OCEANSCOPE*

A proposed internationally-funded partnership with the global shipping industry for sustained ocean observation.

*http://www.scor-int.org/Publications/OceanScope_Final_report.pdf

Background

Starting in the 1850's mariners have routinely reported on weather and sea surface conditions, observations that quickly led to better sailing times and safety at sea.

These activities expanded after WWII leading to greatly improved knowledge of surface water properties and upper ocean temperature - all successful programs, but lack of coordination and synergy between them preclude scalability and incentives for developing new measurement skills.

To address this deficiency and explore ways forward SCOR/IAPSO sponsored an Industry/Science Working Group called OceanScope.

The OceanScope concept:

To equip commercial ships with automated instrumentation to accurately measure and report upon the currents and the physical, chemical and biological characteristics of the water column throughout the world ocean. The resulting freely shared data will be a fundamental resource for understanding the climatic state and health of our planet.

Significantly, a number of white papers at the OceanObs'09 conference called for a capability of this kind.

The final report proposes a formal partnership with industry, the reasons are simple:

The Partnership

A partnership with the shipping industry would bring industry and the ocean observing communities together

It would coordinate the installation and operation of instrumentation on a fleet of commercial vessels

It would identify vessels and vessel-builds relevant to routes of interest

It would stimulate and enable the development of full water-column capable measurement technologies

The Advantages of a partnership:

Provides a stable framework for sustained observation for both operational and ocean research communities

Standardizes procedures for collecting, calibrating, distributing and archiving all data

Provides scalability towards far better coverage than is possible today

To provide a NASA-like framework for developing new initiatives for these sea-level ‘satellites’

A few

instrumented

vessels

Four distinct benefits to the ocean observing communities:

1. Forecasting services:

   improved knowledge of currents => fuel savings

2. Fronts and the mesoscale:

   fundamental importance to all modeling activities

3. Ocean and climate:

   transport of heat, freshwater, CO_2, nutrients

4. The state of the ocean:

   CO_2 , acidity, biomass change, ...

The good news

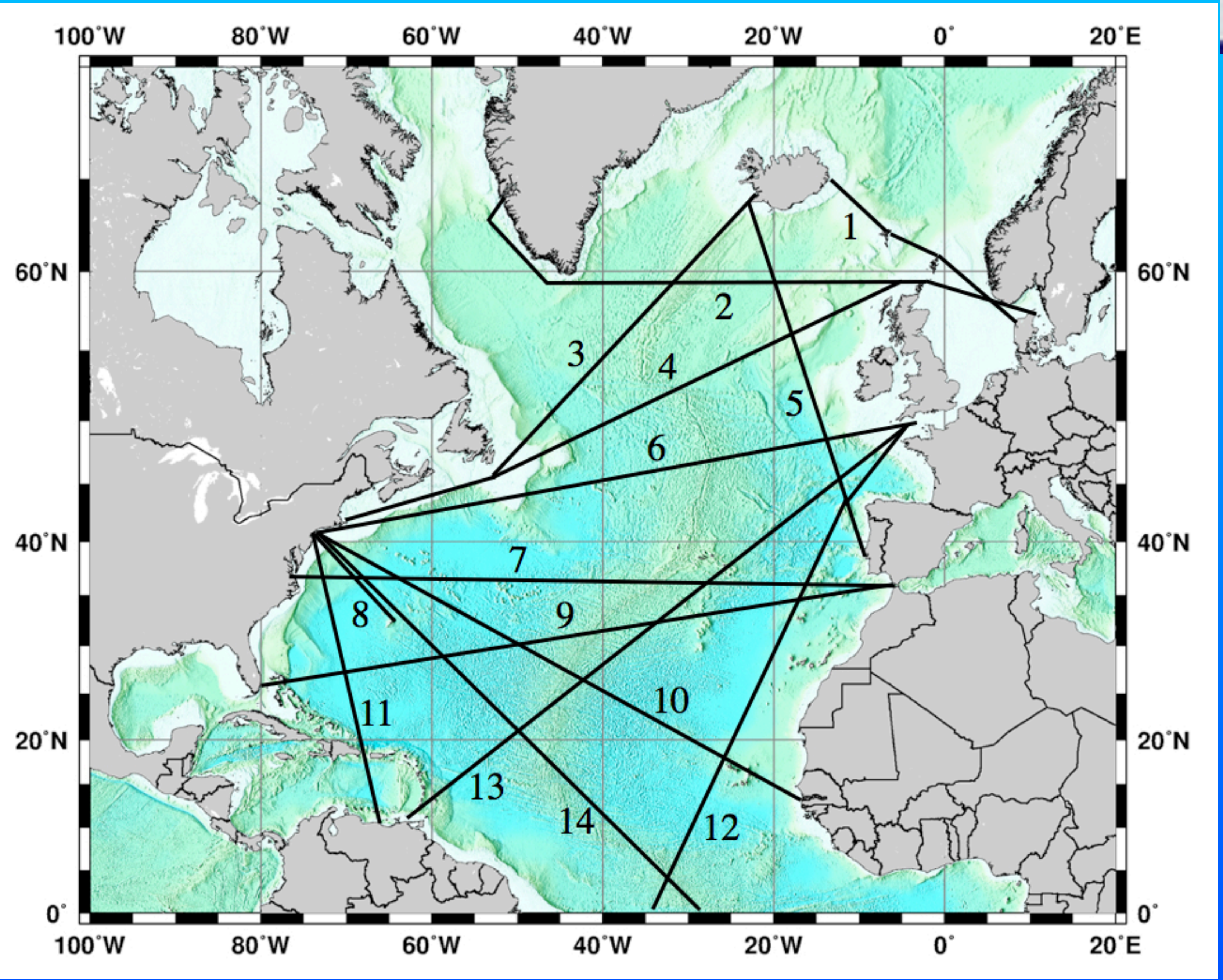
The merchant marine industry participated in the development of the OceanScope report. They have in many ways signaled their willingness to be of service:

1. Their past record of supporting ocean observation.
2. The ICS* participation in the SCOR/IAPSO working group.
3. Naval architecture participation in same working group.
4. MAERSK sponsored the WOC working group last December.
5. The ICS* is prepared to host meeting to explore EEZ issues.
6. Willing to build "OceanScope-ready" vessels/modify at haul.

*International Chamber of Shipping — 70% of global shipping.

Phase One: The North Atlantic

Subpolar, and subtropical gyres would be covered; equatorial coverage could be enhanced.



Already, quite a few routes operate XBTs, CPRs, TSGs. Four vessels have ADCPs.

The chart shows the initial set of 14 routes proposed to be monitored with 20 fully equipped OceanScope merchant marine vessels. A five year spin-up is proposed.

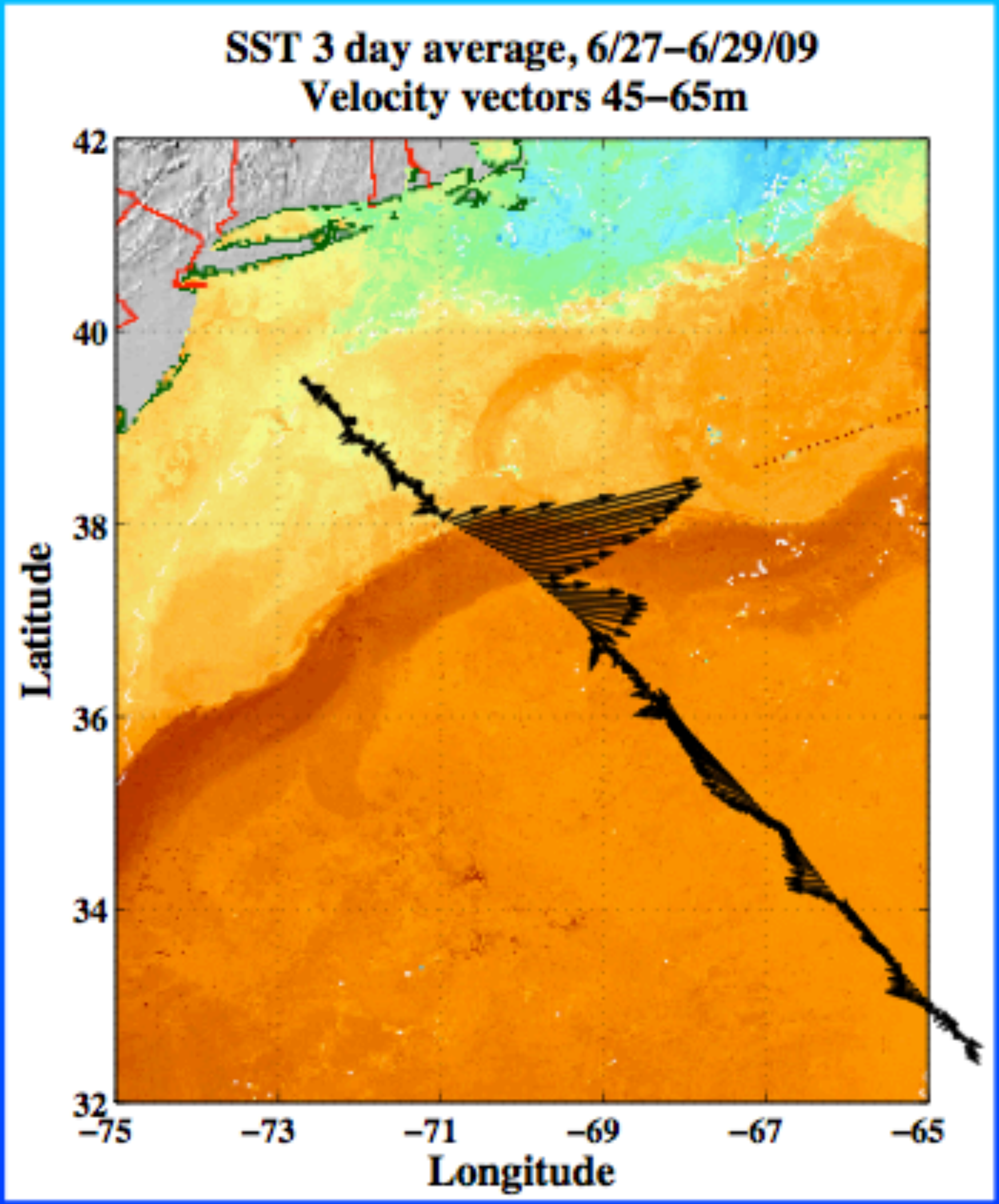
OCEANSCOPE:

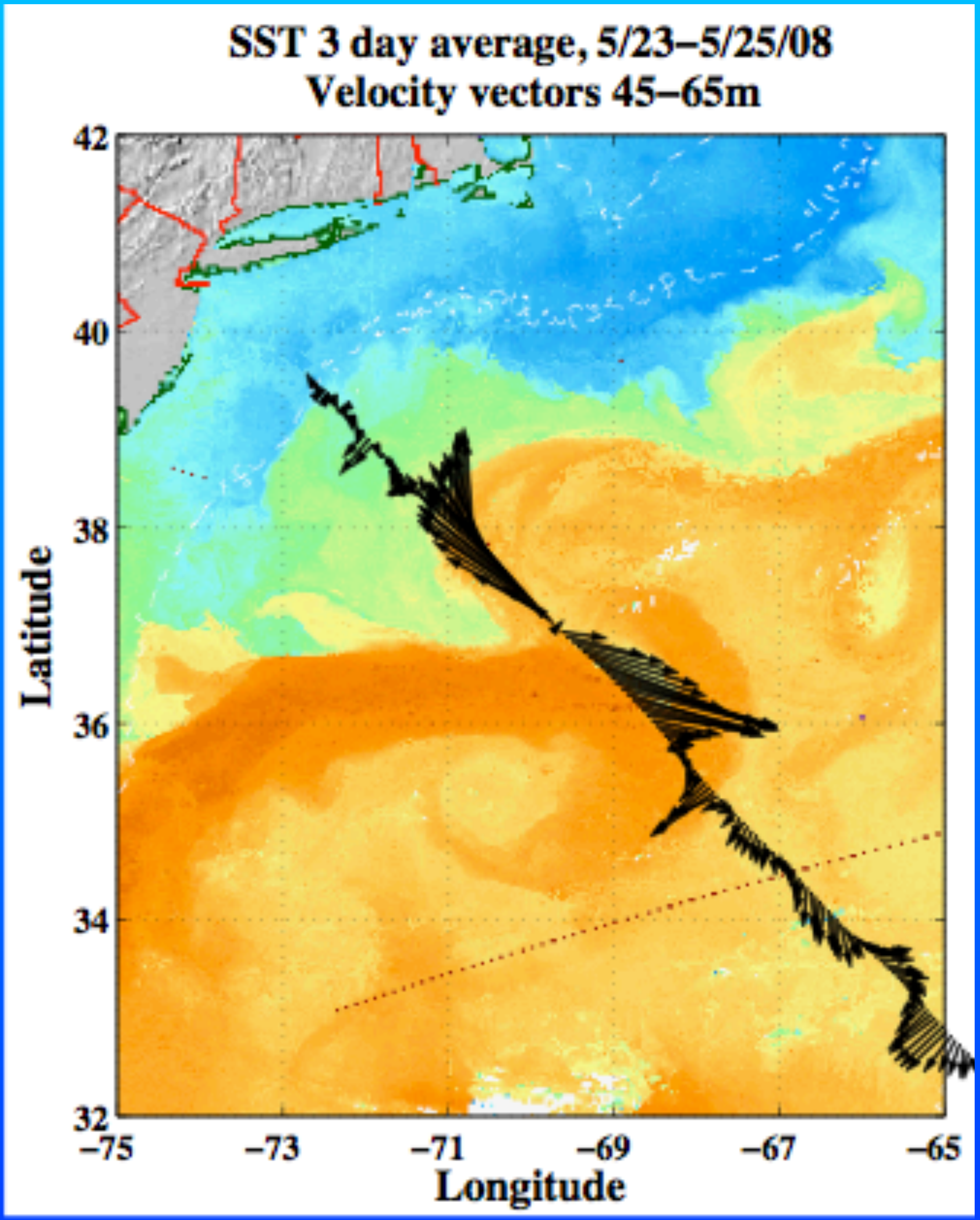
For those of us in this room, a central feature would be that all OceanScope vessels would be equipped with acoustic Doppler current profilers (ADCP).

This would enable the direct and accurate measurement of currents, transports and property fluxes from the surface down.

I'll conclude this talk with some examples (briefly since much is already in the literature):

The Oleander operation - ongoing since Fall 1992

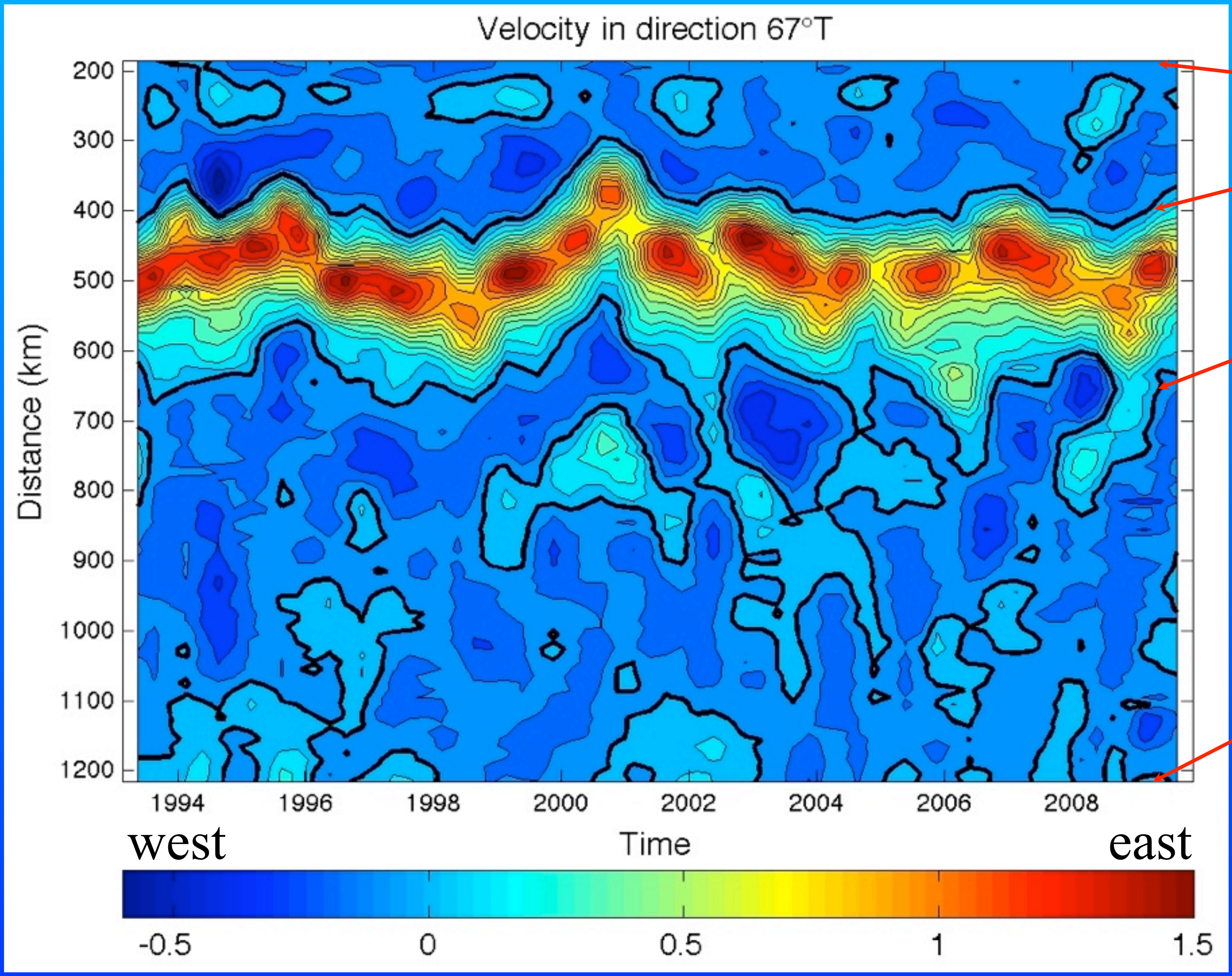


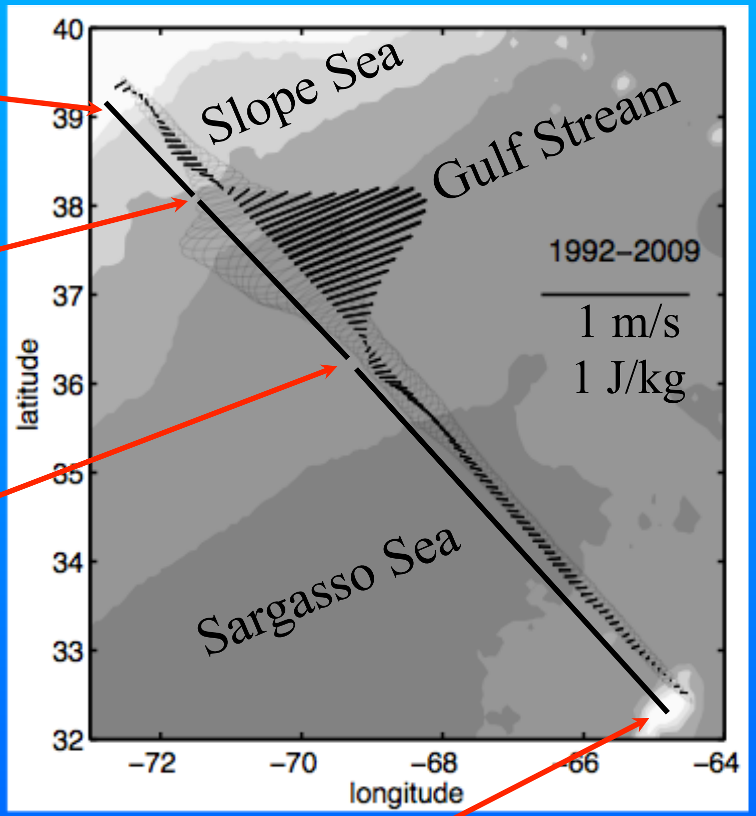


Strikingly different states of the Gulf Stream

Advantage of ADCPs on MM-vessels: repeat sampling.

Hovmöller diagram of velocity between shelf break and Bermuda.





Warm colors to the NE, cool colors the the SW. Heavy line = 0 m/s.

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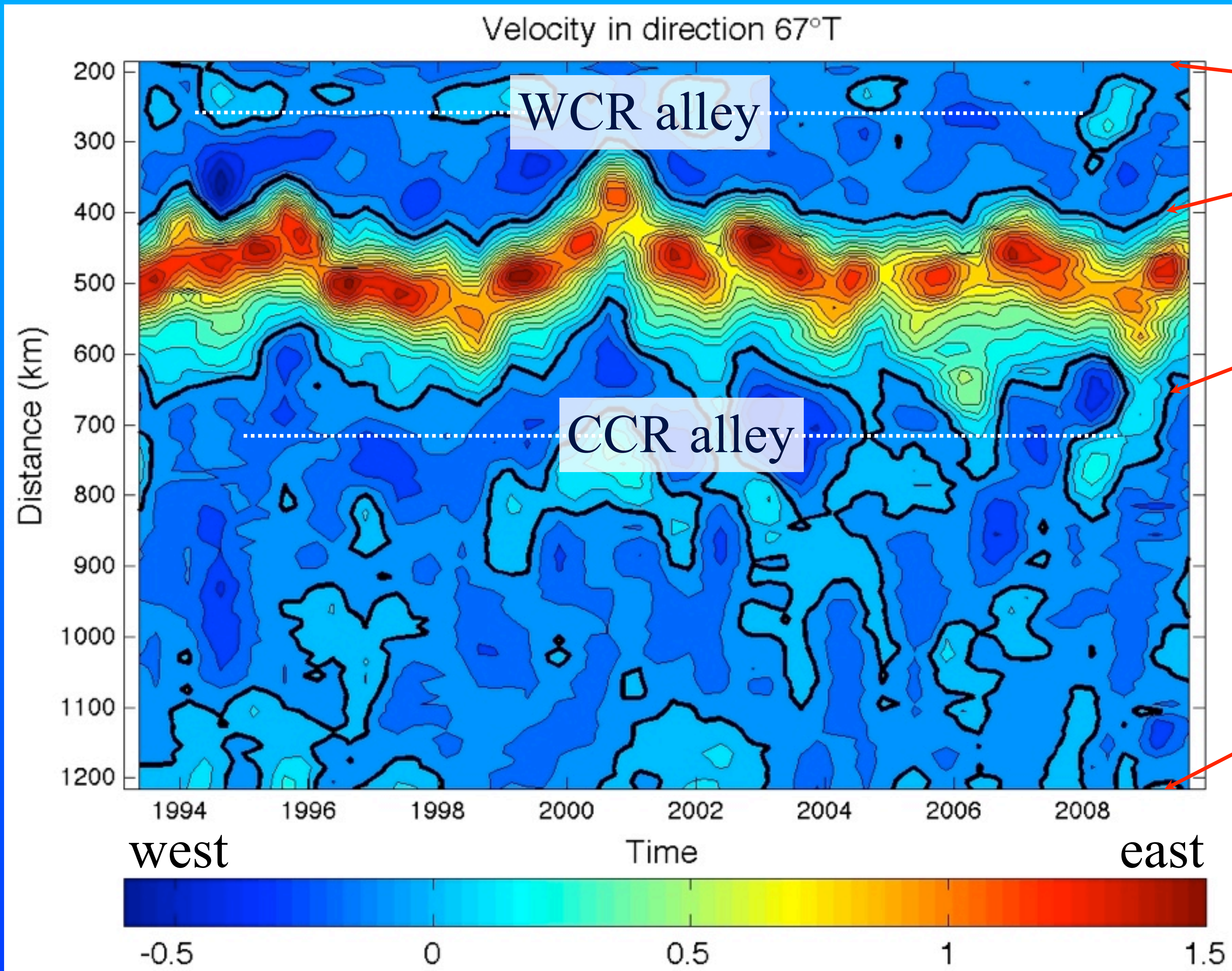

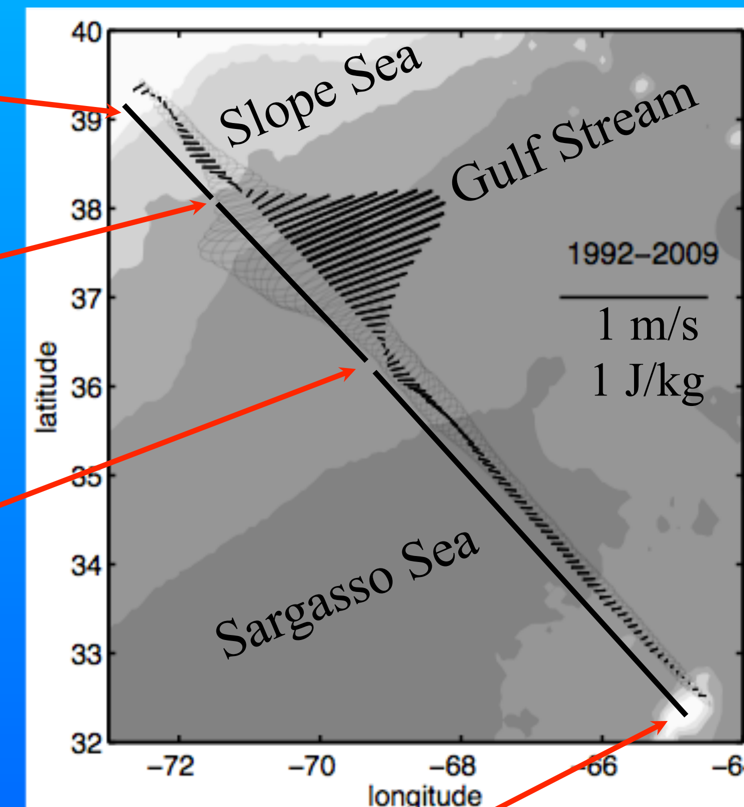

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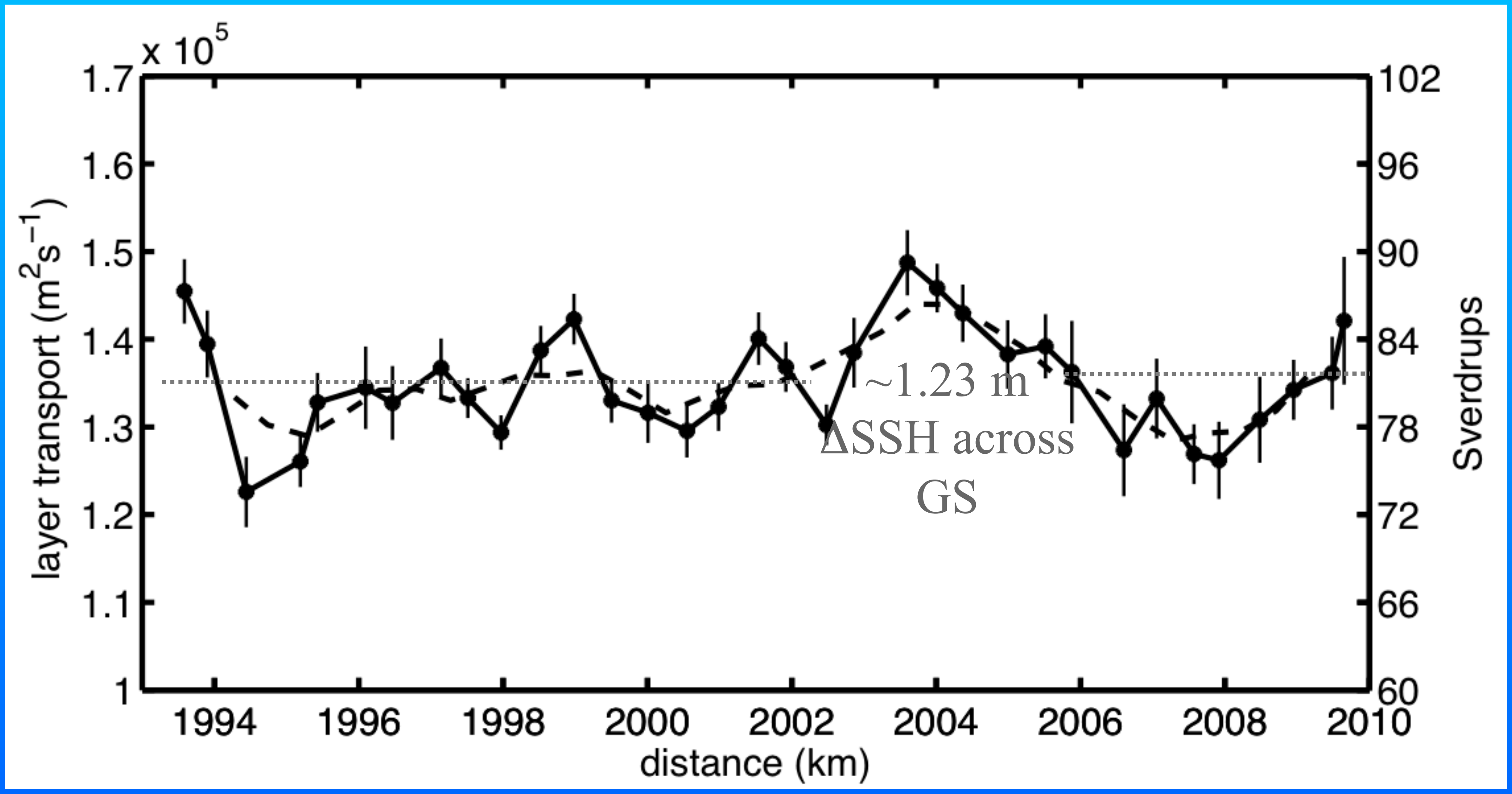
Gulf Stream transport in natural coordinates:

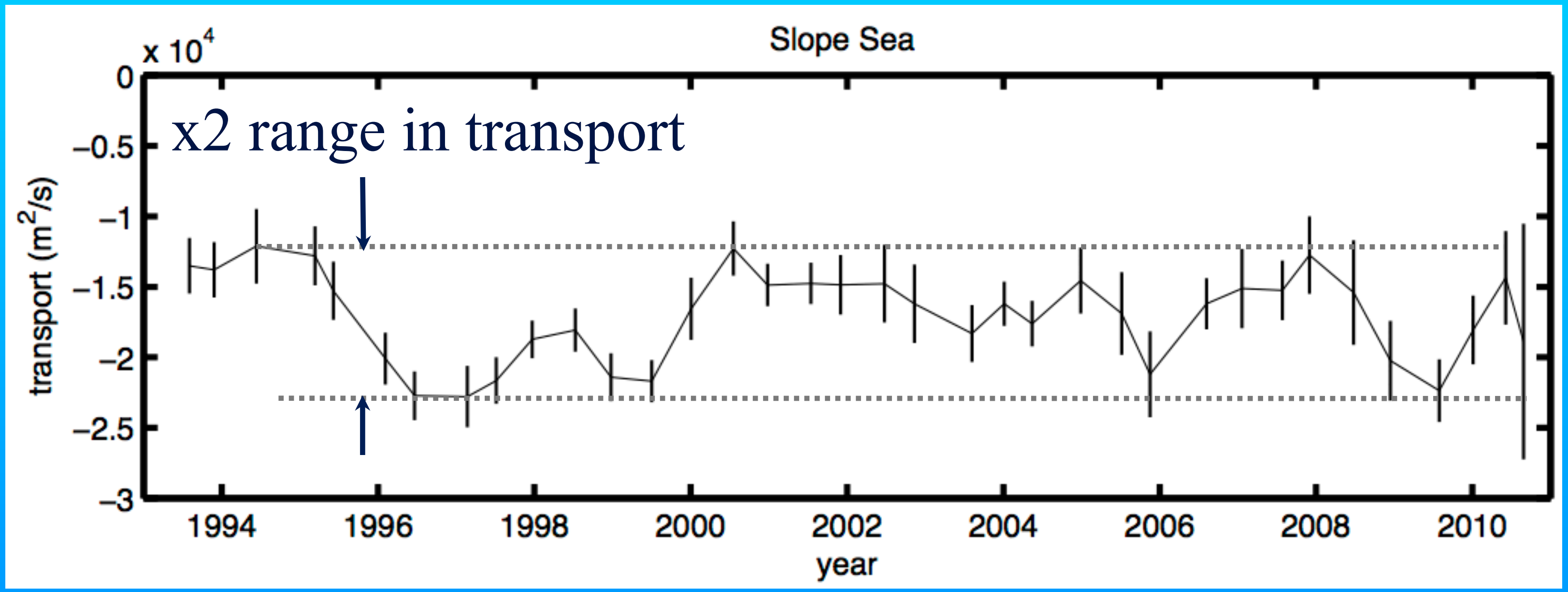
Layer Transport



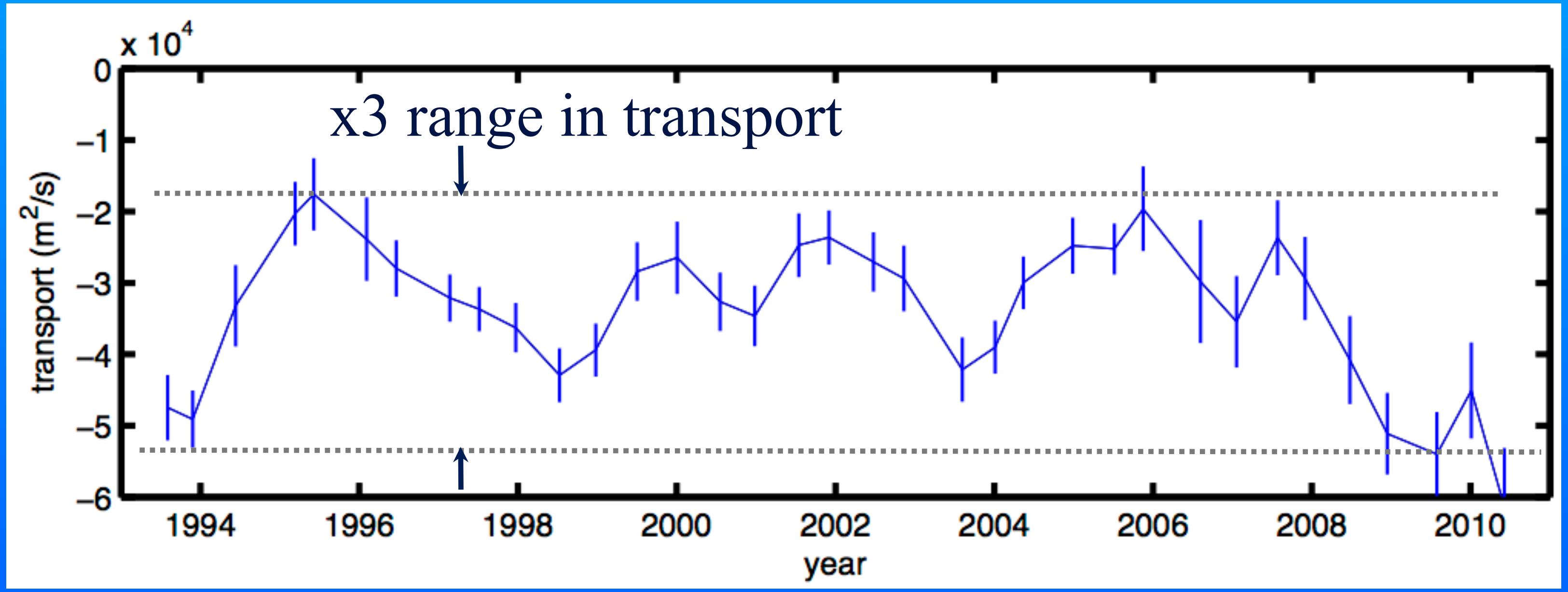
0-2000 m transport ~LT*600

RMS interannual variability ~ 3% is clearly quantifiable through repeat sampling. By combining these direct measurements with earlier hydrographic studies we know that Gulf Stream transport has been quite stable (little/no secular trend) over the last 80 years.

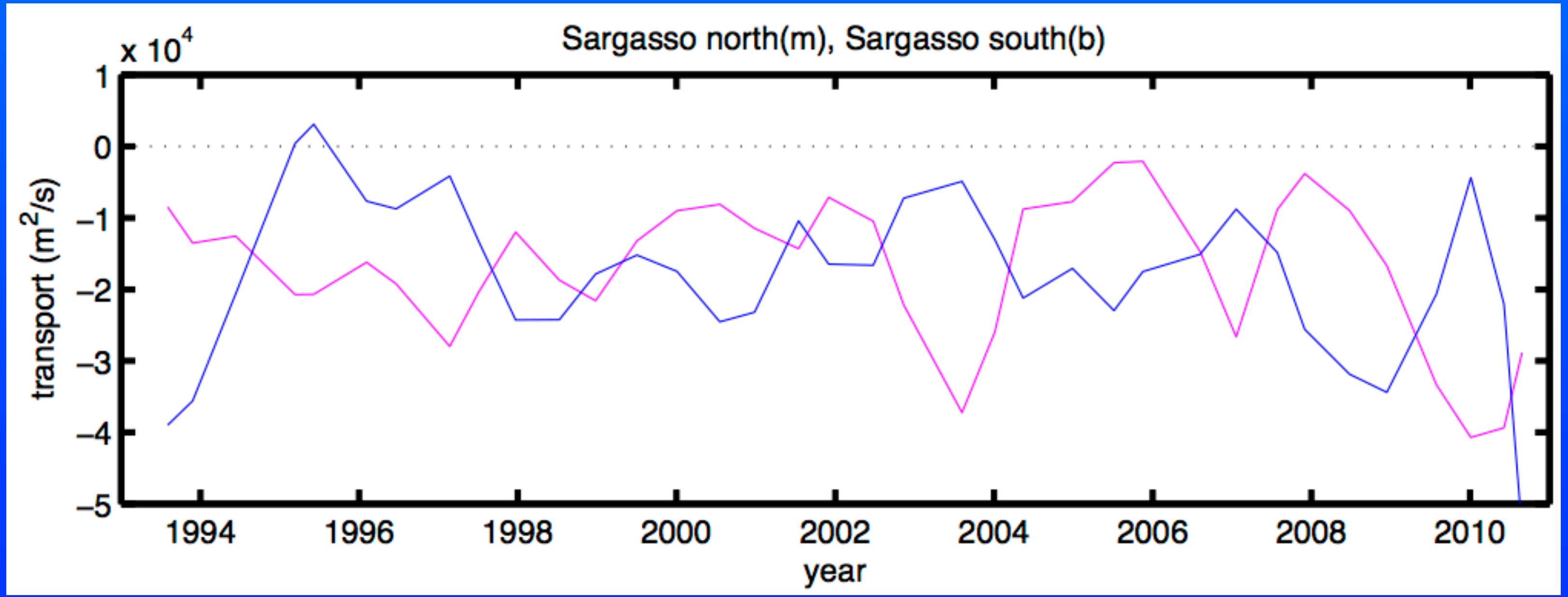
Interannual variability



LT: 1.8×10^4 m^2s^{-1} ~ 18 Sv if extended to 1000 m. Note factor 2 range (mostly thermohaline?).

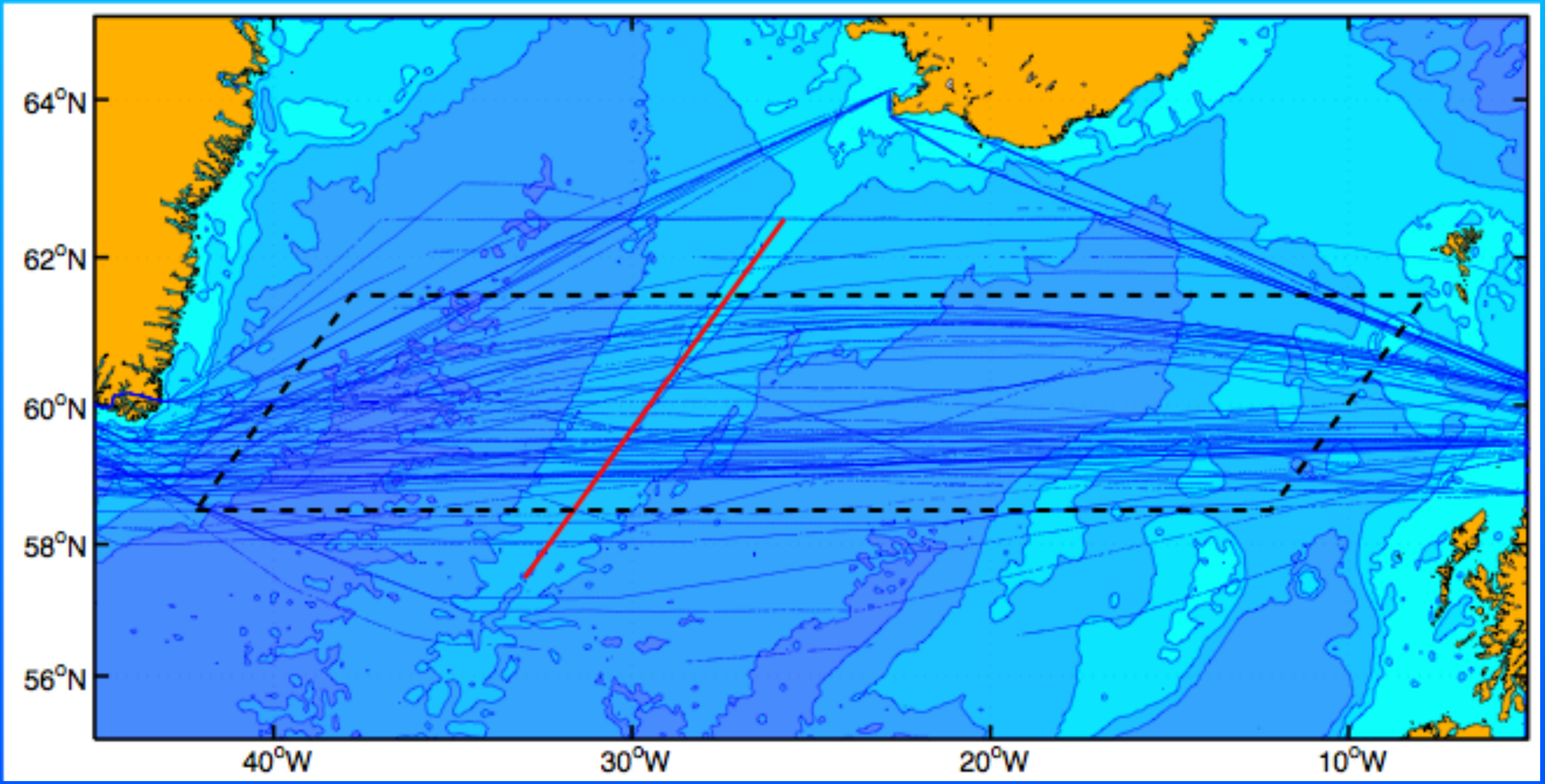


LT: 3.2×10^4 m^2s^{-1} ~ 32 Sv if extended to 1000 m. Note factor 3 range (mostly wind-driven?).

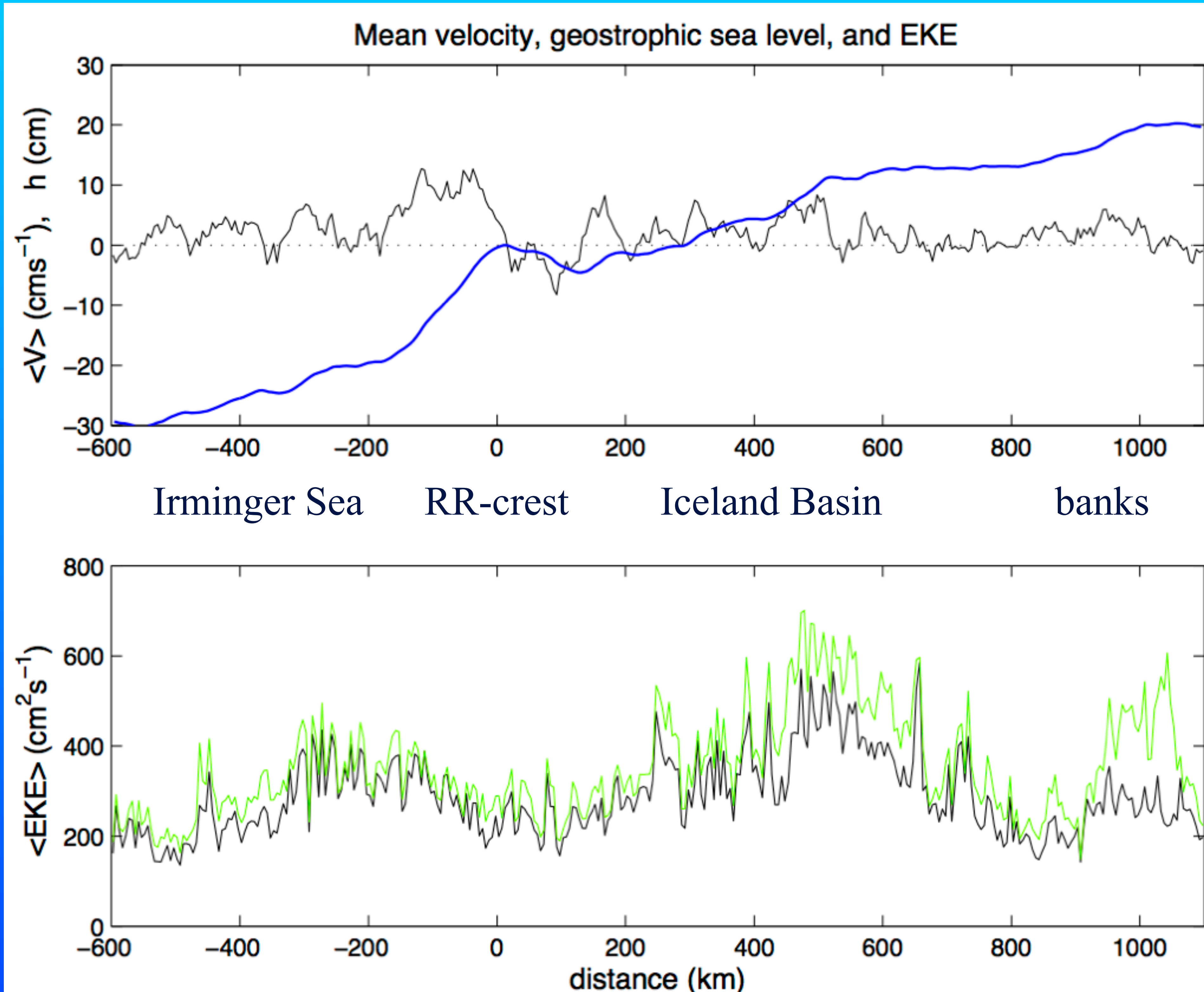


Northern and southern Sargasso Sea transport strikingly out of phase.

The 1999 - 2002 Nuka Arctica operation - restarting now



The results are organized in terms of zonal distance from ridge crest.



Mean velocity every 5 km.
Geostrophic sea level.

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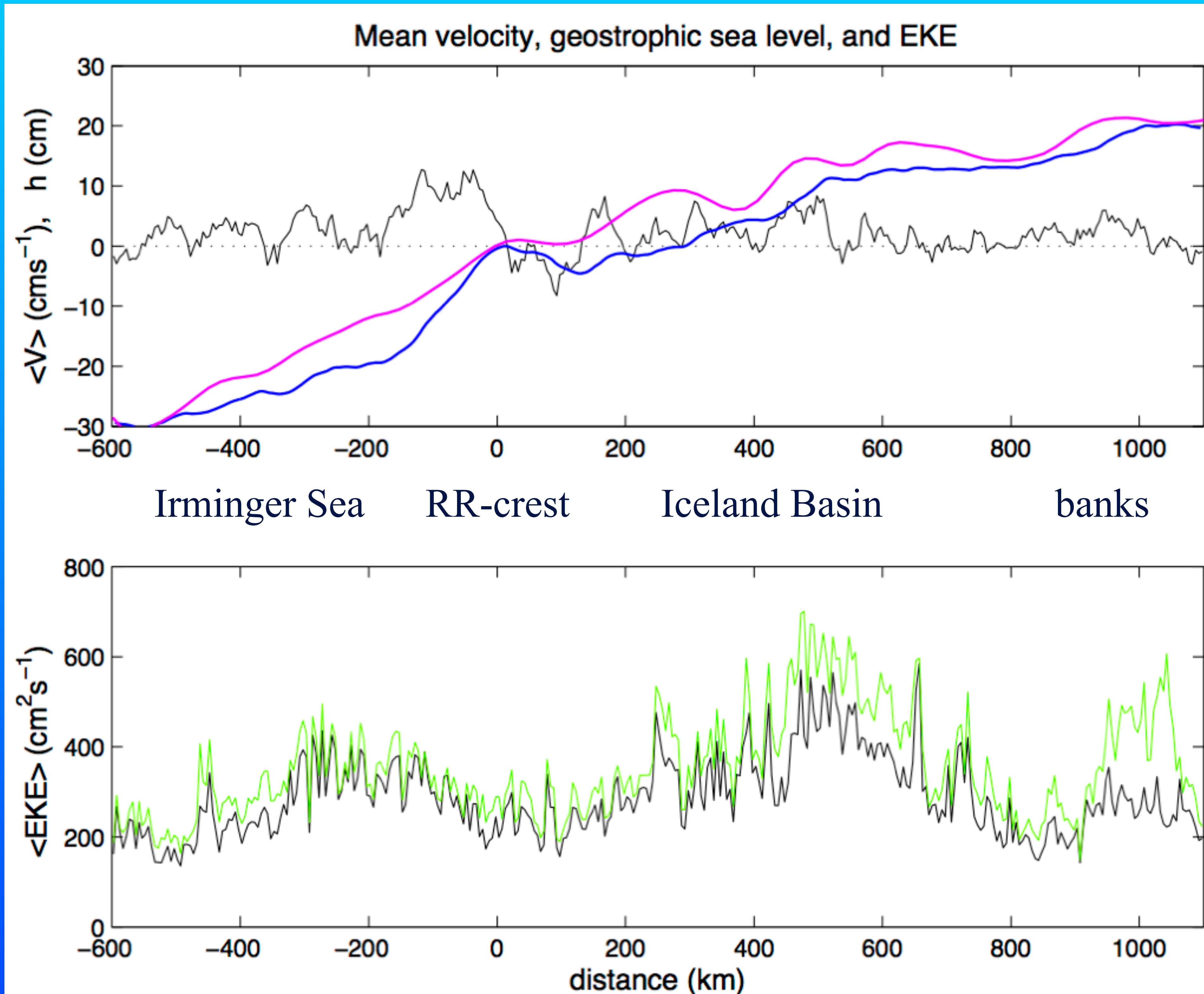
before
after
detiding.

~10 sections/year for a total ~ 42 used here



Mean velocity every 5 km.
Geostrophic sea level.
AVISO 4-yr mean SSH.

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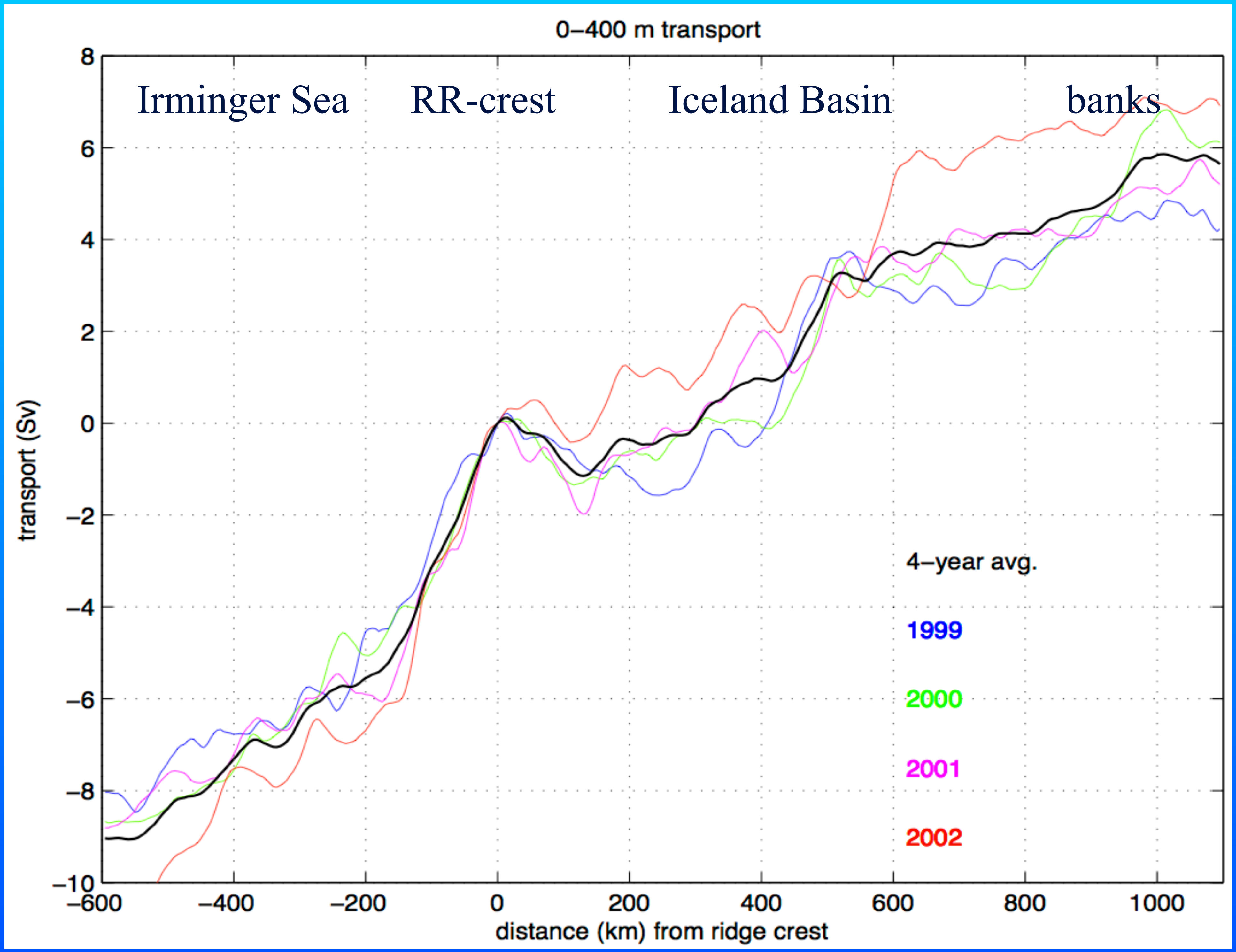
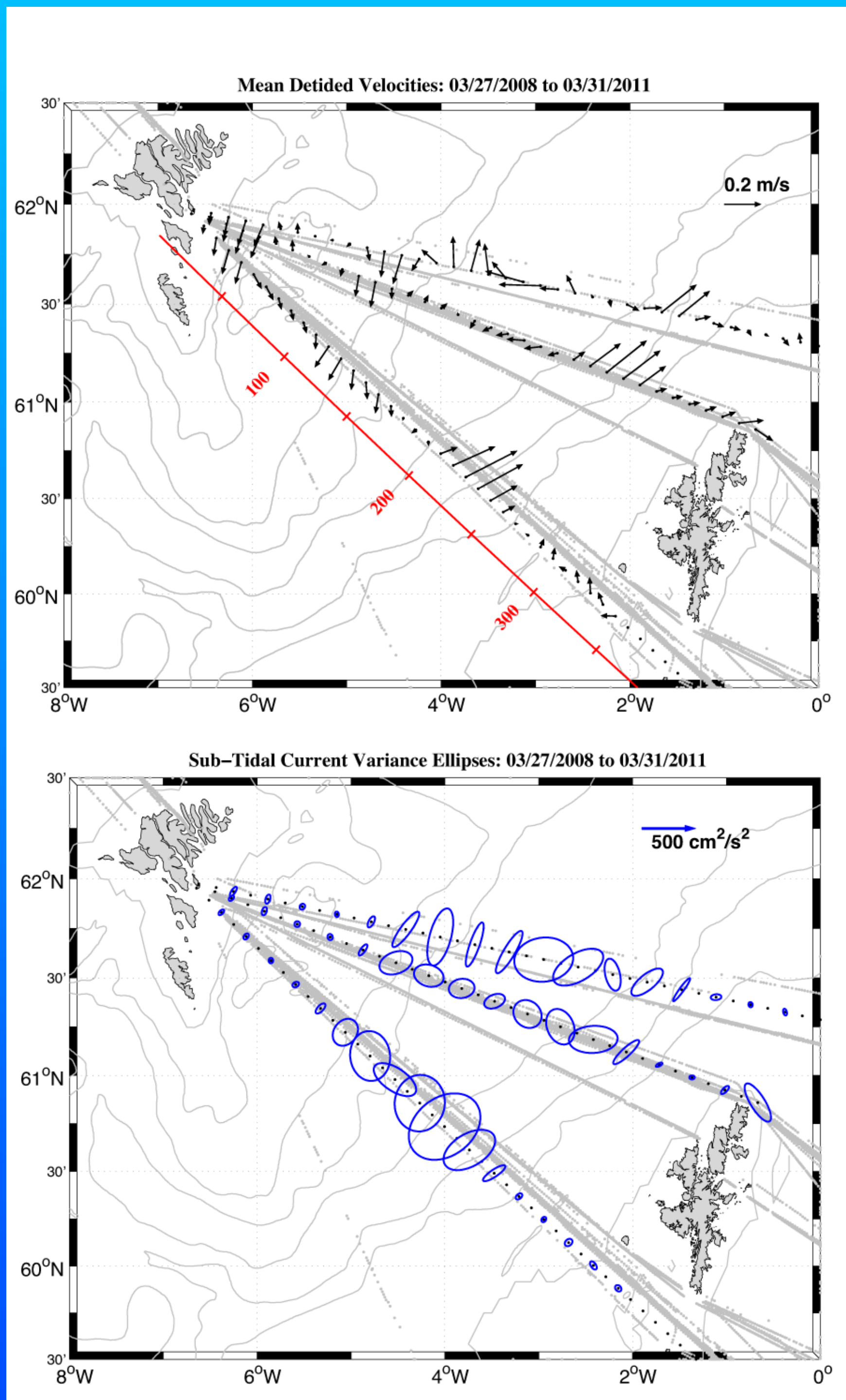
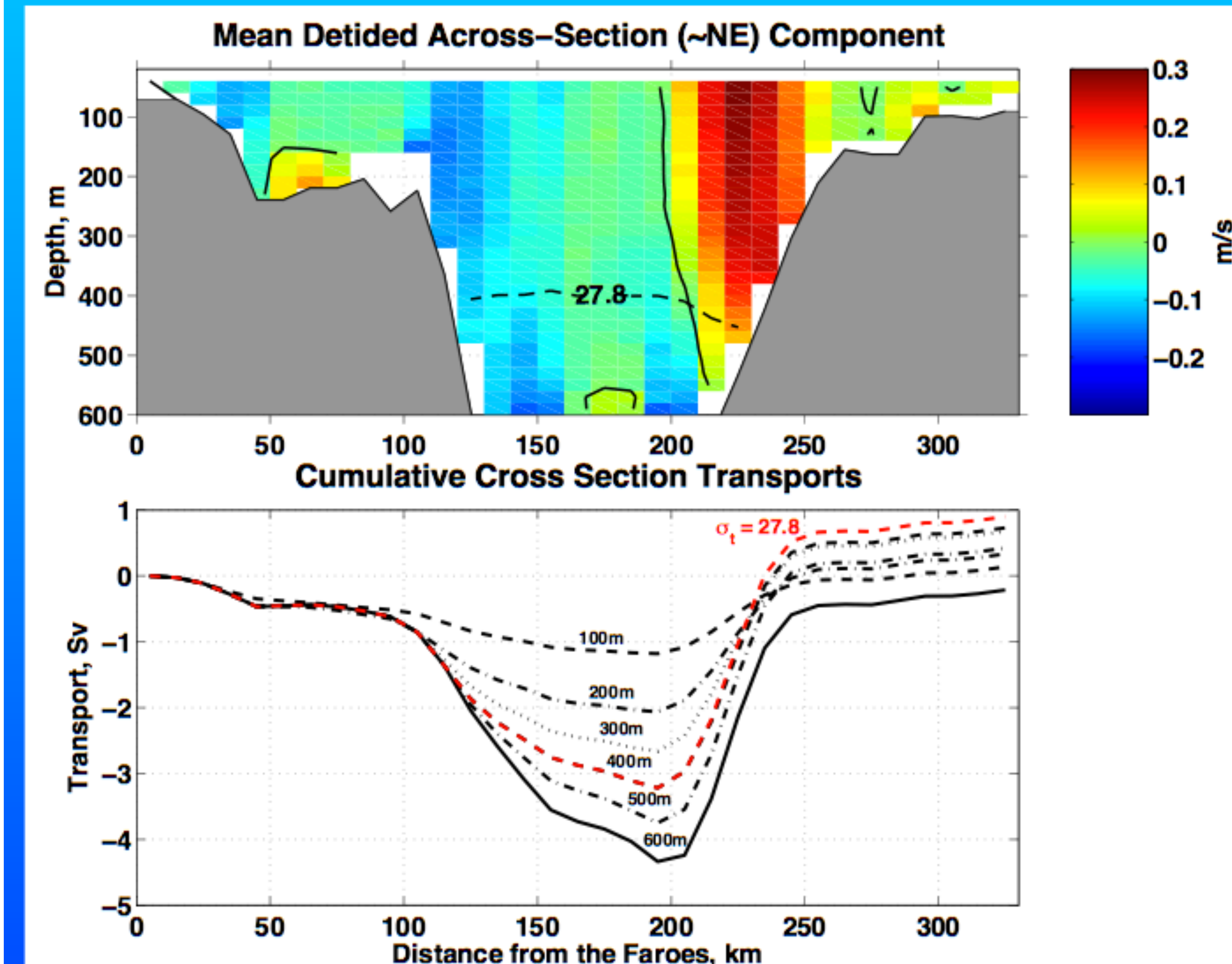


0-400 m volume transport for each year and overall average (this does not include Slope Current, TBD).

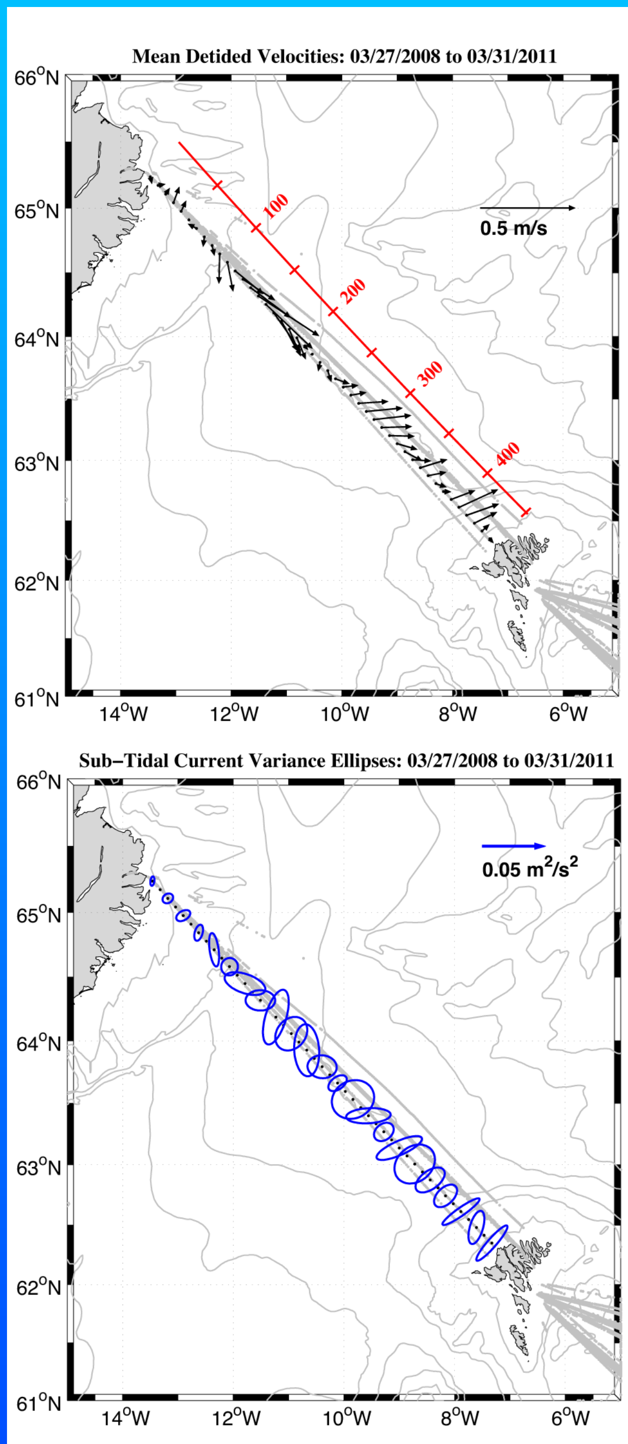
The Norröna operation - ongoing since 2009

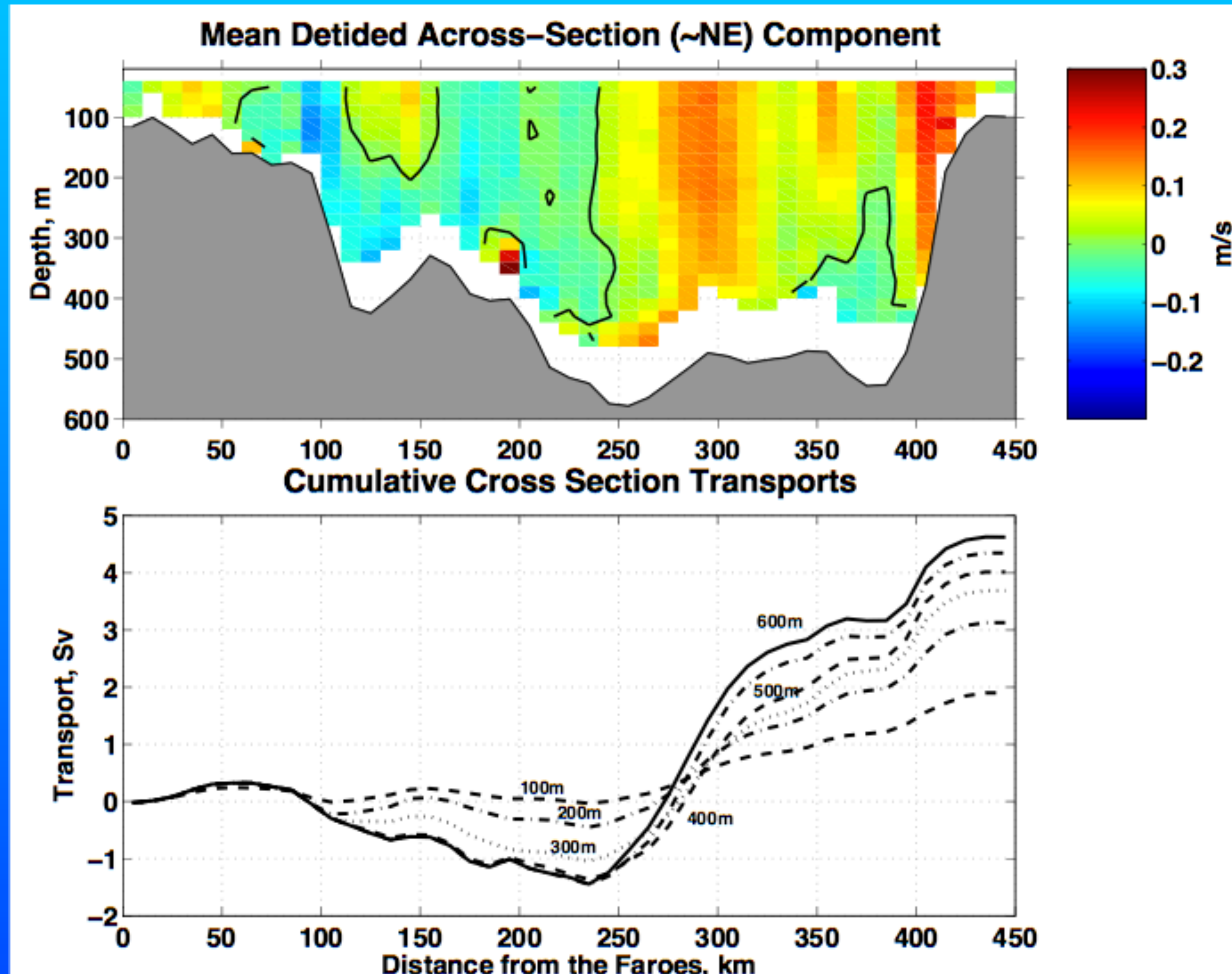




Faroe-Shetland Channel: well-defined Slope Current, strong tidal circulation around the Faroes.

The Norröna operation - ongoing since 2009



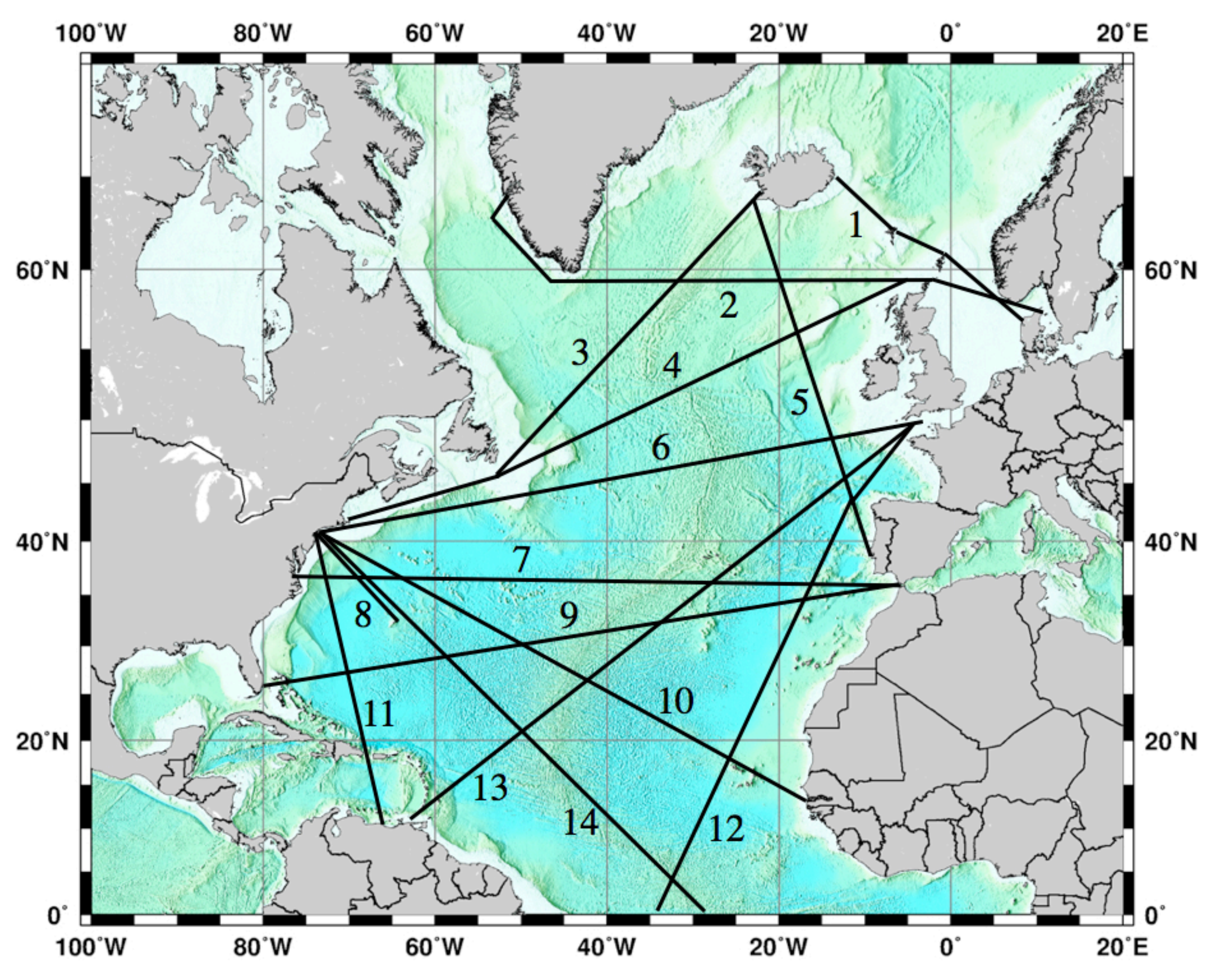


Iceland-Faroe ridge: well-defined inflow, strong tidal circulation around the Faroes, outflows in west and at depth.

Norröna project summary to date:

	Volume flux (Sv)			Heat flux (TW)			Salt flux (kg $s^{-1}*10^8$)		
	Net	north	south	Net	north	south	Net	north	south
Sum	3.6	10.1	-6.5	176	287	-111	1.19	3.34	-2.15

Total inflow = 10.1 + 0.8 (west of Iceland) = 10.9 Sv.
Subtract from this 1.6 Sv Faroes tidal component for a net 9.3 Sv entering and circulating through the Nordic Seas.



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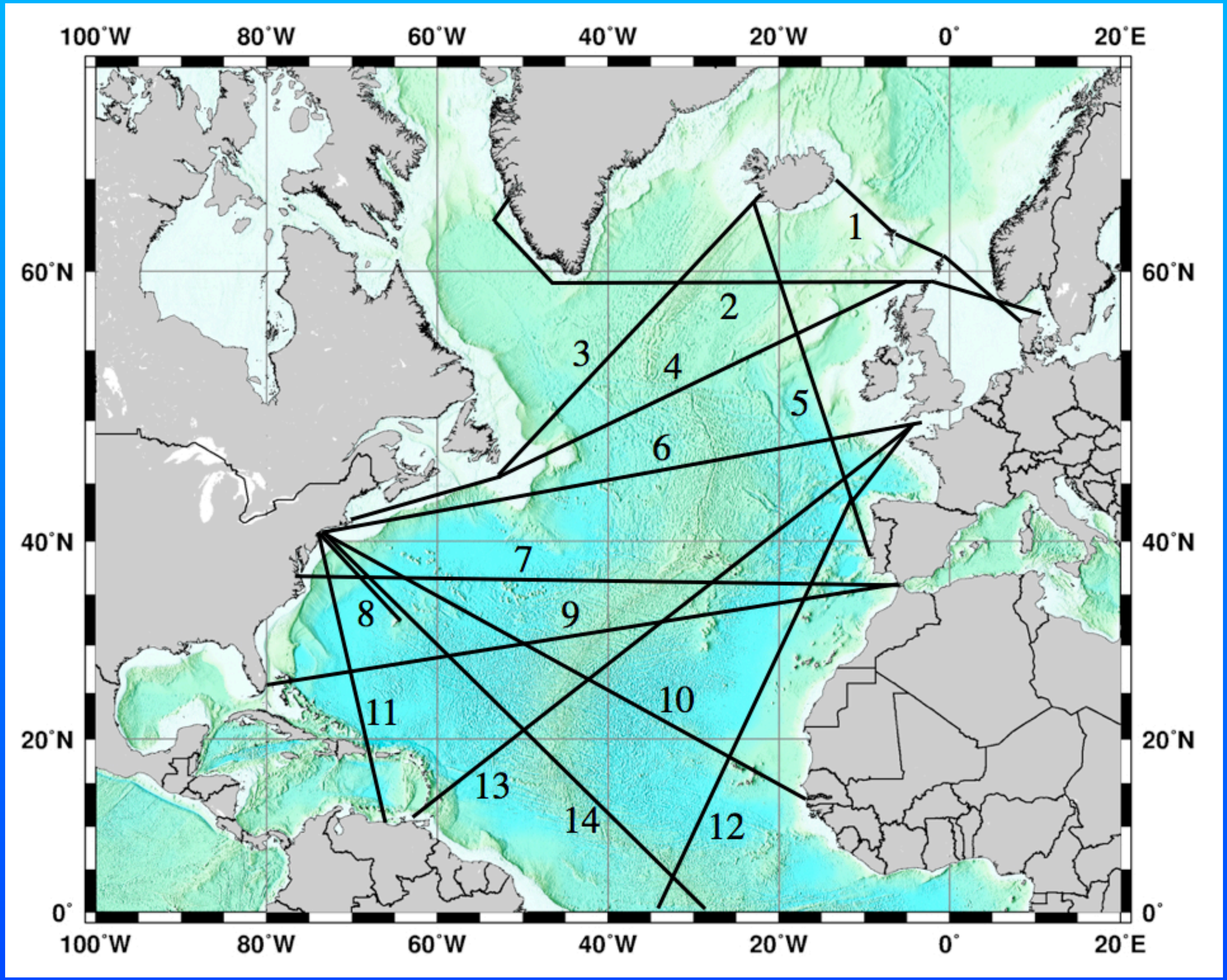

Thank you!

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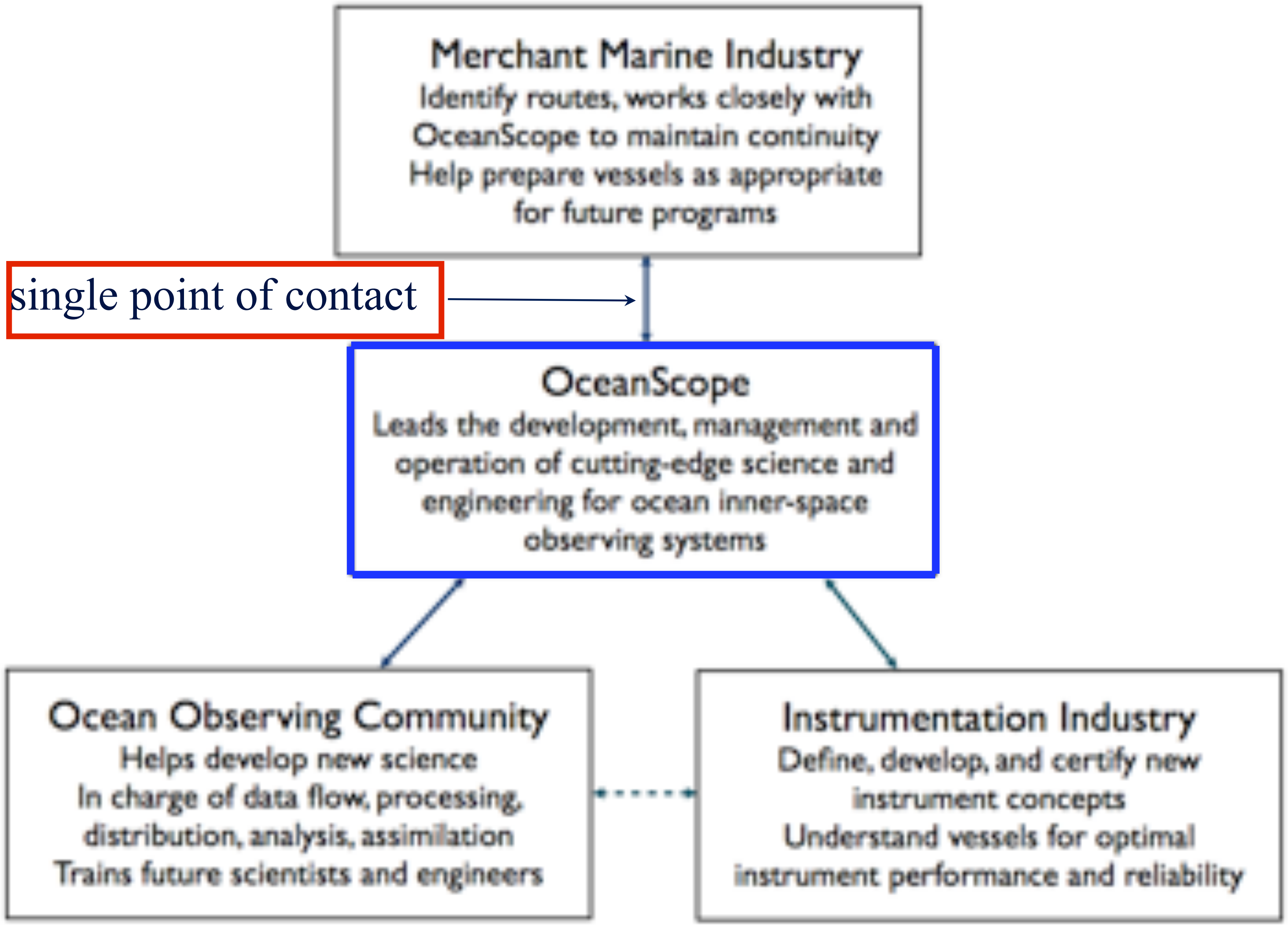
Proposed OceanScope structure



single point of contact

data freely available in realtime

market incentives

Implement through an international NGO

Phase One over 5 years with full infrastructure then in place:

Hardware/installation costs with CO_2:	20 x 0.5	~10M$
Operating costs: 20 ships x 2 years (full operation)		~9.8M$
Telemetry costs (1 kB = 0.20$, 25 kB/day)		~0.1M$
OceanScope office:		~7.5M$
Total 5-year cost:		~28M$

For 100 ship global operation:
Installation ~50M$, Operation ~25M$/yr.