OceanScope: Satellites of the Sea

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What is truly unique about the OceanScope concept is its proposal to directly measure ocean currents, to create synergies by integrating circulation measurements with simultaneous present and next-generation chemical and biological measurements and to freely distribute these data to the international research and operational ocean communities.

“OceanScope” Vessel Capabilities

Near Surface Properties/Met Data – AMOS
ADCP(s) – supplementary GPS/B_T
Automated XBT launchers

……..
pCO2 systems
M-AERI
Full VPN connection to shoreside?

AMOS Installation

- Located in bow thruster space

PARAMETERS

- Sea Surface Temperature
- Sea Surface Salinity
- Tuner Designs C6
  - DOM
  - Chlorophyll *a*
  - Turbidity
  - Phycoerythrin
  - Crude Oil
  - Optical brighteners
- pCO_2 (separate module)

AMOS Technology

- Uses “off-the-shelf” components
- Uses National Instruments cRIO Real Time Controller (as opposed to running from a computer system)
- Program is burned into memory
- Critical functions are executed in an FPGA, improving reliability
- Written in LabVIEW Graphical Programming Language
- Bio-fouling controlled through fresh water flushing and mechanical wipers
- Turns on and off automatically when entering and departing ports (exclusion zones)

The AMOS “advantge”

- Leak detection: automatic shutdown with audible and visual alarms
- Pressure monitoring: programmable over pressure level signals automatic shutdown
- Bypass valve: programmatically regulates system pressure and flow
- Air bound system: provides pump protection depending on sea state, conditions
- Exclusion zones: system turns on and off automatically based on predetermined lat/lon coordinates
- Network Camera: real time observation of system and valve states
- Extensive monitoring:

  1) Allows diagnosis of problems with system state
  2) Permits instruction of shipboard personnel to perform maintenance

Our Current "Fleet"

CMV/Oleander (BCL)

M/S Norröna (Smyril Line)

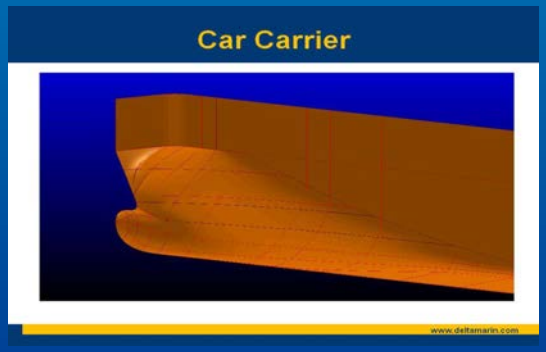
CMV/Nuka Arctica (Royal Arctic Line)

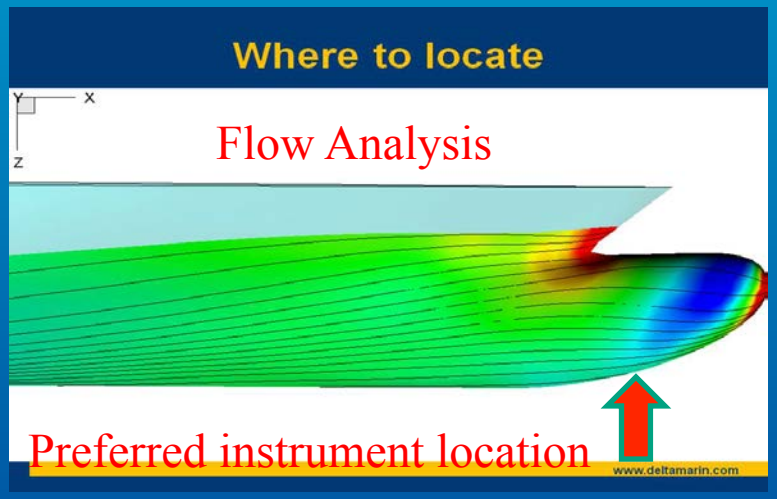
Allure of the Seas (RCCL)

Equinox (Celebrity)

Harmony of the Seas (RCCL 3/2015)

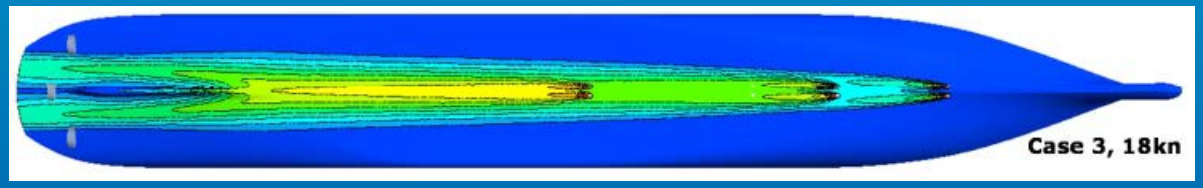
Hull Types and Installation Options



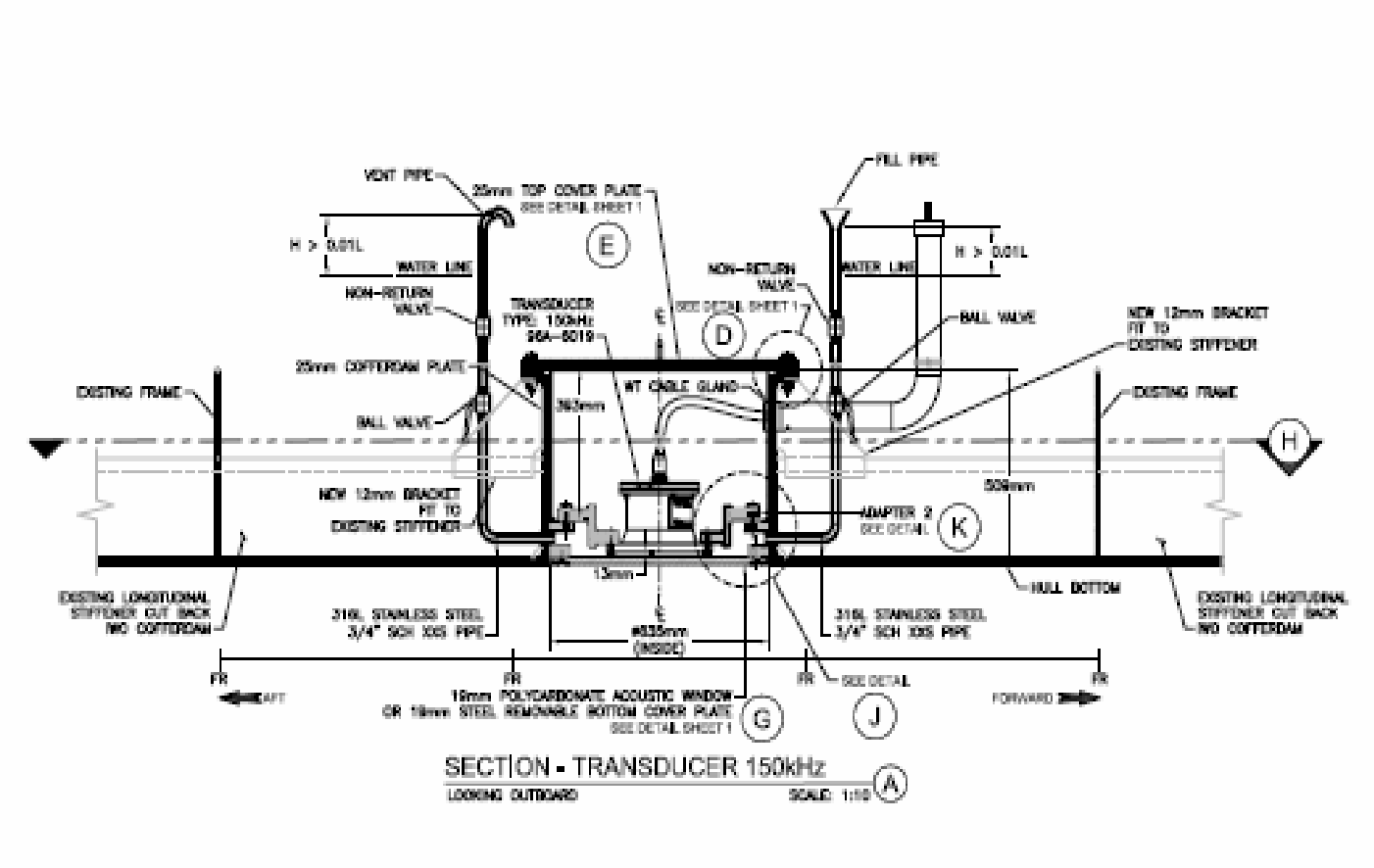


Representative Vessels

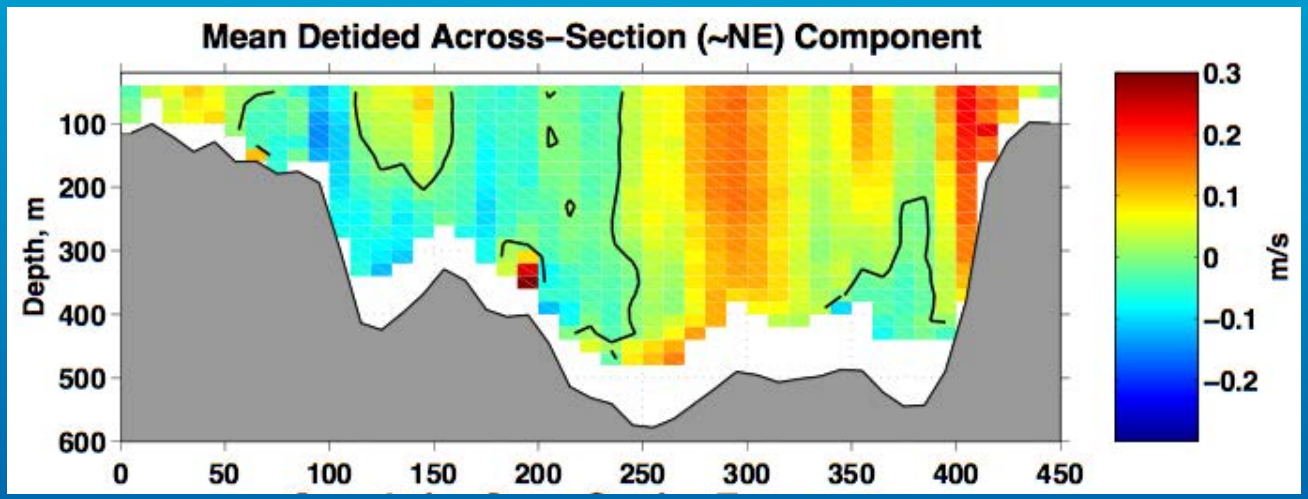
Bubble Sweepdown Issue



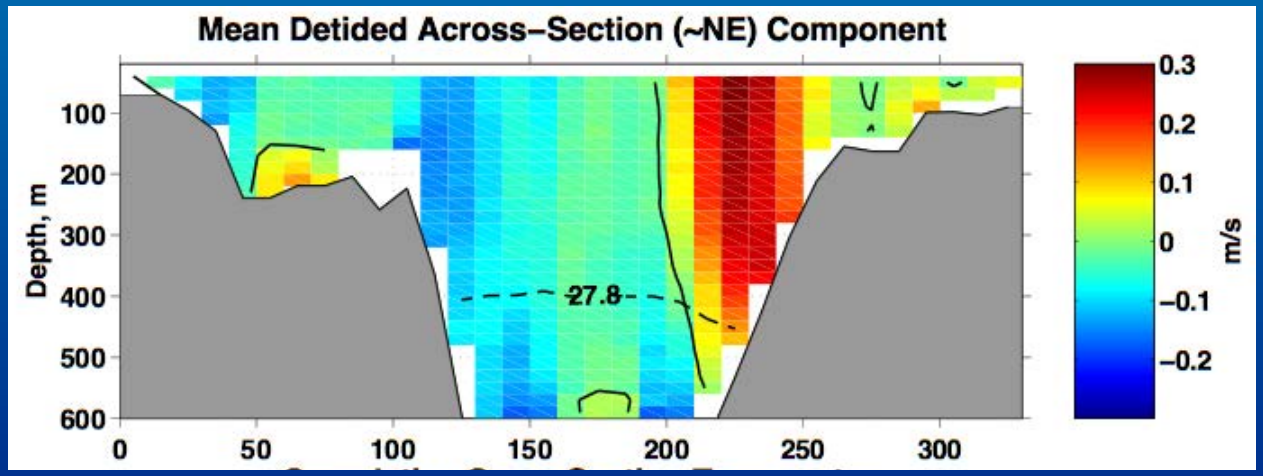
Modular ADCP Installation



Repeated ADCP lines can be used to Estimate Transport



Iceland-Faroe mean north flow = 4.5 Sv



Faroe-Shetland mean north flow = 4.1 Sv

Directly estimated inflow into the Nordic Seas between Iceland and Scotland = 8.5 Sv.

To Quantify GS Variability

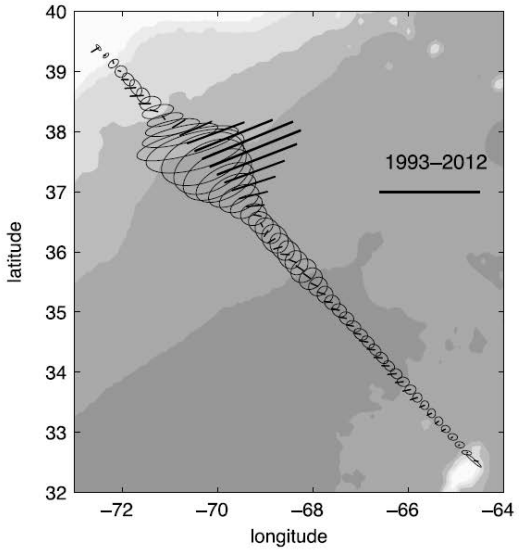
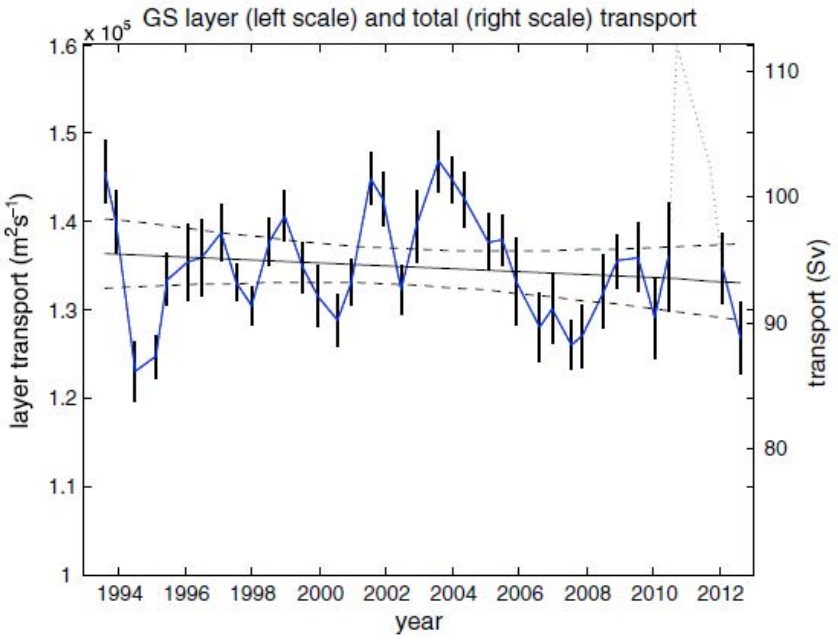
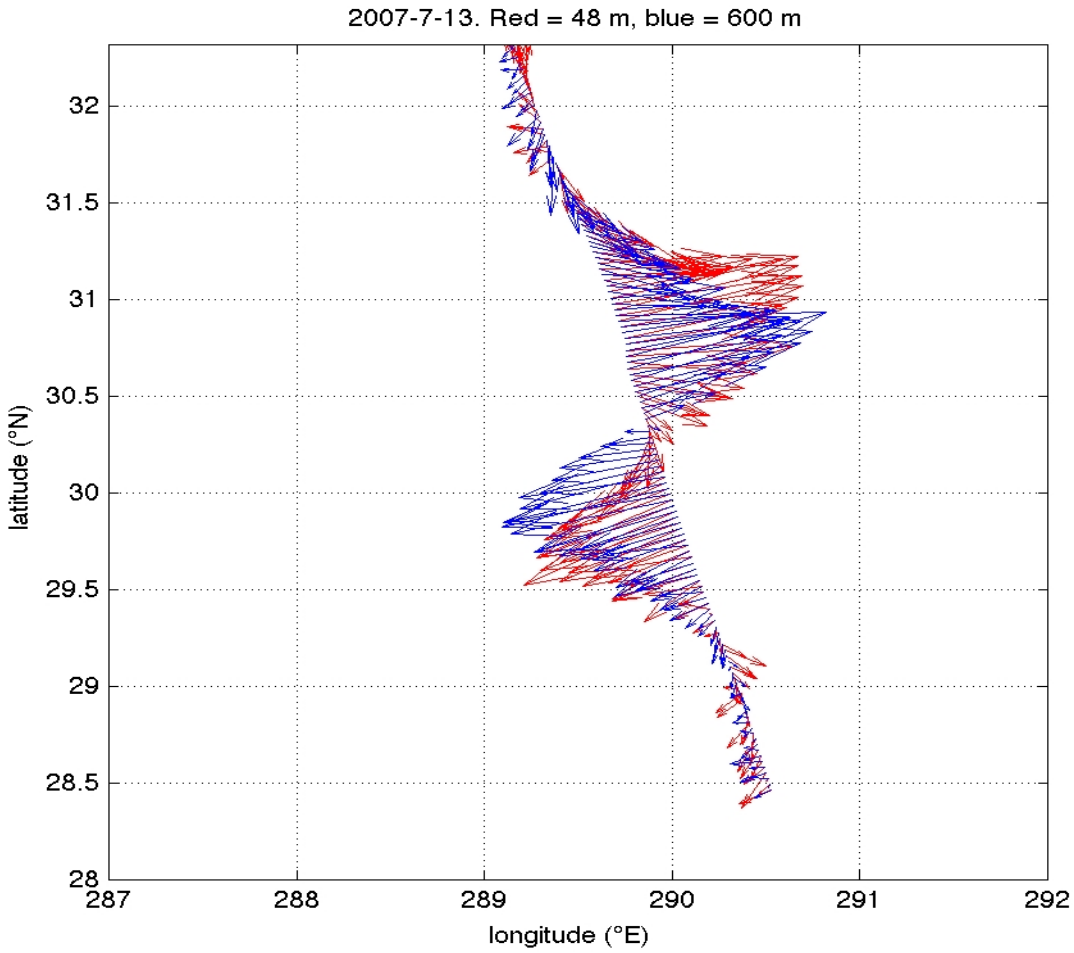


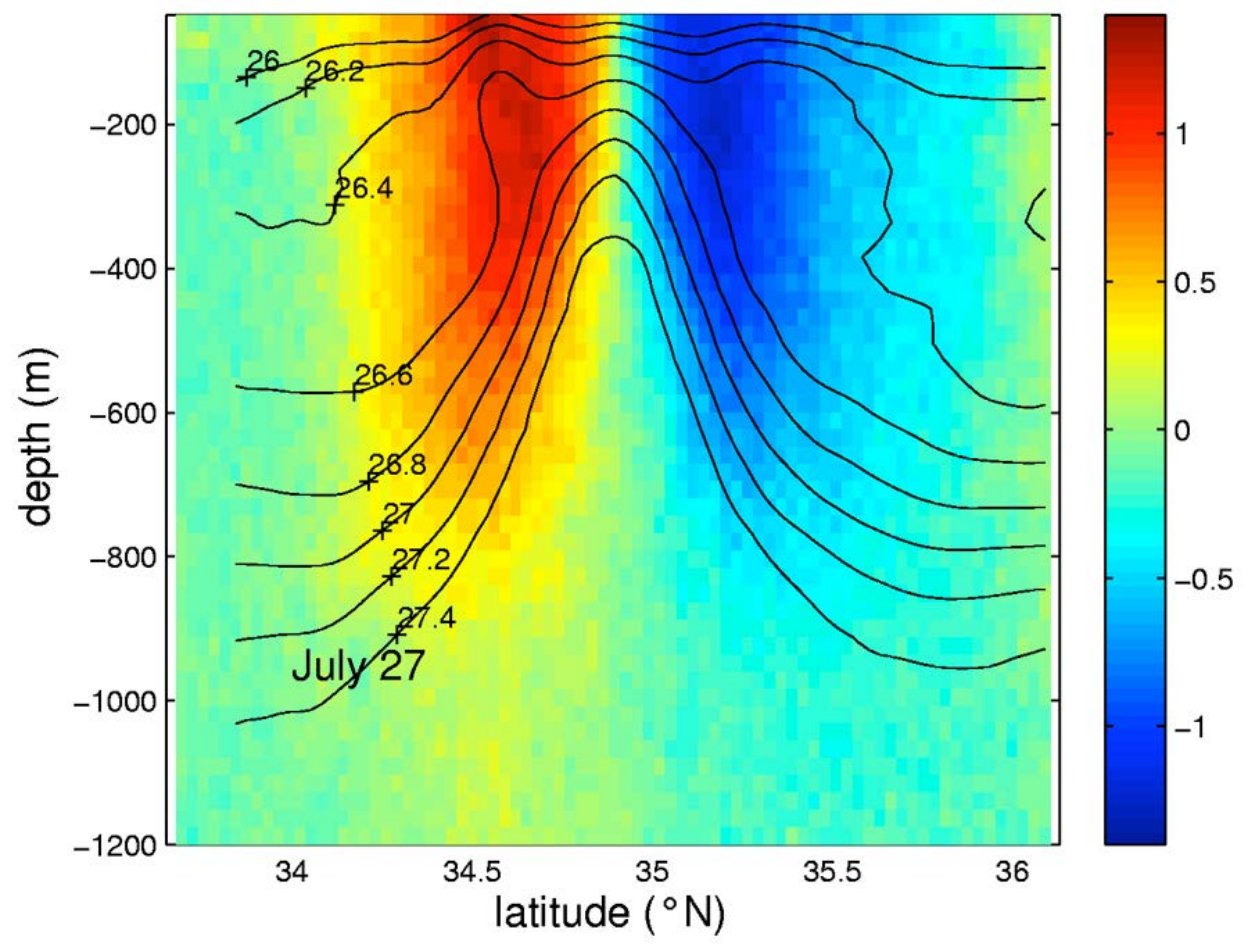
Figure 1. Mean velocity and variance ellipses between the mid-Atlantic Bight shelf break and Bermuda at 52/55 m depth for the 1993–2012 period. The bar corresponds to 1 m s^{-1} and 0.5 m^2 s^{-2}, respectively. The depth contours range from 1000 to 5000 m.



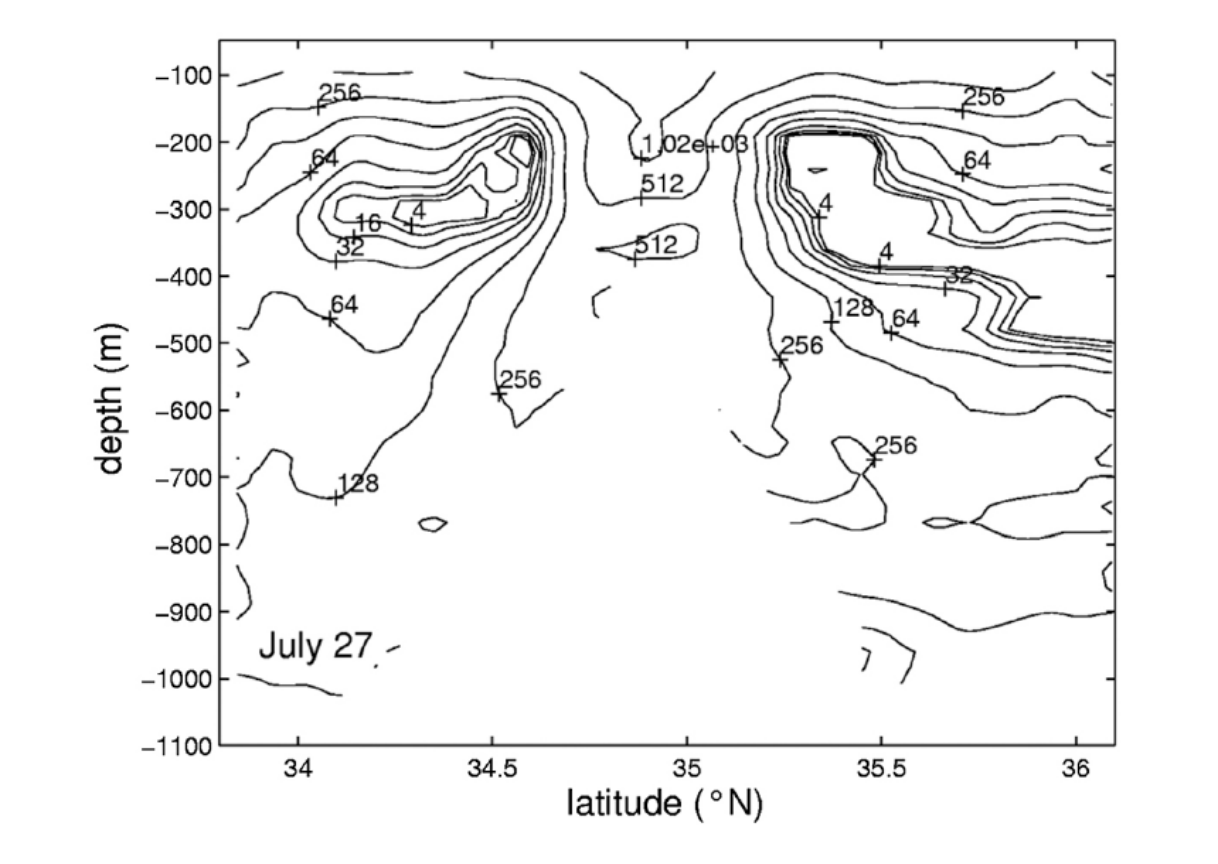
To Measure Mesoscale Eddy Velocity



Good enough velocities to estimate density



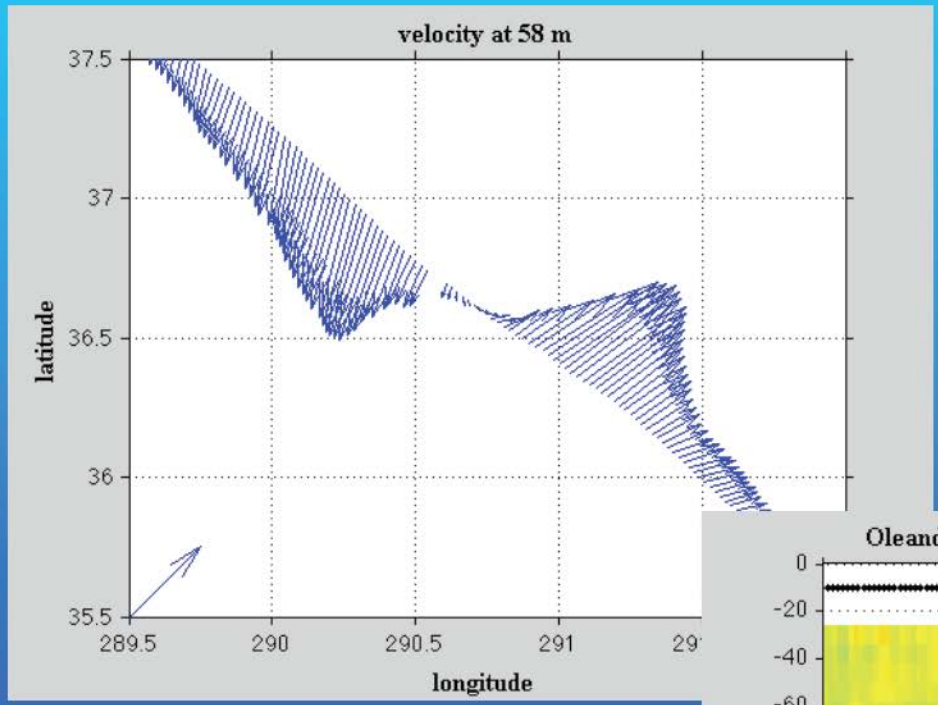
Good Enough for Potential Vorticity

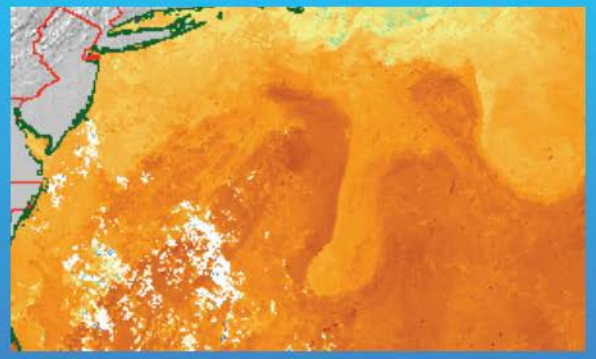


But I am a Biological Oceanographer:

An ADCP yields not just Doppler Shift
but also Signal Strength !!

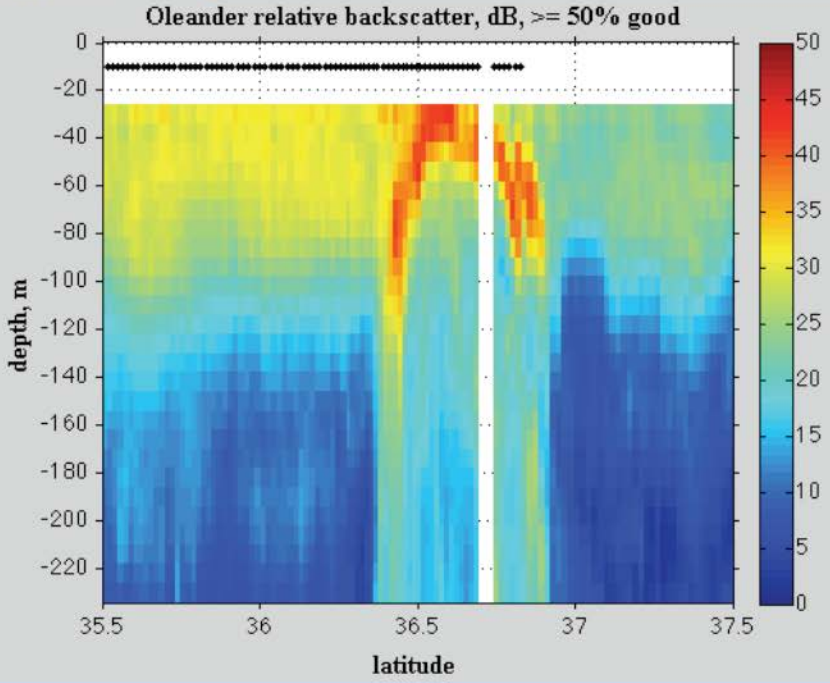
CCR Zooplankton at the GS Front



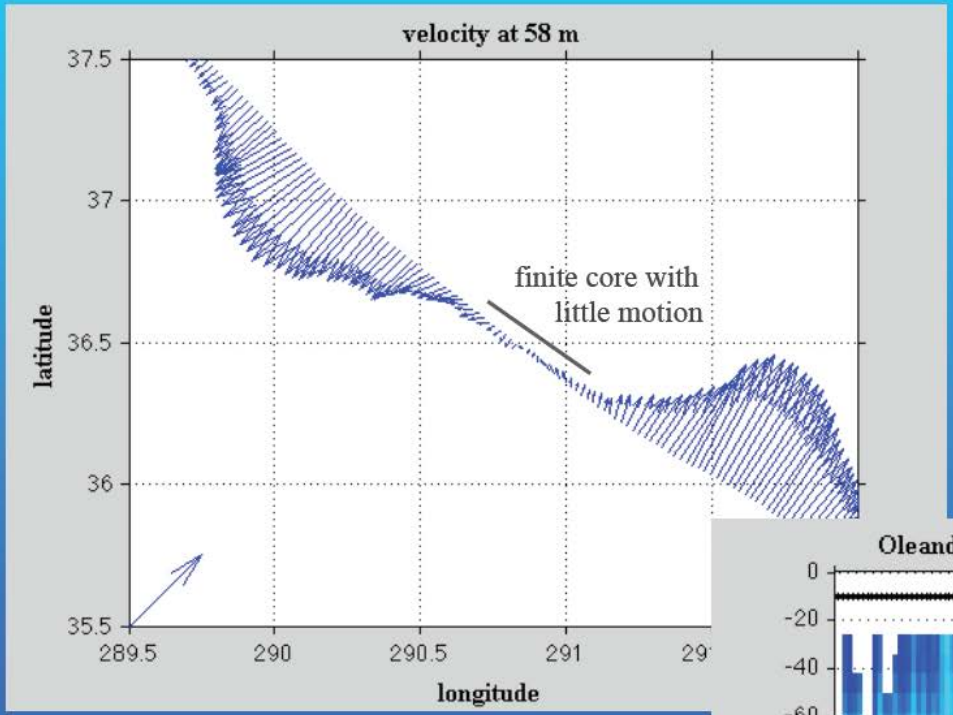


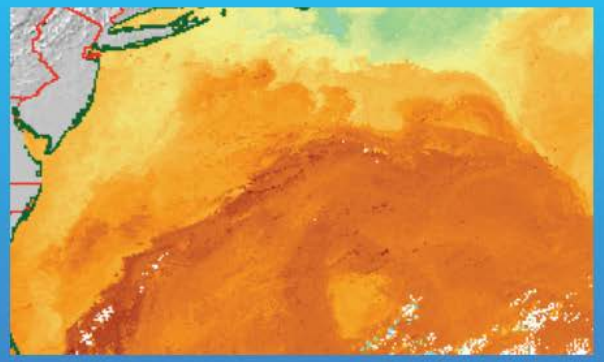
September 2, 2000

Slice through GS trough shows sharp biomass boundary between Slope and Sargasso waters.



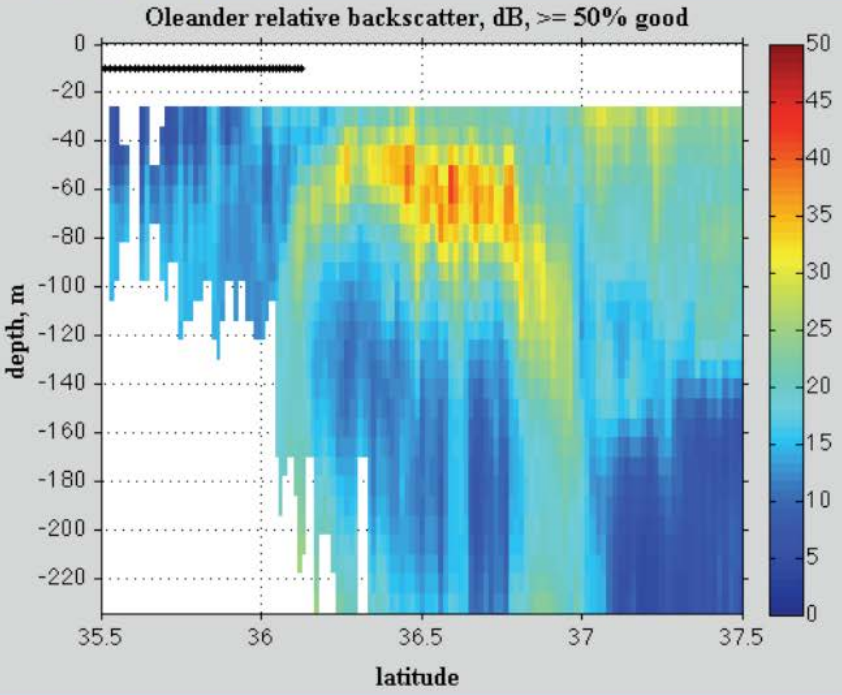
CCR just 1 week later





September 9, 2000

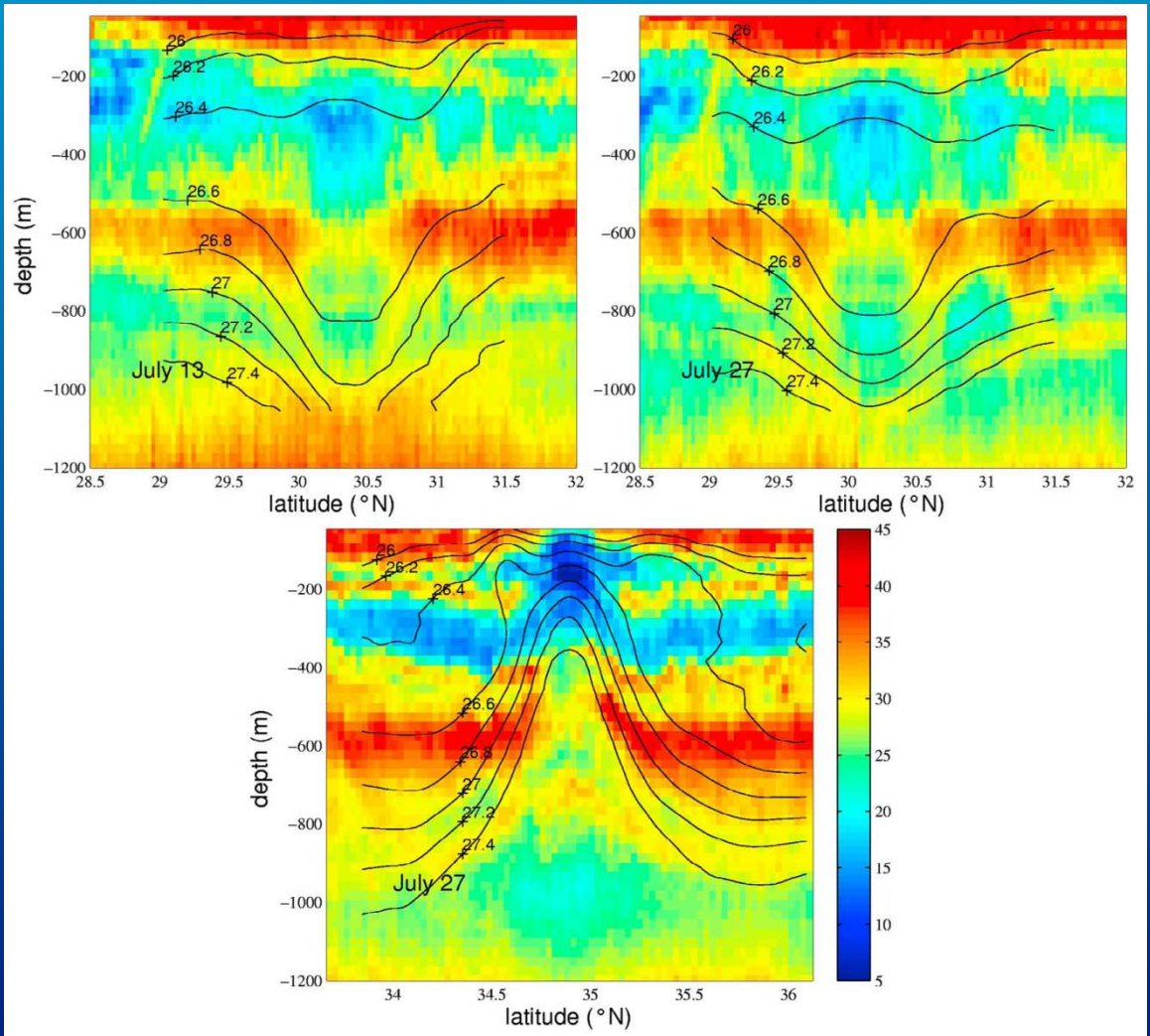
1 week later nascent CCR shows remnants of GS structure: ring current and quiet center



More than just the plankton…

Mesopelagic Fish

Mesopelagic Biomass SS (38KHz)



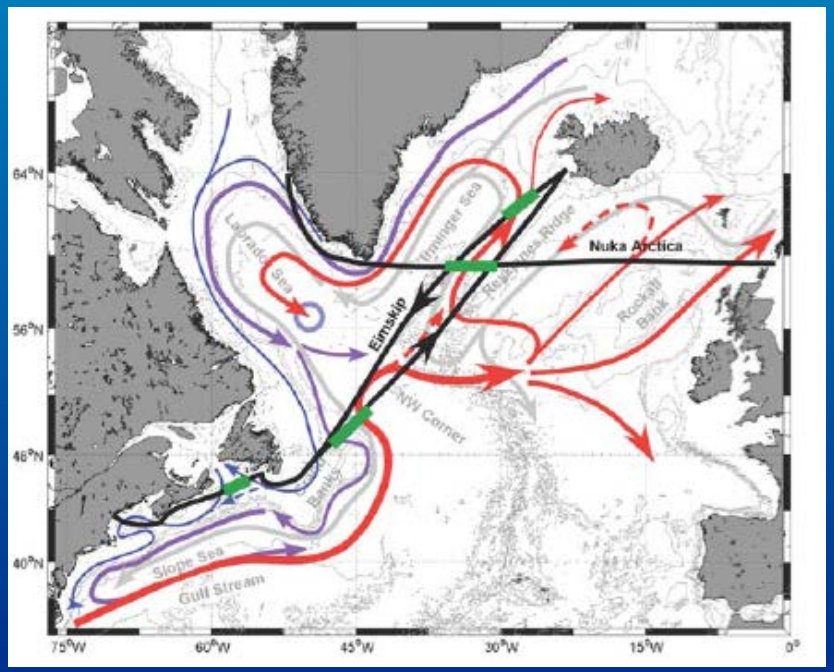
Anti-Cyclonic Eddy

Cyclonic Eddy

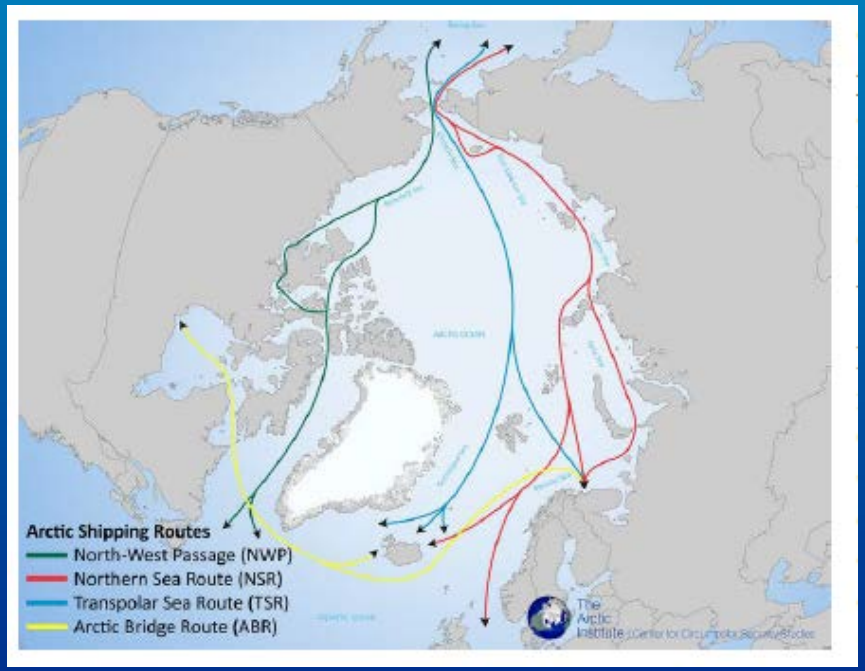
A Highly Counter-Intuitive Result !

Emerging Opportunities to Expand Our Fleet

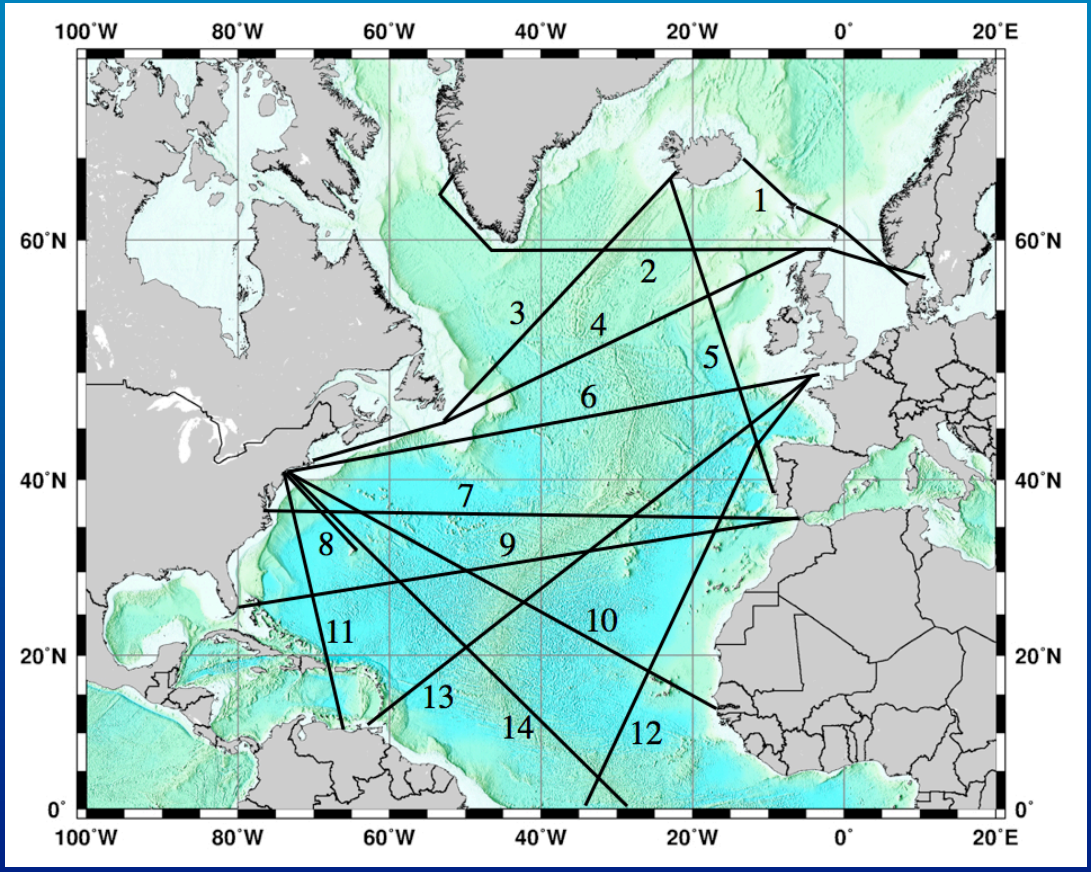
Elm-Skip / NSF



Arctic Ocean / S.Korea



Beginning to Populate OceanScope Phase One



Promising Technology Developments

- AutoXBT Launcher Options
- Improved Expendable Probes - Climate Quality Physics (CT) and BioChemical Parameters (pH, O2, Chlorophyll)
- UHDAS for OceanScope
- Dual Frequency/Adjustable Beam Angle Phased Array ADCPs

Conclusions

Realizing OceanScope could open up entirely new fields (of oceanic properties) for detailed and quantitative description.

OceanScope can provide unique information complementing research fleet and GOOS

Progress Slow and Timing Terrible

BUT

We are Moving Forward !!

Acknowledgements

NSF

ONR

NASA

Royal Caribbean Lines Ltd.

Celebrity Line

Bermuda Container Line

Smyril Line

QUESTIONS

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