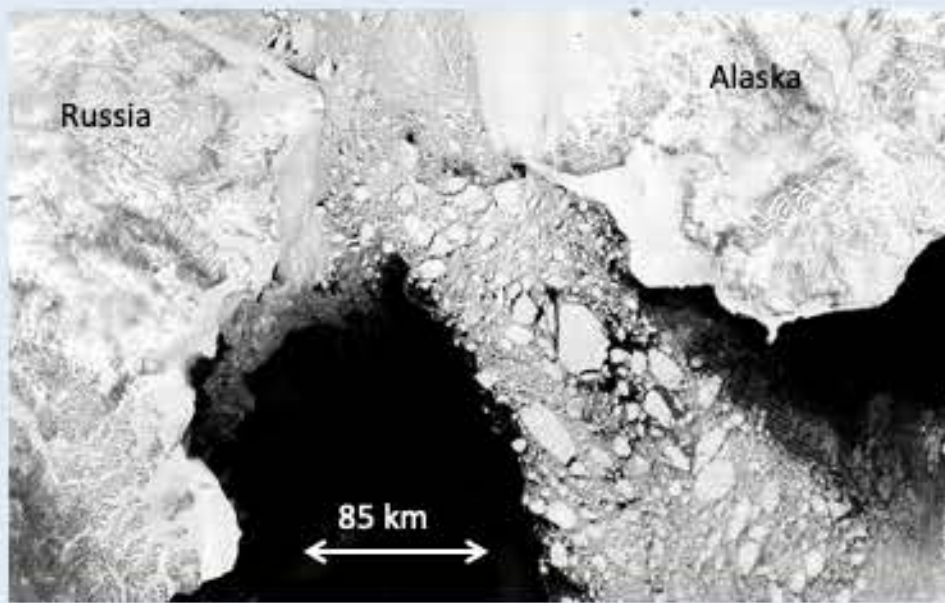


## Background

Accurately representing the processes of wave-sea ice interactions is critical to simulating the changing wave climate in polar regions.

Sea ice floe sizes span a wide range of scales, described statistically by their floe size distribution (FSD).

**Waves are critical to simulating FSD in the marginal ice zone**



Floes in the Bering Sea (MODIS)

## New Configurable Options in E3SM

- WW3 Spectral resolution: # of wave frequencies
  - 25, 36 (default), or 50 Frequency Bins
- Number of Ice Floe Categories:
  - 1 (default), 12,
- Use Floe Size Distribution: T/F
  - Allow column physics to calculate Floe Size Distribution (must use icepack column physics package)
- Allow wave Breaking of Ice Floes: T/F
  - Use wave information in Column physics. (requires use of 'Icepack' column package)

## Wave – Sea Ice Coupling Infrastructure

### Wave Watch III

#### Wave Variables Sent to coupler:

- Significant wave height (Hs)
- **Wave Spectra**
  - function of wave frequencies
- **Wave-to-ice stress (future?)**

#### Ice Vars received from Coupler :

- Ice Fraction
- Ice Thickness
- **Mean Ice Floe Size Diameter**

### MPAS – Sea Ice

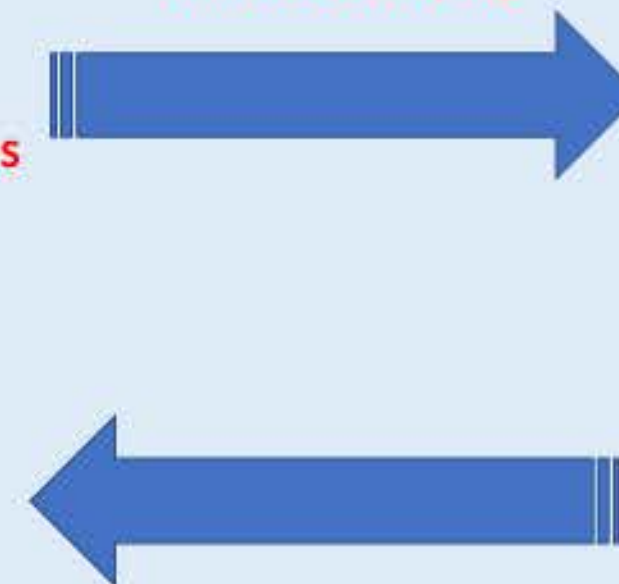
#### Wave Variables Received from Coupler:

- **Significant wave height (Hs)**
- **Wave Spectra**
  - function of wave frequencies
- **Wave to ice stress (future?)**

#### Ice Variables sent to coupler:

- Ice Fraction
- Ice Thickness
- **Mean Ice Floe Size Diameter**

Red = New infrastructure for wave-ice coupling



## “Floe Size Distribution” and “Ice Floe Breaking” in MPAS-SI

### Floe Size Distribution

- Ice floe size depends on advection of floes, thermodynamics (i.e growth due to freezing, or loss due to melting), mechanical processes (collisions, etc), and breaking due to waves

$$\frac{\partial f(r, h)}{\partial t} = -\overbrace{\nabla \cdot (f(r, h)\mathbf{v})}^{\text{Advection}} + \underbrace{\mathcal{L}_T}_{\text{Thermodynamics}} + \underbrace{\mathcal{L}_M}_{\text{Mechanical}} + \underbrace{\mathcal{L}_W}_{\text{Waves}}$$

### Wave Fracturing of Ice Floes

- Assumes sea ice flexes with the sea surface height field
- Ice Floe breaks if 'strain' exceeds critical threshold
- Resulting floe diameter = distance between the extrema in sea surface height field

