Synergistic use of remote sensing data for the study of the Azores and St. Helena current systems

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Context

Azores Current (AzC) vs. St. Helena Current (StHC, also known as Tristan da Cunha Current): Previous studies suggest a similar forcing source for both currents independent of any geographical peculiarity (Juliano and Alves, 2007).

Similarities:

- Origin: western boundary currents (Gulf Stream and Brazil for AzC and StHC, respectively);
- Horizontal structure, intensity and meridional width;
- Interaction with North and South Atlantic currents (NAC and SAC, respectively);
- Associated subsurface adjacent countercurrent flows;
- Main cores found at similar latitudes (34ºN and 34ºS for AzC and StHC, respectively).

Differences:

- Zonal extension;
- Greater proximity between StHC and SAC;
- Proximity of the Agulhas Rings corridor.

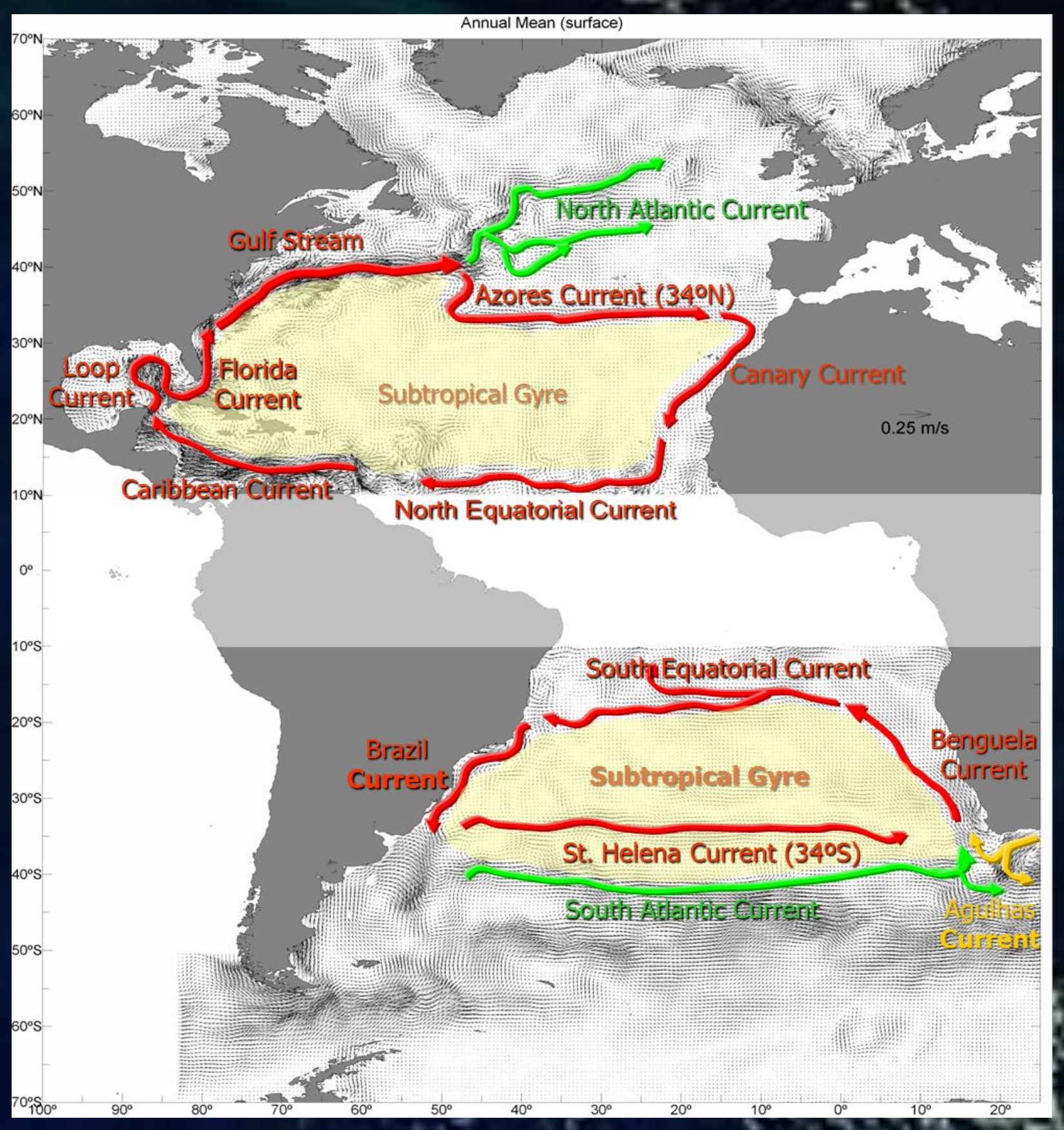


Figure 1: Surface (5 db) mean field of the horizontal absolute velocity (ms^{-1}) from in situ data and main current systems in the Atlantic (Juliano and Alves, 2007). Both AzC and StHC originate at the western boundary current of the corresponding hemisphere (Gulf Stream and Brazil Current for AzC and StHC, respectively) and present interaction with North and South Atlantic currents (NAC and SAC, respectively).

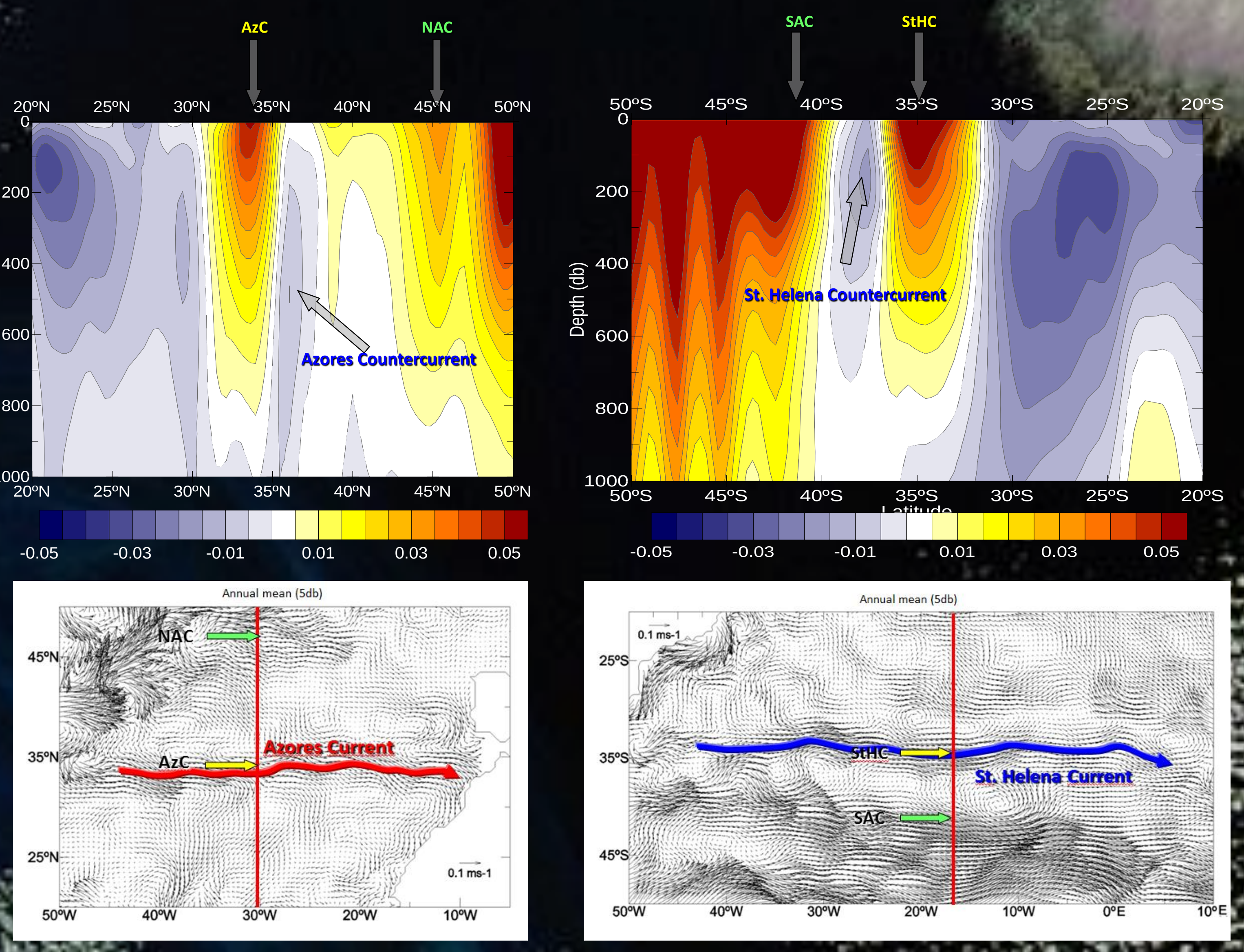


Figure 2: Vertical (top) and horizontal (bottom) structures of AzC (left) and StHC (right) from in situ data. The main cores are found at similar latitudes, 34ºN and 34ºS for AzC and StHC, respectively. StHC presents a larger longitudinal extension and is closer to SAC than AzC is from NAC. Top: eastward velocity in ms^{-1} for longitude shown by the red vertical line. Similar horizontal structure, intensity and meridional width and associated subsurface adjacent countercurrent flows are observed.

Main aims:

- Assess the congeneracy of AzC and StHC and their associated fronts with data synergy of satellite altimetry (SLA, EKE , ADT, surface geostrophic velocity), SST and hydrological in situ data;
- Improve the knowledge of the South Atlantic variability, the Atlantic inter-hemispheric connections and the correlation of long-period oceanic variability with Atlantic phenomena of coupled atmosphere-ocean variability;
- Determination of the AzC and StHC axes from both altimetry (using the gradient of absolute dynamic topography and the direction of geostrophic velocity) and SST (maximum SST gradient) data and assess their spatial and temporal variabilities

SST data processing:

- Data extracted from global optimally interpolated data product provided by NOAA – combined in-situ and IR SST products from AVHRR on board a series of NOAA satellites from Jan-1992 to Jun-2002, and further combined with MW SST products from AMSR-E on board Aqua from Jun-2002 to Sept-2011;
- Contextual median filtering (Belkin and Reilly, 2009);
- Spatial resolution: 0.25º×0º.25;
- 10-days composite grids;
- Study period: Jan-1992 to Sept-2011.

SLA data processing:

- Data extracted from RADS (T/P, ERS-2, Envisat, Jason-1 and Jason-2);
- MSS: DNSC08;
- SLA grids generated by objective analysis with realistic space-time correlation functions (Le Traon et al., 1998; Ducet et al., 2000).
- Spatial resolution: 0.25º×0º.25;
- 10-day interval;
- Study period: Jun-1995 to Dec-2011.

Results:

- Preliminary results show the existence of significant EKE inter-annual variability for both AzC and StHC; largest EKE values for AzC are found in 1995-1996 and from 2007 onwards whereas for StHC these are centred in 2000 (Fig. 4);
- Previous studies for the period 1995-2006 show the existence of variability in the AzC axis position, being the AzC in its southernmost position in 1995-1998 → the ongoing study shall extend this analysis to 1992-2011 and to the StHC region;
- Unlike for the altimetry-derived SLA signature, no significant inter-annual variability has been so far detected for the current-associated thermal fronts (Fig. 6); the ongoing study shall further investigate this issue by analysing SST gradient and exploring other data products and/or methodologies.

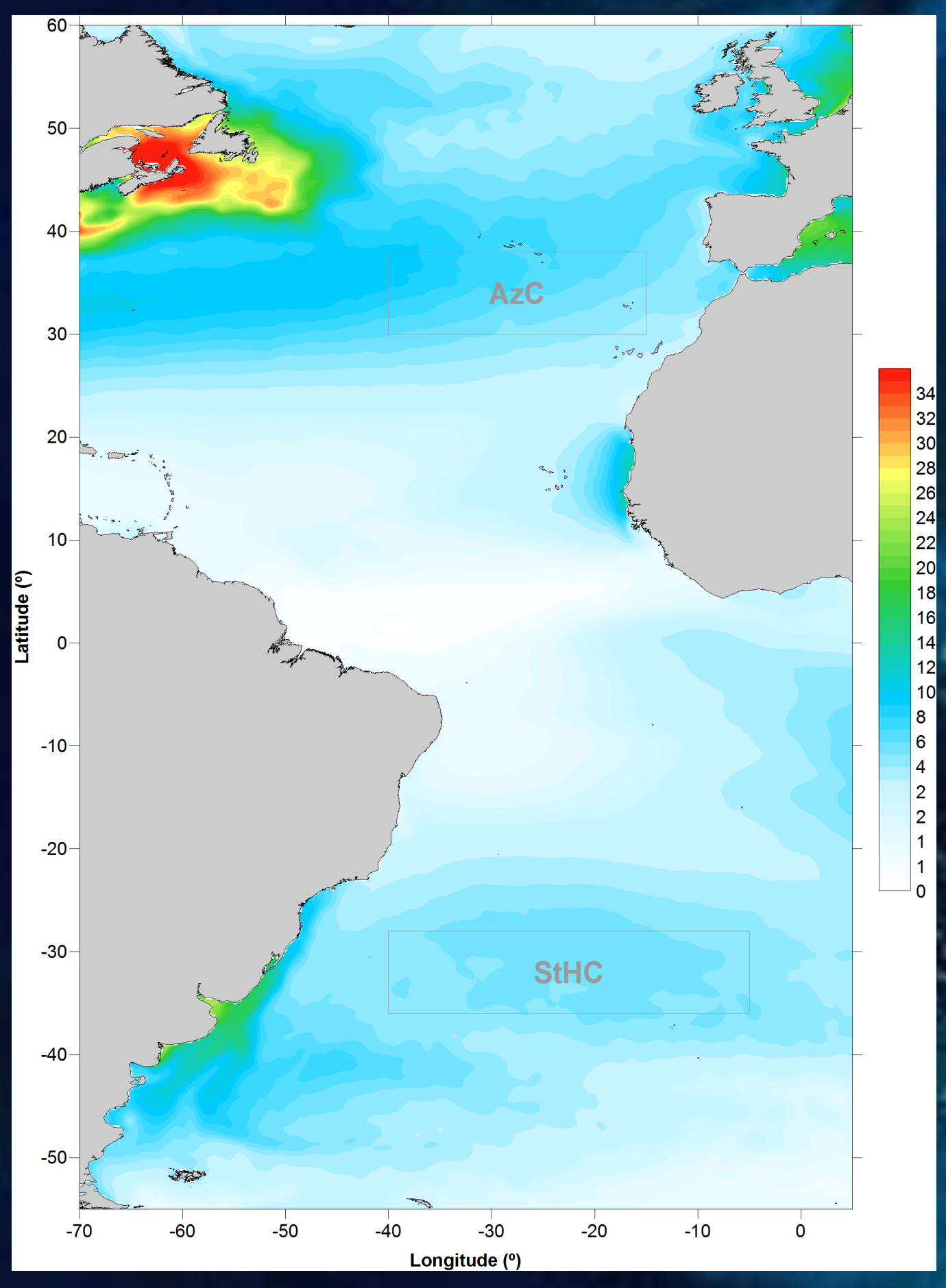


Figure 3: SST variance (ºC^2) for the 1992 -2011 period and selected AzC and StHC regions.

- Future work shall also encompass the calculation of the time series of the zonally-integrated Sverdrup transport and relate them to the meridional migration of the currents.

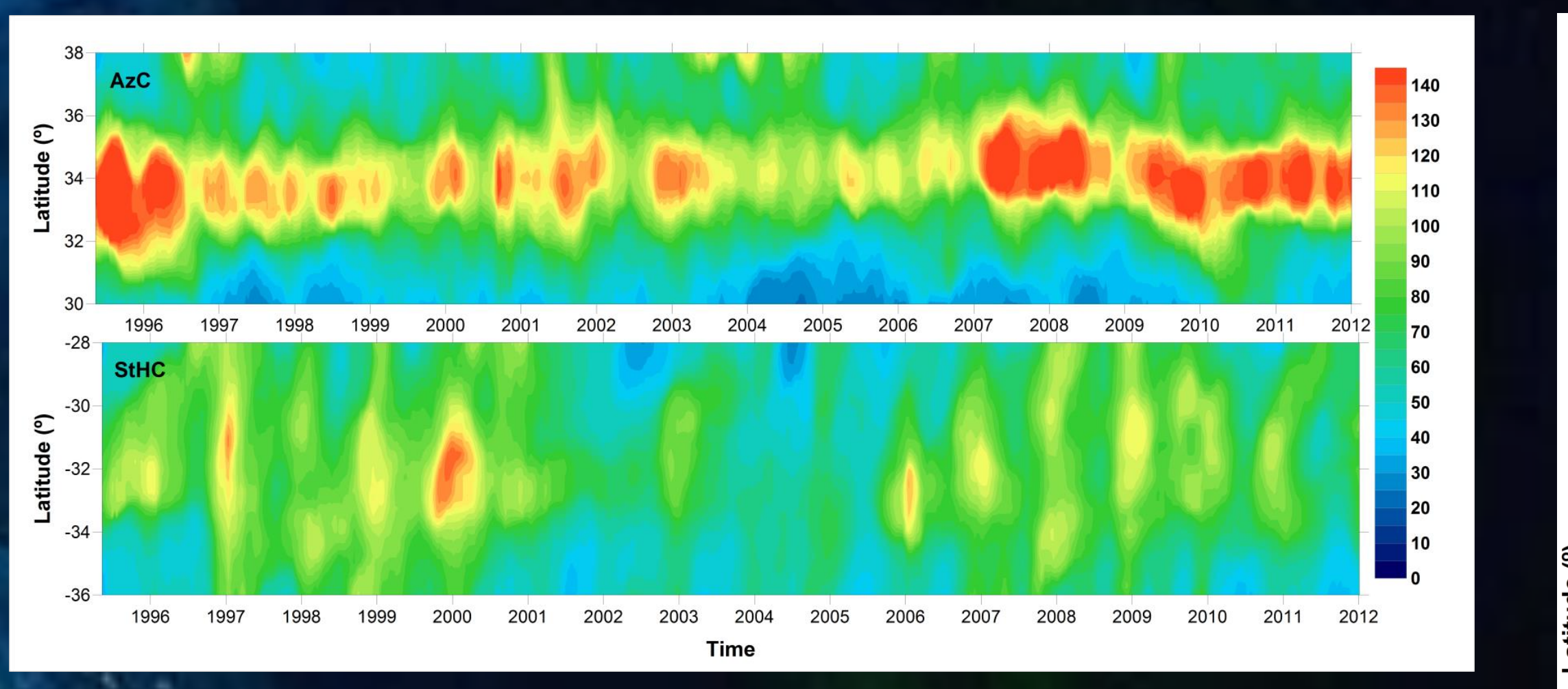
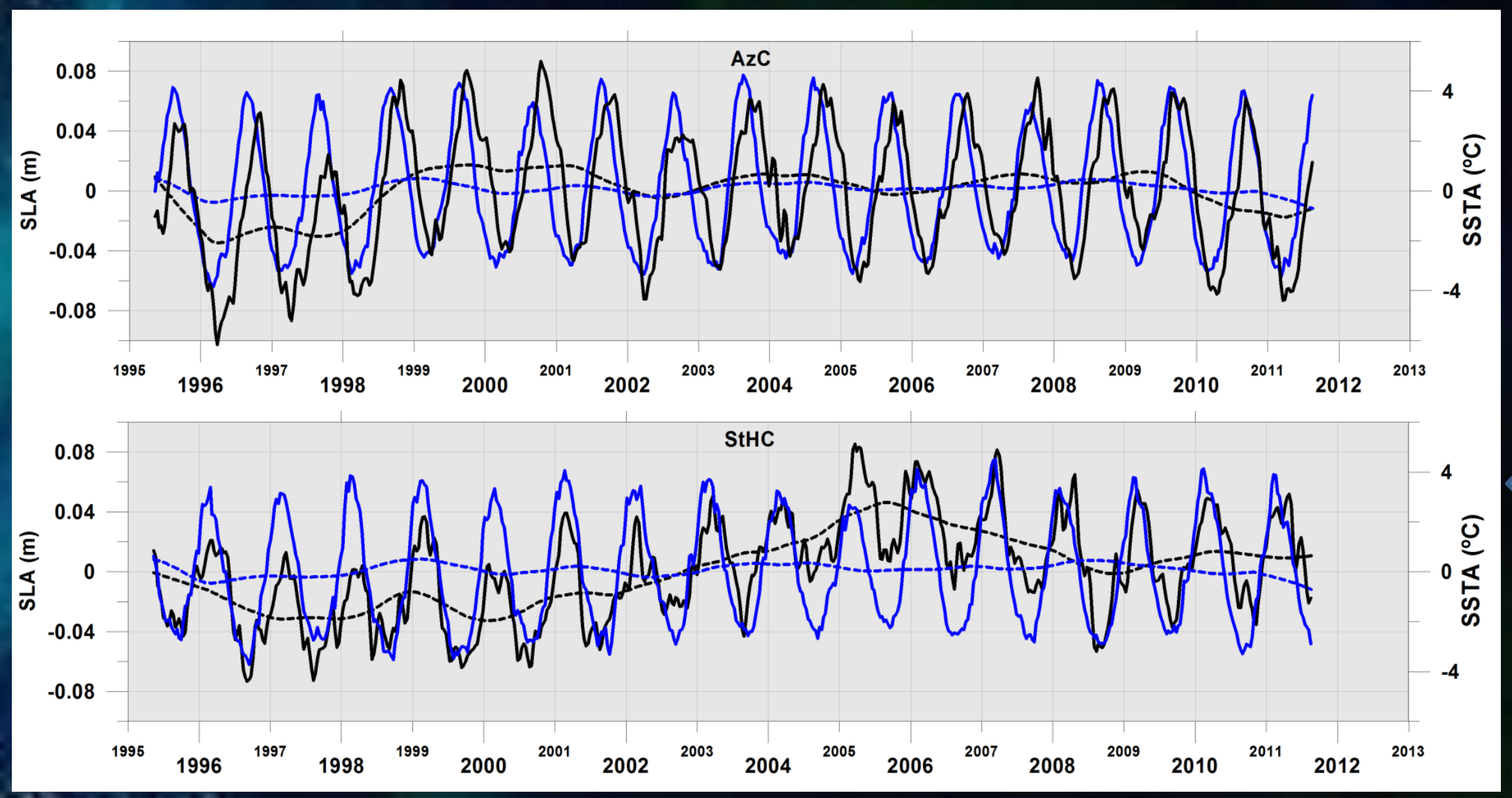


Figure 4: Time-latitude diagram of Eddy Kinetic Energy (EKE) for AzC (top) and StHC (bottom) (per unit mass, in cm^{2}s^{-2}) averaged over 15ºW-40ºW and 5ºW-40ºW, respectively.



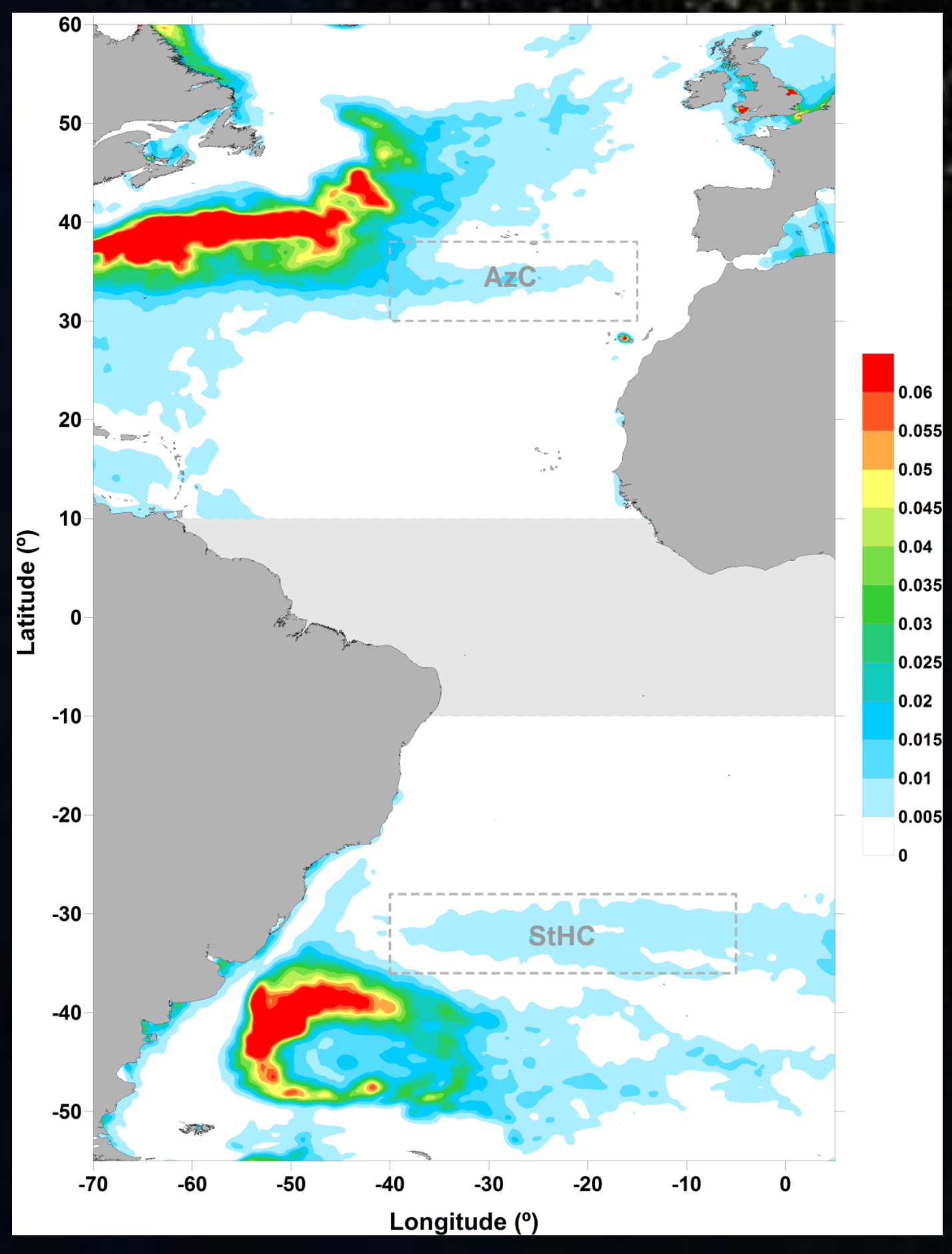


Figure 5: SLA variance (m^2) for the 1995-2011 period and selected AzC and StHC regions.

Figure 6: SLA (black) and SST anomaly (blue) time series for AzC (top) and StHC (bottom) regions and inter-annual components (dotted lines) from STL (Seasonal and Trend decomposition using Loess) filtering procedure (Cleveland et al., 1990).

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Background image: ESA 2012 – cropped from “A southern summer bloom” (Envisat/MERIS)