

Pathways of the upwelling water in the Benguela Current

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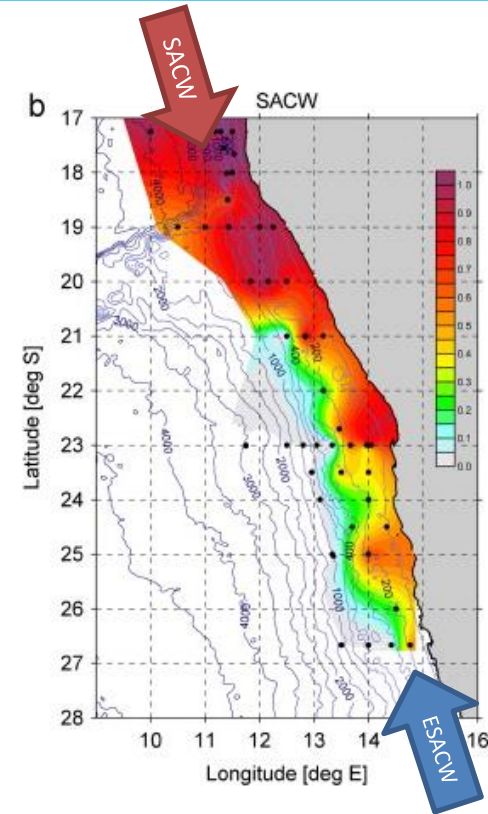
The Benguela Upwelling System is a confluence zone of

- East South Atlantic Central Water (ESACW)
- South Atlantic Central Water (SACW)

The composition of the water is important since determines its properties (Temperature, Salinity)

- Do the ocean models reproduce the observed water masses?
- Where does the upwelling water originate?
 - Source regions
 - Depths

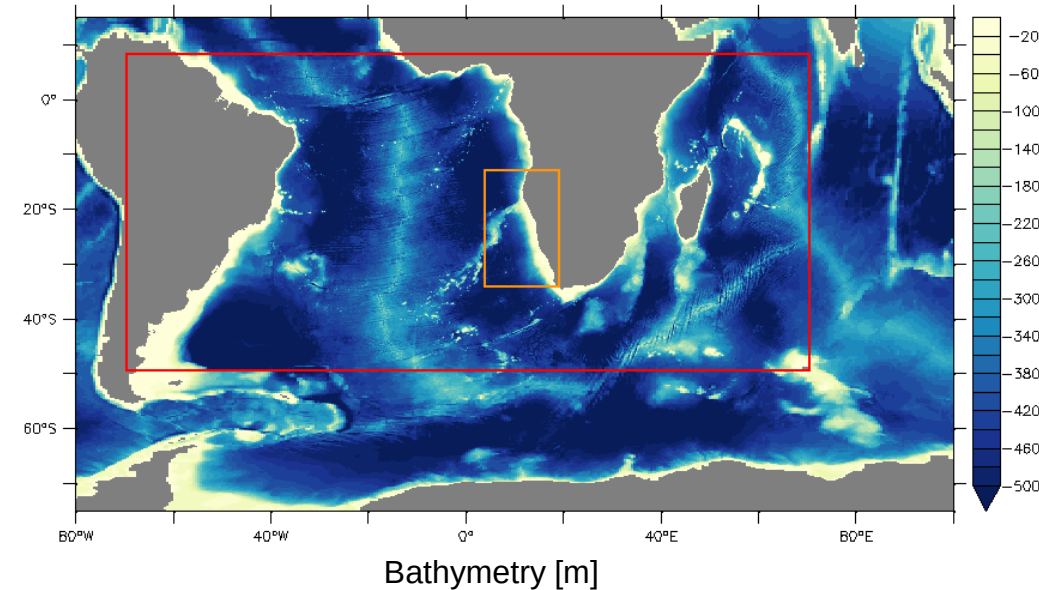
We tried to answer these questions by calculating backward Lagrangian trajectories in a high-resolution model



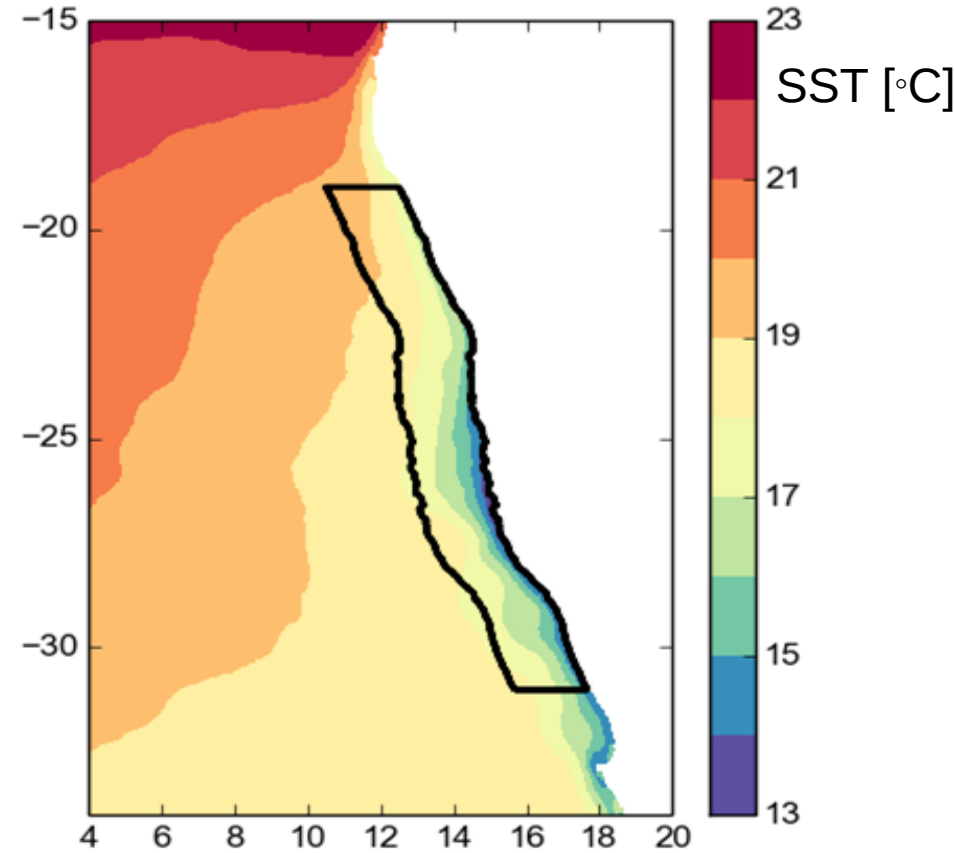
Observed SACW
(Figure from Fennel et al., 2012)

- NEMO 3.1.1
- z-coordinates, 46 vertical levels
- QuikSCAT/CCMP blended wind forcing
- CORE2 surface forcing

| | | |
|------------------------------------------------------|-------|---------------------------|
| Base model "ORCA05" | 1/2° | globally |
| One nest INALTO1 (Durgadoo et al. 2013) | 1/10° | 8°N – 50°S 70°W – 70°E |
| Nest in nest "REBUS30" | 1/30° | 13°S – 34°S 4°E – 19°E |

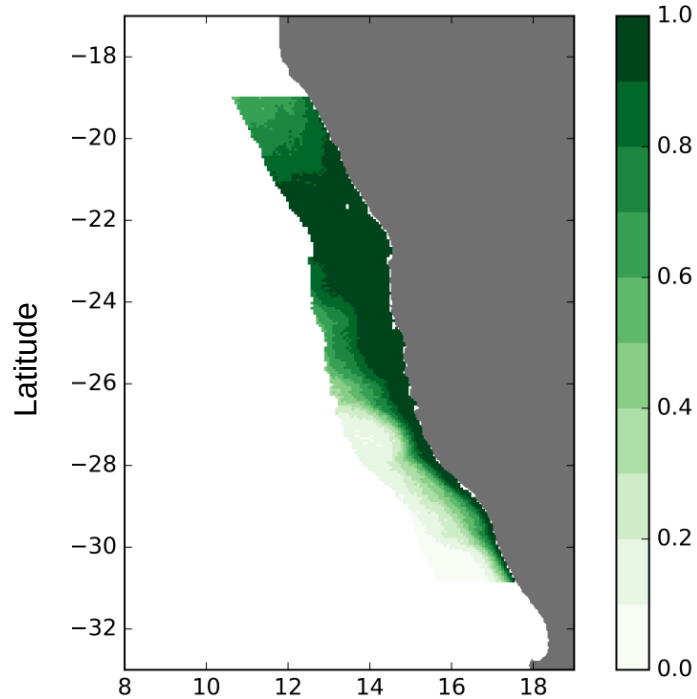


- ARIANE software
 - Second nest of REBUS30 with blended wind
 - Seeding 2005 and 2006, every 5 days
 - Calculating **backward** to 2000
 - 19°S-31°S,
coast – 2° offshore,
1 particle for every 2/30°
 - Seeding depths: 10m, 15m, 20m, 25m
- **3.28 million particles**



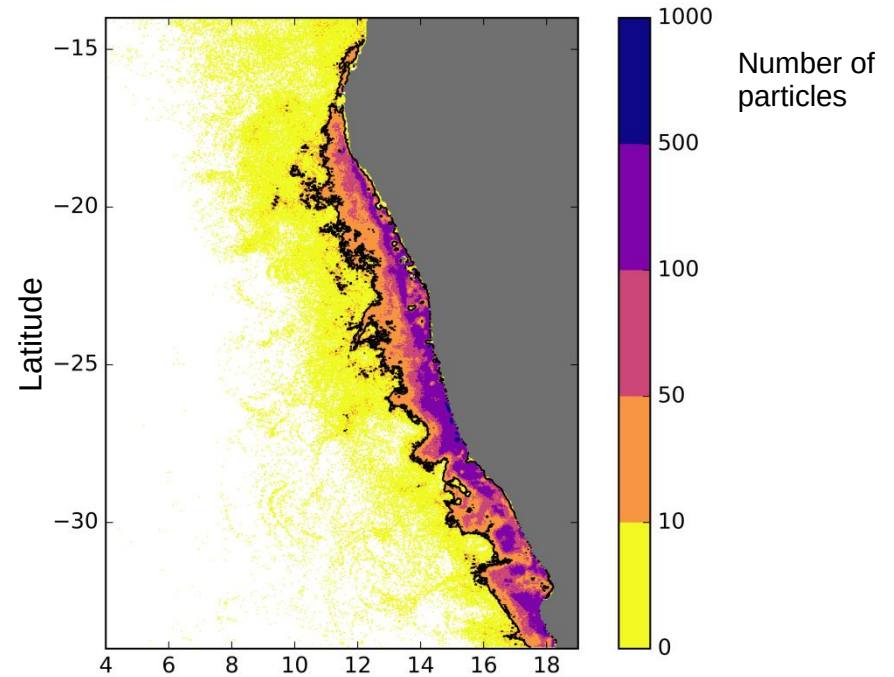
Do the particles upwell?

Most of the particles upwell ...



Percentage of upwelled particles starting in that position

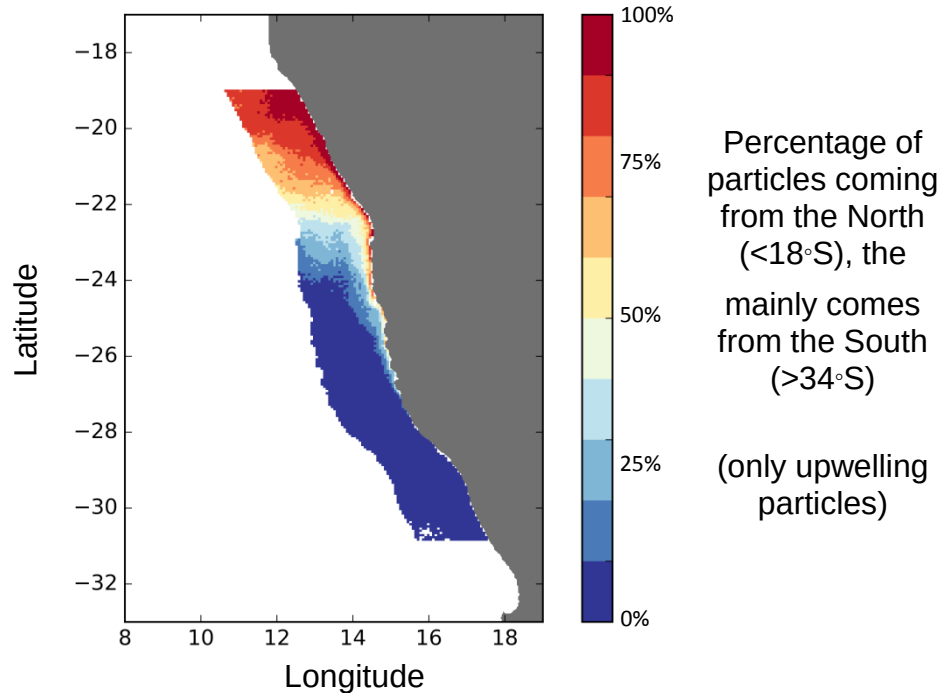
...near the coast



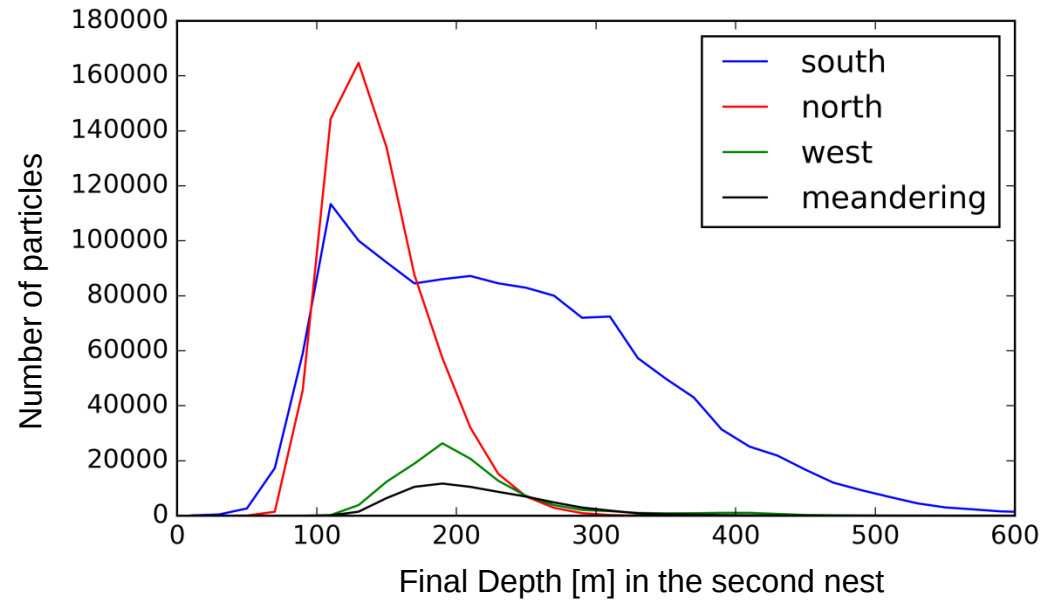
Position of the first crossing of 100m depth

The upwelling water mainly comes

..from the North in Northern Benguela and at the coast,
from the South in the South Benguela and offshore..

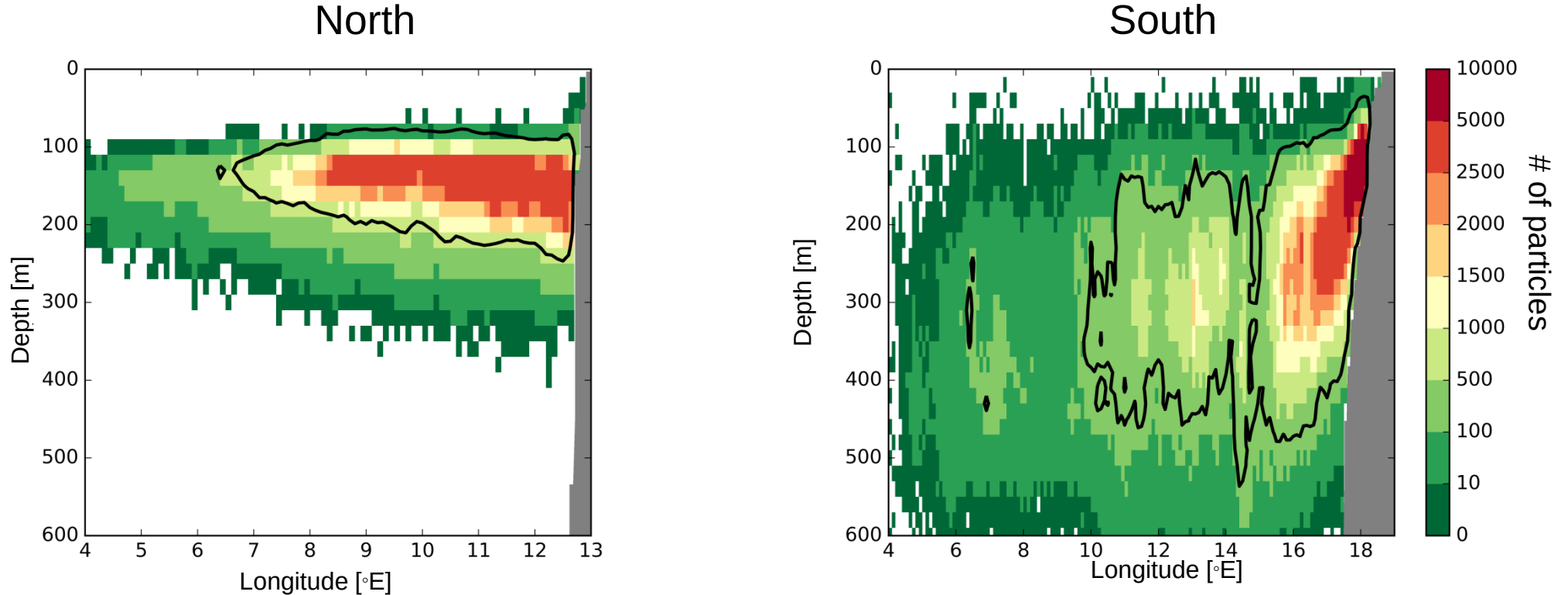


...and from 100m to 400m depth



Where does the upwelling water originate?

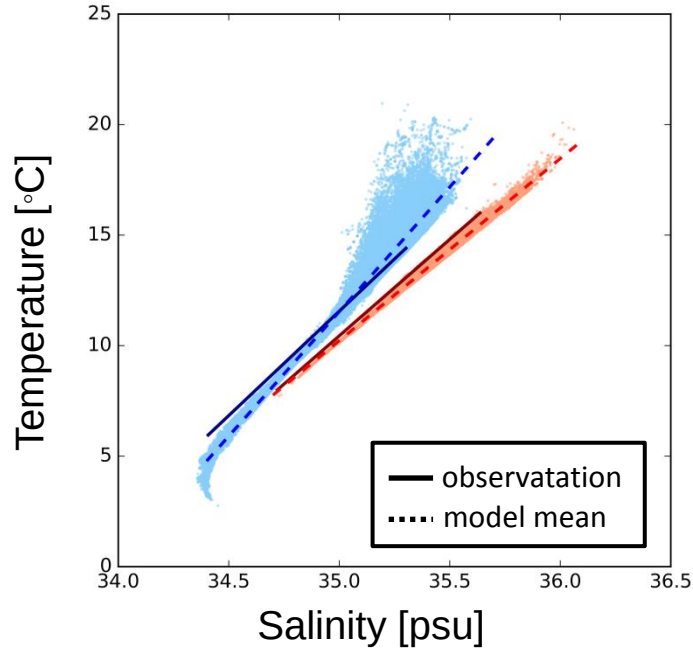
The upwelling water comes mainly from near the coast:



Position before leaving the second nest

Properties of the upwelling water

Statistics of the temperature and salinity at the positions and time when the particles leave the second nest



North (SACW)

$$T = (13.2 \pm 1.2)^\circ\text{C}$$

$$S = (35.38 \pm 0.14) \text{ psu}$$

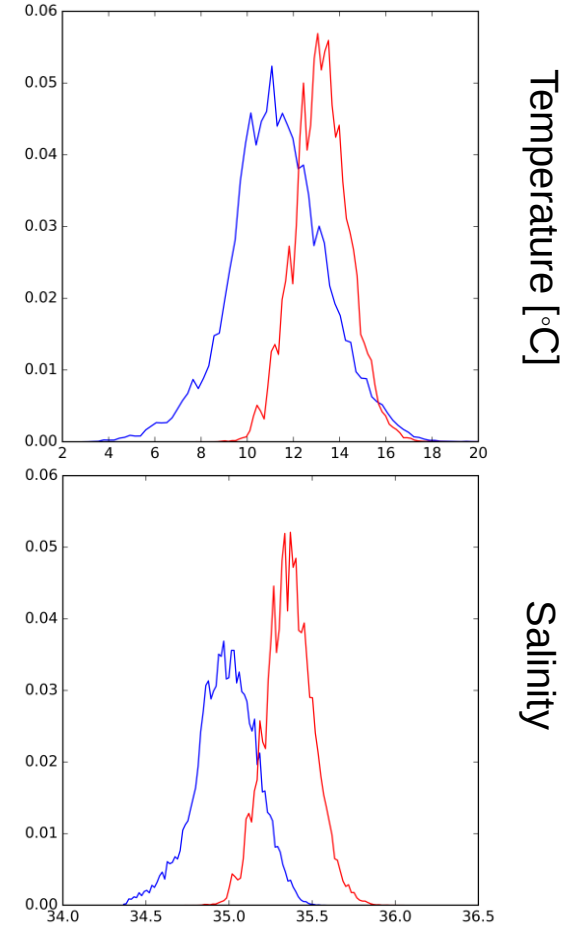
South (ESACW)

$$T = (11.3 \pm 2.0)^\circ\text{C}$$

$$S = (34.98 \pm 0.18) \text{ psu}$$

→ Similar density

(only particles leaving below 100m at the northern/southern boundary)

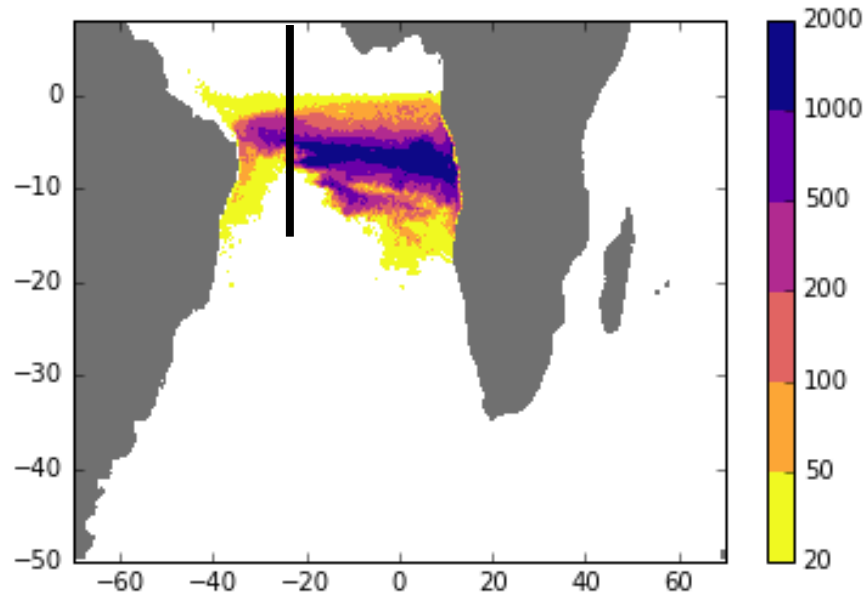


Observed Values:

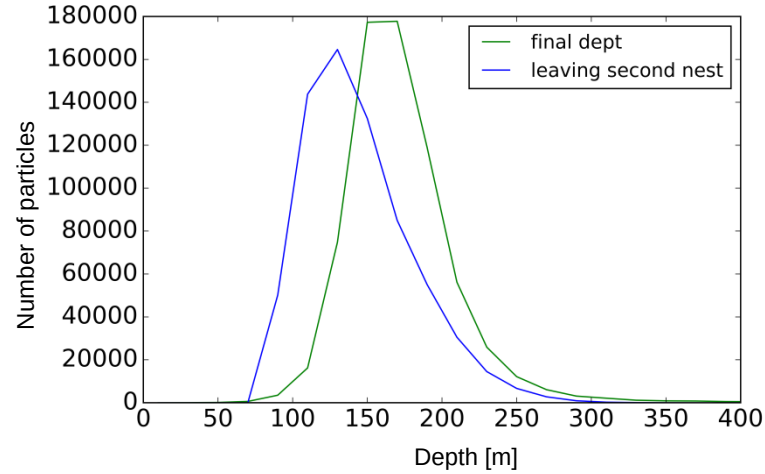
Poole and Tomczak, 1999 (ESACW)

Mohrholz et al., 2008 (SACW)

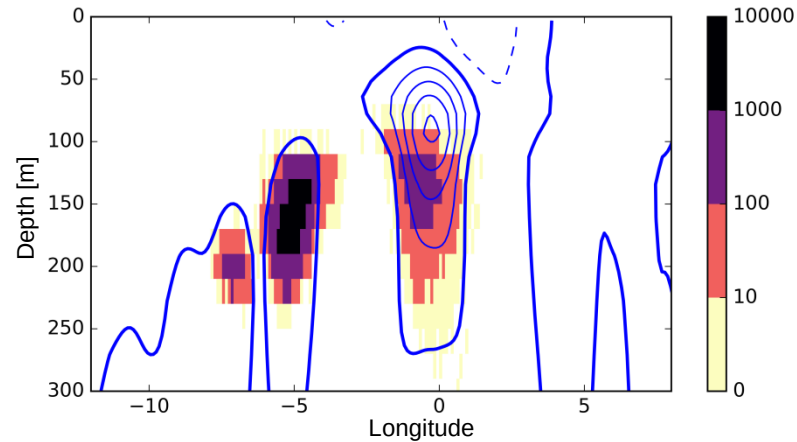
Continuation in First nest: SACW



Particle positions during the 3. year



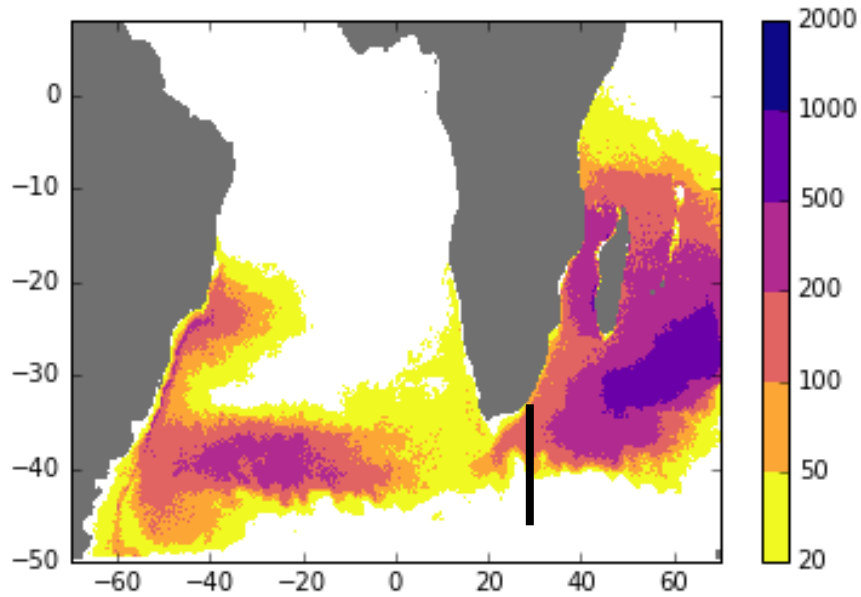
Initial depth distribution in the first nest (blue) and final depth distribution (green)



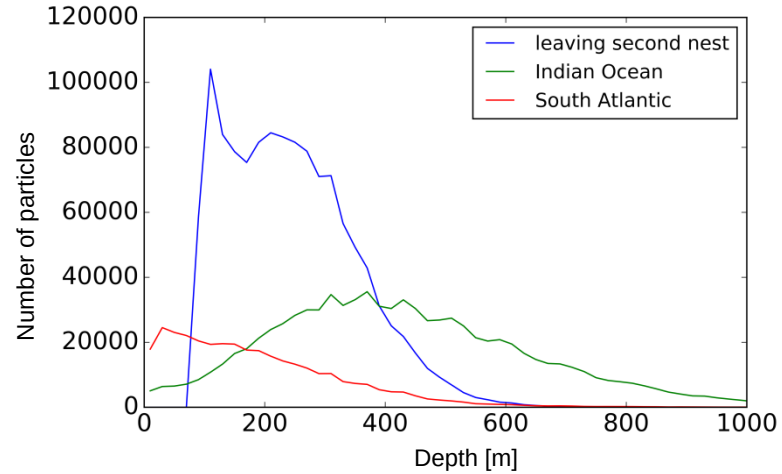
Position of first crossing of 23°W

→ More upwelling water from the SEUC than the EUC

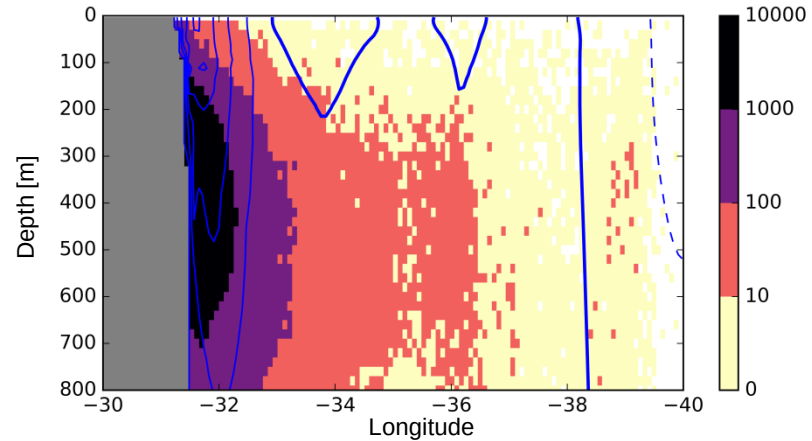
Continuation in First nest: ESACW



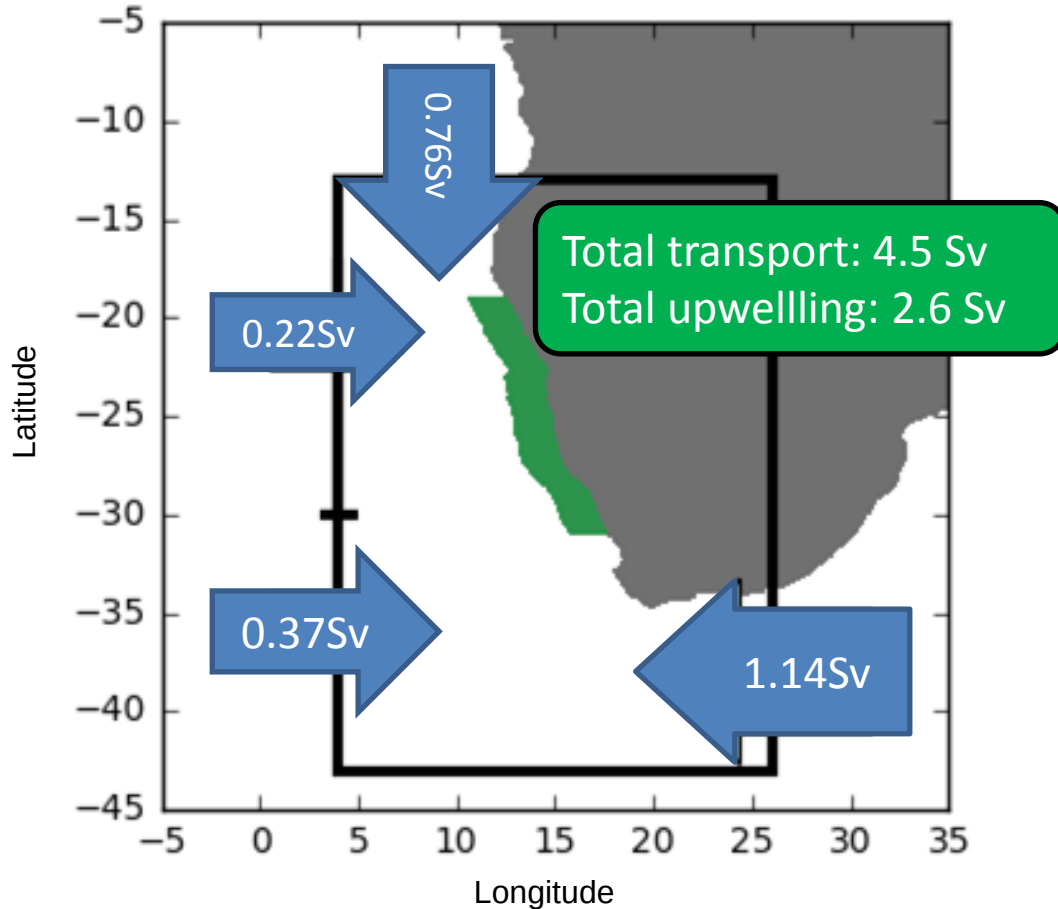
Particle positions during the 3. year



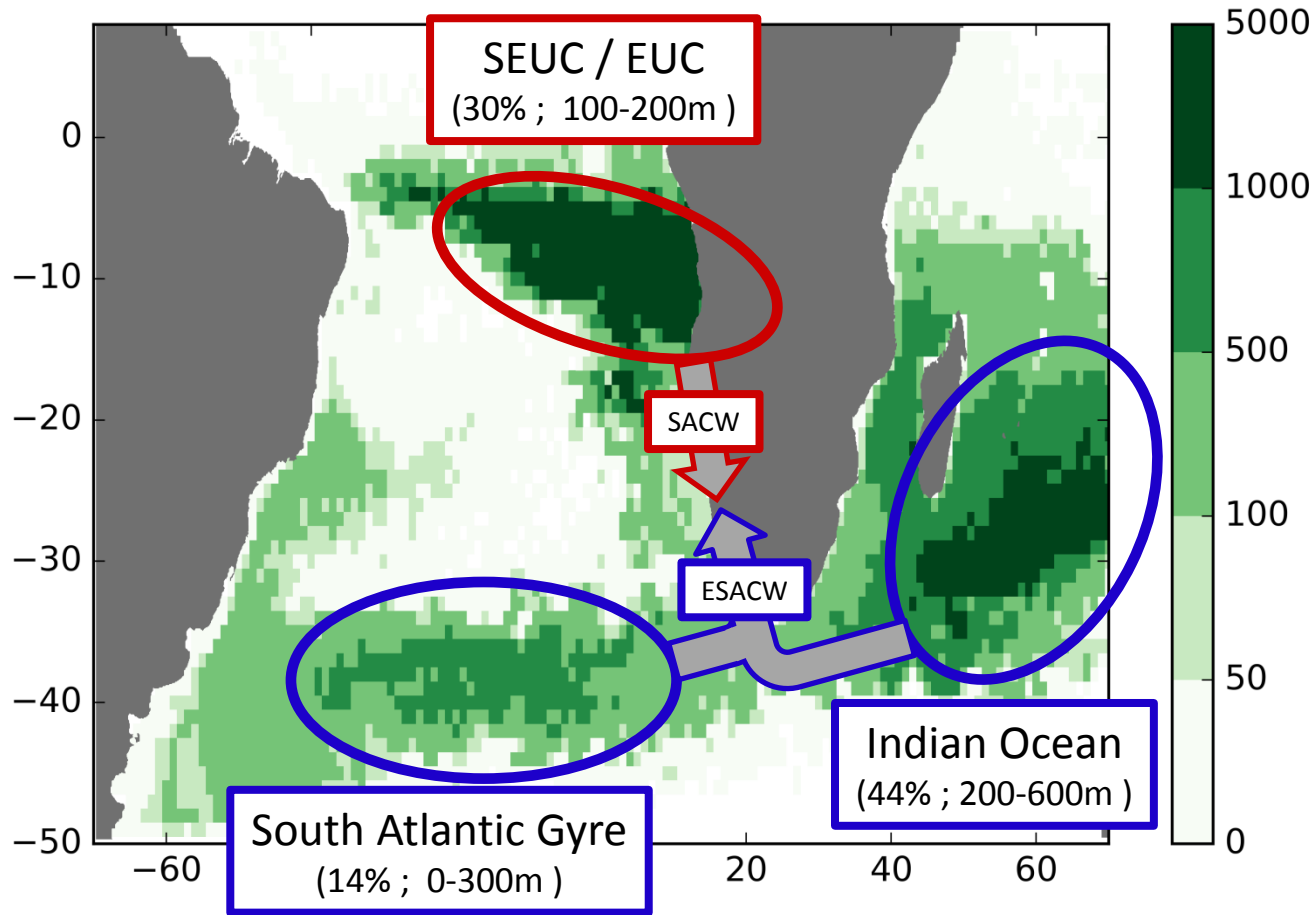
Initial depth distribution in the first nest (blue) and final depth distribution for Indian Ocean particles (green) and South Atlantic gyre particles (red)



Position of first crossing of 30°E



- Most upwelling water originates in the Indian Ocean
- Smaller contributions from the Angola Current & South Atlantic gyre



- Model reproduces the observed SACW/SACW distribution and properties
- 3 Sources of the upwelling water:
 - Indian Ocean
 - Tropical Atlantic
 - South Atlantic Gyre