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

(MIILES: 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-IIB rocket)
- Oct. 12: Continuous observations started
- Apr. 21, 2010: Observations suspended
- Jan 19, 2011: JAXA officially announced termination of the normal operation

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Sample of Real Spectrum in the First Observation

band A (091012000062)

2009/10/12 03:22:14, N23.30 W173.83, SZA=55.8 deg

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

(Kikuchi et al., 2010, JGR)
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 Ozonesonde 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 ozonesonde 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)

(Imai et al., 2013a, JGR; modified)
Diurnal variations in ozone

Chemistry climate model nudged with the global meteorological fields

**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

(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.)  
(Imai et al., 2013b, JGR)
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
(Incoming electromagnetic wave from atmospheric molecules)
Data Processing Flow

Level 0 data: Raw Signal Data

Level 1 data: Spectrum Data

Level 2 data: Vertical Profile
(O\(_3\), HCl, ClO, CH\(_3\)CN, O\(_3\) isotopes, HOCl, HNO\(_3\), HO\(_2\), BrO)
Comparisons in the mesosphere (50-80km)

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

(1) **Diurnal Variation of Stratospheric Ozone**
- 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

(2) **Study for Bias in Ozoneonde Data**