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A Mechanism of Stratospheric Ozone Influence on Tropospheric Circulation Patterns

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Downward propagation of stratospheric signals to the troposphere and the possibility of stratospheric anomalies affecting surface weather and climate have recently been subjects of active discussion and research. In the present study, we investigate a specific mechanism of connections between ozone distribution and temperature field in the stratosphere and features of general circulation in the troposphere and analyze the causal relationship between them. On the practical side, this implies studying the possibility of stratospheric ozone influence on tropospheric medium-range weather patterns, seasonal weather forecasting, and regional climate characteristics.

Analysis of several decades of observational data, which has been performed at the A.I. Voeikov Main Geophysical Observatory, suggests a clear relation between the stratospheric ozone distribution, stratospheric temperature field and planetary-scale air-masses boundaries in the troposphere [1]. Furthermore, it has been shown that each global air-mass, which can be attributed to the corresponding circulation cell in a conceptual model of tropospheric general circulation, has a distinct “regime” of ozone vertical distribution in the stratosphere [1-3].

Proceeding from atmospheric reanalyses combined with satellite and ground-based observations, we study time evolution of the upper-level frontal zones (stationary fronts) with the relevant jet streams, which can be treated as boundaries of global air-masses, in connection with the tropopause height and distribution of ozone in the stratosphere. For that, we develop an algorithm for automated identification of jet streams, stationary fronts and tropopause surface from gridded data (reanalyses or modelling results), and apply it for several cases associated with rapid changes in the stratospheric temperature and ozone fields, including SSW events. Aiming to study the causal relationship between the tropospheric circulation patterns and changes in the stratospheric ozone field, we estimate the time lag between these categories of processes on different time scales.

Finally, we discuss the possibility to use the elementary circulation mechanisms classification (by B.L. Dzerdzeevski) in connection with analysis of the stratospheric ozone field and the relevant stratosphere-troposphere interactions.

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