Validation of the version 4.5 MAESTRO ozone and NO_2 measurements

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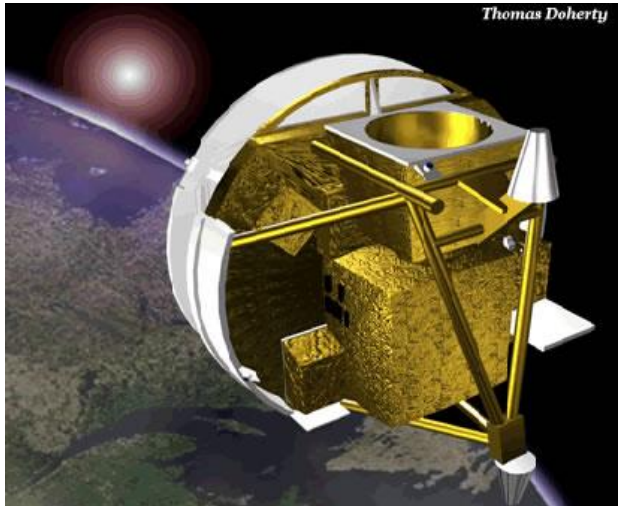
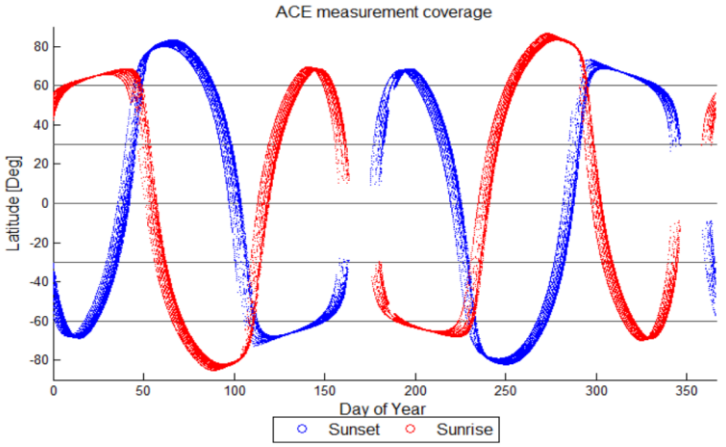
Atmospheric Chemistry Experiment

The ACE mission aboard the Canadian SCISAT satellite was launched August 2003 into a circular low-Earth orbit (74° inclination, 650 km altitude).



Two instruments are aboard SCISAT:

- Atmospheric Chemistry Experiment – Fourier Transform Spectrometer (ACE-FTS)
- Measurement of Aerosol Extinction in the Stratosphere and Troposphere Retrieved by Occultation (MAESTRO)



MAESTRO – Instrument

The MAESTRO instrument:

- Composed of a pair of UV-Vis grating spectrometers.
- Employs the solar occultation technique to make measurements.
- Records spectra in the 285 – 1030 nm region with 1 – 2 nm resolution.
- Possesses a 1.2 km vertical FOV on the limb, with a 1 – 2 km effective vertical resolution.

After 2015, no light with wavelength < 500 nm was transmitted through the instrument. As of late 2023, a recovery to ~20% initial intensities has been observed.

MAESTRO – Version 4.5 Retrieval

The MAESTRO trace gas retrieval is based on a two-step approach:

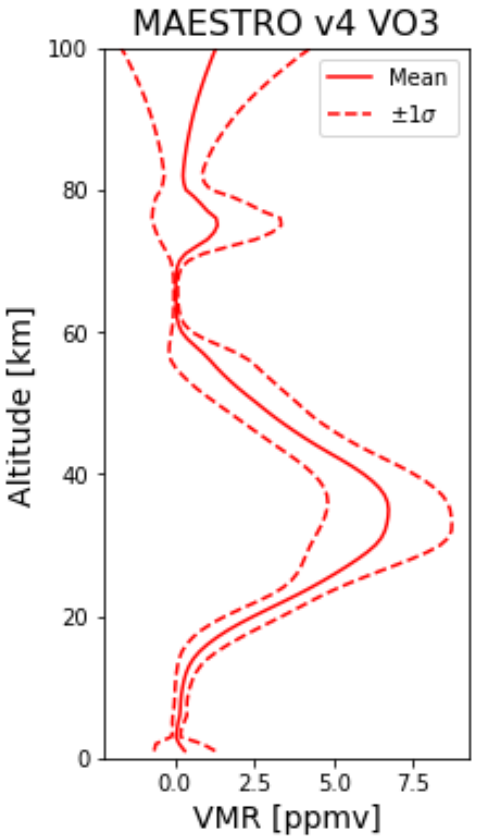
1. A differential optical absorption spectroscopy (DOAS) technique yields line-of-sight column densities.
2. A Twomey-Tikhonov algorithm inverts these to yield VMR profiles.

The retrieval is performed on an altitude grid spanning 5 – 80 km.

The inversion uses the ACE-FTS version 5.2 pressure and temperature profile data as input.

Currently yields a Vis.-ozone, UV-ozone, and NO_2 product.

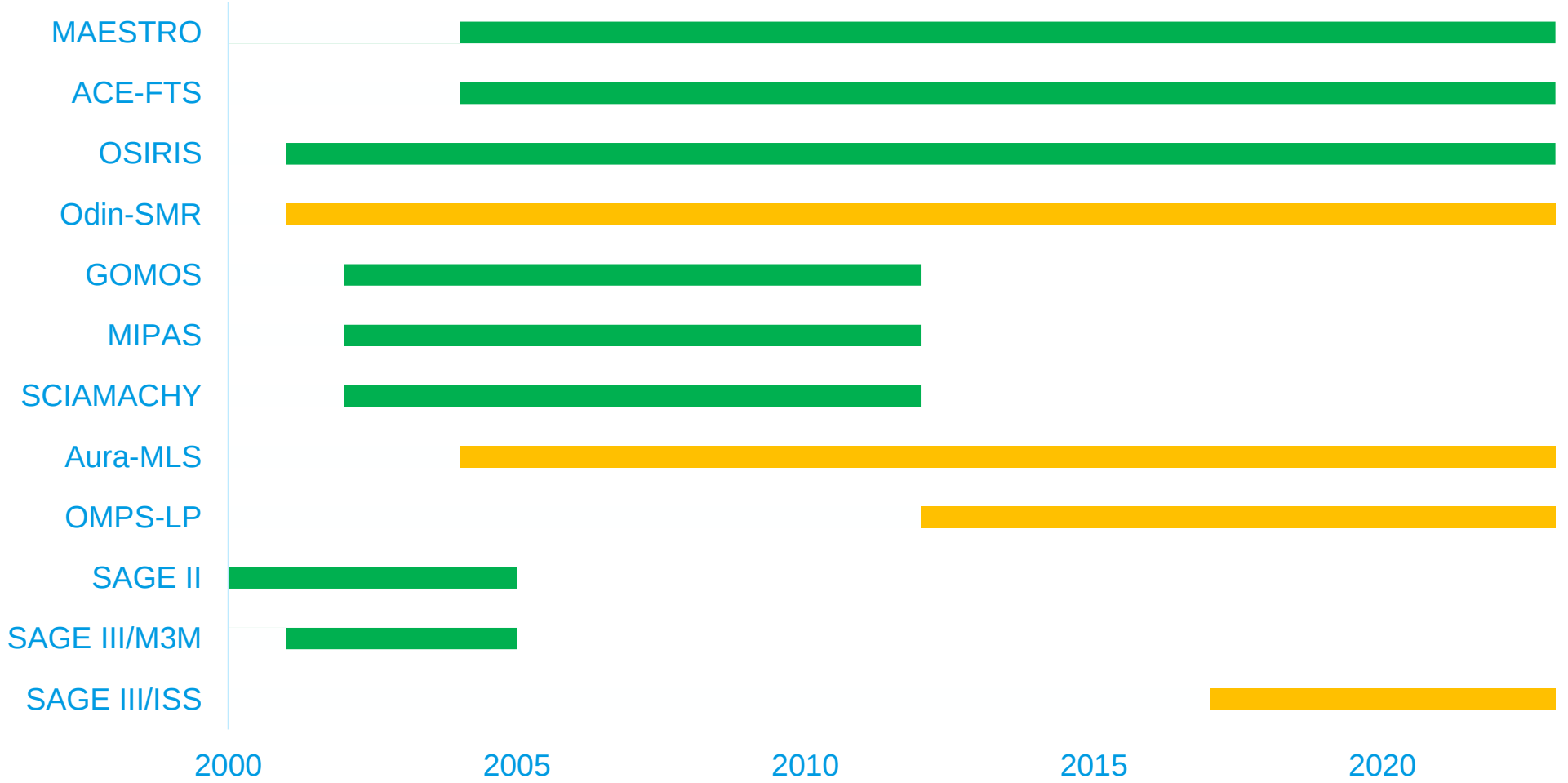
- The UV-ozone is viable until December 2009, and the NO_2 until July 2009.



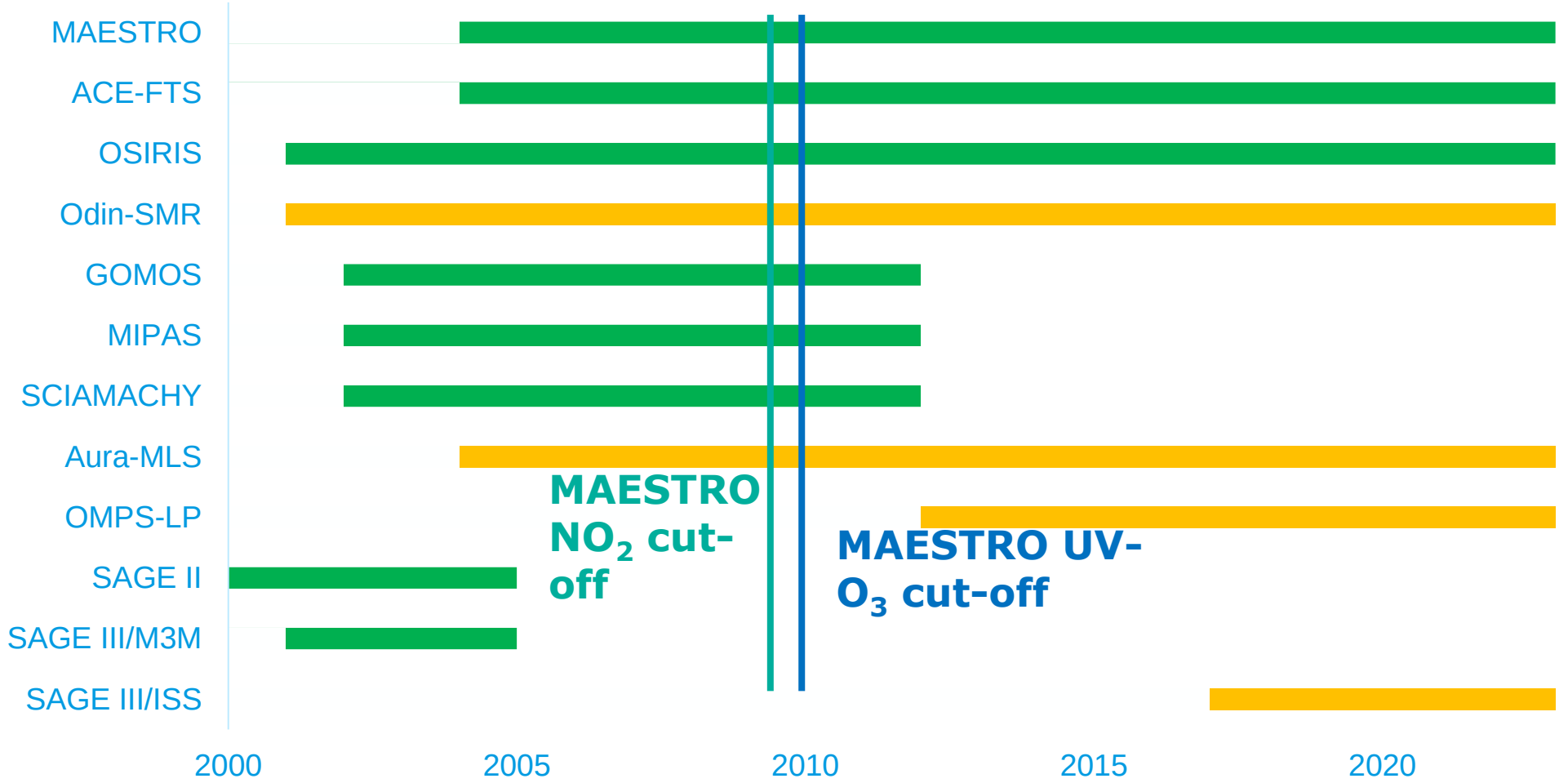
Comparison Instruments

Instrument	Version	Gas species	Measurement period	Observation method
ACE-FTS	4.1/4.2, 5.2	O_3, NO_2	2004 – present	Solar occultation
OSIRIS	7.2	O_3, NO_2	2001 – present	Limb scatter
Odin-SMR	3.0	O_3	2001 – present	Limb emission
GOMOS	IPF 6.01	O_3, NO_2	2002 – 2012	Stellar occultation
MIPAS	IMK-IAA 8_261	O_3, NO_2	2002 – 2012	Limb emission
SCIAMACHY	IUP 3.5	O_3, NO_2	2002 – 2012	Limb scatter
Aura-MLS	5.3	O_3	2004 – present	Limb emission
OMPS-LP	2.6	O_3	2012 – present	Limb scatter
SAGE II	7.0	O_3, NO_2	1984 – 2005	Solar occultation
SAGE III/M3M	4	O_3, NO_2	2001 – 2005	Solar occultation
SAGE III/ISS	5.3	O_3	2017 – present	Solar occultation

Comparison Instruments



Comparison Instruments



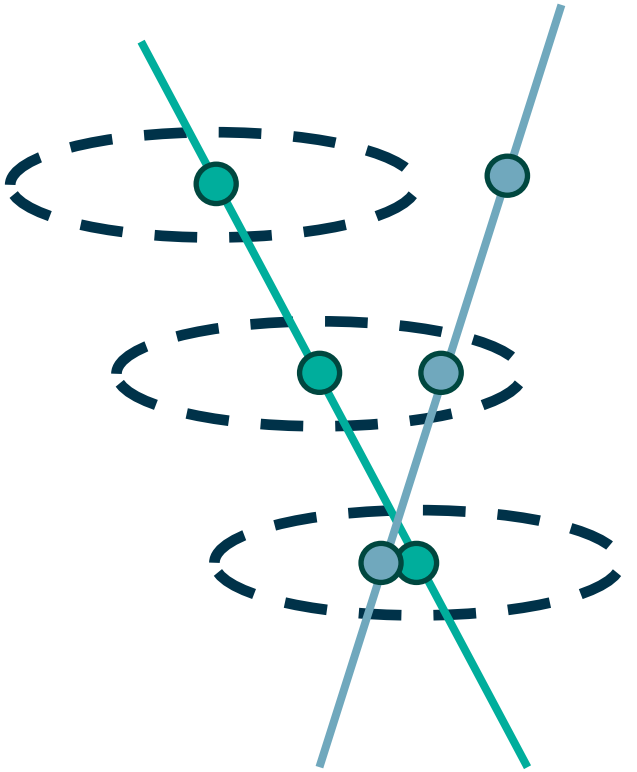
Comparison Methodology

Comparison profiles were linearly interpolated onto a uniform 1 km grid (0 – 100 km).

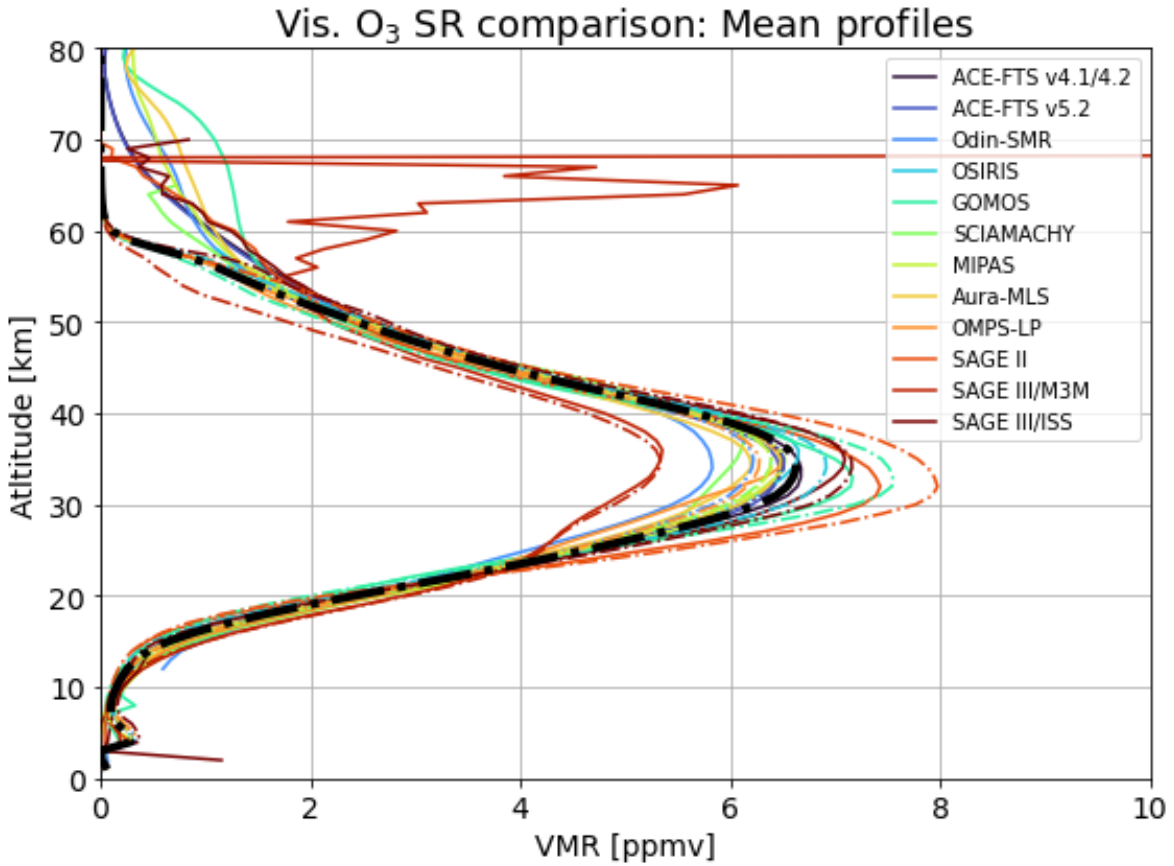
Two coincidence criteria were employed

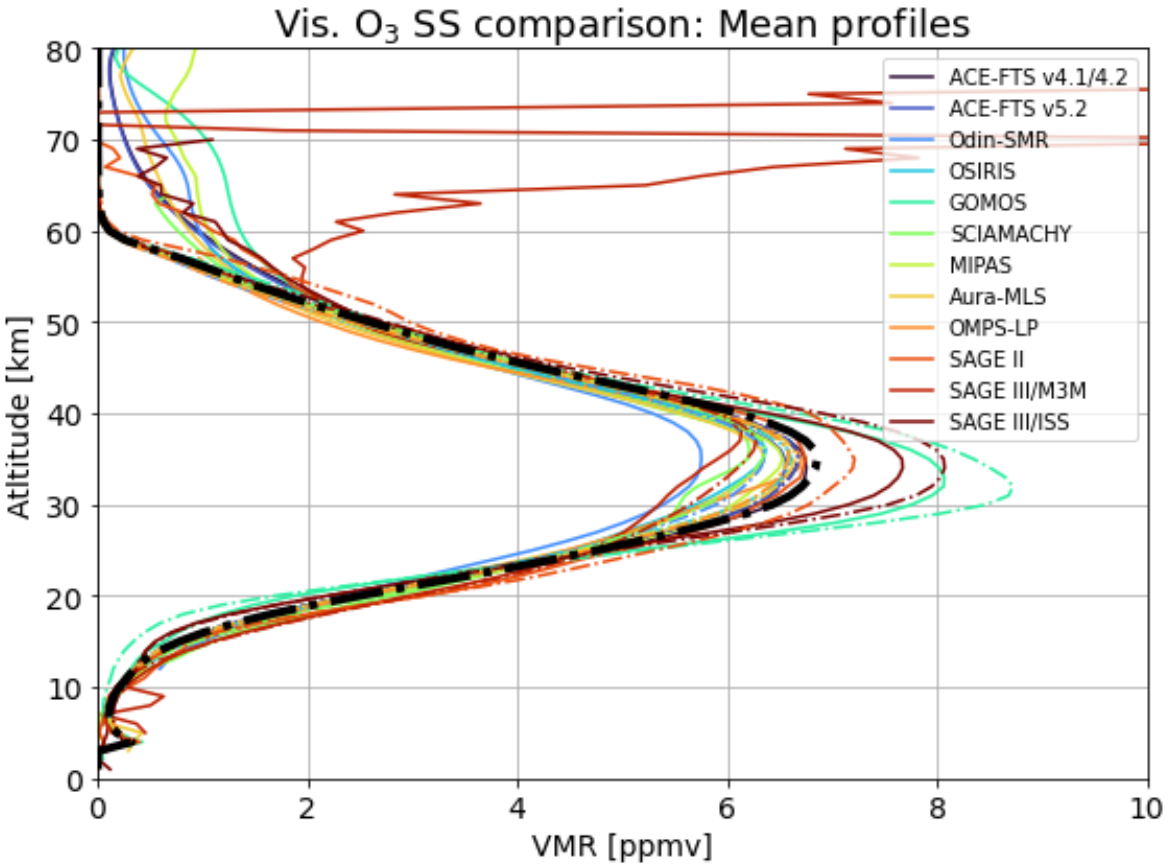
- Temporal: Measurements made within 8 hours
- Spatial: Measurements made within 1000 km.

Diurnal scaling of NO_2 was accomplished using monthly multiyear-mean zonal-mean scaling factors produced by Strode et al. (2022).



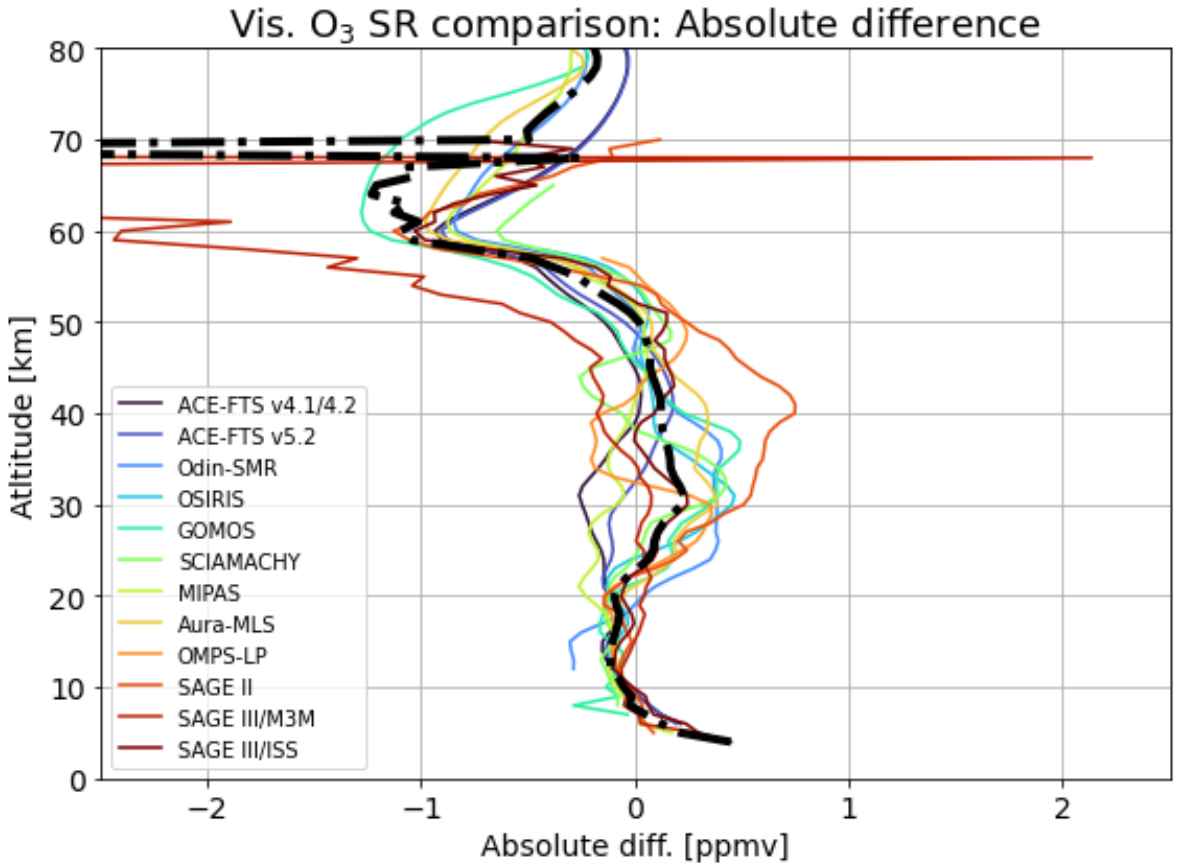
Results – Vis.-ozone

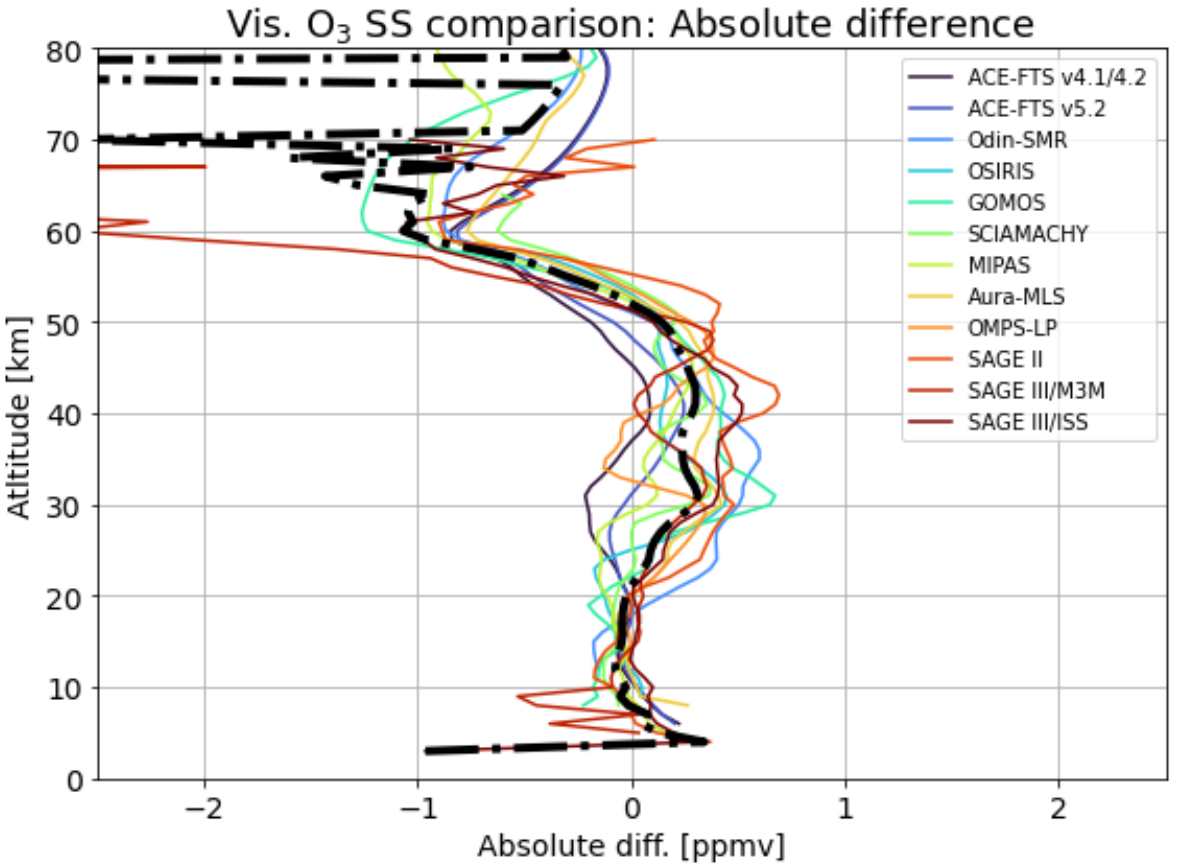




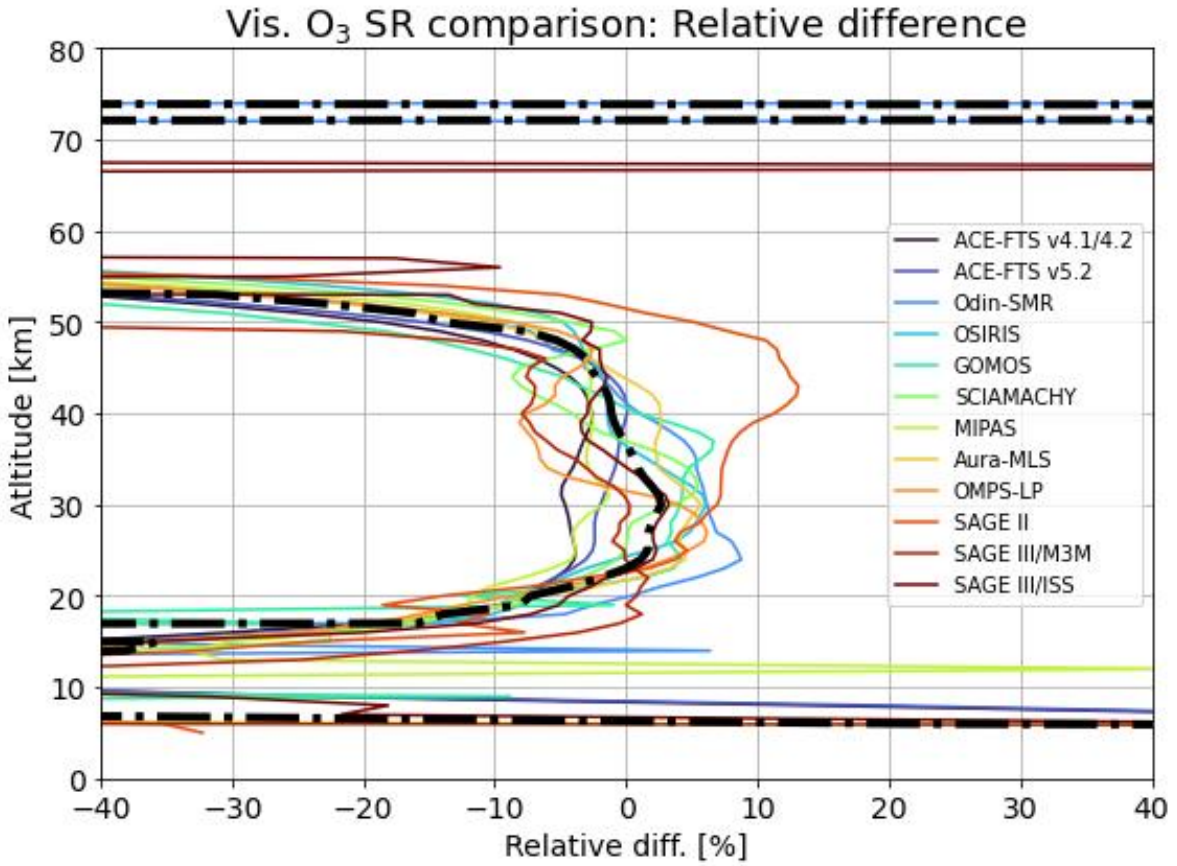
MAESTRO Comparison Instruments

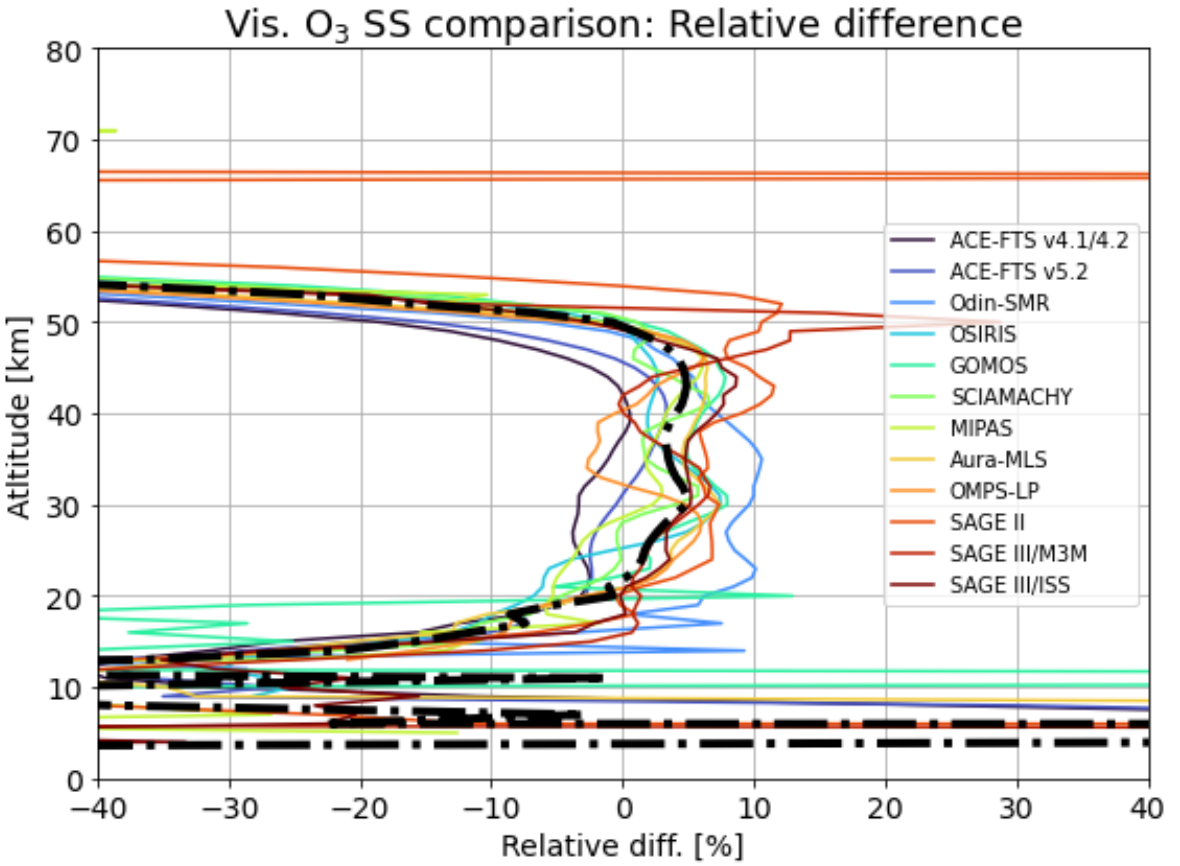
Results – Vis.-ozone





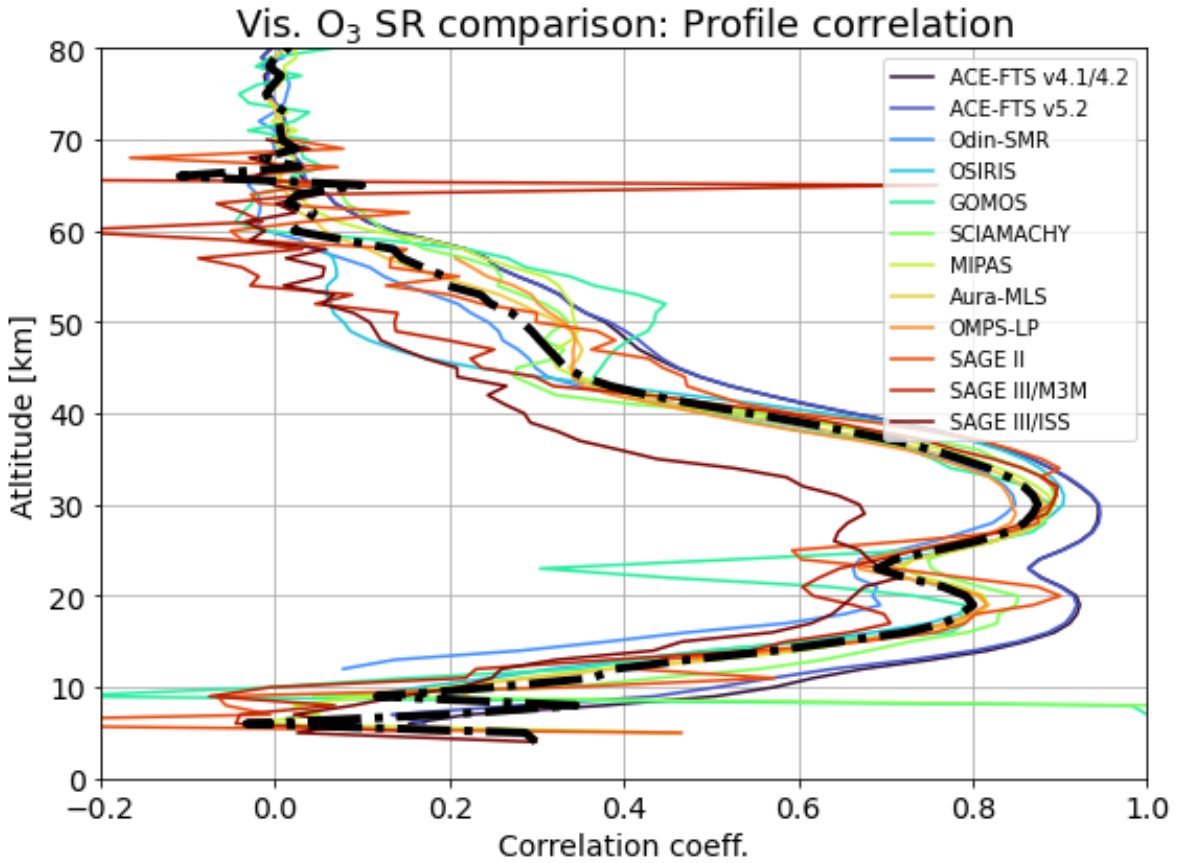
Results – Vis.-ozone

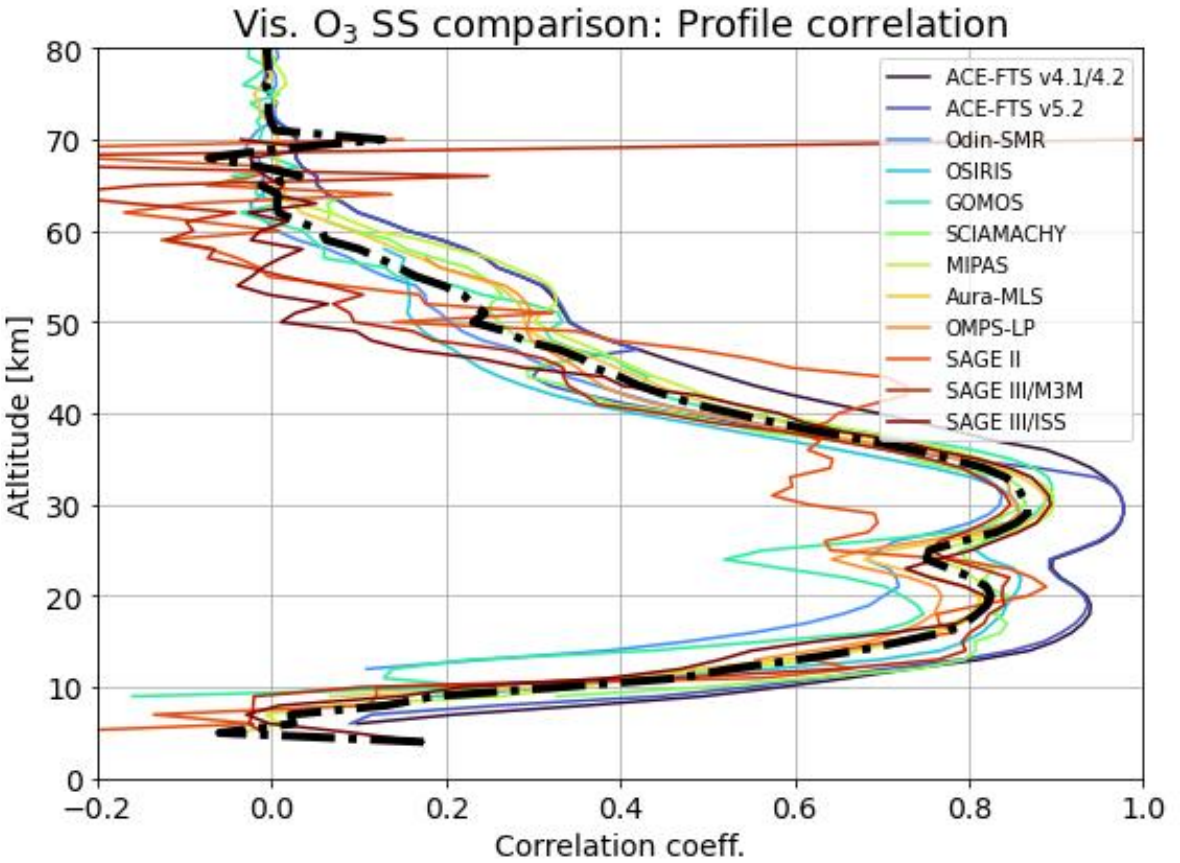




2.3 – 8.2 % (20 – 50 km)

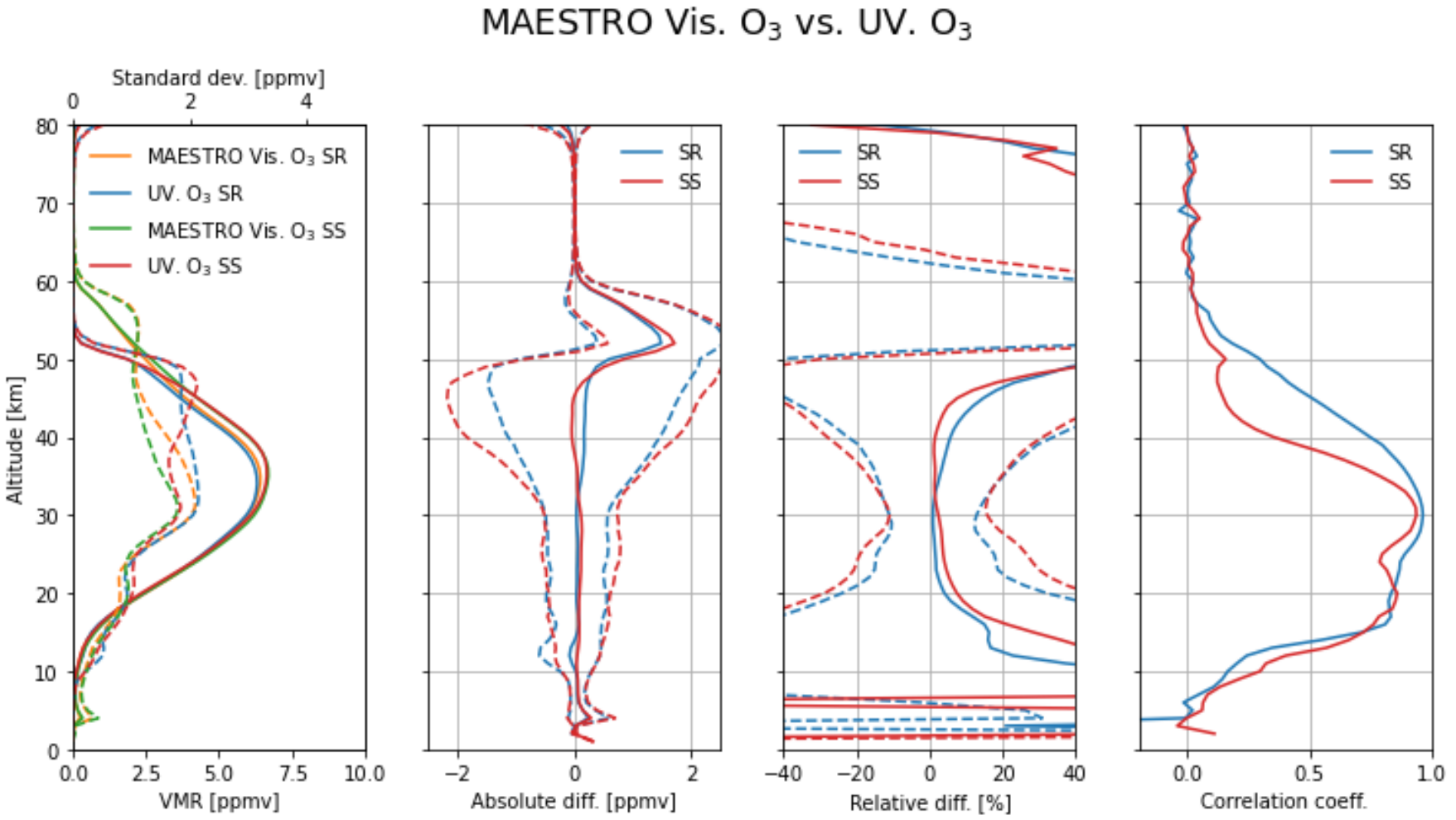
Results – Vis.-ozone



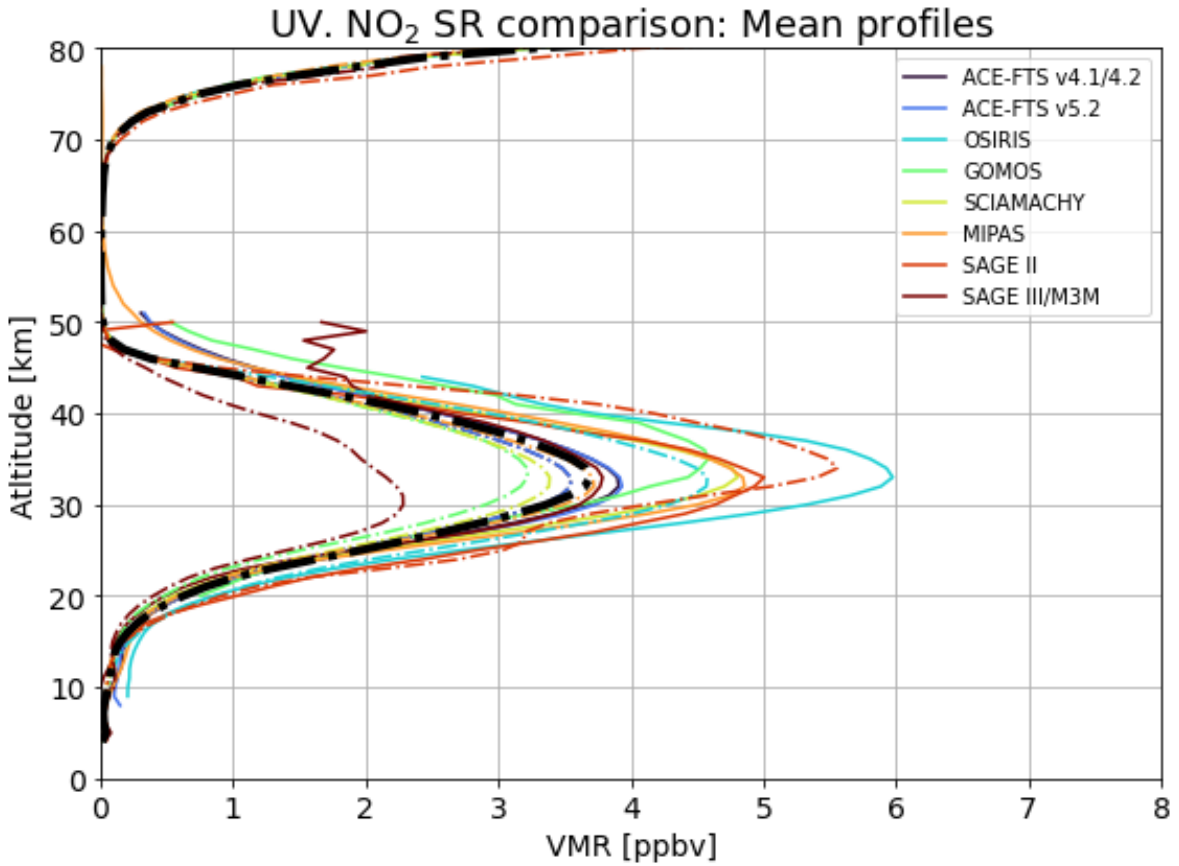


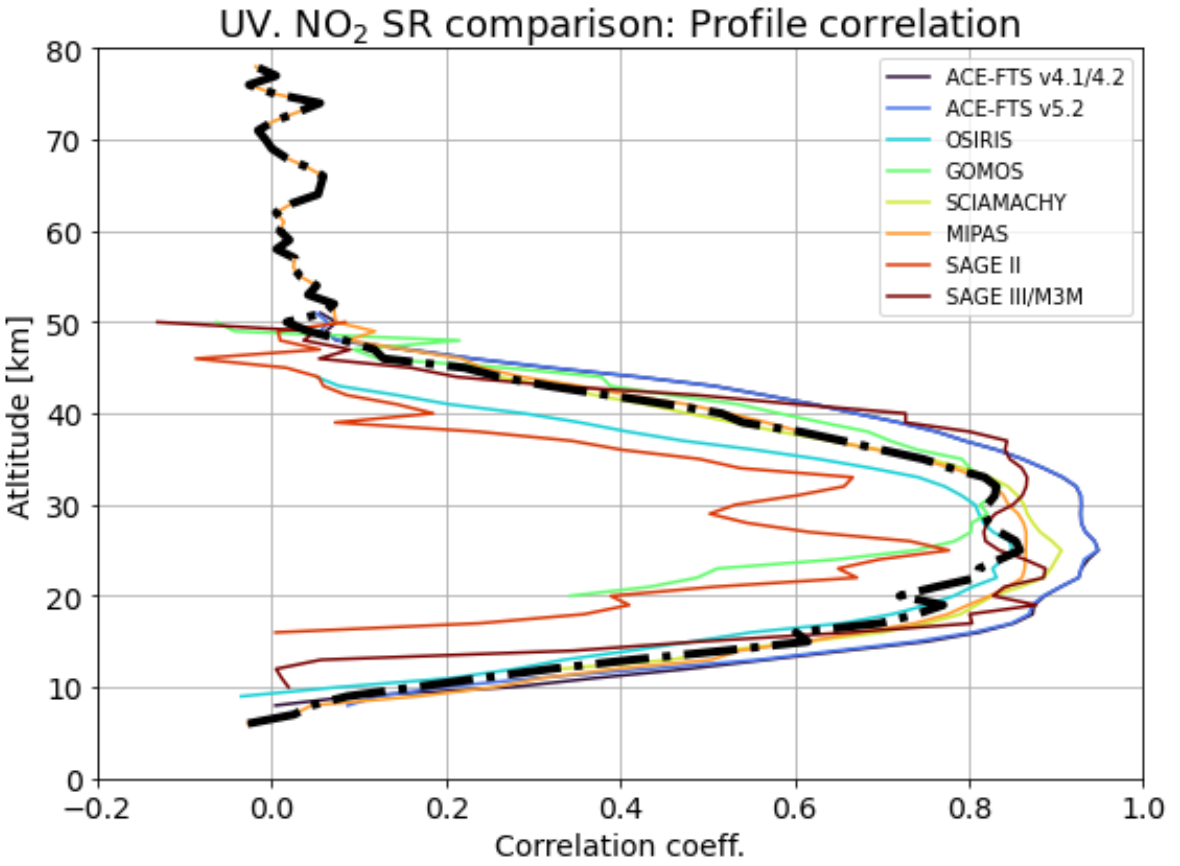
r > 0.70 (15 – 40 km)

Results – UV-ozone



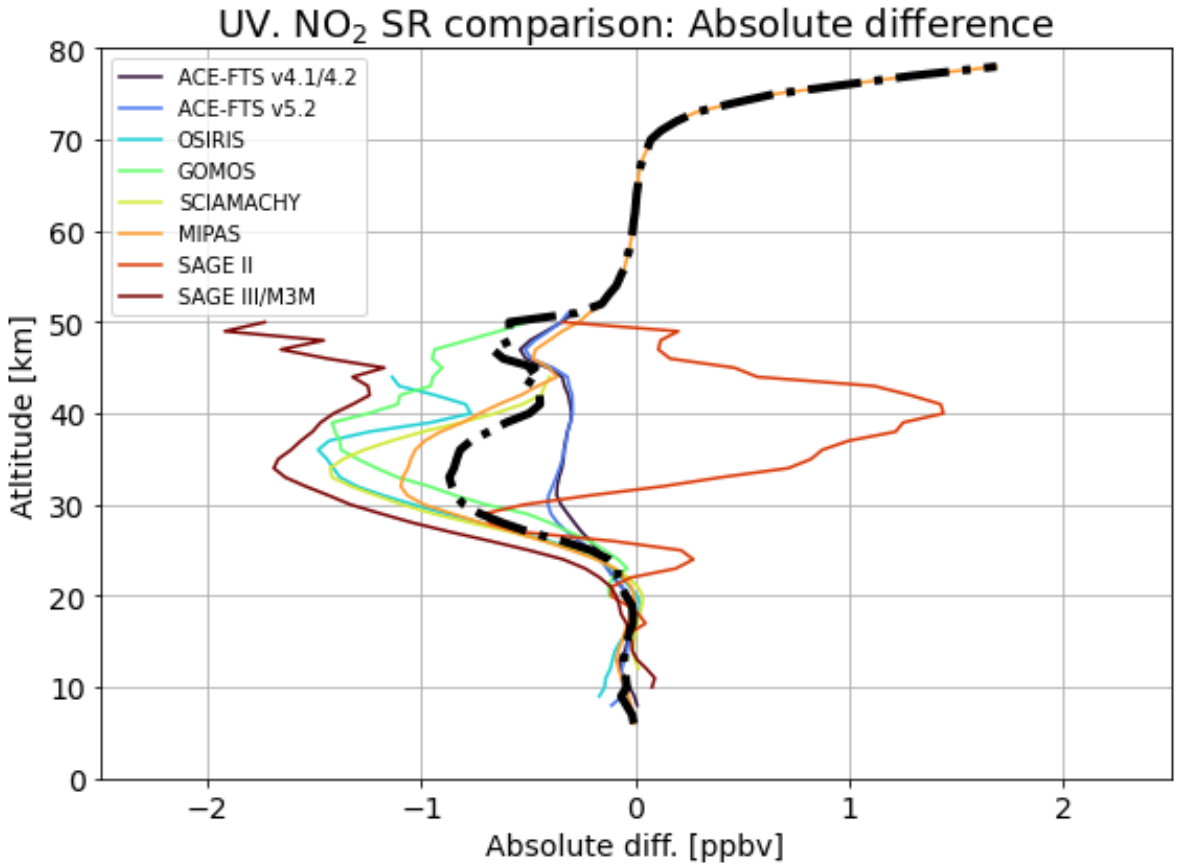
Results – NO_2

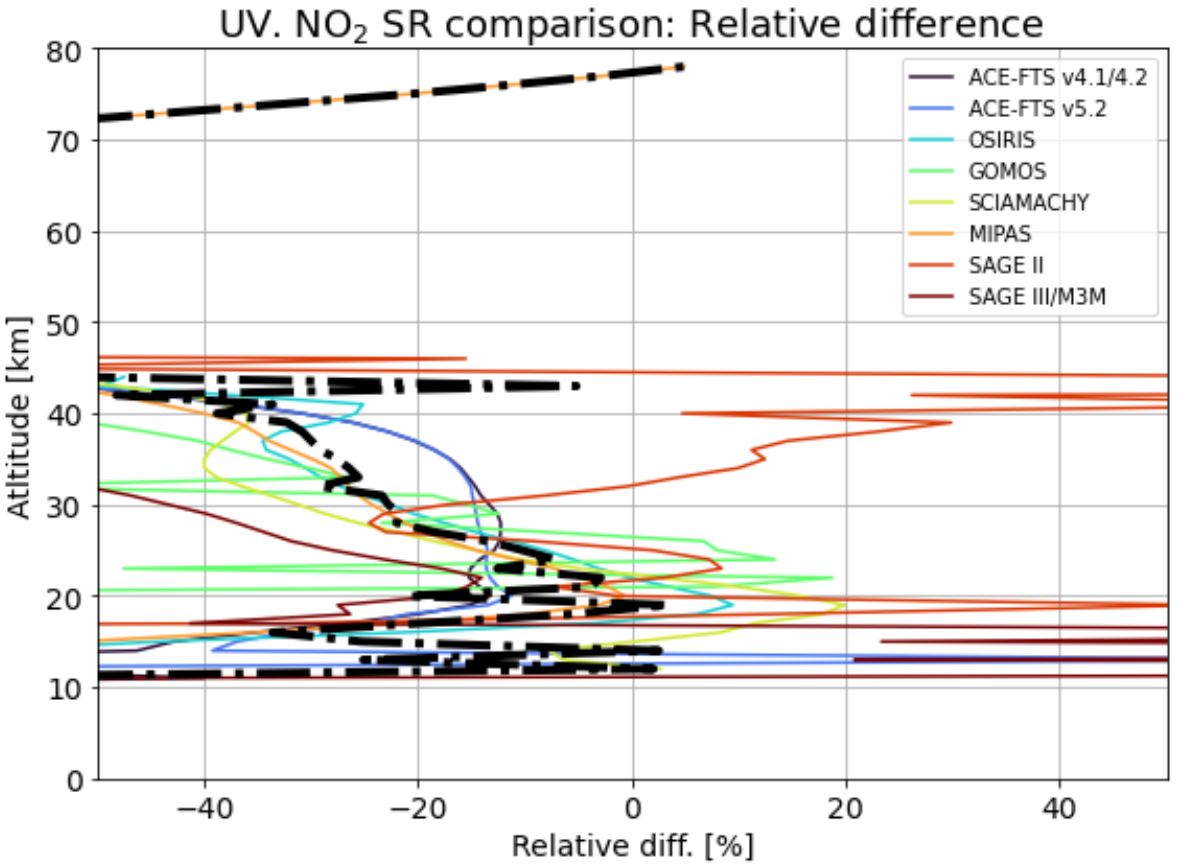




MAESTRO Comparison Instruments

Results – NO_2





8.5 – 43.4 % (20 – 40 km)

Summary

The v4.5 MAESTRO ozone and NO_2 products have good agreement with other datasets in the stratosphere.

MAESTRO Product	Bias	Mean difference	Difference range	Correlation
Vis.-ozone	Small high bias	**2.7 %** (20 – 50 km)	**2.3 – 8.2 %** (20 – 50 km)	r > 0.70 (15 – 40 km)
UV-ozone	Small high bias	**3.4 %** (20 – 45 km)	**2.9 – 11.9 %** (20 – 45 km)	r > 0.70 (15 – 35 km)
NO_2	Low bias	**20.0 %** (20 – 40 km)	**8.5 – 43.4 %** (20 – 40 km)	r > 0.70 (15 – 40 km)

Summary

New v4.5 MAESTRO product shows good agreement with other datasets.

Date available from https://databace.scisat.ca/level2 (registration required)