WMO EARTH SYSTEM STRATEGY
CLOSING THE GAP ON THE INTEGRATION OF CRYOSPHERE

Global Cryosphere Watch – connecting scientific and operational communities of practice

WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM

EARSeL-10
Bern, 6 February 2023

Rodica Nitu
WMO Secretariat
Global Cryosphere Watch

Overview

- Cryosphere in the WMO Unified Data Policy
- Global Cryosphere Watch (GCW) priority activities
- GCOS 2022 Implementation Plan

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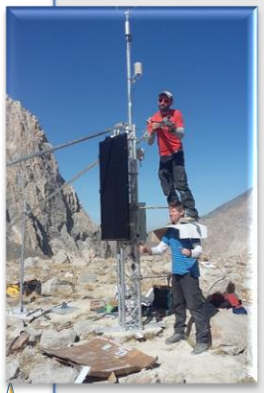
GCW Global Cryosphere Watch

Global Cryosphere Watch

Bridge between operational (WMO Members) and cryospheric research communities, **globally**



Support:

- to <u>sustainably</u> enhance capabilities for observing the cryosphere,
- access to/exchange and utilization of cryospheric data
- foster dissemination of cryospheric products (based on **in situ, space-based, and airborne observations as well as models)**

- **Cryosphere functions and services to society**
  - *weather and climate **regulating** functions → climate services,*
  - ***provisioning** and cultural functions: **cryosphere is future water!** →*
  - *cryosphere for **transportation and infrastructure** → e.g. sea ice services, etc*
  - *increased risk of **hazards** from accelerated cryosphere changes → **UN Early Warning Systems for All***
- Critical role of partner organizations and research programmes;

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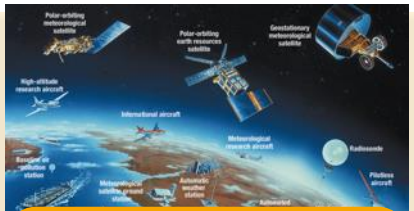
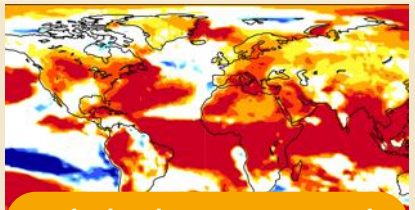
GCW Global Cryosphere Watch

WMO Unified Data Policy (2021):
Successful delivery and use of weather and hydroclimate services rests on globally designed and managed data infrastructure



Observations from the entire globe

International exchange of observations



Global Numerical Weather Prediction

GLOBAL ACTIVITIES

Local Data Processing, forecast, warning and advisory products

Delivery of weather and climate services

Effective decision making and

REGIONAL AND LOCAL ACTIVITIES

Requirements and gap analysis

Data Policy: Weather related date, Climate, Hydrology, Atmospheric Composition, **Cryosphere,** Ocean, Space Weather,

Catalogue of Core (free and unrestricted exchange**) and Recommended data**

- **cryo core data (today) -** snow depth (precipitation)

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https://library.wmo.int/doc_num.php?explnum_id=11256

Requirements and gap analysis:

(WMO RRR):

Cryosphere for Atmospheric (e.g. GNWP, etc), Ocean, Hydrological, and Integrated ES Applications

WMO OSCAR | The repository of requirements for observation of physical variables

Cryosphere –Application category:

- Terrestrial Cryosphere Forecasting and Monitoring
- **Sea-Ice Forecasting and Monitoring**
- Cryospheric Climate Monitoring: GCOS
- **Cryospheric Disaster Risk Reduction**

Foster initiatives -

Satellite cryosphere product intercomparisons, e.g. SIN'XS

Mountain Snow (2023)

2023 – evolution of Polar Space Task Group (PSTG) :

ToRs and modus operandi with CGMS and CEOS

Stronger links to operational applications

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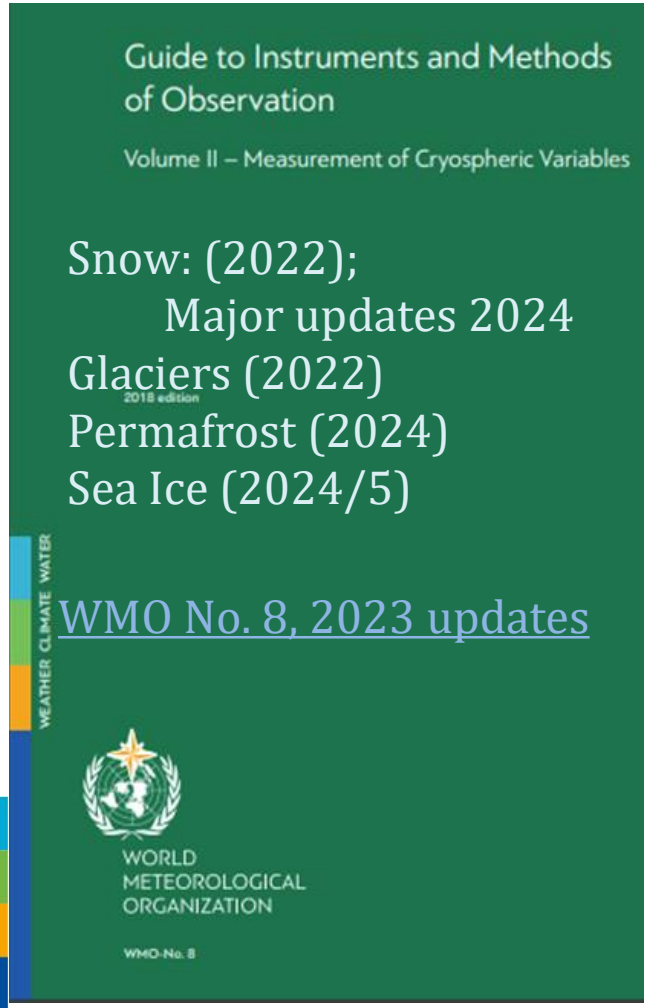
Sustainably enhance capabilities for observing the cryosphere and access to/exchange and utilization of cryospheric data



Snow: (2022);
Major updates 2024
Glaciers (2022)
Permafrost (2024)
Sea Ice (2024/5)

WMO No. 8, 2023 updates

Snow Monitoring Competence Centre Davos (MLC) (Switzerland):

- integration of surface-based remote sensing & in situ measurements & models
- Relationship with facilities from a **developing country**

IACS-MRI-GCW Joint Body on the status of the mountain snow cover (SMSC)

- WMO Report: State of Cryosphere Monitoring in Central Asia – 2022
- Andes - 2023

Capacity development

Third Pole Regional Climate Centre Network (TPRCC-Network)

Northern TP Node

- Consortium: **China** (Lead), Mongolia, Nepal, Bhutan, Pakistan

Southern TP Node

- Consortium: **India** (Lead), Nepal, Bhutan, Bangladesh, Myanmar

Western TP Node

- Consortium: **Pakistan** (Lead), Tajikistan, Uzbekistan, Afghanistan, China

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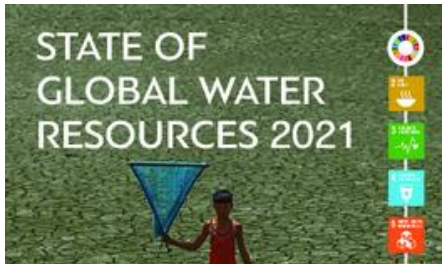
GCW Global Cryosphere Watch

Working together

- Enhance ES Predictions through the integration of cryosphere information at all scales → Workshop 6-8 March 2023
- Mountain Snow Satellite product Intercomparison: concept development, with EUMETSAT (27-28 March 2023)
- Snow ECV
- GCW Data Portal (Met Norway): Advance Cryosphere and Polar Data Interoperability
- **2025 – UN International Year for Glaciers Preservation**

Outreach and Advocacy: more needed!!!



Annual global

Final report launch Mar-Apr 2023

Key indicators, high-impact events, and risks and impacts in partnership with other UN agencies.

Decadal global

2011-2020 report in preparation

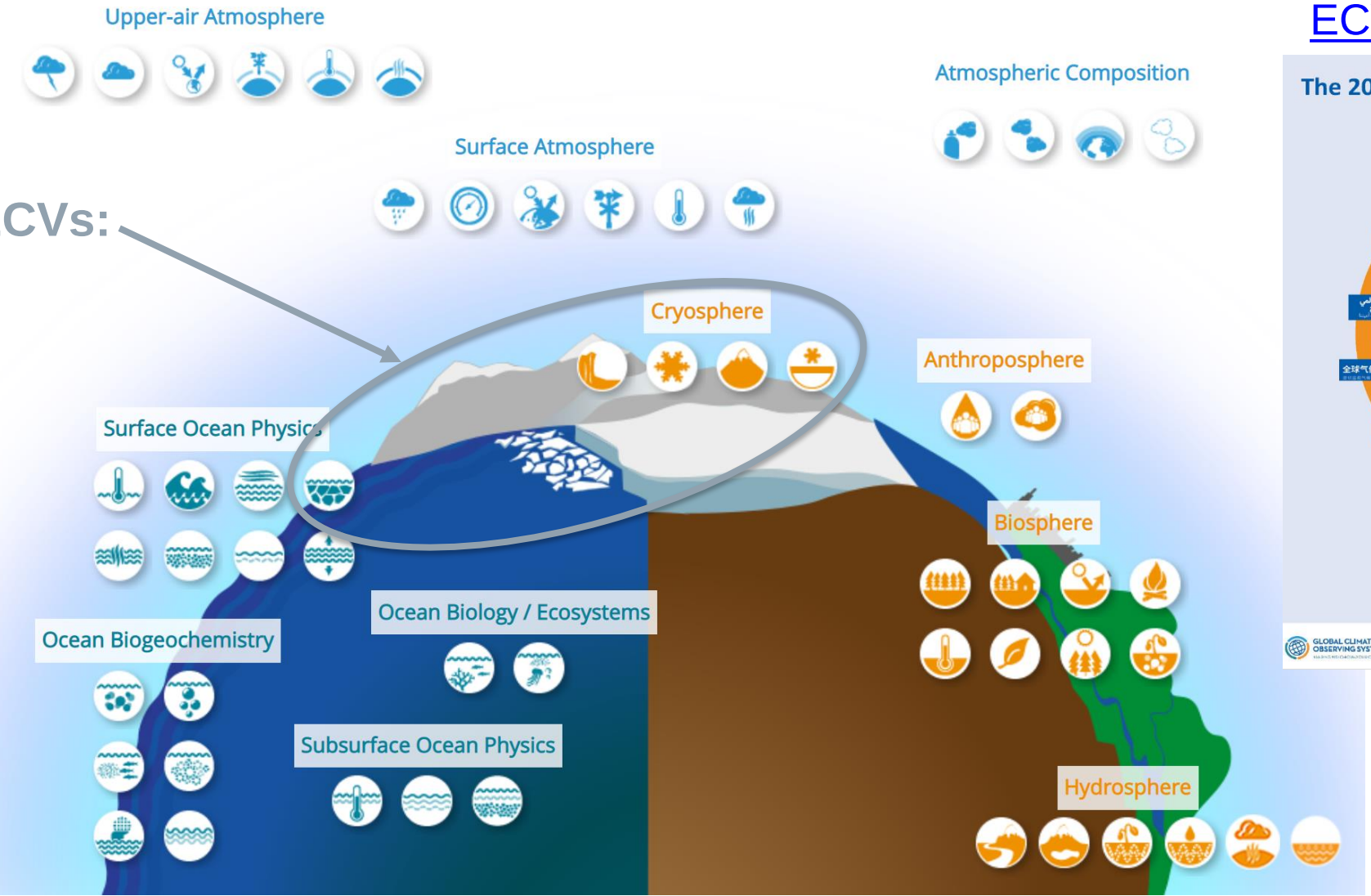
Will be released at COP28 in 2023

Annual regional

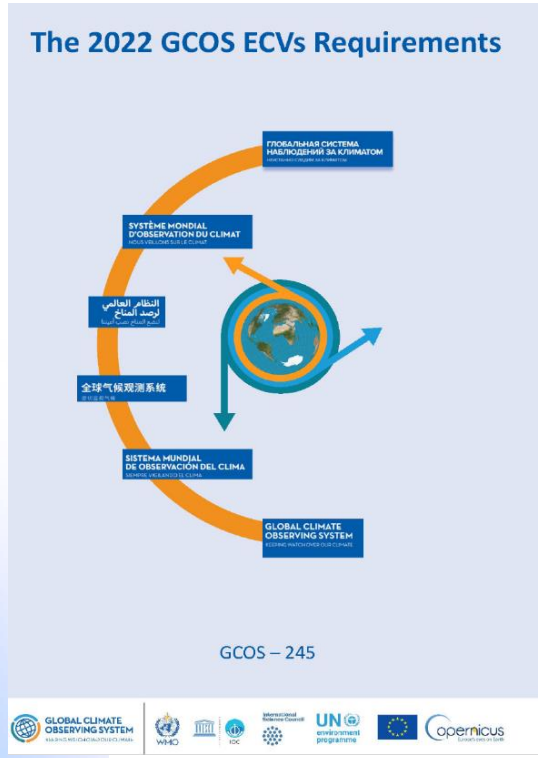
ECVs – Essential Climate Variables: Cryosphere

Cryosphere ECVs:

- Sea Ice
- Snow
- Glaciers
- Permafrost
- Ice Sheets / Ice Shelves



[GCOS Report on ECVs requirements]



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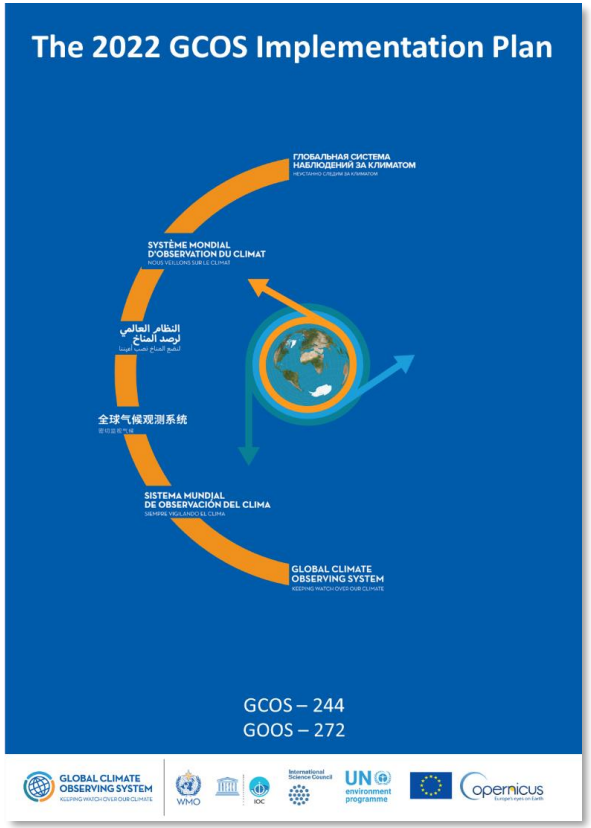
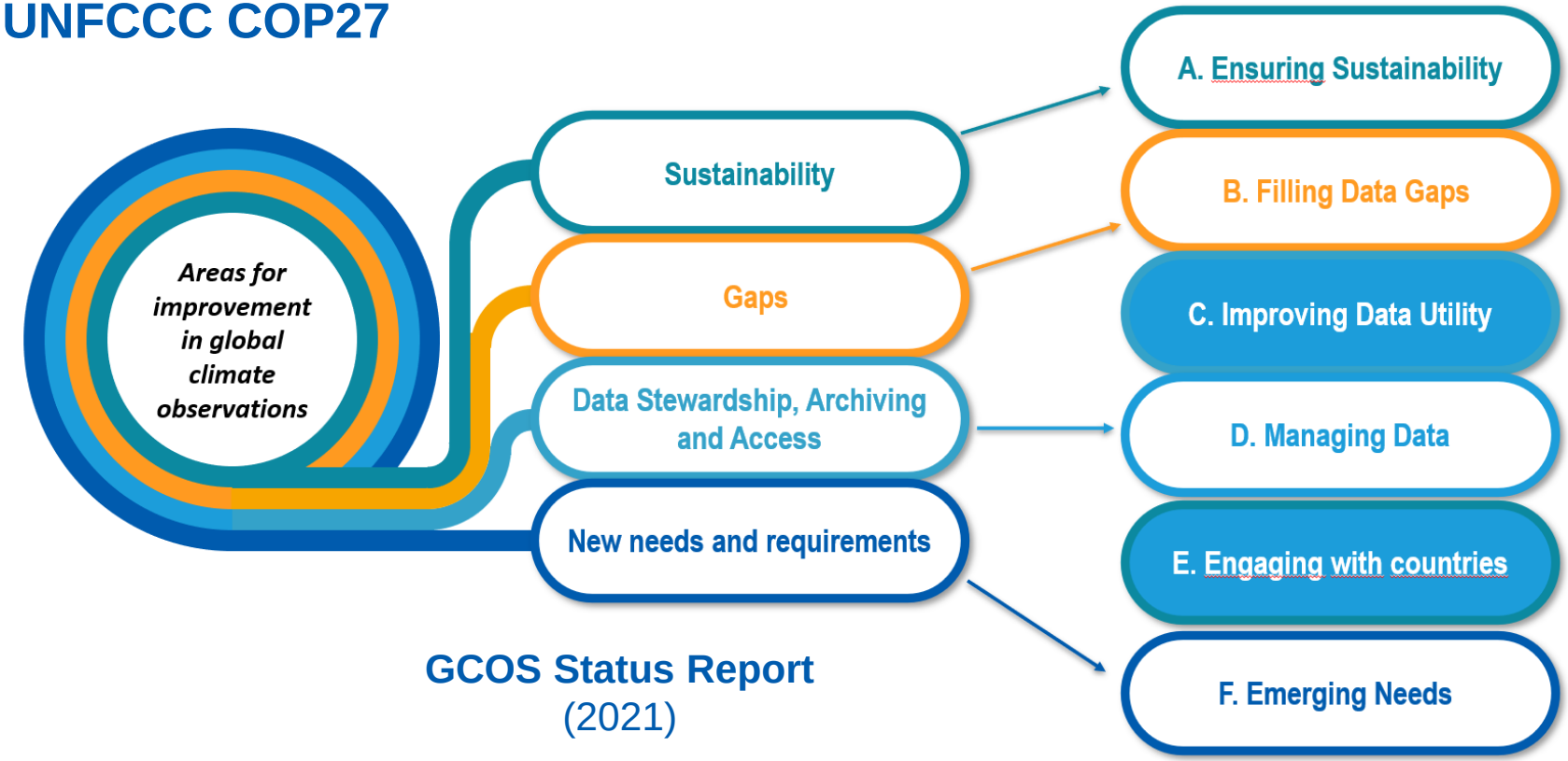
GCOS – Global Climate Observing System

New GCOS Implementation Plan released in 2022 and Endorsed by UNFCCC COP27



Themes for actions identified in the GCOS IP



GCOS Status Report (2021)

Recommended Actions

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Antonio Bombeli - abombelli@wmo.int (terrestrial panel)
Belen Martin Miguez - bmartinmiguez@wmo.it (ocean panel)

ECVs – Essential Climate Variables: Cryosphere

Cryosphere ECVs: Sea Ice, Snow, Glaciers, Permafrost, Ice Sheets /Ice Shelves

[GCOS Report on ECVs requirements]

	ECVs	ECV product
OCEAN	Sea Ice	Sea Ice Concentration
		Sea Ice Thickness
		Sea Ice Drift
		Sea Ice Age
		Sea Ice Surface Temperature (IST)
		Sea ice Surface Albedo
		Snow Depth on Sea Ice
LAND	Snow	Area Covered by Snow
		Snow Depth
		Snow-Water Equivalent
	Glaciers	Glacier Area
		Glacier Elevation Change
		Glacier Mass Change
	Ice Sheets and Ice Shelves	Surface Elevation Change
		Ice Velocity
		Ice Volume Change
		Grounding Line Location and Thickness
	Permafrost	Permafrost Temperature (PT)
		Active Layer Thickness (ALT)
		Rock Glacier Velocity (RGV)

8.2 ECV: Glaciers

8.2.1 ECV Product: Glacier Area

Name	**Glacier Area**				
Definition	Inventory of map-projected area covered by glaciers.				
Unit	km^2				
Note	Glacier area is the map-projected size of a glacier in km^2. The product comes as worldwide inventory of glaciers outlines with various related attribute fields (e.g. area, elevation range, glacier characteristics). Typically, a minimum size of 0.01 or 0.02 km^2 is applied, to avoid including small ice patches which do not flow and are therefore not glaciers.				
Requirements					
Item needed	**Unit**	**Metric**	**[1]**	**Value**	**Notes**
Horizontal Resolution	m		G	1	Spatial resolutions better than 15 m (e.g. the 10 m from Sentinel 2) are preferable as typical characteristics of glacier flow (e.g. crevasses) only become visible at this resolution (Paul et al. 2016).
			B	20	The horizontal resolution of 15-30 m refers to typically used satellite sensors (Landsat and ASTER) to map glaciers.
			T	100	At coarser resolution the quality of the derived outlines rapidly degrades.
Vertical Resolution			G	-	N/A
			B	-	
			T	-	
Temporal Resolution	y		G	1	The temporal sampling "Annual" means that each year the availability of satellite (or aerial) images should be checked to identify the image with the best snow conditions (i.e. snow should not hide the glacier perimeter).
			B		
			T	10	Decadal data used to evaluate glacier change in regional scale.
Timeliness	y		G	1	
			B		
			T	10	For multi-temporal inventories at decadal resolution, the timeliness of the product availability is not so important.
Required Measurement Uncertainty	%	Random error of glacier outlines produced in dependency of remote sensing imagery used, with respect to the total glacier area	G	1	Glacier outlines mapped with a resolution of 1 m remote sensing images (take glacier area in average as 1 km^2)
			B	5	Glacier outlines mapped with a resolution of 15-30 m remote sensing images (take glacier area in average as 1 km^2)
			T	20	Glacier outlines mapped with a resolution of 100 m remote sensing images (take glacier area in average as 1 km^2)

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GCOS IP Actions

At least 7 relevant to Cryosphere
+ data management issues (theme D)

Theme	31 Actions	Implementing Bodies											
		WMO	NMHS	Space agencies	GOOS	Reanalysis Centers	Global Data Centers	Research organizations	National Agencies	Parties to UNFCCC	Academia	Funding Agencies	GCOS
A: ENSURING SUSTAINABILITY	A1. Ensure necessary levels of long-term funding support for in situ networks, from observations to data delivery	x	x					x			x	x	x
	A2. Address gaps in satellite observations likely to occur in the near future			x									
	A3. Prepare follow-on plans for critical satellite missions			x									
B: FILLING DATA GAPS	B1. Development of reference networks (in situ and satellite Fiducial Reference Measurement (FRM) programs)	x	x	x				x				x	x
	B2. Development and implementation of the Global Basic Observing Network (GBON)	x	x		x								x
	B3. New Earth observing satellite missions to fill gaps in the observing systems			x									
	B4. Expand surface and in situ monitoring of trace gas composition and aerosol properties		x					x	x			x	
	B5. Implementing global hydrological networks	x	x	x			x						
	B6. Expand and build a fully integrated global ocean observing system		x	x	x			x	x		x		
	B7. Augmenting ship-based hydrography and fixed-point observations with biological and biogeochemical parameters				x			x					
	B8. Coordinate observations and data product development for ocean CO_2 and N_2O	x			x			x	x				
	B9. Improve estimates of latent and sensible heat fluxes and wind stress		x	x	x			x			x		
	B10. Identify gaps in the climate observing system to monitor the global energy, water and carbon cycles							x				x	x
C: IMPROVING DATA QUALITY, AVAILABILITY AND UTILITY, INCLUDING REPROCESSING	C1. Develop monitoring standards, guidance and best practices for each ECV	x		x	x								x
	C2. General improvements to satellite data processing methods			x				x			x		
	C3. General improvements to in situ data products for all ECVs		x					x			x		
	C4. New and improved reanalysis products			x		x					x		
	C5. ECV-specific satellite data processing method improvements			x		x							
D: MANAGING DATA	D1. Define governance and requirements for Global Climate Data Centres	x					x						x
	D2. Ensure Global Data Centres exist for all in situ observations of ECVs	x	x		x				x			x	x
	D3. Improving discovery and access to data and metadata in Global Data Centres						x					x	x
	D4. Create a facility to access co-located in situ cal/val observations and satellite data for quality assurance of satellite products	x	x	x				x					
	D5. Undertake additional in situ data rescue activities	x	x							x		x	x
E: ENGAGING WITH COUNTRIES	E1. Foster regional engagement in GCOS	x			x					x			x
	E2. Promote national engagement in GCOS		x							x	x		x
	E3. Enhance support to national climate observations									x		x	x
F: OTHER EMERGING NEEDS	F1. Responding to user needs for higher resolution, real time data	x	x	x				x			x		x
	F2. Improved ECV satellite observations in polar regions			x				x			x		
	F3. Improve monitoring of coastal and Exclusive Economic Zones		x	x	x			x			x		
	F4. Improve climate monitoring of urban areas	x	x					x	x		x		x
	F5. Develop an Integrated Operational Global GHG Monitoring System	x		x				x	x		x		x

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GCOS IP Actions relevant to Cryosphere

Action A2: Address gaps in satellite observations likely to occur in the near future
Including satellite observations of Altimetry in the polar regions and Global scale ice surface elevation.

Action A3: Prepare follow-on plans for critical satellite missions
Sea ice and icebergs (or floating ice).

Action B3: New Earth observing satellite missions to fill gaps in the observing systems
Develop operational techniques to estimate permafrost extent.

Action C4: New and improved reanalysis products
Develop coupled reanalysis (ocean, land, sea-ice).

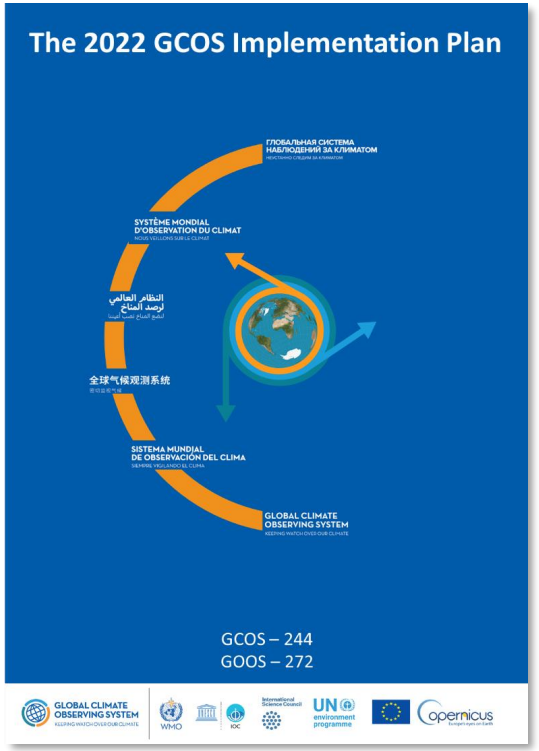
Action C5: ECV-specific satellite data processing method improvements
Generate timely permafrost products from high res. satellite observations.

Action F1: Responding to user needs for higher resolution, near real time data
Including cryosphere data (e.g. sea ice, ice sheets, permafrost, snow, glaciers).

Action F2: Improved ECV satellite observations in polar regions, including:

- Sea Surface Salinity of polar oceans.
- Greenhouse gases at high latitudes with a focus on the permafrost regions in wintertime.
- Sea-ice thickness.
- Surface temperatures of all surfaces (sea, ice, land).
- Atmospheric ECVs at the very highest latitudes.
- Albedo for all surfaces (land and sea-ice).

GCOS Implementation Plan



...and Theme D with
Actions on data management

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World Meteorological Organization
Organisation météorologique mondiale