

Atmospheric Measurements and Cal/Val activities conducted by ASC (ALOMAR) NILU and MET Norway

ALOMAR – Arctic Lidar Observatory



Alomar - atmospheric measurements

› Lidar Measurements:

ALOMAR Tropospheric Lidar, 3+2 Aerosol and Cloud Measurements
- Depolarisation, Backscatter, Extinction and Layer Structure

ALOMAR Ozone Lidar (DIAL System)

- Stratospheric Ozone density and ozone column
- Stratospheric Clouds and Temperature up to 50 km
- Water vapour mixing ratio in the troposphere (under construction)

› RPAS/Aircraft Measurements

- Temperature, Humidity and wind profiles up to 6000m
- Black Carbon and Aerosol Scattering

Cal/Val activities conducted by ASC (ALOMAR)

› Sentinel-5P validation plans

- Aerosol: Index, Layer Height and Column
- Ozone Profiles and Column

› ADM/AEOLUS validation plans

- Aerosol Index, Layer Height and Column
- Airborne Wind Measurements

› Airborne Campaign Measurements

- Contributions to international Cal/Val activities in Northern Scandinavia

› Activities for upcoming Sentinel, Earth Care and other Missions planned

Proposal Summary - NILU

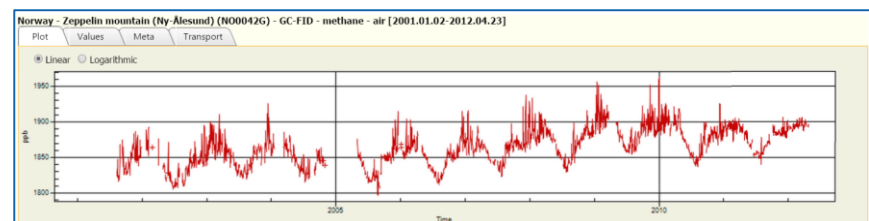
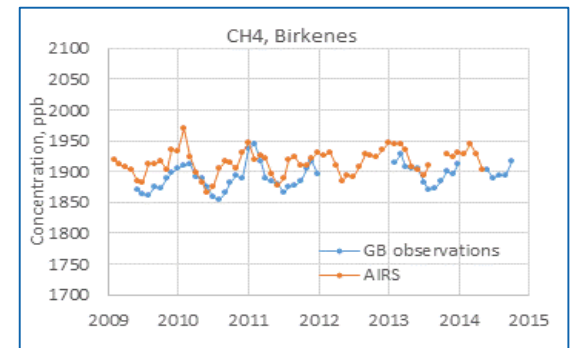
- Main goal: Validate methane (CH_4) and nitrogen dioxide (NO_2) products from TROPOMI onboard Sentinel-5P.
- The project aims to
 - evaluate the **quality and quantify the uncertainties** of the CH_4 and NO_2 products through a **combination of comparisons** against high-quality **near-surface observations** as well as **inter-comparison with satellite** product of proven quality.
- The project is divided in two work packages:
 - WP1 Methane
 - WP2 Nitrogen dioxide

WP1: Validation of the S5P methane product in the Arctic

- **Absolute validation** of CH₄ total column from Sentinel-5P will be carried out against the well characterised **long-term**, and the near-real-time, **near-surface observations** from the Norwegian Observatories at Birkenes (2009-present) and Zeppelin (2001-present). Data from other Arctic sites, e.g. Ny-Ålesund and Sodankylä may also be used.

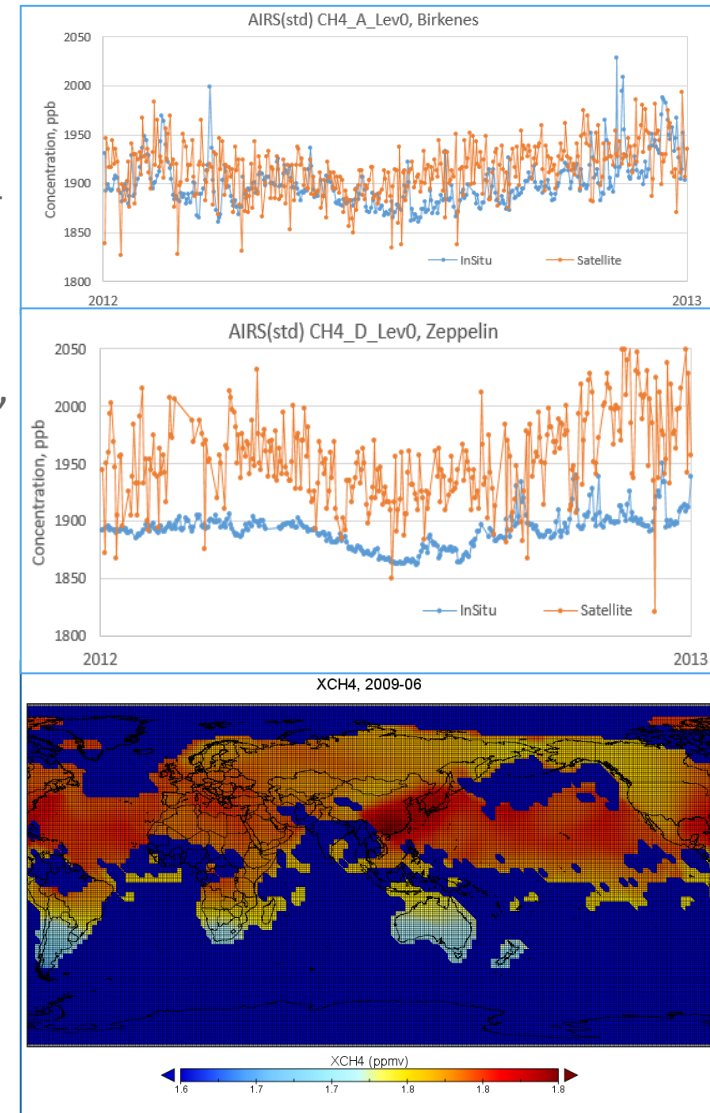


- Data sources
 - EBAS <http://ebas.nilu.no>
 - EVDC <http://evdc.nilu.no>



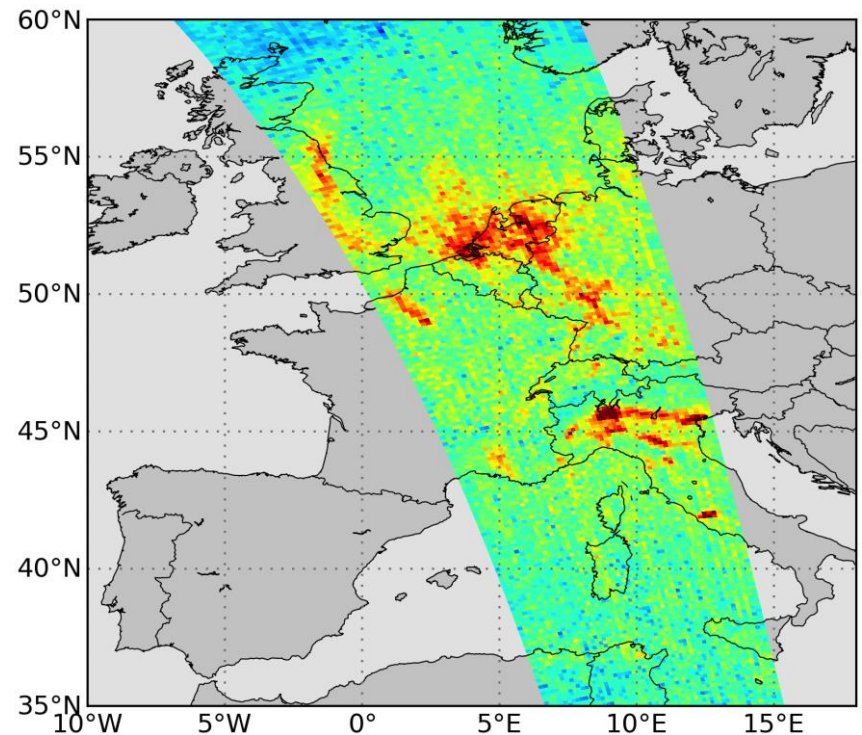
WP1: Validation of the S5P methane product in the Arctic

- **Relative validation** will be carried out by **inter-comparing** the CH₄ total column from Sentinel-5P against GOSAT-IBUKI, AQUA-AIRS and MetOp-IASI CH₄ products.
- Longer time series of satellite data from GOSAT, IASI, AIRS, in addition to the SCIAMACHY data, are in-house, and new products are downloaded from the primary sources as soon as they become available.
- The relative validation will cover both polar areas and other parts of the globe, e.g. mid-latitudes.
- Global and regional difference maps between TROPOMI CH₄ and other EO products will be generated for studies of the spatial patterns in inter-sensor biases.



WP2: Validation of Nitrogen Dioxide

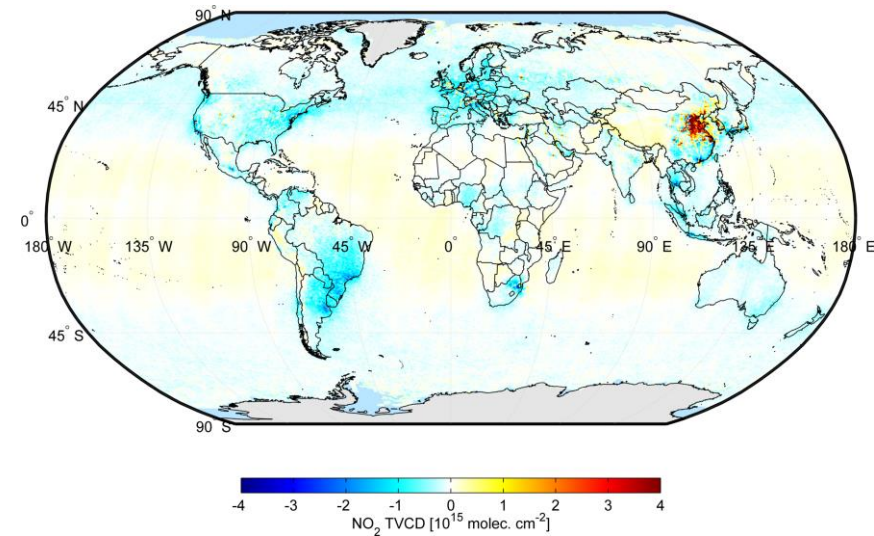
- Nitrogen dioxide is among the most important air pollutants and one of the primary products of TROPOMI/S5P
- TROPOMI/S5P will provide an unprecedented spatial resolution of $7 \times 7 \text{ km}^2$
- Thorough validation of the data necessary, both using ground observations and other satellite instruments
- NILU focus here on inter-sensor comparisons: Intended as complementary method to ground-based NO_2 validation with MAX-DOAS (and other) instruments, to provide spatial perspective at global and regional scale



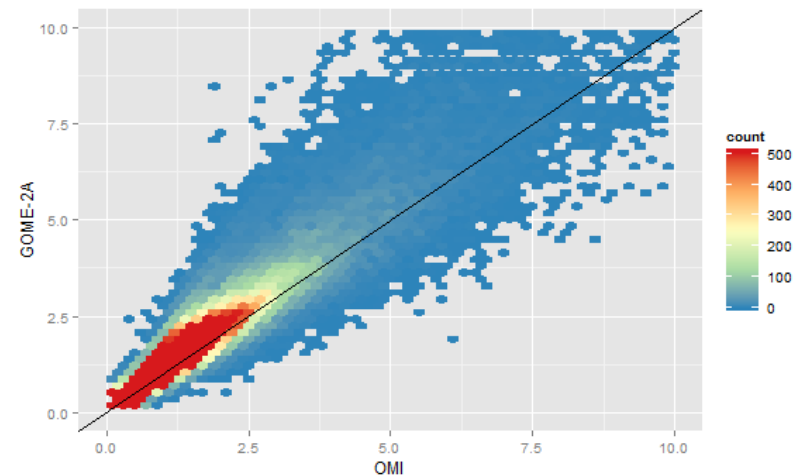
Spatial variability of NO_2 over Europe, measured with OMI's spatial zoom mode ($\sim 13 \text{ km} \times 12 \text{ km}$ at nadir)

WP2: Methodology

- Global inter-comparison with other NO₂ products (hopefully operational at time of S5P launch): OMI and GOME-2A/B
- Complementary to validation against MAX-DOAS data
- Main focus: Tropospheric NO₂ column (most relevant for air quality)
- Total NO₂ column also to be evaluated
- Primarily targeting highly polluted areas
- Careful matchup between instruments taking into account different sensor and product characteristics such as
 - Overpass time
 - Spatial resolution
 - Different properties of retrieval algorithm
- Qualitative comparison with respect to spatial patterns
- Quantitative statistical analysis of spatial and temporal inter-sensor differences at global, regional, and local scale



Difference between tropospheric NO₂ from OMI and GOME-2 for the 2007-2012 period



Scatterplot of 2007-2014 mean tropospheric NO₂ column from OMI versus GOME-2A

Met Norway cal/val activities

ESA cal-val AO application approved: First round 2007, updated 2014:

“High Resolution, High Latitude Regional Model Cal-val of ADM-AEOLUS”

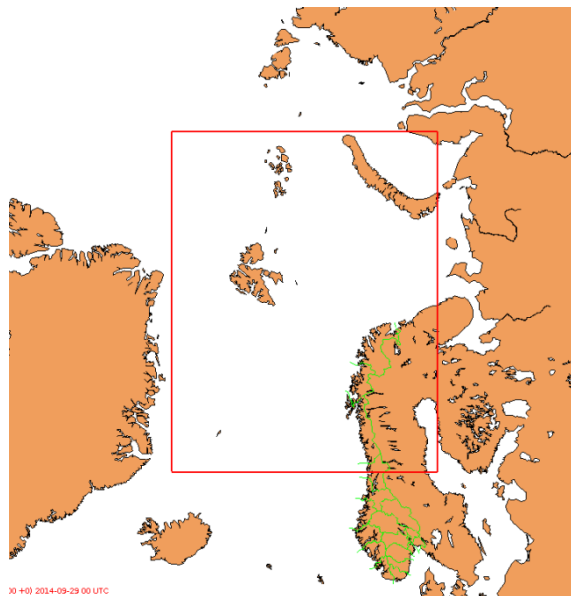
Main points:

- Collocation and statistics vs regional NWP model
- Statistics vs regional aerosol model
- Comparison with radiosonde data (possibly extra launches)
- Assimilation in regional NWP model

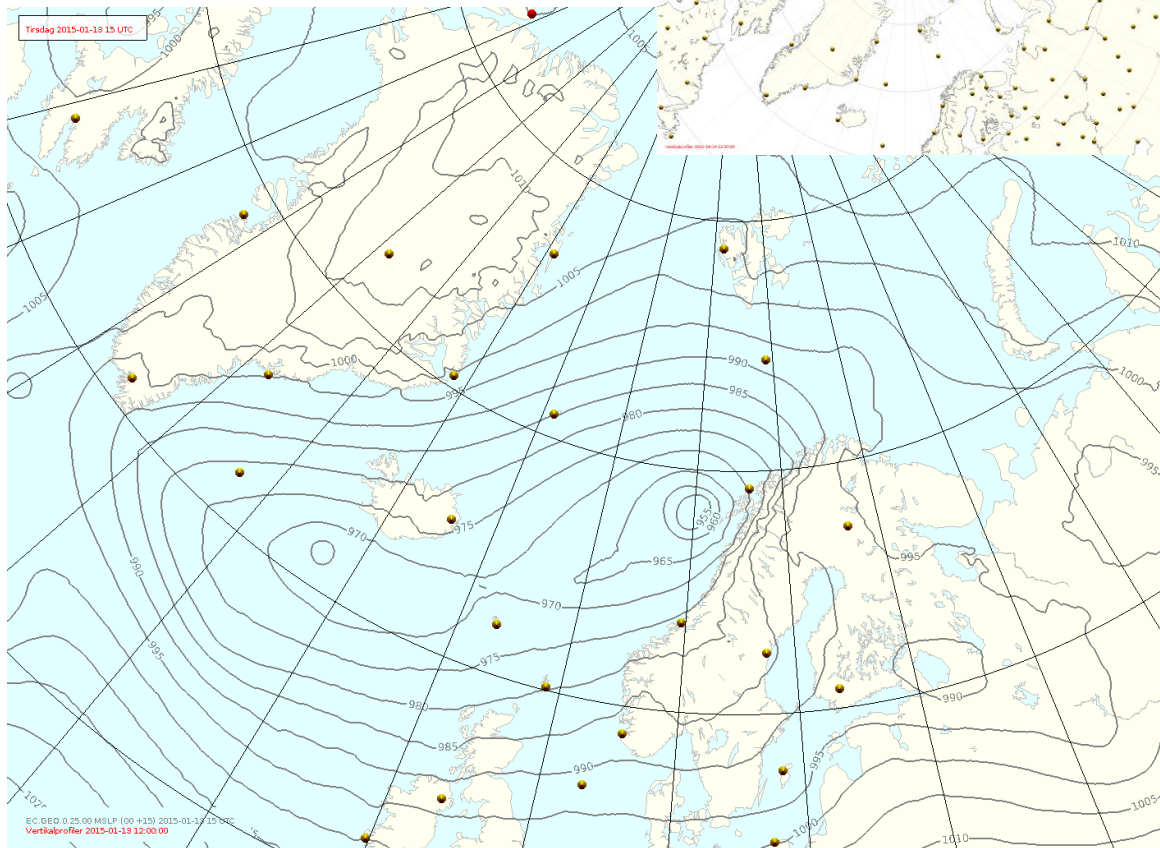
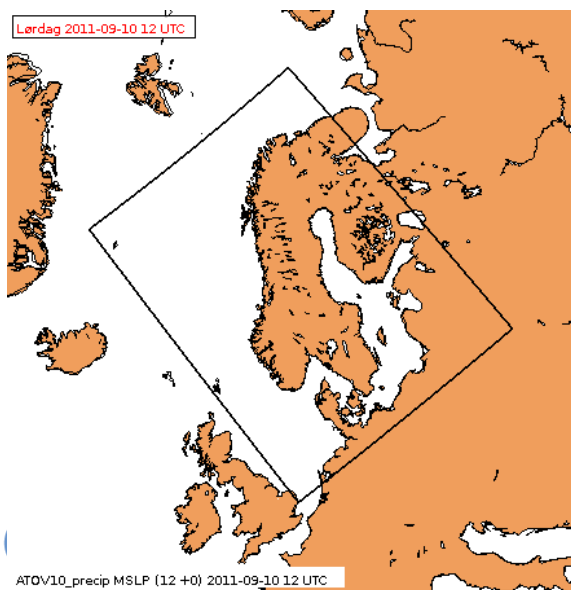
Coordination with other Norwegian efforts at ALOMAR and NILU (funding not yet settled - plans for joint PRODEX project funding)

Radiosonde coverage

ARCTIC



METCOOP



Typical distribution of radiosondes in the area (yellow dots) at cutoff time (russian sondes arrive later)

Cal/val: Colocation with radiosondes

Radiosonde stations on high latitudes are in favourable positions for providing collocations with Aeolus wind observations.

- Norwegian sondes on the Arctic islands Jan Mayen, Bjornoya and Svalbard and on mainland (in particular Andøya, close to Alomar)
- Norwegian radiosonde stations launch 2-4 times per day
- In addition to the regular launches, extra "targetted launches" at Aeolus overpass time could be done