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Detection and variability of the Congo River plume from satellite derived sea surface temperature, salinity, ocean colour and sea level

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The Congo River in Africa has the world's second highest annual mean daily freshwater discharge and is the second largest exporter of terrestrial organic carbon into the oceans. It annually discharges an average of 1,250 $\times$ 10^9 m^3 of freshwater into the southeast Atlantic producing a vast fresh water plume, whose signature can be traced hundreds of kilometres from the river mouth. Large river plumes such as this play important roles in the ocean carbon cycle, often functioning as carbon sinks. An understanding of their extent and seasonality is therefore essential if they are to be realistically accounted for in global assessments of the carbon cycle.

Despite its size, the variability and dynamics of the Congo plume are minimally documented. In this paper we analyse satellite derived sea surface temperature, salinity, ocean colour and sea level anomaly to describe and quantify the extent, strength and variability of the far-field plume and to explain its behaviour in relation to winds, ocean currents and fresh water discharge. Empirical Orthogonal Function analysis reveals strong seasonal and coastal upwelling signals, potential bimodal seasonality of the Angola Current and responses to fresh water discharge peaks in all data sets. The strongest plume-like signatures however were found in the salinity and ocean colour where the dominant sources of variability come from the Congo River itself, rather than from the wider atmosphere and ocean. These two data sets are then analysed using a statistically based water mass detection technique to isolate the behaviour of the plume.

The Congo's close proximity to the equator means that the influence of the earth's rotation on the fresh water inflow is relatively small and the plume tends not to form a distinct coastal current. Instead, its behaviour is determined by wind and surface circulation patterns. The main axis of the plume between November and February, following peak river discharge, is oriented northwest, driven by the wind and Ekman surface currents and possibly a northern branch of the Benguela Coastal Current. From February through to May the main axis swings towards the southwest, extending 750 km from the mouth, coinciding with a westerly shift in the wind direction and an increase in its speed. From June through to August, when discharge is at a minimum and the plumes salinity is highest, the main axis of the plume extends up to 850 km westward, but retreats to 440 km throughout the autumn. Following the end of the coastal upwelling period and an increase in river discharge the plumes salinity starts to rise again and the equatorward fresh water tongue re-establishes itself.