

QA4E0

Effect of clouds on the data quality and uncertainty of trace gas total column retrievals

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Objective

- Trace gas retrievals are not restricted to cloudless conditions and are still possible with (thin) clouds in front of the sun.
- Investigation of the impact of clouds (thickness and type) for the first time in more detail

Methods / data sets

- Trace gas total columns (NO₂, O₃, HCHO and H₂O) for 4 different stations (Rome, Athens, Davos, Izana) and aux data (DQ flags, uncertainty, wrms, atmospheric variability)
- AOD data from AERONET / PFR, COD from PFR
- (All-sky camera)
- Daily plots of all variables, plots for correlation / dependency

Goal

investigate if/how additional cloud information (e.g. PFR) can refine quality flagging of PGN operational data products

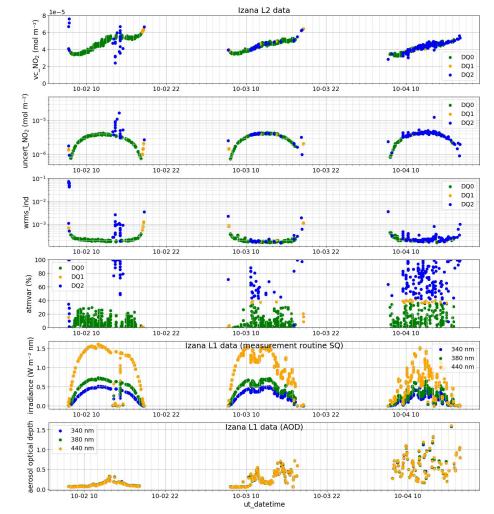


🖫 Results: Izana NO₂

- 02.10.2023: thin cloud at 3 pm, atmvar and vertical column uncertainty (+ wrms_ind) increases
- spread and uncertainty of the vertical NO₂ columns becomes larger and data during this event has the lowest quality (DQ2 flagged)

 03.10.2023: 3 short cloud events, irradiance reduction only maximal 20 %, uncertainty unaffected

 04.10.2023: mix of sunshine and thicker clouds during whole day, AOD cloud flagged

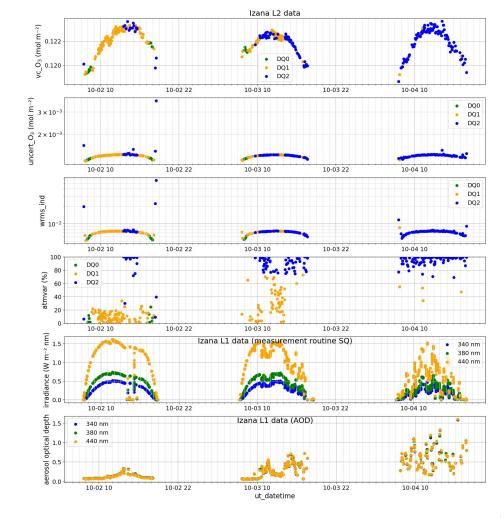


🔊 Results: Izana O₃

 02.10.2023: thin cloud at 3 pm increases atmospheric variability to 100 % and thus to low quality

- 03.10.2023: 3 cloud events, irradiance reduction only maximal 20 %, uncertainty unaffected, but data is lowest quality during
 - Quality check of O₃ more sensitive for clouds than for NO₂

 04.10.2023: mix of sunshine and higher? clouds during whole day, AOD often cloud flagged

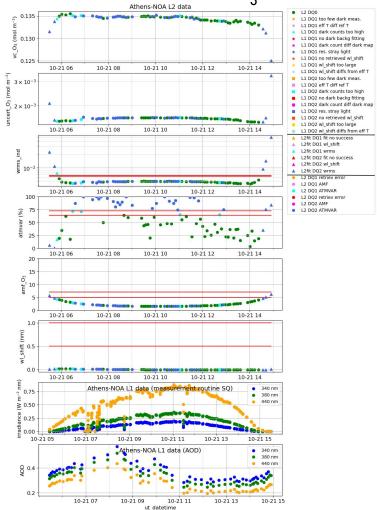




Results: Athens-NOA NO₂ 0.0008 L2 DQ0 * L1 DQ1 too few dark meas. E 0.0006 * L1 DO1 eff T diff ref T L1 DQ1 dark counts too high E 0.0004 . L1 DO1 no dark backg fitting * L1 DQ1 dark count diff dark map 0.0002 * L1 DQ1 res. stray light L1 DO1 no retrieved w/ shift 0.0000 L1 DO1 wl shift too large 10-21 05 10-21 07 10-21 09 10-21 11 10-21 13 10-21 15 L1 DQ1 wl shift diffs from eff T L1 DQ2 too few dark meas. L1 DO2 eff T diff ref T L1 DQ2 dark counts too high L1 DQ2 no dark backg fitting L1 DQ2 dark count diff dark map L1 DQ2 res. stray light L1 DQ2 no retrieved wl shift L1 DO2 wl shift too large 10-21 05 10-21 07 10-21 09 10-21 11 10-21 13 10-21 15 L1 DQ2 wl shift diffs from eff T L2fit DQ1 fit no success L2fit DQ1 wl_shift ⊕ 10⁻ ▲ L2fit DQ1 wrms ▲ L2fit DQ2 fit no success ▲ L2fit DQ2 wl_shift ▲ L2fit DQ2 wrms L2 DQ1 retriev error L2 DQ1 AMF L2 DQ1 ATMVAR 10-21 05 10-21 07 10-21 09 10-21 11 L2 DQ2 retriev error L2 DQ2 AMF L2 DQ2 ATMVAR 10-21 05 10-21 07 10-21 09 10-21 11 10-21 13 20 0N 10 10-21 05 10-21 07 10-21 09 10-21 11 10-21 13 10-21 15 0.20 € 0.15 # 0.10 ≥ 0.05 0.00 10-21 05 10-21 07 10-21 15 Athens-NOA L1 data (measurement routine SC • 340 nm 0.75 440 nm ≥ 0.50 ≥ 0.25 0.00 10-21 09 10-21 05 10-21 07 10-21 11 10-21 13 10-21 15 Athens-NOA L1 data (AOD) • 340 nm • 380 nm 9 440 nm 10-21 07 10-21 11 10-21 13 10-21 15

ut datetime

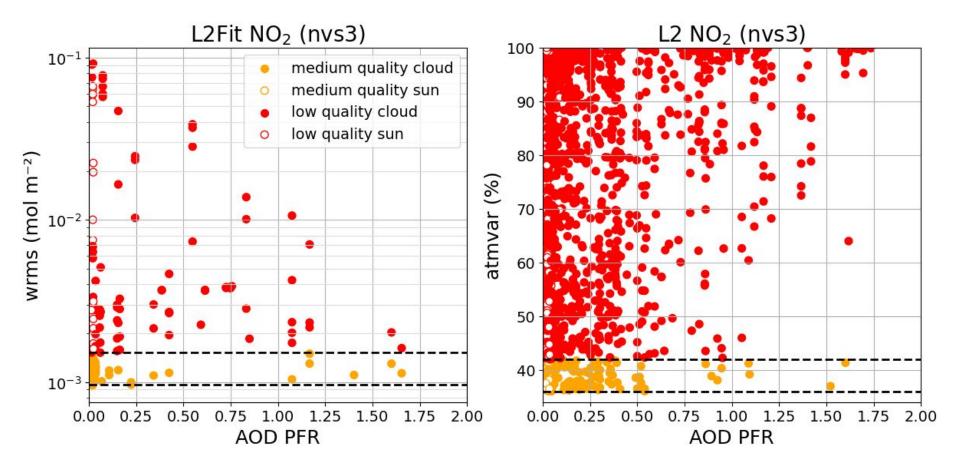
Results: Athens-NOA 0₃





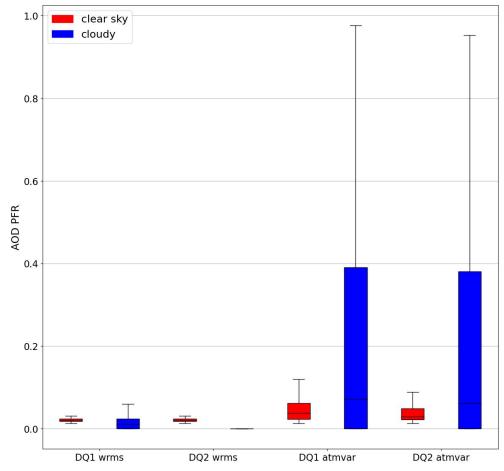
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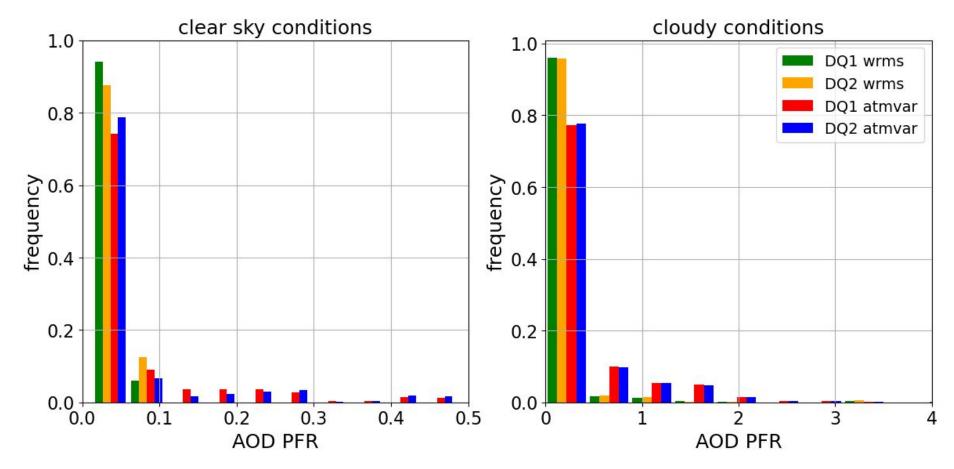


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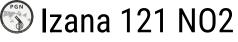




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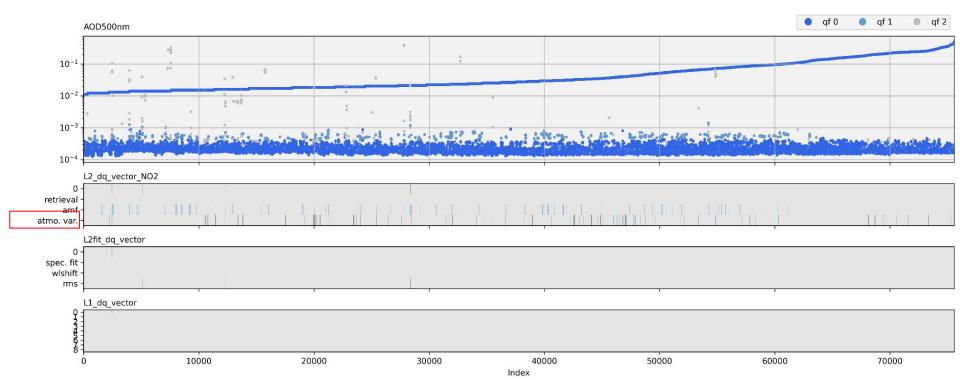




2023

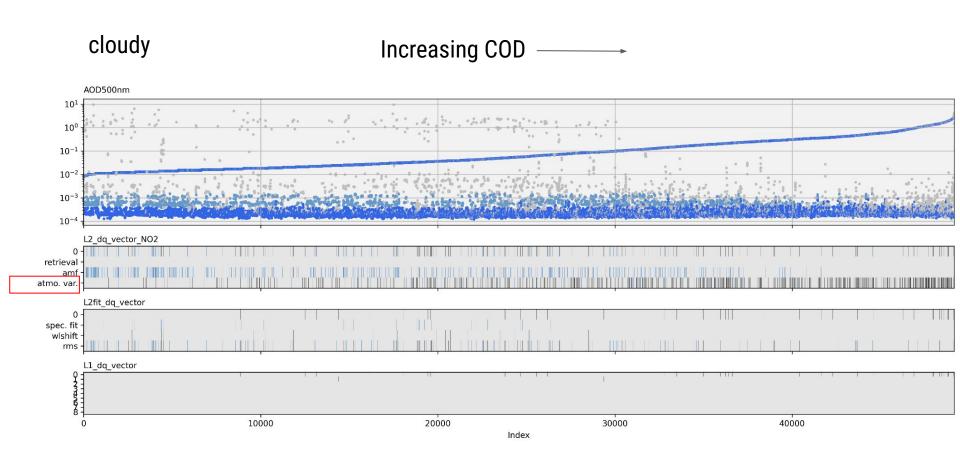


Increasing AOD ———





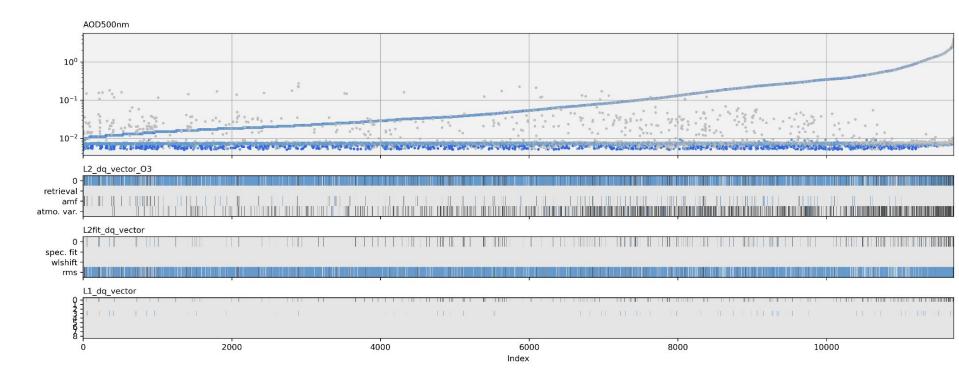
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cloudy







Conclusion / outlook

- Investigation of the impact of clouds (thickness and type) for the first time in more detail
- Highly dimensional visualization / analysis

Atmospheric variability criteria is too strict
 (DQ1, medium data quality often too conservative)

Refinement of DQ criteria

