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

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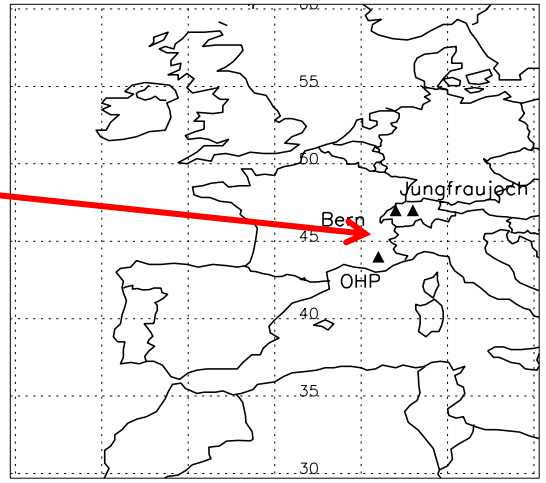
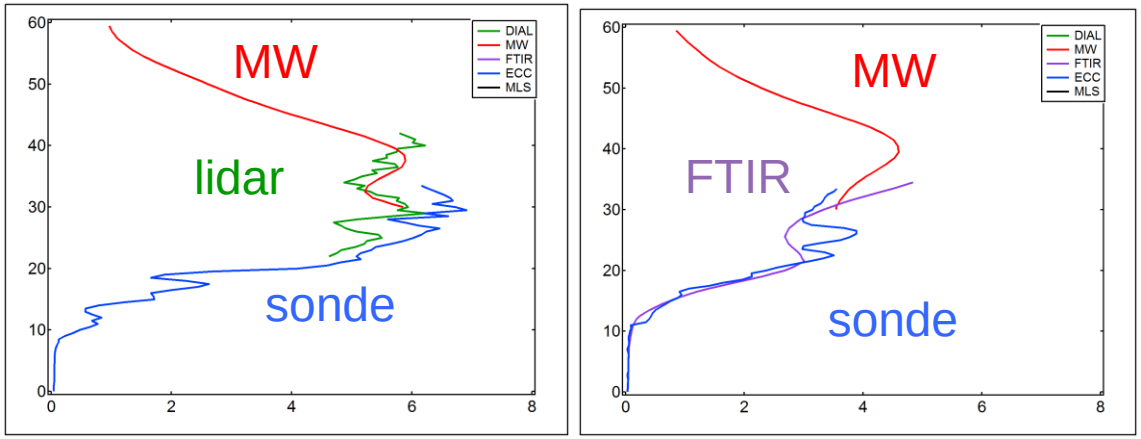
NORS WP6

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...

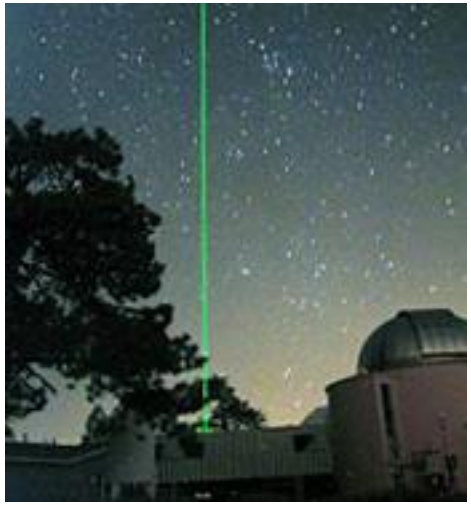


Example of ozone profile measurements at NyAlesund

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

Measurement techniques

DIfferential Absorption Lidar technique

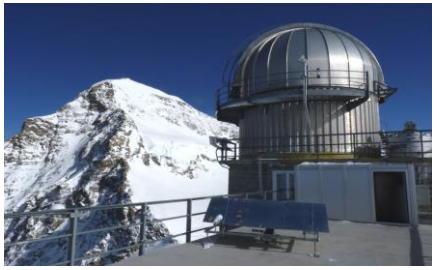


- ✓ Active technique
- ✓ Emission of two laser radiations at wavelengths characterized by a different ozone absorption cross section (308 nm and 355 nm)

MicroWave Ozone spectrometer

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

Fourier Transform InfraRed spectrometer



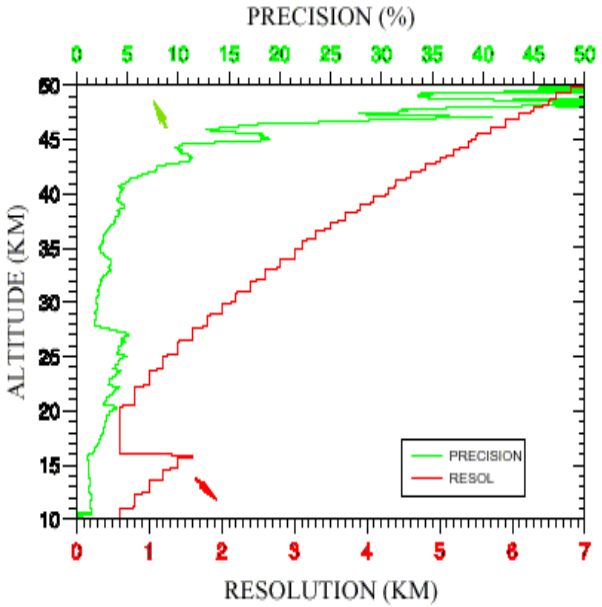
- ✓ Passive technique
- ✓ Atmospheric absorption spectra used for the retrieval of ozone
- ✓ wide spectral range 600 – 4500 cm^{-1}
- ✓ high spectral resolution

Vertical resolution

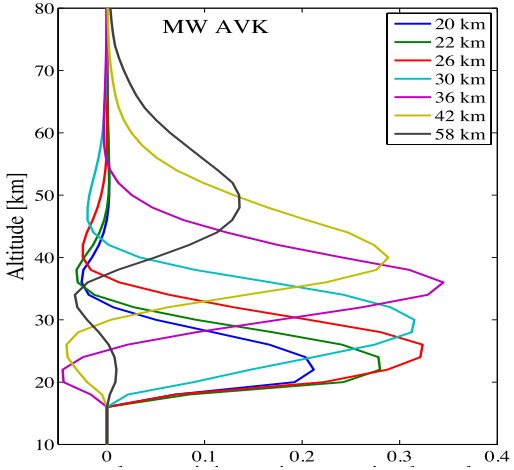
Active remote sensing

Passive remote sensing

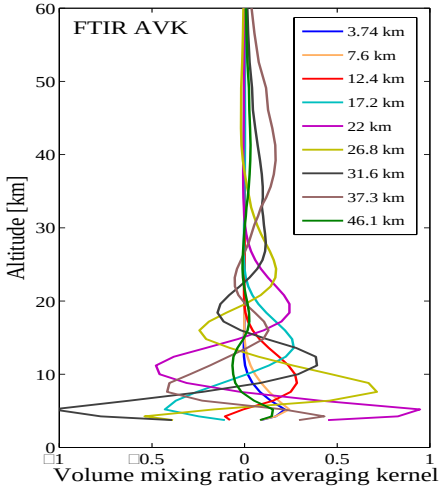
OHP lidar



Microwave Bern



FTIR Jungfraujoch

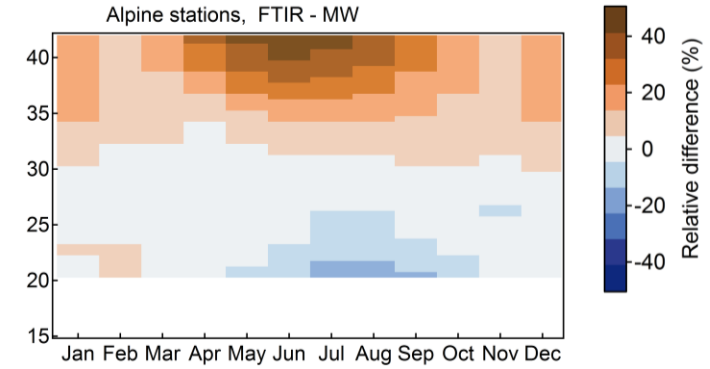


	Altitude range (km)	Resolution(km)
LIDAR	10 – 45	1 – 4.5
Microwave	20 – 60	10 – 15
FTIR	4 – 42	7 – 15
Ozone sondes	0 – 35	0.3

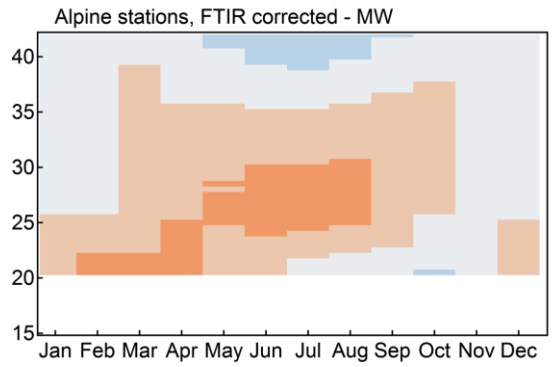
Evaluation of systematic differences

Example of Alpine station

FTIR - MW



FTIR corr - MW

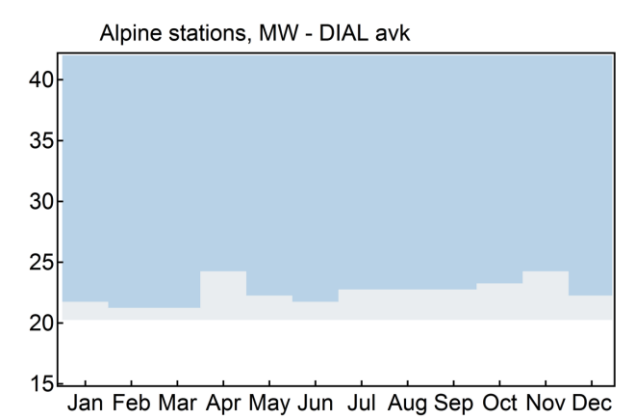


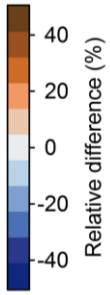
A priori profile correction

MW: monthly climatology
FTIR: annual climatology

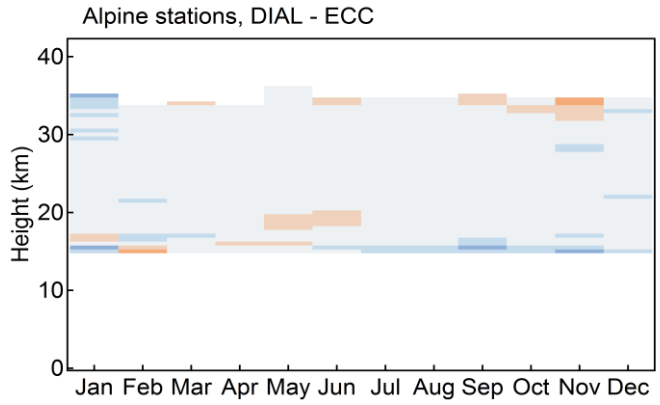
-> correction of FTIR a priori

MW - DIAL smoothed



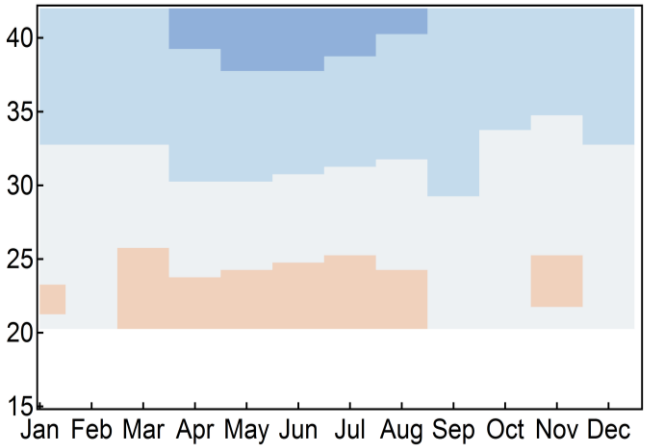


DIAL - ECC

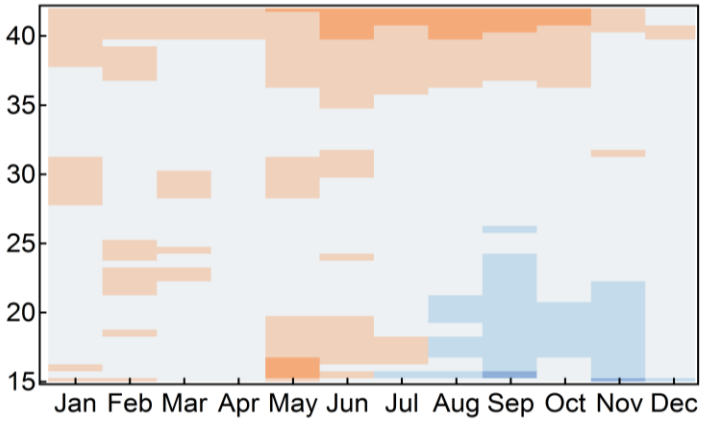


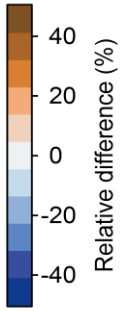
Systematic differences with AURA-MLS

MW - MLS smoothed

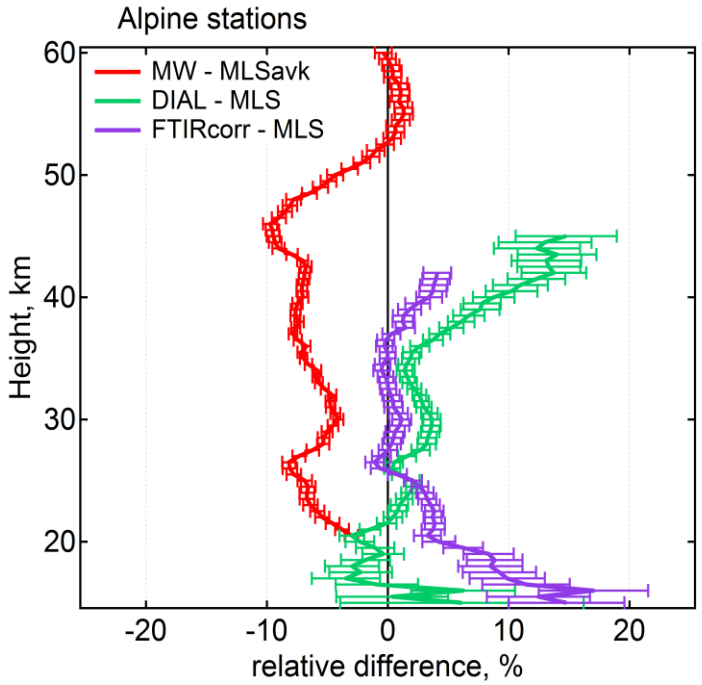


DIAL – MLS





Annual average



Ozone profile integration

Main steps:

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

Data integration

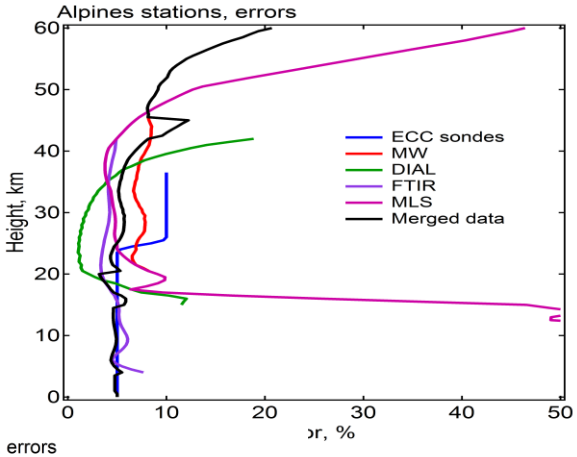
$$O_3(z) = \sum_{i=1}^{n} w_i(z) B_i(z) G_i(z) O_{3i}(z)$$

Error weight

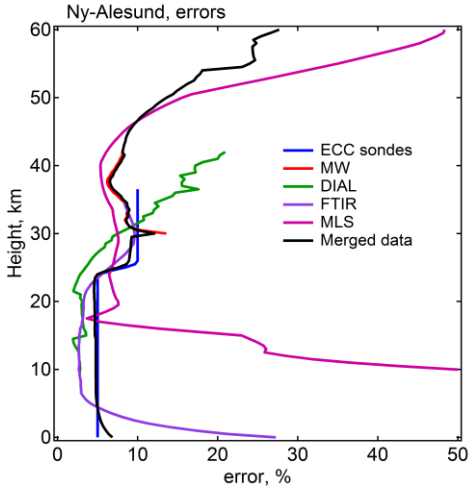
Instrumental bias

Geophysical bias

Alpine station



Ny Alesund



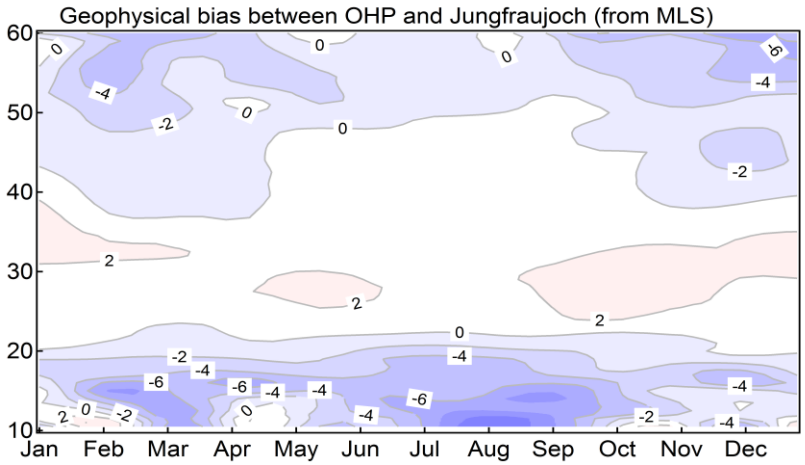
Merged ozone profile reported for more than one measurement at the station

Geophysical bias

Distance between stations:

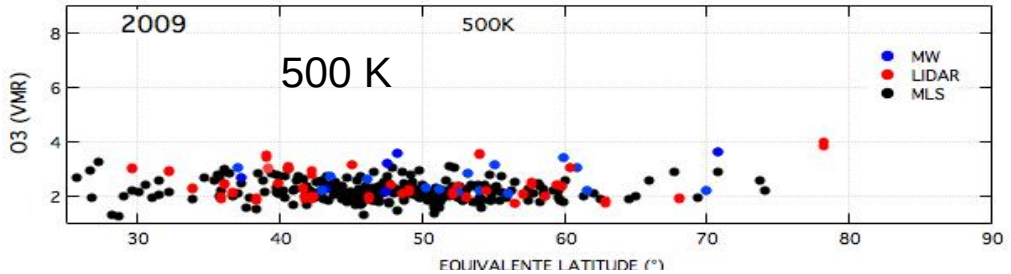
Bern – Jungfraujoch: ~ 60 km
OHP – both other stations: ~ 400 km

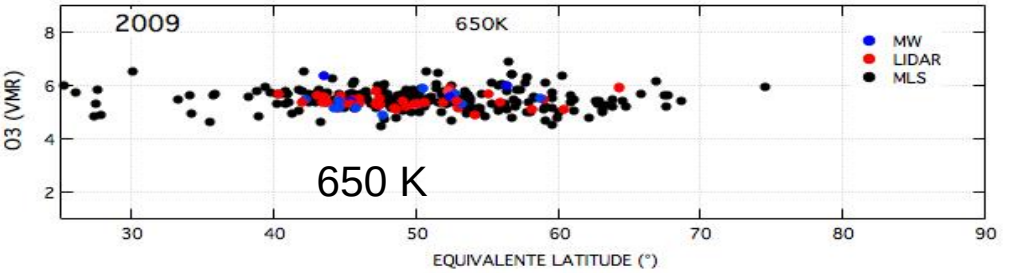
Difference between coincident MLS ozone measurements at OHP and Jungfraujoch



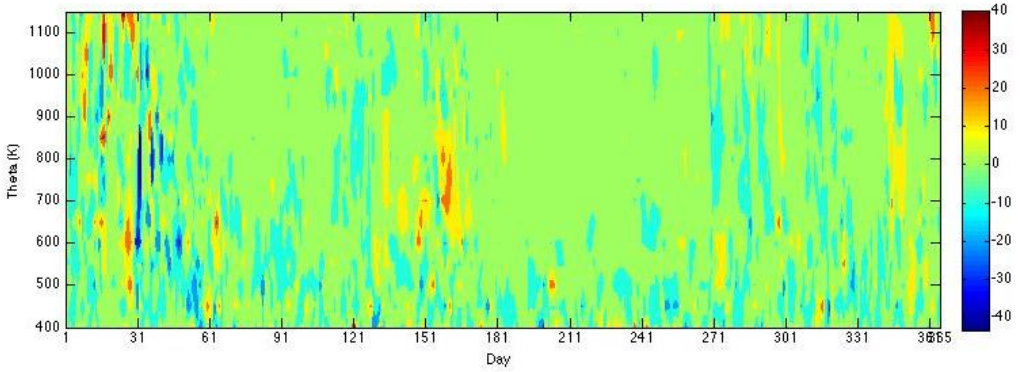
Very small geophysical bias between the stations

Ozone mixing ratio vs equivalent latitude





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



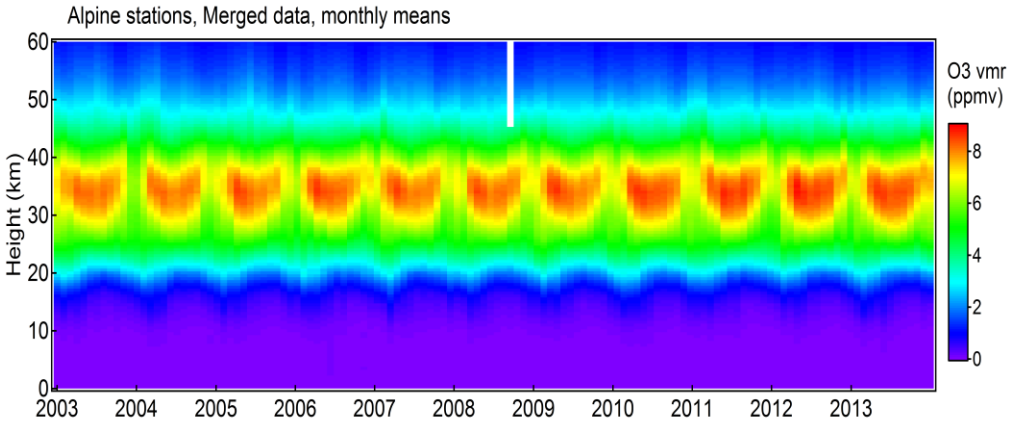
Alpine station

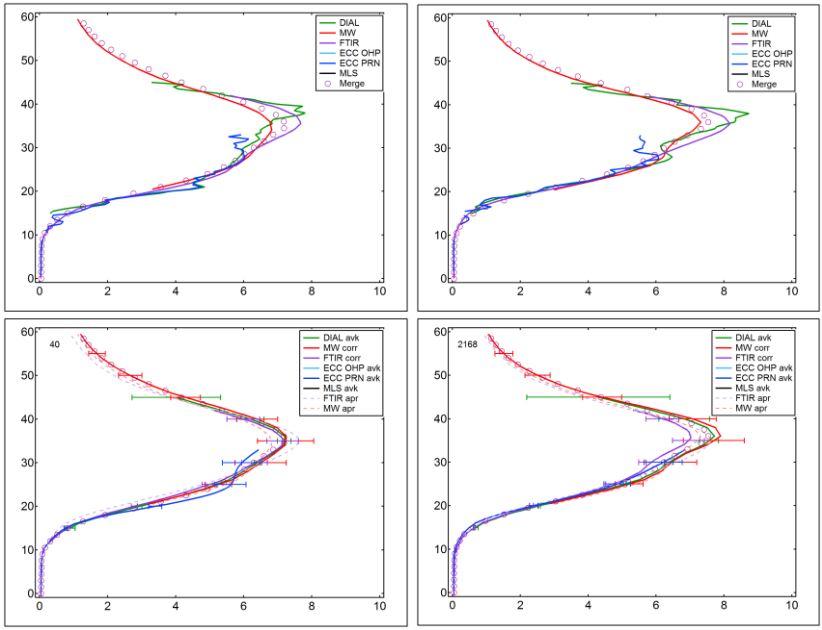
Merged ozone profile data: nb of meas.

- 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

Coincidences:

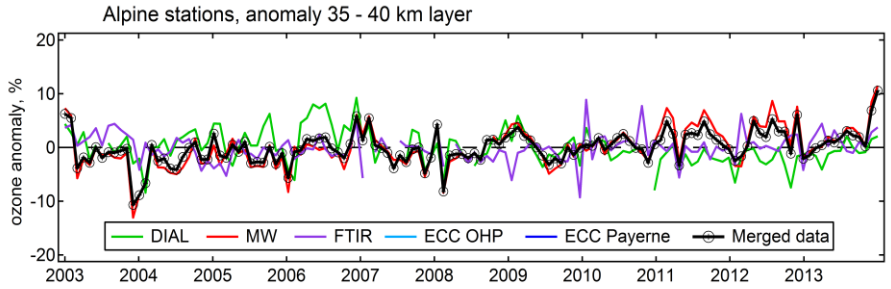
1389 more than 2 meas.
869 more than 3 meas.

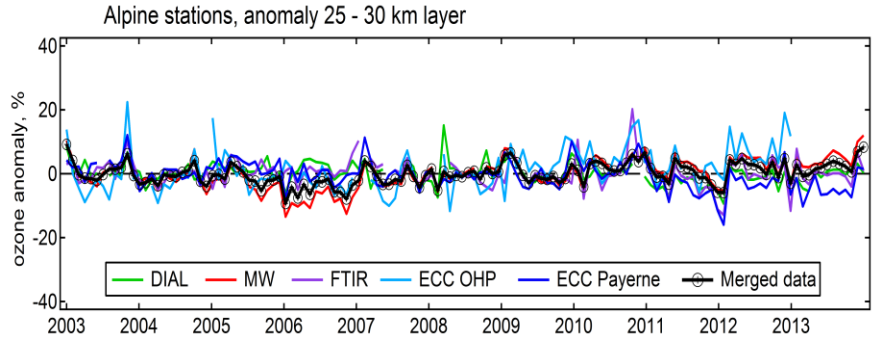


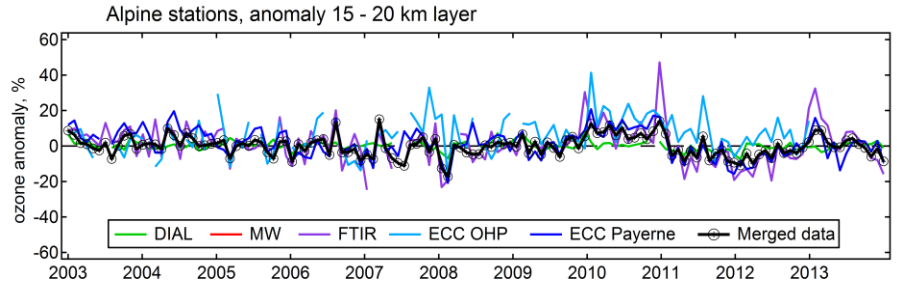


Alpine station

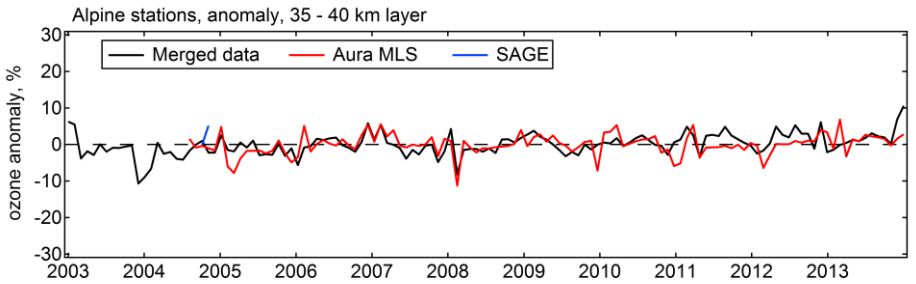
merged O3 vs individual

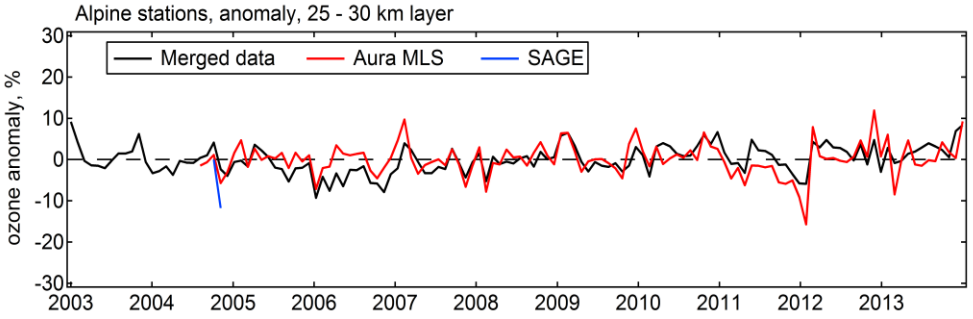


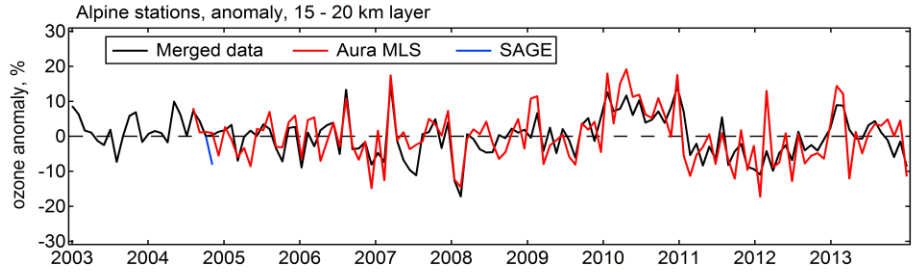




merged O3 vs MLS

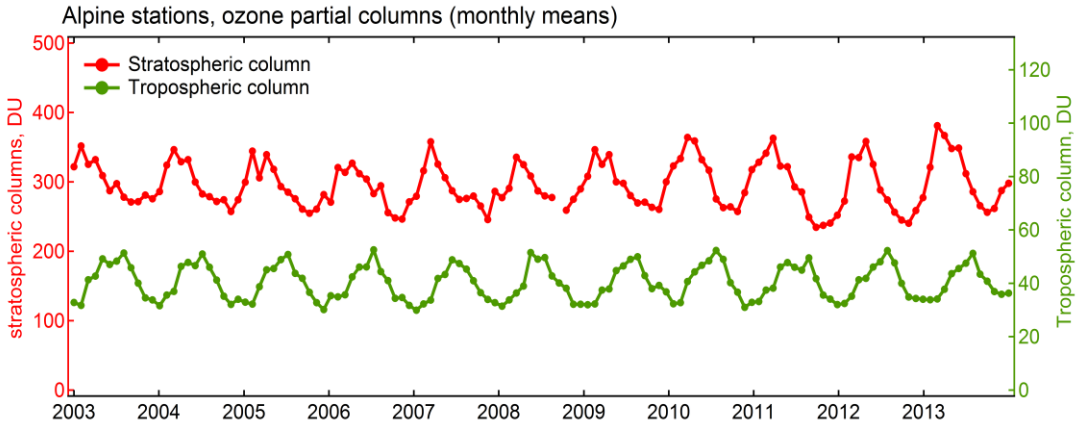






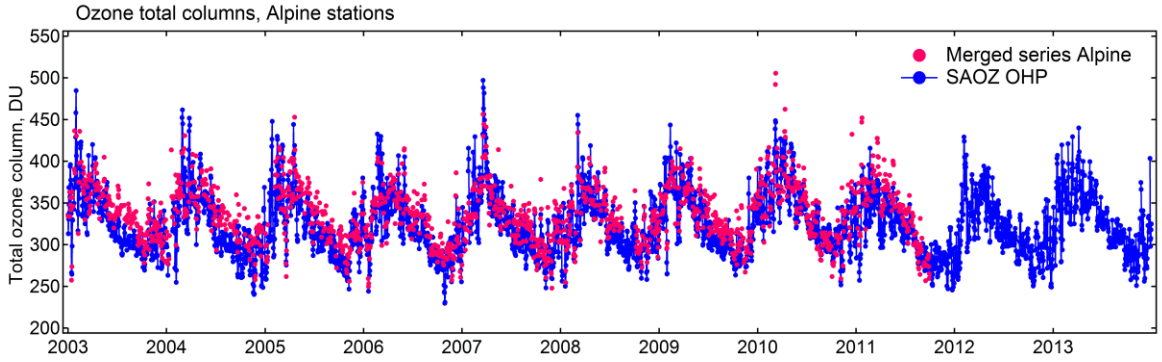
Alpine station

Ozone partial columns



Calculation of WMO tropopause altitude using NCEP data

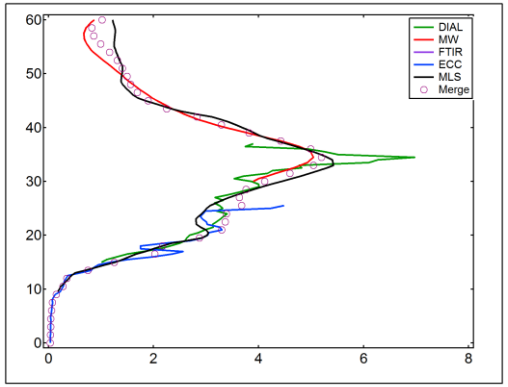
Comparison of total ozone columns with SAOZ measurements

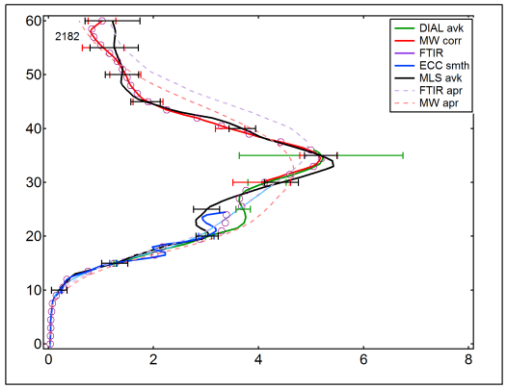


NyAlesund

Merged ozone profile data:

	nb of meas.
• Smoothed lidar data (MW averaging kernels)	129
• MW data corrected from bias with MLS data	1216
• FTIR data	83
• Smoothed ozone sonde data (FTIR averaging kernels)	811

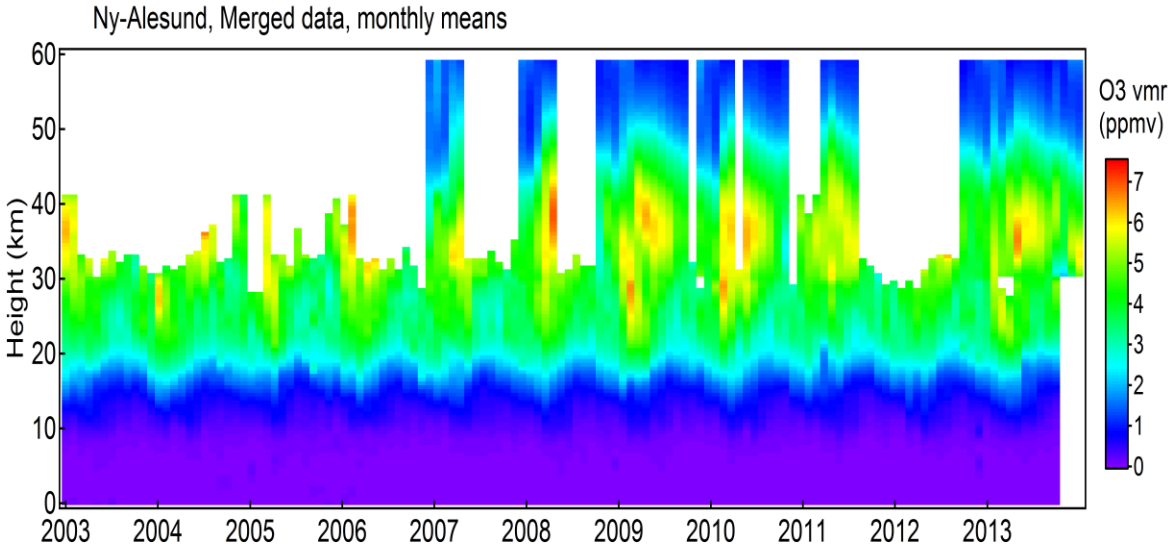




Coincidences:

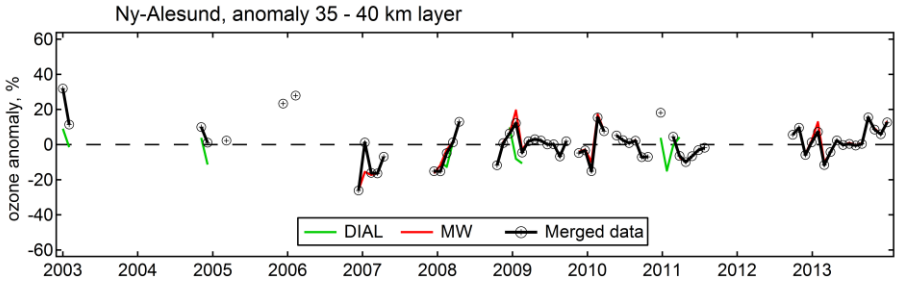
310 more than 2 meas.

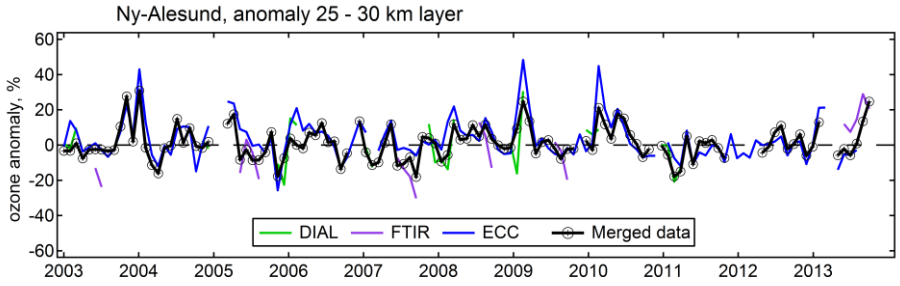
17 More than 3 meas.

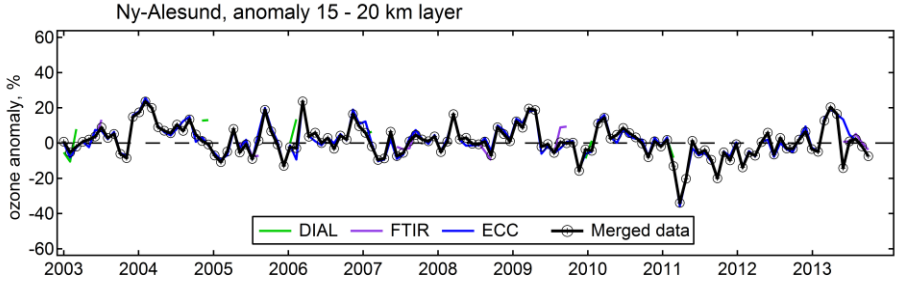


NyAlesund

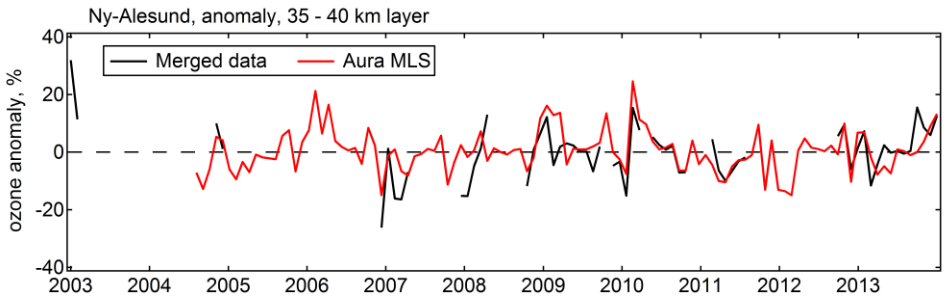
merged O3 vs individual

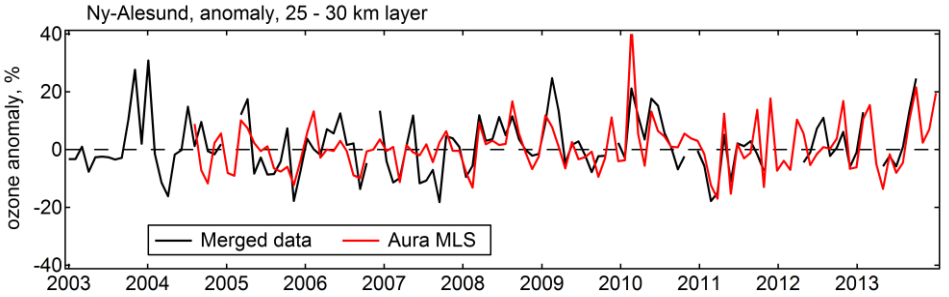


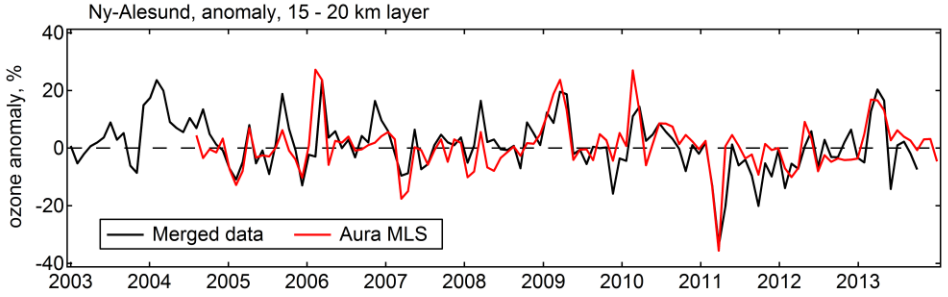




merged O3 vs MLS

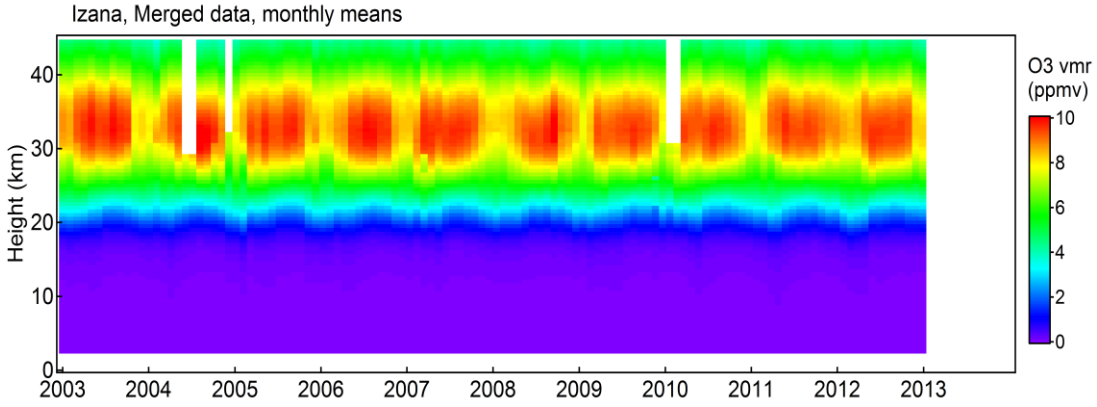






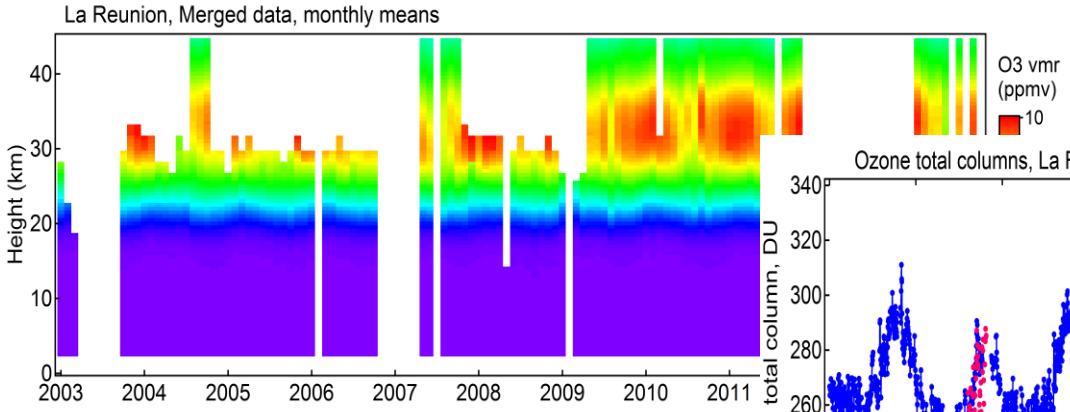
Izaña and La Réunion Island

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



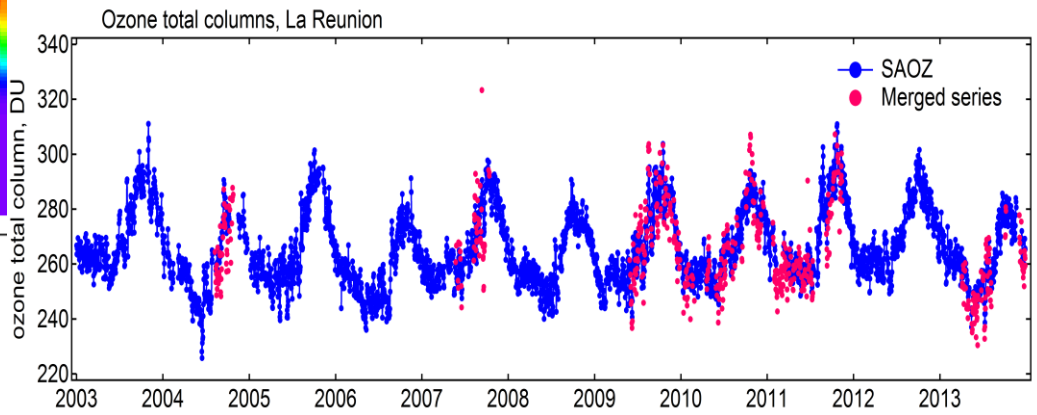
Izaña

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!