# A new 20-year dataset of ground-based NO2 vertical column density observations over Rome, Italy, for calibration/validation of spaceborne radiometers

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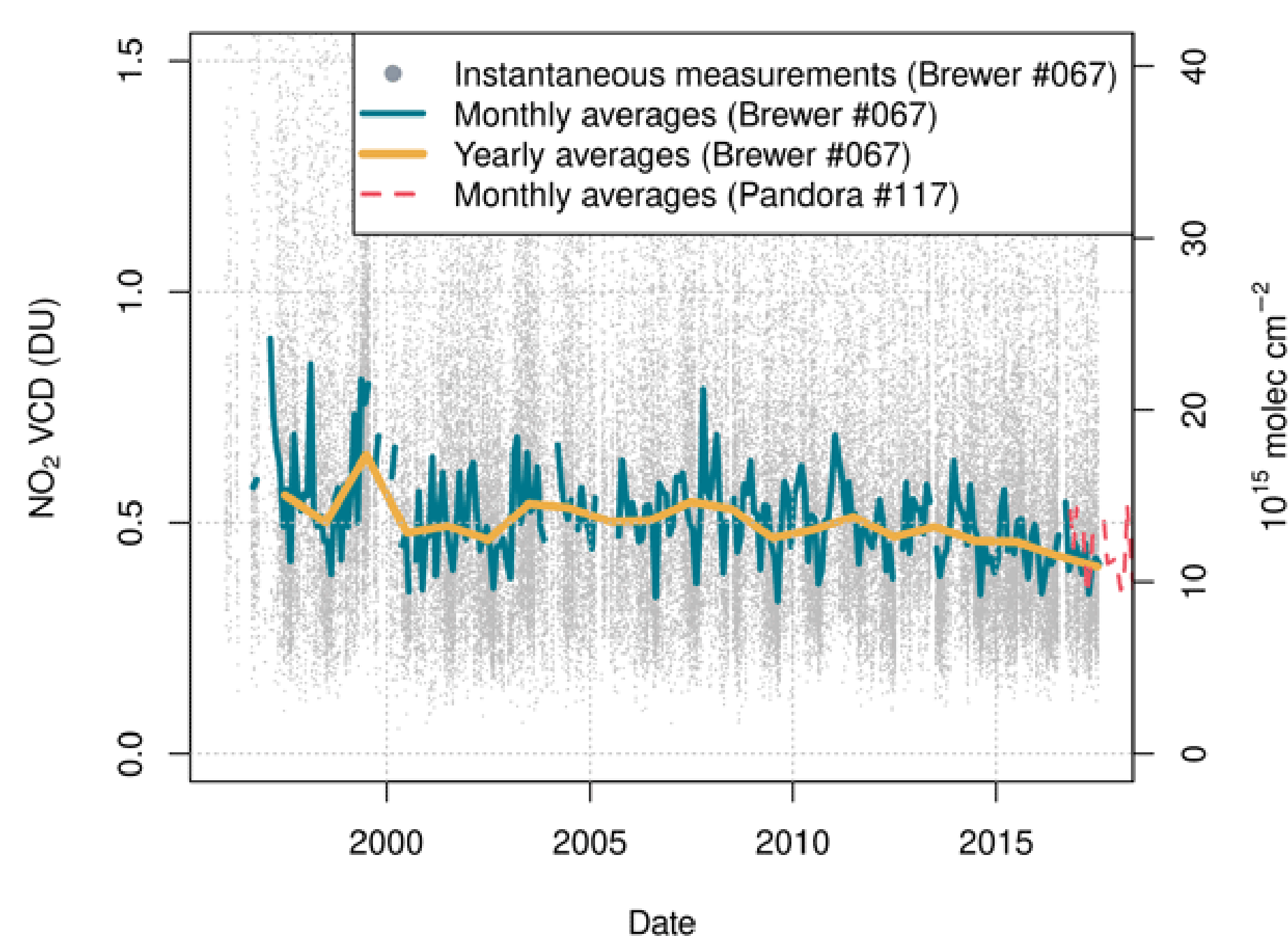
Figure 1 (above). Nitrogen dioxide VCDs retrieved in Rome since 1996 as obtained with the novel algorithm. The monthly averages of the retrievals from Pandora #117, operating at APL since 2016, are also shown for comparison (dashed line).

NO2 VCD measurements in Rome (1996-2017)

A 20-year long dataset of NO2 vertical column densities (VCDs, Fig. 1) over Rome retrieved from a Brewer spectrophotometer (#067) has been made available in the frame of the BAQUNIN project (www.baqunin.eu) [1,2].
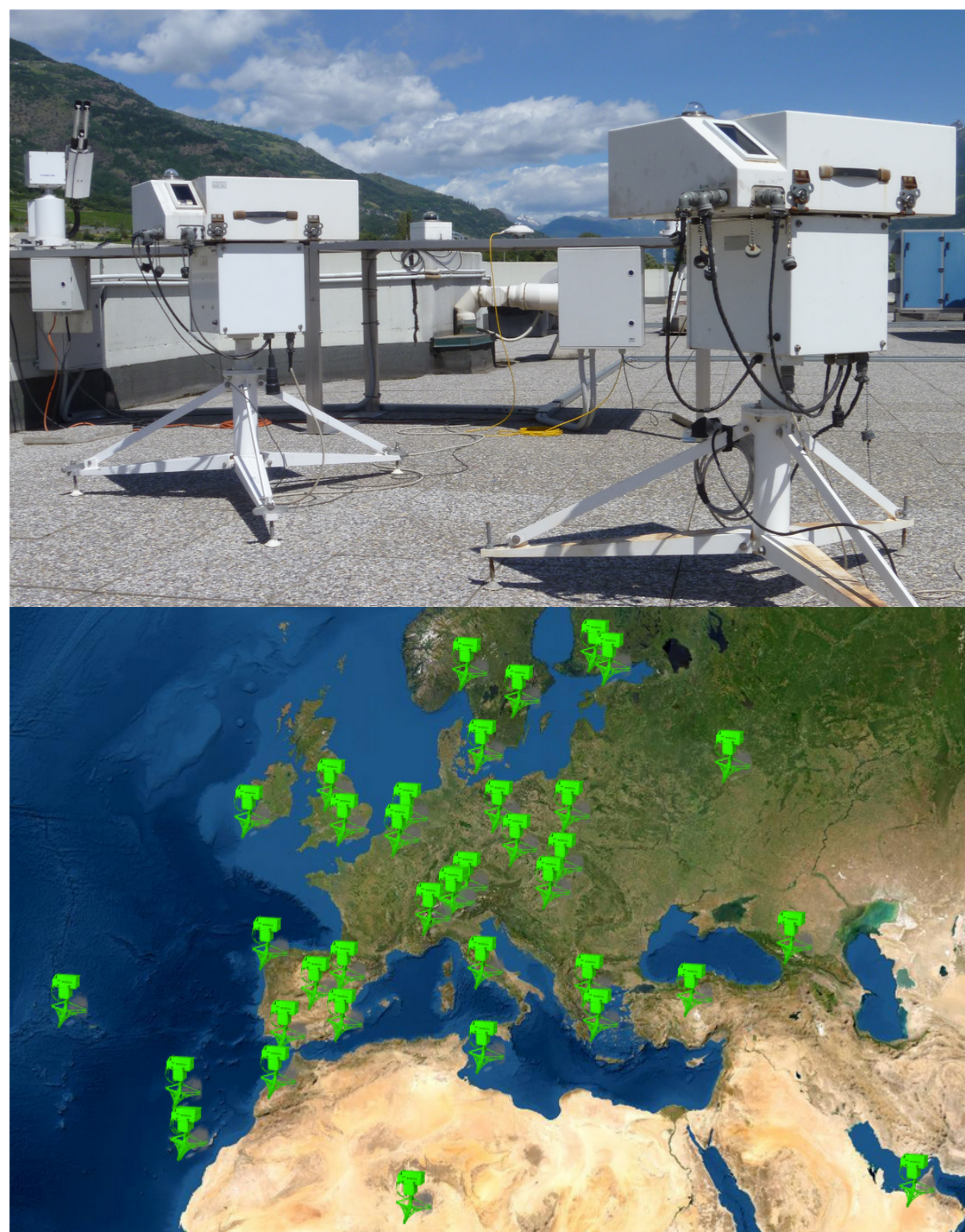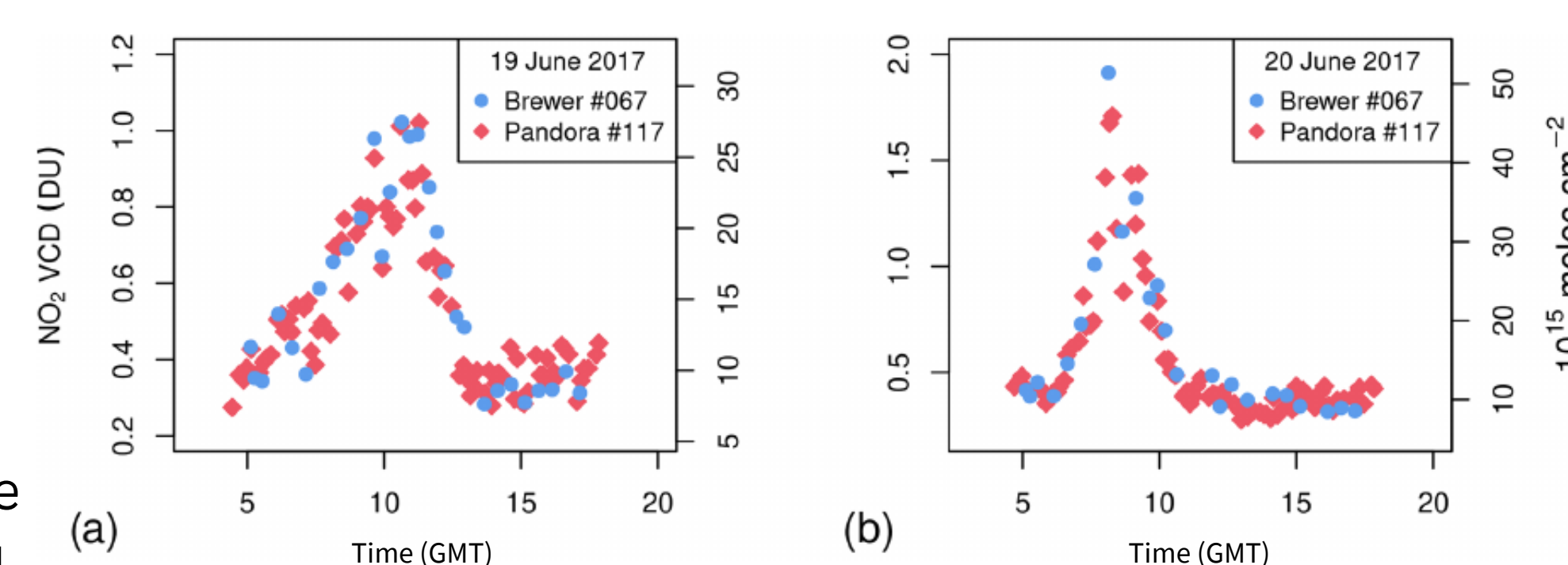
The high quality of the Brewer NO2 retrievals is demonstrated by independent comparison with a co-located Pandora spectrometer (#117), over a 1-year long period (2016-2017, Figs. 2-4). This represents the first intercomparison of NO2 retrievals between a MkIV Brewer and a Pandora instrument.
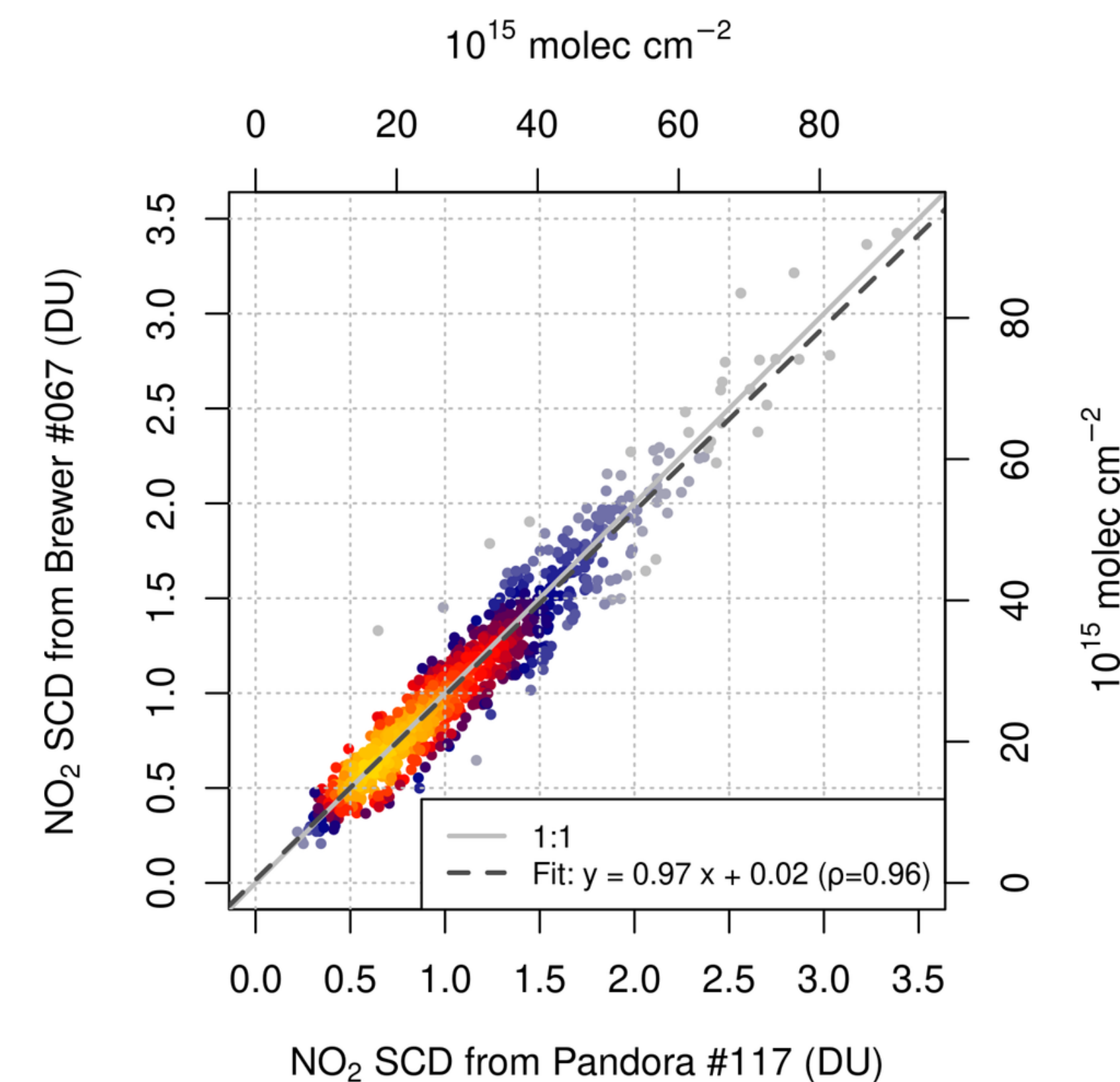
Figure 2 (top right). Comparison of the NO2 slant column densities retrieved from Brewer #067 and Pandora #117 at APL (Rome). The linear correlation index is 0.96, the slope 0.97 and the offset 0.02 DU.

Figure 3 (right). Independent retrievals from instantaneous measurements by Brewer #067 and Pandora #117 on two selected days (19–20 June 2017).

Figure 4 (left). Atmospheric Physics Laboratory (APL) at Sapienza University, the urban station ("component") of the BAQUNIN supersite where the comparison was performed.
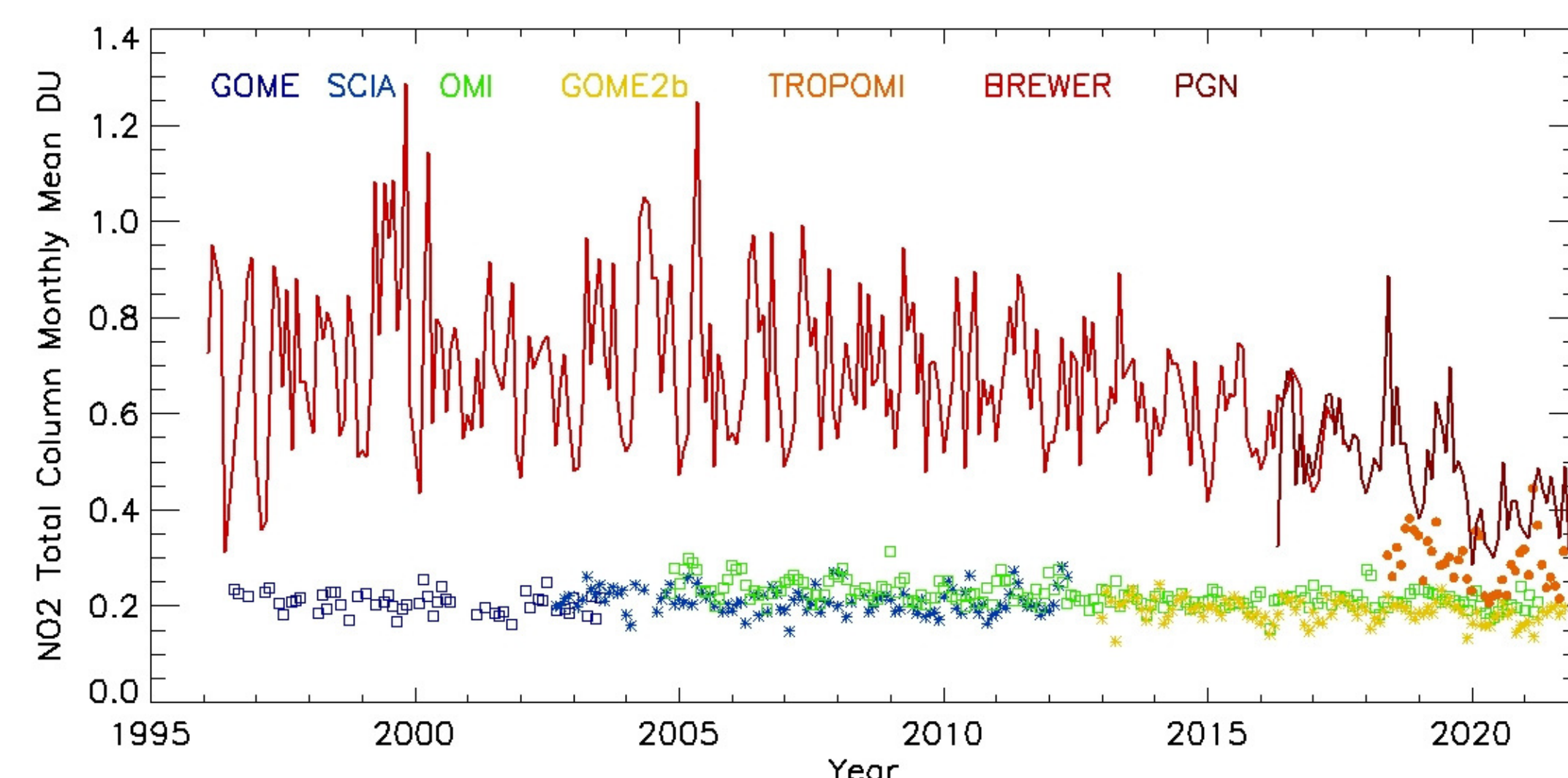

Brewers and NO2

Hundreds of Brewer spectrophotometers (Fig. 5) are employed throughout the world to monitor ozone VCDs. Based on the peculiar absorption of solar radiation in the visible range, NO2 concentrations can also be retrieved by MkIV Brewers. The new algorithm presented here includes updated spectroscopic datasets and accounts for additional atmospheric compounds and instrumental artefacts. Long-term changes in the Brewer radiometric sensitivity are tracked using statistical methods for in-field calibration. The technique can be replicated on the more than 80 MkIV spectrophotometers operating worldwide.

Benefits from the present dataset

The 20-year long dataset can be exploited for cal/val exercises with spaceborne radiometers (Fig. 6), notably those belonging to heritage missions (due to lack of accurate multidecennial ground-based reference series). This is particularly useful in urban environments, where underestimations by satellites usually occur (Fig. 6).

Moreover, the Rome series may be useful for comparison with photochemical models, better aerosol retrievals from both ground and space (removal of NO2 absorption) and air quality trend analyses.

Figure 5. Brewer spectrophotometers #066 (operating in Aosta) and #067 (normally operating in Rome) during an intercomparison campaign (above) and locations of the European Brewer stations (below) within the EUBREWNET network (eubrewnet.aemet.es).

Figure 6. Comparison of the NO2 VCD over Rome as retrieved from several satellite missions (see coloured legend), and ground-based retrievals from Brewer and Pandora (PGN) instruments.

References
[1] https://doi.org/10.5281/zenodo.4715219
[2] Diémoz et al., 2021, Earth Sys. Sci. Data (DOI 10.5194/essd-13-4929-2021)