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| Submitted by: Chair of the GCW-AG  12.X.2022 |

## PROGRESS REPORT ON THE OPERATIONALIZATION OF THE GLOBAL CRYOSPHERE WATCH (GCW):

## Transition and the pre-operational plan 2020–2023, Resolution 18 (EC-73)

## *Introduction*

The Global Cryosphere Watch (GCW) is the crosscutting activity area of WMO addressing the needs of its Members and their partners for **authoritative**, **actionable,** and **accessible science-based** **information** on the **state of the cryosphere** as a key component **of Earth system observations**. GCW is mandated to support Members in sustainably enhancing their capabilities for observing all components of the cryosphere, for accessing and utilizing the cryospheric data and for developing value-added analyses and indicators **based on in situ, space-based, and airborne observations** of the cryosphere, **as well as models**, to meet defined information needs at the core of the [WMO Strategic Plan](https://library.wmo.int/doc_num.php?explnum_id=9939)[[1]](#footnote-2), 2020–2023, and the [WMO Water Ambitions](https://public.wmo.int/en/our-mandate/water).

Members require cryospheric information for representing dynamic Earth system processes and for implementing the coupling of ocean cryosphere-atmosphere-land systems at all latitudes and elevations for weather, sea ice, climate and hydrological monitoring, forecasting, and prediction, with a focus on operational monitoring to support safety on land and sea ice.

## *GCW implementation*

(a) The GCW Surface Observing Network (CryoNet and contributing stations) was incorporated into the WMO Integrated Global Observing System (WIGOS) (EC-70);

(b) Cryosphere-specific regulatory and guidance material was published by WMO, including as contributions to the Global Climate Observing System (GCOS) Implementation Plan (2016):

 [*Technical Regulations, Volume I – General Meteorological Standards and Recommended Practices*](https://library.wmo.int/index.php?lvl=notice_display&id=14073#.YE80d0BFyUl) (WMO-No. 49) , Part I, Chapter 8, Attributes specific to the Observing Component of GCW;

 [*Manual on the WMO Integrated Global Observing System, Annex VIII to the WMO Technical Regulations*](https://library.wmo.int/index.php?lvl=notice_display&id=19223#.YE808p1KiUk)(WMO-No. 1160), Chapter 8, Attributes specific to the Observing Component of GCW;

 [*Guide to Instruments and Methods of Observation*](https://library.wmo.int/index.php?lvl=notice_display&id=12407#.YE81QkBFyUl) (WMO-No. 8), Volume II – Measurement of Cryospheric Variables;

 Cryospheric specific metadata was included in the [*WIGOS Metadata Standard*](https://library.wmo.int/index.php?lvl=notice_display&id=19925#.YE81a0BFyUk) (WMO-No. 1192);

(c) The [GCW Data Portal](https://gcw.met.no/node/6) was established by the Norwegian Meteorological Institute;

(d) BUFR Table for the international exchange of snow depth and water equivalent of snow cover data — published in the [*Manual on Codes*](https://library.wmo.int/index.php?lvl=notice_display&id=10684#.YE81lEBFyUk) (WMO-No. 306); this facilitated a 60% increase in the exchange of snow data from 2017 to 2020;

(e) [Assessments](https://globalcryospherewatch.org/assessments/) and [trackers](https://globalcryospherewatch.org/satellites/trackers.html) on the state of the cryosphere are published regularly on the GCW website, e.g. snow trackers and seasonal snow cover assessments;

(f) [Snow Watch framework](https://globalcryospherewatch.org/projects/snowreporting.html) of activities, which includes the [Snow Product inventories](https://globalcryospherewatch.org/reference/snow_inventory.php);

## *GCW Progress report 2020-2022*

### *Sustaining cryospheric observations*

(a) GCW-relevant updates to the [*Guide to the WMO Integrated Global Observing System*](https://library.wmo.int/doc_num.php?explnum_id=11137), (WMO-No. 1165):

* Section 10.2 — Guidance for the Registration of GCW stations — published 2021;
* Station Sets — the implementation of the CryoNet Clusters (WMO-No. 1160, Appendix 8) — INFCOM-2;

(b) GCW observing network:

* GCW is a designated authority for the allocation of WIGOS Station Identifiers (WSI) network code 21000, for GCW stations when Members are not in the position to issue a WSI — [*Guide to the WMO Integrated Global Observing System*](https://library.wmo.int/doc_num.php?explnum_id=11137), (WMO-No. 1165);
* GCW Secretariat working with the Observing Systems Capabilities Analysis and Review Tool (OSCAR)/Surface National Focal Points to transfer the already approved GCW stations and on the registration of additional cryospheric observations operated by Members, in OSCAR/Surface;

(c) The Global Basic Observing Network (GBON):

* Snow Depth is one of the GBON variables;
* About 8% of snow depth observations exchanged via the Global Telecommunication System (GTS) are registered in OSCAR/Surface, in 2022;
* GCW is working with Members and the European Centre for Medium-Range Weather Forecasts (ECMWF) to register the currently operational snow depth observations on the station already in OSCAR/Surface;

(d) [*Guide to Instruments and Methods of Observation*](https://library.wmo.int/index.php?lvl=notice_display&id=12407#.YE823EBFyUk) (WMO-No. 8), Volume II, Measurement of Cryospheric Variables:

* Glaciers Best Practices — for INFCOM-2 approval: [Draft Recommendation 6.2(2)/1 (INFCOM-2)](https://meetings.wmo.int/INFCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/INFCOM-2-d06-2(2)-UPDATE-GUIDE-WMO-NO-8-draft1_en.docx?Web=1),
* Permafrost and sea ice: are under development; for approval by INFCOM-3,
* Ice sheets, ice shelves, and lake and river ice to be initiated by 2023;

GCW will continue to facilitate theuse of space-based cryospheric data and products and will support the redefinition of the role of the Polar Space Task Group (PSTG), formerly under the remit of the Executive Council panel on Polar and High-mountain Observations, Research and Services (EC-PHORS).

*Cryosphere Observing Requirements and Statement of Guidance*

The consolidation of requirements for cryospheric observations and related capabilities within the framework of the WMO Rolling Review of Requirements, as evolved by INFCOM-2, the contributions to the OSCAR Requirements database and the WIGOS 2040 vision, and the associated Statements of Guidance, are key priorities of GCW, expecting completion by 2024.

* A dedicated Task Team on Cryosphere Observing Requirements (CRYORA) was established in 2021.
* In 2021/2022, a review of the published cryosphere observing requirements was conducted by a consultant. The report submitted will be used as a basis for the work going forward, building on the [*Cryosphere Theme Report of the Integrated Global Observing Strategy*](https://stratus.ssec.wisc.edu/igos/docs/cryos_theme_report.pdf) (WMO/TD-No. 1405, 2007) and working with the Joint Expert Team on Earth System Observing System Design and Experiments (JET-EOSDE).
* Two pilots will be launched, one on Terrestrial Cryosphere Monitoring, and the second on Sea-ice forecasting, as part of the implementation of the new Rolling Review of Requirements (RRR) process.

*Sustaining cryospheric data systems and data management*

The GCW Data Portal is the bridge between WMO and non-WMO data management frameworks and data providers, some of which have limited data management capabilities.

(a) The [GCW Data Portal](https://gcw.met.no/node/6) — proposed as a WIS 2.0 pilot project, [Draft Recommendation 6.3(1)/1 (INFCOM-2)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/INFCOM-2-d06-3(1)-IMPLEMENTATION-WIS-2-0-draft1_en.docx&action=default) led by Norway, to establish a Data Collection and Processing Centre. Activities:

 Pursue open access to the data from GCW stations (real time and archived) and promote Network Common Data Form (NetCDF) following the Climate and Forecast (CF) convention as the preferred format for cryospheric data;

 Support GCW station operators, in particular those with limited data management capabilities, with access to the GCW developed software stack relying on [MeteoIO](https://meteoio.slf.ch/), transforming their data to structured NetCDF/CF (FAIR compliant) format;

 Publishing data from GCW stations and provide analysis-ready data, progressively from 2023;

(b) GCW actively contributed to the development of the WMO Unified Data Policy —[Resolution 1(Cg-Ext(2021))](https://library.wmo.int/doc_num.php?explnum_id=11113/#page=9). A section Cryosphere was added to Annex 1 of the Policy.

(c) Data and metadata: contributions made to the [*WIGOS Metadata Standard*](https://library.wmo.int/index.php?lvl=notice_display&id=19925#.YE82eEBFyUk) ([WMO-No. 1192](https://library.wmo.int/index.php?lvl=notice_display&id=19925)) and the [*Manual on Codes*](https://library.wmo.int/index.php?lvl=notice_display&id=10684#.YE81lEBFyUk) ([WMO‑No. 306](https://library.wmo.int/index.php?lvl=notice_display&id=10684))), for glaciers, permafrost, and snow. Sea ice metadata will be finalised and submitted by mid-2023.

(d) Interoperability with representative data centres under way, e.g. Third Pole Environment Data Centre, the Geological Survey of Denmark and Greenland (GEOS), the Global Terrestrial Network for Permafrost (GTN-P), etc.;

*GCW “watch” functions: access to value-added cryospheric data*

1. Snow Watch:
2. Annual Snow Assessments published. 2021/22 available at <https://globalcryospherewatch.org/assessments/snow/>
3. Designation of the WMO Measurement Lead Centre on Snow Monitoring — Snow Monitoring Competence Centre, Davos (Switzerland) — [Draft Decision 6.2(7)/1 (INFCOM-2)](https://meetings.wmo.int/INFCOM-2/_layouts/15/WopiFrame.aspx?sourcedoc=/INFCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/INFCOM-2-d06-2(7)-MEASUREMENT-LEAD-CENTRE-ON-SNOW-MONITORING-draft1_en.docx&action=default);
4. Expert contributions to the development of cryosphere-related products for use by HydroSOS, as of 2021; cryosphere — a pilot of HydroSOS;
5. Active engagements with the European Space Agency (ESA) SnowPEx2 Satellite Snow Product Intercomparison and Evaluation Exercise (SnowPEx), initiated in 2020;
6. Workshop to develop concept for Mountain Snow Intercomparison Exercise — November 2022;
7. Co-lead — the [Joint Body on the Status of Mountain Snow Cover](https://cryosphericsciences.org/activities/jb-status-mountain-snow-cover/), with the International Association of Cryospheric Sciences and Mountain Research Initiative, 2022–2025;

(b) Sea Ice Watch:

* 1. WIGOS Sea Ice variables: consultations underway for harmonizing between operational and research communities, for the Arctic and Antarctica, and with the WMO [*Sea Ice Nomenclature*](https://library.wmo.int/doc_num.php?explnum_id=4651), WMO-No. 259;
  2. Sea Ice Best Practices — [surface-based observations](https://public.wmo.int/en/resources/bulletin/global-cryosphere-watch-%E2%80%93-sea-ice-information-science-and-operations) — initiated in 2021;
  3. GCW — co-custodian of the GCOS Sea Ice Essential Climate Variables (ECV) with the Ocean Observations Physics and Climate Panel (OOPC) — agreement 2020;
  4. Published [A New Structure for the Sea Ice Essential Climate Variables of the Global Climate Observing System](https://journals.ametsoc.org/view/journals/bams/103/6/BAMS-D-21-0227.1.xml) (T. Lavergne, S Kern, et al, 2022);
  5. Engagements with the Marine Meteorology and Oceanography Standing Committee (SC-MMO) of the Services Commission (SERCOM), as of 2021;
  6. 13–15 November 2019 GCW Workshop — to foster an intercomparison to characterize available data and products — which led to the initiation of the ESA Sea Ice Thickness Intercomparison Exercise (SIN’XS); 2022–2024;

(c) Expert contributions to the development of relevant cryospheric products for Regional Climate Centres (RCCs) for polar and mountain regions, specifically the Third Pole RCC — network (TPRCC-network), Arctic RCC-network and the Antarctic RCC-network;

(d) Contributions to the WMO Bulletins

### *Partnerships*

GCW has been actively collaborating with:

(a) [Arctic Passion](https://arcticpassion.eu/) — Pan-Arctic Observing System of Systems — implementing Observations for Societal Needs;

(b) Memorandum of Understanding between WMO and the Third Pole Environment programme (2019);

(c) [Mountain Research Initiative](https://mountainresearchinitiative.org/) (MRI);

(d) [Arctic Observing Networks (SAON) Roadmap to Arctic Observing and Data Systems (ROADS) strategy](https://arcticobserving.org/);

(e) SAON-Arctic Data Committee (ADC) and the Data Management System of the Scientific Committee for Antarctic Research (SCADM);

(f) Existing observing networks in polar and high-mountain areas, [ArcticNet](https://arcticnet.ulaval.ca/), the International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT), the International Network for Alpine Research Catchment Hydrology (INARCH), etc.

## *GCW Governance*

[Resolution 7 (INFCOM-1)](https://library.wmo.int/doc_num.php?explnum_id=11197/#page=146) established the GCW Advisory Group (GCW-AG) to coordinate the GCW activities, as an evolution from EC-PHORS.

The Study Group on Cryosphere Crosscutting functions — Global Cryosphere Watch (SG-Cryo) developed recommendations on the mandate of GCW as an operational activity of WMO, to be approved by INFCOM2, [Draft Resolution 6.6/1](https://meetings.wmo.int/INFCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/INFCOM-2-d06-6-RECOMMENDATION-SG-CRYO-INTEGRATION-CRYOSPHERE-EARTH-SYSTEM-draft1_en.docx?Web=1) (INFCOM-2), together with updated GCW-AG terms of reference, [Draft Resolution 5.2(1) (INFCOM-2).](https://meetings.wmo.int/INFCOM-2/English/1.%20DRAFTS%20FOR%20DISCUSSION/INFCOM-2-d05-2-SUBSIDIARY-BODIES-draft1_en.docx?Web=1)

Currently, the GCW-AG structure includes:

(a) Cryosphere and Polar Observations and Cryosphere Observing Requirements to work in coordination with the Standing Committee on Earth Observing Systems and Monitoring Networks (SC-ON);

(b) Cryosphere and Polar Data, working in coordination with the Standing Committee on Information Management and Technology (SC-IMT);

(c) Snow Watch, Sea Ice Watch — taking a dedicated focus from observations, to data, to data assimilation and model verification. Stronger links with the Standing Committee on Data Processing for Applied Earth System Modelling and Prediction (SC-ESMP) is expected following the approval of recommendations from SG-CRYO;

(d) Task Teams on Glaciers and Permafrost with an active engagement with the Standing Committee on Measurements, Instrumentation and Traceability (SC-MINT).

*Communication and outreach*

The GCW website ([globalcryospherewatch.org](http://globalcryospherewatch.org/)) and the [WMO Cryosphere](https://public.wmo.int/en/our-mandate/focus-areas/cryosphere) web pages will continue to publish the well-appreciated links to assessments and news relevant to the cryosphere under [“Cryosphere Now](https://globalcryospherewatch.org/state_of_cryo/)”, and “[Cryosphere in the News](https://globalcryospherewatch.org/news/cryo_in_the_news.html)”.

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1. In the context of the WMO Strategic Plan, Earth is being considered as an integrated system of atmosphere, ocean, cryosphere, hydrosphere, biosphere and geosphere, which informs policies and decisions based on a deeper understanding of the physical, chemical, biological and human interactions that determine the past, current and future states of Earth. [↑](#footnote-ref-2)