SEARCH Update

ARCSS AHW
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SEARCH

- The Arctic is in the midst of a major change involving Atmosphere, Ocean, and Land.
- Impacts on the ecosystem and society
- The Arctic change is connected to changes in the atmospheric circulation of the Northern Hemisphere and global climate.
- Future course is unknown
- Requires long-term program of observations, analysis, modeling, integration and application to society's response.

A Changing Arctic

Unaami

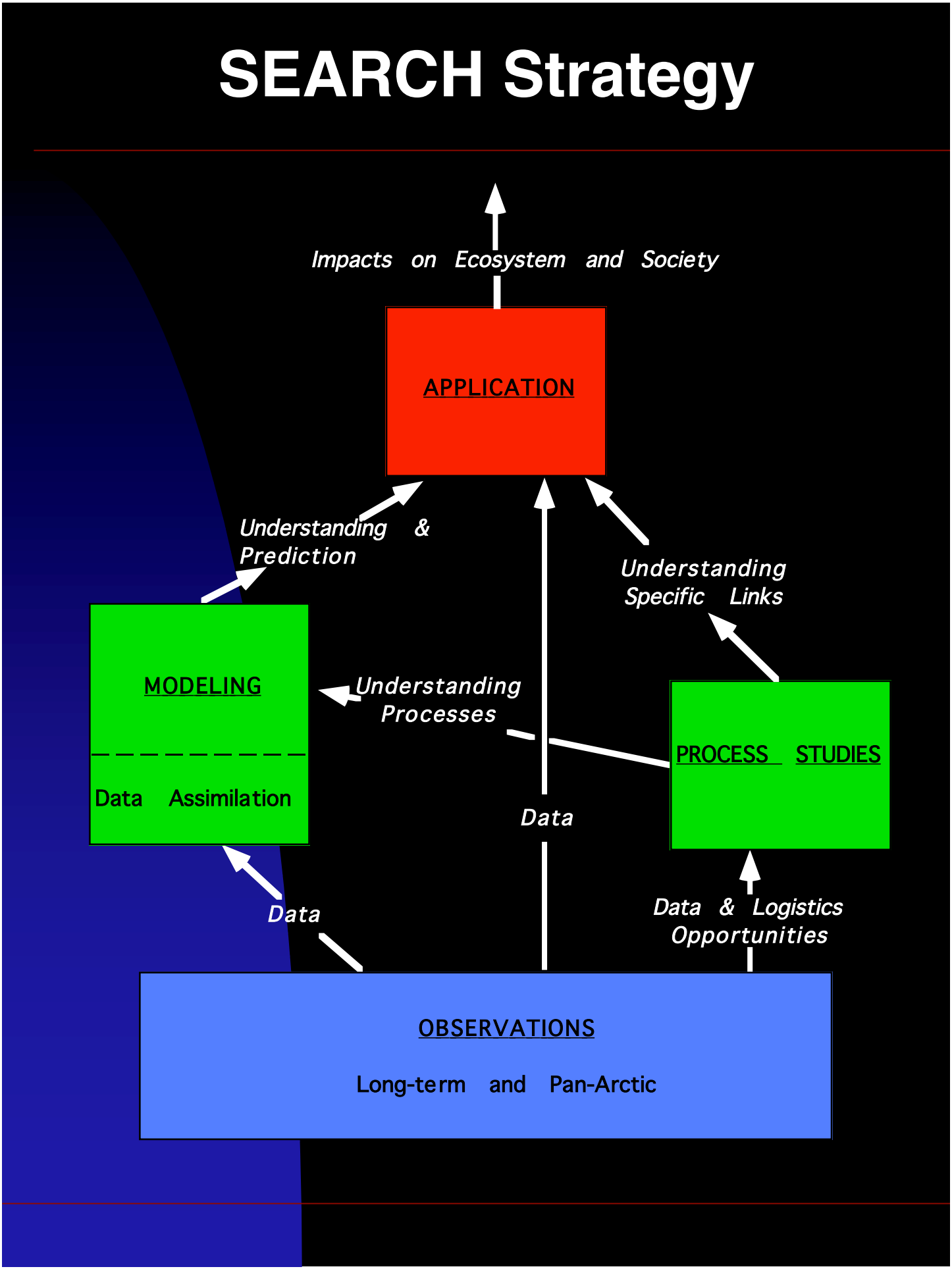
- The complex of changes that have dominated the Arctic in the last 2 decades

- Unaami characterized by among other things:
  - Drop in Arctic atmospheric pressure
  - Increased SAT in N. Europe & Russian Arctic
  - Cyclonic ocean circulation, rising coastal sea level
  - Increased Atlantic water temperature
  - Decreased ice cover
  - Decreased Beaufort Sea salinity

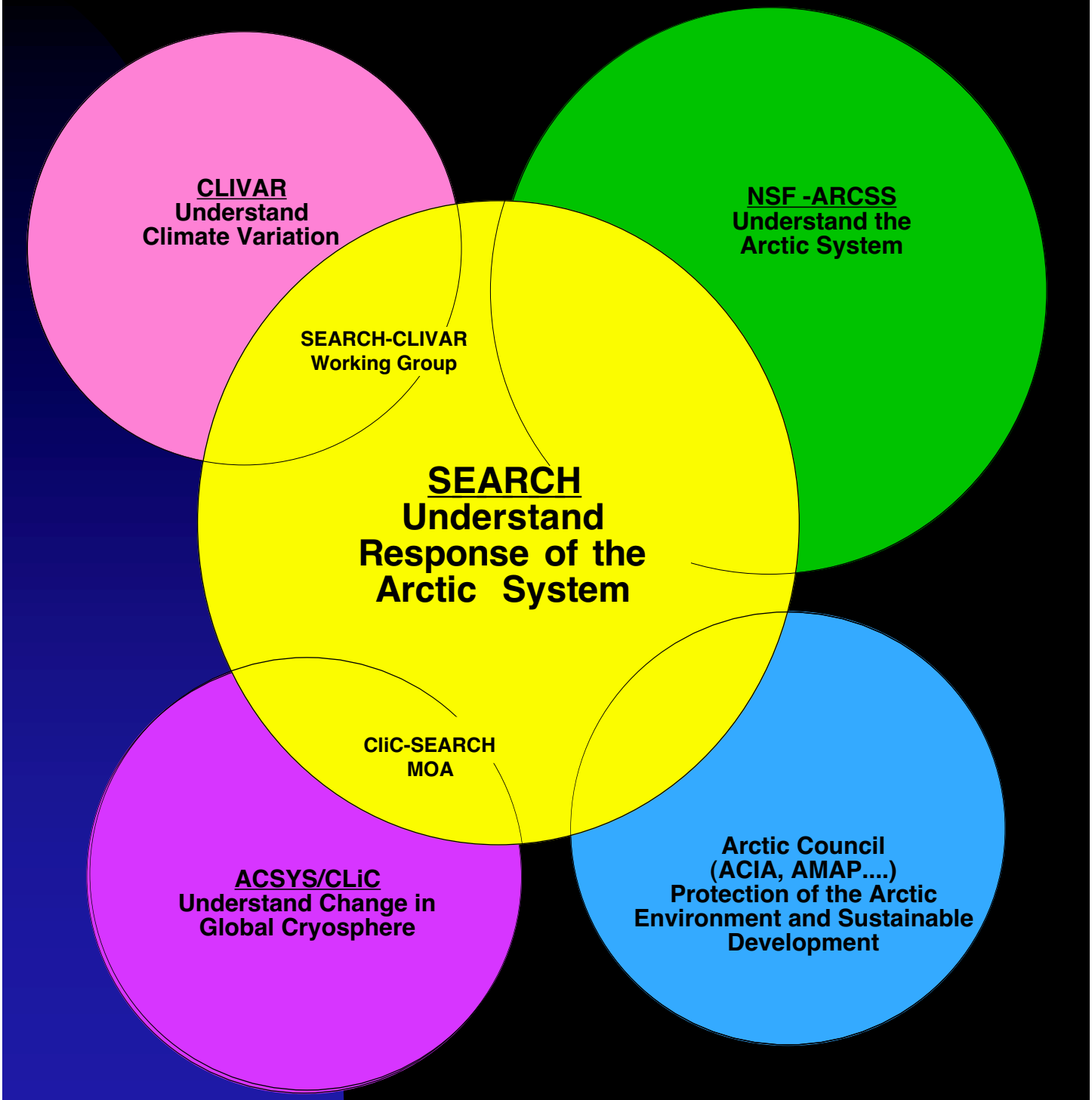
- From the Yup'ik word meaning tomorrow, synonymous with change for Arctic residents - transportation, food gathering, quality of life

- The "El Nino of the North"

SEARCH Strategy



SEARCH and Other Programs



Recent SEARCH Developments

- Science Plan published Summer 2001:
  http://psc.apl.washington.edu/search/ index.html
- IWG Completes 2003 Funding Implementation Framework and IARPC submits to OMB Sept 2001
- SSC & IWG developing bridging Science Implementation Strategy:

  A) Questions, Priorities, Organization
  B) Terms of Reference
  C) Implementation Plan Skeleton
- Arctic and Sub-arctic Ocean Flux (ASOF) Workshop
- Atmospheric and Cryospheric Change in the Arctic (ACCA) Workshop
- First SEARCH AO :
  Arctic Freshwater Cycle: Land/Upper-Ocean Linkages

SEARCH Tasks
&
Modes of Variability

- Outreach activities to educate about SEARCH
- Refine implementation in areas such as:
  - Marine Ecosystem
  - Terrestrial Ecosystem
  - Arctic Ocean and Sea Ice
  - Societal Impacts and Application
- <u>Modes of variability are important to implementation:</u>

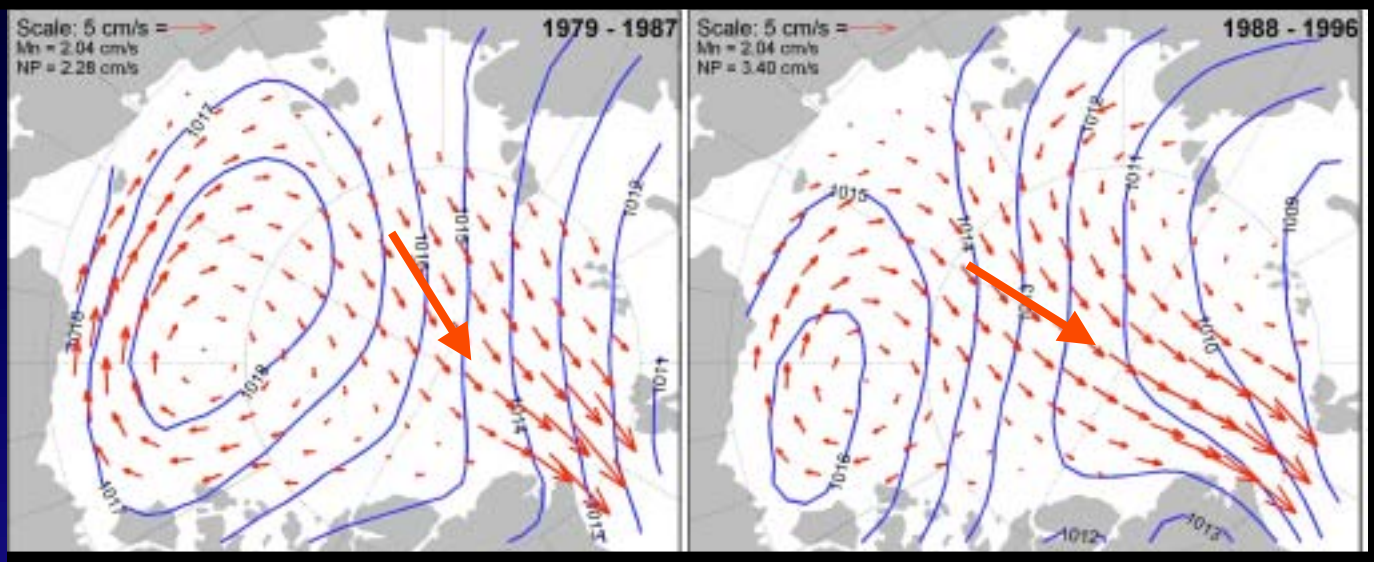
✈ Learning modes of variability helps our understanding of the system

✈ Extreme modal response (Unaami) reveals internal dynamics

✈ Key to intelligent sampling decisions

Ice and Atmospheric Pressure Changes

Surface Atmospheric Pressure (contours) and Ice Velocity (arrows) Averaged 1979-87 and 1988-96



Steele & Boyd (1998)

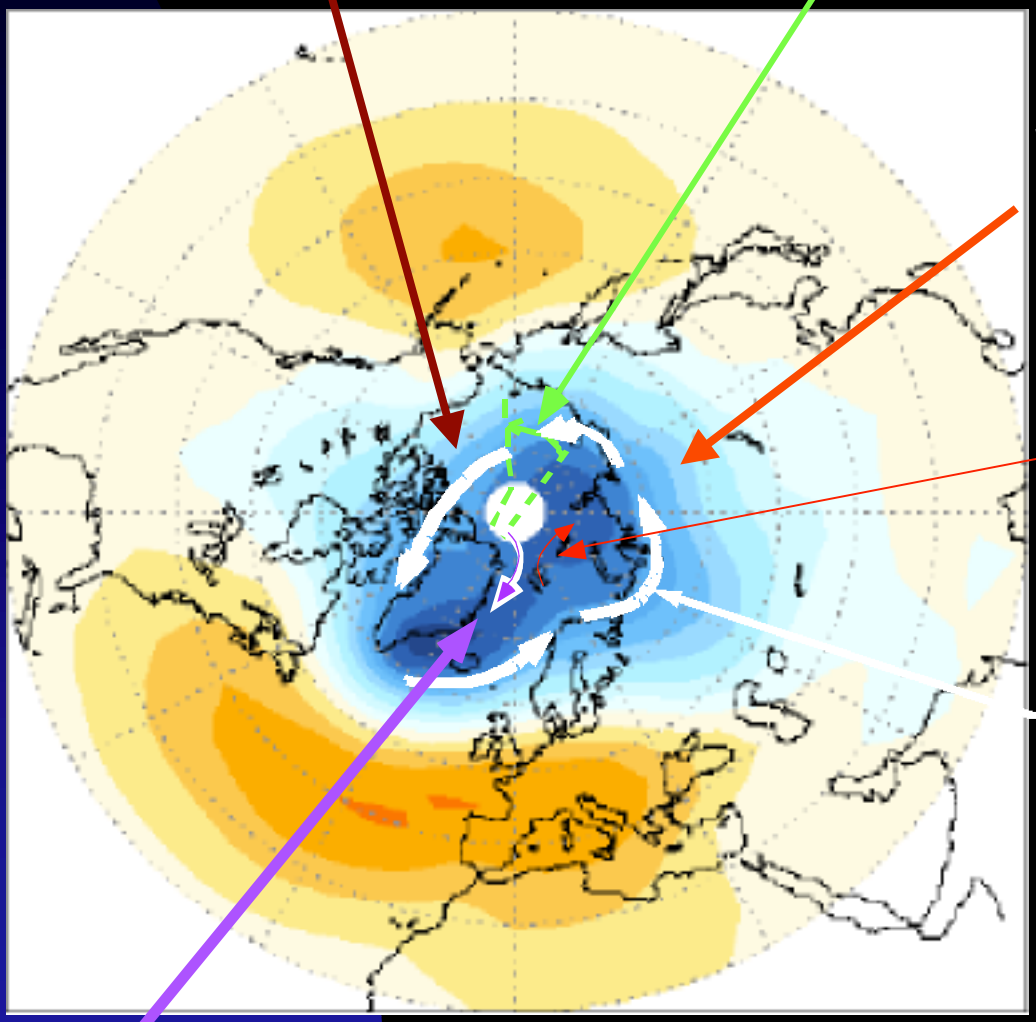
- Beaufort High decreased and shifted east in 1990s
- Transpolar Drift of ice shifted axis counterclockwise producing a more cyclonic motion in 1990s
- Ice extent decreased 3% per decade
- ICE THICKNESS DECREASED 42% in last 30 years

(Comparison of submarine data, Rothrock et al, 1999)

Connection to Global Climate

Increase in Polar Vortex
- Weakens Beaufort High
- Increases open water
- Decreases Albedo
- Increases radiative heating & melt
- Freshens upper Beaufort Sea

Increase in Polar Vortex
- More cyclonic ocean circulation
- Shift in front and Transpolar Drift
- Russian shelf water to Beaufort



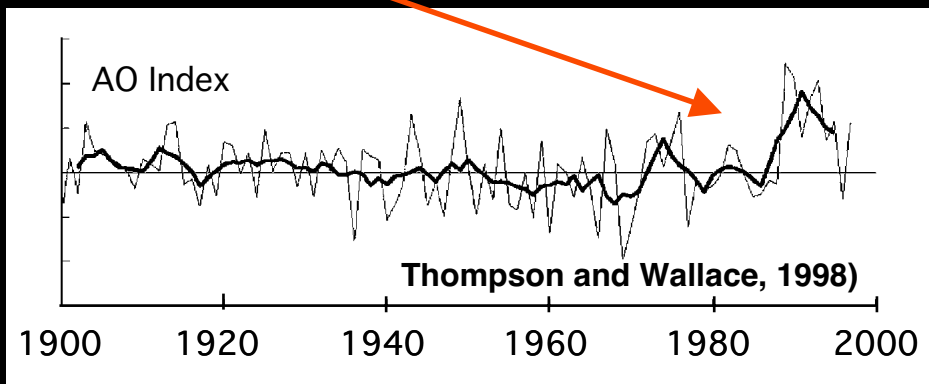
Warm air advection
- increases SAT
- warms permafrost

Warm air over Greenland Sea allows warmer Atlantic Water in Arctic Ocean

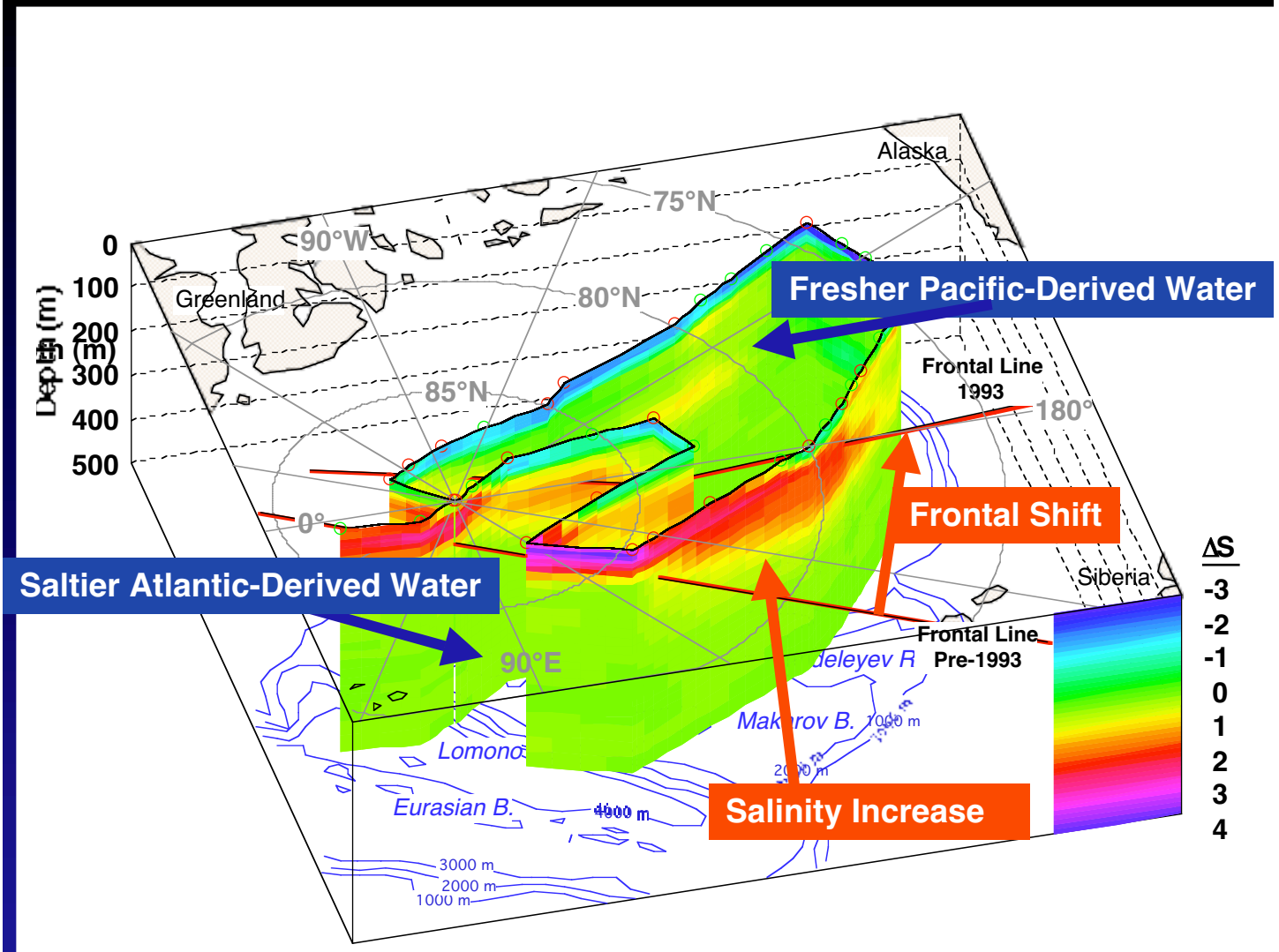
Low pressure spins up Polar Vortex, brings warm air to Greenland Sea and Russian Arctic

Cyclonic Circulation
- Increases export of fresh water
- Increases stratification in Greenland and Labrador seas
- Inhibits global ocean overturning

Rising AO means lowers atmospheric pressure over the Arctic.



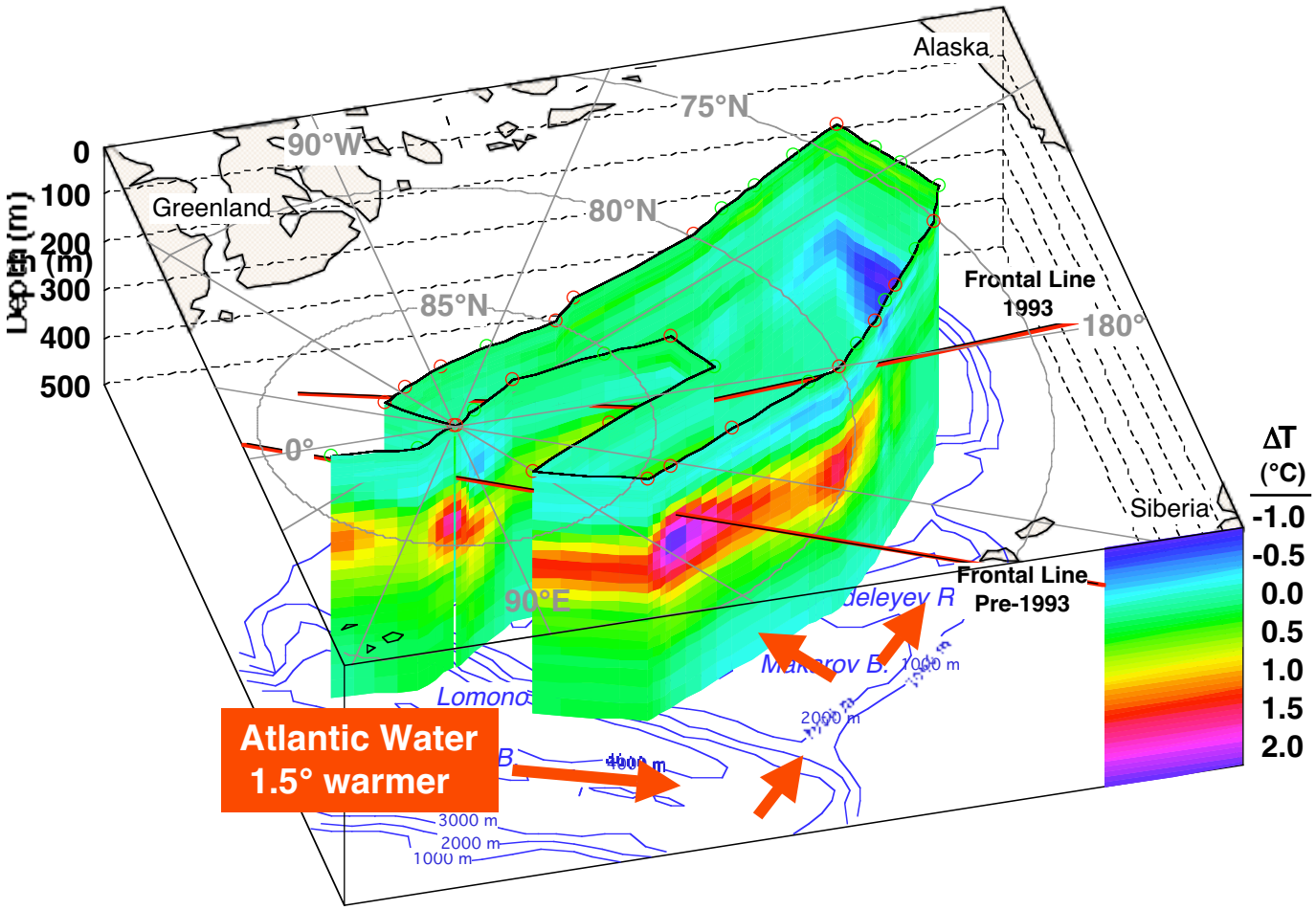
Ocean Changes
Salinity Difference, Pargo '93 - Climatology



From Morison, J. H., K. Aagaard, and M. Steele, 2000, Recent Environmental Changes in the Arctic: A Review, *Arctic*, *53*, 4.

- **Shift in front between Atlantic and Pacific waters**
- **Salinity increase in the upper 200 m of the Makarov**
- **Surface salinity decrease in Beaufort Sea (SHEBA)**

Pargo '93 - Climatology
Early Indication of Change from ARC-Instigated 1993 SCICEX



From Morison, J. H., K. Aagaard, and M. Steele, 2000, Recent Environmental Changes in the Arctic: A Review, *Arctic*, *53*, 4.

- Appearance of warm cores over ridges
- Increase in Temperature maximum of over 1.5°
- Atlantic Water Temperature maximum is shallower

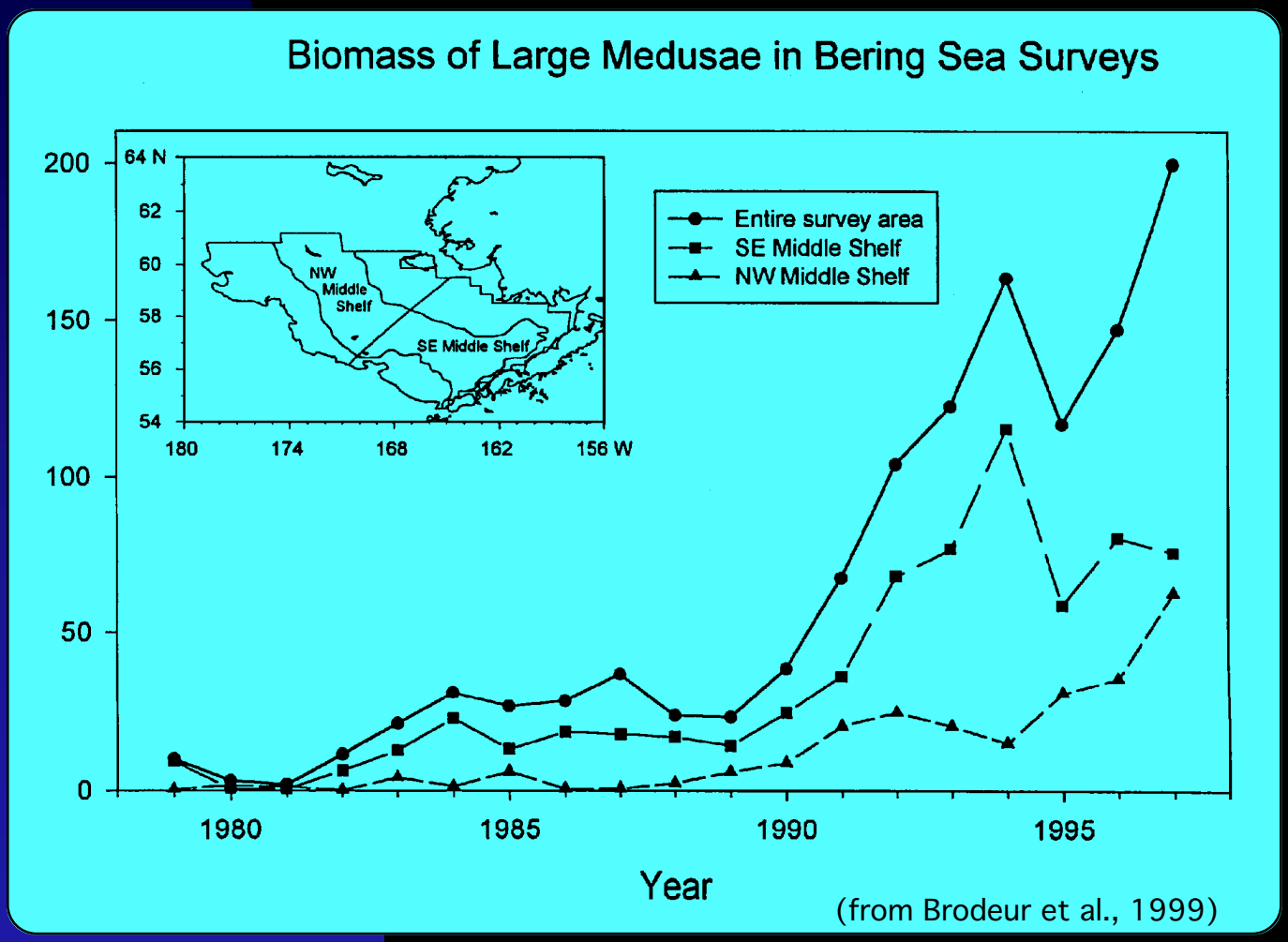
Modes of Variability Caveats

- Regime shifts likely involve the rise and combination of previously less interesting modes

  Keep some broad sampling in the mix

- Small perturbation in physical mode can create nonlinear change in other parts of the system

  (e.g., ecosystem):



- Modes of Variability still provide a useful paradigm.