# THE COLD AND WARM CONTRIBUTIONS TO THE EASTERN SOUTH ATLANTIC SUBTROPICAL GYRE

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## BACKGROUND

The returning limb of AMOC is mainly supplied by the northward transport of lighter upper ocean waters from the South Atlantic Ocean back into the high latitudes:

- Cold-fresh water route - from the Pacific Ocean through the Drake Passage (Rintoul, 1991)
- Warm-salt water route - from the Indonesian throughflow, crossing the Indian Ocean via the Agulhas Current (Gordon, 1986)

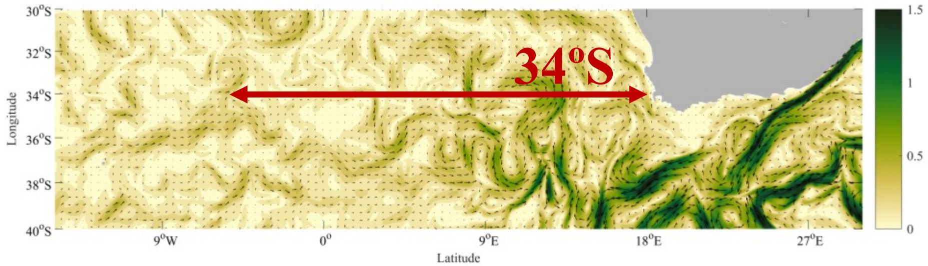



**Figure 1**. Surface velocity on 21/12/2019 and 34ºS section selected to release the Lagrangian particles.

## OBJECTIVE

Here we carry out numerical simulations of Lagrangian trajectories to identify the multiple direct and indirect cold and warm intermediate-water pathways reaching the eastern South Atlantic subtropical gyre:

- Predominant trajectories and percentage of particles
- Transit times
- Changes in thermohaline properties and water mass transformations
- Spatiotemporal variability (summer vs. winter).

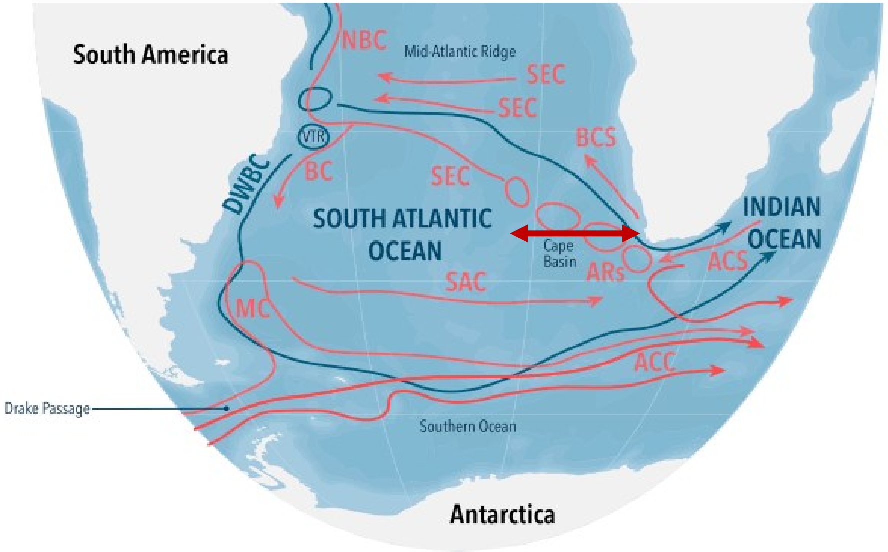



**Figure 2**. (a) Upper (red) and lower (blue) limbs of the AMOC. **Bower et al., 2019**

## DATA & METHOD

→ We use the daily velocity and thermohaline fields of the numerical model GLORYS12v1 product for the whole 2019 year and compute trajectories through the **Parcels** code.

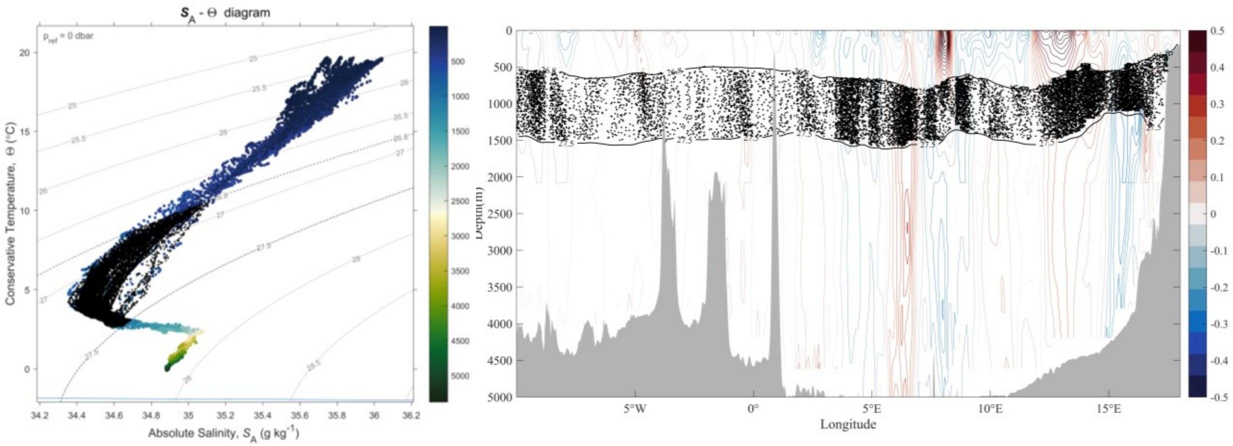
→ Release Lagrangian particles backward in the 34°S section for 50 years with a 5-days resolution during the whole summer and winter.

→ Particles correspond to Antarctic Intermediate Water (AAIW) parcels defined between 26.8< σ <27.5 kg $m^{-3}$ according to the salinity minimum layer.

→ Particles are proportional to geostrophic transport. Each of them corresponds to ~0.01 Sv.

**34ºS SECTION- INTERMEDIATE WATERS 26.8< σ <27.5**

RELEASED ON DECEMBER (21/12/2019) | Net AAIW transport in 34°S is 12.2 Sv




RELEASED ON JUNE (21/06/2019) | Net AAIW transport in 34°S is 22.2 Sv

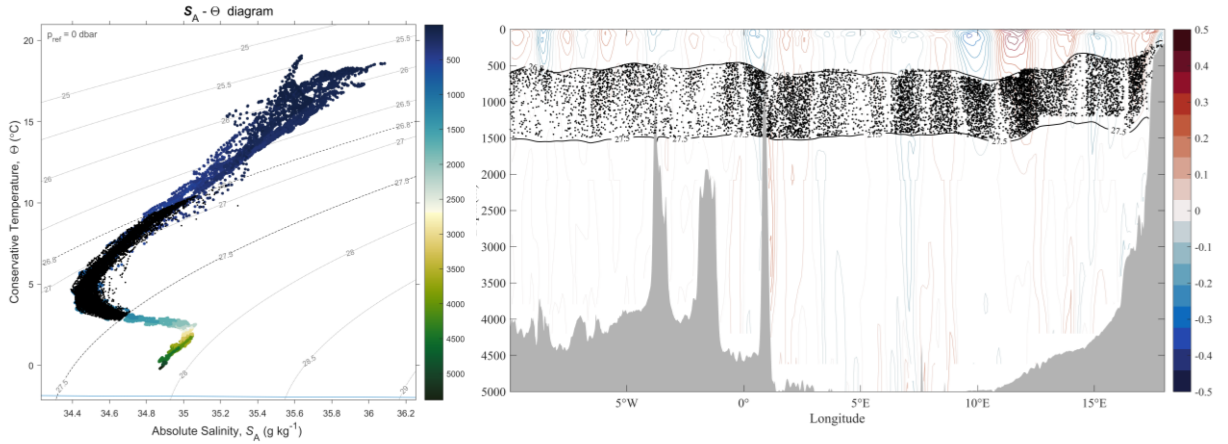



**Figure 2**. Mean (a) θ-S diagrams and (b) contours of the velocity meridional component along the 34°S vertical section with the Lagrangian released particles represented in black. The upper panels correspond to particles released on 21/12/2019 and the bottom ones on 21/06/2019.

# RESULTS: JUNE (21/06/2019)

## INTERMEDIATE WATERS FROM DRAKE PASSAGE

→ Most of the particles last between 4-5 years to be incorporated into the subtropical gyre.

→ From 64°W to 34°S

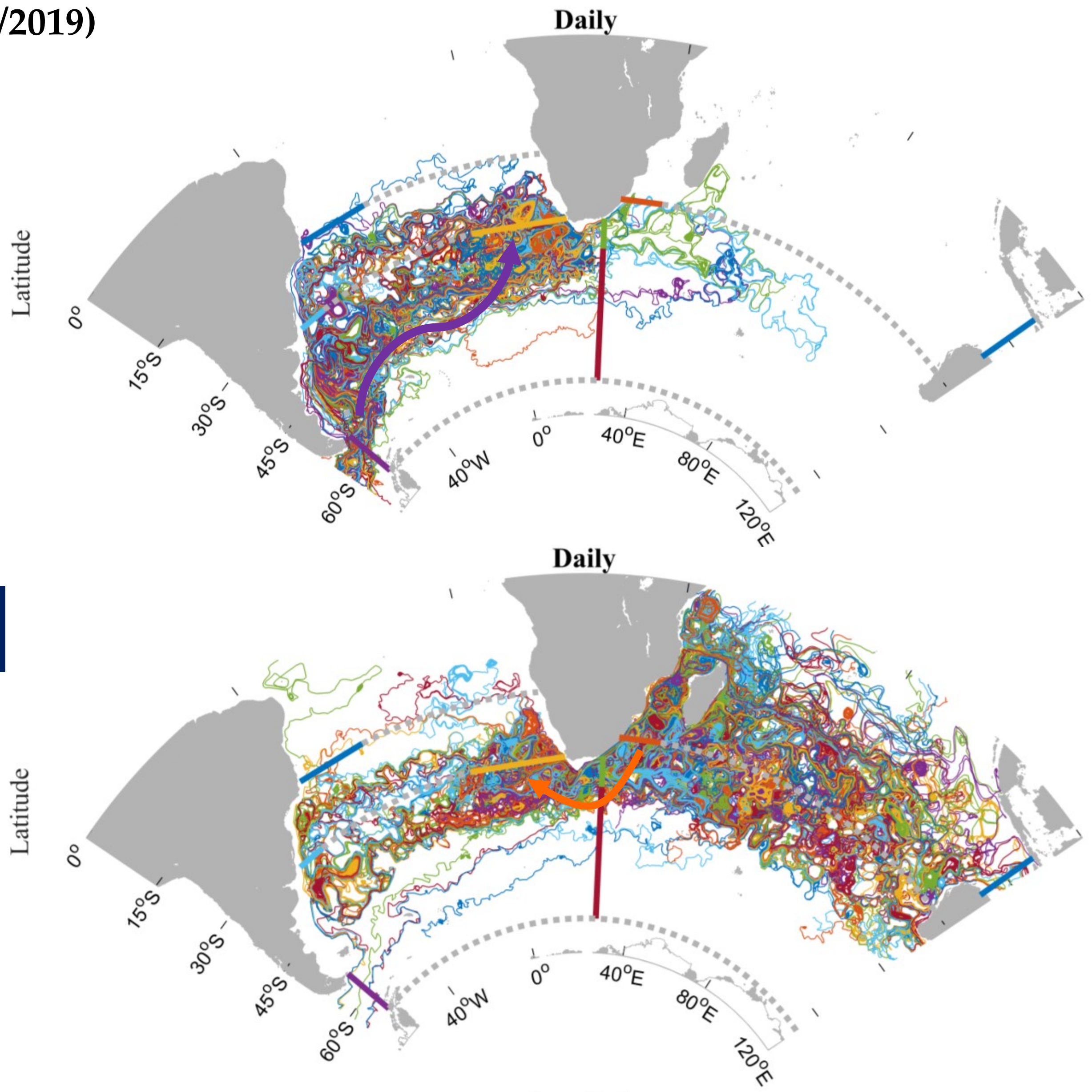
The 7.8 % of particles cross the Drake with 7.8 Sv.

## INTERMEDIATE WATERS FROM AGULHAS CURRENT

→ Most of the particles last less than 1 years to be incorporated into the subtropical gyre.

→ From 30°S to 34°S

The 7.4 % of particles cross the Agulhas with 7.4 Sv.



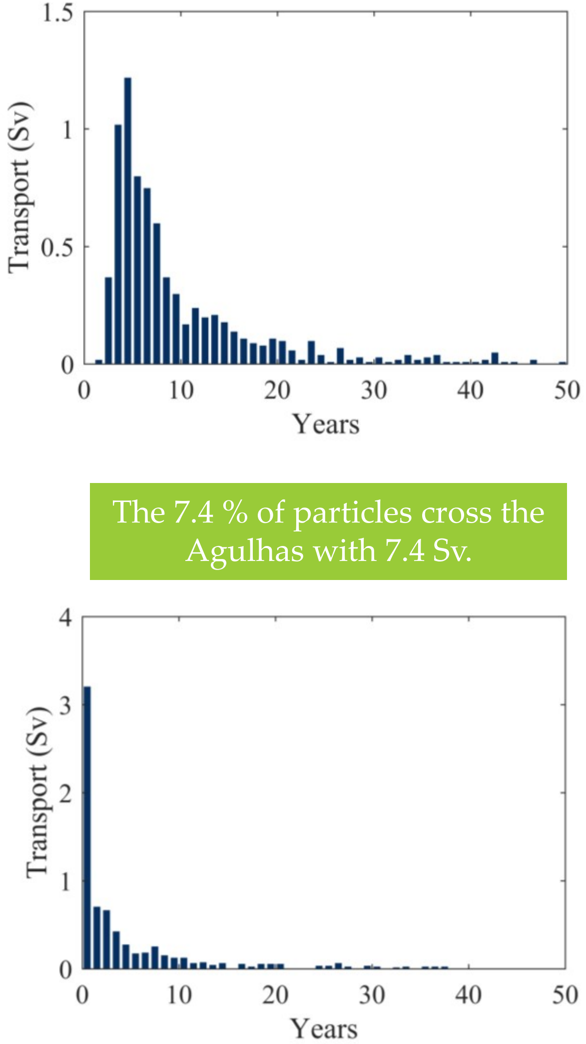




**Figure 3**. Particles trajectories of particles that follow the cold-water route and warm route, and their transit time histogram, both released in summer.

RELEASED ON JUNE (21/06/2019)

RELEASED ON DECEMBER (21/12/2019)

INTERMEDIATE WATERS PROBABILITY

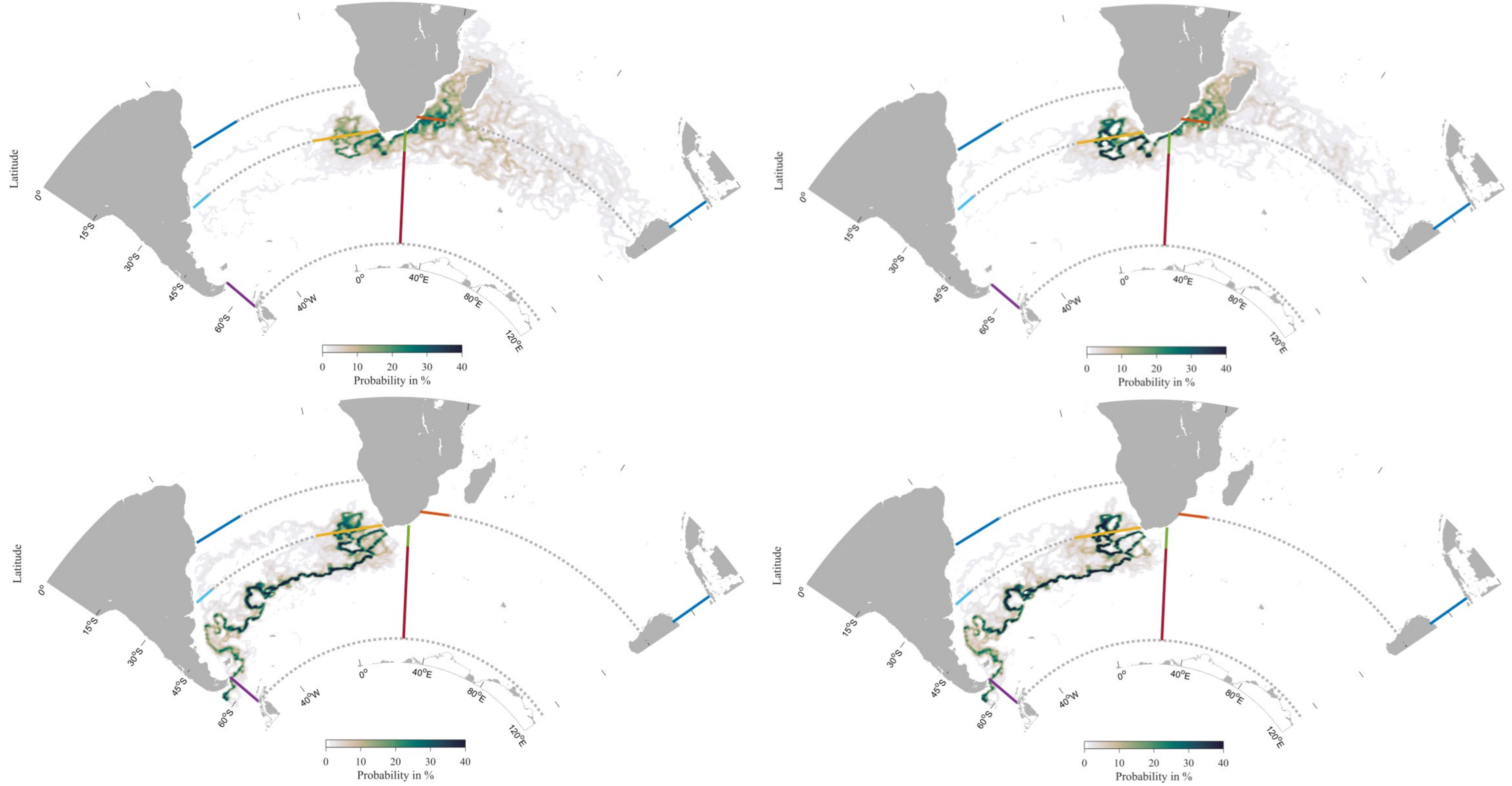
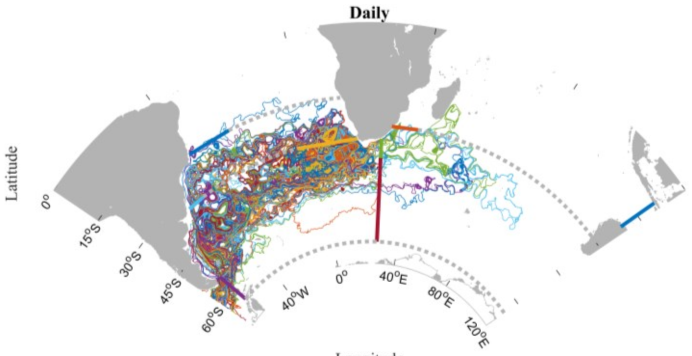
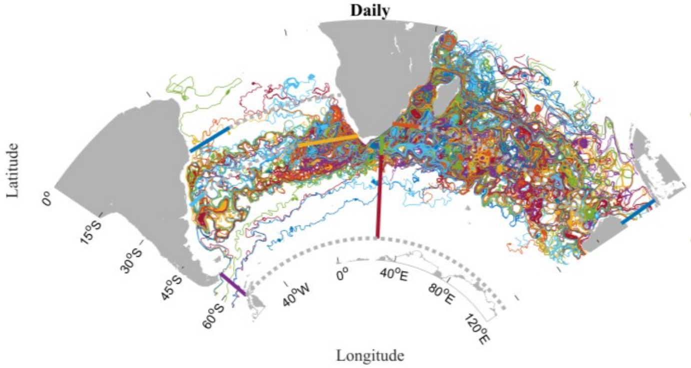



**Figure 4.** Probability in percentage to follow a particular trajectory (particles counted only once) of particles that follow the cold/warm route both released in summer and winter.

## INTERMEDIATE WATERS – JUNE (21/06/2019)




→ Drake source:
- 11.1 years
- 4.1 years
- 9.8 years




→ Agulhas source:
- 11.8 years
- 0.04 years
- 2.0 years

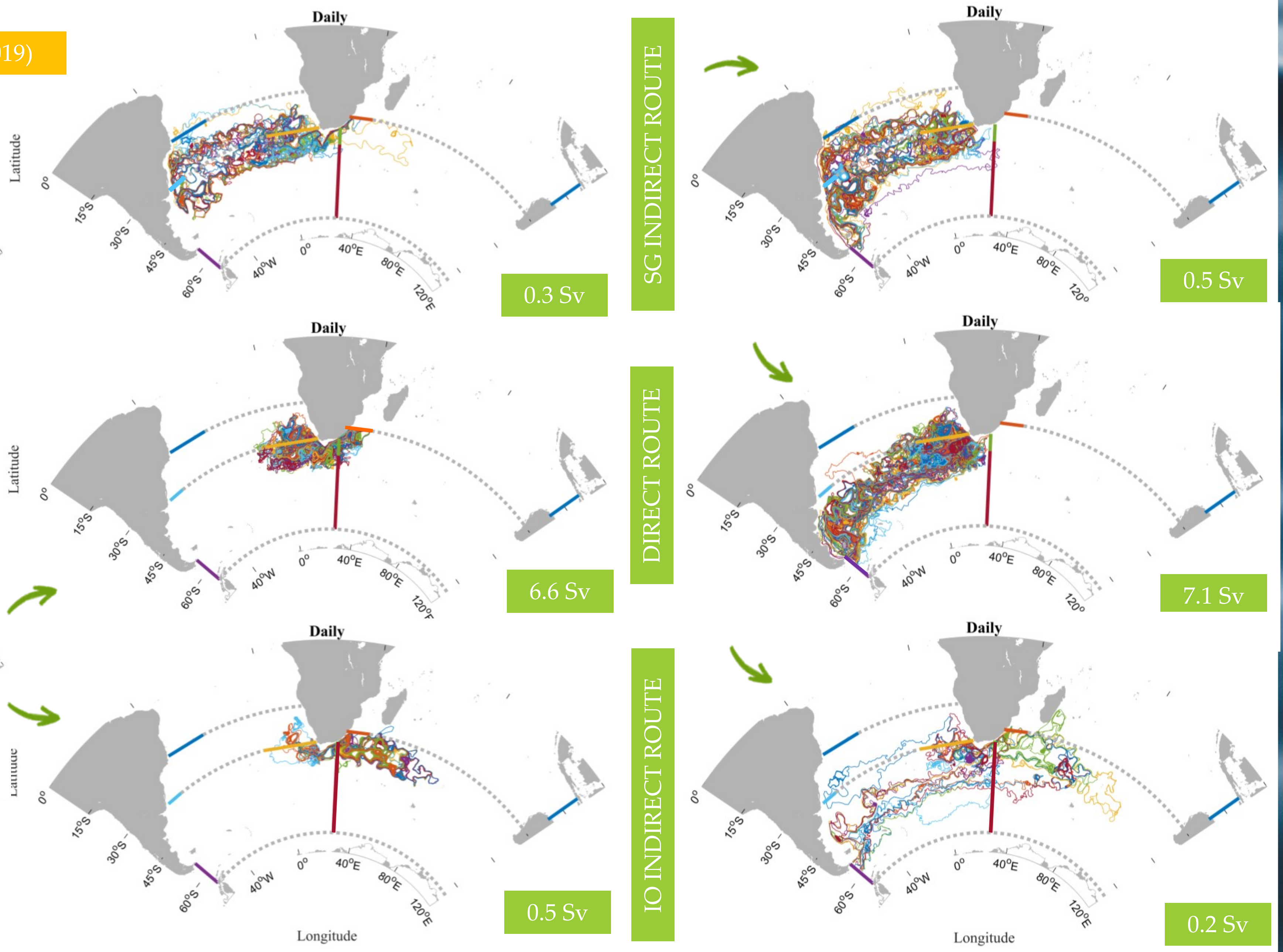



**Figure 5**. Individual particles trajectories.

## **INTERMEDIATE WATERS 34°S → Drake Passage** - Potential temperature, Salinity, and Depth (released in June)

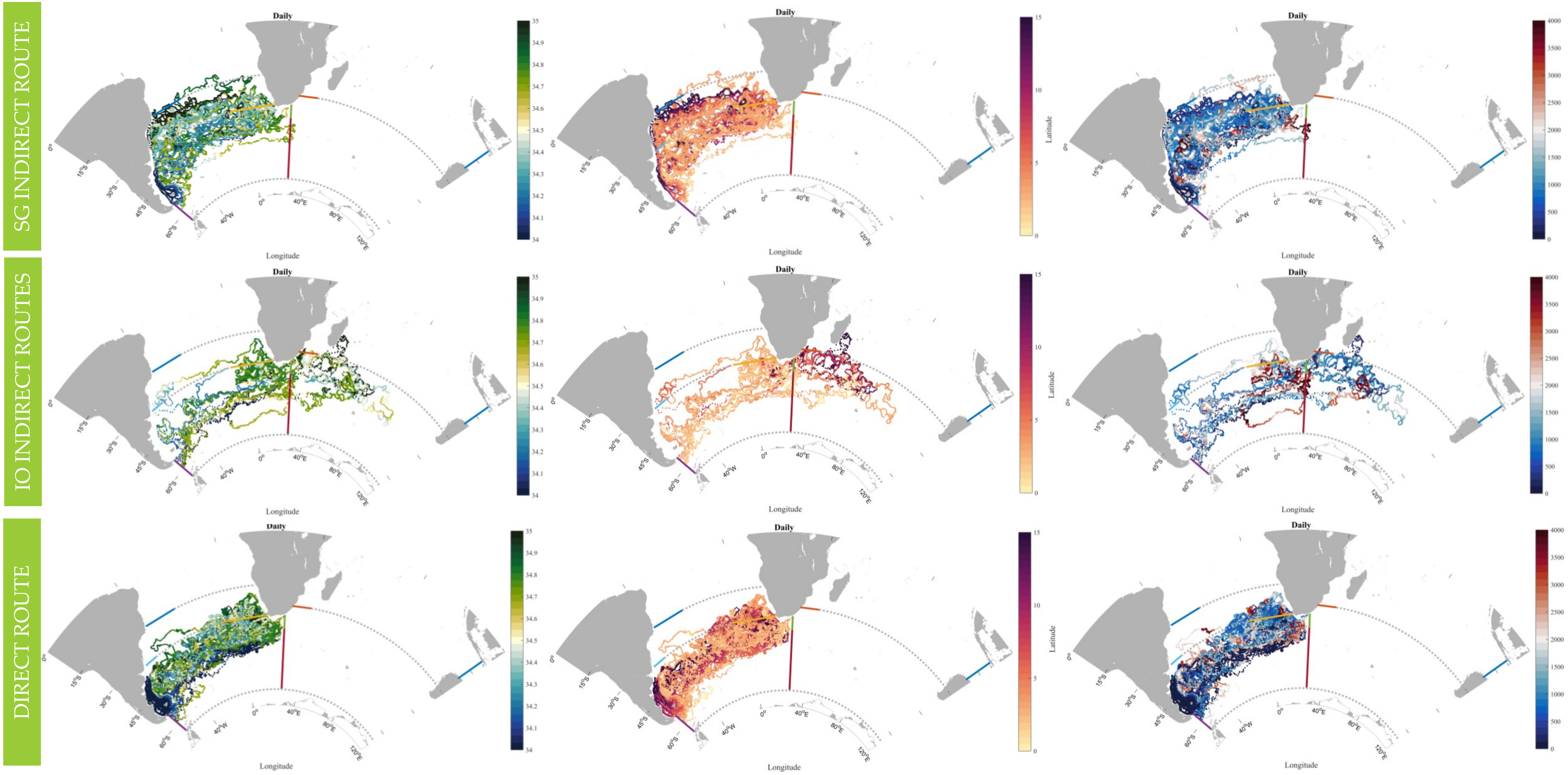



**Figure 6.** Thermohaline properties and depth along the Lagrangian particle trajectories for the three main pathways that form the cold water route.

## WATER MASS TRANSFORMATION

→ The transport of intermediate waters from Agulhas and Drake in June is very similar (7.4% as compared with 7.8%), while in December there is a larger difference (Agulhas dominates with 14.4%).

→ Both in June and December, only slight water mass transformations take place, with a predominance of source intermediate waters.

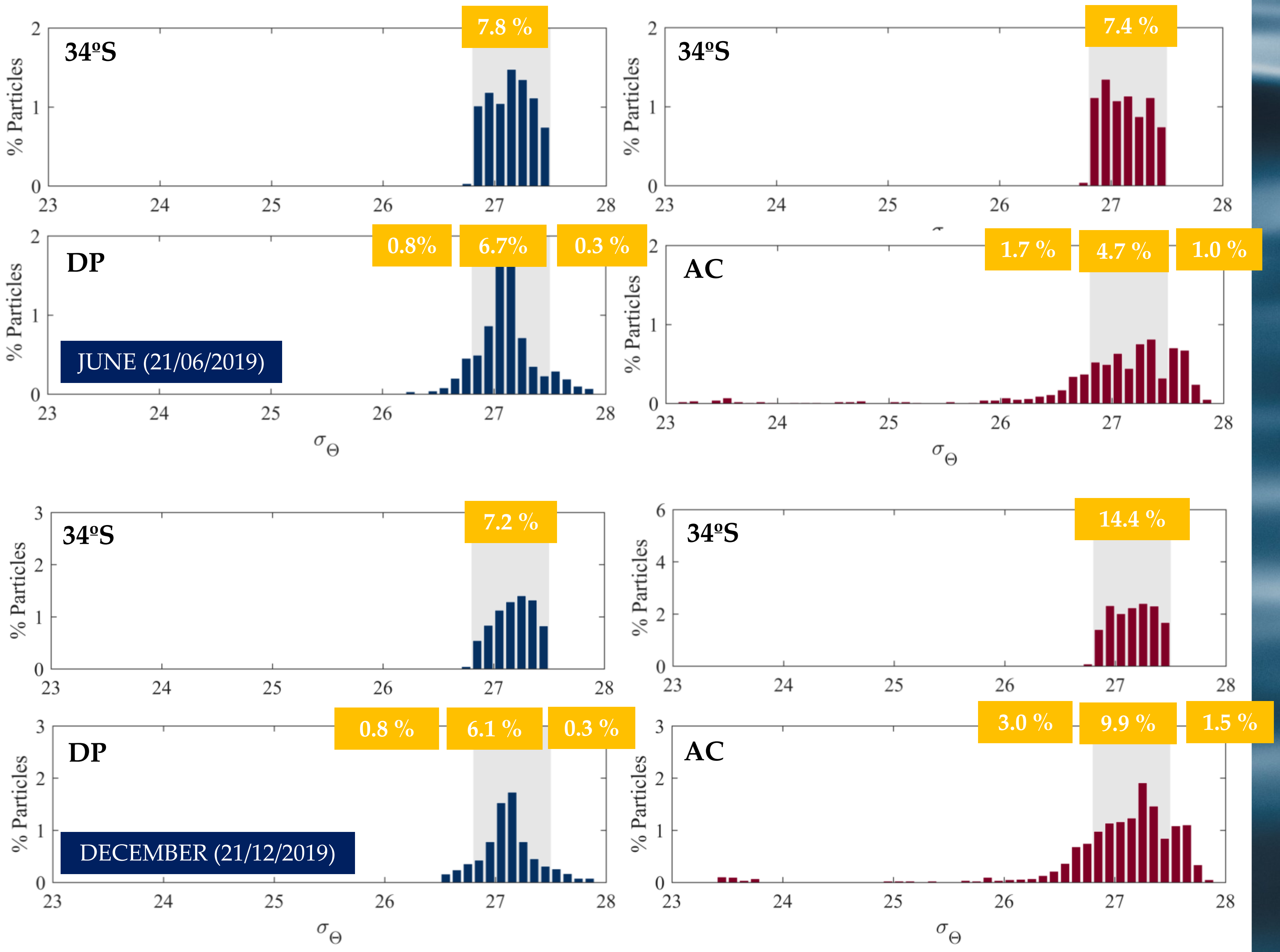



**Figure 7.** Percentage of particles that experience water mass transformations along their path for different isopycnal layers

## PRELIMINARY RESULTS

→ Between 78 and 85% of the particles do not cross the Agulhas and Drake sections. However, about 25% of the particles do not reach the domain boundaries in 50 years.

→ Generally, the warm contribution to the intermediate waters at 34ºS is higher than the cold contribution except in early June.

→ The three individual pathways are always present but the direct path dominates.

→ The largest changes in thermohaline properties occur in the confluence zones of the Malvinas-Brazil Current and the Agulhas-South Atlantic Current.

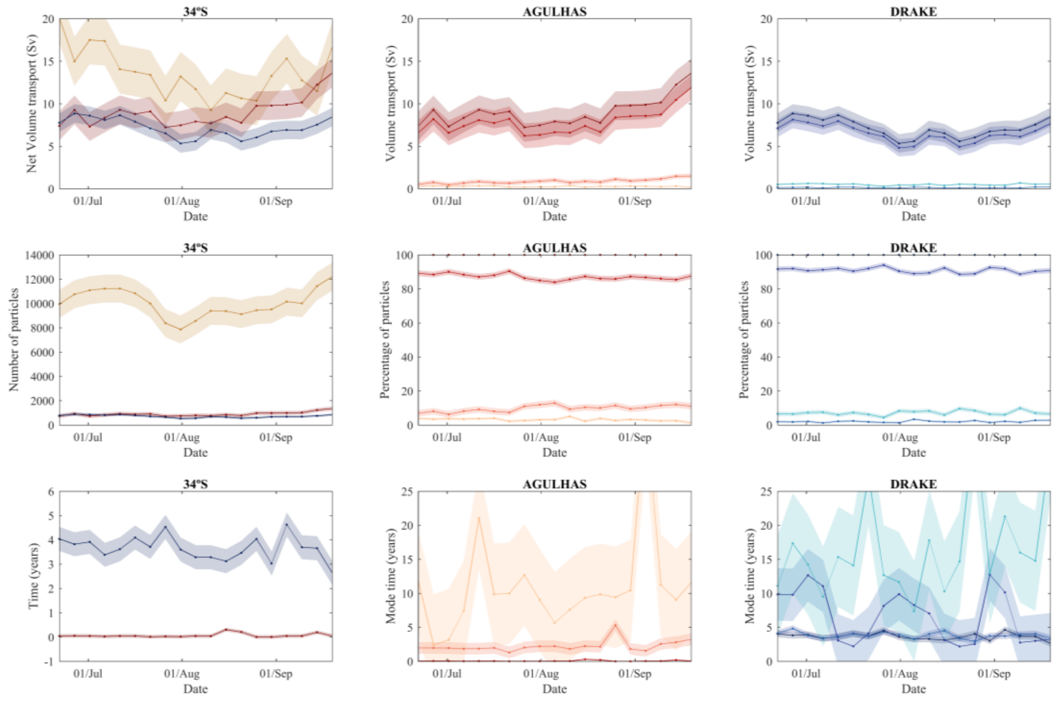



**Figure 8**. Volume transport, number of particles and time transit from the Agulhas and Drake source according to the total/individual pathways for the whole austral winter period.

## WORKING ON…

- Daily velocity fields (from 2015 to 2019)
- Particles released the whole summer and winter for each year.
- Backward for 75 years.