Circulation and Cross-Shelf Exchanges in the Agulhas Bank Region

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1. Introduction

The Agulhas Bank (AB) is the broad shelf region protruding from the southern tip of the African continent. This region is bounded by two distinct boundary regimes: the Agulhas Current, which is the western boundary current of the South Indian ocean, and the Benguela Coastal Current, which is the eastern boundary current of the South Atlantic Ocean. In this poster we use a model and satellite data to characterize the bank's circulation

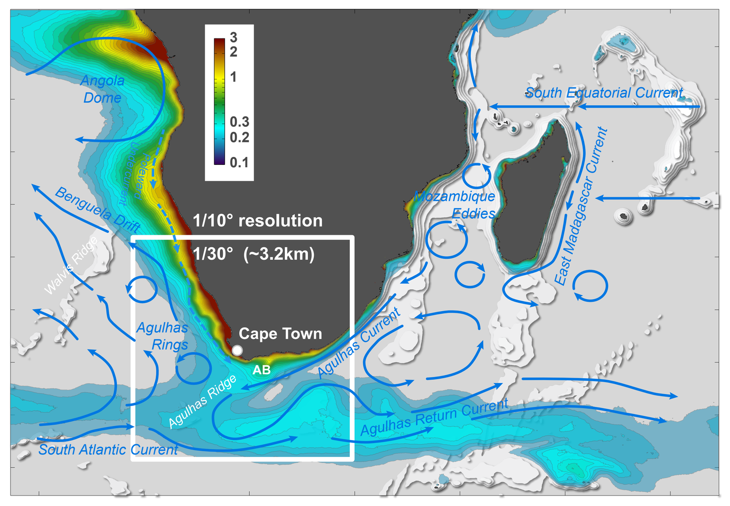

Figure 1. 1998-2019 mean satellite chlorophyll [mg.m-3]

2. Kinematics: Mean and Seasonal cycle

We use a numerical model to characterize the AB circulation and identify its drivers. The model uses a 1/30° grid of the AB nested into a 1/10° grid (*Fig. 1*). The simulation was run for the period 1992-2015 using ERA5 surface forcing.

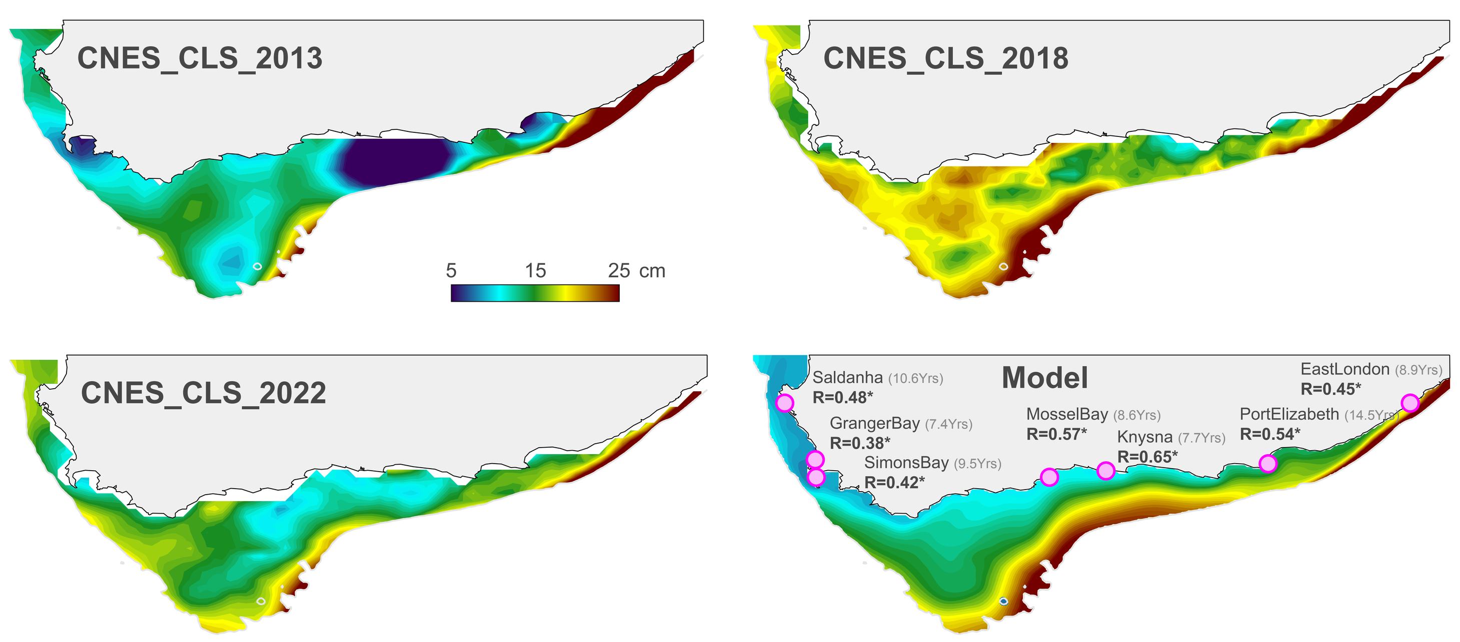

Figure 2. Mean Dynamic Topography from satellite and Mean Model SSH. Correlation coefficients between model and tide gauge data are also shown

3. Kinematics: Interannual Variability

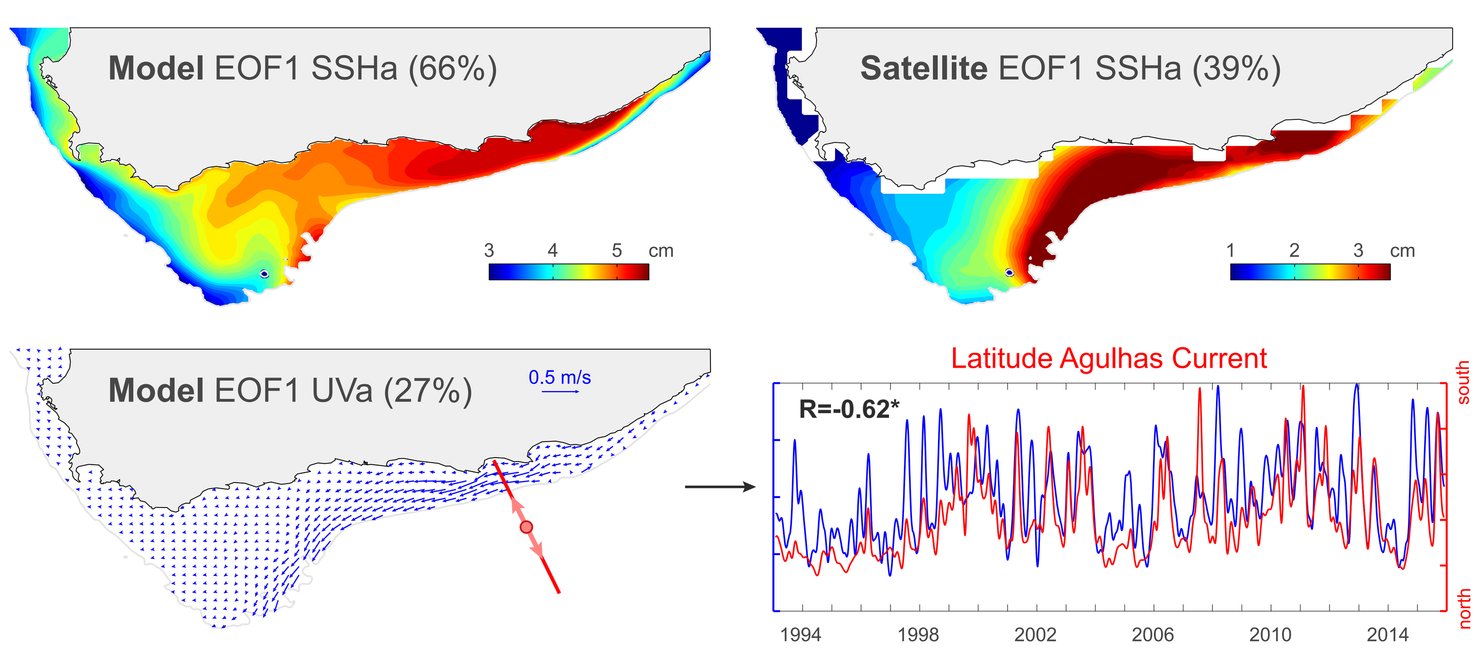

Figure 3. First Modes of the anomalous SSH and circulation

4. Kinematics: Agulhas Current - Bank interaction

The Agulhas current flowing along the edge of the Agulhas Bank influences the Bank's circulation. In particular, the separation of the Agulhas Current from the shelfbreak - pulses - will enhance the westward shelf transport. This interaction can also be inferred from the coarse resolution 1/4° AVISO altimetry.

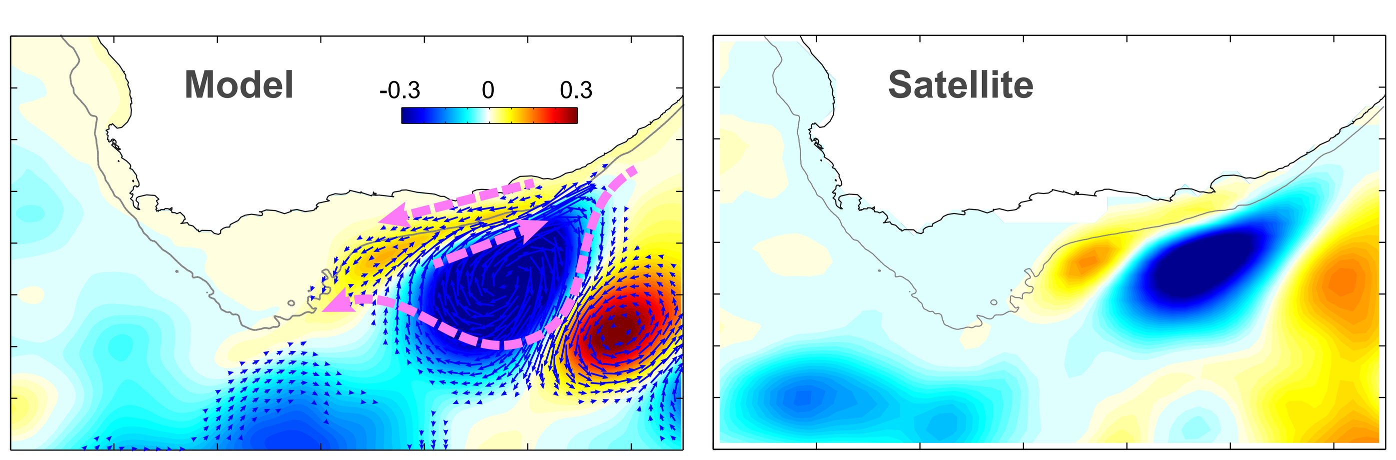

Figure 4. Composite map of anomalous SSH during time when the Agulhas Current shifts South

5. Dynamics: Agulhas Current - Bank interaction

The model solution indicates that the latitudinal position of the Agulhas Current is highly correlated with the SSH variability at the shelf break (Fig. 5).
When the core of the Agulhas Current is moving south, the SSH at the shelf break increases. As a consequence, the geostrophic adjustment of the positive anomalous SSH at the shelf break generates a westward shelf shelf current (Fig. 6).

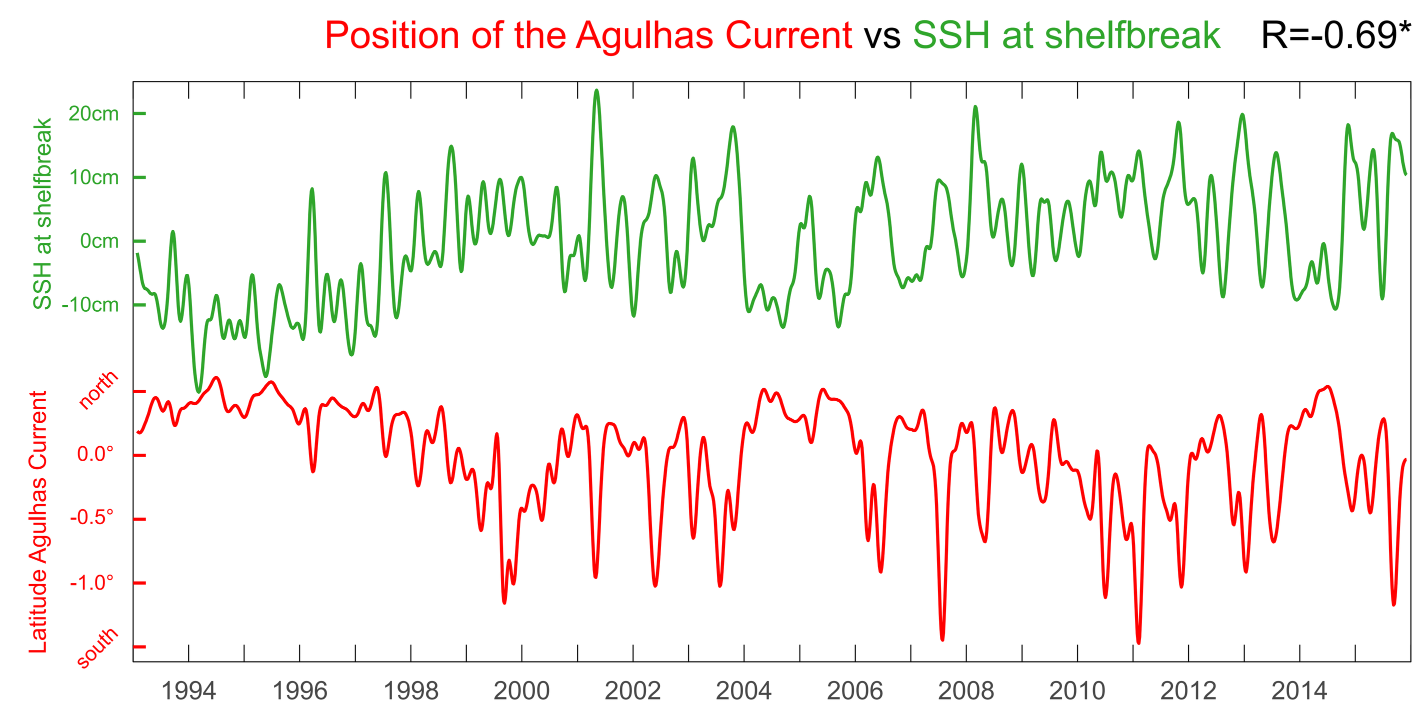

Figure 5. Time series of the anomalous SSH at the shelfbreak (green) and the latitude of the Agulhas Current core (red). The correlation coefficient between the two time series is R=-0.69

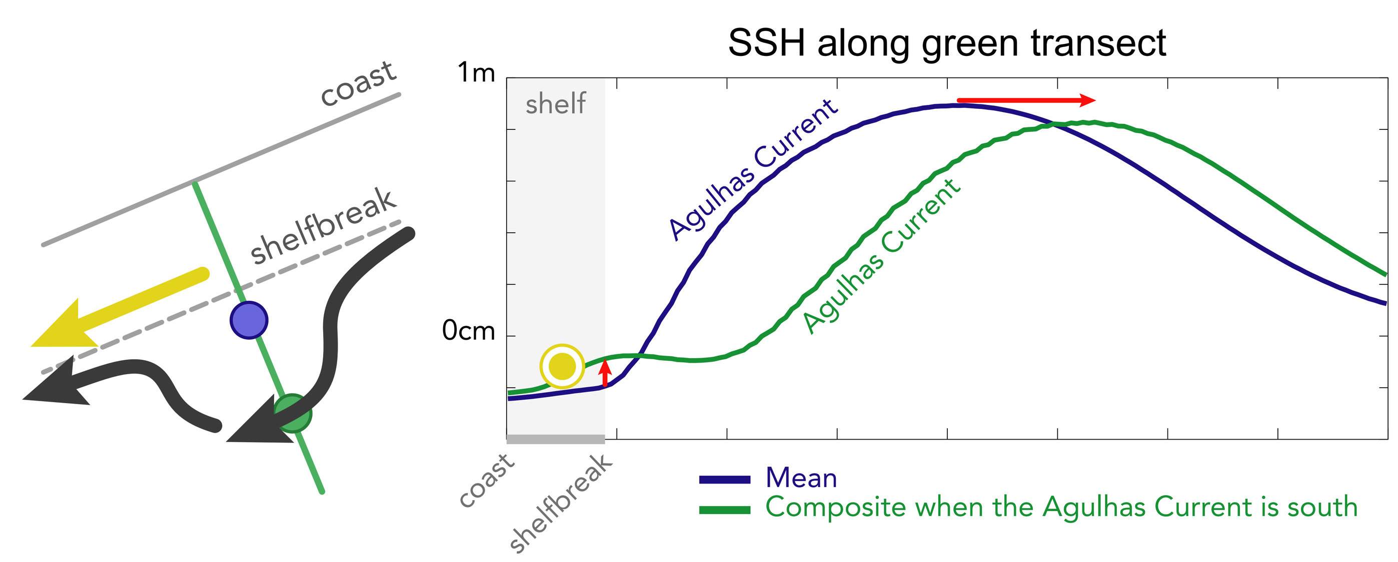

Figure 6. SSH across the Agulhas Current (green transect).

The analysis of the Along Track altimetry SLA (Track #20) exhibits similar correlation coefficients: R = - 0.47* between the SLA at the shelf break and the latitudinal position of the Agulhas Current defined as the maximum geostrophic velocity

Cyclonic flows are highly common along the shelf break (>20% of the time; Fig.7). The core of these eddies is anomalously cold and fresh, suggesting the advetion of shelf waters offshore. Such eddies play also an important role in the local vertical mixing with vertical velocities higher than 20m/day

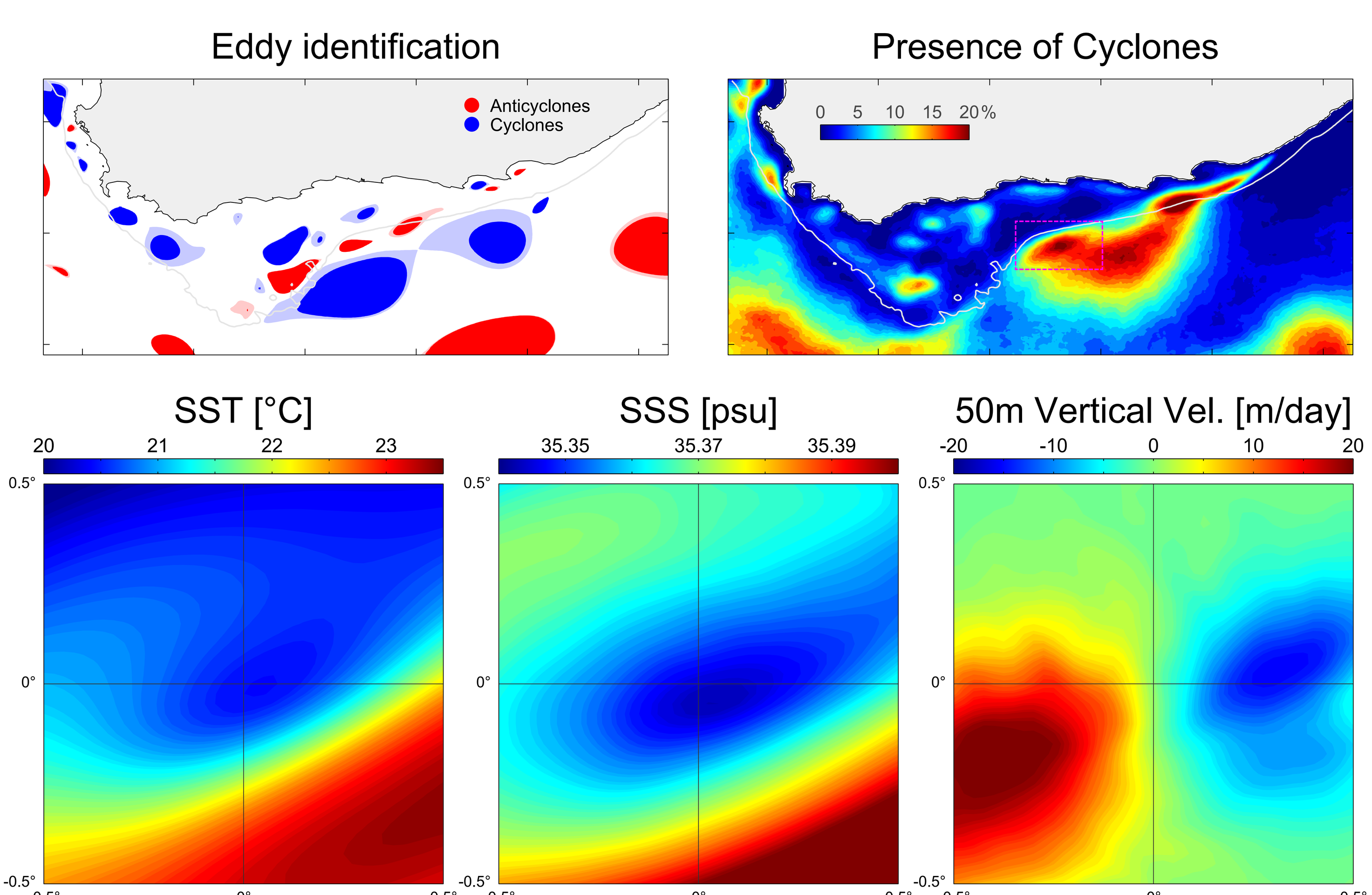

Figure 7. Eddy Composite maps of SST, SSS, and vertical velocity at 50m deep

6. Dynamics: Cross-shelf Exchanges

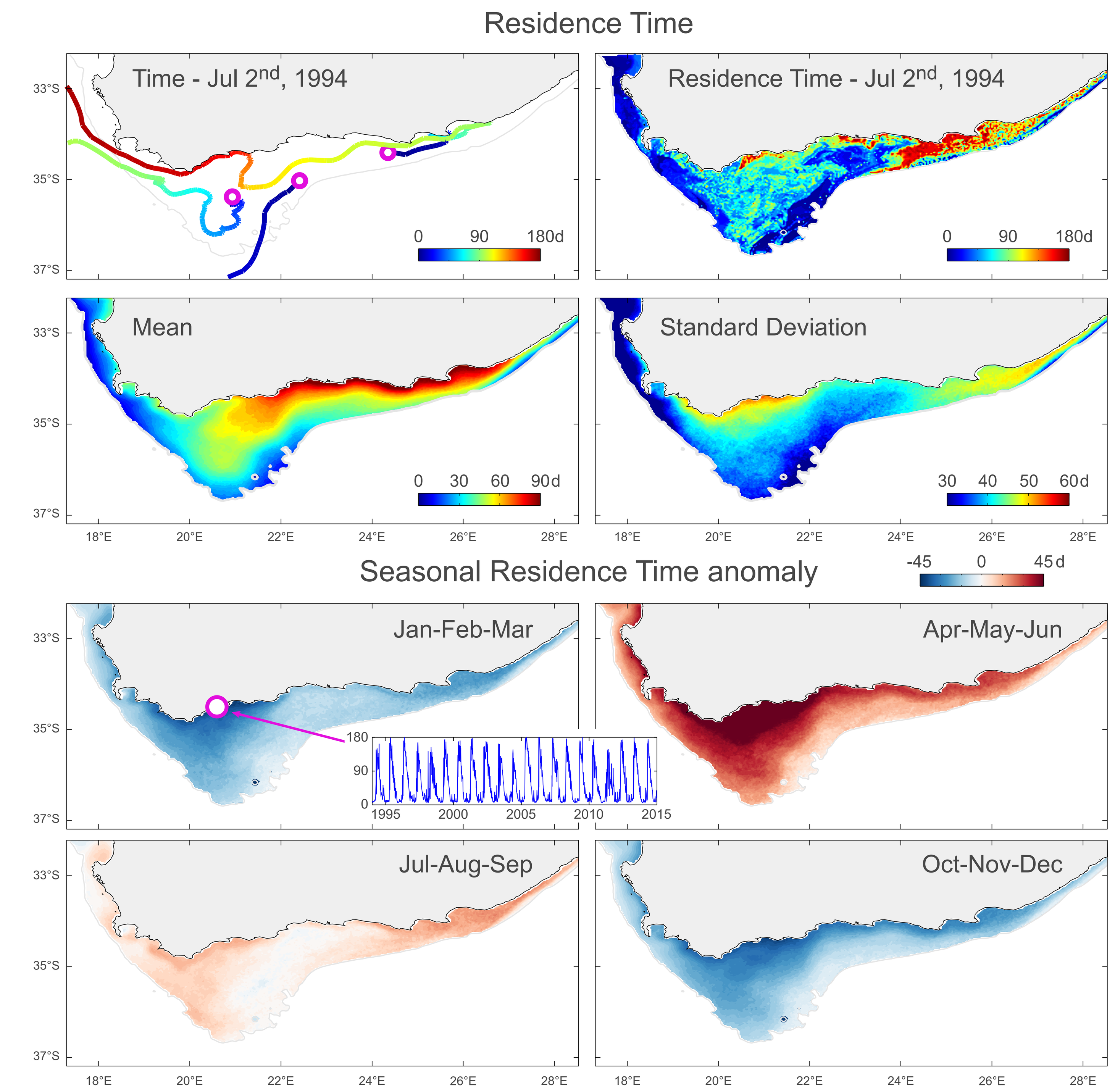

Figure 8. Residence Time. Snapshot, Mean, and Seasonal Cycle anomaly

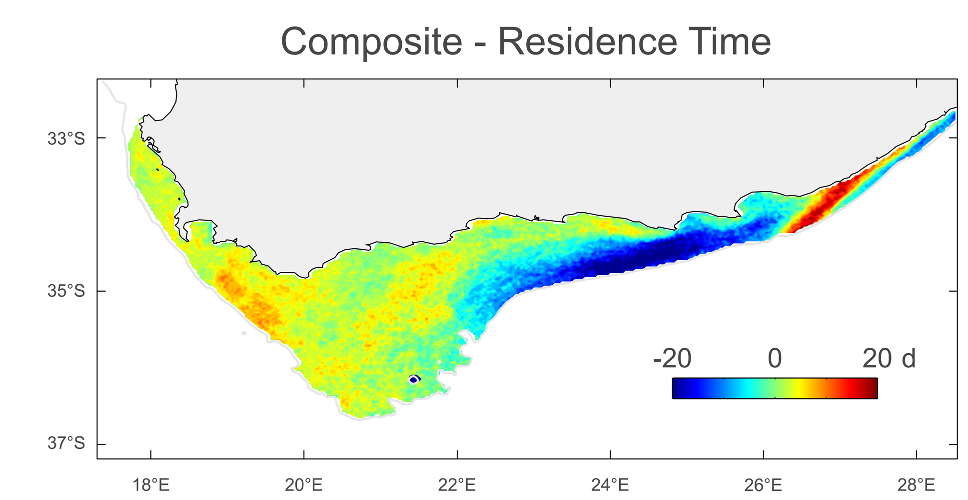

Figure 9. Composite map of anomalous residence time during time when the Agulhas Current shifts South

The residence time is calculated as the time it takes from an offline particle to leave the AB. A coastal particle takes on average 2-3 months to leave the shelf with a strong seasonality (+/- 1 month; Fig. 8). The passage of cyclonic eddies along the shelfbreak has a strong impact on the residence time (Fig. 9).

The cross-shelf exchange is further described using model passive tracers, in particular one released within the Agulhas Current below 200m which illustrates the entrainment of Agulhas current water into the shelf at the bottom boundary layer (Fig. 10)

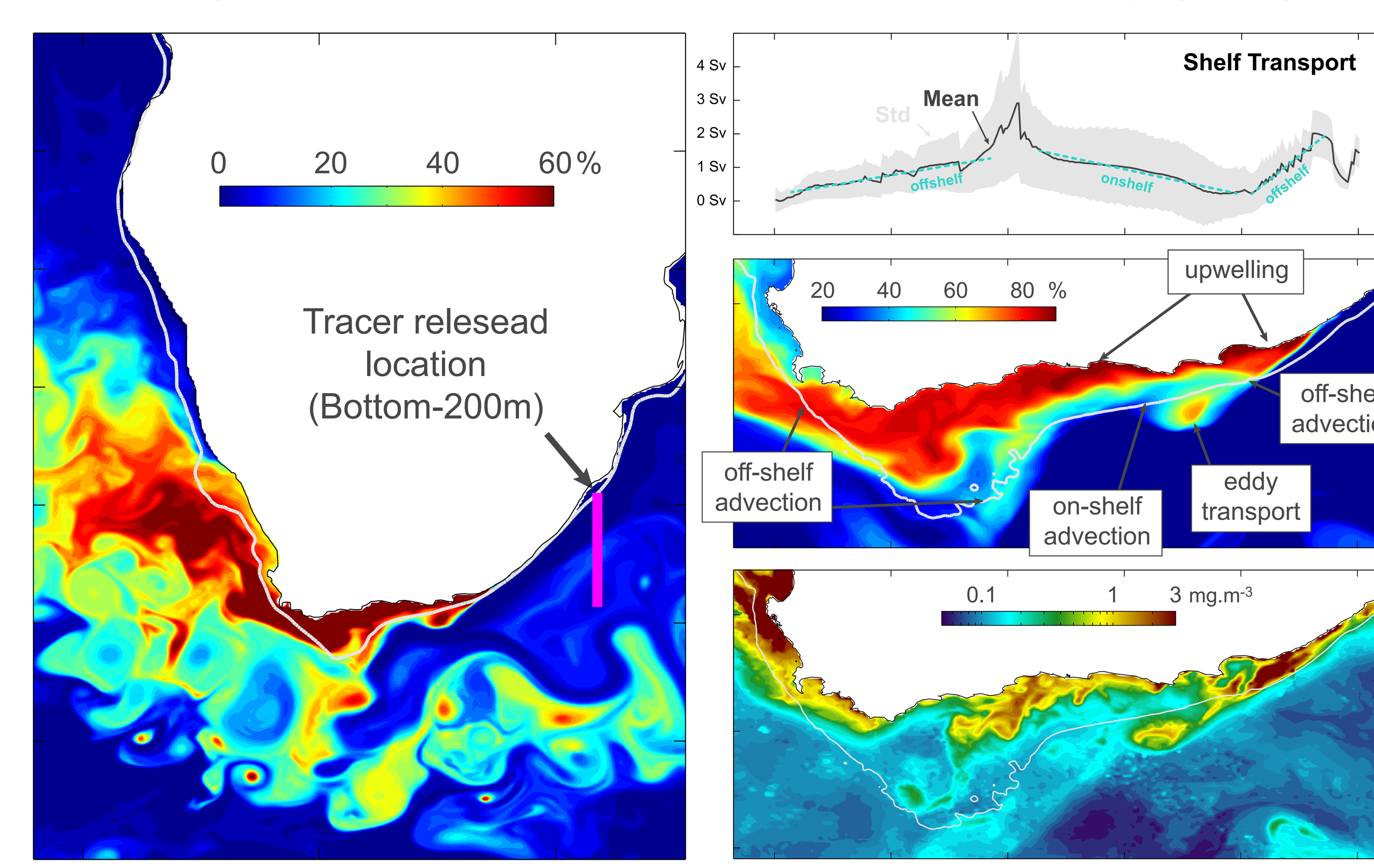

Figure 10. Surface Tracer concentration (03/15/2009) and satellite chlorophyll concentration (02/02/2009)