GCW-CryoNet
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Coordination: at national scale, esp. for sites outside the Greenland Ice Sheet (GEM), and contribution of individual programmes to global datacenters and networks

Operations:

- It takes years of R&D to develop a satisfactory technical setup
- Sensors can't be serviced promptly
- Large benefit from standardized systems at each site
- Data: realtime instantaneous vs. averaged, full offline
- Special requirements: aspirated radiation shields, radiometer tilt meter, low data latency (how low?) → tradeoffs: e.g. 10 min instantaneous aspirated Tair and RH
- Special issues: h of sensors above ground only constant in summer or never at all, h above m.s.l. changes (predictably) all time
- Opportunities: sharing fieldwork expenses, transfers from research netowrks to the monitoring programme, contribution from related activities

Greenland ice sheet is larger than any single project, institute or country can currently monitor alone, and has global relevance (sea level rise) → DK, US, NL, JP

- Most (all) operators have both science and monitoring interests and capabbilities
- Different operators, data policies, formats
- Different procedures, quality checks, recalib.
- Most data are underused (because recent, because not public, because not realtime, because 'special', …)

In common:

Expensive → need sustained funding → funding is national → who should benefit: scientists, operators, **policymakers** → they make things happen – or not.

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HOW (1): make the benefits visible both to policymakers and the general public by increasing actual use of ground observations(operational, research, 'state of cryospehre' assessments, outreach):

- Define a limited set of **prompt, reliable, clear, representative, easily communicated and understood products** capturing the **state of the crysophere**, its **variability** and **trends**, both over time and space.

- Encourage adoption of **low latency satellite telemetry** for remote ground sites. When carefully planned, it can be done with modest costs and power requirements.

- Define authoritative and easy to access sources for these products. (reusing what already exists!)

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HOW (2): engage in capacity building supporting countries interested in initiating monitoring programmes:

- Provide initial ‘turn-key’ instruments, systems and procedures …
- … but also train personnel in the construction of further systems
- Train personnel in the field setup and maintenance of the instruments
- Support in establishing a proper data flow and metadata management
- Support setting up initial operational products

Of relevance to definition of tiers/reference site/super site/global site…

All we do in CryoNet should have global relevance when seen as a network, but not all sites provide data of global relevance in themselves.

- There is essentially one all-important factor for policy makers and the political level (those who provide money for all the rest to happen): is this relevant for **global themes** like sea level rise, climate change, and **national themes** like water resources. →

- There are 3 main types of goals, with different requirements (besides data quality):

  1) assessing climate normals and detecting change
     → Long, uninterrupted, consistent

  2) supporting climate model and remote sensing cal/val.
     → representative of wide homogeneous surroundings, right timing, local to ROI, able to support campaigns and experiments

  3) processes understanding
     → uninterrupted, consistent, comprehensive (relative to the cryosphere element being monitored). Research networks have a big role here

- high gradient environments like high relief mountain areas or the margin of the ice sheet require transects spanning the gradient

- difficulties and scale issues involved in comparing ground point measurements with gridded datasets from RCM models and remote sensing observations → either ~ flat homogeneous regions, or transects and arrays of ground points spanning known gradients

Of relevance to definition of tiers/site/supersite/…:

- Specific challenges of specific environments:
  - changing station elevation with surface melt,
  - Limited accessibility for unplanned maintenance,
  - special constraints: power availability, high radiation →

  → tradeoffs: e.g. 10 min instantaneous aspirated Tair and RH

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- difficulties and scale issues involved in comparing ground point measurements with gridded datasets from RCM models and remote sensing observations → need for either ~ flat homogeneous regions, or transects and arrays of ground points spanning geophysical gradients

1) define standard quality requirements and instructions for monitoring sites and automatic stations → benefits users, new and existing operators, research projects, funding bodies

- Specify requirements, best practices and guidelines for the measurement and quality assurance of field observations specific for cryosphere, including traceability and strict requirements for complete metadata.

- Carefully assess the negative impact of any change or additional requirement on existing programmes, in terms of costs, data continuity, and homogeneity (e.g. aspirated shields, averaging vs.instantaneous, …)

2) promote the development of operational analysis and synthesis products based on CryoNet real-time as well as archived monitoring data

- In a first stage: model and remote sensing products consistent with ground observations e.g.: surface temperature from satellite calibrated with ground measurements, or accompanied by ground control values

- In a second stage: products integrating ground observations, remote sensing and climate models (e.g., surface mass balance of the Greenland Ice Sheet)

3) Assist operators of future monitoring networks and research projects by removing the costs, delays, uncertainties and quality issues connected with designing, producing and setting up ad hoc technical solutions for applications where good previous experience exist:

- provide a set of recommended and well documented reference designs for modular and flexible automatic stations suitable for various environments. E.g.: **entire glacier AWS**, **real-time comms kits**, ablation meters, ...
- The reference designs should be modelled after proven success stories from existing monitoring programmes, and provide the option of obtaining ready to use systems if so desired
- Provide actual contact points where actual support is available

4) increase the public availability of otherwise closed (and after some time often lost) field observations

- Encourage research funding bodies to mandate the public availability of field data produced within research projects, with a time-limited embargo to allow for research and publication time. This could be acceptable if applying PI's could expect the funding body to cover reasonable costs for data documentation, validation, formatting to the CryoNet-defined standard, and delivery to an open repository.

- Create a specific 'label' ('CryoNet Snapshot' perhaps?) for deliberately short-term, but systematic, documented and quality controlled ground time series

- Create a specific 'label' ('CryoNet Legacy' perhaps?) to promote the retrieval, documentation and digitization of unique legacy datasets

5) increase availability within CryoNet partners of key proprietary datasets locked behind licensing walls, such as the SPOT imagery and SPIRIT DEM products which were temporarily made available for free during the IPY, or Radarsat-2 SAR data.

- Lobby for access to be granted on a nominal co-funding basis between the provider and the user, where the user is allowed to pay in-kind, e.g. by processing SAR data to ice surface velocity. Underused processing and analysis capacity may exist which is not fully exploited due to prohibitive data costs, especially for vast Arctic regions. It would be a win-win solution, as no income is really lost for the provider, and their data gain a wider visibility.

6) promote wide participation of affiliated CryoNet sites to relevant research and development projects. Among current issues are:

- coordinating round robin exercises involving competing climate models or remote sensing products and assessing their performance against actual ground mesurements
- pscaling from the in situ measurements scale,
- Development in monitoring of solid precipitation and accumulation,
- parameterization of snow compaction and meltwater retention,
- standardize the reporting of measurement accuracies,
- improving remote sensing albedo and surface temperature products, …

  - By defining standards for CryoNest sites, ideally all sites in a given region of interest should be relevant and easy to include in research projects, regardless of the specific data providers operating the stations.

  - Lobby for appropriate funding bodies to devote resources for this

  - Coordinate the community and provide early information on upcoming calls for applications

7) After what already exist is made fully available through CryoNet, facilitate augmentation of existing permanent monitoring sites, and conversion of selected temporary research sites into permanent monitoring sites:

- Define gaps in coverage (spatial, temporal, parameters)
- Define a set of recommended measurements of relevant cryosphere parameters, with clear rationales and priorities for their addition to existing sites or future sites. Set incremental tier requirements providing a meningful ‘upgrade path’
- Encourage and facilitate early collaboration between research projects and monitoring projects which may be operating in the same country or region

- GCW and CryoNet may promote a framework for periodic assessments of state of the cryosphere, at the regional (e.g. Greenland) and hemisphere or global scale.

- GCW and CryoNet may assist raise seminal funding for ‘exotic’ under-researched components of the cyosphere, such as e.g. perennial cave ice (in karst), which may hold unexplored potential (stable isotopes, chemistry, crystallography, pollen, radiocarbon, stratigraphy, …)