Meten van luchtvervuiling
satelliet en burger vullen elkaar aan

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Satellite measurements

- How to measure air pollution from space
- From concentrations to emissions
- Emission variability
- Future missions: TROPOMI

Low-cost ground measurements

- iSPEX results on a city level
- KNMI NO2 sonde: City-Sonde campaign
- Solving sensor issues
The Ozone Monitoring Instrument (OMI)

EOS Aura satellite
Sun-synchronous Orbit

- 700-800 km altitude
- Always same orientations towards sun: rotates eastward about 1 degree each day.
- Each orbit experiences about 30 minutes darkness and 72 minutes sunlight
- OMI local overpass time: 13:00
- Daily global coverage
Measuring trace gases from space
World map NO$_2$

OMI 2005-2008
Emission Inventories: Bottom-up approach

Emission = Factor x Activity

- Based on statistics
- Emission factors often unknown
- Often outdated, incomplete or simply wrong
From concentrations to emissions: Basic tools

NO$_2$ retrievals from OMI and GOME2

CHIMERE 0.25°×0.25°
Properties of DECSO*

Takes transport into account
enables high resolution (~25×25 km²)

Relatively fast
enables operational emission estimation

Emission updates by addition
enables detection new hotspots / relocation existing hotspots

* Daily Emission estimates Constrained by Satellite Observations
NO$_2$ hot spots in the Middle East
NO$_2$ hot spots in the Middle East

Tropospheric NO$_2$ for 2008 by OMI

$10^{15}$ molec/cm$^2$
NO\textsubscript{2} hot spots in the Middle East

NO\textsubscript{x} emissions EDGAR v4.2 2008

1e10 kg(N) m\textsuperscript{-2} s\textsuperscript{-1}

0.0 0.2 0.4 0.6 0.8 1.0
Korea at night
North vs South Korea

NO$_x$ emissions by OMI (2011)

Nighttime lights by VIRRS
China: Economic indicators

Average annual income per capita, 1980-2008

China’s electricity production, 1980-2010

Number of vehicles in Beijing, 1998-2015

China’s urbanization, 1980-2011

Source: China Statistical Yearbook, China Daily (17/2/09)
Decrease of NO$_x$ emissions in China

![NOx Emission in East China](chart)

![NOx emission peak year](map)
Case study:

The monthly NO\textsubscript{x} emission estimates by DECSO in Nanjing for 2013 and 2014, and the monthly NO\textsubscript{x} emission of the MEIC inventory of 2010. The shaded areas show the error of the mean NO\textsubscript{x} emission estimates from DECSO.

*Ding et al., Atmos. Chem. Phys. Discuss., 15, 2015*
The ESA Sentinel-5 Precursor (S-5P) is a pre-operational mission focusing on global observations of the atmospheric composition for air quality and climate.

The TROPOspheric Monitoring Instrument (TROPOMI) is the payload of the S-5P mission and is jointly developed by The Netherlands and ESA.

The planned launch date for S-5P is 2016 with a 7 year design lifetime.

**TROPOMI**
- UV-VIS-NIR-SWIR nadir view grating spectrometer.
- Spectral range: 270-500, 675-775, 2305-2385 nm
- Spectral Resolution: 0.25-1.1 nm
- Spatial Resolution: 7x7km²
- Global daily coverage at 13:30 local solar time.

**Contribution to Copernicus**
- Total column O₃, NO₂, CO, SO₂, CH₄, CH₂O, H₂O, BrO
- Tropospheric column O₃, NO₂
- O₃ profile
- Aerosol absorbing index & layer height
iSPEX: measure aerosols with your smartphone

Measurements Amsterdam, 8 July 2013
Amsterdam
iSPEX 8 July 2013 (averaging 10 closest measurements)
Relation to ground measurements

7 Jul 2013 (<1.5 km)

5 Sep 2013 (<1.5 km)
KNMI NO$_2$ sonde
Meting van NO₂ rond de RAI, 11 nov 2013

Diagram: Grafiek tonend de concentratie van NO₂ in verschillende locaties tijdens de dag. De locaties zijn aangeduid als Tramhalte, Beursvloer, Garage en Snelweg. De y-as draagt de concentratie van NO₂, terwijl de x-as de tijdsduur in seconden aangeeft.
First results City-Sonde, 3 June 2015
Welcome to Snuffle.org!

Air pollution is very difficult to measure. Apart from the expensive, professional equipment, more and more inexpensive alternatives become available. Because of the many scattered initiatives, information about the usefulness of these low-cost sensors is difficult to find. This wiki intends to bring together all the available information about sensors (i.e., the components sensitive to air pollution) and sensor boxes (i.e., practical devices containing sensors).

Here you will find information on manufacturers, the current state of technology, sensor specs, sensor issues, and evaluation reports. This is a public knowledge base to which everybody can contribute. If you have information which you would like to share, please register yourself and contribute to this wiki.

Gases
- O3 (Ozone)
- NO2 (Nitrogen Dioxide), NO (Nitric Oxide), NOx (Nitrogen Oxides)
- SO2 (Sulphur Dioxide)
- CO (Carbon Monoxide)
- CO2 (Carbon Dioxide)
- H2S (Hydrogen Sulfide)
- NH3 (Ammonia)
- VOC (Volatile Organic Compounds)

Particulate matter / Aerosols