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Tropical tropospheric ozone variability and the influence of 2015 El Niño event

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The distribution of tropospheric ozone in the atmosphere is a balance between production, transport, and loss processes. The analysis of its global distribution is a precondition for understanding changes in its natural variability. Using 20 years (1996–2015) of harmonised tropical tropospheric columns of ozone (TTCO), retrieved with the Convective Clouds Differential method on GOME, SCIAMACHY, and GOME-2 data, a tropical tropospheric ozone mean state sorted by seasons can be established. TTCO present a distinctive wave-one pattern for all seasons, maximizing ($\sim$ 40 DU) over the south Atlantic Ocean in autumn while having low values (<15 DU) over the Pacific Ocean. Tropospheric ozone has been found to decrease significantly over southern Africa, the southern tropical Atlantic, south-east tropical Pacific Ocean, and central Oceania by $\sim$3 DU/decade and increase over central Africa and southern India by $\sim$2 DU/decade for the studied period. The contribution of oscillating factors such as ENSO, QBO, solar, and seasonal cycles to tropospheric ozone variability have been quantified by applying a multi-linear regression model. ENSO is found to contribute by up to +7 DU over the Indian and western Pacific Oceans and by -10 DU over the eastern Pacific Ocean during 1996 to 2015. Tropospheric ozone increases by $\sim$ 7 DU due to solar cycle over parts of the northern and southern tropics. QBO contributes in total $\sim$ 5 DU to the tropical tropospheric ozone variability, mainly over the southern tropics. The seasonal cycle has a stronger contribution in tropospheric ozone over the northern tropics and the Atlantic Ocean on the order of $\sim$ 15 DU and elsewhere its total contribution is less than 10 DU. The seasonal cycle of tropospheric ozone is the weakest over the west Pacific (< 5 DU). The influence of 2015 El Nino event on tropospheric ozone concentrations is investigated in a spacial study. Simulations of tropospheric ozone along with its precursors form the ECHAM-MESSY model [Joeckel et al., 2016] are used in order to compare them with the observed CCD TTCO anomalies between September to December 2015. The simulated ozone precursors (CO and NO_2) by EMAC were generally underestimated compared with the satellite observations. EMAC was found to overestimate tropical tropospheric ozone mainly over the northern Africa, the Indian ocean, and the north-east Pacific ocean by 10-15 DU and underestimated tropospheric ozone over the Atlantic, the west Pacific ocean, and the central-south Africa by 10-15 DU compared to CCD results. Simulations of tropospheric ozone from the EMAC model for two modes, one with and one without biomass burning emissions was studied in order to separate the effect of biomass burning and dynamical processes. The results suggest that dynamics have mainly modulated the TTCO anomalies during 2015 El Nino event, with the exception of the Indonesian region where biomass burning resulted in a tropospheric ozone increase of about +10 DU. Finally, new TTCO from TROPOMI/S5p will be presented.