Geophysical Research Abstracts,
Vol. 11, EGU2009-6626, 2009
EGU General Assembly 2009

Diagnostics of extra-tropical ozone laminas and equatorial ozone variations deduced from the HIRDLS data and models

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In the lower stratosphere ozone profiles measured by sondes and HIRDLS (High Resolution Dynamics Limb Sounder) instrument on Aura satellite frequently display thin vertical layers of substantially enhanced or decreased mixing ratios, which are called laminas. The 2005-2007 HIRDLS ozone data, model simulations and reported ozone analyses are used to evaluate statistics of monthly frequencies of the transport events that produce laminas. For the extra-tropical lower stratosphere the observed and simulated frequencies of laminas demonstrate the similar annual variations. In the extra-tropics of Northern Hemisphere (NH) the strong annual cycle of laminas with most frequent counts during March-April and low lamination rates between August and October is consistent with seasonal variability deduced from regional analysis of multi-year ozonesonde data. Global analysis of HIRDLS data and models show the similar seasonal drifts of preferential geographical regions of frequent counts of laminas in the NH. As diagnosed in the Southern Hemisphere (SH) ozone lamina events are less frequent compared to the NH. For extra-tropics of SH, the noticeable growth of lamina frequency is also observed for winter-spring months. The inter-hemispheric differences in the statistics of observed and simulated laminas can be related with larger variations of barotropic and baroclinic wave activity in the NH compared to less variable waves in the SH. In mid-latitudes of both hemispheres annual cycles of ozone laminas are correlated with more frequent movements of the extra-tropical tropopause during winter-spring months. In contrast, reported ozone analyses that assimilate ozone data with restricted vertical resolutions can fail to reproduce the observed frequency of laminas. Possible interpretation of this shortcoming in vertical structures of analyzed ozone is suggested. The multi-year statistics of laminar constituent structures (ozone and nitric acid) observed by HIRDLS with dynamically consistent vertical (about 1 km) and horizontal (about 1 degree along orbits) sampling can be a good metrics for evaluation of models and chemical data analyses including the vertical structure of composition in the extra-tropical lowermost stratosphere. In the equatorial stratosphere the multi-year space-borne constituent data help to evaluate the tropical vertical structures of models and analyses including amplitudes of semiannual, annual and quasi-biennial ozone oscillations. In this study using the 2005-2007 HIRDLS ozone we examine equatorial ozone vertical structures in the stratosphere produced by chemistry-climate models, GEOS-5 ozone analyses and chemistry-transport models driven by GEOS meteorological fields.