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Statistical analysis and modelling study of local ozone anomalies in Europe

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Local ozone anomalies constitute an important short-term component of the stratospheric ozone variability and are usually defined as synoptic-scale deviations in the total ozone column field, having a characteristic lifetime of about a week or a few days. The present study is devoted to investigation of the statistics, dynamical structure and formation mechanisms of local ozone anomalies.

First, we process observational and reanalysis data to obtain statistics of all cases of negative ("mini-holes") and positive ("mini-highs") anomalies over the territory of Europe during the last two decades, paying attention to such issues as definition of anomalies, their possible classification, and algorithms for their objective identification. Furthermore, we investigate several prominent cases of both negative and positive anomalies, focusing on the underlying dynamical processes. For that purpose, we combine observations and reanalysis with global-scale numerical simulations by ECMWF OpenIFS model and regional mesoscale simulations by WRF model. Special attention is paid to the cases of deepest negative ozone anomalies (e.g., the 1997-1998 ozone mini-hole, which is responsible for the minimal total ozone column value ever observed over Belarus, 163 DU), and of springtime and summertime ozone mini-holes, when sufficiently low total ozone column values coincide in time with intense solar irradiation. Finally, we discuss the connection of local ozone anomalies with surface weather phenomena, their predictability in numerical weather modelling, and the role of local ozone anomalies in the broad context of stratosphere-troposphere interactions research.