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Stratosphere-Troposphere Interactions in Positive Local Ozone Anomalies Formation Case Studies

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One of the characteristic phenomena in Northern Hemisphere ozone layer dynamics in recent decades is the increasing number of observed negative (positive) local ozone anomalies, defined as local areas with very low (very high) total ozone column. Ozone anomalies formation and development is a complicated process involving both the stratosphere and the troposphere.

The importance of negative local anomalies study is due to significant biological impact of the associated low total ozone values; accordingly, negative anomalies were a subject of intense research. On the other hand, positive anomalies have received less attention. However, from the climate and weather research point of view, study of both categories of anomalies is of great interest. For example, it has been shown that total ozone content field over polar regions can serve as a predictor of future atmospheric circulation in mid-latitudes [1].

It has been argued [2] that sizeable ozone anomalies correspond to a certain stratification of the atmosphere, and that negative and positive anomalies are characterized by opposite "dipole structures": combinations of independent circulation processes in the troposphere and the stratosphere.

The present study focuses on the influence of tropospheric processes on stratospheric ozone dynamics and the associated ozone anomalies development. On the basis of WRF-ARW modelling system, adapted for our study, we analyze the relationship between pressure formations in the troposphere and the stratosphere and their impact on stratospheric ozone distribution, using GFS meteorological data for WRF input data and TOMS data for ozone maps.

We conclude that:
- Higher total ozone values are observed in the rear part of the cyclone and the front part of the anticyclone, confirming the "dipole structure" hypothesis.
- Projections of the anomalies on the 50 hPa and 15 hPa isobaric surfaces are situated in the transient zone between warm air and cold air regions.
- The "dipole structure" hypothesis is not valid in case of negative anomalies formed by the polar vortex.
- Ozone anomalies form "dipole structures" only if ozone deviation values exceed 20% - 30%, otherwise these structures are not present.
- Ozone anomalies, which follow one another in a series, are component parts of the long atmospheric waves.
- Observed isohypses distortions on the 500 hPa, 300 hPa and 100 hPa surfaces form "tongues" in the direction of anomalies movement. These distortions influence movement of surface pressure systems.

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