Harmonized Quality Assessment of Nadir Ozone Profile Data from UV-visible and TIR Satellites within the Climate Change Initiative on Ozone (Ozone_cci+)

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Rationale:

Nadir ozone profile observations from two families of European sounders:

UV-visible spectrometers of the GOME-type, launched regularly since 1995 (GOME, SCIAMACHY, OMI, GOME-2A/B/C, TROPOMI, and upcoming Sentinel-5 UVN series) and TIR emission sounders of the IASI-type, launched regularly since 2006 (IASI on Metop-A/B/C platforms and upcoming IASI-NG on Metop-SG)

Nadir ozone profile retrievals from these measurements are developed, improved, harmonised, and validated in the context of the European Space Agency's Climate Change Initiative on ozone: ESA Ozone_cci+

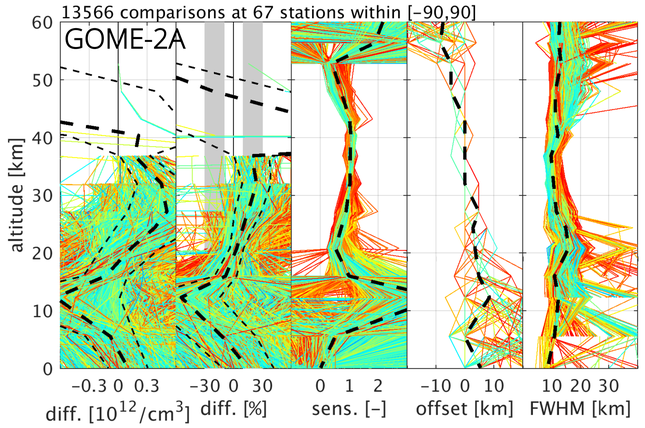
This work reports on the Quality Assessment of the latest UV-visible and TIR nadir ozone profile retrieval versions in terms of data and info content; representativeness; bias, dispersion, and drift with respect to sonde and lidar measurements; and their mutual consistency and dependences on influence quantities.

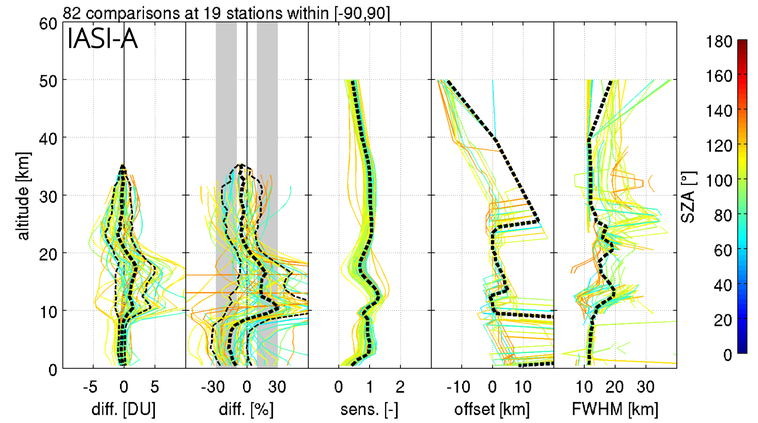
Satellite data specifics:

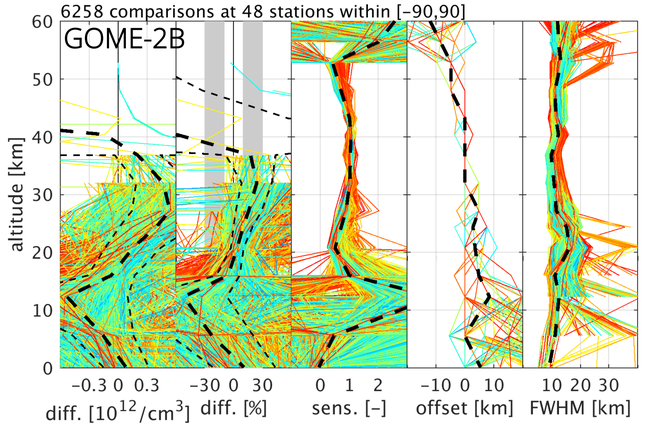
Instrument	Latest processor version	Validation period
GOME	RAL v03(01)	1995/06-2011/06
SCIAMACHY	RAL v03(00)	2002/08-2012/04
GOME-2A	RAL v03(02)	2007/01-2020/10
GOME-2B	RAL v03(03)	2014/06-2020/11
OMI	RAL v02(14)	2004/10-2019/08
IASI-A/B/C	FORLI v20191122	2019/12-2021/01

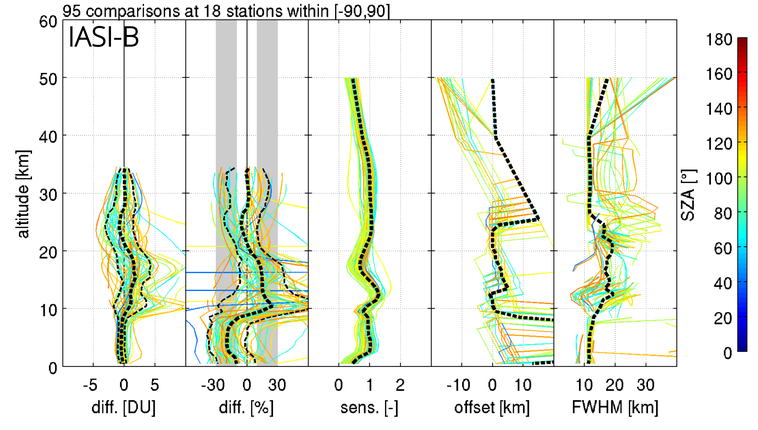
Summary:

Quality Indicators (User Req.)	GOME(-2A/B), SCIAMACHY, OMI	IASI-A/B/C
L2 observation frequency (daily to weekly)	Global coverage within 3 days	Both day-time and night-time daily
Horizontal resolution (20-200 km)	32 to 160 km along track, 52 to 320 km across	12 km
Vertical resolution (6 km layers up to entire troposphere)	Fixed grid with up to 6 km layers but 10-15 km kernel width and SZA dep. tropospheric fluctuations	Fixed 1 km grid but 10-15 km kernel width and UTLS fluctuations
DFS / independent layers	5-6 with 0.5 seasonality	2-4 with meridian and seasonal dependence
Vertical sensitivity	UTLS peak ~3 with under-sensitivity right above and below	Outliers around UTLS
Height registration uncertainty / vertical retrieval offset	< 10 km	5-10 km on average, but strong (sub-tropopause) features
Systematic error estimated from comparison bias	< 10 % in stratosphere, +/- 10-30 % in troposphere	< 10 % stratospheric bias, 20-30 % positive (UTLS) to ~20 % negative (troposphere)
Random uncertainty estimated from comp. dispersion	~10 % in stratosphere, ~40 % in troposphere	~10-30 %, slightly reduced for v20191122
Total uncertainty (16 % below 20 km, 8 % above 20 km)	~10 % in stratosphere at minimum to 20-50 % in troposphere	~10 % stratosphere, 20 % in tropsosphere, higher in UTLS
Dependence on influence quantities	Bias outliers in the troposphere of Arctic winter, equatorial UTLS, and Antarctic winter and spring, higher SZA yields larger DFS, smaller bias	Thermal contrast especially in polar troposphere and tropical UTLS, agrees with DFS/sensitivity dependence
Stability (1-3 %/dec.)	No significant GOME and OMI drift, positive tropospheric drift for SCIAMACHY and GOME-2A/B	Order of -10 %/decade in troposphere, insignificant above UTLS

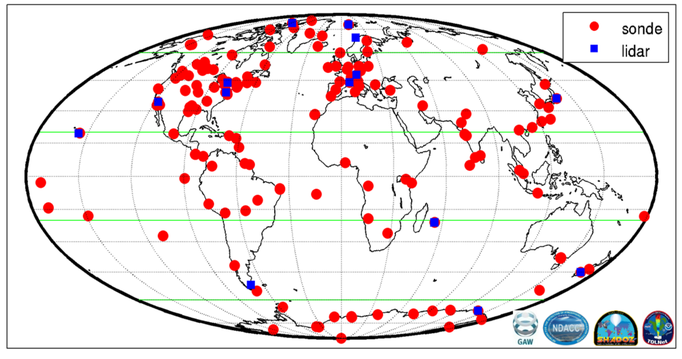


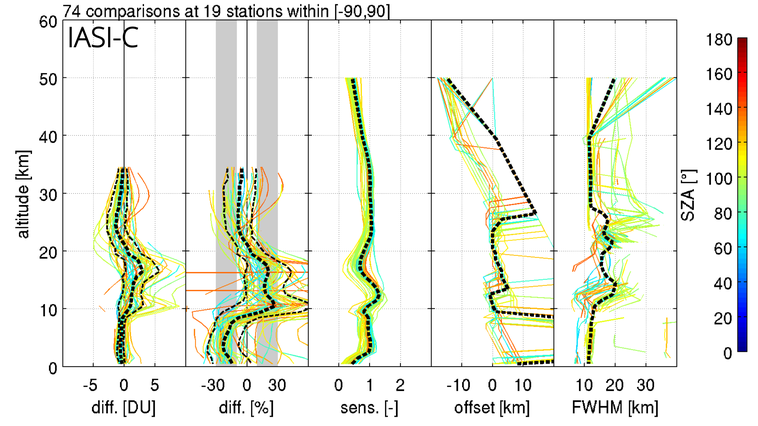






Reference measurement sites:





Reference: Ozone_cci+ Product Validation and Intercomparison Report (PVIR) v3.0, 2021, https://climate.esa.int/en/projects/ozone/key-documents/