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Evaluation of TROPOMI upper tropospheric NO₂ using MAX-DOAS measurements at Izaña

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Free and upper tropospheric NO₂

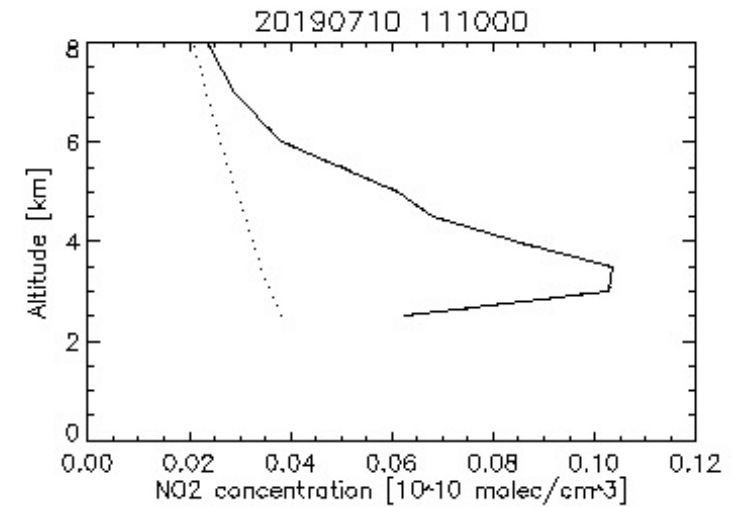
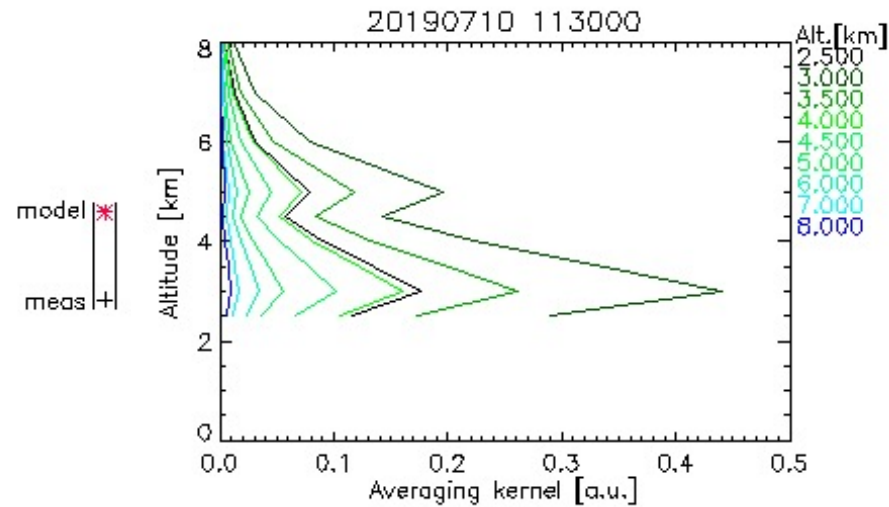
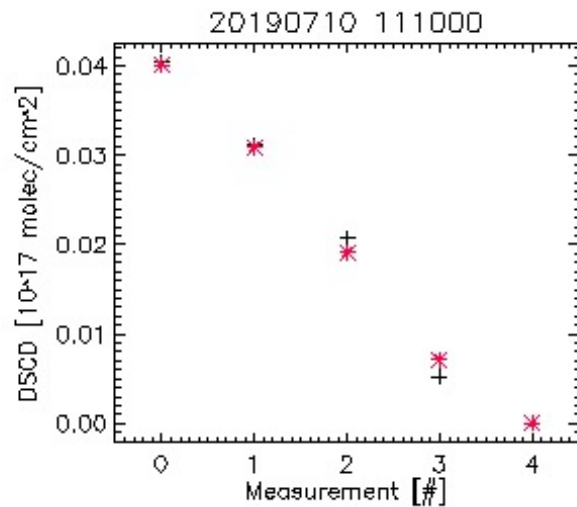
- Sources: upward and downward transport, lightning, aircraft emissions
- Sinks: photolysis, reaction with HO_x radicals
- NO_x is longer lived in the upper- than lower-troposphere meaning it plays a key role in tropospheric O₃ chemistry
- Very limited satellite-validation capability

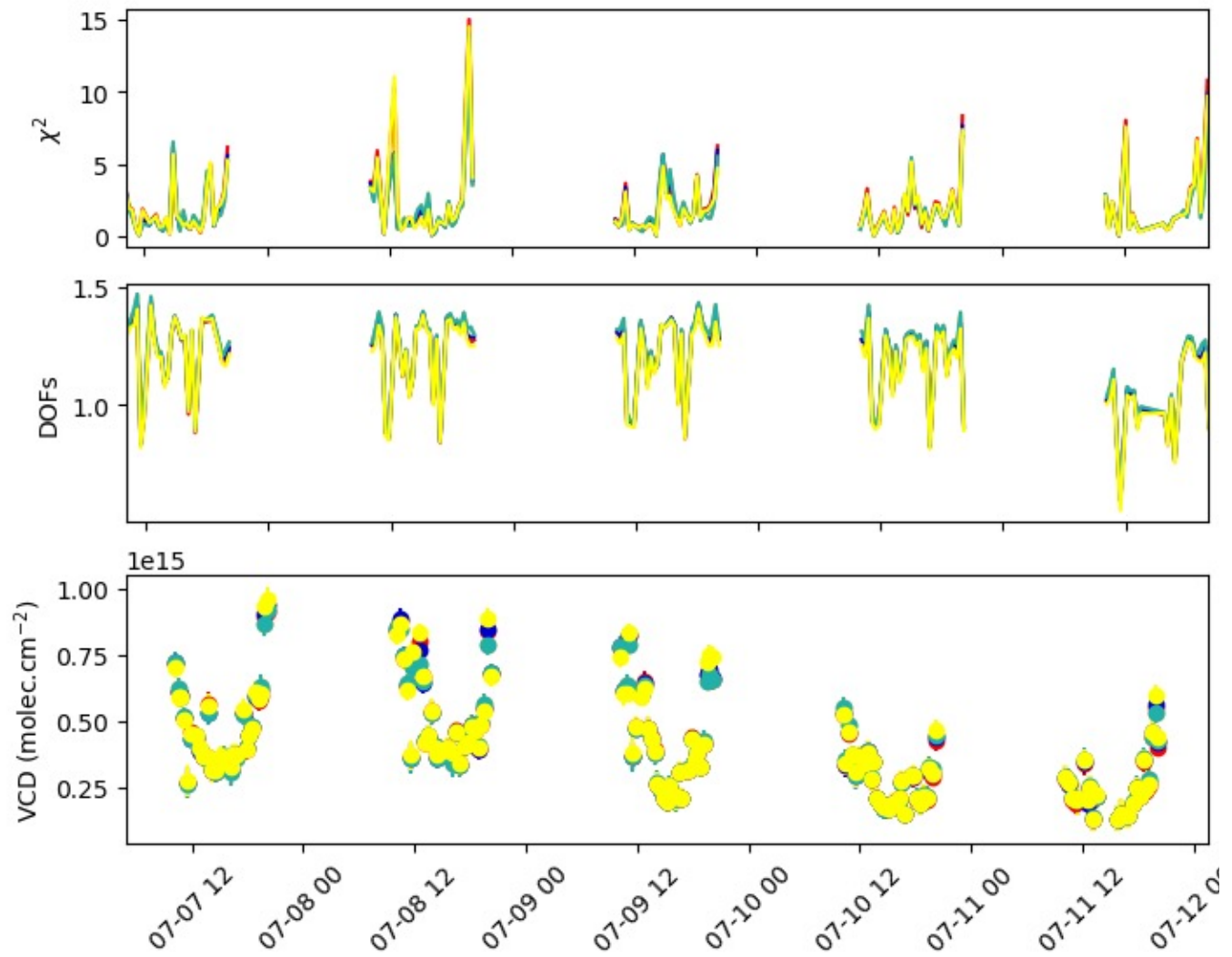
Izaña MAX-DOAS

- Tenerife, Canary Islands, 2373 m asl
- Previously, NO₂ concentrations at station level have been retrieved using a modified geometric approach* *L. Gomez et al., ACP, 2014*
- We aimed to retrieve column amounts, through profile retrieval approach, for comparison to satellite observations

Setting up the retrieval

- We used the HEIPRO algorithm to retrieve columns of NO₂ above Izaña site
- Retrieval between 2.7 and 8 km
- Constant (with altitude) aerosol extinction profile used, 0.01 km⁻¹
- Constant (with altitude) NO₂ a priori profile used, 20 ppt



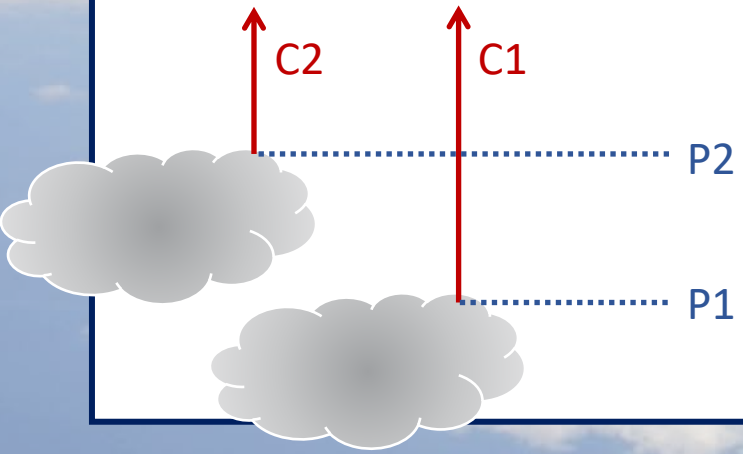
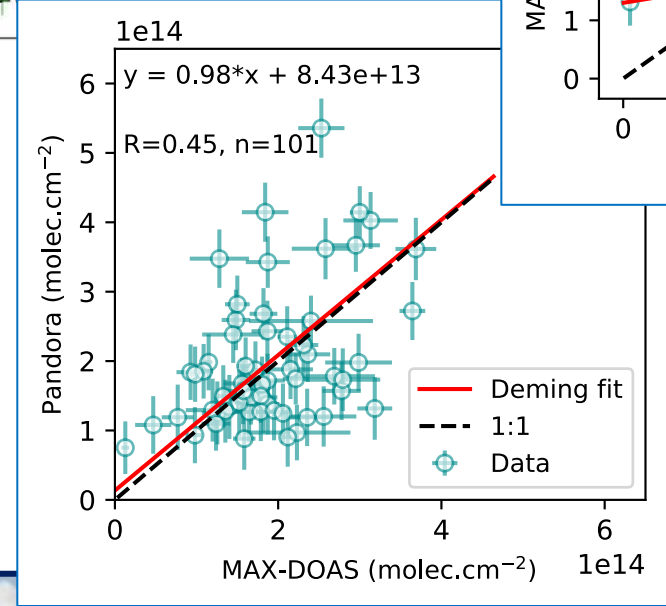
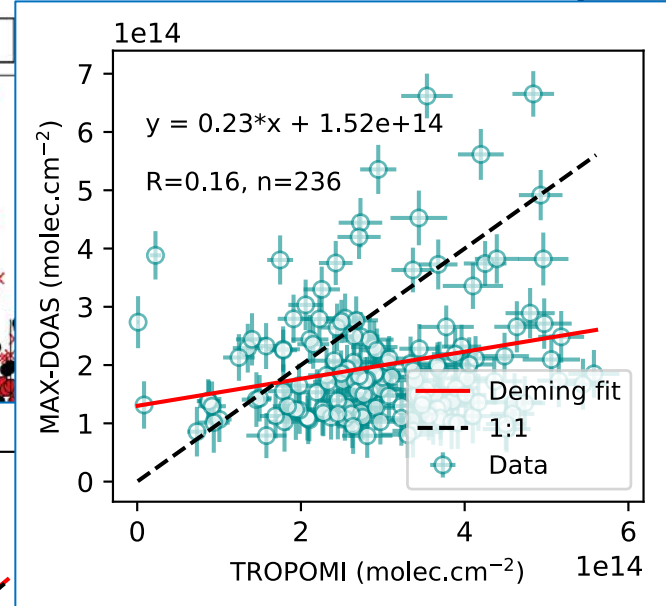
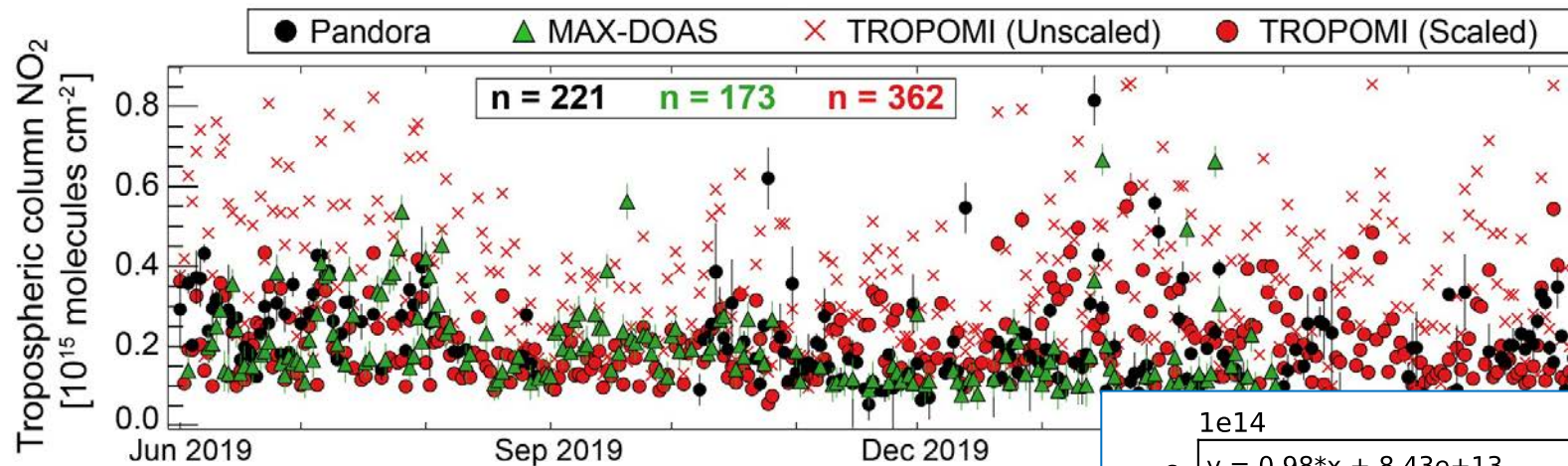


Legend

- Const. Aerosol a priori extinction 0.001
- Const. Aerosol a priori extinction 0.020
- Const. NO₂ a priori VMR 10 ppt
- Const. NO₂ a priori VMR 40 ppt
- NO₂ retrieval without HEIPRO aerosols (prescribed constant extinction 0.01)

• No appreciable difference in retrieval Chi squared, degrees of freedom for signal or the retrieved NO₂ column.

Agreement between MAX-DOAS, TROPOMI and Pandora



Cloud slicing:

$$\bar{X} \propto \frac{\Delta C}{\Delta P}$$

Summary

- Robust retrieval of NO₂ columns above the Izaña site was achieved
- Reasonable temporal agreement was found between direct sun (Pandora) and MAX-DOAS columns
- No temporal correlation between MAX-DOAS and TROPOMI, but not necessarily expected given significant measurement differences
- MAX-DOAS measurements have contributed a strong second point of evidence to suggest high-bias of TROPOMI free- and upper-tropospheric NO₂

References

This work is published in: *E. A. Marais et al., AMT, 2021, doi:10.5194/amt-14-2389-2021*

Izaña observatory and MAX-DOAS: *L. Gomez et al., ACP, 2014, doi:10.5194/amt-7-3373-2014*

Cloud slicing: *J. R. Ziemke et al., JGR Atmospheres, 2001, doi:10.1029/2000JD900768*