ARCTIC-HYCOS PROJECT STEERING COMMITTEE MEETING

REYKJAVIK, ICELAND 23-24 MARCH 2015

FINAL REPORT

Table of Contents

1. Introduction and welcome

The Arctic-HYCOS Project Steering Committee meeting was held on 23 and 24 March 2015 Reykjavik, Iceland at the Icelandic Meteorological Office (IMO) (Vedurstofa Islands) at Bustadavegur 7. The list of participants is attached as **Annex I**.

Mr Árni Snorrason, Director General of IMO and Permanent Representative for WMO to Iceland, welcomed participants to the meeting and to Iceland. He outlined that about six years ago the hydrological and meteorological services in Iceland were amalgamated, and the combined service now also has responsibility for earthquake and volcano monitoring. Mr Snorrason also briefly recounted the history of Arctic-HYCOS starting with a meeting in Helsinki in 2003 through to current activities. He emphasized the importance of the activities of Arctic-HYCOS.

Mr A. Pietroniro also welcomed the participants and provided a summary of the activities to be discussed at the meeting. He recalled that the purposes of Arctic-HYCOS were to advance the operational exchange of hydrological data in the pan-Arctic region leading to improved estimates of fresh-water flux to the Arctic Oceans and seas, increase our understanding of hydrological processes in the north, advance hydrological modelling and prediction, and advance hydrological operational practices and procedures in harsh environmental conditions (e.g., under ice measurements). He also took the opportunity of thanking Iceland for hosting the meeting.

Mr H. Lins, President of the WMO Commission for Hydrology (CHy), also thanked Iceland for hosting the meeting. He also welcomed participants and underlined that Arctic-HYCOS might be considered by some to be an anomaly, considering the technical and scientific capabilities of participating NHSs. However, given such capabilities, Arctic-HYCOS could establish through example how observational data can be accessed and shared, and such approaches may well be a model that could be adopted for use by other HYCOS projects. He noted that Arctic-HYCOS has helped us change in how we think about HYCOS and what it can encompass.

2. Meeting objectives and adoption of agenda

Mr A. Pietroniro recalled the outcomes of the previous meeting held in Geneva, Switzerland, on 26-27 March 2014, including the development of the first work plan for the project, which spanned the period of 1 April, 2014 through 31 March, 2015. He indicated that the objectives of this meeting were to assess progress against the current work plan and to develop a new work plan for 1 April 2015 through 31 May 2016.

The agenda was adopted without modification and is contained in **Annex II**. It was requested that some information be provided on other WMO initiatives or activities that might be of pertinence to Arctic-HYCOS, such as the Year of Polar Prediction 2017-2019 and WMO Executive Council Panel of Experts on Polar Observations, Research and Services (EC-PORS), within the scheduled discussions of the meeting.

3. Network design

Mr R. Lammers provided a brief overview of the activities that had been undertaken regarding the selection and identification of “flow to ocean” stations and “representative of hydrological regime” stations. He indicated that he had developed an initial list and had provided it to all participating countries, with all responding with suggested revisions. He had

decided to exclude small basins within the “flow to ocean” network, with a restriction that the basins must be larger than 5,000 km^2. After merging all responses, his final list contains 70 “flow to oceans” stations and 631 “representative of hydrological regime” stations. This list will form the new Arctic-HYCOS database, with different flags being used to denote each network type. He noted that the “flow to oceans” stations when combined cover 67% of the pan-Arctic drainage area or approximately 16 million km^2 of the total landmass of 24 million km^2 draining into the pan-Arctic ocean and seas. There was related discussion on whether stations that had been discontinued should be considered for inclusion in both networks, resulting in general agreement that such stations should also be included in both networks and be denoted accordingly.

Mr Lammers noted that a further possible refinement would be in agreeing upon possible attributes of stations that comprise the “representative of hydrological regime” network. It was agreed that previous Commission for Hydrology attributes for establishing a reference basin network, similar to the efforts undertaken within Canada and the U.S.A. should be reviewed and considered for adoption. It was noted though that the WMO attributes might be too restrictive and care should be given to establishing the attributes for this network, which should also consider the intended purpose or use that would be made of these identified sites. In doing so, it was thought that new terminology, such as “climate sensitive” stations, might be useful to describe the selected sites.

There was also a brief discussion regarding the general ability to share data from all sites, given that some countries might not have the authorization to disclose them. It was mentioned that this might be the case where data are collected for a third party such as a power utility where such data are considered proprietary and can influence power transactions within financial markets. It was thought that such restrictions might be time limited, with data becoming available once they were no longer market sensitive. An effort by participants would be required to see which specific sites were restricted and if an arrangement could be made to allow sharing of data after a certain time period had passed.

4. Network update by country

Canada

Mr Pietroniro mentioned that the Water Survey of Canada (WSC) has 19 staff working north of 60. He indicated that there were currently 237 sites monitored with 200 of these being available in real-time. Of these, 38 are suitable for the “flow to ocean” network. He also indicated that the WSC is ISO 9001 and QMS certified. He also described the quality assurance routines followed for real time provisional streamflow data. Currently, he indicated there was usually a period of 18 months prior to having data approved in final form, with delays in so doing because of staff shortages. He noted that in one office it could take upwards of 3 years for this to be accomplished due to staff turnover.

U.S.A.

Mr J. Conaway, during his presentation, noted that Mr Lammers had removed a number of stations monitoring streamflow discharges into the Bering Strait. He indicated that further consideration should be given to including these sites in the flow to ocean network as they were important in understanding circulation northwards and their influence on temperature and salinity. These stations when combined contribute 800 km^3 of freshwater annually to the Gulf of Alaska to the Bering Sea. It was suggested that Mr Lammers and Mr Conaway further discuss the matter of inclusion of these sites in the networks, as there was no strong

argument put forward for their exclusion.

Mr Conaway also provided a review of the recent climatology affecting Alaska. He indicated that global ocean temperatures have been warmer than normal and have provided warm, moist air to the land masses. Air temperatures have been approximately 10^{o} F (4.7^{o} C) warmer than normal for October 2014 through February 2015 for Alaska. This was the second consecutive year with no snow, resulting in 50 to 60 fewer days of snow cover duration. This recent climatology has seriously modified the shape and distribution of flow as represented in the hydrographs. There are now multiple freeze-up and breakups of ice on rivers, which in turn negatively affects ground transportation that relies heavily on ice roads. There have been rapid spring breakups, resulting in higher peaks that can form ice jams. Flows have also been lower due to the reduced recession limb on the hydrograph from lack of melting snow. Overall, annual volumes remain relatively stable, with redistribution of flows occurring within the year.

Iceland

Ms Jórunn Harðardóttir provided an update on activities in Iceland. She indicated they are making efforts to construct “best” possible future hydrometric network for Iceland taking into consideration spatial coverage, data quality, and cost-efficiency. There current activities are almost ISO 9001 compliant; while she noted that since 2008, there have been budget reductions totaling almost 35%.

Ms Harðardóttir commented that the number of stations selected for the Arctic-HYCOS networks depends on their definition, while there are currently only 4 stations contributing to the flow to ocean network, with these having a good likelihood of having continued long-term monitoring. She noted there is a possibility of adding an additional 20 stations to those currently being sent to GRDC to be included in the Arctic-HYCOS “representative of hydrological regime” network. She concluded by indicating that they would revisit the network of sites within Iceland so as to allow maximum contributions to the Arctic-HYCOS networks, which might result in an additional 16 or so sites being put forward. It was also indicated that there has been a recent trend in hydro companies taking over the operation of stations. There was concern expressed that this might jeopardize future access to data from such sites.

Finland

Ms J. Korhonen presented on hydrological monitoring in Finland. Finnish Environment Institute (SYKE) is responsible for the co-ordination of the hydrological monitoring network and the operation of relevant data systems. Hydrological fieldwork is done by 13 regional centres. Additionally, local observers are engaged. She also recalled that only a small amount of Finnish rivers flow into the Arctic Ocean, as most flow to the Baltic Sea.

The national network consists of about 300 stations for surface water level and river discharge measurement. She also indicated that their national water level network will be totally automated during next few years, with 84% of sites already providing real-time data. The currently identified HYCOS stations all have real-time capabilities.

She noted that their organization had received a 20% reduction in direct budget funding, which will probably result in a reduction to the size of the network in 2016. This will affect more the regional monitoring network, while HYCOS identified stations are national.

Changes in field operations will occur through outsourcing planned by ministries for maintenance of stations and discharge measurements, especially for sites in remote

northern areas. There is a potential that maintenance problems may become more frequent in the future.

She noted that 10% of the drainage area of Finland flows to the Arctic and is monitored with 16 water level and discharge stations, having data collected every 15 minutes and transmitted hourly. She further noted that 8 stations provided by Finland have approximately 50 years of data on average, and Finland could contribute even more stations with real-time data transfer capabilities. She mentioned that all “natural” stations have rating curves, while no Finnish stations where selected for inclusion in the flow to oceans network. She reiterated that most rating curve stations provide biased estimates of streamflow discharge during the ice covered period, with these being corrected later. Hence, it should be recognized that real-time data that are provided during the winter season are not accurate.

Ms Korhonen also spoke on Finnish water temperature data. She noted that most new automatic stations have water temperature sensors and provide such data in real time. Currently a student is doing validation of these data.

Norway

Mr M. Johnsrud reported that Norwegian Water Resources and Energy Directorate (NVE) is managing a network of about 2000 stations on different parameters, of which about a quarter are reporting in real time. NVE has approximately 60 stations in operation observing water temperature. This network is coordinated with that of the Norwegian Meteorological Institute to support the provision of avalanche and debris flow forecasts. He indicated that 50 to 60% of these stations are owned by the NHS, while the others are owned by power companies, with the NHS retaining responsibility for data control. As part of this responsibility, he indicated that they had conducted an exercise last year involving field hydrologists to assess data quality. The outcome indicated a huge range of results especially during ice covered periods. This further enforced the need for international recommended practices and procedures particularly during ice covered periods.

Mr Johnsrud noted that there is a Norwegian hydrological network report undertaken every 10 years, with the current one covering up to the year 2020. NVE has selected a hydrological reference dataset for studies of hydrological change. From this network, 7 stations are of particular relevance to Arctic-HYCOS, with 5 being on the mainland and 2 in Svalbard.

Mr Johnsrud indicated that further thought should be given to including additional Norwegian water level and discharge stations in Arctic-HYCOS for which rating curves and provisional discharge data are available. Such sites lie further south (Bergen-border between Arctic and northern Atlantic). There are a number of good quality stations having long periods of record, while the current sites stop south of Gaula. Mr Johnsrud indicated that he will do another review of Richard’s station list that might result in additional stations being contributed to Arctic-HYCOS.

Mr Johnsrud raised the concept of glacial monitoring or monitoring of glaciated basins in the participating countries. The general sense was that this had merit and might be considered in a future work plan.

There was a general comment that with revisiting the networks of various countries, there might also be the possibility of adding some Swedish stations north of 68, even though they flow into the Baltic Sea.

Russian Federation

Mr V. Vuglinsky noted that there has been a dramatic decrease exceeding 30% in the number of stations operated from 1986 to 2014. For sites north of 60, there were 787 stations in 1986; while there are only 453 remaining in 2014 (GRDC receives 317). For sites north of 67, reductions have been even more dramatic. In 1986, there were154 stations; while in 2014, there remain only 53 stations (GRDC receives 34). Amidst this, new sensors have been installed to monitor water level and temperature on some sites. Real-time communications is being tested as a pilot for some sites, although routine processing of data in real-time is not yet done. It was noted that due to the current economic situation, further budget reductions of 10-15% for Arctic stations might occur, and the quality of data from Arctic regions may deteriorate.

Mr Vuglinsky noted there were 23 regional hydrological data centres operating in Russia. It was not clear within this distributed model who would have responsibility for making data available. He indicated that he expected to send an updated archive of data to GRDC, but was not certain when this might occur.

General Discussion

There was a brief discussion regarding Arctic-HYCOS and its potential linkages with other WMO initiatives, such as EC-PORS. It was noted that EC-PORS coordinates WMO activities in the Arctic, Antarctic and high mountainous areas of the world. It was further noted that the next EC-PORS meeting would be in September 2015 in Iceland, where it would be advantageous to report to it on progress with respect to Arctic-HYCOS. It was also noted that it would be advantageous to "advertise" Arctic-HYCOS at the upcoming WMO Congress-17 through a roundtable on Arctic activities (1st week of WMO Congress). It would be an opportunity to provide an overview of some ongoing/recent Arctic-HYCOS activities and plans.

There was also some discussion on Arctic-HYCOS and how far it could possibly extend beyond the traditional HYCOS themes. For example, it could be construed as the hydrological component of EC-PORS, contributing to hydrological modelling, prediction and services. Two additional initiatives were mentioned including the recent letter on Polar Prediction (hydrology, cryosphere, meteorology) within the global modelling community (coupling with sea ice and snow) and the Global Cryosphere Watch, where Cryonet could be linked with Arctic-HYCOS. It was noted that there was a huge interest in water resources monitoring, both for flood and drought management.

It was expressed that Arctic-HYCOS might evolve into provision of hydrological services (GFCS linkages) eventually focusing more on developing near real-time forecasts and derived products. To help develop this concept, participating countries agreed to prepare and share a list of products and services that they currently produce. For example, Finland undertakes hydrological modelling in an operational context. It was stressed that it was important when considering development of products and services for Arctic-HYCOS that the initiative remain operationally focused.

5. Exchange of data and information

Accessibility of Data (Mr R. Lammers)

Mr R. Lammers provided a table summarizing the availability of data by country and their ease of access. He noted that many cells in the table were outdated based on discussions at

this meeting. He questioned if the intent was to establish an automated system to acquire most recent real-time streamflow discharge data. He noted that GRDC only collects approved historical (archived) Quality Controlled data, while Mr Looser indicated that he did not foresee being able to deal with real-time data due to staffing issues and general inadequate levels of funding to do so.

Mr Lammers suggested the creation of an historical data archive covering a common period that would include the identified 79 currently active flow to (Arctic basin) ocean stations. There was some discussion regarding whether a common time period was desired or if all data available for each stations would be preferred. There was general agreement that the latter was preferred, as all data for sites are valuable for certain types of analyses. It was also felt to be important that discontinued stations be identified in addition to active ones, flagging the station status accordingly. Mr Lammers was requested to work with GRDC once his list of sites had been finalized through interaction with participating countries and subsequently create an historical archive of the Arctic-HYCOS flow to ocean database, which would have unlimited access to all and would be so identified. All participants agreed that their data in this common database could be so made available to all.

There was also some discussion on how to obtain and make real-time provisional data available for all using facilities other than GRDC. It would be possible to do bulk downloads (data scraping) on a daily basis by each country. These data could be made available through a web site. It was indicated that although finer time scales might be available depending on the organizations, the recommended time step for Arctic data would be daily. Possibly hourly would be provided by an organization, but these would be averaged to make daily values accessible. It was agreed that efforts to access real-time data so that they are available for all should be included in the new work plan.

Hydrometric information exchange for Arctic-HYCOS (Mr Silvano Pecora)

Mr S. Pecora noted that there is an on-going transition occurring from the traditional approach of providing Hydrological Year Books to the provision of web services, where data are continuously accessible. He presented on the 5-star development scheme on water data sharing and basically outlined a process that would be required to attain fully functioning web services.

Various questions arose as to how NMHSs could provide data using WaterML to an external server given restrictions on access to databases, where these data could be hosted, who would maintain them, and where would the catalogue of basins reside, etcetera. It was indicated that it would be most beneficial to have an actual functioning pilot application to show that it works, thereby providing a model that can be assessed for broader use. How this could be attained will follow in later discussions. There was agreement that such an endevour for Arctic-HYCOS would be beneficial.

GRDC -- Advances regarding sharing Arctic-HYCOS data (Mr U. Looser)

Mr U. Looser indicated that the GRDC database as of March 2015 has 2413 gauging stations as being within the Arctic drainage basin. Data comprise both daily and monthly discharge. He also provided an update on the exact numbers from each country that contributes to the GRDC Arctic database, and he also provided a breakdown of those countries participating in Arctic-HYCOS and the status of their updates to the GRDC.

Mr Looser indicated that it was indeed possible to make a common database of Arctic-HYCOS identified stations available freely to all. It was again noted that there was a need to synchronize the Arctic-HYCOS list of stations being developed by Mr Lammers, through the

assistance of participating countries, with that of the GRDC identified Arctic stations. Mr Looser indicated that the GRDC could create by end of May 2015 an Arctic-HYCOS database (zip file, flags added for network 1 and 2) and allow freely available downloads via their web site provided all countries agreed with making their data so available. Representatives of all countries provided their verbal agreement to the GRDC making contributed data identified as being part of the Arctic-HYCOS database freely available.

Mr Lammers was requested to develop a schematic diagram indicating how many stations were available each year for each network and possibly by country.

WHOS and Arctic-HYCOS (Mr Harry Lins)

Mr H. Lins (President, CHy) provided an overview of the WMO Hydrological Observing System (WHOS), as an effort to facilitate online access to near real-time and historical discharge data contained in the water information systems of countries around the world that make their data freely and openly available via the internet. WHOS is envisaged as providing the worldwide hydrological network that was planned as WHYCOS in 1993, but that never came to fruition. The original WHYCOS design was for a global network of 1,000 stations, operated in conjunction with a distributed water information system, to capture data and information on the hydrological cycle. As a result of the need to fill gaps in the spatial coverage of observing stations, particularly, in the developing world, WHYCOS shifted its emphasis to capacity building through the establishment of regional HYCOS projects. It was anticipated that, over time, these projects would collectively form the building blocks of WHYCOS. When this happened, however, all work ceased on establishing the remainder of the global network based on existing stations, and the goal of building a worldwide hydrological database has never been realized. To rectify this situation, WHOS has been proposed as a simple web-based portal to near real-time and historical hydrological data that are already freely and openly available online. As HYCOS projects mature and are able to provide data, they would be included within WHOS. In this regard, Arctic-HYCOS is viewed as a critical example of what other regional HYCOS projects can and should aspire to, because it is already capable of providing data to WHOS.

Mr H. Lins indicated that the WMO Integrated Global Observing System (WIGOS) facilitates access to data. He indicated a map-based interface was being developed to make data of NHSs available publically. He provided an example through the USGS water monitor website. Eventually, this would lead to the “WHOS World Wide Portal”. This could, in turn, be interfaced with a Hydrological Information System (HIS) data registry and web services. He noted that Arctic-HYCOS would be a good test case to pilot the demonstration of these capabilities. This prototype could also demonstrate the utility of WaterML2.0 as a common standard in time for the next meeting of CHy (Nov 2016). In order to accomplish this, one aspect that requires further attention is the determination of the basic mediator/attribute questions to be asked. Subsequently, each respective NHS would then have to develop and provide appropriate metadata (modify database, if necessary) to answer these agreed-upon mediator questions.

It was noted that there are two options for proceeding. One option is that each NHS develops its own web service or alternatively pushes their data to the WMO Information System (WIS) metadata catalogue to be accessed. This latter approach is the WMO “solution” currently used for meteorological data. It was further noted that most NHS can do real-time pushing of data but do not allow on-demand pulling from a “mediator”. In this solution, it was not certain if an Arctic Global Information System Centre (Arctic GISC) would be required or not.

Messrs Lins and Pecora were requested to follow-up with WMO staff familiar with WHYCOS

and WIS in April to propose to the Arctic-HYCOS Project Steering Committee options and actions required to provide the functionality discussed on making data publically available.

As part of this process, the importance of attributes upon which interrogation may proceed was deemed as being very important. An example was sited where 27 attributes were categorized by the USGS. Mr Lins indicated that he would lead the effort to develop such a categorization of attributes to facilitate each user querying the mediator.

In summary, there were 3 separate tracks put forward to advance public sharing of data. They were:

1) Arctic-HYCOS database made available at GRDC for downloading, with the leads being Messrs Lammers and Looser;
2) Adoption of WaterML2.0 web services at GRDC, with the leads being Messrs Pietroniro, Lins, Looser and NHS representatives; and
3) WHOS/WIS/WIGOS solution, with leads being Mr Lins and the CHy AWG with assistance of the WMO Secretariat.

6. Review of operational practices and procedures

As per the Arctic-HYCOS work plan of April 1, 2014 to March 31, 2015, information was to be prepared on under ice measurements using an ADCP and monitoring temperature.

U.S.A. Update (Mr J. Conaway)

Mr Conaway provided a comprehensive presentation on procedures and practices of the USGS, as well as products and approaches that are under development. He stated by noting the importance of correcting stage record. He presented on some of the work of the USGS Hydroacoustics Work Group that are advancing techniques and methods such as ADCP exposure time requirements, application of moving bed tests, and others. For example, he noted that now it has been established that a minimum of 12 minutes (720 s) exposure are required when taking a measurement rather than specifying a minimum number of transects such as 4. He also highlighted the development of the Velocity Mapping Toolbox (VMT) to improve the utility of data and their quality. He also presented on complementary software under development that will allow for standardized processing of all ADCP measurements. He noted that interim techniques have been developed for flow measurements under ice and were drafted by the Water Survey of Canada with input from the USGS. The USGS has recommended following these guidelines. As well, Mr Conaway spoke to the problems commonly encountered when taking measurements under ice using either mechanical or hydroacoustic technologies. He went through in detail how the USGS in Alaska produce ice-affected daily discharge records. He noted that throughout the year, data are published to 15 minute intervals, while when ice-affected, data are only made available on a daily basis. He indicated that possibly 2 trips were made under ice conditions to take measurements.

Mr Conaway also presented an overview of how the USGS undertake water temperature monitoring. General interest was shown with others commenting on how their approaches differ. It was evident that work remains on establishing recommended practices and procedures for monitoring water temperature at hydrological stations.

Canada Update (Mr A Pietroniro)

Mr Pietroniro provided a general overview of the hydrometric operations including its partnerships within Canada, highlighting the importance of consistency and reliability of

approaches used. He noted that the WSC had recently developed guidelines for taking measurements under ice using ADCP technology, with input from the USGS. He also commented that the WSC is committed to adapting the index velocity approach for under ice conditions. As well, he commented that the WSC is interested in increasing the use of currently marginalized approaches such as the dilution method and use of cameras. The latter is particularly useful for closely monitoring ice formation and break-up, which can greatly assist in interpretation of data for estimation of discharge, as well as monitoring surface velocities.

Open Discussion (All)

Mr Pietroniro indicated that it might prove helpful if all participants cooperated in the development of a manuscript that would be an update to the 1990 copyright protected publication of P. Pelletier et al. documenting under ice flow measurements. The intent was simply to review and update the material for publication in a journal. As well, an additional effort would be needed to provide documentation of participating countries approaches for compilation into a compendium of practices and procures. Once compiled, these could be reviewed to see if agreement can be reached on recommended procedures and practices that could be put forth to assist countries in taking measurements under harsh environmental conditions and in estimating streamflow discharges under ice cover conditions.

7. Hydrological modelling and prediction - Arctic-HYPE application (Ms B Arheimer and Mr D. Gustafsson)

It was noted that the Arctic-HYPE 3.0 application has advanced considerably since the last meeting. Efforts have been made to quality assure input data and routing details. Further verification work is required by participants to ensure routing information is correct. Web services have been developed to allow dissemination of model output. It was noted that the model can reflect regulation plans and irrigation activities. Operational forecasts having short term to seasonal horizons can be developed and issued. The system could provide alerts to NHSs and emergency services. There was mention that this could be perceived as an oversimplification of the forecasting undertaken by countries and could be compounded by lack of rigor at smaller scales. It was not certain if such a service or at what scale such service should be provided by Arctic-HYPE on behalf of Arctic-HYCOS, and further discussion of the Project Steering Committee is required before coming to a decision on this important point.

It was noted that further consideration might be given in the modelling of gross versus effective drainage areas, which represents closed drainage areas that contribute infrequently to the generation of streamflow discharge. Examples were cited of how this is done for the prairies in North America.

It was mentioned that a poster had been developed on Arctic-HYPE, and Mr Pietroniro indicated that he would develop a small number of slides (approximately 6 or so) that could be used by participants on providing an overview of Arctic-HYCOS to interested parties. The poster and presentation slides will be made available on the Arctic-HYCOS website once they have been provided to the WMO Secretariat.

8. Development of annual work plan for 2015-2016

A draft work plan was developed and appears as **Annex III** to this report.

9. Date and venue of next meeting

The participants were pleased to learn of and accepted the kind invitation from the representative of the U.S.A., Mr J. Conaway, to host the next meeting of the Project Steering Committee of Arctic-HYCOS in Fairbanks, Alaska, with the meeting being tentatively scheduled for 24-26 May 2016.

10. Summary and closing remarks

The participants thanked the hosts of the meeting once again and commented on the lovely facilities and efforts undertaken by the hosts that contributed to the positive atmosphere of the meeting. Participants looked forward to the work to be undertaken and in advancing the implementation of Arctic-HYCOS. It was agreed that the report of the meeting would be circulated for comment prior to its finalization likely to be completed within one month of the meeting. Mr Pietroniro thanked everyone for their active participation in the meeting and agreed that work had been advancing well and looked forward to discussing achievements at the next meeting.

Annex I

LIST OF PARTICIPANTS

CANADA	
Dr Alain PIETRONIRO Director, Water and Climate Services Meteorological Service of Canada National Hydrology Research Centre 11 Innovation Blvd, Saskatoon **SASKATCHEWAN S7N 3H5**	Tel: +1 306 975 4394 Cell: +1 306 230 2635 Email: Al.Pietroniro@ec.gc.ca
Ms Grace KOSHIDA Meteorological Service of Canada Monitoring and Data Services Directorate 373 Sussex Drive, Block E1 OTTAWA K1A 0H3	Tel: +1 613 944 7829 Email: Grace.Koshida@ec.gc.ca
FINLAND	
Ms Johanna KORHONEN Finnish Environment Institute Mechelininkatu 34a P.O. BOX 140 **FI-00251 HELSINKI**	Tel: + 358 295 251 302 Fax: + 358 954 902 590 Email: johanna.korhonen@ymparisto.fi
GERMANY	
Mr Ulrich LOOSER Head, Global Runoff Data Centre (GRDC) In the Federal Institute of Hydrology (BfG) Am Mainzer Tor 1 **56068 KOBLENZ**	Tel: +49 261 1306 5224 Fax: +49 261 1306 5722 Email: looser@bafg.de Web: http://grdc.bafg.de
ICELAND	
Dr Árni SNORRASON Director General Icelandic Meteorological Office Bústaðavegur 9 **IS-108 REYKJAVÍK**	Tel: +354 522 60 00 Cell: +354 893 42 22 Fax: +354 522 60 01 Email: arni.snorrason@vedur.is
Dr Jórunn HARÐARDÓTTIR Managing Director for Processing & Research Icelandic Meteorological Office Bústaðavegur 9 **IS-108 REYKJAVÍK**	Tel: +354 862 83 23 Fax: +354 522 60 01 Email: jorunn@vedur.is
Mr Odinn THORARINSSON Managing Director Observations Icelandic Meteorological Office Bústaðavegur 9 **IS-108 REYKJAVÍK**	Tel: +354 522 60 00 Cell: +354 861 94 91 Fax: +354 522 60 01 Email: odinn@vedur.is

ITALY	
Dr. Ing. Silvano Pecora ARPA SIMC – AREA IDROLOGIA Via Garibaldi, 75 **43121 PARMA**	Tel : +39 052 127 43 78 Fax : +39 052 177 40 56 Email : specora@arpa.emr.it
NORWAY	
Mr Morten JOHNSRUD Director, Hydrology Department Norwegian Water Resources and Energy Directorate (NVE) Middelthunsgate 29 P.O. Box 5091 Majorstua **N-0301 OSLO**	Tel: +47 22959595 or +4722959202 (direct) Cell: +47 93040340 Fax: +47 22959216 Email: moj@nve.no
RUSSIAN FEDERATION	
Prof. Valery VUGLINSKY Deputy Director for Science State Hydrological Institute 2nd Line 23 **ST PETERSBURG 199053**	Tel: +781 23233458 Fax: +781 23231028 Email: vvuglins@vv4218.spb.edu
SWEDEN	
Mr David GUSTAFSSON SMHI / Swedish Meteorological and Hydrological Institute **SE - 601 76 NORRKÖPING**	Tel : +46 (0)11 495 86 74 Email : David.Gustafsson@smhi.se Web: www.smhi.se
Ms Berit ARHEIMER SMHI / Swedish Meteorological and Hydrological Institute **SE - 601 76 NORRKÖPING**	Tel : +46 (0)11 495 82 60 Email : berit.arheimer@smhi.se Web: www.smhi.se
UNITED STATES OF AMERICA	
Dr Harry F. LINS U.S. Geological Survey (USGS) 415 National Center **RESTON, VA 20192**	Tel: +1 703 648 5712 Cell: +1 571 218 5077 Email: chy.president@gmail.com
Mr Jeffrey S. CONAWAY U.S. Geological Survey 4210 University Drive Anchorage **ALASKA 99508-4626**	Tel: 1-907-786-7041 Fax: 1-907-786-7150 Email: jconaway@usgs.gov
Dr Richard LAMMERS Research Assistant Professor University of New Hampshire Earth Systems Research Center Water Systems Analysis Group Morse Hall, Room 211 8 College Road **DURHAM, NH 03824**	Email : richard.lammers@unh.edu

WMO SECRETARIAT-SWITZERLAND	
Dr Paul PILON Chief, Hydrological Forecasting & Water Resources Division Climate and Water Department World Meteorological Organization 7 bis Avenue de la Paix C.P. 2300, 1211 Geneva 2	Tel: +41 22 730 83 58 Fax: +41 22 730 80 43 Email: ppilon@wmo.int

Annex II

FINAL AGENDA

ARCTIC-HYCOS 2nd Project Steering Committee Meeting
Reykjavik, Iceland, 23-24th March 2015
Icelandic Meteorological Office (Vedurstofa Islands) at Bustadavegur 7
Forgardur Room

23rd March 2015

Purpose of the session on Day 1 is to assess progress on the Annual Work Plan 2014-2015 and to address issues/questions on data acquisition and exchange.

09:00 – 09:30	*Coffee, Fruit/biscuits provided*
09:30 – 10:00	Introduction and Welcome (Árni Snorrason & Alain Pietroniro)
10:00 – 10:15	Meeting objectives and adoption of the agenda (Alain Pietroniro)

Review of Work Plan progress April 2014-March 2015

10:15 – 11:30	**Priority 1 and 2:** Network Design for "Flow to Ocean" Stations and Network Design for Stations "Representative of Hydrological Regime" – List of stations update (Richard Lammers) – Network update (by country-10 minutes each) – Canada: update (Alain Pietroniro) – USA: update (Jeffrey Conaway) – Iceland: update (Jórunn Harðardóttir)
11:30 – 12:30	*Lunch provided (IMO Canteen)*
12:30 – 13:30	**Priority 1 and 2:** Network update (by country – 10 minutes each) – Finland: update (Johanna Korhonen) – Norway: update (Morten Johnsrud) – Russian Federation: update (Valery Vuglinsky) – Open discussion (all)
13:30 – 13:45	**Priority 4: (A)** Exchange of Data and Information Summary – Accessibility of data (Richard Lammers)
13:45 – 15:00	Open discussion on data exchange and the path forward (Alain Pietroniro) - all
15:00 – 15:30	*Health Break (Coffee, fruit/biscuits provided)*
15:30 – 16:15	**Priority 4: (B)** Hydrometric information exchange for Arctic-HYCOS (Silvano Pecora) – Pilot project and application of WaterML 2.0
16:15 – 16:45	**Priority 4: (C)** GRDC-Advances regarding sharing Arctic-HYCOS data (Ulrich Looser)
16:45 – 17:00	Wrap up

24th March 2015

Purpose of the session on Day 2 is to continue assessing progress on the Work Plan 2014-2015 and develop the Work Plan for April 2015-March 2016.

08:30 – 09:00	*Coffee, fruit/biscuits provided*
09:00 – 09:15	Review of Day 1 (Alain Pietroniro)

Review of Work Plan progress April 2014-March 2015 (continued)

09:15 – 09:45	**Priority 4: (D)** WHOS and Arctic-HYCOS (Harry Lins)
09:45 – 10:45	**Priority 3:** Review of Operational Practices and Procedures (Alain Pietroniro) –Countries' submission of standards/procedures - preliminary – Canada: update (Alain Pietroniro) – USA: update (Jeffrey Conaway) – Open discussion (all)
10:45 –11:30	**Priority 5: (A)** Application of Hydrological Modelling and Prediction – Arctic-HYPE application (David Gustafsson)
11:30 – 12:30	*Lunch provided (IMO Canteen)*

Development of Annual Work Plan April 2015-March 2016

12:30 – 15:30	Development of Annual Work Plan 2015-2016 –Project priorities and leads –Deliverables, milestones and their status –Formation of working groups (if needed)
15:30 – 16:00	*Health Break (coffee, fruit/biscuits provided)*
16:00 – 16:15	Adoption of Annual Work Plan 2015-2016
16:15 – 16:30	Date and venue of next meeting
16:30 – 17:00	Summary, meeting report and closing remarks

Annex III

Arctic-HYCOS Work Plan April 1, 2015 – March 31, 2016

Project Name	**Objective**	**Deliverable and milestones**	**Project Lead**	**Work Plan** **Status and Milestones**
Network Design for "Flow to Ocean" Stations	Synchronize lists (R. Lammers and GRDC) Agree on criteria to select Arctic-HYCOS stations Compile and finalize list of Active Flow-to-Ocean Gauges	1. Finalize list of Flow-to-ocean stations (Active and Discontinued) and alternates to active upstream gauges where possible 2. Richard to canvass members for missing data/metadata **Deadline mid April 2015**	Al/Richard	

Network Design for Stations "Representative of Hydrological Regime"	Synchronize lists (R. Lammers and GRDC) Compile and finalize list of Active and Discontinued gauges for hydrology network	• Finalize list of hydrology network stations - Active and Discontinued **Deadline mid April 2015**	Al/Richard	
Interim Arctic-HYCOS database	Creation of database and making data freely available	1. GRDC to create Arctic-HYCOS subset database (zip file, flags added for network 1 and 2) and allow downloads via their web site – all countries agreed to sharing data **Deadline end of June 2015** 2. Examine potential links for web service under GRDC as an Arctic-HYCOS pilot **Deadline end of March 2016**	GRDC with assistance of Richard	

WHOS WaterML2.0 standard prototype	Creation of database and making data freely available	1. Determine basic mediator/attribute questions to be asked: 2. Each respective NHS would then have to provide appropriate metadata (modify database, if necessary) to answer these mediator questions 3. Each NHS reviews GAGES approach of 27 attributes – decide which attributes to use 4. Investigate and report on any advances WHOS/WIS solution for Arctic-HYCOS 5. Develop pilot application to demonstrate solution for Arctic-HYCOS **Deadline items 1-4 end of March 2016** **Deadline for item 5 to be determined**	Harry/Silvano	
Under Ice Operational Practices and Procedures	Share and develop under ice standards/methods - all members	1. Update Pelletier et al 1990 article and publish as a peer-reviewed journal article-HESS **Deadline, first draft October 2015** 2. Prepare outline of WMO recommended practices and procedures document on	1. Al with input from member countries 2. Jeff	

		discharge determination under ice-covered conditions **Deadline end of March 2016**		
Reporting of Arctic-HYCOS activities	Develop material for promoting Arctic-HYCOS and ascertain current services provided by members	1. Provide Arctic-HYCOS background information and poster available for upcoming events of interest (slides) 2. All members provide list/collation of Arctic activities and services they currently provide for use at WMO Congress (May 2015) and EC-PORS (September 2015) **Deadline: Slides/Poster April 12, 2015**	1. Slides: Al/Grace; Poster: David/Berit 2. All	.
Arctic-HYPE application		• David to contact member countries to confirm input data (station location, routing scheme, land use, reservoirs, diversions)	David/All	
Water Temperature Data		1. All members to review USGS procedures for river temperature and discuss at next HYCOS meeting (Richard to share his paper on Russian rivers outlining procedures) 2. Richard to assess what river	1. Jeff/All 2. Richard	

		temperature data are available in Arctic countries		
River/Lake Ice		• All members assess what river/lake ice data are available in Arctic countries for next year´s meeting	All	