Description of the zonal jet system in the Equatorial Atlantic as inferred from ARGO drifters

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ABSTRACT

We analyze various subsets of ARGO profilers at different parking depths with the objective of evaluating the current system for surface (0 m), central (200, 250 and 400 m), intermediate (1000 and 1100 m) and upper deep (1500, 1900 and 2000 m) waters in the Equatorial Atlantic Ocean. The surface velocity is estimated as the mean value of the differences between successive positions estimated by the Argos satellites. The subsurfeace velocities result from the differences between the last location available before descending to the parking depth and the first location immediately after the ascending profile. The number of data points changes with latitude, with some large latitudinal data gaps for the deep parked buoys that suggests the existence of a dominant zonal motion, but the density of drifters is large enough to resolve a coherent mean velocity field with 1º × 1º resolution from 30ºS to 30ºN. The drifters' trajectories confirm the existence of a very well defined system of zonal jets, with alternating eastward and westward currents. This system of jets is very coherent in time and extends all across the Atlantic Ocean, only broken at both margins, in particular by the North Brazil Current system. The surface currents are westward except at the equator, indicative of the wind drift, but its intensity still shows substantial inversions that resemble the known surface current field. At all other depths the zonal jet system typically consists of four to eight relatively intense currents and counter-currents, each jet being 2-3º wide and stretching all across the ocean with a maximum mean magnitude of several cm/s. This mean magnitude is largest for central waters, about 6 to 8 cm/s, followed by deep waters, about 4 to 6 cm/s, and finally intermediate waters (1 to 4 cm/s, possibly because these drifters are parked close to the edge between intermediate and deep waters). A gross error estimate provides good confidence to our results.

RESULTS

SURFACE

Fig.1

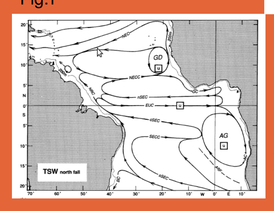
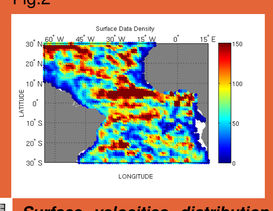


Fig.2



Surface velocities distribution. (Fig.1): Schema of surface winter currents from Stramma & Schott (1999). (Fig.2): Surface Argo data distribution. (Figs.3,4): Surface meridional and zonal velicity from ARGO data.(Fig.5): Surface velocity components, Black (zonal), Red (meridional).

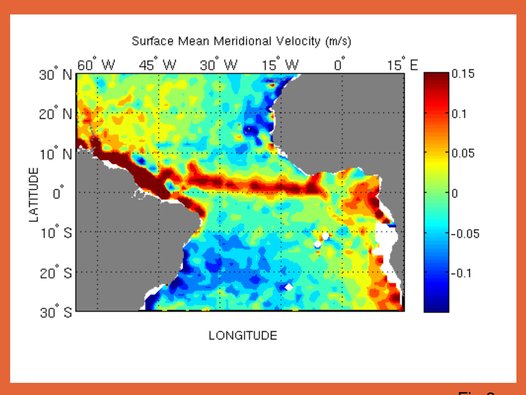


Fig.3

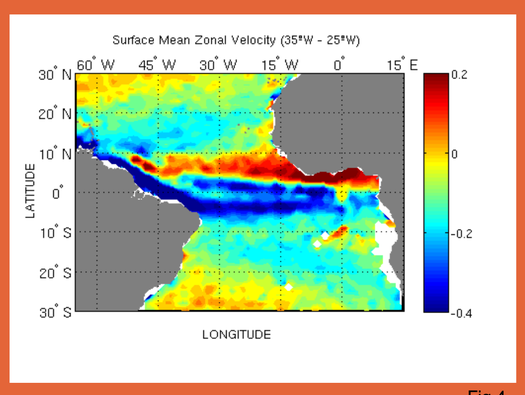


Fig.4

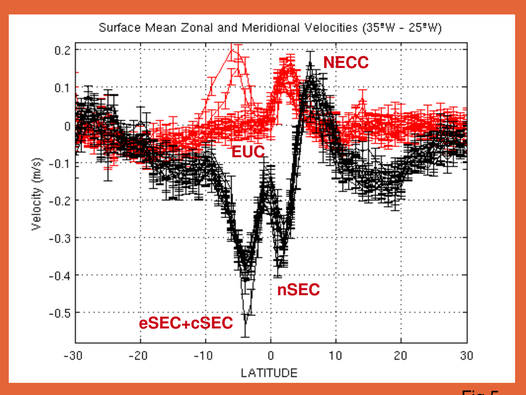


Fig.5

CW

Fig.6

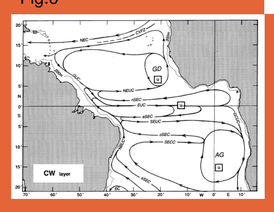
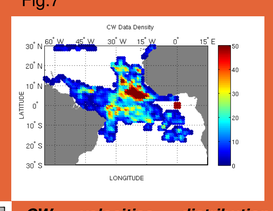


Fig.7



CW velocities distribution. (Fig.6): Schema of CW currents from Stramma & Schott (1999). (Fig.7): CW Argo data distribution. (Figs.8,9): CW meridional and zonal velicity from ARGO data. (Fig.10): CW zonal velocity. 1 line per degree between 35ºW and 25ºW.

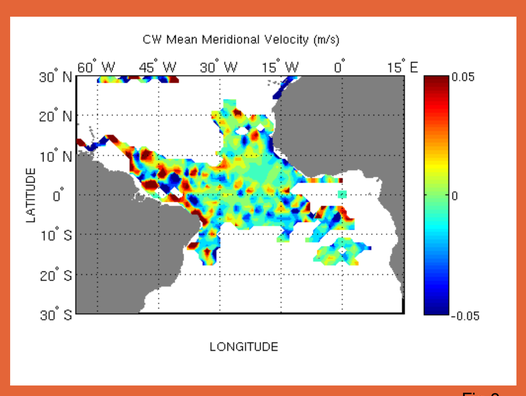


Fig.8

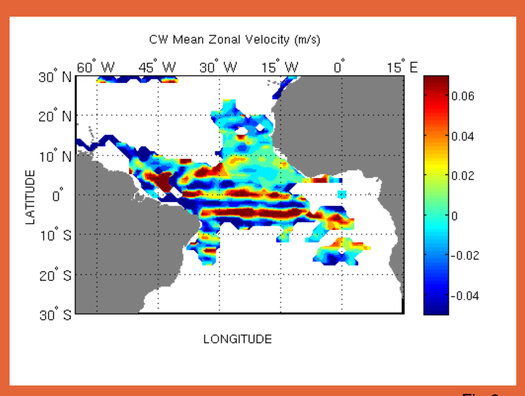


Fig.9

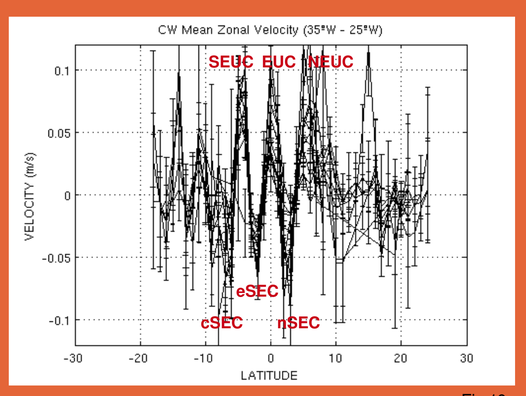


Fig.10

AAIW

Fig.11

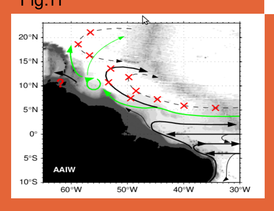
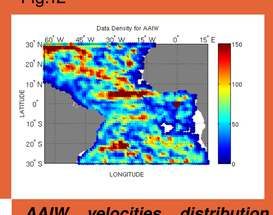


Fig.12



AAIW velocities distribution. (Fig.11): Schema of AAIW currents from Lankhorst (2009). (Fig.12): AAIW Argo data distribution. (Figs.13,14): AAIW meridional and zonal velicity from ARGO data.(Fig.15): AAIW zonal velocity. 1 line per degree between 35ºW and 25ºW.

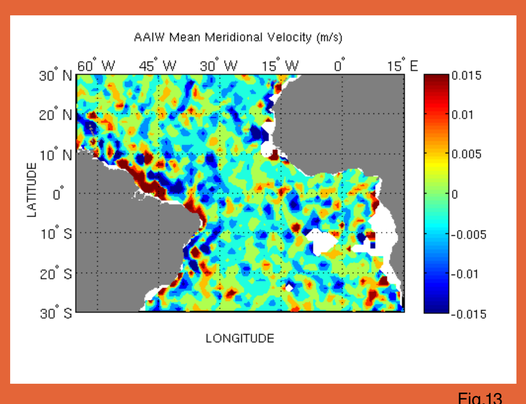


Fig.13

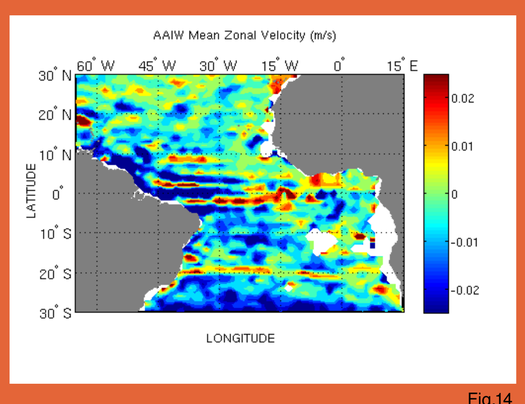


Fig.14

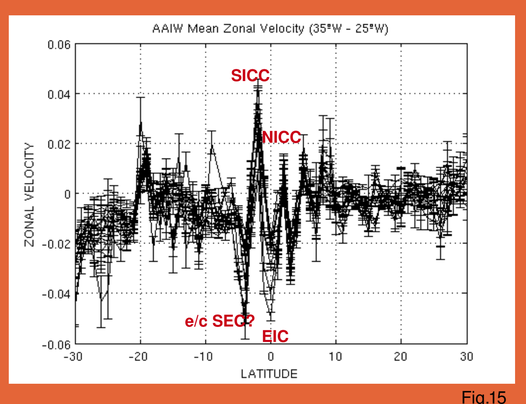


Fig.15

uNADW

Fig.16

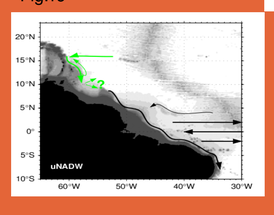
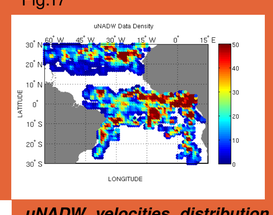


Fig.17



uNADW velocities distribution. (Fig.16): Schema of uNADW currents from Lankhorst (2009). (Fig.17): uNADW ARGO data distribution. (Figs.18,19): uNADW meridional and zonal velicity from ARGO data. (Fig.20): uNADW zonal velocity. 1 line per degree between 35ºW and 25ºW.

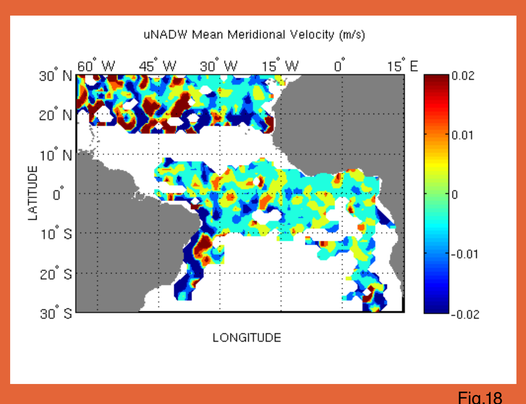


Fig.18

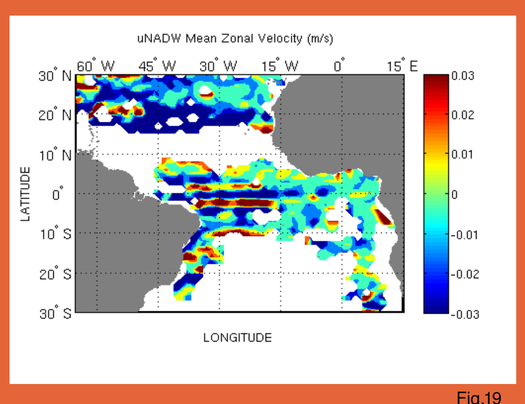


Fig.19

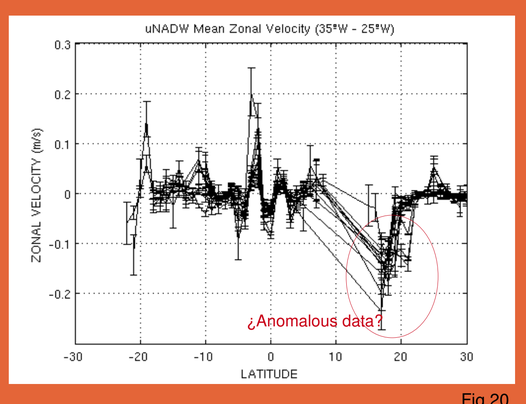


Fig.20

CONCLUSIONS

- A simple calculation of deep velocities calculation from ARGO drifters trajectory data, without any correction, draws a consistent pictureof the equatorial currents system at different depths. The data reproduce the previously described equatorial currents, and also adds some novel features, in particular an alternating equatorial zonal current pattern.
- Despite the fact that the different zonal equatorial current systems are stronger at the west margin, but extend almost all across the Atlantic Ocean, with some individual jets traced up to the east coast.
- This alternating zonal pattern, is broken only at the western margin by the NBC, which constitutes the main inter-hemisphere path for both southern and equatorial/tropical waters.

FURTHER DEVELOPMENT

- Improve the deep velocity calculation in order to reduce the effect of the horizontal drifting during the vertical migrations
- Study the seasonal variability at the surface and intermediate layers (higher data density).
- Validation of the results with ADCP and LADCP data from cruise MOC2-Equatorial.

Acknowledgements

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