

Validation of SMILES level 2 version 2.4 products

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Introduction

The Superconducting Sub-millimeter Limb-emission Sounder (SMILES) onboard Japan Experiment Module (JEM) of the International Space Station (ISS) have observed atmospheric minor constituents related with ozone chemistry, such as O₃, HCl, ClO, HO₂, HOCl and BrO, with high sensitivity. Especially, O₃, HCl and ClO can be detected with altitude up to the mesosphere (around 80km). In comparison with the stratosphere, "in situ" photochemistry controls concentration of minor constituents, so that we can examine current understanding of whole atmospheric chemical reactions by the direct comparison with SMILES observational data and results from numerical model calculations. The characteristics of ozone and chlorine compounds in stratosphere and mesosphere are reported with the latest version (v2.4) of SMILES level-2 data.

Specification of SMILES Level-2 (L2) Data

Time period 2009/10/12 - 2010/4/21 (Entire SMILES obs. period)
Version v2.4 (008-11-0502)
Latitudinal Coverage (nominal) 38 degS - 65 degN

Validation Criteria

Criteria (Satellites) ± 2 hours, $\pm 2^\circ$ latitude, $\pm 8^\circ$ longitude.
(SD-WACCM) ± 0.25 hours, $\pm 0.95^\circ$ latitude, $\pm 1.25^\circ$ longitude.
(MIROC3.2-CTM) ± 0.25 hours, $\pm 1.3^\circ$ latitude, $\pm 1.3^\circ$ longitude.
Day/Night Distinguished with Solar Zenith Angle (**Day:** 0° - 60°, **Night:** 120° - 180°)

Results of Validation

Ozone (Fig. 1):

(16 - 35 km) SMILES ozone data show reasonable agreement with MLS, MIPAS, SMR, ACE-FTS and SD-WACCM, but the differences show slightly negative slopes above 24 km for satellite data except for SMR

(35 - 50 km) All the satellite data and CTMs agree within 20%

(50 - 90 km) Good agreement still can be seen even up to the altitude of 70 km (daytime) / 82 km (nighttime)

Related papers: Imai et al. (JGR, 2013), Smith et al., (JGR, 2013), Imai et al. (submitted to JGR)

HCl (Figs. 2 and 3):

(20 - 50 km) Reasonable agreement within 10%, but the differences for MLS and ACE-FTS show negative slopes above 30 km and widen as the altitude increases.

(50 - 90 km) Comparisons with SD-WACCM shows in excellent agreement, and the SMILES HCl shows constant value (about 3.2 ppbv) as theoretically expected.

(Latitude-altitude cross-sections)

Among zonal-mean statistics of SMILES, satellite (MLS) and model (WACCM), there is no latitudinal dependence, but the SMILES HCl shows slightly larger values within 5% differences at 48 km in comparison with WACCM results.

ClO (Figs. 4 and 5):

(Daytime) Good agreements with the models in the altitude range of 25-60 km

(Nighttime) Good agreements with the models in the altitude range of 30-70 km

(Diurnal variation) Both SMILES data and WACCM model similarly picture local time coverage

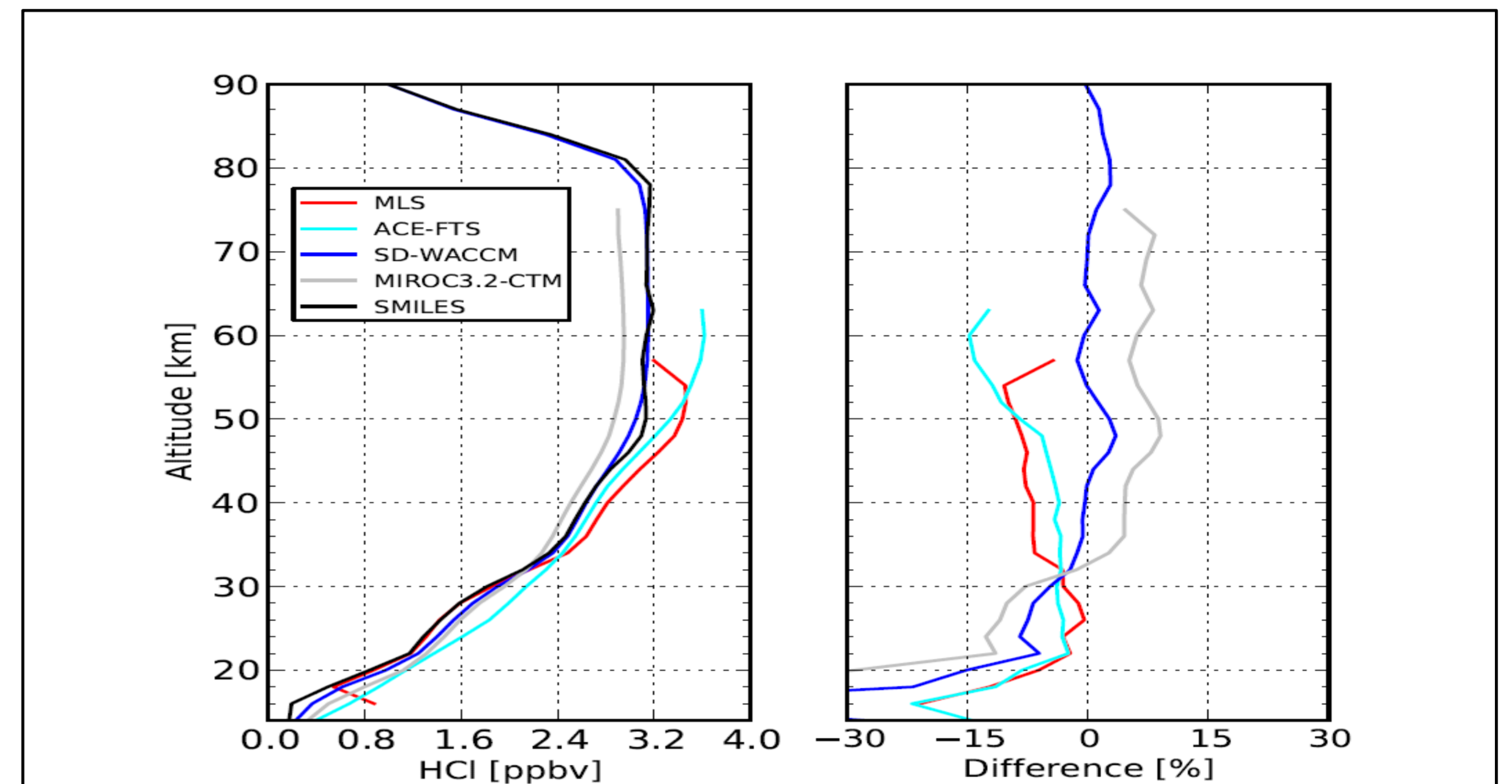


Fig. 2. Statistical summary of coincidence events between SMILES ozone data and other observations and model calculations.

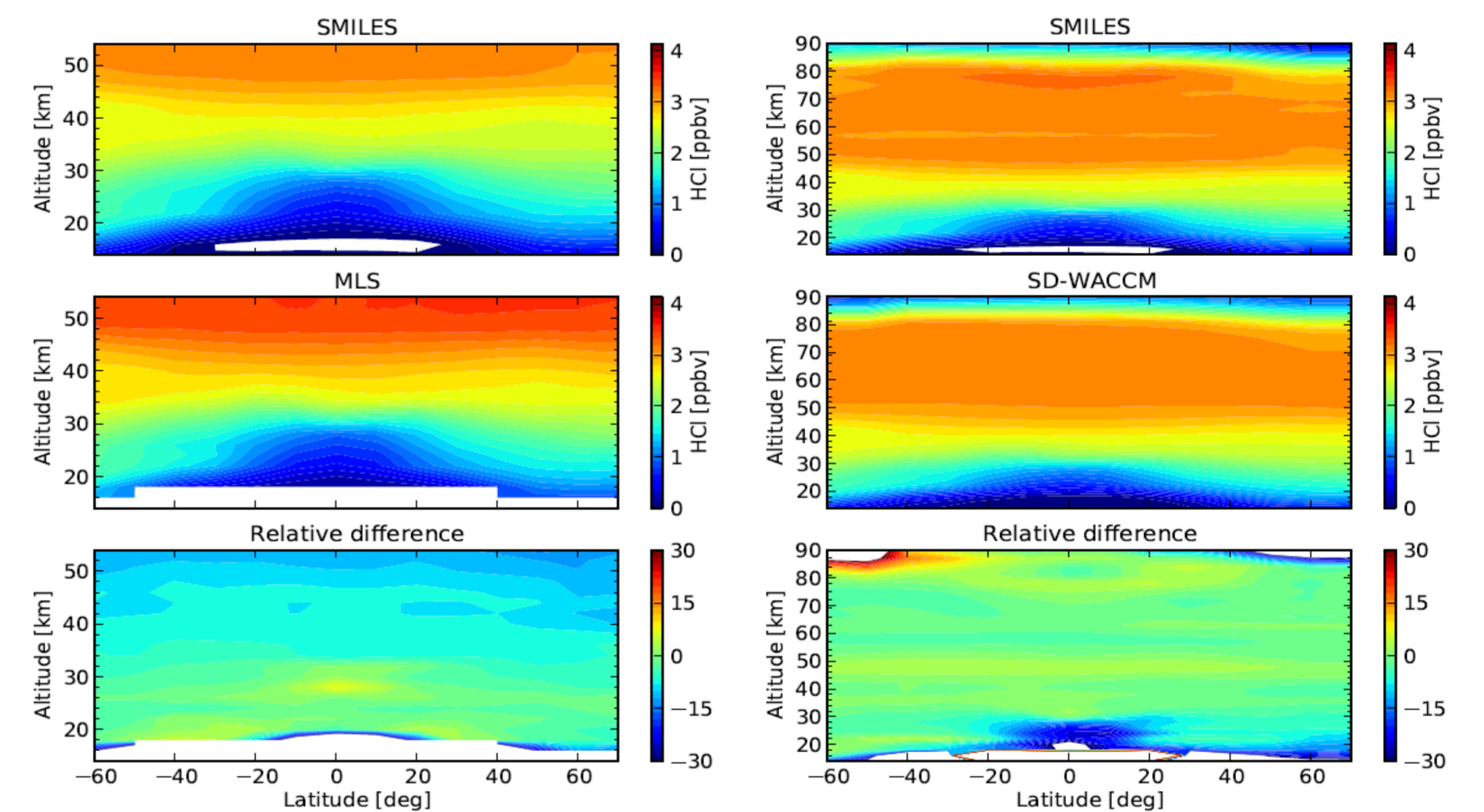


Fig. 3. Contour plots of zonally averaged HCl for (SMILES - MLS) (left) and for (SMILES - WACCM) coincidences (right) for 6-month data; SMILES (top), comparisons (middle), and average relative difference (bottom).

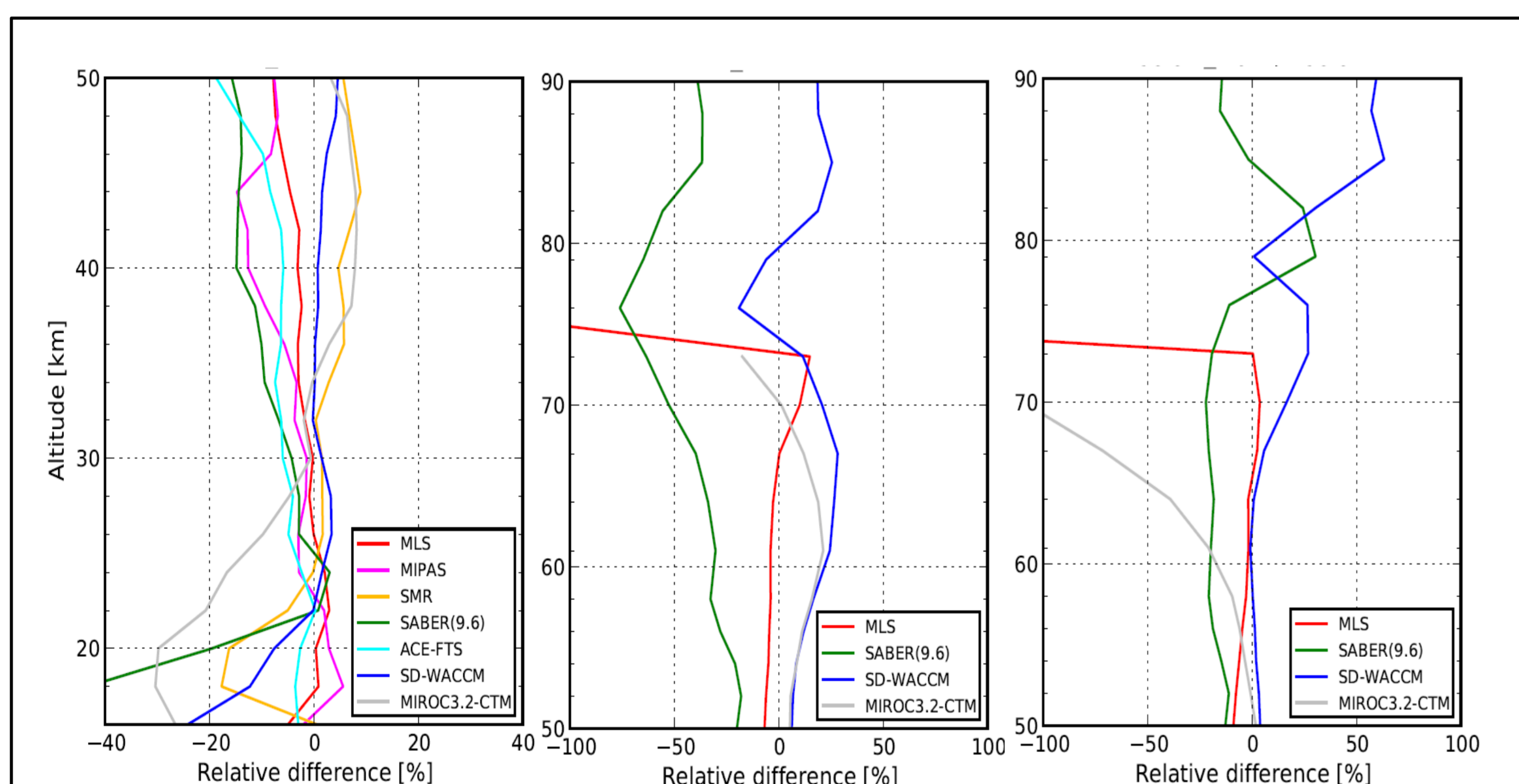


Fig.1. Average relative differences between SMILES and other data sets over all latitude bands in the stratosphere (left), and in the mesosphere for daytime (middle) and nighttime (right).

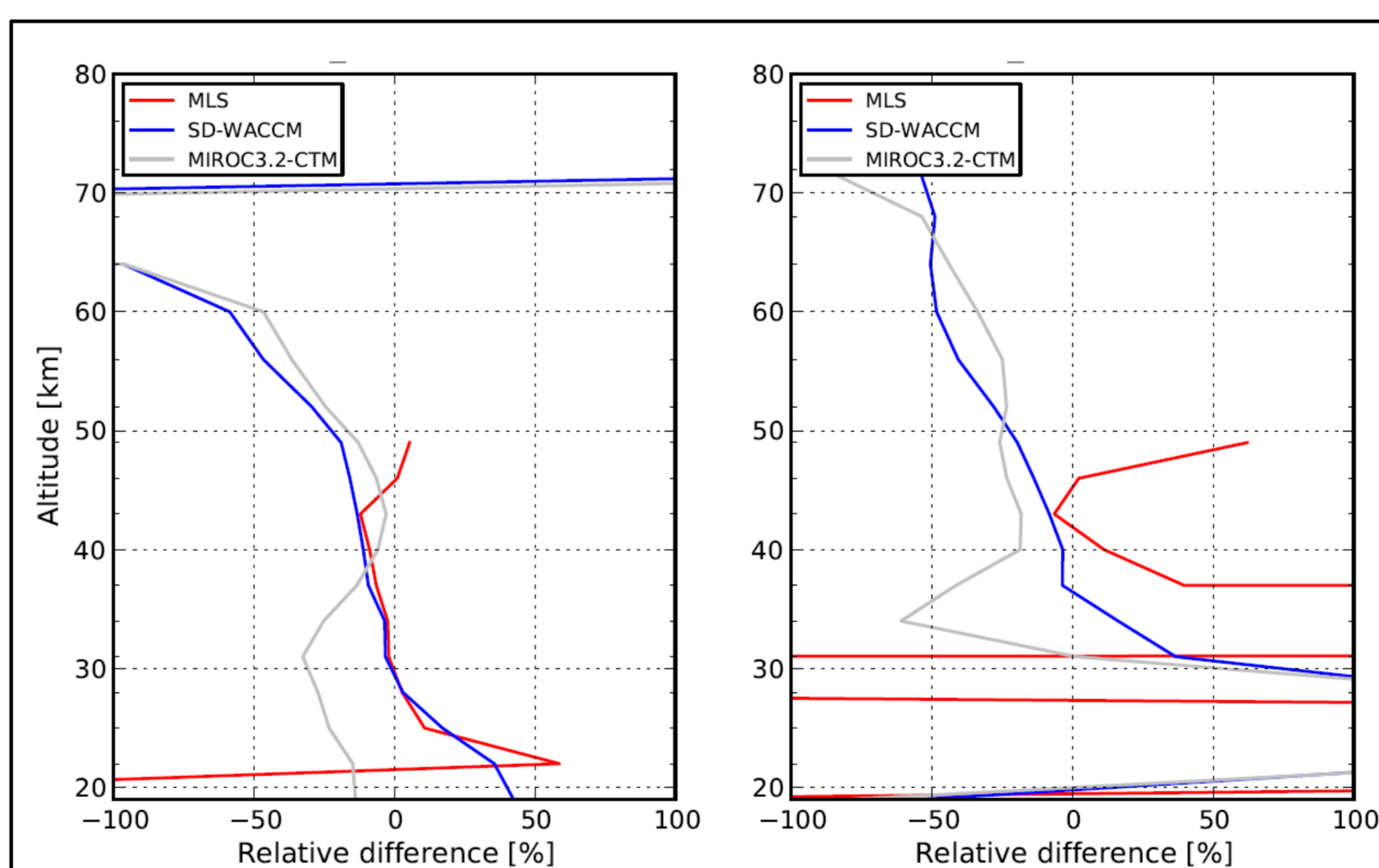


Fig. 4. Average relative differences between SMILES and other data sets over all latitude bands for daytime (left) and nighttime (right).

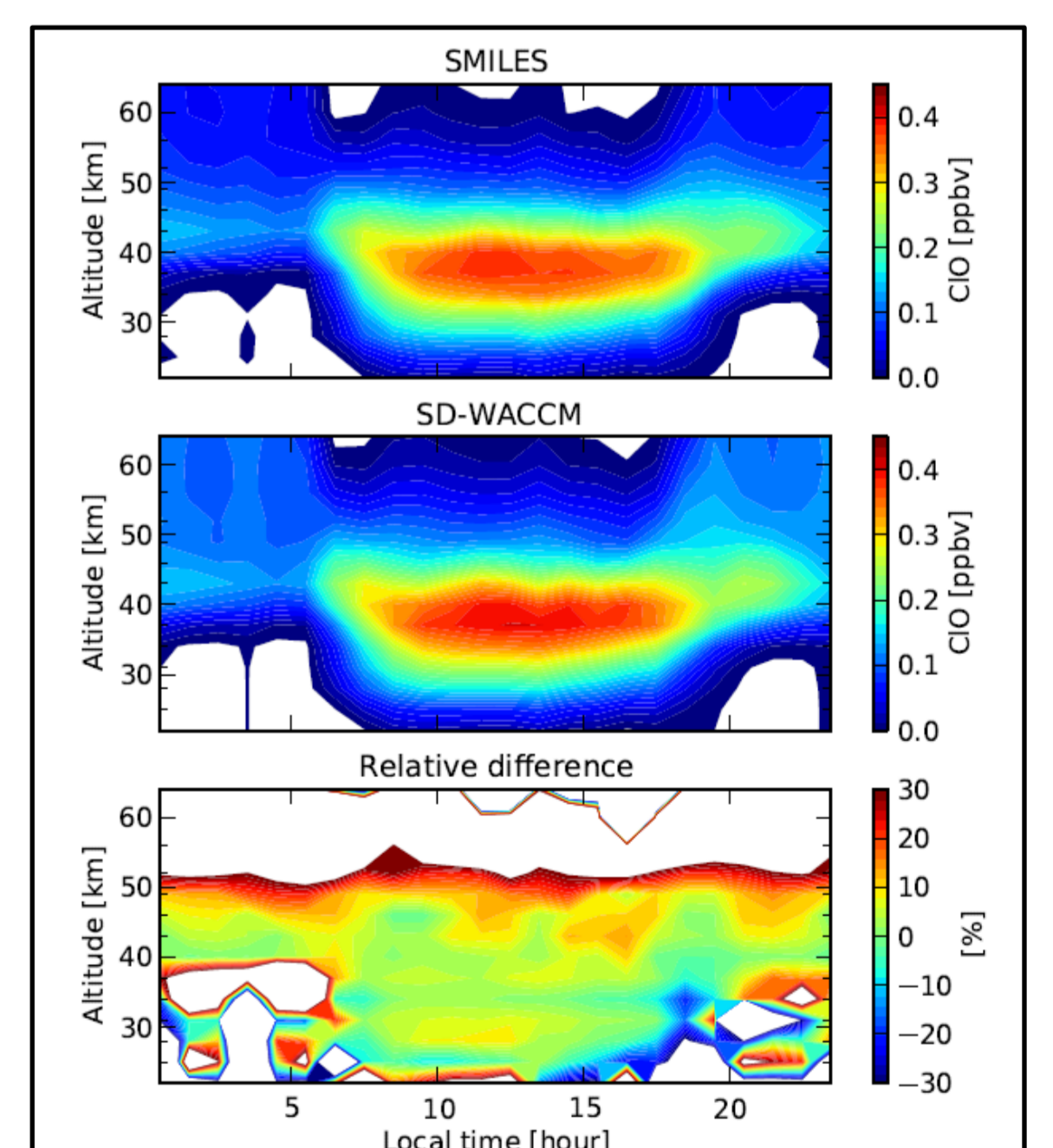


Fig. 5. Contour plots of Local time-height cross-sections: (top) SMILES, (middle) SD-WACCM, and (bottom) relative difference.

Summary

Comparisons of the stratospheric ozone with correlative data show agreements generally within 10%. In the mesosphere, the agreement is also good and better than 50% at 70 km for the daytime and even at 82 km for the nighttime. Agreements for HCl are less than 10% in the altitude range from 20 - 50 km. In the higher altitudes, a small notch is shown in the altitude profile but there is still in excellent agreement with SD-WACCM, and the SMILES HCl shows an almost constant value (about 3.2 ppbv) as theoretically expected. For ClO, good agreements are shown in the altitude range 25 - 60 km for the daytime and 30 - 70 km for the nighttime, and their local time coverage capture the diurnal variability very well.

Published Papers

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