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First O₃ and NO₂ observations over the Indian Ocean by mobile Mini-SAOZ

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In the frame of the MAP-IO (Marion Dufresne Atmospheric Program - Indian Ocean) project a Mini-SAOZ (Système d'Analyse par Observation Zénithale) UV-Visible spectrometer was installed onboard Marion Dufresne vessel to provide simultaneous measurements of total ozone (O₃) and nitrogen dioxide (NO₂) columns. The analysis is done by DOAS (Differential Optical Absorption Spectroscopy) method following the NDACC (Network for the Detection of Atmospheric Composition Change) recommendations. Zenith sky measurements are performed from sunrise to sunset until a Solar Zenith Angle (SZA) of 94°. The exposure time is adjusted automatically between 0.01s to 60s in order to optimize the signal and the spectra are co-added in memory during a 60s duty cycle. The data from a GPS device is used for SZA, location and time calculation. The dark current of the detector is subtracted from each spectrum. O₃ and NO₂ morning and evening vertical columns are averaged between 86 and 91 SZA.

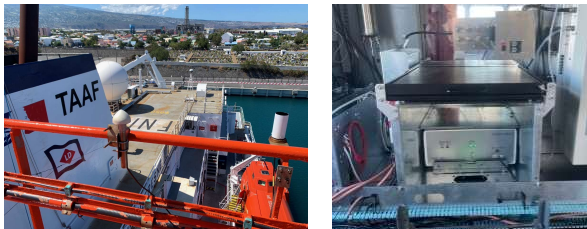


Figure 1. Left: GPS antenna and optical head installed outdoor at 30 m above the instrument. Right: Mini-SAOZ in Meteo room.

The Mini-SAOZ is working in an operational way since the beginning of the project in January 2021. It was considered as a pilot mobile platform for the Central processing of SAOZ UVVIS Unit in the frame of CREGARS (Centre for Reactive Trace Gases Remote Sensing) of ACTRIS.

In this presentation, three years of continuous measurements are shown and various studies are presented.

An example: Satellite comparisons

Observations at ground are usually used as reference dataset for the validation of satellite observations in order to detect a systematic error or a drift or also to ensure a continuity and coherence between different spatial missions. The last satellite

mission monitoring O₃ and NO₂ columns with a very high-resolution is Sentinel 5 Precursor (S5P) mission (Veefkind et al., 2012) carrying onboard the TROPOMI (TROPOspheric Monitoring Instrument) instrument. The observations of TROPOMI were already compared to the measurements of SAOZ/NDACC instruments, for O₃ see Garane et al. (2019) and for NO₂ Verhoelst et al (2021).

The Mini-SAOZ of Marion Dufresne is also compared to the SAOZ instruments of Réunion (20.9°S, 55.5°E) and Kerguelen (49.3°S, 70.3°E) NDACC stations. The Mini-SAOZ was already compared to other UVVIS instruments in the frame of CINDI 2 campaign at Cabauw, The Netherlands. Its performances are within the expected UVVIS WG recommendations (Kreher et al., 2020). Figure 2 shows the intercomparison of ozone total columns between Mini-SAOZ observations at Marion Dufresne, TROPOMI co-located data.. The columns observed by SAOZ/Mini-SAOZ instruments are superimposed to the figure when the ship is close to both NDACC stations at $\pm 0.2^\circ$ in latitude and longitude. A very good agreement is observed between the different measurements with a mean bias within $\pm 1\%$.

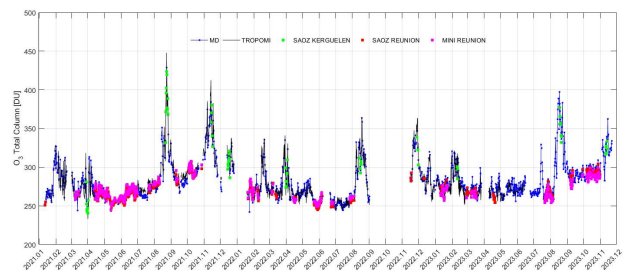


Figure 2. Evolution of the total ozone column observed by the Mini-SAOZ of Marion Dufresne, TROPOMI and NDACC SAOZ of Reunion and Kerguelen.

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Garane, K., et al. (2019) *Atmos. Meas. Tech.*, 12, 5263–5287.

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Veefkind, J. P., et al. (2012) *Rem. Sens. Env.*, 120, 70–83.