INTAROS

INTAROS exploitation of exiting observing systems

Roberta Pirazzini[1], Michael Tjernström[2], Peter Thorne[3], Andreas Ahlstrøm[4], Francisco Navarro[5], Carsten Ludwigsen[6], David Gustafsson[7], Torill Hamre[8], Hanne Sagen[8], Stein Sandven[8]

(1) Finnish Meteorological Institute, Helsinki, Finland
(2) Department of Meteorology, Stockholm University, Stockholm, Sweden
(3) National University of Ireland Maynooth, Maynooth, Ireland
(4) Geological Survey of Denmark and Greenland, Copenhagen, Denmark
(5) Politechnic University of Madrid, Madrid, Spain
(6) Technical University of Denmark, Kongens Lyngby, Denmark
(7) Swedish Meteorological and Hydrological Institute, Norrköping, Sweden
(8) Nansen Environmental and Remote Sensing Center, Bergen, Norway

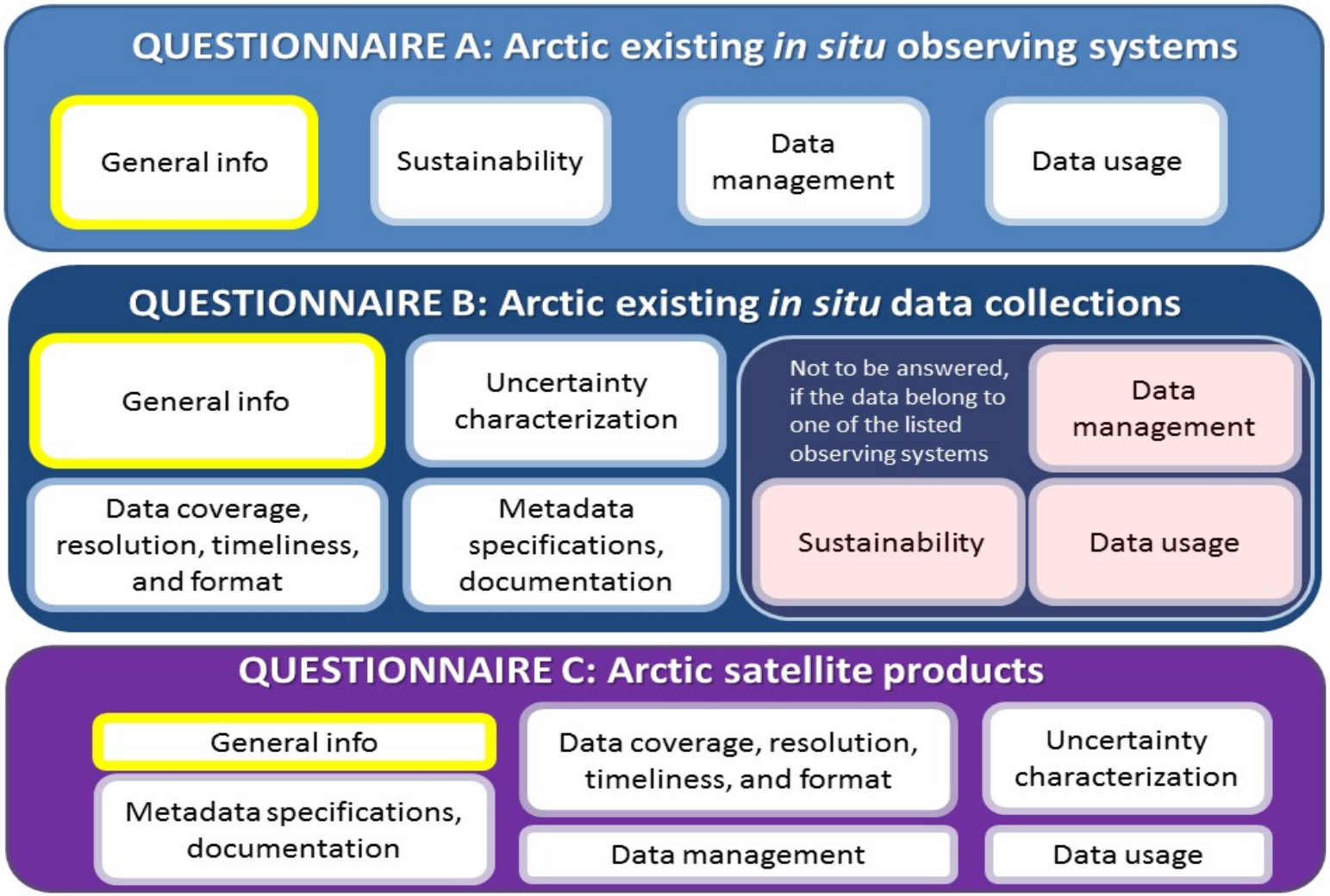
Main objectives

1. to perform a **gap analysis and maturity assessment** of the existing Arctic observing systems and
2. to **enhance the quality and accessibility** of existing Arctic data

1. and 2. are pre-requisites for the development and optimization of an integrated Arctic Observing system

Gap analysis and maturity assessment

Survey

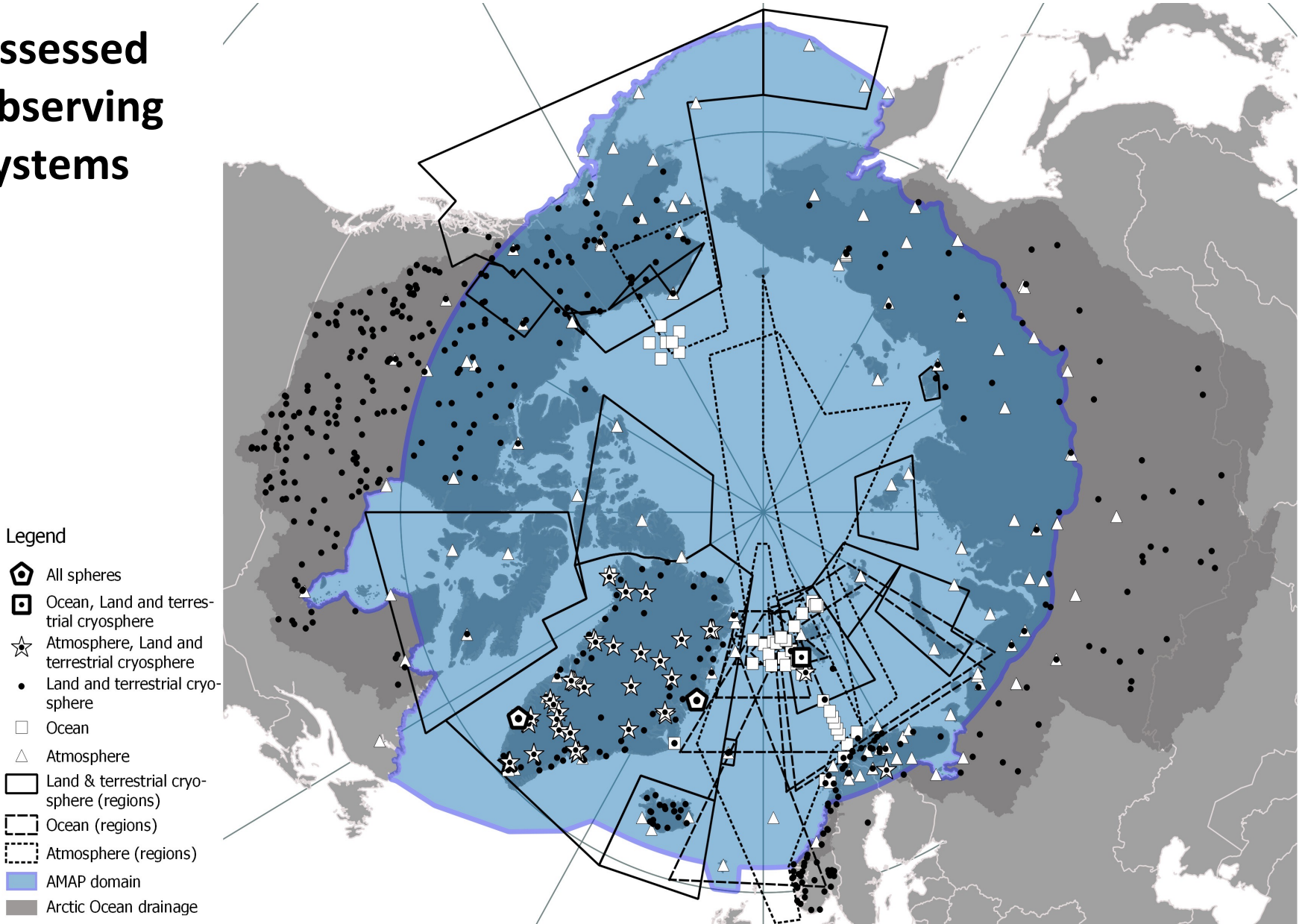


(Modest) model sensitivity studies

ATMOSPHERE: ECMWF model sensitivity to radiosounding observations
OCEAN MIT GCM sensitivity to SSH and salinity
LAND inverted modeling of 'field of view' for GHG tower network.

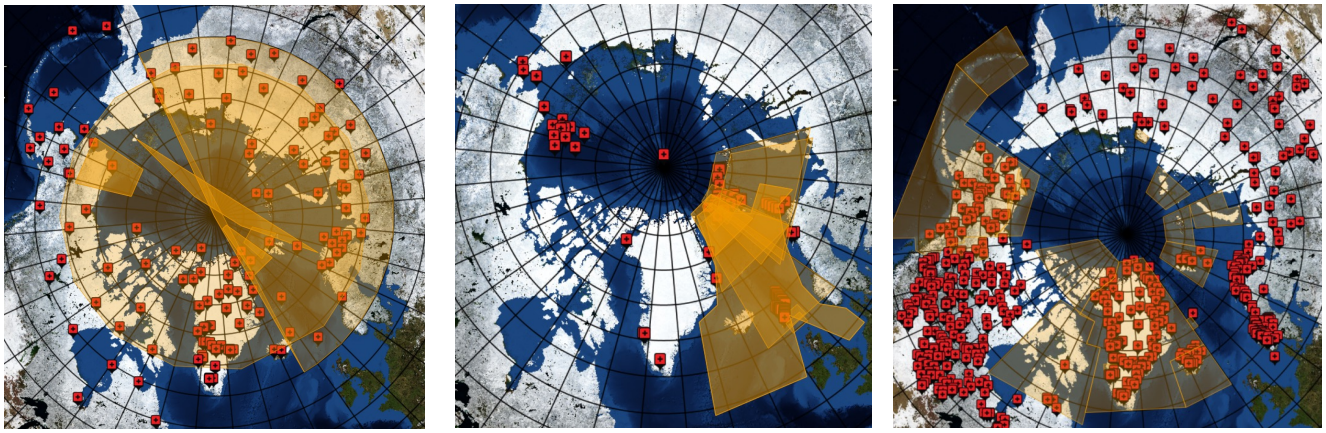
Gap analysis and maturity assessment

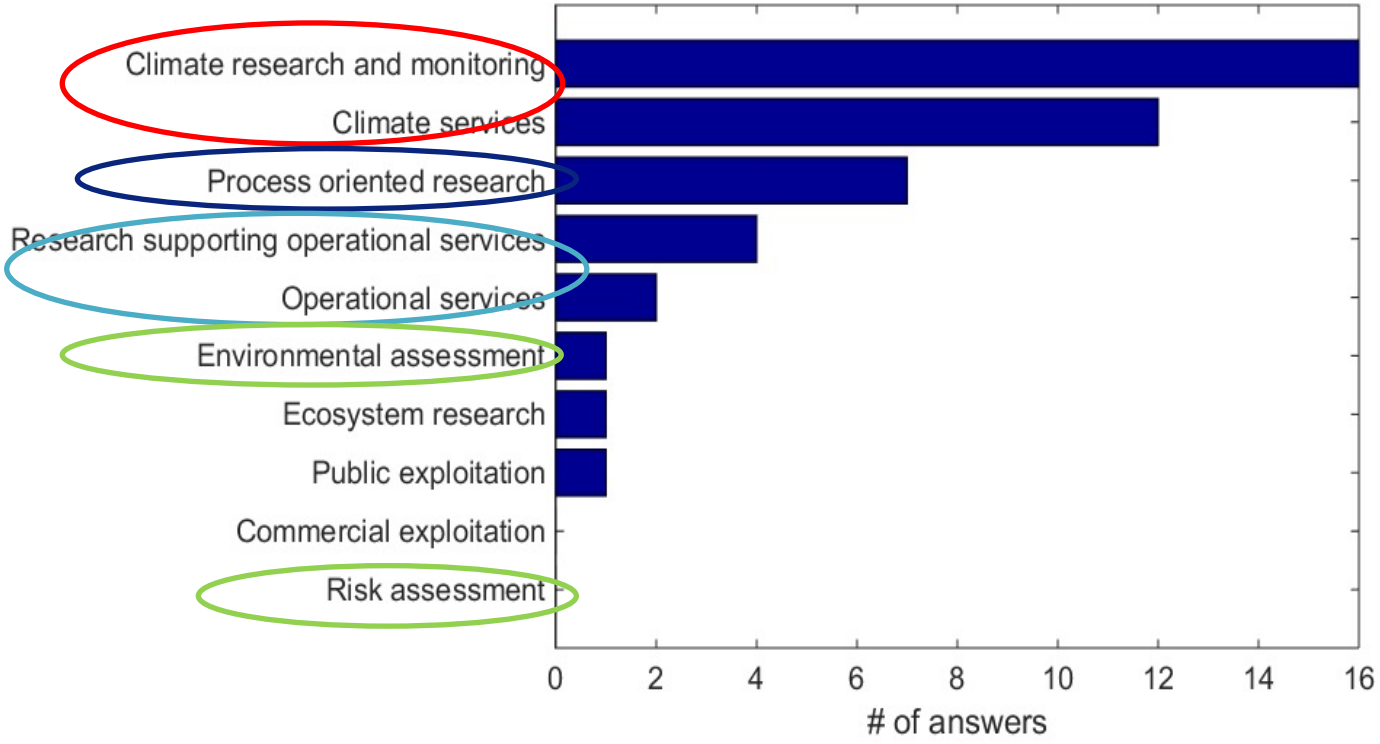
Assessed observing systems



Gap analysis and maturity assessment

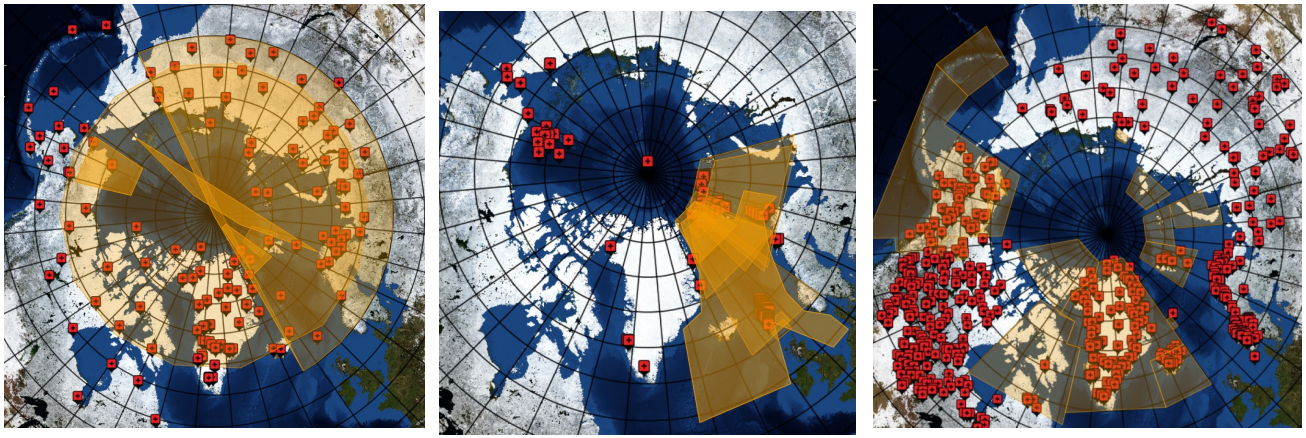
Atmosphere: overview of the surveyed observing systems

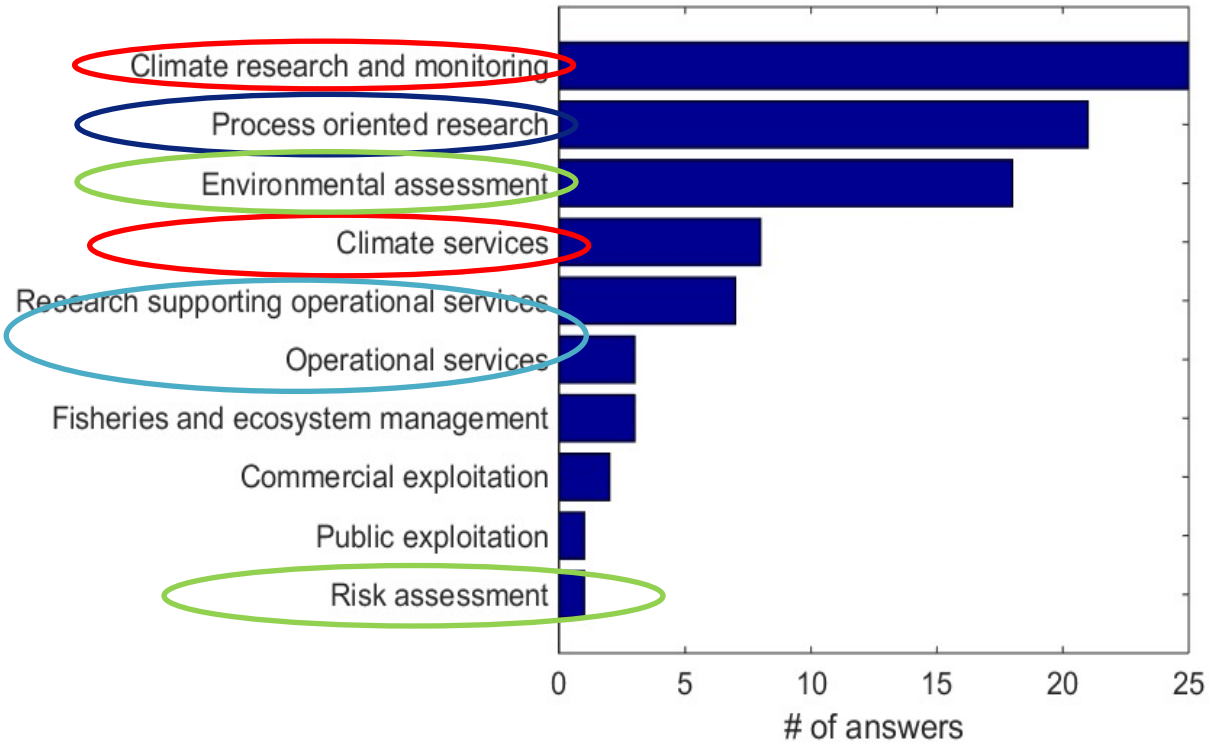




Gap analysis and maturity assessment

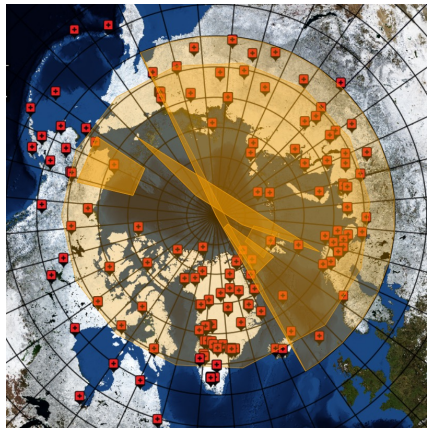
Ocean & Sea Ice: overview of the surveyed observing systems

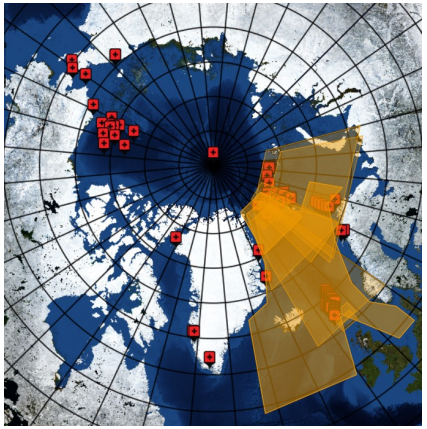


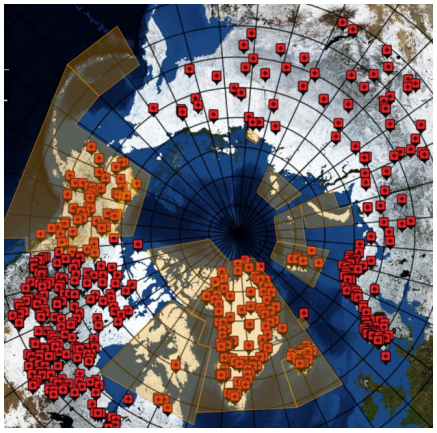


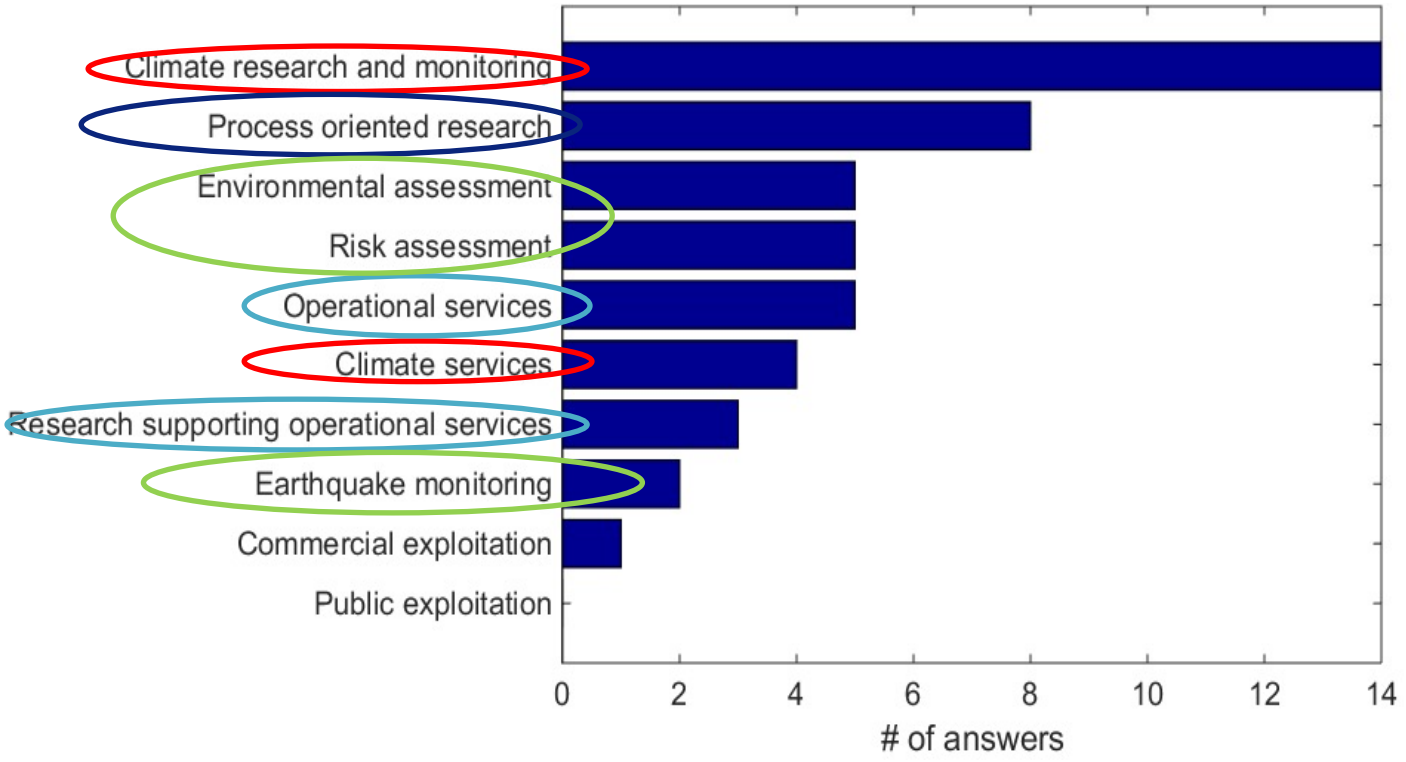
Gap analysis and maturity assessment

Land and terrestrial cryosphere: overview of the surveyed observing systems









Gap analysis and maturity assessment

Identified gaps in the Marine environment

Atmosphere: Observational gaps are in almost everything, especially in the vertical structure of atmosphere and of clouds; satellite retrievals, especially of clouds and profiling, are inadequate

Ocean & sea ice: Main gaps are in the vertical structure under ice, biogeochemical and biological observations, long-term moorings, sea-ice thickness and snow on the ice

Identified gaps in the Terrestrial environment

Atmosphere: There is need of increased data quality in some parts of the Arctic; long-term process (e.g. “super site”) observations of clouds and aerosols, especially in Russian Arctic where trace gas and trace-gas fluxes also have gaps

Land & cryosphere: Main gaps are in: scarcity of number/type of snow, glacier & ice sheet mass balance observations; availability of near-real-time observations; lack of characterization of satellite products

Gap analysis and maturity assessment

MATURITY SCORES: Assessed categories and subcategories and System Maturity Matrix structure for in situ observing systems, modified via category selection from that from GAIA-CLIM.

Data management	Sustainability	Uncertainty	Metadata	Documentation
Storage	Scientific and expert support	Traceability	Standards	Description of methodology
Access	Funding	Comparability	Collection level	Validation report
User feedback	Site represent-tativeness	Standards	File level	User guidance
Updates		Validation		
Version control		Uncertainty quantification		
Data preservation		Routine quality management		

Gap analysis and maturity assessment

Name of Observing system	METADATA			DOCUMENTATION			UNCERTAINTIES						DATA MANAGEMENT						SUSTAINABILITY			MATURITY CLASS
	Standards	Collection Level	File Level	Description	Validation Report	Series User Guidance	Traceability	Comparability	Standards	Validation	Quantification	Quality Management	Storage	Access	User feedback	Updated to record	Version control	Preservation	Expert support	Funding support	Site representativeness	
*A-TWAIN	1	2	4	1	2	2	2	2	na	na	2	3	2	6	1	2	2	4	5	3	na	CMP
*A-TWAIN PL	3	3	3	3	3	2	3	2	na	na	3	4	3	5	2	2	2	2	4	3	na	CMP-BSL
*AREX	4	3	3	3	2	2	4	3	na	na	4	2	6	5	2	3	2	3	4	4	na	CMP
ArgoPoland	4	3	4	2	3	2	5	4	na	na	2	4	6	6	1	3	4	4	4	3	na	BSL
EGO gliders	5	4	5	2	2	2	2	4	na	na	2	4	6	5	3	3	3	4	3	4	na	CMP-BSL
*FRAM	5	2	3	1	1	1	6	6	2	1	2	1	6	5	2	4	4	4	6	5	na	CMP-BSL
IMR BSOMA	1	2	3	2	2	2	2	1	2	2	2	3	4	3	2	2	1	4	5	4	na	CMP
IMR FHS	3	3	3	2	2	3	2	2	na	na	2	2	4	5	2	4	1	4	5	5	na	CMP-BSL
IMR FHScoast	3	2	3	4	1	2	2	2	na	na	1	1	4	4	2	na	1	4	4	5	na	CMP
IMR SI	na	2	2	3	2	4	2	2	na	na	2	2	2	3	2	3	1	3	4	3	na	CMP
GLOSS-Greenland	3	1	na	1	2	2	2	2	1	1	1	5	4	3	2	2	2	3	3	3	3	CMP
R/V Håkon Mosby	4	3	4	na	na	na	na	na	na	na	na	na	3	4	2	3	2	3	5	5	na	na
*Fram MAS	1	2	3	1	1	1	1	1	2	1	1	1	2	2	1	2	2	3	3	2	na	CMP
NorArgo	1	3	4	3	2	3	2	2	na	na	3	3	6	6	5	4	na	5	6	3	na	BSL
AC-AHC2	na	na	na	2	2	1	2	2	2	1	2	1	2	2	2	2	2	3	1	1	1	CMP
*RNA	3	3	4	1	2	2	5	2	na	na	3	5	6	5	1	6	3	5	3	5	na	CMP-BSL
*GAW	4	2	2	3	2	2	2	2	na	na	2	1	6	5	2	2	2	5	5	5	4	CMP
*Regional GAW	4	3	2	3	2	2	2	2	na	na	2	1	6	5	2	2	2	5	5	5	4	CMP
*ACTRIS	4	5	5	4	2	3	5	5	na	na	5	5	6	5	5	5	2	5	6	6	4	BSL
GRUAN	5	5	5	6	5	6	6	5	6	6	6	5	6	6	5	5	5	5	5	6	5	REF
GOS met	1	5	4	1	2	3	2	2	3	1	1	4	6	6	5	4	4	5	3	5	1	CMP-BSL
*Atmospheric ship-based campaigns	1	2	2	1	1	1	1	1	1	1	1	1	2	3	2	2	2	4	1	1	na	CMP
Fluxnet	1	3	3	3	3	3	2	2	3	2	2	2	4	3	1	3	3	4	1	2	3	CMP-BSL
*World Glacier Monitoring Service-Fluctuations of Glaciers Database	5	3	3	3	2	3	na	na	3	3	3	3	6	6	3	3	5	5	5	6	3	BSL
Glacier Thickness Database	4	3	3	3	2	3	na	na	3	3	3	3	6	6	3	3	5	5	5	6	3	BSL
GLISN network Greenland	6	6	6	6	6	6	5	5	6	3	3	6	6	6	3	3	3	6	6	3	6	BSL-REF
*Norwegian National Seismic Network	6	6	5	6	4	5	6	6	na	na	6	5	6	6	2	1	1	5	6	6	5	BSL-REF
GNET - GPS networks	5	5	5	6	5	5	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	REF
Randolph Glacier Inventory	4	3	3	3	2	3	na	na	3	3	3	3	6	6	6	3	5	5	5	6	3	BSL
Arctic-HYCOS	5	2	5	1	1	2	4	3	na	na	2	4	5	5	1	4	4	4	5	5	5	CMP-BSL
*Greenland Ecosystem Monitoring program	1	2	1	1	1	1	1	1	1	1	1	1	2	4	2	2	2	3	5	6	na	CMP
IMR Barents Sea Winter Survey	1	2	2	1	1	1	1	1	1	1	1	1	3	3	1	2	1	3	1	6	na	CMP
*IMR-PINRO Ecosystem Survey	1	2	2	1	1	1	2	2	1	1	1	1	2	3	2	2	1	4	1	6	na	CMP
*NIVA Barents Sea FerryBox	3	3	3	3	2	4	1	3	na	na	2	3	1	3	2	2	2	3	6	4	na	CMP-BSL
Pan-Eurasian Experiment	4	3	3	2	2	2	2	2	1	1	2	1	2	2	2	2	2	4	3	5	3	CMP
*Sodankylä station	1	3	3	1	2	2	2	2	na	na	2	1	2	5	2	4	2	3	6	6	4	CMP
*Airborne observations of surface-atmosphere fluxes	1	2	4	1	1	1	2	3	1	2	2	2	2	2	2	na	2	4	4	4	5	CMP
*PROMICE automatic weather station network	1	3	5	4	1	3	1	1	1	2	2	3	5	6	2	6	5	5	6	6	4	CMP-BSL
*Hornsund Station	5	3	3	2	1	2	1	1	2	1	1	1	4	3	2	2	2	4	4	5	3	CMP
Tower network for atmospheric trace gas mixing-ratio monitoring	4	4	3	3	3	3	6	6	6	6	6	5	2	2	2	3	4	4	3	3	3	BSL

Gap analysis and maturity assessment

Synthesis of Maturity: terrestrial environment

atmosphere, land and terrestrial cryosphere and **multidisciplinary**

(Shades of red correspond to the maturity scores)

Observing systems	Sustainability	Data management	Uncertainty handling	Metadata handling	Documentation
GRUAN, ACTRIS, ICOS, GNET-GPS Network, GLISN, NNSN, Arctic-HYCOS	High	High	High or medium-high	High	High
Global/regional GAW, PROMICE, GlaThiDa, WGMS-FoG, RGI	High	High or medium-high	Low	Medium-high	Medium
Radiosoundings network, GOS Surface synoptic measurements, Sodankylä supersite	High	Medium-high	Medium-high	Medium	Low
Radiosounding network, GEM	High	Medium-high	Low	Low	Low
Hornsund supersite	Medium	Medium	Low	Medium	Low
GC-Net	Medium	Medium	No information	No information	No information
Tower network for atmospheric trace gas mixing-ratio monitoring	Medium	Low	High	Medium	Medium
luxnet, PEEX, Airborne observations of urface-atmosphere fluxes	ow-Medium	Low-Medium	Low	Medium	Low

Gap analysis and maturity assessment

Synthesis of Maturity: marine environment

ocean and sea ice, atmosphere, and **multidisciplinary**

(Shades of red correspond to the maturity scores)

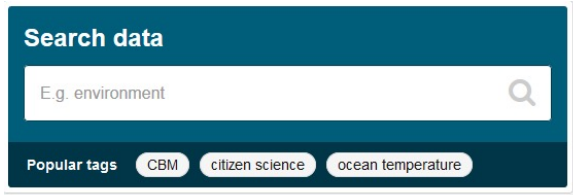
Observing systems	Sustainability	Data management	Uncertainty handling	Metadata handling	Documentation
FRAM	High	Medium	Low-medium	Medium-high	Low-medium
IMR PINRO Ecosystem Survey & Barents Sea Winter Survey, Greenland Ecosystem Monitoring Programme	High	Low-medium	Low	Low	Low
NorArgo	Medium	High	Low-Medium	Medium	Medium
IOPAN Long-term Monitoring in Svalbard Fjords	Medium	High	Not assessed	Not assessed	Not assessed
Argo Poland	Medium	Medium-High	Medium-high	Medium	Low-Medium
A-TWAIN / A-TWAIN Poland	Medium	Medium-High	Low	Low-medium	Low
NIVA Barents Sea FerryBox	Medium	Low-medium	Medium-high	Medium	High
IOC Tide Gauges in Greenland, AREX	Medium	Low-Medium	Low	Low	Low
International Arctic Buoy Programme	Medium	Low-Medium	Not assessed	Not assessed	Not assessed
Atmospheric field experiment (ASCOS, ACSE, N-ICE), Polarstern soundings	Low	Low-medium	Low-medium	Low-medium	Medium
Fram Strait Multipurpose Acoustic System	Low	Low	Low	Low-Medium	Low

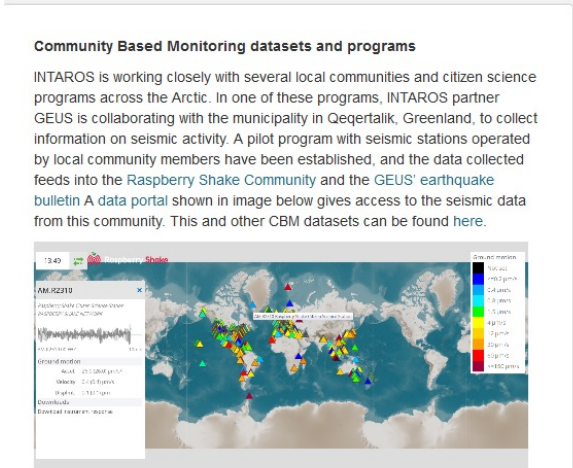
Enhanced data quality and accessibility

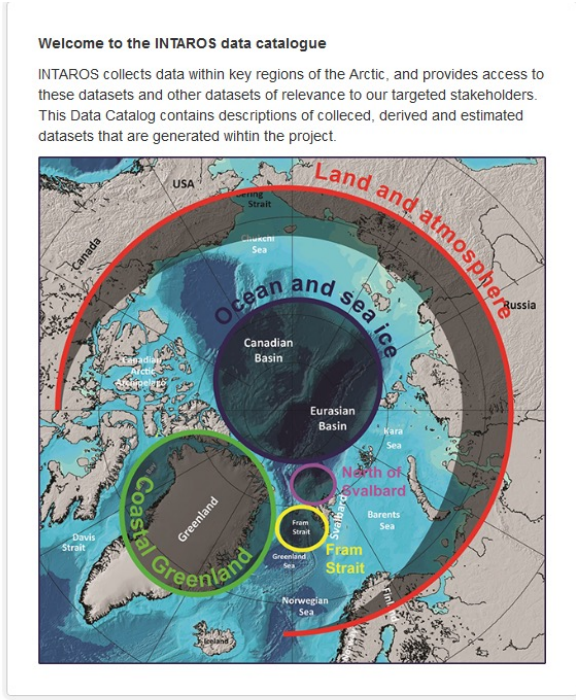
- Improved data products
- Compilation of data products from distributed databases
- Harmonization of sparse data following best practices and protocols

Now available trough:

- **open access databases**
- **INTAROS Data Catalogue** https://catalog-intaros.nersc.no/







Synthesis and recommendations (1)

- High sustainability is a proxy for high scores across the board and such systems result from national, regional or global infrastructures often not specific to the Arctic ⇒

  Integrate Arctic observing in existing national/regional/global program rather than inventing new Arctic specific systems

- Scientific campaigns/expeditions provide the highest quality observations, but are deficient in almost all other aspects, especially on sustainability and data management ⇒

Revision of funding mechanisms:

- **increase coordination/shared funding between operational and scientific driven observations**
- **involvement of private sector**

Synthesis and recommendations (2)

- **Arctic Ocean**: A lack of in-situ observing capacity across all disciplines. Almost nothing in the atmosphere; subsurface installations robust but few, and they deliver data in delayed mode ⇒

  Paradigm shift in system design where field experiments correspond to the reference system, satellites to baseline and reanalysis replaces the comprehensive level

- **Arctic land**: Quality is a larger problem than coverage ⇒

  Upgrade and complement existing stations, rather than expanding new networks; deploy new technology at existing stations

- **Satellites**: provides the only data with sufficient spatial and temporal cover, but quality is sometimes lacking ⇒

  Invest in in situ Cal/Val multidisciplinary supersites and field campaigns to improve satellite retrievals, models and data assimilation

Multidisciplinary supersites/experiments!

Thank you!