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Classification of tropospheric ozone profiles over Johannesburg based on mozaic aircraft data

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Abstract. Each ozone profile is a unique response to the photochemical and dynamic processes operating in the troposphere and hence is critical to our understanding of processes and their relative contributions to the tropospheric ozone budget. Traditionally, mean profiles, together with some measure of variability, averaged by season or year at a particular location have been presented as a climatology. However, the mean profile is difficult to interpret because of the counteracting influences present in the micro-structure. On the other hand, case study analysis, whilst revealing, only applies to isolated conditions. In a search for pattern and order within ozone profiles, a classification based on a cluster analysis technique has been applied in this study. Ozone profiles are grouped according to the magnitude and altitude of ozone concentration. This technique has been tested with 56 ozone profiles at Johannesburg, South Africa, recorded by aircraft as part of the MOZAIC (Measurement of Ozone and Water Vapor aboard Airbus In-service Aircraft) program. Six distinct groups of ozone profiles have been identified and their characteristics described. The widely recognized spring maximum in tropospheric ozone is identified through the classification, but a new summertime mid-tropospheric enhancement due to the penetration of tropical air masses from continental regions in central Africa has been identified. Back trajectory modeling is used to provide evidence of the different origins of ozone enhancements in each of the classes. Continental areas over central Africa are shown to be responsible for the low to mid-tropospheric enhancement in spring and the mid-tropospheric peak in summer, whereas the winter low-tropospheric enhancement is attributed to local sources. The dominance of westerly winds through the troposphere associated with the passage of a mid-latitude cyclone gives rise to reduced ozone values.

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