Basin-scale inputs of cobalt, iron, and manganese from the Benguela-Angola front to the South Atlantic Ocean

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ABSTRACT: We present full-depth zonal sections of total dissolved cobalt, iron, manganese, and labile cobalt from the South Atlantic Ocean. A basin-scale plume from the African coast appeared to be a major source of dissolved metals to this region, with high cobalt concentrations in the oxygen minimum zone of the Angola Dome and extending 2500 km into the subtropical gyre. Metal concentrations were elevated along the coastal shelf, likely due to reductive dissolution and resuspension of particulate matter. Linear relationships between cobalt, N_2O, and O_2, as well as low surface aluminum supported a coastal rather than atmospheric cobalt source. Lateral advection coupled with upwelling, biological uptake, and remineralization delivered these metals to the basin, as evident in two zonal transects with distinct physical processes that exhibited different metal distributions. Scavenging rates within the coastal plume differed for the three metals; iron was removed fastest, manganese removal was 2.5 times slower, and cobalt scavenging could not be discerned from water mass mixing. Because scavenging, biological utilization, and export constantly deplete the oceanic inventories of these three hybrid-type metals, point sources of the scale observed here likely serve as vital drivers of their oceanic cycles. Manganese concentrations were elevated in surface waters across the basin, likely due to coupled redox processes acting to concentrate the dissolved species there. These observations of basin-scale hybrid metal plumes combined with the recent projections of expanding oxygen minimum zones suggest a potential mechanism for effects on ocean primary production and nitrogen fixation via increases in trace metal source inputs.