

Recent results from SMILES data

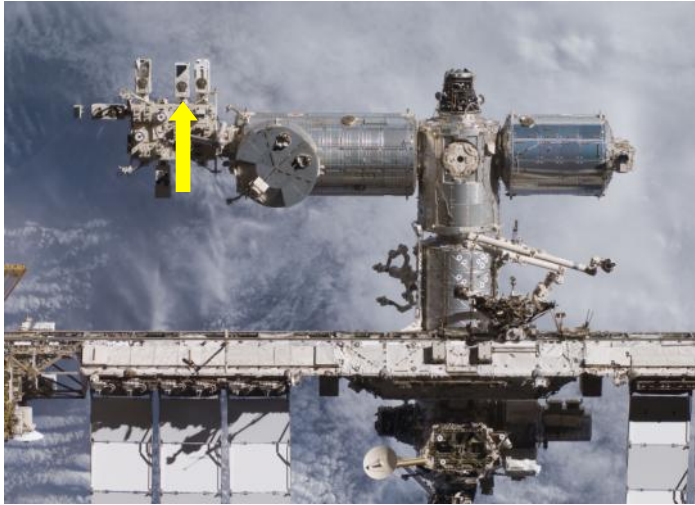
Takashi KOIDE, Takuki SANO (ISAS/
JAXA*)

Masato SHIOTANI (Kyoto University)

** Inst. of Space and Astronautical Science,
Japan Aerospace Exploration Agency*

SMILES mission and status

(SMILES: Superconducting Submillimeter-Wave Limb-Emission Sounder)



Mission objectives

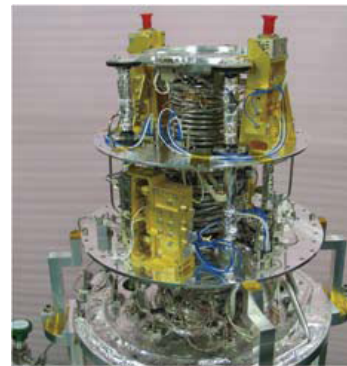
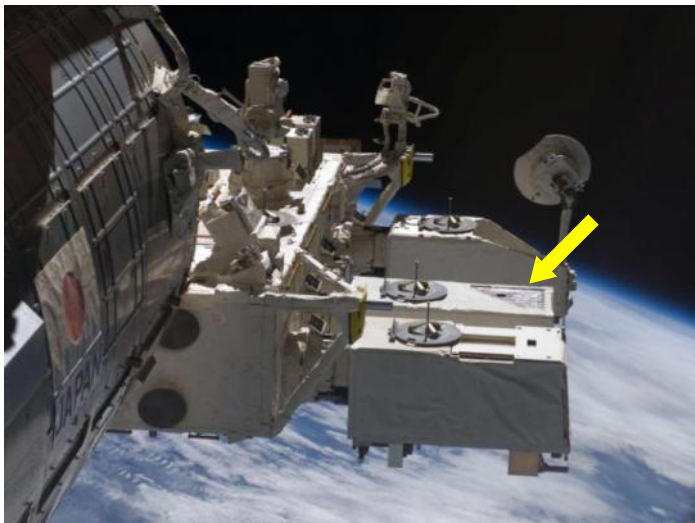
- Demonstration of superconducting mixer and 4-K mechanical cooler
- High-sensitivity observations in the middle atmosphere

Observations

- Latitude 65N to 38S
- Altitude 20km to 120km
- About 1600 observation points per day

Status

- Sep. 11, 2009: SMILES launch (H-II/B rocket)
- Oct. 12: Continuous observations started
- Apr. 21, 2010: Observations suspended
- Jan 19, 2011: JAXA officially announced termination of the normal operation

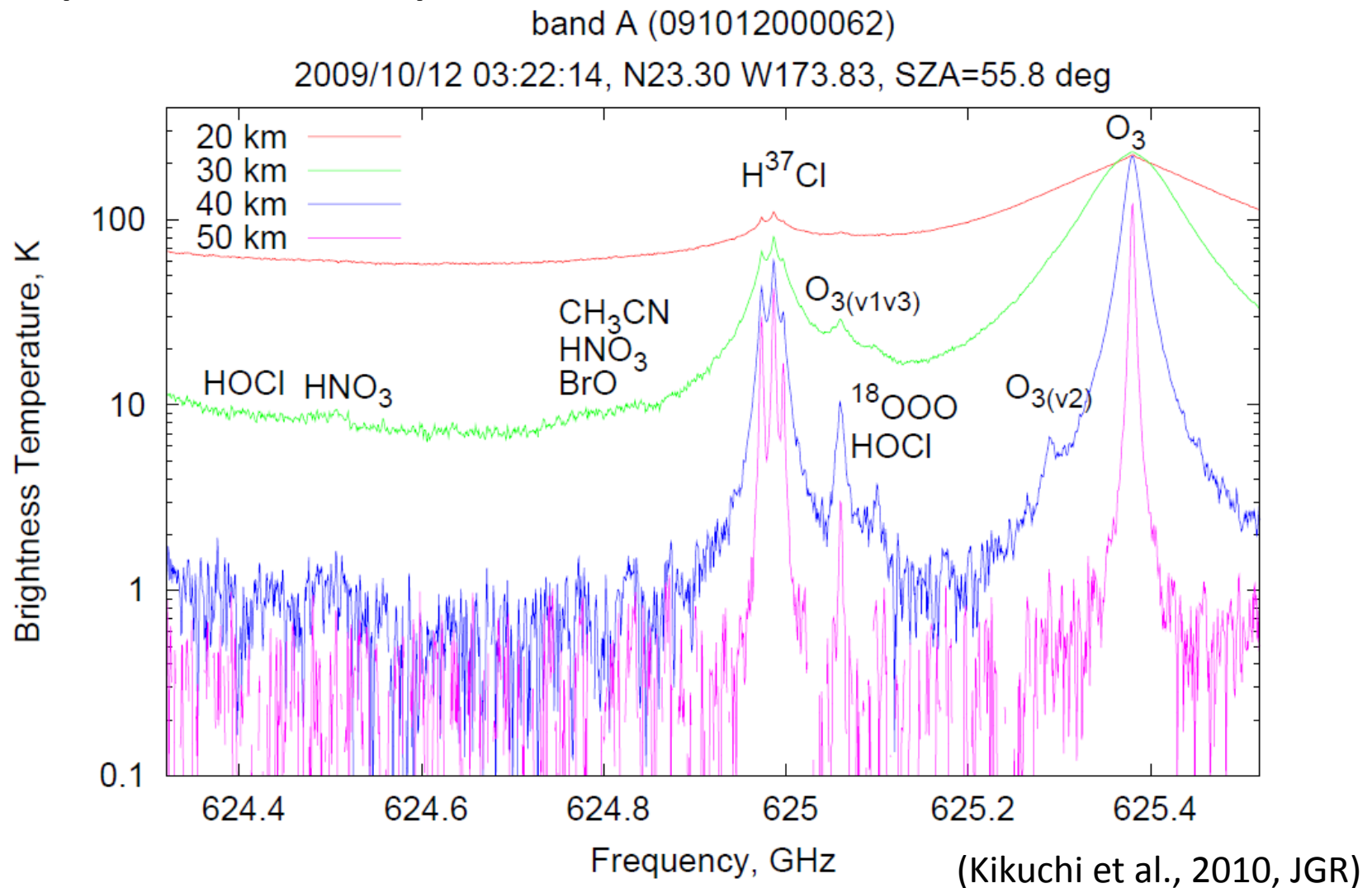


Mechanical Cooler



Detector (SIS mixer)

Sample of **Real** Spectrum in the First Observation



Due to the cooling of the detector, random noise in the spectrum < 1 Kelvin

Major scientific results with SMILES observation data

(1) Diurnal Variation of Stratospheric Ozone

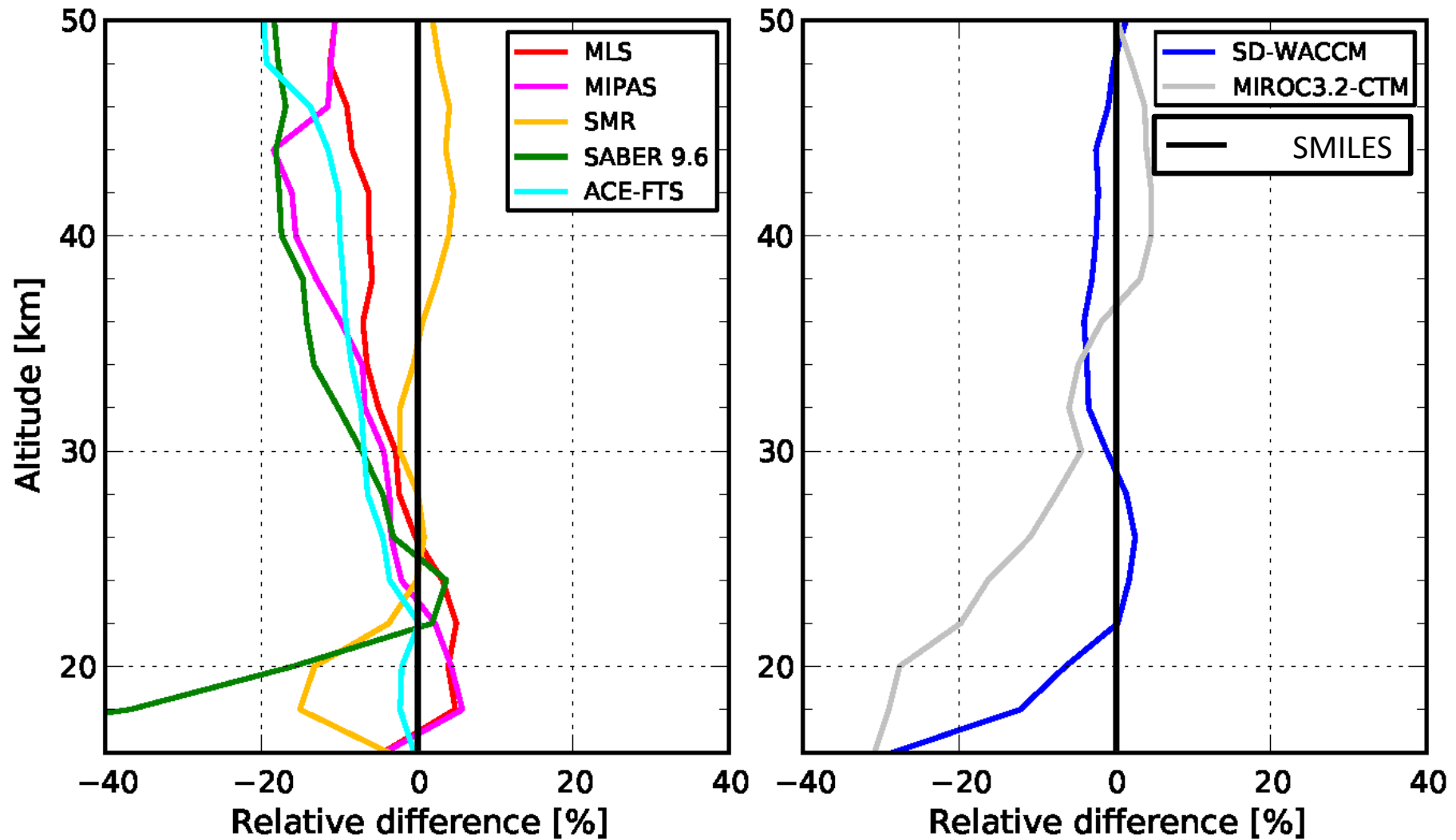
With high sensitivity of SMILES observation data, **this ozone variation has been detected as a first case in the world** (Sakazaki et al., 2013, JGR).

Ground-based observation confirmed the variation. (Parrish et al., 2013, ACPD). Some bias according to observation local time must be considered in the discussion of long-term trend with using several satellite data. (Sakazaki et al., 2014).

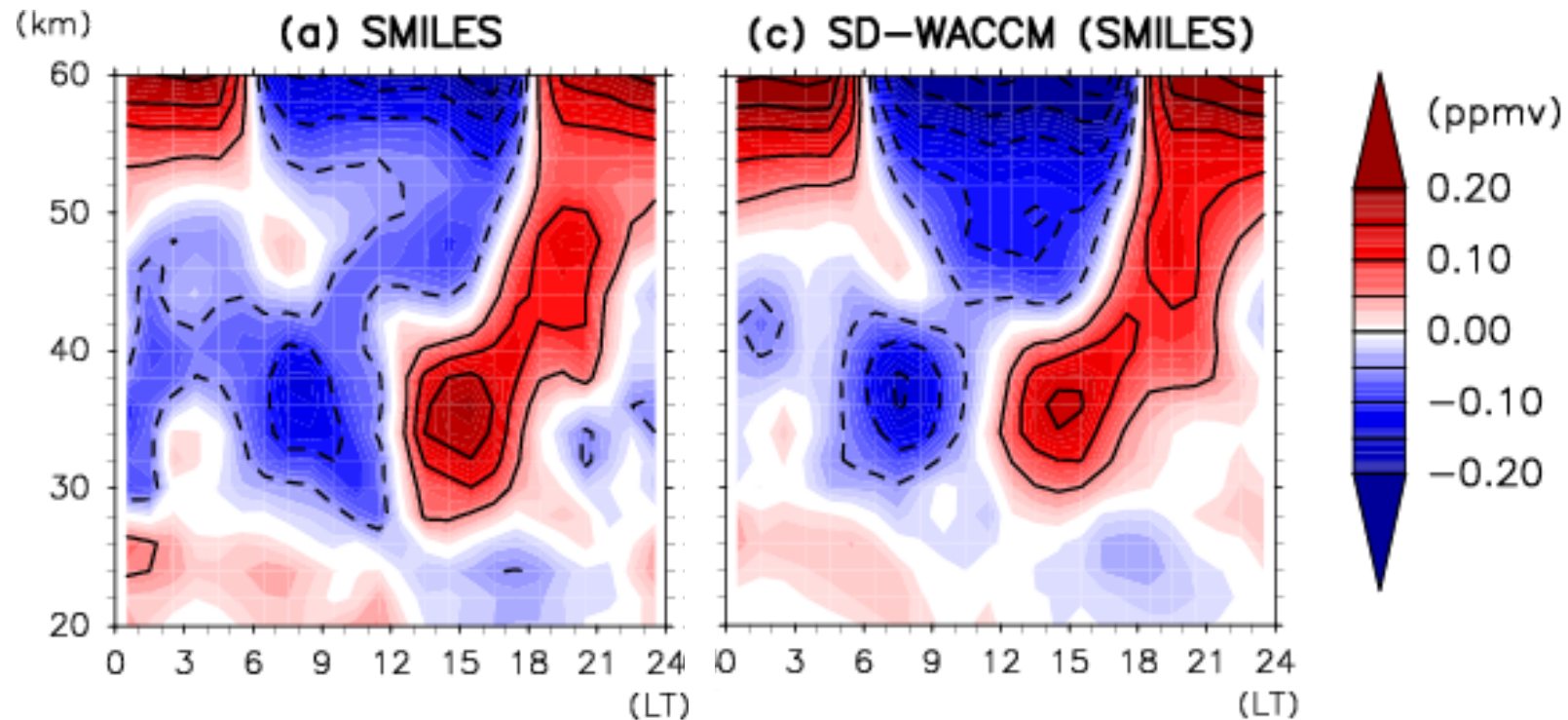
(2) Study for Bias in Ozone sonde Data

Quality of SMILES ozone data is confirmed in comparison and validation with several existing satellite data. (Imai et al., 2013a, JGR; Smith et al., 2013, JGR). Indication of **possible negative bias in ozone sonde according to response time in sonde instrument**, from comparison between SMILES and sonde data. (Imai et al., 2013b, JGR).

Comparisons of ozone with other data (20-50km)



Diurnal variations in ozone



Diurnal amplitude

20–30 km: 0.05 ppmv (1%)

30–40 km: 0.15 ppmv (2-3%)

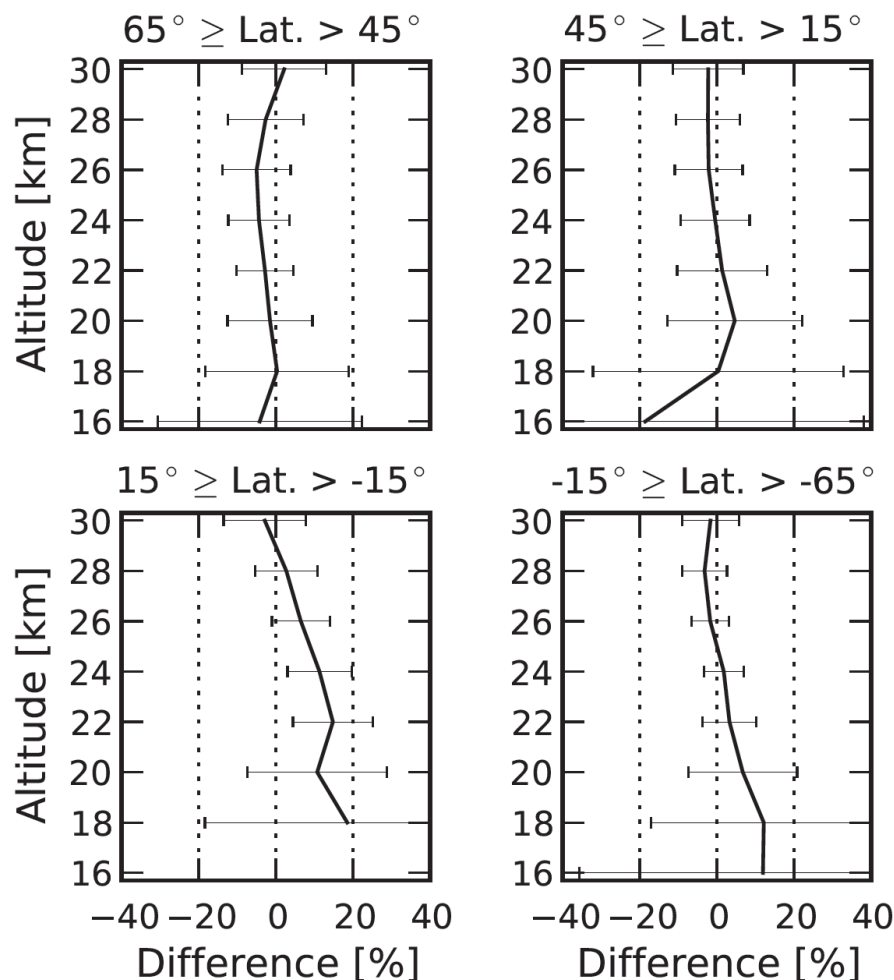
40–50 km: a minimum of 0.1 ppmv (3-4%) at about noon

a maximum of 0.1 ppmv (3-4%) in the late afternoon

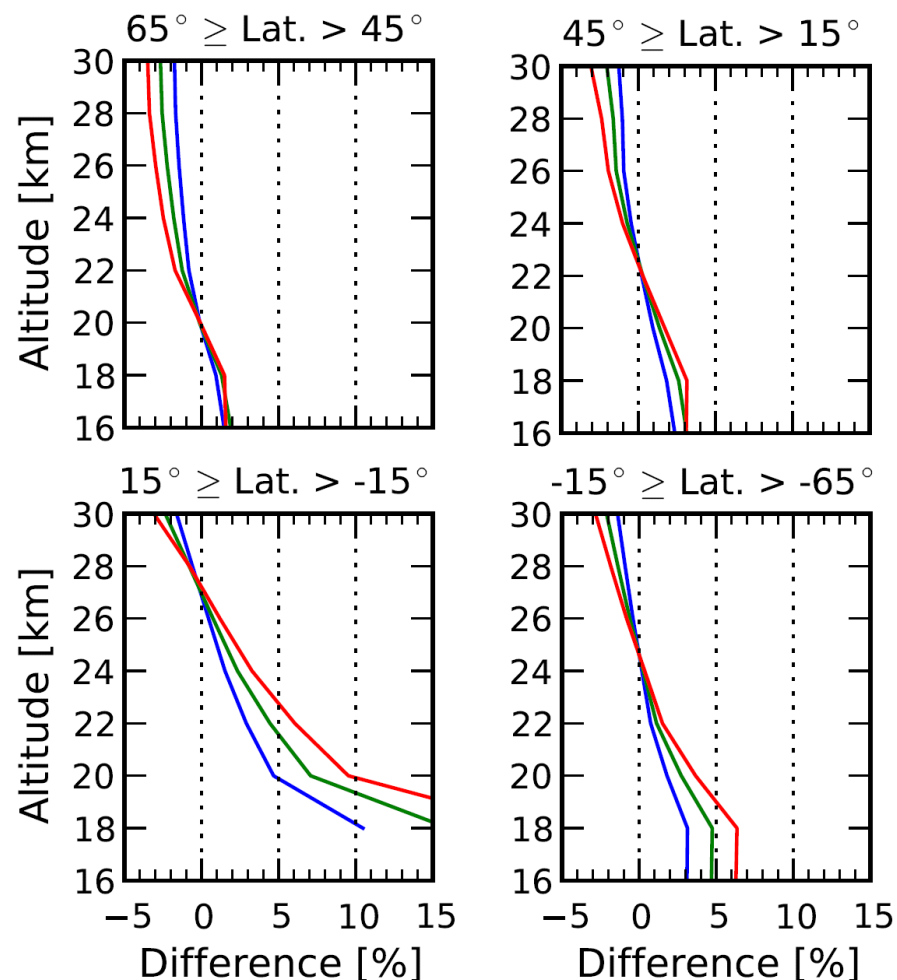
Chemistry climate model nudged with
the global meteorological fields

(Sakazaki et al., 2013, JGR)

Comparison of ozone profiles with ozonesondes



Average relative differences for selected four ozonesonde sites.



Correction amount for the four latitude bands. (20 secs., 30 secs., and 40 secs.)

SMILES Level 2 products

Major Updates:

- v1.0 (005-06-0024): for retrieval test (2010/01/23 released)
- v2.0 (007-08-0300): major update (2011/10/04 released)
- v3.0a (118-12-0603): algorithm modification (2014/02/27 released)

Datasite:

<http://darts.isas.jaxa.jp/iss/smiles/>

- Open to the public – Download available without registration
- Data center in ISAS/JAXA – Suitable for long-term operation and maintenance

SUMMARY

- SMILES made high sensitivity measurements with lower noise than other instruments, and reasonable retrieval results were obtained.
- Ozone diurnal variations are detected even in the mid and lower stratosphere, and are explained by photochemistry and dynamics.
- Nudged chemistry-climate models may have very good capability to represent the space-time structure of minor species.
- We released the SMILES level 2 data to the public as well as science community. (The newest version is v3.0a)

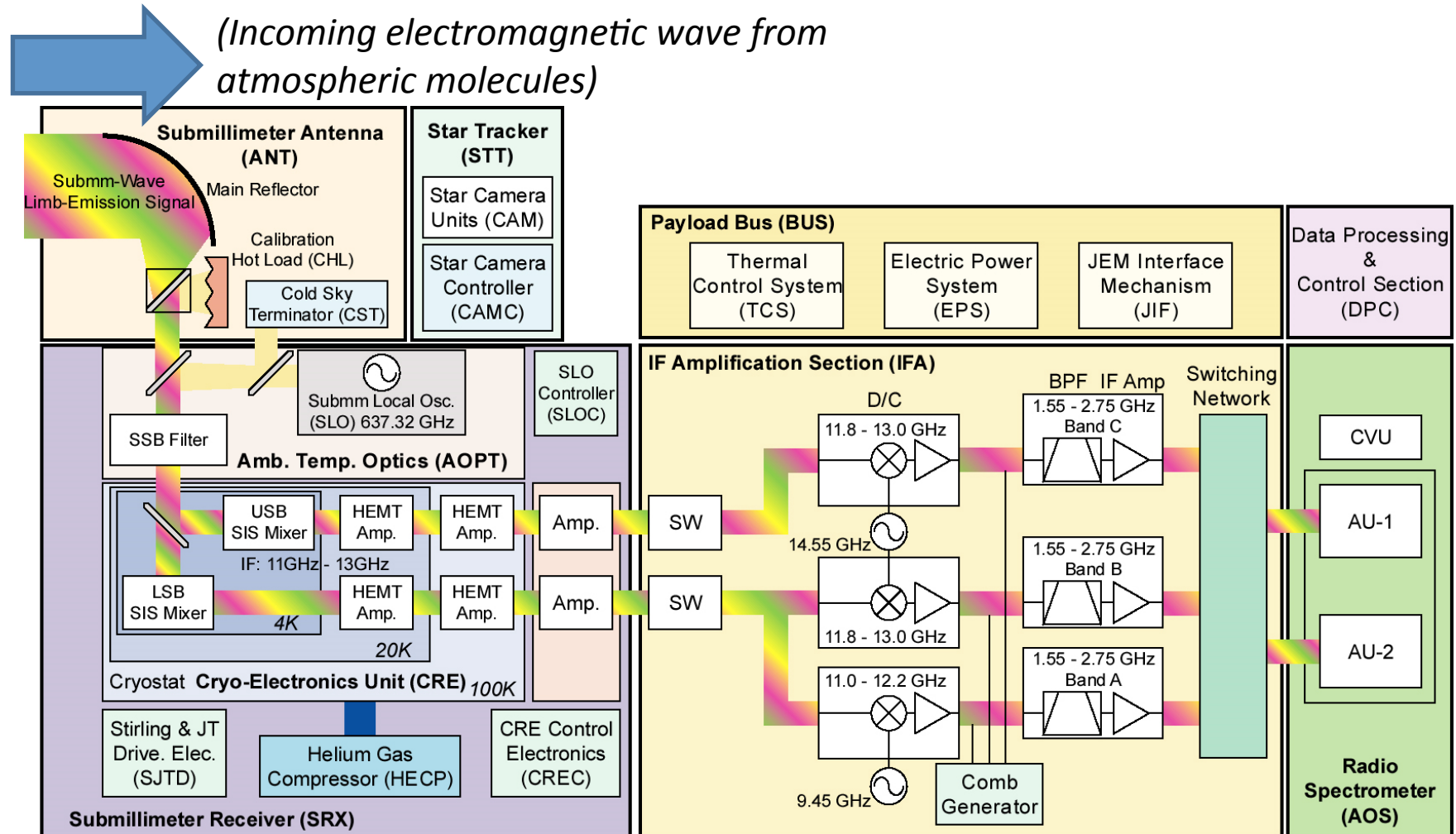
Please visit at the SMILES web page (<http://smiles.tksc.jaxa.jp>)
as well as the data site (<http://darts.isas.jaxa.jp/iss/smiles/>)

Future (Possible) Tasks

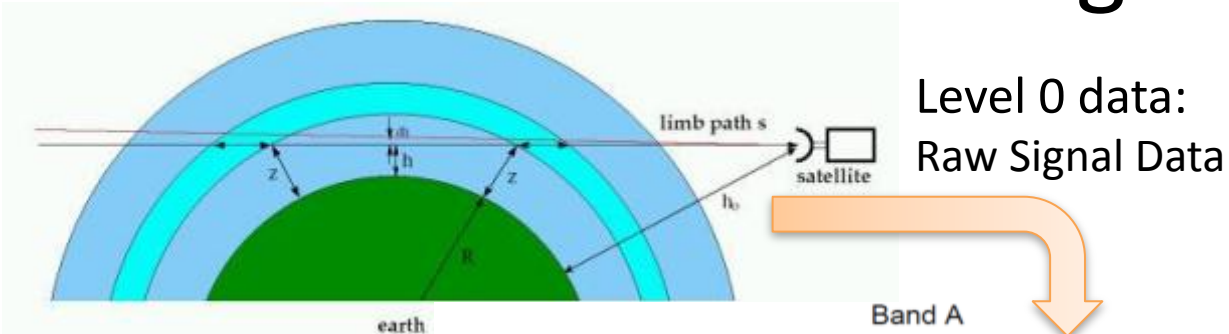
- Comparisons with ground-based observation data rather than ozonesonde (Lidar, Umkehr, ...)
- Collaboration with atmospheric model groups, considering assimilation and so on.

Back-up Slides

Instrument Block Diagram

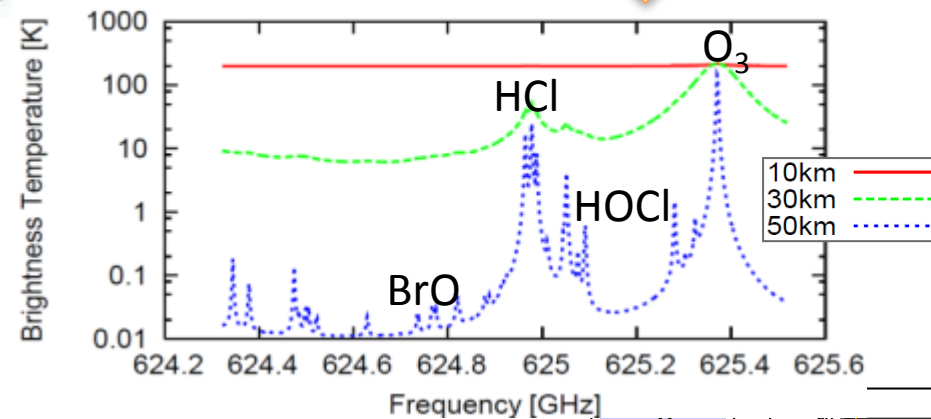


Data Processing Flow

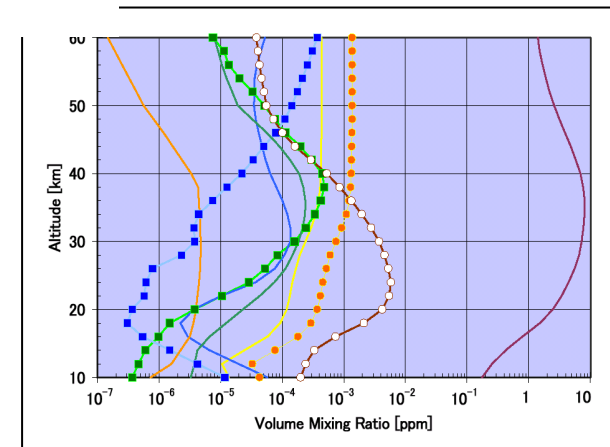
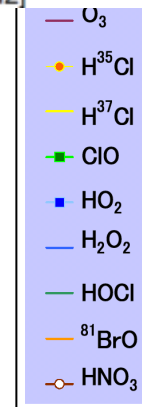


Level 0 data:
Raw Signal Data

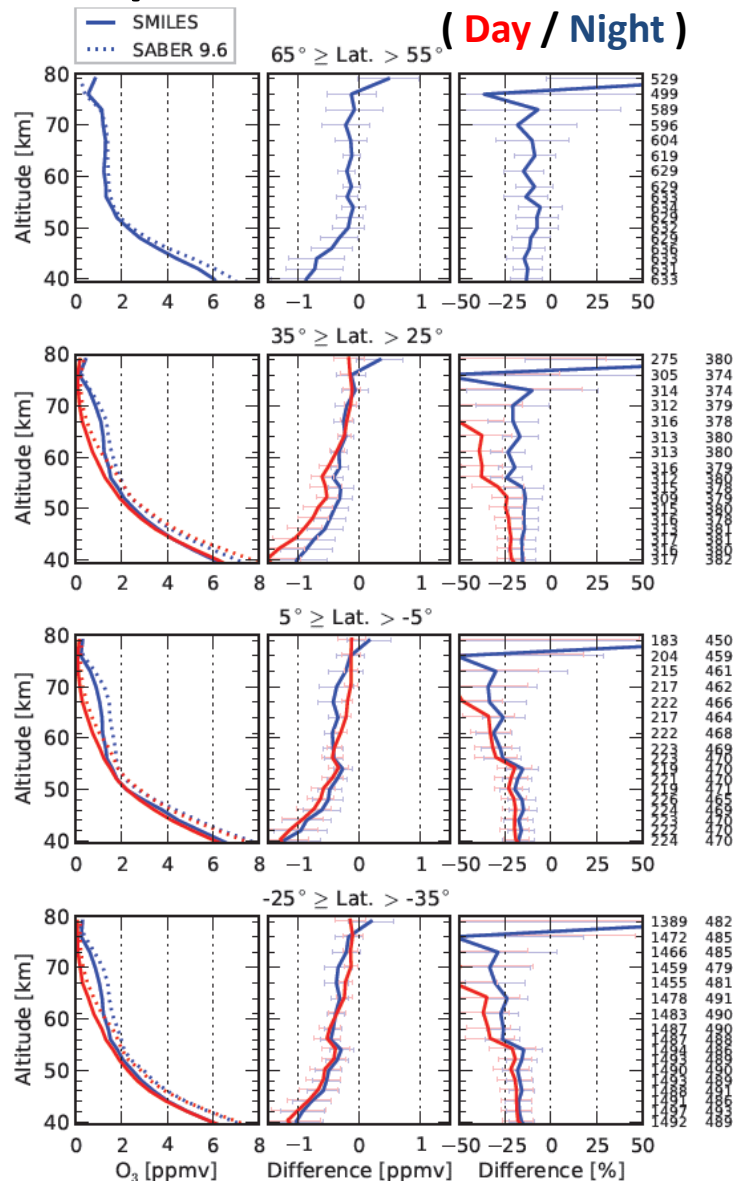
Level 1 data:
Spectrum Data



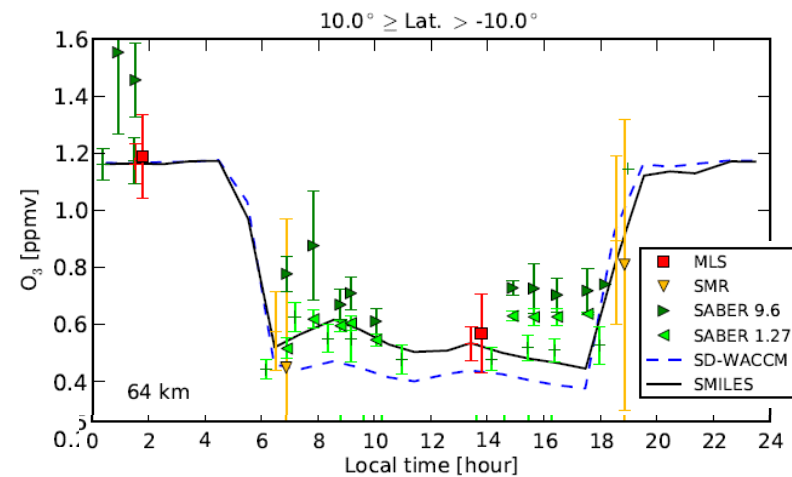
Level 2 data:
Vertical Profile
(O_3 , HCl , ClO , CH_3CN , O_3 isotopes,
 $HOCl$, HNO_3 , HO_2 , BrO)



Comparisons in the mesosphere (50-80km)



← Comparison with SMILES and SABER (onboard TIMED satellite)



SMILES can detect diurnal variations, according to observations at various local time.

References

(1) Diurnal Variation of Stratospheric Ozone

- Sakazaki et al., “Diurnal ozone variations in the stratosphere revealed in observations from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) on board the International Space Station (ISS)”, JGR Atmosphere, doi: 10.1002/jgrd.50220
- Parrish et al., “Diurnal variations of stratospheric ozone measured by ground-based microwave remote sensing at the Mauna Loa NDACC site: measurement validation and GEOSCCM model comparison”, ACPD, doi:10.5194/acpd-13-31855-2013
- Sakazaki et al., “Sunset–Sunrise Difference in Solar Occultation Ozone Measurements (HALOE, SAGE II, and ACE–FTS) and its Relationship to Tidal Vertical Winds”, in preparation

(2) Study for Bias in Ozonesonde Data

- Imai et al., “Validation of ozone data from the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES)”, JGR Atmosphere, doi: 10.1002/jgrd.50434
- Smith et al., “Satellite Observations of Ozone in the Upper Mesosphere”, J. Geophys. Res. Atmos., doi:10.1002/jgrd.50445
- Imai et al., “Comparison of ozone profiles between Superconducting Submillimeter-Wave Limb-Emission Sounder and worldwide ozonesonde measurements”, JGR Atmosphere, doi: 10.1002/2013JD021094