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Monitoring the Amazon plume northwestward transport along Lagrangian pathways

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Large rivers are important to marine air-sea interactions and local biogeochemistry. By modifying the local and regional sea surface salinity (SSS), the freshwater inputs associated with major river plumes cause the formation of a layer near the surface with salinity stratification but near-uniform temperature, known as the barrier layer (BL). The BL prevent exchanges between the warm mixed layer and the cold ocean interior, and thus affect the vertical mixing of heat between the mixed layer and the thermocline. This can have an important impact on air-sea interactions such as hurricanes intensification. Our study focuses on the Amazon and Orinoco rivers, respectively the first and fourth world's largest rivers in terms of discharge. Amazon-Orinoco waters are carried northwestward by the North Brazilian Current (NBC) during the first part of the year and then eastward along the North Equatorial Counter Current. The hurricane season in the tropical Atlantic extends from June through November, the period of Amazon-Orinoco plume maximum northwestward extension, on a hurricane route.
Being able to monitor the spatial and temporal dispersal of the Amazon and Orinoco river plumes is therefore important to better understand their impact on barrier layer thickness and SST variation at seasonal to interannual time scales. Variations from year to year in spatial extent of the plume may result from several processes including changes in Amazon discharge, ocean advection, turbulent mixing, and wind field. Satellite remote sensing data provide several means to visualize the surface dispersal of the Amazon plume, with ocean color data being the first to track it in the tropical Atlantic ocean further than 1000 km from shore. With the launches of the ESA Soil Moisture and Ocean Salinity (SMOS) and the NASA Aquarius/SAC-D missions, we are now able to use the SSS observations in combination with ocean color, altimetry and sea surface temperature observations to track surface plume area.
The objective of this study is to investigate the interannual variability in Amazon-Orinoco freshwater transport from the rivers' mouth northwestward over 2010-2014. We use a Lagrangian advection method to track the particles and follow their biophysical properties along their trajectory using measurements from Aquarius, SMOS, and Aqua MODIS. The pathways of the Amazon-Orinoco plume waters can therefore be analyzed and quantified, enabling an investigation of the biophysical processes associated with the Amazon River and Orinoco River freshwaters as they are advected from the river mouth to the open ocean. From one year to another, the amount of Amazon-Orinoco particles reaching the northwestern part of the plume is variable causing different physical and biogeochemical influences in the area. In 2011, a larger amount of particles reaches that area, the mechanisms responsible for this unusual northwestward transport of the shallow plume waters are under investigation, such as river discharge, advection, NBC rings. On the contrary, in 2014, fewer particles reach this northwestern area taking a more coastal pathway. This suggests a higher influence of the Orinoco River that year.