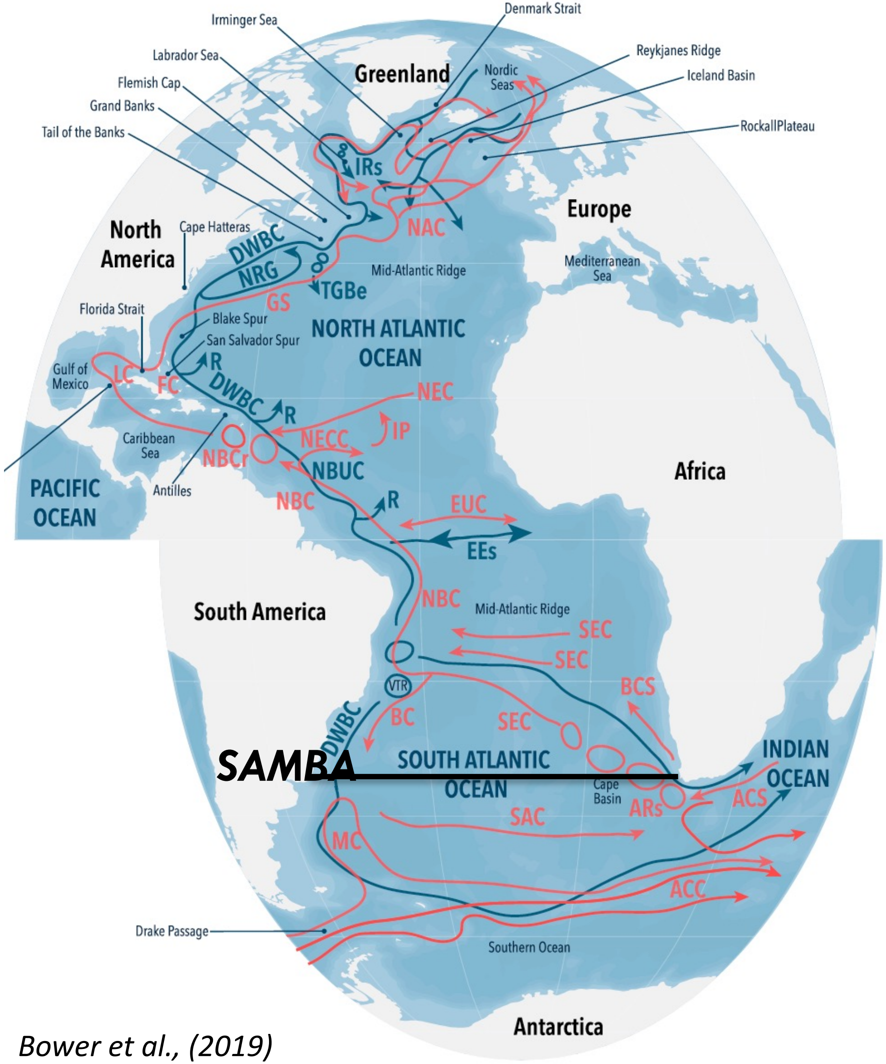
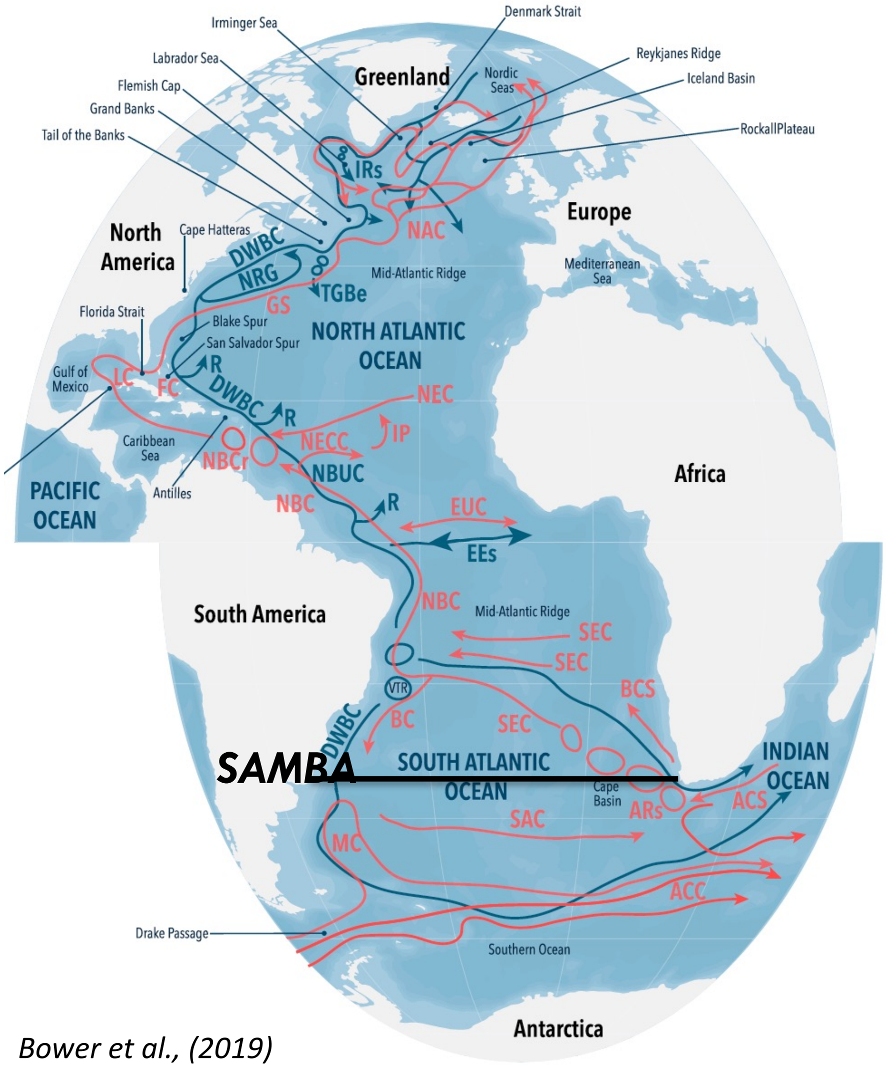


Bower et al., (2019)

Recent observational advances from the South Atlantic Meridional overturning circulation Basin-Wide Array (SAMBA) at 34.5S

Renellys C. Perez
NOAA/AOML



Bower et al., (2019)

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South Atlantic Meridional Overturning Circulation

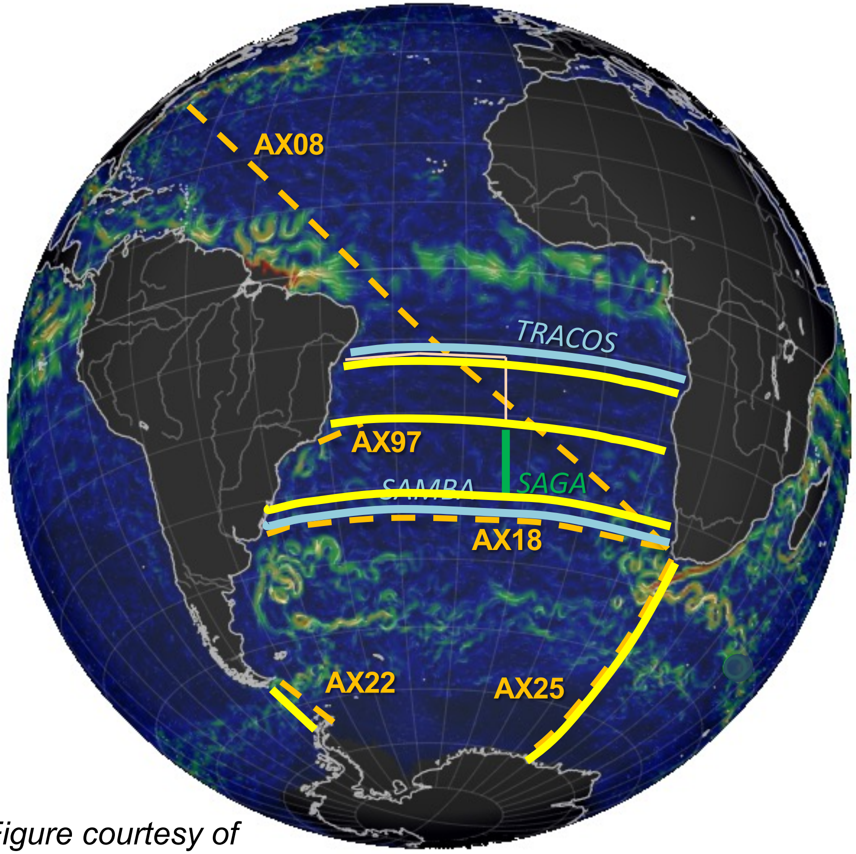


Figure courtesy of Alberto Piola

The SAMOC initiative began in 2007 with the goal of measuring the strength and variability of the AMOC-related volume, heat and freshwater transports in the South Atlantic and interocean exchanges.

Countries involved include: Argentina, Brazil, France, Germany, Mexico, Norway, Spain, South Africa, United Kingdom, United States, and Uruguay

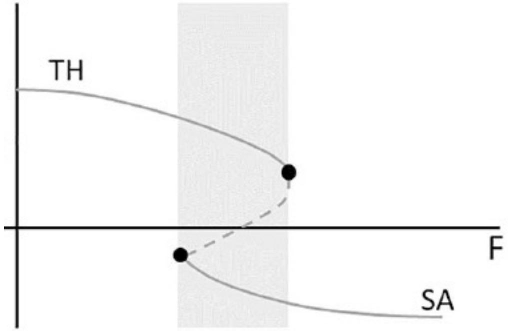
***SAMBA**: South Atlantic MOC Basin-wide Array*
***TRACOS**: TRopical Atlantic Circulation and Overturning at 11S*
***SAGA**: South Atlantic Gateway Array*
Trans-basin & interocean XBT transects
Trans-basin & interocean CTD transects
In situ & altimetry synthesis estimates

Importance of the South Atlantic Ocean

Only basin with **net equatorward heat transport** (Talley, 2003)

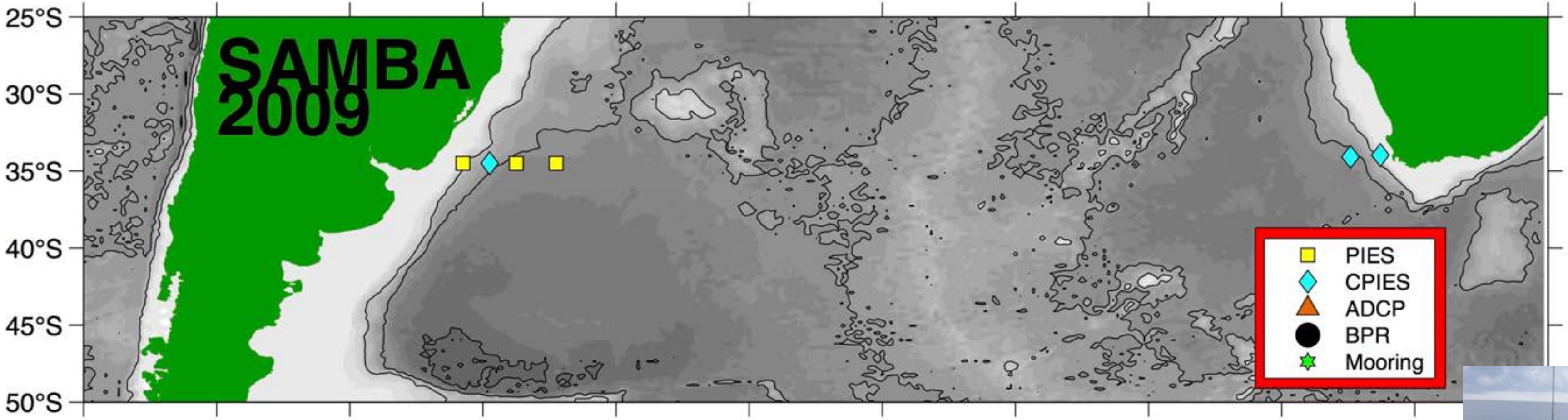
Gateway for water masses formed in Pacific, Indian, and Southern Oceans to **exchange, mix, and flow into North Atlantic** (de Ruijter et al., 1999; Sloyan and Rintoul, 2001; Lumpkin and Speer, 2007; Speich et al. 2007; Ruhs et al., 2019)

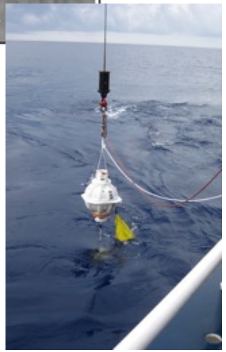
Direction of net salt transport into South Atlantic can control the **AMOC monostability or bistability** with potentially large consequences on global weather and climate (Stommel, 1961; deVries and Weber, 2005; Dijkstra, 2007; Huisman et al., 2010; Drijfhout et al., 2011; Weijer et al., 2019)



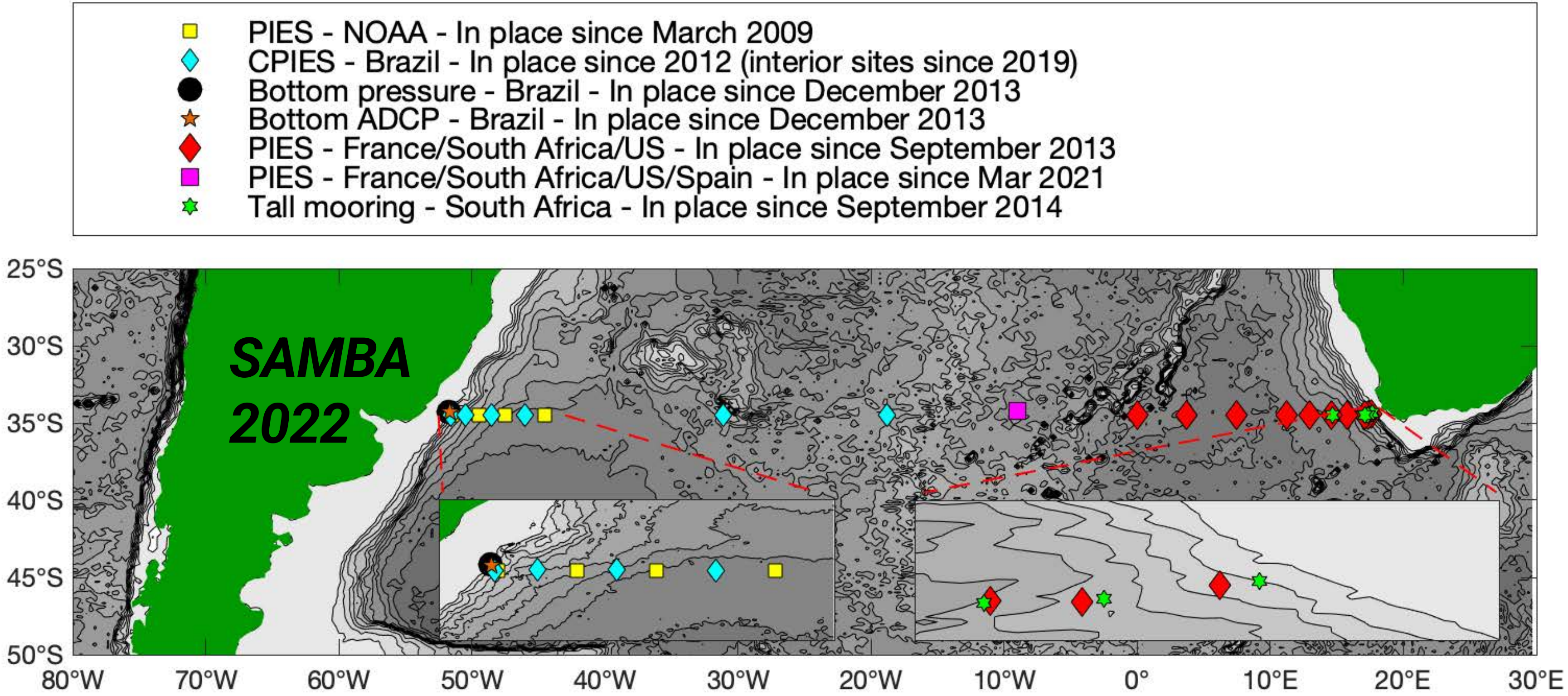
"By 2300, an AMOC collapse is as likely as not for high emission pathways and very unlikely for lower ones, highlighting that an AMOC collapse can be avoided in the long term by CO_2 mitigation (medium confidence). … there are considerable knowledge gaps in adaptation responses to a substantial AMOC weakening." IPCC report (2019)

Evolution of SAMoc Basin-wide Array





Evolution of SAMoc Basin-wide Array

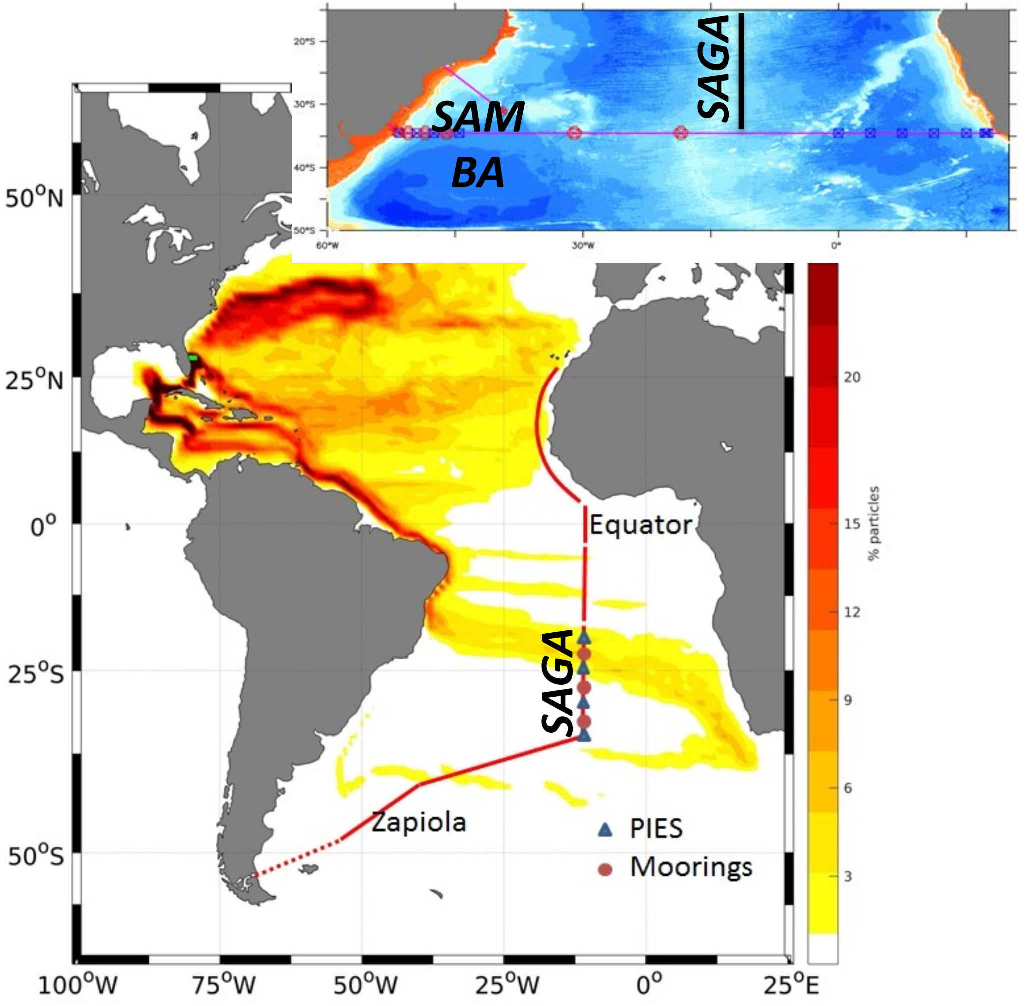


New Programs: SAGA (2021)

During first SAGA cruise in March-April 2021, three moorings and 4 PIES were deployed

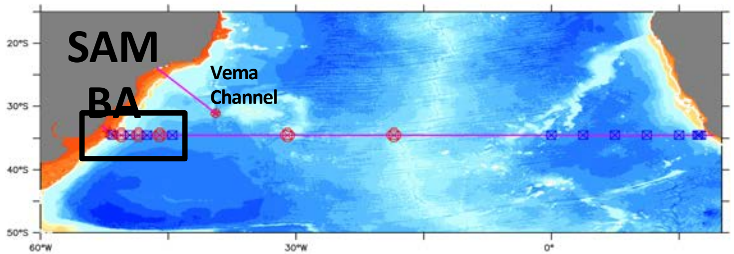
The southernmost PIES (34S, 9W) augments the SAMBA line

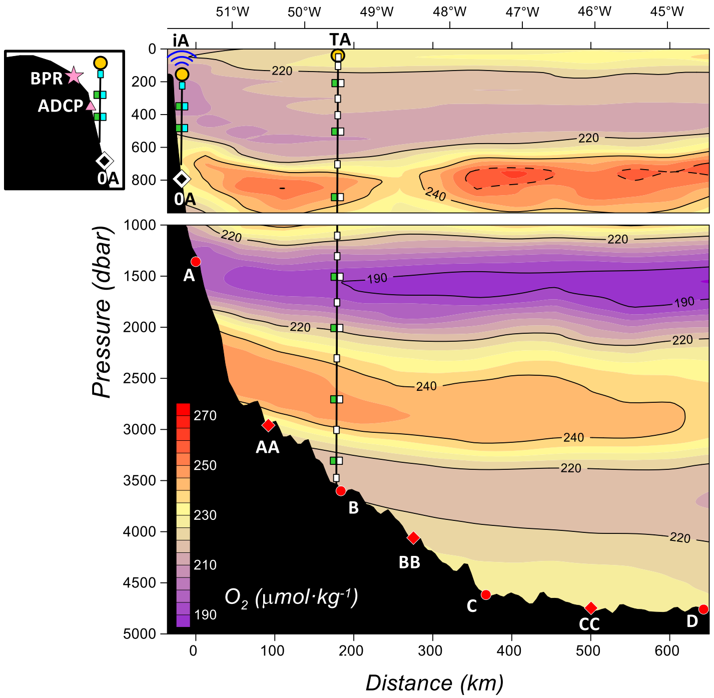
Goal is to monitor the interior flows that connect subtropical and tropical South Atlantic gyres



Slide Courtesy of Jose Lluis Pelegri, Collaboration between Spain, Mexico (with one PIES from South Africa, France, and US)

New Programs: iAtlantic & TRIATLAS (2022)





Alberto Piola and Maria Paz Chidichimo

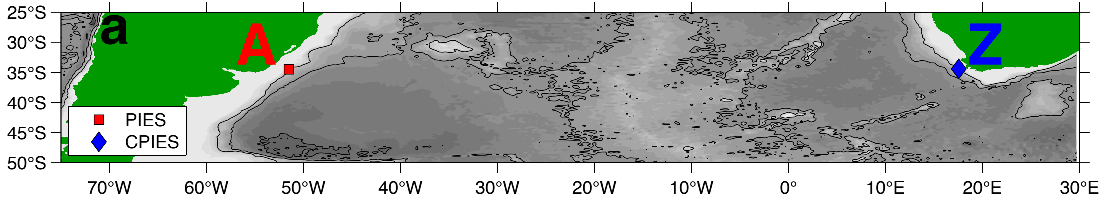
iA: **iAtlantic Mooring** at the **700 m isobath** (top ADCP & T/S/O_2 level; 2 T/S/O_2/Current levels) (Lead: SHN-CONICET/AR)

- Direct time series observations of **Brazil Current** and improve constraints on the **subtropical freshwater transports**
- Help understanding processes associated with the reduction in the **dissolved oxygen** concentration.

TA: **TRIATLAS Mooring** at the **3450 m isobath** (T/S/Currents at several levels) (Lead: GEOMAR)

- Provide **full-depth density measurements**
- Add information of the structure and variability in the lower limb of the overturning circulation (**DWBC**)
- Provide insight into **mechanisms/drivers of circulation changes**

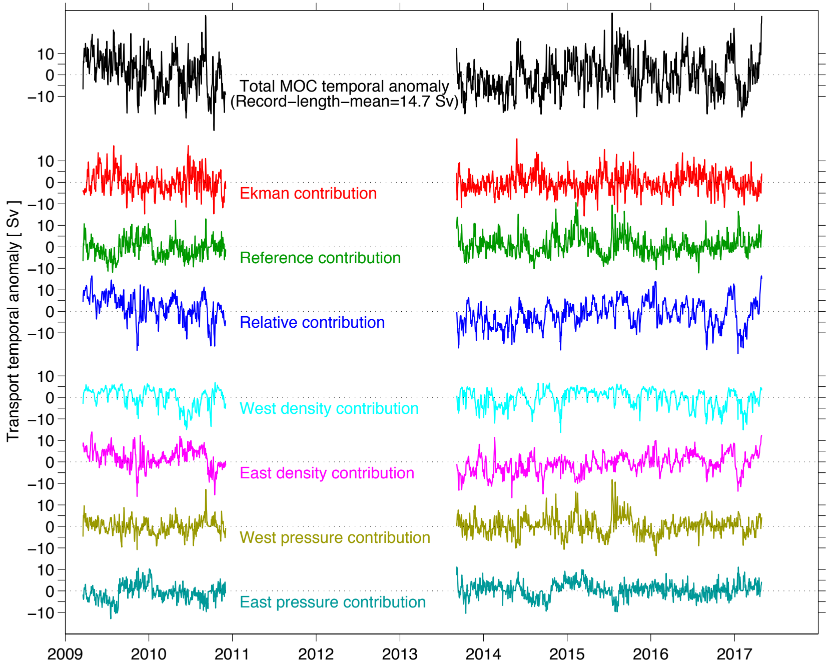
SAMBA Pilot Array: MOC time series



Multi-year record: 2009-2017
Mean: 14.7 Sv
Standard Deviation: 8.3 Sv

Density-driven changes are largest source of variability (**blue**), with large Ekman (**red**) & pressure (**green**) contributions

Density and pressure changes on both boundaries are important



Meinen et al. (2018)

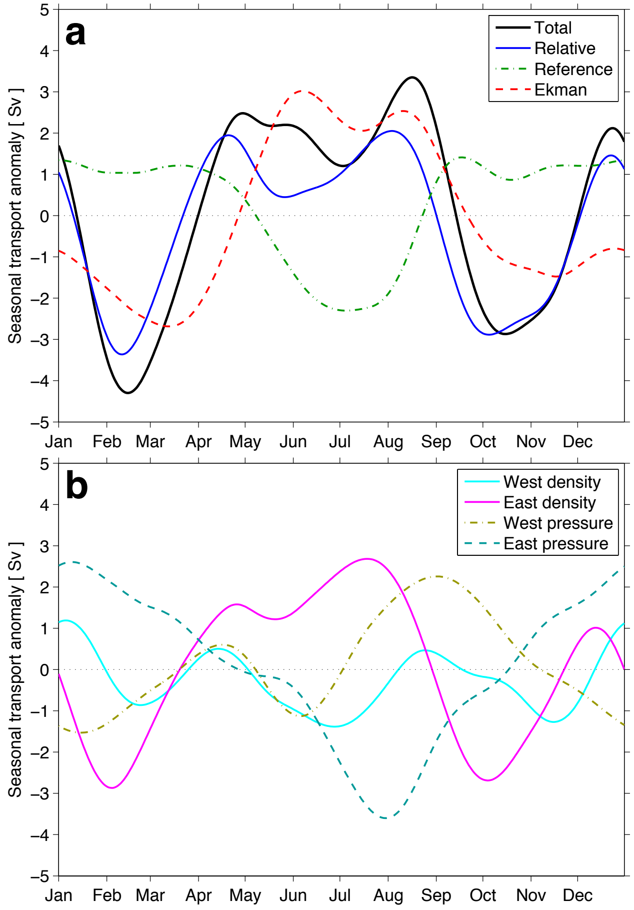
SAMBA Pilot Array: MOC seasonal cycle

Total MOC semi-annual seasonal cycle with +/- 4 Sv range and peaks in austral winter and summer

Seasonality of density (**blue**), pressure (**green**), Ekman (**red**) components are roughly equivalent

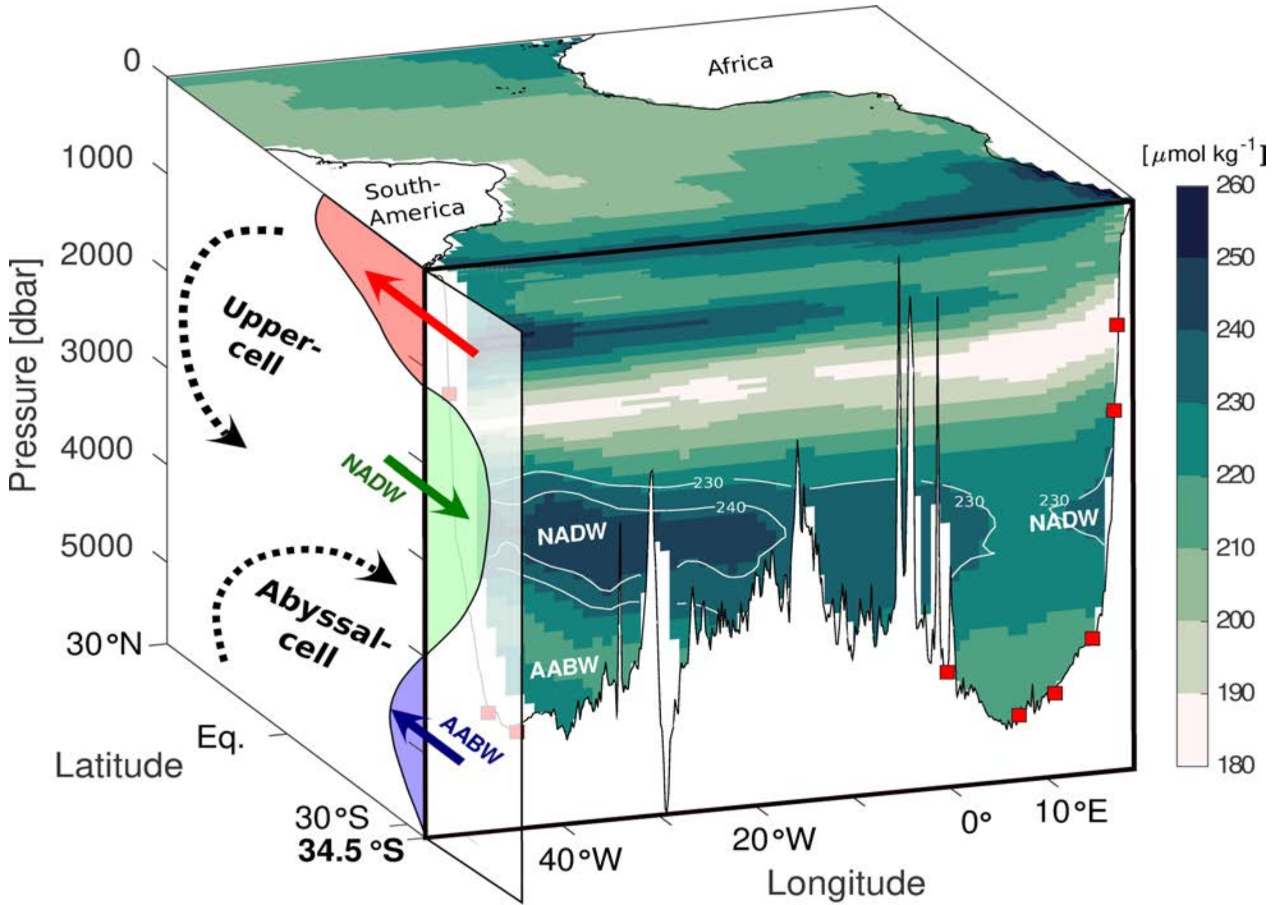
Need all three components to resolve MOC seasonal cycle

Density and pressure changes on eastern boundary more important



Meinen et al. (2018)

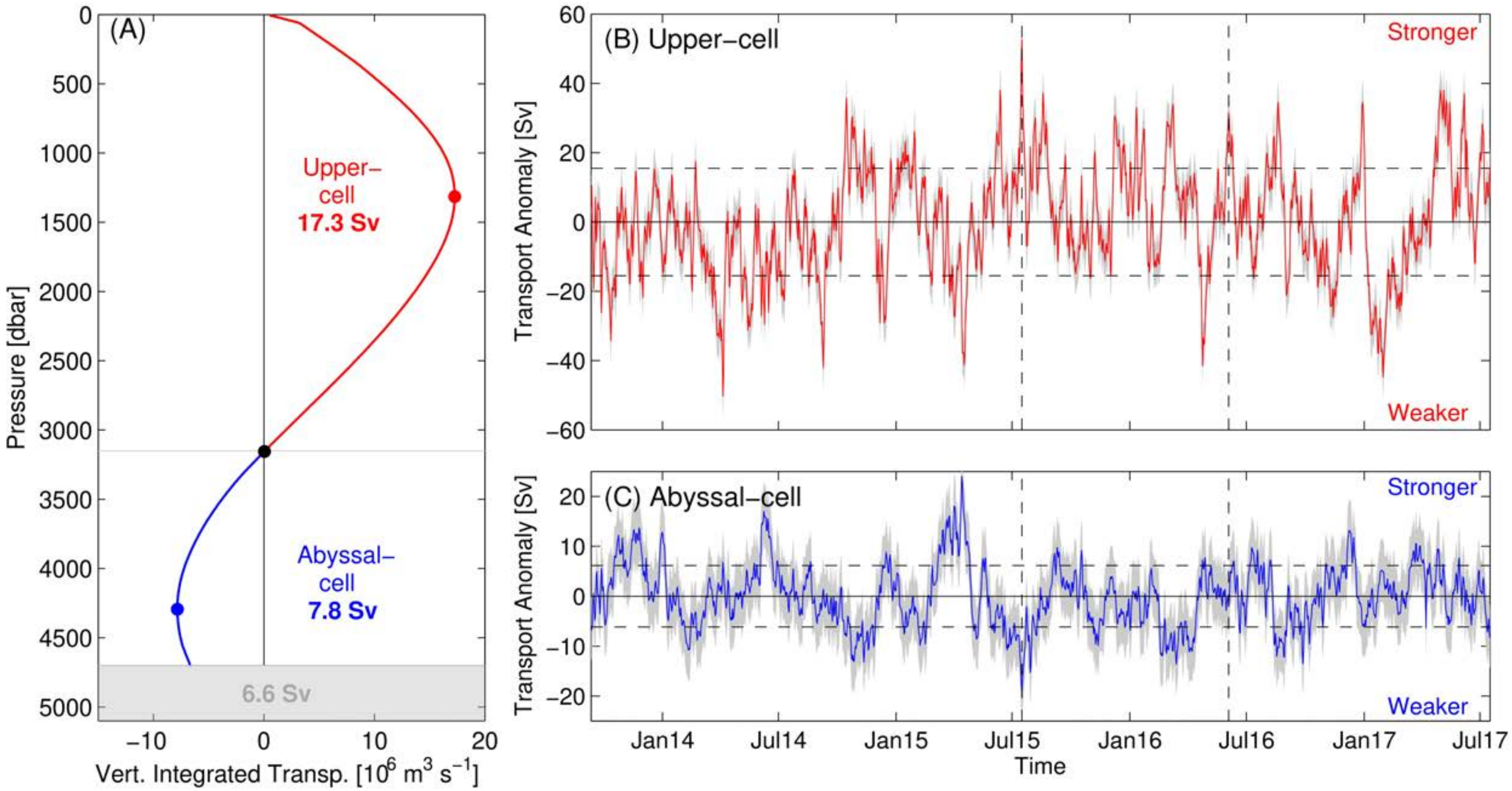
MOC transport using nine SAMBA moorings



Enhanced spatial resolution afforded by using all of the available moorings allow us to observe, for the first time, the variability of both the upper-cell and the underlying abyssal cell ($MOC_{abyssal}$)

Kersalé et al. (2020)

SAMBA 9-Site: MOC and $MOC_{abyssal}$ transports



Kersalé et al. (2020)

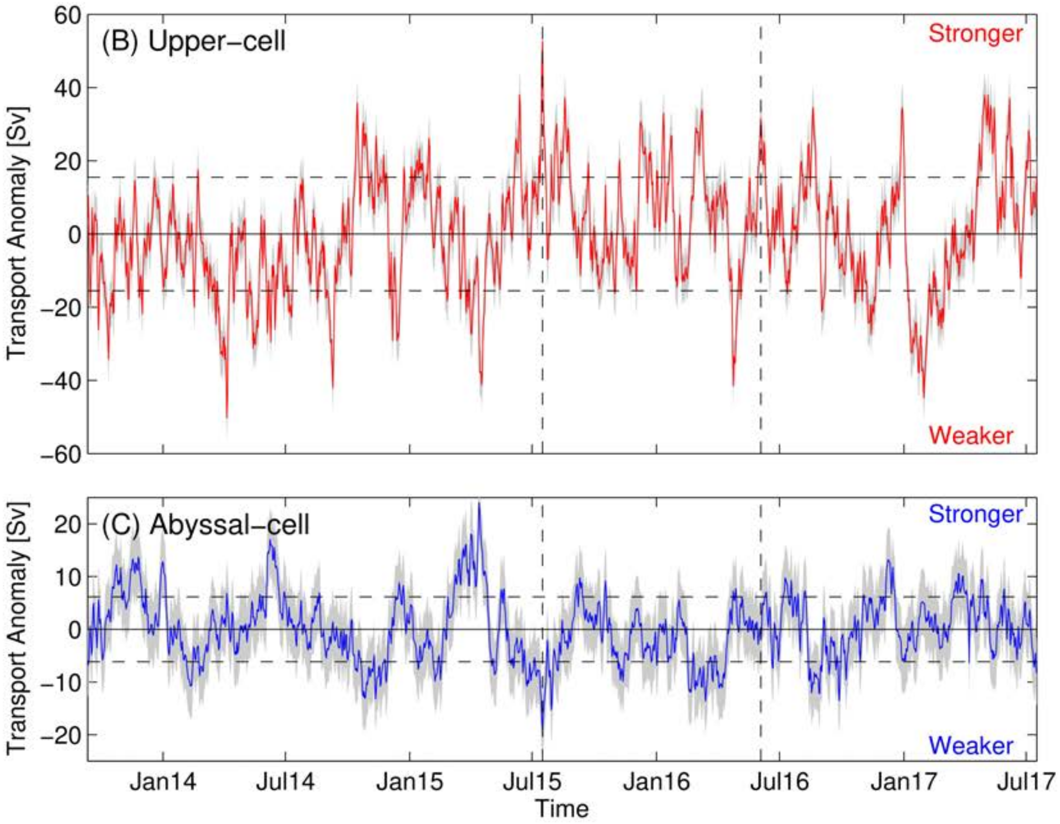
SAMBA 9-Site: MOC and $MOC_{abyssal}$ transports

Highly energetic AMOC in both cells (σ = 15.5 Sv, 6.2 Sv)

Variations in the abyssal-cell appear to be largely independent of the overlying upper-cell variability

No meaningful trends are observed in either cell

Longer time series will be necessary to interannual variability and to detect long-term trends



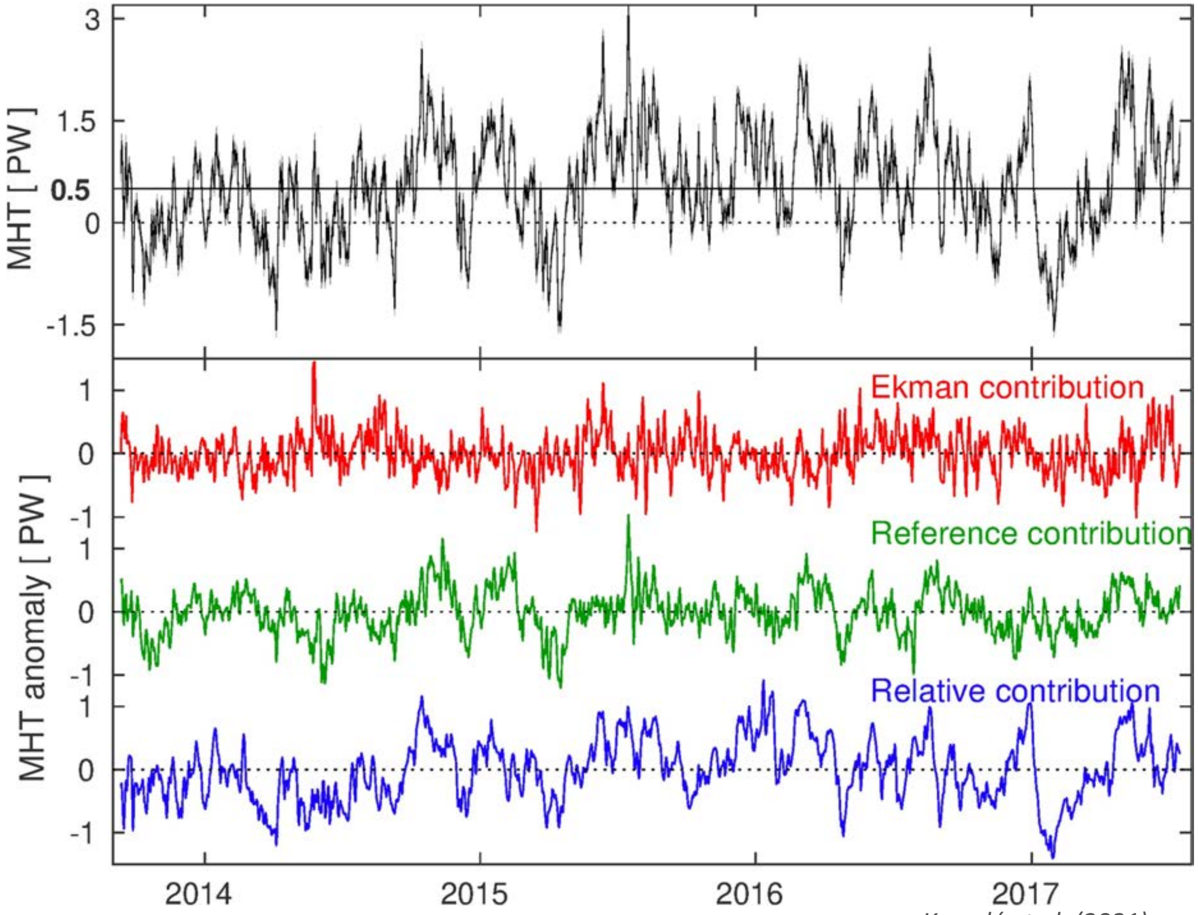
Kersalé et al. (2020)

SAMBA 9-Site: Meridional Heat Transport

Daily MHT time series at 34.5S from 2013 to 2017

MHT is highly correlated with changes in the strength of the MOC, and modestly anticorrelated with $MOC_{abyssal}$

Although relative contribution dominates MHT, both Ekman and reference contributions are important.

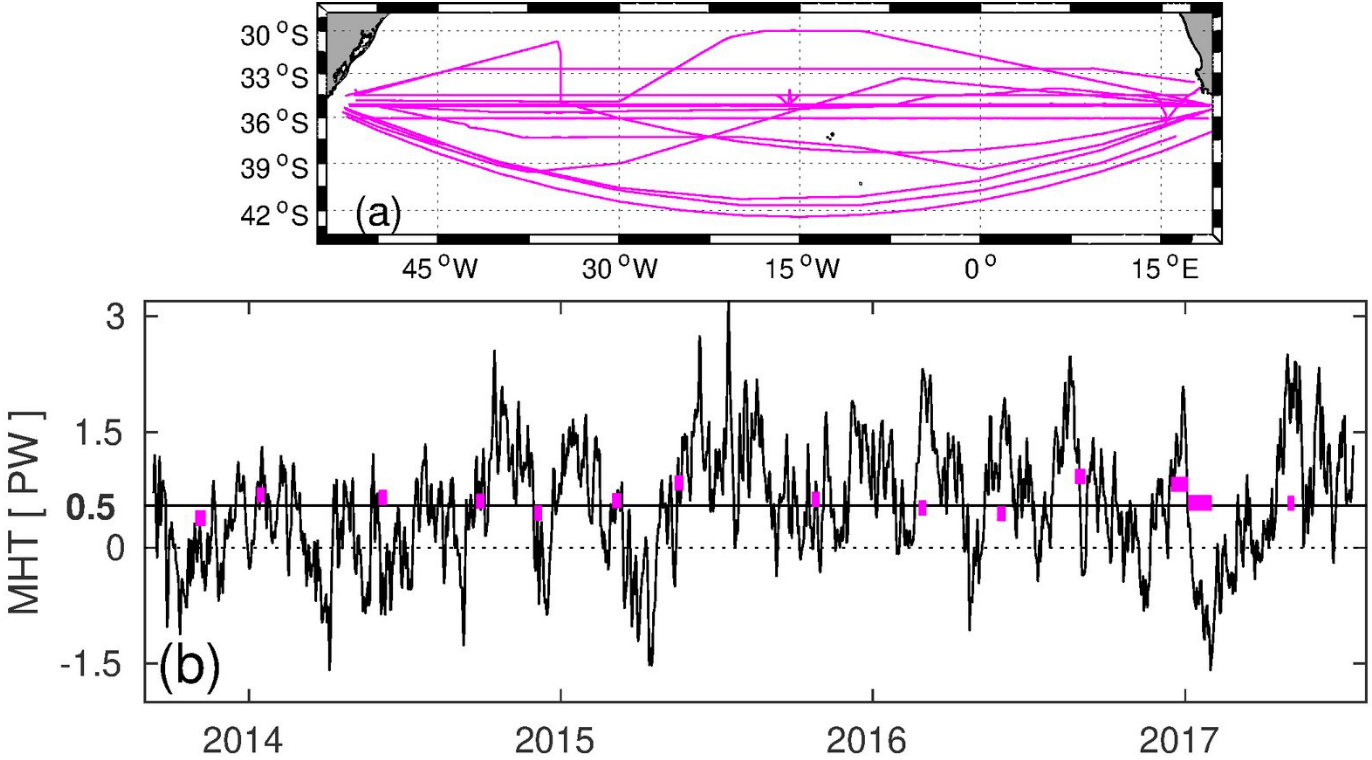


Kersalé et al. (2021)

Comparison of MHT estimates at 34.5S

There is good agreement between mean MHT estimated from daily SAMBA timeseries and AX18 XBT transect data

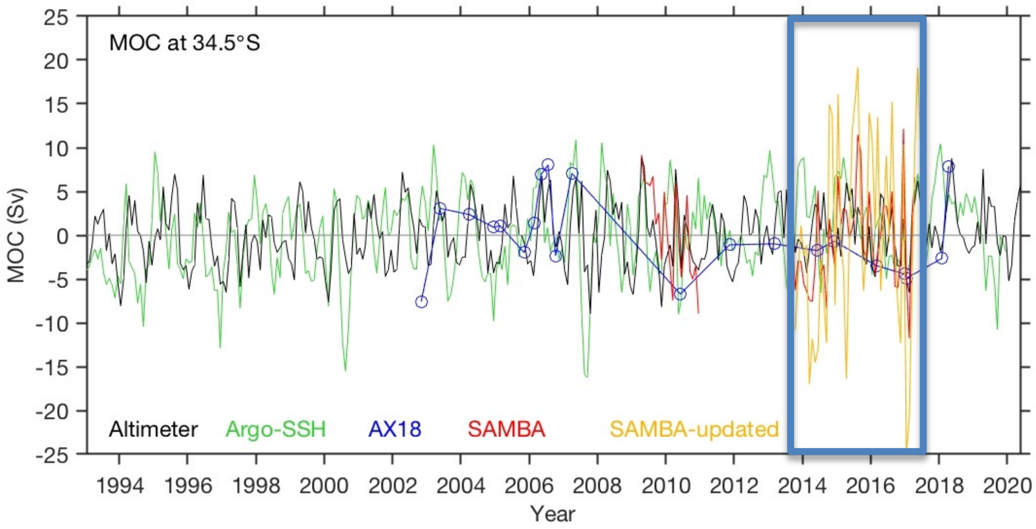
High-frequency MHT variability may cause asynopticity issues for trans-basin hydrographic sections

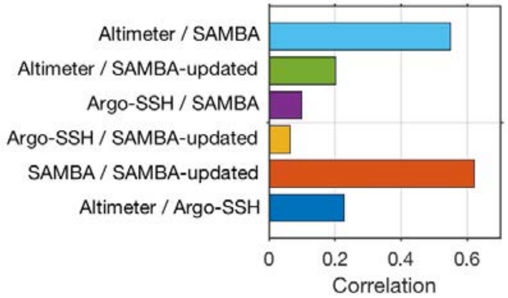


Kersalé et al. (2021)

Comparison of MOC estimates at 34.5S

Much stronger MOC variability is estimated from SAMBA compared to other observational platforms. It is necessary to understand the physical and methodological reasons for these disparities as best as possible given the uncertainties associated with each technique. We need longer time series to do a more robust comparison.



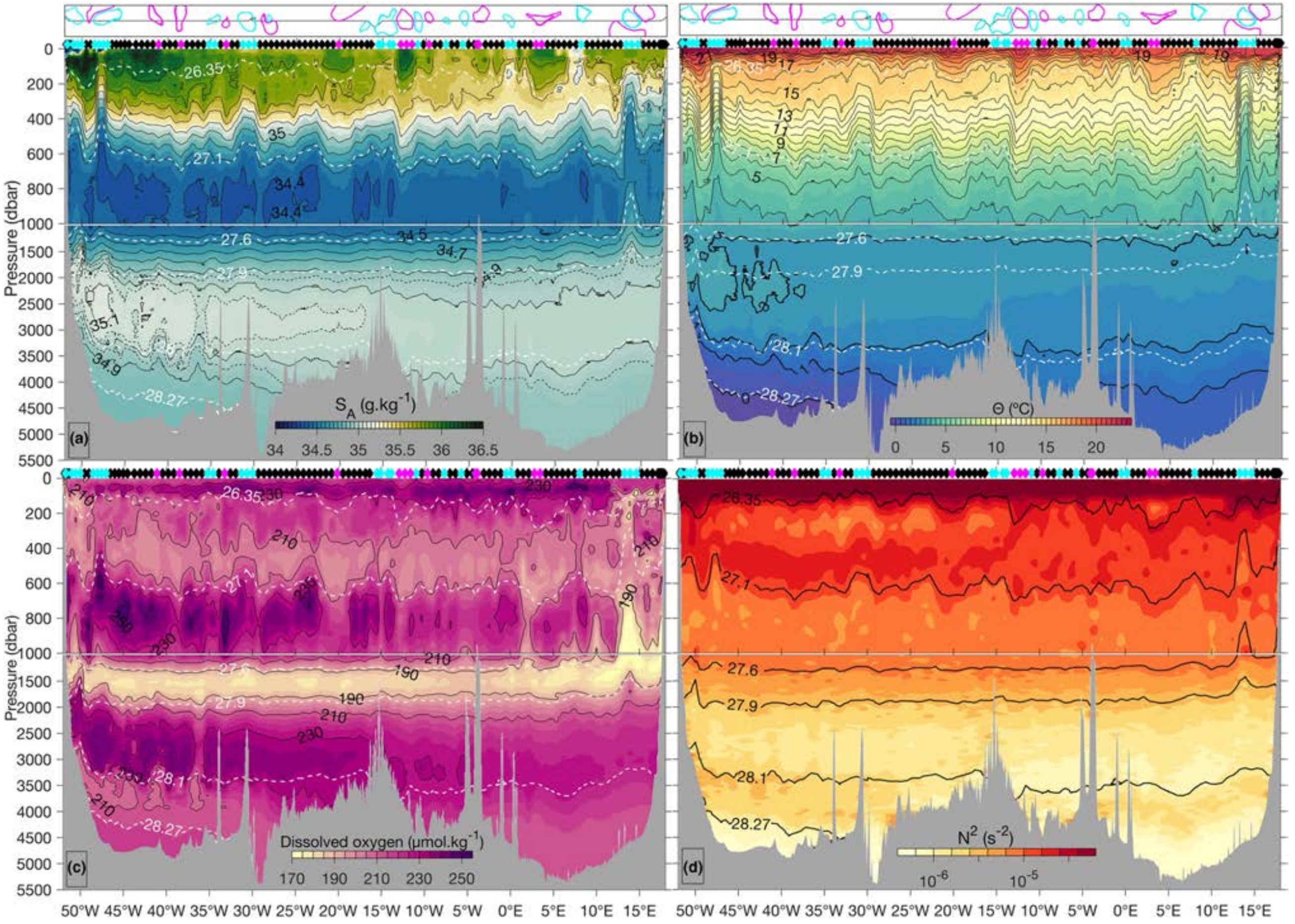


Slide courtesy of S. Dong

MSM60 hydrographic line along 34.5S (2017)

MOC = 15.64 Sv
$MOC_{abyssal}$ = 2.4 Sv
MHT = 0.27 PW
MFT = **0.23 Sv**

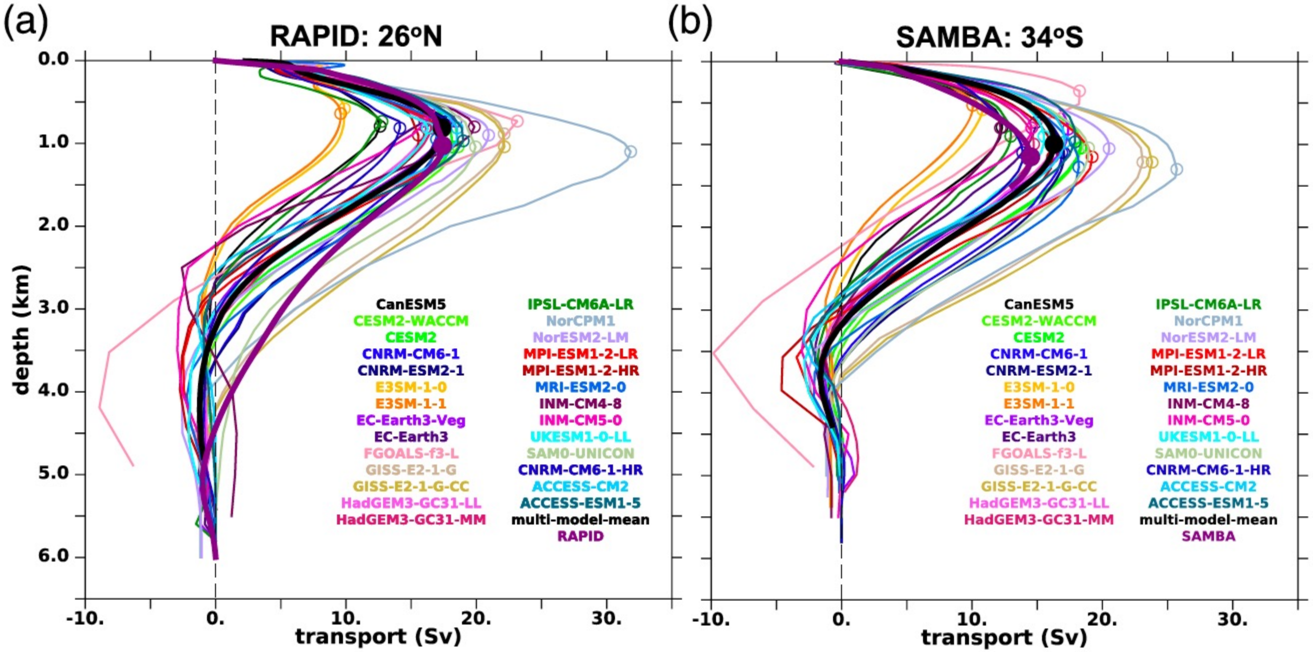
Excluding mesoscale eddies from the section increased the MHT by 0.12 PW, due to presence of many cold core eddies during cruise



Manta et al. (2021)

Providing Data to Model Community

We are providing observations that are being used to **validate and inform improvements to state-of-the-art numerical models and data assimilation systems**



Weijer et al. (2020)

SAMBA-West and SAMBA-East

SAMBA-West PIES and CPIES moorings were used to study daily variations of the Brazil Current, Deep Western Boundary Current (DWBC), and abyssal flows offshore of the DWBC *(Meinen et al., 2017; Valla et al., 2019; Chidichimo et al., 2021)*

In the Argentine basin, **SAMBA-West** hydrographic data, PIES, and a microcat mooring in Vema Channel have been used to examine recirculation and mixing in intermediate/deep layers and to detect long-term warming trends at sites below 4000m *(Valla et al., 2018; Meinen et al., 2020; Campos et al. 2021)*

SAMBA-East PIES and tall moorings were used to study daily variations of the Benguela Current and Deep Eastern Boundary Current, as well as buoyancy changes associated with currents, eddies, and filaments *(Kersalé et al., 2018, 2019; Russo et al., 2022)*

Summary and Conclusions

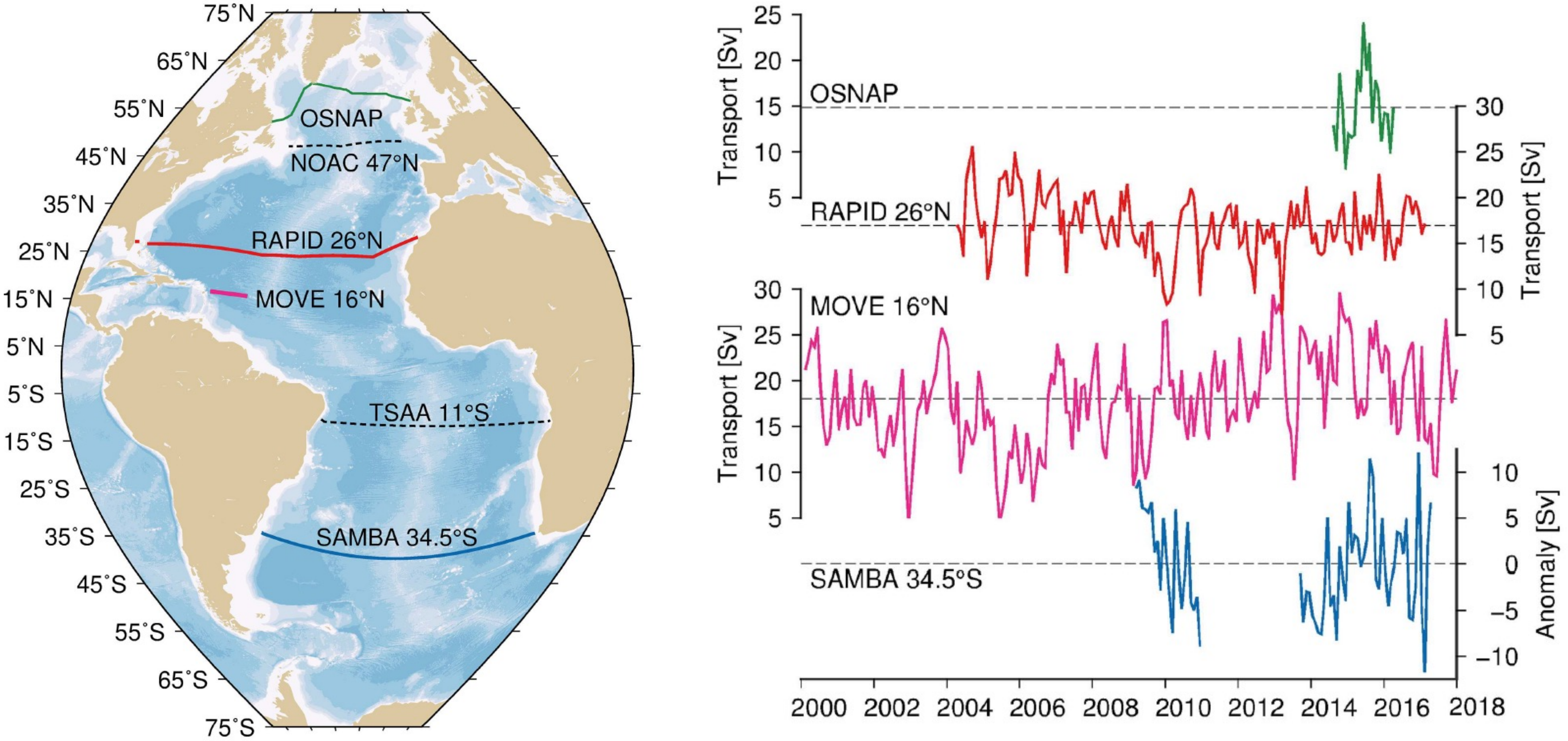
The SAMBA/SAMOC observational community has made exciting progress with expanding suite of observational products, with which we are characterizing the **temporal variability (lots of high-frequency variability), spatial structure, and connectivity of AMOC and its components**

The community is using this data to **examine mechanisms** controlling AMOC and boundary current variability in the South Atlantic, and their **impacts** on heat content, sea level, weather and climate

We are providing observations that are being used to **validate and inform improvements to state-of-the-art numerical models and data assimilation systems**

As the data records become longer, we anticipate that their use by the community will increase

Multi-latitude Comparisons



Frajka-Williams et al. (2019)

New and Notable

Members of the SAMOC community are working on a **SAMOC observational science review article** that will be submitted to Nature Communications Earth & Environment led by Maria Paz Chidichimo with participation from scientists in Argentina, Brazil, France, Germany, South Africa, and the United States.

We are also writing on a **short comment article focused on SAMOC's history**, especially its history of **diversity, inclusion, and international collaboration**.

We are **updating the 2-site MOC and DWBC time series** through the middle of 2019. We looking forward to **resuming fieldwork** on the western boundary in 2022 to extend these records further (SAMBA-East has collected data through 2021). We plan to do **sensitivity studies** to see how the number of sites used in the MOC calculation reduces the uncertainty in our MOC estimates.

Questions? Renellys.C.Perez@noaa.gov

Thank you to the NOAA Global Ocean Monitoring and Observing program and the NOAA Atlantic Oceanographic and Meteorological Laboratory for supporting the Southwest Atlantic MOC ("SAM") project

Thank you to our SAMBA international partners (and their funding agencies) in Argentina, Brazil, France, South Africa, without whom we could not do SAMBA field work; and to the larger SAMOC community for support of our efforts

A lot of work goes into going into the field to maintain the arrays and collect and processing the data, and we thank the people that routinely do so

Thank you to US AMOC Science Team for bringing us all together!