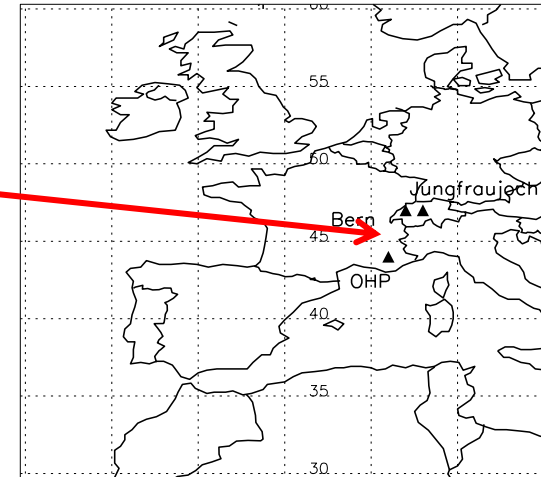


Comparison and merging of ozone profile data from various measurement techniques at 4 NDACC stations

*S. Godin-Beekmann, S. Khaykin, M. Pastel
LATMOS, OVSQ, UVSQ-UMPC-CNRS, France*

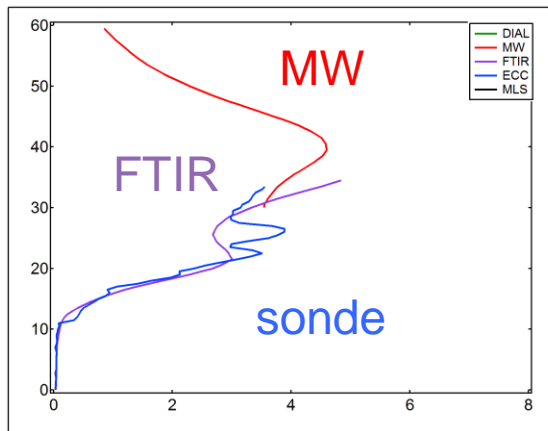
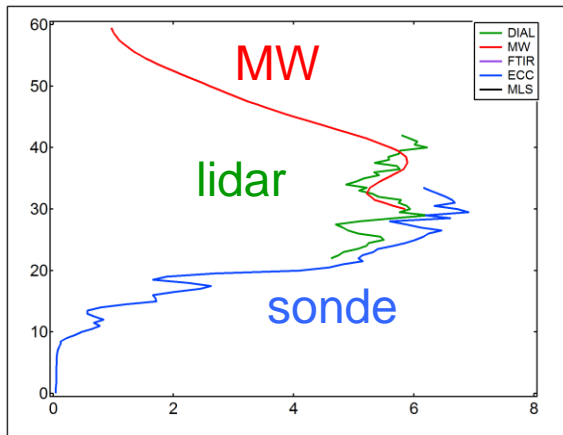
NORS WP6

Objective: Develop a methodology for integrating ground-based data sources and provide consistent ozone vertical distribution time series at 4 NDACC stations.



Rationale

Variety of ozone profile measuring techniques providing measurements with different altitude range, vertical resolution, uncertainty, etc...



Example of ozone profile measurements at NyAlesund



Combine the various data sets for easier
MACC ozone profile product validation

Measurement techniques

Differential Absorption Lidar technique



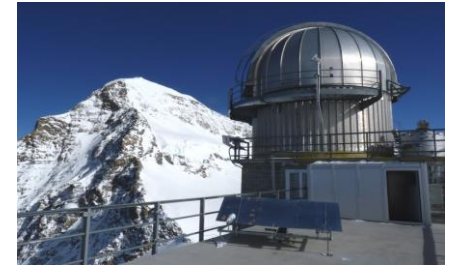
- ✓ Active technique
- ✓ Emission of two laser radiations at wavelengths characterized by a different ozone absorption cross section (308 nm and 355 nm)

MicroWave Ozone spectrometer



- ✓ Passive technique
- ✓ Measures ozone emission lines in the submillimeter range

Fourier Transform Infrared spectrometer

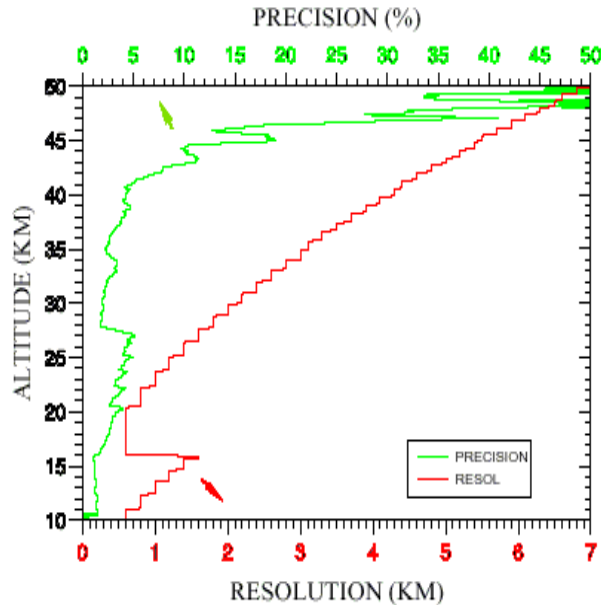


- ✓ Passive technique
- ✓ Atmospheric absorption spectra used for the retrieval of ozone
- ✓ wide spectral range 600 – 4500 cm⁻¹
- ✓ high spectral resolution

Vertical resolution

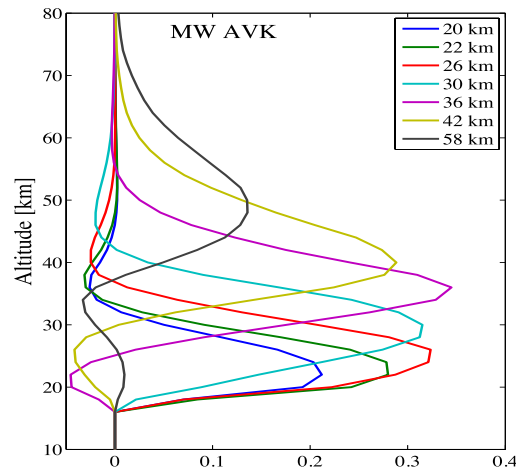
Active remote sensing

OHP lidar

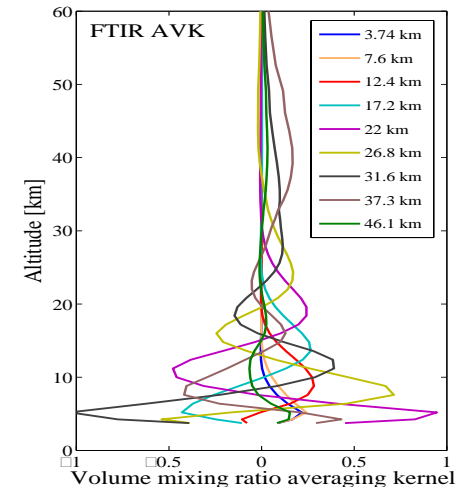


Passive remote sensing

Microwave Bern



FTIR Jungfraujoch

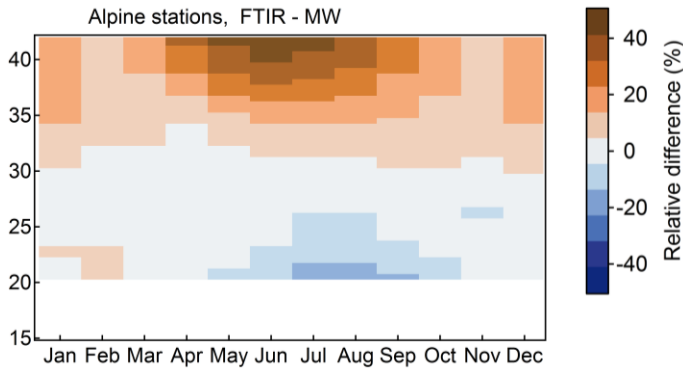


	Altitude range (km)	Resolution(km)
LIDAR	10 – 45	1 – 4.5
Microwave	20 – 60	10 – 15
FTIR	4 – 42	7 – 15
Ozone sondes	0 – 35	0.3

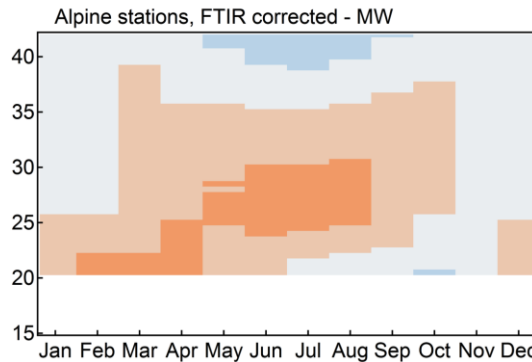
Evaluation of systematic differences

Example of Alpine station

FTIR - MW



FTIR corr - MW



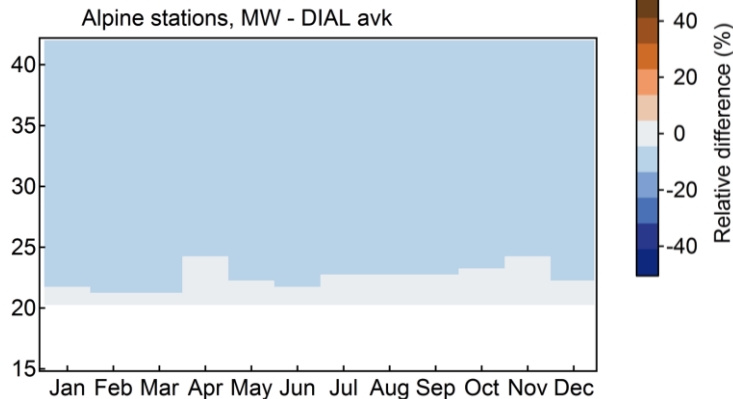
A priori profile correction

MW: monthly
climatology

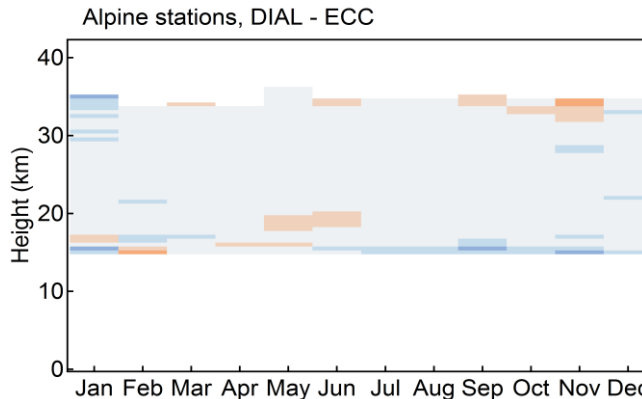
FTIR: annual climatology

-> correction of FTIR a
priori

MW - DIAL smoothed

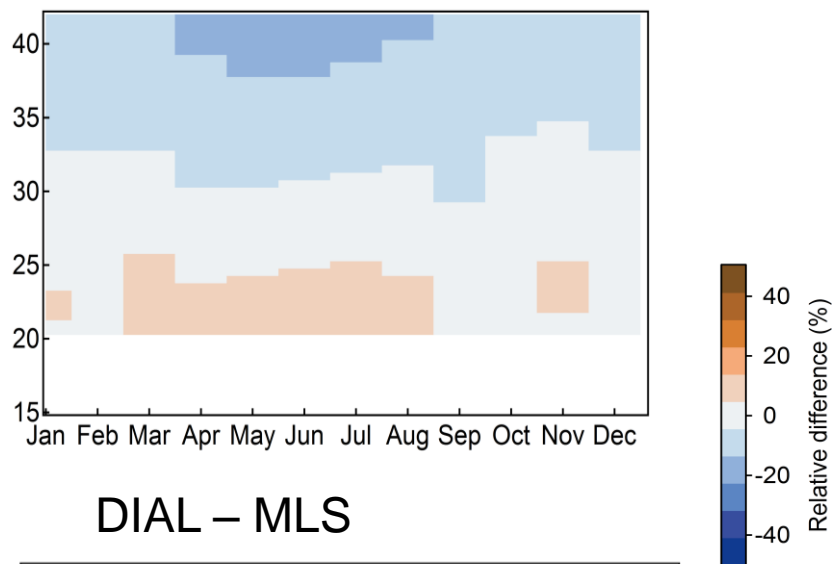


DIAL - ECC

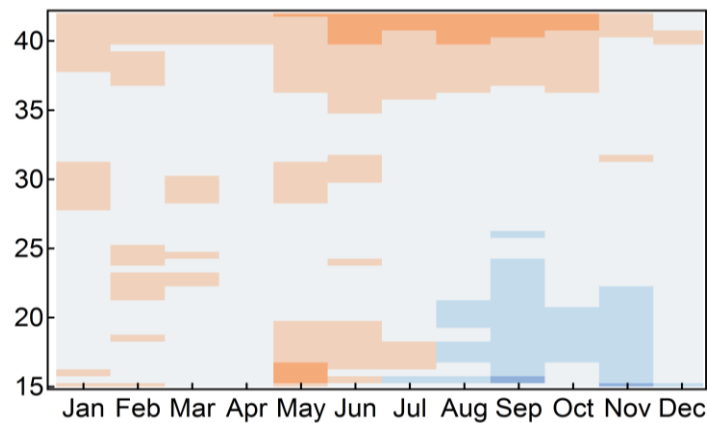


Systematic differences with AURA-MLS

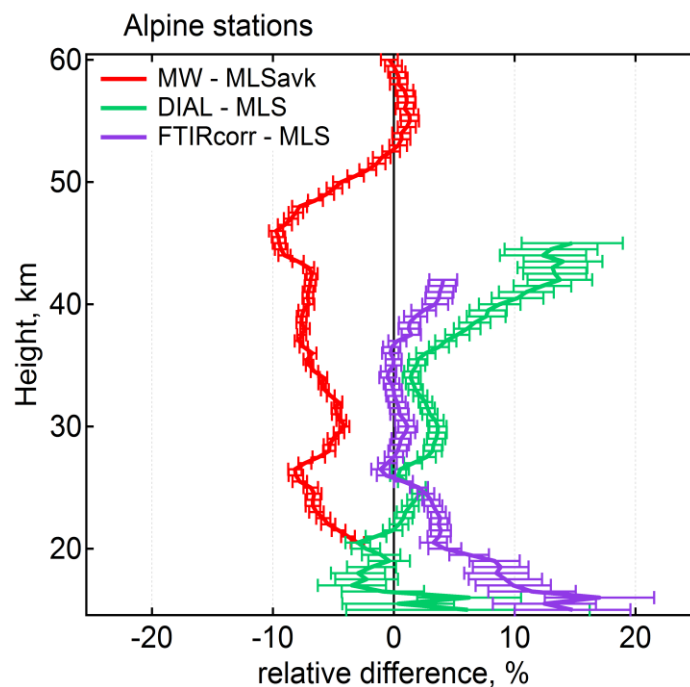
MW - MLS smoothed



DIAL - MLS



Annual average



Ozone profile integration

Main steps:

- Smooth higher resolved profiles using $X_s = X_a + A(x_h - x_a)$
AVK (FTIR, MW)
- Check for difference in a priori
- Check for systematic bias (MLS)

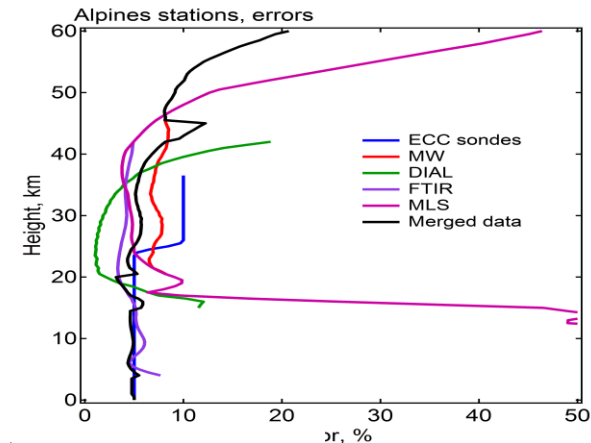
Data integration

$$O_3(z) = \prod_{i=1}^n w_i(z) B_i(z) G_i(z) O_{3i}(z)$$

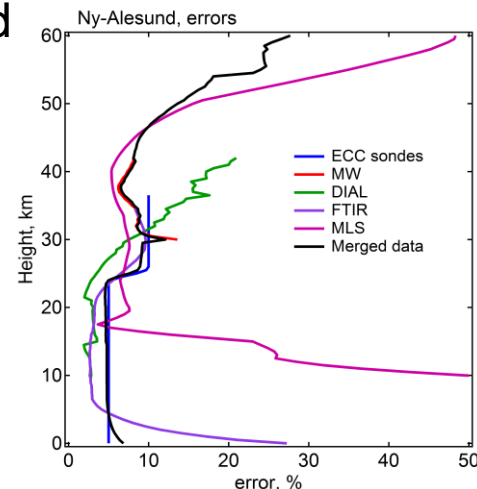
$i=1$ → Error weight
 $B_i(z)$ → Instrumental bias
 $G_i(z)$ → Geophysical bias

Merged ozone profile reported for more than one measurement at the station

Alpine station



Ny Alesund



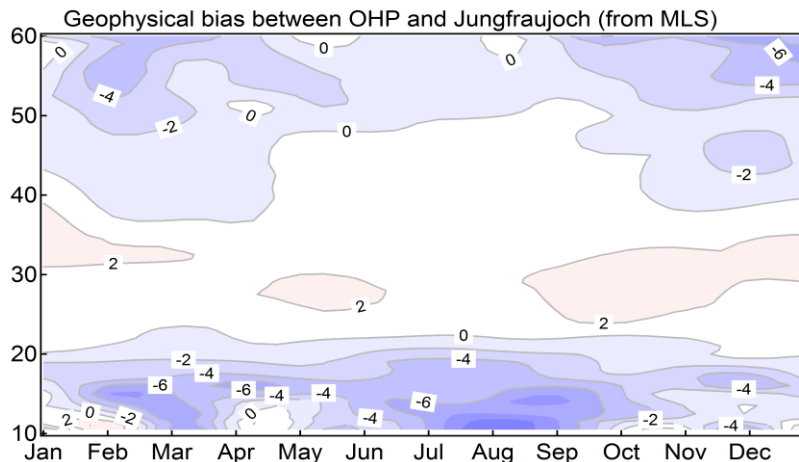
Geophysical bias

Distance between stations:

Bern – Jungfraujoch: ~ 60 km

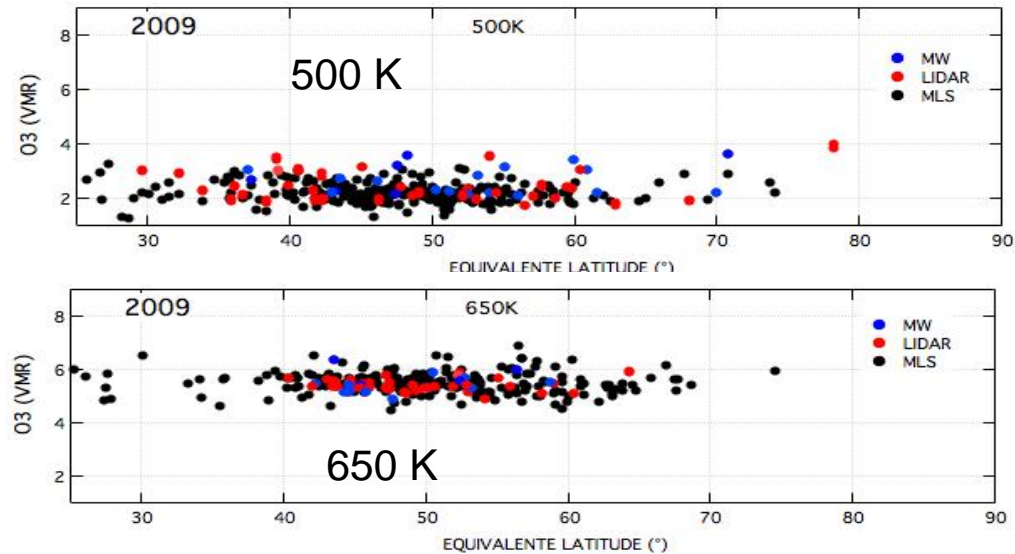
OHP – both other stations: ~ 400 km

Difference between coincident MLS
ozone measurements at
OHP and Jungfraujoch

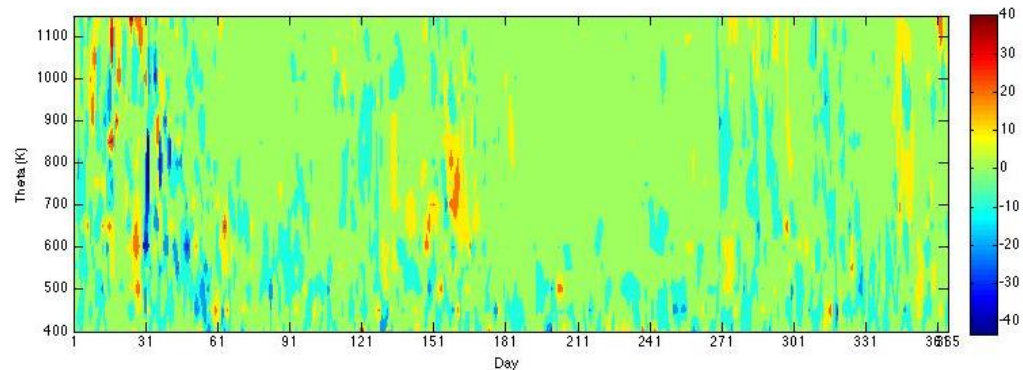


*Very small geophysical
bias between the stations*

Ozone mixing ratio vs equivalent latitude



Equivalent latitude difference between OHP and Bern (°) - 2013



Alpine station

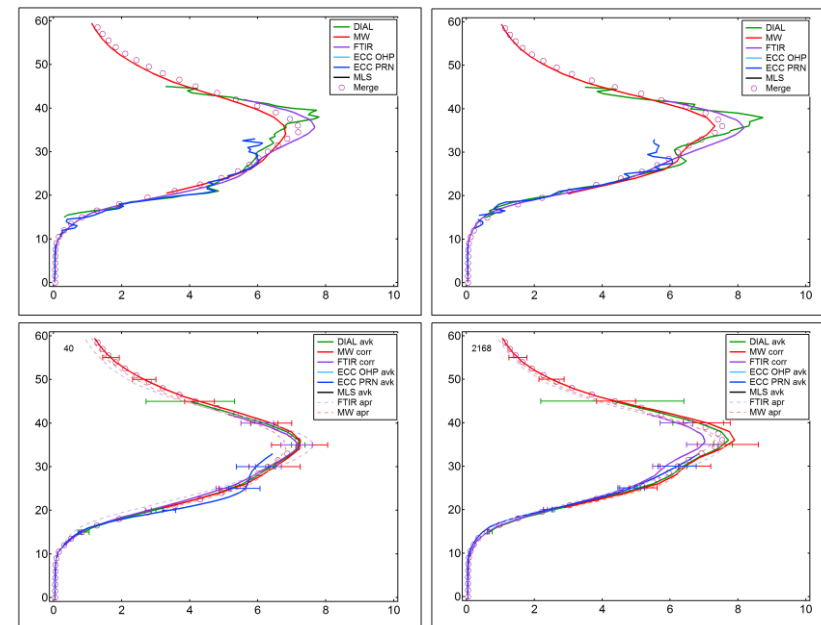
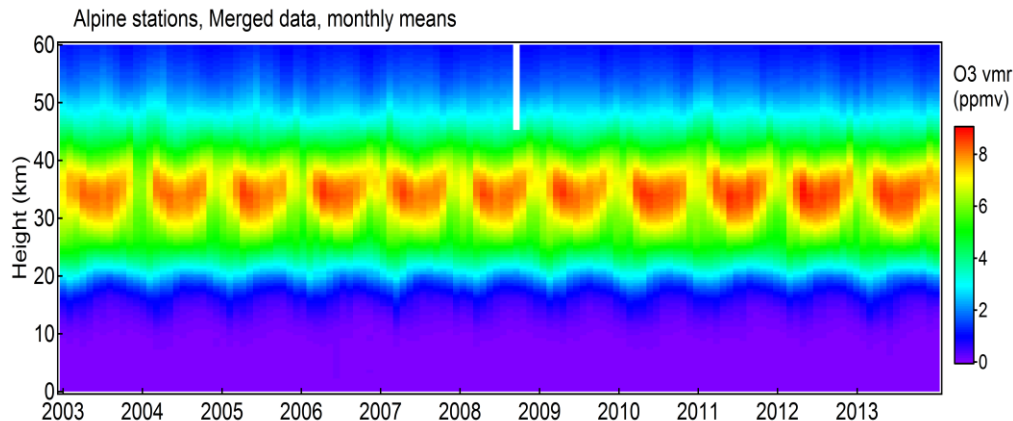
Merged ozone profile data:

- | | |
|---|------|
| • Smoothed OHP lidar data (Bern MW averaging kernels) | 1299 |
| • Bern MW data corrected from climatological bias with MLS | 3798 |
| • Jungfraujoch FTIR data corrected using MW a priori profiles | 1169 |
| • Smoothed OHP ozone sonde data (Jungfraujoch FTIR averaging kernels) | 448 |
| • Smoothed Payerne ozone sonde data (Jungfraujoch FTIR averaging kernels) | 1521 |

nb of meas.

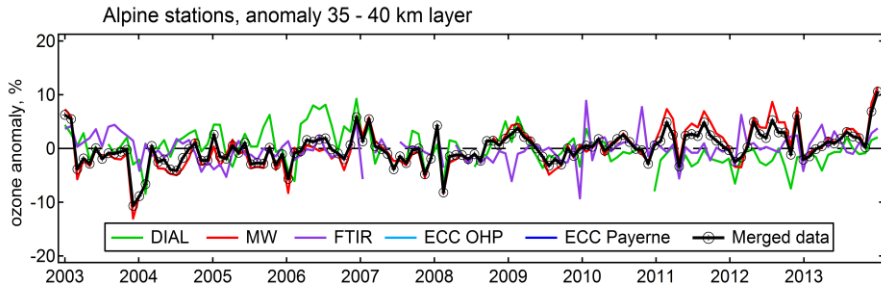
Coincidences:

1389 more than 2 meas.
869 more than 3 meas.

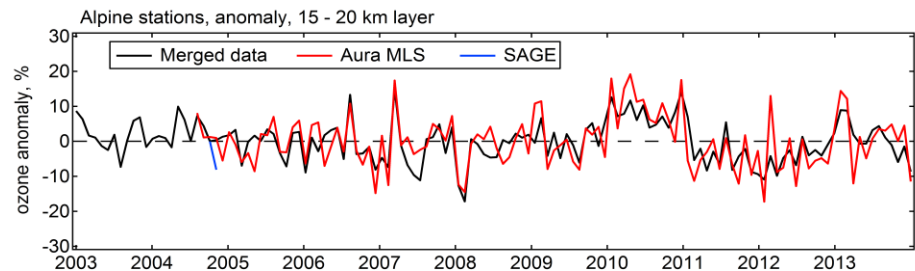
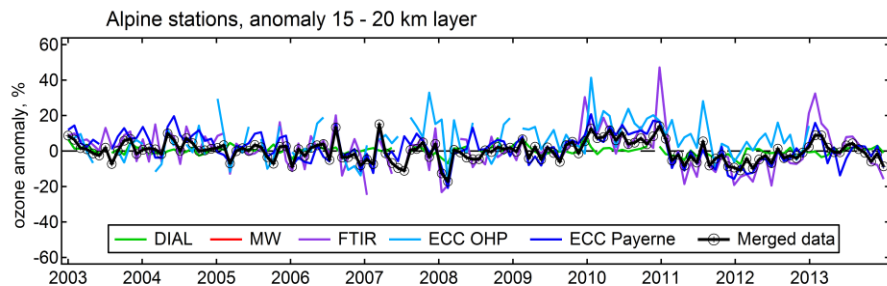
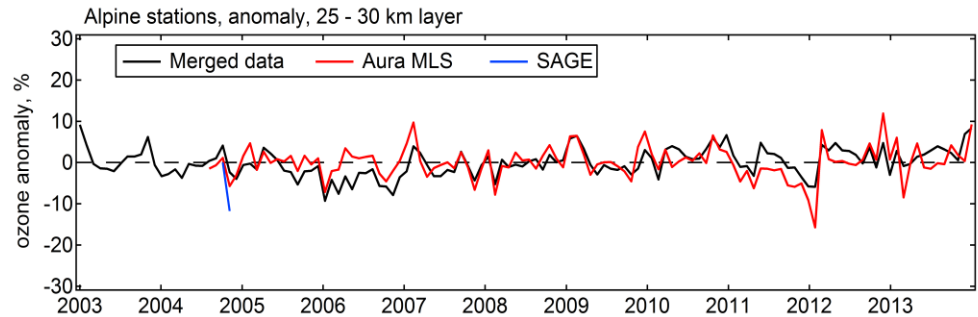
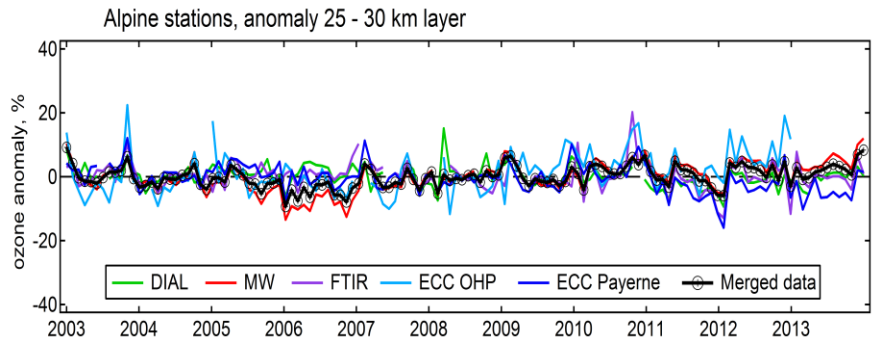
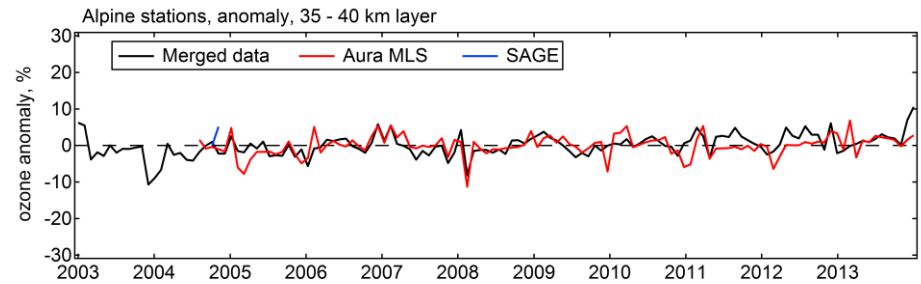


Alpine station

merged O3 vs individual

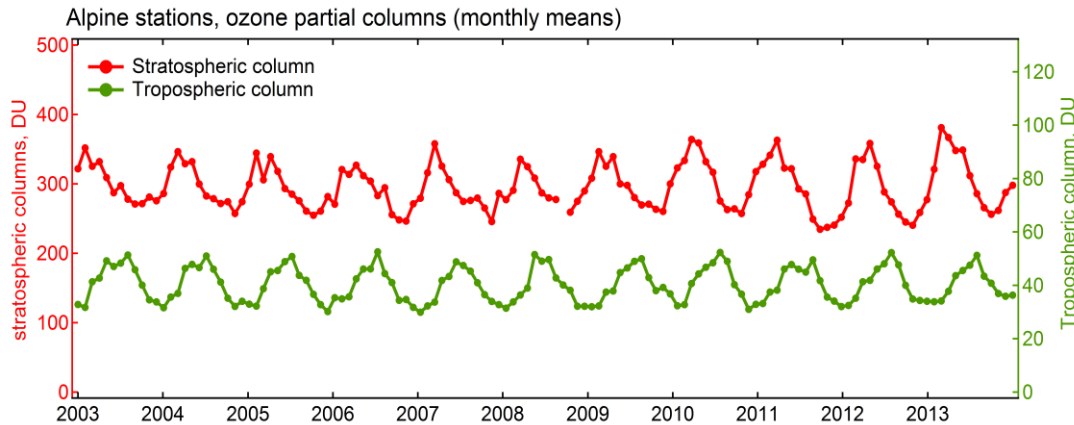


merged O3 vs MLS



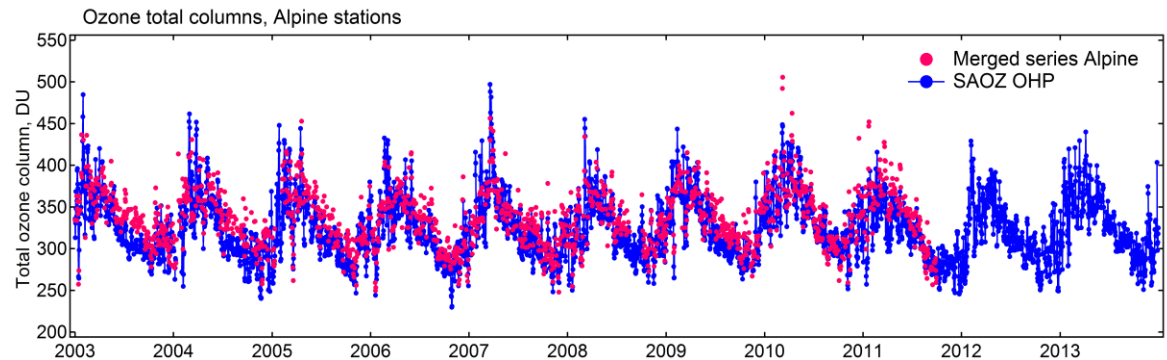
Alpine station

Ozone partial columns



Calculation of WMO
tropopause altitude
using NCEP data

Comparison of total ozone columns with SAOZ measurements



NyAlesund

Merged ozone profile data:

- Smoothed lidar data (MW averaging kernels)
- MW data corrected from bias with MLS data
- FTIR data
- Smoothed ozone sonde data (FTIR averaging kernels)

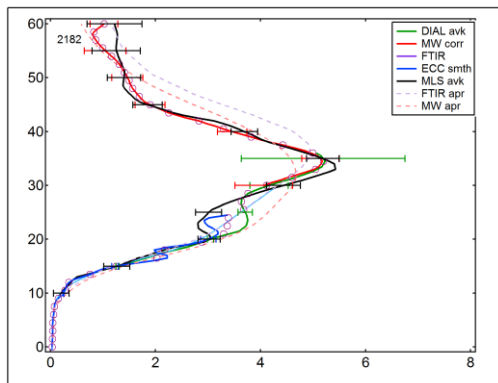
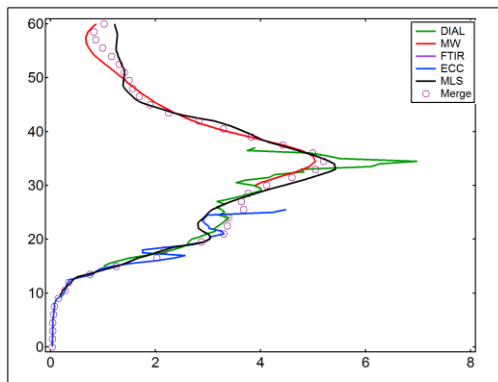
nb of meas.

129

1216

83

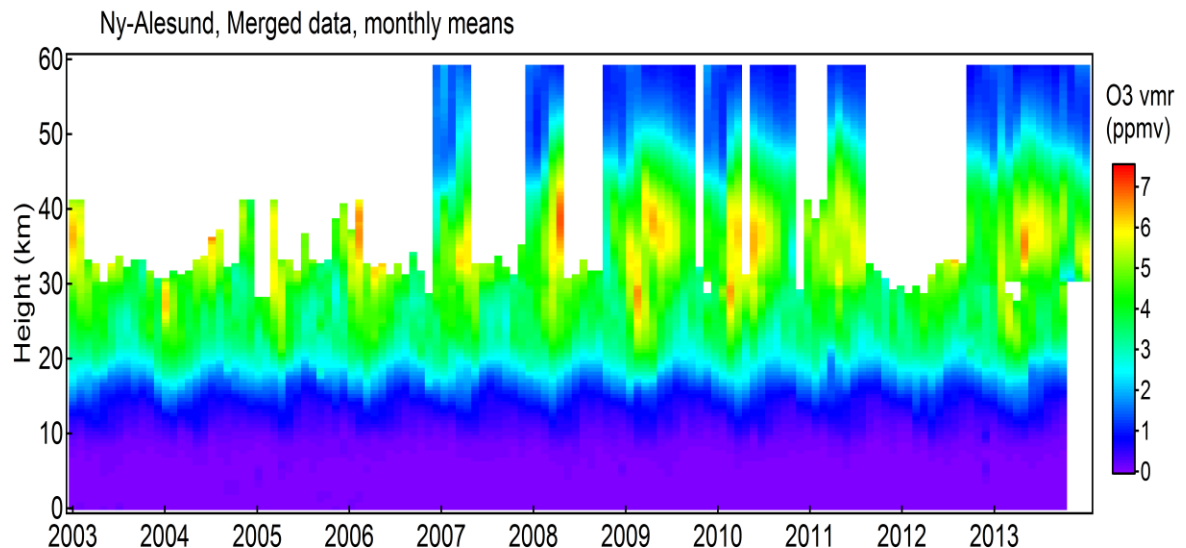
811



Coincidences:

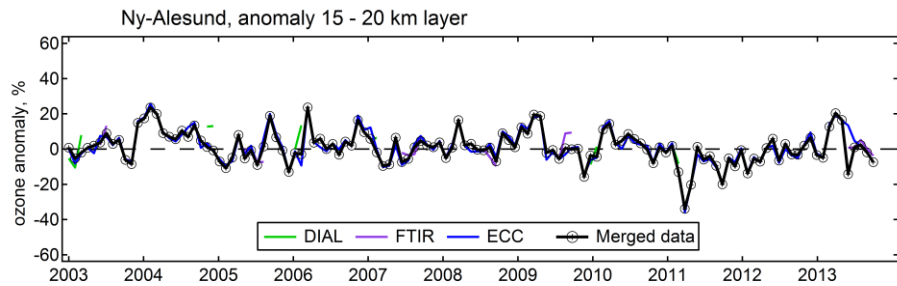
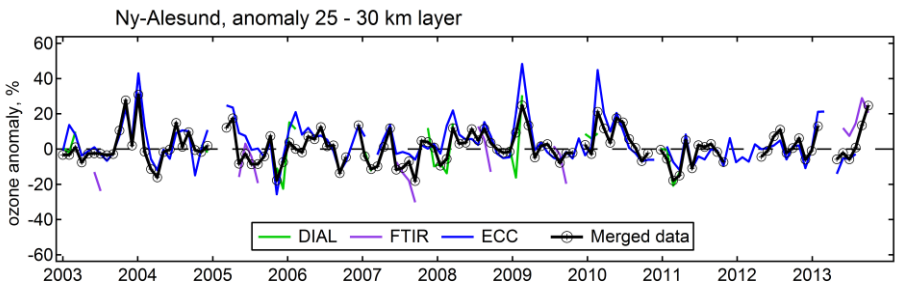
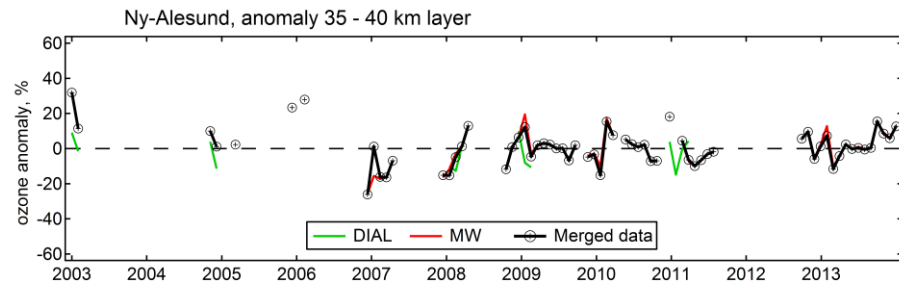
310 more than 2 meas.

17 More than 3 meas.

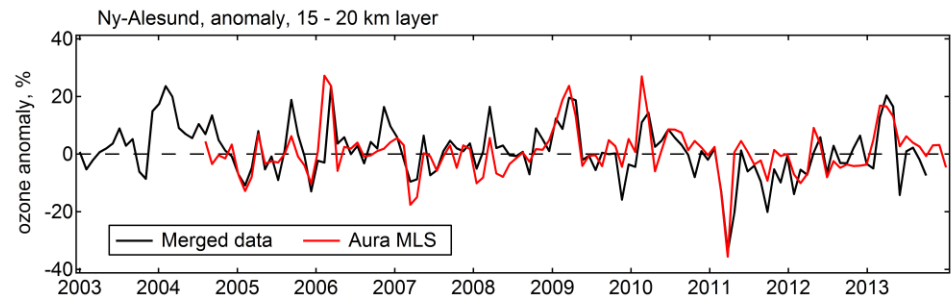
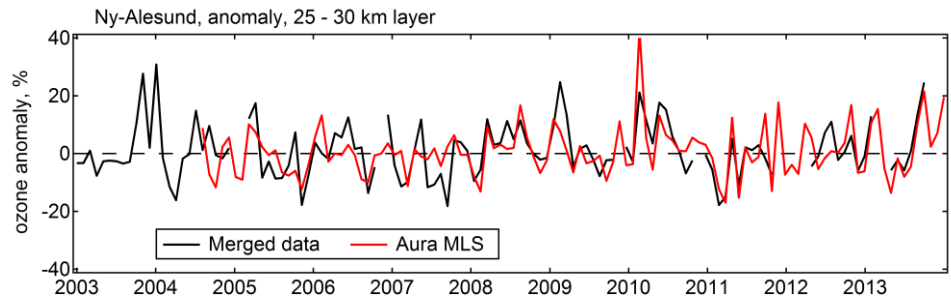
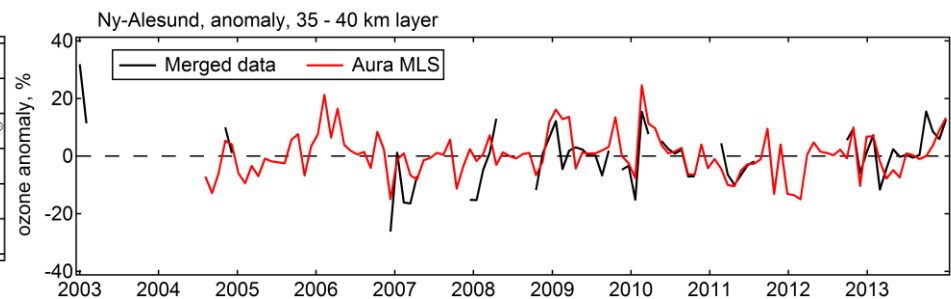


NyAlesund

merged O3 vs individual

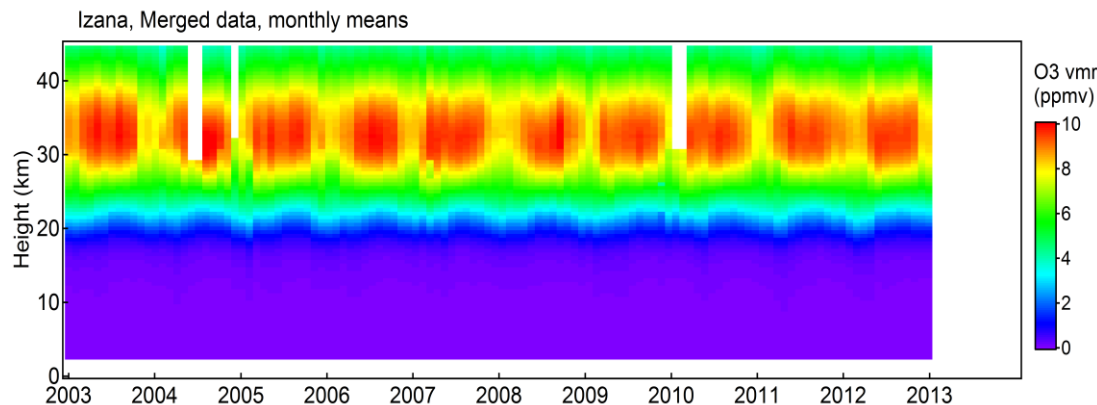


merged O3 vs MLS



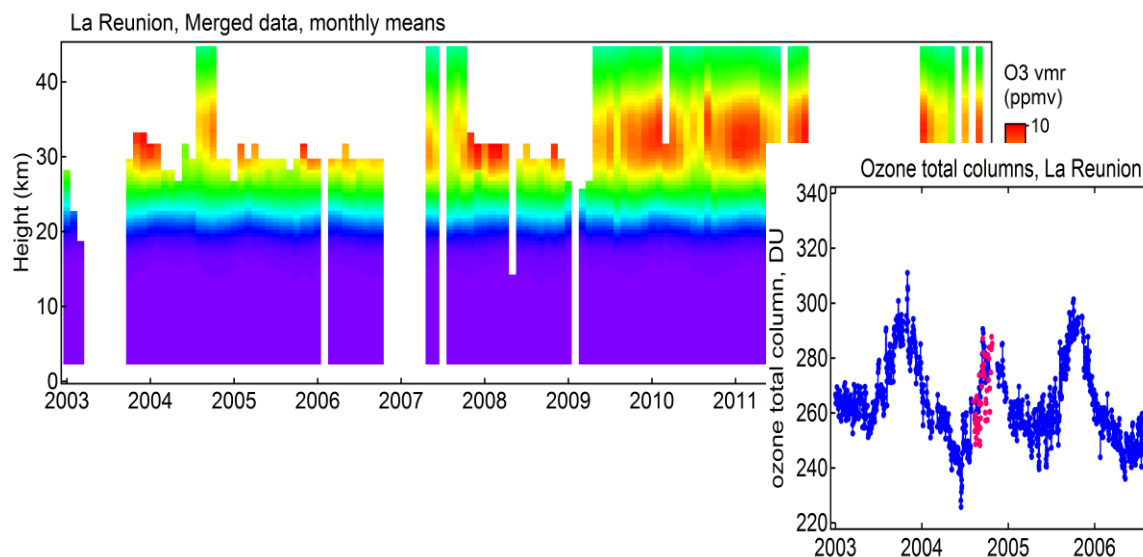
Izaña and La Réunion Island

Only FTIR and ozone sondes measurements at both stations
few ozone lidar measurements at La Réunion Island over the period



Izaña

362 coincidences



La Réunion

48 coincidences

Conclusions

- Ozoneprofile data sets have been produced at 4 NDACC stations together with stratospheric and tropospheric partial columns
- Data delivered within the NORS project and available for use upon request
- Good consistency of the data and good comparison with total ozone measurements (SAOZ)
- Next step: compare with MACC ozone profiles

Thank you for your attention!