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Interannual atmospheric variability forced by the deep equatorial Atlantic Ocean

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Climate variability in the tropical Atlantic is determined by large-scale ocean-atmosphere interactions, particularly affecting deep atmospheric convection over the ocean and surrounding continents. Besides influences from the Pacific El Niño - Southern Oscillation and the North Atlantic Oscillation, the tropical Atlantic variability is dominated by two distinct coupled climate modes of variability: the thermodynamic meridional mode and the dynamic zonal mode that are mainly active at decadal and interannual time scales, respectively. Here we report evidence that intrinsic ocean dynamics of the deep equatorial Atlantic also affect sea surface temperature, wind, and rainfall in the tropical Atlantic region and constitute a 4.5-year climate cycle. Specifically, vertically alternating deep zonal jets of short vertical wavelength with a period of about 4.5 years and amplitudes of more than 10 cm/s are observed in the deep Atlantic Ocean to propagate their energy upward, towards the surface. They are linked, at the sea surface, to equatorial zonal current and eastern Atlantic temperature anomalies with amplitudes of about 6 cm/s and 0.4^{o}C, respectively, which are associated with distinct wind and rainfall patterns. Analyzing the seasonality of the surface expressions it is found that the amplitude of the 4.5-year cycle of equatorial zonal velocity is seasonally independent, whereas the corresponding amplitude of eastern Atlantic SST anomalies at this period are instead strongest during boreal summer and November/December. These periods are identified as cold seasons with shallow thermocline depths in the east and active Bjerknes positive feedback. During boreal spring when the tropical Atlantic is uniformly warm, the influence of the 4.5-year zonal velocity anomalies on SST via anomalously upwelling is weak and not amplified by ocean-atmosphere interactions. Such behavior is consistent with the equatorial surface flow forced by intrinsic deep ocean dynamics, while associated SST variations are seasonally modulated. Although deep jets are also observed in the Pacific and Indian oceans, only the Atlantic deep jets appear to oscillate on interannual time scales. This oscillatory behavior can be exploited to improve predictions of sea surface temperature in the tropical Atlantic. The understanding of deep jet generation and upward energy transmission through the Equatorial Undercurrent warrants further theoretical study.