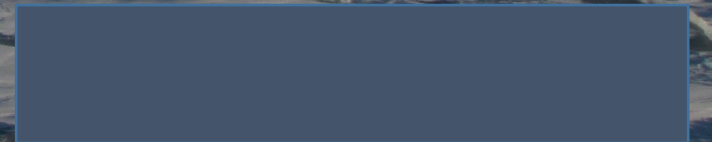


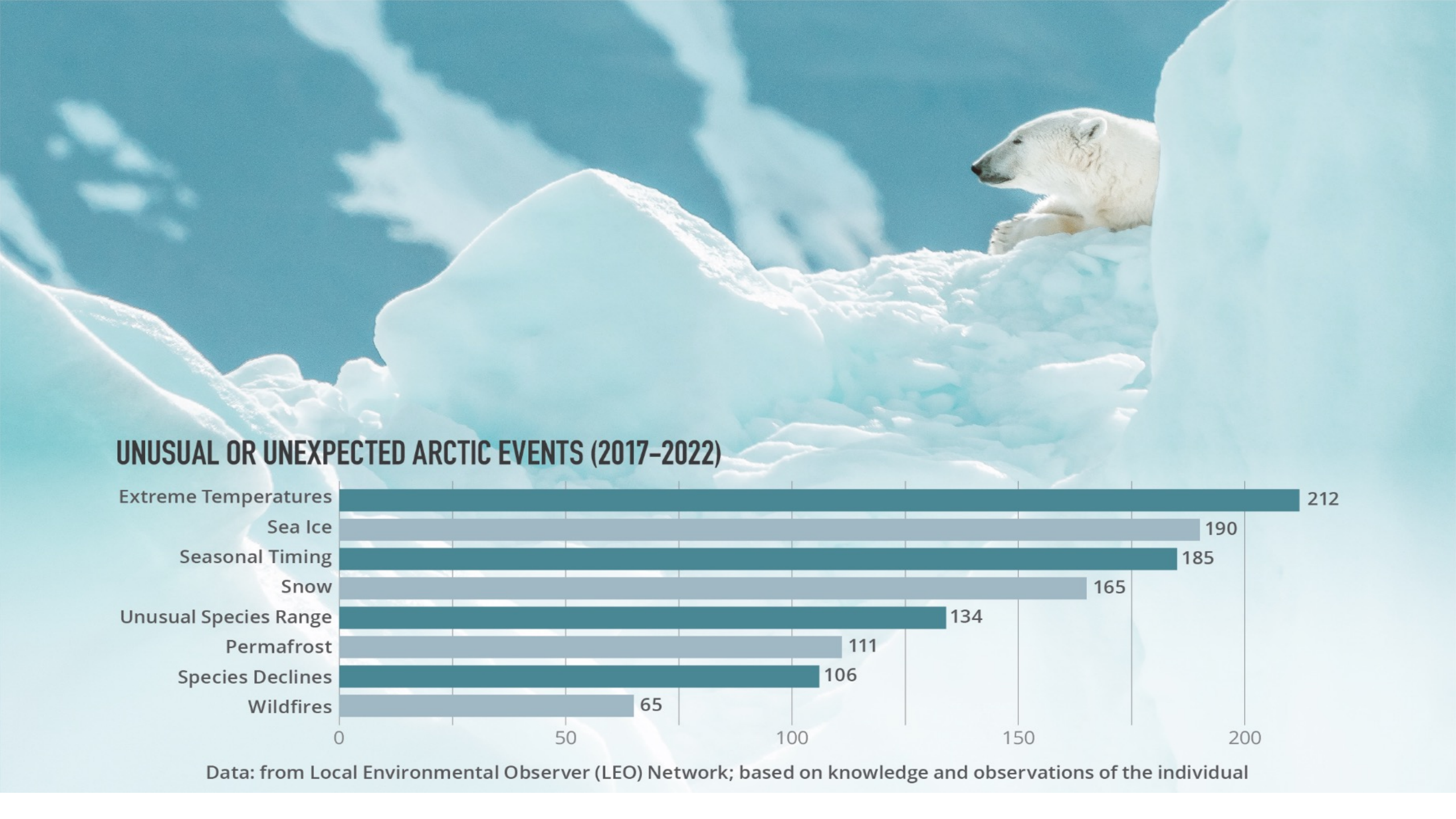
# Less Climatic Resilience in the Arctic, More Rare Events

James E. Overland

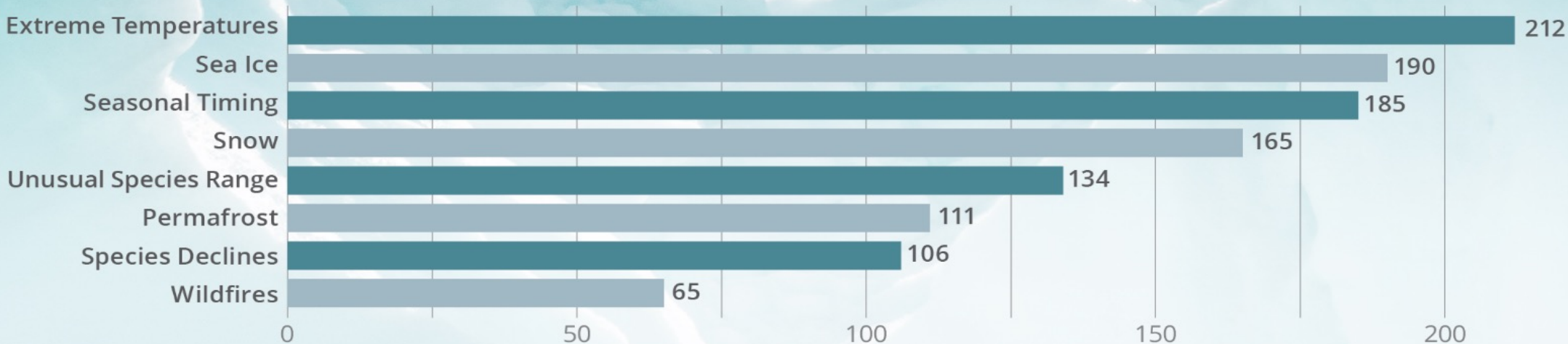
NOAA/Pacific Marine Environmental Laboratory  
Seattle, WA





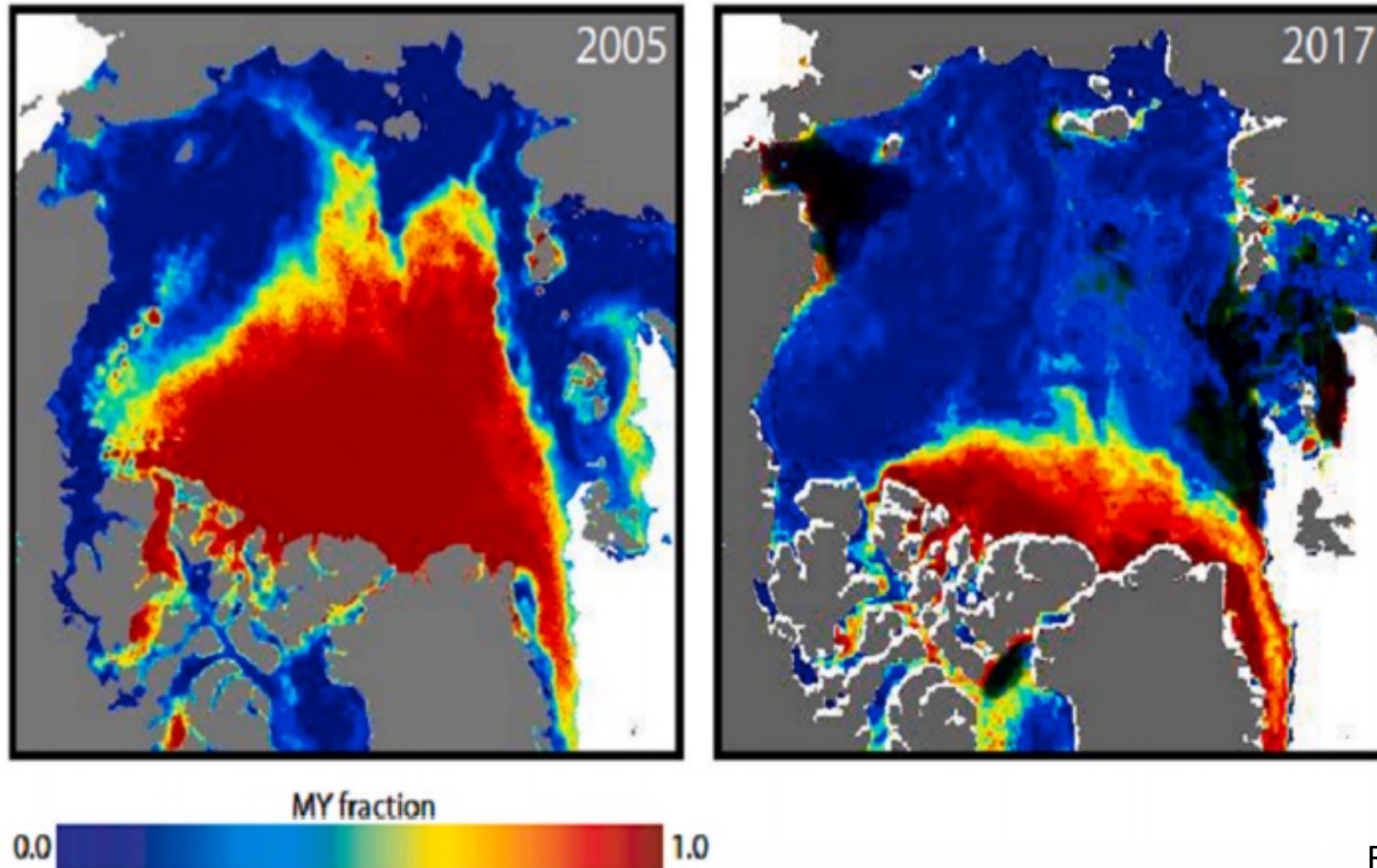


# UNUSUAL OR UNEXPECTED ARCTIC EVENTS (2017-2022)

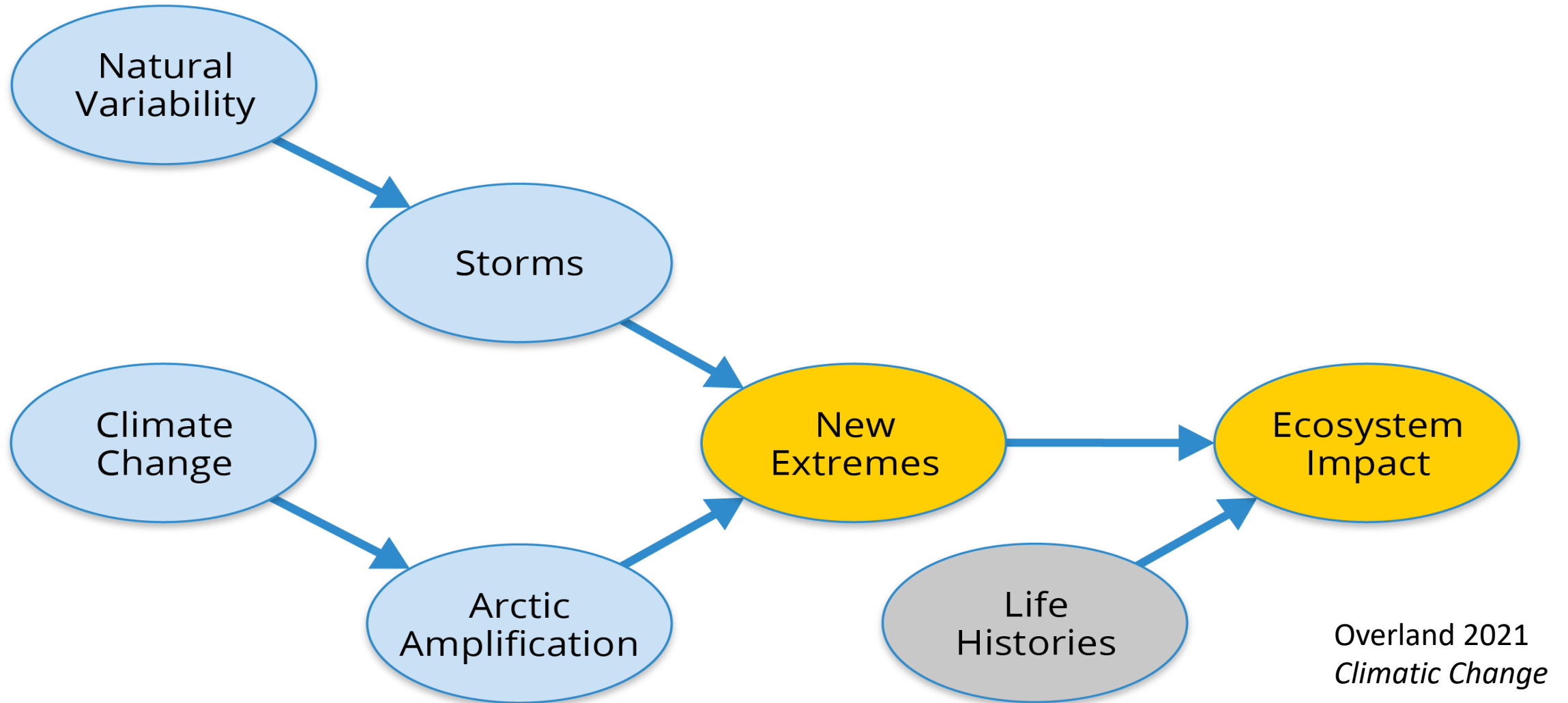


Data: from Local Environmental Observer (LEO) Network; based on knowledge and observations of the individual

# Sea Ice Volume Loss: 70 % More responsive to Storms; Non-Linear



# Conceptual Model of causal network for new ecosystem impacts from extremes





A wide-angle photograph of a winter landscape. The foreground and middle ground are filled with numerous trees heavily laden with snow, their branches creating a complex, white web. The ground is a smooth, undisturbed expanse of white snow. In the background, rolling hills or low mountains are visible, their peaks and slopes also covered in snow. The sky is a clear, pale blue, and the overall lighting suggests a bright, sunny day, with some areas of the snow appearing slightly yellowed or illuminated by a low sun.

## THREE TAKE-AWAYS

- Multiple extreme events in the Arctic at or beyond previous records, often record-shattering
- Radical uncertainty concerns events whose determinants are insufficiently understood for forecasting (*hint: Use Scenarios*)
- Normal range of weather combines with Arctic Amplification (*Temperatures, Sea ice and Permafrost thaw*) to cause extremes



# The 2020 Siberian heat wave January-June

Wildfire

Permafrost thaw

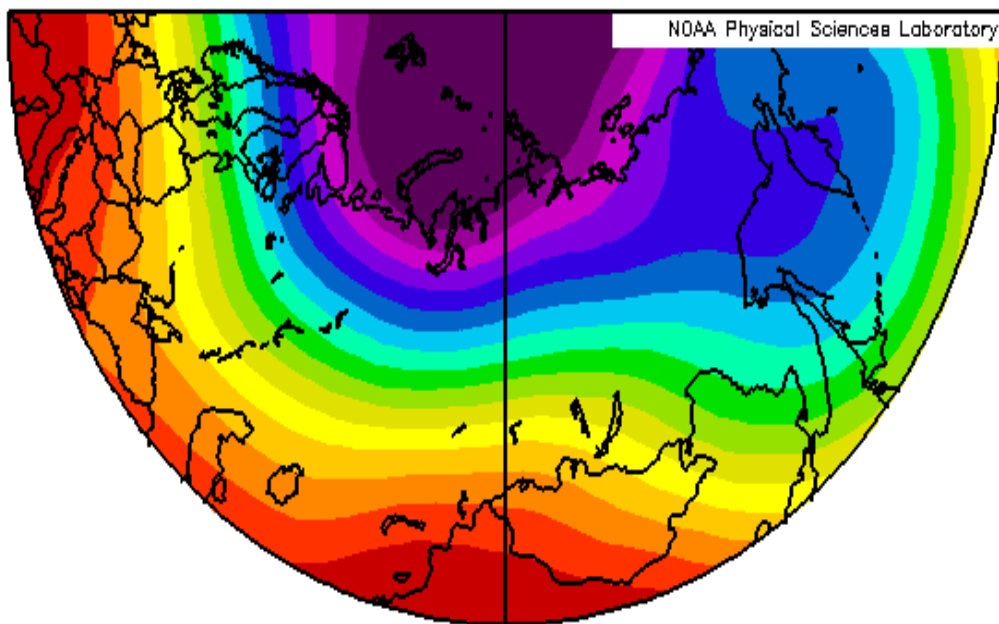
Delayed sea ice freeze-up



# Jet stream Polar vortex anomaly

## Jan-April 2020

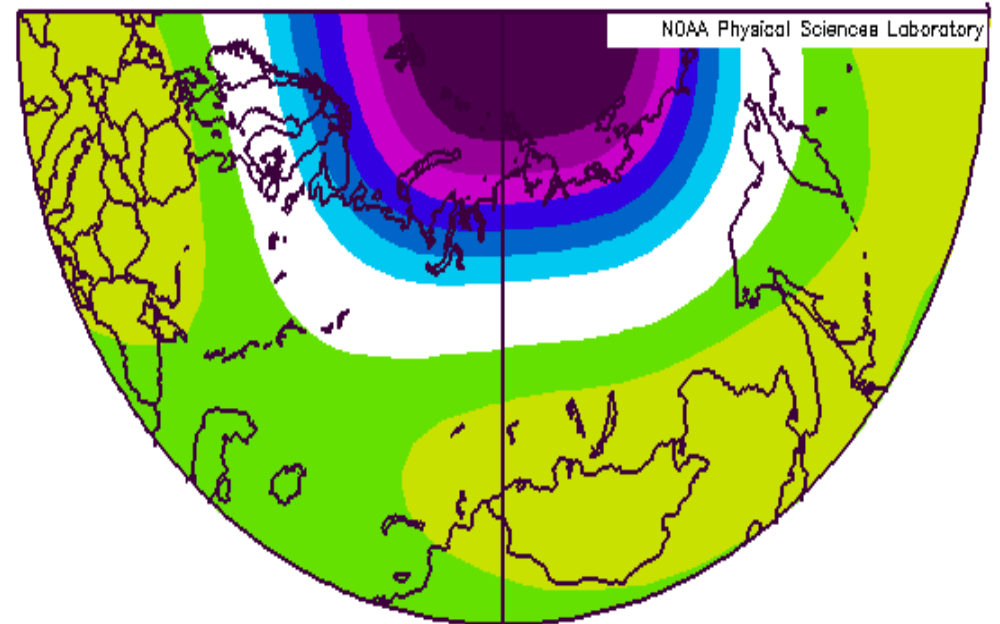
NCEP/NCAR Reanalysis  
700mb Geopotential Height (m) Composite Mean



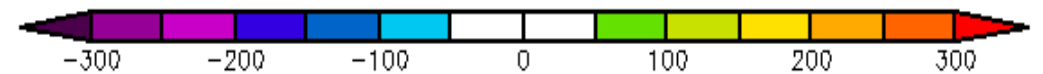
Jan to Apr: 2020



NCEP/NCAR Reanalysis  
100mb Geopotential Height (m) Composite Anomaly 1981–2010 climo



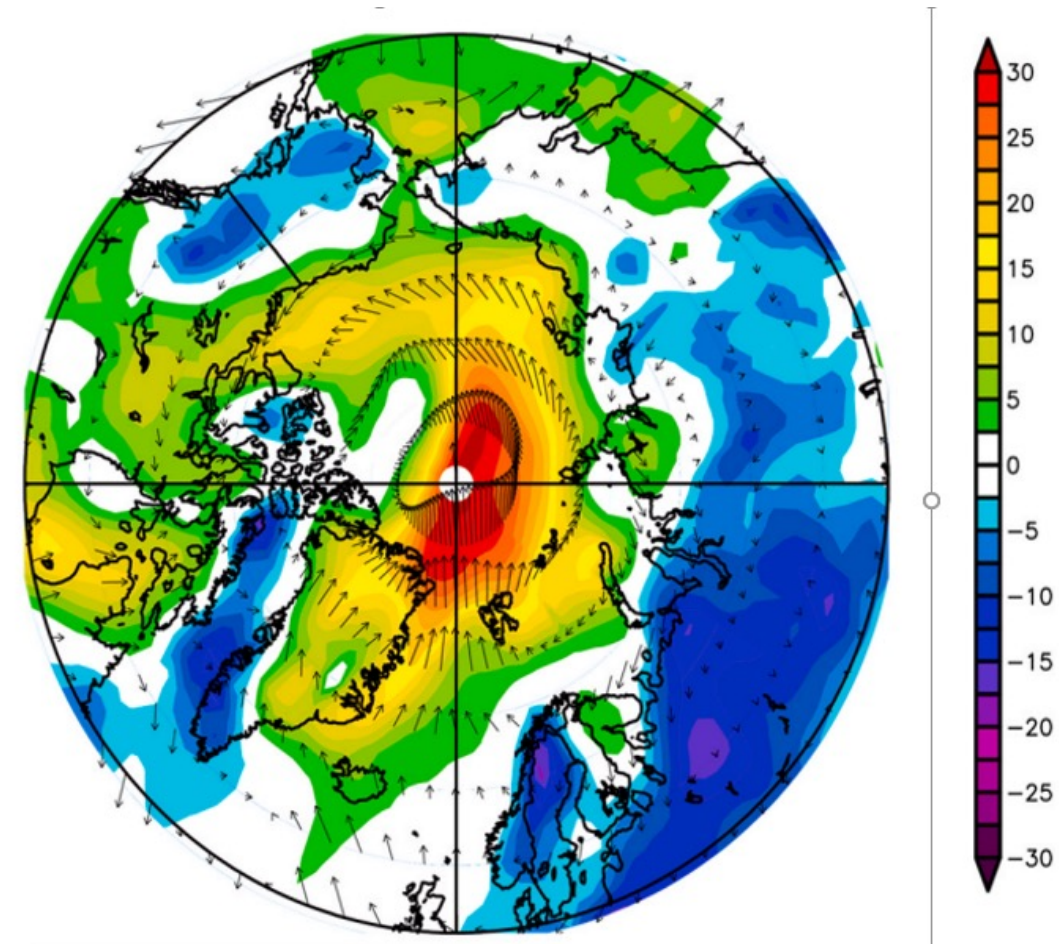
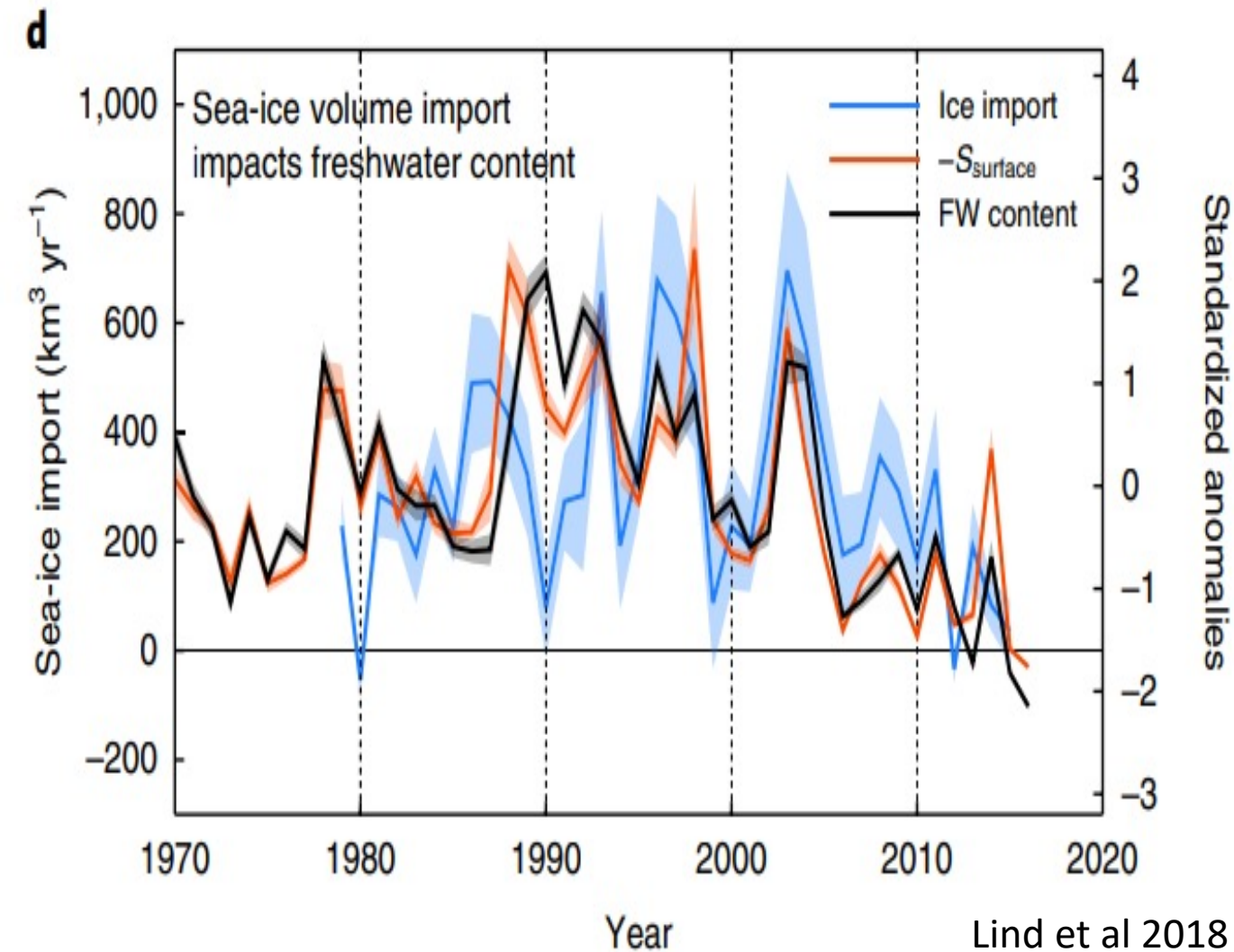
Jan to Apr: 2020





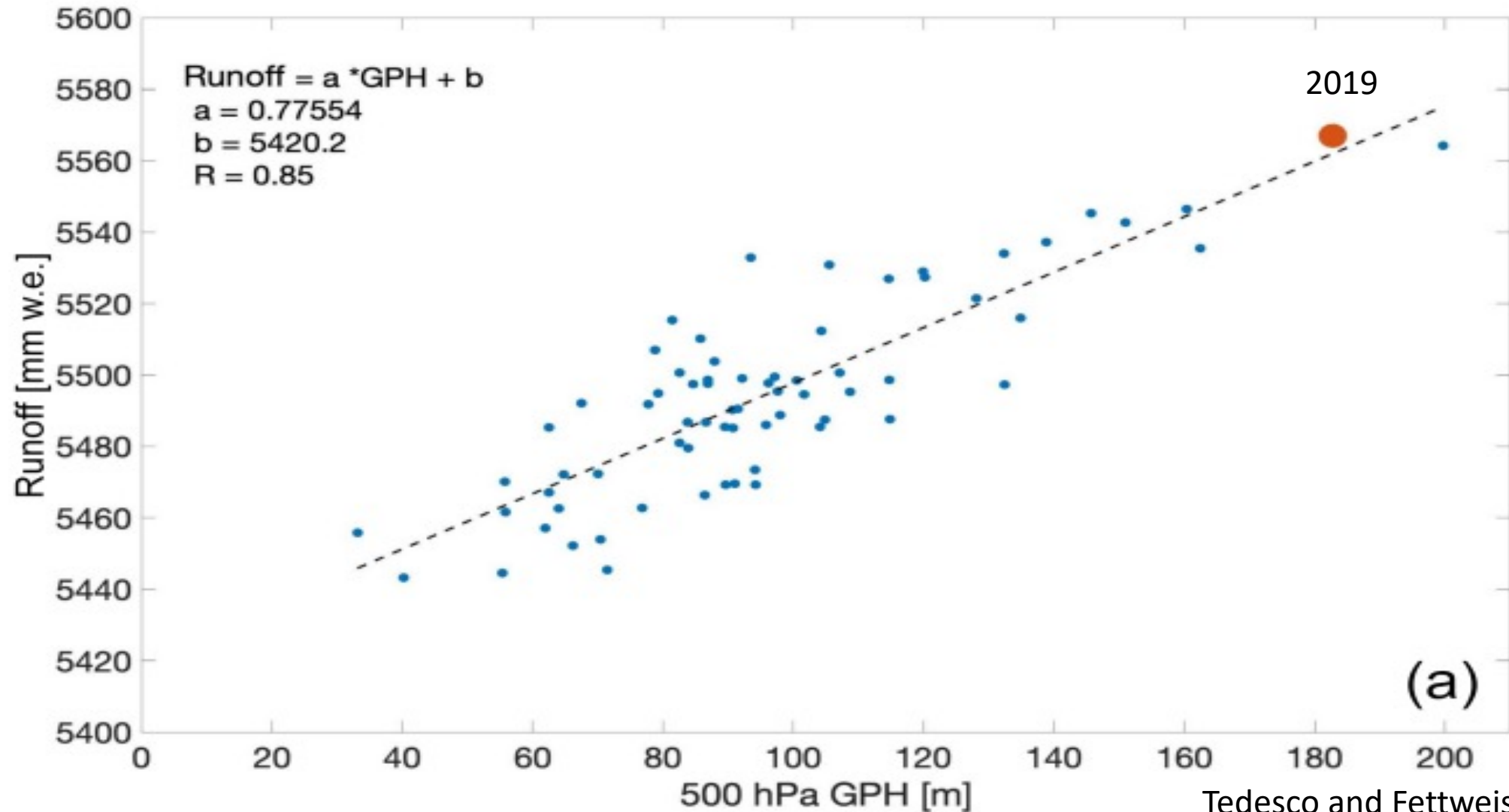
# Barents Sea Atlantification

25 Feb 2018



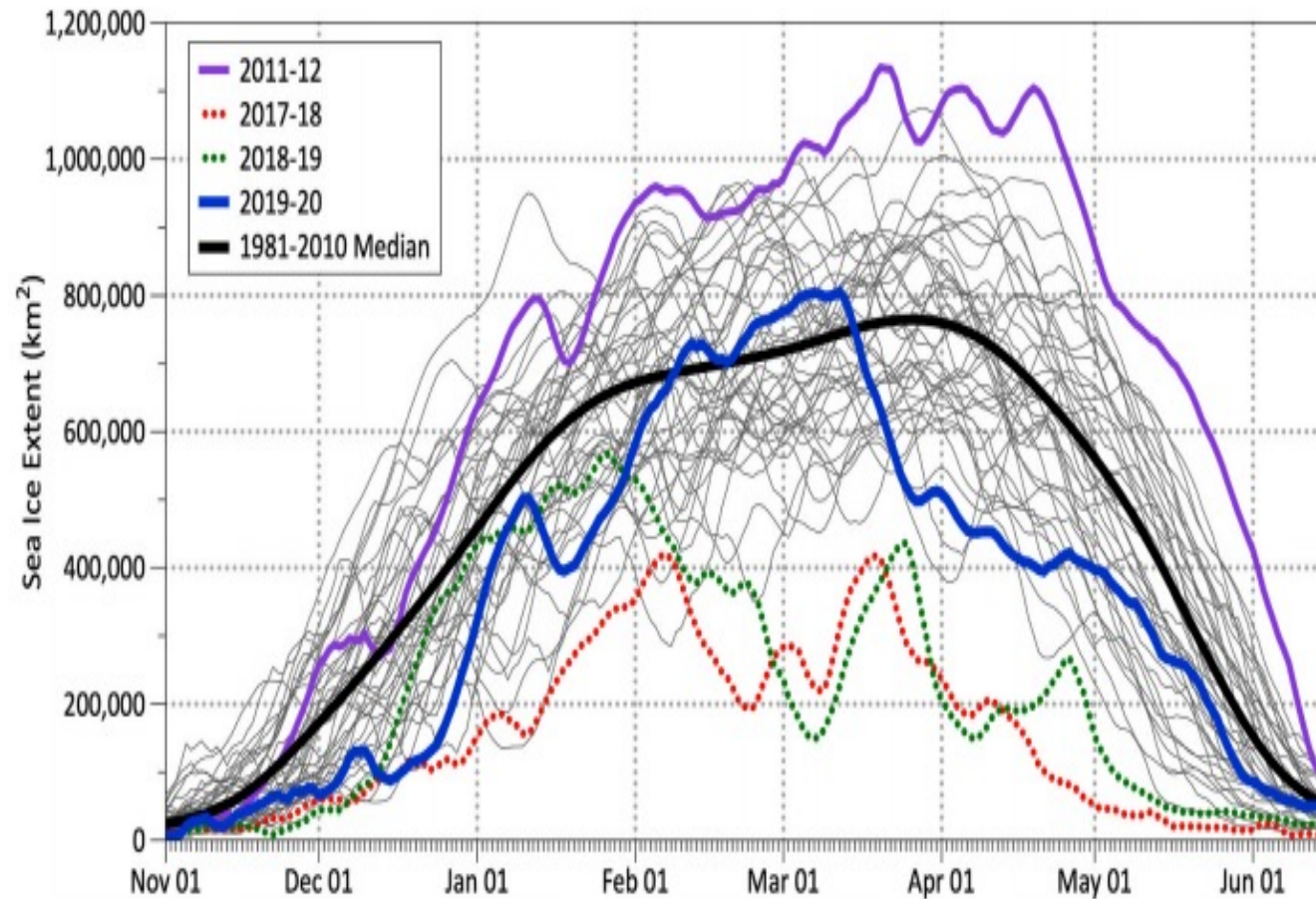


# Greenland: Weather Causal Connection





# Bering Sea Winter 2018 & 2019



Sea ice

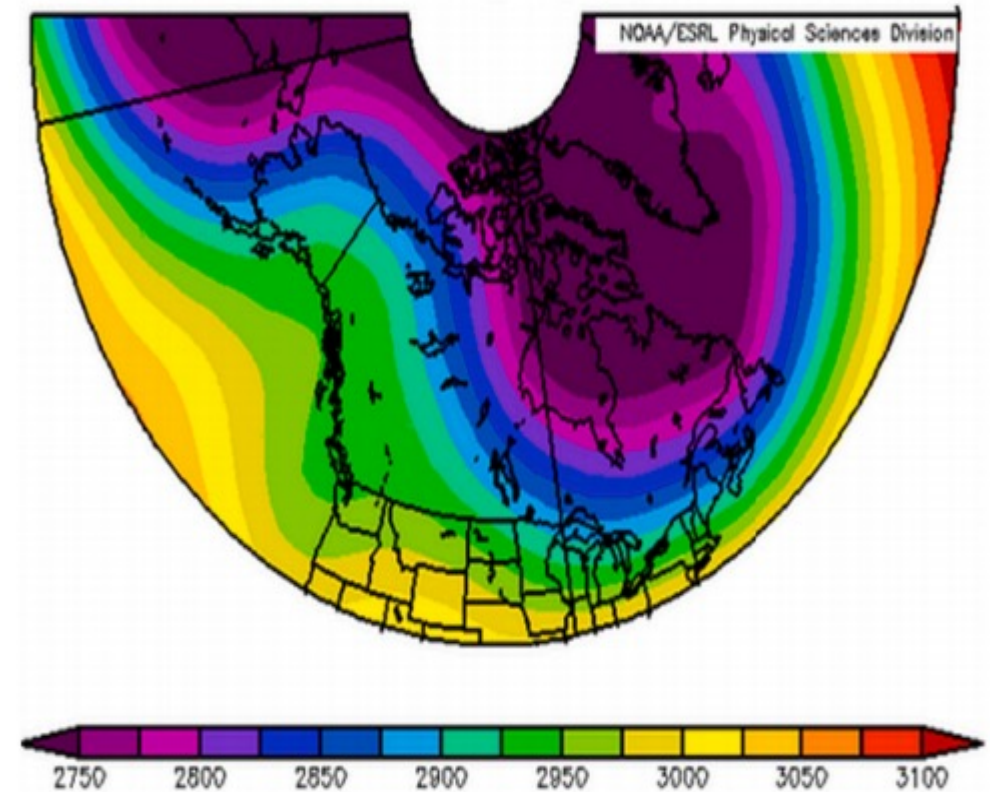
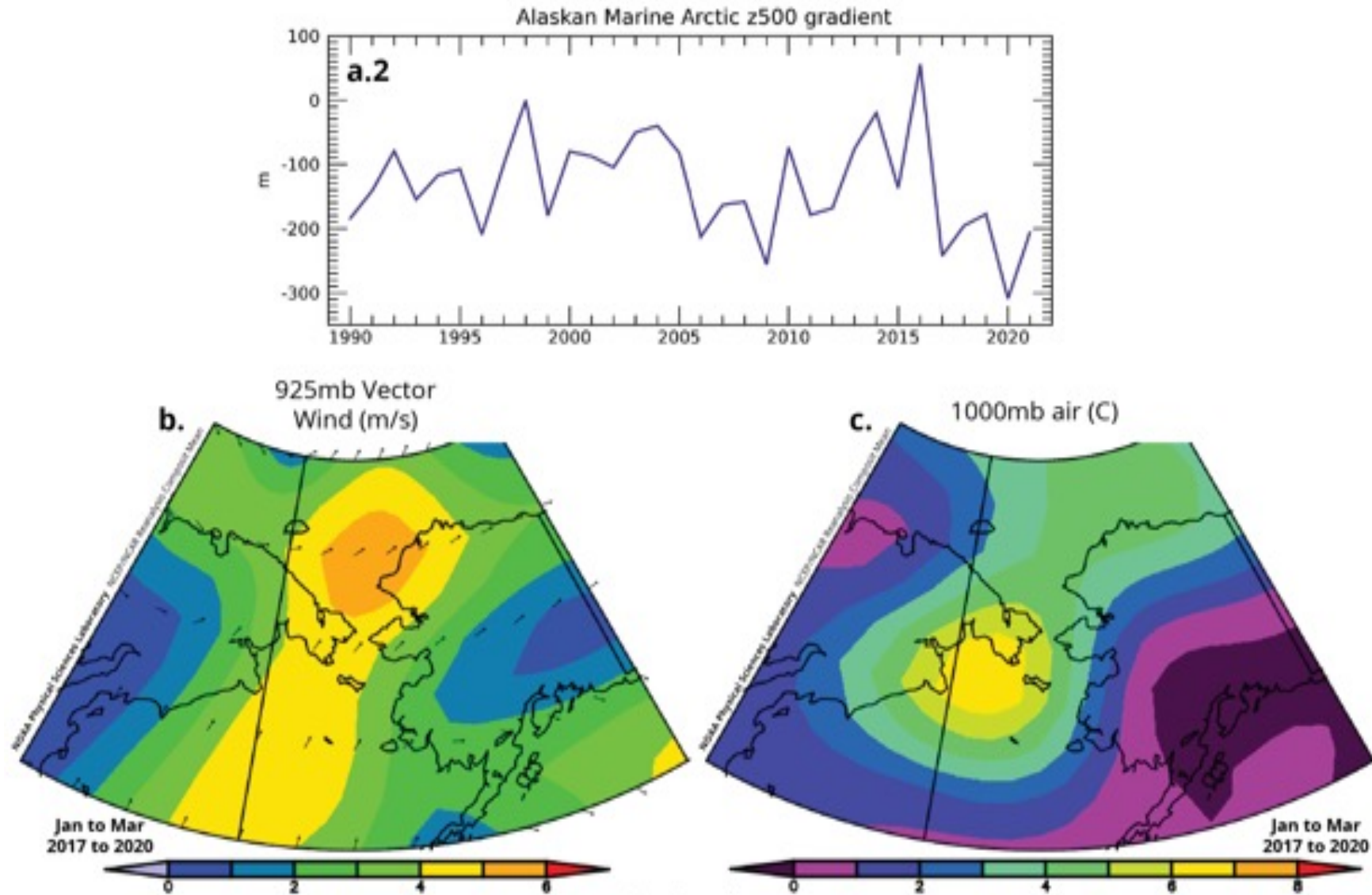


Fig. 4. 700 mb geopotential height for February–March 2019 showing a wavy jet stream (purple/blue) that supported southerly winds and no sea ice growth



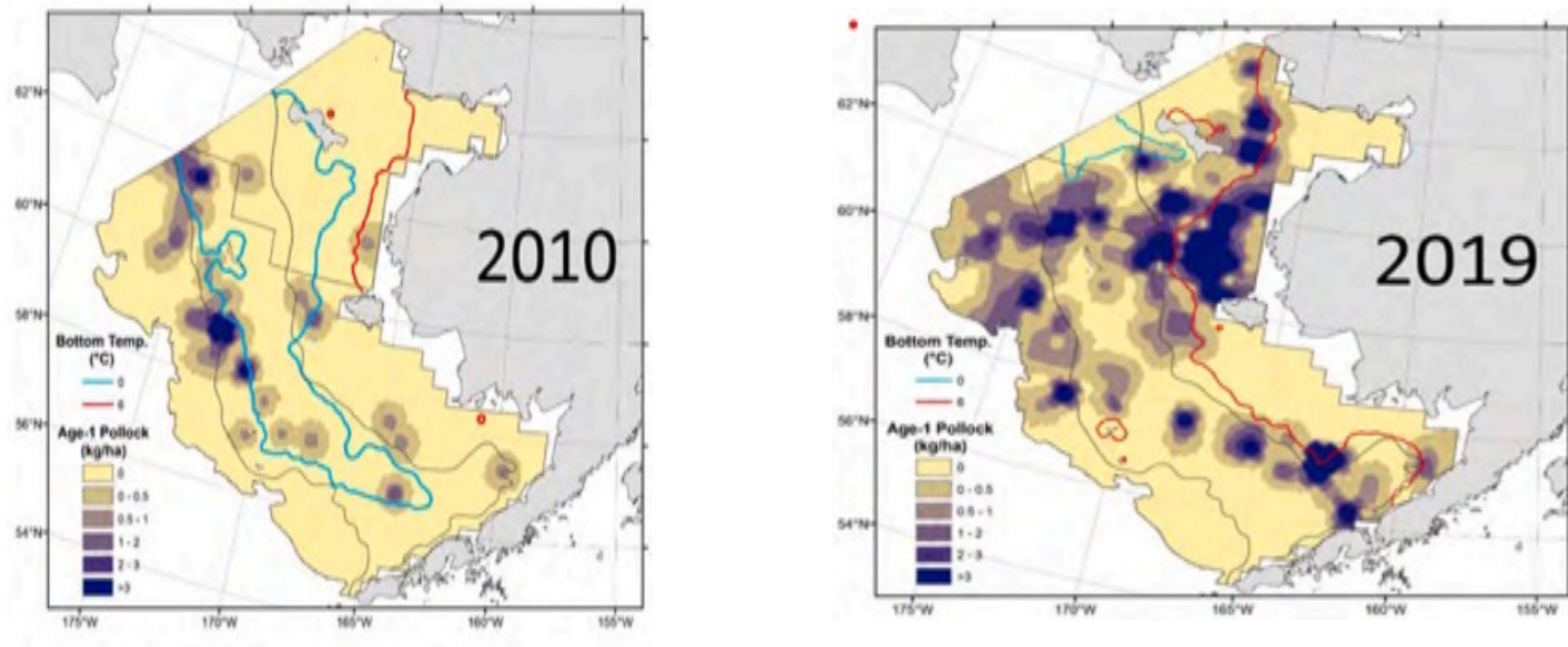
# Weak Arctic Front Continuing





# Pollock, Cod move to North Bering in 2018 & 2019

## Lack of food in South (Euphausiids), Ice seal Mortality



Eisner et al. 2020

Adult Cod and Pollock are top down Predators

Eleven major community impacts through 2021

Arctic change is faster than models;  
Less resistance to change;  
The Arctic is in a period of  
Radical Uncertainty

Events well beyond previous records

Extremes tied to weather events

*Events vary by type, timing and location:*

Events(*i*)

\*Greenland ice mass loss;

\*Sea ice is thin and more mobile;

\*Permafrost thaw; \*wildfires;

Fractal?

\**Ecosystem reorganization;*

\*Asian cold events

Non-linear

Extreme Impacts =  $\Pi$

Cascade

Cumulative Changes are





# Factor Analysis of Arctic Amplification

## AO not selected

