Early Experience in Semantics: The Semantic Sea Ice Interoperability Initiative

Ruth Duerr

Partners:
Mark A. Parsons, Siri Jodha Singh Khalsa, Peter Pulsifer
National Snow t Ice Data Center, Univ. Colorado

Peter Fox, Deborah McGuinness, James McCusker
Tetherless World Constellation, RPI

Semantic Sea Ice Interoperability Initiative

Image courtesy Andy Mahoney, NSIDC

SSIII works to make Arctic data more useful to more people.

Extend a network of Arctic data and systems and harmonize metadata.
Create integrative sea ice ontologies and encourage their use.
Improve the discovery, understanding, and use of sea ice data.

Photo courtesy Ted Scambos, NSIDC

We focus first on sea ice data, because sea ice is a fundamental, integrative component of the Arctic system that is undergoing rapid change.

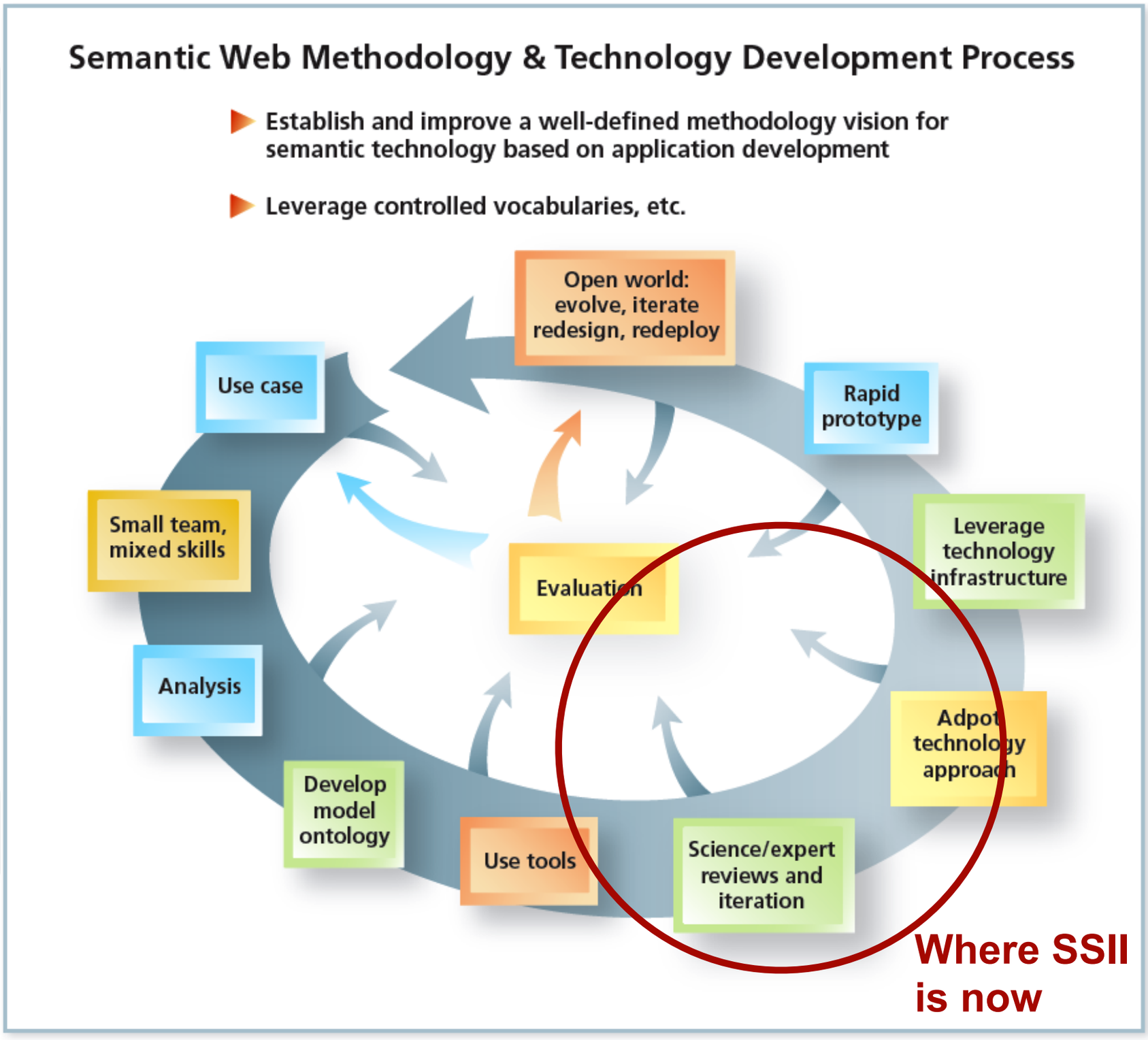
We begin with research and operational shipping perspectives and then explore how or whether we can incorporate local knowledge and other ways of knowing.

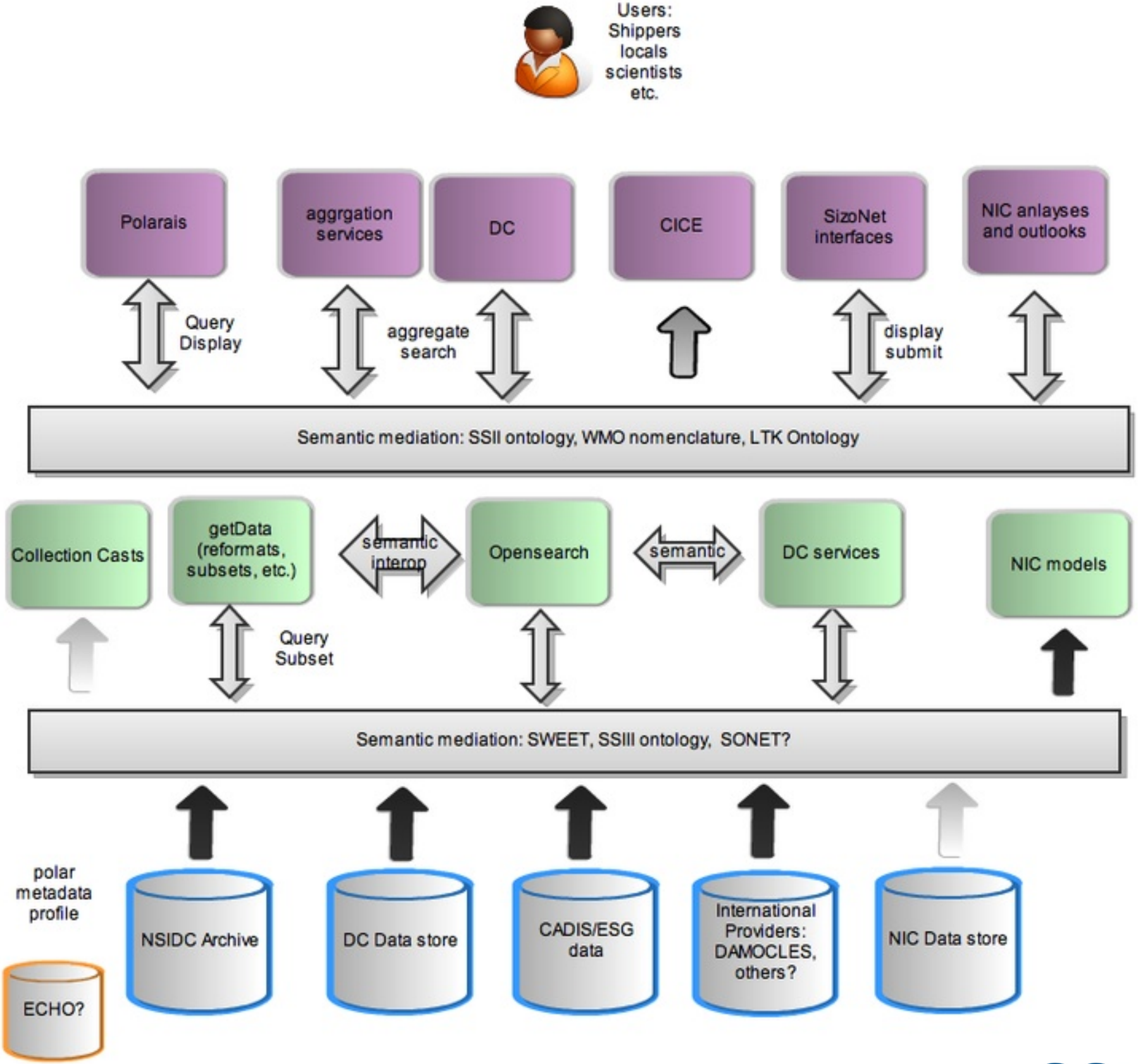
SSIII Objectives

- Extend, strengthen, and enhance the interoperability of the established and growing network of the IPY Data and Information Service and Polar Information Commons.
- Develop a detailed, yet broad, sea ice ontology linked to relevant marine, polar, atmospheric, and global ontologies and semantic services.
- Explicitly incorporate elements of local and traditional Arctic knowledge in the ontology.
- Provide NSIDC sea ice data using the ontology and encourage the use and evolution of the ontology by others.
- Integrate the sea ice ontology into developing global and polar ontologies and related semantic frameworks.
- Improve the discovery, understanding, and use of sea ice data by enabling faceted searches in existing and developing search interfaces.

Modern informatics enables a new scale-free** framework approach

- Use cases
  - requirements
- Stakeholders
  - Virtual org.
- Distributed authority
- Access control
- Ontologies
- Maintaining Identity





SSIII Notional Architecture

Semantic Sea Ice Interoperability Initiative

NSIDC

photo courtesy *The Inquisitr*

Operational Perspective

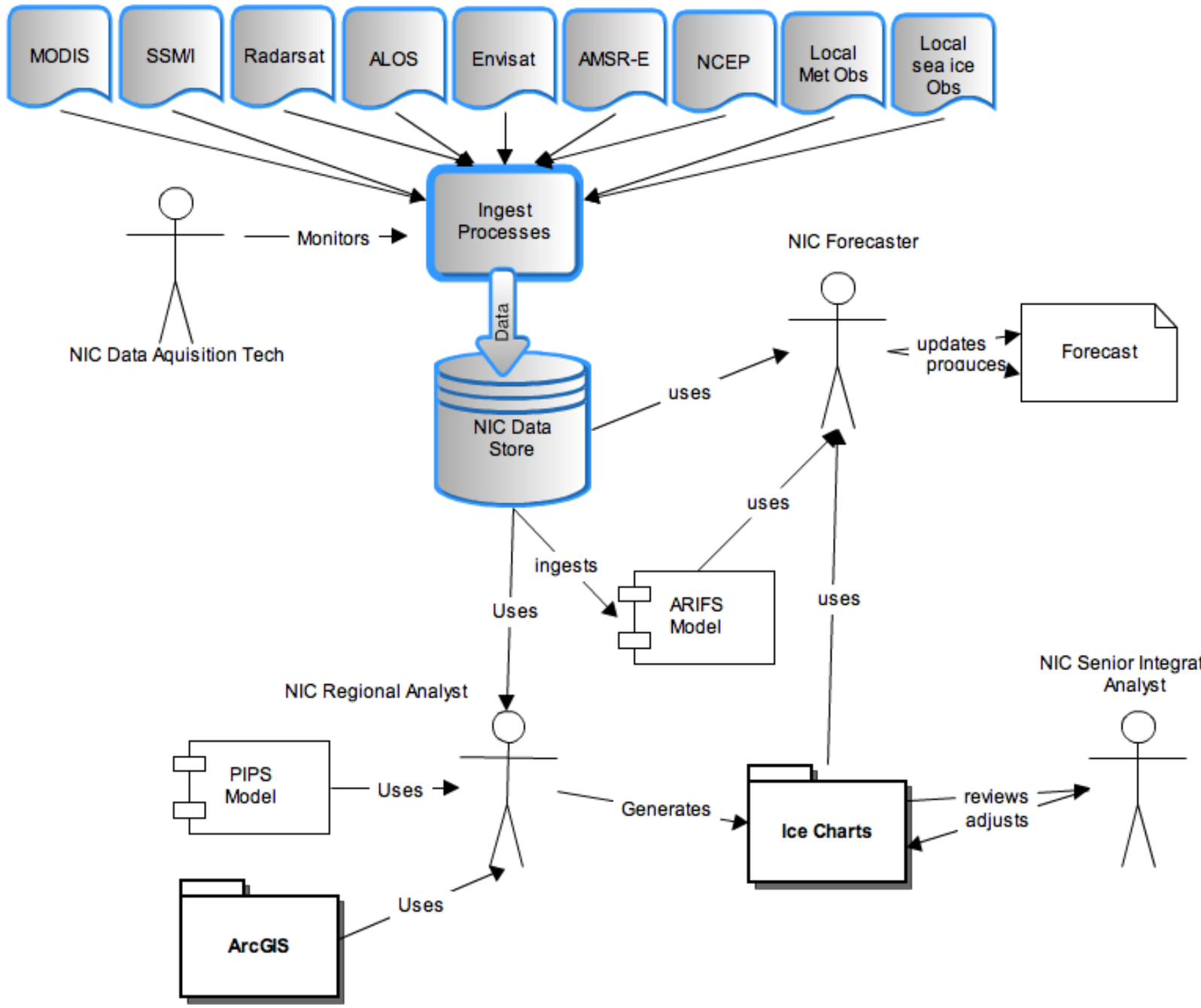
A Coast Guard Icebreaker cutting a path for a tanker to get fuel to the iced in city of Nome, Alaska.

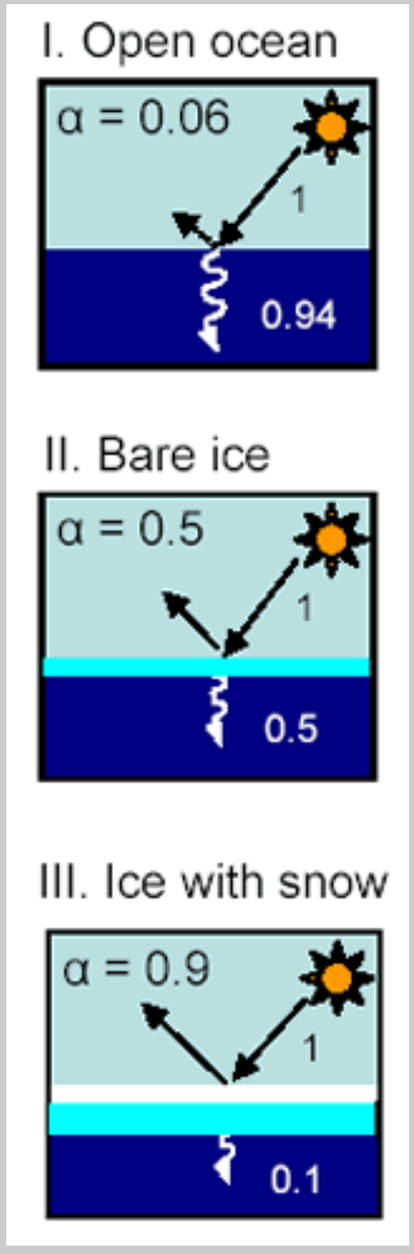
Semantic Sea Ice Interoperability Initiative

National Snow and Ice Data Center
University of Colorado at Boulder

Use Case 1:
When can a ship get from the U.S. west coast through the Bering Strait to the North Slope of Alaska – Barrow-Prudhoe Bay?

Goal: To provide seasonal ‘outlooks’ and forecasts for opening week dates for non-ice-strengthened vessel operations through the Bering Strait with destination of the North Slope of Alaska with the result of probabilistic range of days for safe passage along with duration of applicability (e.g. week plus or minus). Provide these seasonal outlooks initially 3 months in advance. Generate and maintain forecasts of when sea ice conditions affect safe ship passage 1-2 (up to 7) days in advance.


MODIS
SSM/I
Radarsat
ALOS
Envisat
AMSR-E
NCEP
Local Met Obs
Local sea ice Obs
Ingest Processes
Monitors
NIC Data Aquisition Tech
Data
NIC Data Store
NIC Forecaster
updates
produces
Forecast
uses
uses
ingests
ARIFS Model
Uses
uses
NIC Regional Analyst
NIC Senior Integrating Analyst
PIPS Model
Uses
Generates
Ice Charts
reviews
adjusts
ArcGIS
Uses



Research Perspective

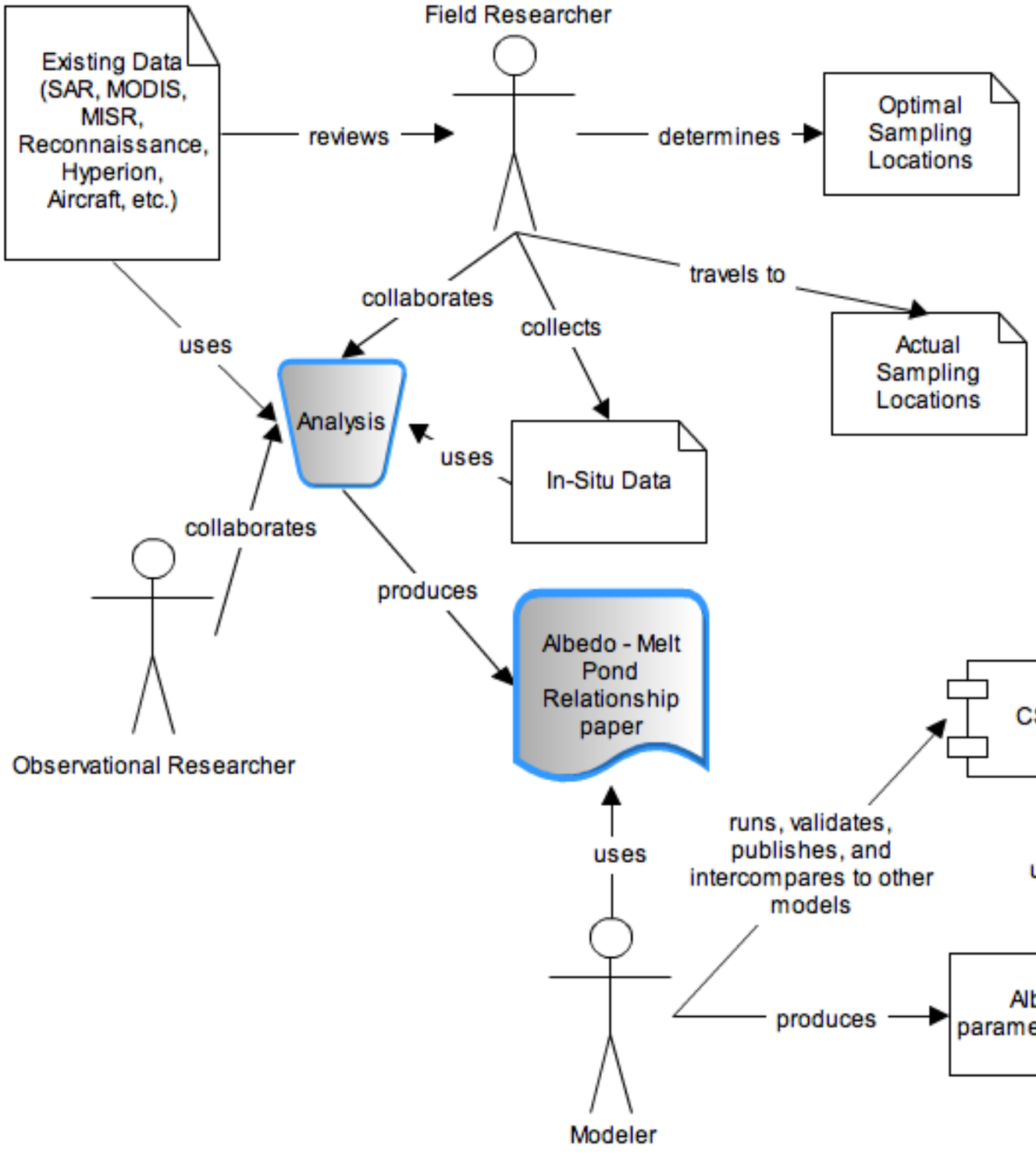
How is the changing sea ice affecting the ice-albedo feedback?

Semantic Sea Ice Interoperability Initiative

National Snow and Ice Data Center
University of Colorado at Boulder

Use Case 2:
Improved parameterization of factors affecting the spectral albedo of the Arctic Ocean.

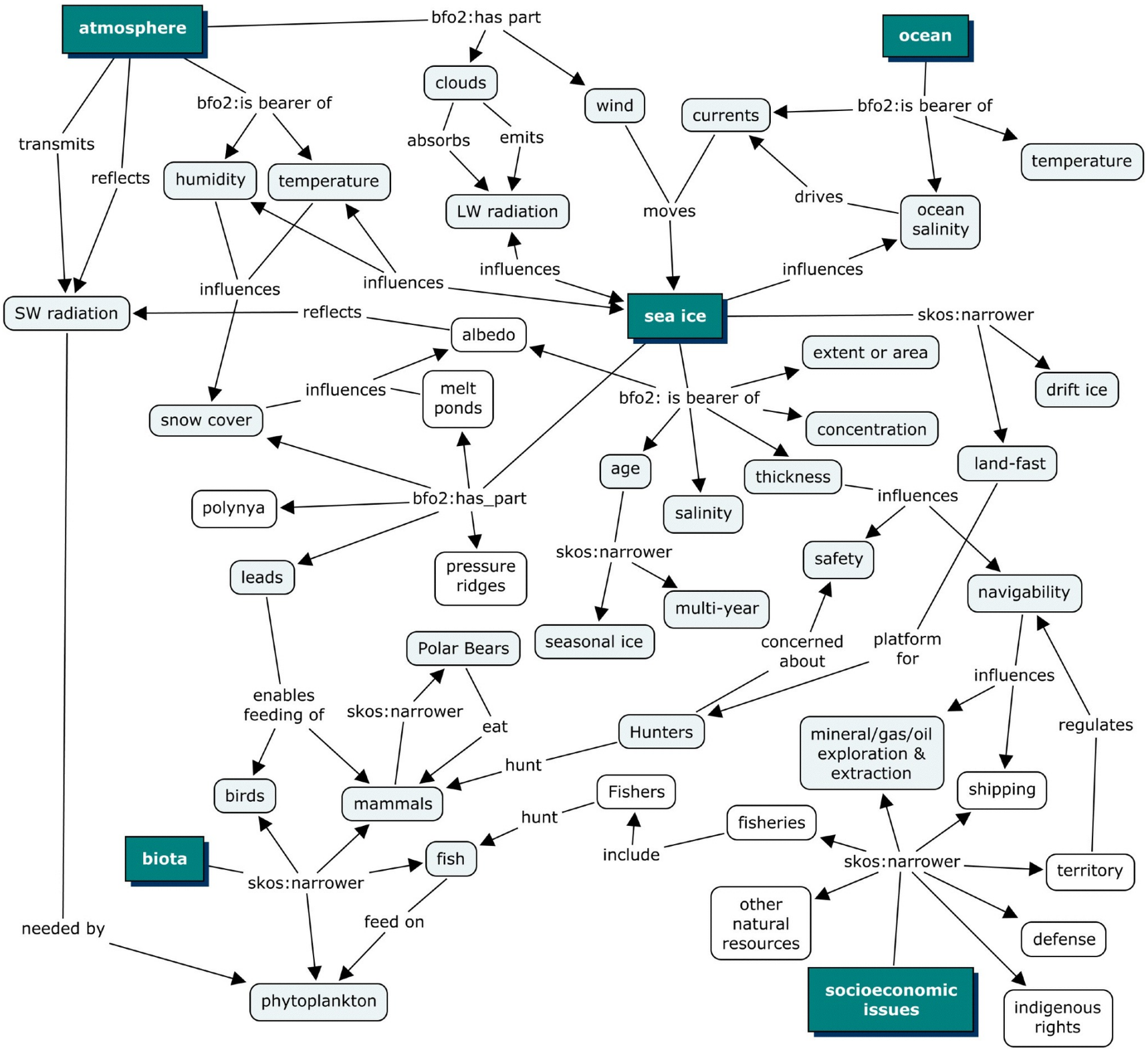
Goal: The Arctic sea ice cover is changing due to decreases in thickness, age, and area; changes in snow cover, surface-melt, and ice surface topography; increases in the length of the melt season; new importance of seasonal ice; and increased importance of events such as rain on snow and “snow ice” formation. The goal here is to develop an improved parameterization of the factors that affect surface visible and near-IR band albedo for the Arctic Ocean, so that global climate models can more accurately account for these changes.


Field Researcher
Existing Data (SAR, MODIS, MISR, Reconnaissance, Hyperion, Aircraft, etc.)
reviews
determines
Optimal Sampling Locations
collaborates
travels to
uses
collects
Actual Sampling Locations
Analysis
uses
In-Situ Data
collaborates
produces
Albedo - Melt Pond Relationship paper
Observational Researcher
CSIM
uses
runs, validates, publishes, and intercompares to other models
uses
produces
Albedo parameterization
Modeler

The Local Indigenous Perspective

- earlier break up / later freeze up (2-3 weeks each)
- increased weather variability / traditional forecasts no longer work
- sea ice thinner; poorly formed (poor strength/integrity)
- seasonal calendar off; some names no longer apply
- etc. etc.

photo ©Shari Gearheard



Initial sea ice concept map

Semantic Sea Ice Interoperability Initiative

NSIDC

The first workshop

- Invited:
  - Sea ice remote sensing scientist - Walt Meier
  - Sea ice modeler - Marike Holland
  - Sea ice operations - Pablo Clemente-Colon
  - Sea ice observer - Don Perovich
- Spent two days iterating between the use cases and concept maps

SSIII Semantic Sea Ice Interoperability Initiative

NSIDC

The first workshop

- This:
  - Determine when sea ice conditions are optimal to send a resupply ship into Barrow (or Thule or wherever).
- Became:
  - Provide seasonal ‘outlooks’ and forecasts for opening week dates for non-ice-strengthened vessel operations through the Bering Strait with destination of the North Slope of Alaska with the result of probabilistic range of days for safe passage along with duration of applicability (e.g. week plus or minus, duration). Provide these seasonal outlooks initially 3 months in advance. Generate and maintain forecasts of when sea ice conditions affect safe ship passage 1-2 (up to 7) days in advance.

SSIII
Semantic Sea Ice Interoperability Initiative

NSIDC

Albedo Use Case Ontology

File Edit Format Collaborate Tools Window Help

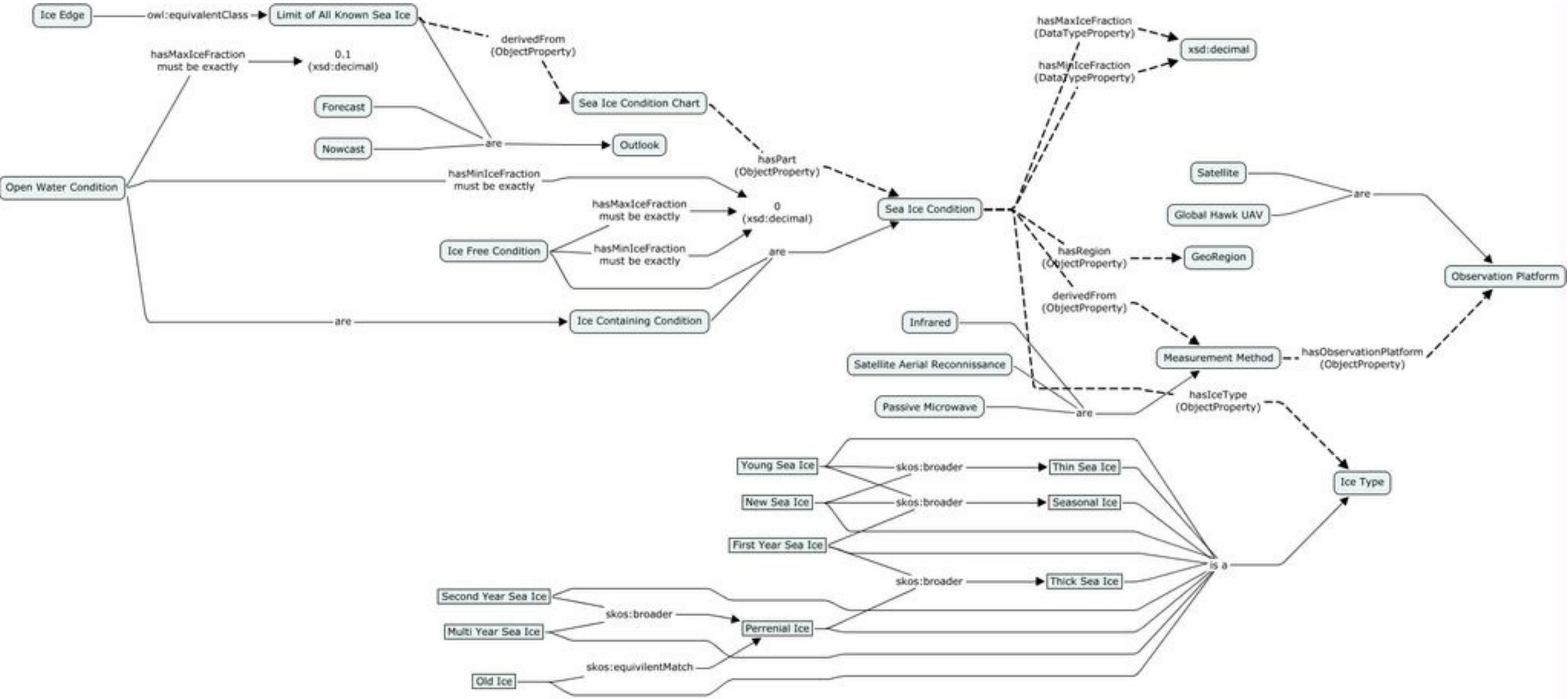
100

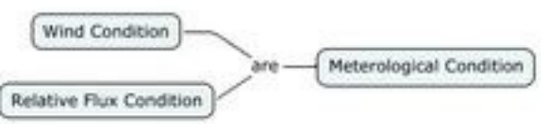
SecondYearIce
MultiYearIce
are
PerennialIce
OldIce
are
hasMaxIceThickness must be exactly
hasMinIceThickness must be exactly
ThickFirstYearIce
120 (xsd:decimal)
hasMinIceThickness must be exactly
200 (xsd:decimal)
hasMaxIceThickness must be exactly
are
MediumFirstYearIce
are
FirstYearIce
are
ThickIce
hasMinIceThickness must be exactly
70 (xsd:decimal)
ThinFirstYearIce
hasMaxIceThickness must be exactly
hasMinIceThickness must be exactly
30 (xsd:decimal)
hasMaxIceThickness must be exactly
PancakeIce
SheetIce
are
YoungIce
are
SeasonalIce
are
hasMinIceThickness must be exactly
10 (xsd:decimal)
are
GreaseIce
FrazilIce
NilasIce
are
NewIce
hasMaxIceThickness must be exactly
ThinIce
hasMinIceThickness must be exactly
0 (xsd:decimal)
SeaIce
OpenWater
FrazilProcess
PancakeProcess
WaveAction
CongelationProcess

View as Web Page
http://cmapspublic3.ihmc.us/rid=1J55XK1VS-D3C37G-RNY/Albedo Use Case Ontology.cmap

SSIII Semantic Sea Ice Interoperability Initiative

NSIDC





Seasonal Outlook

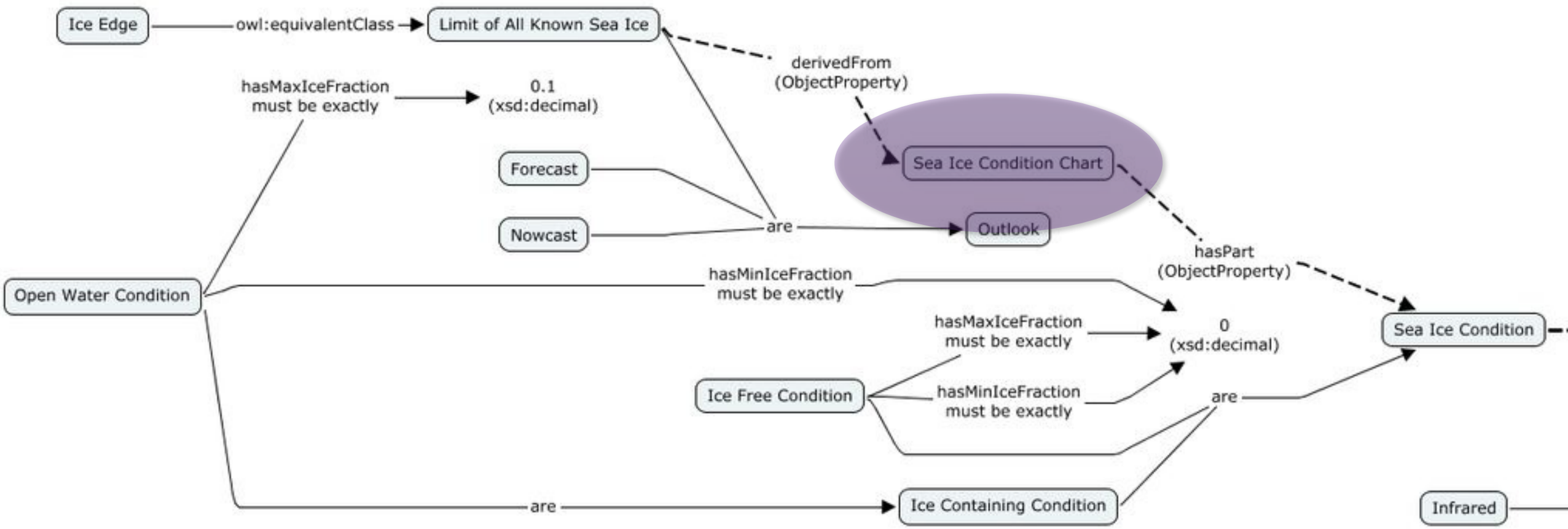
Surface Temperature

Condition Description

Semantic Sea Ice Interoperability Initiative

NSIDC

Identification of an important boundary object



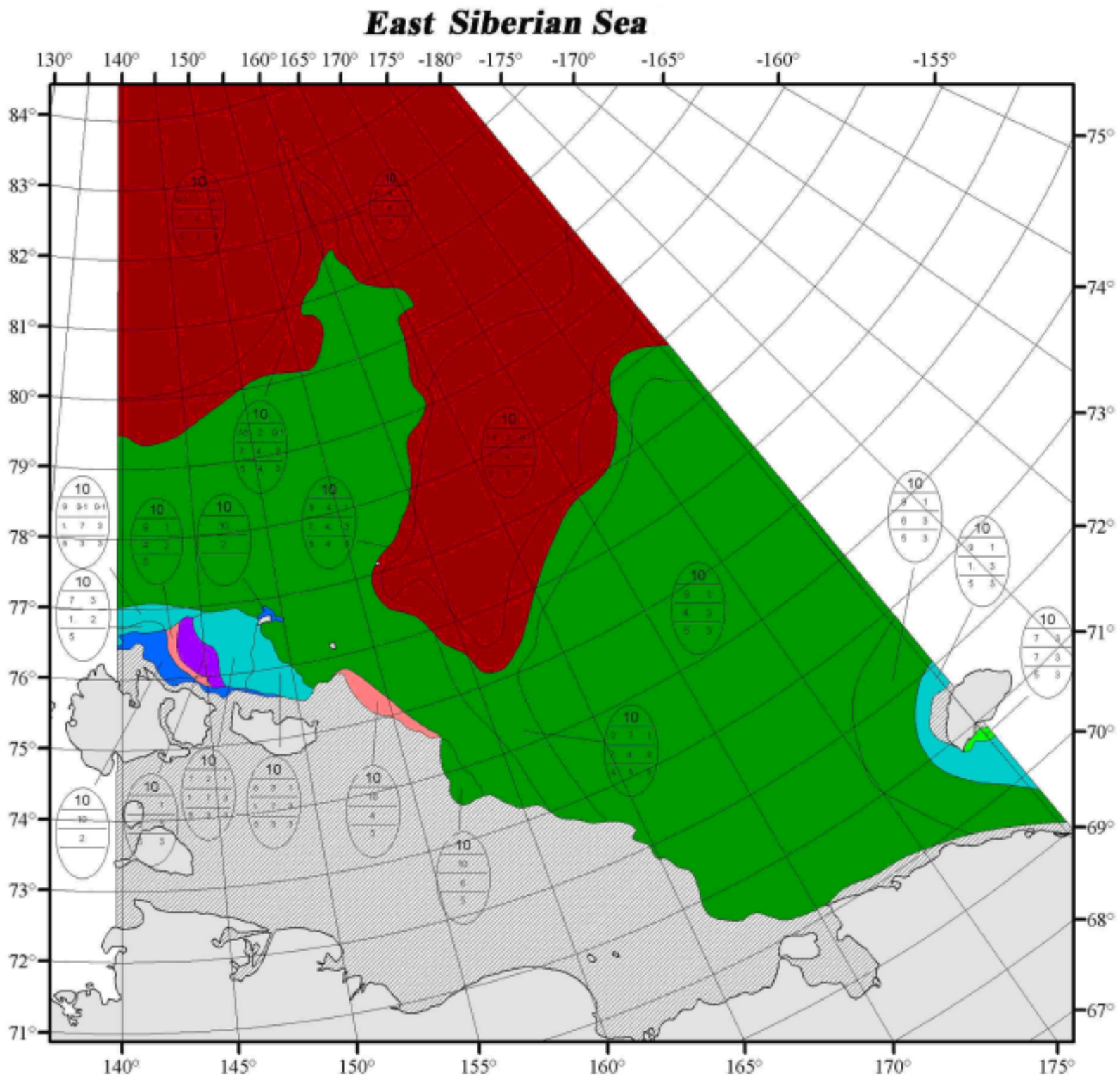
Semantic Sea Ice Interoperability Initiative

NSIDC

Арктический и Антарктический
научно-исследовательский
институт Росгидромета

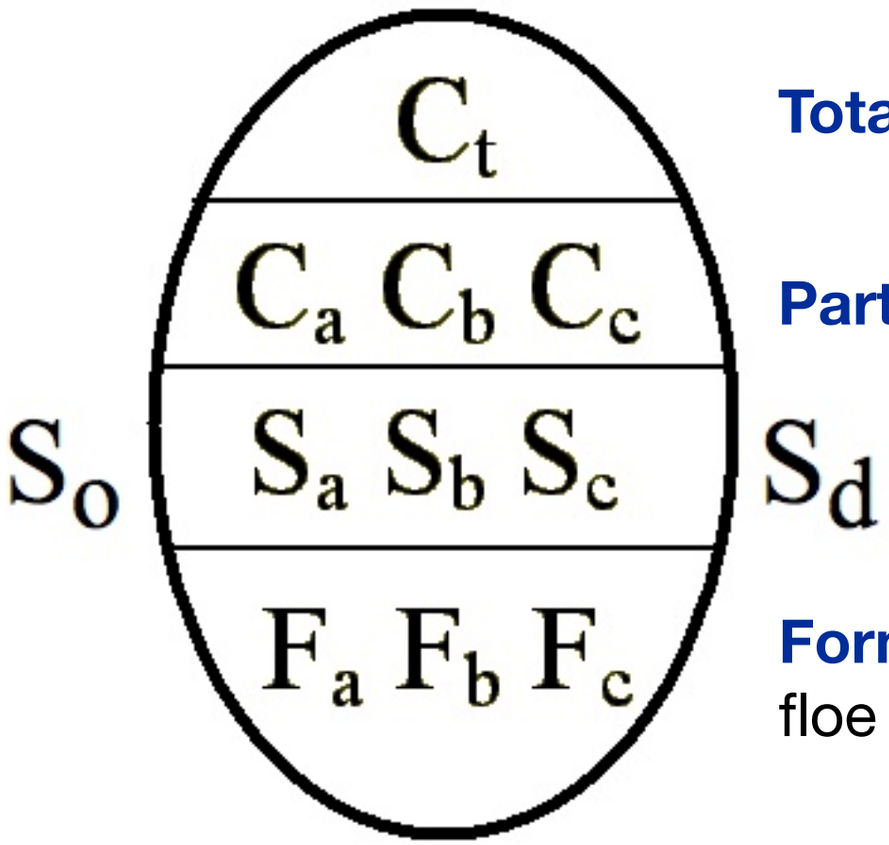
Arctic and Antarctic Research
Institute of Roshydromet

Feb. 28 - March. 02 2005



Example sea ice chart with egg codes

The “Egg Code”



Total Concentration (in tenths or a range)

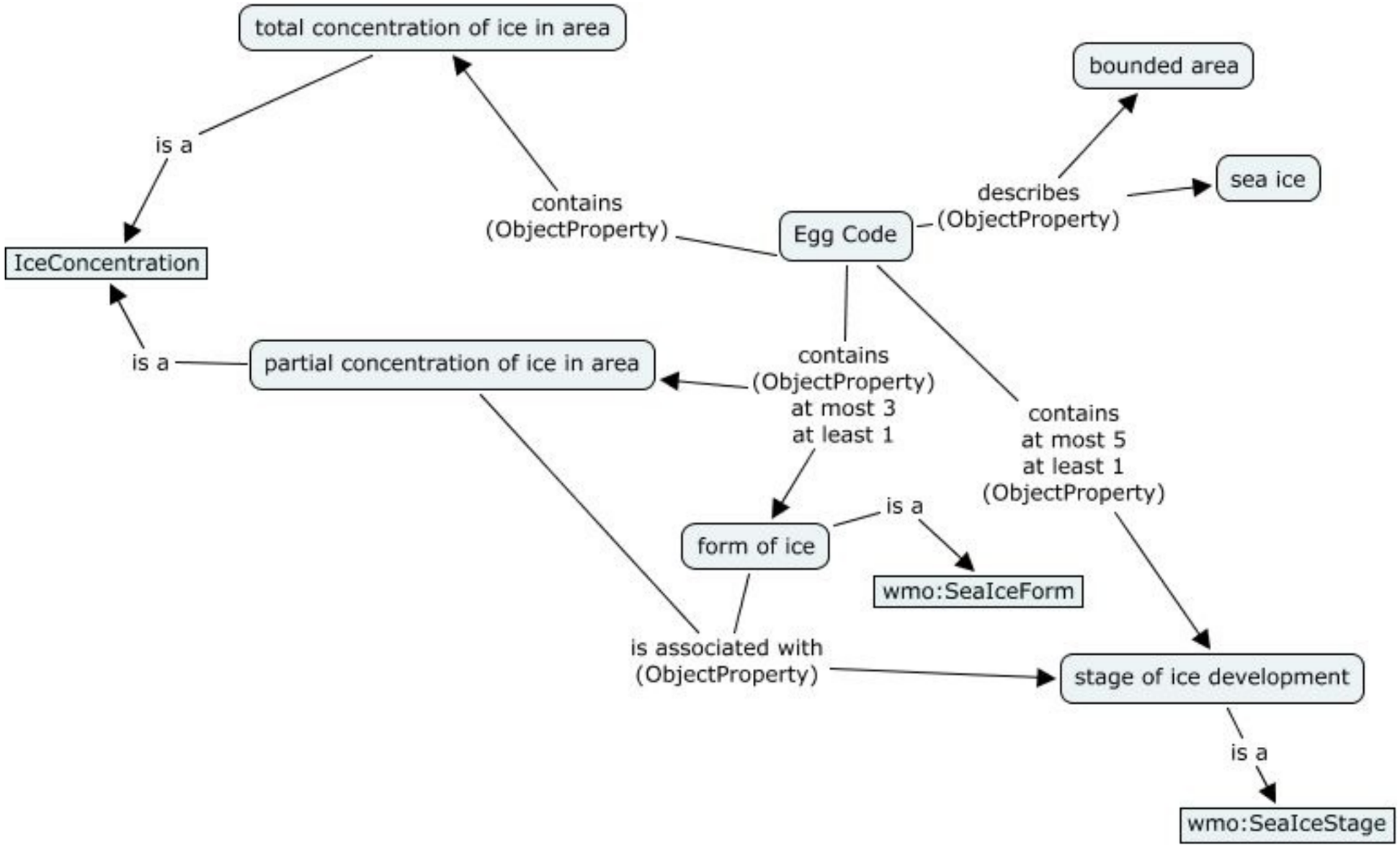
Partial Concentration for different thicknesses (in tenths)

Stage of Development for different thicknesses (codes for defined terms partially based on thickness, e.g. “nilas”, “first year”, “multi-year”)

Form of ice (codes for defined terms largely based on floe size, e.g. “pancake”, “vast ice floe”)

Relates to the “WMO Sea Ice Nomenclature”

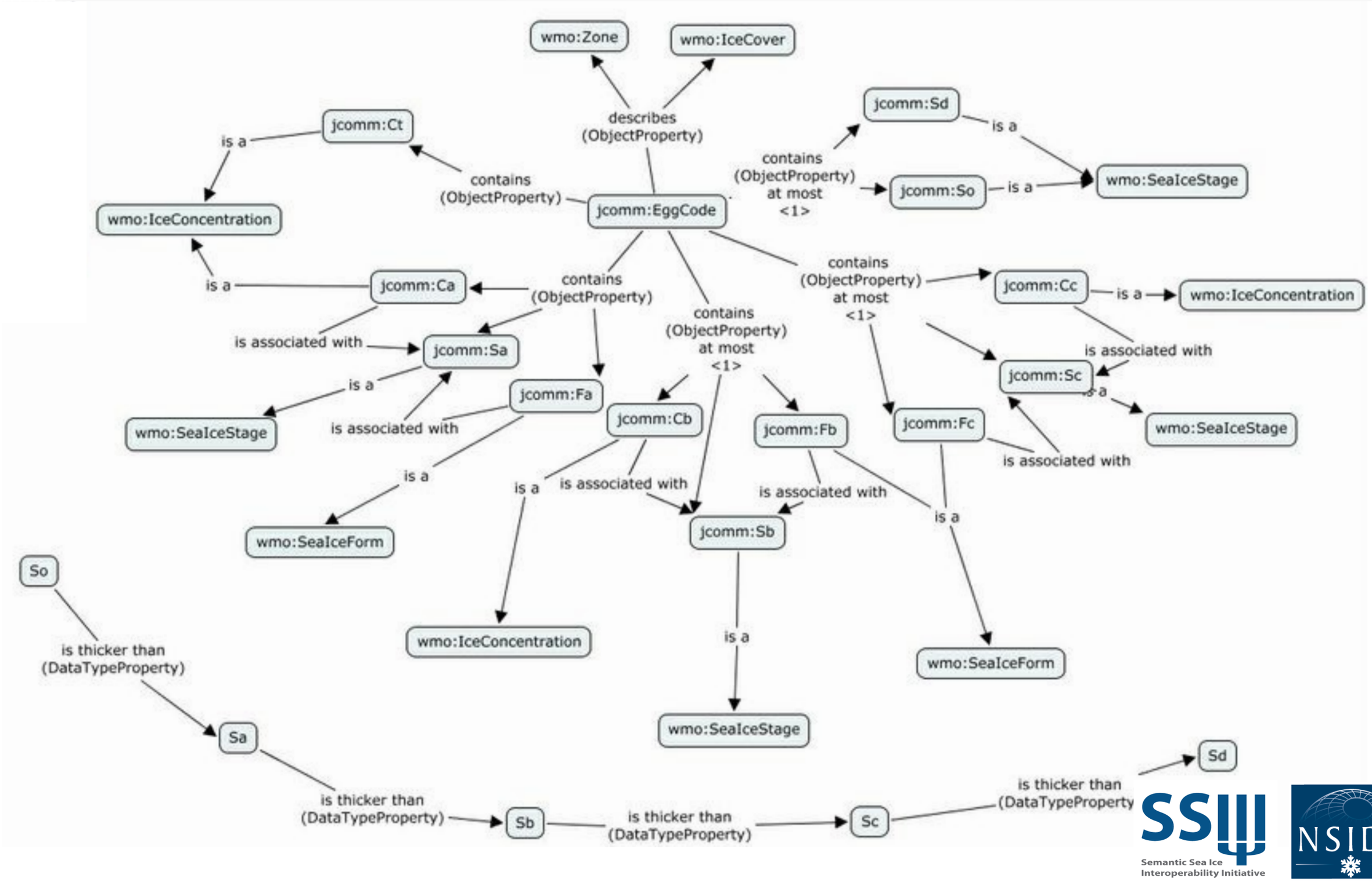
Egg Code - First Attempt



SSIII
Semantic Sea Ice Interoperability Initiative

NSIDC

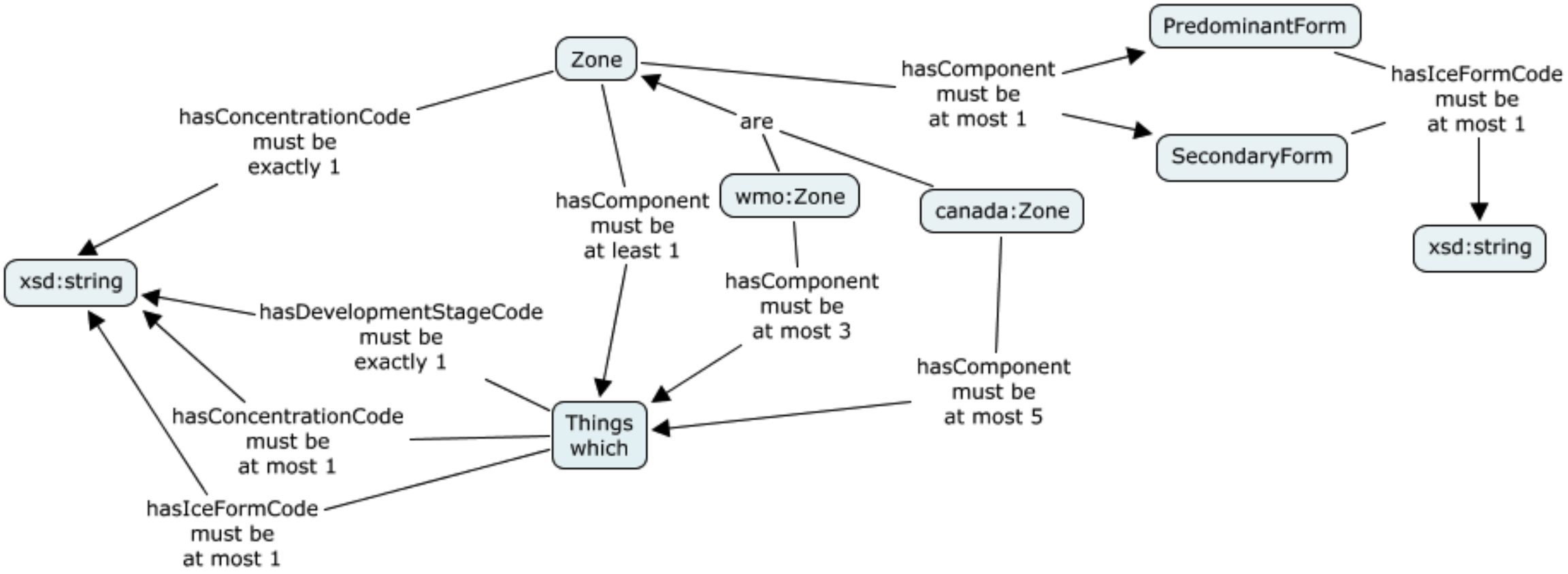
Egg Code - Second Attempt



Semantic Sea Ice Interoperability Initiative

NSIDC

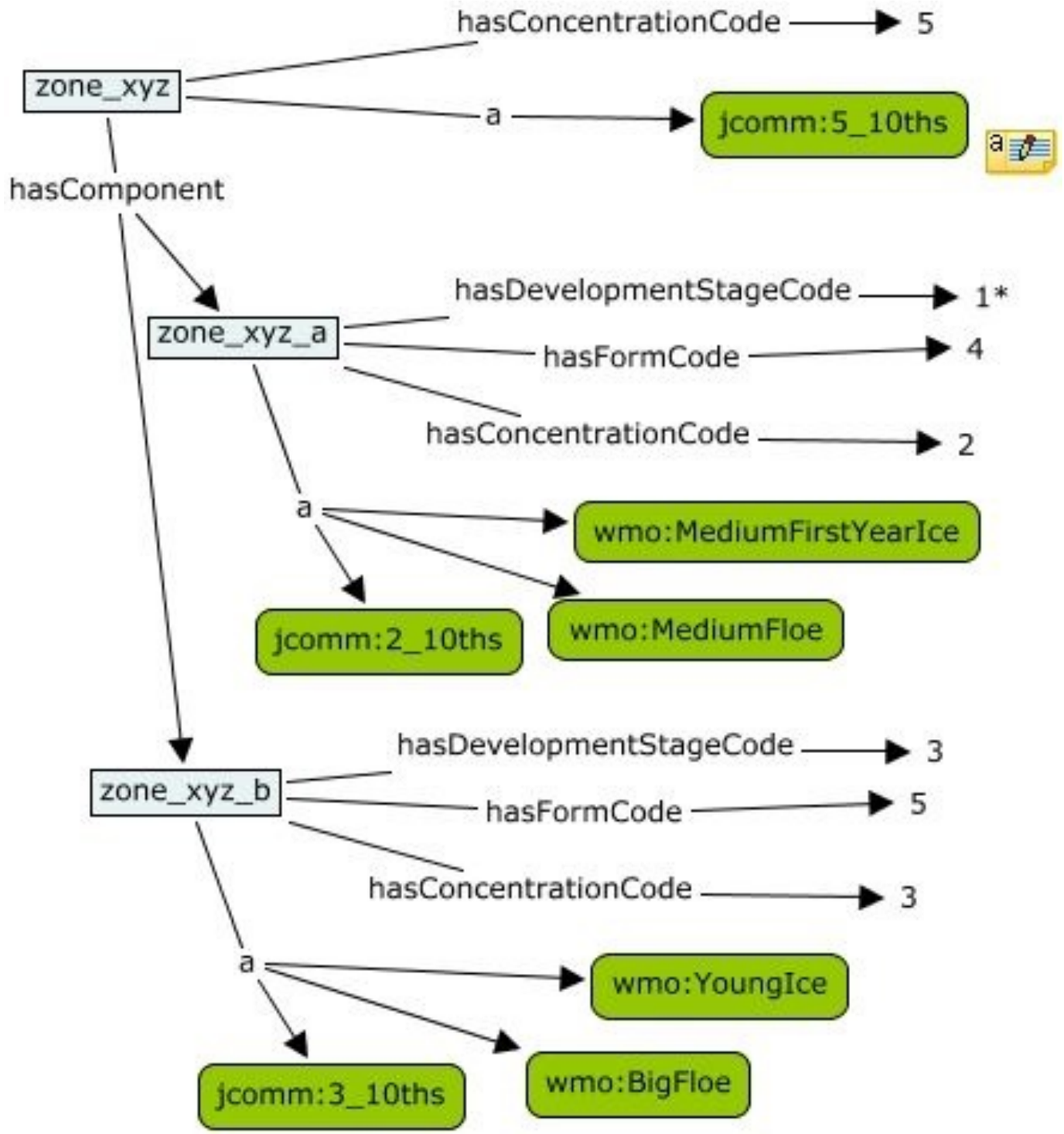
Egg Code - Third Attempt



Semantic Sea Ice Interoperability Initiative

NSIDC

Egg Code - What that looks like when you use real numbers

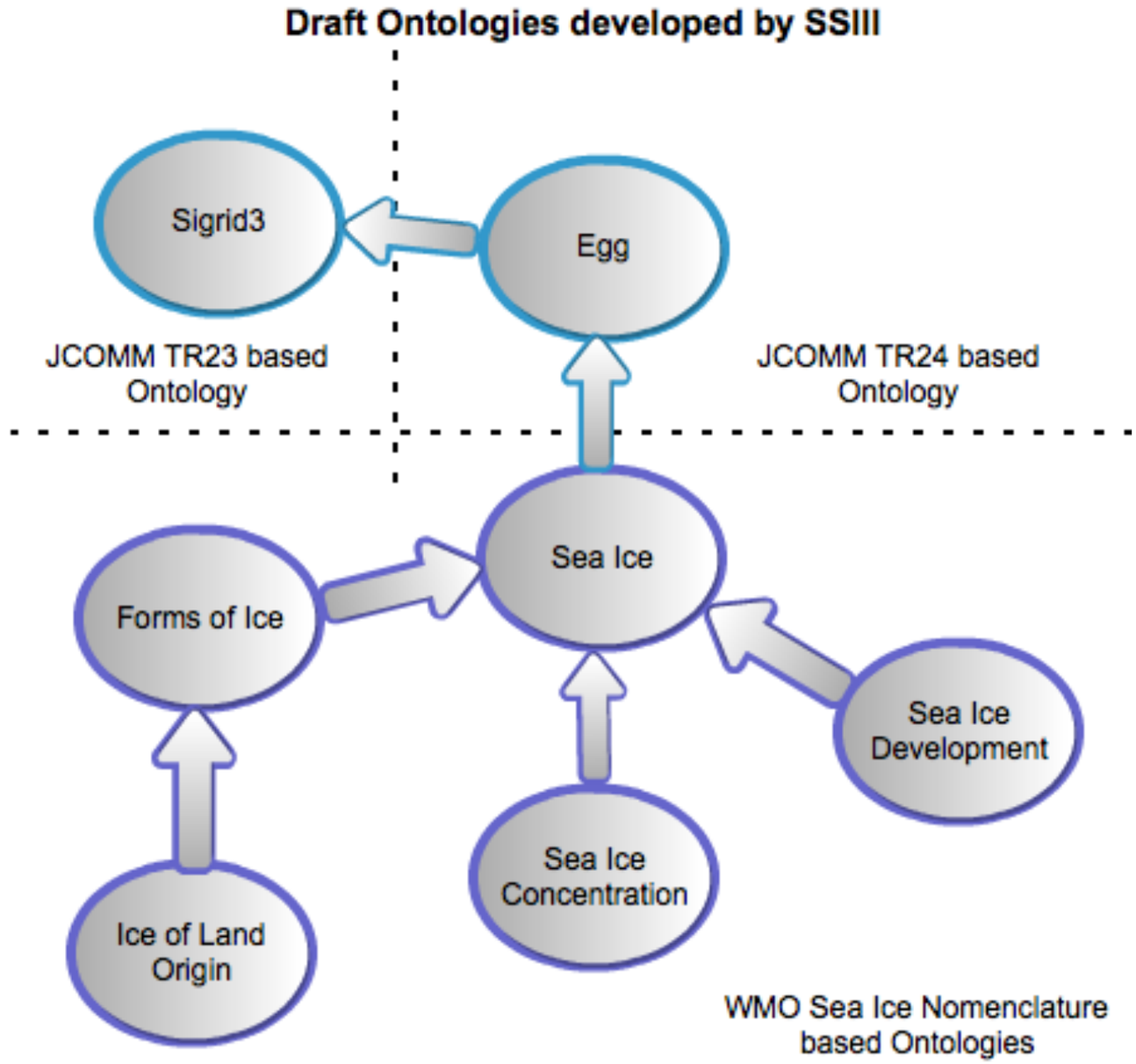


Semantic Sea Ice Interoperability Initiative

NSIDC

Creating the ontologies

- Protege is not really ready for prime time
  - Meant for experts
  - Not very stable or reliable
  - End up editing the files manually fairly often
- Examples:
  - Edit in Manchester ontology language
  - Save in Owl



SSIII Semantic Sea Ice Interoperability Initiative

NSIDC

Expert Review

- Making ontologies accessible to real users

seaice-concentration.owl - ssiii - SSIII ontology development - Google Project Hosting

seaice-concentration.owl - ssiii...

```
206     <EquivalentClasses>
207         <Class IRI="CompactPackIce"/>
208         <ObjectIntersectionOf>
209             <ObjectComplementOf>
210                 <Class IRI="ConsolidatedIce"/>
211             </ObjectComplementOf>
212             <DataHasValue>
213                 <DataProperty IRI="hasMeanIceConcentration"/>
214                 <Literal datatypeIRI="&xsd;double">1.0</Literal>
215             </DataHasValue>
216             <DataHasValue>
217                 <DataProperty IRI="hasStdDevIceConcentration"/>
218                 <Literal datatypeIRI="&xsd;double">0.01</Literal>
219             </DataHasValue>
220         </ObjectIntersectionOf>
221     </EquivalentClasses>
222     <EquivalentClasses>
223         <Class IRI="ConsolidatedIce"/>
224         <ObjectIntersectionOf>
225             <DataHasValue>
226                 <DataProperty IRI="hasMeanIceConcentration"/>
227                 <Literal datatypeIRI="&xsd;double">1.0</Literal>
228             </DataHasValue>
229             <DataHasValue>
230                 <DataProperty IRI="hasStdDevIceConcentration"/>
231                 <Literal datatypeIRI="&xsd;double">0.001</Literal>
232             </DataHasValue>
233         </ObjectIntersectionOf>
234     </EquivalentClasses>
235     <EquivalentClasses>
236         <Class IRI="Ice-free"/>
237         <ObjectIntersectionOf>
238             <DataHasValue>
239                 <DataProperty IRI="hasIceOfLandOrigin"/>
240                 <Literal datatypeIRI="&xsd;boolean">false</Literal>
241             </DataHasValue>
242             <DataHasValue>
243                 <DataProperty IRI="hasSeaIce"/>
244                 <Literal datatypeIRI="&xsd;boolean">false</Literal>
245             </DataHasValue>
246             <DataMaxCardinality cardinality="0">
247                 <DataProperty IRI="hasMeanIceConcentration"/>
248                 <Datatype abbreviatedIRI="xsd:decimal"/>
249             </DataMaxCardinality>
```

Ontology Browser

Ontolog... | Action Ite... | Libre – ttdl... | A (Y3) Dat... | Abstract C... | National G... | Hierarchica... | Quality an...

devsnowdev.nsidc.org/ontology-browser/classes/1467916028/

agu fall 2011

Most Visited | Getting Started | Latest Headlines | Igloo Intranet | Pivotal Tracker | SSIII | DC Wiki | DC Contour | Bookmarks

Ontology Browser v1.4.2

Help

All ontologies | find

Ontologies | Classes | Object Properties | Data Properties | Annotation Properties | Individuals | Datatypes | DL Query | **Options**| Render labels ☑

Classes

+ Thing
  + Ice with Development Stage
    + First-year ice
      - Medium first-year ice
      - Thick first-year ice
      - Thin first year ice/white ice
    + New ice
      - Frazil ice
      - Grease ice
      - Shuga
      - Slush
    + Nilas
      + DarkNilasOrIceRind
        - Dark nilas
        - Ice rind
      - Light nilas
    + Old ice
      - Multi-year ice
      - Residual first-year ice
      - Second-year ice
    + Young ice
      - Grey ice
      - Grey-white ice
- License
- Work

Young ice permalink

http://purl.org/wmo/seaice#YoungIce

Annotations (3)

- source "http://www.aari.nw.ru/gdsidb/docs/wmo/nomenclature/WMO_Nomenclature_draft_version1-0.pdf#Section3.3"
- comment "Ice in the transition stage between nilas and first-year ice, 10-30 cm in thickness. May be subdivided into grey ice and grey-white ice."
- label "Young ice"

Superclasses (2)

- Ice with Development Stage
- *hasIceThickness* **only** decimal [<"0.3"(decimal), >="0.1"(decimal)]

OWL HTML inside

zotero

What's Next?

Semantic Sea Ice Interoperability Initiative

NSIDC

- Operational use case
  - Install development version of Virtuoso triple store
  - Run script to load Virtuoso with NSIDC Sigrid 3 data
  - Make endpoint publicly accessible
- SJSK how best to "model the model"
- Peter Pulsifer working on incorporating traditional knowledge into the ontology suite

General Thoughts

- Semantics is still in the wild-wild-west stages
- Vocabularies are a good way to start
- Ontologies are never done...
- Hard to make progress with only very part time staff
- This stuff is fun!

Questions?

photo courtesy NOAA