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On the origin of tropospheric O_3 over the Indian Ocean during the winter monsoon: African biomass burning vs. stratosphere-troposphere exchange

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Abstract. This study investigates the origin of a commonly observed feature in the O_3 profiles: mid tropospheric O_3 maxima (300--500 hPa) over the tropical Indian Ocean. A comparison and analysis of model simulations, using a 3-D global climate-chemistry model, and measured O_3 profiles from the INDOEX campaign is presented. European Centre for Medium-Range Weather Forecast (ECMWF) meteorological analyses have been assimilated into the 3-D model to represent actual meteorology. The model realistically simulates the observed mid-tropospheric O_3 maxima. The analysis of the model simulations shows that the major source of the mid-tropospheric O_3 maxima is advection of polluted air masses from continental biomass burning areas over Africa, with generally only a small contribution of stratospheric O_3. Previous studies hinted at stratosphere-troposphere exchange (STE) along the subtropical jet (STJ) as the primary source of the mid-tropospheric O_3 maxima over the Indian Ocean. Analysis of the model simulations shows that the mechanism causing the mid-tropospheric transport of African biomass burning pollution and stratospheric air masses are frontal zones or waves passing along the subtropical jets, causing advection of tropical air masses in the prefrontal (equatorward) zone. Furthermore, the frontal zones or waves also cause STE at the poleward side of the STJ. The model simulations also indicate that the contribution of STE in general is minor compared to advection and in situ tropospheric production of O_3 for the mid-tropospheric O_3 budget over the Indian Ocean region.

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