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Coastal upwelling limitation by salinity-driven onshore geostrophic flow in the northern Gulf of Guinea

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Coastal upwelling occurs in summer in the northern Gulf of Guinea, offshore Côte d'Ivoire and Ghana. It is divided in two upwelling cells found east of Cape Palmas and Cape Three Points forced by different processes. Recent studies show that, while upwelling east of Cape Palmas is mainly driven by the detachment of the eastward Guinea Current from the coast, upwelling east of Cape Three Points is mainly driven by local winds. Further east, the Niger River creates a low salinity plume. In this work, we investigate the role of salinity on the eastward extension of the Cape Three Points upwelling. Indeed, it has been shown in other regions that wind-driven upwelling can be compensated by onshore geostrophic flow. Along the northern coast of the Gulf of Guinea, the eastward decrease in salinity due to the Niger plume likely creates an eastward increase in sea level and a northward (onshore) geostrophic flow. This geostrophic compensation can also be reinforced by the eastward increase in temperature, as upwelling weakens. By comparing the alongshore evolution of Ekman and geostrophic upwelling indices, based on satellite winds and altimetric currents, we quantify the contribution of geostrophy to the upwelling limitation. A high-resolution regional simulation (NEMO) is then used to further understand the dynamics and decompose the respective contributions of salinity and temperature to the onshore geostrophic flow. Sensitivity experiments with and without rivers are also carried out to assess more directly the influence of the Niger plume on coastal upwelling.