The Three Roles of the Rapid Data Delivery System (RDDS) of NORS

All (NORS, NDACC, ...)

Klemens Hocke + colleagues at IAP (University of Bern)

Outline

1 Introduction

2 First Role of RDDS: „Cross-validation“

3 Second Role of RDDS: „Capacity building, Discussion, Testing“

4 Third Role of RDDS: „Data assimilation?“

5 Conclusions

Weather Forecast is not enough

From A. Benedetti et al.: Aerosol and Chemical Weather Forecasts

Heat Wave and Fires Russia 2010


BBC News - Fog from peat fires blankets Moscow amid heat wave - Mozilla Firefox

http://www.bbc.co.uk/news/world-europe-10762921

BBC NEWS EUROPE

26 July 2010 Last updated at 13:12

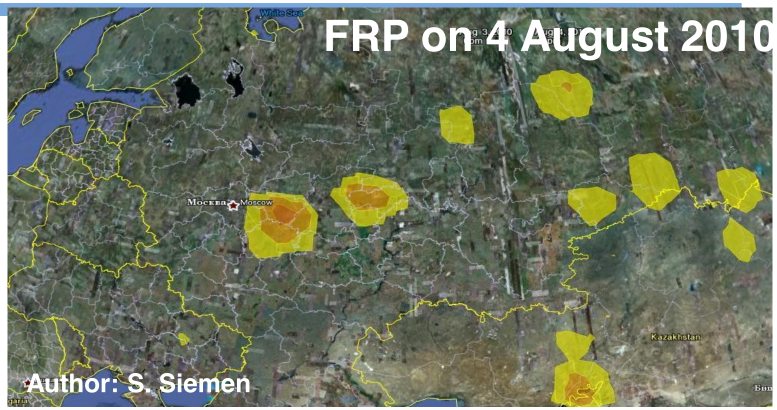
Fog from peat fires blankets Moscow amid heat wave

An acrid fog from forest and peat fires has blanketed Moscow, as the Russian capital swelters in a record heat wave.

Firefighters were trying to douse 60 fires covering 59 hectares (145 acres) in the countryside outside Moscow on Monday, the emergencies ministry said.

People with bronchial problems were advised to stay indoors as the level of toxic particles in the air rose five to eight times above the norm.

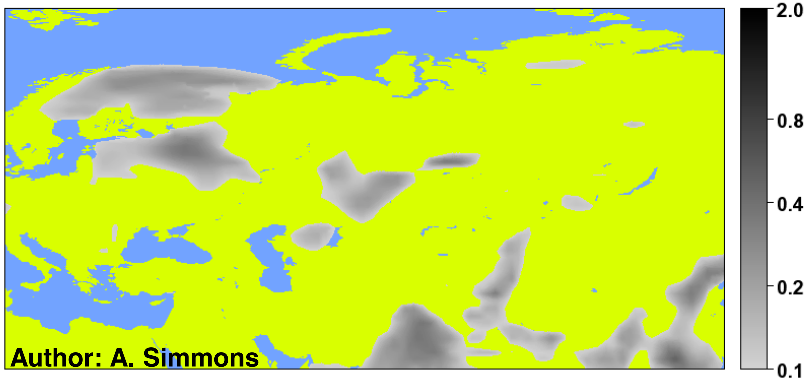
The Kremlin was barely visible as a pungent fog closed in on baking Moscow



Source: wikipedia

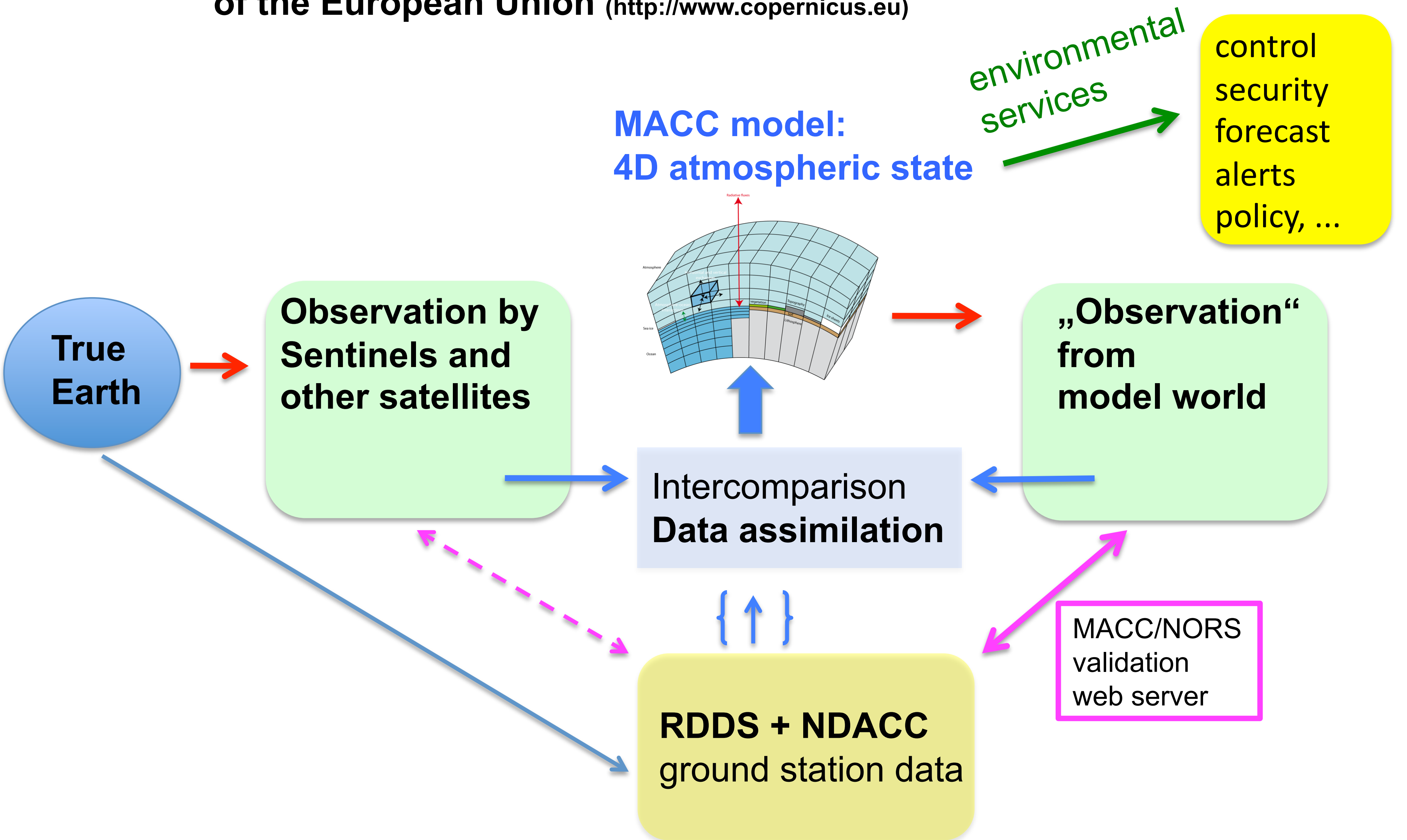
2010072603

Aerosol optical depth due to black carbon and organic matter

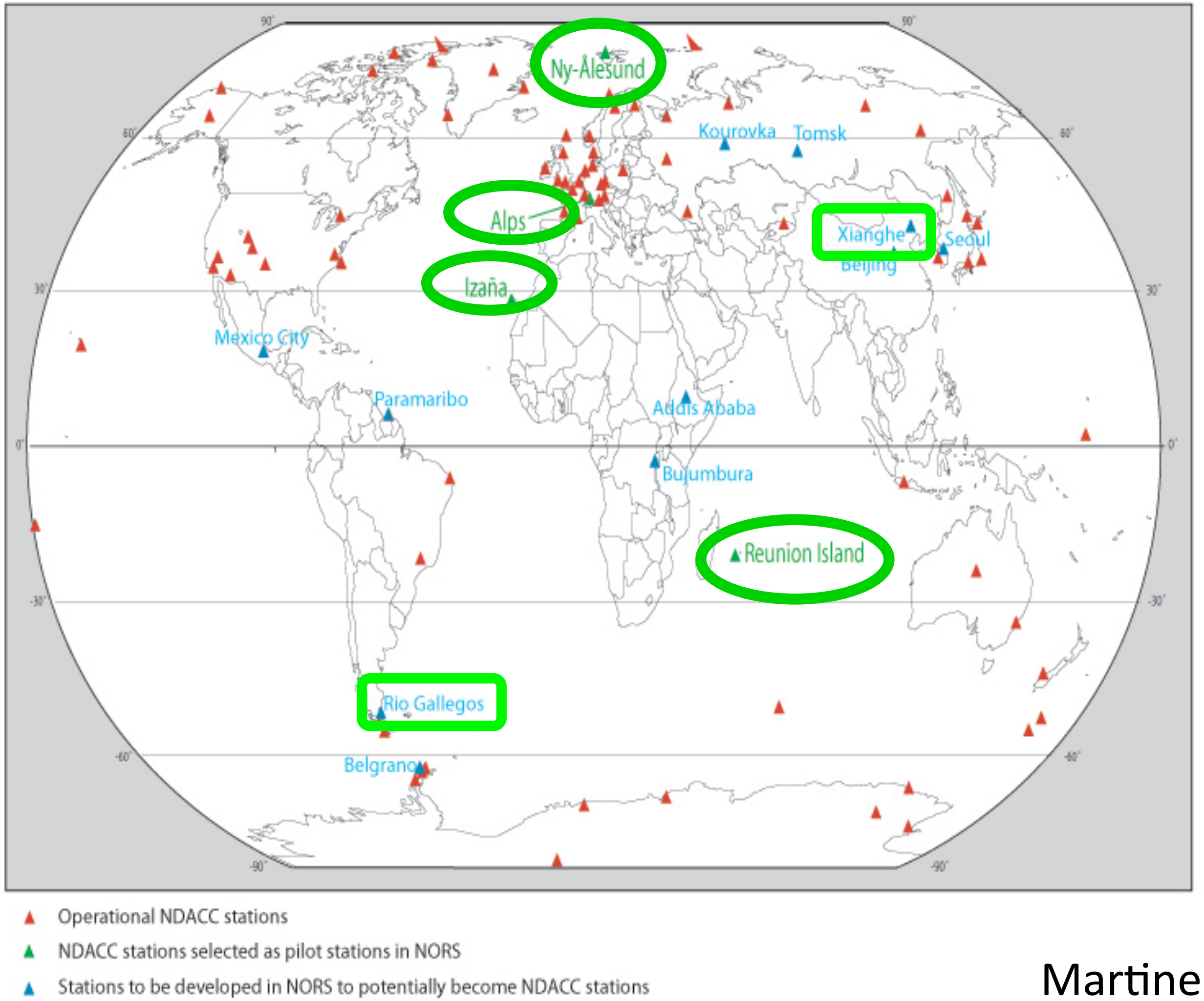


The daily jump in the modeled smoke distribution is due to the assimilation of satellite information on the fires

Copernicus Earth Observation Programme
of the European Union (http://www.copernicus.eu)



NORS Network of Ground-based Remote Sensing Stations (RDDS within NDACC)



Martine De Mazière

	DOAS	MAX DOAS	Lidar	MWR	FTIR
Ny Alesund	(O_3, NO_2)			O_3	(CH_4, CO)
Bern (Alps 1)				O_3, H_2O	
Jungfraujoch (Alps 2)	O_3 , NO_2				CH_4, CO, NO_2, O_3
OHP (Alps 3)	O_3 , NO_2		O_3		
Izana	O_3 , NO_2				CH_4, CO, NO_2, O_3
Xianghe		aerosol, NO_2			
Maido, La Réunion			(O_3)		CH_4, CO, NO_2, O_3, HCl, HF, HNO_3
St. Denis, La Réunion	(O_3 , NO_2)				
Rio Gallegos	O_3 , NO_2				

Rapid Data Delivery System RDDS
First Role: Control + Validation

ftp://ftp.cpc.ncep.noaa.gov/ndacc/RD/

Delivery of ground station data **within 4 weeks**

→ fast control of satellite instruments

→ validation of MACC model data

→ optimisation of ground station network

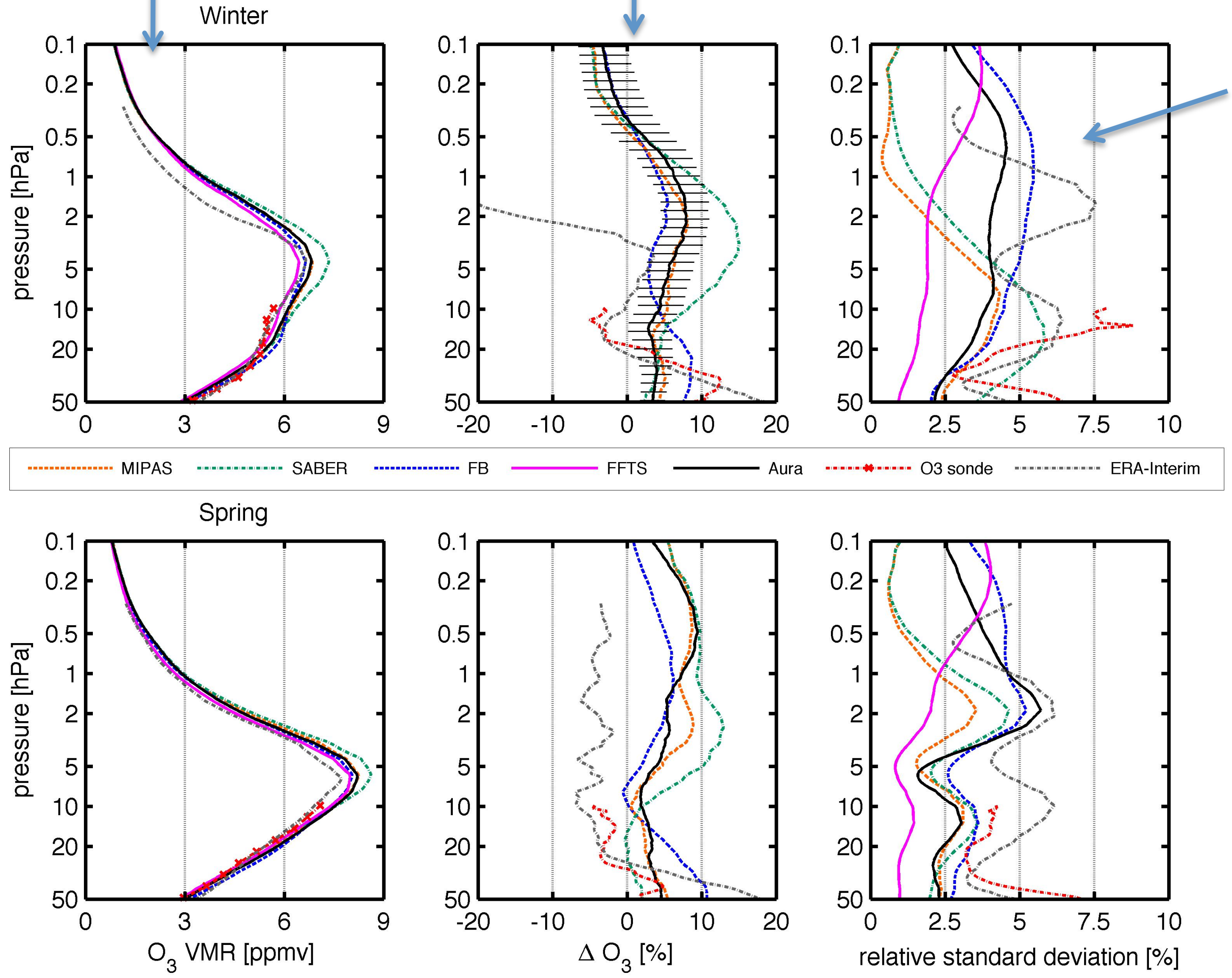
-File format: HDF GEOMS (+ uncertainties, kernels, a priori, ...)

-RDDS is part of NDACC

Example for intercomparison of satellite, ozone sonde and MWR

mean profiles of O_3 VMR

bias: satellite – GROMOS FFTS



error of the mean

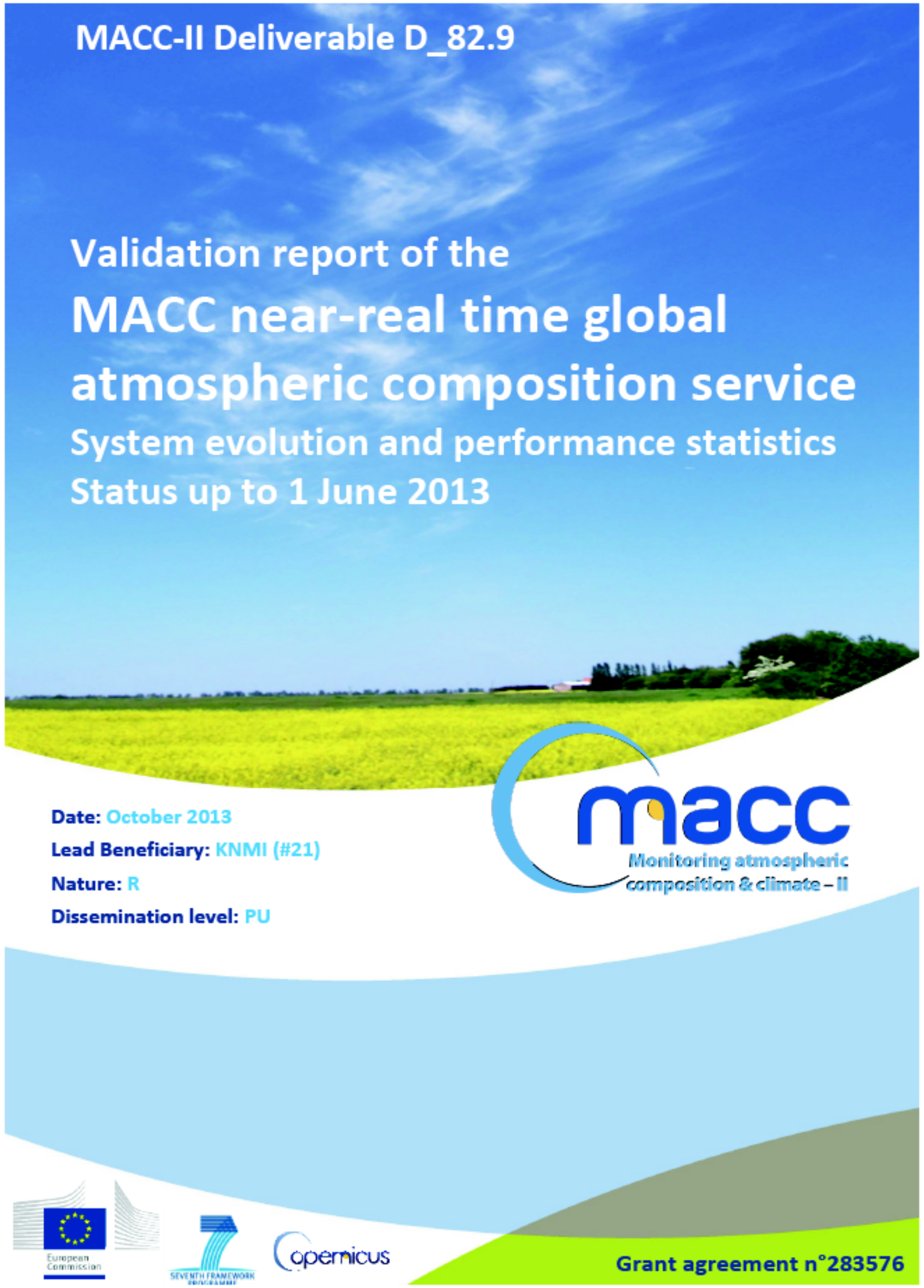
$$\sigma / \sqrt{n}$$

(< 0.15 ppm)

Studer et al., AMTD 2013

NORS and MACC

(from R. Engelen)


MACC-II Deliverable D_82.9

Validation report of the

MACC near-real time global atmospheric composition service

System evolution and performance statistics

Status up to 1 June 2013

Date: October 2013

Lead Beneficiary: KNMI (#21)

Nature: R

Dissemination level: PU

macc

Monitoring atmospheric composition & climate – II

Grant agreement n°283576

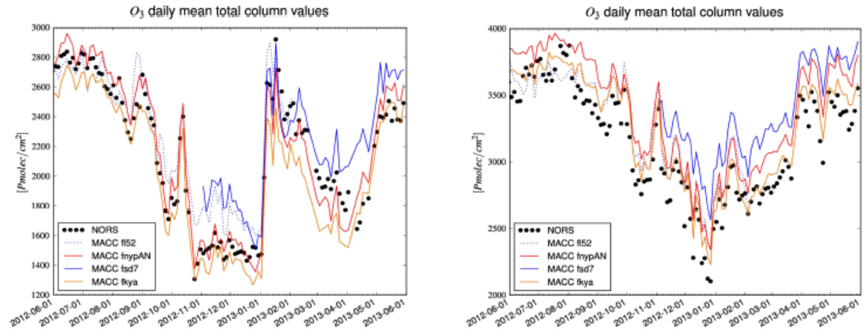


Figure 3.6.8: Stratospheric ozone columns (20-60km) by MACC_osuite (red), MACC_fcnrt_MOZ (orange), MACC_CIFS_TM5 (blue, full line), and MACC_fcnrt_TM5 (blue, dotted line), compared to NORS MWR data (black dots) at Ny Alesund (79°N, 12°E, left) and Bern (47°N, 7°E, right) for the period June 2012-May 2013. The MWR averaging kernels are applied to model output and all time series are smoothed with a 3-day running mean for readibility.

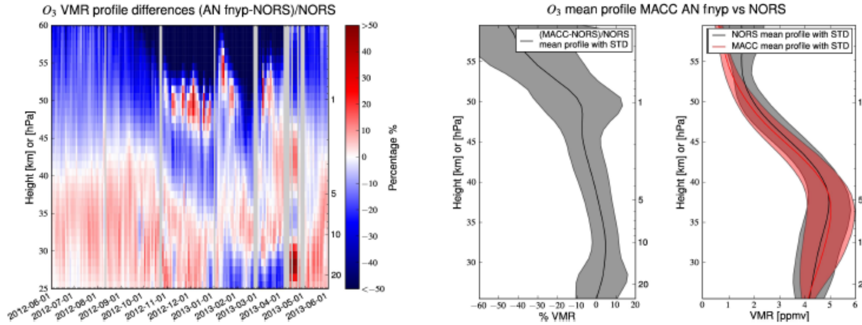


Figure 3.6.10: as previous figure but above Ny Alesund.

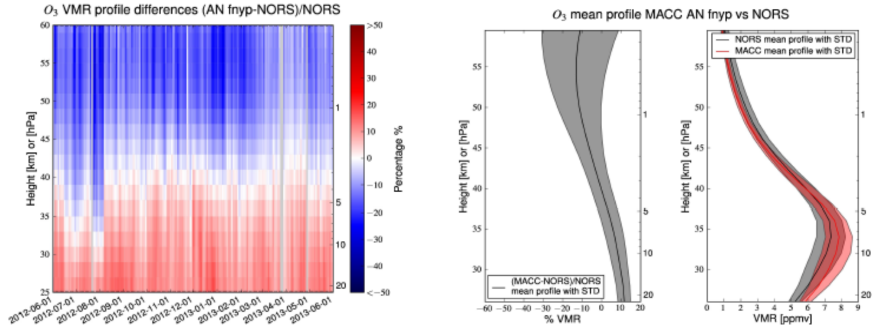


Figure 3.6.9: Time series of the relative differences between the MACC_osuite and MWR observations at Bern for the period June 2012-May 2013 (left), mean relative bias +/- one standard deviation of differences (middle) and O_3 mean profiles over the same period (right).

The Second Role of RDDS: Capacity building, Discussion, Testing

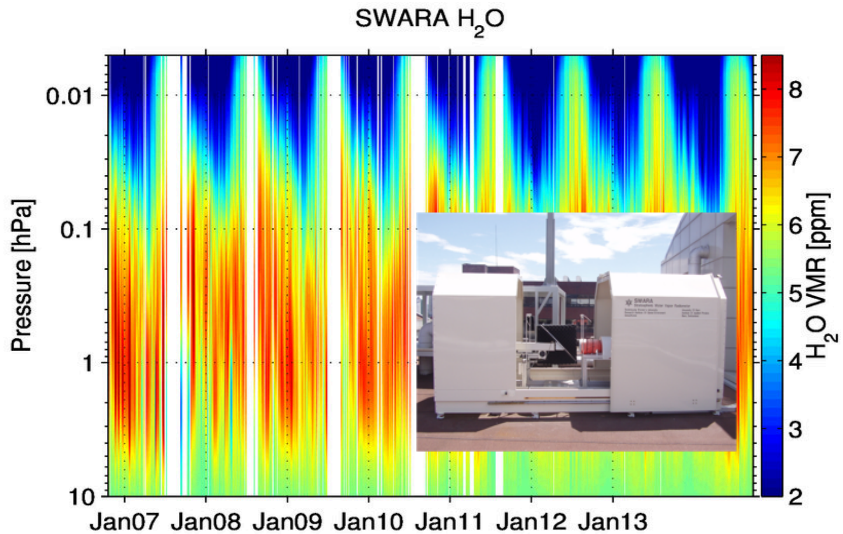
RDDS is small, flexible and tolerant:

-new instruments can submit their data to RDDS before they are accepted for NDACC

-new data formats can be tested

-discussions are easier within the smaller group of RDDS partners compared to NDACC

H_2O radiometer at Zimmerwald



H_2O radiometer at Seoul
(J.J. Oh, collaboration with N. Kämpfer)

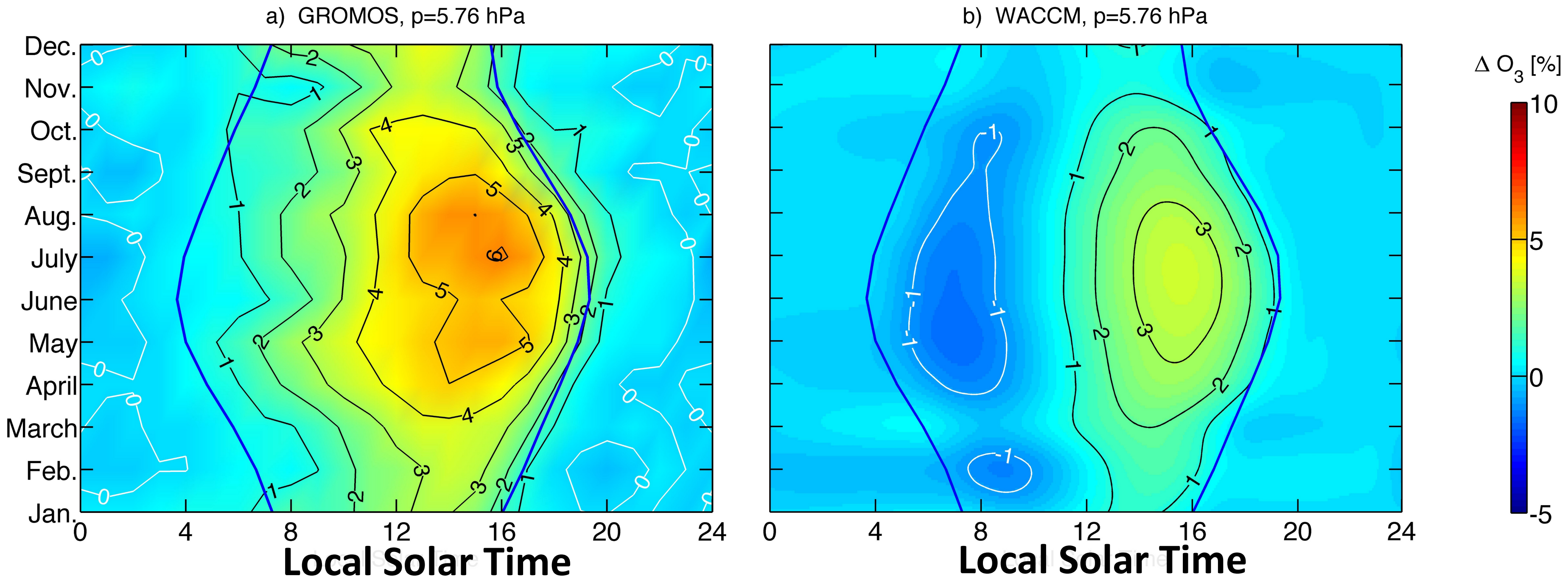
The Third Role of RDDS:
Assimilation of Ground Station Data into MACC?

Ground stations cover the **local time domain**

➔ Assessment of sampling bias due to satellite orbit drift

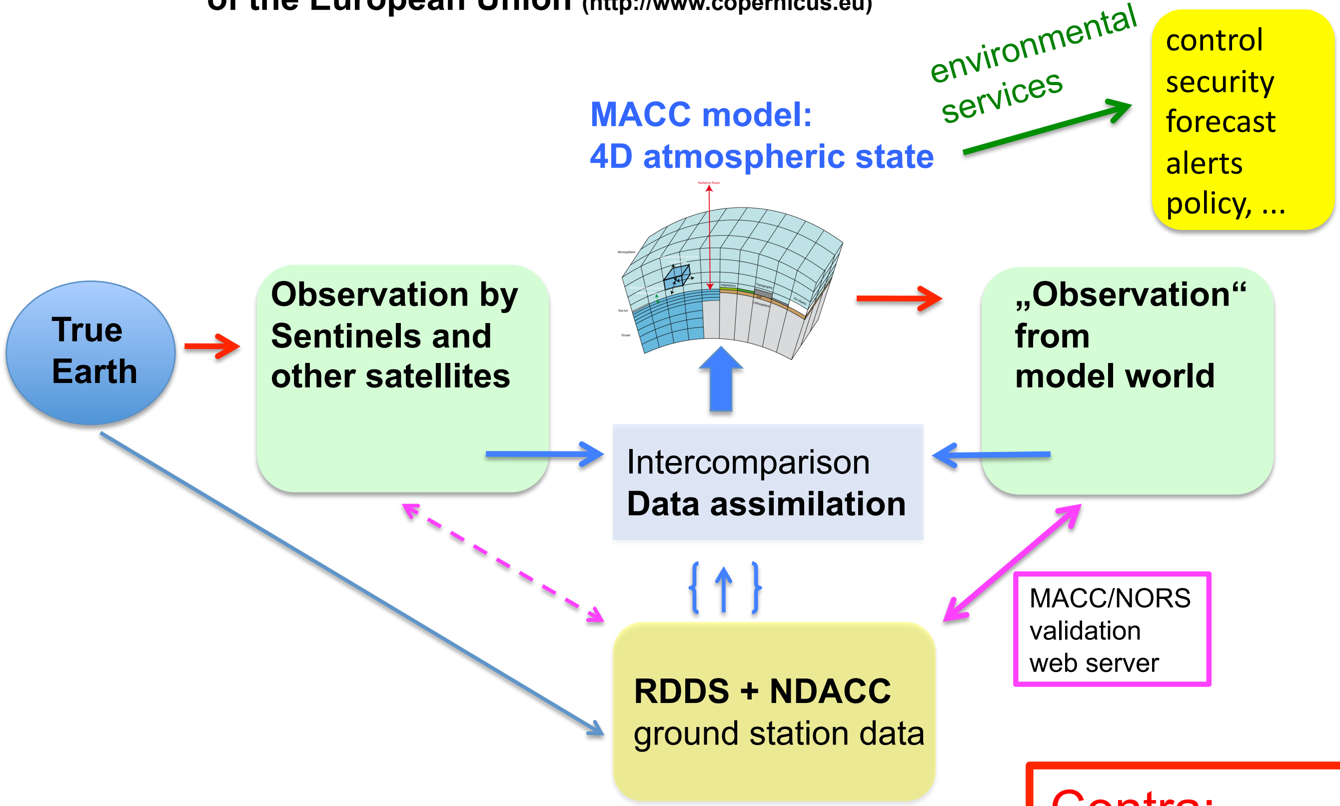
Climatology of the **diurnal cycle** in stratospheric ozone (Studer et al., ACP 2014):

Observation (MWR, Bern): **Model:**



The Third Role of RDDS: Assimilation of Ground Station Data into MACC?

Copernicus Earth Observation Programme
of the European Union (http://www.copernicus.eu)



Contra:
MACC looses the independent RDDS data for cross-validation

Conclusions

- ✓ NORS has concrete output: monitoring, infra-structure and research
- ✓ RDDS and the Validation Web Server are „building blocks“ of the Copernicus Earth Observation programme
- ✓ RDDS provides HDF GEOMS data for cross-validation between ground-based remote sensing stations, satellites and models (e.g., MACC)
- ✓ RDDS fosters basic research on atmospheric phenomena, e.g., diurnal cycle in stratospheric ozone
- ✓ RDDS is a tool for cooperation, discussion and capacity building for scientists and engineers worldwide

Acknowledgment

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Especially: **Ian Boyd** and **Roger Lin** who helped us in all questions concerning GEOMS HDF, change of variable names, operational data delivery, ...

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Target:

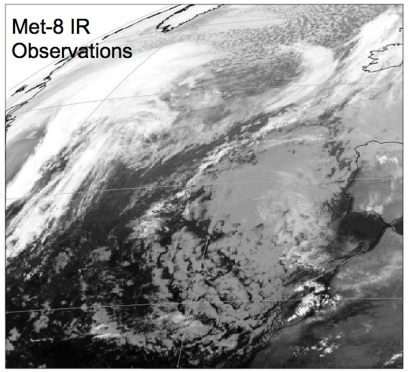
Atmospheric state (wind, temperature, composition, ...) of the past, present and future

Method or Strategy:

Data assimilation of observations into a numerical model based on physical laws

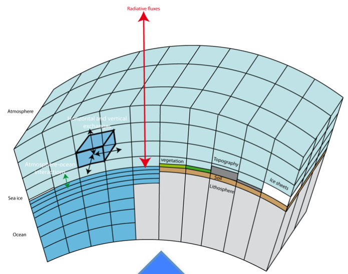
True Earth

Observation

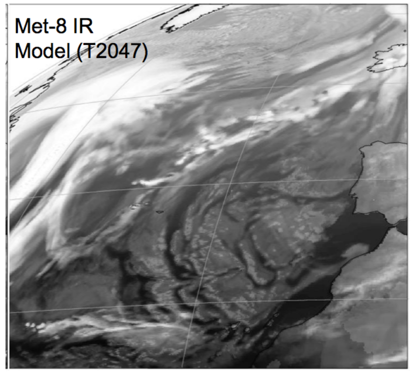


water vapor channel, 6-7µm from ECMWF

Earth system model (4D atmospheric state)



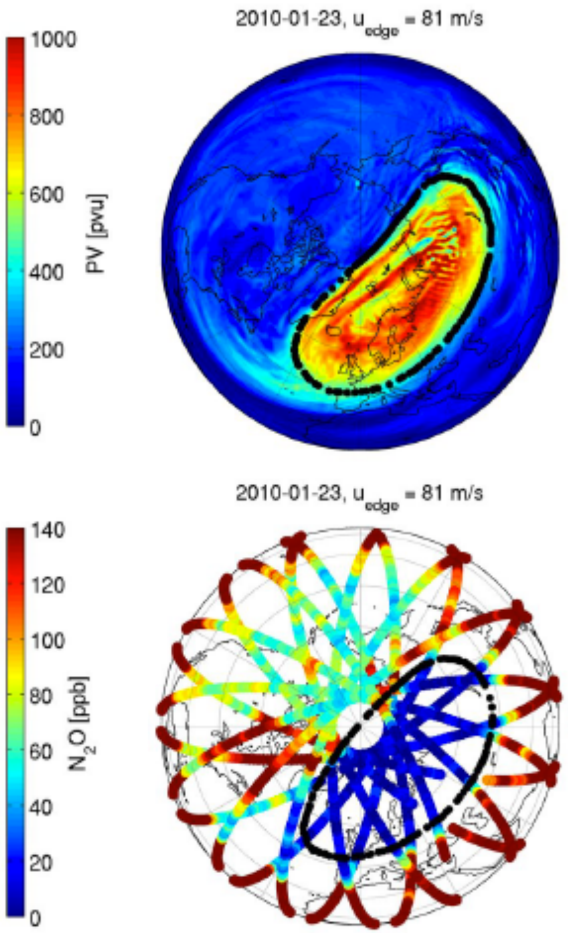
„IR image“ of the **model world**



Intercomparison
Data assimilation

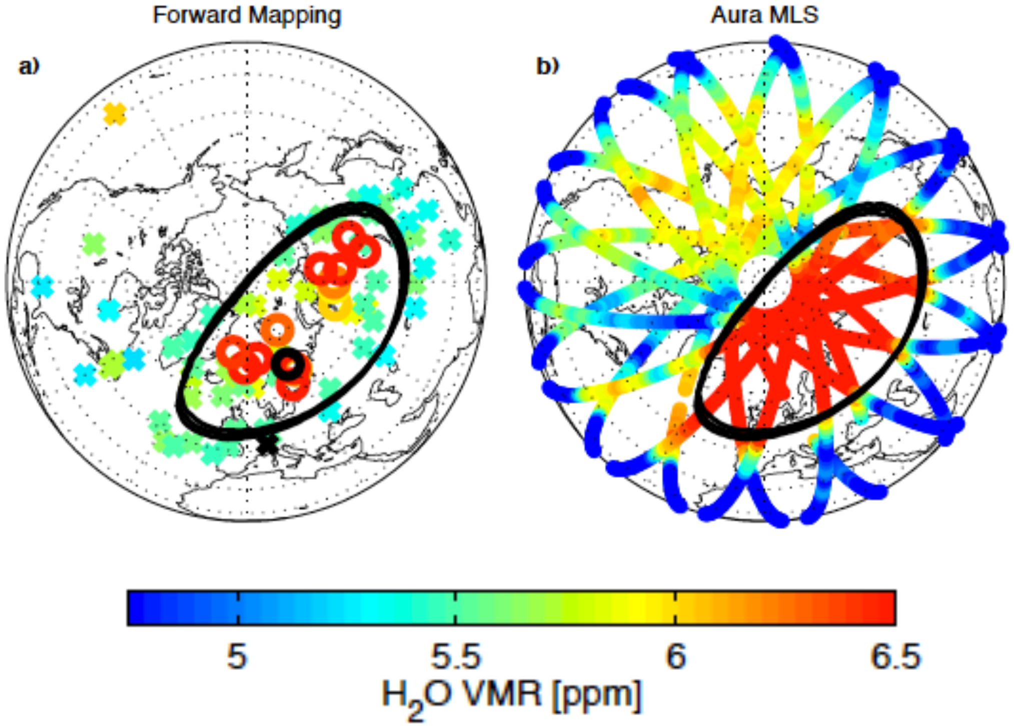
Stratospheric Polar Vortex: a lot of informations from three stations

Potential Vorticity (PV), z≈32 km



Water vapor, z≈32 km

3 ground stations satellite



Dominik Scheiben et al., ACP, 2012

NORS Data User Guide (Example)

A. Instrument fiche

Table 4. DOAS/MAXDOAS instrument fiche

Instrument	Multi-AXis Differential Optical Absorption Spectrometer (MAX-DOAS)
Platform	ground-based
Measuring technique	Solar light absorption spectrometry
Observation geometry	Looking at scattered light from the zenith and various directions above the horizon. Some instruments also perform direct sun observations.
Units	Total columns (mol/cm2) and volume mixing ratio per atmospheric layer (vmr) and partial column per atmospheric layer (mol/cm2)
Vertical resolution	Strongly varying from 100 m close to the ground to column above 5 km
Horizontal resolution	Depending on solar zenith angle of measurement, vertical layer position and wavelength range used and atmospheric aerosol load and vertical profile of the target species: the horizontal resolution decreases as the SZA increases and if the target gas is located higher in the atmosphere. In the boundary layer, it decreases with increasing aerosol load and towards shorter retrieval wavelengths.
Temporal resolution	Better than 1 minute for tropospheric column, 10 minutes for stratospheric columns at twilight, typically 15 – 30 minutes for profile in the troposphere
Vertical range	0-70 km
Horizontal range	0 – 50 km in the troposphere
Stability/drift	avoided by thermal stabilisation, use of zenith reference spectra and instrument line shape verifications with spectral measurements and / or numerical determination of slit width
Precision	???
Systematic uncertainty	Determined by spectroscopic uncertainties (5 – 10%) and radiative transfer uncertainties (10 – 20%)
Daytime/ nighttime	Only daytime
Weather conditions	Best measurements at clear sky, good tropospheric profiles at homogeneous cloud conditions, stratospheric columns nearly independent of weather conditions. Direct sun observations only possible if solar disk is visible.
Interferences/ contamination	Spectral interferences for weak absorbers at low concentrations possible

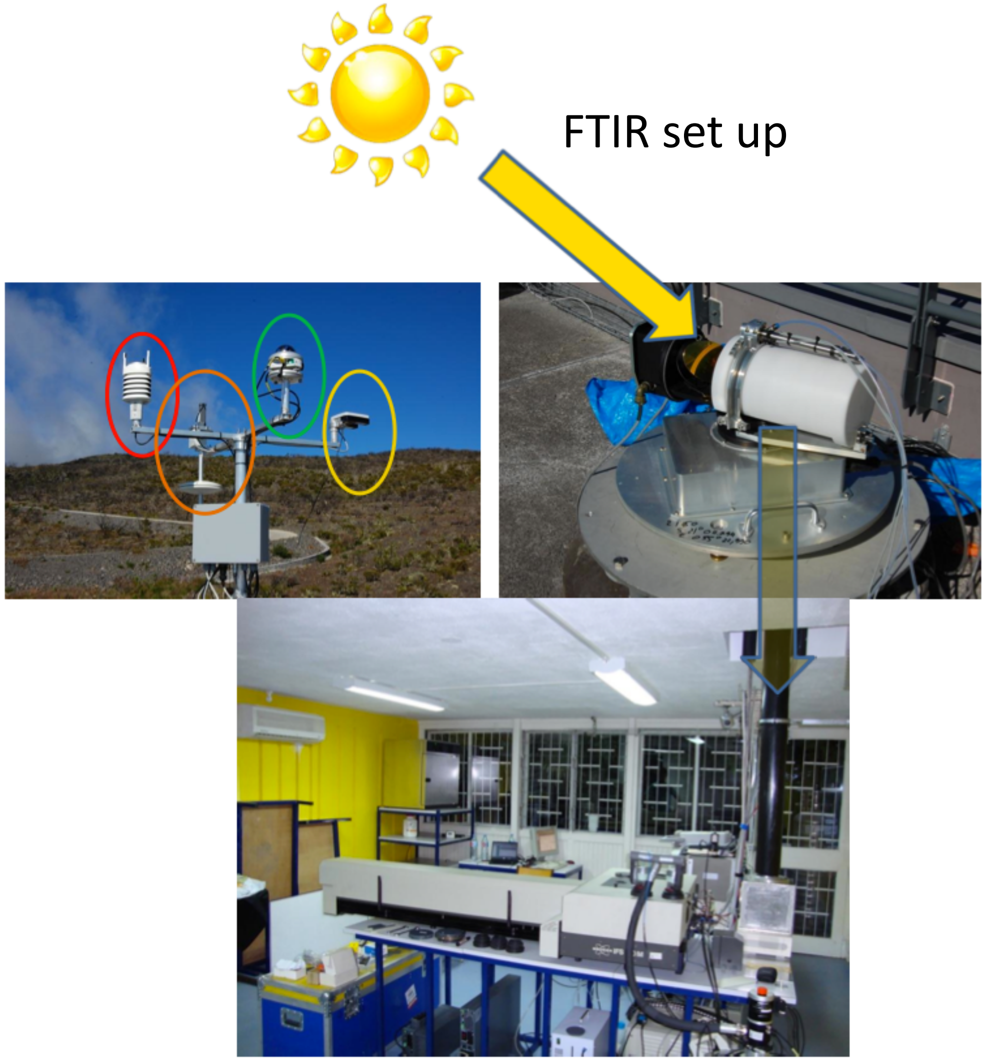


Figure 1. Experimental set-up

Figure 1 shows an experimental setup. Top left: meteostation; top right: suntracker; bottom: Fourier transform spectrometer. The meteo station includes a Vaisala wind/humidity/rain detector (in the red circle), a sunshine detector (total solar irradiance) (in the green circle), a high-precision barometer (in the orange circle) and a presence-of-rain detector (in the yellow circle).