



Diurnal variation of O₃, ClO, HOCl, HO₂, and BrO observed by JEM/SMILES

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SMILES; Superconducting Submillimeter-Wave Limb Emission Sounder is a 4 K cooled 625-650 GHz limb sounder to observe O₃, HCl, ClO, HO₂, HOCl, BrO, HNO₃, and O₃ isotopes. SMILES had been operated on the International Space Station from Oct. 12, 2009 to Apr. 21, 2010. Since ISS is 51° inclined orbit, 30-45 days SMILES zonal mean could provide diurnal variation of chemical species in the stratosphere and mesosphere. Diurnal variation of O₃, ClO, HOCl, HO₂, and BrO are compared with two nudged CGCM calculations (SD-WACCM; Specified-dynamics WACCM, and MIROC) and satellite observations.

Diurnal variation of O₃ agreed with SD-WACCM over 50-82 km, but small peak in the morning (7 am local time) is apparent for the SMILES but not for the SD-WACCM at 70 km.

Diurnal variation of ClO agreed quite well between SMILES L2 ver. 2.2 and SD-WACCM from 19 to 76 km altitude region. But nighttime ClO value of SMILES L2 ver. 2.2 above 50 km is less than SD-WACCM (70%), which is not clearly explained by the SMILES retrieval issue or our current knowledge of chemical kinetics.

Diurnal variation of HOCl also agreed quite nicely from 31 to 76 km. SMILES HOCl retrieval is difficult since it is strongly affected by nearby O₃ isotope and O₃ hot band lines, as well as very strong HCl line. The nighttime build up of HOCl observed SMILES at 44-68 km are nicely reproduced by the SD-WACCM calculation using JPL2006 chemical kinetics dataset. But chemical kinetics calculation using SMILES ClO, HO₂, and HOCl at 35-45 km altitude supported much faster reaction rate of ClO + HO₂ given by JPL2010.

HO₂ diurnal variation also agreed with SD-WACCM from 24 to 72 km. Above 76 km, SMILES L2 ver. 2.2 needs modification of a priori and its co-variance, and we will get better agreement with model calculations. SMILES L2 ver. 2.2 also shows night time bias due to AOS (Acousto-Optics Spectrometer) characteristics.

SMILES Band C BrO observation is strongly interfered by overlapping O₃ isotope lines, and it is currently under test retrieval stage. SMILES BrO L2 ver. 2.2 looks appropriate (answering independent of a priori value) from 19 to 64 km. After the sunset build-up and slow nighttime decay of BrO observed SMILES L2 ver. 2.2 agreed well with SD-WACCM. SMILES BrO value has negative bias from 25 to 37 km, and it should be subtracted for scientific usage.

In general, SMILES L2 ver. 2.2 agreed well with SD-WACCM calculation. Agreement with MIROC is much less since the MIROC model use simplified chemistry package. We believe that the SMILES and SD-WACCM agreement is not false (a priori origin) but both SMILES observation and CGCM calculation made by SD-WACCM are enough precise and accurate.