



FINNISH METEOROLOGICAL INSTITUTE

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# **Comparison of TROPOMI/Sentinel-5 Precursor NO<sub>2</sub> product with ground-based observations in Helsinki and first societal applications**

**Iolanda Ialongo**, Henrik Virta, Henk Eskes, Jari Hovila, and John Douros



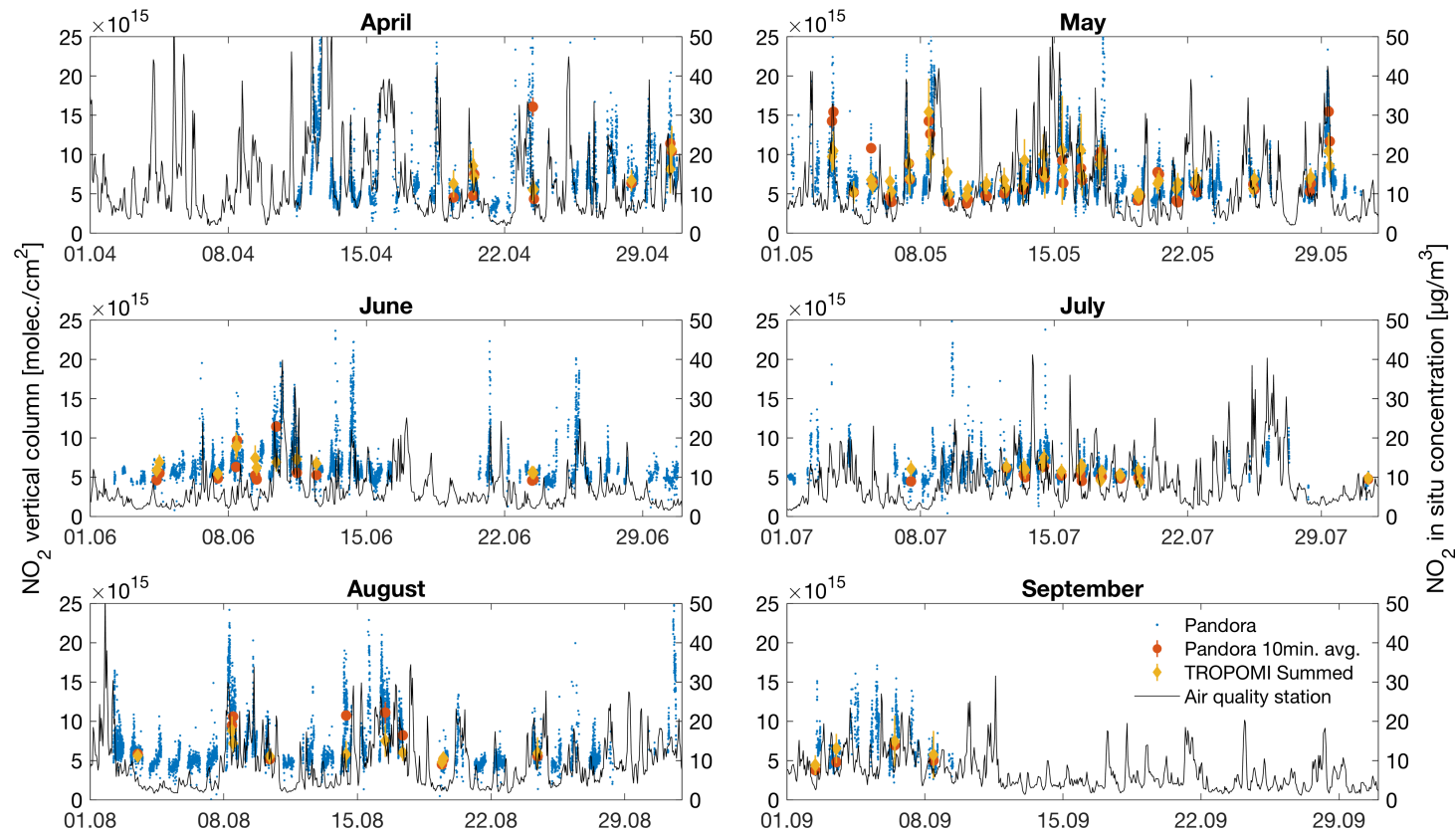
# Datasets

Location: **Kumpula, Helsinki**

Time period: April-September 2018

Colocation criteria: Time:  $\pm 10$  min, Overlaying pixel

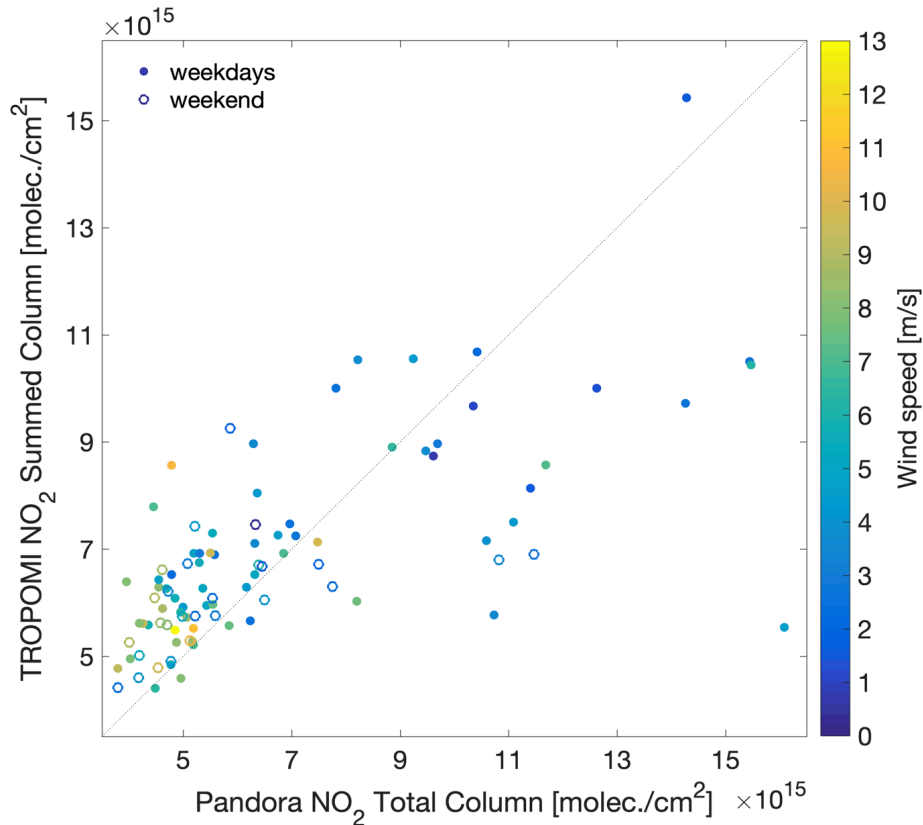
Data screening: TROPOMI QA>0.75, Pandora QF=0,1,10,11



- **TROPOMI summed columns**
- **Pandora total columns**
- **Pandora total columns (ovp)**
- **In situ NO<sub>2</sub> concentrations**

# Scatterplot comparison

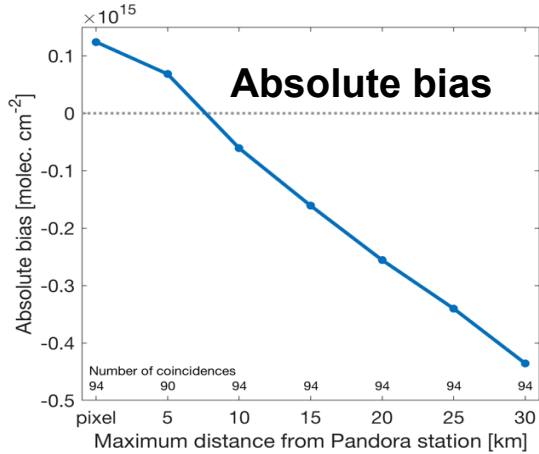
TROPOMI Summed NO<sub>2</sub> column vs  
Pandora total column



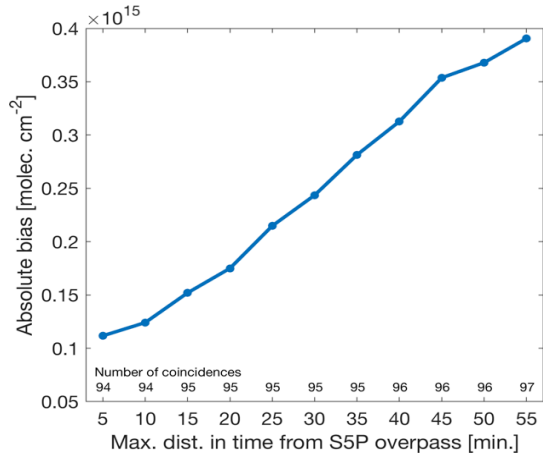
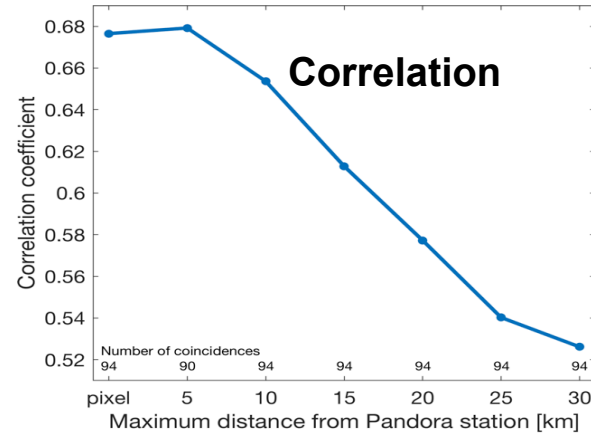
MEAN BIAS = 9.9% ( $1.2 \times 10^{14} \text{ molec./cm}^2$ )  
 $r=0.68$   
slope=0.42

- TROPOMI NO<sub>2</sub> is smaller than the GB for high NO<sub>2</sub> due to dilution within the pixel and higher for low NO<sub>2</sub> (stratospheric overestimation?)
- NO<sub>2</sub> levels smaller in the weekend due to reduced emission from commuter traffic
- NO<sub>2</sub> levels smaller for strong wind conditions due to transport/dilution

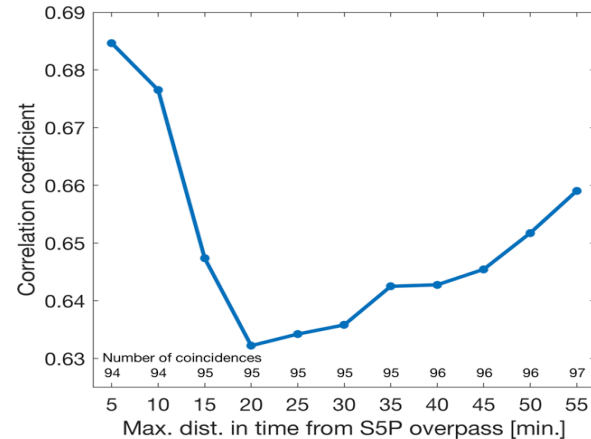
# Effect of the overpass criteria



- MD gradually shifts towards negative values when the radius increases
- averaging over a larger area causes the resulting TROPOMI vertical columns (used in the comparison) to become smaller than those obtained from the single overlaying pixel because of the inhomogeneous spatial distribution of NO<sub>2</sub>
- Correlation decreases at the same time

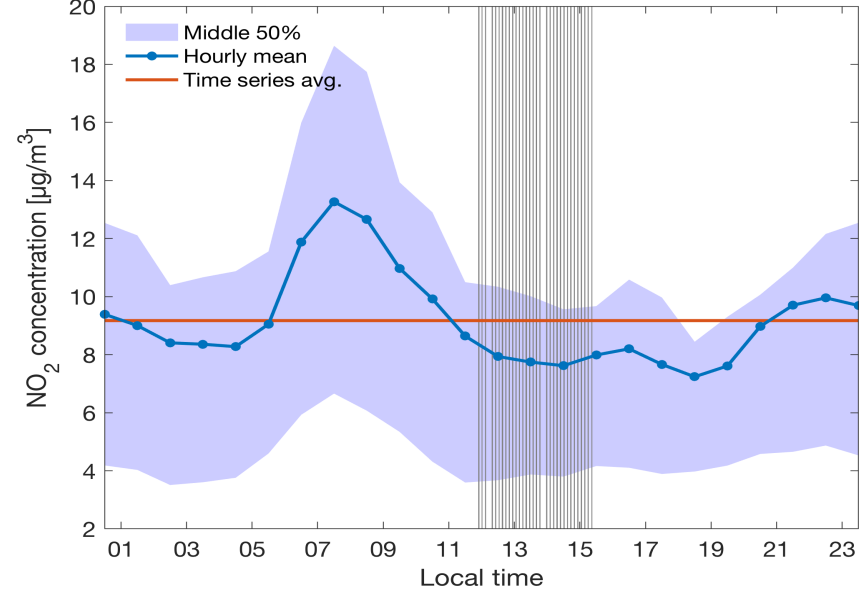
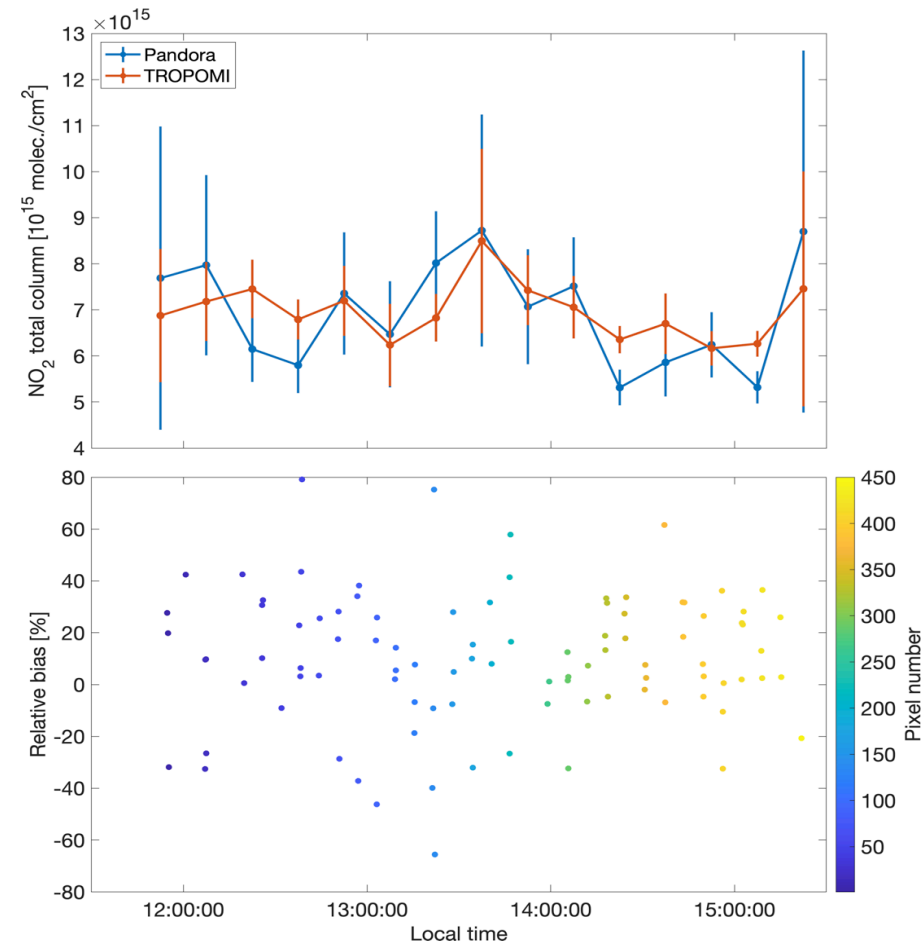


- MD increases with increasing temporal averaging interval
- Averaging over an increasing time range generally slightly reduces the Pandora total column values used in the comparison with TROPOMI, making the MD more positive.



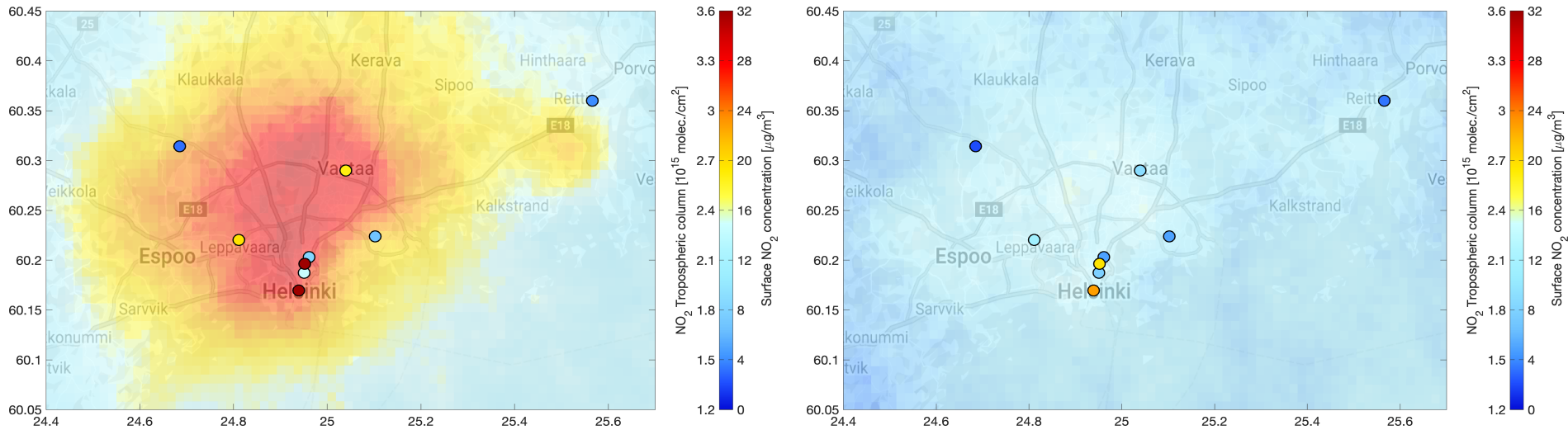


# Daily variability



- TROPOMI overpass time is between 12-15 local time. We miss the traffic related morning and afternoon peaks but TROPOMI  $\text{NO}_2$  value represent about the daily average condition.
- The first ovp of the day corresponds to the left side of the orbit (smaller pixel numbers) while the second to the right side (higher pixels number). The rel. difference is similar but the dispersion in the latter case is somewhat smaller.

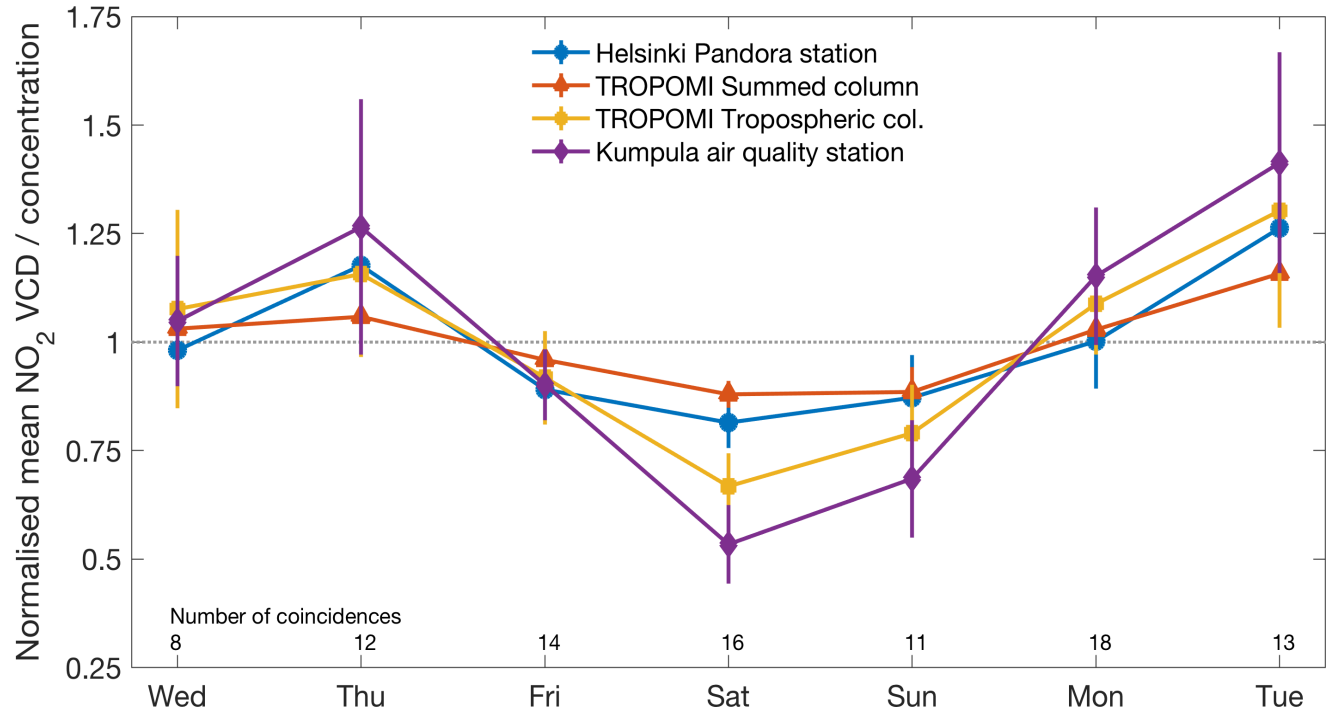
# Weekly variability



- NO<sub>2</sub> levels smaller in the weekend due to reduced emission from commuter traffic
- Both satellite and in situ measurements observe the same weekend effect but quantitatively in situ measurements are more sensitive to changes in pollution occurring at the surface (see next slide)

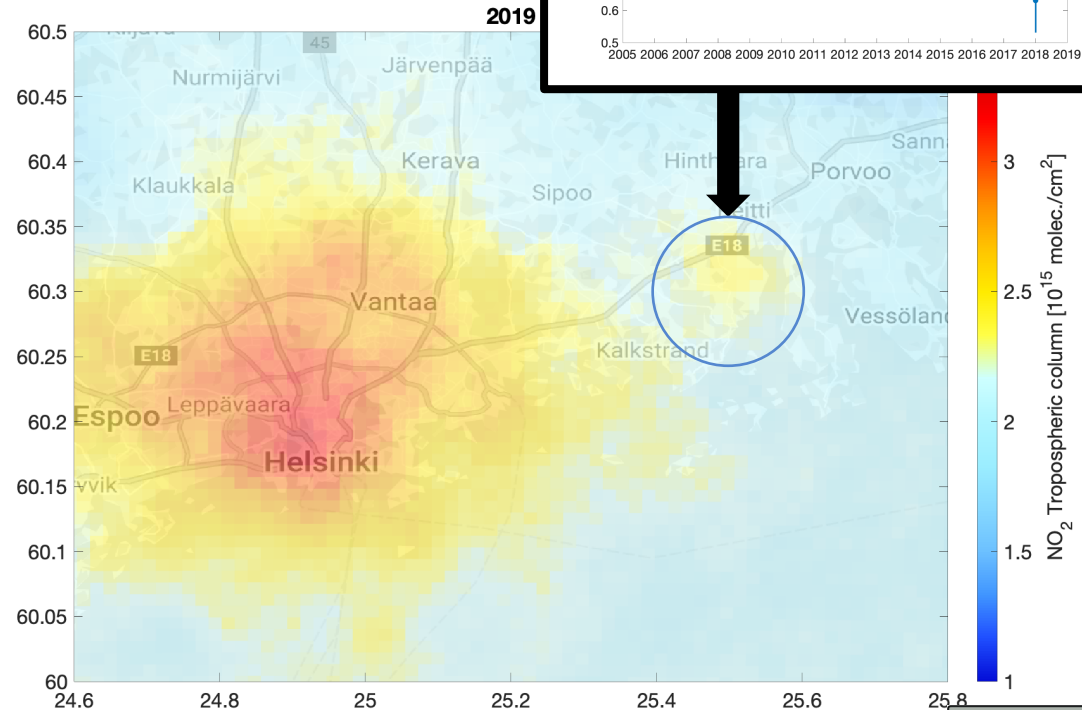
# Weekly variability

- NO<sub>2</sub> surface concentrations show about 30–50 % smaller values during the weekend compared to the weekly average
- TROPOMI tropospheric columns are about 20–30 % lower
- Pandora and TROPOMI summed NO<sub>2</sub> vertical are about 10–20 % lower. This is because no weekend effect is expected in the stratospheric fraction of the NO<sub>2</sub> column.



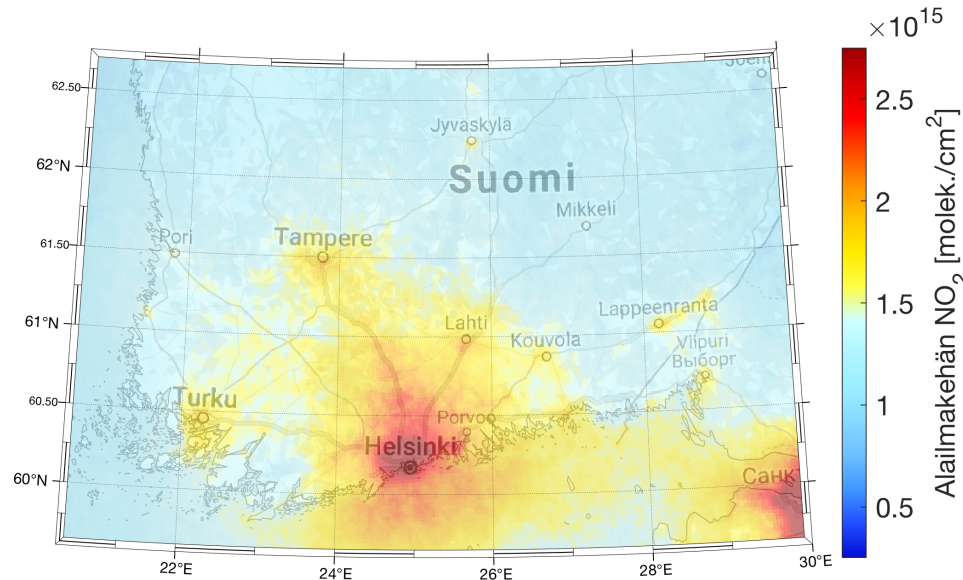
# Societal applications: NO<sub>2</sub> monitoring over oil refineries to support corporate responsibility

- NO<sub>2</sub> emission from oil refineries in Kilpilahti (Porvoo, 40 km East from Helsinki) detected from satellite-based TROPOMI NO<sub>2</sub> tropospheric columns maps
- OMI NO<sub>2</sub> time series show a similar decrease from satellite- and in situ measurements since 2005 over the refinery
- Information used in company (NESTE) annual sustainability report
- Method: iterative interaction and consulting, service planned on annual basis



# Societal applications: Report to ministry of Environment

- **Aim:** evaluate satellite-based NO<sub>2</sub> observations capability to complement traditional in situ surface measurements for air pollution monitoring in Finland
- High resolution NO<sub>2</sub> maps over Finland have been produced from TROPOMI NO<sub>2</sub> observations and compared to Pandora and in situ observations (see next slide)
- **Results** reported to the Finnish Ministry of Environment (FME) to support decision making and will be used in future applications and reporting at national/EU level
- Method: iterative interaction, reporting and consulting, service planned on demand



**Outcome: Report to FME (in Finnish) available [here](#)**

See more in the display by H. Virta May, 7<sup>th</sup> at 10:45

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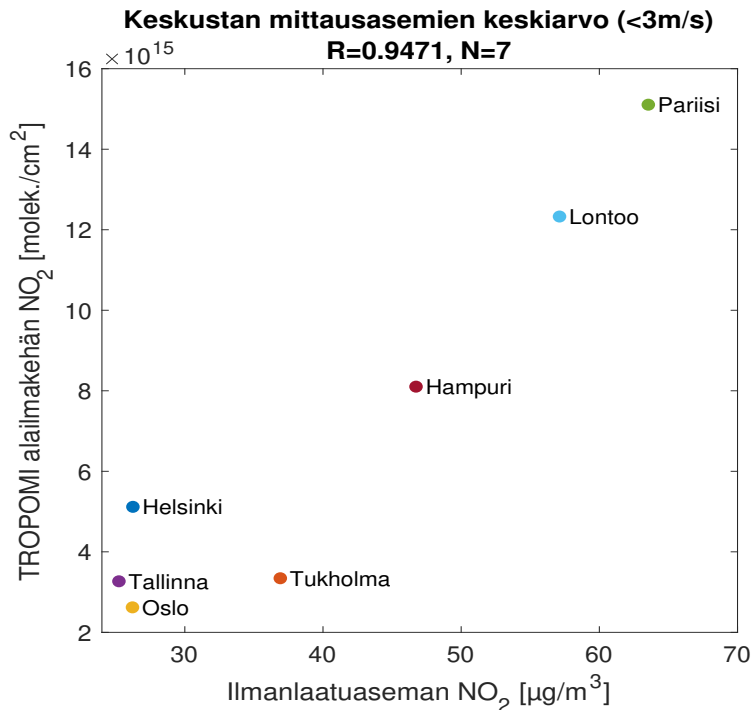
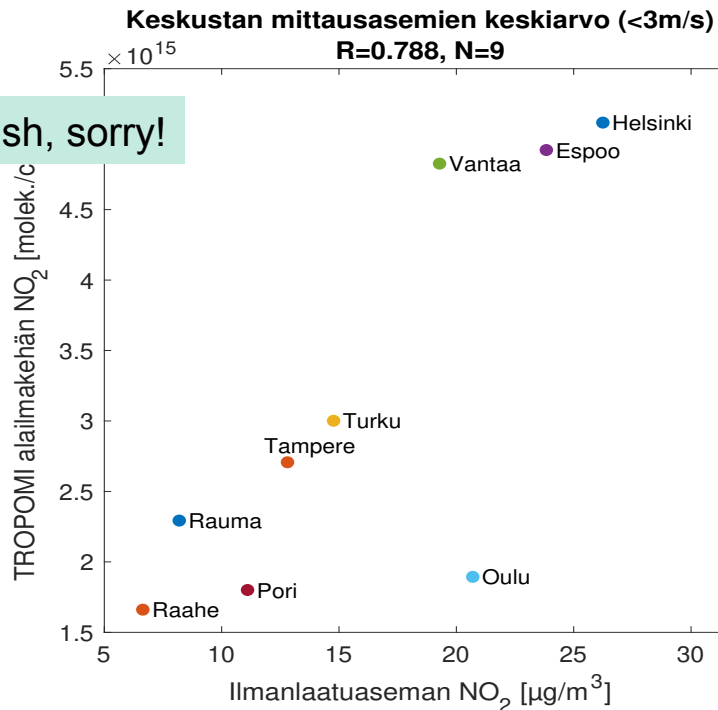
**Evaluating the Potential of Satellite Measurements in Air Quality Monitoring: A Project for the Finnish Ministry of the Environment ▶**

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# Correlation with in situ AQ measurements

In Finnish, sorry!



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# Thank you

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## REFERENCES

- Ialongo, I., Virta, H., Eskes, H., Hovila, J., and Douros, J.: Comparison of TROPOMI/ Sentinel-5 Precursor NO<sub>2</sub> observations with ground-based measurements in Helsinki, Atmos. Meas. Tech., 13, 205–218, <https://doi.org/10.5194/amt-13-205-2020>, 2020.