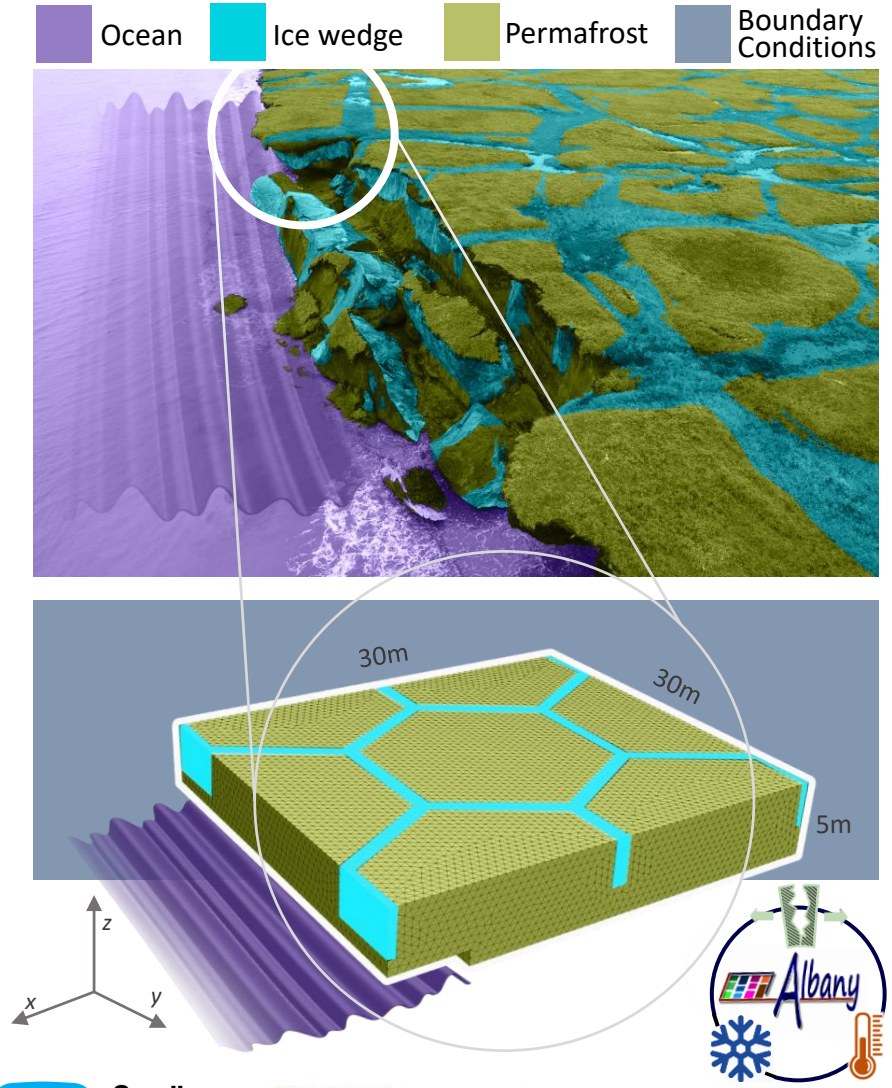
Arctic Coastal Erosion (ACE) Model



LOCATION SPECIFIC DATA

BOUNDARY CONDITIONS

Arctic System Reanalysis *(Historic)*

HYCOM *(Historic)*

RCP 8.5 Earth System Models *(Projections)*

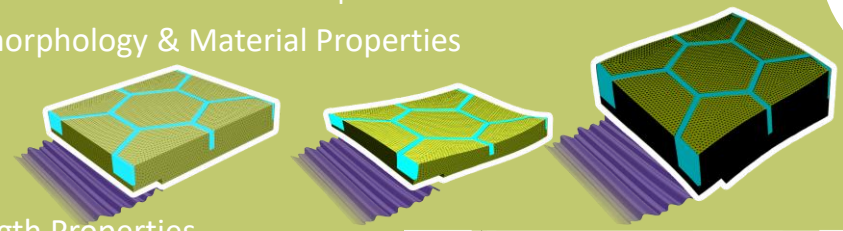
- WIND SPEED / DIRECTION
- ATMOSPHERIC TEMP
- PERMAFROST TEMP
- OCEAN ICE EXTENT
- OCEAN CURRENTS
- OCEAN TEMP

TERRESTRIAL \ TERRESTRIAL

Albany: 3-D multi-physics based finite element model

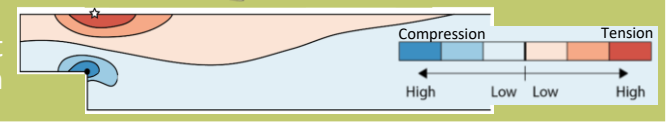
- MECHANICAL: 3D finite deformation plasticity model
- THERMAL: transient temperature and ice saturation evolution

Geomorphology & Material Properties



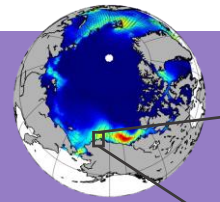
Strength Properties

- MATERIAL: ice content determines strength

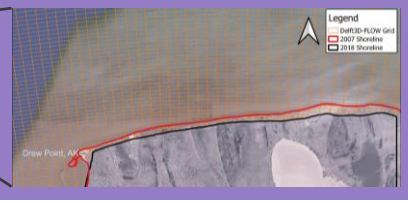


OCEAN

Circum-Arctic:
Wave Energy (WW3)



Nearshore:
coupled wave & circulation (SWAN-Delft3D)



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Oceanographic Modeling Suite

WW3
Development of wave field in the Arctic to develop nearshore BC's

- surface winds
- ice cover

SWAN
Wave set-up conditions 2-way coupled with circulation

- high resolution near shore environment
- wave energy inclusive of induced current effects

Delft3D-FLOW
Circulation and thermal conditions 2-way coupled with waves

- capture induced currents in nearshore
- capture set-up (storm surge and runup)

Historic

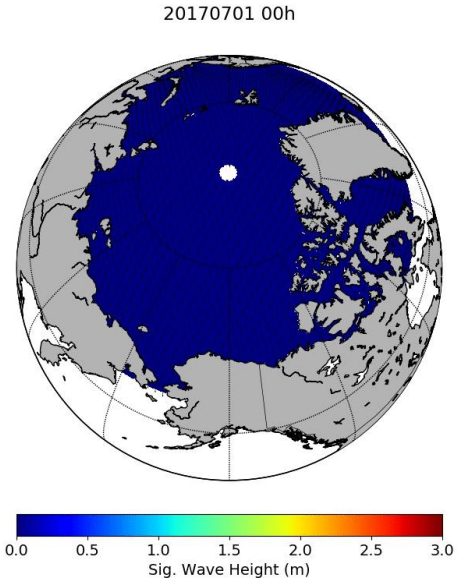
- 2007-2019 (ASRv2 & ERA5)

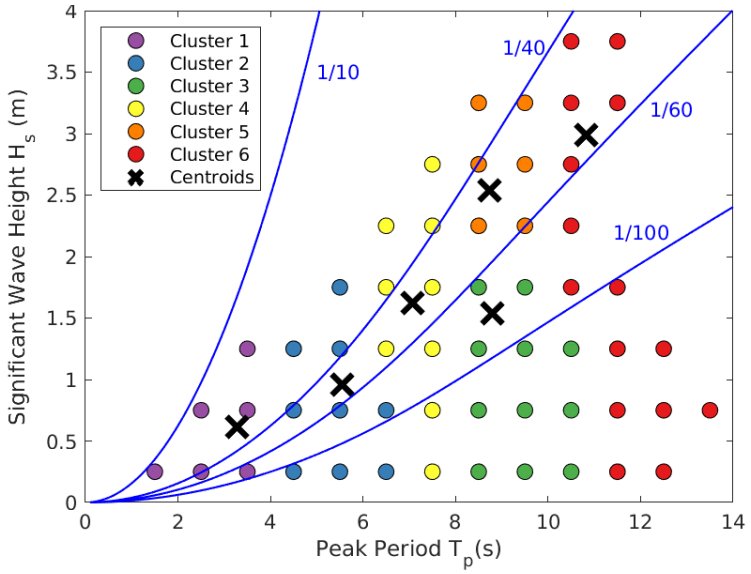
Projected

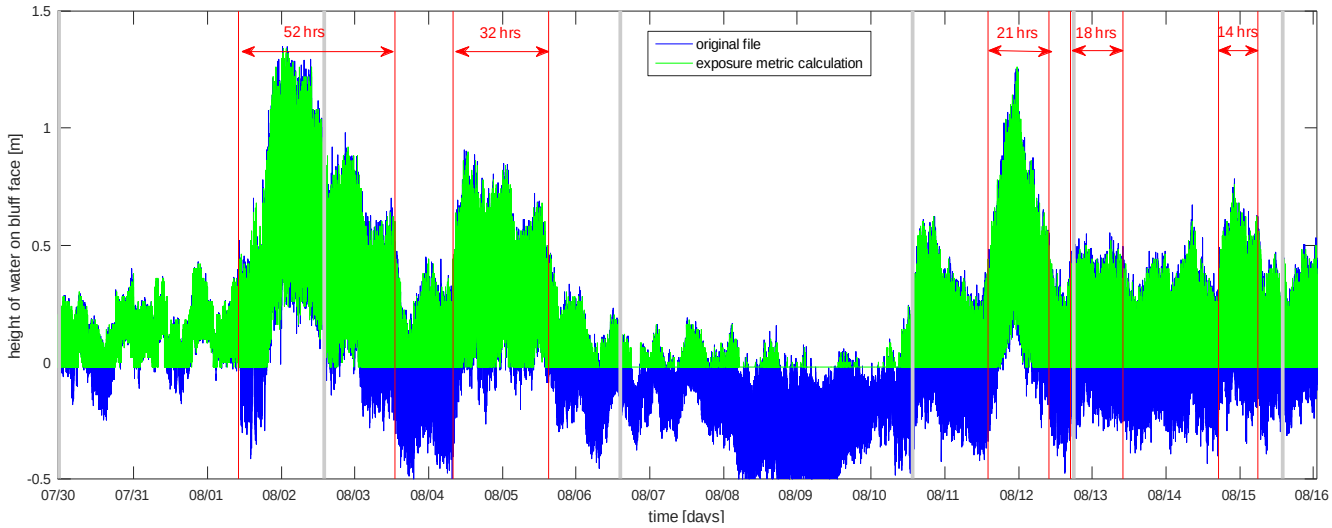
- 2020 – 2040 (SNAP-dynamically downscaled RCP8.5)

50m & 100m Bathymetric Contours

- Statistical wave environment parameters output every deg longitude







Terrestrial Model

Thermal Model – requires geometry

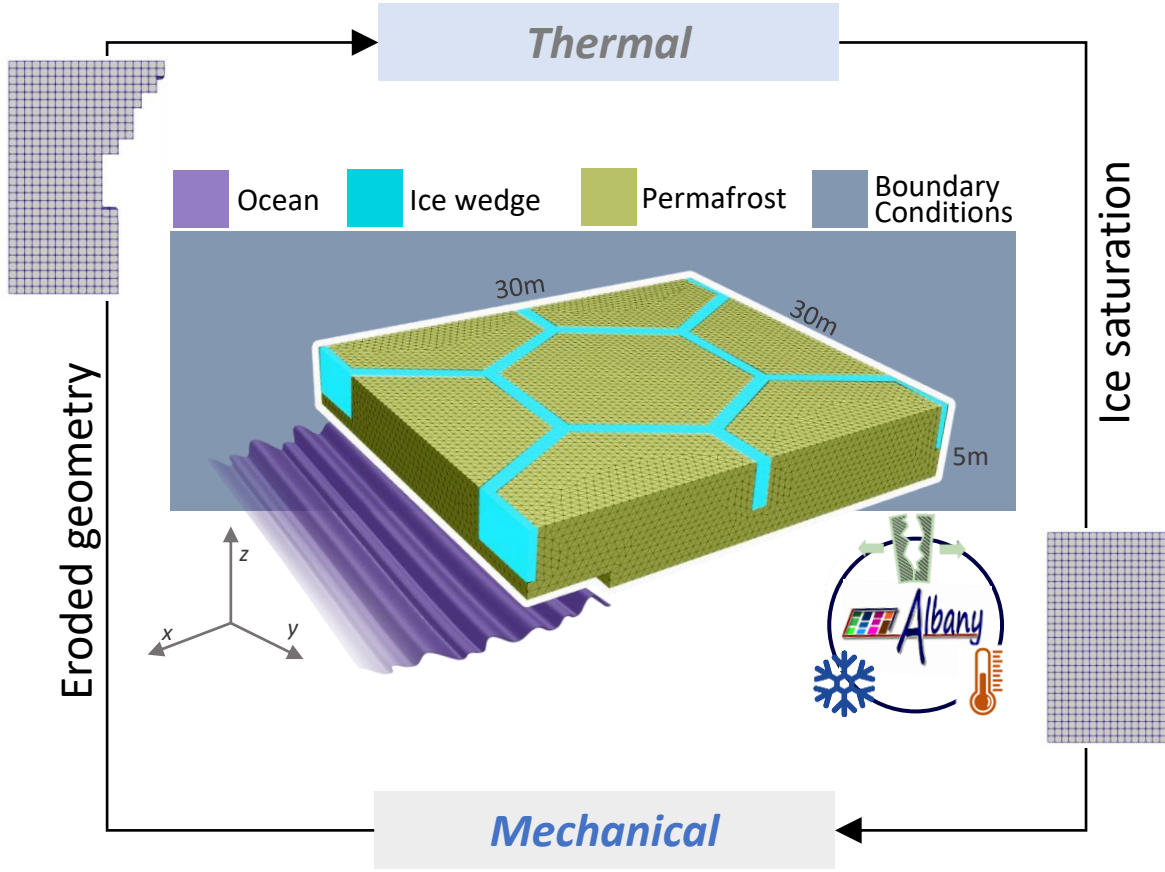
- 3D thermal PDE's implemented in Albany evolve temperature and ice saturation in permafrost
- Developed thermal properties from mixture models of constituent material properties
- Applies temperature B.C.s and salinity / water contact history

Mechanical Model—requires ice saturation

- Albany is a 3D finite deformation plasticity model
- Domain will deform according to computed stress
- Domain changes geometry according to failure criteria

Schwarz framework—coupling

- Iterative approach—independent solutions (therm/mech)
- There is no direct dependence between mechanical and thermal PDE's; *dependence is achieved through the material model*

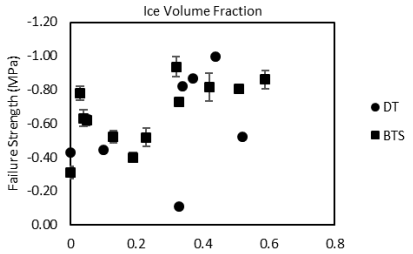


This modeling framework uniquely allows for any form of material deformation

Research Challenges

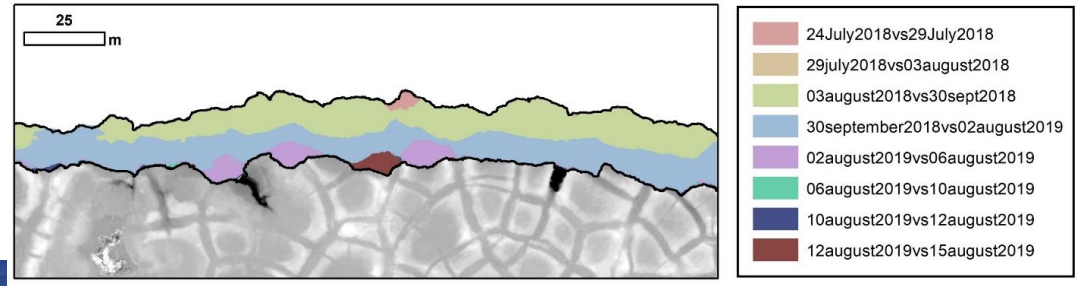
How can we improve estimates of geochemical and sediment land-to-ocean fluxes from coastal change?

TOC fluxes from 9 km coastline @ Drew Point ***~equivalent*** to TOC fluxes from largest rivers draining North Slope (e.g. Sagavanirktok or Kuparuk)



What measurements are needed to ensure model accuracy over a wide variety of environments?

How can we improve and expand upon characterizations of temperature dependent permafrost strength?



How do we downscale boundary conditions, i.e. how accurate is “accurate enough”?

How can we upscale erosional processes when they are so dependent on local conditions (storms, material properties, etc.)?