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METEOROLOGISKA INSTITUTET
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Applications of Satellite Observations of Tropospheric NO_2 at High Latitudes for Monitoring Air Quality (ILMA): objectives and first results

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Objectives

1. Increase the scientific exploitation of satellite data at high latitudes, with focus on tropospheric NO_2 observations.

2. Evaluate the quality of satellite NO_2 products at high latitudes (e.g., for snow/ice surface cover) through comparison with ground-based observations.

3. Provide information for retrieval algorithm developments for the upcoming TROPOMI on Sentinel 5 Precursor.

4. Design a pilot demonstration study for air quality monitoring using satellite data for Helsinki Region Environmental Service Authority (HSY).

Dataset

OMI NO_2 total and tropospheric columns from standard product, SP (Bucsela et al., 2013) and DOMINO product (Boersma et al., 2011) are used.

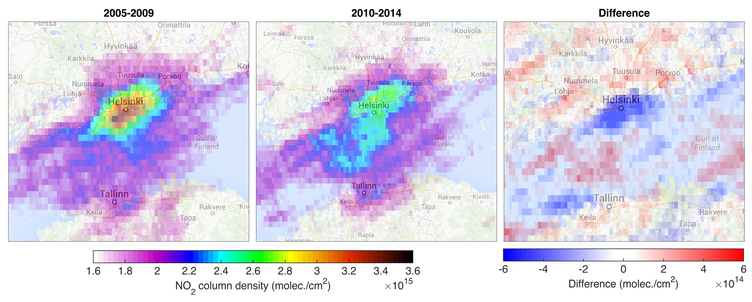

Fig. 1 OMI tropospheric NO_2 during the last 10 years over Helsinki. A reduction by about 20% is observed.

NO_2 total column from Pandora spectrometer located at Kumpula site (Helsinki). Pandora measures sun and sky radiance spectra from 270 to 530 nm in 0.5 nm steps with 1.6° field of view (Herman et al., 2009).
Time resolution: about 90 s
Measurement error = 0.1 DU

The **NO_2 surface concentrations** available at Kumpula are obtained from SMEAR database (Junninen et al., 2009).
Website: http://avaa.tdata.fi/web/smart/smear
The measurements are derived from chemiluminescence analyser with detection limit 0.5 ppb.

Comparison between OMI and Pandora NO_2

May

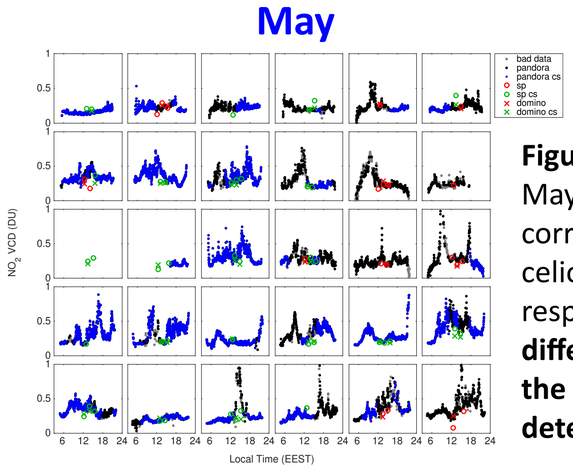

Figure 2. OMI and Pandora NO_2 total columns during May 2012. Blue dots and green circles/crosses correspond to clear sky conditions based on celiometer cloud cover and OMI cloud fraction (CF), respectively. **More than 70% of the cloud-screening differences correspond to SZA>75°, suggesting that the observing geometry might affect the cloud detection.**

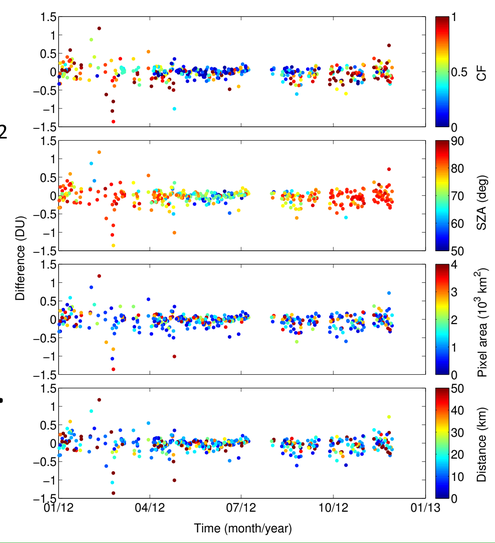

Figure 3. Comparison between OMI and Pandora NO_2 total column. Color scale corresponds to OMI CF, solar zenith angle (SZA), pixel area and distance between the city center and the center of the pixel**. Large SZAs correspond to cloudy autumn-winter days and to larger differences between OMI and Pandora. The median relative difference is 1% and -6% for clear sky and all sky conditions, respectively.**

Seasonal cycle

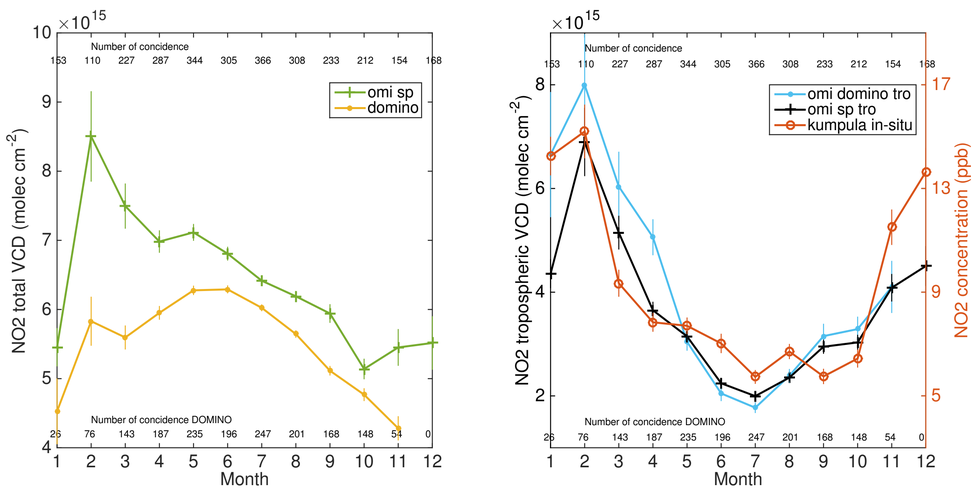

Figure 4. Seasonal cycle during 2005-2014. **Left panel:** OMI total column monthly means for CF<0.5. **Right panel:** OMI NO_2 tropospheric column and surface concentration monthly means. Different datasets show similar seasonal cycle with the largest values in winter. **OMI tropospheric column best reproduces the surface concentration seasonal cycle.**

Weekly cycle

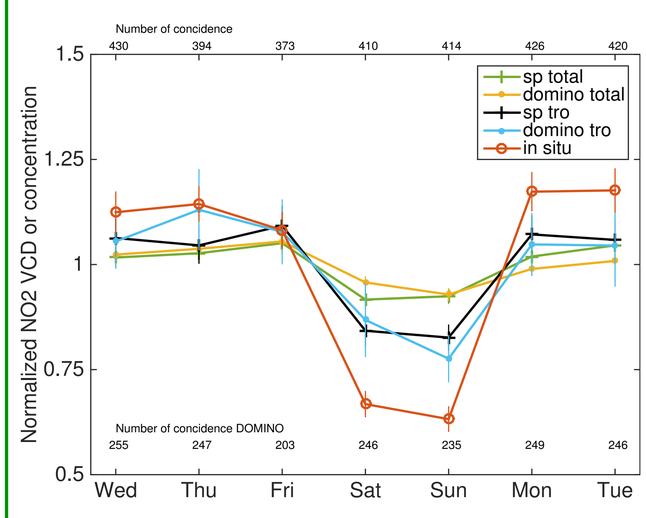

Figure 5. NO_2 weekly cycle for CF<0.5 from OMI total and tropospheric columns and surface concentrations in Helsinki **during 2005-2014**. The mean values for each day of the week are normalized with the weekly mean values to enhance the relative changes. **All datasets show smaller NO_2 values during the weekend compared to the weekdays.**

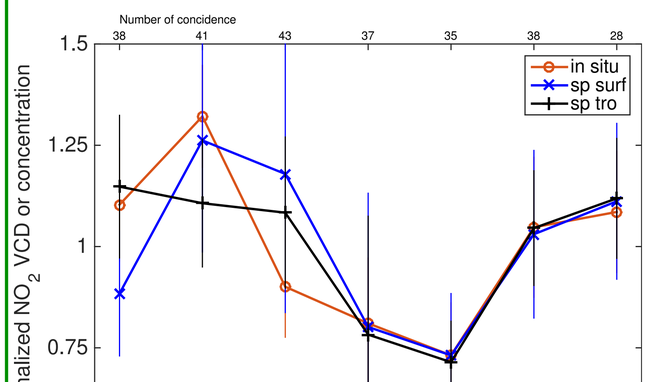

Figure 6. Comparison of NO_2 weekly cycle from OMI tropospheric columns and surface concentrations from Kumpula air quality station in Helsinki and from OMI tropospheric column converted to surface concentrations. The concentration (C) is obtained using the method by Knepp et al. (2013):

$$C = \frac{OMI_{tro}}{h * const}.$$

The PBL heights (h) are derived from LIDAR observations **during 2011-2013**. **Satellite-derived data show similar weekend effect than ground-based surface concentrations.**

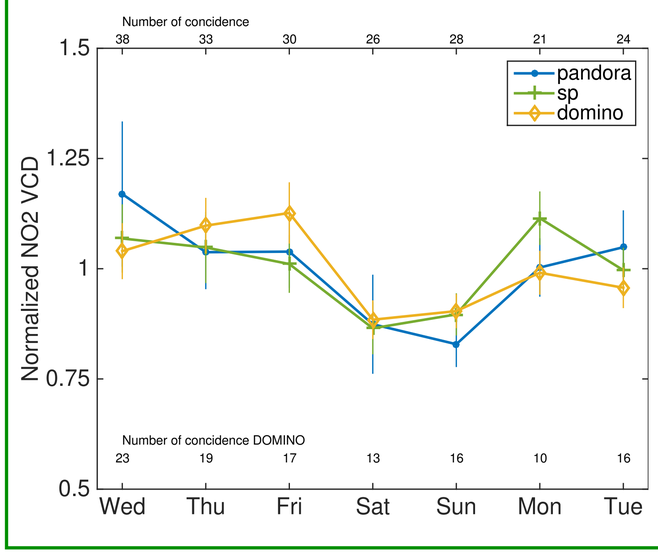

Figure 7. Comparison of NO_2 total column weekly cycle from OMI and Pandora spectrometer observations in Helsinki **during 2012**. **Satellite data show similar weekend effect than ground-based total columns.**

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