet/questionnaire).
 - It is recommended, though not required, that the applicant present the station at a GCW meeting before beginning the application process.
 - By submitting the application for a core station, the applicant is implicitly agreeing that the station meets the CryoNet Minimum Requirements. A commitment to longevity, data quality, and data distribution is particularly important.
2. Core sites must also submit a site concept paper.
3. For stations that are operated by the WMO Member's NMHS, the WMO Permanent Representative (PR) of the station's operating country sends a letter of endorsement to WMO. For stations that are operated by other national entities, there must be a written agreement between that entity and the PR. For stations that are located in another country... (*The Secretariat will revise this item.*)
4. The application is examined by the WMO Secretariat for completeness.
5. The GCW CryoNet Team, in consultation with relevant experts, evaluates the application. This is normally done annually, but may be expedited in some situations. There are no site visits.
6. If the Team recommends that the station **not** be included in the GCW surface network, feedback is provided to the applicant. The application can be modified and resubmitted at any time.
7. If the Team recommends that the station be included in the network, the GCW Steering Group (GSG) makes its determination. This is normally done at GSG annual meetings. If the GSG recommends that the station **not** be included in the GCW surface network, feedback is provided to the applicant.
8. If the GSG recommends the station for inclusion in the network, the station is conditionally accepted and enters a one-year trial period. The station shall operate according to the Minimum Requirements, including the submission of data and metadata.
9. If the GSG recommends the station for inclusion in the network, the final approval is made by the WMO Executive Council (EC). EC meets annually.

Each CryoNet station will be evaluated annually by the Team to ensure that it continues to meet the Minimum Requirements. If it does not, a timeline for correcting deficiencies will be mutually agreed upon by the Team and the station representatives. If no agreement can be reached, the station will be removed from the CryoNet network or, by mutual agreement, will become a contributing station.

A change in the station type, core or contributing, requires reapplication. This entails a modification to the original application, resubmission, and re-evaluation by the Team and GSG. It does not require approval by EC.

Stations may be withdrawn at any time from the GCW surface network by request, in writing, of the station owners/operators.

When an application is submitted via the online questionnaire process, the station is listed on the GCW website as "candidate". It is not yet part of the GCW surface network. When the GCW Steering Group recommends stations for inclusion in the surface network, for all practical purposes they are part of the GCW network and will be listed on the website accordingly. They are not, however, officially part of the network until approved by EC.

Meetings of Regional Associations and Technical Commissions 2016-2019 for which GCW Input will be Required

	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC
2016						FINAC WMO Bureau EC-68			RA II-16		CBS-16 China	CHy-15 Italy
2017				RA IV-17		FINAC WMO Bureau EC-69	CAS-17 Indonesia		RA VI-17	JCOMM-5 Indonesia		RA V-17
2018			CCI-17 Morocco/ Chile	CAgM-17 Korea		FINAC WMO Bureau EC-70	CAeM-16 Geneva		CIMO-17 Turkey	RAI-17 I B C S - 3		RA III-17
2019					FINAC WMO Bureau Cg-18 CIGG	EC-71						

WMO RESOLUTION 60: WMO POLICY FOR THE INTERNATIONAL EXCHANGE OF CLIMATE DATA AND PRODUCTS TO SUPPORT IMPLEMENTATION OF THE GFCS

Through this resolution WMO Members were, among others, urged to (i) provide the additional GFCS relevant data and products that are required to support and sustain the operational climate services as the core element of the Framework and WMO initiatives at the global, regional and national levels and, further, as mutually agreed, to assist other Members to enhance access to GFCS relevant data and products and in the provision of climate services in their countries; (ii) establish funding mechanisms, including new investments, for sustaining the network of stations and sensors needed for the global observing systems for climate, and also the maintenance and operation of the data preparation and management systems necessary to support the implementation of the resolution; (ii) strengthen their commitment to the free and unrestricted exchange of GFCS relevant data and products;

DEVELOPMENT OF A GCW GUIDE AND MANUAL FOR BEST PRACTICES

Draft suggestion for a Workplan/Timeline

Best practices team: Charles Fierz (WSL/SLF), Þorsteinn Þorsteinsson (IMO), Michele Citterio (GEUS), Wolfgang Schöner (UGraz), Vasily Smolyanitsky (AARI), Jeff Key (NOAA)

January-February 2016:

- Continued survey of existing manuals and reports.
- Focal points contacted and asked to deliver information about national reports/manuals.
- As a global effort GCW must produce a Guide and a Manual that will reflect specific conditions characterizing the cryosphere in different regions.

End of February:

- Short summary document and new draft workplan distributed to entire Cryonet group and GCW Steering Group.

March-April 2016:

- Decide what can be extracted from older reports/manuals (with permission), and what new developments in measurement techniques/data reduction need to be emphasised in a new guide/manual.

End of May 2016:

- Draft of the structure of a new GCW Guide to cryospheric practices ready (formal writing will start when the structure has been decided).
- Ideas for the structure of a GCW Manual being developed simultaneously.
- Collaboration with COST group on snow-related best practices?
- Relation to CIMO guide?
- Have outline/draft ready for september CBS meeting
- Input/feedback from WMO expert groups at this stage.

September-December 2016:

- Writing starts, 1st version of Guide ready by the end of the year.

Mid-year 2017:

- *GCW Guide to the Cryosphere* published
- Plans for *GCW Manual on Best Cryospheric Practices* fully developed

Mid-year 2017 – Congress 2019:

- Work on Manual: Compilation, discussion, writing, editing, publishing.

2020: GCW in operational phase

Information and Services Working Group Work Plan, 2015-2017

#	Task	Deliverable/activity	Due	Responsible	Status	Comment
<i>Portal Team:</i>						
1.1	Integrate relevant data centres	Much of the data that is relevant for GCW is hosted by non WMO data centres. Using relevant networks like CLIC, ICSU WDS, WIS and others, relevant data centres are identified and contacted.	Continuous	Øystein Godøy, METNO Team	Ongoing	Integration of data centres depends on the availability of metadata interoperability interfaces.
1.2	Software development	The GCW catalogue is depending on contributing data centres and the description these provide of their data. As this documentation varies in structure and content, translations are required to provide a unified search interface to all data. This requires continuous adaptation of the software as well as implementation of semantic translations. Interfaces to data is also likely to evolve over time and the software need to be adapted accordingly to provide higher order services on data where possible.	Continuous	Øystein Godøy, METNO Team	Ongoing	
1.3	Establish GCW Catalogue Interoperability Forum	Based on the data centres already integrated with the GCW catalogue a GCW interoperability group is identified. This group will act as reference group for the development of interoperability guidelines. The group cooperates using electronic tools.	2016Q1	Øystein Godøy	Not formally started	Pending first version of interoperability guidelines

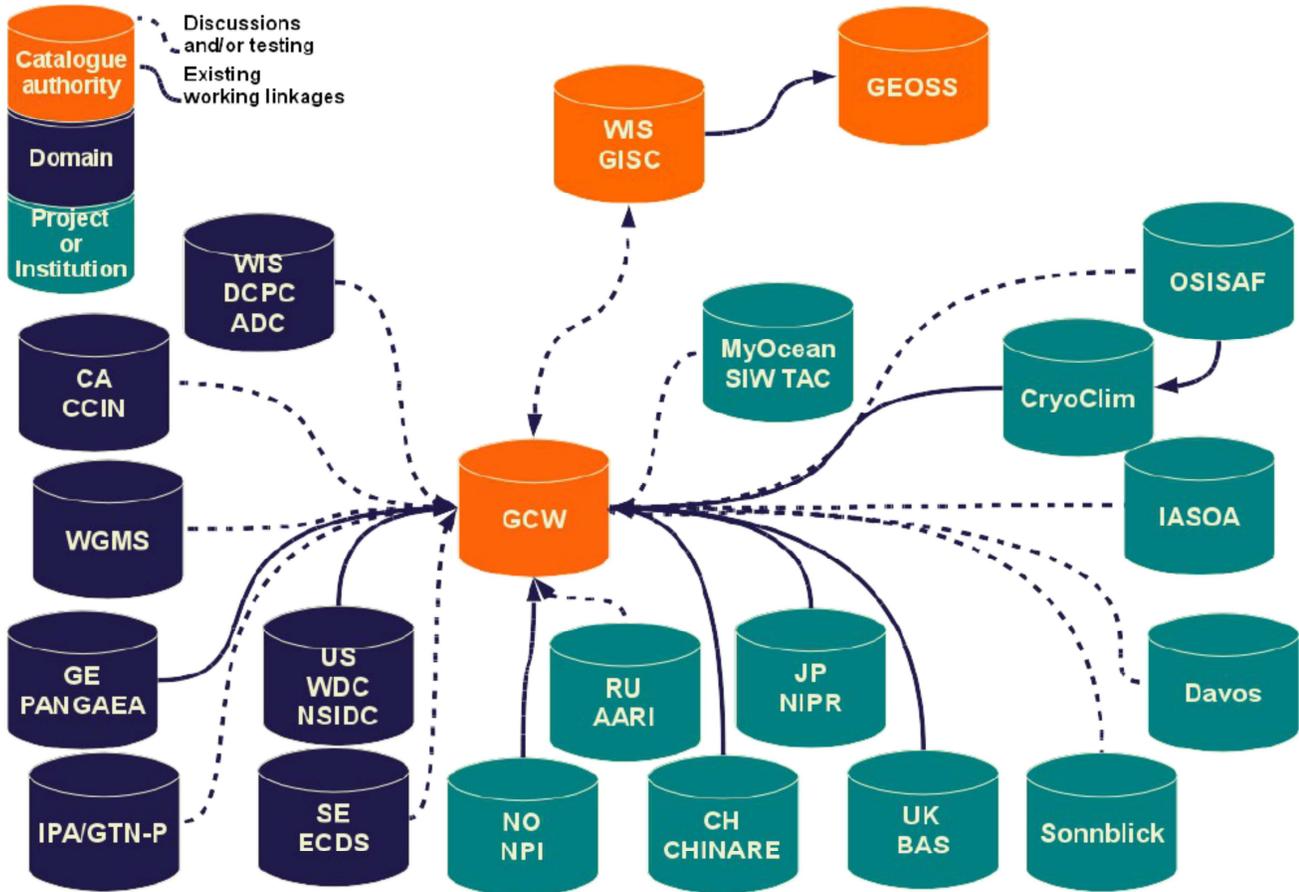
#	Task	Deliverable/activity	Due	Responsible	Status	Comment
1.4	Develop catalogue interoperability guidelines	As GCW depends on a number of data centres that belong to different data management frameworks or are independent, it is useful to develop a formal document of the interoperability standards supported as well as references to relevant documentation developed by e.g. WMO, ICSU WDS, Research Data Alliance and GEOSS. The purpose is to have material on best practise that may help data centres establish machine interfaces that are support the distributed nature of GCW data management while acknowledging that GCW depends on a heterogeneous community.	Draft 2015Q3 2016Q3	Øystein Godøy, Portal Team	Started	This depends on the involvement of a GCW interoperability forum as well as the GCW Portal Team for liason with external activities. First version available. Must be available for CBS, i.e. September.
1.5	Establish the GCW catalogue as a WIS DCPC	Following the joint CryoNet and Web Portal meeting the Davos June 2014, steps to establish the GCW catalogue as WIS DCPC is being taken. This process includes planning of the necessary steps prior to sending a formal application to WMO and subsequently the formal process of evaluation of the proposal by WMO before a potential acceptance.	Approved DCPC by 2016Q4	Bard Saadatnejad (Øystein Godøy)	Started	Due estimate taking into account the approval process of WMO. Pending updated WIS implementation plan at METNO.
1.6	Analyse the problem of duplication of metadata through harvesting	Duplication of metadata records in global catalogues may arise from metadata harvesting as the same metadata may have many paths to a global catalogue. The intention is to describe this problem and to identify potential solutions including those identified by other efforts (e.g. RDA, WMO, ICSU).	2015Q4	Øystein Godøy, Portal Team	Started	Related to WIS/WIGOS activities.
1.7	Develop a GCW Catalogue Operations Manual	Development of a GCW Catalogue Operations Manual will increase the transparency of the GCW Catalogue. It will address issues raised in this work plan and provide the basis for bilateral agreements with contributing data centres.	Draft 2015Q4 2016Q3	Øystein Godøy, (Steve Foreman), Portal Team	Started	First version available. Must be available for CBS, i.e. September.

#	Task	Deliverable/activity	Due	Responsible	Status	Comment
1.8	Develop bilateral agreements with contributing data centres	To avoid duplication of data in global catalogues like WIS and GEOSS, bilateral agreements with contributing data centres are required to define whether harvested metadata should be exposed using machine interfaces by the GCW catalogue or not. A template for agreements has to be developed. While WIS has formal procedures for interaction between data centres, many of the GCW contributing data centres are not WMO members and a pragmatic approach is required to slightly formalise the interaction (e.g. expected service level and error handling) between the GCW catalogue and contributing data centres.	Draft 2016Q1 Continuous	Øystein Godøy, (Steve Foreman)	Planning	This may be separated in two issues. One relating to exposure towards WIS and one on the relation between WIS and GEOSS. If there is a mechanism determining selective exposure of metadata between WIS and GEOSS that can be utilised in this context. The reference group for this work is the GCW Catalogue Interoperability Group. Check e.g how this is handled in GAW.
1.9	Adapt harvested metadata to WMO requirements	The metadata harvested by the GCW catalogue comes from a variety of data centres using a number of standards that differs from the WMO standards. Harvested metadata must be adapted to WMO requirements prior to potential exposure through WIS.	Continuous	Bard Saadatnejad, (Øystein Godøy), METNO Team	Ongoing	Exposure of harvested metadata through WIS depends on the consent of the originating data centre. It is especially important to avoid duplication of records in GEOSS as WIS is connected to GEOSS. Tools for adaptation of metadata is being developed, but procedures is required as well.
1.10	Connect GCW catalogue to WMO GTS for datasets generated by non-WMO members	Much of the GCW community and datasets are external to WMO. Some of these datasets may be useful in real time applications and to support this the GCW catalogue must be able to provide these data on GTS upon request from the GCW community.	2017Q4	Øystein Godøy, METNO Team	Planning	Pending interoperability guidelines and availability of interoperability interfaces for data. Real time access to requested data can also be supported through Internet, but without the guaranteed timeliness of WMO GTS. GTS connection requires a justified request from the GCW user community.

#	Task	Deliverable/activity	Due	Responsible	Status	Comment
1.11	Interaction with GCW user community	In order to continuously adapt the system requirements for the GCW Portal, the GCW user community (including the CryoNet sites) is consulted. Specifically is ongoing GCW activities like Snow Watch important for continuous communication.	Continuous	Øystein Godøy	Started	In the initial phase this is done through joint CryoNet and Portal meetings and through interaction at various conferences. Presentations of GCW Portal made at SciDataCon2014, ADC2014/2015, PDF II.
1.12	Interaction with relevant WMO activities	In order to link GCW activities to relevant WMO activities mutual representation in working bodies and exchange of working documents is required.	Continuous	Øystein Godøy	Started	Participation in TT-WMD. This requires support from the WMO secretariat.
1.13	Integration of Snow Watch Archive with the GCW Portal	The Snow Watch team is planning to develop an archive for snow products. This archive must be structured and documented for integration with the GCW Portal. The Portal team will contribute to design and definition of interfaces.	2016Q4	Øystein Godøy, Kari Luoju	Not started	
1.14	Integration of Snow Watch inventory with the GCW Portal	The Snow Watch team has created an inventory of relevant snow products. This is available in the website, but should be complemented with metadata pointing to actual data in the GCW Portal.	2016Q4	Øystein Godøy, Kari Luoju	Not started	
1.15	Testing against selected CryoNet stations	Development of exchange interfaces for metadata and data between CryoNet stations Weissfluhjoch, Sonnblick and Sodankylä and the GCW Portal. Testing of flows and update of the interoperability guidance material.	2016Q4	Øystein Godøy, Kari Luoju, Wolfgang Schöner, Charles Fierz	Started	
1.16	Joint CryoNet, Best practises and Portal Meeting	Meeting to discuss publication and sharing of CryoNet datasets.	2017Q1	Øystein Godøy, Wolfgang Schöner	Not started	
1.17	Transformation of controlled vocabularies to machine readable form	The vocabularies developed to describe the scientific parameters measured/estimated in the cryospheric components must be available in machine readable form and cross walked to other vocabularies.	2017Q4	Øystein Godøy	Not started	Depends on the results of the terminology team. It is important that vocabularies suitable for description of the variables handled in datasets are generated.

#	Task	Deliverable/activity	Due	Responsible	Status	Comment
1.18	Integration of CryoNet data in the GCW Portal	Dedicated effort to integrate CryoNet data streams (real time and archived) in the GCW Portal. The dedicated effort is focusing on Sonnblick, Sodankylä and Weissfluhjoch since interfaces to these have been tested. Other potential stations can be included in the effort provided they have established the proper interoperability interfaces.	2017Q4	Øystein Godøy, Kari Luojus, Wolfgang Schöner, Charles Fierz	Started	
<i>Website and Outreach Team:</i>						
2.1	Revise station questionnaire based on new CryoNet structure	The CryoNet station-site structure was revised in December 2015. The questionnaire will be modified accordingly.	February 2016	Jeff Key	Not started	
2.2	Add additional products to the Cryosphere Now pages	Some new products are available, notably sea ice thickness from ESA and JAXA.	March 2016	Jeff Key	Started	
2.3	Add additional “trackers”	Add trackers for surface temperature, albedo, and sea ice thickness.	March 2016	Jeff Key	Started	
2.4	Update glossary and requirements as needed	Add additional glossary terms and sources as needed. Update observational requirements as needed.	Continuous	Jeff Key	Ongoing	
<i>Terminology Team</i>						
3.1	Establish partnerships for glossary development	Partnerships with other organizations that have cryosphere interests, notably IACS, will foster community consensus for the glossary definitions. Jointly formulate a plan for completing the GCW Cryosphere Glossary.	Dec 2016	Charles Fierz, Gino Casassa, Jeff Key	Started	
3.2	Update glossary with additional sources	Add IPCC cryosphere term definitions to the glossary	Sept 2016	Jeff Key, Gino Casassa, Charles Fierz	Started	

STATUS OF PORTAL LINKAGES (DECEMBER 2015)



**GLOBAL CRYOSPHERE WATCH (GCW)
TERMINOLOGY TEAM**

Pan-Cryospheric Glossary

GCW has now incorporated the following 19 existing snow & ice glossaries (<http://globalcryospherewatch.org/reference/glossary.php>) including some 2500 cryospheric terms, 1500 of which are unique:

1. Australian Bureau of Meteorology
2. ASPECT
3. Canada National Climate Archive
4. Environment Canada
5. EU Climate-ADAPT
6. IACS-UNESCO Seasonal Snow on the Ground
7. IACS-UNESCO Glacier Mass Balance
8. IPCC WGII AR5
9. NOAA Hydrologic Terms
10. NOAA Snow/Ice
11. NSIDC
12. Sea ice nomenclature WMO No. 259, TP 145
13. USGS Glossary of Glacier Terminology
14. USGS Glossary of Selected Glacier-Related Terminology
15. UK Antarctic Place-Names Committee
16. WMO METEOTERM
17. WMO Sea Ice Nomenclature Version 1.0 by Bushuyev
18. IPCC AR5 WG1 Glossary
19. UNESCO-WMO International Glossary of Hydrology

GCW is considering incorporating the following 6 glossaries:

Multi-Language Glossary of Permafrost and Related Ground Ice Terms. 1998, revised 2005. IPA.
<http://nsidc.org/fgdc/glossary/>

Terminological Guide of the South American Geocryology. D. Trombotto, P. Wainstein & L. Arenson. 2014.

Glossary of Permafrost and Related Ground-Ice Terms. National Research Council of Canada. 1988.

The Dictionary of Physical Geography, 4th Edition
<http://www.wiley.com/WileyCDA/WileyTitle/productCd-111878233X.html>

Illustrated Glossary of Snow and Ice. 1973. Terence E. Roberts, Brian Birley, Swithinbank, Charles, Armstrong.
<http://www.amazon.com/illustrated-Glossary-Snow-Terence-Armstrong/dp/0901021016>

Photo glossary of glaciological terms
<http://www.swisseduc.ch/glaciers/glossary/>

GCW plans to enrich at first the glossary database with existing and authoritative published glossaries. In that regard suggestions from the community are being sought of relevant glossaries not already considered.

A second stage of the GCW "pan-cryospheric glossary" is to select a few hundred, or better even more than 1000, key concepts (entries) for which already existing definitions largely agree within different glossaries.

A third stage would be to discuss and agree upon a definition for concepts where the different existing glossaries do not completely agree, or do not agree at all, by either adapting existing definitions, or by creating a new consensus definition. For this stage expert groups for each cryospheric element (sea ice, glaciers, ice sheets, seasonal snow, lake & river ice, frozen ground) would have to be established, ideally from different backgrounds, different organizations and different nationalities. By and large, this last stage will definitely be the most challenging, although the "controversial" list of concepts is expected to be rather short.

In summary, it would be fantastic for the purpose of implementing such a "pan-cryospheric" glossary to draw on the collaboration from the cryosphere community at-large and also ideally the endorsement of all relevant Cryo Organizations.

LIST OF ACTION ITEMS ARISING FROM THE MEETING

No.	Ref.	Action item	By whom	Deadline
CryoNet				
1	2.1	Take the lead in co-ordinating the establishment of regional working groups, as appropriate, with support from regional experts.	Secretariat	
2	2.1	Discuss setting up an “issue tracking” system for keeping track of progress between meetings with Øystein Godøy for implementation.	Secretariat, Ø. Godøy	
3	2.2	Will continue building interactions and partnerships with communities such as HarmoSnow, IASC, EU-PolarNet and the EU JPI, both within Europe and globally.	W. Schöner + support of GCW experts	
4	2.2	Contact John Pomeroy, who is INARCH chair, to discuss appropriate linkages for GCW and for CryoNet as several INARCH sites could be CryoNet station/sites (and vice versa).	W. Schöner & B. Goodison	
5	2.2	Work with the CryoNet and Portal Teams to assess the appropriate approach for including CryoNet sites/stations metadata in OSCAR/Surface.	Secretariat, W. Schöner, Ø. Godøy	
6	2.3	Asked to review the WMO Trip Report of the meeting with UNESCO (Meeting File/Meeting Form No: S-OME 187-2011) and to provide an update and follow-up on actions/activities and recommendations since the meeting.	Secretariat	
7	2.3	Include funds in their 2016 budget proposal to support one participant from each Andean country to participate in the 2016 joint WMO/UNESCO workshop. (UNESCO would be asked for the same support)	Chair, Vice-chair of GSG	
8	2.3	Contact WMO Education and Training Programme about possible support of this workshop activity and to identify opportunities for collaboration and funding for GCW to provide training sessions to build capacity.	W. Zhang	
9	2.4	Contact Xiao Cunde requesting a written update on the open and ongoing action items from the 1st Asia CryoNet meeting (Annex 3).	Chair of GSG	January 15
10	2.4	Given the size and diversity of the Asia CryoNet region, the CryoNet Team felt there was a need for need more representation from Asia CryoNet and that a second representative to work with Xiao Cunde would be beneficial. The Chair of the CryoNet Team will discuss this further at the Salekhard meeting.	W. Zhang	
11	2.4	Noting the need for a stronger link between CAS, CMA and GCW, D/OBS will discuss with	W. Zhang	

No.	Ref.	Action item	By whom	Deadline
		CMA about its involvement and potential contributions to GCW. Qin Dahe will also be consulted on this issue.		
12	2.5.1	The Table in ANNEX 5, and on the website, needs to be updated to reflect the new CryoNet structure for stations and sites.	W. Schöner M. Citterio C. Fierz J. Key	
13	2.5.2	A sub-group was established to evaluate the stations that have been approved for pre-operational testing: Wolfgang Schöner, V. Smolyanitsky, Michele Citterio, Charles Fierz, permafrost rep (from GTN-P steering community), and lake ice (possibly a SWIPA author).	W. Schöner V. Smolyanitsky C. Fierz M. Citterio permafrost rep lake ice rep	
14	2.5.2	Ask Vladimir Romanovsky to help evaluate permafrost and the Alaska NWS River Forecast Center for a river/lake ice expert as they still do operational measurements.	R. Thoman	
15	2.5.2	The CryoNet document and the selection process should be forwarded to GCW partners to assess if requirements are clear (e.g. WIGOS, WIS, WGMS, GTN-P, GTN-G, IPA, GCOS, GAW, IACS, and IHP)	?	
16	2.5.2	The CryoNet Team in completing templates from questionnaires and getting information on time steps of observations. Identify specific tasks and appropriate actions.	M. Ondráš C. Hutin Chair of CryoNet	
17	2.5.3	Finalize the revised minimum requirements for a CryoNet station/site and ensure these are included in the relevant GCW documents.	CryoNet Team Secretariat	
18	2.5.6	The “GCW surface observing network” is comprised of CryoNet and contributing stations. This is a type of tiered network. This wording has to be rationalized to ensure consistency in all GCW documents.	?	
19	2.5.6	GCW needs to have a representative at the next WIGOS design team meeting.	M. Citterio (if available)	
20	2.5.6	The updated version of the CryoNet Network Design document will be sent to all CryoNet team members for comment by January 8, 2016.	?	
21	2.5.6	GCW is included in the WIGOS manual; hence changes are submitted to ICG-WIGOS which in turn reports to Executive Council (EC). This document should not be rushed for the April meeting. The GSG Chair recommended that GCW submit what is available at the 2016 ICG-WIGOS meeting, and if the document still needs work, then it be submitted to the	Secretariat to co-ordinate with Chair and vice-chair of Observations WG	2016 ICG-WIGOS meeting

No.	Ref.	Action item	By whom	Deadline
		November meeting of CBS for review and then to ICG-WIGOS in early 2017.		
22	2.5.6	The CryoNet Team is to finalize ANNEX 8, revising as appropriate (e.g. minimum requirements) and with Secretariat support, ensure that all GCW documents reflect the revised structure of the surface observing network.	CryoNet Team	
23	2.5.7	Secretariat to check for letters received to date.	Secretariat	
24	2.5.7	Determine a procedure for sharing with other centers.	Ø. Godøy, C. Fierz, Secretariat (support)	
25	2.5.7	Draft procedure is to be finalized, with support from Secretariat.	Secretariat	January 31, 2016
26	2.5.8	Follow up on the submission of the Formigal questionnaire (contact Samuel Buisan).	J. Key	
27	2.5.9	A small data policy group (Øystein Godøy, Þorsteinn Þorsteinsson, Thomas Johanneson) was established to review data policies and prepare a draft GCW data policy for review before the next meeting. Þorsteinn and Thomas will take the lead.	Ø. Godøy Þ. Þorsteinsson T. Johanneson	
28	2.5.9	The issue of data exchange and hence data policy will need to be discussed at the Salekhard CryoNet meeting. The outcome of the discussion is to be provided to the data policy group.	?	
29	2.6	The list and associated resolution should be available by the end of September 2016 to allow for translation into all WMO languages before the CBS meeting. Secretariat will coordinate with the CryoNet chair to facilitate this process.	Secretariat CryoNet chair	End of September 2016
30	2.7.3	The Primer should be ready for the CBS meeting. The document will need to be translated so it should be ready by end of September. Wolfgang Schöner will lead completion of the document which must be reviewed by the CryoNet Team and Observations WG before submission to CBS.	W. Schöner CryoNet Team Observations WG	End of September 2016
31	2.7.3	Engage a person to prepare the lake ice section. (Rick Thoman will ask the Alaska NWS River Forecast Center for expert to join the CryoNet team).	R. Thoman	
32	2.7.4	Recommend to the GSG the creation of a Best Practices Task Team under the Observations Working Group.	GCW Steering Group	
33	2.7.4	Guide where there should be consultation and to manage the internal WMO process.	Secretariat	
34	2.7.4	Ensure community consultation and feedback so there is global acceptance of the Guides and Manual.	Best Practices Team Secretariat	

No.	Ref.	Action item	By whom	Deadline
Portal				
35	3.3.1	Ask WMO, through the Secretariat, to engage with ICSU on data management issues.	GSG Secretariat	
36	3.3.3	CryoNet Team, WIS, and data centers should be asked for their advice and feedback on the guidelines proposed.	GSG	
37	3.3.4	The GSG, CryoNet Team, WIS, and data centers should be asked for their advice and feedback on the proposed manual.	Ø. Godøy ?	
38	3.3.5	Continuing the support for seeking accessibility of data from CryoNet sites.	Secretariat C. Hutin	
39	3.3.6	The current drafts (guide to CryoNet sites in the dialogue with the GCW Portal team) should be sent to Steve Foreman to review and submit to the WIS OPAG as documents for ultimate approval by CBS.	?	
40	3.3.6	The following experts are recommended to be members of the Portal Team: Hironori Yabuki, Julie Friddell, Peter Pulsifer, and Lynn Yarmey; the GSG is requested to approve.	GSG	
41	3.3.6	The Team is asked to consider the need for a data management expert for high mountain regions.	?	
42	3.3.6	The chair was asked to prepare a workplan for the next 2 years; this has been completed and is included in ANNEX 13.	Ø. Godøy ?	
Website				
43	4.2	Provide information to add real-time data for the Southern Hemisphere.	G. Casassa	
44	4.2	Glaciers at CryoNet sites could be added to glacier sections.	CryoNet Team	
45	4.2	Further discussion is required to identify how GCW can get both human and financial resources to conduct specific tasks such as data processing and development of products for the website.	?	
46	4.2	The Website Team will initiate inclusion of these regional products on the website.	Website Team	
47	4.2	Rick Thoman, through the US PRCC team, will promote the development of such cryospheric products as a regional pan-Arctic cryosphere product for the PRCC.	R. Thoman	
48	4.5	The team was asked to address how GCW trackers can be included in WMO's Annual Climate Statement. The Secretariat will discuss with Omar Baddour who is responsible for producing the statement.	Secretariat	
Other business				

No.	Ref.	Action item	By whom	Deadline
49	7.	Team leads are requested to share funding opportunities with other team leads and with team members.	Team leads	
50	7.	It is recognized that team leads and members are very busy and students or interns could help with writing proposals as well as providing support to team leads. Secretariat and Team leads should identify opportunities to support the project in this manner.	Secretariat Team leads	
51	7.	The group was informed that ECMWF will run a Climate Change Service, for which validation of models will require long-term observations. Wolfgang Schöner will follow up with Gianpaolo Balsamo on this potential link.	W. Schöner	
52	7.	Sue Barrell will keep GCW informed of Australian opportunities which may evolve from a review of their Antarctic program.	S. Barrell	
53	7.	Mark Drinkwater will keep GCW informed of potential opportunities related to the validation of Copernicus.	M. Drinkwater	
54	7.	It was noted that funding for ETSI was in doubt and they asked whether GCW could help, although GCW has no funding allocated for this activity. Secretariat is asked to investigate the situation and advise the GSG Chair and vice-chair on this situation.	Secretariat	
55	7.	There needs to be a concerted effort to engage young scientists in GCW, drawing on the accomplishments of APECS. An invitation should be extended to a representative of APECS, or someone like Jenny Baeseman with a strong background in engaging young scientists, to participate in next year's GSG meeting.	?	