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Regionally resolved impact of ENSO on the variability of the Brewer-Dobson circulation and of water vapor entering the tropical lower stratosphere

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The El Nino Southern Oscillation (ENSO) is an important natural and regional climate variability resulting from the interaction between atmosphere and ocean in the tropical Pacific. Based on simulations with the Chemical Lagrangian Model of the Stratosphere (CLaMS) for the period 1979-2013, with model transport driven by the ECMWF ERA-Interim reanalysis, we discuss the impact of ENSO on the variability of the dynamics and trace gas composition in the lower stratosphere during the boreal winter.

Although the zonally averaged picture of all relevant processes is well established in the literature, the spatially localized character of the ENSO anomaly shows significant longitudinal differences. Our regionally-resolved 3d analysis at 390 K potential temperature level reveals that not only ENSO-related temperature anomalies are confined to the tropics between 180 and 300 E but also anomalous wave propagation and breaking, as quantified in terms of EP flux divergence, with strongest local contribution during the La Nina phase. This anomaly is coherent with respective anomalies of water vapor and ozone derived from CLaMS, the latter being in an excellent agreement with the Aura Microwave Limb Sounder (MLS) observations. There are significant regional differences in water entering the stratosphere of more than 1 ppmv between the La Nino and El Nino configurations.

Thus, during La Nina, when convection is more confined to the Western Pacific, the flow in the lower stratosphere is strongly disturbed by equatorial planetary waves which mainly dissipate around the tropical tropopause between 180 and 300 E. These waves which originate in the northern hemisphere, propagate southward and can even reach the southern hemisphere. On the other hand, during El Nino the eastward shift of tropical convection pattern comes along with almost symmetric subtropical jets, so that the waves propagating from below can force the deep branch of the Brewer-Dobson circulation.