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Anomalously Strong and Rapid Drying of the Tropical Lower Stratosphere in 2016: Connections to the QBO and ENSO

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From December 2015 through November 2016, monthly mean anomalies of coldpoint temperatures (CPTs) in the tropical lower stratosphere decreased –3.1°C, from 1.0 to –2.2°C. In response, monthly tropical mean SWV anomalies at 83 hPa dropped from 0.9 to –1.0 ppmv (–1.9 ppmv) during the same 12-month period. The strength of this decline in SWV anomalies is equivalent to ∼50% of the long-term December tropical average SWV abundance. In addition, average decreases in tropical CPT and SWV anomalies in the Eastern Hemisphere were 2.3°C and 0.9 ppmv larger than those in the Western Hemisphere. To better understand these strong decreases, we examine the evolution of two dynamical phenomena that drive inter-annual variations in tropical CPTs and SWV: the quasi-biennial oscillation (QBO) and the El Niño Southern Oscillation (ENSO). At the start of 2016, westerly winds associated with the QBO warm phase were present at tropical CPT altitudes and strong El Niño conditions prevailed in the tropical Pacific region. By mid-2016, ENSO was shifting to La Niña conditions after a year of strong El Niño. Ordinarily, this transition would have put the ENSO and QBO cycles out of phase for the remainder of 2016. Instead, the atypical evolution of the QBO in early 2016 prematurely brought cold temperatures to CPT altitudes, and the two cycles remained in phase during 2016. We explore the combined influences of the QBO and ENSO during 2016 that strongly and rapidly dried the tropical lower stratosphere, especially in the Eastern Hemisphere.