IMPORTANCE OF ATTRIBUTION FOR ASSESSING THE POLICY AND REGULATORY IMPACT OF EARTH OBSERVATIONS

Jason Gallo

IDA Science & Technology Policy Institute

July 2, 2019

IDA SCIENCE AND TECHNOLOGY POLICY INSTITUTE

Image Credit: Galen Dossin, NSF. Pine Island Glacier

SOCIETAL BENEFITS ARISING FROM ARCTIC SCIENCE AND OBSERVATIONS

Arctic science and observations contribute to:

- The protection of life and property
  - *e.g.* Weather predictions, sea ice forecasts, atmospheric and water models
- Economic productivity
  - *e.g.* Identification of energy and mineral resources, surface and ocean transportation systems and infrastructure, fishing
- Community resilience
  - *e.g.* Long-term trends that disrupt local activities and safety, including coastal erosion, changes in permafrost, reduction in seasonal sea ice cover
- Fundamental understanding of the Arctic system
  - *e.g.* Increased understanding of connections between Arctic and non-Arctic systems, reducing uncertainty in seasonal and inter-annual projections
- Arctic science and observations improve decision-making across sectors (e.g. scientific, economic, social, and security)

WHAT IS UNIQUE ABOUT SCIENCE AND OBSERVATIONS IN THE ARCTIC?

- The Arctic is remote, but its processes are not isolated
  - Changes to physical, social, and economic systems and processes globally affect the physical, social, and economic processes in the Arctic
  - Changes to physical, social, and economic systems and processes in the Arctic affect physical, social, and economic processes globally
- Societal benefits in the Arctic are both local and global
  - *e.g.* Understanding sea ice extent and thickness benefits communities, governments, researchers, and commercial interests in the Arctic as well as international governments, researchers, and commercial interests
- Because the Arctic is remote and sparsely populated relative to other areas, there are challenges deploying and maintaining observational system. This can lead to significant information gaps
  - These observations are a mixture of remotely sensed and in situ physical, social, and economic measurements
- Many Arctic communities and social and economic infrastructure in the Arctic are vulnerable to rapid changes in the Arctic system and its processes

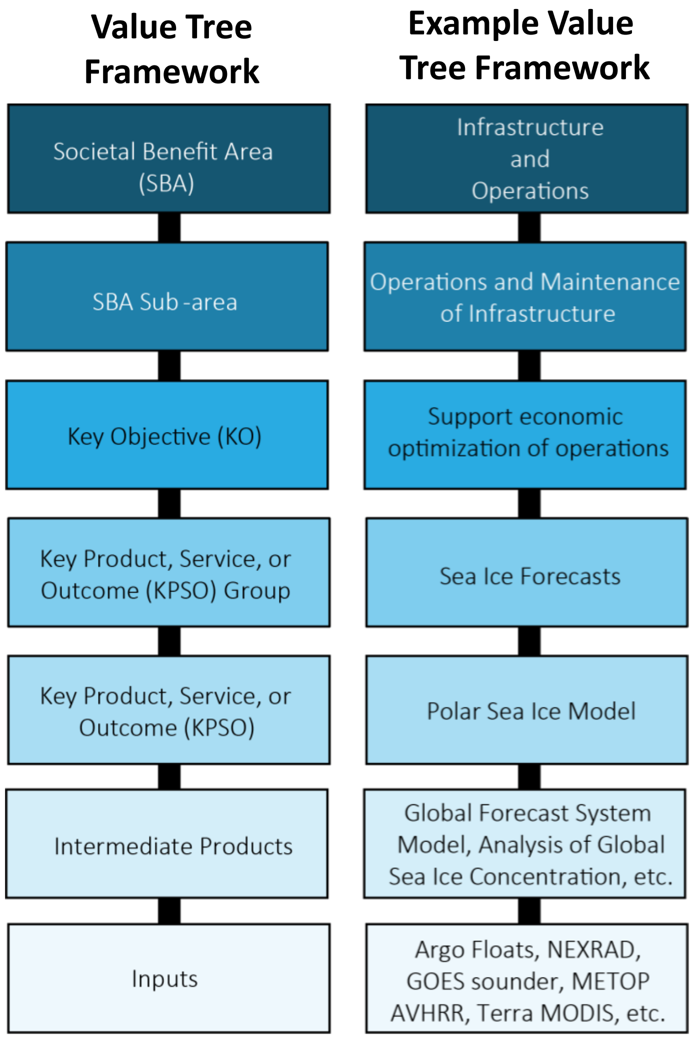
EARTH OBSERVATION ASSESSMENT 2016

- NASA Authorization Act of 2010 (Section 702) instructed the Director of the White House Office of Science and Technology Policy (OSTP) to “establish a mechanism to ensure greater coordination of the research, operations, and activities relating to civilian Earth observation of those Agencies”
- In response, an interagency group led by OSTP, NASA, NOAA, and USGS conducted assessments (2012 and 2016) of the Earth observation portfolio that the government relies on to meet its civil objectives
- Federal Participation
  - USGEO Assessment Working Group (AWG), Co-Chaired by NASA, NOAA, and USGS
  - 300 federal research scientists and managers on 13 Societal Benefit Area (SBA) teams
  - 1,000 subject matter experts involved in the data elicitation process
  - 3,000 elicitation interviews with subject matter experts
- Assessment General Statistics
  - 217 unique key federal objectives identified
  - 1,722 unique Earth observation products surveyed
  - 1,323 total Earth observation inputs (systems, sensors, networks, databases, and surveys)
  - 53,720 nodes in the resulting network model

- Agriculture and Forestry
- Biodiversity
- Climate
- Disasters
- Ecosystems (Terrestrial and Freshwater)
- Energy and Mineral Resources
- Human Health
- Ocean and Coastal Resources and Ecosystems
- Space Weather
- Transportation
- Water Resources
- Weather
- Reference Measurements

VALUE TREE FRAMEWORK

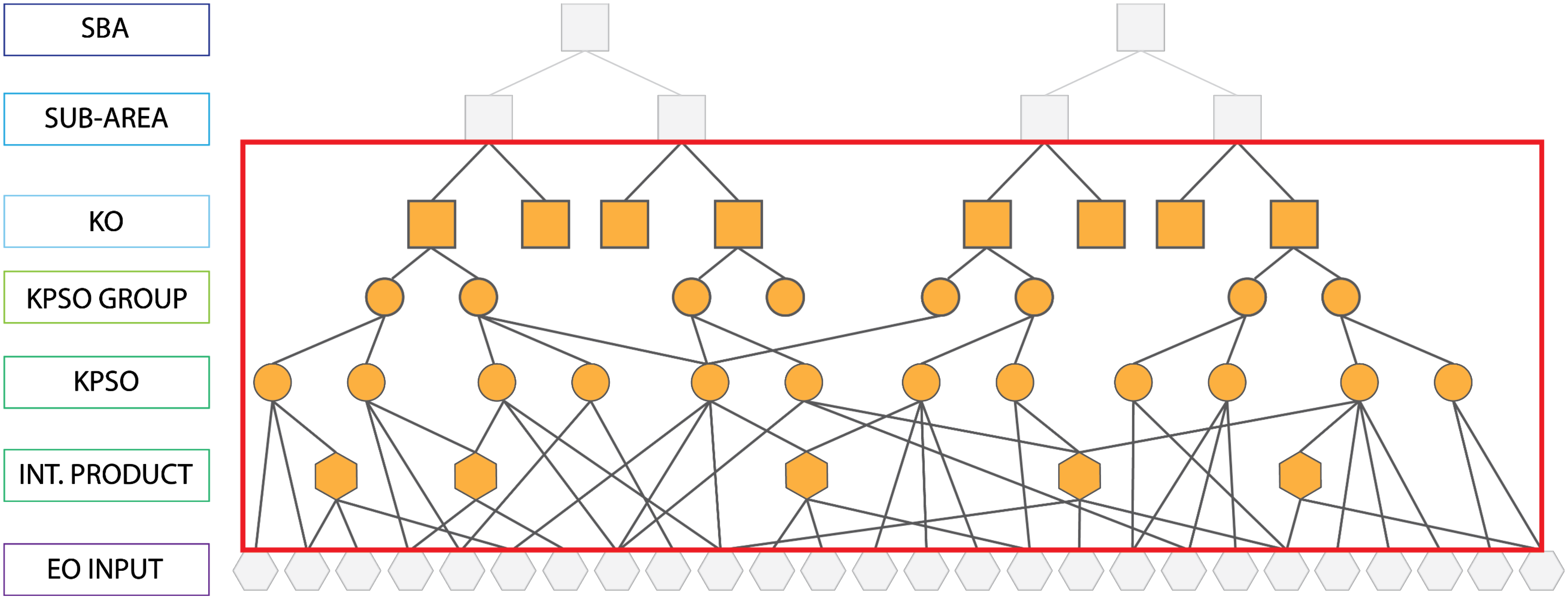
- The assessment uses a value tree analysis approach
  - Relies on expert domain knowledge to develop a hierarchical framework connecting thematic areas of societal benefit and underlying objectives (both operational and research)
  - Establishes the connection between societal benefit and Earth-observing inputs through the key products, services, and research outcomes that they support
  - Observations include sustained and experimental remote and in situ observations at national, regional, and local and community scales taken by governments, academic researchers, local groups, and individual citizens



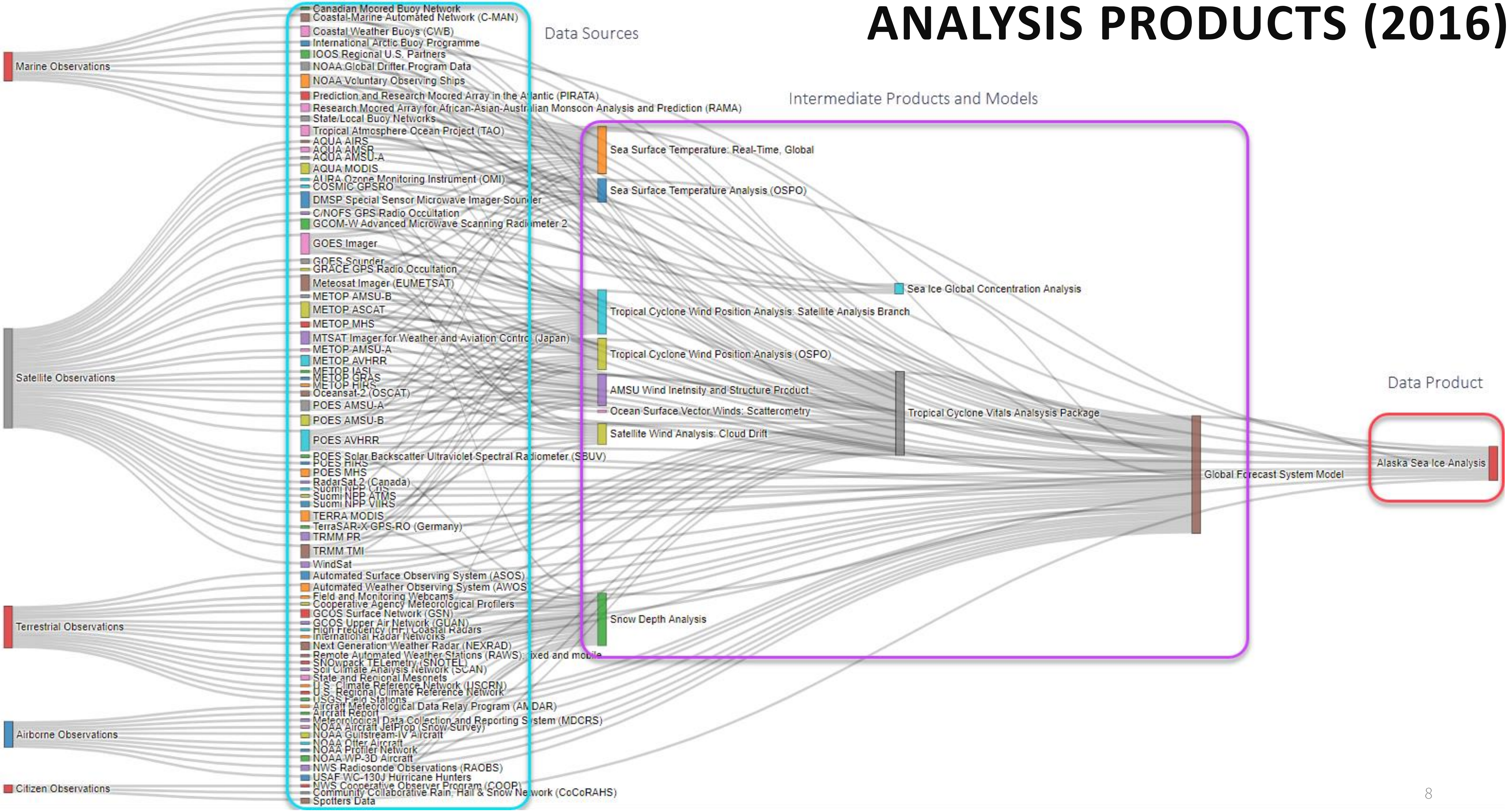
ASSESSMENT DATA COLLECTION OVERVIEW

- The assessment employed multi-attribute decision-making methods from operations research and modified Delphi expert elicitation methods
- For each data and information product, elicitors asked subject matter experts to:
  - Identify the list of input data sources that contribute to the key information product, including:
    - Direct observations from observing systems
    - Datasets
    - Intermediate products
    - Model outputs
  - Evaluate the data sources by:
    - Relative criticality
    - Performance
- Expert judgments about relative criticality and performance are quantified using a standardized scale
- The data are then used to build a structure for each product that maps into the value tree, as specified by individual expert teams

ASSESSMENT DATA IS NETWORKED



INPUTS TO ALASKA SEA ICE ANALYSIS PRODUCTS (2016)

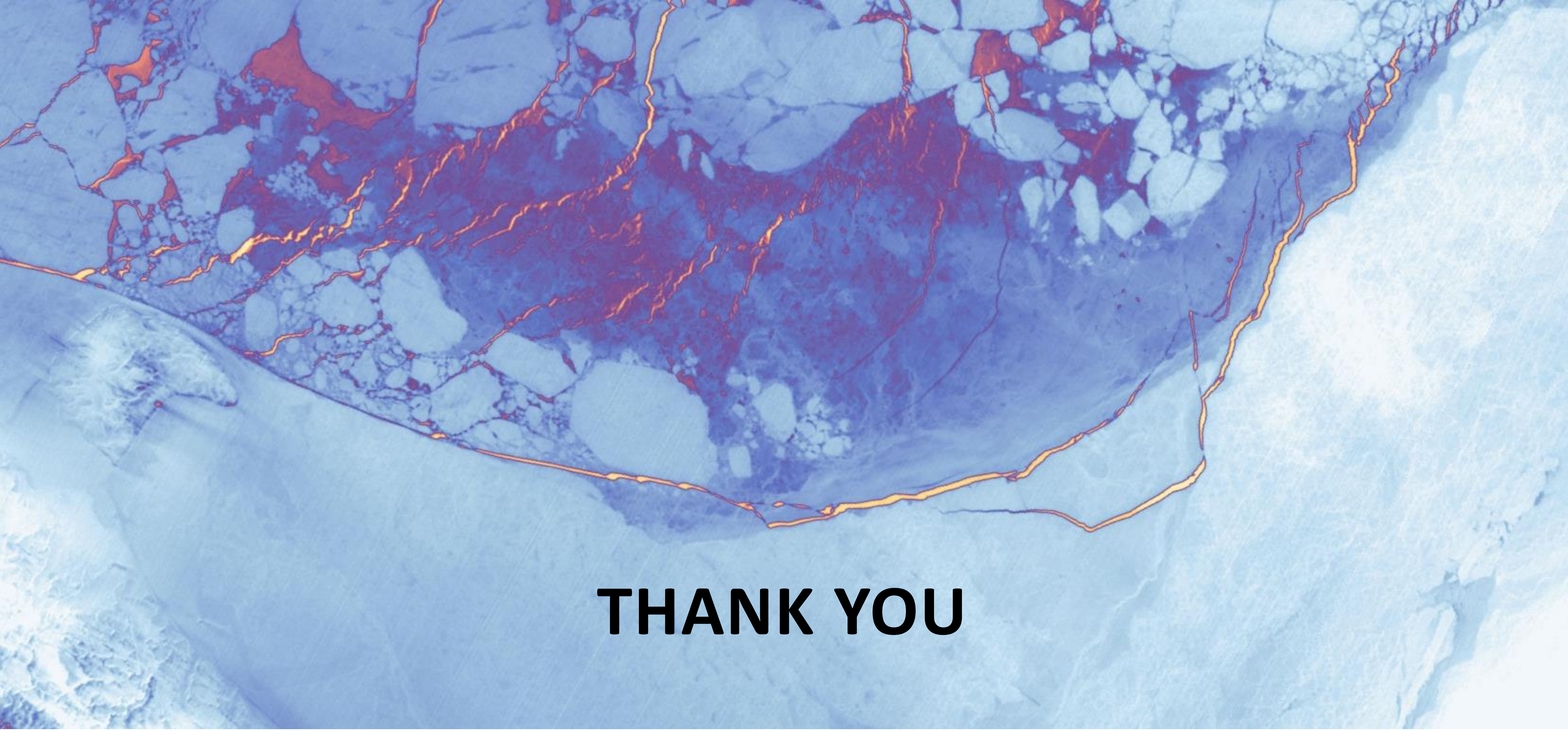


ATTRIBUTION CONSIDERATIONS

- Many information products are derived from multiple and heterogeneous Earth observation sources
  - Those sources are rarely used for only one application, so to capture the value of an individual source it is important to understand the range of its uses
  - Sources are complimentary – many measurements are used in conjunction and their value is affected by the presence or absence of other measurements
  - Sources are owned/operated by a diverse set of partners (domestic, international, state/provincial, local, tribal, international, commercial, and academic)
- Intermediate products are often the result of computationally intensive modeling programs
- Considering platforms
  - A satellite may carry multiple sensors, each collecting unique measurements that may be used for distinct or overlapping purposes and therefore sensors need to be disaggregated in assessments
  - Losing one sensor on a platform will not necessarily diminish the value each of other sensor or diminish the value of other sensors in the same way and therefore the relationship between sensors needs to be examined
- Considering networks
  - In many Earth observation networks each node is identical/similar but it’s location is unique (e.g. stream gauges)
  - Value often lies in observations made across nodes in a network.
  - The loss of an individual node may not diminish the value of the information from the network, but aggregate losses may

FINAL THOUGHTS

- Free and open data are not free
- The provision of Earth observation data and information products is the result of significant public and private investments in observation systems and programs, data management and distribution, research and analysis, modeling, reanalysis, and information product development
- Policy decision-makers need reliable information on the what observations the public and private sectors rely on in order to identify what to invest in and who to partner with to maintain valuable services, support the research enterprise, and to identify gaps and areas for improvement



THANK YOU

jgallo@ida.org

IDA SCIENCE AND TECHNOLOGY POLICY INSTITUTE