Response of stratospheric water vapor and ozone to the unusual timing of El Niño and QBO disruption in 2015–2016

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The stratospheric circulation determines the transport and lifetime of key greenhouse gases, including water vapor and ozone, which radiatively impact surface climate. The unusually warm El Niño Southern Oscillation (ENSO) event aligned with a disrupted Quasi–Biennial Oscillation (QBO) caused an unprecedented perturbation to this circulation in 2015–2016. Here, we quantify the impact of the alignment of these two phenomena in 2015–2016 on lower stratospheric water vapor and ozone from satellite observations. We show that the warm ENSO event substantially increases water vapor and decreases ozone in the tropical lower stratosphere. The QBO disruption of the prevailing westerly phase by a suddenly emerging easterly phase significantly decreases global lower stratospheric water vapor and tropical ozone from early spring to late autumn. Thus, this QBO disruption reverses the lower stratosphere moistening triggered by the alignment of the warm ENSO event with westerly QBO in early boreal winter. Our results suggest that the interplay of ENSO events and QBO phases will be crucial for the distributions of radiatively active greenhouse gases in a changing future climate, when increasing El Niño-like conditions and decreasing lower stratospheric QBO amplitude are expected.

Key words: QBO disruption, El Niño 2015-2016, stratospheric Water vapor and Ozone, Puzzling water vapor, Anomalous stratospheric circulation.