THEME#4:
Are predicted changes in the arctic system detectable?

OAII Focus on:
Detecting Change(s) in the Arctic System

- Ocean (heat, salt/freshwater, other properties)
- Sea Ice (extent, thickness, drift, leads, polynyas)
- Atmosphere (SLP, SAT, precipitation, ozone layer, aerosols)

Main uncertainties: northward heat transport
sea ice thickness/volume
sea ice and freshwater export

Wieslaw Maslowski,
Naval Postgraduate School, Monterey, CA
ARCSS-All Hands Meeting, Seattle, WA, 02/20/2002

Arctic Oscillation Index

The Arctic Oscillation signature in the wintertime geopotential height and temperature fields

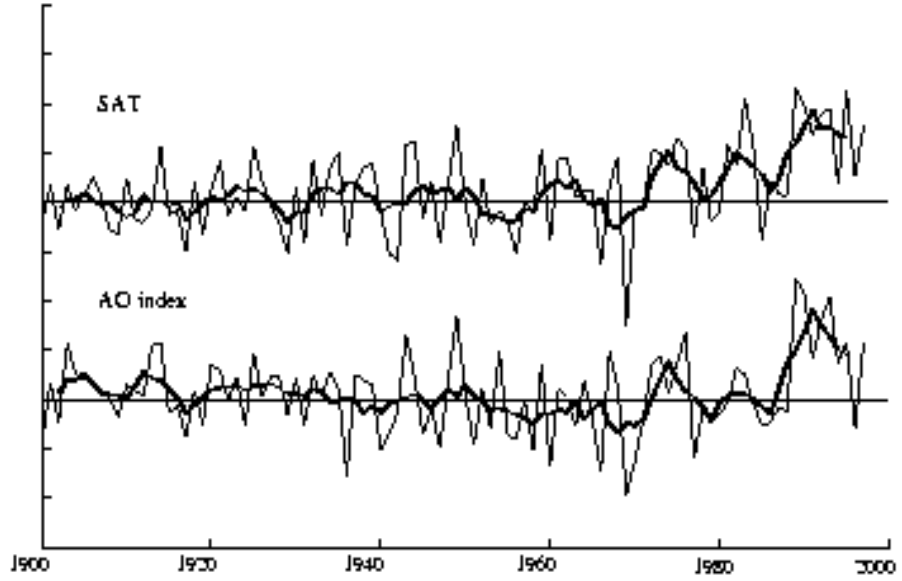
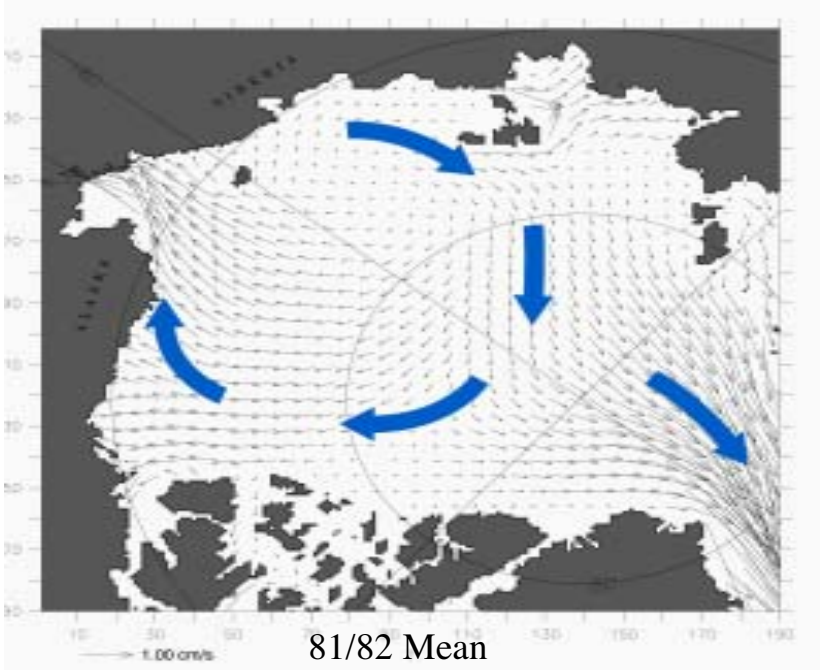


Figure 5. *Top to bottom*: Normalized wintertime expansion coefficient time series for the SAT and SLP regression maps of Fig. 1 for 1900-1997. The light lines denote unsmoothed seasonal averages ($r = 0.86$); heavy lines denote five-year running means.

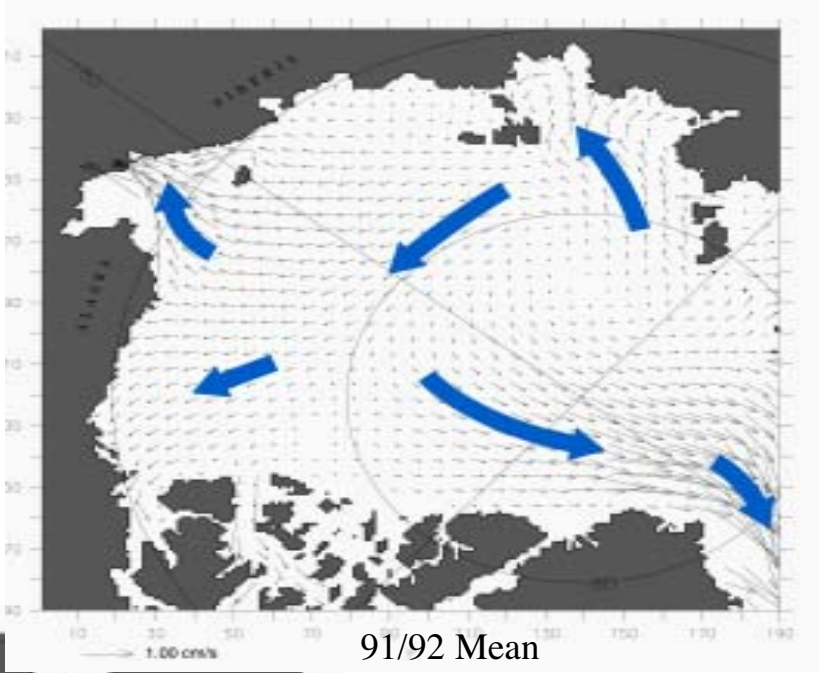
Thompson and Wallace, *1998*

Other 'players': North Atlantic Oscillation (NAO),
Pacific Decadal Oscillation (PDO), other?

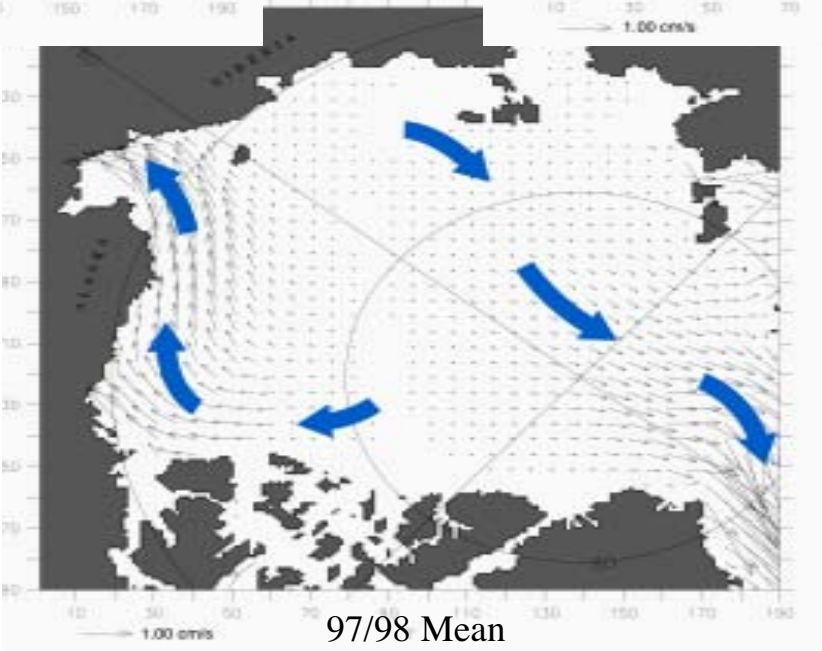
NPS Model Mean Sea Ice Drift



81/82 Mean



91/92 Mean

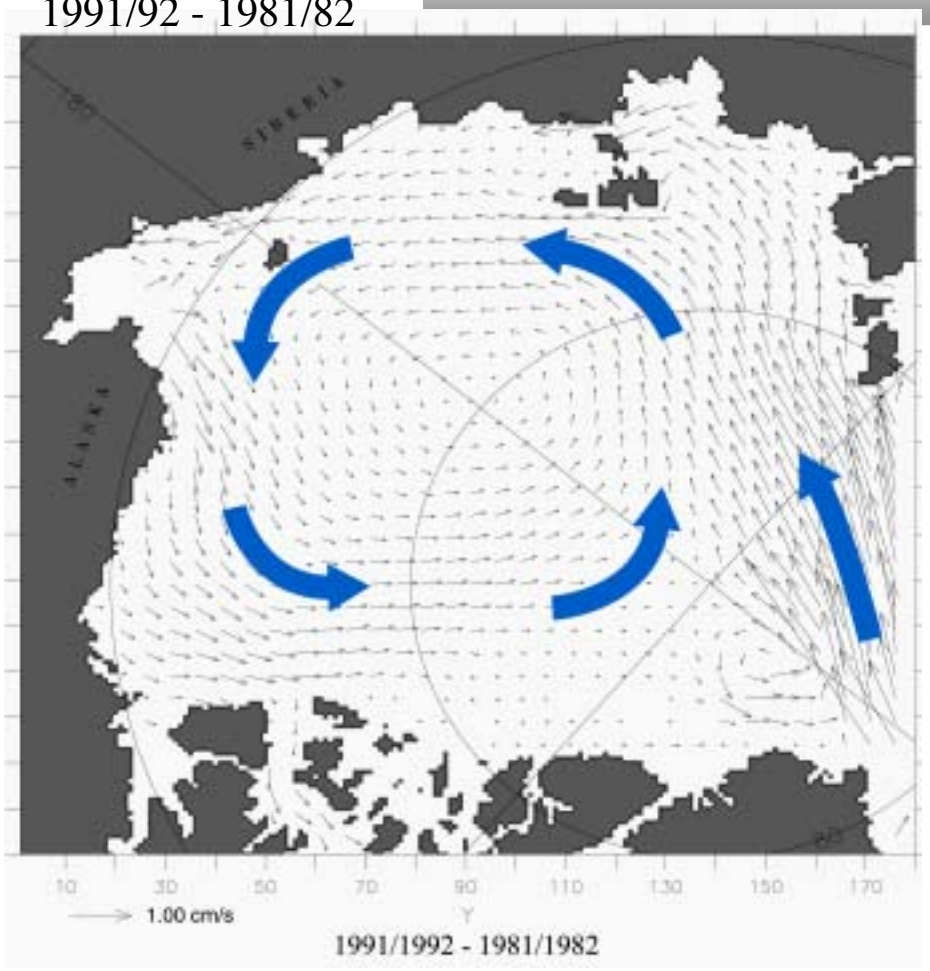


97/98 Mean

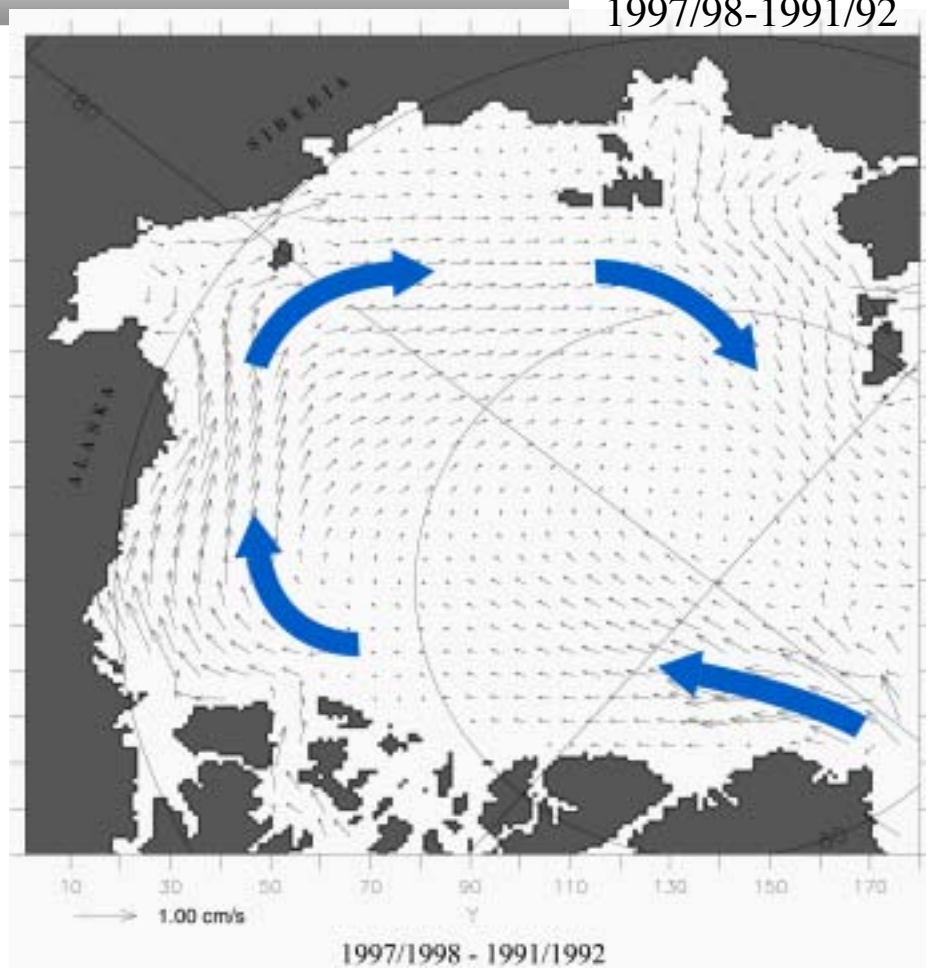
Maslowski et al., 2001.

Model Mean Sea Ice Drift Anomalies

1991/92 - 1981/82

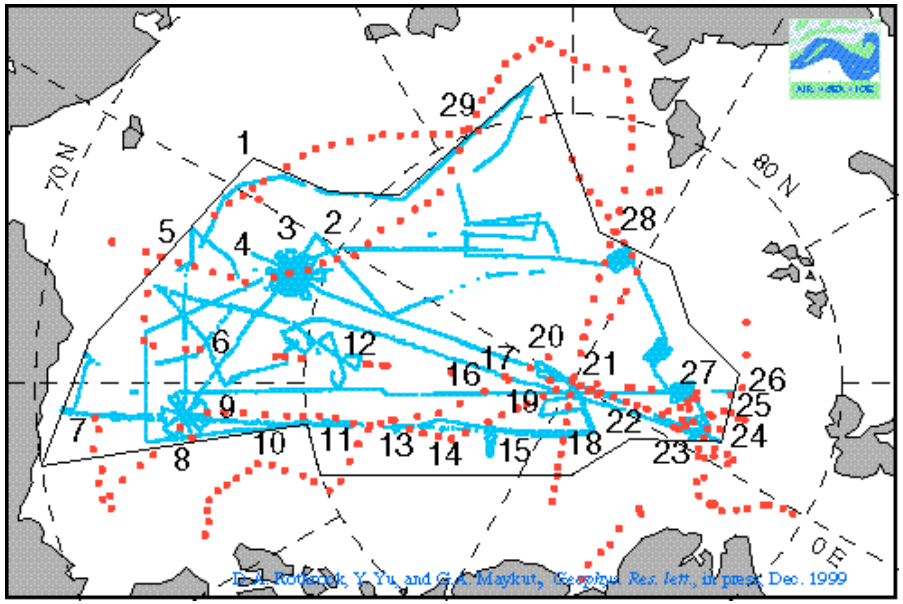


1997/98-1991/92

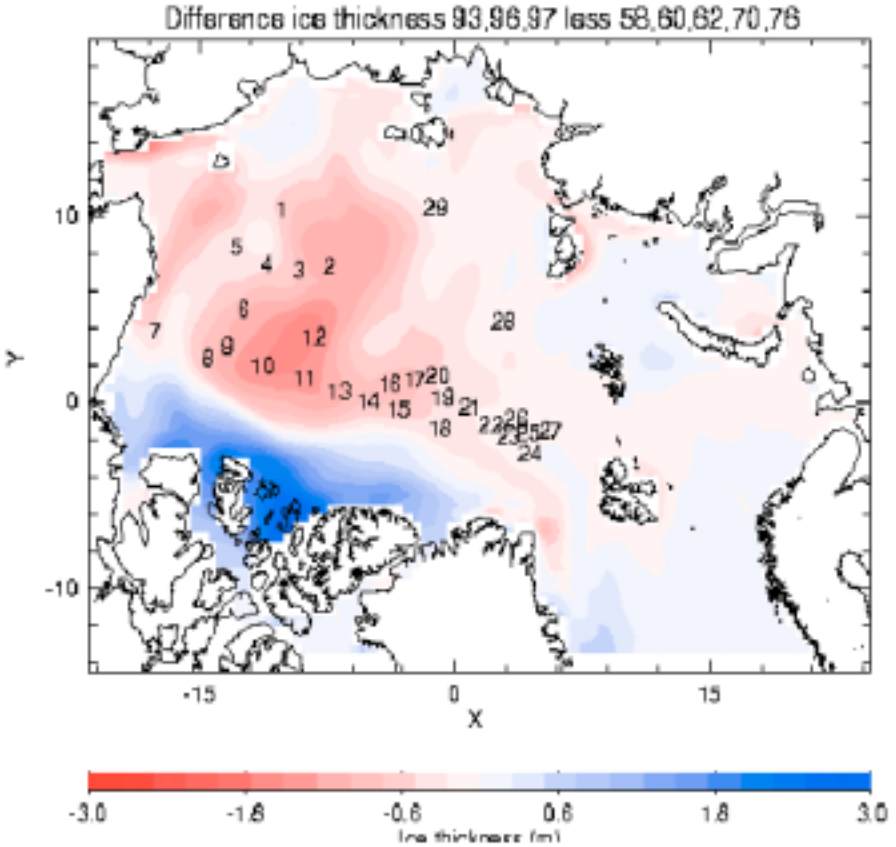


- Data collection through the International Arctic Buoy Program (IABP) should be continued!
- Remote sensing provides information on sea ice extent

Sea Ice thickness: thinning or re-distribution?



Rothrock et al., 1999

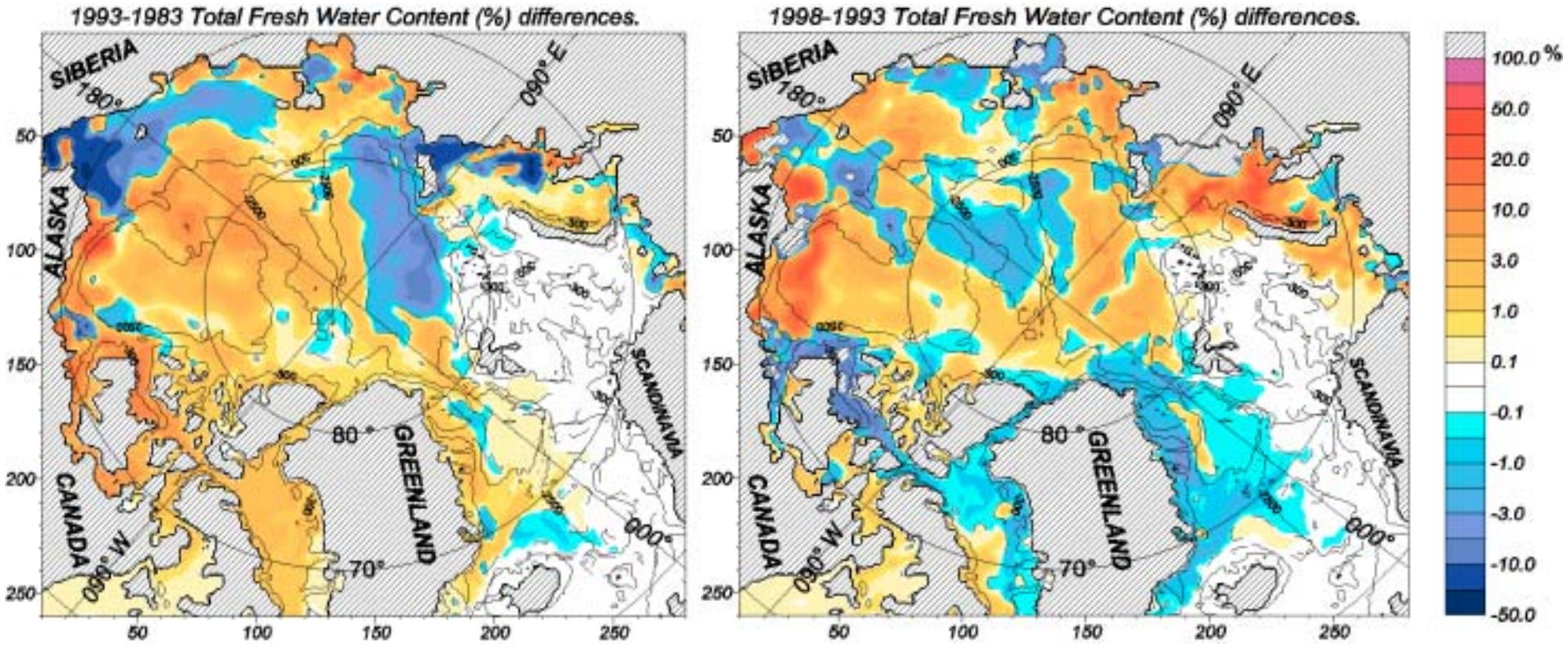


G. Holloway:

http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/jpod/projects/arc_thin/thin1.htm

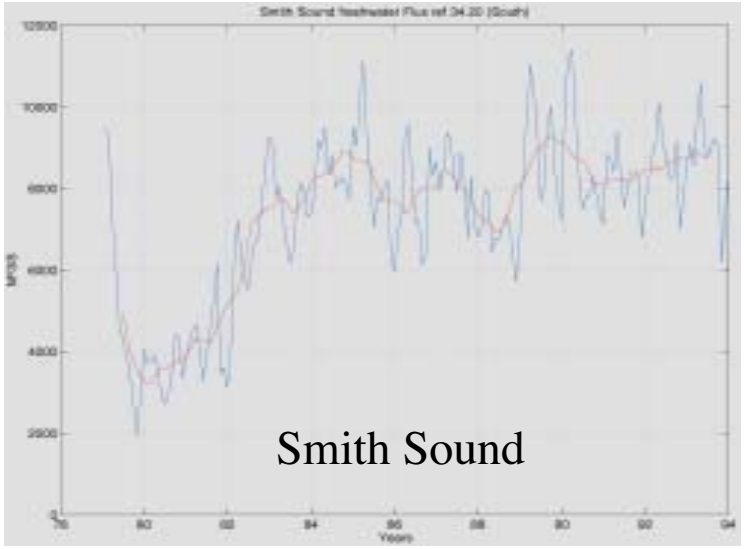
- Remote sensing (RGPS, ERS-1, ERS-2) provide some information on ice thickness but … use of submarines would be ideal

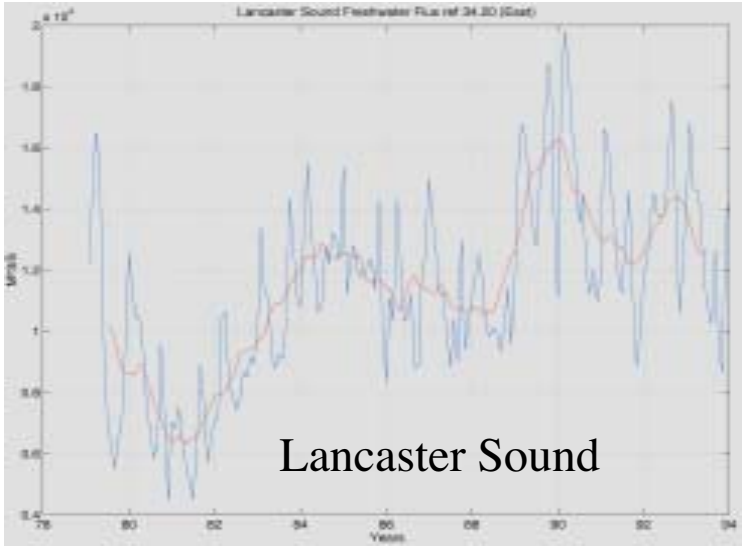
Modeled Total Fresh Water Tracer Anomaly Concentration (0-20m) in 1993-83 (left) and 1998-93 (right)

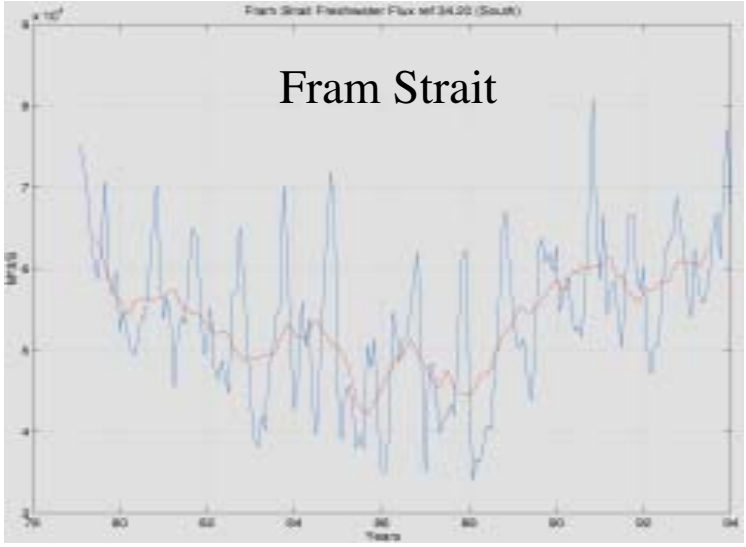


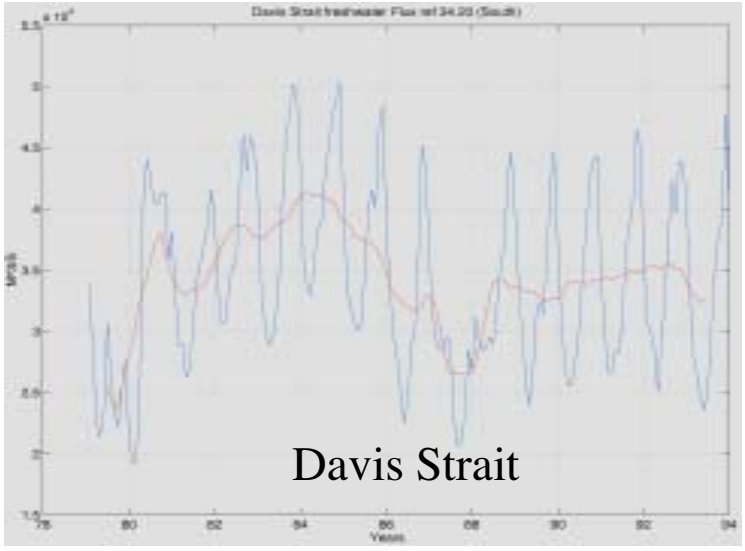
Oceanic freshwater export - the critical link between the pan-Arctic hydrologic cycle and global change! (to be addressed in Arctic-CHAMP, ASOF?)

Fresh Water Fluxes from the Arctic Ocean



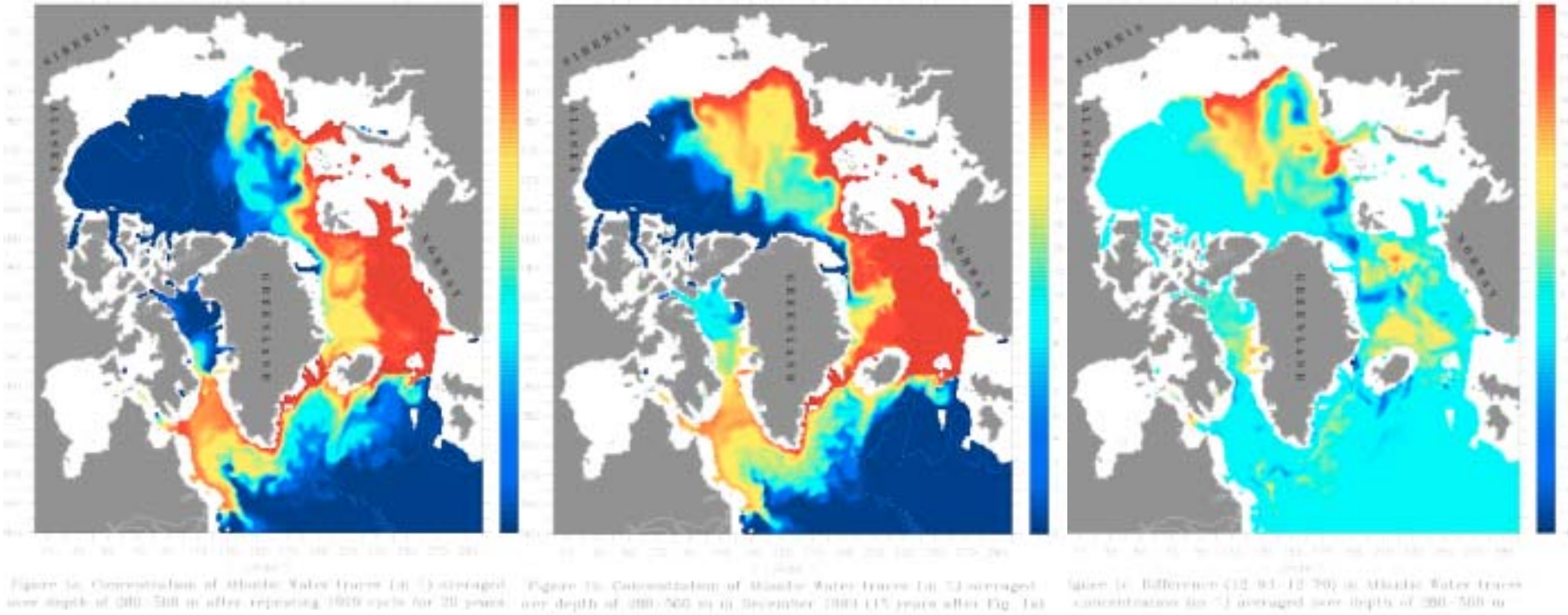






- temporal and spatial differences in detecting change

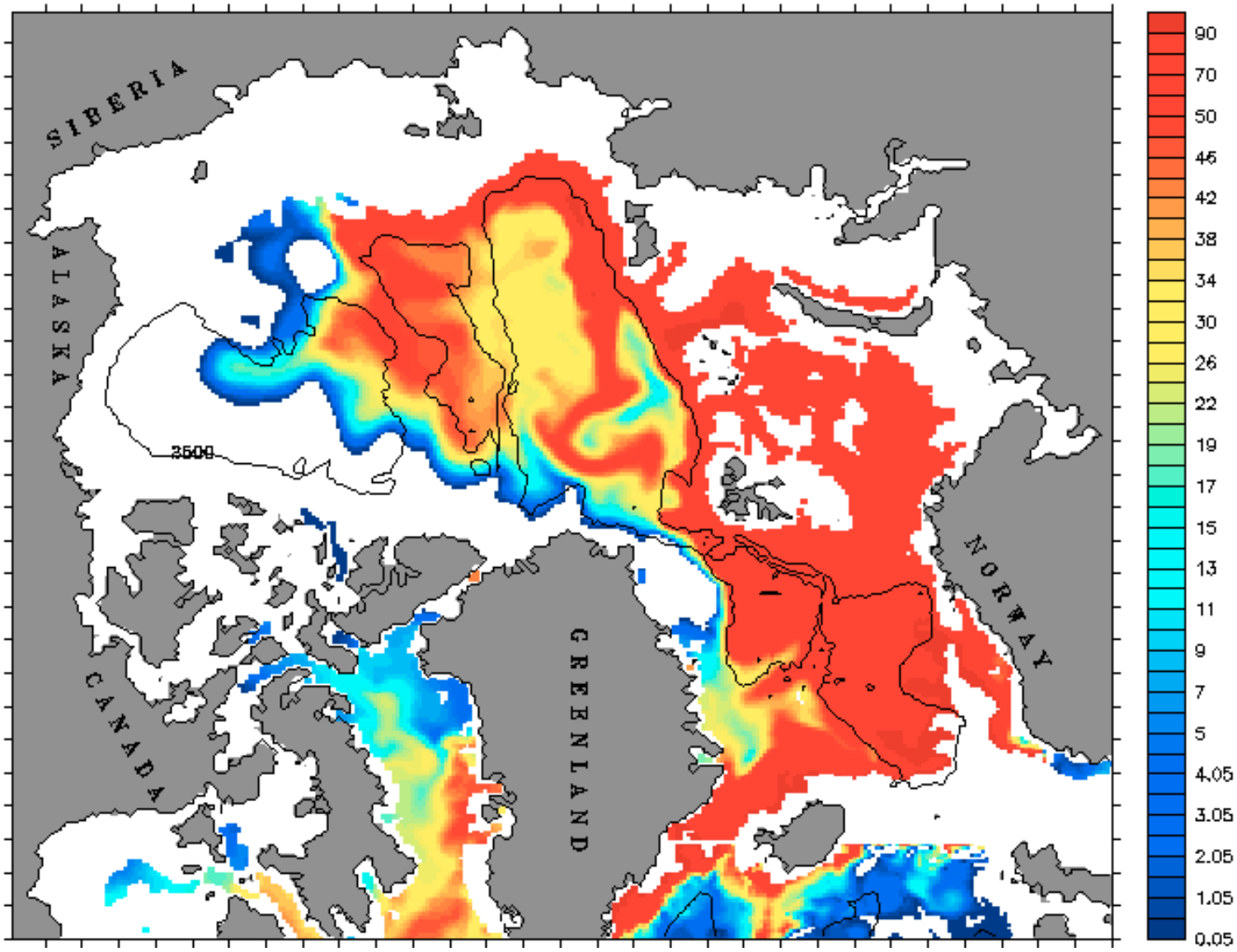
Atlantic Water Tracer Concentration (%) at depth 280-360m in 1979 (left), 1993 (middle) and 1993-1979 Anomaly (right)



Maslowski et al., 2000; also Zhang et al., 1998, Karcher et al. Submitted

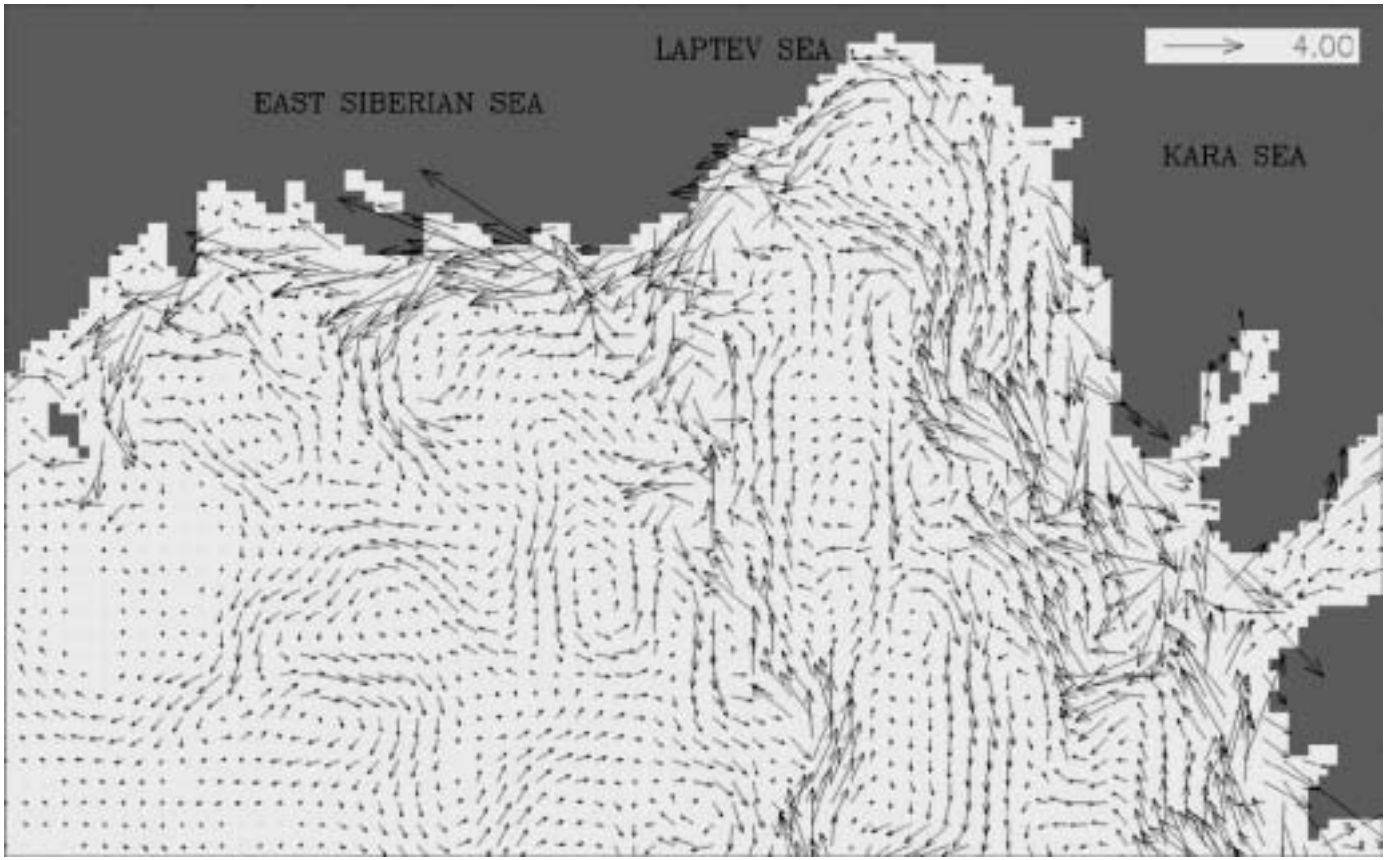
Data collected during the 1990s was critical in detecting the change
(e.g. Morison et a., 1998; ideal platforms: submarine and icebreaker).

Atlantic Water Tracer Concentration (180-220m) in 1998



Model ‘predicted’ change - needs to be verified!

Modeled velocity difference (cm/s) averaged over depth of 180-560 m between the 3-year mean of 1991-93 and the mean of last 3-years of the 20-year spinup using 1979 forcing.



Conclusions from a modeler:

1. A regional Arctic climate model (at sufficiently high resolution) should provide predictive capability for the region at seasonal to interannual scales

2. A regional/nested approach might be required for realistic representation of the Arctic region in global climate models

So what should be done in the next decade:

1. Continuation/expansion of ice/ocean database is critical to detecting change and its effects nn the Arctic System:
   - cross-basin transects (e.g. submarines, AUVs)
   - long time series (in key locations)
   - use of biogeochemical data to aid in detecting change
2. Increase coordination of observational and modeling efforts to maximize available resources for research
3. Emphasize the potential role of the Arctic System in global change => more $$ for arctic science