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Dynamic contributions to the sea surface salinity variations along the equator and the coast of the Gulf of Guinea

H. Berger (1,2), A.M. Tréguier (2), and N. Perenne (1)
(1) Actimar, Brest, France, (2) LPO, CNRS-Ifremer-IRD-UBO, Brest, France

Seasonal variations of the sea surface salinity in the Gulf of Guinea are linked to the important variations of fresh water from precipitations and coastal runoffs. However, as freshwater forcing terms are not sufficient to explain all observed variations, dynamical contribution must be analyzed. Here, we investigate the impact of the equatorial upwelling from May to August during the salinisation of the basin and the southward extension of the Congo plume along the coast between February and March.

We use a tropical Atlantic (1/4°) configuration with a high horizontal (1/12°) and vertical resolution (100 levels) nested grid for the Gulf of Guinea based on the NEMO/AGRIF platform. Mixed layer trends are computed to allow a quantitative analysis of the contribution of each mechanism during the equatorial upwelling.

At basin scale, it appears that evaporation and decreasing fresh water discharge cannot explain the intensity of the salinisation along the equator, especially during May and June. Surface temperature and salinity patterns show that regions where the salinisation is the most important correspond to upwelling regions and suggest that subsurface water are responsible for the dynamic part of the salinisation. However, mixed layer trends for salinity along the equator and the coast show that the main dynamical contribution come from horizontal advection. The horizontal contribution results from a transport of higher salinity water formed in regions where the E-P-R balance tends to increase the salinity before the upwelling takes place.

The low salinity observed south of 10°S along the coast cannot be due to local fresh water forcing, which is weak in the area. During three weeks in between February and March, we show that an eastward and southward reversal of the surface circulation along the equator and the coasts of Gabon and Angola advects water from the Congo plume to the south. Along the southern coast, local wind forcing is not responsible for the reversal as Ekman transport and pressure gradient due to the plume do not change before and during the reversal. In addition, a local resurgence at the surface of the Gabon Congo Undercurrent (GCUC) is not an explanation as water masses transported by the GCUC are not found at the surface. Sensitivity tests on the wind forcing reveal that the reversal seems to be forced at larger scale in the equatorial region and more in the Gulf of Guinea than in the western part of the Atlantic basin.

Our simulations demonstrate that coastal and equatorial dynamic are strongly connected in the Gulf of Guinea. As a consequence, along the coast dynamical contribution to variations of the sea surface salinity result both from equatorial forcing for the stronger events (May/June salinisation, southward extension of the Congo plume) and local forcing for mean offshore advection of the low salinity water.