

### FINNISH METEOROLOGICAL INSTITUTE WEATHER · SEA · CLIMATE · SPACE

### Improving societal impact of satellite-based atmospheric observations for air pollution monitoring using Sentinel data

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### **TROPOMI/Sentinel 5P**



Launched 13 October 2017 on a Sun-syncronous polar orbit with overpass time at 13:30.<sup>2</sup>

### **Science products**



### TROPOMI measures Sun light backscattered from the atmosphere and the surface



## Nitrogen dioxide (NO<sub>2</sub>)





### Urban AQ monitoring in Helsinki

TROPOMI NO<sub>2</sub> data are suitable for air pollution monitoring on daily scale.

May 29, 2018



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## **Urban AQ monitoring: tropospheric NO<sub>2</sub>**

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Satellite tropospheric  $NO_2$  data can be combined with in situ AQ data.



## **Urban AQ monitoring: tropospheric NO<sub>2</sub>**

Weekly cycle

#### Antwerpen

Reduction during weekend: -31.7%



### Only weak winds are considered here to remove the largest part of transport from Helsinki.

#### Time-averaged Tropospheric NO<sub>2</sub> (resolution 0.01°) ×10<sup>15</sup> 5.5 2018-05-10 13:01 - 2018-07-31 14:06 Vihti Porvoo 5 60.4 4.5 4 3.5 2 5.5 5 1 1 1.5 2 1.5 1 1 1 1 1.5 1.5 1.5 1 1 1 1 Vantaa 60.3 O Helsinki **Espoo**o Catitude 5:09 Kirkkonummi 60.1 **Kilpilahti** 60 0.5 59.9 0 25.6 24.2 24.4 24.6 24.8 25 25.2 25.4 25.8 08/11/18 8 Longitude Picture: Henrik Virta, FMI

~3 months data

Data within 10 km from the source are rotated to simulate a scenario with winds only from east to west. The results is the small plume eastward from Porvoo refinery. This scenario proves that we can detect the small signal

coming from the refinery and can be used to estimate annual emissions.



Longitude



### **Urban AQ monitoring: trend analysis**

#### Year-to-year comparison to highlight pollution changes







## India's bad air quality

Poor air quality over North India (Punjab) due to crop residue burning



NO2 Emission (Sentinel5p) 27/10/18

smoke detection (sentinel3 1km) 27/10/18

active fire detections(VIIRS 375m) 27/10/18



## Sulfur dioxide (SO<sub>2</sub>)

SO2 is emitted by power plants, metal smelters, oil refineries and volcanoes



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## **Sulfur dioxide emissions**



Lon



# **Support to Finnish CleanTech sector**

### Tsumeb, Namibia

A large reduction (about 80%) in  $SO_2$ concentrations and emissions was observed after the implementation of a sulfuric acid plant (designed to remove  $SO_2$  emissions to the atmosphere) at the smelter by Finnish cleantech company Outotec Oy in 2015.





## Formaldehyde (CH<sub>2</sub>O)

CH2O is released from forest fires and transform into CO





## **Carbon Monoxide (CO)**

CO is released from incomplete combustion processes (forest fires and anthropogenic sources.



## **Aerosol Index (AI)**

Al is an indicator of absorbing aerosols (smoke, ash, desert dust)

MODIS/NASA

NO2 KNMI/ESA

CO SRON/ESA

Los Angeles

MONTANA

United States

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CENTERS

OKCAHO!

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FERRAL



### **Long-range transport of pollutants**

- Different pollutants can be transported long distances
  Long-range = several hundreds or thousands kilometers
- The transport of pollutants depend on:
  - Pollutant's typical "lifetime" in the air
  - Magnitude, and sometimes also height of the emission
  - Vertical and horizontal air flow, wind speed near the surface
  - Weather conditions (e.g. rain)
- Pollutants that typically travel long distances include e.g.
  - Desert dust
  - Smoke and carbon monoxide (CO) from large fires
  - Sulphur dioxide (SO<sub>2</sub>) and ash from volcanic eruptions



150°E

165

CO in November 2017 show long-range transboundary air pollution transport from India to China.

120°E

135

150

120

90°E

90

105

60°E

60

75

### **Dust from Sahara**



### **Smoke from Canada**



- Note that long-range transported pollution may or may not affect air quality at surface.
  - (Passive) satellite instruments see only the total column, not the vertical distribution of pollutants<sup>21</sup>







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