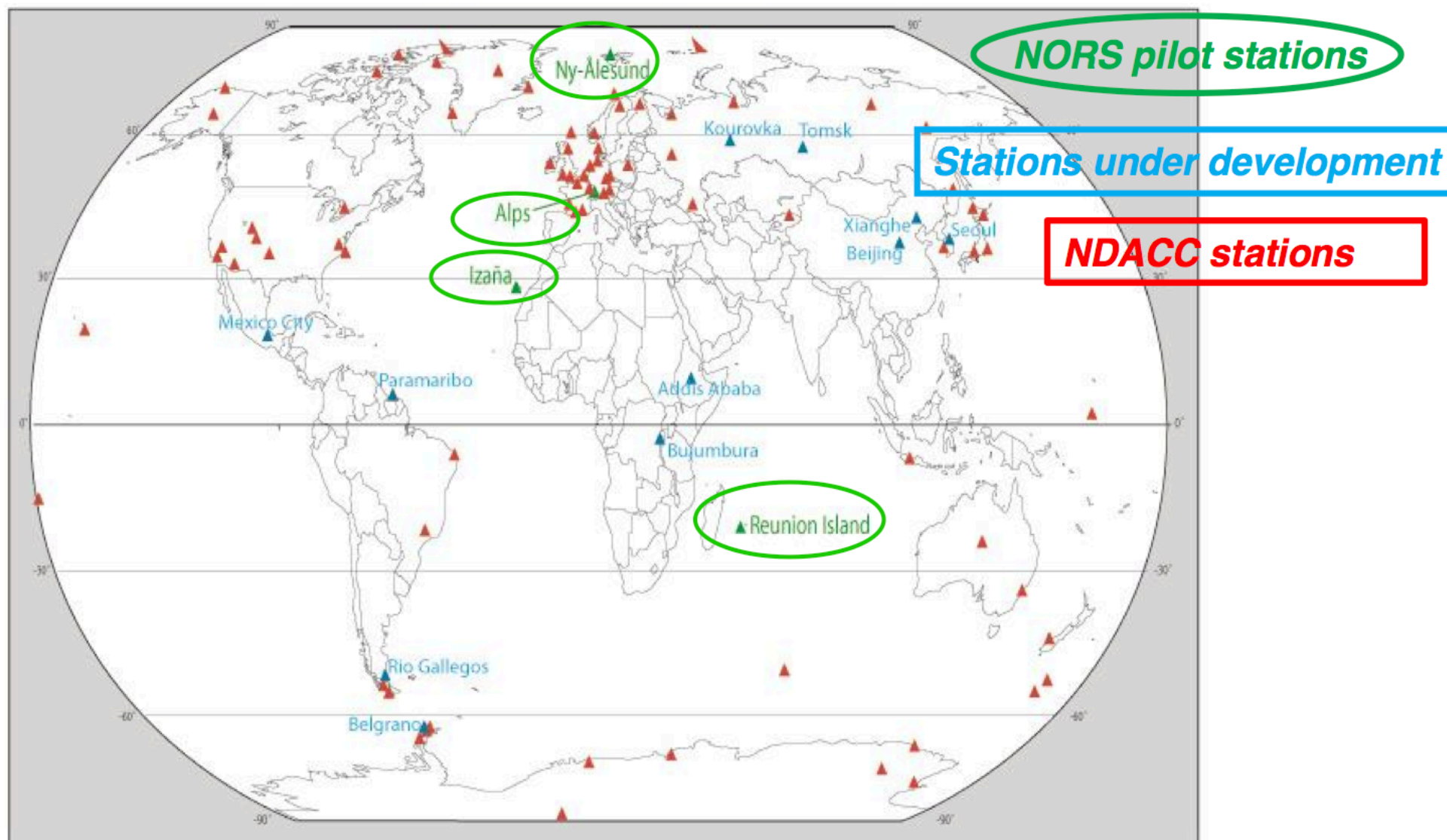


Outline of the use of FTIR measurements in the NORS validation server



Goals

- To deliver in situ monitoring data from ground-based remote sensing instruments with minimal delays to the Copernicus Atmospheric Service (CAS) for the purpose of assessing the quality of the CAS products
- To establish remote sensing monitoring capabilities outside of W-Europe
- To develop and provide integrated products for validation
- To build a Web-based validation server for CAS products – providing automatic default validation reports
- To become a sustainable validation service for many CAS products on the quasi-global scale



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

NORS

- NORS is a demonstration project
- target NORS data products in the validation server
 - tropospheric and stratospheric ozone columns and vertical profiles up to 70 km altitude;
 - tropospheric and stratospheric NO₂ columns and profiles;
 - lower tropospheric profiles of NO₂, HCHO, aerosol extinction;
 - tropospheric and stratospheric columns of CO
 - tropospheric and stratospheric columns of CH₄
- 4 NDACC techniques:
LIDAR, MW, FTIR, UV-VIS DOAS
- 4 NDACC pilot stations

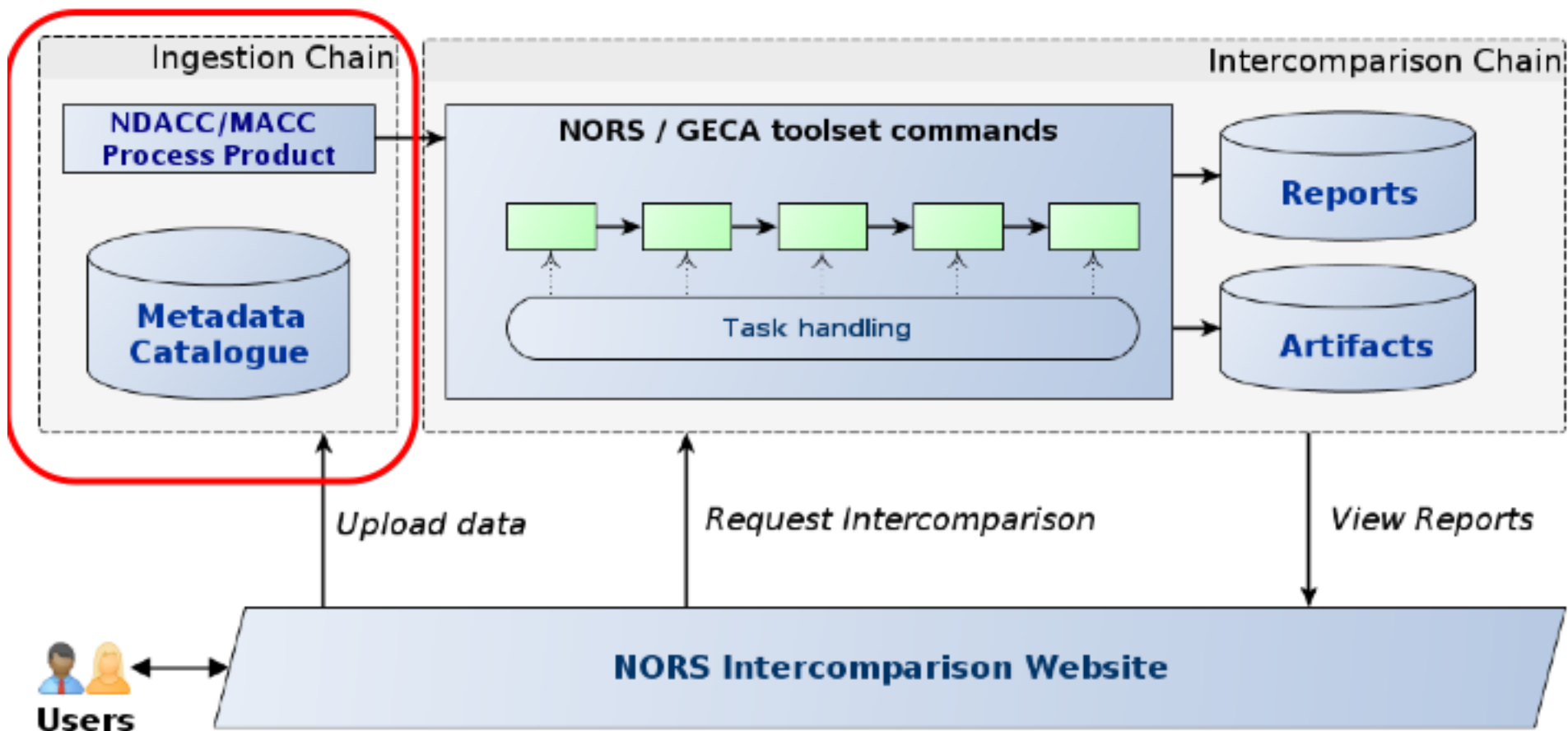
FTIR products := CH₄, O₃, CO profiles and columns

Skill scores used in validation reports

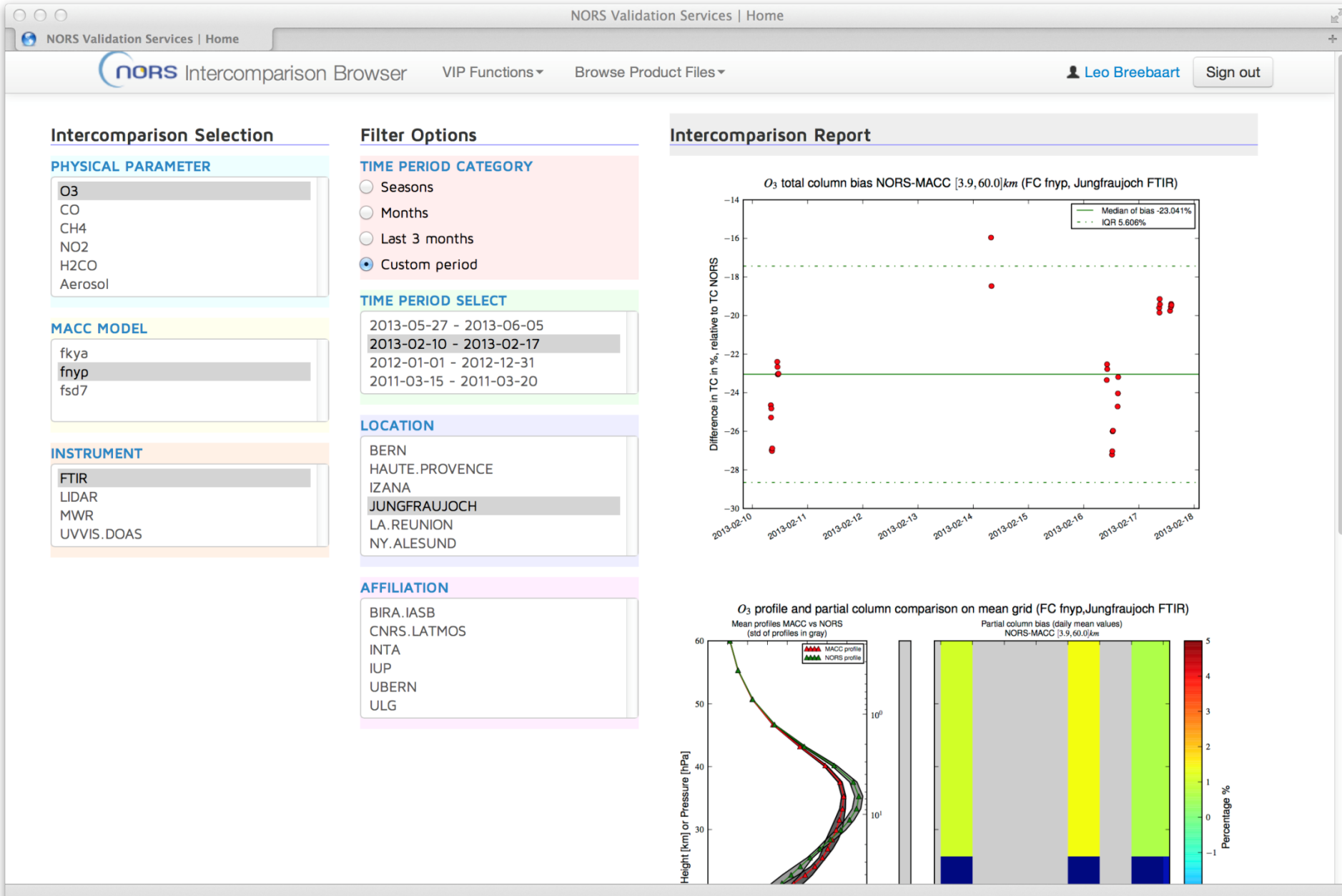
- Difference of total and partial columns
(MACC-NORS)/NORS
- Relative difference of total columns
(MACC-NORS)/($\frac{1}{2}(\text{MACC}+\text{NORS})$)
- Profile differences
- Taylor diagrams

Eskes H., et al. Skill scores and evaluation methodology for the MACC II project. MACC-II VAL D_85.2.

Server setup



NORS Validation Server Web interface

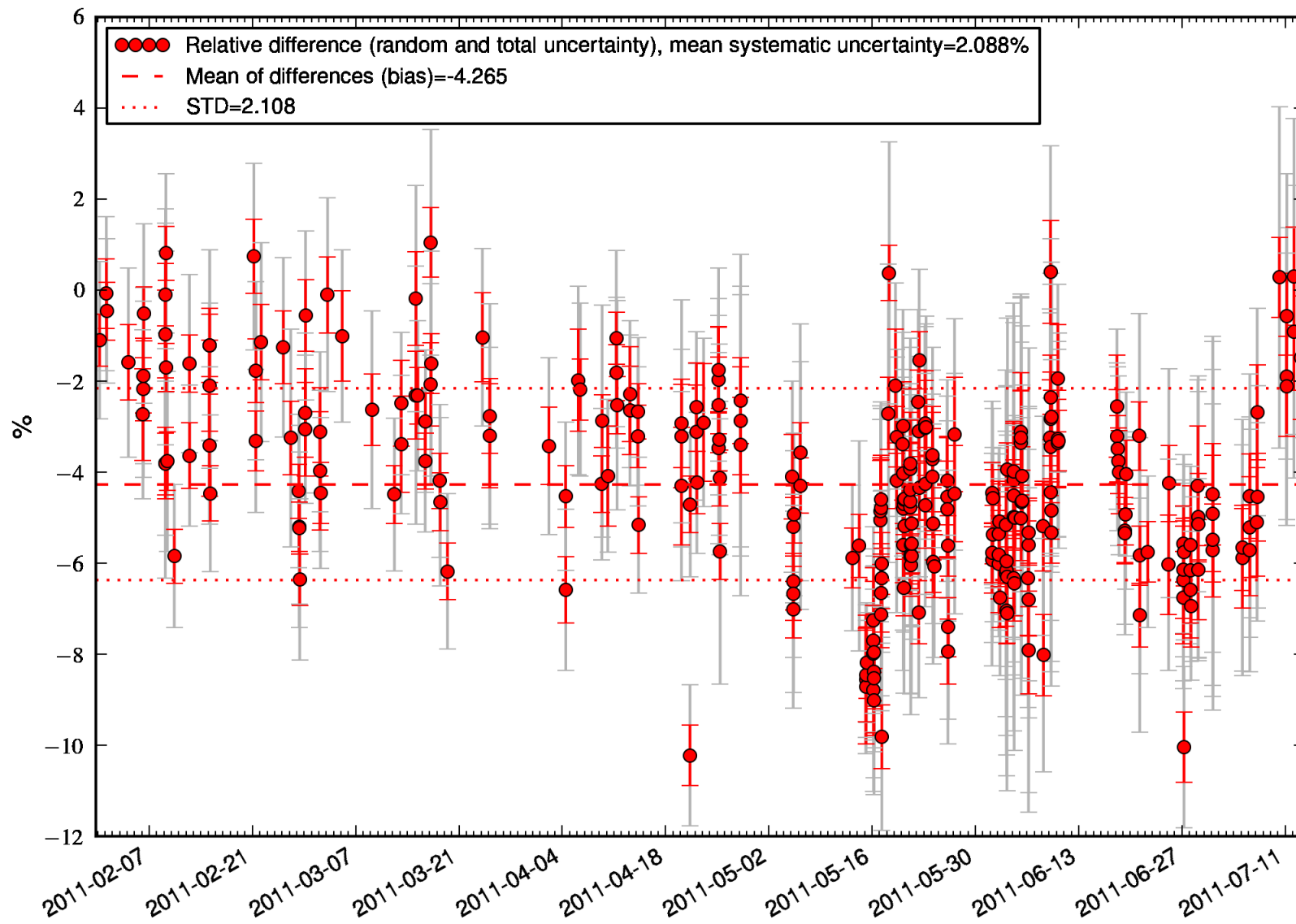


Some examples of graphical output

- O₃
- CO
- CH₄

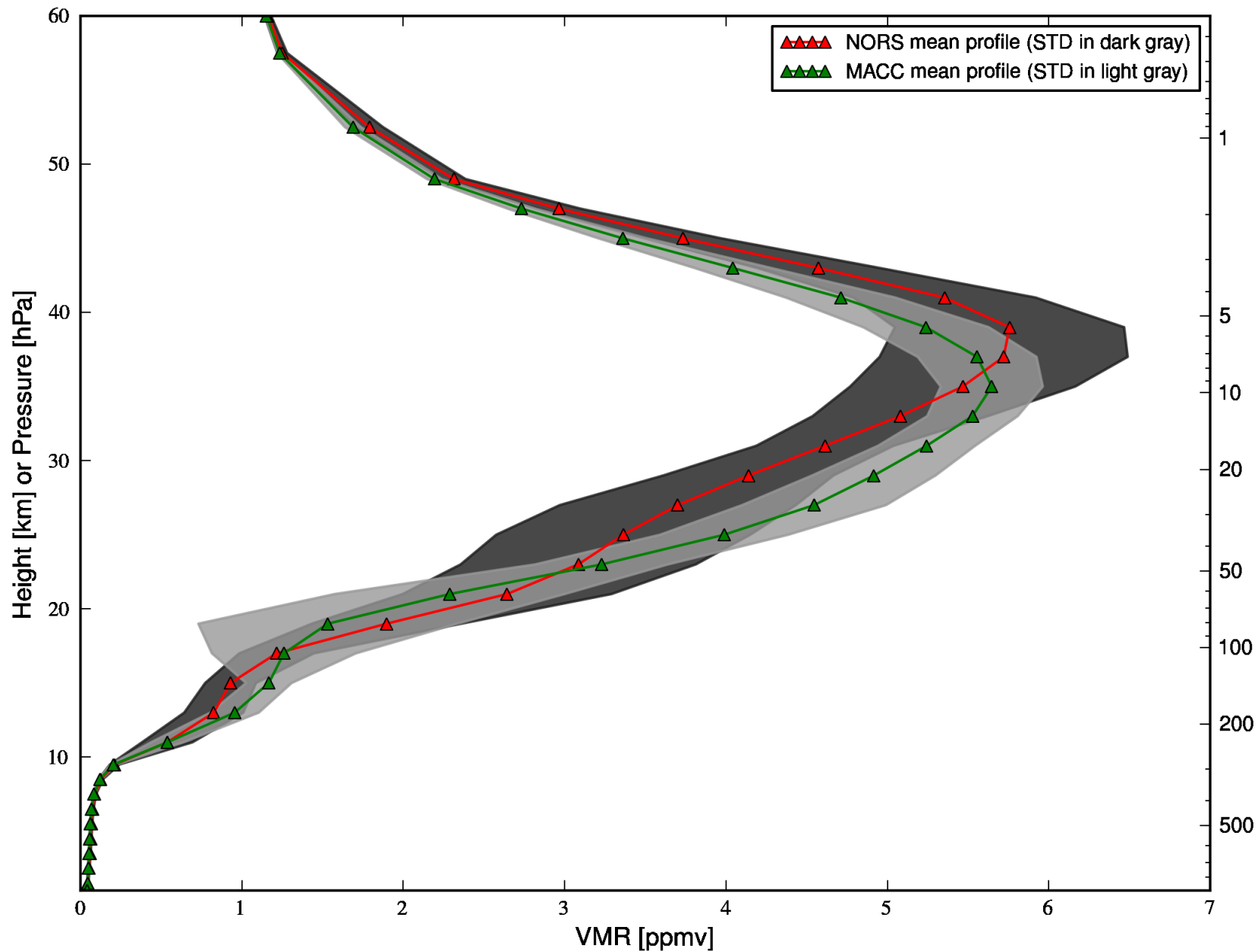
O_3 total column differences (MACC-NORS)/NORS

(1 – 60km, AN f93i, La Reunion FTIR, 11/01/31 - 11/07/13, 276 measurements)



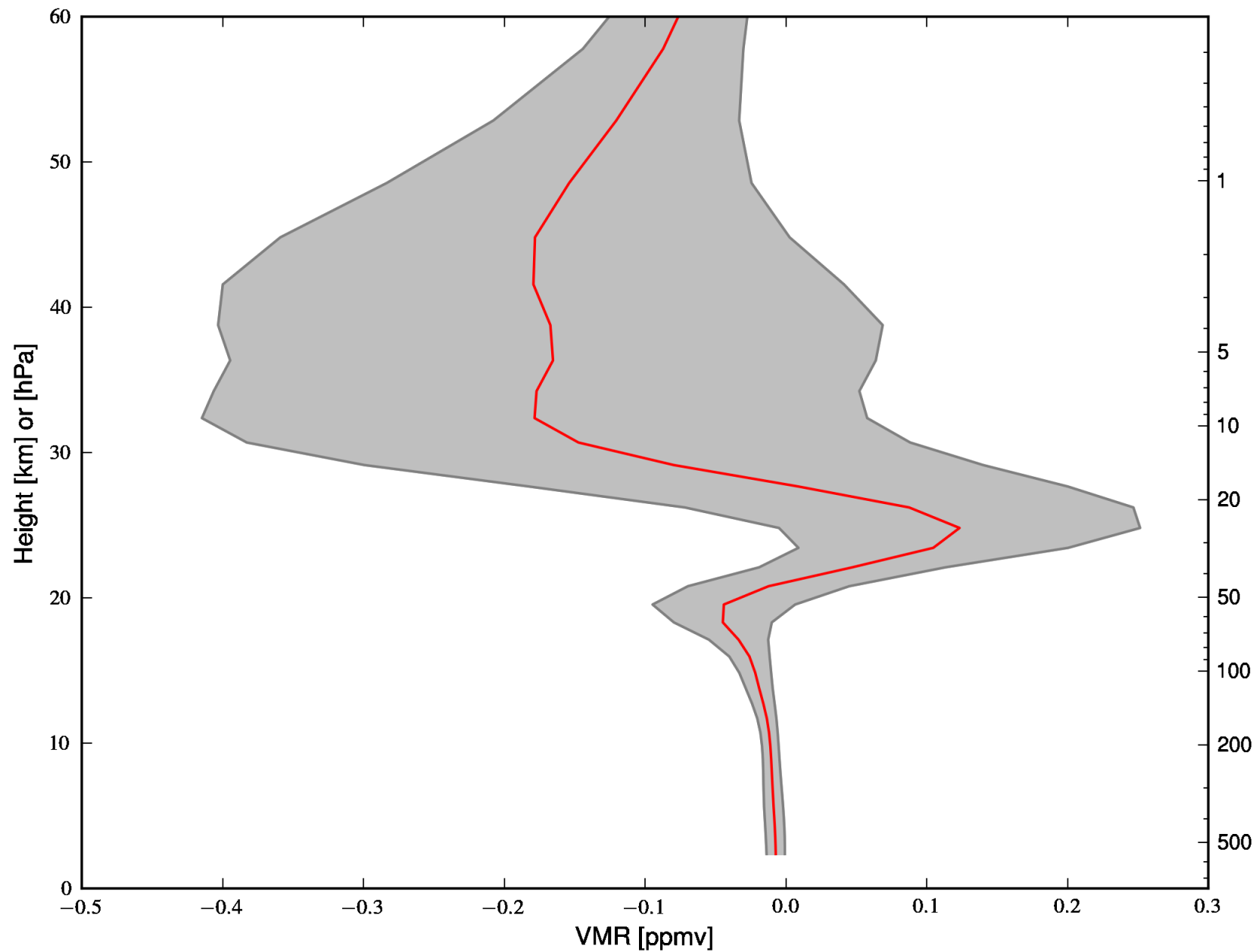
Mean O_3 profiles MACC vs NORS

(1 – 60km, AN f93i, Ny Alesund FTIR, 11/03/29 - 11/07/26, 84 measurements)



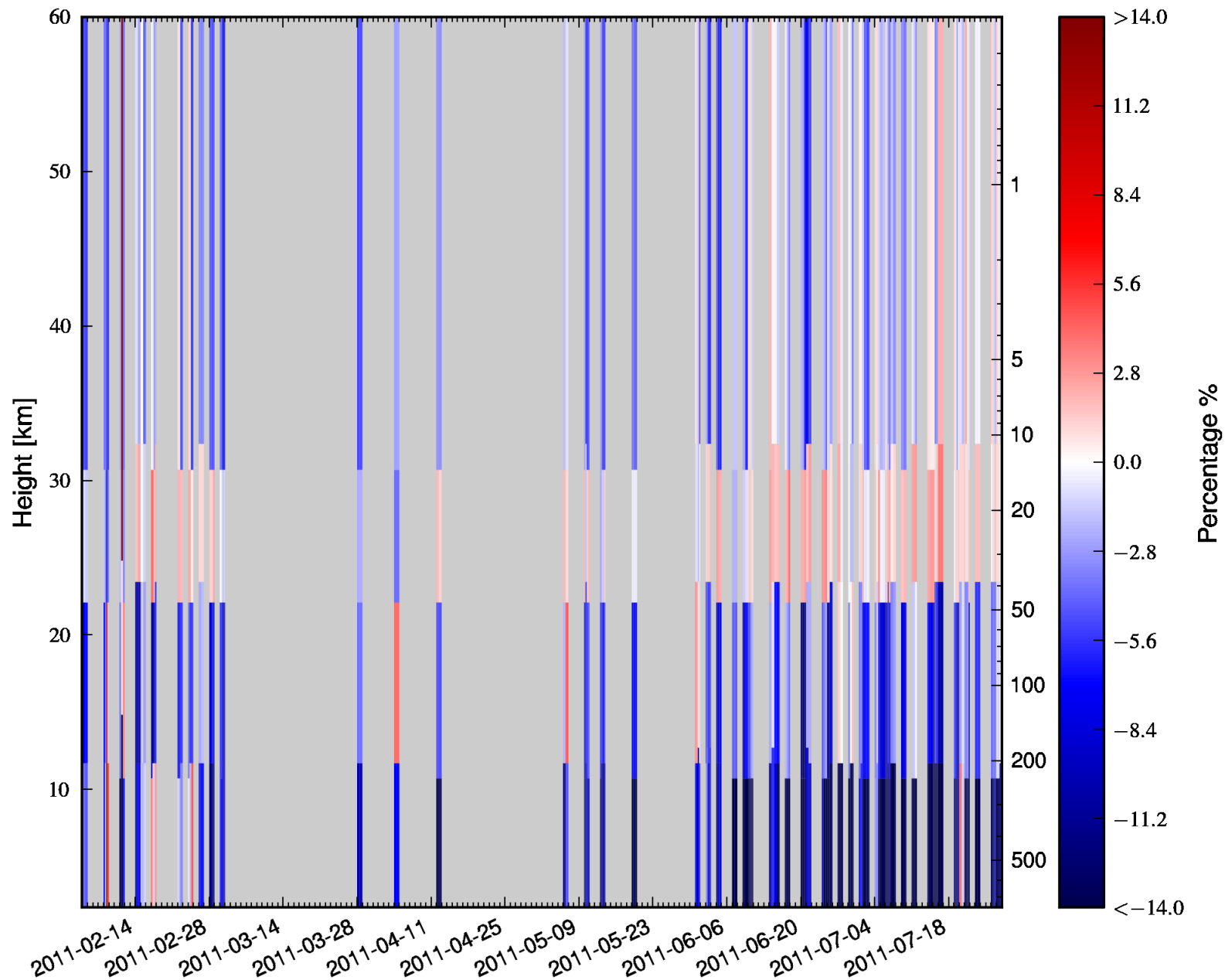
O_3 profile difference and standard deviation (MACC-NORS)

(2 – 60km, AN f93i, Izana FTIR, 11/02/04 - 11/07/27, 292 measurements)



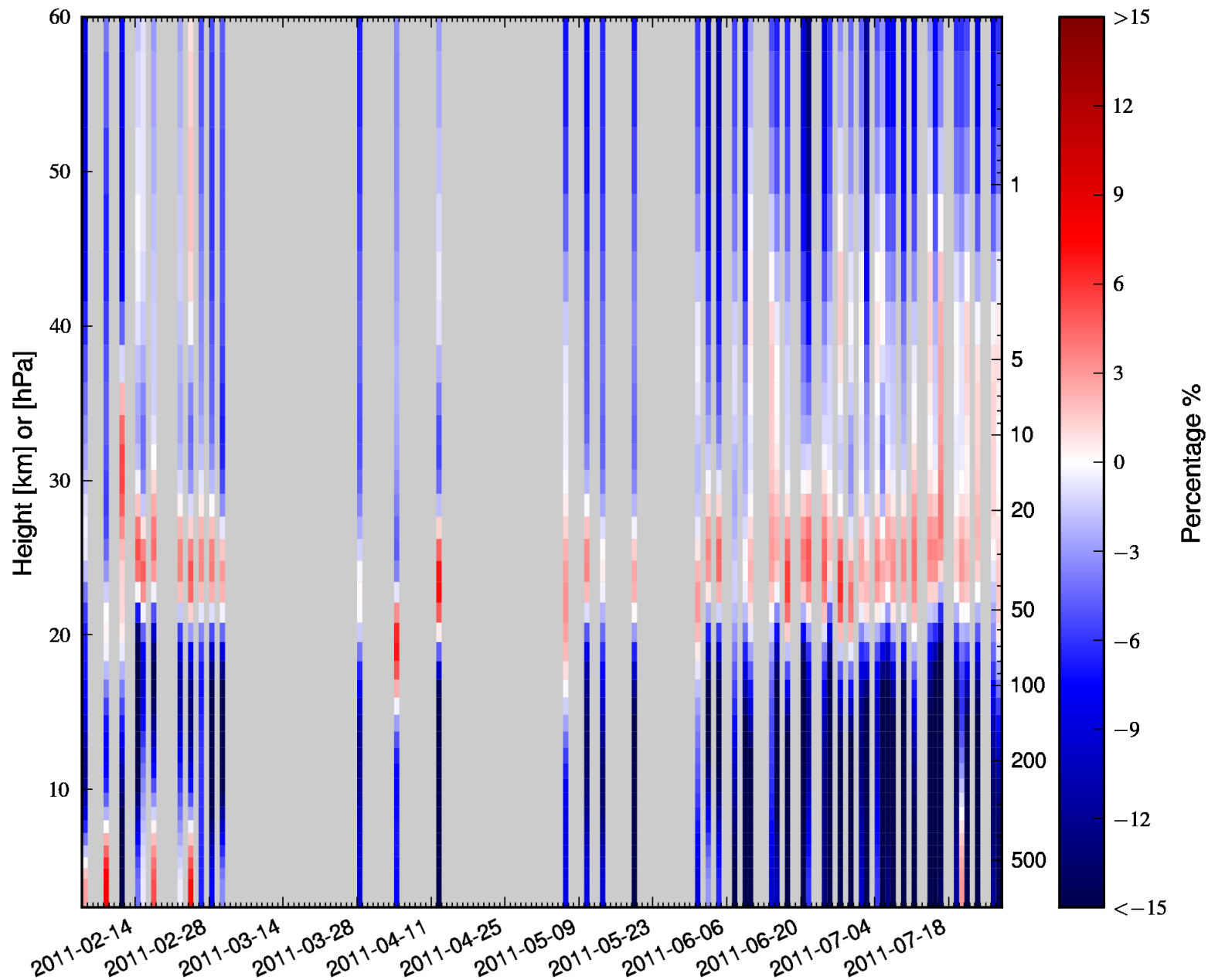
O_3 partial column differences (MACC-NORS)/NORS

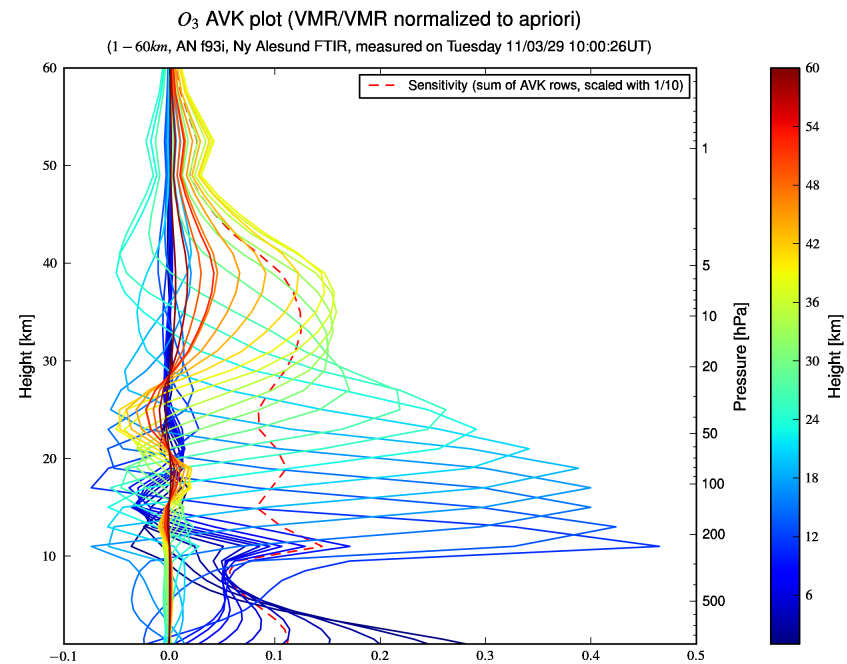
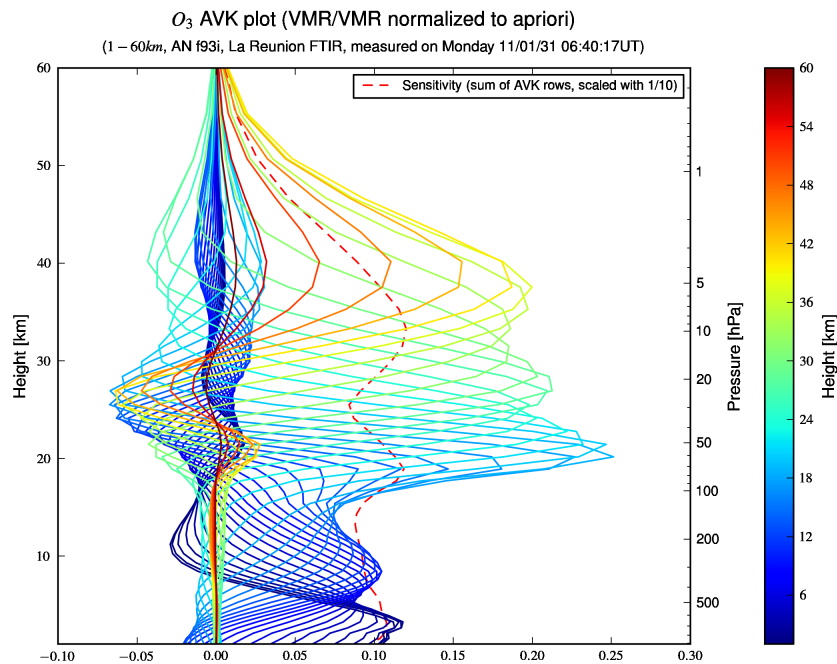
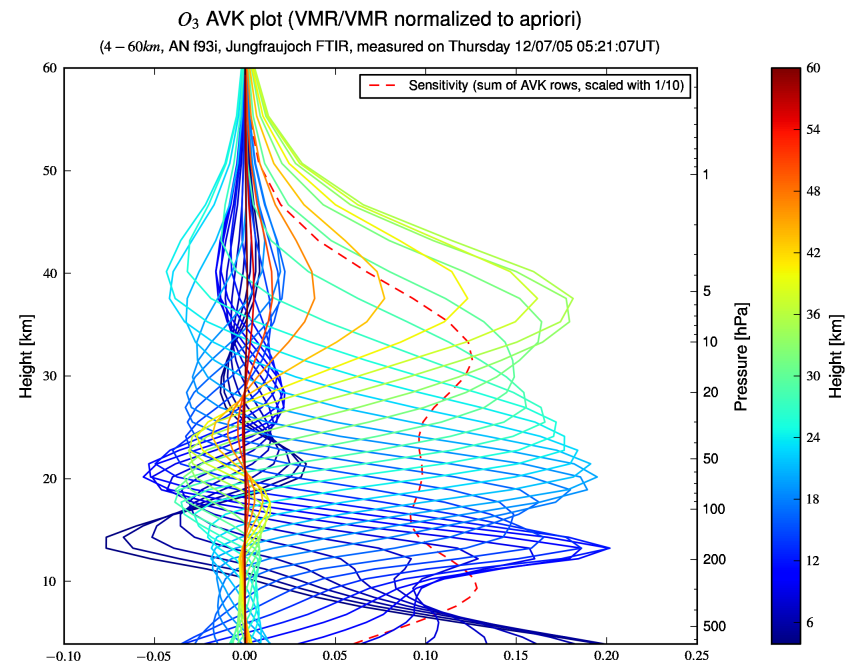
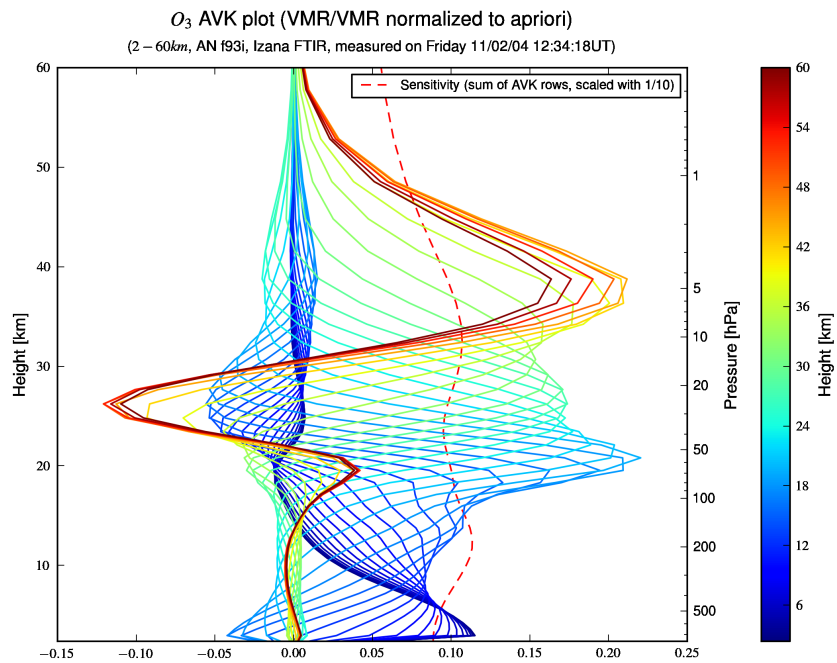
(2 – 60km, AN f93i, Izana FTIR, 11/02/04 - 11/07/27, 292 measurements)



O_3 VMR profile differences (MACC-NORS)/NORS

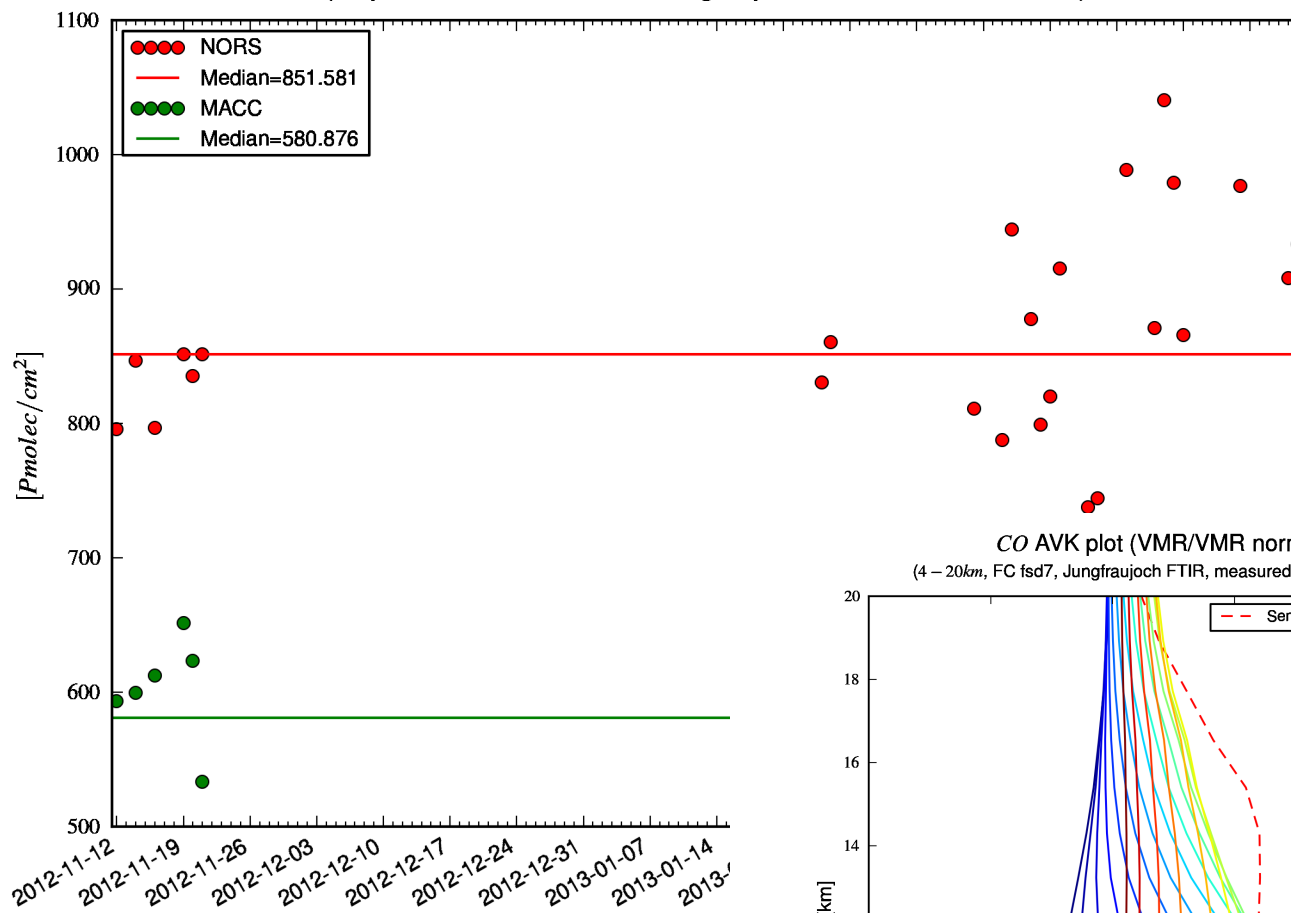
(daily mean, 2 – 60km, AN f93i, Izana FTIR, 11/02/04 - 11/07/27, 292 measurements)





CO total column values

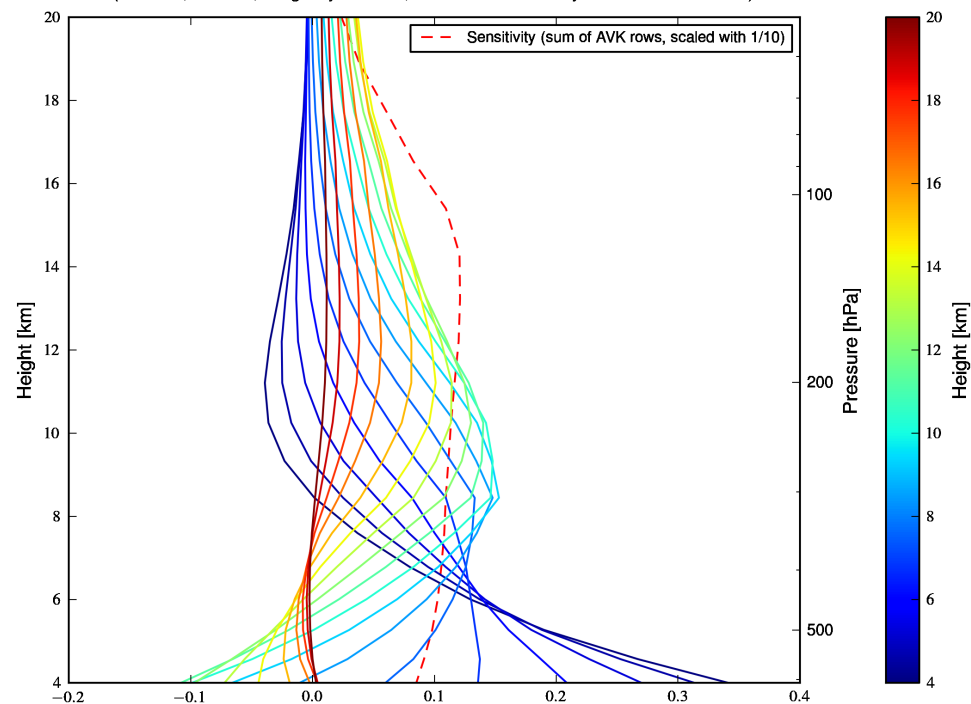
(daily mean, 4 – 20km, FC fsd7, Jungfraujoch FTIR, 12/11/12 - 13/03/16)



CO

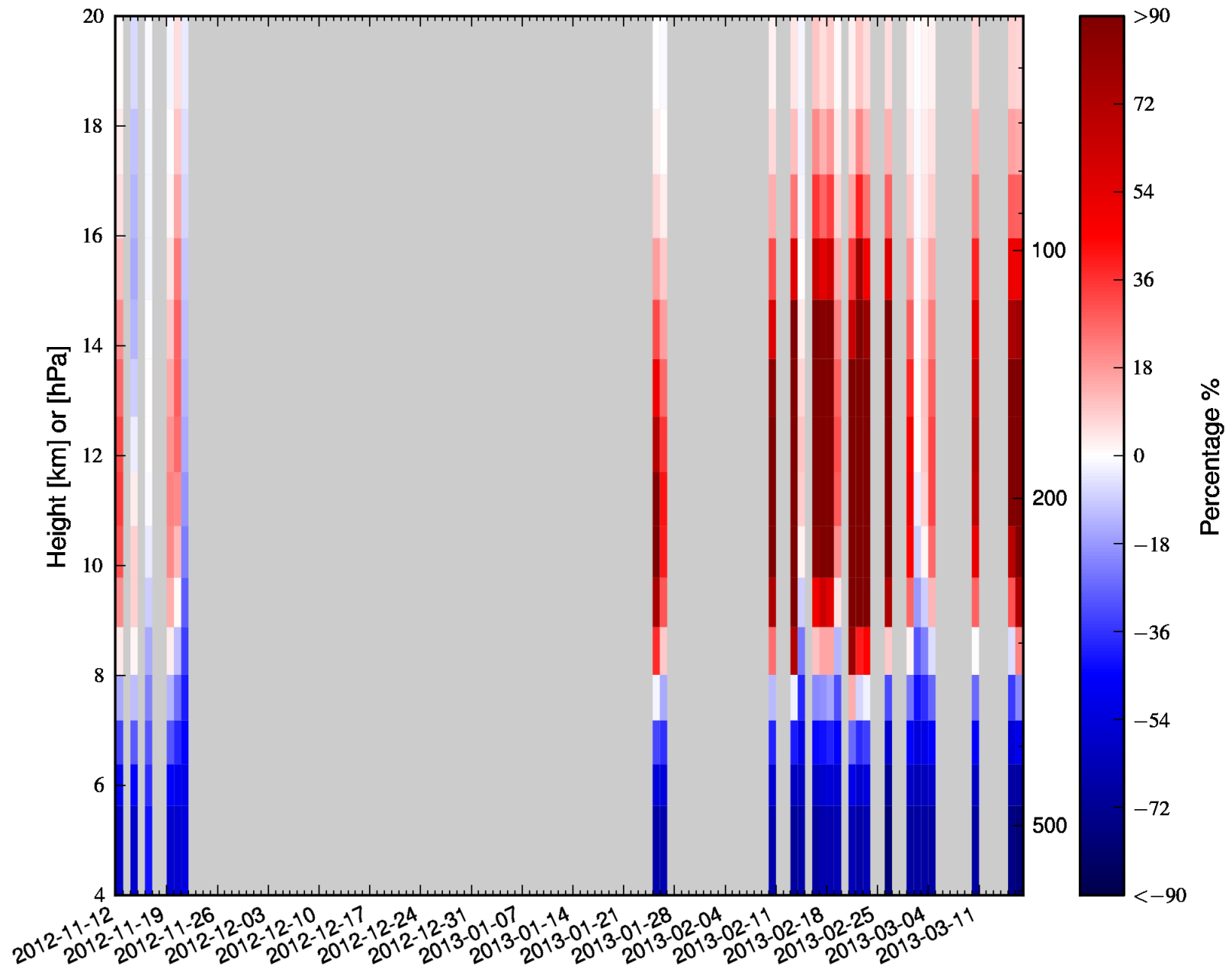
CO AVK plot (VMR/VMR normalized to apriori)

(4 – 20km, FC fsd7, Jungfraujoch FTIR, measured on Monday 12/11/12 08:07:40UT)



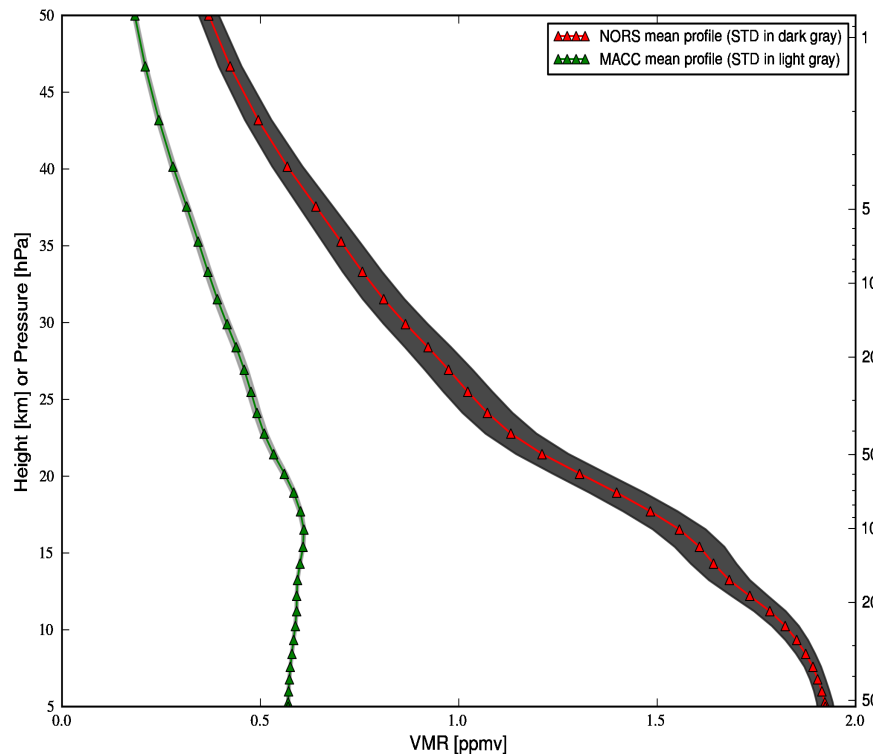
CO profile differences (MACC-NORS)/NORS

(daily mean, 4 – 20km, FC fsd7, Jungfraujoch FTIR, 12/11/12 - 13/03/16)



Mean CH_4 profiles MACC vs NORS

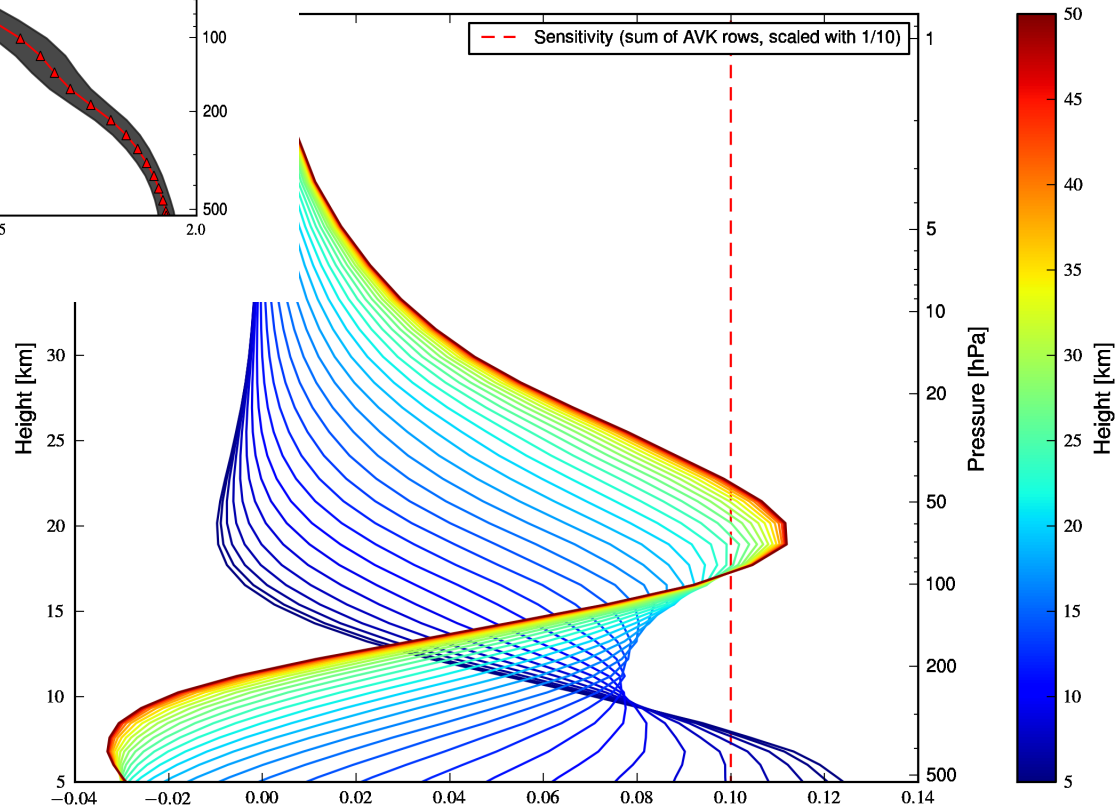
(5 – 50km, FC fsd7, Jungfraujoch FTIR, 12/11/12 - 13/03/16)



CH₄

'K plot (VMR/VMR normalized to apriori)

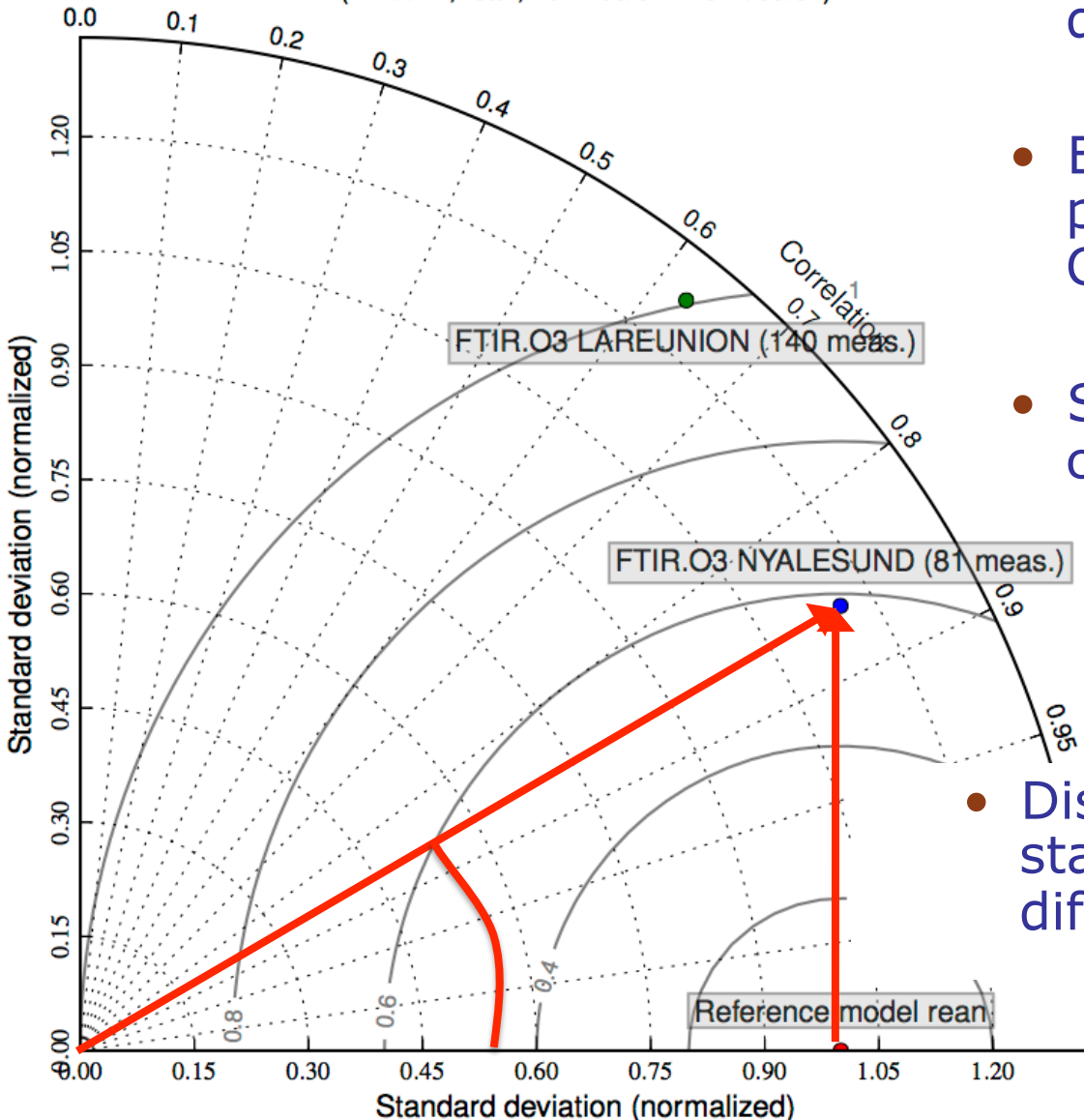
Jungfraujoch FTIR, measured on Monday 12/11/12 09:26:35UT



Taylor diagrams for intercomparison

Taylor diagram for O_3 total column values

(1 – 60km, rean, 2011/03/01 - 2011/06/01)



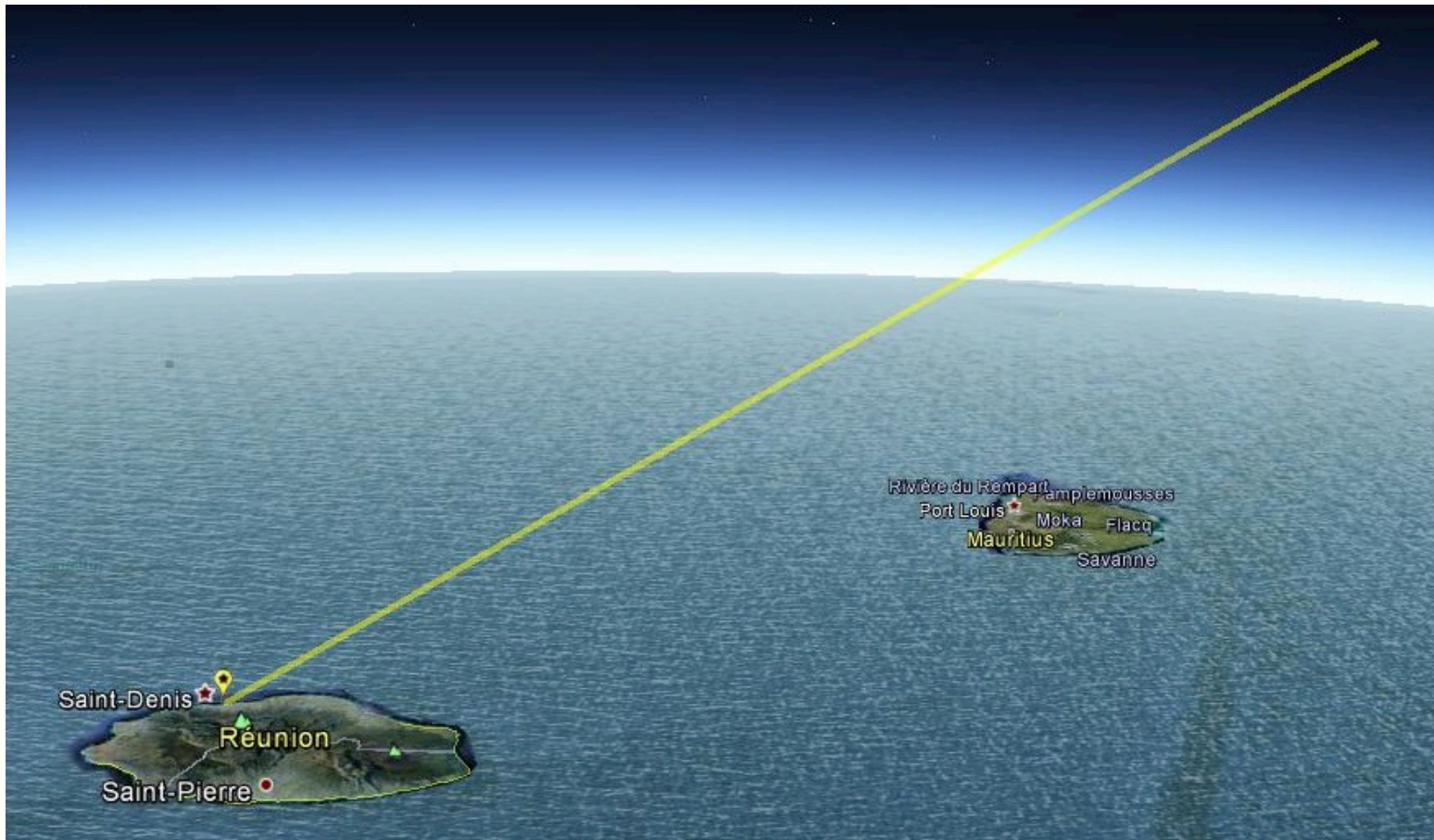
- Compare 1 model against different NORS stations
- Each pair 'Model-Station' provides statistics with STD, COR
- Stations are plotted in polar coordinates:
radial distance=normalized STD
 $\cos(\text{angle})=\text{COR}$
- Distance between model and station = normalized STD on differences between tc's

Some computational details

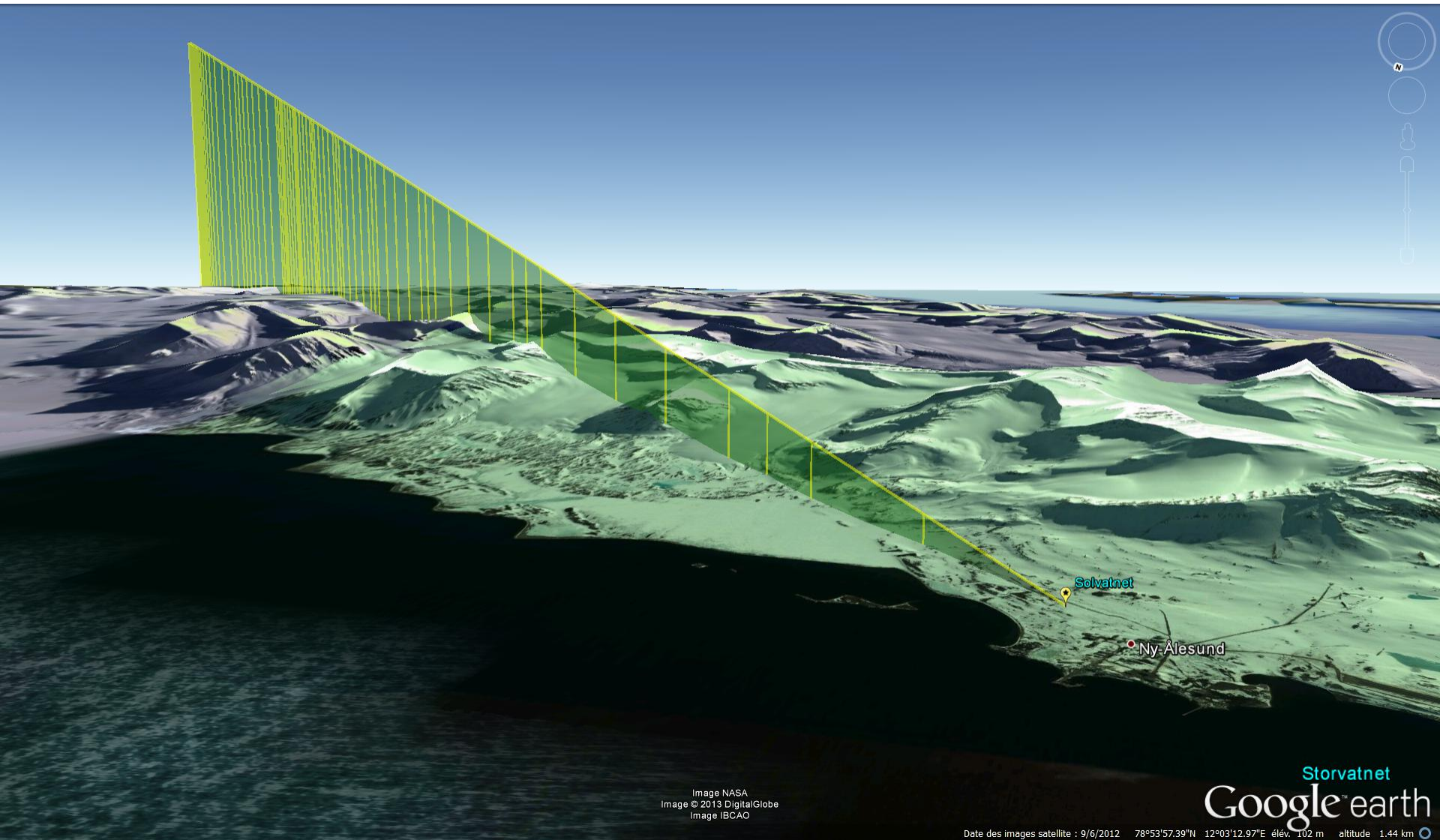
- Extraction of a model profile
- Smoothing of the model profile
- Interpolation of partial column profiles

Some computational details

- Extraction of a model profile
 - Uses a c++ program `Raytrace' that computes the light path of a given FTIR measurement

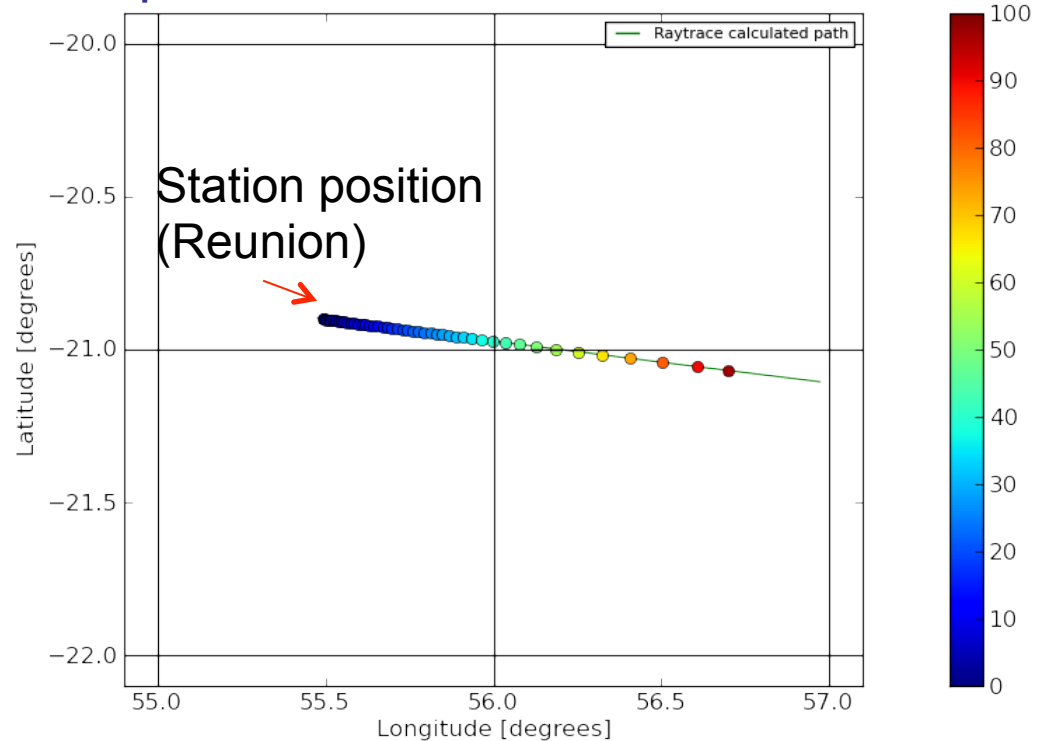
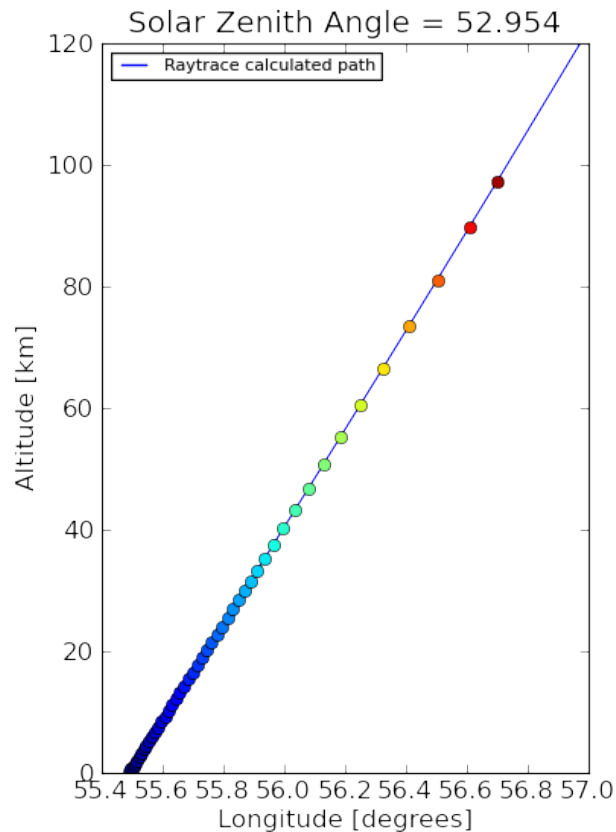


Ny Alesund 80.9° SZA

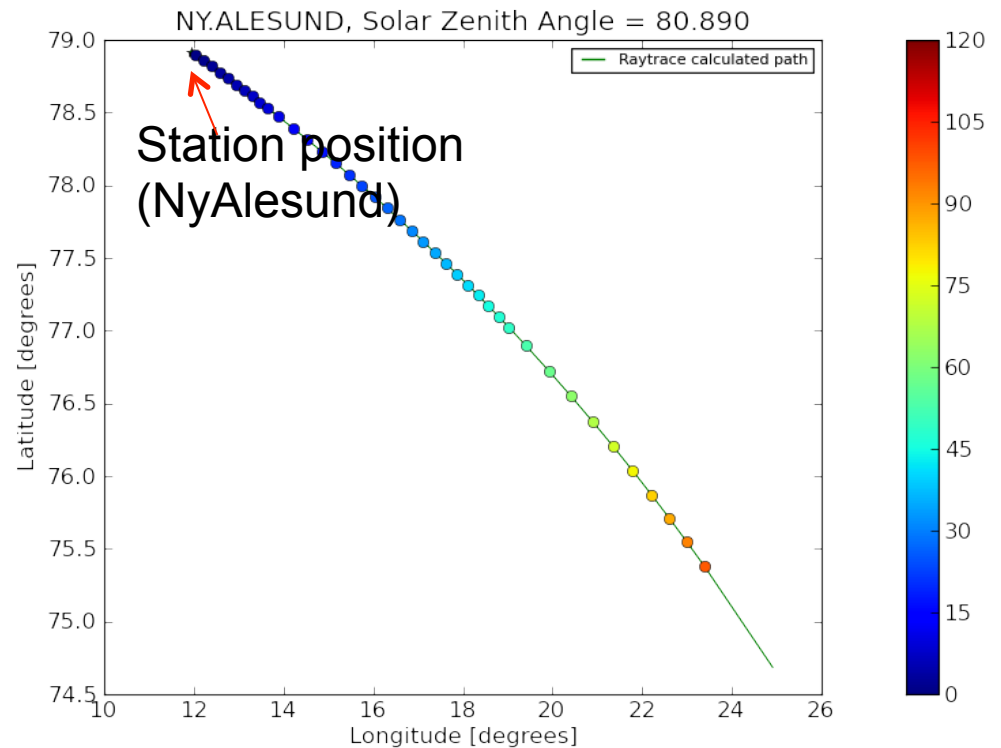
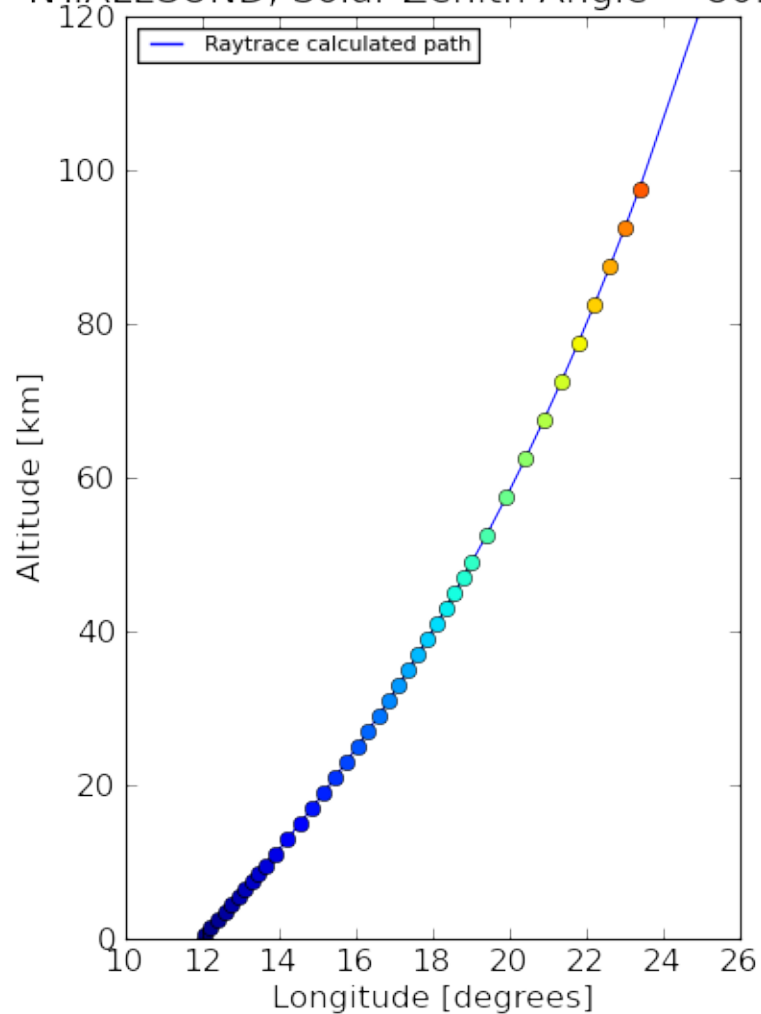


Some computational details

- Extraction of a model profile
 - Uses a c++ program 'Raytrace' that computes the light path of a given FTIR measurement
 - The model profile is extracted along this light path:
for each NORS height -> an interpolated model profile VMR is calculated

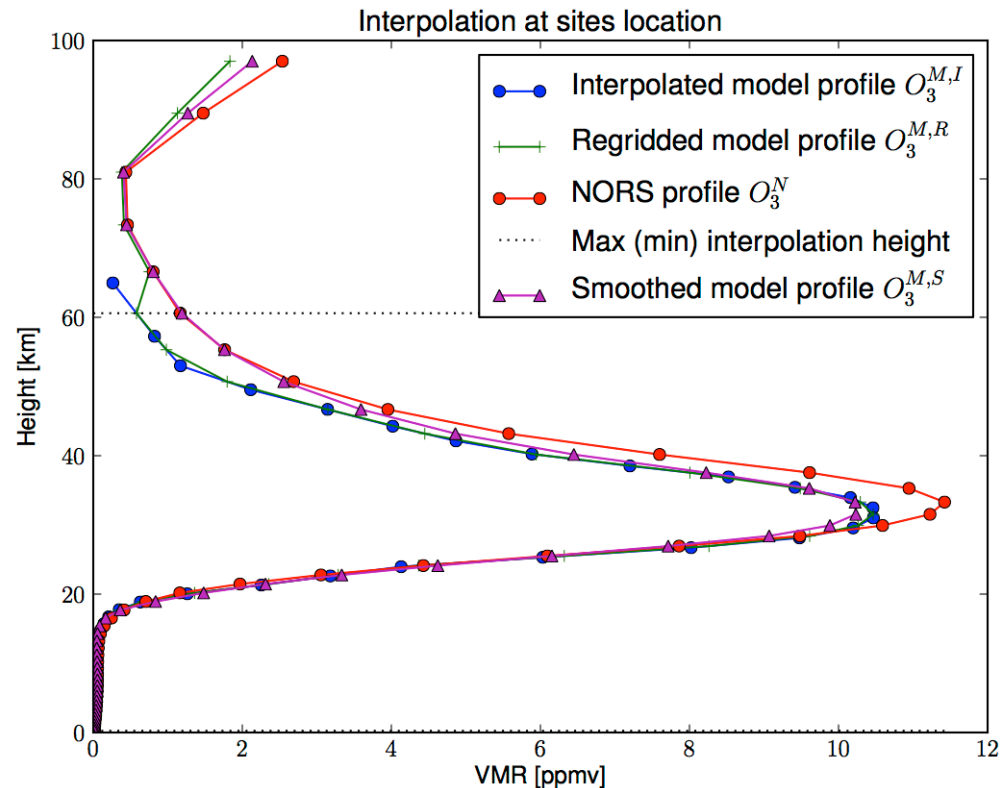


NYALESUND, Solar Zenith Angle = 80.890



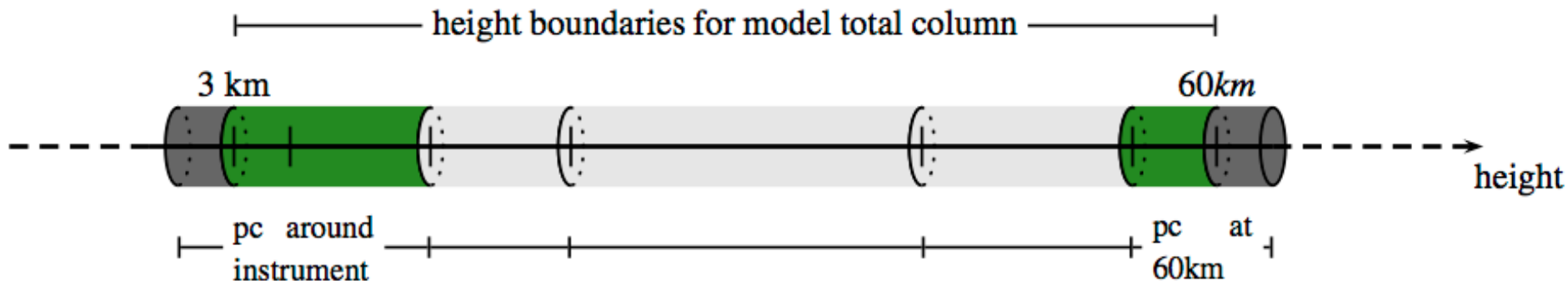
Some computational details

- Smoothing of the model profile
 - Model data goes to $\pm 60\text{km}$
 - NORS profiles and AVK's go to $\pm 100\text{km}$
 - Extend MACC profile with apriori of NORS profiles



Some computational details

- Interpolation of partial column profiles
 - Total columns of NORS O3 data should be restricted to 60km



- The total column is obtained by dividing the boundary partial columns proportional to the height fraction

Site information for St Denis and Maito – Reunion Island

➤ BIRA-IASB Team

M. De Mazière, F. Desmet, B. Dils, C. Hermans, B. Langerock,
C. Vigouroux, F. Scolas, N. Kumps,

➤ LACy team

J.L. Baray, J.M. Metzger, T. Gaudo, JP Cammas,
V. Duflot (will come back)

Site information for St Denis and Maido

- See poster by F. Desmet
- New instrument (Bruker 125HR) at Maido since March 2013, almost fully dedicated to NDACC
- Bruker 125HR at St Denis mainly dedicated to TCCON
- Rapid data delivery (< 1 month after acquisition) for NORS targets is operational for spectra measured at St Denis (Maido will follow soon)
- Rapid delivery is done using SFIT2
(until all routines can be updated to use SFIT4)
- Ongoing: verification of our uncertainty calculations compared to the ones implemented in SFIT4
- Reanalysis will be done using SFIT4
- Almost ready for data re-submission

- Kohlhepp, R., et al., Observed and simulated time evolution of HCl, ClONO₂, and HF total columns, *Atmos. Chem. Phys.*, 12, 3527-3556, 2012.
- Merlaud, A., M. De Mazière, C. Hermans, and A. Cornet, Equations for solar tracking, *Sensors*, 12, 4047-4090, 2012. doi:10.3390/s120404074
- Vigouroux, C., T. Stavrakou, C. Whaley, B. Dils, V. Duflot, C. Hermans, N. Kumps, J.-M. Metzger, F. Scolas, G. Vanhaelewyn, J.-F. Müller, D. B. A. Jones, Q. Li, and M. De Mazière, Time-series of biomass burning products (HCN, C₂H₆, C₂H₂, CH₃OH, and HCOOH) from ground-based FTIR measurements at Reunion Island (21°S, 55°E) and comparisons with model simulations, *Atmos. Chem. Phys.*, 12, 10367-10385, 2012.
- Kerzenmacher, T., B. Dils, N. Kumps, T. Blumenstock, C. Clerbaux, P.-F. Coheur, P. Demoulin, O. García, M. George, D. W. T. Griffith, F. Hase, J. Hadji-Lazaro, D. Hurtmans, N. Jones, E. Mahieu, J. Notholt, C. Paton-Walsh, U. Raffalski, T. Ridder, M. Schneider, C. Servais, and M. De Mazière, Validation of IASI FORLI carbon monoxide retrievals using FTIR data from NDACC, *Atmos. Meas. Tech.*, 5, 2751-2761, 2012.
- Duflot, V., Hurtmans, D., Clarisse, L., R'honi, Y., Vigouroux, C., De Mazière, M., Mahieu, E., Servais, C., Clerbaux, C., and Coheur, P.-F.: Measurements of hydrogen cyanide (HCN) and acetylene (C₂H₂) from the Infrared Atmospheric Sounding Interferometer (IASI), *Atmos. Meas. Tech. Discuss.*, 5, 7567-7586, (doi: 10.5194/amtd-5-7567-2012), 2012.

Funding situation for Reunion stations

- EU NORS funding until mid-2014
- ESA PRODEX A3C until end 2013 – decreasing strongly in 2014-2015
- National AGACC-II funding until end 2014
- BRAIN-be pioneering project for validation of TCCON measurements with aircore - end 2013 – end 2015 (TBC)

Funding of long-term monitoring is problematic !!