6th Euro-Argo Users Meeting

Circulation patterns in South Atlantic Intermediate Waters as seen from Argo inferred velocities

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Outline

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    - Lagrangian approach
- **Results**
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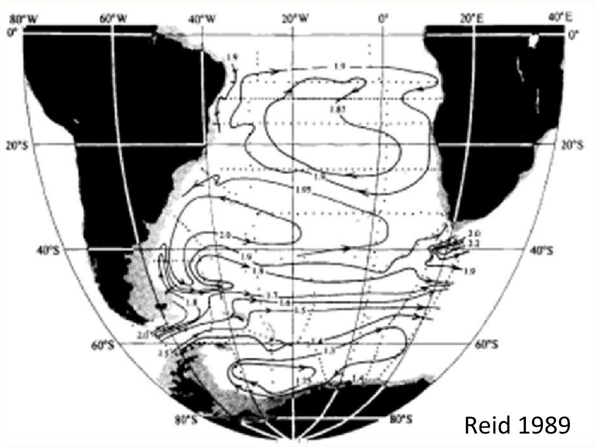
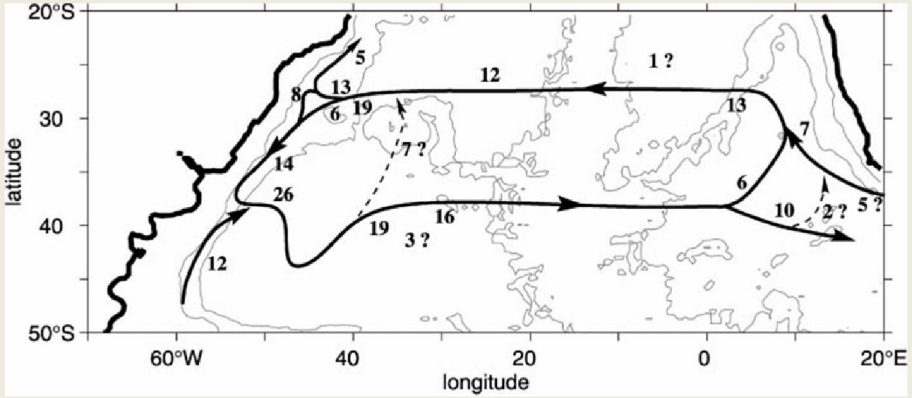
    - Time estimation
    - Argo velocity data vs Glorys2v4

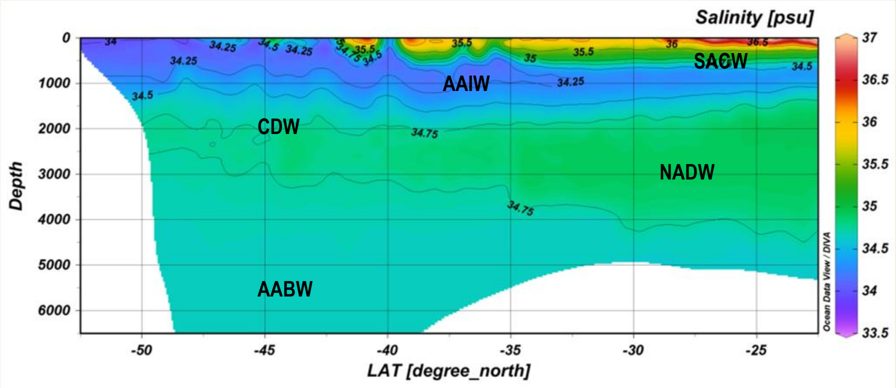
AAIW in the South Atlantic Ocean



Reid 1989

- Anticyclonic Sub-Tropical gyre -> basinwide recirculation.
- Fed mainly by Malvinas Current and Agulhas system and Polar Front subduction.
- Directly related to the northward branch of the AMOC.
- Potential density range (27.00 – 27.35) kg/m^3 (Schmid et al. 2000).

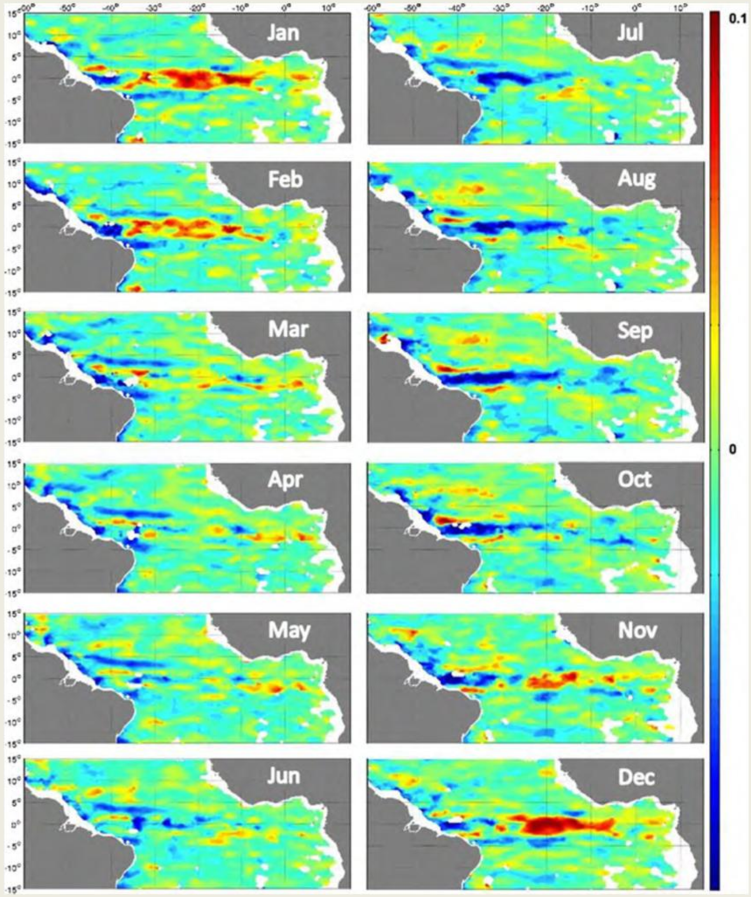




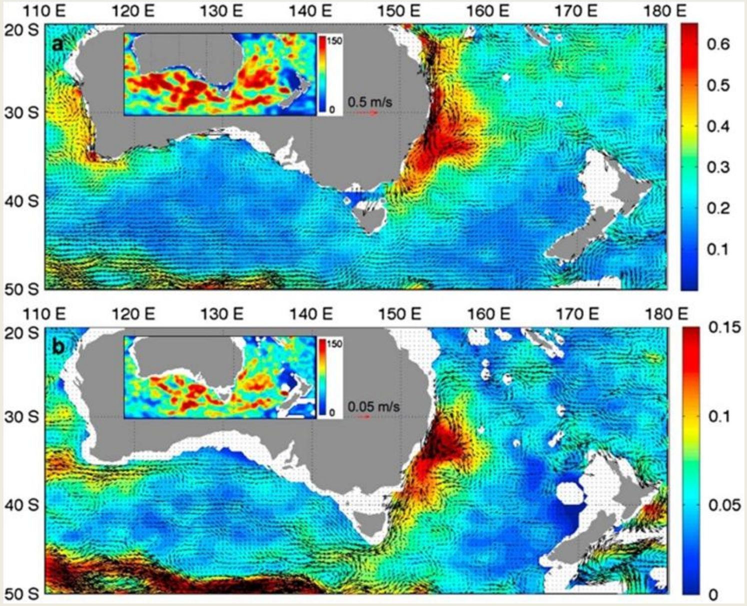
Schmid et. al 2000

Argo inferred velocities

Argo velocity data sets: Ollitrault et al. 2006, Lebedev et al. 2007 and Rosell-Fieschi 2015.



Rosell-Fieschi et. al 2015



Rosell-Fieschi et. al 2013

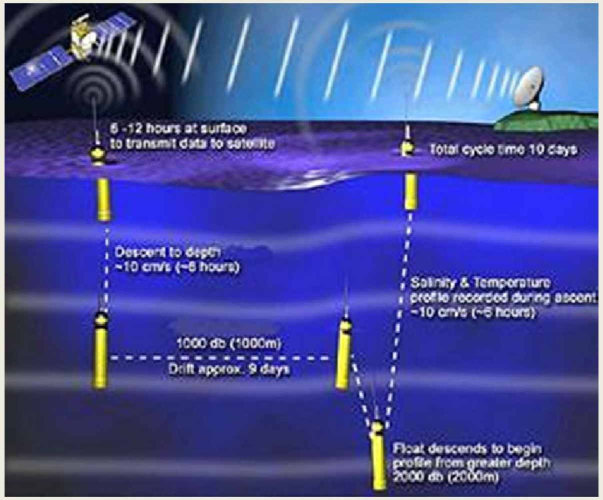
Argo velocities at 1000 dbar can be used as a reference layer to estimate overlaying circulation.

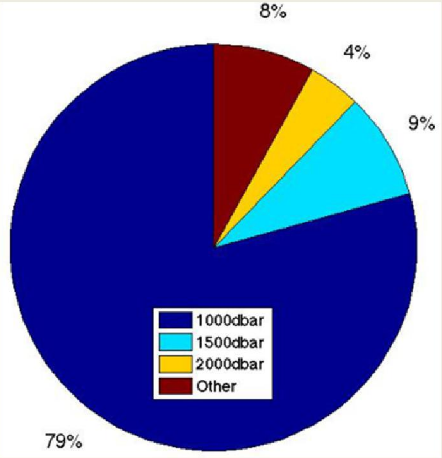
Aim of work

- Study the circulation patterns of the South Atlantic currents at 1000 dbar using a Lagrangian deterministic analysis.
- Estimate recirculation times of intermediate waters using 2D velocity field inferred from Argo floats position.
- Comparation between 1000 dbar Argo velocities with the reanalysis model Glorys 2v4.

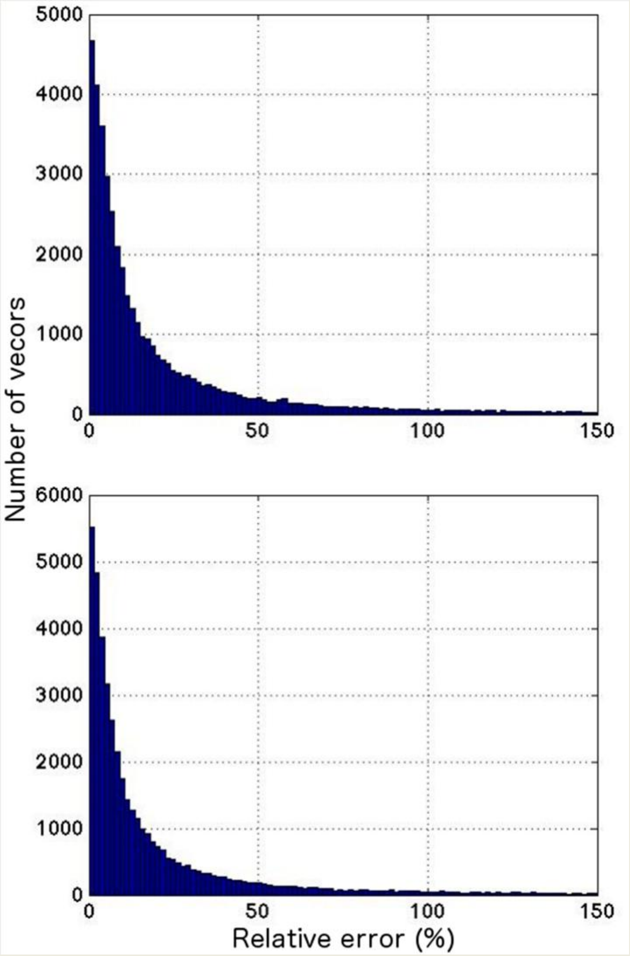
Argo velocities at 1000 dbar

- First and last position of a float cycle is used.
- Individual velocity estimates are spatially and temporally averaged with a resolution depending on the available data.
- Hexagonal cells of 110 km of radius are used (1°x1° resolution aprox.).
- Minimum of 25 observations are used for each cell.
- Monthly climatological time serie smoothed with a 10-day running average.





Argo velocities at 1000 dbar



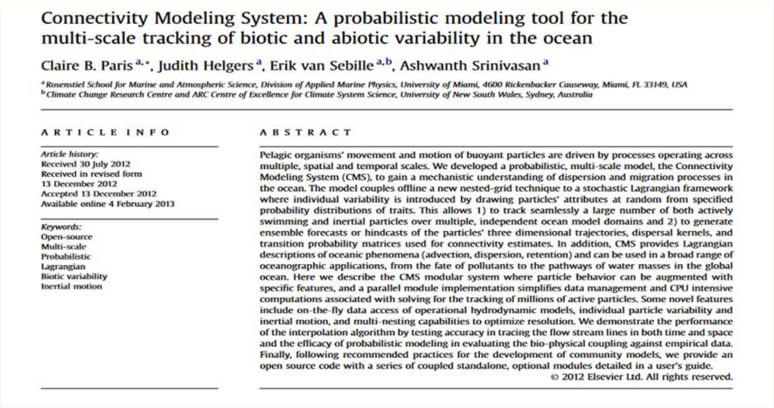
Source of error:

- Positioning accuracy.
- Drift during vertical migration (represents only 5% of the cycle).
- Time gap between surfacing/immersion position and the first/last satellite position.
- Non-instrumental error source (ocean dynamics).

Error estimation:

- Obtained assuming one same velocity within the entire time gap.
- The difference betwen assumed surface and deep velocity, corresponds to the vertical migration error.

Lagrangian approach



Connectivity Modeling System: A probabilistic modeling tool for the multi-scale tracking of biotic and abiotic variability in the ocean

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ABSTRACT

Pelagic organisms' movement and motion of buoyant particles are driven by processes operating across multiple, spatial and temporal scales. We developed a probabilistic, multi-scale model, the Connectivity Modeling System (CMS), to gain a mechanistic understanding of dispersion and migration processes in the ocean. The model couples offline a new nested-grid technique to a stochastic Lagrangian framework where individual variability is introduced by drawing particles' attributes at random from specified probability distributions of traits. This allows 1) to track seamlessly a large number of both actively swimming and inertial particles over multiple, independent ocean model domains and 2) to generate ensemble forecasts or hindcasts of the particles' three dimensional trajectories, dispersal kernels, and transition probability matrices used for connectivity estimates. In addition, CMS provides Lagrangian descriptions of oceanic phenomena (advection, dispersion, retention) and can be used in a broad range of oceanographic applications, from the fate of pollutants to the pathways of water masses in the global ocean. Here we describe the CMS modular system where particle behavior can be augmented with specific features, and a parallel module implementation simplifies data management and CPU intensive computations associated with solving for the tracking of millions of active particles. Some novel features include on-the-fly data access of operational hydrodynamic models, individual particle variability and inertial motion, and multi-nesting capabilities to optimize resolution. We demonstrate the performance of the interpolation algorithm by testing accuracy in tracing the flow stream lines in both time and space and the efficacy of probabilistic modeling in evaluating the bio-physical coupling against empirical data. Finally, following recommended practices for the development of community models, we provide an open source code with a series of coupled standalone, optional modules detailed in a user's guide.

Turbulence module:

$$X^{n+1} = X^{n} + u\Delta t + (2K_x/\Delta t)^{1/2}Q$$

Buoyancy module:

$$w_{total} = w + \frac{9.81\ d^2\Delta\rho}{18\mu}$$

$$\mu = 1.88 \times 10^{-3} - (4 \times 10^{-5}\ T)$$

Multi-scale tracking *Modelling Connectivity System* (Paris et al., 2013):

- This Lagrangian model offers different tools to describe physical features of the particles: turbulence and buoyancy.
- Particles are seeded within Argo velocity field and compared with the reanalysis model **GLORYS2v4**.
- Seeding frequency depends on the velocity magnitude of each time-step.

Lagrangian approach

GLORYS2v4

NEMO v3.1

Spatial de resolution :1/4° + 75 z levels.

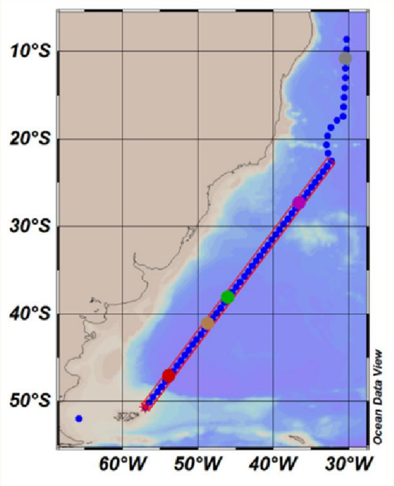
Daily output between 1993 and 2015.

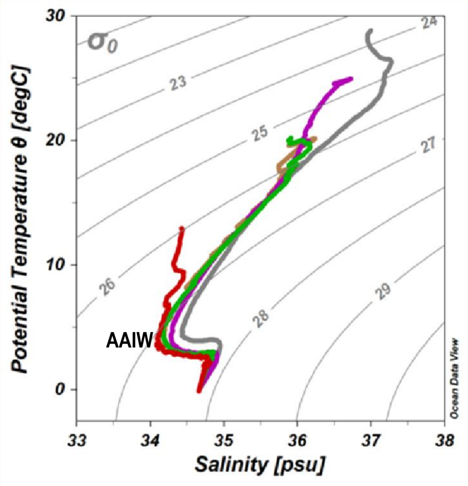
Atmospheric forcing through Era-Interim reanalysis.

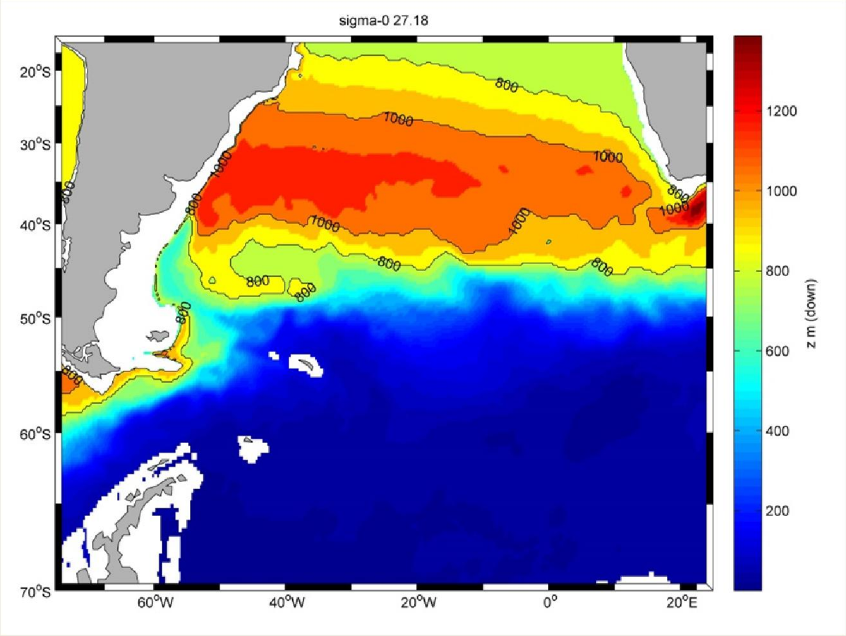
Data assimilation of T, S, SSH, SIC, SST and MLD.

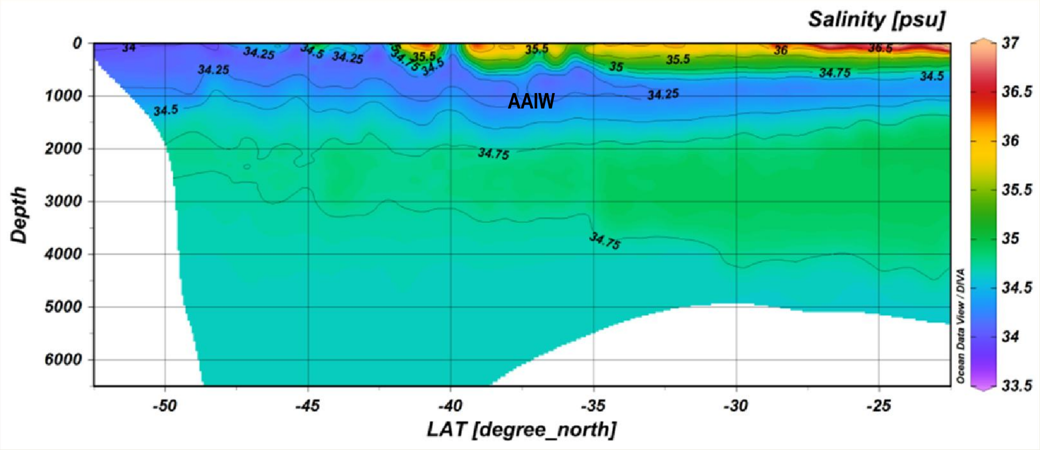
AAIW distribution

FICARAM Cruise, 2010

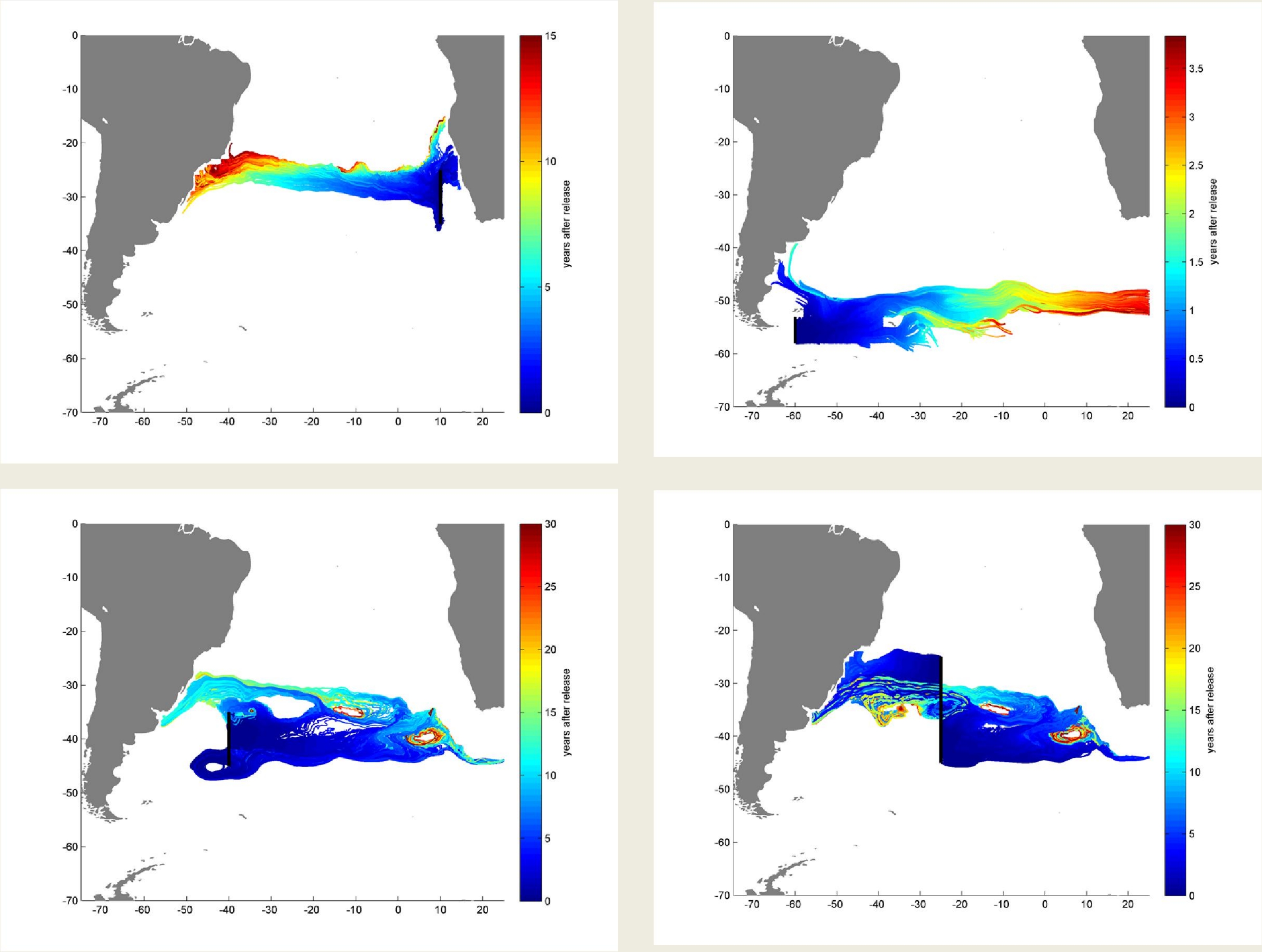




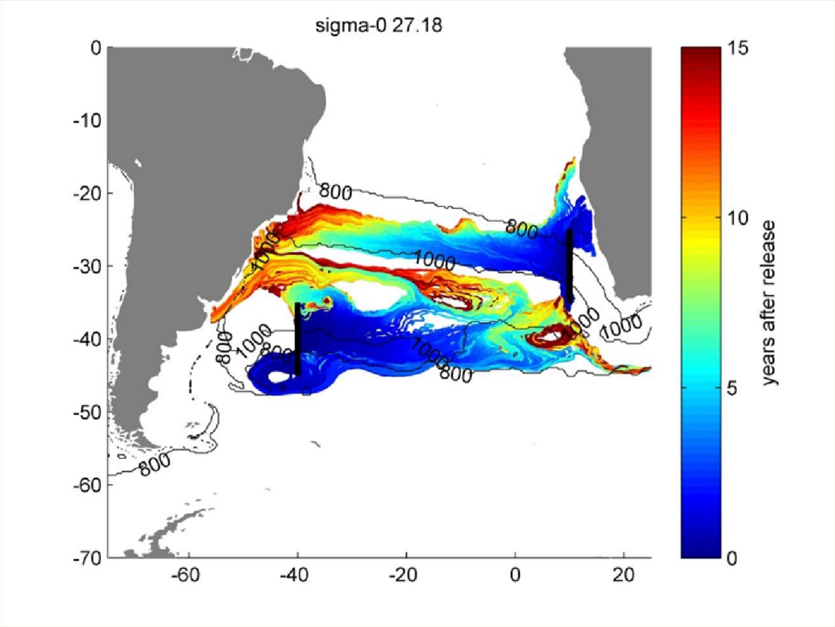


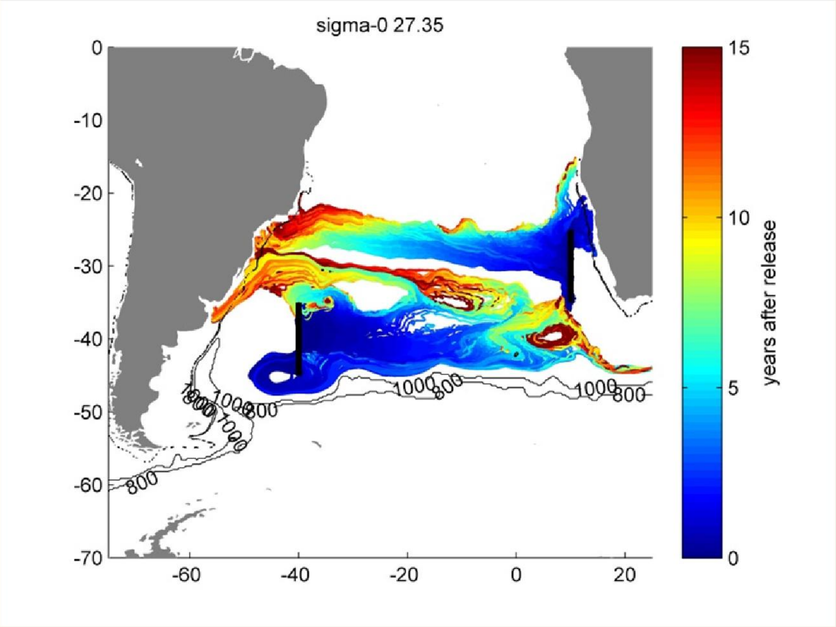


Time estimation



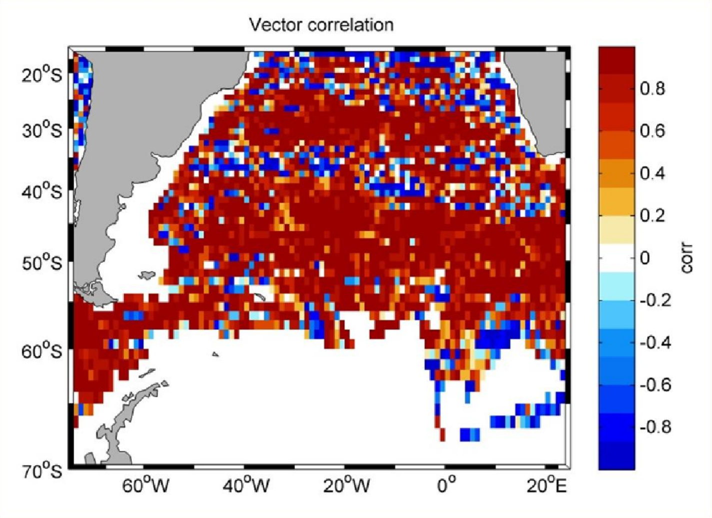
Time estimation

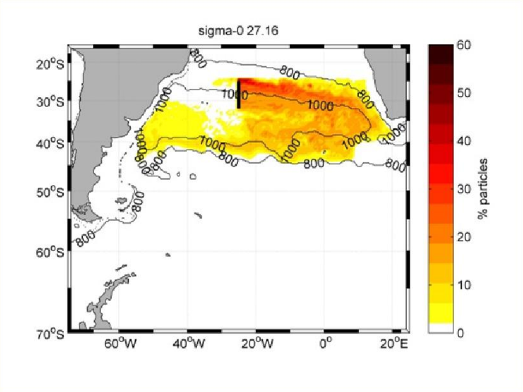


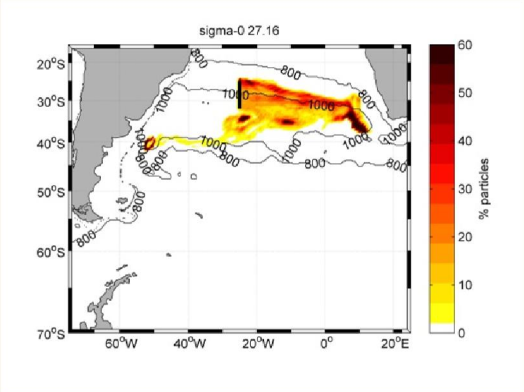


- Argo velocities correspond to the lower half of the AAIW layer.
- Particles seeded in the southern branch of the subtropical gyre follow different recirculation paths.

Argo at 1000 dbar vs Glorys2v4



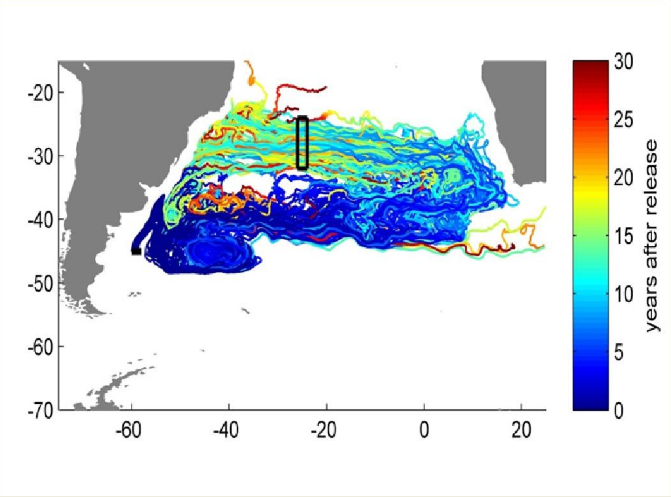


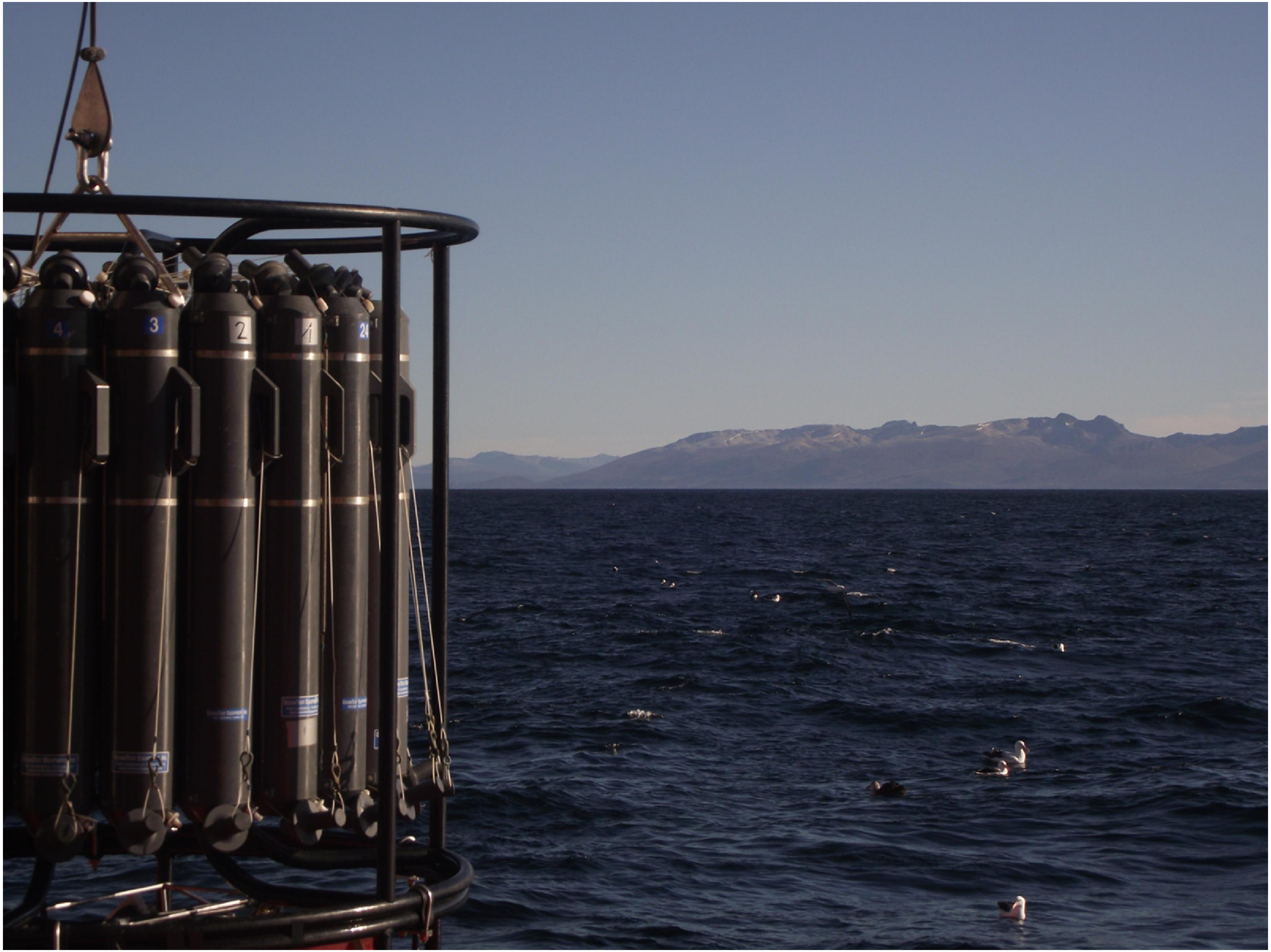


- Good correlation between both margins of the subtropical gyre.

- Despite diferences in particle dispersion, Argo shows to be useful to locate the water source.

- Recirculation times do not differ substantially when using Glorys and Argo velocities.

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