Tuning the retrieval: treat or cheat

Klemens Hocke, Simone Studer

(Nik Kämpfer, Axel Murk)

Institute of Applied Physics (IAP)
Oeschger Centre for Climate Change Research (OCCR)
University of Bern

NDACC Microwave Radiometry Workshop, Bern, 8-11 January 2013

Outline

1. NORS and RDDS

2. Error analysis (ground-based microwave radiometry)

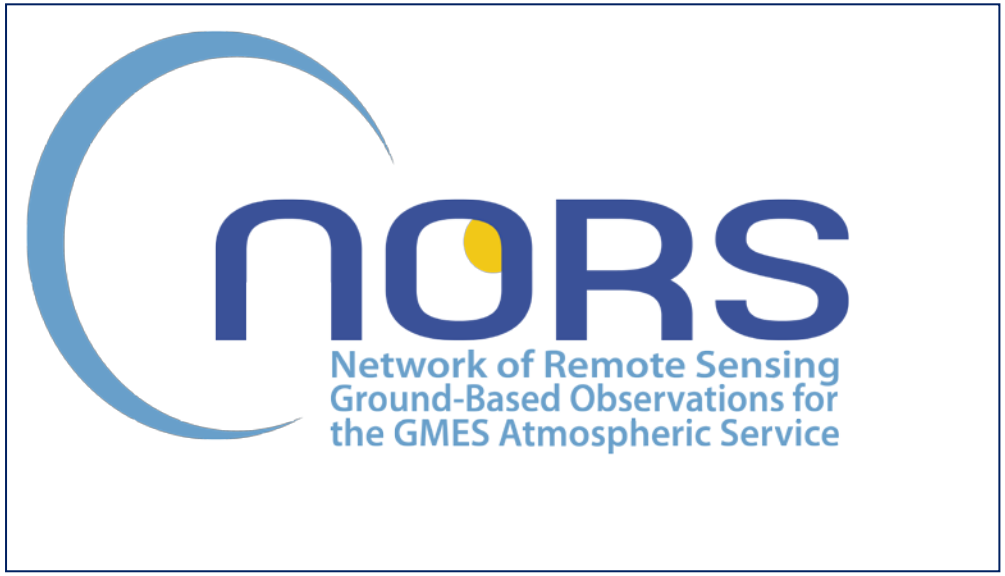
3. Removal of systematic errors

4. Strategies for the development and validation of retrieval algorithms

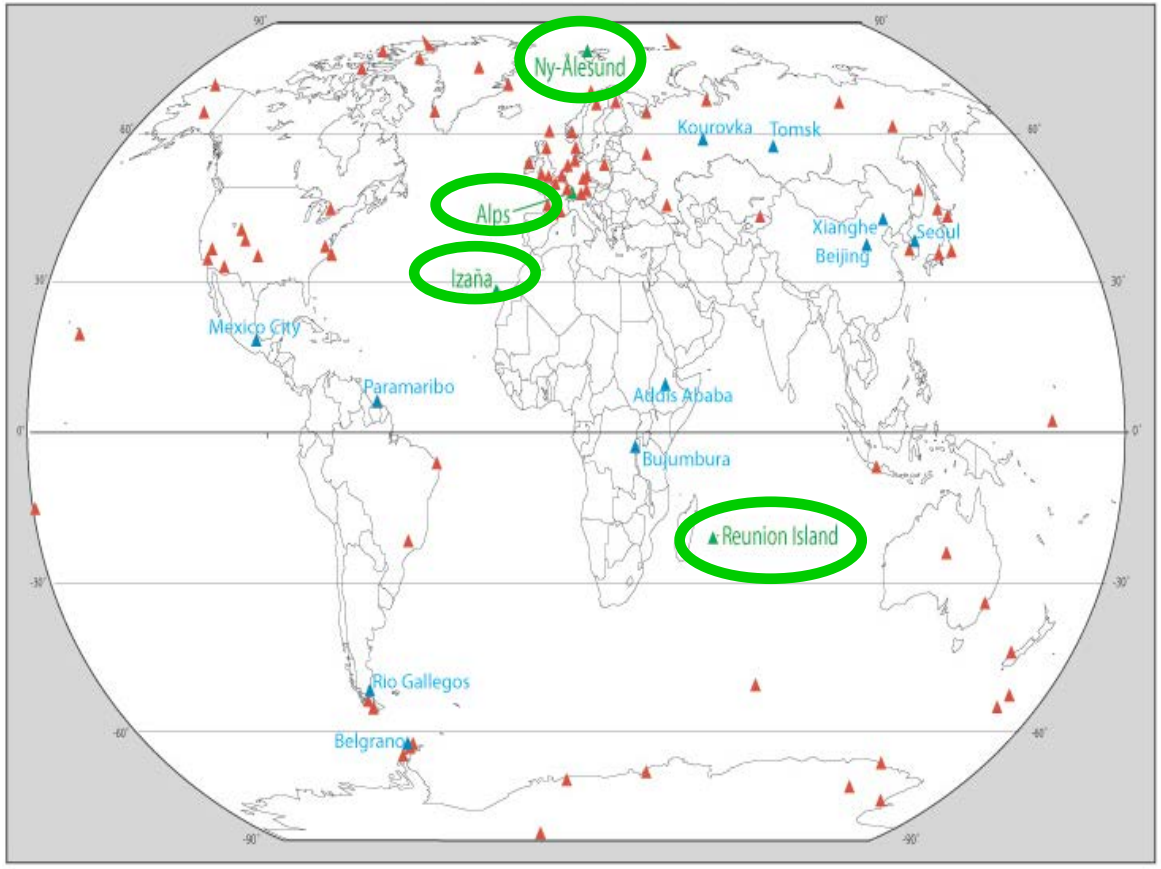
5. Conclusions

NORS and RDDS

EU project NORS:
Demonstration Network Of ground-based Remote Sensing observations in support of the GMES Atmospheric Service
http://nors.aeronomie.be/



NORS Network (within NDACC)



- Operational NDACC stations
- NDACC stations selected as pilot stations in NORS
- Stations to be developed in NORS to potentially become NDACC stations

from NORS project leader Martine De Maziere

NORS and RDDS

Collected observations of NORS:
Atmospheric composition (O_3, NO_2, HCHO, CH_4, ...) measured by

- DOAS, UV-VIS, FTIR
- Lidar
- MW Radiometer

Rapid Data Delivery System (RDDS) within NDACC:

- „Rapid“ means data submission within 4 weeks after observation
- HDF GEOMS format (=> Ian Boyd)

What are the aims of the Rapid Data Delivery System (RDDS)?

- Data center of ground-based remote sensing data for validation/calibration of satellites (ESA Sentinel, ...)
- **... in support of MACC**

  (data assimilation and forecasting)

- ... for „us“ (refinement of retrieval by cross-validation, long-term trend studies, archiving ...)
- ... for NDACC (preparing and testing the step from NASA Ames to GEOMS HDF files)

MACC Project – Data Access

http://www.gmes-atmosphere.eu/data/

Monitoring atmospheric composition & climate | Login | Site map | Print

macc Monitoring atmospheric composition & climate

GMES

Search Content

HOME | NEWS | CATALOGUE | PRESS ROOM | ABOUT THE PROJECT | CONTACT US

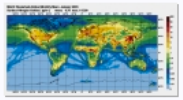
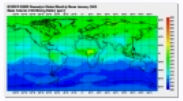
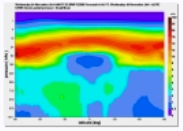
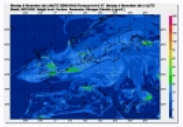
Home > Data Access >

Home
- News
- Press Room
- About the Project
- Operational Info
- Contact us
- Jobs

Today's Forecasts
- Reactive Gases
- Aerosols
- European Air Quality
- UV Index
- Ozone Layer
- CO2

Latest Analyses
- Fire Monitoring
- European Air Quality
- Reactive Gases
- Aerosols

Data Access

DATASET	PARAMETERS	PERIOD	AREA	LINK
MACC datasets				
 **MACC Reanalysis**	chemical and aerosol species, meteorological parameters	1.1.2003 - 31.12.2010	global	
GEMS datasets				
 **GEMS Reanalysis**	chemical and aerosol species, meteorological parameters	1.1.2003 - 30.4.2009	global	
 **GEMS Near-real-time Analysis/Forecast Suite**	chemical and aerosol species	5.7.2008 - 29.9.2009	global	
 **GEMS Regional Air Quality Forecasts**	chemical and aerosol species	last 8 days	Europe	

Services
- Air Quality & Atmospheric Composition
- Climate Forcing
- Ozone Layer & Ultra-Violet Radiation
- Solar Radiation
- Emissions & Surface Fluxes

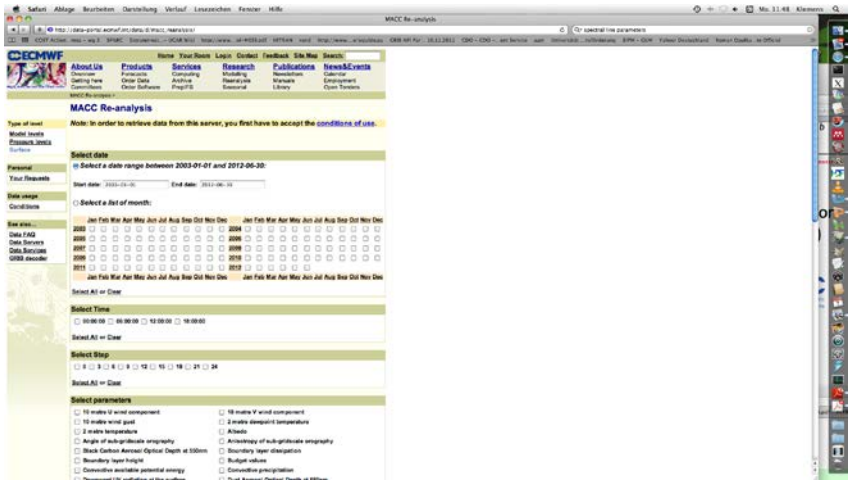
ACCESS CATALOGUE

MACC-II is a Collaborative Project (2011-2014) funded by the European Union under the 7th Framework Programme.
It is coordinated by the European Centre for Medium-Range Weather Forecasts and operated by a 36-member consortium.

Data product of MACC chemical reanalysis

e.g., 6-hourly global fields of O_3 or H_2O (at pressure levels)

MACC uses the infra-structure of ECMWF:



Inness et al., ACPD, 2012
The MACC reanalysis:
an 8-yr data set of
atmospheric composition

http://data-portal.ecmwf.int/data/d/macc_reanalysis/

Interesting Question:

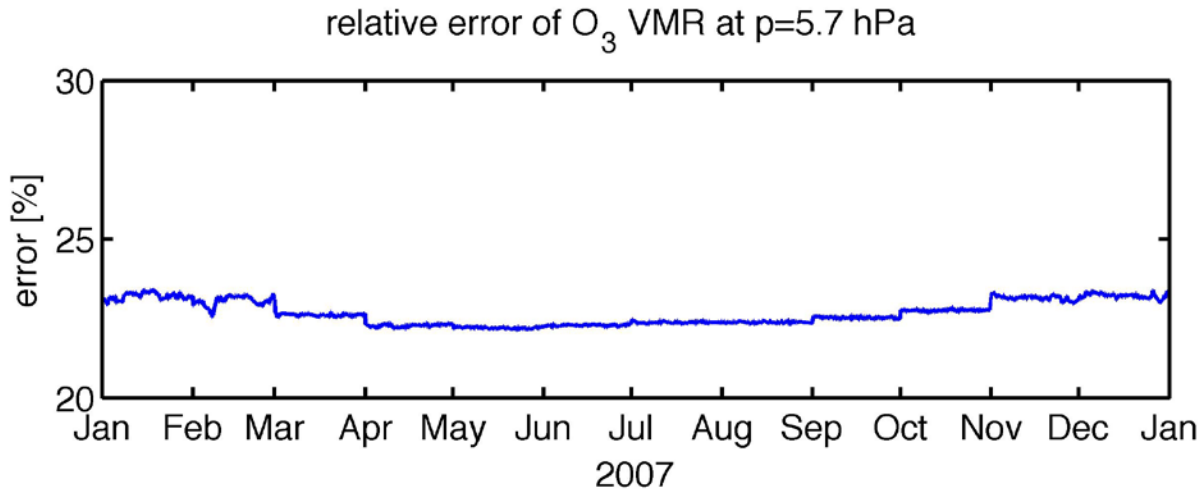
Are the error profiles provided by us (NDACC and NORS) appropriate for data assimilation and forecasting?

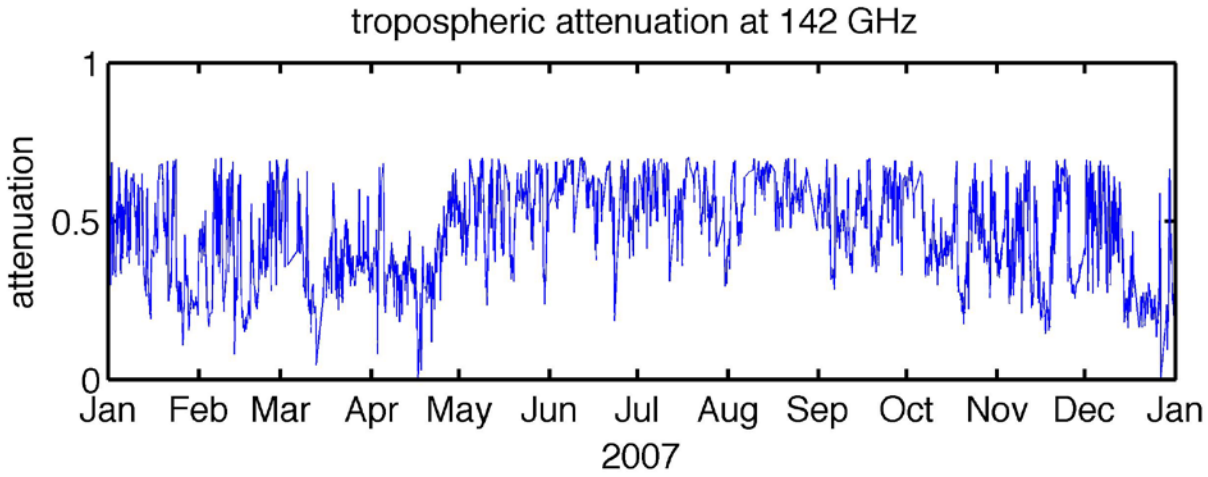
- Error analysis for NDACC and NORS data products is possibly performed for large time scales (> 1 month, e.g., assumed error of apriori profile)

-Time scales of interest for MACC are 1 day to 1 week

- Modellers possibly take the error profiles provided by data center (communication between the NORS and the MACC community is a bit poor)

How is the estimated error for GROMOS, a 142 GHz microwave radiometer?





OEM (Rodgers) gives an almost constant error (archived at NDACC)

though the attenuation of ozone emission by tropospheric water vapor is quite variable

(retrieval is not performed for values > 0.7 !)

Error analysis

Error analysis was designed in view of long-term trend detection in stratospheric ozone

1) a robust retrieval has the priority (➔avoid rapid changes in error estimates of spectral radiance and apriori ozone profiles)

2) tropospheric opacity almost not considered in the error analysis (since it may change the seasonal cycle of ozone)

3) almost the same error for individual channels of the filter bench (to avoid artificial oscillation in the ozone profile)

4) a priori error from a climatology

➔Error profiles of GROMOS are almost useless for the purpose of MACC (data assimilation and chemical weather forecast)

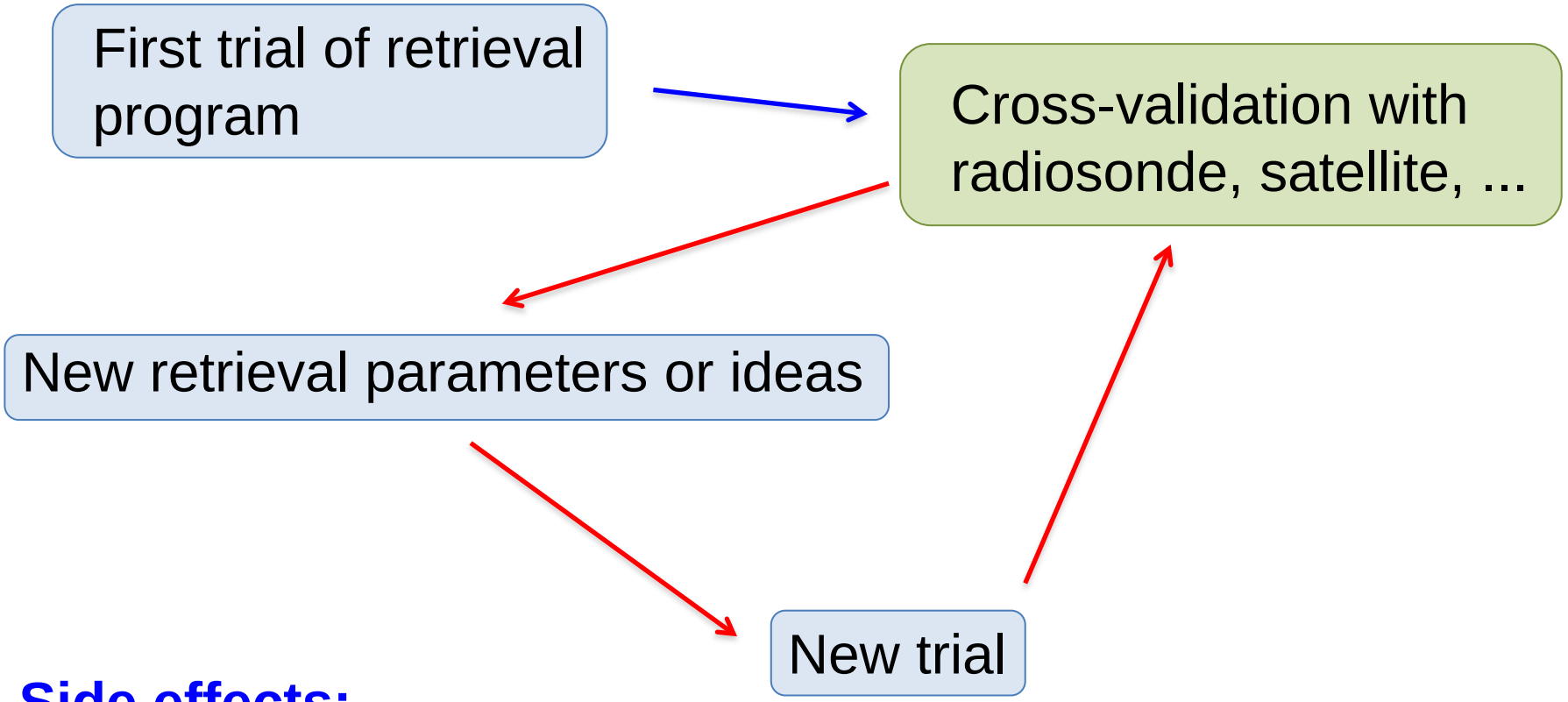
... better take the error estimates derived from cross-validations???

How does a retrieval program arise?

1) Reading of Rodger ‘s book
2) Measure the errors of the radiometer in a laboratory
3) Programming of the retrieval by use of the derived errors
4) Cross-validations with coincident observations from other instruments
5) If cross-validations are okay (or if you trust your own results more than the others) then enter the operational phase

Constant systematic errors may not matter for trend estimation

Is tuning of a retrieval program allowed?



Side effects:

- measurements might be tuned towards a wrong reference
- loss of independence
- one error might be compensated by another error

Example:
Removal of systematic error in lower stratospheric ozone

GROMOS: observed ozone emission in the wings of the 142 GHz ozone line is about 10% less than expected (model spectrum derived from ozonesonde measurements)

This effect occurred for FFT spectrometer and digital filter bench

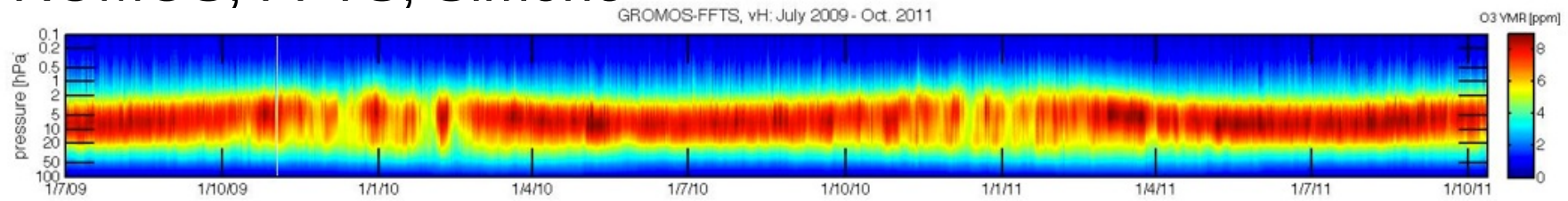
1) Because of a baseline? Removal of a residual difference spectrum seems to be difficult because of seasonal changes

2) Because of wrong spectral line parameters?
   Idea came from retrieval paper of Mathias Palm.
   The two new spectral parameters (pressure broadening and peak intensity) gave good ozone results for all seasons

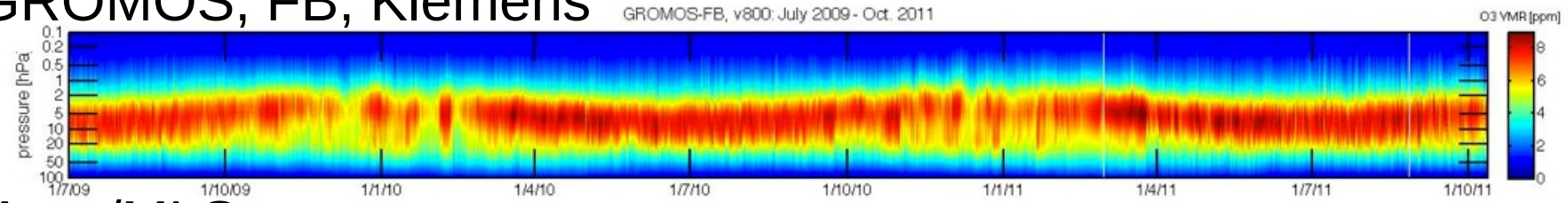
Ozone above Bern: GROMOS, Aura, MIPAS 2009-2011

UNIVERSITÄT BERN

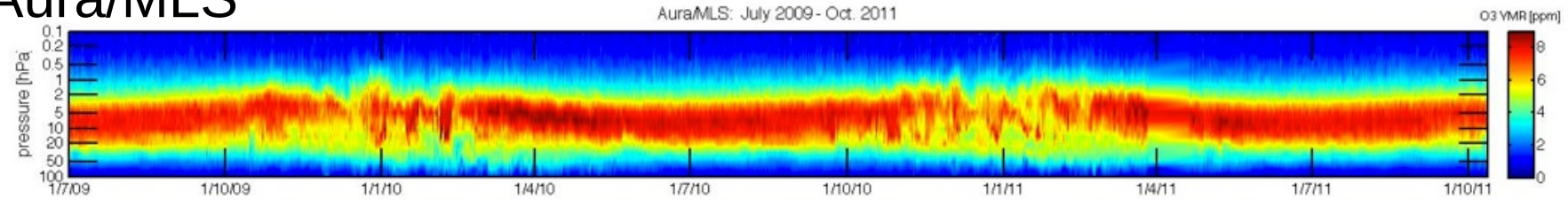
GROMOS, FFTS, Simone



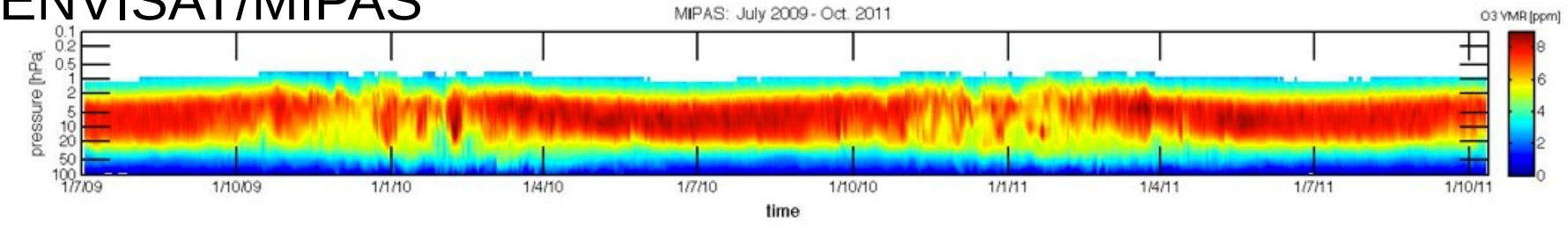
GROMOS, FB, Klemens



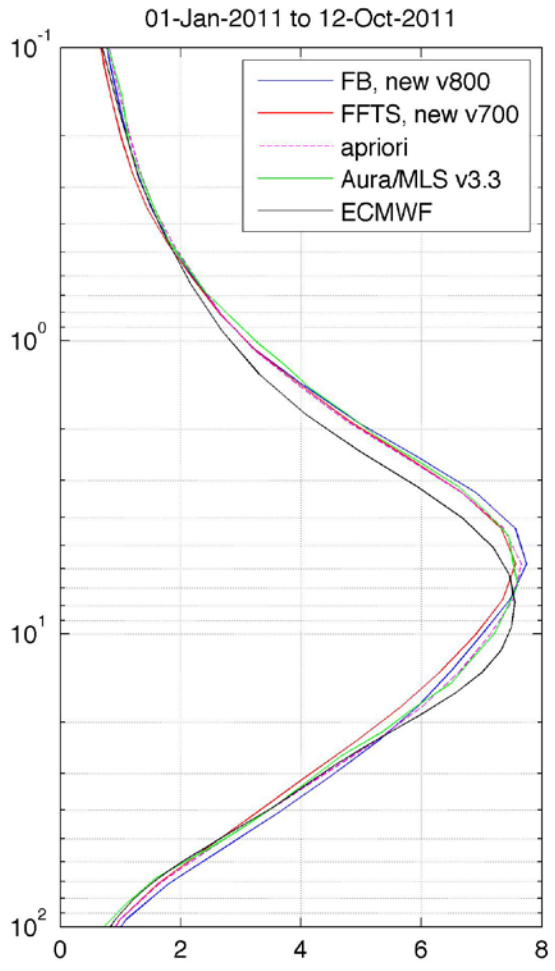
Aura/MLS

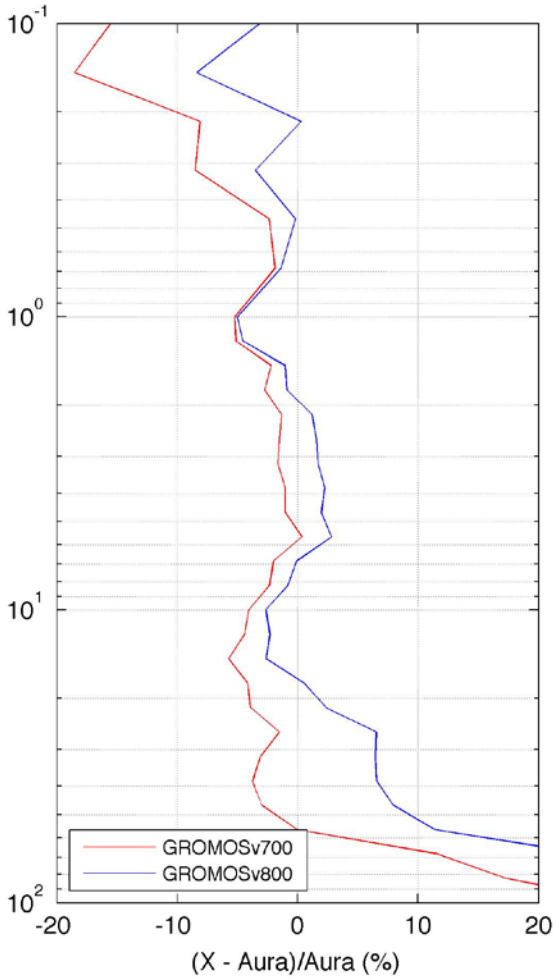


ENVISAT/MIPAS



Courtesy of Simone Studer





Difference profiles for 10 months in 2011:

Red: FFTS – Aura (Simone)

Blue: FB – Aura (Klemens)

Preliminary result: GROMOS and Aura are within about 5% agreement from 30 hPa to 0.4 hPa

Conclusions

1. There are open questions concerning the use of error profiles from NDACC for the purpose of data assimilation and medium-range forecast

2. Tuning: treat or cheat? Model parameters of weather models are tuned in an optimal manner for different situations. Is this approach desirable for retrieval programs?

3. Retrieval strategy and decision making (e.g., baseline correction or change of spectral line parameter) is unclear. Removal of systematic errors?

4. A lot of time and energy is wasted by retrieval students and supervisors because of a lack of information and the unclear situation