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| WEATHER CLIMATE WATER | **World Meteorological Organization**  **COMMISSION FOR OBSERVATION, INFRASTRUCTURE AND INFORMATION SYSTEMS**  **Third Session** 15 to 19 April 2024, Geneva | **INFCOM-3/Doc. 8.4(5)** |
| Submitted by: Chairs of SC-ESMP and AG-GCW  14.III.2024  **DRAFT 1** |

**AGENDA ITEM 8: TECHNICAL DECISIONS**

**AGENDA ITEM 8.4: WMO Integrated Processing and Prediction System**

# ROAD MAP FOR THE INTEGRATION OF CRYOSPHERE IN THE WMO INTEGRATED PROCESSING AND PREDICTION SYSTEM

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| **Summary** |
| **Document presented by:** Chair, Advisory Group on the Global Cryosphere Watch  **Strategic objective 2024–2027:** 2.3  **Financial and administrative implications:** within the parameters of the Strategic and Operating Plans 2024–2027 additional resources are required for organizing the delivery of WMO Integrated Processing and Prediction System (WIPPS) Pilot Projects, when approved  **Key implementers:** INFCOM, in consultation with RB, SERCOM, RAs, partners.  **Time frame:** 2024–2026  **Action expected:** Consider and adopt the proposed draft Decision. |

# DRAFT DECISION

## Draft Decision 8.4(5)/1 (INFCOM-3)

### Road map for the integration of cryosphere information and products in the WMO Integrated Processing and Prediction System (WIPPS)

### The Commission for Observation, Infrastructure and Information Systems decides to endorse the road map for the integration of cryosphere information and products in the WIPPS, as presented in the [annex](#annex) to the present decision.

See [INFCOM-3/INF. 5](https://meetings.wmo.int/INFCOM-3/InformationDocuments/Forms/AllItems.aspx) for more information.

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Decision justification:

The road map addresses actions from the following resolutions:

[Resolution 58 (Cg-18)](https://library.wmo.int/idviewer/56690/193) Future integrated seamless Global Data Processing and Forecasting System collaborative framework

[Resolution 2 (Cg-19)](https://library.wmo.int/idviewer/67177/21) WMO Strategic Plan 2024–2027

[Resolution 4 (Cg-19)](https://library.wmo.int/idviewer/67177/61) United Nations Early Warnings for All

[Resolution 6 (Cg-19)](https://library.wmo.int/idviewer/67177/80) Priorities to address global and regional impacts of changes in the cryosphere

[Resolution 18 (EC-73)](https://library.wmo.int/idviewer/57838/338) Transition and pre-operational plan of the Global Cryosphere Watch

[Resolution 4(INFCOM-2)](https://library.wmo.int/idviewer/66287/76) Closing the gap on the integration of cryosphere in the Earth System Strategy of WMO

[Draft Recommendation 8.4(1) (INFCOM-3)](https://meetings.wmo.int/INFCOM-3/_layouts/15/WopiFrame.aspx?sourcedoc=%7b08F7179E-47D1-4C6C-B640-821417FFD207%7d&file=INFCOM-3-d08-4(1)-AMENDMENT-TO-MANUAL-ON-WIPPS-draft1_en.docx&action=default) Amendments to the *Manual on the WMO Integrated Processing and Prediction System* (WMO-No. 485)

The road map has been developed through consultations, as documented in the:

1. Report of the Joint Workshop on Integration of Cryosphere in the WMO Integration Data Processing and Prediction (WIPPS) of the Advisory Group – Global Cryosphere Watch (AG‑GCW) and the Standing Committee on Data Processing for Applied Earth System Modelling and Prediction (SC-ESMP), 6–8 March 2023, Oslo (Norway);
2. Report of the second meeting of the Advisory Group on the Global Cryosphere Watch (AG-GCW), 27–29 February 2024, Anchorage, Alaska (USA);
3. Report of the thirteenth meeting of the Executive Council Panel on Polar and high-Mountain Observations, Research, and Services (PHORS-2024), 13–15 February 2024, Oslo (Norway);
4. Report of the RA II Regional WMO Integrated Global Observing System (WIGOS) Workshop, 25–29 November 2023, Beijing (China).

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## Annex to draft Decision 8.4(5)/1 (INFCOM-3)

## Road map for the integration of cryosphere information and products in the WMO Integrated Processing and Prediction System

### Background

[Resolution 6 (Cg-19)](https://library.wmo.int/idviewer/67177/80) - Priorities to address global and regional impacts of changes in the cryosphere, agreed to five priorities for addressing global and regional impacts of changes in the cryosphere, to enable the sustainable and equitable support to Members in understanding, responding, mitigating, and adapting to the global and regional impacts of the irreversible changes in the cryosphere and their downstream impacts and the increased disaster risks. The WMO Integrated Processing and Prediction System (WIPPS) is an effective mechanism to meet the emerging needs for information on the cryosphere through the sustained contribution of WIPPS centres at global and regional levels.

The present road map for the integration of cryosphere products in WIPPS has been developed through consultations between the Advisory Group on the Global Cryosphere Watch (AG-GCW) and the Standing Committee on Data Processing for Applied Earth System Modelling and Prediction (SC-ESMP), as documented in the report of joint workshop organized on 6–8 March 2023 in Oslo, Norway and the work of AG-GCW, since. The road map aims at addressing information needs as identified in Resolution 6 (Cg-19).

As many of the potential products are still in the research domain, this road map includes high level recommendations for pilot projects, as documented in the Collaborative Framework for Seamless Global Data Processing and Forecasting System ([Resolution 58 (Cg-18)](https://library.wmo.int/idviewer/56690/193)).

The implementation of this road map is a shared responsibility of AG-GCW and SC-ESMP, and will require close engagements with partners and other programmes.

Once made available, these products would be disseminated as core or highly recommended products, including by the Arctic Regional Climate Centre Network (Arctic RCC-Network), the Third Pole Regional Climate Centre Network (TPRCC-Network), the future Antarctic Regional Climate Centre Network (Antarctic RCC-network), and other mechanisms.

### Milestones

**2.1** **Integration in the Manual on WIPPS of cryosphere products available from global and regional producing centres**

The following operational products were recommended and have been included in the amendments to the [*Manual on the WMO Integrated Processing and Prediction System*](https://library.wmo.int/records/item/35703-manual-on-the-wmo-integrated-processing-and-prediction-system) (WMO‑No. 485), as included in the [draft Recommendation 8.4(1) (INFCOM-3)](https://meetings.wmo.int/INFCOM-3/_layouts/15/WopiFrame.aspx?sourcedoc=%7b08F7179E-47D1-4C6C-B640-821417FFD207%7d&file=INFCOM-3-d08-4(1)-AMENDMENT-TO-MANUAL-ON-WIPPS-draft1_en.docx&action=default):

* + Core products: snowfall and water equivalent of snow cover (a.k.a snow water equivalent (SWE)) from Global Producing Centres for Sub-Seasonal Forecasts and Long-range Forecasts (GPC-SSF and GPC-LRF)
  + Recommended products: snowfall, snow depth, and SWE from Regional Specialized Meteorological Centres for limited area Numerical Weather Prediction (NWP) (Regional Specialized Meteorological Centres (RSMCs) for Limited area NWP), for those regions where snow is expected
  + Recommended products: sea ice concentration from GPCs-SSF and GPCs-LRF.

The following additional activities have been recommended:

* Verification of the currently available sea ice concentration, potentially, in collaboration with the World Weather Research Programme (WWRP) Joint Working Group on Forecast Verification Research (JWGFVR).
* Evaluation of the feasibility of the highly recommended products, as above, as core products.
* Evaluation of the viability as recommended products of short range sea ice forecasting (e.g. regionally downscaling of global model outputs), already introduced by some regional climate modelling centres (e.g. Norway, etc.).
* Evaluation of the feasibility on snow temperature and sea ice temperature as recommended or core products.

Further changes and amendments to the Manual on WIPPS will be prepared as required.

#### 2.2 Daily outputs from seasonal models in support of the detection of extreme events

#### The feasibility of generating and disseminating daily outputs from seasonal models for the detection of extreme events would be considered by the relevant Expert teams of SC-ESMP and recommendations may be made for formalizing them. Currently, such products are available for Copernicus and on the WMO Lead Centre for Long-Range Forecast Multi-Model Ensemble (<https://www.wmolc.org/>) and from some GPC-LRFs.

Expected delivery by INFCOM-4.

#### 2.3 Survey on other available products on the cryosphere or relevant to characterize changes in the cryosphere

AG-GCW and SC-ESMP will organize a survey of other products which may be already available from designated WIPPS centres (global and regional) on the cryosphere or which are relevant to characterizing changes in the cryosphere (e.g. linked to the predictability of cryosphere hazards as are extreme precipitation events or increased temperatures leading to increased risks of glacier lake outburst floods, etc.).

This survey will be addressed to non-designated Earth System Modelling centres, as well.

The results of the survey are expected to lead to recommendations on (1) opportunities for new products to be considered for WIPPS, (2) interest on obtaining designation as WIPPS centres, (3) on improving the verification of identified products, and (4) potential intercomparisons of products from coupled models and from post-processing applications, e.g. for snowfall quality estimation.

The results and the recommendations of the survey will be compiled in a report to INFCOM-4.

#### 2.4 Designation of RSMC for Limited Area NWP for polar regions

Norwegian Meteorological Institute expressed interest in being designated as RSMC for short range limited area forecasting for the Arctic, according to requirements outlined in the Manual on WIPPS (WMO-No. 485), with a focus on snow and sea ice products.

The deadline for designation is INFCOM-4.

Other institutions operating similar forecasting models are invited to consider this designation.

### 2.5 Proposals for potential WIPPS Pilot Projects on the cryosphere

In the framework of the Earth System approach to data processing and prediction and as defined in the as documented in the Collaborative Framework for Seamless Global Data Processing and Forecasting System (Resolution 58 (Cg-18)), the WIPPS Pilot Projects are seen as a practical mechanism to explore further development and facilitate implementation to meet emerging needs, including those for information on the changes in the cryosphere and their impacts.

AG-GCW, in collaboration with its partners will prepare recommendations to SC-ESMP, on pilot projects to address emerging needs. Their implementation will proceed based on the SC-ESMP decisions.

All projects will develop recommendations on the potential for new WIPPS products and/or new types of centres, as well as the additional work for enabling their operationalization.

#### 2.5.1 Cold region hydrological products

AG-GCW will foster the development of a concept for a WIPPS pilot project for cold region hydrology.

Deadline for proposal: end of 2024.

The concept will consider:

* Mature pan-Arctic and/or cold-regions hydrological models available in the research domain, today, and outputs from WIPPS centres
* Integration of data on snow, glaciers, permafrost, and large ice masses, in the context of sparse observations
* Develop recommendations for potential intercomparisons
* Feedback to the operational producing centres.

On longer term, an evaluation of the runoff into the ocean and its representation in the existing pan-arctic hydrological models, may be considered, linked to the evaluation of uncertainties in modelling ice sheet melt and sea level rise.

#### 2.5.2 Sea Ice thickness model output product evaluation

AG-GCW will foster the development of a concept for a pilot project on the evaluation of sea ice thickness (SIT) products from global and regional models, and on their feasibility as WIPPS core or highly recommended.

Deadline for proposal: end of 2024.

The concept will include SIT products from WIPPS centres and the evaluation of the assimilation of available satellite SIT products.

The project would aim at integrating results from the Polar Prediction Project and the Sea Ice-thickness product iNter-comparison eXerciSe, [SIN’XS](https://sinxs.noveltis.fr/); it will develop recommendations on the observing systems for SIT in support of verification and the initialization of models.

#### 2.5.3 Ice-sheet Surface Mass Balance monitoring and prediction products

In response to the need for stronger international coordination on the development of ice-sheet surface mass balance monitoring and prediction products, AG-GCW will coordinate the development of a concept for a potential WIPPS pilot project on ice-sheet surface mass balance (for Antarctica, Greenland), in consultation with relevant communities.

Deadline for proposal: end of 2025.

The project would explore the sustainability, consistency, and standardization of information on the ice-sheet melt and the contribution to sea level rise and on the link between this and the impacts on coastal areas and small islands. While ice-sheet surface mass balance models for climate timescale have been adopted within the World Climate Research Programme (WCRP) community, none are operational, except those developed by the [Danish Meteorological Institute](http://polarportal.dk/en/news/news/surface-mass-balance-of-the-greenland-ice-sheet/) (DMI).

AG-GCW will consult with relevant communities active in this domain, with the WMO Executive Panel on Polar and High-Mountain Observations, Research, and Services (PHORS), the Research Board and its programmes (WCRP, WWRP), the International Association of Cryospheric Sciences (IACS) and its division on ice sheets, the Scientific Committee for Antarctic Research (SCAR), Members, and other partners, and will consider:

1. Existing products and potential for sharing of data with operational centres;
2. Availability of reanalysis level products for surface mass balance and the characterization of ice sheets in surface schemes.

The WIPPS centres will be invited for their interest in developing global models for icesheets. ArcticRCC-Network and the future Antarctic RCC-network will play a critical role in the dissemination of these products.

#### 2.5.4 Cryosphere Hazards

The international community is increasingly concerned with the emergence of cryosphere hazards. The inventorying of these hazards and the consistency in their monitoring and reporting are lagging most of the other hazards. The existing predictive capabilities are mostly in the research domain and have limited coordination.

A concept for a potential WIPPS pilot project will be developed by AG-GCW and the Third Pole Environment (TPE) program, to scope out the components required for a sustained approach in support of developing Early Warning Systems. Other critical stakeholders are, PHORS, IACS, the International Permafrost Association (IPA), the Research Board and the Services Commission (SERCOM) through its Standing Committees.

Deadline for proposal: end of 2024.

The proposal will include several components:

* A synthesis of cryosphere hazard categories, their characterization and monitoring, prediction requirements and challenges.
* Inventory of existing and potential products from WIPPS centres.
* Best practices for Glacier Lake Outburst Floods (GLOFs), e.g. inventory of glacier lakes, risk mapping and assessment, and monitoring and prediction requirements and gaps.
* Recommendations for pilot projects, potentially through TPRCC-Network.
* Recommendations for the adequate representation in the Cataloguing of Hazardous Weather, Water, Climate, and Space Weather Events (CHE) developed by WMO and the United Nations Office for Disaster Risk Reduction.

#### 2.5.5 Pilot products for permafrost

AG-GCW will coordinate the development of a concept for a potential WIPPS pilot project on permafrost products in consultation with the Research Board, the ArcticRCC-Network, IPA, GCOS, etc.

Deadline for proposal: end of 2025.

A formal designation in WIPPS for permafrost monitoring products would be a significant incentive for data sharing by multiple operators of observing programmes for permafrost, most of them operated by research institutions.

Permafrost prediction products will become feasible in the future, from land surface schemes. Currently, demonstration products for permafrost prediction are close to operational at climatological and pan-arctic scale, but for mountains, this would remain a challenge.

#### 2.5.6 Icebergs monitoring and forecasting products

The feasibility of a WIPPS pilot project for iceberg monitoring and forecasting products will be explored between AG-GCW and the International Ice Charting Working Group (IICWG).

A concept proposal being considered for INFCOM-5, depending on the results of the survey proposed under item 2.3.

If implemented, the pilot would provide a template for standardization of products, verification standards and the potential for designation of producing centres. The scope may include existing iceberg mapping, the use of observations to track icebergs, etc.

### Long-term exploratory proposals for new types of centres

#### 3.1 Long term – Exploratory demonstration project for high-mountain centres

The concept of high-mountain monitoring and prediction centres, providing weather, climate, and hydrological products, was first discussed at the [WMO High Mountain Summit](https://highmountainsummit.wmo.int/en/call-action) (2019).

AG-GCW and SC-ESMP will coordinate the organization of a scoping workshop for developing the concept of global high-mountain prediction centres, together with PHORS. The workshop would explore pathways to address the need for mountain representative products at different scales, in the weather, climate, hydrological domains, based on the experience and engagements of TPRCC-Network.

Workshop timeline: 2026

#### 3.2 Long term – Centres of excellence on cryosphere processes and services

The concept of a centre of excellence on cryosphere processes and services, concentrating on the flow of information into supporting risk assessments and other services, has been recommended in the context of accelerated changes in all cryosphere subdomains and their impacts, globally.

AG-GCW will foster consultation with the goal of developing a concept proposal, in close collaboration with SC-ESMP, other WMO bodies, and relevant partners and it will incorporate the lessons learned from the implementation of actions of this road map.

Deadline for proposal: INFCOM-5

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