Simulated and Observed Transport Estimates Across the Overturning in the Subpolar North Atlantic Program (OSNAP) Section

2024 CESM OMWG WINTER MEETING

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NSF National Center for Atmospheric Research (NCAR)

08 FEBRUARY 2024

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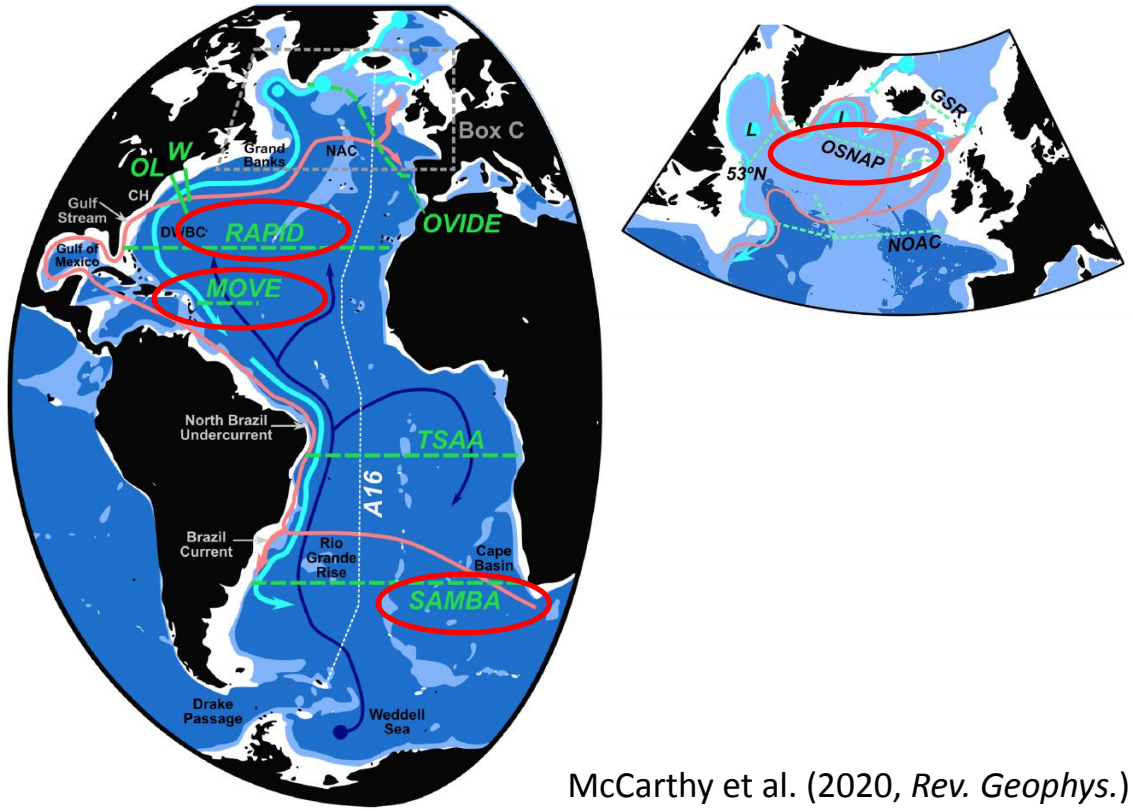
Background

Consistent comparisons of model simulations of AMOC characteristics with those from available observations are essential for i) assessing the quality of our models and advancing their fidelity, and ii) identifying challenges with observations.

A python-based Meridional ovErTurning diagnostIC (METRIC) package is being developed. The package enables consistent calculations of AMOC estimates at several observational sites from ocean general circulation models and is freely available to the community at https://github.com/NCAR/metric.



AMOC: Atlantic Meridional Overturning Circulation

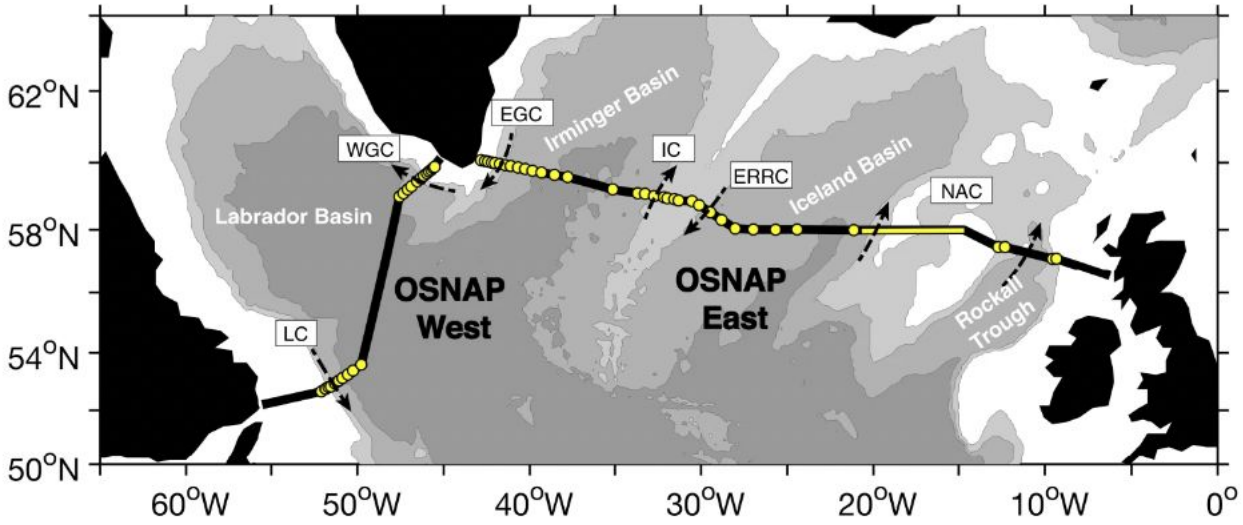
McCarthy et al. (2020, *Rev. Geophys.*)

Background

As part of the US – UK WISHBONE and SNAP-DRAGON projects, we are evaluating simulated transports across the OSNAP sections in a set of forced ocean – sea-ice (FOSI) simulations both at low (nominal 0.25°-1°) and high (~0.1° or finer) horizontal resolutions – ideally pairs of simulations with the same model. The simulations follow the OMIP protocol.

Simulations with POP2, NEMO, MOM6, HYCOM, and MPAS-O are / will be included.

Locations of OSNAP moorings (Li et al. 2021)



Participating groups include:
NSF NCAR, DOE LANL, FSU, NOAA GFDL (?), NOC, GEOMAR, CMCC, UKMO, ….

OSNAP Array

OCEAN CIRCULATION

A sea change in our view of overturning in the subpolar North Atlantic

M. S. Lozier[1*], F. Li[1*], S. Bacon[2], F. Bahr[3], A. S. Bower[3], S. A. Cunningham[4], M. F. de Jong[5], L. de Steur[5]†, B. deYoung[6], J. Fischer[7], S. F. Gary[4], B. J. W. Greenan[8], N. P. Holliday[2], A. Houk[9], L. Houpert[4], M. E. Inall[4,10], W. E. Johns[9], H. L. Johnson[11], C. Johnson[4], J. Karstensen[7], G. Koman[9], I. A. Le Bras[12], X. Lin[13], N. Mackay[14]‡, D. P. Marshall[15], H. Mercier[16], M. Oltmanns[7], R. S. Pickart[3], A. L. Ramsey[3], D. Rayner[2], F. Straneo[12], V. Thierry[17], D. J. Torres[3], R. G. Williams[18], C. Wilson[14], J. Yang[3], I. Yashayaev[8], J. Zhao[3]§

To provide an observational basis for the Intergovernmental Panel on Climate Change projections of a slowing Atlantic meridional overturning circulation (MOC) in the 21st century, the Overturning in the Subpolar North Atlantic Program (OSNAP) observing system was launched in the summer of 2014. The first 21-month record reveals a highly variable overturning circulation responsible for the majority of the heat and freshwater transport across the OSNAP line. In a departure from the prevailing view that changes in deep water formation in the Labrador Sea dominate MOC variability, these results suggest that the conversion of warm, salty, shallow Atlantic waters into colder, fresher, deep waters that move southward in the Irminger and Iceland basins is largely responsible for overturning and its variability in the subpolar basin.

- OSNAP estimates indicate that the Labrador Sea (west) does not contribute much to AMOC mean and variability, but instead the processes in the eastern subpolar gyre impact AMOC.
- These findings are in contrast with the long-standing, model-based view that Labrador Sea dominates AMOC variability on decadal to multi-decadal time scales.

OSNAP observations cover the Aug 2014–June 2020 period.

Geophysical Research Letters

RESEARCH LETTER
10.1029/2020GL089793

Reconciling the Relationship Between th
and Labrador Sea in OSNAP Observations

SCIENCE ADVANCES | RESEARCH ARTICLE

OCEANOGRAPHY

An outsized role for the
in the multidecadal vari
overturning circulation

Stephen Yeager[1,2]*, Fred Castruccio[1,2], Pi
Elizabeth Maroon[4], Justin Small[1,2], Hong

Article

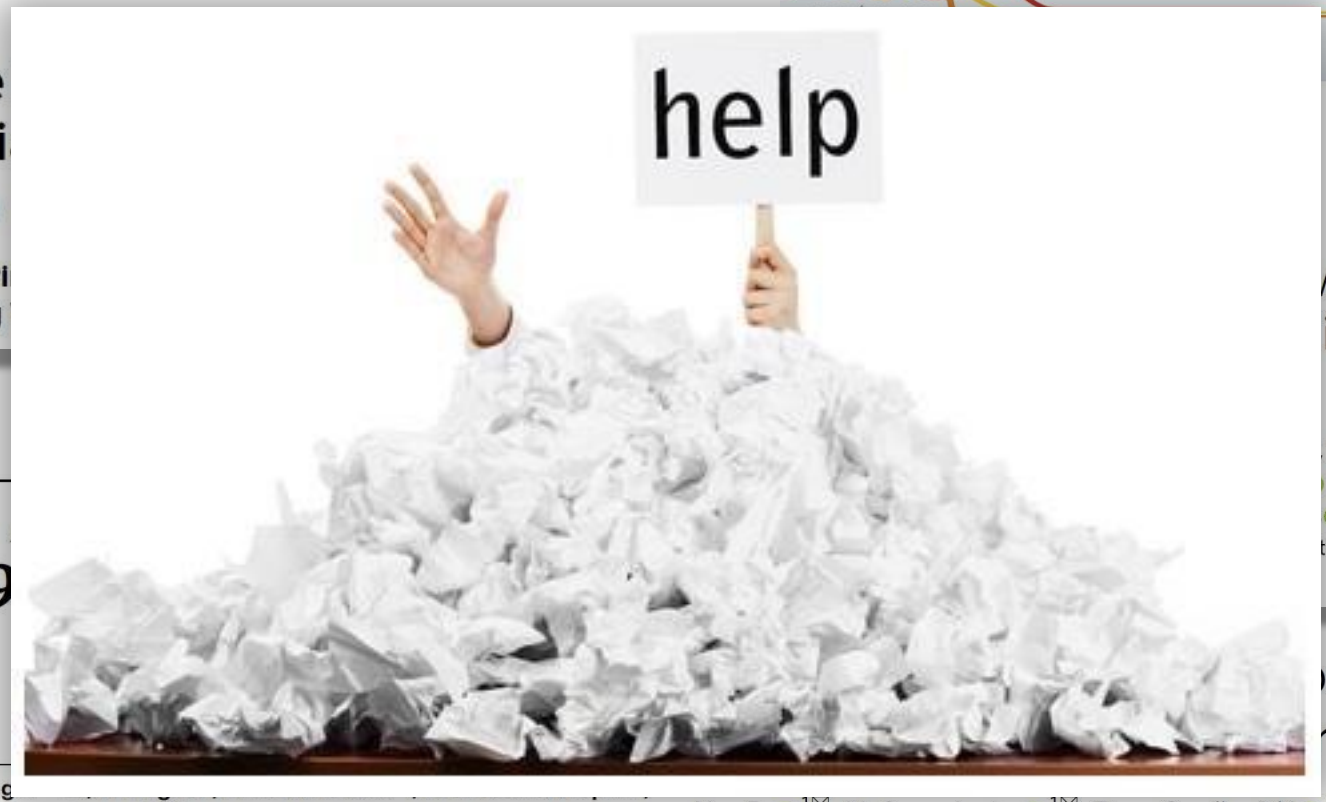
Decadal changes in
to the excessive 199
convection

Received: 11 November 2022

Accepted: 21 July 2023

C. W. Böning
K. Getzlaff[1] & A. Biastoch[1,2]

L. C. Jackson[1] · T. Petit[2]



nature geoscience

ARTICLES

https://doi.org/10.1038/s41561-019-0517-1

ompensated overturning in the

Check for updates

western boundary density
ional Overturning

S. A. Cunningham[5], M. F. de Jong[6], B. deYoung[7],
[3], J. Holte[10], L. Houpert[3], M. E. Inall[5,11], W. E. Johns[12],
[4,10], P. Lherminier[14], X. Lin[15], H. Mercier[16],
[4], D. Rayner[3], F. Straneo[10], V. Thierry[14], M. Visbeck[13],

nal Overturning
North Atlantic

Yao Fu[1✉], M. Susan Lozier[1✉], Tiago Carrilho Biló[2], Amy S. Bower[3], Stuart A. Cunningham[4], Frédéric Cyr[5], M. Femke de Jong[6], Brad deYoung[7], Lewis Drysdale[4], Neil Fraser[4], Nora Fried[6], Heather H. Furey[3], Guoqi Han[8], Patricia Handmann[9], N. Penny Holliday[10], James Holte[2], Mark E. Inall[4,11], William E. Johns[12], Sam Jones[4], Johannes Karstensen[9], Feili Li[13], Astrid Pacini[3,15], Robert S. Pickart[3], Darren Rayner[10], Fiammetta Straneo[2] & Igor Yashayaev[14]

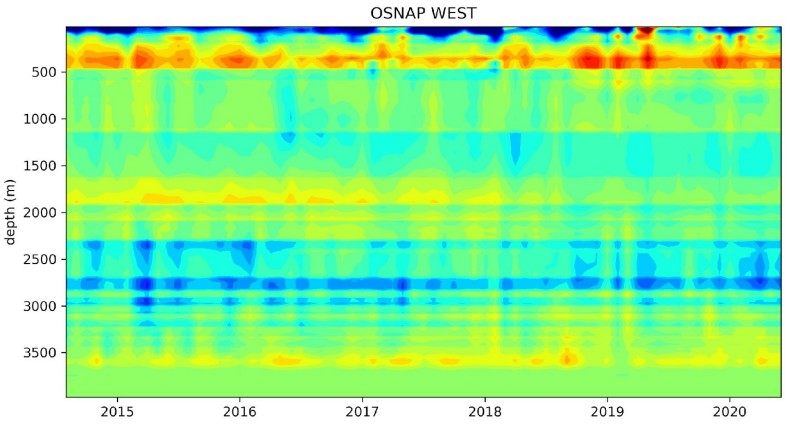
NSF NCAR Operated by UCAR

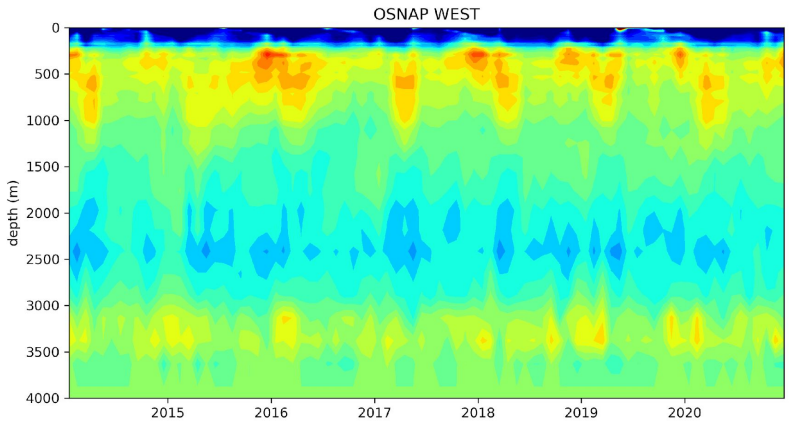
Raw Transports Across OSNAP Sections

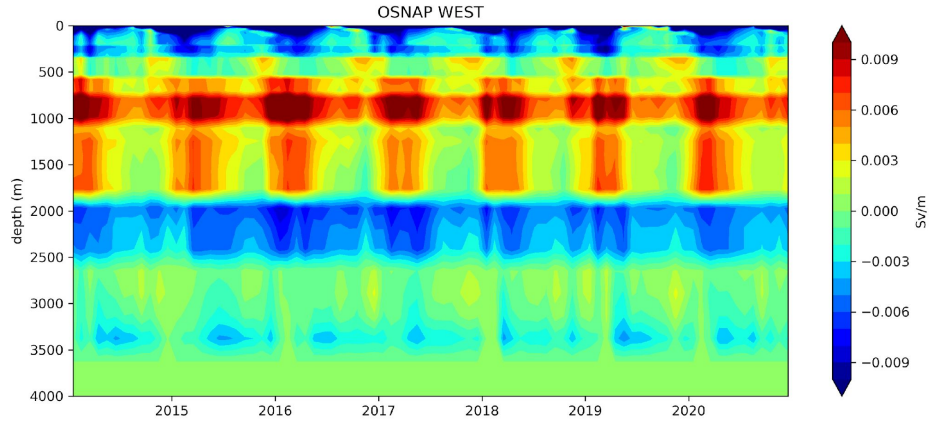
Observations

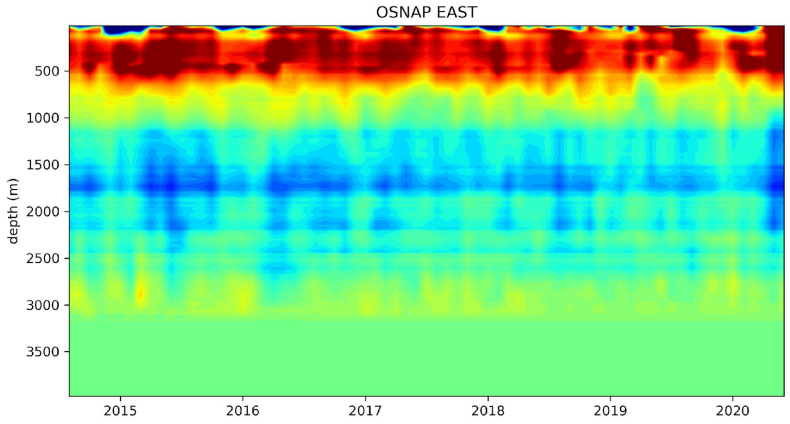
CESM-0.1°

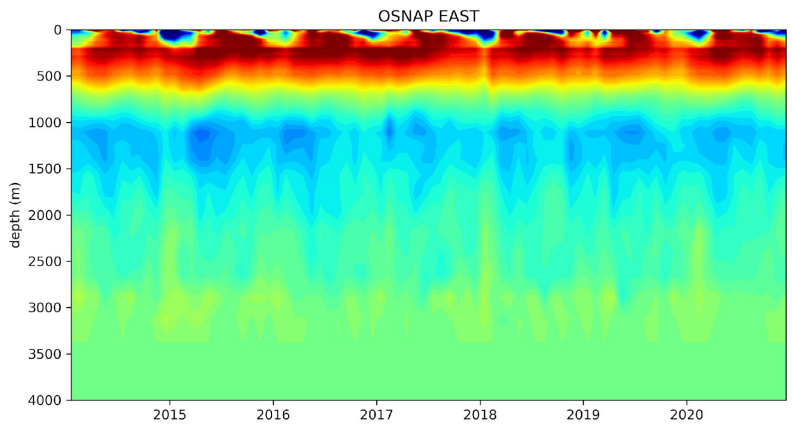
CESM-1°

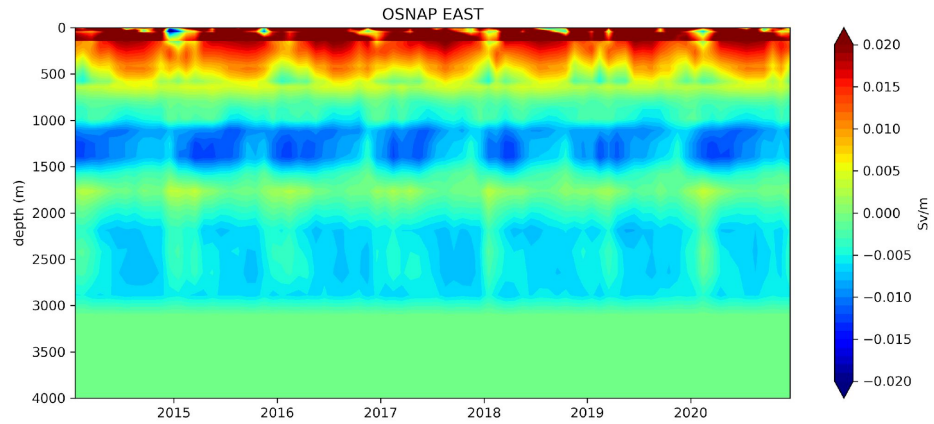








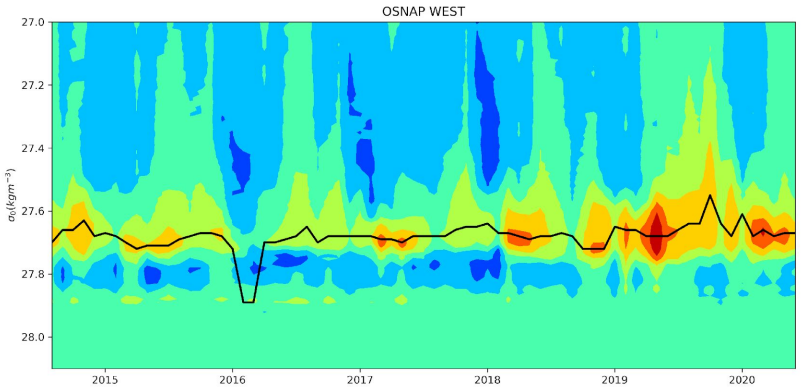


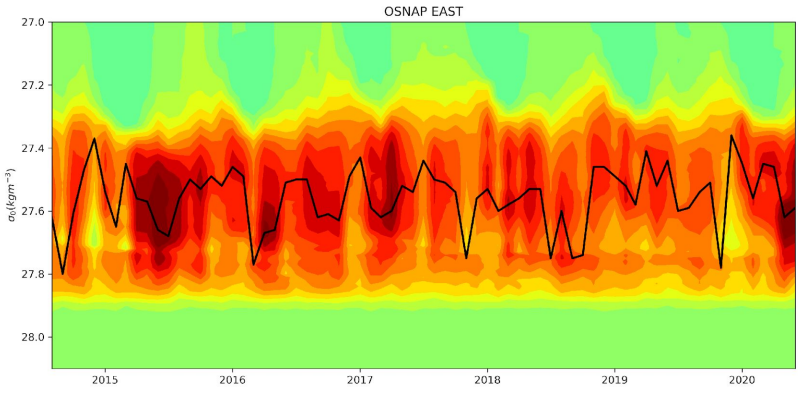


in Sv / m

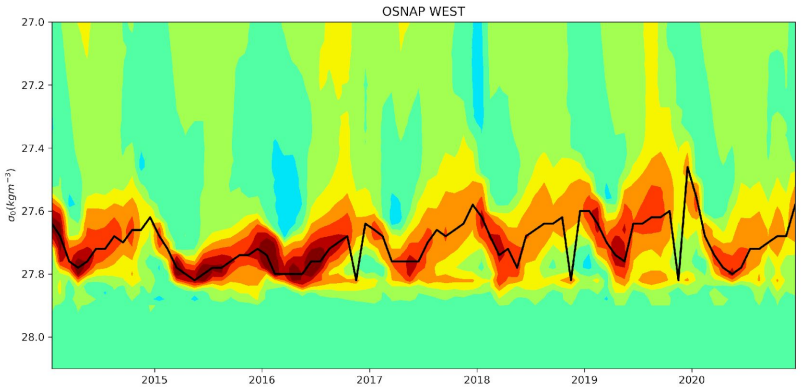
Transports in Density Space Across OSNAP Sections

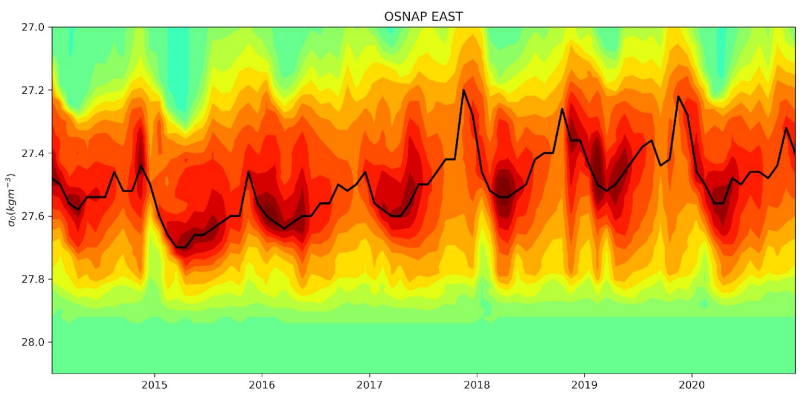
Observations



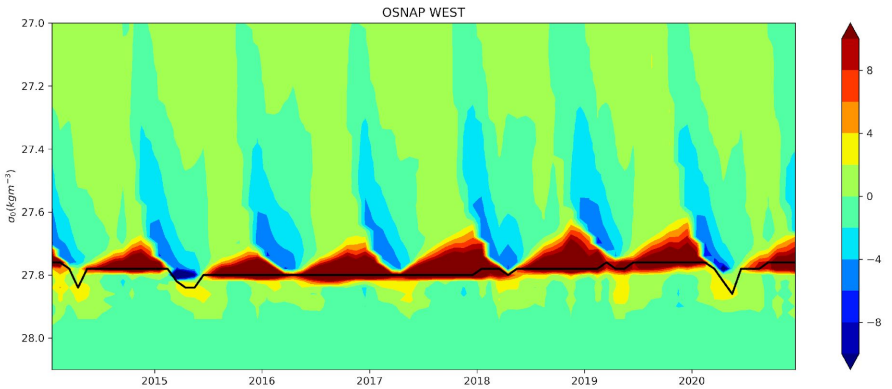


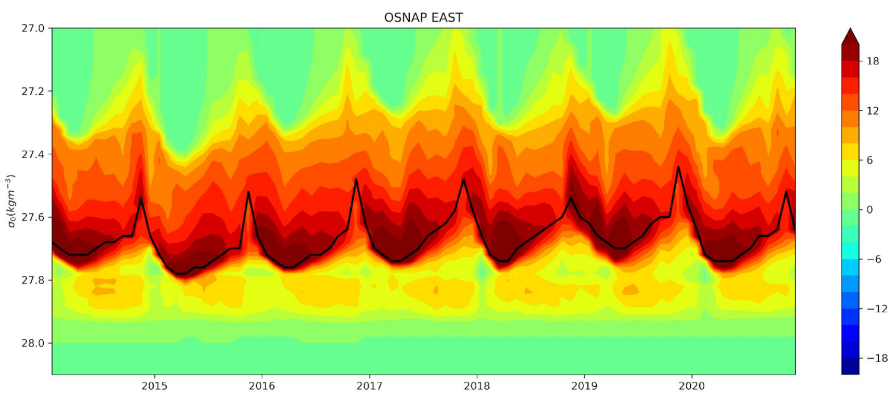
CESM-0.1°





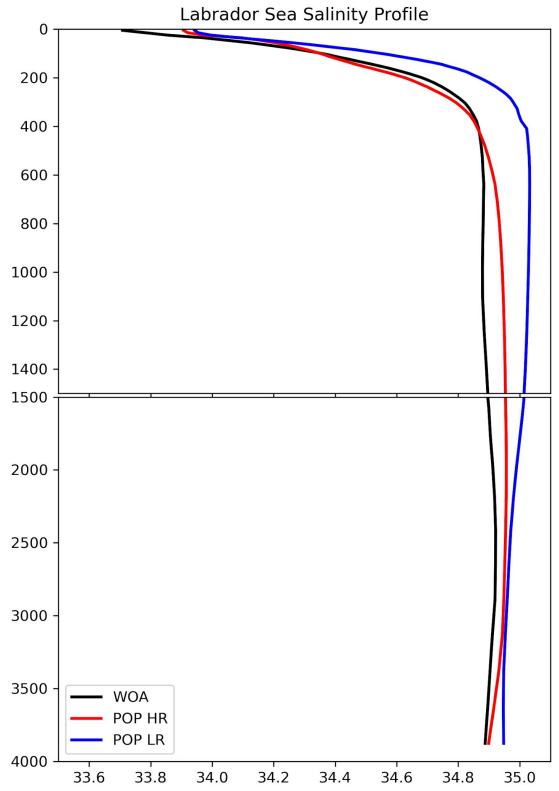
CESM-1°





in Sv

Labrador Sea Profiles



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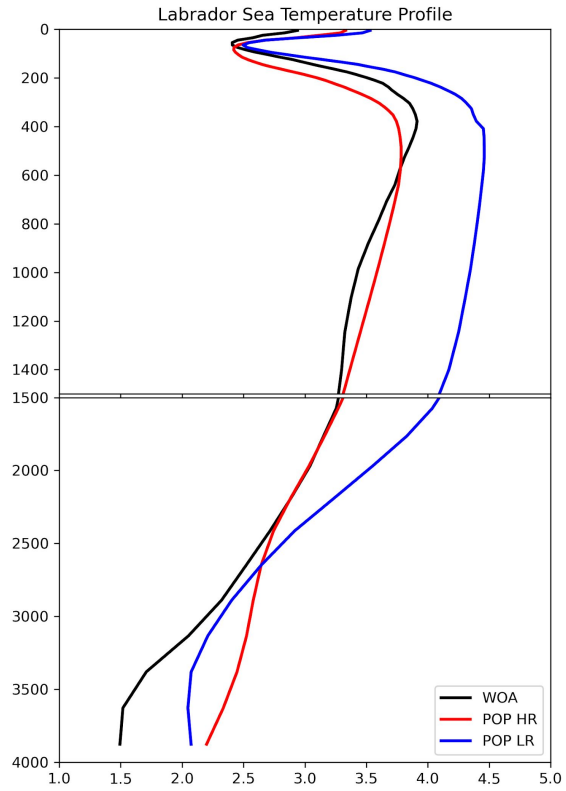

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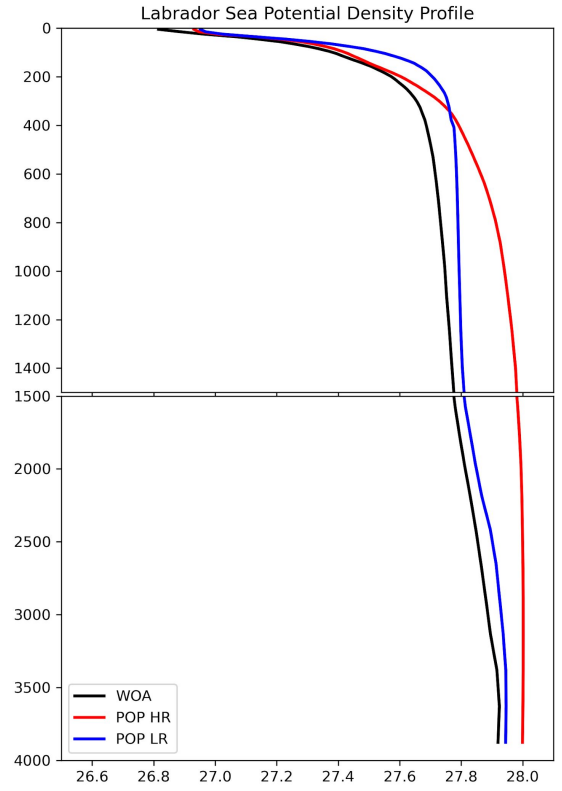
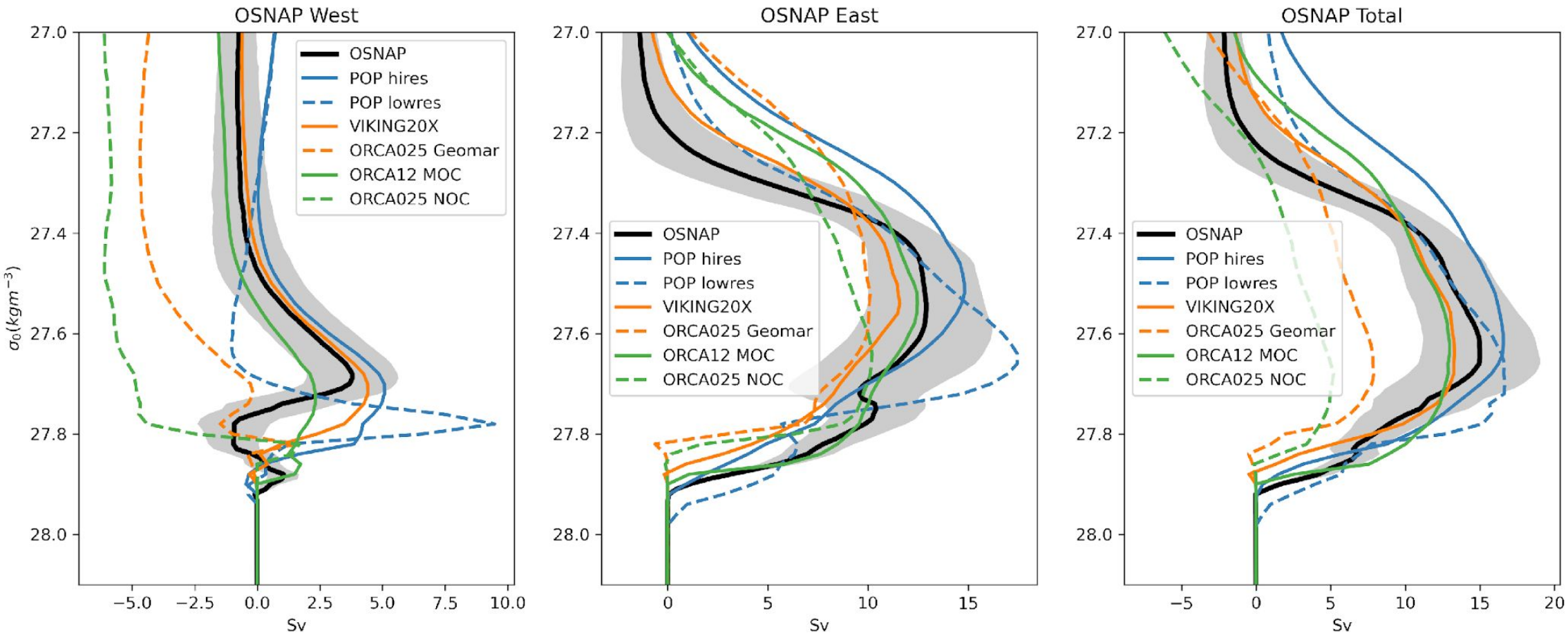
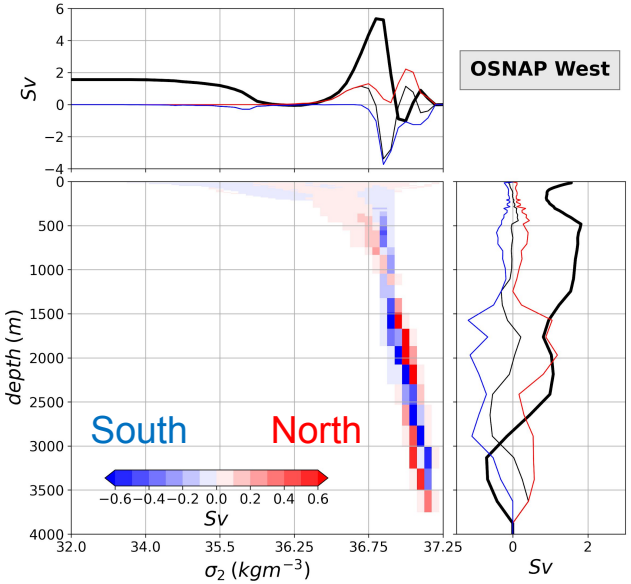


kg m^{-3}

Time-Mean Transports Across OSNAP Sections



Observations



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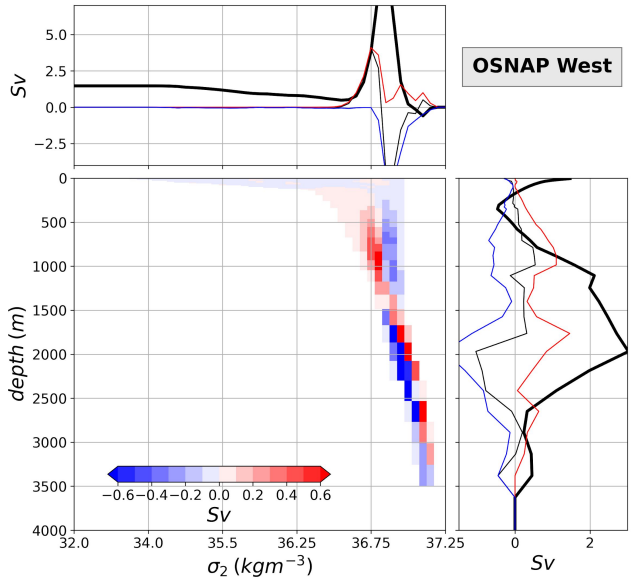

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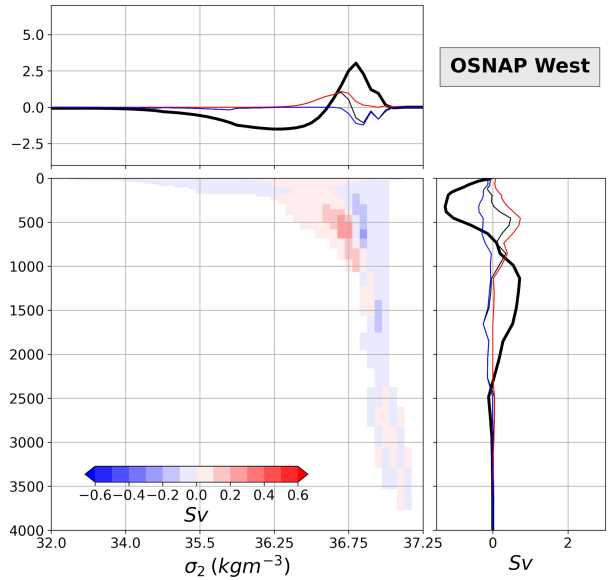

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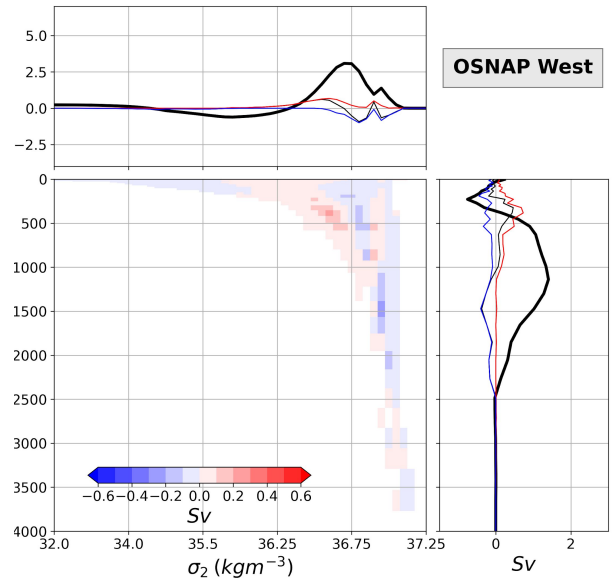

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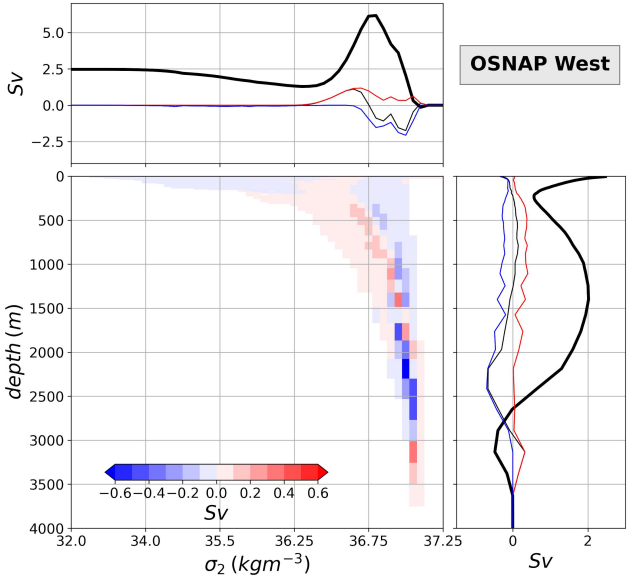

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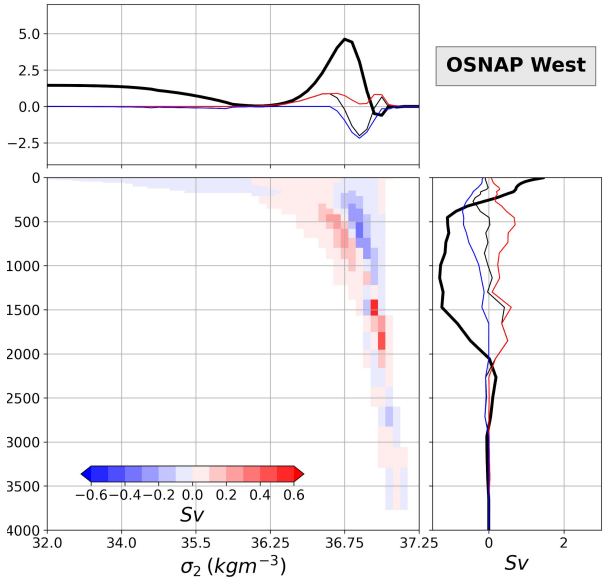

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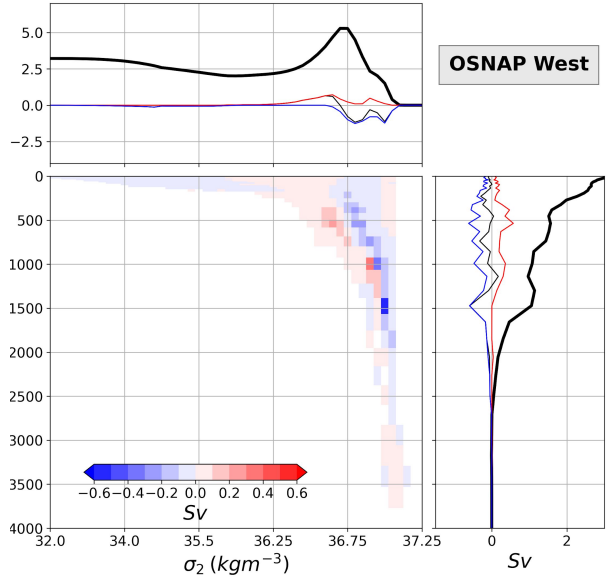
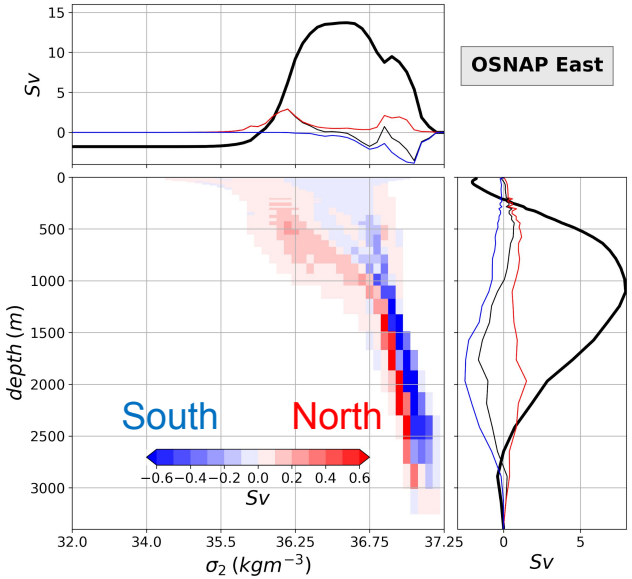


Observations



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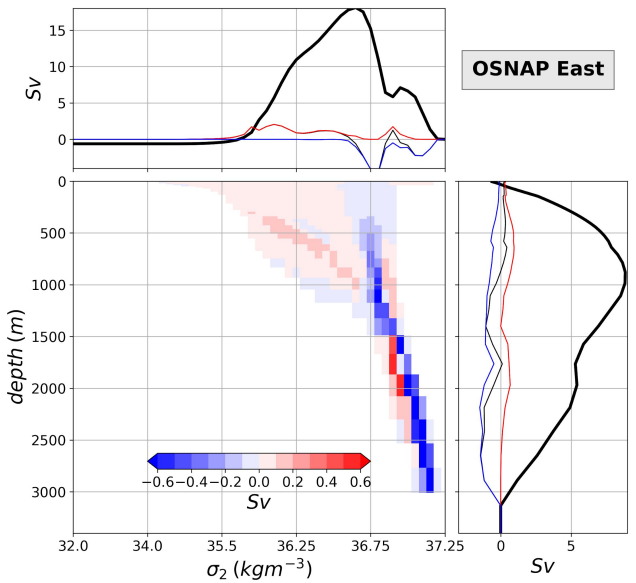

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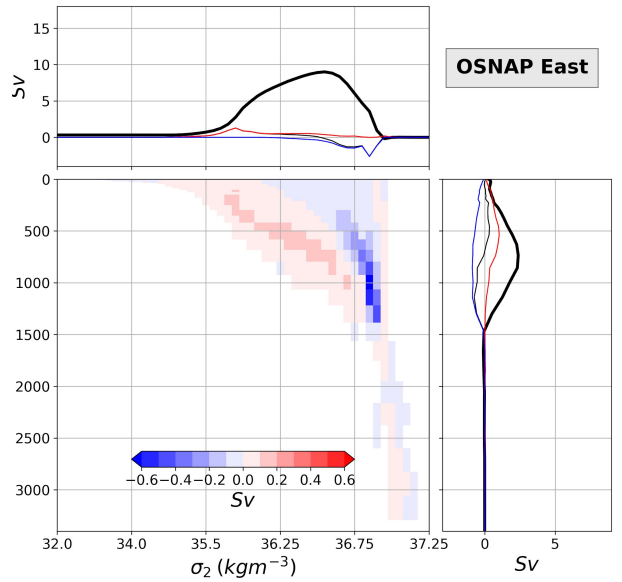

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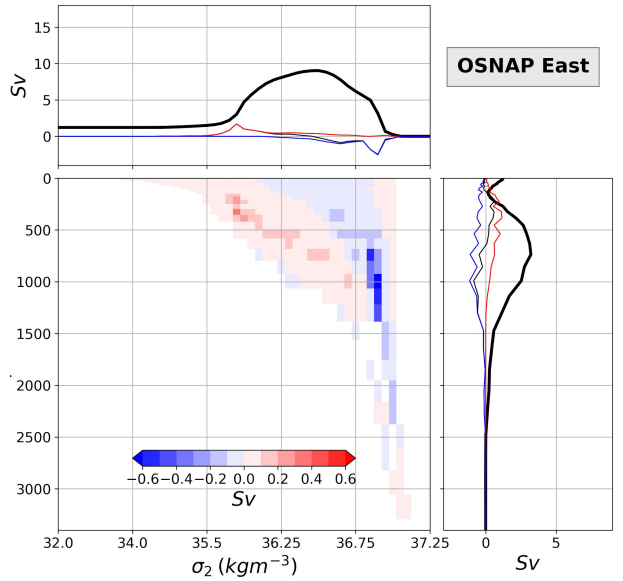

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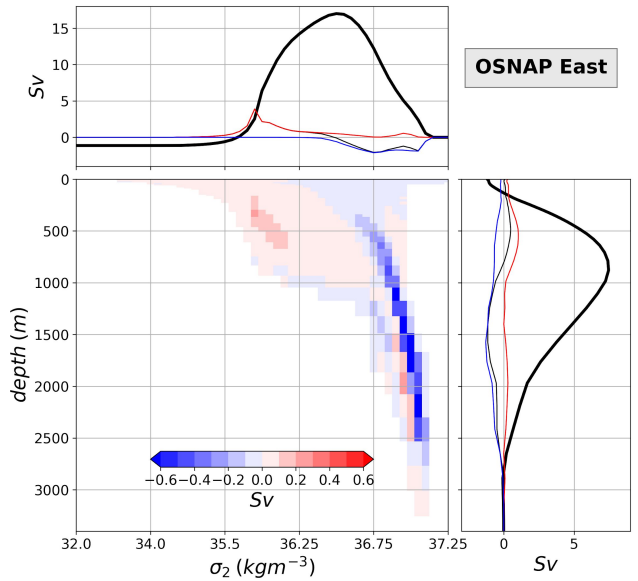

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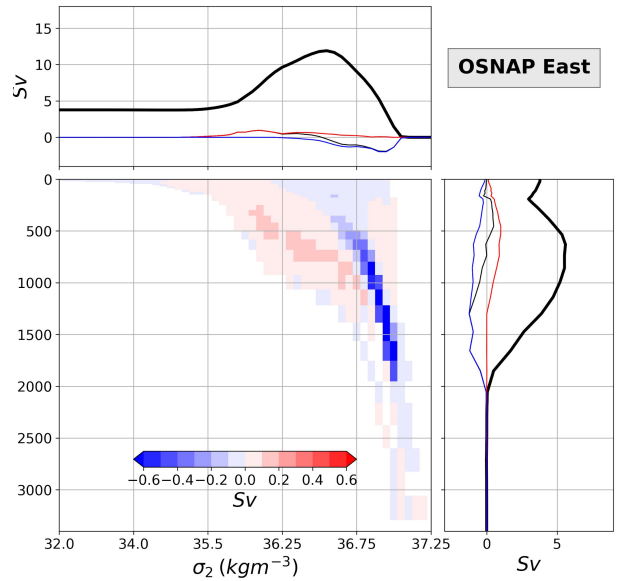

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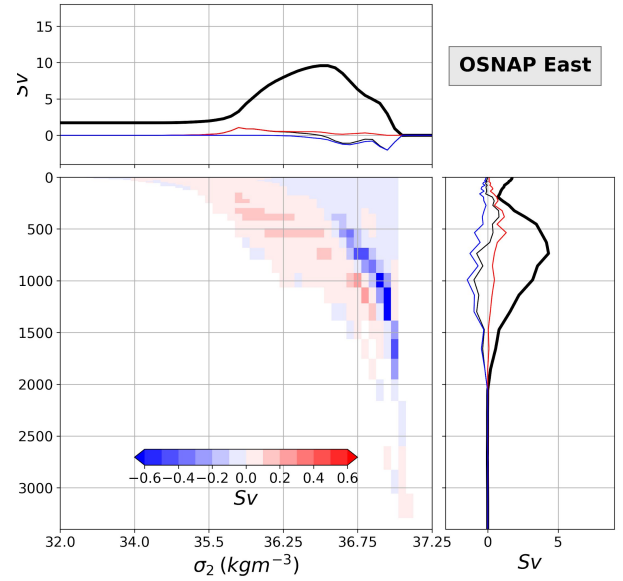

Summary

- CESM-HR shows rather good agreement with observations.
- σ–z histogram of AMOC transport can be used to show the cancelations occurring in both σ- and depth spaces, illustrating the horizontal circulation contributions to AMOC in complimentary ways.
- Analysis will be expanded to include:
  - Transports in T & S space;
  - T & S diagrams (?);
  - Section properties;
  - Seasonal cycle and inter-annual variability;
  - WMF / T
  - …..