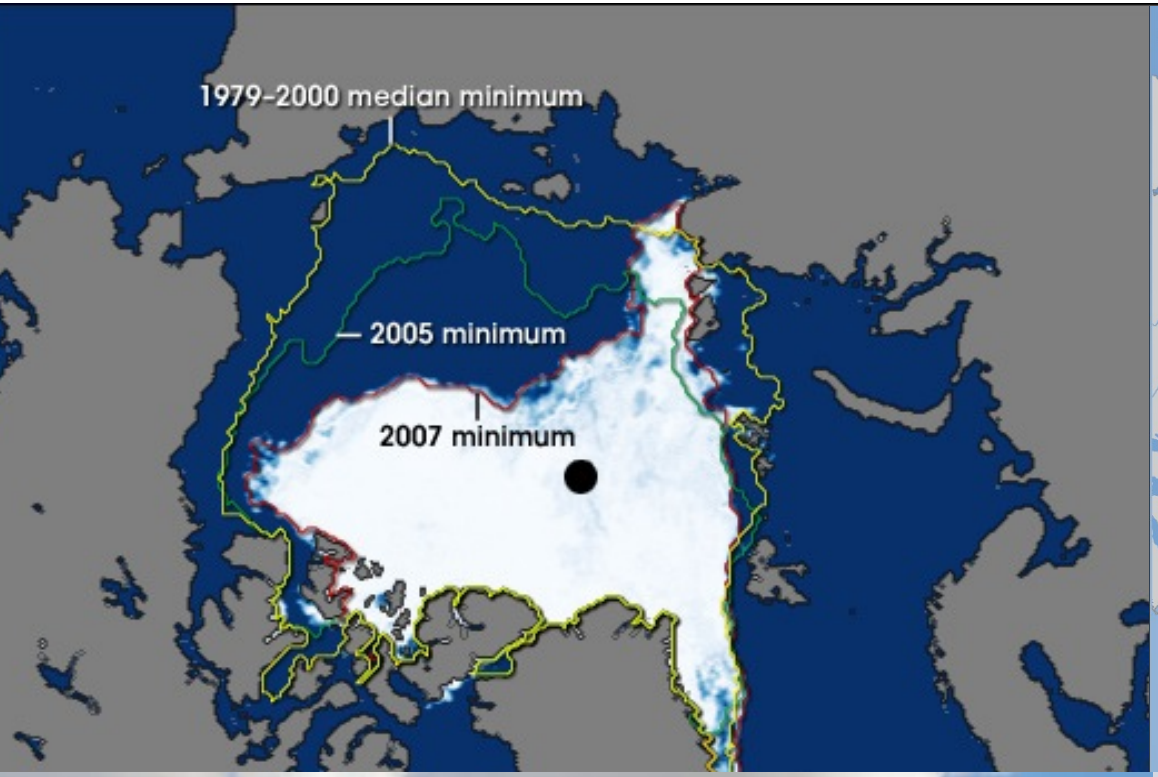
Ten years of OMI measurements in Finland – a high latitude perspective

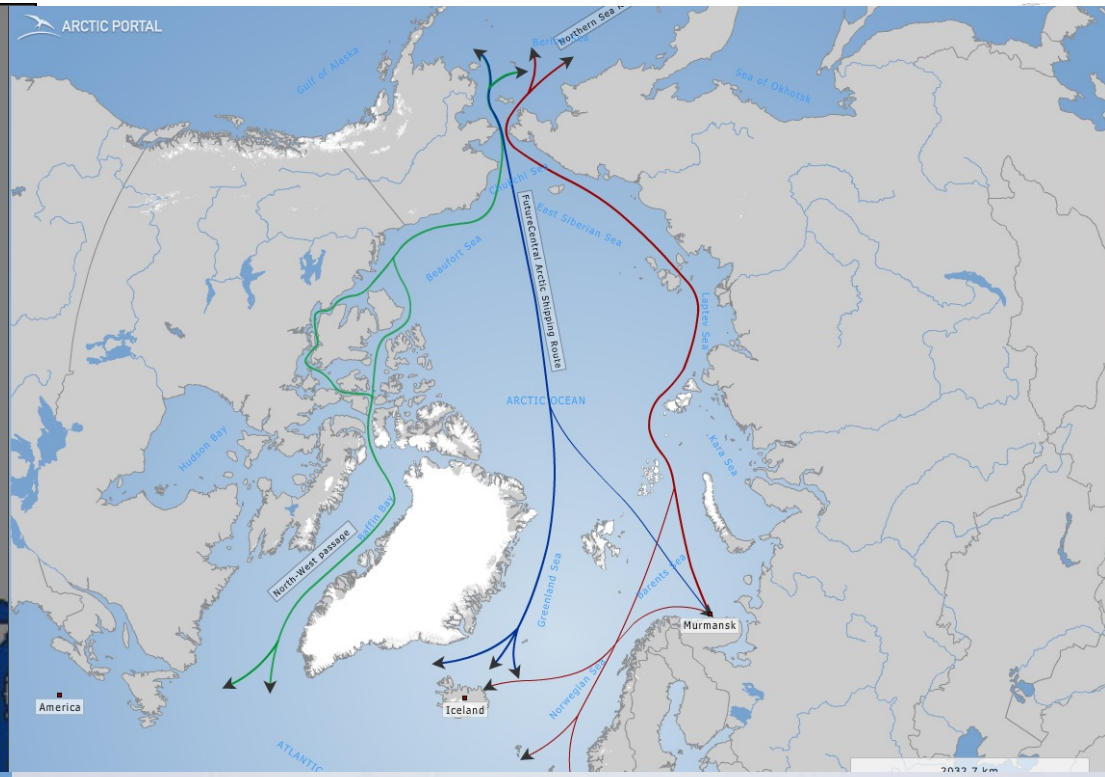
Aura Science Team meeting
College Park, September 15-18, 2014

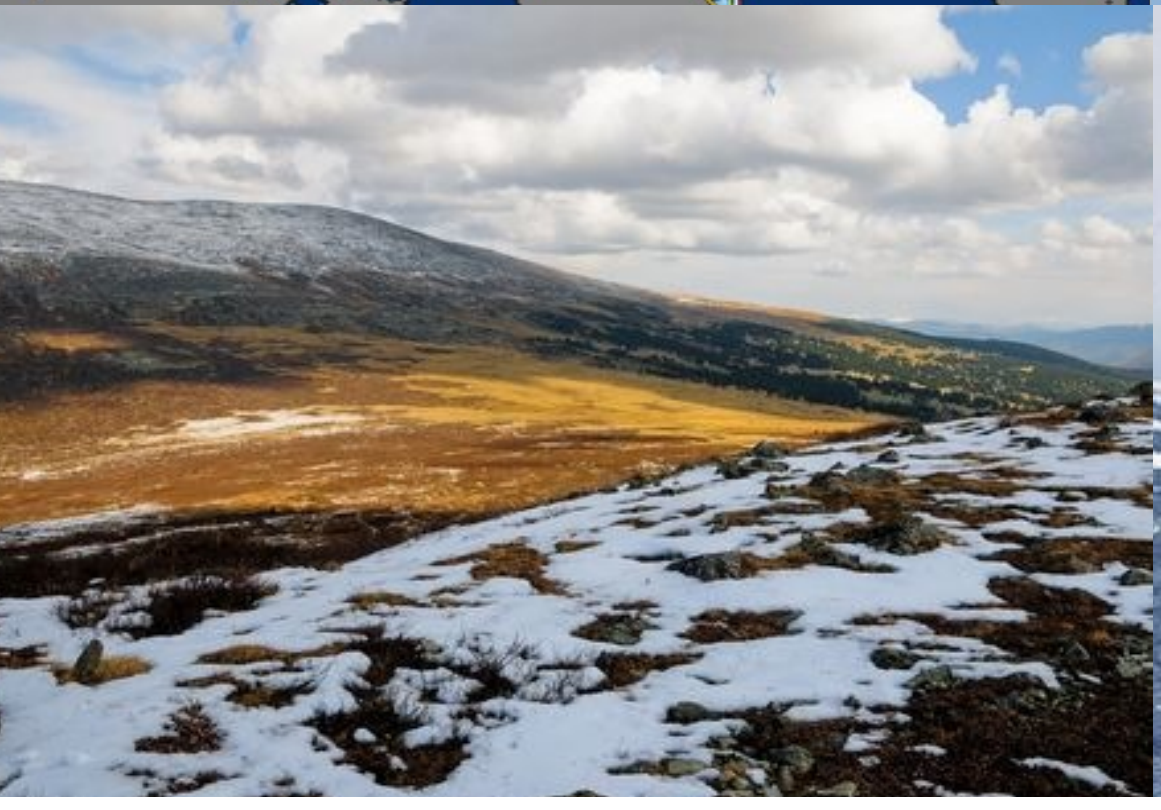
J. Tamminen, A. Arola, S. Hassinen, I. Ialongo,
R. Kivi, S. Tukiainen, J. Hakkarainen, J. Hovila,
A. Lindfors, T. Ryyppö, J. Vira, M. Sofiev, FMI

P. Levelt, P. Veefkind, F. Boersma, KNMI

P.K. Bhartia, J. Joiner, N. Krotkov, J. Herman, NASA


1979-2000 median minimum
2005 minimum
2007 minimum


ARCTIC PORTAL
Gulf of Alaska
Sea of Okhotsk
Northern Sea
East Siberian Sea
Beaufort Sea
FutureCentral Arctic Shipping Route
ARCTIC OCEAN
Hudson Bay
Kara Sea
Baffin Bay
North-West passage
Greenland Sea
Barents Sea
Murmansk
America
Iceland
Norwegian Sea
ATLANTIC



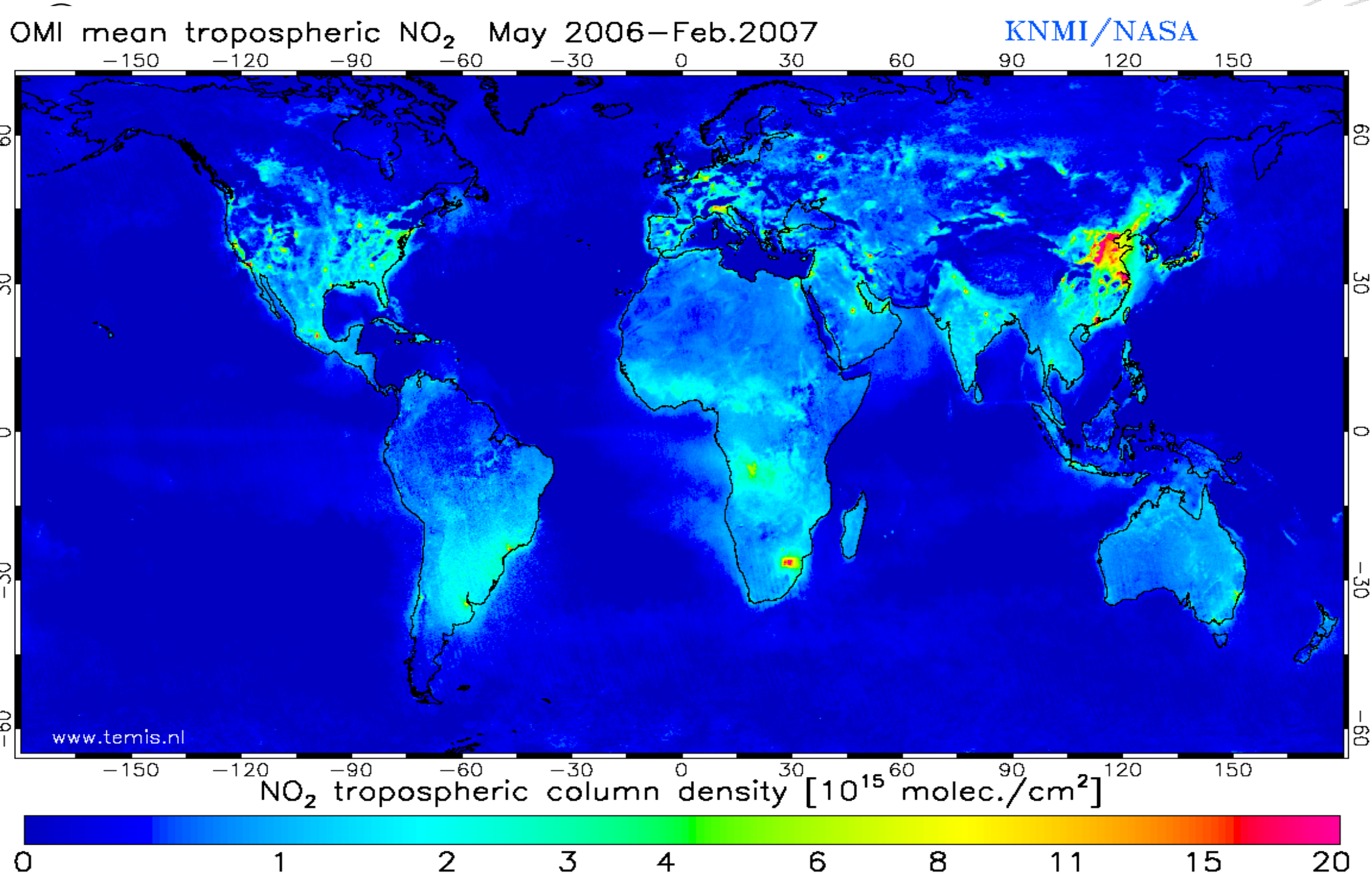


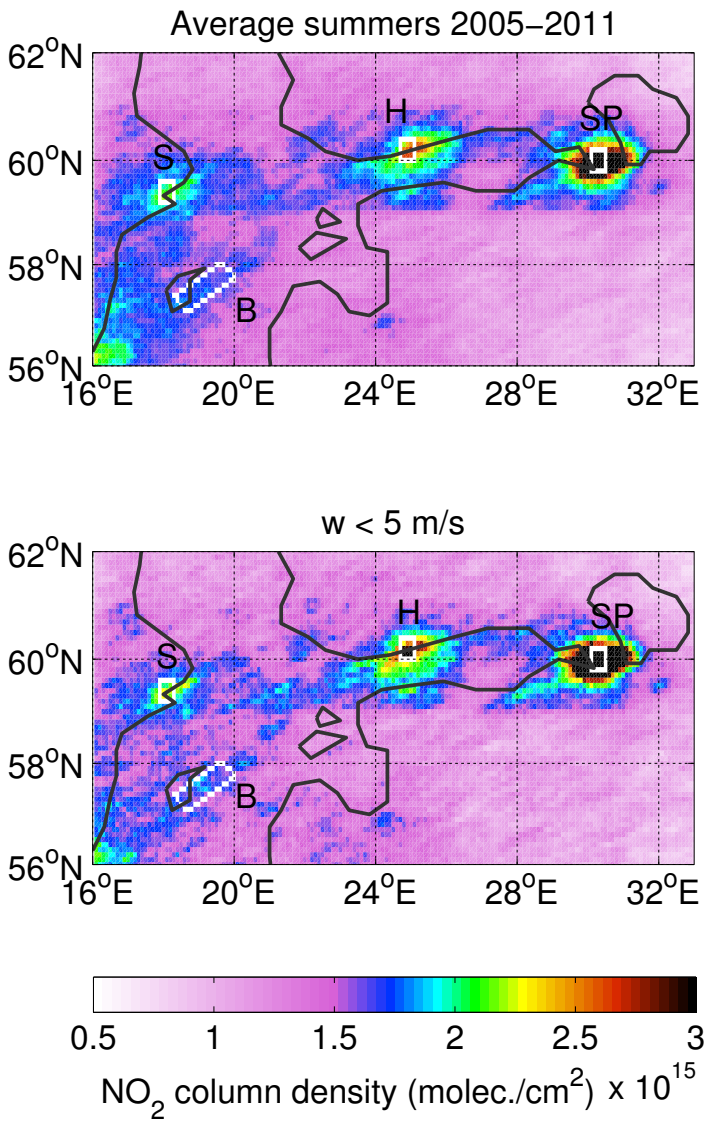
Figure from TEMIS service (www.temis.nl)

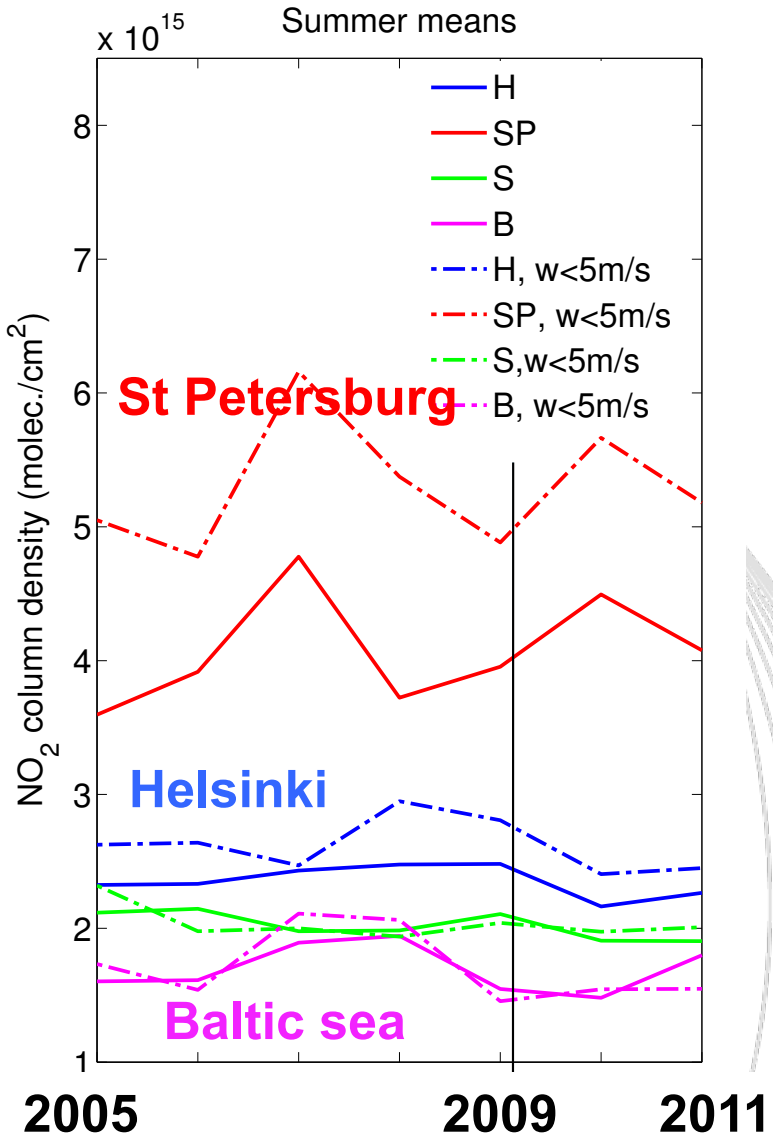
Ialongo, et.al, AMT 2014

OMI tropospheric NO_2: time series

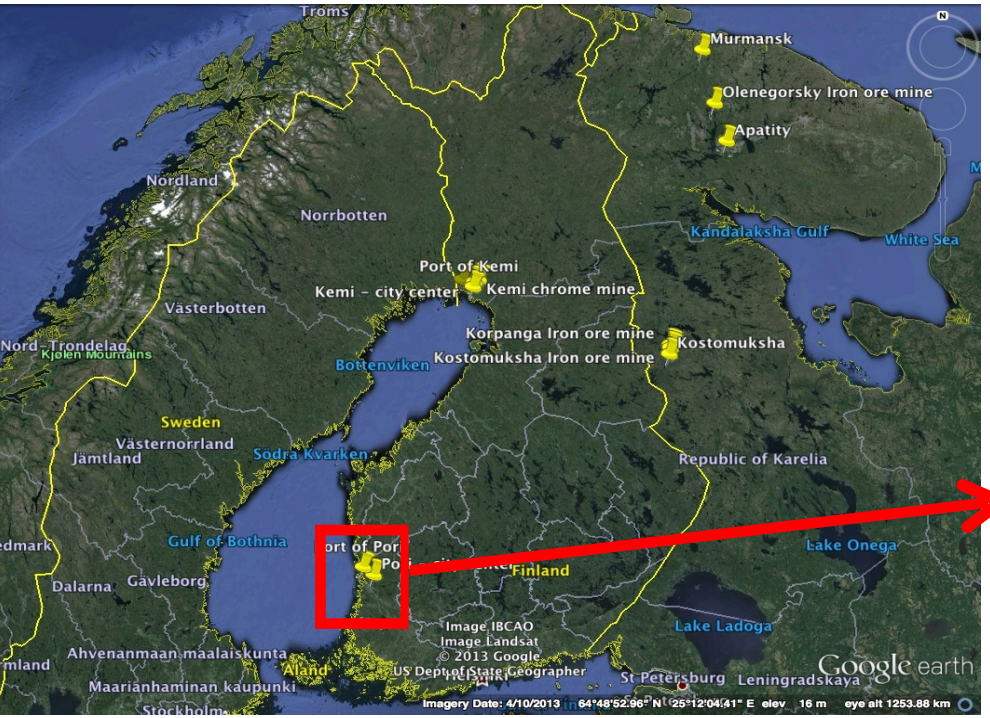
All winds
2005-11

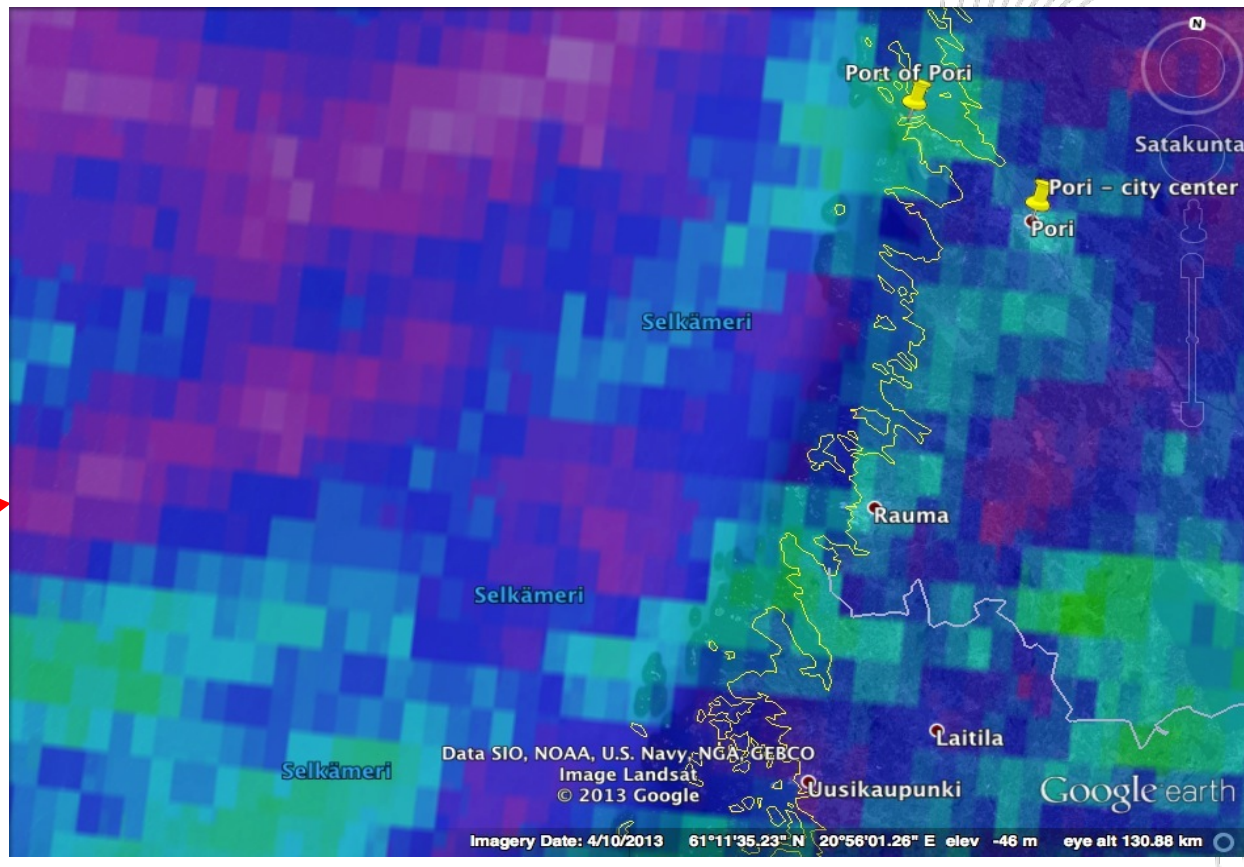
Weak winds

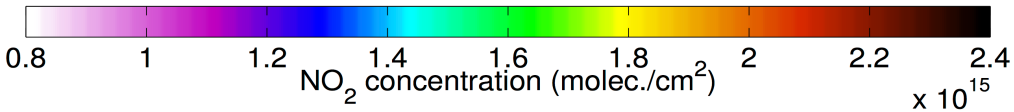




Detection of emission hotspot in Northern Europe





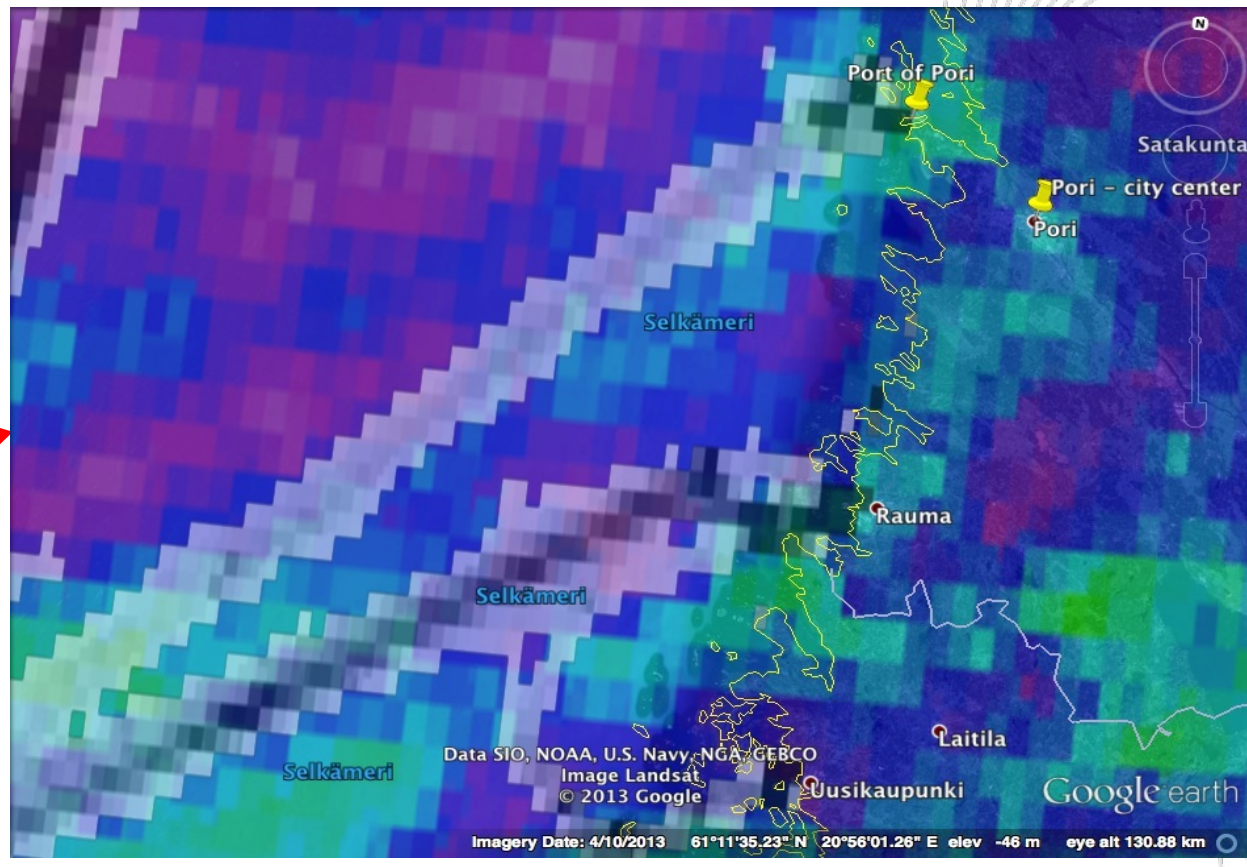


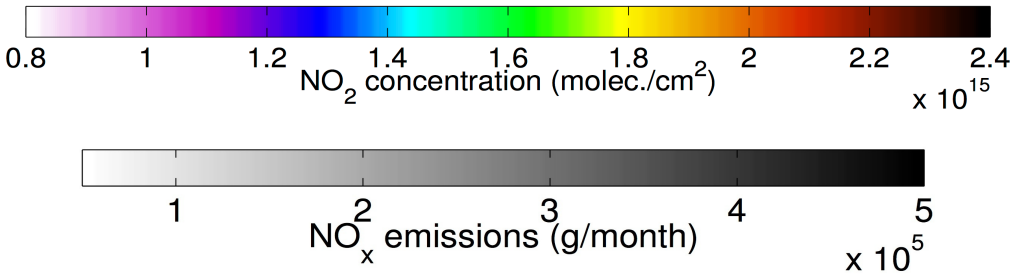
Pori port and city center

OMI NO2 (summer 2005 - 2011)

Figure I. Ialongo, FMI

Detection of emission hotspot in Northern Europe





Pori port and city center
Overlap with STEAM ship emissions

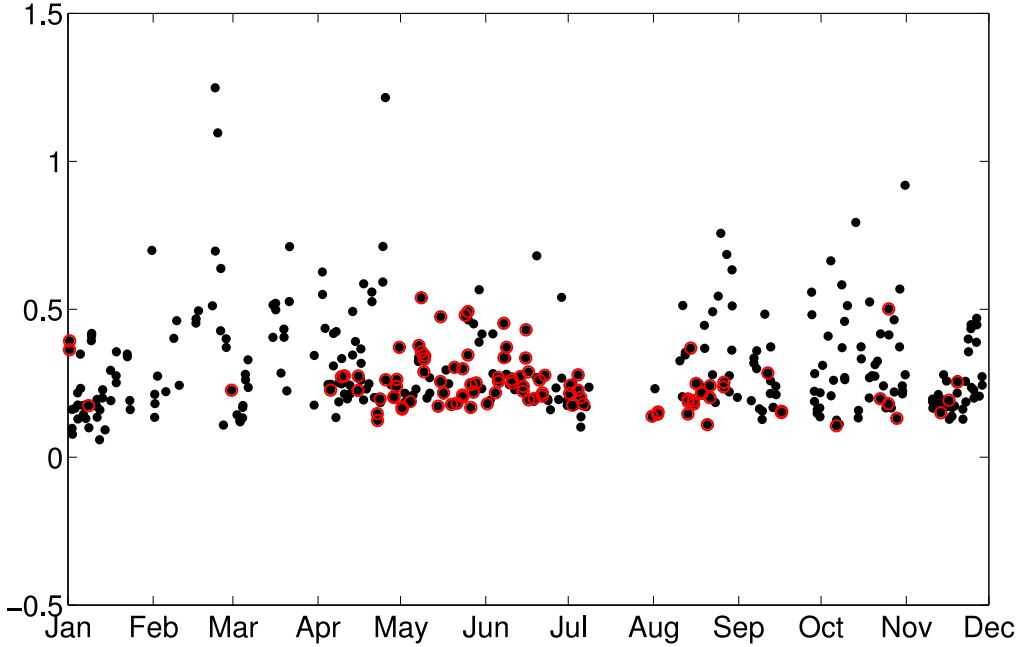
OMI NO2 (summer 2005 - 2011)

Figure I. Ialongo, FMI

OMI NO_2 vs. Pandora at Helsinki

NASA's Pandora at FMI, Helsinki

NO_2 [DU] observations



Differency [DU]

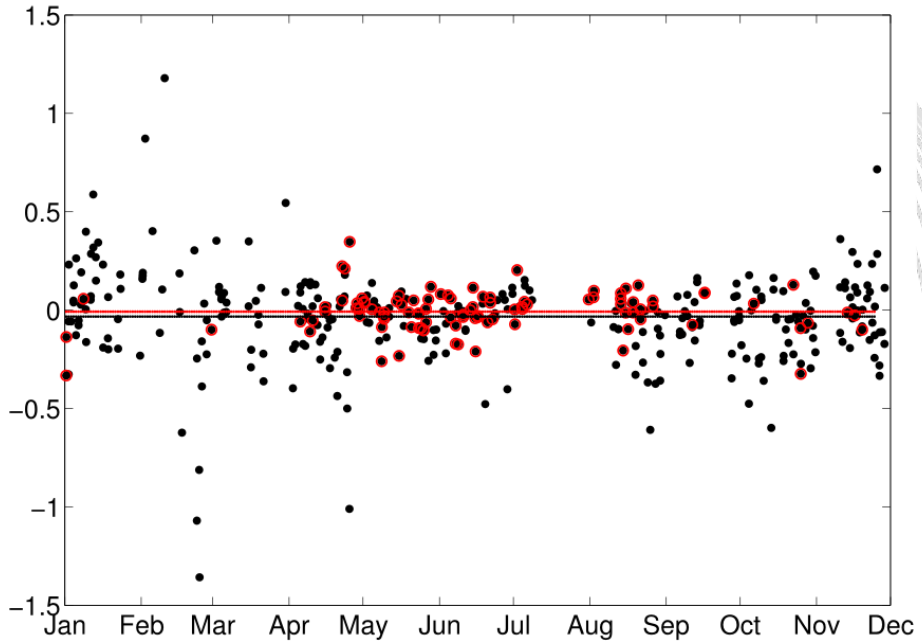


Figure I. Ialongo, FMI

Weekly cycle

- Similar weekly cycle in Helsinki observed by OMI and Pandora

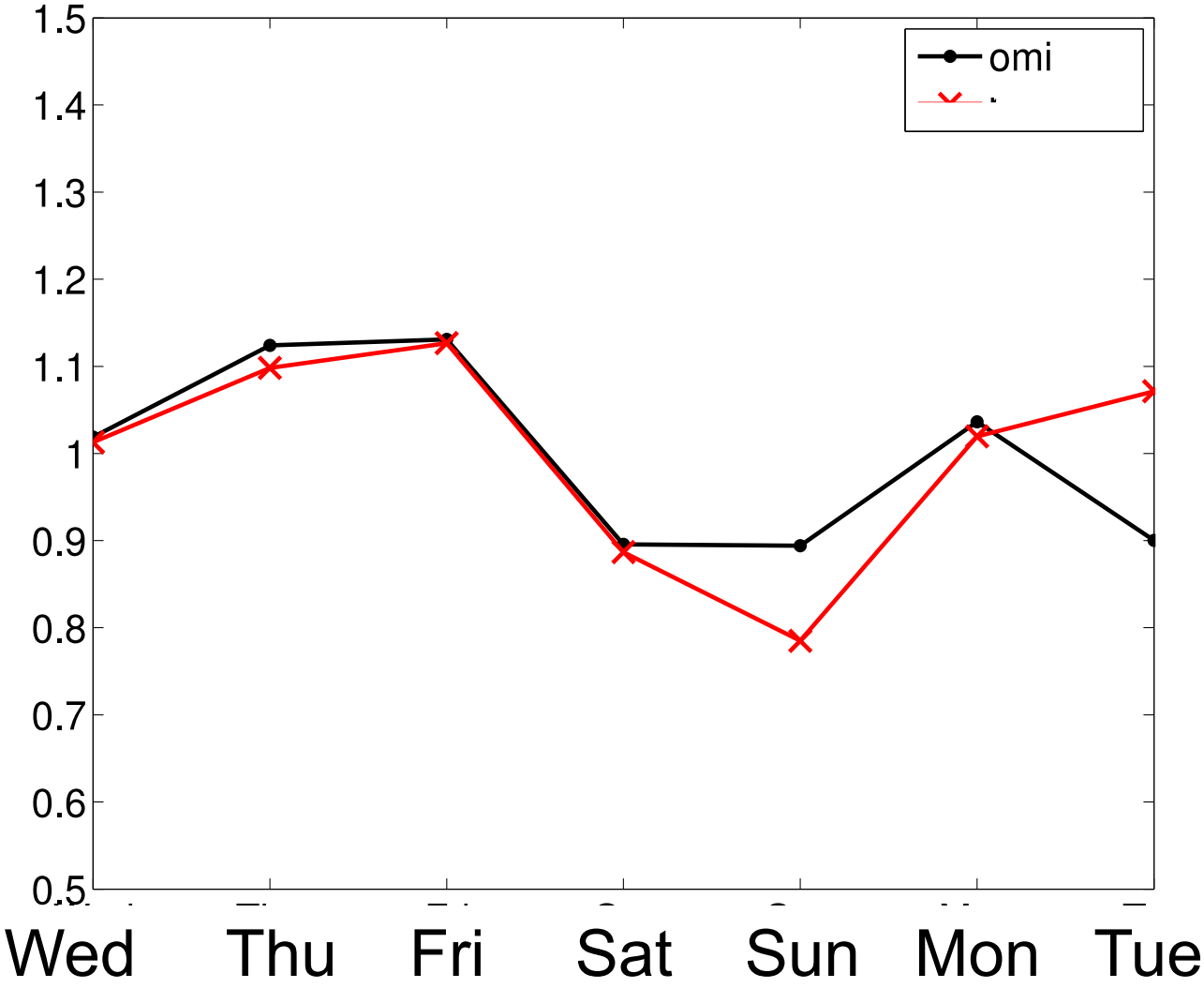
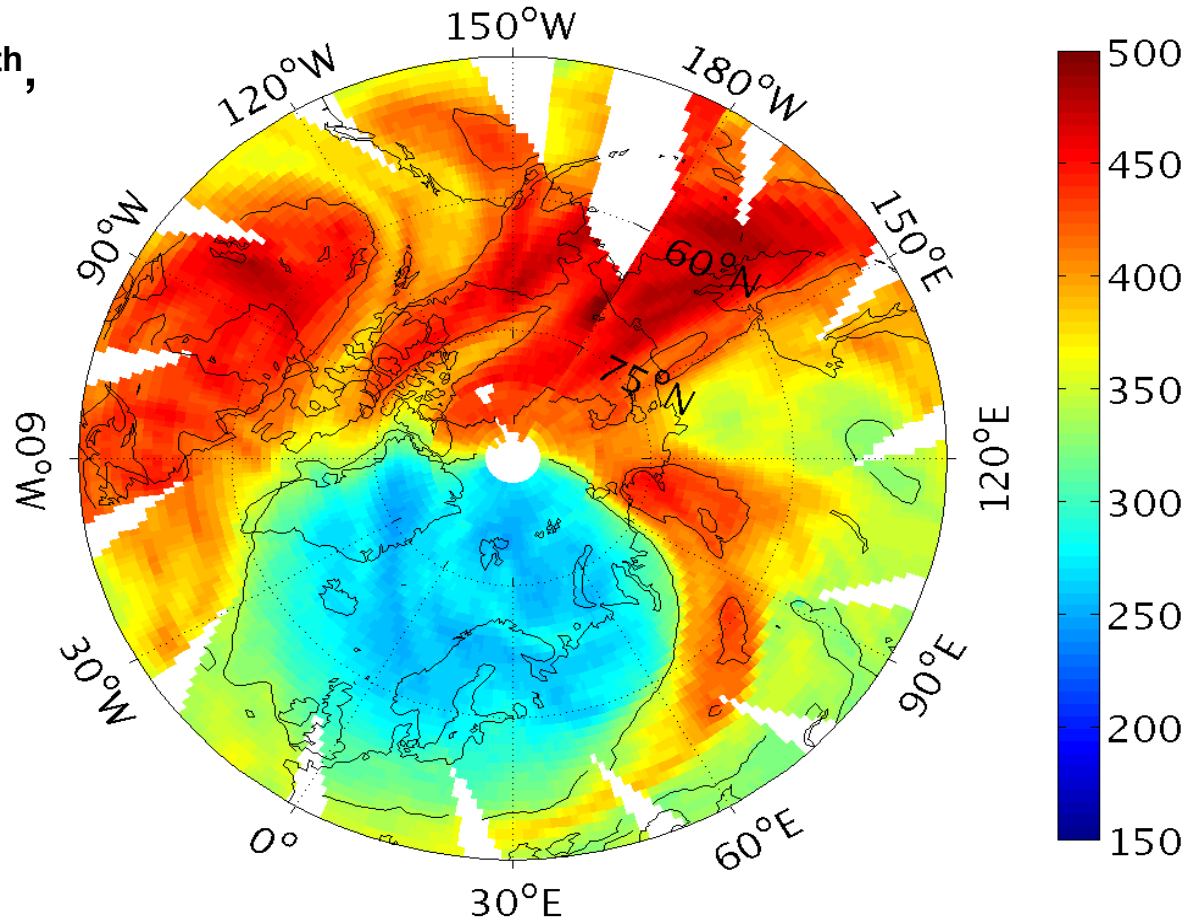


Figure I. Ialongo, FMI

Antarctic ozone hole 2011

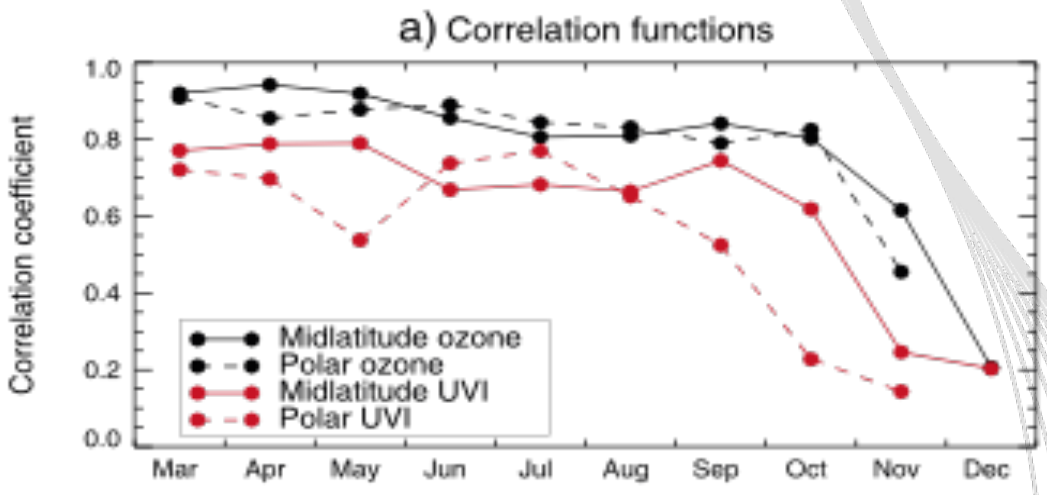
March 28th, 2011



Karpechko, A. Yu., et al. JGR, 2013

Link between spring-time ozone and summer-time UV

- Based on OMI and TOMS ozone and UV time series: Inter-annual variability in springtime ozone abundance explains up to 20–40% of the summer UV variability in Northern hemisphere high and mid-latitudes.
- Arctic ozone depletion 2011 increased the March–August cumulative erythemal clear-sky UV dose in the Northern Hemisphere extratropics by 3–4% compared to the climatology



Correlation functions between the TOMS/OMI March extratropical (north of 35°N) total ozone and monthly mean total ozone and noontime UVI in polar latitudes (north of 60°N) and mid-latitudes (35–60°N) from March to December. (Absolute values shown for red lines.)

OMI UV-radiation product by FMI

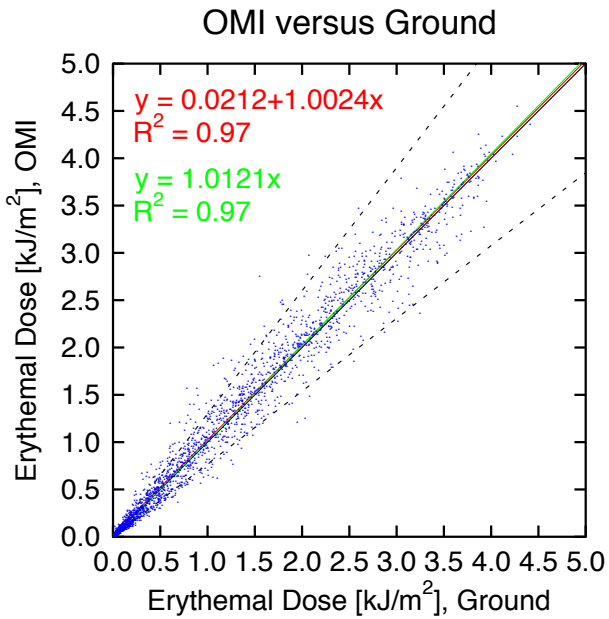
Motivation:

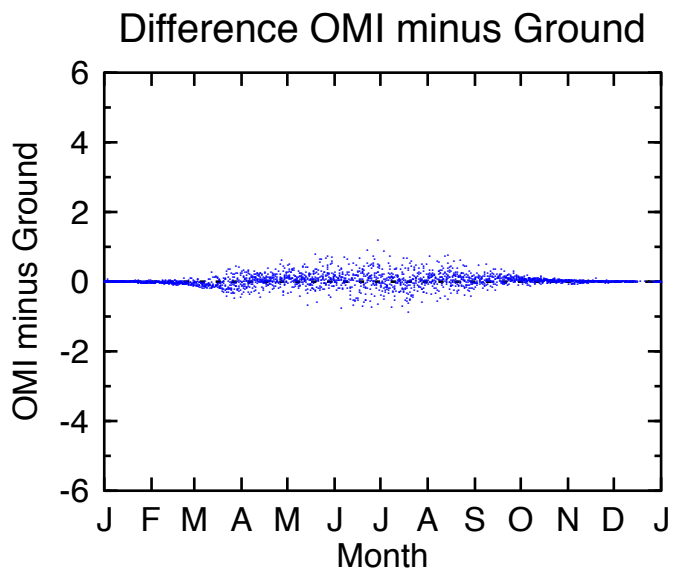
- **Human health, both positive and negative effects**
- **Supporting protocol monitoring**
- **Ecosystems, vegetation**
- **Air quality and Climate, photochemistry, oxidisation**
  - *e.g. recent publication by Cory et al, Science, 2014 discusses the importance of photochemical oxidation, for the release of CO_2 from thawing permafrost.*

On-going validation by G. Bernhard et al.

Validation of UV erythemal daily dose at Arctic

Jokioinen





- The bias is typically between 5-15%
- However, in some cases bias considerably larger, up to 50%
  - Often connected to unrealistic albedo values.
  - e.g. Trondheim: Large positive bias in spring (because of high albedo used by OMI), and large scatter due to clouds

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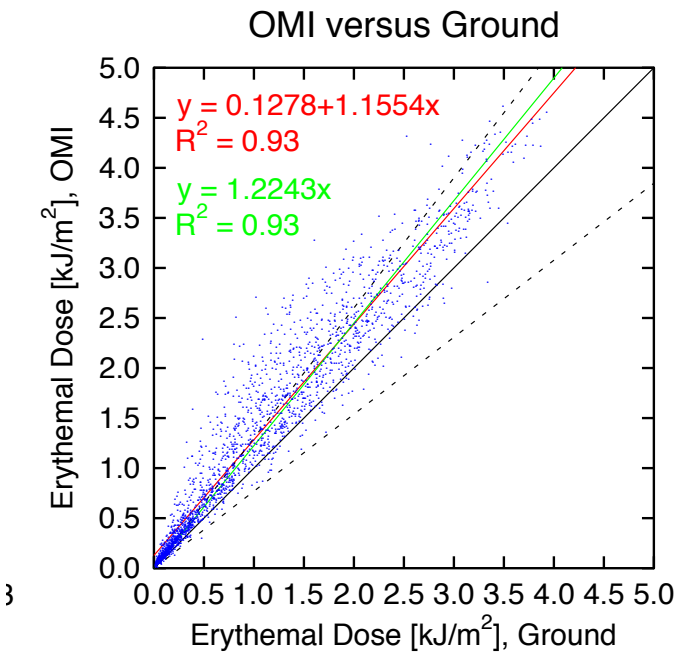
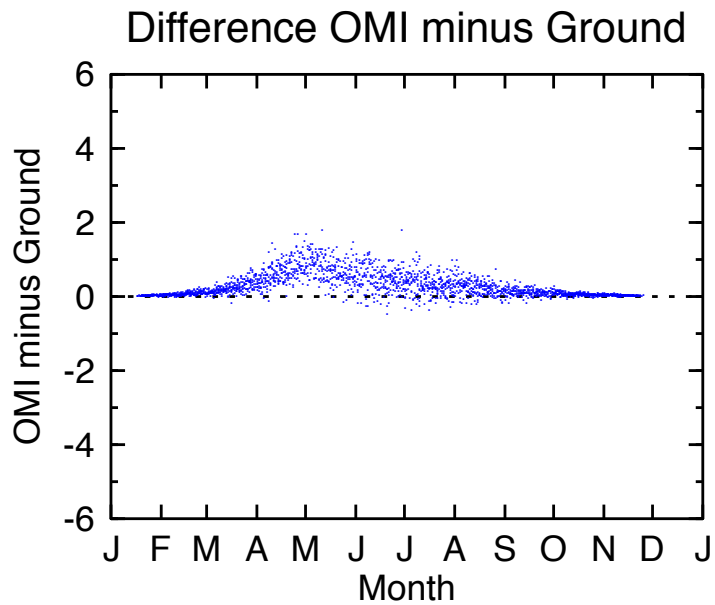
Trondheim





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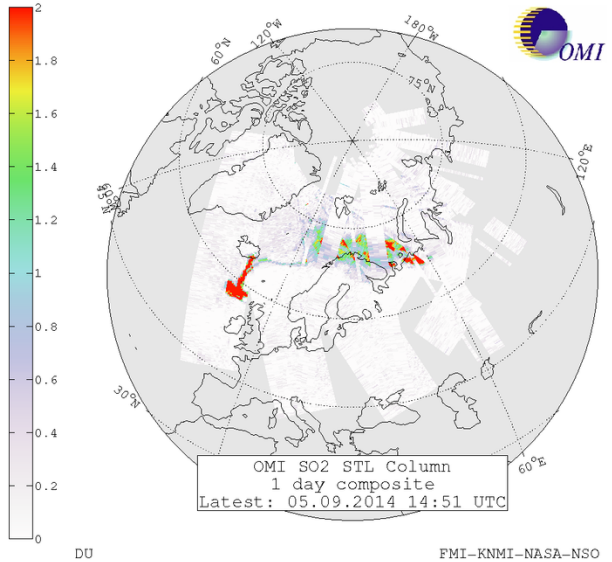
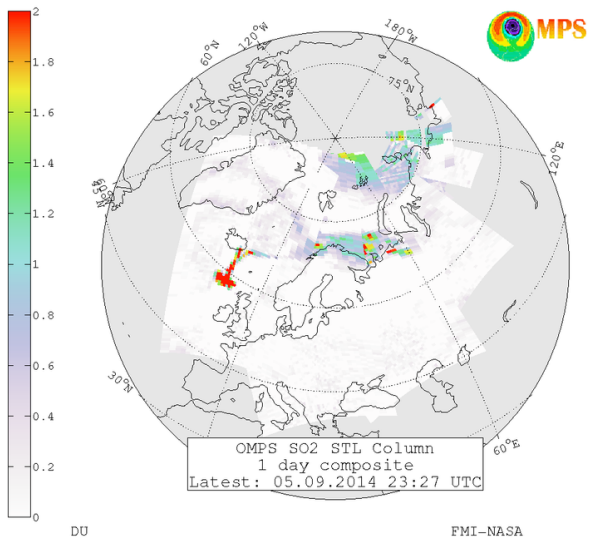
SO_2 from Bárðarbunga, September 2014





OMI and OMPS Very Fast Delivery products at sampo.fmi.fi

Agreement between OMI, OMPS and Sodankylä Brewer

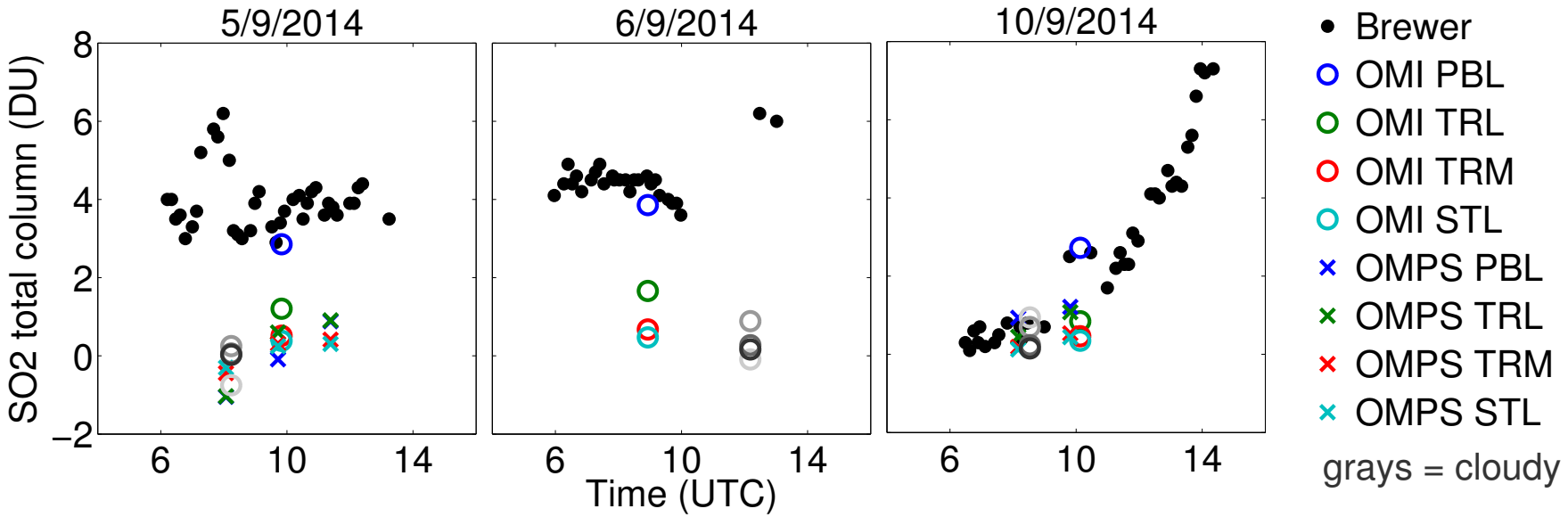


Figure thanks to R. Kivi, I. Ialongo, FMI

Reduced visibility in Lapland

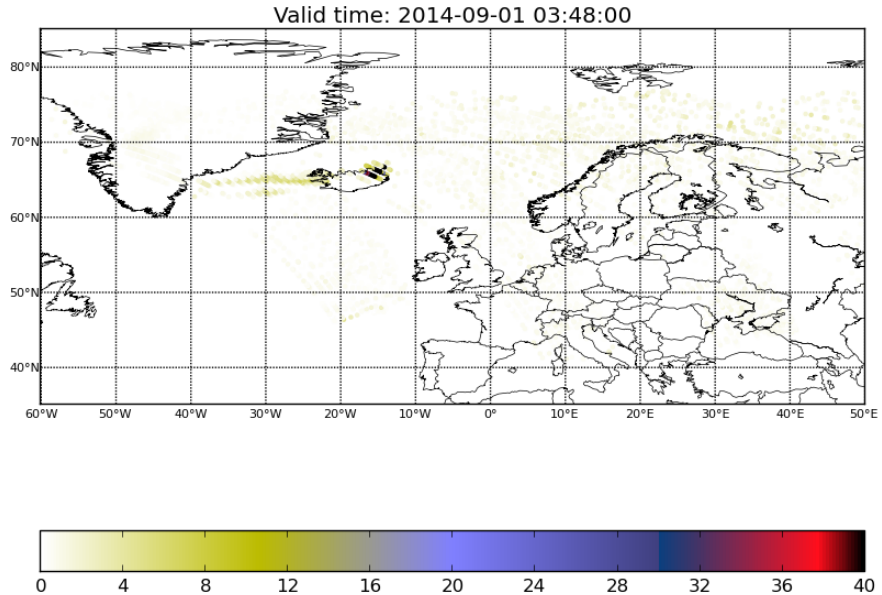
- View from Sammaltunturi towards Pallastunturi
- Reduced visibility on Sep 11, 2014, Relative humidity < 70%

Foto: Lihavainen, FMI

Foto: J.Hatakka, FMI

SILAM 4D-var assimilation Bárðarbunga, September 2014

OMI SO_2



SILAM assimilation SO_2

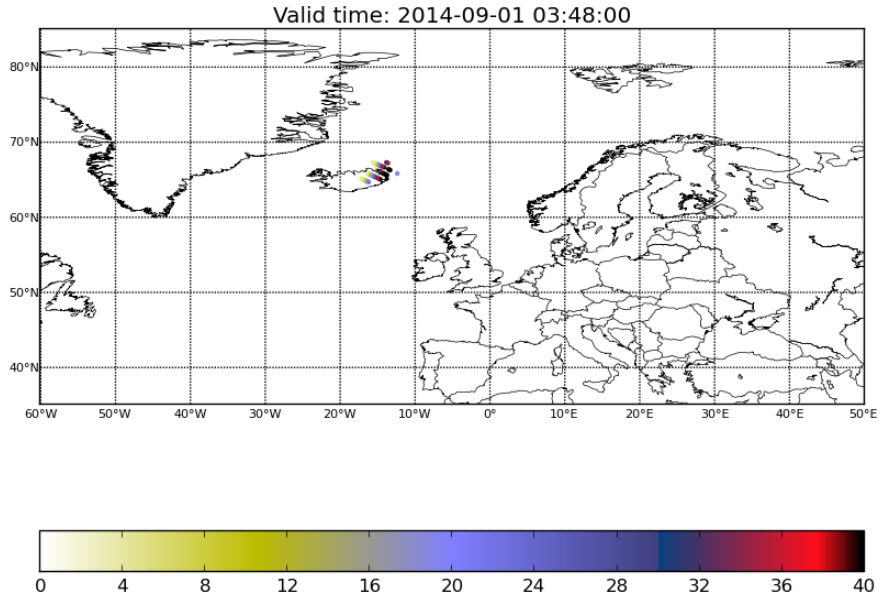


Figure J. Vira, FMI

SILAM 4D-var assimilation Bárðarbunga, September 2014

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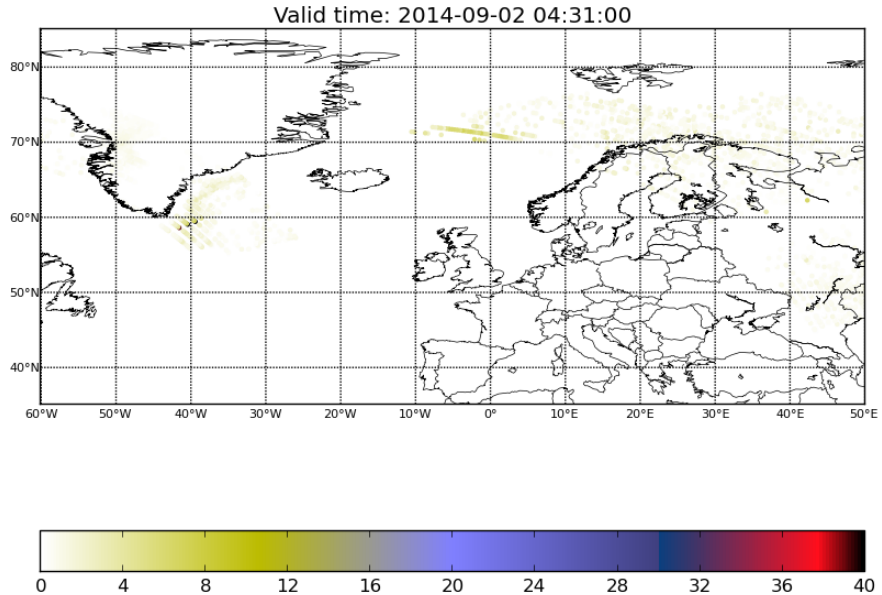

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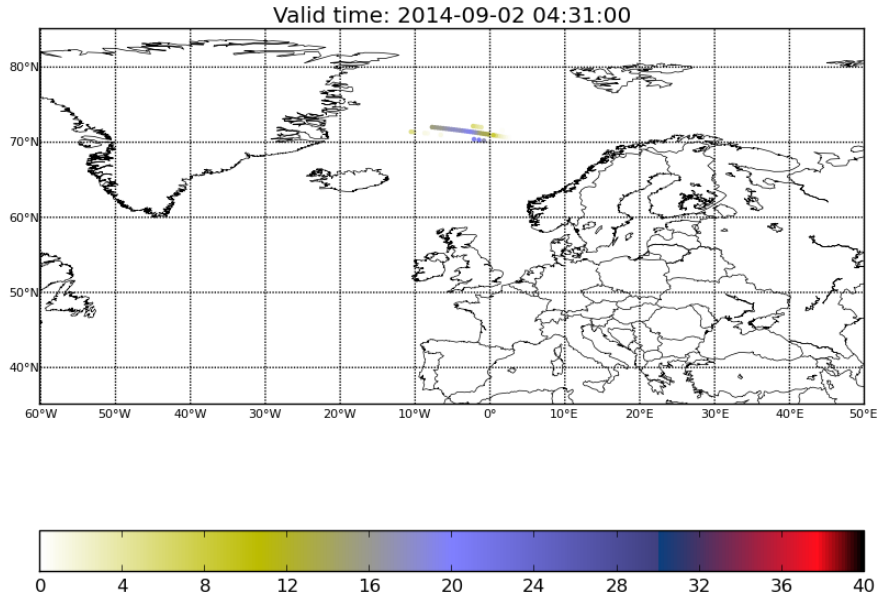

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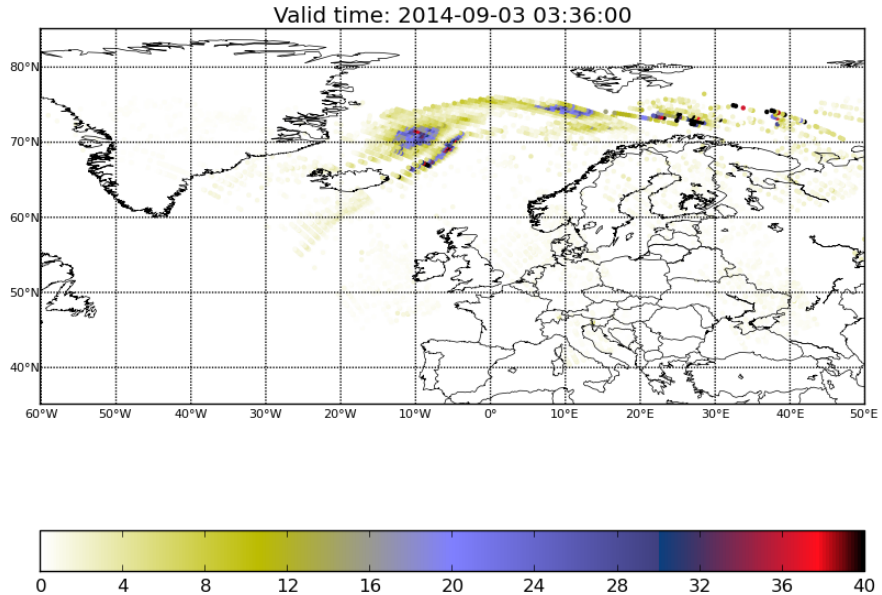

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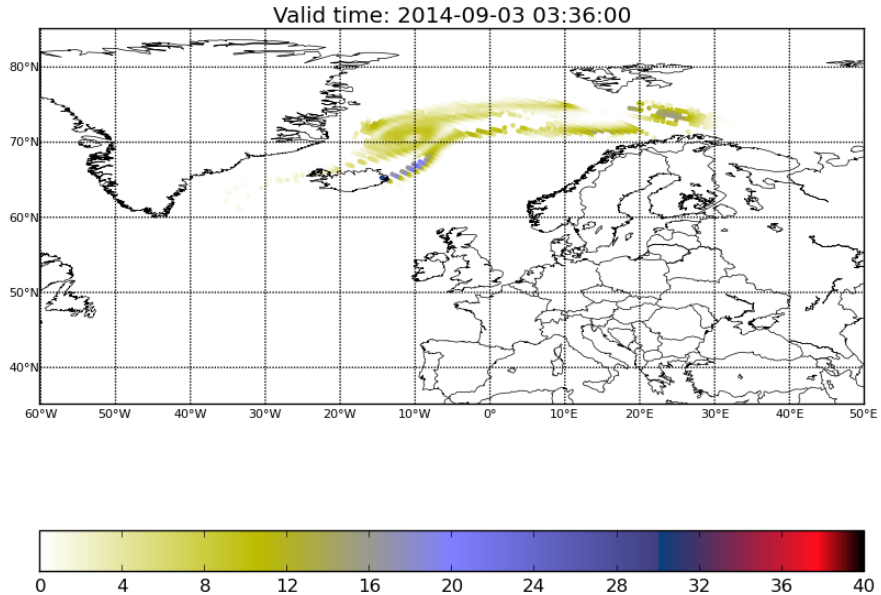

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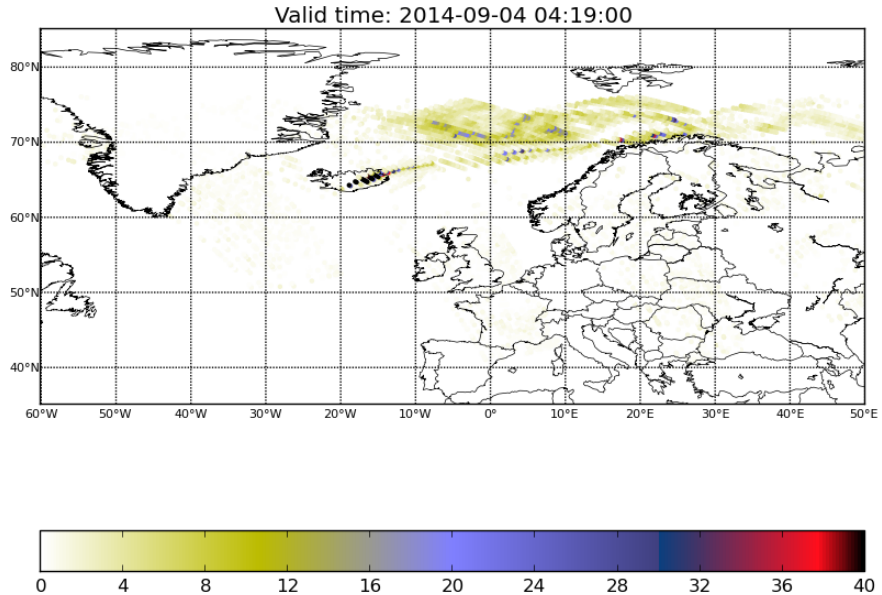

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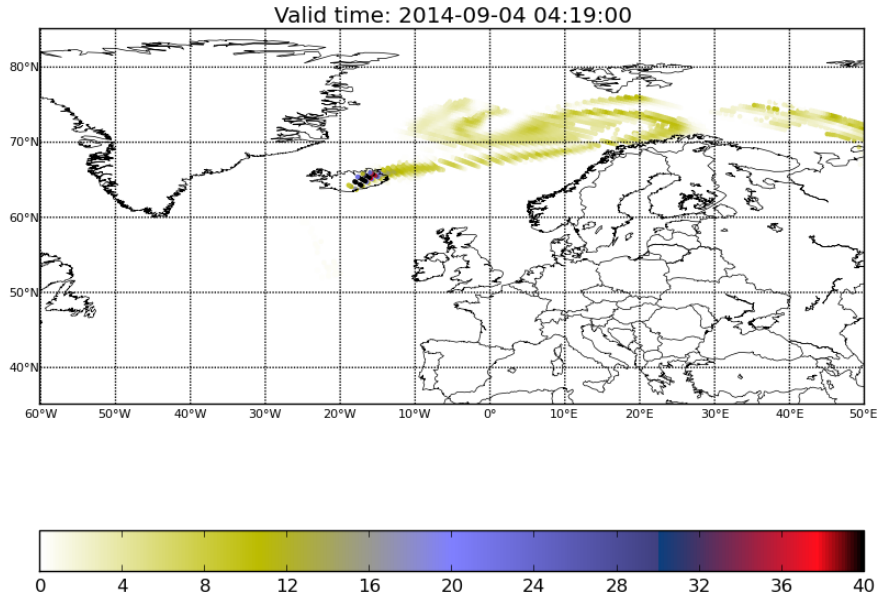

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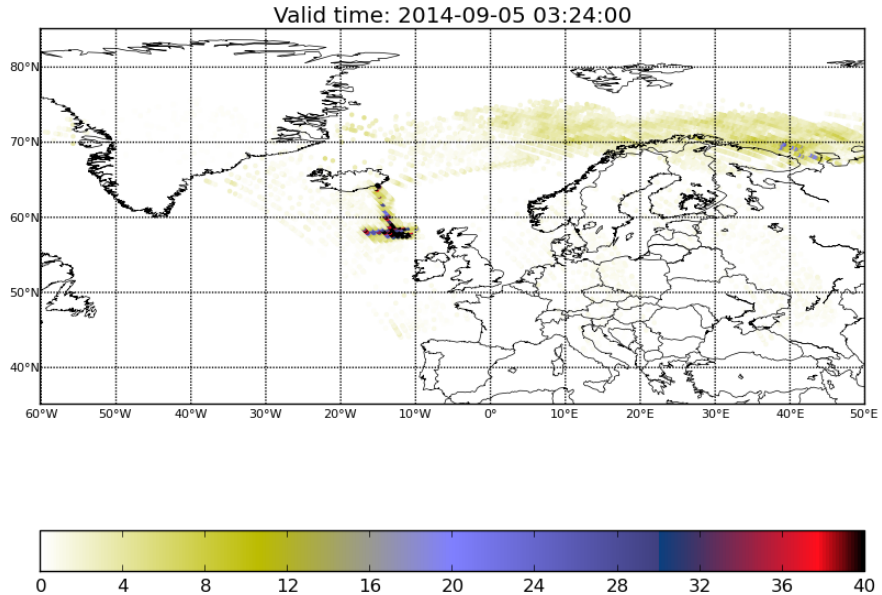

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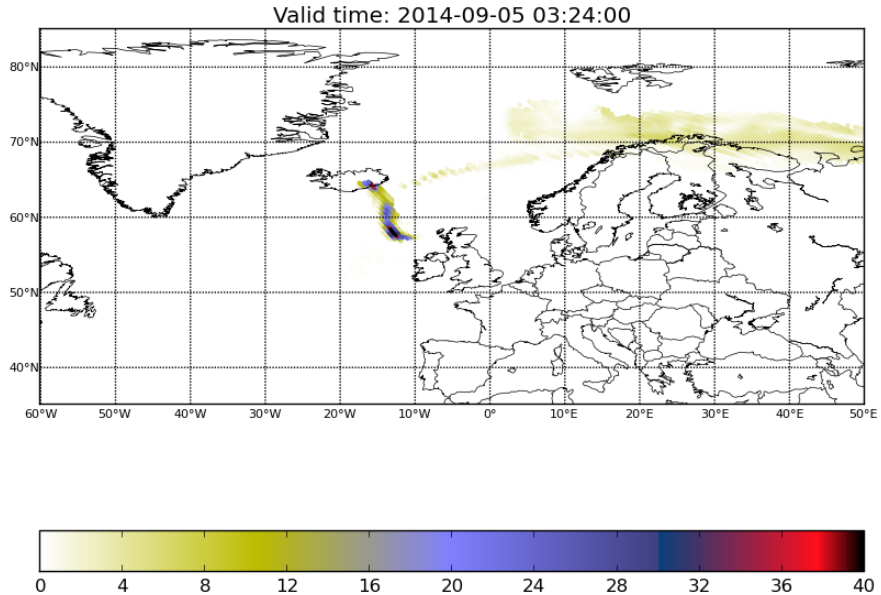

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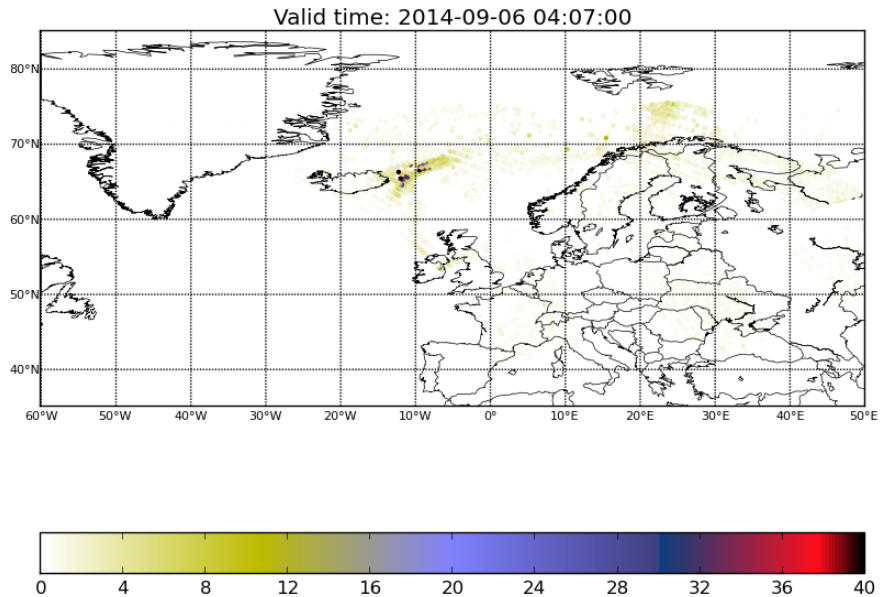

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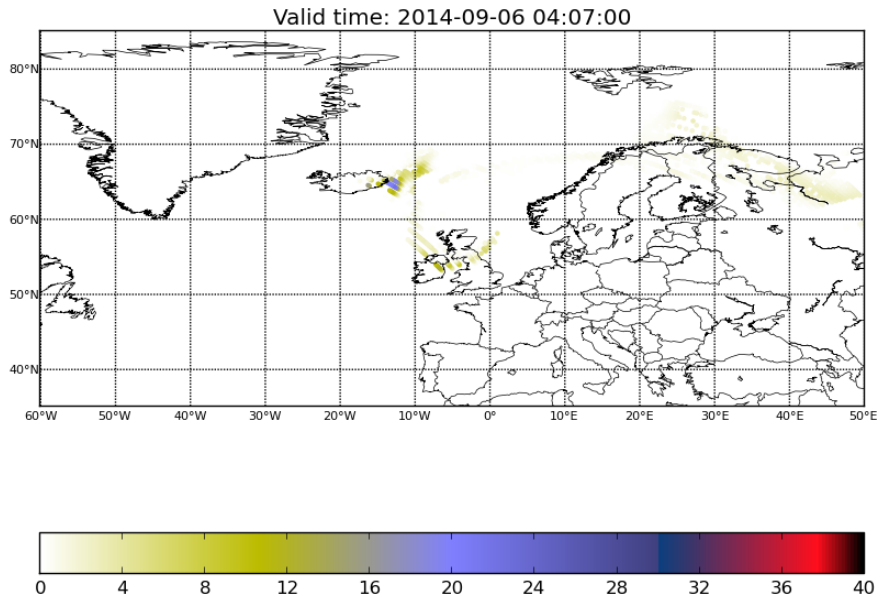

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SILAM 4D-var assimilation Bárðarbunga, September 2014

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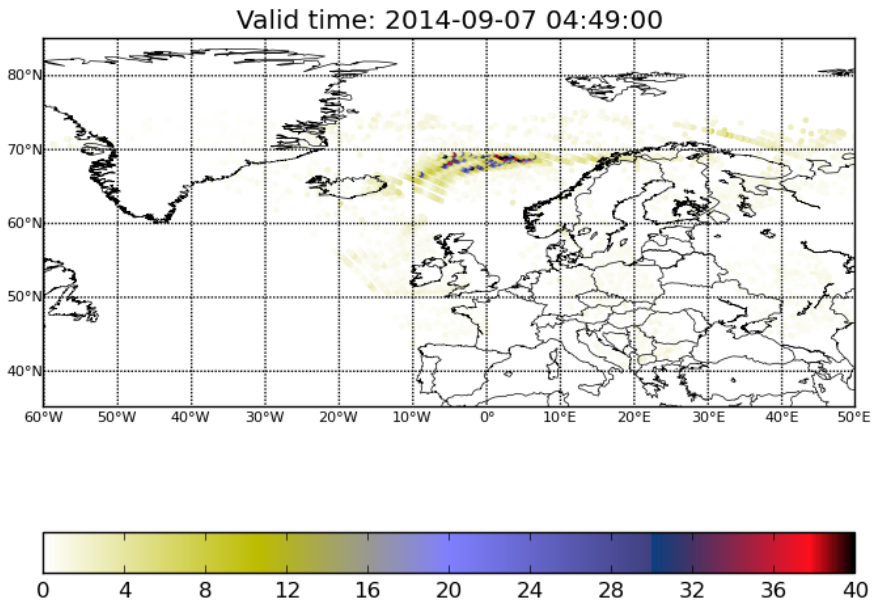

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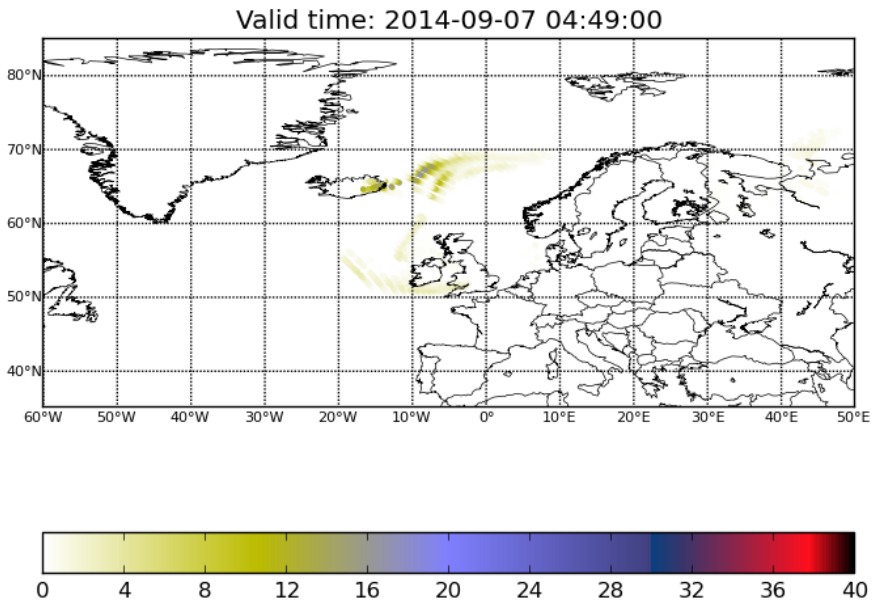

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SILAM 4D-var assimilation Bárðarbunga, September 2014

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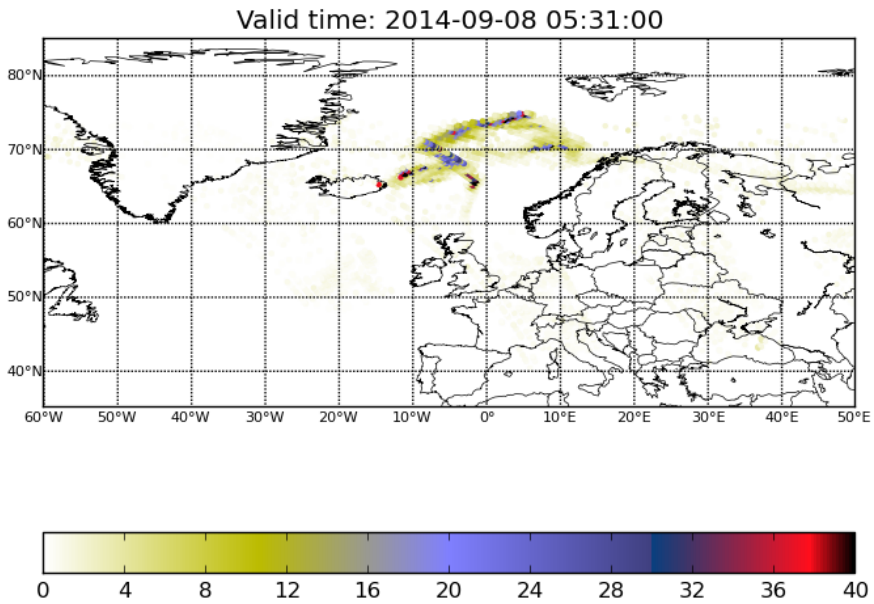

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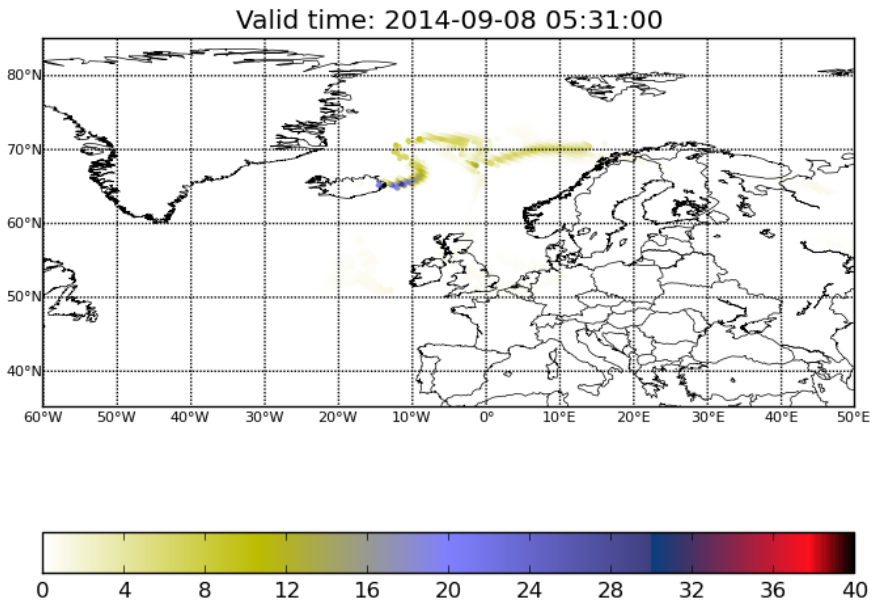

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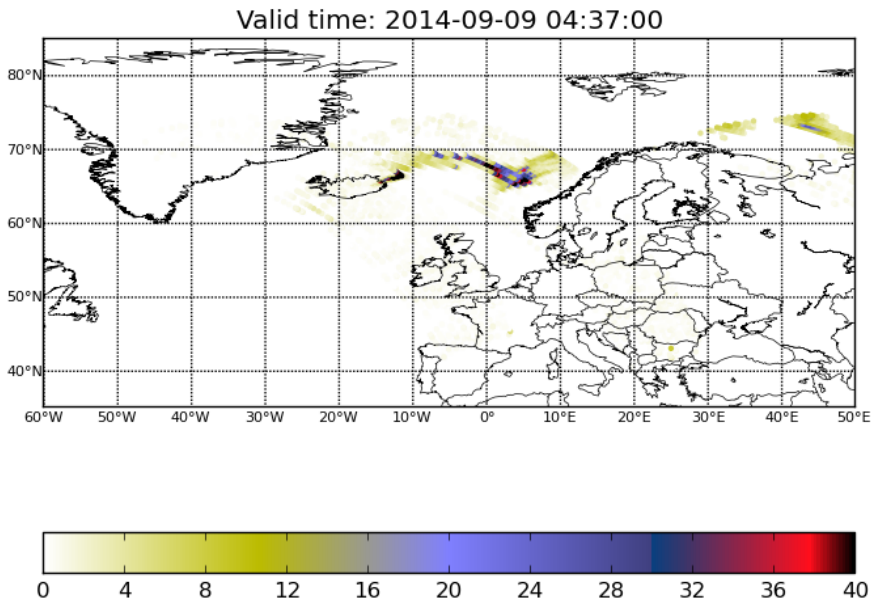

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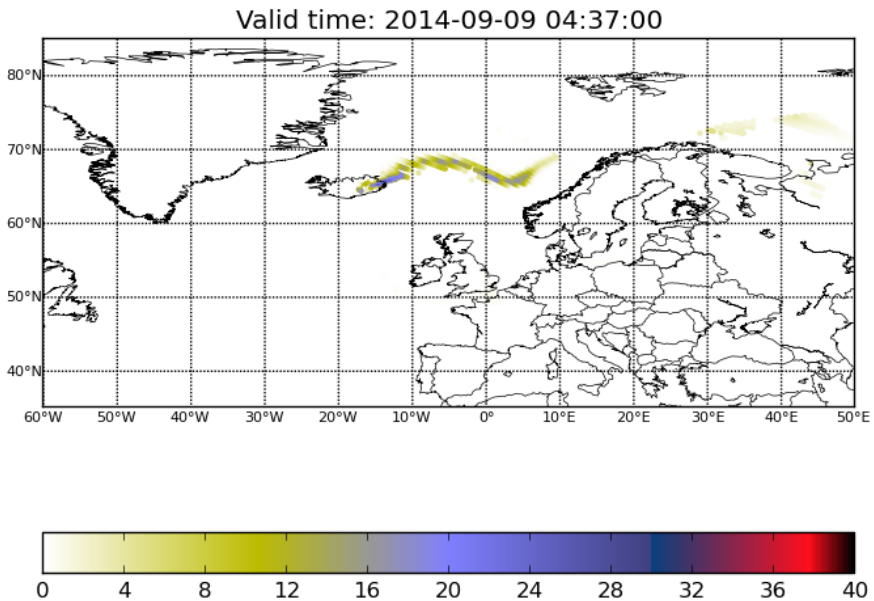

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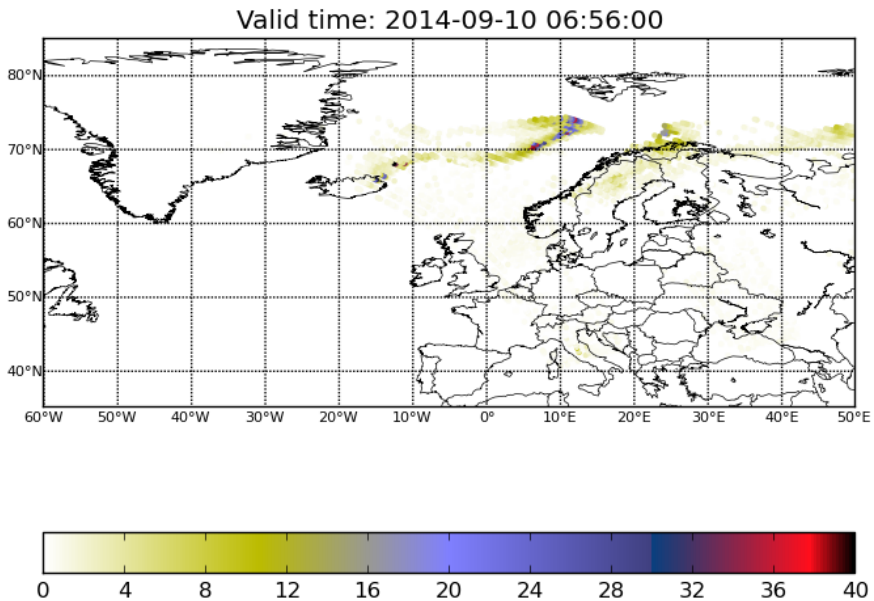

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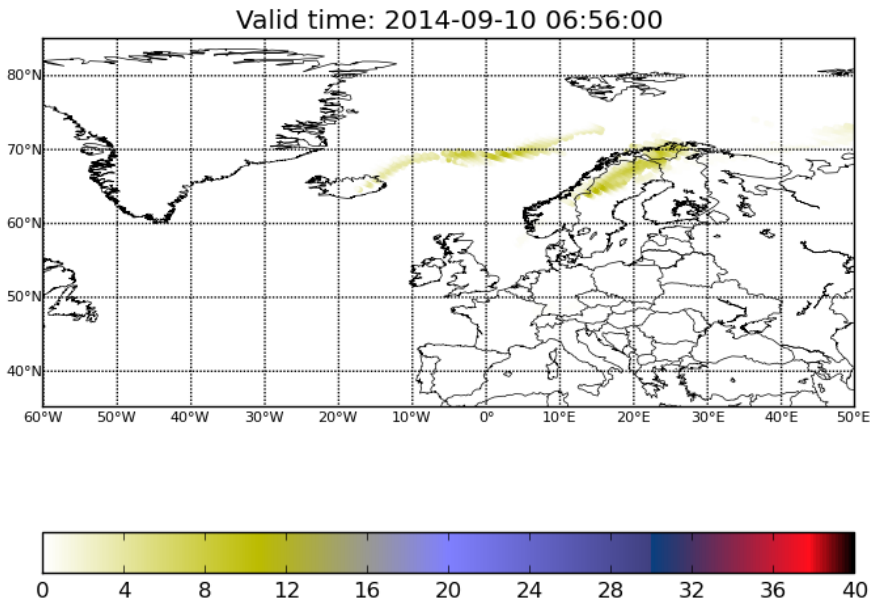

Figure J. Vira, FMI

SILAM 4D-var assimilation Bárðarbunga, September 2014

- SILAM assimilation using OMI SO2 indicated SO2 concentrations of 80-100 ug/m3 in Lapland
- Sulfate aerosols amounts in agreement with surface observations but highest values about at 3 km.
- Lidar observations indicate aerosols at boundary layer only.

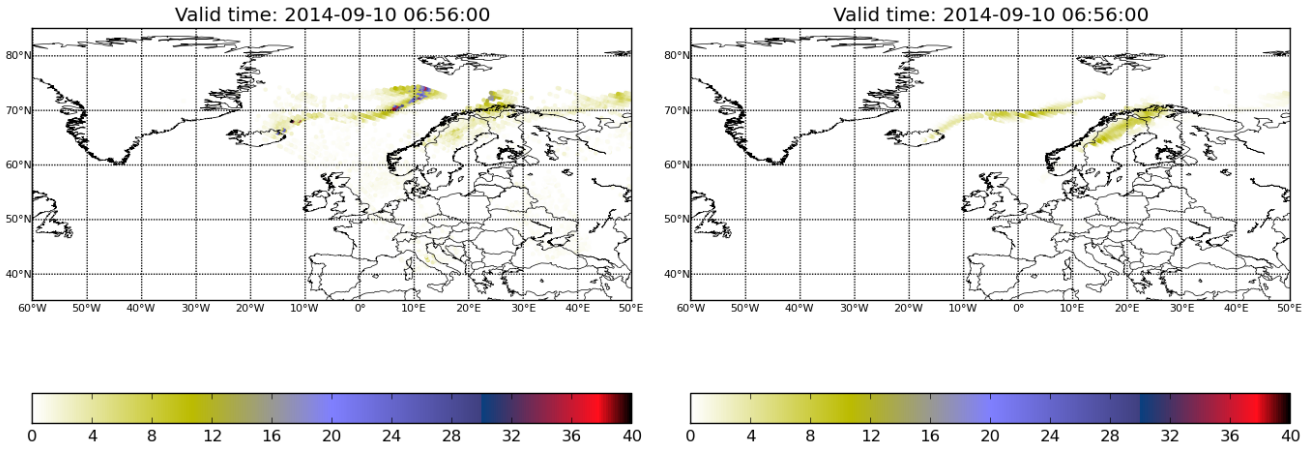

Figure J. Vira, FMI

Summary

- OMI and recently also OMPS Very Fast Delivery products of volcanic ash are very useful for supporting the air traffic safety and monitoring air quality.
- The NO_2 observations at high latitudes, though close to the detection limit, have shown interesting potential for air quality monitoring.
- Improved treatment of clouds and albedo may improve the UV-products further in particular at high latitudes

- **The expected environmental changes in the Arctic emphasize the importance of air quality and climate observations at high latitudes also in the future**
  - **OMI has had a very important role in demonstrating what satellites can do.**

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