



National Snow and Ice Data Center
Supporting Cryospheric Research Since 1976



Arctic Observations and Data: Using and Ecosystem Approach and Systems Science to Enhance Information Flow for Fisheries Research

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 Research Scientist, National Snow and Ice Data Center,
 CIRES, University of Colorado

26 October 2017



ARCTIC DATA COMMITTEE



Arctic Data: Opportunities, Challenges and the Way Forward

See <http://arcticdc.org/meetings/adc-meetings/interoperability-workshop> for links to resources

Sustaining Arctic Observing Network (SAON)

SAON Data Management Workshop Report

Developing a Strategic Approach

Prepared By:
Gillian B. Lichota, NOAA Arctic Research Program
Simon Wilson, AMAP



The Importance of the Polar Regions
Canada, to
Data Science

TOWARDS AN INTERNATIONAL POLAR DATA NETWORK

P L Pulsifer^{1*}, L Yarmey¹, Ø Godøy², J Friddell³, W Manley⁷, A Gaylor⁸, A Hayes⁹, S Nickels¹⁰, C

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- *Email: pulsifer@nsidc.org
- ²Norwegian Meteorological Institute, Henrik Mohns plass 1,
- ³Canadian Cryospheric Information Network, University of Victoria N2L 3G1, Canada
- ⁴Research Data Alliance, Rensselaer Polytechnic Institute, Troy, NY
- ⁵CEN: Centre d'Etudes Nordiques, Laval University, Quebec
- ⁶NIOZ Royal Netherlands Institute for Sea Research, Texel, The Netherlands
- ⁷Institute of Alpine and Arctic Research, University of Colorado

POLAR CONNECTIONS

REPORT OF THE POLAR CONNECTIONS INTEROPERABILITY WORKSHOP AND ASSESSMENT PROCESS

7-10 NOVEMBER 2016

Editors: Peter L. Pulsifer, Julie Friddell, Pip Bricher, Øystein Godøy, Colleen Strawhacker, David Arthurs, Lynn Yarmey, Andrew Fleming



[DRAFT]



Recommendations & Observations Arising From the 'International Polar Data Forum'

15-16 October 2013, Tokyo (Japan)

The International Polar Data Forum (comprising of data managers, scientists, and research coordinators) share the following recommendations...



Generation of Observing Systems for the Polar Regions

Summary Report

Prepared for: European Space Agency



Prepared by: Polar View Earth Observation Limited



Data Management for Arctic Observing

A Community White Paper

Prepared for the Arctic Observing Summit 2013

Peter L. Pulsifer¹, Lynn Yarmey¹, Øystein Godøy², Julie Friddell³, Warwick F. Vincent⁴, Taco

Polar Connections

Published: 23 August 2016

Interoperability Workshop and Assessment Process



- 1 National Snow and Ice Data Center
- 2 Norwegian Meteorological Institute
- 3 Canadian Cryospheric Information Network
- 4 CEN: Centre d'Etudes Nordiques
- 5 NIOZ Royal Netherlands Institute for Sea Research

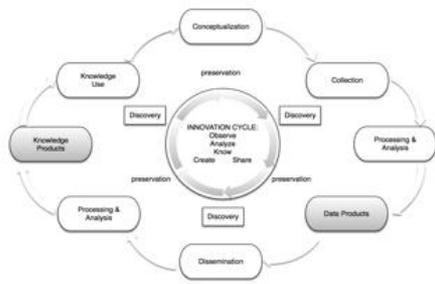
Response to the
Open Geospatial Consortium Request for Information on Arctic Spatial Data

Statement of Principles and Practices for Arctic Data Management
April 16, 2013

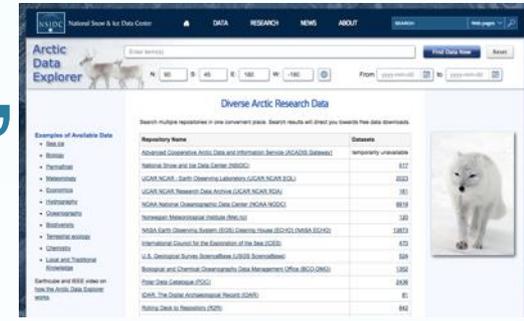
All IASC-endorsed scientific results shall be verifiable and reproducible through ethically open access to all data necessary to produce those results. Data shall be preserved, accessible, and used in accordance with scientific norms of fair attribution and use.

To this end, IASC Council approves the following actions:

1. Endorsement of the Statement of Principles and Practices for Arctic Data



The Data Vision, Challenge

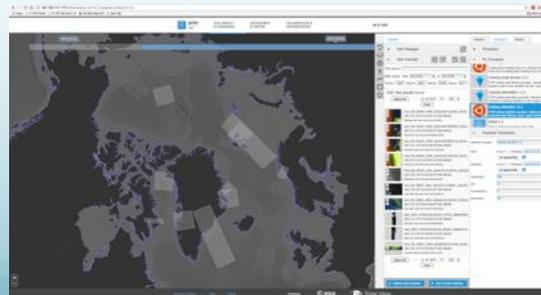


<http://nsidc.org/acadis/search/>

- “Common access, Single Window” to discuss and access data through information technology
- High quality, ethically open data preserved over time (sustainability)
- Data as a service
- Interoperability (share data among various information systems in a useful and meaningful manner)
- Inclusive of Indigenous and local perspectives
- Access to big data and powerful analytical tools (e.g. cloud platforms)
- Cost effective!



Pulsifer xxet al. 2014



Screen capture complements of Polar View

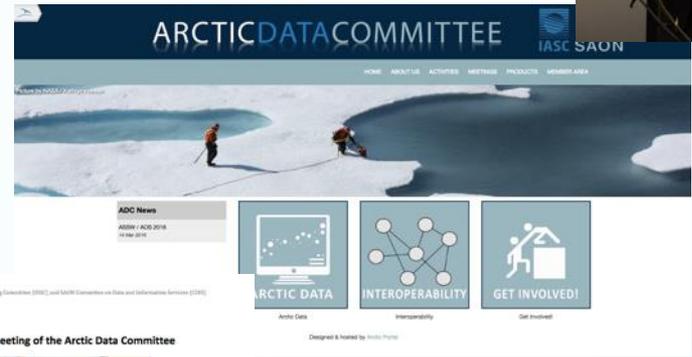


<http://eloka-arctic.org/communities/yupik/atlas/index.html>



Arctic Data Committee

- Formed Nov '14
- IASC-SAON partnership
- National and voluntary members + Indigenous (2017)
- Promote and enable:
 - Understanding the system
 - Effective data policy
 - Infrastructure
 - Ethically open access
 - Attribution
 - Standards and interoperability – **FEDERATED SEARCH, SEMANTICS**



Statement of Principles and Practices for Arctic Data Management April 16, 2013

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To this end, IASC Council approves the following actions:

1. Endorsement of the Statement of Principles and Practices for Arctic Data Management;
2. Establishment of an IASC Data Standing Committee;
3. To undertake measures towards adoption of national data policies consistent with

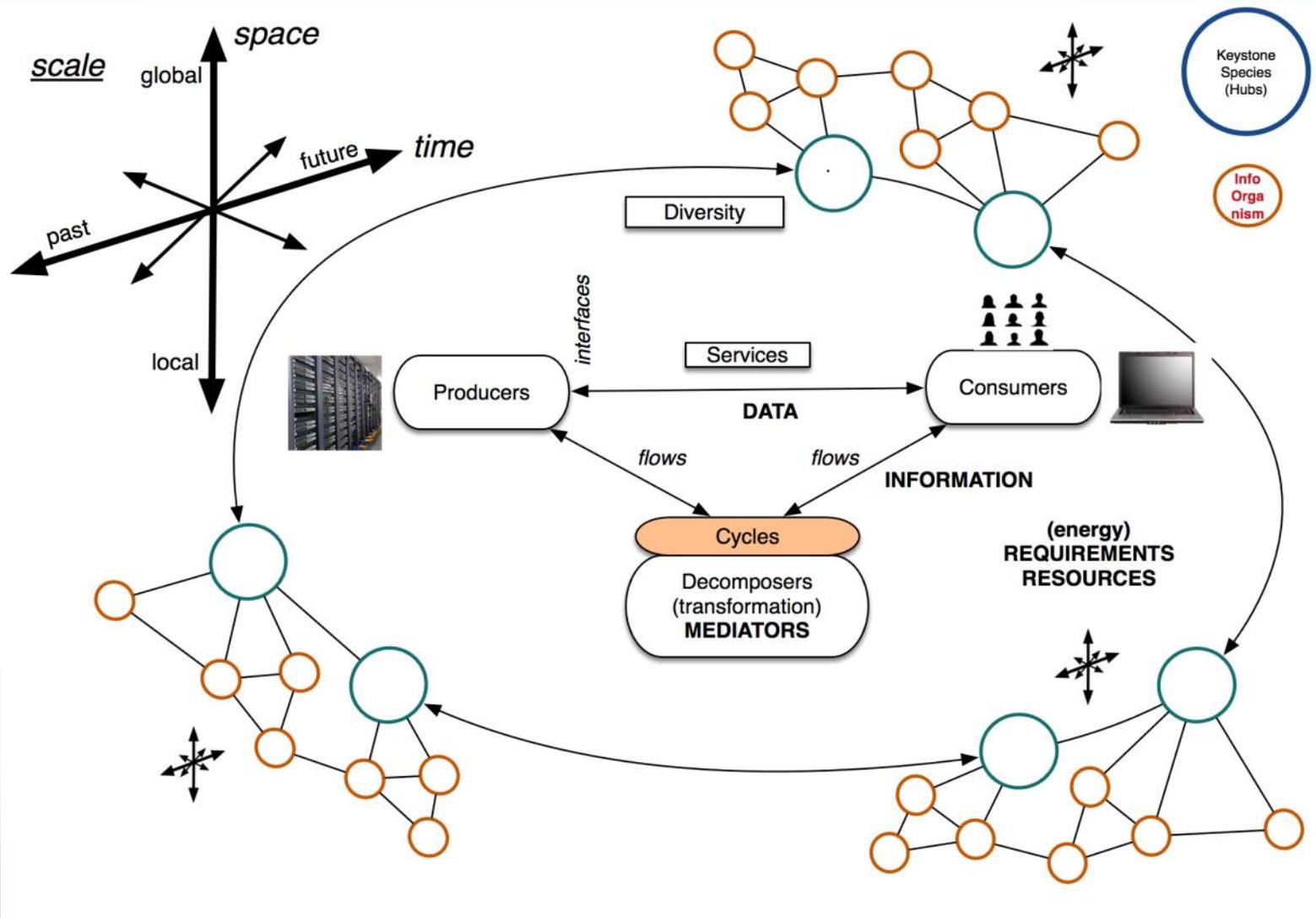
Montreal 16-18 Sept. 2017



<https://www.rd-alliance.org/plenaries/rda-tenth-plenary-meeting-montr%C3%A9al-canada>

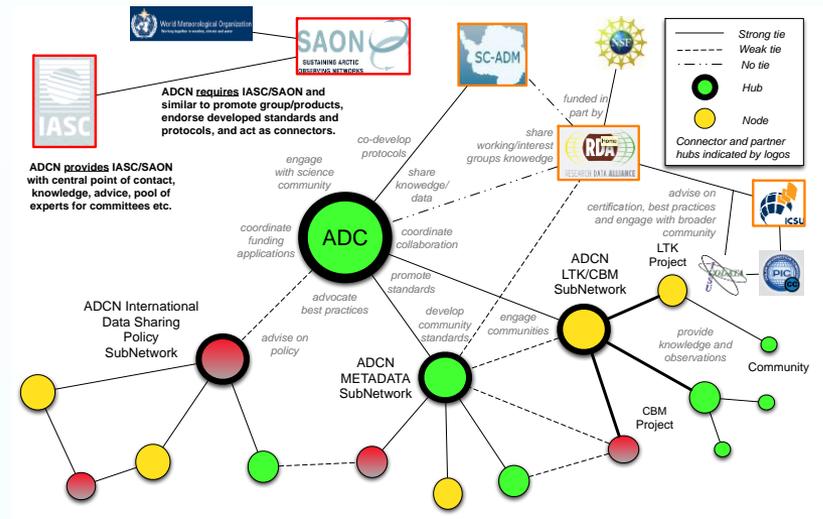
Achieving the Vision: Data as a System

Data Ecosystem

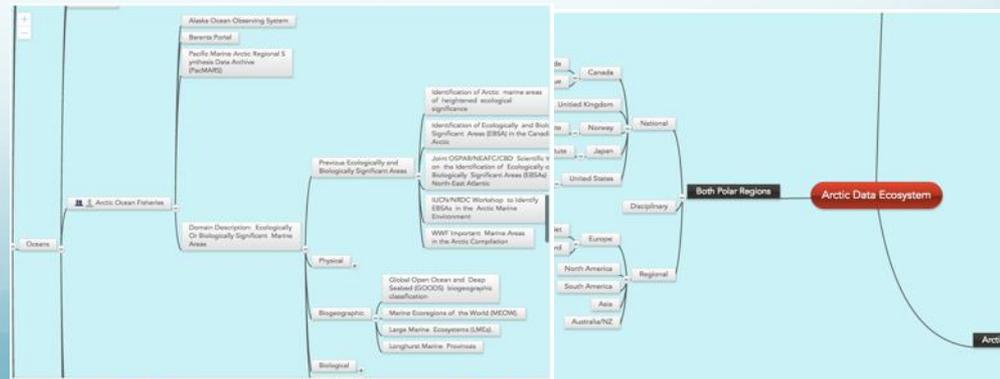


Network Systems Science and the Need for a Distributed System

- Need to guide the design of a robust network that achieves the Vision – pragmatic, Agile
- Robust networks include **multiple *hubs*** and less connected nodes – “loose ties” + “hub and spoke (**scale free networks**)”
- **Distributed, multi-scale** system is what we have and what we **want!**
- Strengths: responsive, resilience, diversity, avoids catastrophic failure



Pulsifer, P. L., Yarmey, L., Godøy, Ø. et al. (2014). Towards an International Polar Data Coordination Network. *Data Science Journal*, 13, 94–102. doi:<http://dx.doi.org/10.2481/dsj.IFPDA-16>



Species (nodes): cyberinfrastructures

- Information environments that support:
 - acquisition,
 - storage,
 - management and curation,
 - integration,
 - mining,
 - visualization,
 - other processing services

Species (nodes): mediator organizations

- Organizations that coordinate and drive collaboration to bring about understanding, agreement and a desired result



There are many established and emerging mediator organizations



Understanding the data ecosystem



Dr. Katia Kontar

Postdoctoral Fellow (*Arctic Data e-Cosystem Scientist*)
 Professor Paul Arthur Berkman and Dr. Peter Pulsifer
 Fletcher School of Law and Diplomacy, Tufts University
 24 Months (with possible extension)

POSTDOCTORAL FELLOW
Arctic Data e-Cosystem Scientist

OF FLETCHER SCHOOL OF LAW AND DIPLOMACY AT TUFTS UNIVERSITY

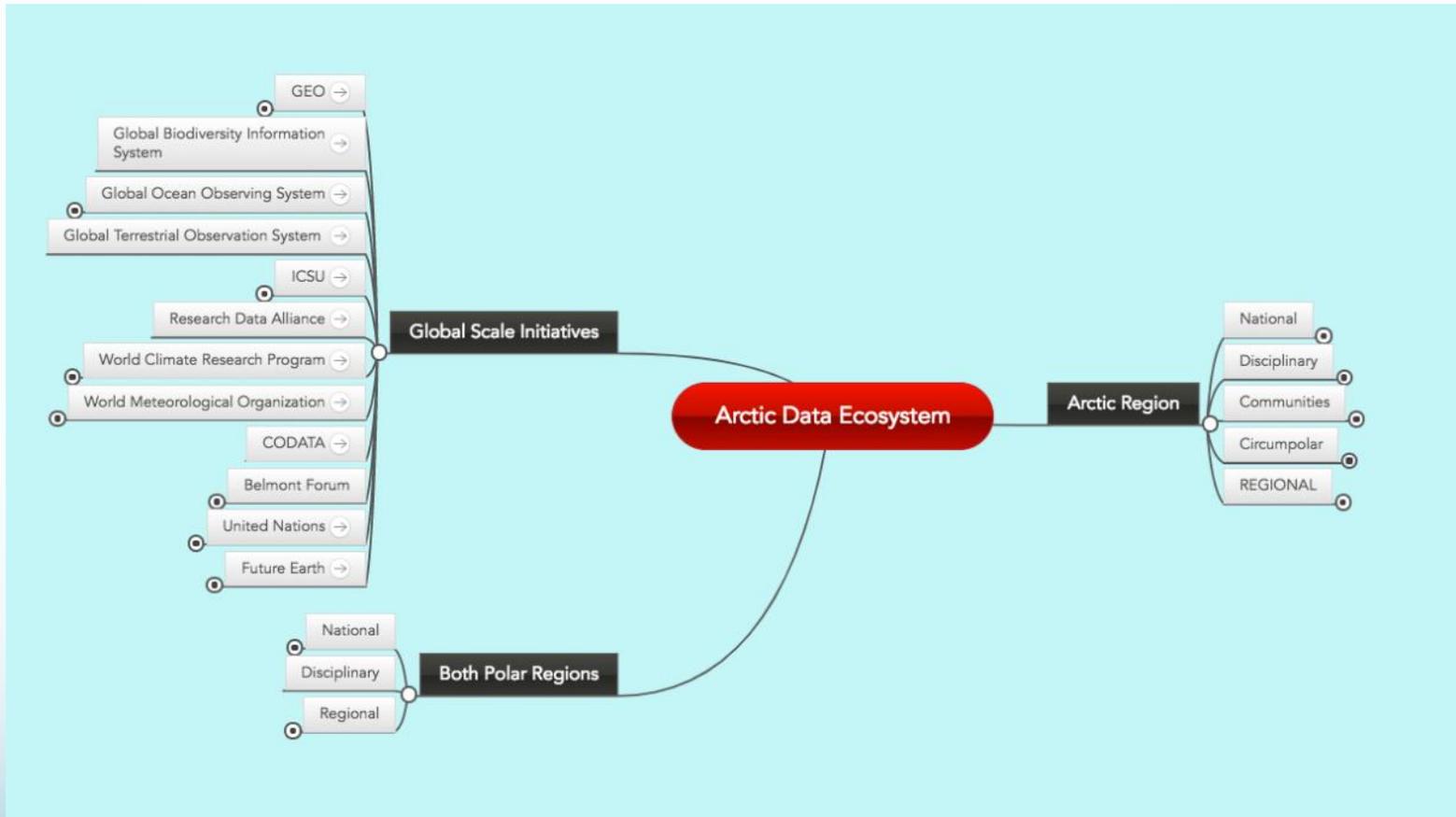
school is committed to educating in an inclusive and supportive environment that welcomes students regardless of national origin, religion or citizenship status. At The Fletcher School, for more than 80 years, we have tried to “know the world.” Our job is to prepare our graduates to be practitioners in every dimension of international relations: economics, finance, diplomatic history, politics, culture, security and many other disciplines. The challenges we face in this turbulent 21st century quite literally transcend borders – we must be ready to *connect* in every sense of the word.

We seek to build partnerships between nations, government agencies and the public/private sector in order to be ready to shape international issues and events. Our extensive network of graduates today serves in every venue in the global milieu – heads of state and government, political leaders in power and opposition, judges, diplomats, senior military officers, corporate leaders at every level, international bankers, and development officials. The Fletcher School

Focus on Arctic Council Corpus

The Evolving System at Multiple Scales

Preliminary System Model



<https://arcticdc.org/products/data-ecosystem-map>

At a high level, the model is quite simple

Global Cyberinfrastructure & Orgs

- WMO
- GEO
- GOOS, IODE
- ...
- RDA
- WDS
- CODATA
- IODE (SeaData(Net)CI)

The top left shows a search results page for 'Sea ice' on the GEOSS Portal. It displays search filters (keyword, format, source, protocol, organisation) and two resource preview cards. The first card is for 'Monthly average polar sea-ice concentration - USGS-005-27' with a collection start date of 1979-10-25. The second card is for 'IDCSIA - IceBridge L4 Sea Ice Freeboard, Snow Depth, and Thickness' with a collection start date of 2009-01-01. To the right is a network diagram of GEOSS partners, including GEO-BEN, GEOCO, GFOI, BLUE PLANET, GEON-GNOME, GSNL, GEO-DARMA, AMON GEOSS, and GEOGLAM. Below this is a banner for 'OceanDataPortal' with the tagline 'Seamless access to ocean data' and logos for IODE and other partners.

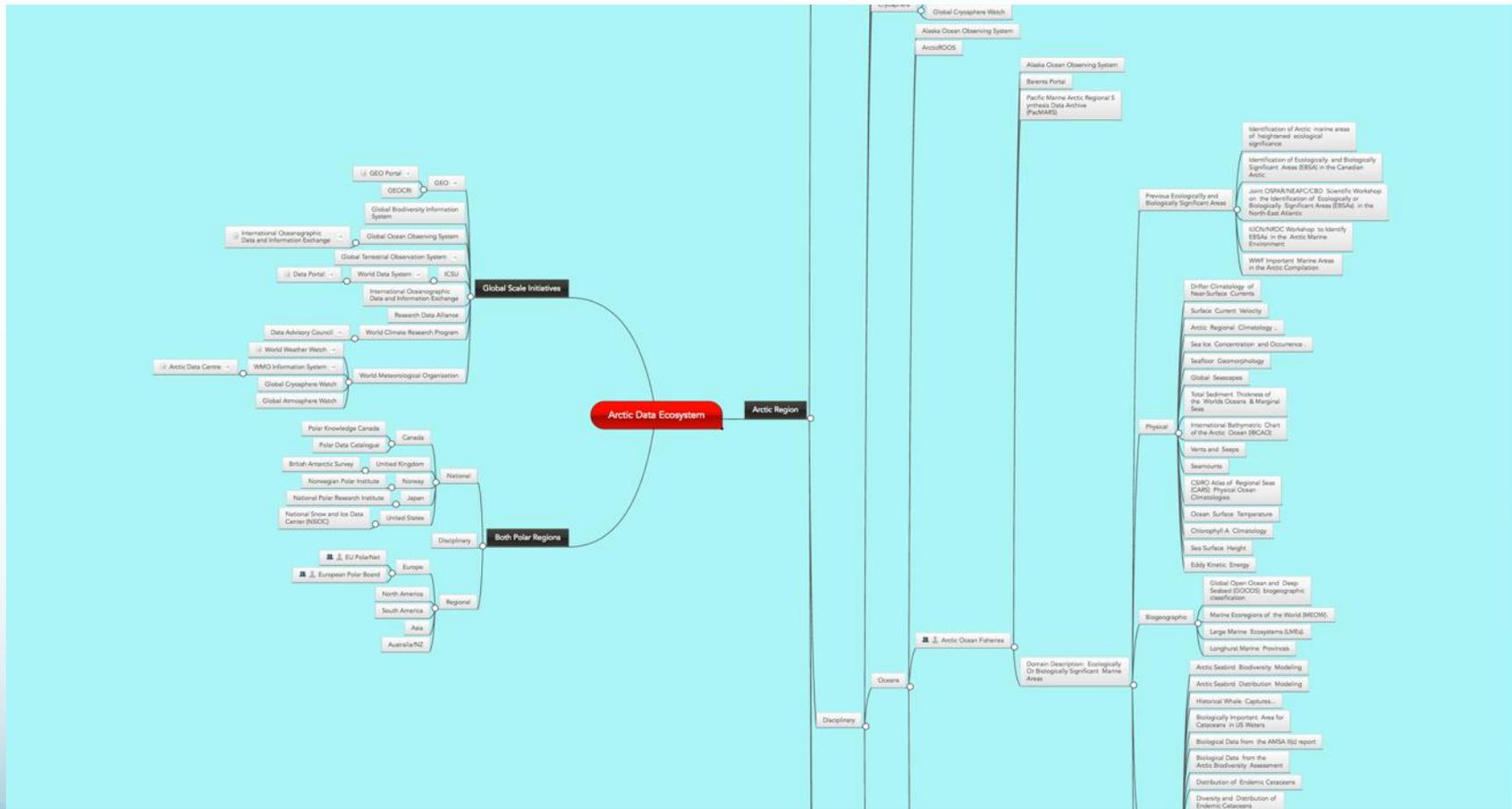
This screenshot shows the WMO website. At the top, it says 'WELCOME TO THE WMO CO' and 'WORLD METEOROLOGICAL ORGANIZATION'. Below the logo, there are navigation menus for 'Planning & Monitoring', 'PROGRAMMES', 'GFCFS', 'AMCOMET', 'Publications', 'Library', 'Learning', 'MeteoTerm', and 'Youth'. A 'WMO Tech' section lists various commissions and systems like 'Commission I', 'Commission II', 'Commission III', 'Commission for Basic Systems - CBS', 'Oceanography - CCI', 'Oceanography - CHy', 'Instruments and Methods of Observation - CIMO', and 'Commission for Oceanography and Marine Meteorology - JCOMM'. A 'SeaDataNet' banner is also visible at the bottom.

This screenshot shows the IODE Ocean Data Portal website. It features a navigation bar with links for Home, Overview, News, Partnership Centre, Information, Data access, Data Network, Training, FAQ, and Contacts. The main content area includes a search bar, a map of the world, and a 'Latest updates' section with several news items dated from July 2016 to September 2016.

This screenshot shows the CODATA website. It features a navigation bar with links for ABOUT CODATA, GET INVOLVED, GROUPS, RECOMMENDATIONS & IDEA FOR DISCUSSIONS, PUBLICATIONS, EVENTS, NEWS & MEDIA, and OUTPUTS. The main content area includes a list of events and announcements, such as 'Call for the IAEA Europe Science Workshop 2016', 'IAEA WDS-100 Collaboration Meeting & 9 June 2016, Nottingham, UK', and 'Request for comments'.

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Unpacking the Model

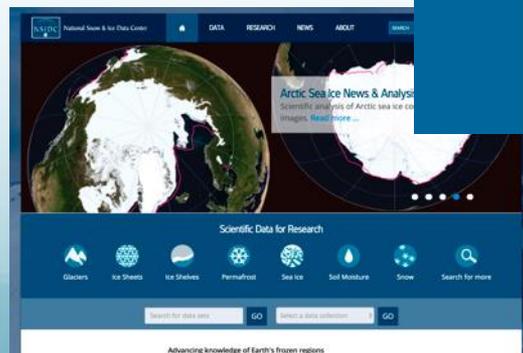
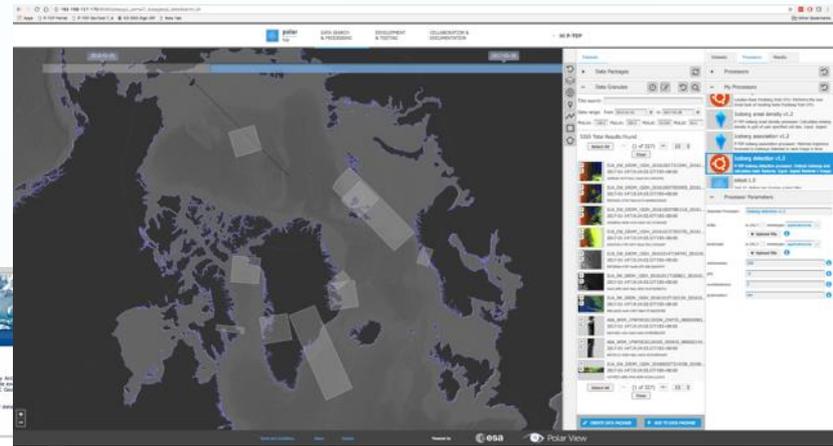


However, further investigation reveals significant complexity

Polar Cyberinfrastructure & Orgs

Screen capture complements of Polar View
<https://www.polardata.ca/>
<https://gcmd.nasa.gov/KeywordSearch/Home.do?Portal=amd>
<http://nsidc.org>

- [Arctic Data Committee](#)
- [SCADM](#), [SOOS](#)
- [GCW](#)
- [GEOCRI](#)
- [AMAP](#), [\(AC WGs\)](#)
- [Arctic SDI](#)
- [Polar View](#) / Polar TEP (
- [EU-PolarNet](#)
- [INTAROS](#)
- [OGC ASDP](#)
- ...



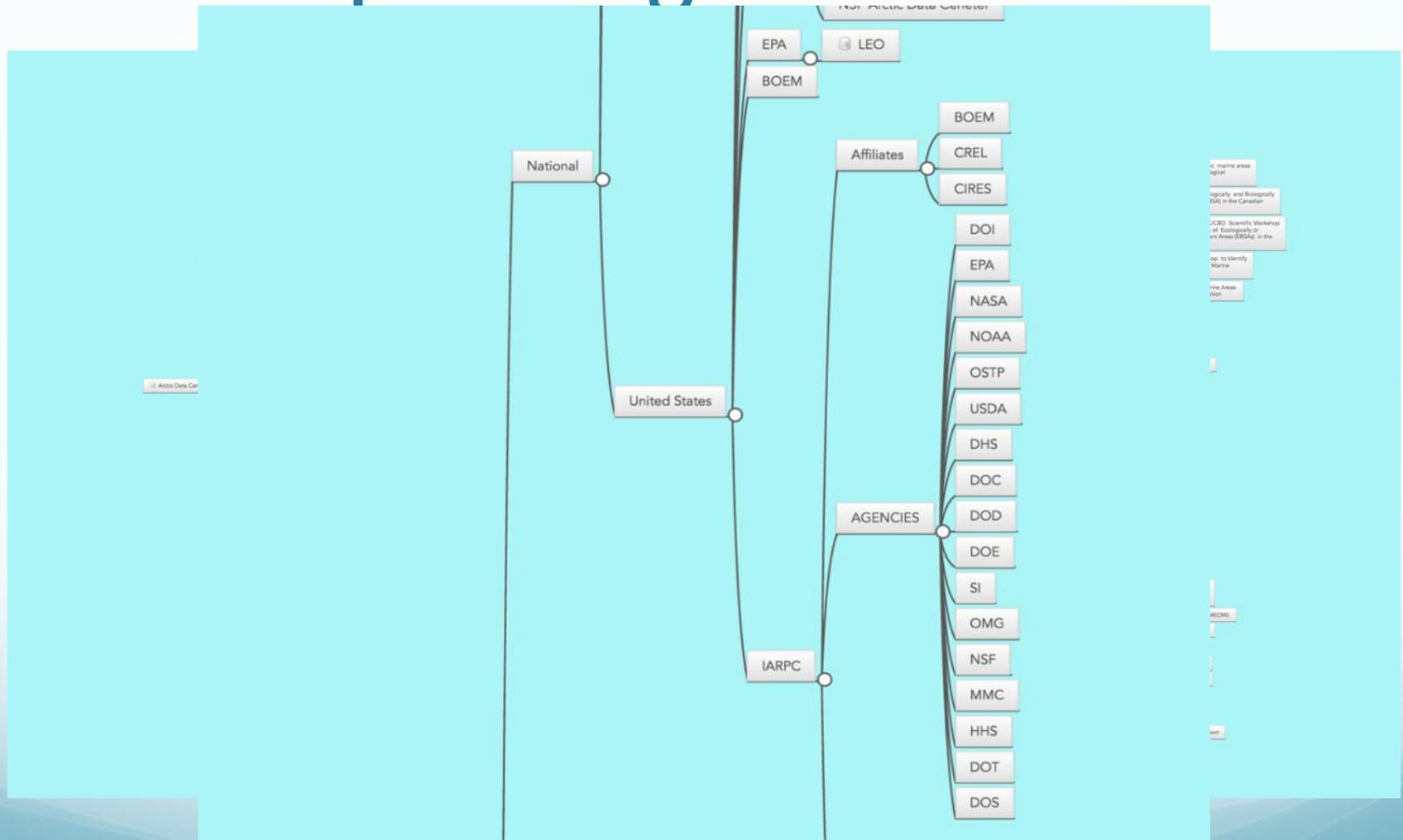
Memorandum of Cooperation

Between
 The SCAR Standing Committee on Antarctic Data Management
 AND
 The IASC-SAON Arctic Data Committee

- Background
- SCAR Standing Committee on Antarctic Data Management was established in 2009 in addition to the work of the Joint Committee on Antarctic Data Management (est. 1997). The mandate of SCADM includes but is not limited to:
 - Promotion of Antarctic data management
 - Establishing Antarctic data management policies and priorities
 - Establishing Antarctic data management policies and priorities
 - Reporting to SCAR on Antarctic data management issues
 - Information about SCADM can be found at: <http://www.scar.org/scadm>
 - IASC-SAON Arctic Data Committee (ADC) was established in 2014 based on an memorandum made in the IASC Statement of Principles and Practices for Arctic Data Management (April 16, 2013). The overarching purpose of the ADC is to promote and foster international collaboration towards the goal of free, ethically open, sustained and easy access to Arctic data through useful, usable, and interoperable systems. This includes but is not limited to:
 - Advising IASC and SAON on matters related to data management and data sharing.

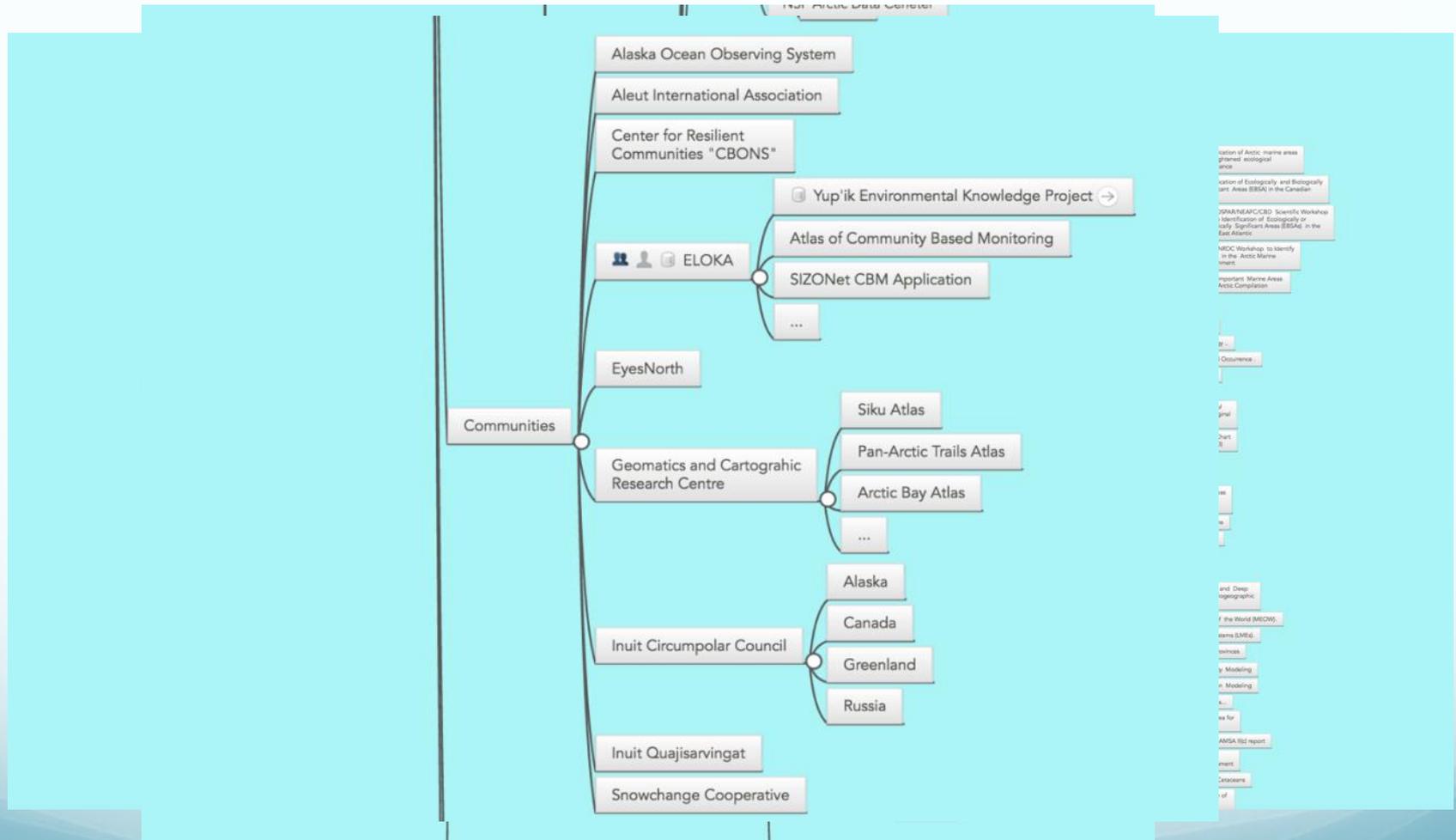


Unpacking the Model



A group like IARPC in the U.S. has its own data ecosystem

Unpacking the Model



As does the community of groups working with community-based data

Local Community Hubs and Nodes

<http://www.arcticcbm.org/index.html>

<http://www.inuitknowledge.ca/>

<https://toolkit.climate.gov/tool/atlas-community-based-monitoring-and-traditional-knowledge-changing-arctic>

<http://ittag.ca/>

<http://prodgis02.utep.edu/BaidCommunityPlanningTool>

- Focus on Community Based Monitoring
- Inuit Knowledge Centre, ICC, ELOKA, DataArc, EyesNorth, GCRC and others

Atlas of Community-Based Monitoring & Indigenous Knowledge in a Changing Arctic

Focus About Welcome Login

Circumpolar Arctic

search the atlas

Scroll through this record to see more information including links to other Community Projects, related media, and associated files.

Project title: SIZONet Community Sea Ice Observing Network

Organization name: Geophysical Institute, University of Alaska Fairbanks

Project contact: Hajo Eicken, Mette Kaufman

Address: Geophysical Institute, University of Alaska Fairbanks, P.O. Box 757320, Fairbanks, AK 99775-7320

Phone number: Hajo: 907-474-7280, Mette: 907-474-5431

E-mail: hajo.eicken@gi.alaska.edu, mrkaufman@alaska.edu

Funded by: National Science Foundation; US Fish and Wildlife Landscape Conservation Cooperatives

Start Date: 2006-04

Progress: Ongoing

Project website: SIZONet.org

Data available: <http://www.sizonet.org/data>

Clyde River Knowledge Atlas

Our Modules About

Clyde River Knowledge Atlas

Inuit qaujisarvingat knowledge centre

HOME INUIT & RESEARCH ABOUT US OUR WORK NAASAUTT CONTACT

Search

Inuit Qaujisarvingat: Inuit Knowledge Centre at ITKI

"Advancing Inuit knowledge for sustainable Arctic science and policy."

Inuit Qaujisarvingat (kow-ye-e-sar-ving-at): Inuit Knowledge Centre was launched in 2010 as a centre on research housed at [Inuit Tapiriit Kanatami](#) in Ottawa.

Inuit Qaujisarvingat is working to bridge the gap between Inuit knowledge and western science and build capacity among Inuit to respond to global interests in Arctic issues.

audio Inuit Qaujisarvingat (kow-ye-e-sar-ving-at)

Niilliajut: Inuit Perspectives on Arctic Security Cover

Niilliajut (to speak up, speak out)
Documenting Inuit Perspectives on important topics

LEARN MORE

Inuit-specific statistics presented in ways that are easy to understand and use.

CONTACT US Links News

ABOUT RESEARCH HERITAGE MEDIA ACTION

WELCOME TO ITTAG

ITTAG specializes in Inuit design and leadership of heritage, media, and research activities in the community and surrounding areas of Clyde River, Nunavut. We work with Elders, youth, and local experts, as well as visiting professionals, to carry out high quality projects that benefit our community and other Nunavummiut. We offer a broad range of expertise and services to support heritage, media, and research activities through our strong relationships in the community and resources found at our building and media centre.

Latest news

1 November 2015

ITTAG receives funding award from Tides Canada

ITTAG is proud to receive a new funding award from Tides Canada to support research on Clyde River's marine environment. The funding will support an ongoing project that will bring together...

WELCOME TO ITTAG

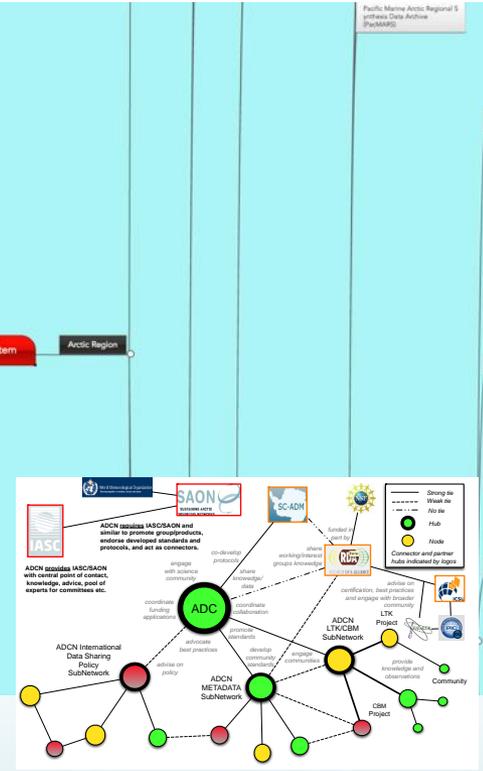
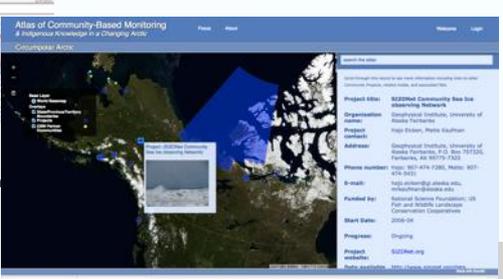
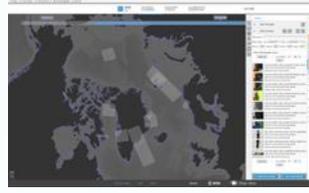
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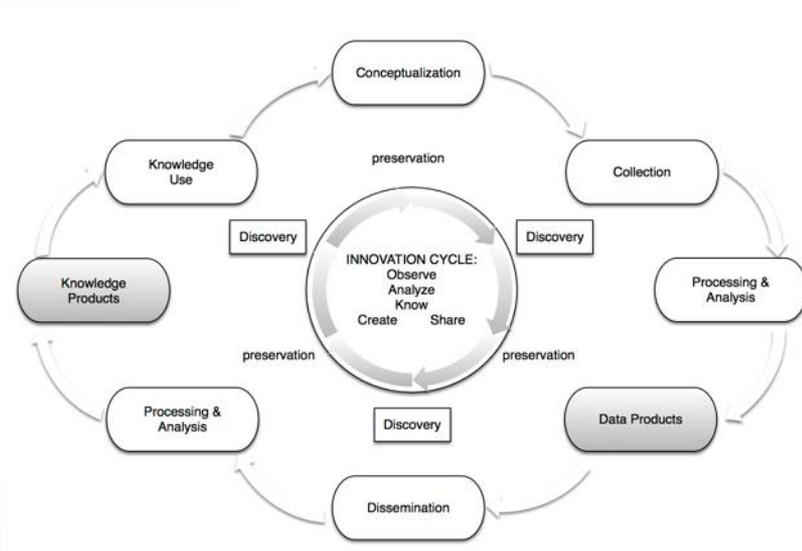


An Arctic Data Ecosystem is Emerging. What can we promote to guide it?



Infrastructure Thinking

- “Data as available as electricity” (Parsons)
- Infrastructure implies a view of data as **foundational** and necessary for contemporary research, livelihoods, policy, sustainability etc.
- Data has a lifecycle, but **not all parts are infrastructure** (preservation vs. visualization)
- Applications built on top of infrastructure
- Infrastructure can be designed and funded differently
- **Sustainability** is key

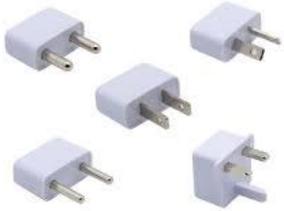


Interoperability

- The capability to share data and function among various information systems in a useful and meaningful manner
- Users require little or no knowledge of system specifics
- Many standards already in place!
- **Semantics (vocabularies) remain a challenge**
- **Fundamental** to creating a **connected, integrated system** (network)



many more ...



Mediators

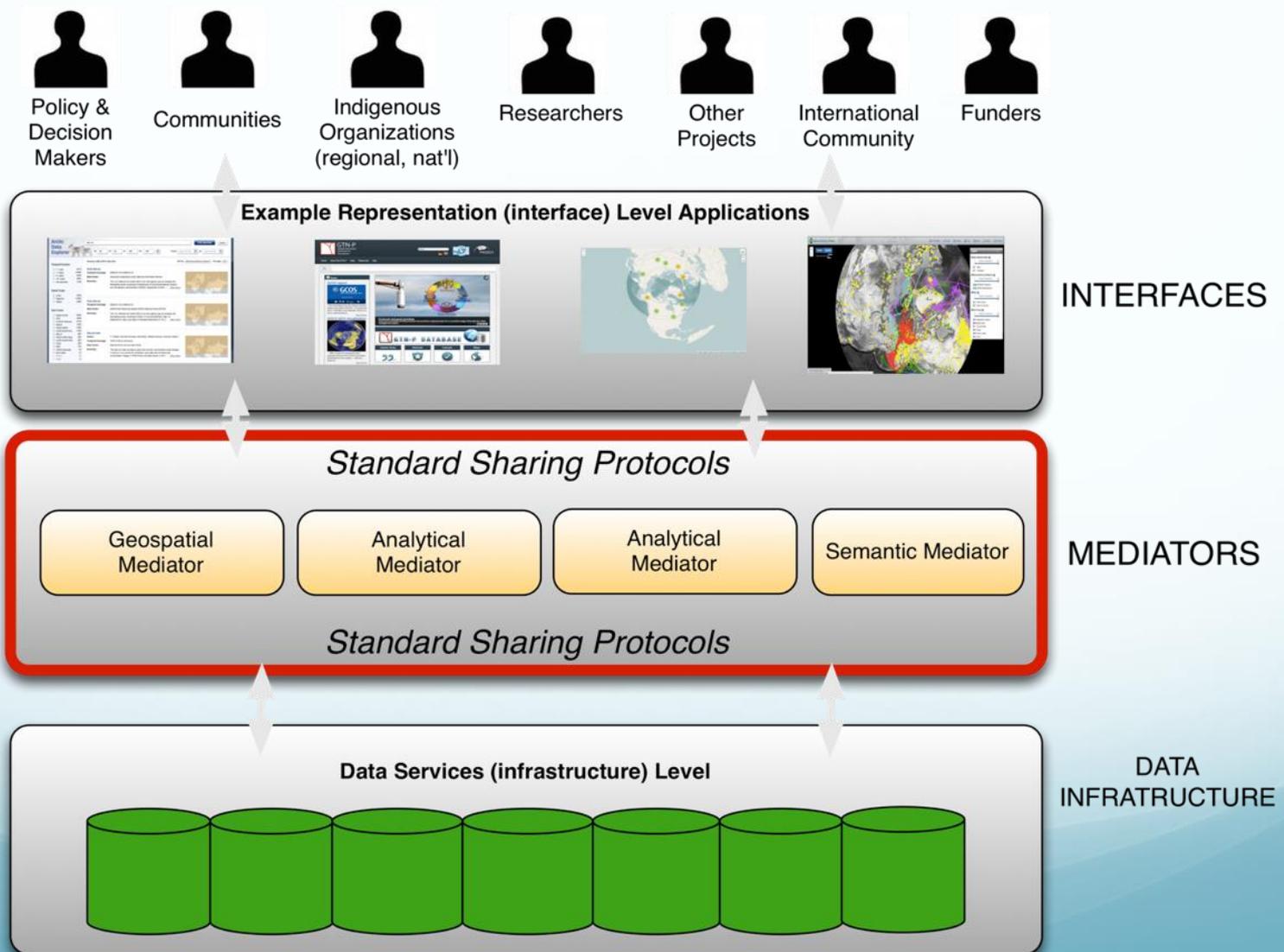
- Full standardization across different communities is difficult
- **Mediators (human and technical)** can aggregate, transform, re-distribute in support of re-use & sharing
- **Mediators** use infrastructure and can be developed and funded separately
- E.g. **Brokering** is emerging as a potential solution to some interoperability issues

<http://gtnp.arcticportal.org/>
<http://www.esrl.noaa.gov/psd/iaso/>
<http://www.arcticobservingviewer.org>
<https://ace.arsc.edu/>
<http://eloka-arctic.org>

The collage illustrates various Arctic data and observation portals. Key elements include:

- ELOKA (Exchange for Local Observations and Knowledge of the Arctic)**: A website with a search bar and navigation menu (Home, About ELOKA, Data Products, Projects, Partners, Outreach).
- ACE (Arctic Collaborative Environment)**: A website with a map of the Arctic and text about data integration and visualization.
- International Arctic Systems for Observing the Atmosphere (IASO)**: A website with a large satellite map of the Arctic and various data layers.
- GTN-P (Global Temporal Network for Permafrost)**: A website with a news section about the GCOS report and a section for protocols and good practices.
- Arctic Observatories**: A circular diagram showing various Arctic observatories, including Cherskii, Tiksi, Barrow, Oulitok Point, Alert, Eureka, Vilrom, Summit, Ny-Alesund, Sodankylä, and Pallas.

Mediation for a Modular, Cost-Effective System



“Polar Data Planning Summit”

- Evolved through SAON retreat June 2017
- Aims to bring together practitioners and signing authorities from funded DM efforts, cyberinfrastructures
- Focus on a specific, bounded case study
- ~ May 2018



Enhancing polar research and decision making: advances in international data sharing through active collaboration

Pulsifer, Peter L. (1) (Presenter), A. Van de Putte (2), P. Bricher (3), C. Strawhacker (1), M. Murray (4), D. Arthurs (5), T. Barnes (6), O. Bermúdez Molina (7), T. de Bruin (8), K. Buckland (6), J. Collins (1), R. Duerr (9), J. Friddell (10), Ø. Godøy (11), T. Hamre (12), H. Jóhannsson (13), U. Jonsell (14), S.J.S. Khalsa (1), E. Kruemmel (15), J. Larsen (16), C. Leone (17), S. Longo (17), M. Maloley (18), R. Nitu (19), A. Olivieri (17), M. Parsons (20), J. Parrott (21), H. Savela (22), S. Schumacher (23), S. Scory (2), D. Scott (1), M. Tacoma (8), S. Tronstad (24), A. Vitikka (25), S. Vossepoul (4) and H.H. Yi (2)

(1) University of Colorado, Boulder CO, United States; (2) Royal Belgian Institute of Natural Sciences, Brussels, Belgium; (3) Southern Ocean Observing System, Hobart, Tasmania, Australia; (4) University of Calgary, Calgary AB, Canada; (5) Polar View, Oxfordshire, United Kingdom; (6) British Antarctic Survey, Cambridge, United Kingdom; (7) IGME, Madrid, Spain; (8) Royal Netherlands Institute for Sea Research, Texel, Netherlands; (9) Ronin Institute for Independent Scholarship; (10) Canadian Cryospheric Information Network/Polar Data Catalogue, University of Waterloo, Waterloo ON, Canada; (11) The Norwegian Meteorological Institute, Oslo, Norway; (12) Nansen Environmental and Remote Sensing Center, Bergen, Norway; (13) Arctic Portal, Akureyri, Iceland; (14) Swedish Polar Research Secretariat, Stockholm, Sweden; (15) Inuit Circumpolar Council, Ottawa ON, Canada; (16) Sustaining Arctic Observing Networks, Oslo, Norway; (17) Consiglio Nazionale delle Ricerche, Rome, Italy; (18) Arctic Spatial Data Infrastructure, Ottawa ON, Canada; (19) World Meteorological Institute, Geneva, Switzerland; (20) Rensselaer Polytechnic Institute, Troy NY, United States; (21) Inuvialuit Regional Corporation, Inuvik NWT, Canada; (22) University of Oulu, Oulu, Finland; (23) Alfred Wegener Institute, Bremerhaven, Germany; (24) Norwegian Polar Institute, Tromsø, Norway; (25) University of Lapland, Rovaniemi, Finland

Abstract submitted to Arctic Change 2017 Conference

Concluding Points

- **Situating** the system
- **Understanding** the system
- **Coordination** in an increasingly complex system – building on existing cybrinfrastructures and mediator technologies and organizations
- **Connecting and sharing across different knowledge domains** (mediation, semantics etc.)

