Improvement of OMI ozone profile retrievals in the troposphere and lower troposphere by the use of the tropopause-based ozone profile climatology

Juseon Bak1, X. Liu2, J. Wei2, L. Pan2, J.H. Kim1, K. Chance1, C. Barnett1
1Atmospheric Science Department, University of Pusan National, Pusan, Korea
2Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts, USA
3National Center for Atmospheric Research, Boulder, Colorado
4NESDIS center for Satellite Application and Research, Camp Springs, Maryland

Validation using the meteorological data

The horizontal and vertical distribution of OMI retrievals on 30 April 2007 with two different ozone climatologies. LLM climatology from McPeters et al. (2007) and our TB climatology, which are evaluated using meteorological data from NCEP FNL tropopause height.

- The FNL 2 Potential Vorticity Unit surface derived at 250 hPa is contoured with the red line. This indicates the transition from the tropospheric air mass to the stratospheric air mass that is correlated with the O3 value of 100 to 300 ppbv.
- Large O3 values are closely collocated with the low tropopause height and large PV values

Using TB climatology significantly improves the spatial consistency in the UT/LS region compared to the LLM climatology.

Validation using the aircraft measurements

We used in situ measurements obtained from the START08 experiment (Pan et al., 2010) as another validation reference.

- OMI retrievals are evaluated in three pressure layers, bounded by the 103, 120, and 250 hPa pressure levels.
- The A-priori O3 and OMI O3 retrievals are closely scattered with respect to ozone sondes at HOHE.
- Using TB climatology significantly improves the spatial consistency in the UT/LS region compared to the LLM climatology.

Summary and discussion

- The criterion to select the collocated sonde data with OMI pixels is within 40° latitude and longitude.
- The comparison was made in terms of RMSD-SONDE and RMSD-GV.
- Significant disagreement between OMI and ozone sondes are distributed over the UTLs.
- OMI retrievals based on TB climatology show the better agreement with sondes than others, by up to a factor of ~2 at mean tropopause (~10 km).
- This improvement illustrates how well the combination of the TB climatology and the daily tropopause height data represents the daily behavior of ozone.

We improve the way to derive the TB climatology.

1. Filtering ozonesonde profiles with the tropopause height > 14 km, in order to confine the use of the TB climatology to the extratropical region

- Ozone variability induced by mixing air masses between troposphere and stratosphere, especially in the vicinity of the subtropical tropopause.

2. Using the TB coordinate to vary the shifting offset is applied, in order to confine the use of the TB climatology to the UTLs region

- Using the TB coordinate reduces the ozone variability by more than 50% around the tropopause for the extratropical latitudinal bands.
- Using TB is not useful where the atmospheric dynamics is expected to be low, tropics, altitudes without 5 km

3. TB/AB climatology is merged to LLM climatology at altitudes relative to tropopause

- The AB climatology shows the highly smoothed ozone variability above ~40 km, compared to LLM, due to the different composition for the stratospheric air masses.
- T/B/AB climatology is derived when the number of ozonesonde profiles with the tropopause height > 14 km is enough.

We examine use of the TB-based climatology for OMI ozone profile retrievals in the UTLS region.

- LLM climatology from McPeters et al. (2007) and our TB climatology, which are evaluated using meteorological data from NCEP FNL tropopause height.

- The FNL 2 Potential Vorticity Unit surface derived at 250 hPa is contoured with the red line. This indicates the transition from the tropospheric air mass to the stratospheric air mass that is correlated with the O3 value of 100 to 300 ppbv.
- Large O3 values are closely collocated with the low tropopause height and large PV values

- Using TB climatology, the O3 transition between tropospheric and stratospheric seems to be more distinct and be better consistent with the 2 PVU surface.
- TB a-priori O3 is highly correlated with the dynamic features, whereas no longitudinal dependence is founded in the LLM ozone field.

Validation of OMI ozone profile retrievals on 30 April 2007 were used, from four stations in northern hemisphere: Wallop Island (47.9N, 11.0E), Sodankyla (67.4N, 26.7E), Hohenpeissenberg (46.9N, 9.6E) and Payervour (66.5N, 7.8W).

The comparison was made in term of RMSD-SONDE and RMSD-GV.