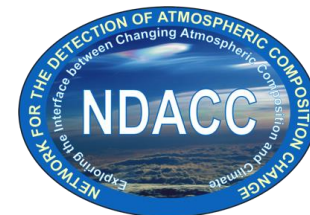




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NORS WP7 report

Final NORS meeting 2014

T. Blumenstock, F. Hendrick, K. Hocke, M. Kiel,
B. Langerock, E. Mahieu, P. Maud, M. Palm,
O. Puentedura, A. Richter ...

Reanalysis of ground-based time series back to 2003

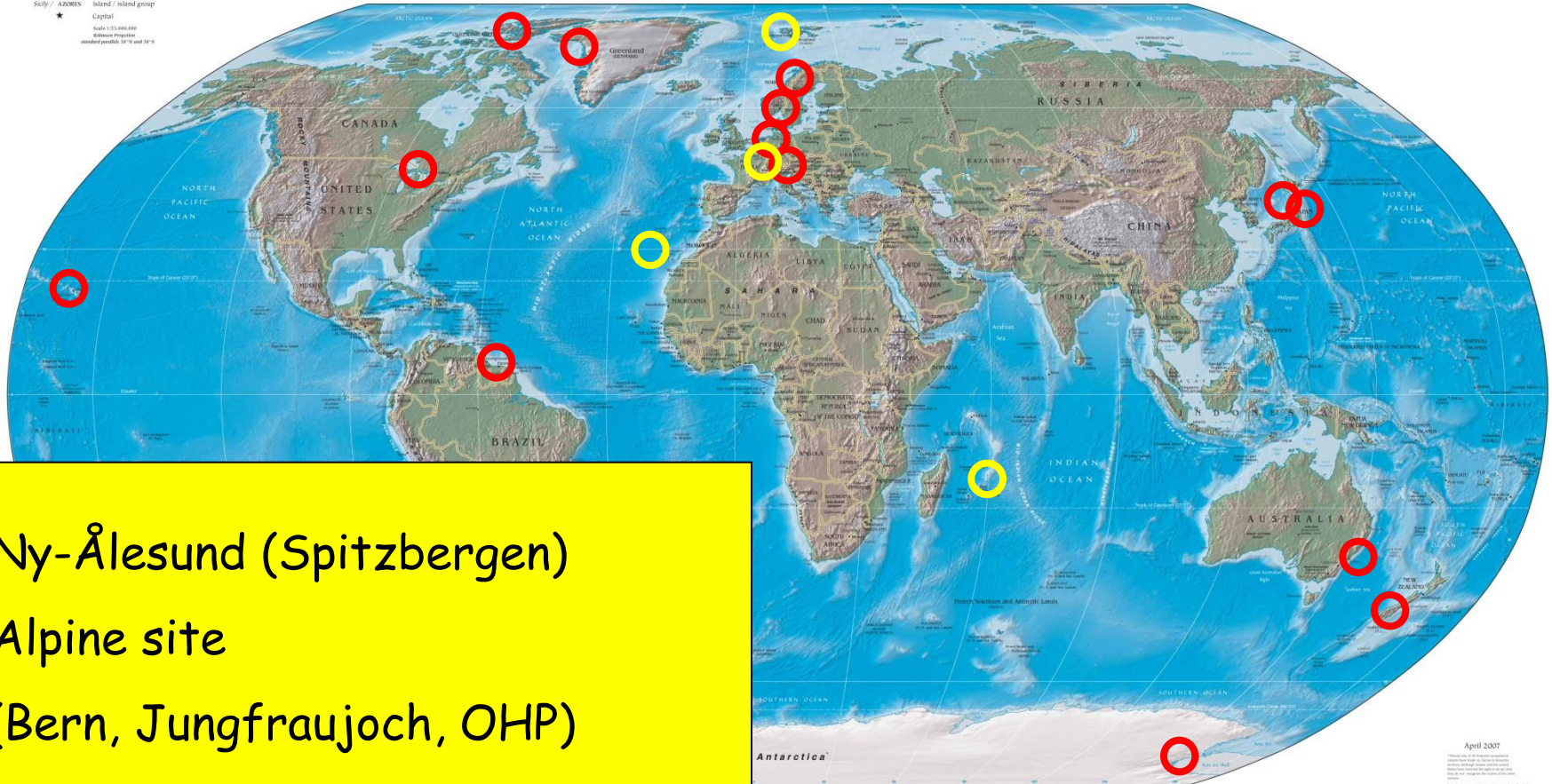
- To achieve a harmonized consistent data set
- Based on WP4 results guidelines for reanalysis were defined first
 - ✓ Stratospheric O_3 columns and NO_2 columns from **DOAS UV-Vis** measurements
 - ✓ Tropospheric and stratospheric columns of O_3 , **CO** and CH_4 from **FTIR** observations
 - ✓ O_3 vertical profiles in the stratosphere between 10 and 50 km from **LIDAR-DIAL** measurements
 - ✓ O_3 vertical profiles in the stratosphere between 20 and 70 km from millimeter wave radiometers (**MWR**)

The data is available in GEOMS format on the **NDACC** data base:
http://www.ndsc.ncep.noaa.gov/cgi-bin/pi/query_data/query_data.pl

O_3
 NO_2
 CH_4
CO

NORS sites

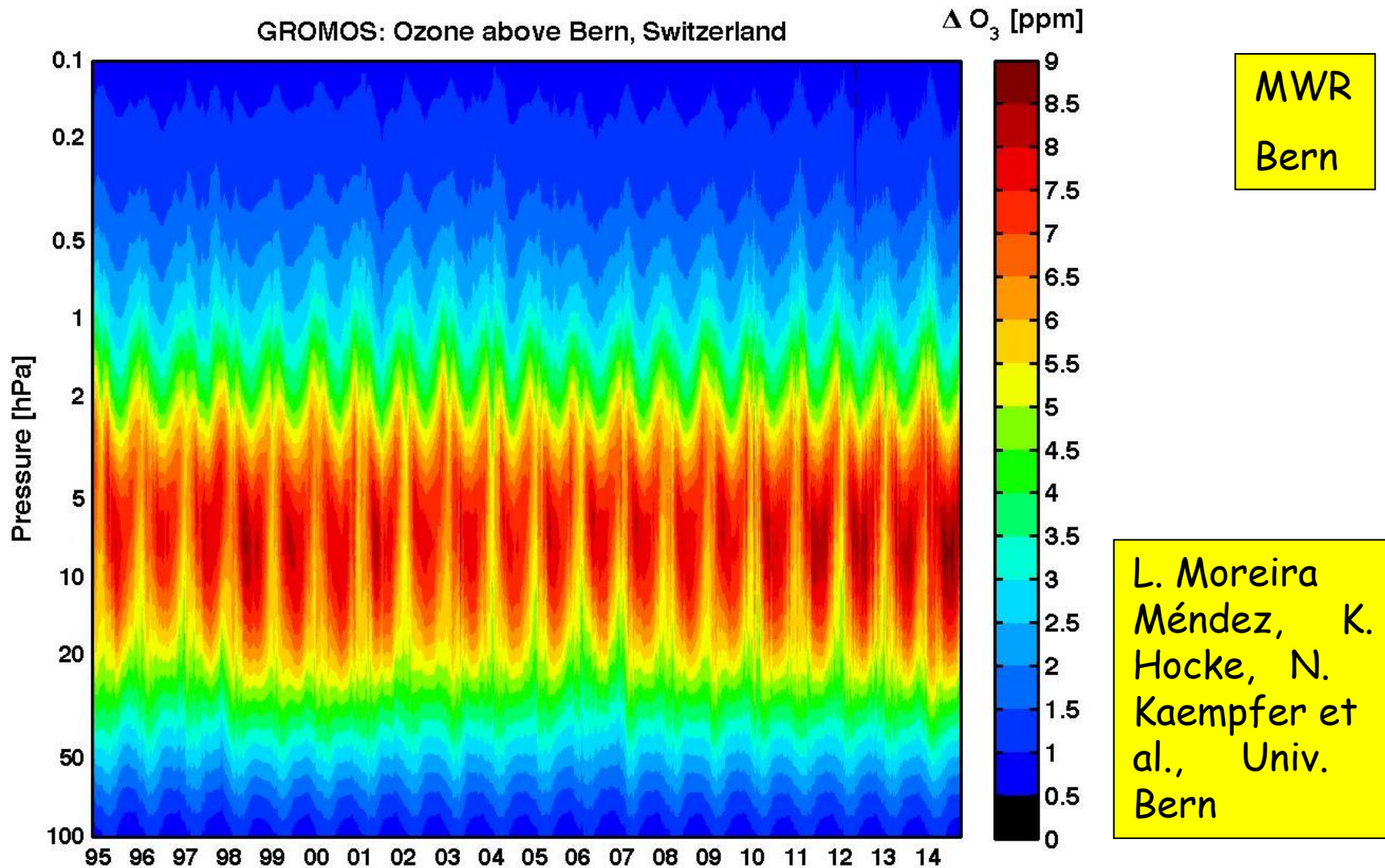
AUSTRALIA Independent state
 Bermuda Dependency or area of special sovereignty
 Sully / AZORES Island / island group
 ★ Capital
 Scale 1:3,000,000
 Reference: Projections
 standard parallels 30°N and 30°S



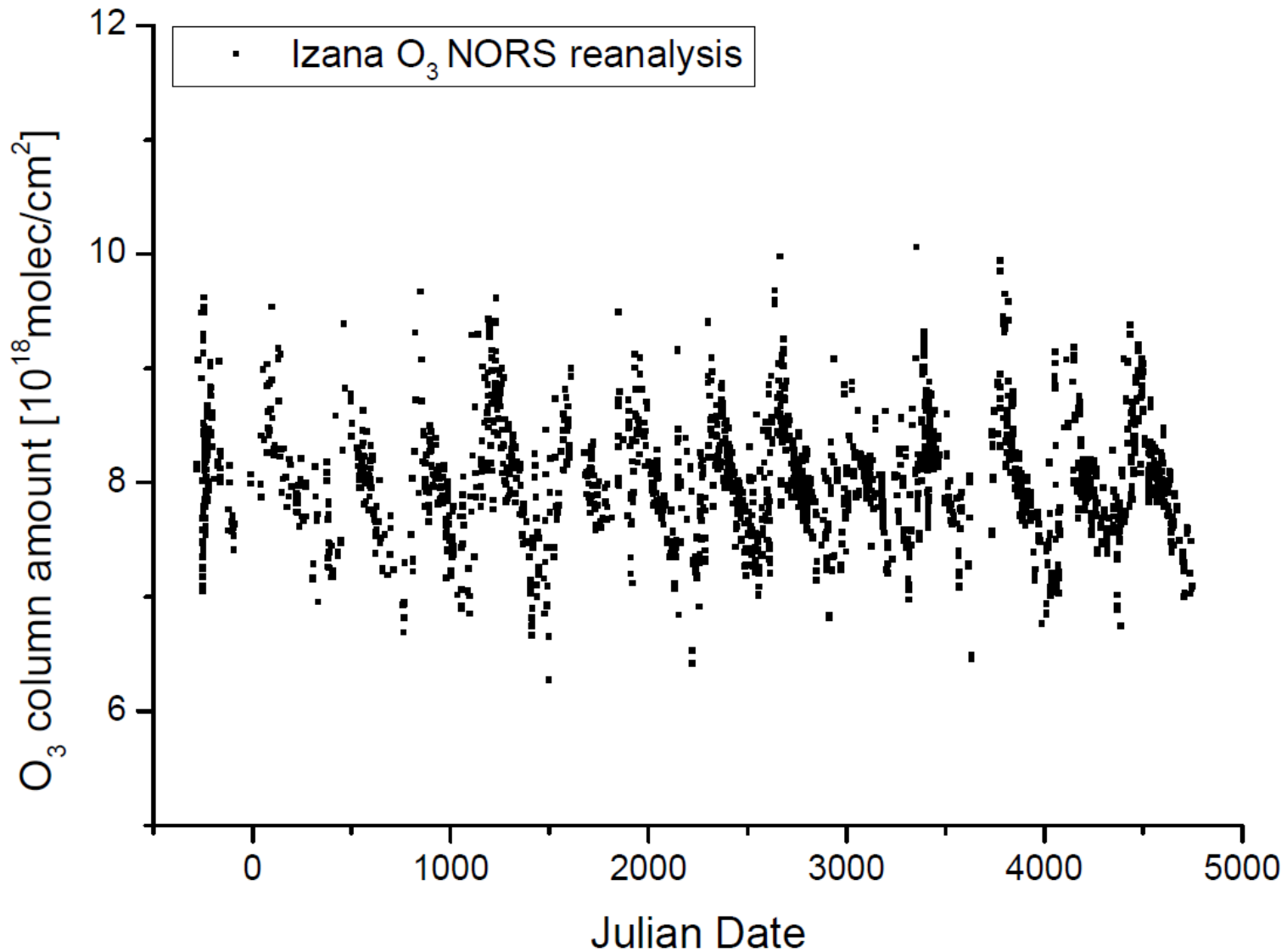
- ✓ Ny-Ålesund (Spitzbergen)
- ✓ Alpine site
(Bern, Jungfrau, OHP)
- ✓ Izaña (Tenerife I.)
- ✓ La Réunion (Maido and St. Denis)

○ NORS site ○ NDACC-FTIR site

Time series of O₃ profiles



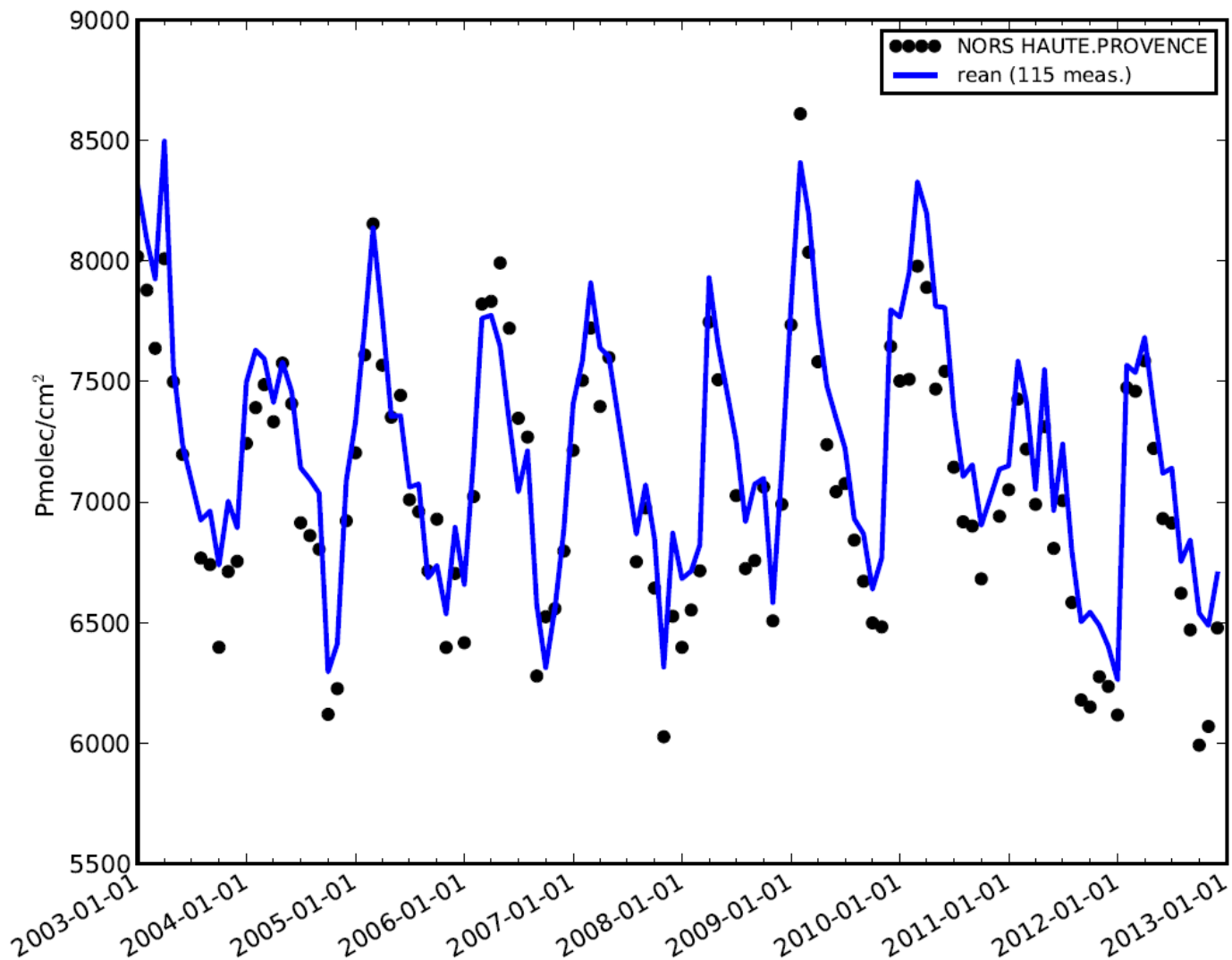
Time series of O_3



FTIR
Izaña

Time series of O_3

monthly mean *LIDAR.O3* partial column values
(15–45km, HAUTE.PROVENCE (lat.=43.9°))

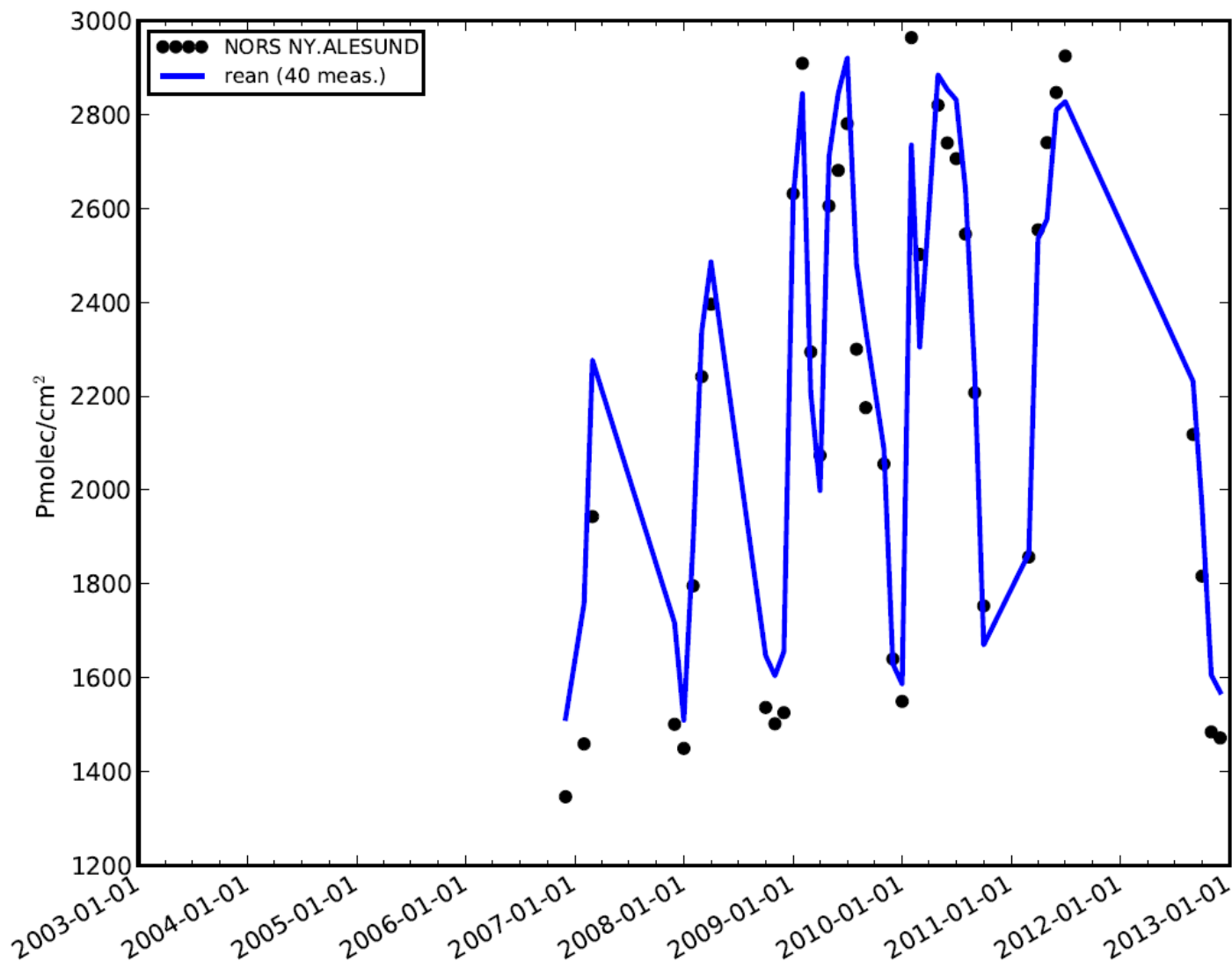


LIDAR
OHP

S. Godin et al., CNRS;
Plot by B. Langerock

Time series of O_3

monthly mean *MWR.O3* partial column values
(25–60km, NY.ALESUND (lat.=78.9°))

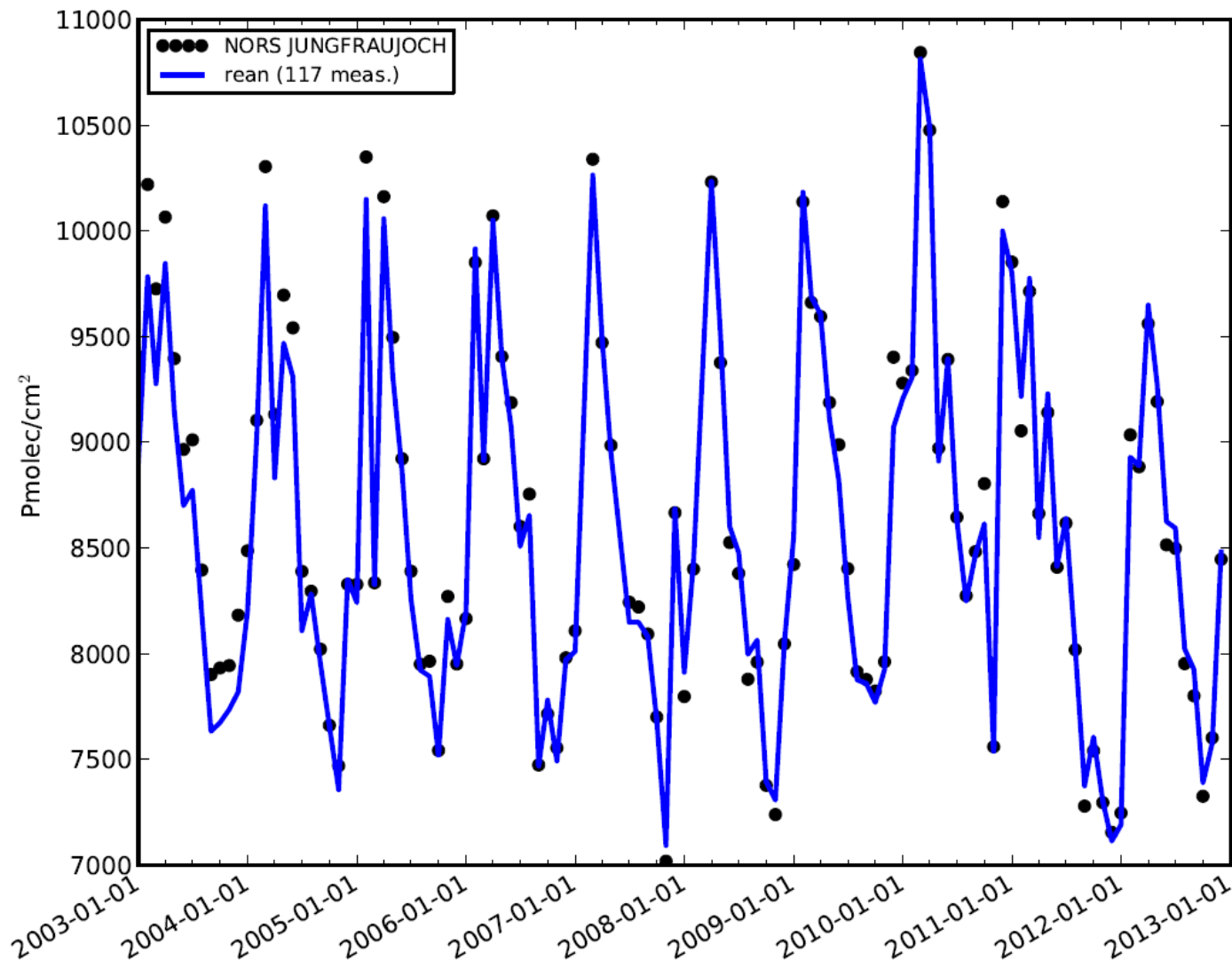


MWR
Ny-Ålesund

M. Palm et al., UBremen;
Plot by B. Langerock

Time series of O₃

monthly mean *FTIR.O3* partial column values
(4–60km, JUNGFRAUJOCH (lat.=46.6°))



FTIR
Jung-
frau-
joch

E. Mahieu
et al., U
Liege;
Plot by B.
Langerock

Ozone trends

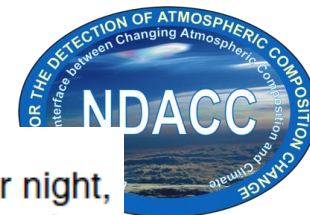


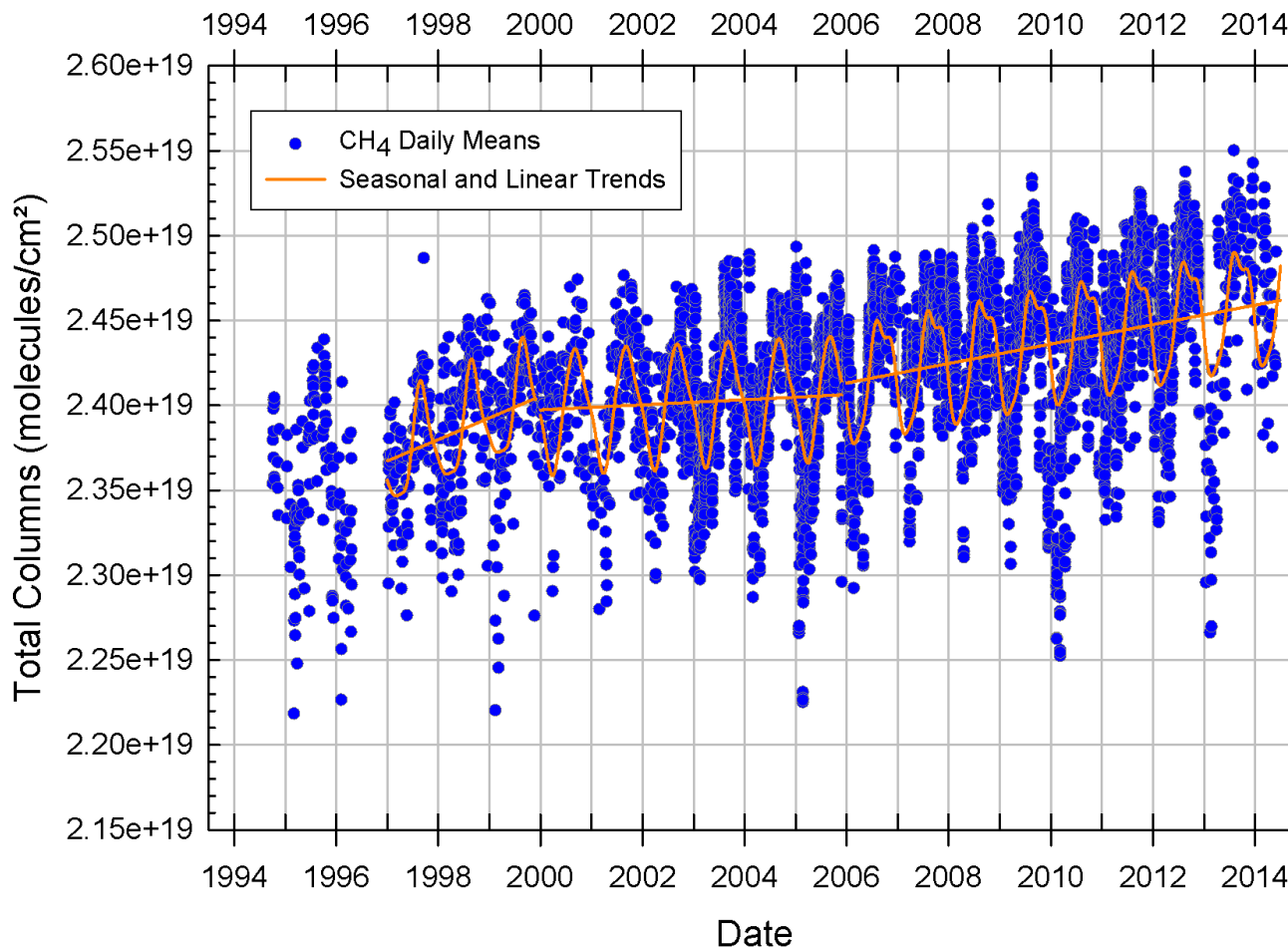
Table 6. Annual trend (in % decade⁻¹) and their 95 % uncertainty ranges. Due to polar night, the measurements at Ny-Alesund, Thule and Kiruna cover only the Mid-March–September, Late-February–Mid-October, and Mid-January–Mid-November periods, respectively. All time series end in September/December 2012 for the present study. The time of start is repeated for each station. See Table 3 for the limits of the layers, different for subtropical stations and mid/high latitude stations. Trends indicated in bold are significant.

FTIR station	Trop	LowS	MidS	UppS	Total columns
Ny-Alesund 1995	-5.8 ± 3.2	-4.2 ± 3.1	-5.5 ± 3.8	+6.7 ± 5.3	-3.0 ± 1.5
Thule 1999 (October)	-5.3 ± 4.4	-0.4 ± 6.3	+0.2 ± 4.4	-2.3 ± 6.5	-2.1 ± 2.6
Kiruna 1996	-0.9 ± 2.5	-3.9 ± 2.6	+0.4 ± 2.6	+7.4 ± 3.4	-0.3 ± 1.6
Harestua 1995	-3.1 ± 2.0	-5.3 ± 4.6	+4.8 ± 4.3	+7.8 ± 5.5	+1.0 ± 2.2
Jungfrauoch 1995	-2.5 ± 2.7	-0.5 ± 3.3	-0.6 ± 1.2	+0.9 ± 1.0	-0.4 ± 1.2
Izaña 1999	+0.7 ± 2.8	-1.7 ± 2.2	-0.1 ± 2.0	+1.6 ± 2.6	+0.5 ± 1.2
Wollongong 1996	-2.2 ± 2.8	+3.1 ± 2.7	+4.0 ± 2.0	+0.2 ± 1.6	+1.9 ± 1.1
Lauder 2001	+7.7 ± 3.5	-3.8 ± 4.1	-0.2 ± 3.5	+2.8 ± 2.4	-0.3 ± 1.8

Vigouroux, C. et al.: Trends of ozone total columns and vertical distribution from FTIR observations at 8 NDACC stations around the globe, *Atmos. Chem. Phys. Discuss.*, 14, 24623-24666, 2014.

Time series of CH₄

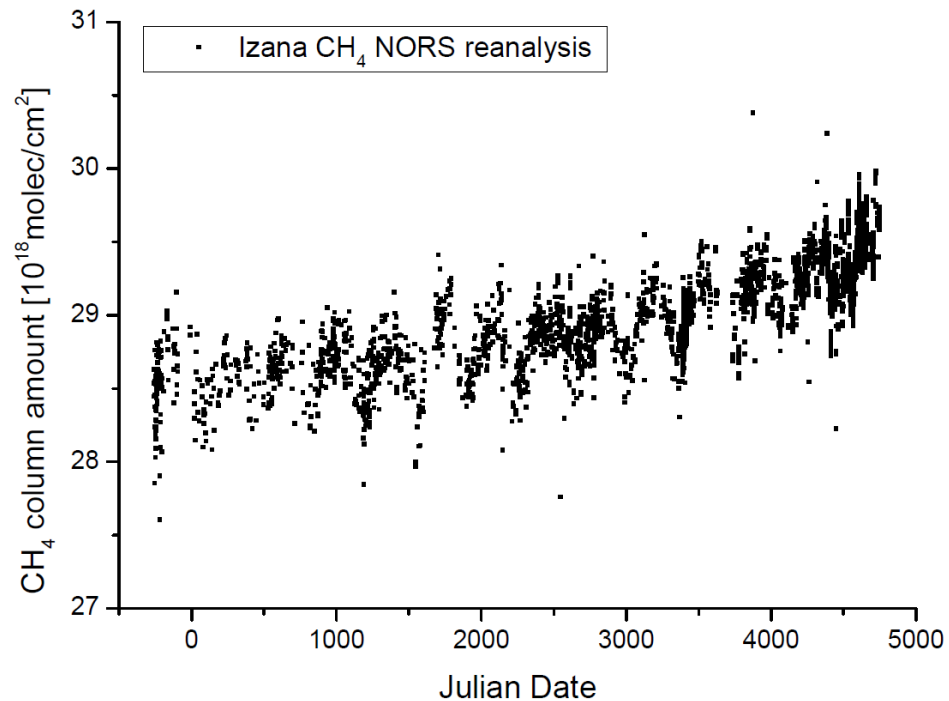
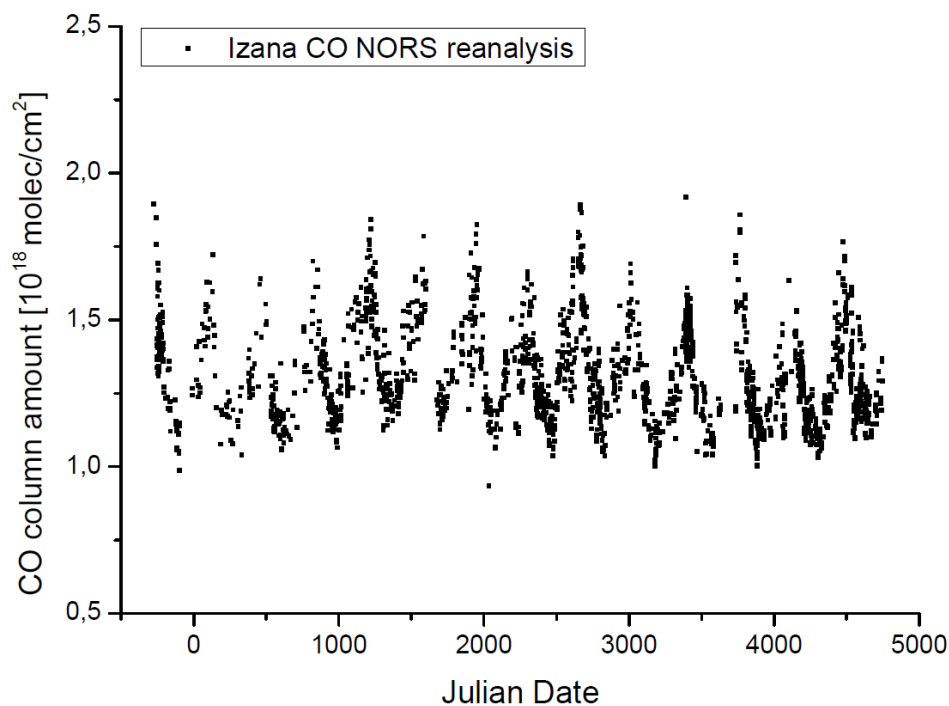
CH₄ above Jungfraujoch (46.5°N, 3.58 km a.s.l.)



W. Bader,
E. Mahieu
et al., U Liege

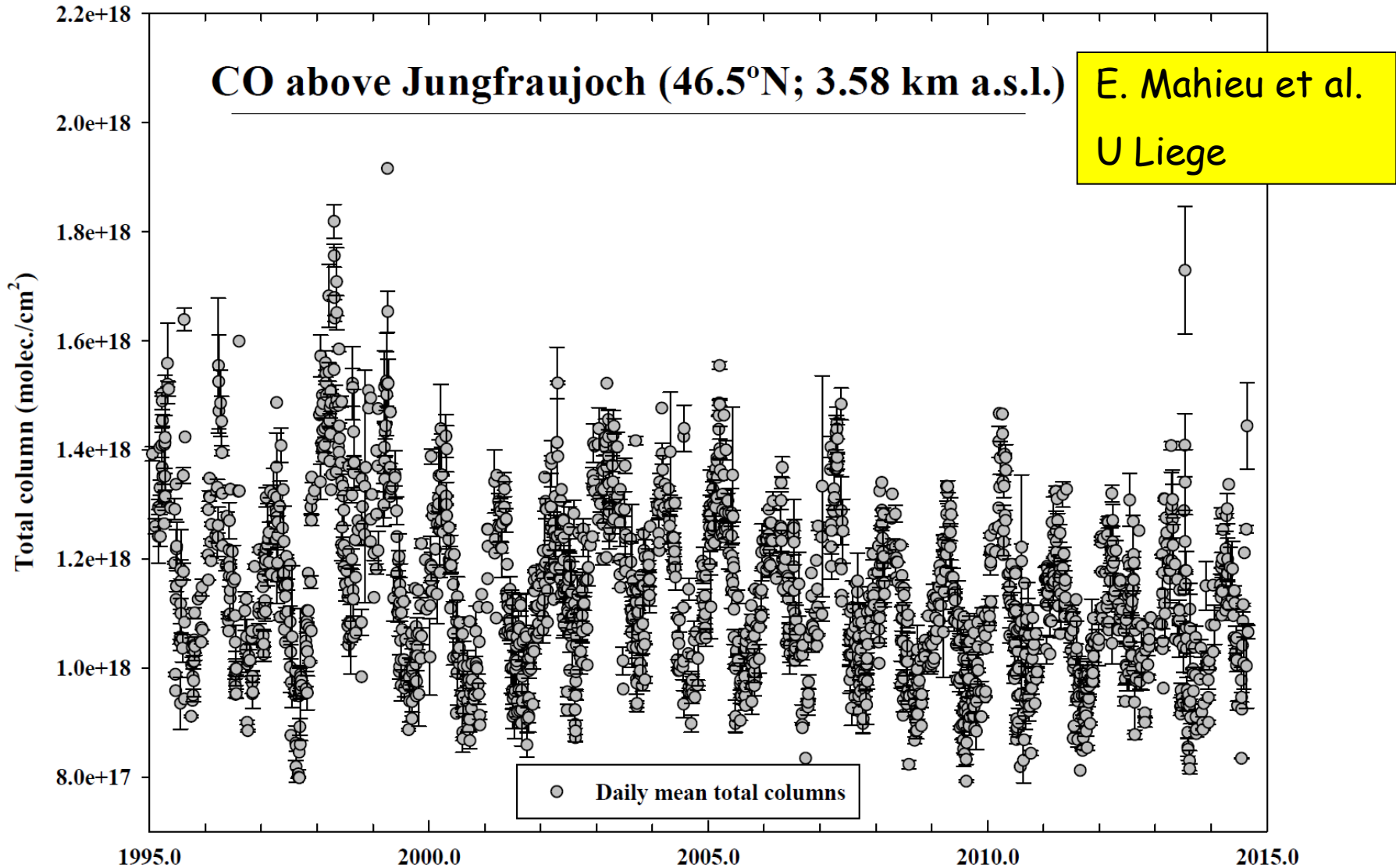
Time series of CO & CH₄

FTIR Izaña



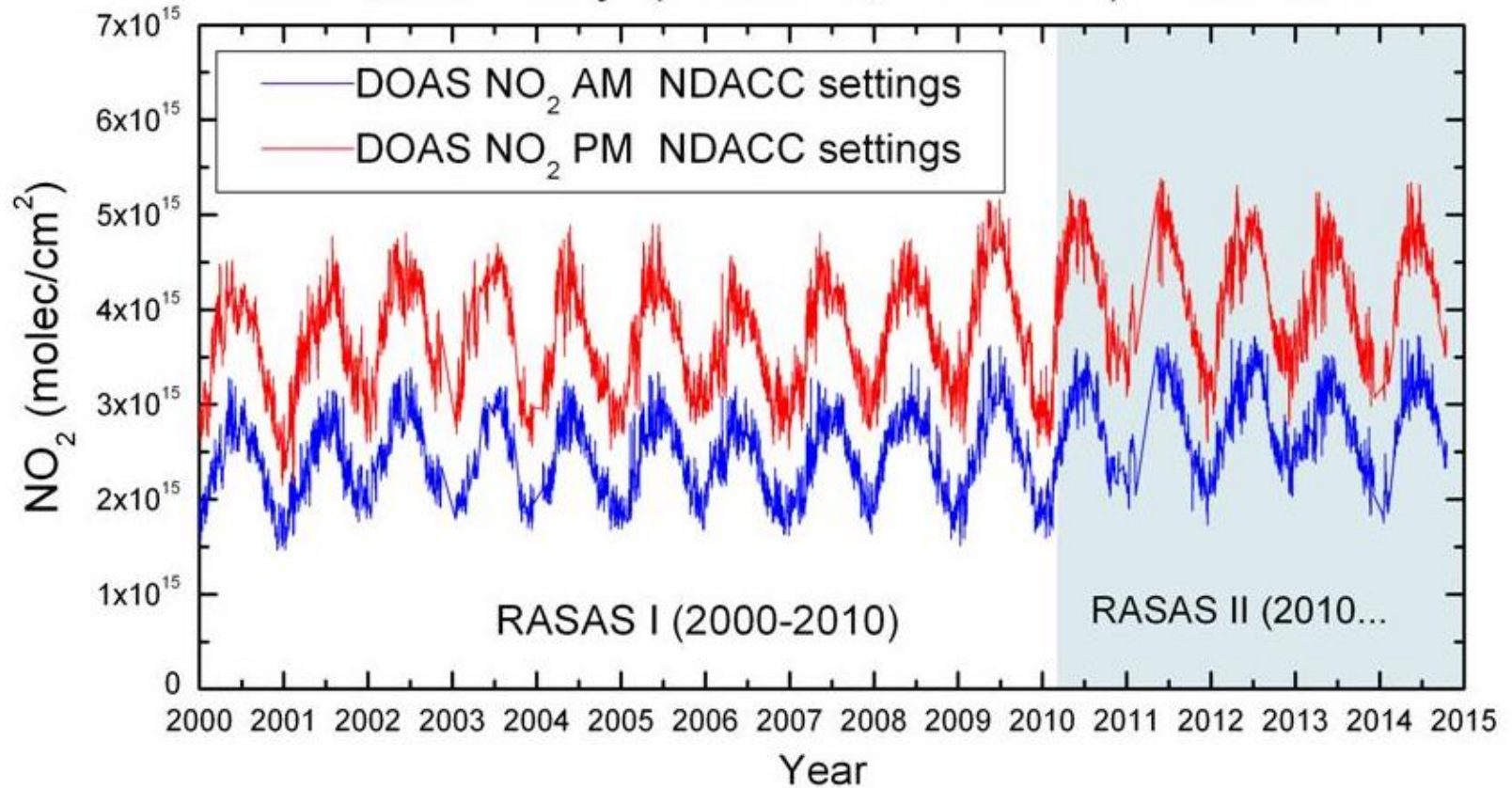
M. Kiel, O. Garcia, F. Hase, M. Schneider, T. Blumenstock et al., KIT & AEMet

Time series of CO



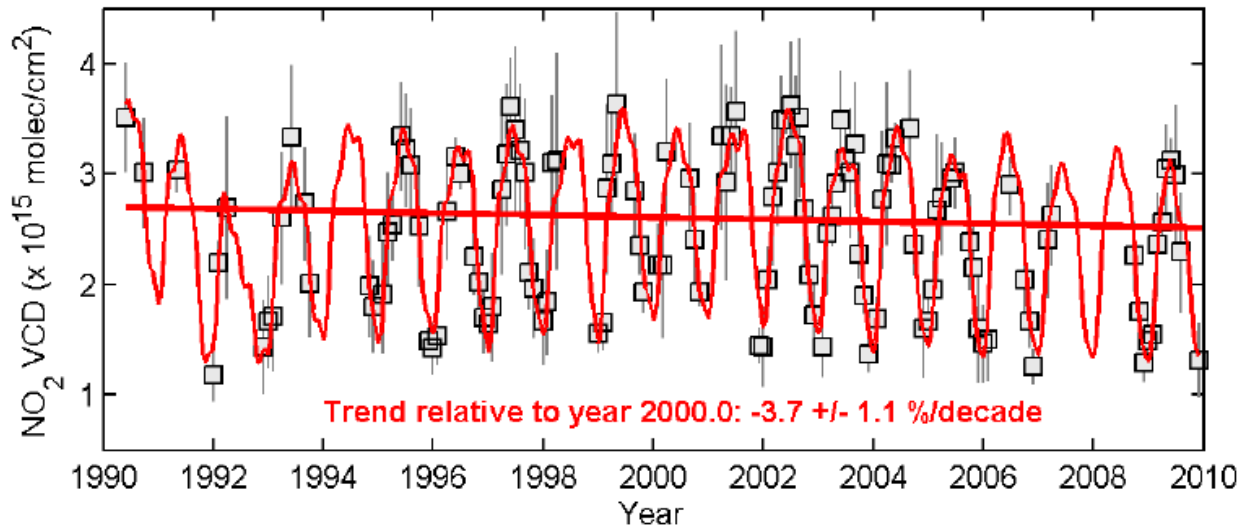


Izaña Observatory (28.309°N, 16.499°W): 2000-2015

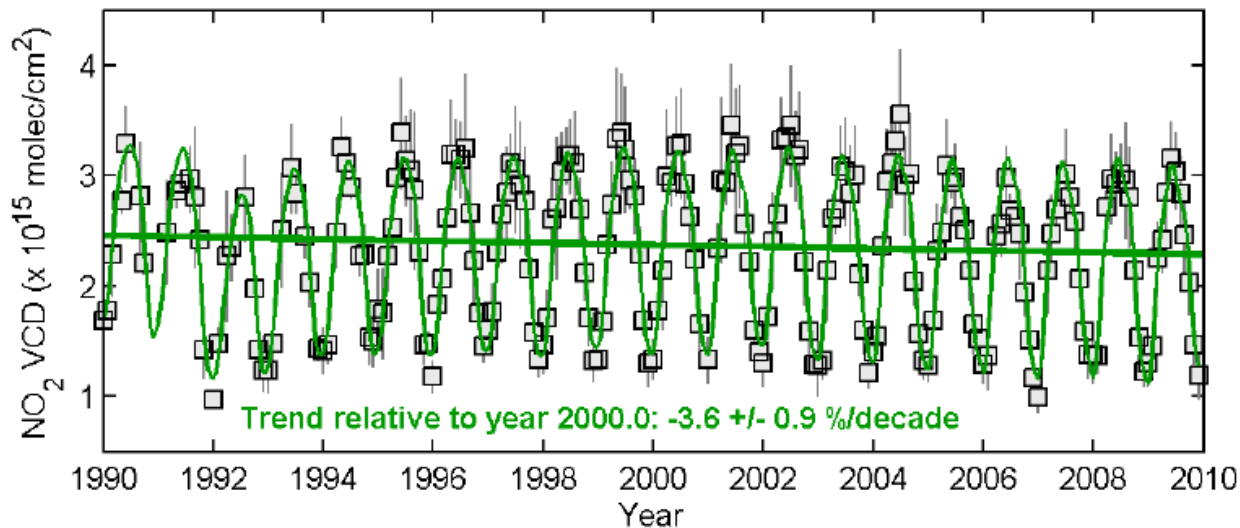


M. Navarro Comas, O. Puentedura, M. Gil et al., INTA Madrid

SAOZ at FTIR SZA



FTIR



F. Hendrick et al.:
 Analysis of stratospheric NO₂ trends above Jungfraujoch using ground-based UV-visible, FTIR, and satellite nadir observations,
 ACP, 12, 8851-8864, 2012

Summary

Reanalysis of ground-based time series back to 2003

- Four sites: Ny-Ålesund, Alpine, Izaña, La Réunion
- Four techniques: DOAS, FTIR, LIDAR and MWR
- Four species: O_3 , NO_2 , CH_4 and CO
- Comprehensive data set covering more than 10 years
- Some examples
 - Time series
 - Trend studies

Merci!

O_3
 NO_2
 CH_4
 CO