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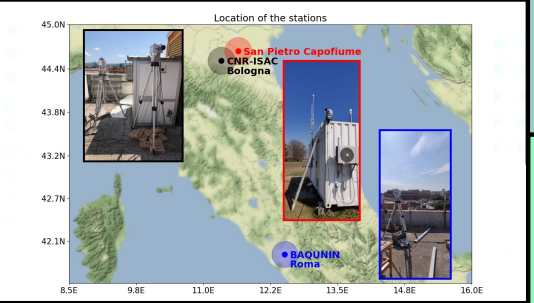
IDEAS-QA4EO DOAS-BO: TOWARDS A NEW FRM4DOAS SITE IN THE PO VALLEY

Paolo Pettinari[1,3,*], Elisa Castelli[1], Enzo Papandrea[1], Massimo Valeri[2], Paolo Cristofanelli[1], Maurizio Busetto[1], Cosimo Fratticioli[1]
[1] Istituto di Scienze dell'Atmosfera e del Clima (CNR-ISAC), Via Piero Gobetti 101, 40129, Bologna,
[2] SERCO Italia S.p.A., Via Sciadonna 24, 00044 Frascati (Rome),
[3] Dipartimento di Fisica dell'Atmosfera, Università di Bologna
Corresponding author. E-mail: p.pettinari@isac.cnr.it

Abstract. The Po valley (Italy) is one of the most polluted regions in Europe. High NO_2 concentrations are often found due to industrial and urban activities and its particular geographical position. However, MAX-DOAS instruments, compliant to the Fiducial Reference Measurements for Ground-Based DOAS (FRM4DOAS) standards were not present in the Po Valley. At the beginning, the purpose of the IDEAS-QA4EO "DOAS-BO: Towards a new FRM4DOAS site in the Po valley" WPs (contract funded by ESA-ESRIN n. 4000128960/19/I-NS) was to fill this gap exploiting TROPOGAS, a custom-built spectrometer developed at CNR-ISAC institute. For this reason, we evaluated its performances and the synergies with in-situ and satellite data during a measurement campaign on the CNR-ISAC roof (Bologna). TROPOGAS was then supposed to be involved in another campaign at BAQUNIN supersite (Rome) to assess the synergies with the Pandora#117 instrument. However, since CNR-ISAC bought a new instrument (SkySpec-2D) compliant to FRM4DOAS requirements, in the frame of an Italian project, we decided to: first, assess the synergy between SkySpec-2D and TROPOGAS, during a measurement campaign in Bologna, and second, move the SkySpec-2D to Rome for the measurement campaign in BAQUNIN against Pandora#117. The results of all the campaigns involve the retrieved NO_2 Vertical Column Densities (VCDs).

Assessment of TROPOGAS performances vs FRM4DOAS requirements (DOI: 10.5281/zenodo.5886858)

- Instrumental guidelines ☹ Ok apart from the FOV (3°). Too wide!!
- Operational guidelines ☺
- Data processing guidelines ☺



Campaign 1 at CNR-ISAC in Bologna: TROPOGAS synergies with in-situ and satellite data (DOI: 10.5281/zenodo.5886896)

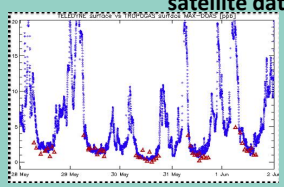


Fig 1: NO_2 concentrations measured in-situ by a chemiluminescent analyzer (blue) compared to surface data retrieved from TROPOGAS MAX-DOAS spectra (red) by a prototypal retrieval algorithm.

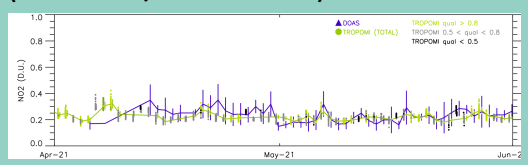
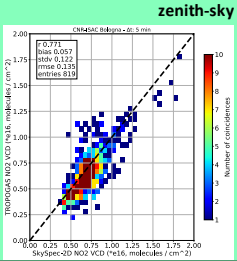


Fig 2: NO_2 VCDs retrieved from TROPOGAS zenith-sky spectra (violet) and from Sentinel-5P TROPOMI measurements (yellow).

Campaign 2 at CNR-ISAC in Bologna: SkySpec vs TROPOGAS (DOI: 10.5281/zenodo.5886950)

The campaign was performed between 4th and 30th August 2021. We compared the NO_2 VCDs from only zenith-sky spectra.

Fig 3: scatterplot of NO_2 VCDs retrieved from SkySpec-2D and TROPOGAS measurements and averaged in 5 minutes intervals.



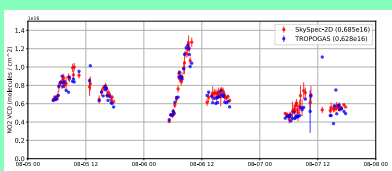


Fig 4: NO_2 VCDs from SkySpec-2D (red) and TROPOGAS (blue) from days 5th to 7th

Campaign 3 at BAQUNIN La Sapienza in Rome: SkySpec vs Pandora#117 (DOI: 10.5281/zenodo.5886950)

The campaign was performed between 6th and 21st September 2021. We compared the SkySpec-2D NO_2 VCDs from zenith-sky spectra with the ones retrieved from Pandora#117 (direct sun measurements).

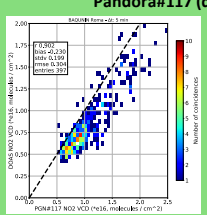


Fig 5: scatterplot of NO_2 VCDs retrieved from SkySpec-2D and Pandora#117 measurements and averaged in 5 minutes intervals.

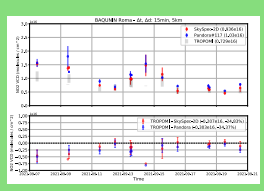
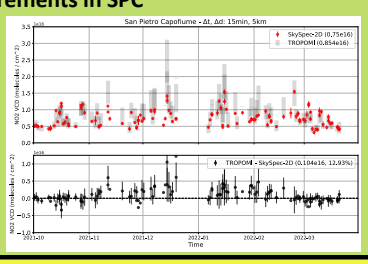


Fig 6: NO_2 VCDs from SkySpec-2D (red) and Pandora#117 (blue) and TROPOMI (grey shadow).

SkySpec-2D routine measurements in SPC

SkySpec-2D has been measuring zenith and off-axis solar spectra in SPC since 1st October 2021. Here's an example of NO_2 VCDs retrieved from its zenith-sky spectra.

Fig 7: NO_2 VCDs retrieved from SkySpec-2D (red) and TROPOMI (grey shadow) in SPC. Here, we consider TROPOMI data in a region of 5 km radius around the «Giorgio Fea» observatory and SkySpec-2D data in 15 minutes around the satellite overpass time.



Conclusions

1) TROPOGAS provides reliable NO_2 concentrations (see Fig. 1 with respect to the chemiluminescent analyzer) and VCDs (see Fig. 2 with respect to TROPOMI).
2) SkySpec-2D vs TROPOGAS: low bias (0.057×10^{16} molec/cm^2) and high correlation of 0.77. Differences are due to instrumental discrepancies (FOV and integration times).
3) SkySpec-2D vs Pandora#117: higher correlation of 0.9 but also higher bias in absolute value (-0.23×10^{16} molec/cm^2). Not only instrumental differences but also different processing and measurement methods.
4) SkySpec-2D and TROPOGAS are now measuring in SPC, in the middle of the Po Valley, and in Bologna, respectively. Since SkySpec spectra are fully compliant to FRM4DOAS requirements, they are routinely provided to the FRM4DOAS community for their central processing.