Changes to Ocean Hydrography

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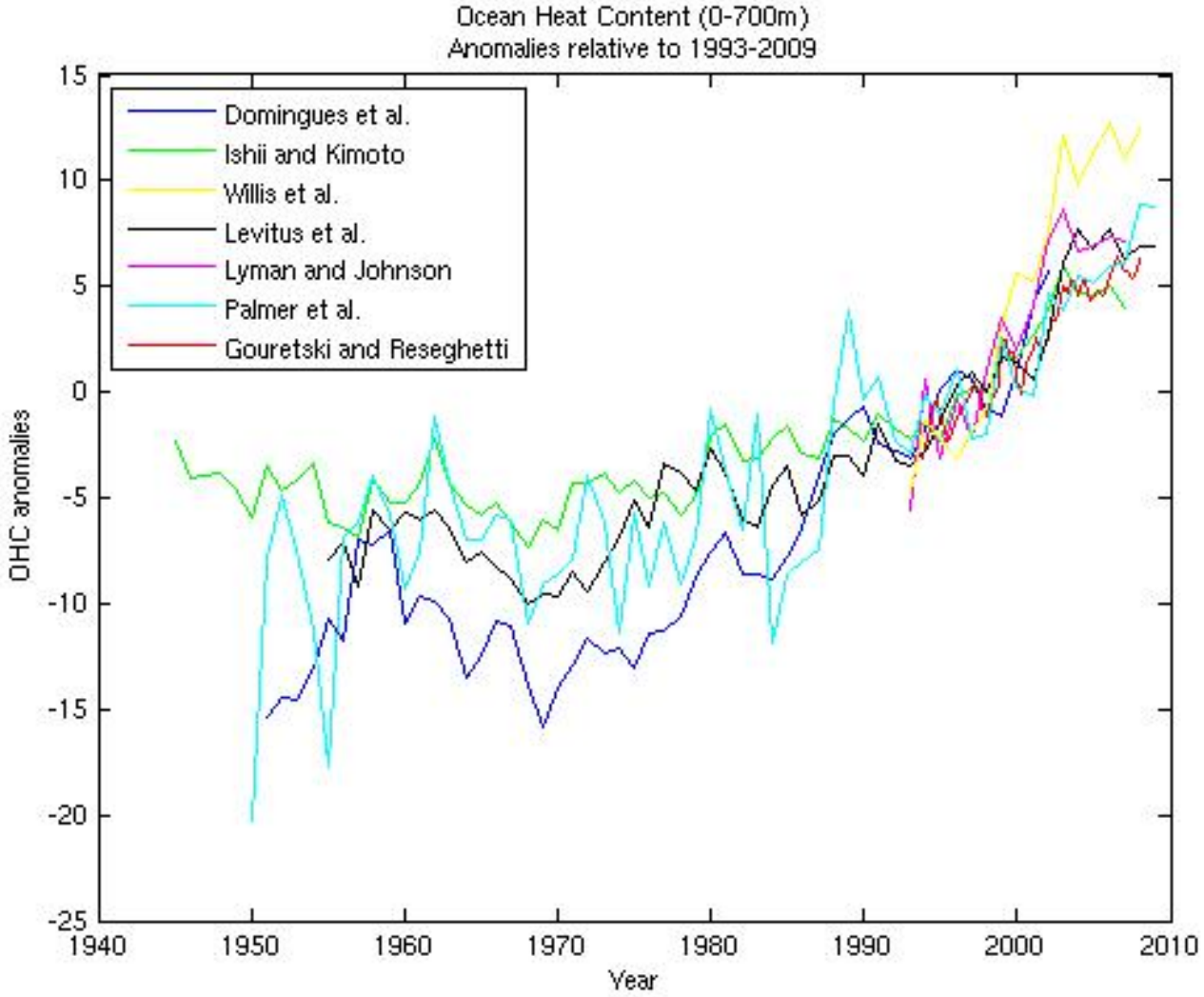
Norwegian Meteorological Institute

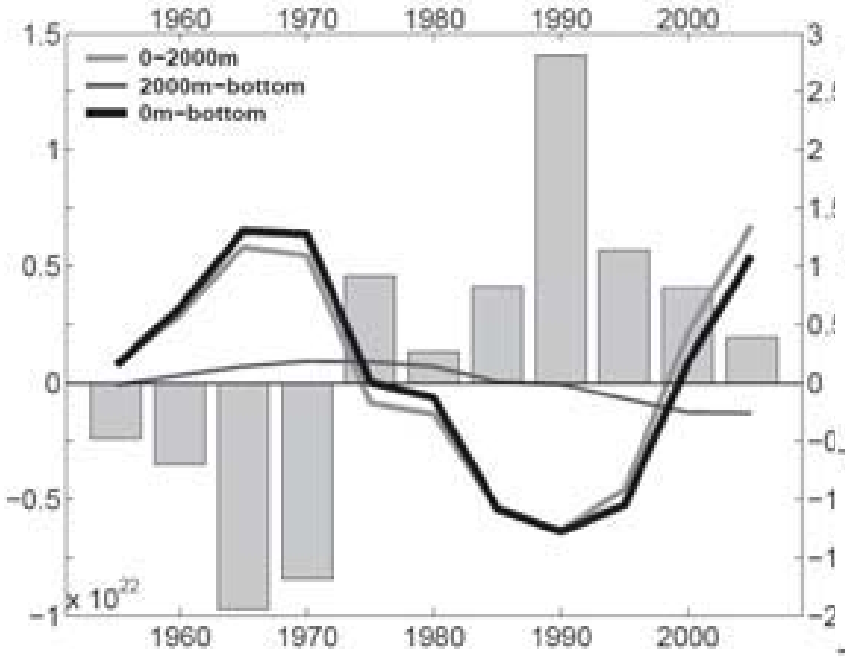
WCRP Polar Climate Workshop
Bergen, October 26, 2010

World Ocean Heat Content

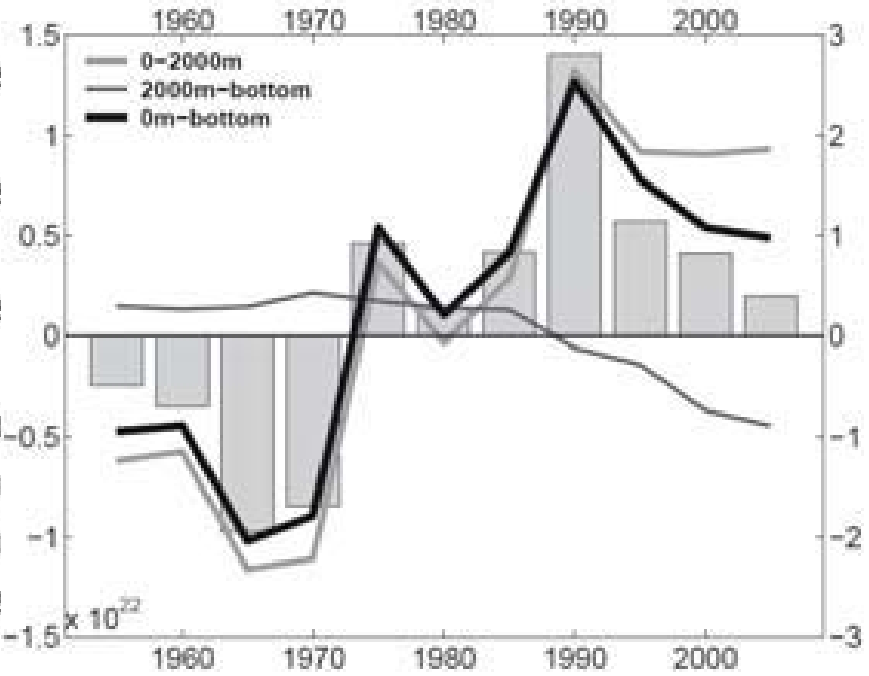


From http://www.ncdc.noaa.gov/bams-state-of-the-climate/2009-time-series/?ts=ohc; see also Trenberth and Fasullo, 2009.

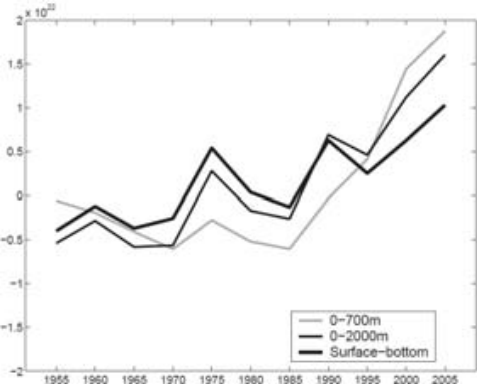
North Atlantic Ocean Heat Content



Subpolar Gyre

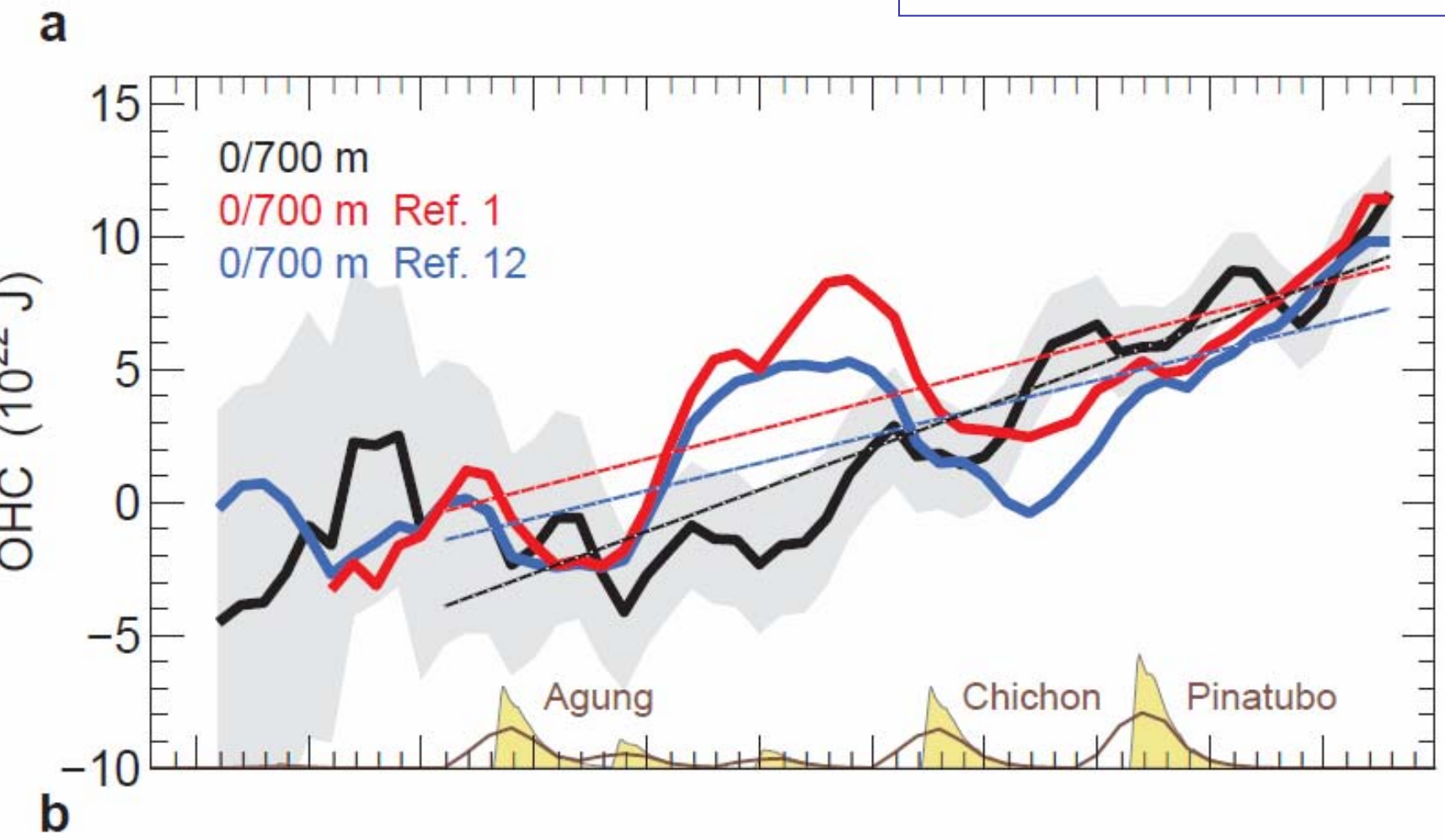


Subtropical Gyre



From Mauritzen, Melsom, Sutton, Curry, in prep.

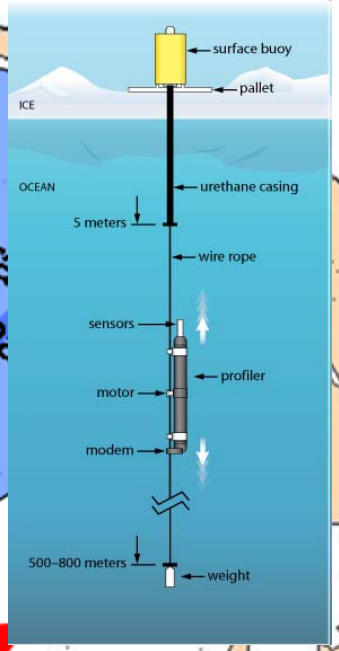
How can we explain something when we don't know what "something" is?



Domingues et al., 2008

iAOOS-Norway team post-IPY Vision

Ice Tethered Profiler



Animal-borne sensors

Collaborative international efforts (ITPs, moorings etc)

Greenland

Fram Strait

Barents Sea

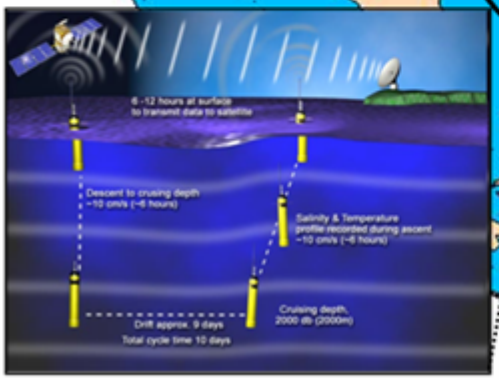
Russia

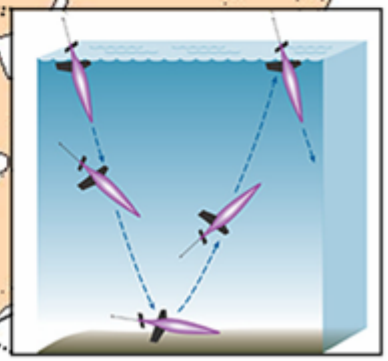
M

Norway

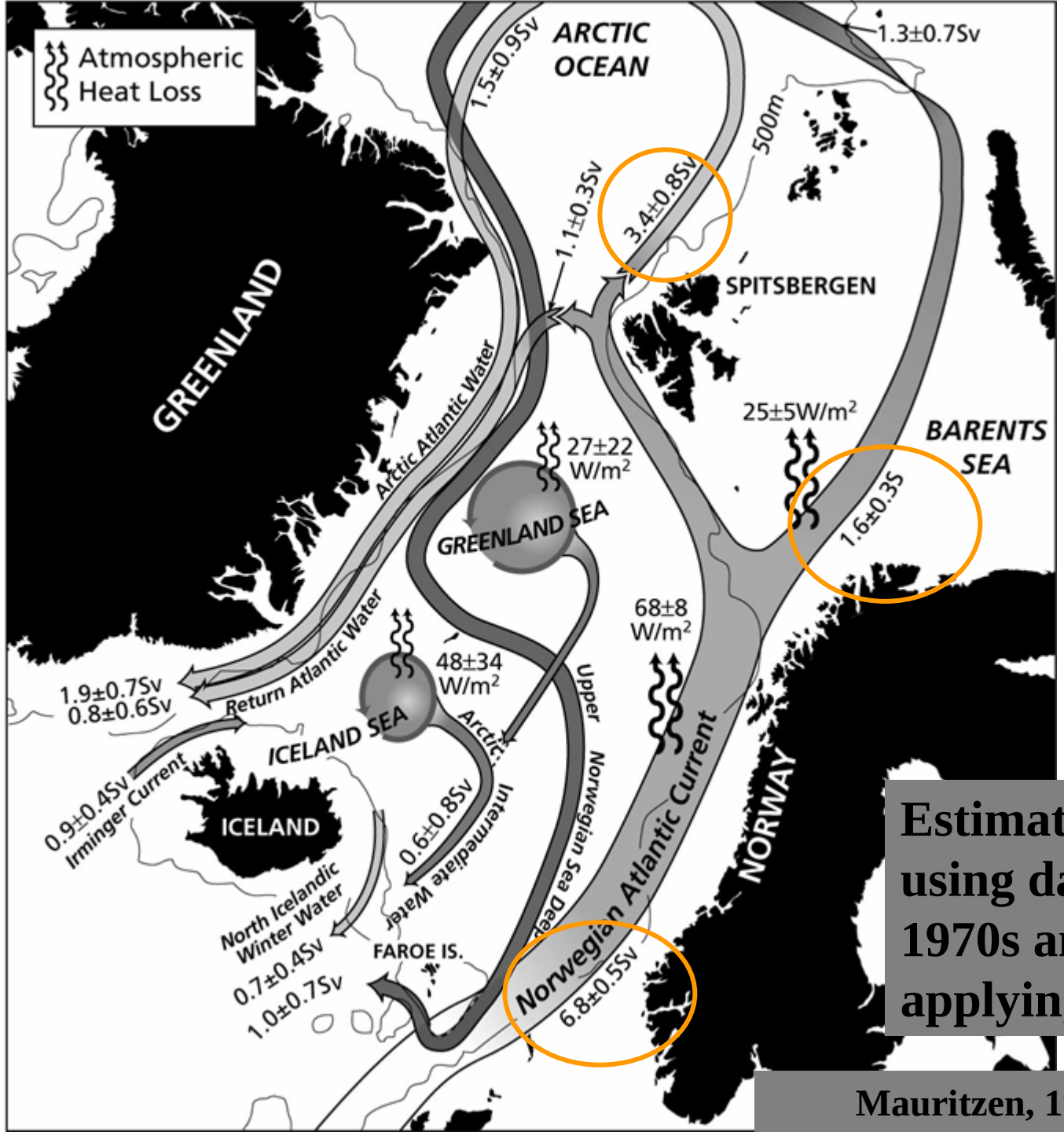
Svinøy

ARGO





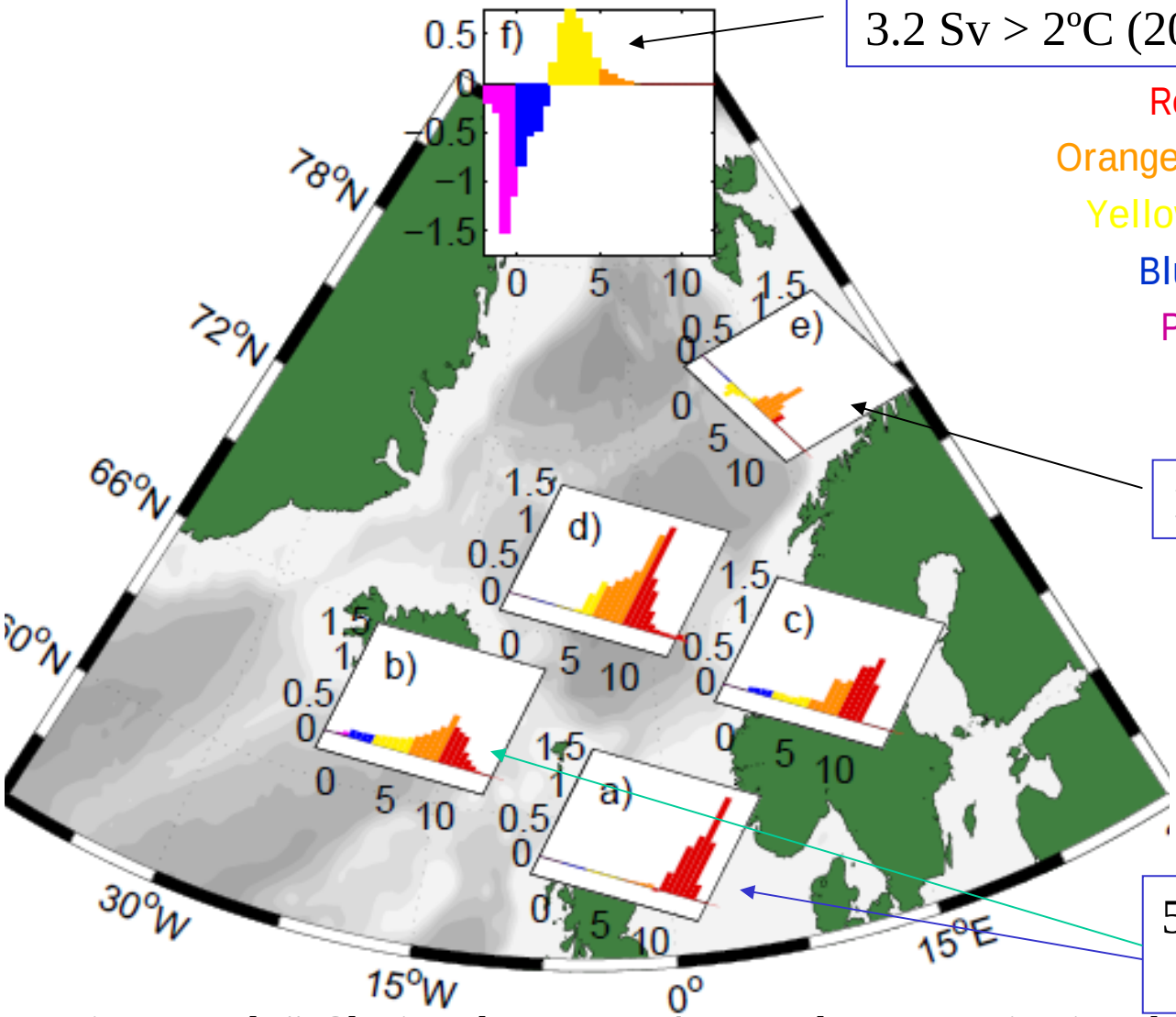
Gliders



Estimate of the MOC, using data from the 1970s and 1980s and applying inverse modeling

Mauritzen, 1996

Transports of the MOC in thermal space, current meter measurements ~1995 ~2010: no significant change in circulation



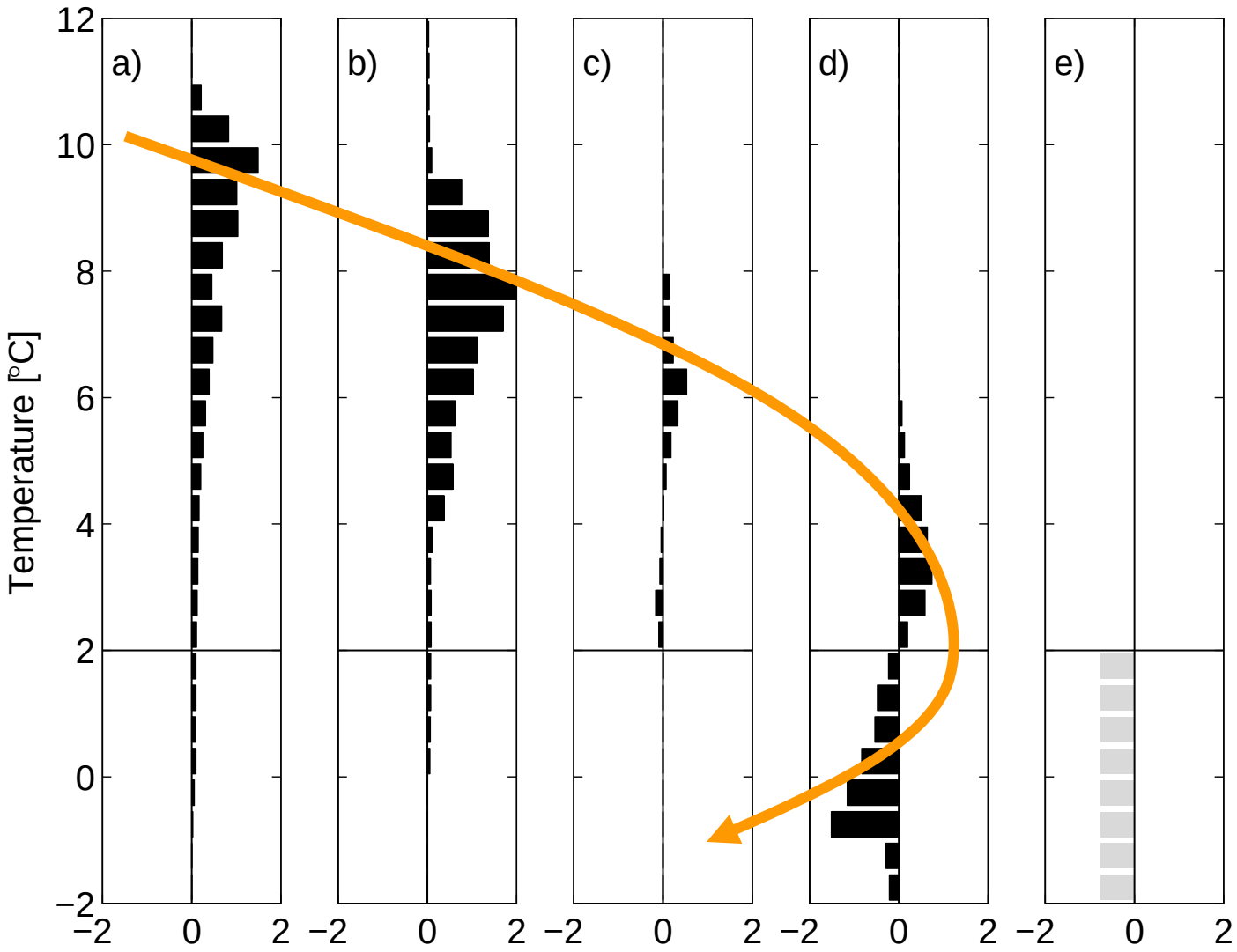
3.2 Sv > 2ºC (2002-2008)

Red: waters warmer than 7.5 ºC
Orange: waters between 5 and 7.5 ºC
Yellow: waters between 2 and 5 ºC
Blue: waters between 0 and 2 ºC
Purple: waters colder than 0 ºC

1.6 Sv > 4.5ºC (2003-2005)

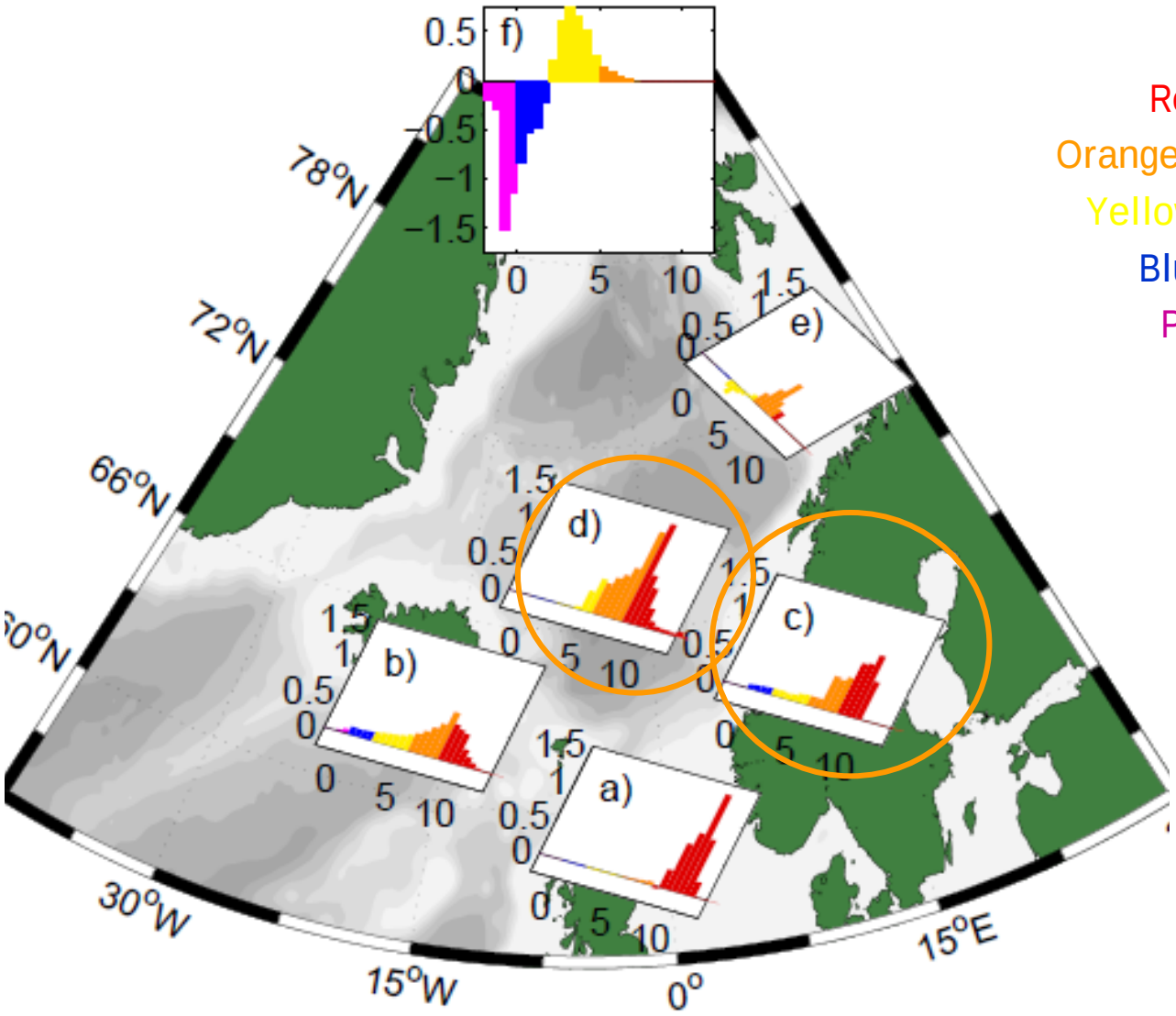
5.8 Sv > 7.5ºC (1997-2001, 1994-2008)

Mauritzen et al. ” Closing the Loop – Approaches to monitoring the state of the Arctic Mediterranean during the International Polar Year 2007–2008”. Accepted, Prog. Ocean.



Mauritzen et al., Acc., ProgOcean.

Transports of the MOC in thermal space



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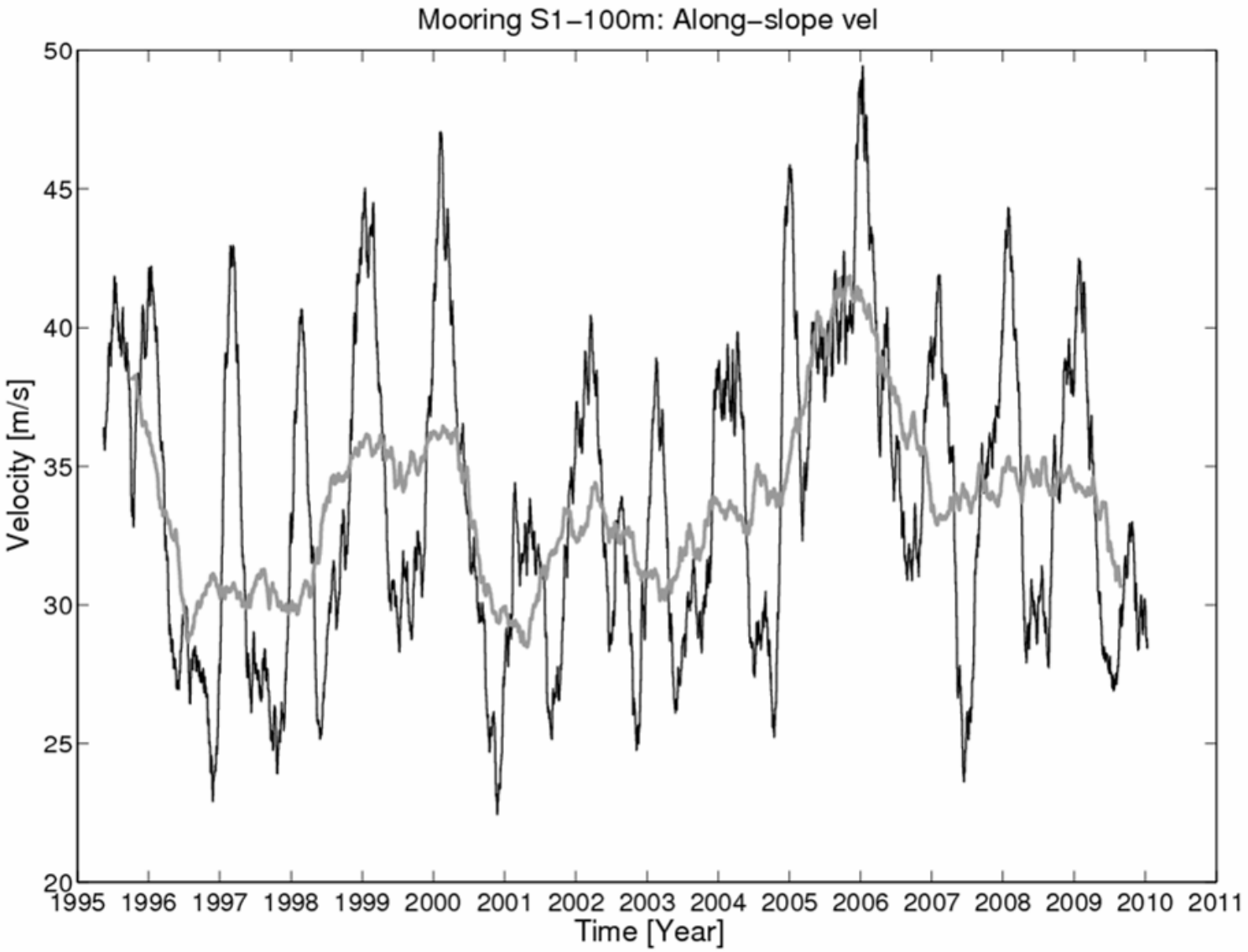
Mauritzen et al., Acc., ProgOcean.

15 years of current meter observations at Svinøy East

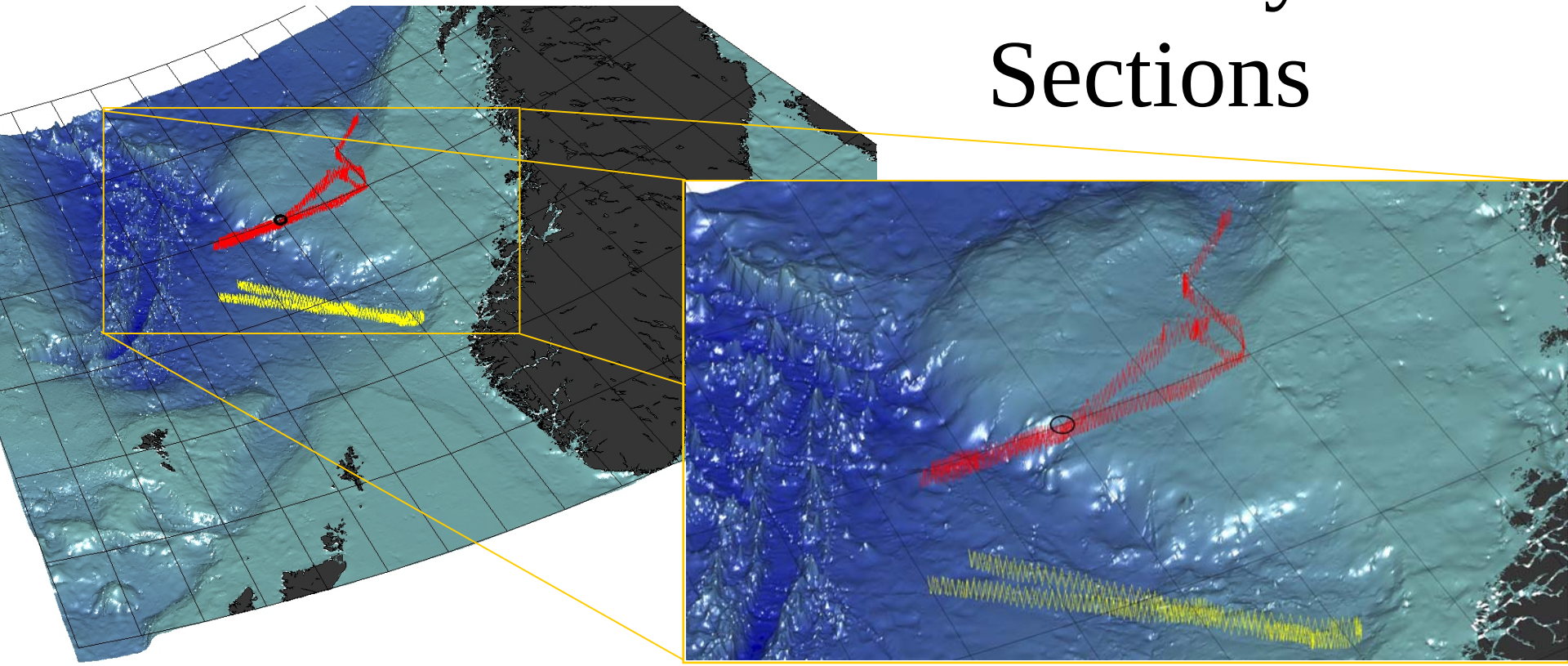


Courtesy K.A. Orvik

Seaglider in the Norwegian Atlantic Current: cooperation between iAOOS-Norway (Høydalsvik, Mauritzen) and APL, UW, Seattle (Craig Lee et al.)

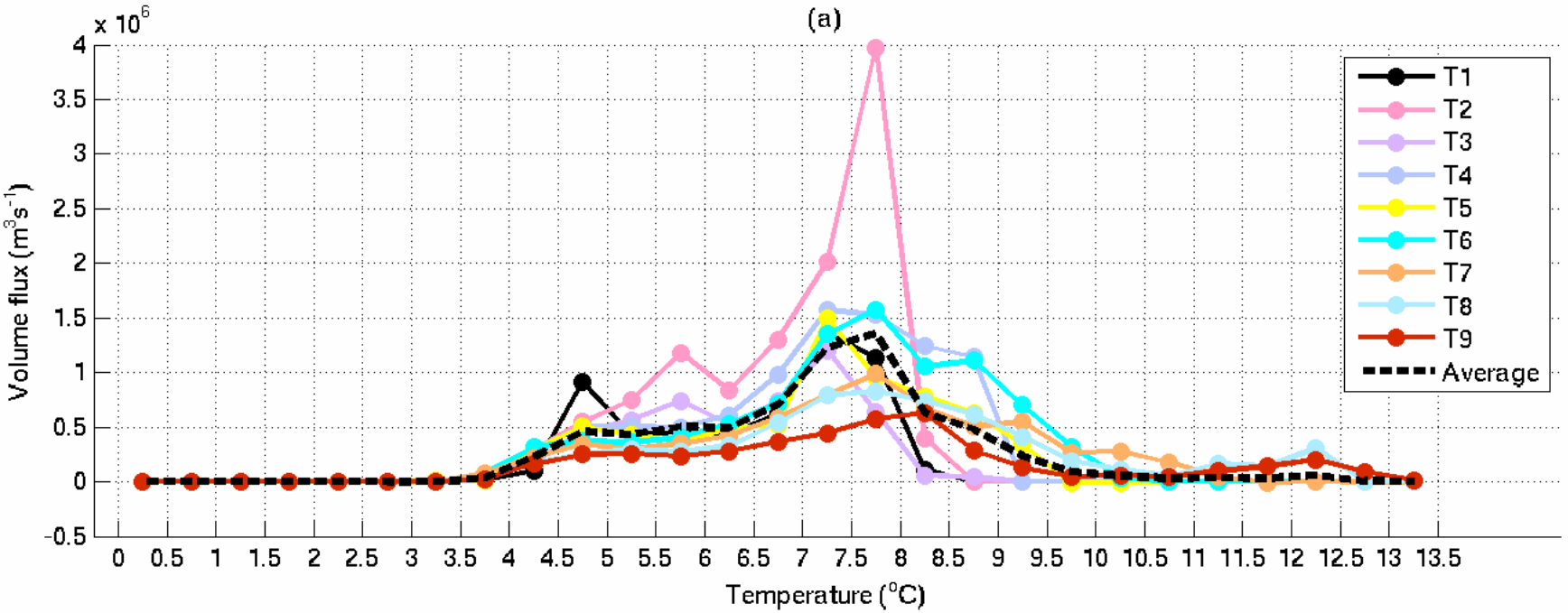
KV Stålbas, July 3, 2008. Photo: F. Høydalsvik

Example tracks from the OWSM and Svinøy Sections

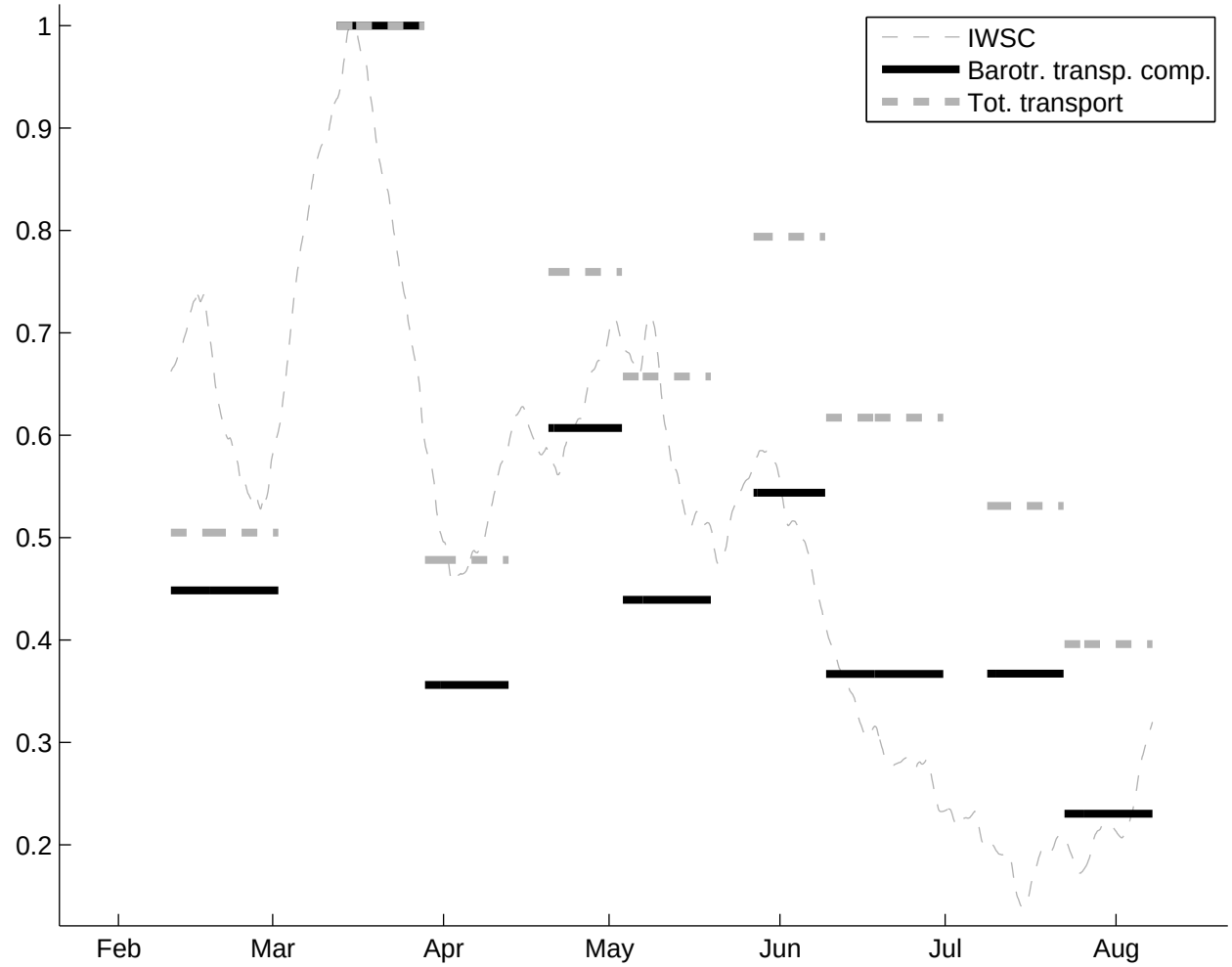


The Seaglider tracks during the IAOOS Seaglider experiment until end of March 2009. Red line: Seaglider SG-017 track for the OWSM Section. Note: The glider was sent from the OWSM Section to the southern limit of the Lofoten Basin for recovery assisted by the Norwegian Coastal Guard. Yellow line: Seaglider SG-160 in the Svinøysund Section. Ocean Weather Station Mike is shown by a 10 km range circle.

Transport in temperature classes, 9 glider sections at Svinøy

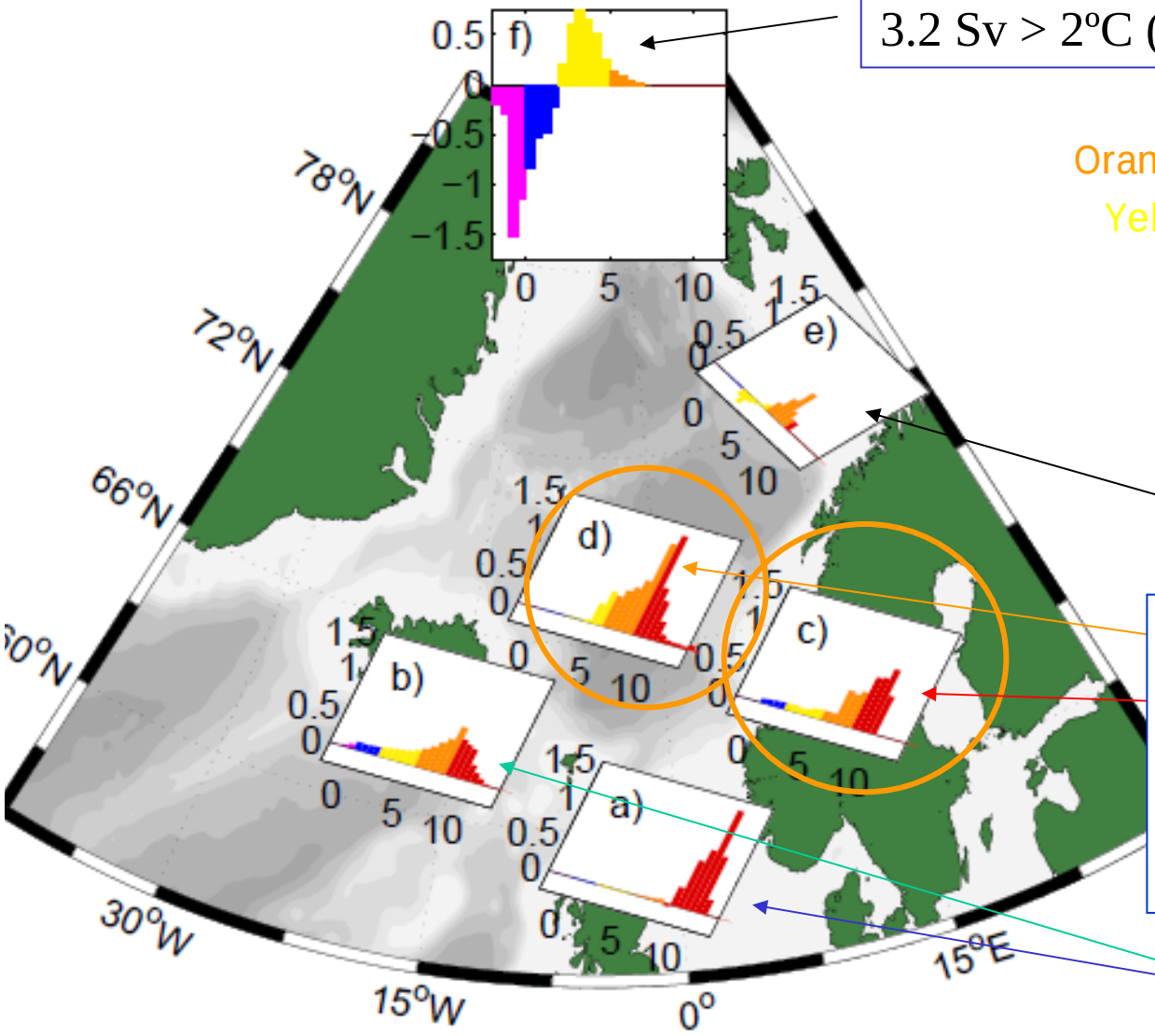


Høydalsvik, Mauritzen, Orvik, Lee, Gobat, in prep.



The Integrated, time-filtered wind stress curl (IWSC) versus the Seaglider transports. **The windstress curl from ECMWF ERA Interim is integrated over the area 50 – 65° N and 30° W – 0° E,** and filtered backwards in time. The maximum correlation between the IWSC and the Seaglider transport during the nine transects is obtained for a filtering length of 67 – 68 days, for both the total transport and the barotropic transport component.The total transport, the barotropic transport component, and the IWSC are plotted against time. All variables are normalized. *Høydalsvik, Mauritzen, Orvik, Lee, Gobat, in prep.*

Transports of the MOC in thermal space



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1.6 Sv > 4.5ºC (2003-2005)

5.9 Sv > 7.5ºC (2009, 1995-1999).
Large entrainment in 5-7ºC range, consistent with Oliver and Haywood 2003

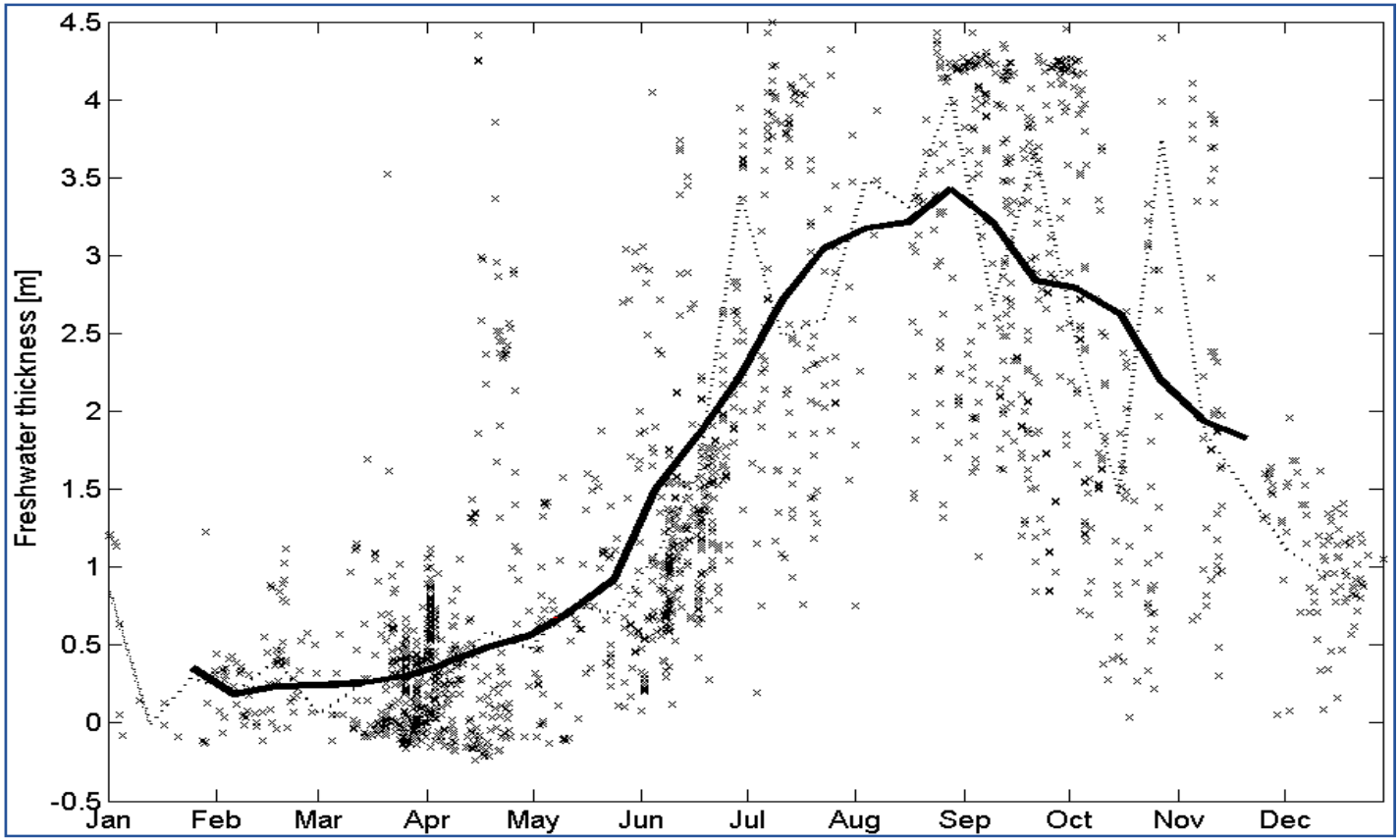
5.8 Sv > 7.5ºC (1997-2001, 1994-2008)

Mauritzen et al., Acc., ProgOcean.

Fate of freshwater: SRDL-CTD tags on hooded sels (MEOP)

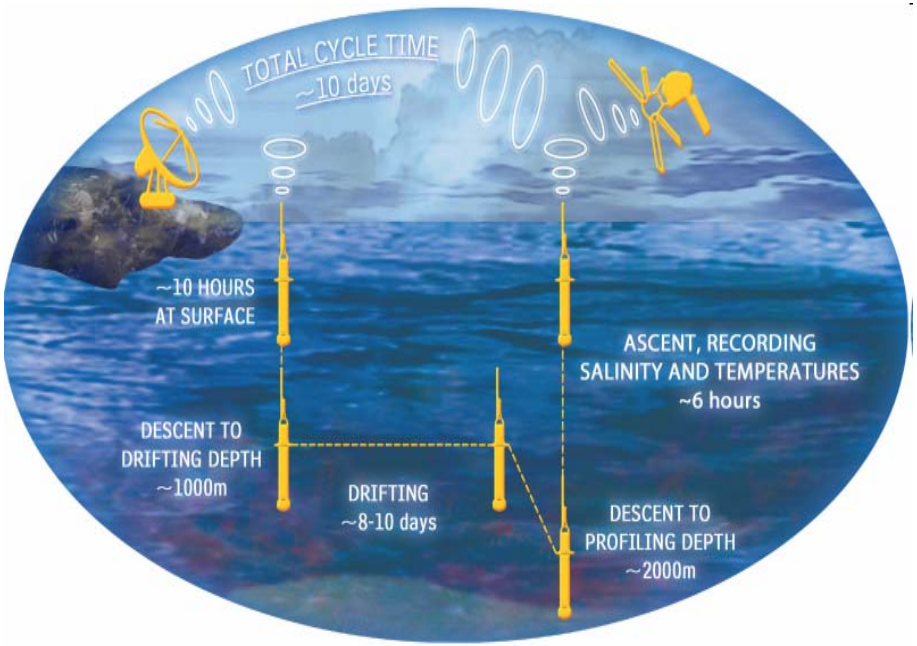
Courtesy K. Kovacs

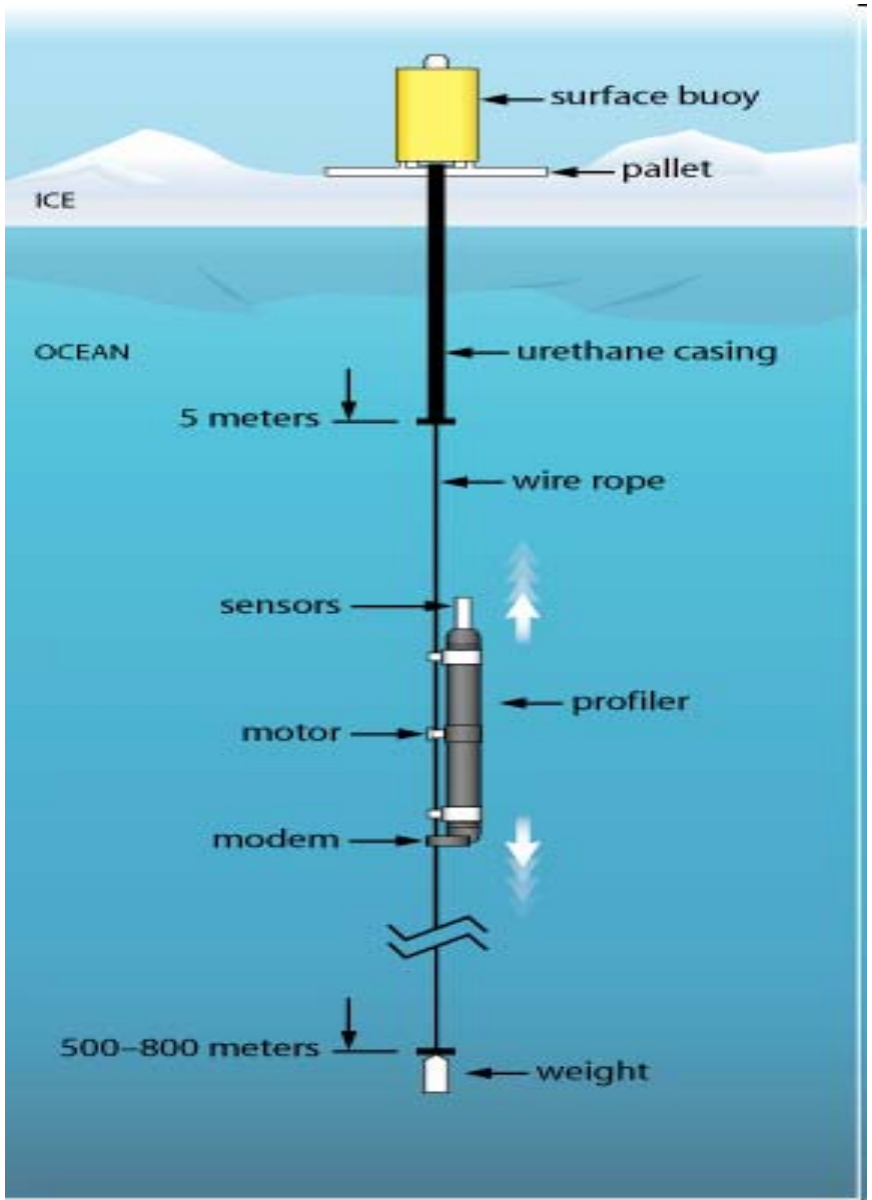
Seasonal cycle, freshwater content in the East Greenland Current.



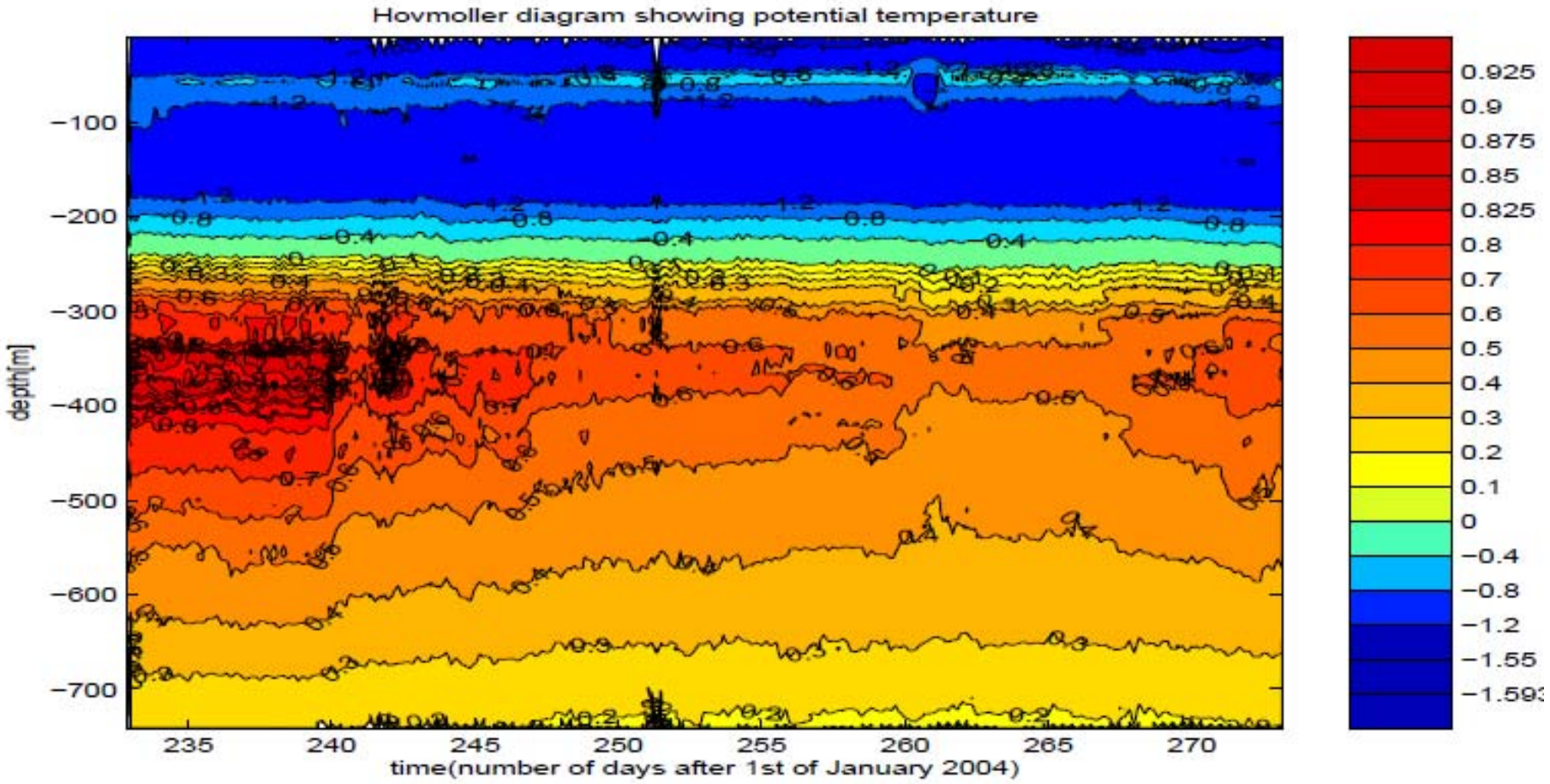
Courtesy: Dodd, Kovacs, Lydersen

ITPs, ARGO system

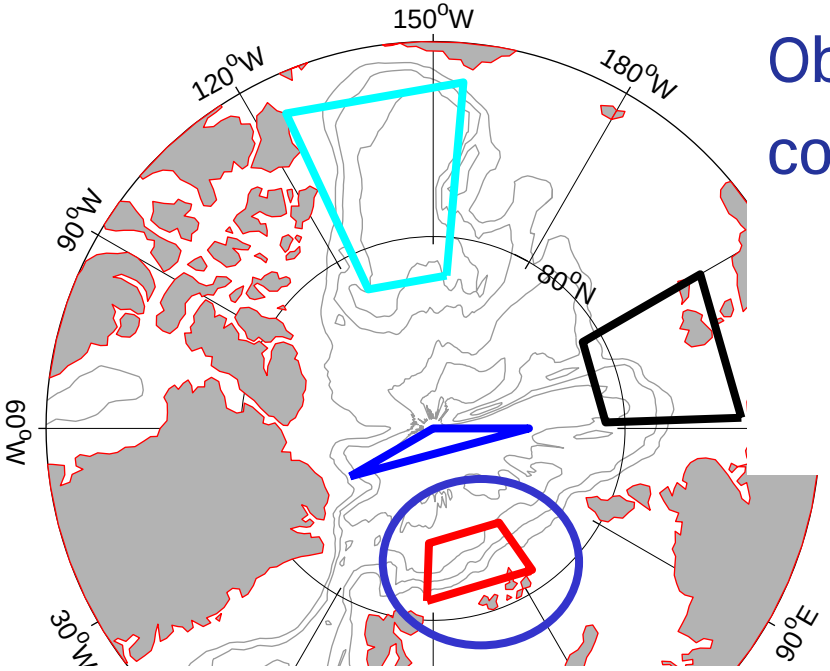




ITP in the Central Arctic, 2004

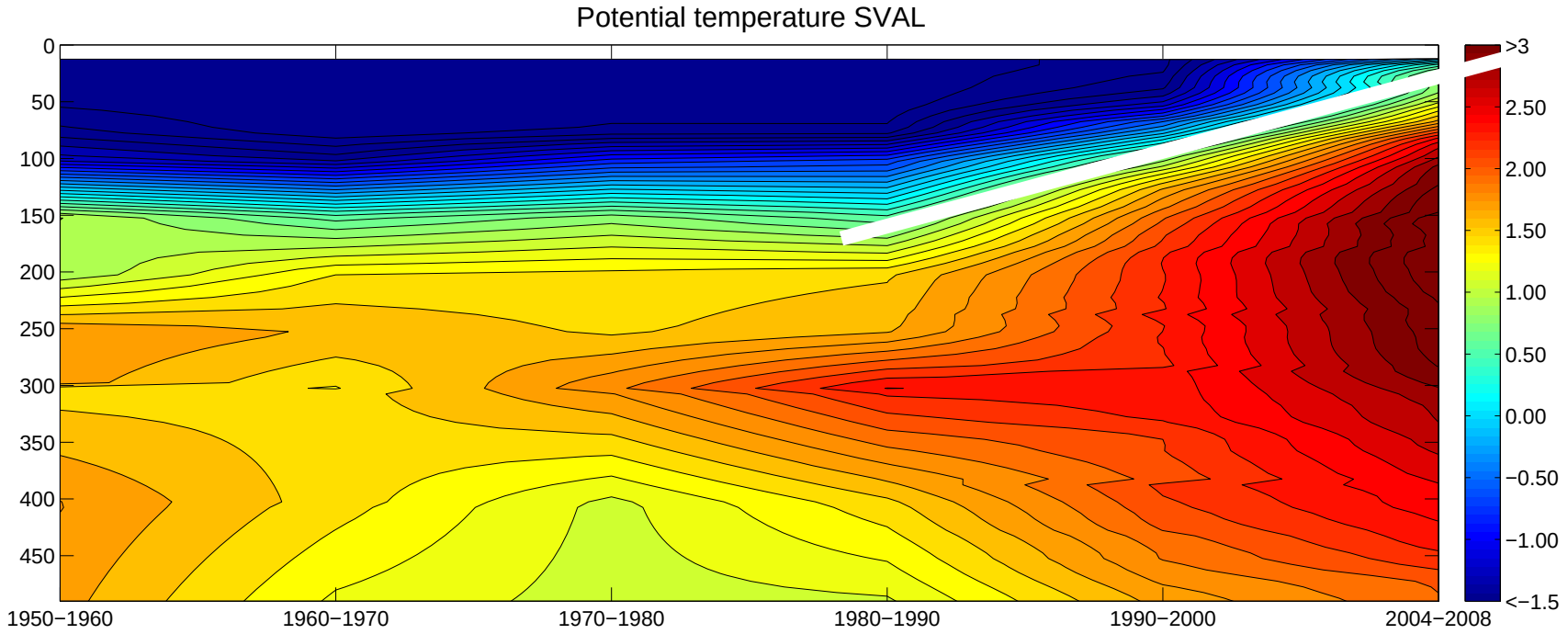


Aasen 2009



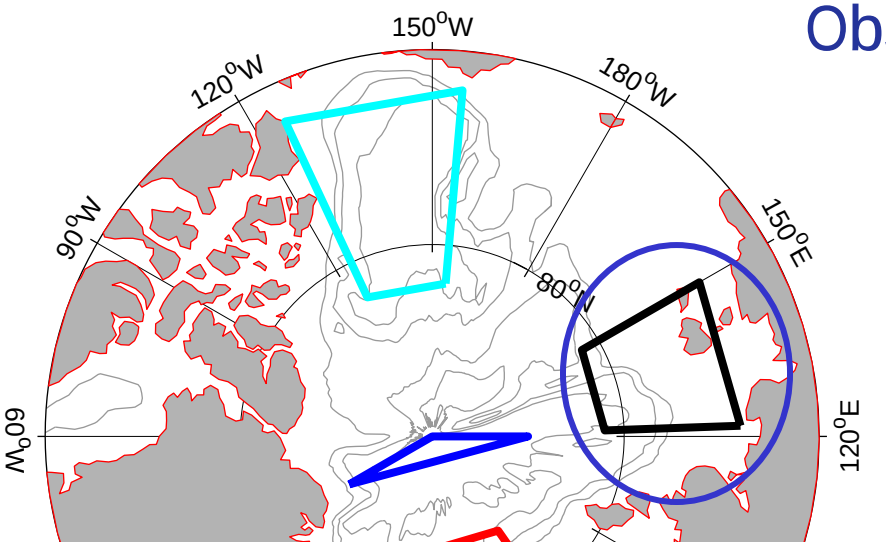
Observed Arctic Ocean temperatures, comparing ITP data to the EWG Atlas: In addition to array of anomalies: temperature increase and water mass uplift (30-60m).

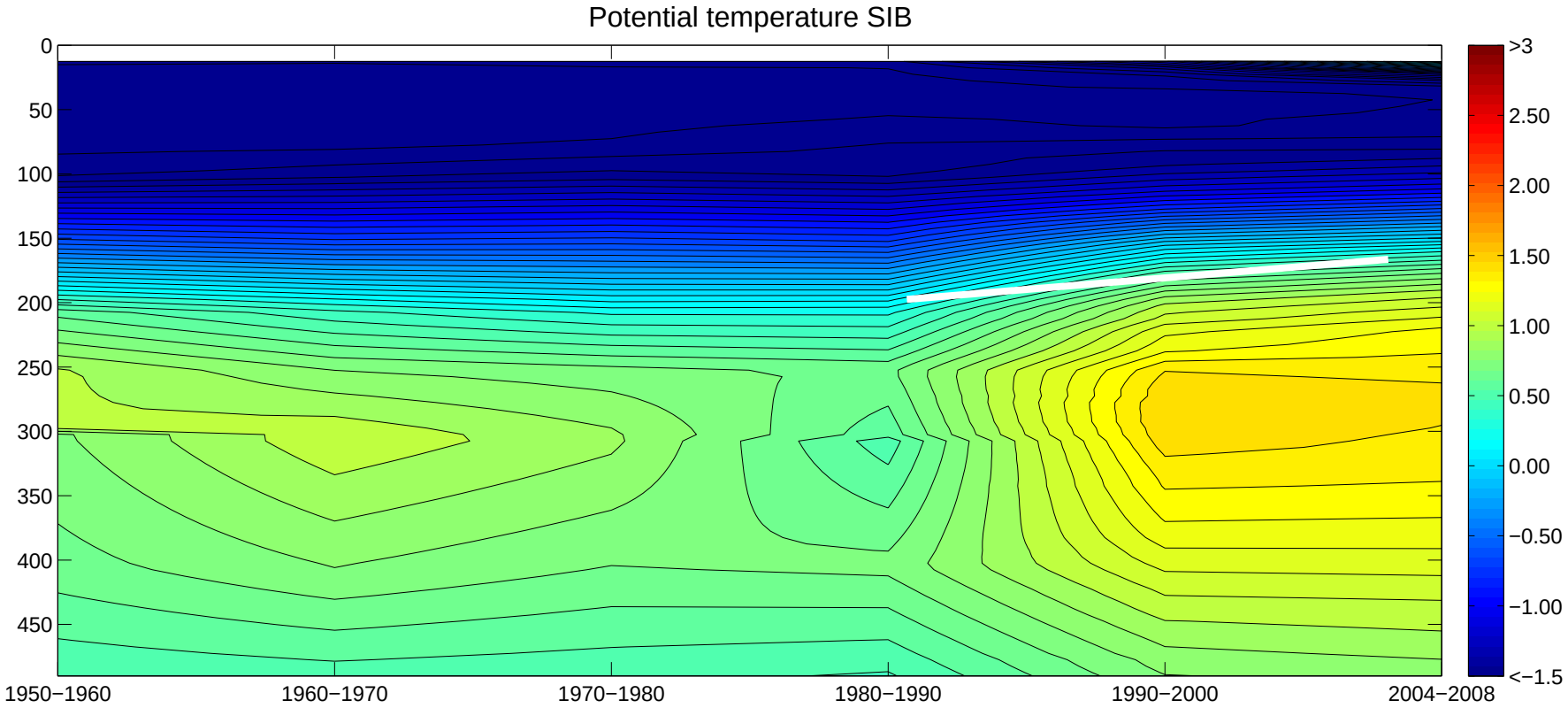
Aasen, 2009



Observed Arctic Ocean temperatures

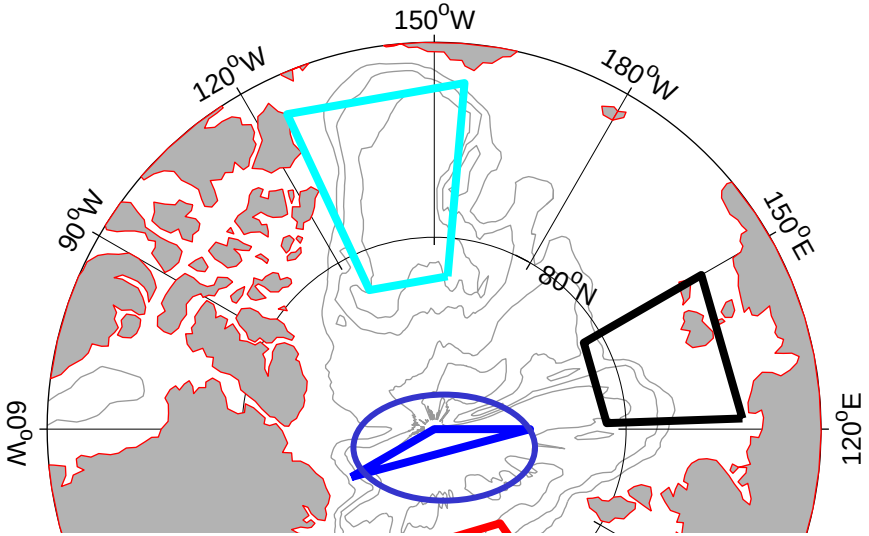
Aasen, 2009



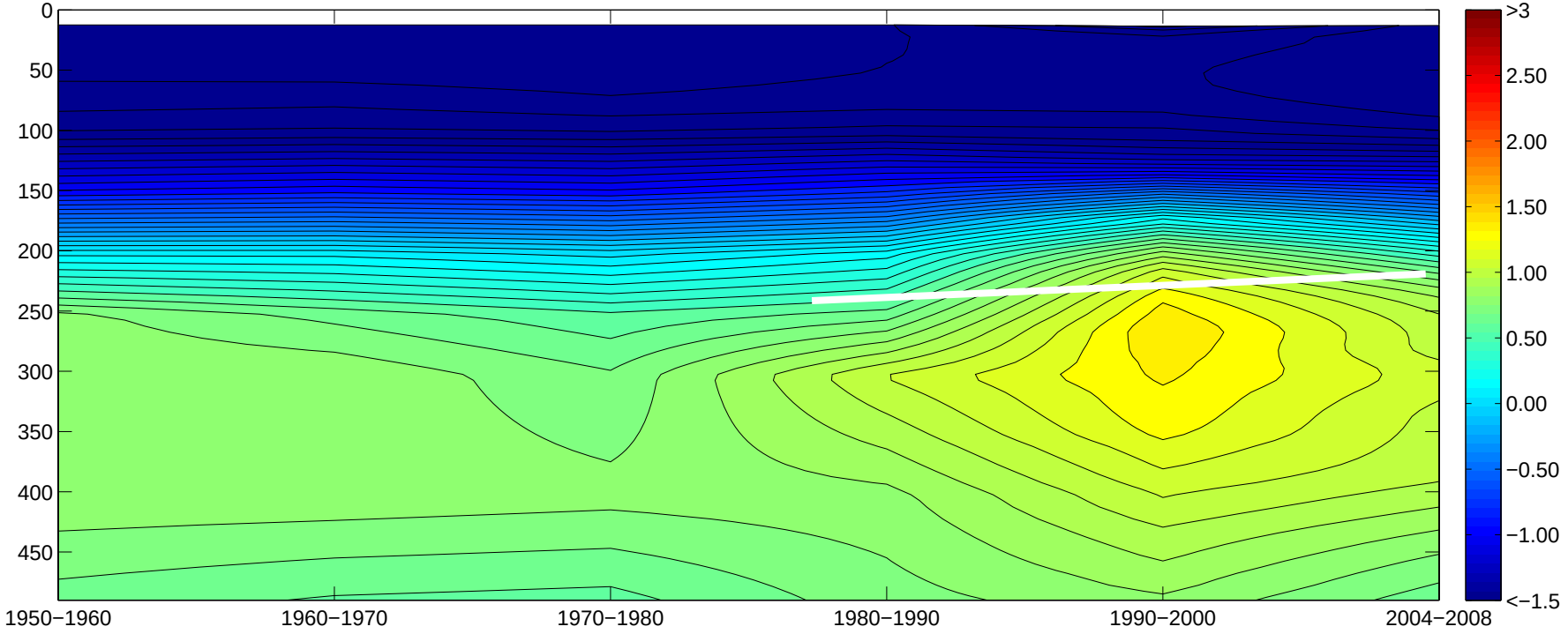


Observed Arctic Ocean temperatures

Aasen, 2009

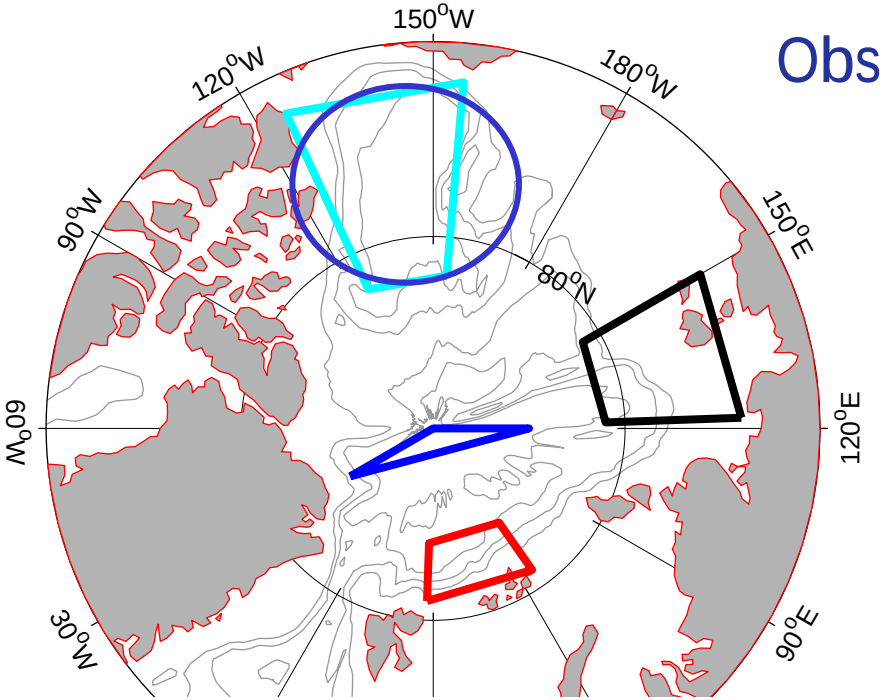


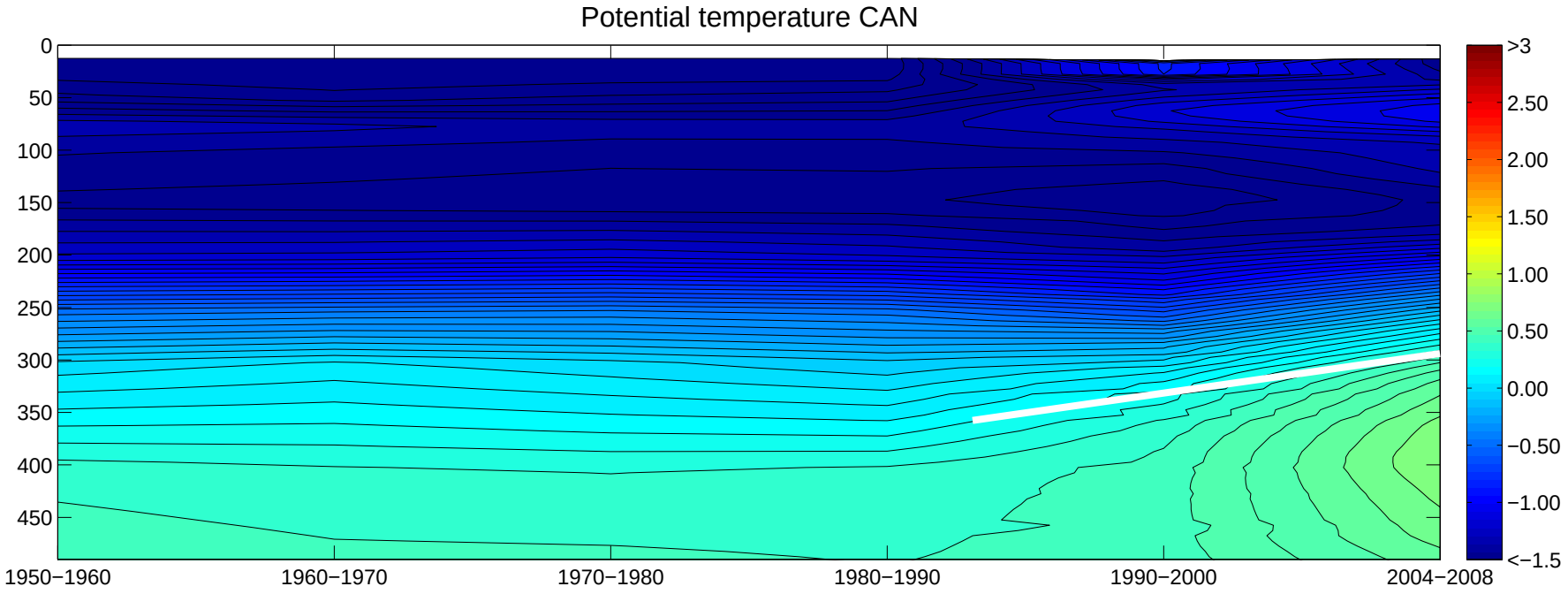
Potential temperature EUR



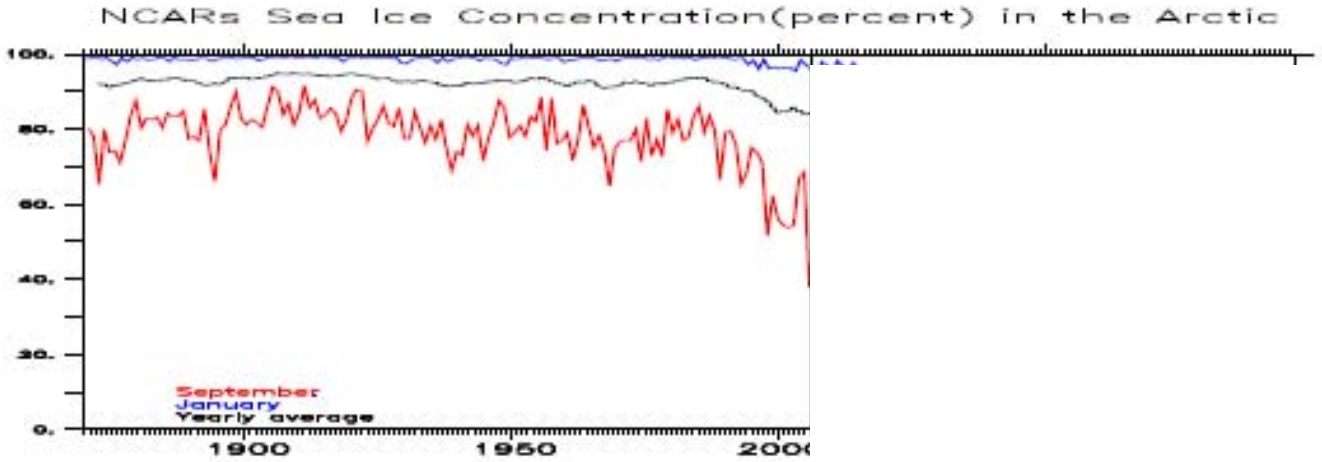
Observed Arctic Ocean temperatures

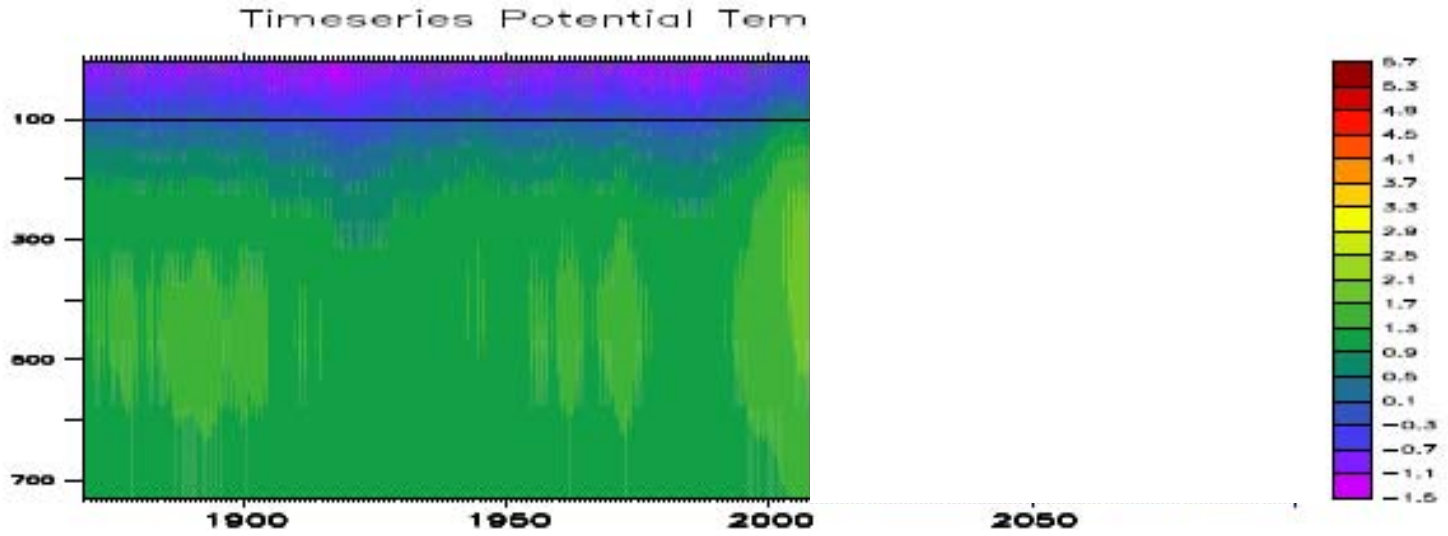
Aasen, 2009





Arctic-wide average





NCAR_CCSM3_0

A2

Aasen 2009

To conclude…

- In the Arctic/subarctic: Subsurface ”revolution” in real-time transmission:
  - 5000 ARGO profiles since 2001
  - 20 000 ITP profiles since 2004
  - 7000 seal-borne CTD profiles during IPY

- **Globally: We need to narrow down the uncertainties in ocean heat content, ocean freshwater content, and ultimately, density, both for reanalyses and operational products. There is only one realization; there is only one solution.**

- Nansen (based on the Fram Expedition): ”Now, when it is too late, I can see what could have been done better; instruments and methods could have been much improved”. He never got a chance to go back. Neither do we.