Interdisciplinary Research For Arctic Coastal Environments (InteRFACE)
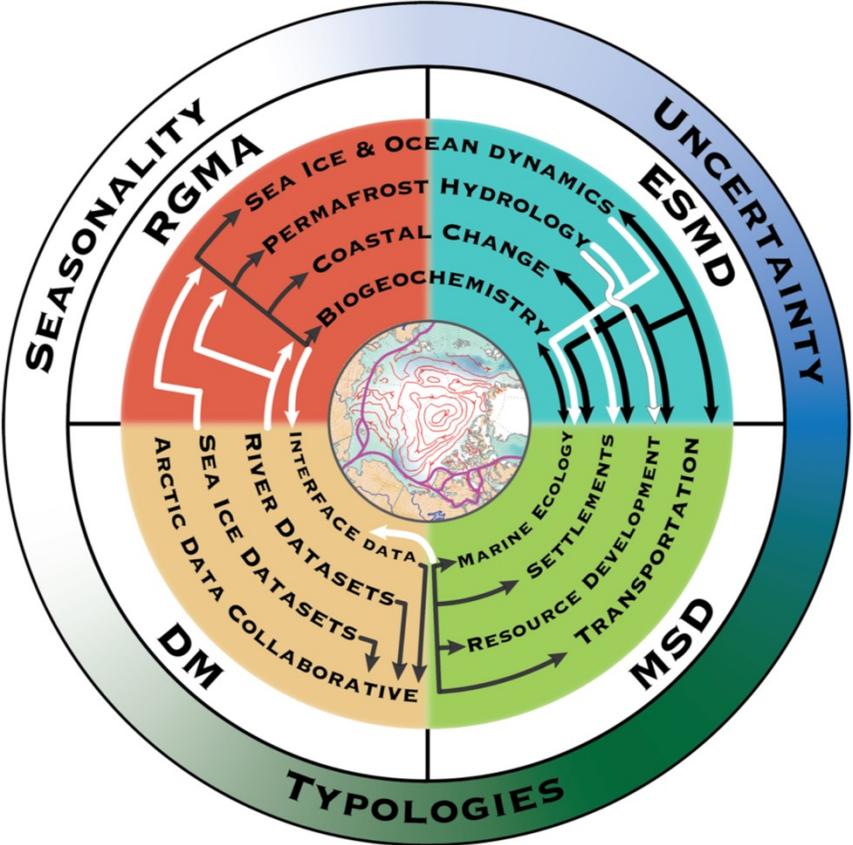
Joel Rowland
Los Alamos National Laboratory

DOE Cyberinfrastructure Working Groups
May 11, 2020

InterFACE

Interdisciplinary, multi-institutional, cross-program, research project to:

To quantify and reduce uncertainties in our fundamental understanding of the magnitude, rates, and patterns of change along the Arctic coast.

By identifying, quantifying and modeling

how the coupled, multi-scale feedbacks among land processes, sea ice, ocean dynamics, coastal change biogeochemistry, atmospheric processes, and human systems will control the trajectory and rate of change across the Arctic coastal interface.
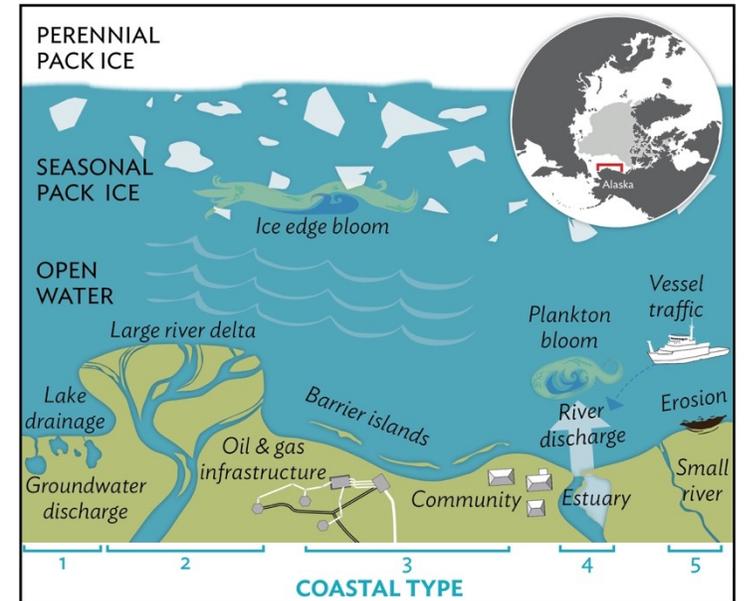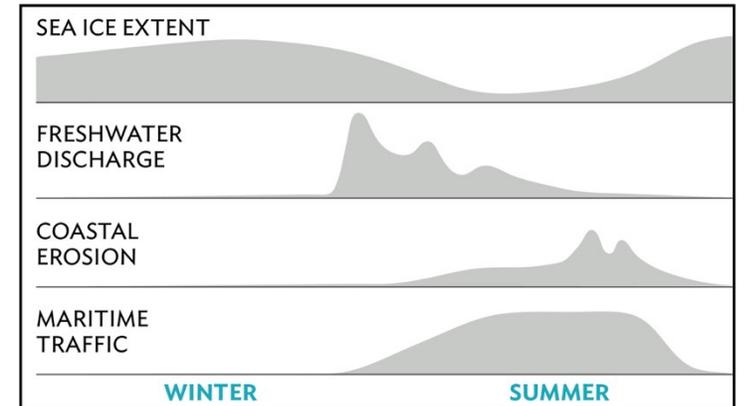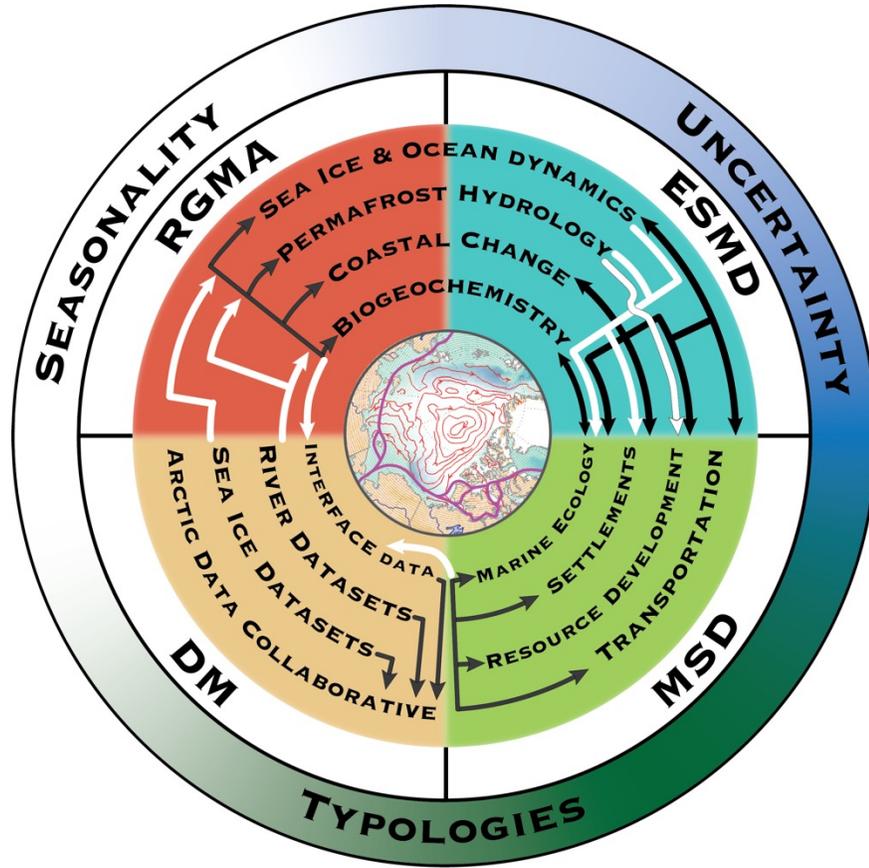
What is INTERFACE?

- 4 sponsoring BER programs
- 5 collaborating institutions
- Focused on integrating and cross-cutting science themes
- Interactions and feedbacks between humans, economics and natural systems
- Coupled feedbacks between land and ocean
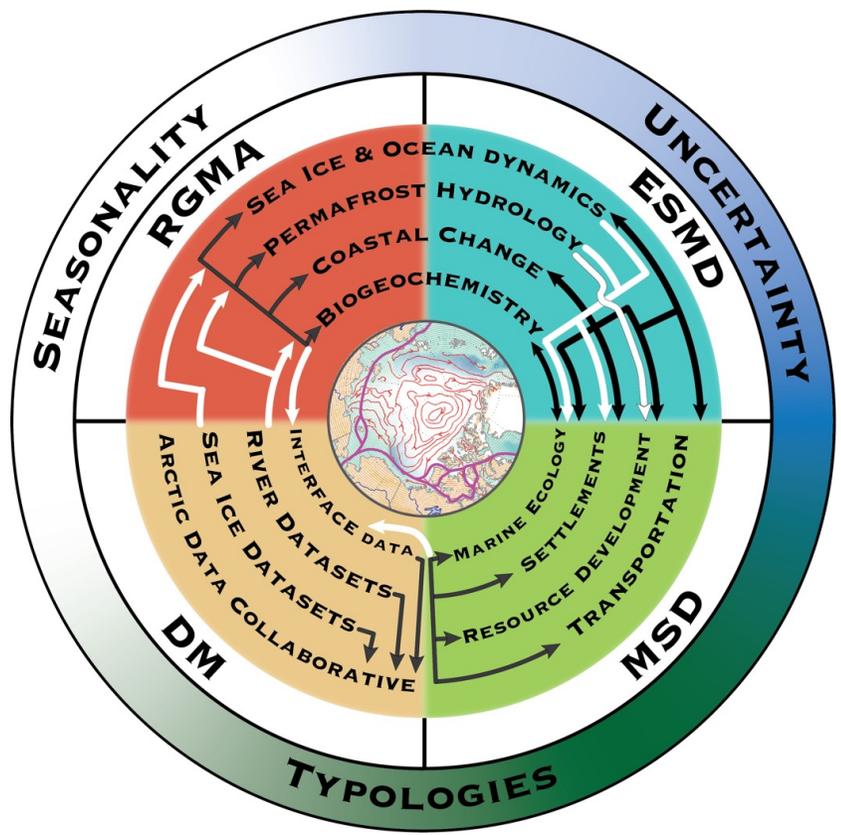
Regional and Global Model Analysis (RGMA)
Joseph

Earth System Model Development (ESMD)
Davis

Multisector Dynamics (MSD)
Vallario

Data Managemet (DM)
Hnilo

Who is INTERFACE?

Sea ice, ocean, marine biogeochemistry, and earth system modeling modeling permafrost hydrology, integrated hydrological modeling, coastal processes, river and delta geomorphology. Extensive field, remote sensing, and modeling experience in Arctic.

Permafrost and integrated hydrological modeling. Model analysis and benchmarking. Representativeness analysis.

Multisector dynamics modeling and analysis. Russian Arctic and oil and gas expertise. Hydrology and river routing modeling in Earth System Models.

Process-rich, thermal-mechanical, multi-physics, finite element modeling of coastal erosion. Ocean wave and model sensitivity analysis expertise. Field experience studying Arctic coastal erosion.

Expertise in marine biogeochemistry, sea ice, permafrost hydrology, and coastal dynamics. Expert knowledge of Alaskan economic, political, and societal dynamics. Economic scenario analysis and development. Deep connections in Alaskan research community for data curation and management for Alaskan stakeholders. Extensive field, remote sensing, and modeling experience in Arctic.

Integrated science focused on feedbacks

Earth System focus on:
- Sea ice and ocean dynamics
- Coastal Change
- Permafrost Hydrology
- Marine Biogeochemistry

Multi-sector dynamics focus on:
- Shipping
- Settlements
- Resource development

NASA Earth Observatory: MODIS July 2007

Ben Jones
Ben Jones (UAF)
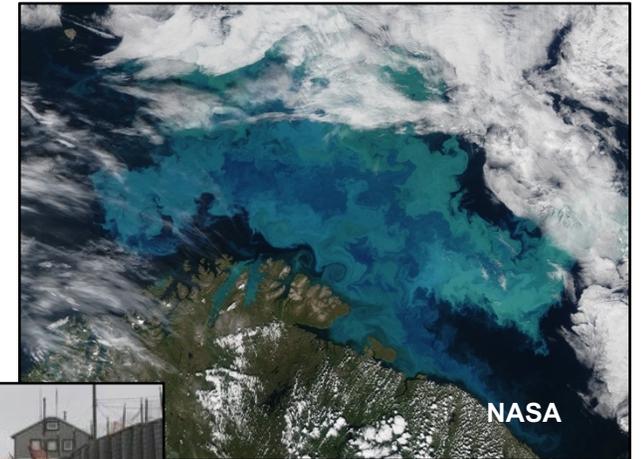
NASA

USGS

Prioritization of Phase I Research

- Impact: fundamental scientific advancements

- Ability to integrate across the program areas and institutional expertise

- Foundational for future work

- Potential to integrate and align with funded and planned DOE and non-DOE research

- Likelihood to achieve success in 3 years

Intensive focus on the North Slope of Alaska

earthweek.com
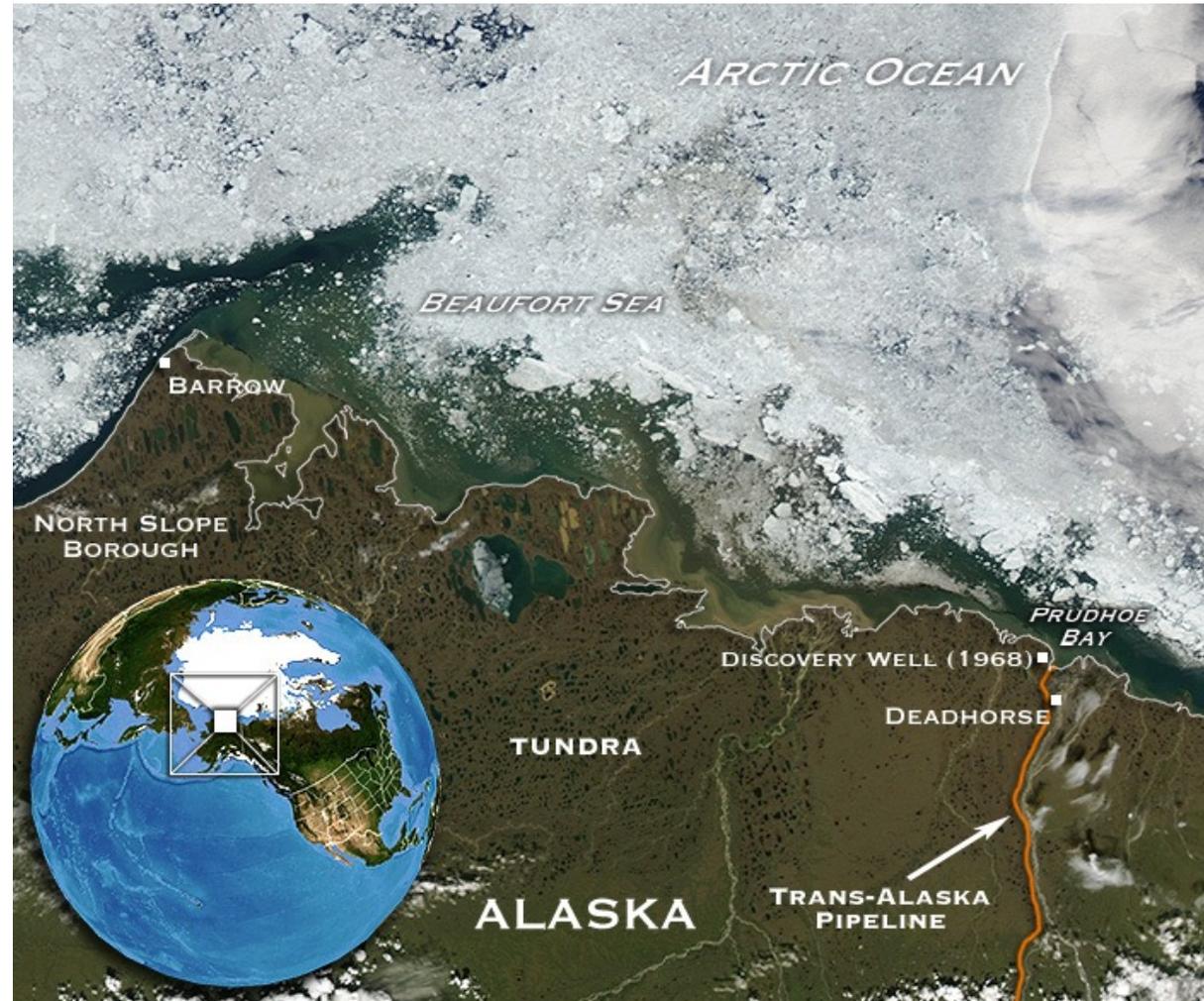
Programmatic foci: RGMA

RGMA 1: How will changing **seasonality of precipitation and thawing permafrost** alter the timing, magnitude, and spatial distribution of **water, sediment, and nutrient fluxes from rivers to the Arctic Ocean** and what are the skills and biases of current ESMs in simulating northern high-latitude river fluxes?

RGMA 2: How will changes **in ocean and sea ice** conditions interact with the physical characteristics of Arctic coasts to **influence the magnitudes, rates, and patterns of coastal change**?

RGMA 3: What is the **ESM ensemble spread** for key indicators of Arctic **sea ice and ocean changes, including sea ice extent and thickness, changes in landfast ice area**, and waves reaching the Alaskan littoral zone?

RGMA 4: How does changing seasonality in riverine fluxes and landfast ice persistence impact **marine ecosystems** in Alaska's arctic coastal waters and shelf seas, and how might this **inform fisheries and human subsistence activities**?

POC: Joel Rowland, Los Alamos National Laboratory
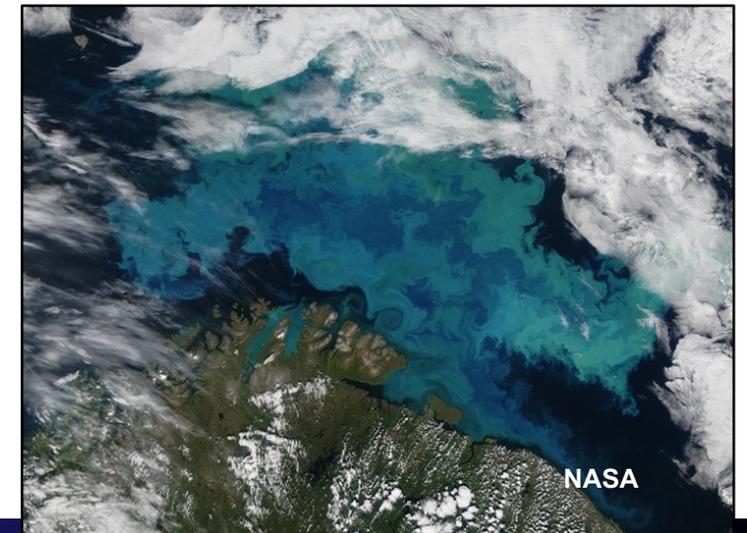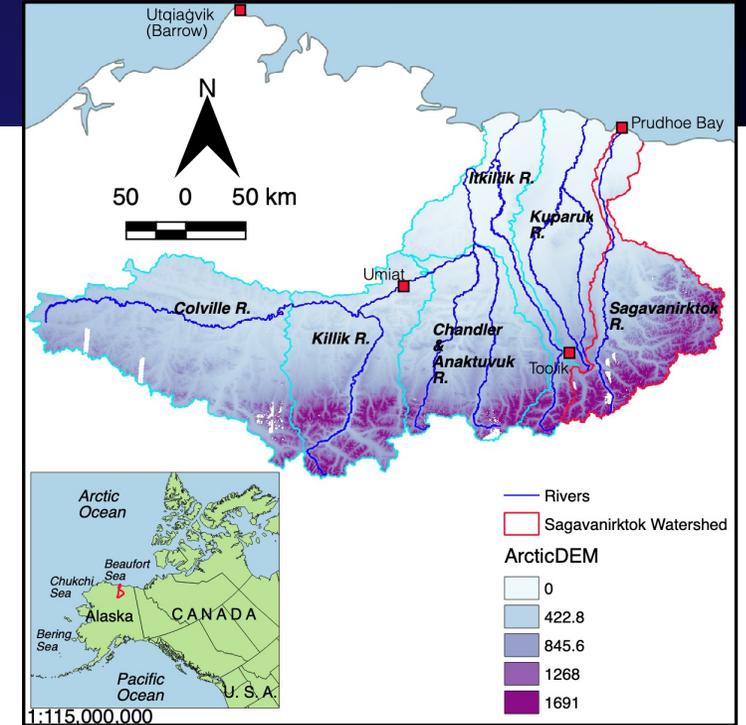
Programmatic foci: ESMD

ESMD 1: How **realistic are fully-coupled E3SM ensemble projections of land hydrology and the Arctic Ocean**, including sea ice and biogeochemistry, over the observational period from 1979 to the present?

ESMD 2: **What impact does global internal variability have on the timing of seasonal sea ice breakup along Alaskan coasts and transport routes in E3SM**, and on autumnal freeze-up in the 21st century?

ESMD 3: How will the **structure and productivity of the marine ecosystem of the Bering, Chukchi and Beaufort Seas respond to future climate conditions**, and how might this inform for commercial fisheries?

CESM V2 E3SM V1 E3SM Arctic Refined Mesh Coast

NOAA Arctic Report Card

Arctic Great Circle Route — Northern Sea Route — Northwest Passage

POC: Andrew Roberts, Los Alamos National Laboratory
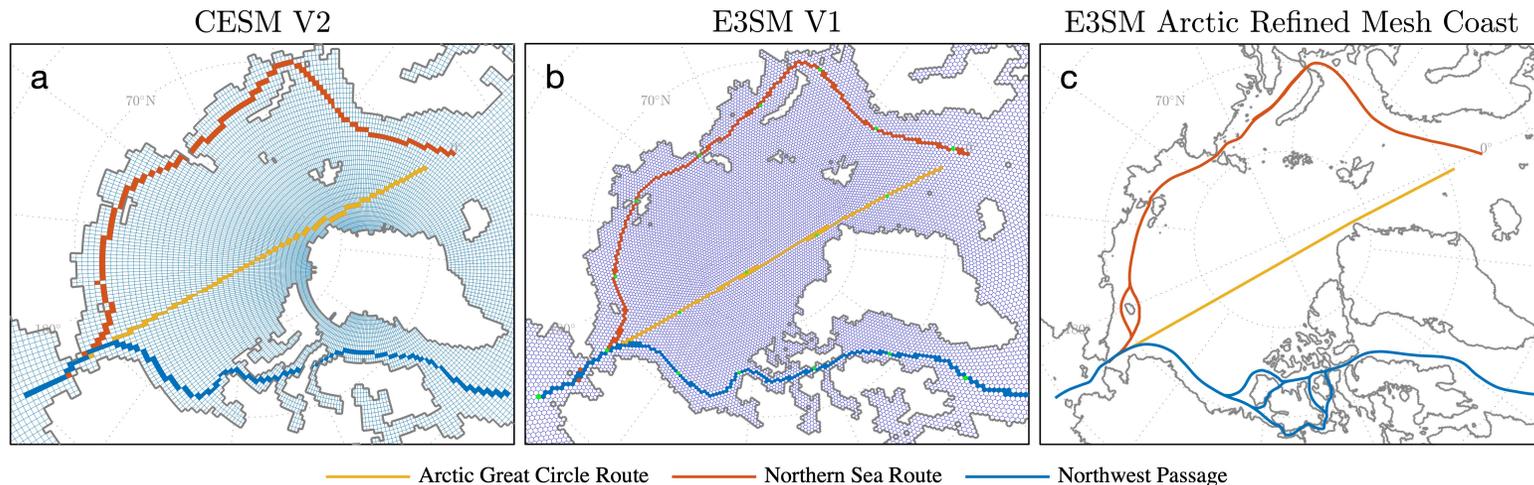
Programmatic foci: MSD

MSD 1: **How will shipping, resource development, and human settlements co-evolve across the Arctic** and within remote rural Arctic communities in response to cryospheric changes and human pressures such as demands for resources and new maritime trade routes? What influences—both exogenous and endogenous—will be most important to this co-evolution?

MSD 2: **Are there critical thresholds in this co-evolution**, for example, at which fossil fuel development is no longer economically viable? At what point are subsistence livelihoods and the existence of coastal settlements themselves unsustainable?

MSD 3: How **will this co-evolution influence, and be influenced by, broader dynamics globally**, including resource production, demand for global shipping, and associated economic activity in other regions of the world?

POC: Stephanie Waldhoff, Pacific Northwest National Laboratory
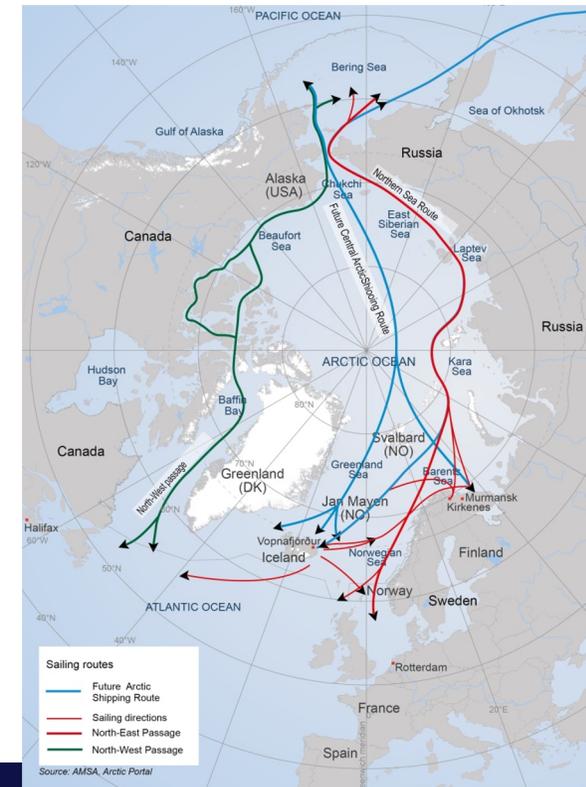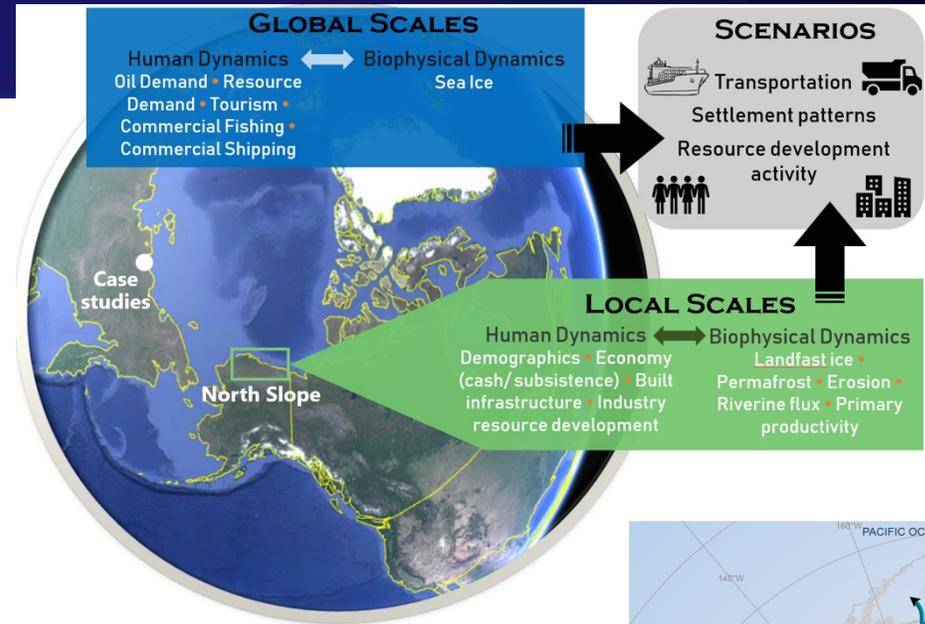
Programmatic foci: DM

Task 1: **Stakeholder data access and explorability.** Arctic data collaborative data products with an eye towards the needs of local, state, and federal government entities, industry, and the research community

Task 2: Data acquisition and curation of historical observations key to the INTERFACE project: hydrology and sea ice

POC: Scott Rupp, University of Alaska Fairbanks
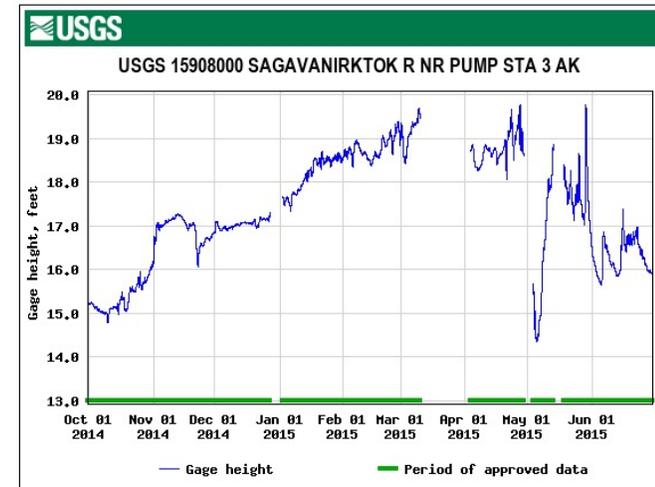
Building Collaborations

DOE:

Energy Exascale Earth System Model (E3SM) - ecosystem project, developing capabilities and sharing developments

High-Latitude Application and Testing of ESMs (HiLAT) - Arctic regionally refined meshes, coastal change, and rivers

NGEE Arctic - linking watershed scale ecosystem changes to broader Arctic change, complimentary modeling efforts

RuBisCO – ILAMB benchmarking development and model testing

Integrated Coastal Modeling (ICoM) – modeling efforts to understand couplings between land and ocean

Inter-agency efforts:

North Pacific Research Board (NPRB) – coordinating observations with modeling and using biogeochemical modeling results to inform fisheries modeling (*Baker and Dickson*)

NOAA – coordination of modeling and data resources for both ocean biogeochemistry and terrestrial hydrology, national water model for Alaska (*Brix, Kinsman, Buesseler*)

USGS – Alaska coastal change: Mapping and modeling coordination (*Erickson and Gibbs*)

NSF – Navigating New Arctic projects (*Nienhuis, Loisel*). LTERs: Toolik and Beaufort Lagoon (*McClelland, Cardenas*)

NASA – Arctic-COLORS (*Tzortziou*), individual PI projects

University Collaborations

BOEM – Landfast Ice Climatology (*Mahoney, UAF*)

Brown U. – Shipping and Sea Ice (*Lynch*)

CUNY – Linking observations to modeling (*Tzotziou*)

CU Boulder – Permafrost modeling, river and delta dynamics (*Overeem*)

NPS – SODA, MOSAIC (*Stanton*)

PerCS-Net – Data and modeling interactions (*Jones*)

SCRIPPS – small scale mixing in Arctic (*MacKinnon*)

U Washington – Model Data comparisons (*Thomson*)

Yale - (ONR) Mathematics and Data Science for Improved Physical Modeling and Prediction of Arctic Sea Ice (*Timmermans*)