Validation of stratospheric ozone data from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) version 2.1

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Abstract

We present verification results of the SMILES v2.1 ozone product by comparing the coincidence statistics with other data sources (ACE-FTS, MLS, MIPAS, SMR, SABER and SD-WACCM). The agreement is within 10% in the altitude range from 18 km to 26 km. In the higher altitudes, although there is still very good agreement with SD-WACCM, the SMILES ozone shows negative slopes with respect to some satellite data.

1. Introduction

The Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) was designed to be aboard the Japanese Experiment Module (JEM) on the International Space Station (ISS) as a collaboration project of Japan Aerospace Exploration Agency (JAXA) and National Institute of Information and Communications Technology (NICT). SMILES was successfully launched and attached to the Japanese Experiment Module (JEM) on the International Space Station (ISS) on September 25, 2009. Mission Objectives are: i) Space demonstration of super-conductive mixer and 4-K mechanical cooler for the submillimeter limb-emission sounding in the frequency bands of 624.32–626.32 GHz and 649.12–650.32 GHz, and ii) global observations of atmospheric minor constituents in the stratosphere (O3, HCl, ClO, HO2, HOCl, BrO, O3 isotopes, HNO3, CH3CN, etc), contributing to the atmospheric sciences. In this study, we validate the SMILES v2.1 ozone product using other data sources (ACE-FTS, MLS, MIPAS, SMR, SABER and SD-WACCM).

2. SMILES ozone measurements

We focus on the ozone product based on the measurement by the Band B, which provides the longest measurement time (about 83 days in total with more than 1000 scans). We conservatively use non-flagged profiles and the altitude level data with a positive calculation error.

3. Definitin of the coincidence measurement

We use the satellite data sets obtained during the SMILES observing period from 12 October 2009 to 21 April 2010. Then, we define time and space criteria for coincidence with the SMILES measurement to be within ±2 hours, ±2° latitude and ±8° longitude, which are comparable or somewhat tight to other inter-satellite validation studies (e.g. Frodevaux et al., 2008; Jegou et al., 2008; Dupuy et al., 2009; Rong et al., 2009). There is large number of coincidence events in the northern mid-latitude region. It is because the SMILES measurement density is higher at these latitudes. On the other hands, for SD-WACCM, we extracted the nearest grid data from all the SMILES observing points. Thus the maximum

difference in time and space is half of the calculation time step and the resolution: ±0.25 hours, ±0.95° latitude and ±1.25° longitude.

4. **Methodology**

For the comparisons, the altitude is converted from geopotential height to geometric height to match the SMILES data. Thus the altitude shown in this study is expressed in geometric height. We also smooth and degrade the high-resolution profiles such as ACE-FTS and SABER by convolving the SMILES ozone averaging kernel functions. Both flagged data points and their corresponding coincident counterparts at each SMILES altitude levels are removed from the following comparisons.

5. **Comparisons**

Figure 1 shows the comparisons of vertical profile in the latitude bin between 55°N and 65°N. From the result, it is found that the agreement is within 10% in the altitude range from 18 km to 26 km. However, in the higher altitudes up to 50 km, although there is still very good agreement with SD-WACCM, the SMILES ozone appears to have a negative bias ~15% with respect to ACE-FTS, MLS, SAEBR and MIPAS. The latitudinal distributions in Figures 2 show that there is no clear latitudinal dependence at all altitude levels. Especially, the agreement between the SMILES and WACCM ozone is less than 10% in the altitude range from 20 km to 50 km at all latitudes.

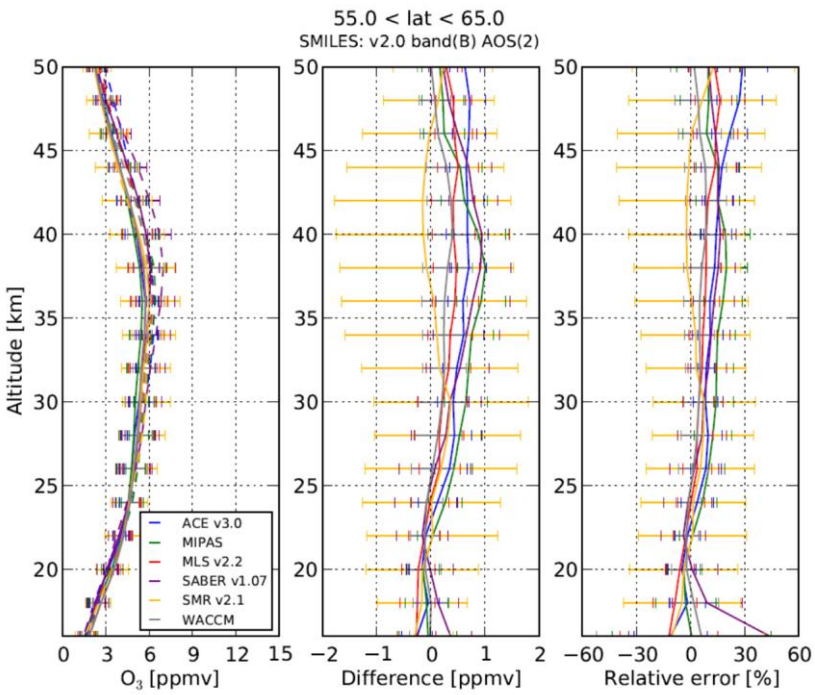

Figure 1 Comparisons of the average values (left) the averaged differences (middle) and the averaged percentage differences (right). The average values and their standard deviation are calculated from the coincident measurements with duplicated data being excluded, while the averaged difference, the averaged percentage difference and their standard deviations are calculated using all the coincident measurements.

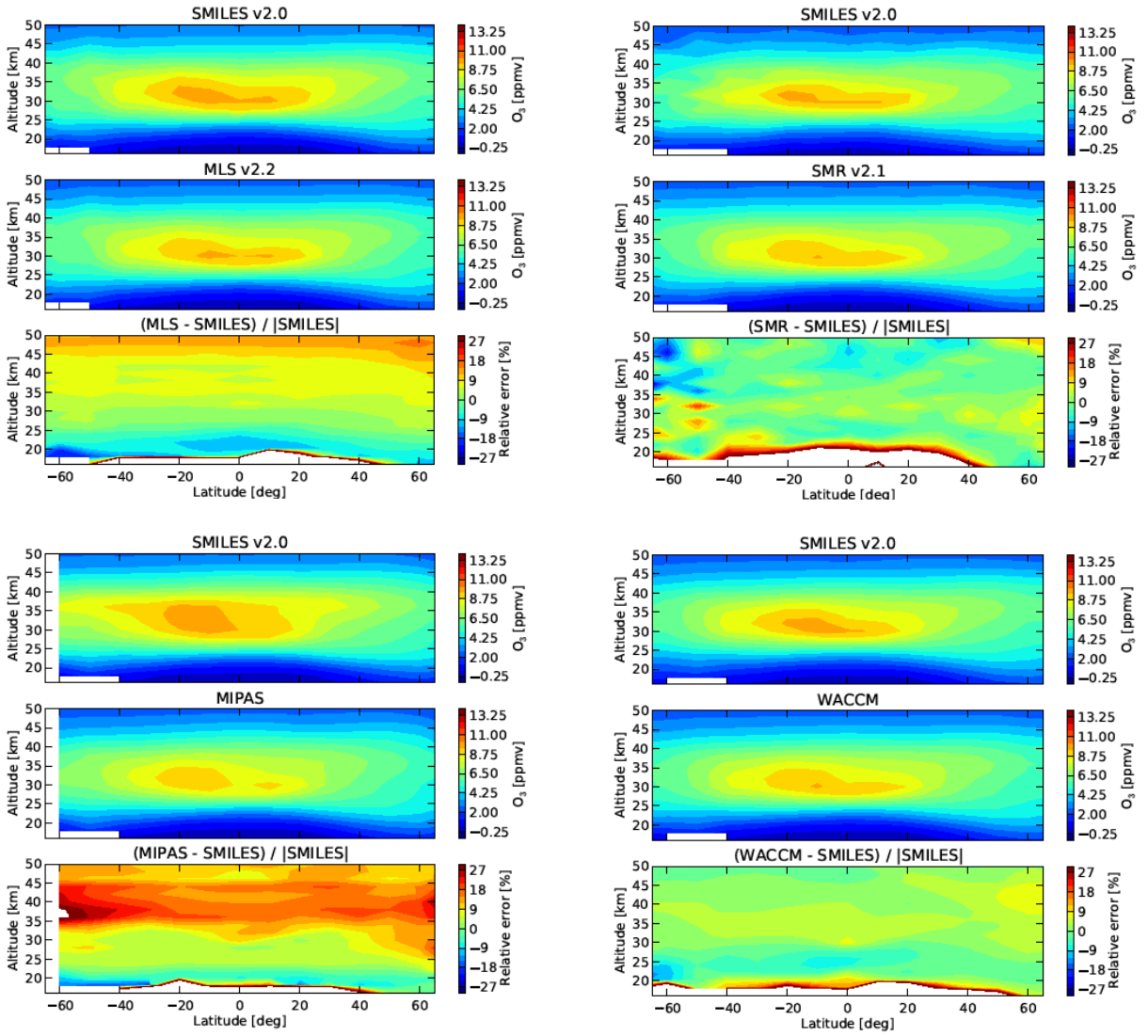

Figure 2 Contour plots of zonally averaged SMILES v2.1 ozone (top), for comparisons (middle) and the percentage difference (bottom).

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