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Factors controlling the distribution of ozone in the West African lower troposphere during the AMMA (African Monsoon Multidisciplinary Analysis) wet season campaign

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Abstract. Ozone and its precursors were measured on board the Facility for Airborne Atmospheric Measurements (FAAM) BAe 146 Atmospheric Research Aircraft during the monsoon season 2006 as part of the African Monsoon Multidisciplinary Analysis (AMMA) campaign. One of the main features observed in the west African boundary layer is the increase of the ozone mixing ratios from 25 ppbv over the forested area (south of 12° N) up to 40 ppbv over the Sahelian area. We employ a two-dimensional (latitudinal versus vertical) meteorological model coupled with an O_3-NO_x-VOC chemistry scheme to simulate the distribution of trace gases over West Africa during the monsoon season and to analyse the processes involved in the establishment of such a gradient. Including an additional source of NO over the Sahelian region to account for NO emitted by soils we simulate a mean NO_x concentration of 0.7 ppbv at 16° N versus 0.3 ppbv over the vegetated region further south in reasonable agreement with the observations. As a consequence, ozone is photochemically produced with a rate of 0.25 ppbv h^{-1} over the vegetated region whilst it reaches up to 0.75 ppbv h^{-1} at 16° N. We find that the modelled gradient is due to a combination of enhanced deposition to vegetation, which decreases the ozone levels by up to 11 pbbv, and the aforementioned enhanced photochemical production north of 12° N. The peroxy radicals required for this enhanced production in the north come from the oxidation of background CO and CH_4 as well as from VOCs. Sensitivity studies reveal that both the background CH_4 and partially oxidised VOCs, produced from the oxidation of isoprene emitted from the vegetation in the south, contribute around 5–6 ppbv to the ozone gradient. These results suggest that the northward transport of trace gases by the monsoon flux, especially during nighttime, can have a significant, though secondary, role in determining the ozone gradient in the boundary layer. Convection, anthropogenic emissions and NO produced from lightning do not contribute to the establishment of the discussed ozone gradient.

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