

# Harmonized retrieval of middle atmospheric ozone from two microwave radiometers in Switzerland

## CONTEXT:

Passive microwave ground-based radiometers provide ozone profiles in the middle-atmosphere (20 to 75 km altitude):

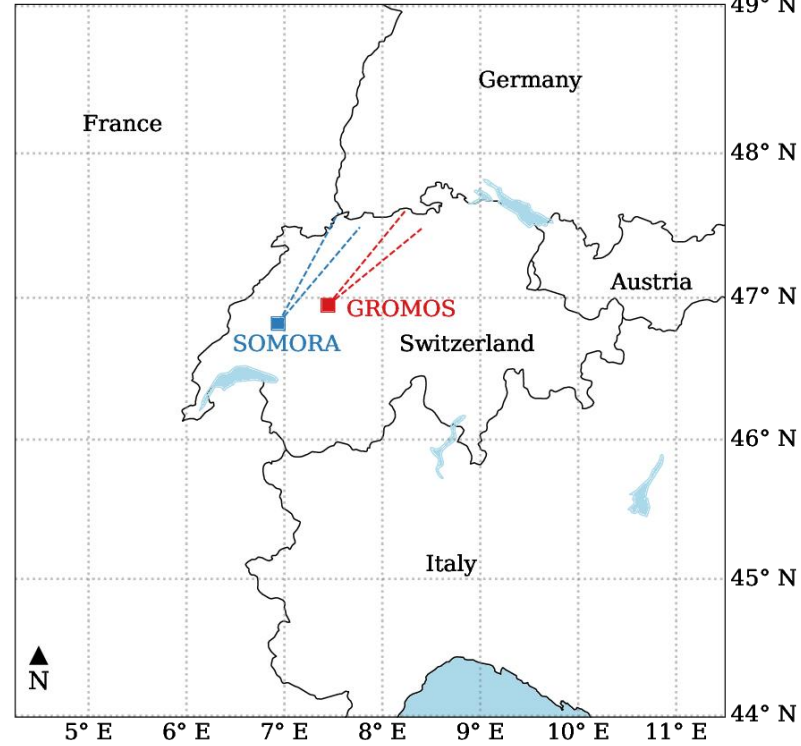
- + day and night capabilities
- + hourly time resolution
- + operate under large range of atmospheric conditions
- low vertical resolution
- instrument operation

## Ozone profiling instruments in Switzerland:

- Two similar microwave radiometers designed at the Institute of Applied Physics in Bern

- Observe the ozone emission line at 142 GHz

- Part of the Network for the Detection of Atmospheric Composition Change (NDACC)



**GROMOS:**

- University of Bern, Bern
- Since 1994

**SOMORA:**

- MeteoSwiss, Payerne
- Since 2000

## MOTIVATIONS:

GROMOS and SOMORA are regularly used to assess ozone trends or perform cross validation of satellite observations over Central Europe.

Their geographic proximity offers a unique opportunity to compare their observations and to assess measurement uncertainties, possible instrumental failures, calibration and retrieval errors.

However, there are inconsistencies in their trend estimates [1] and some anomalies were identified in the GROMOS time series [2].

Similar instruments with different data processing routines which makes them hard to compare before final product.

→ Harmonization project

## GOALS:

Full Harmonization of GROMOS and SOMORA data processing:

- Common calibration and retrieval routines (raw data to ozone profiles)
- All input data (apriori, spectroscopy, atmosphere definition, ...)
- Output files

Reprocessing of two independent ozone data series from 2010 to today where both instruments used similar digital spectrometers

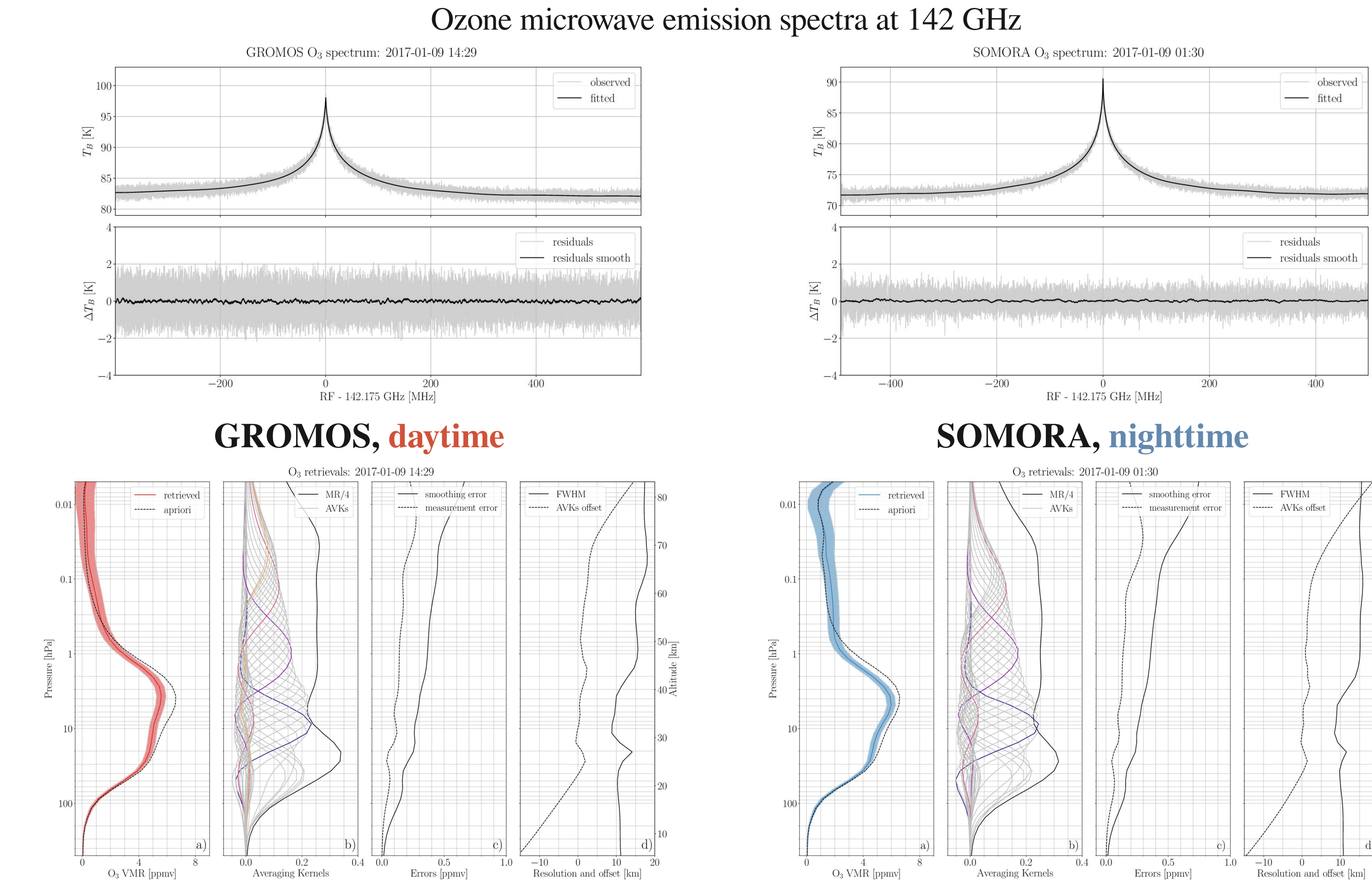
Identify and document anomalous periods on both instruments

## References

- [1] Petropavlovskikh, Irina, et al. "SPARC/IO3C/GAW report on Long-term Ozone Trends and Uncertainties in the Stratosphere." , SPARC Report No. 9, GAW Report No. 241, WCRP-17/2018, 2019.
- [2] Bernet, Leonie, et al. "Ground-based ozone profiles over central Europe: incorporating anomalous observations into the analysis of stratospheric ozone trends." Atmospheric Chemistry and Physics 19.7: 4289–4309, 2019.

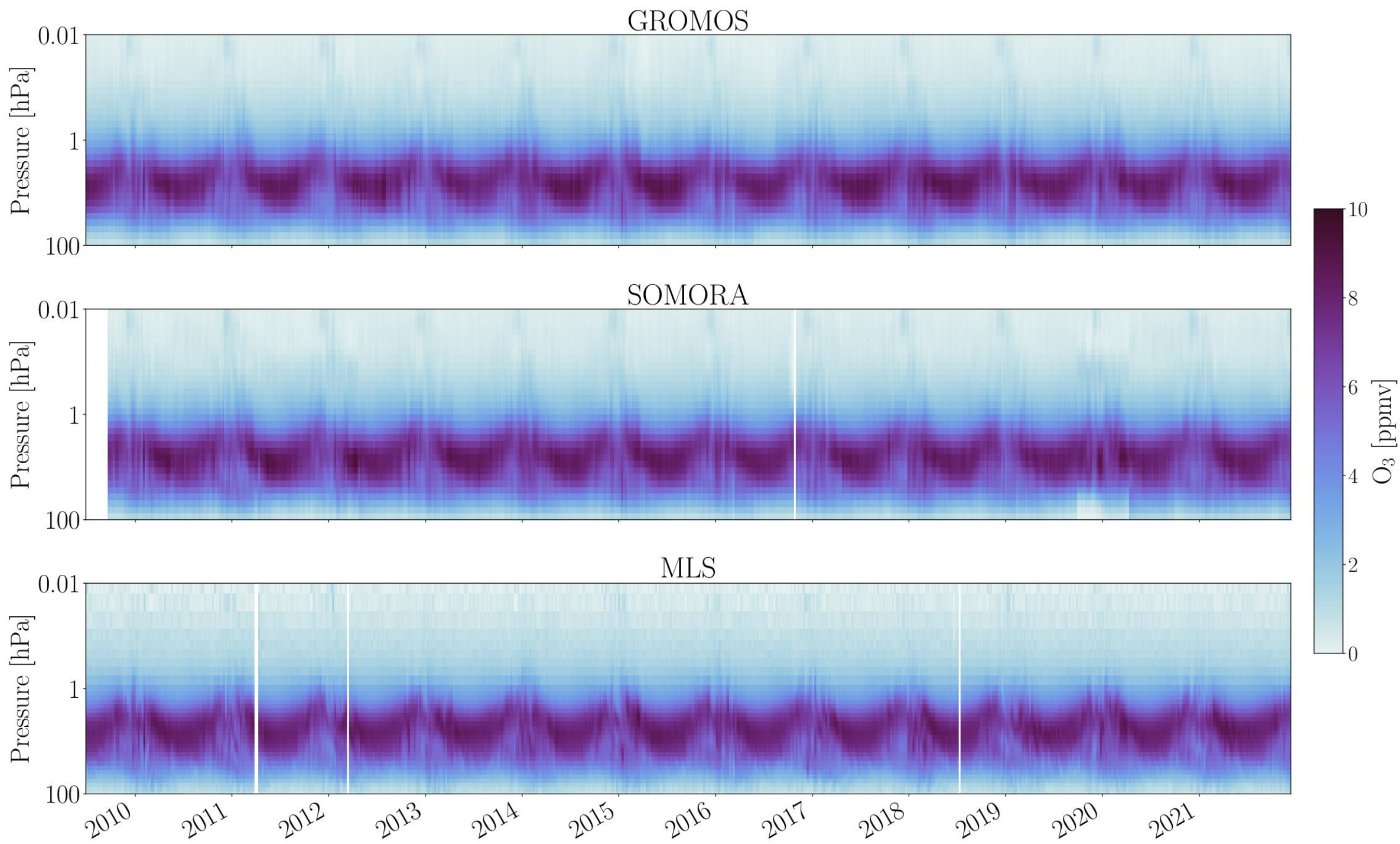
## RESULTS:

Harmonized hourly calibrated spectra and retrievals of O<sub>3</sub> volume mixing ratio (VMR) profiles

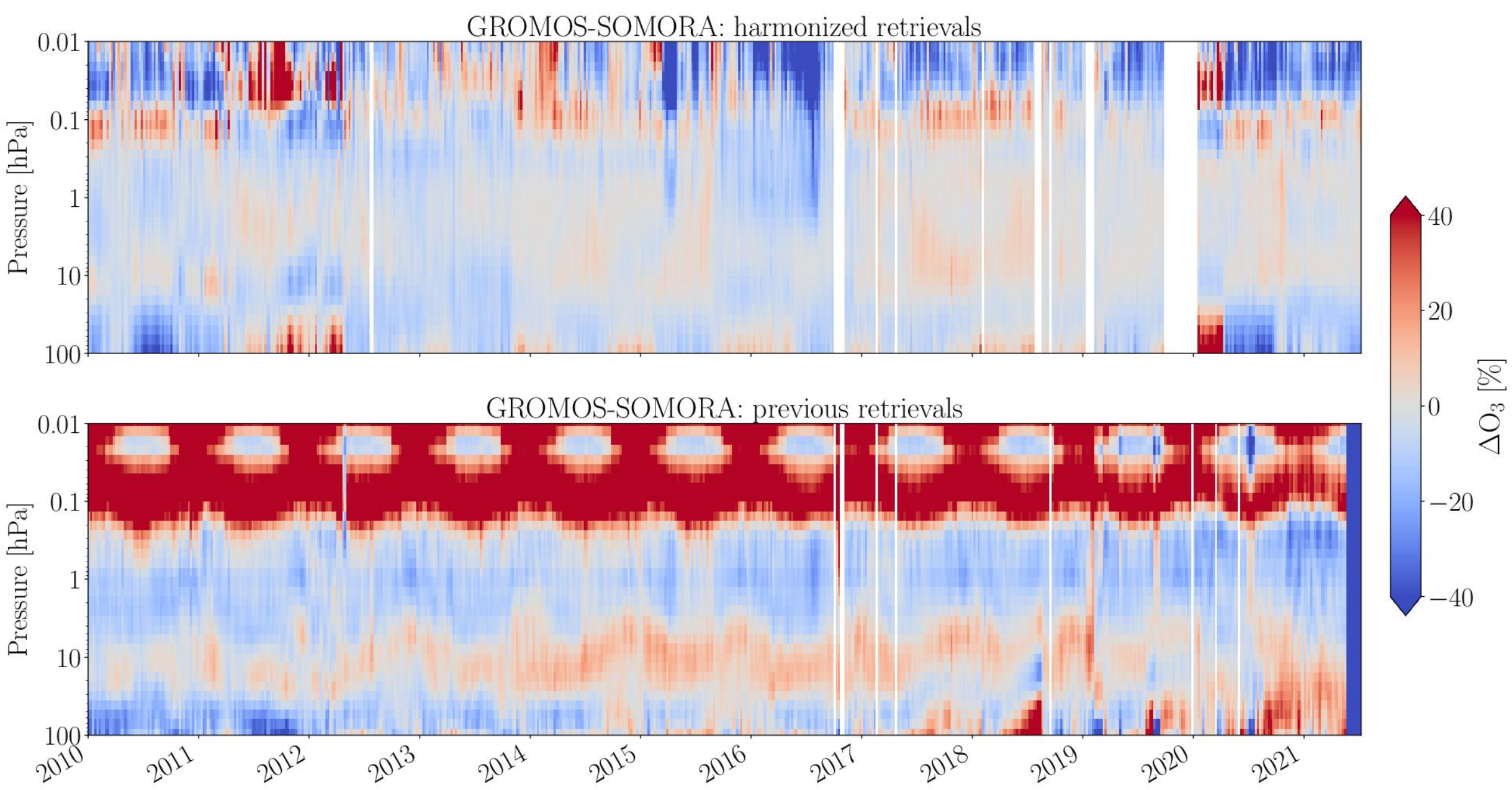


Examples of ozone profile retrievals and diagnostic quantities (level 2)

## Weekly mean ozone time series since 2010



## Comparison with previous retrievals



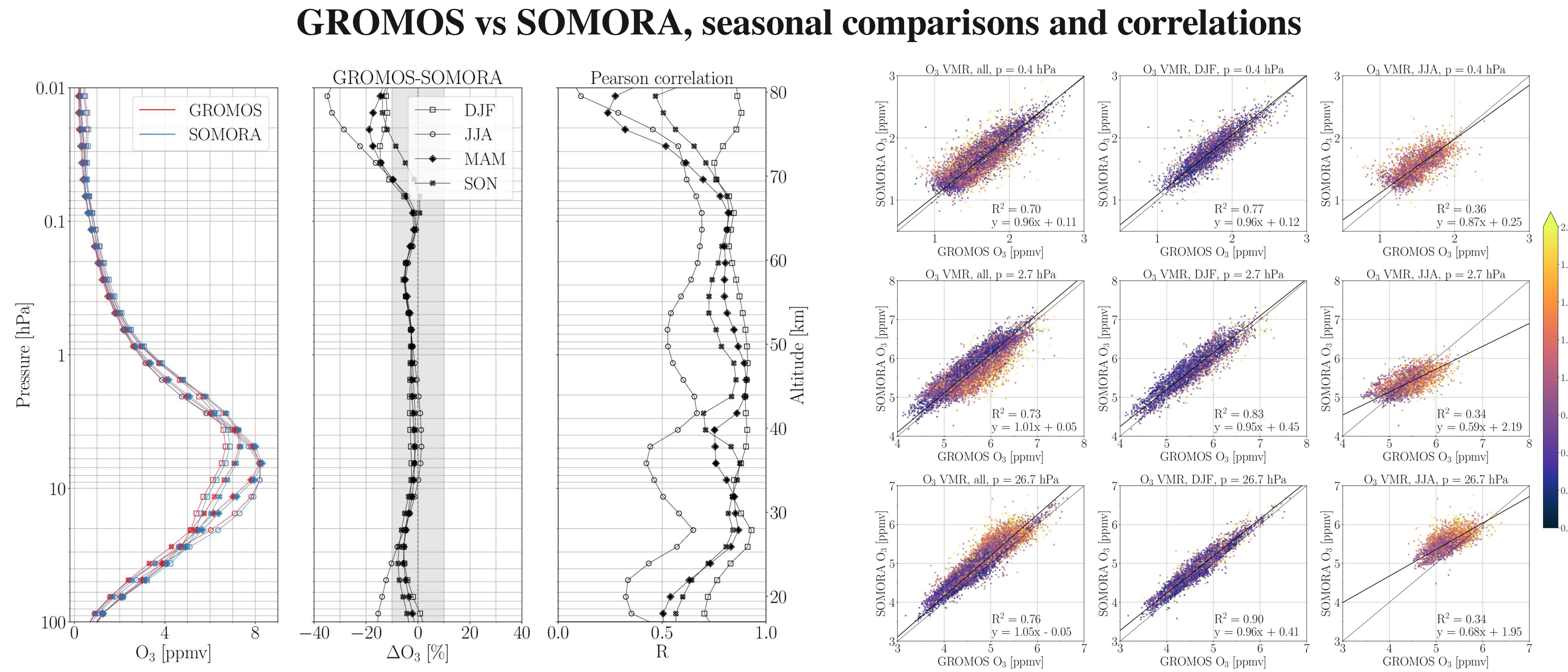
ERIC SAUVAGEAT<sup>1,2</sup>, ELIANE MAILLARD BARRAS<sup>3</sup>, KLEMENS HOCKE<sup>1,2</sup>, ALEXANDER HAEFELE<sup>3</sup>, AXEL MURK<sup>1,2</sup>

<sup>1</sup> Institute of Applied Physics, University of Bern

<sup>2</sup> Oeschger Centre for Climate Change Research, University of Bern

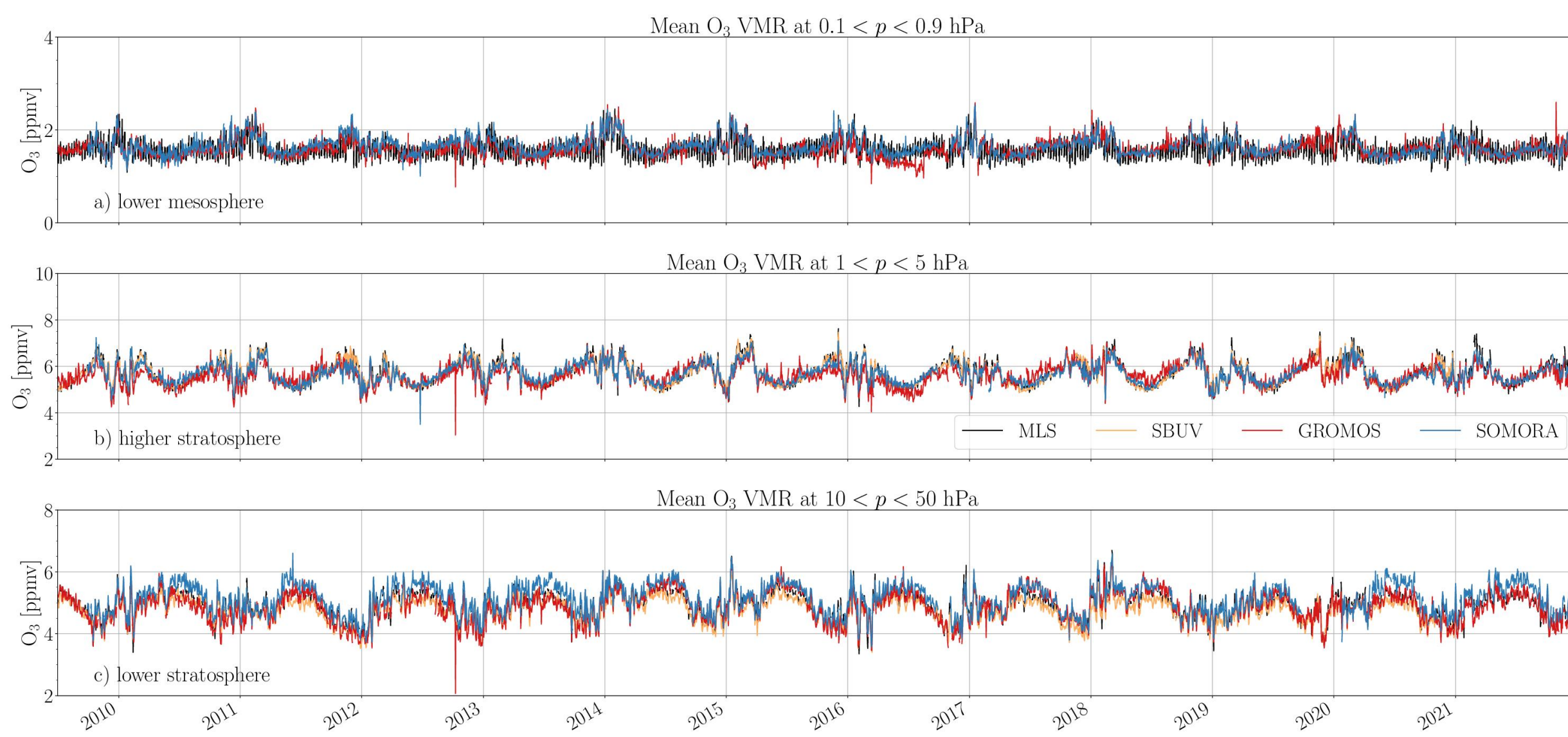
<sup>3</sup> Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland

## VALIDATION:

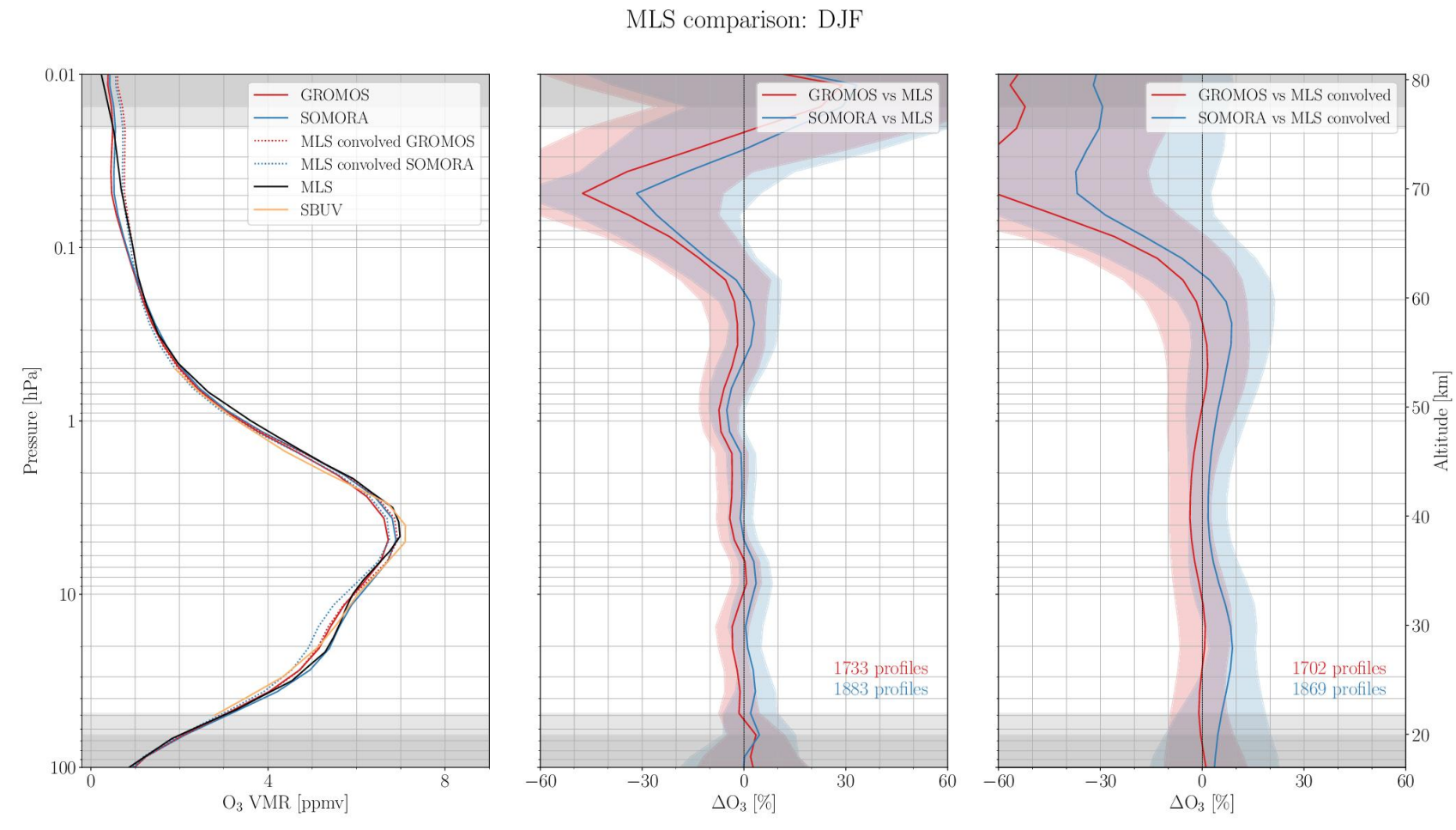


Mean seasonal O<sub>3</sub> profiles comparisons

## Cross-validation against satellites measurements (Aura/MLS and SBUV/2)



## Winter profile comparisons with MLS



## Results summary

- GROMOS and SOMORA agree within 10 % in the middle atmosphere (20-70 km) and show a bias during summertime

- Seasonal comparisons with satellites are mostly within 10 % in the stratosphere and lower mesosphere (up to 60 km).

- O<sub>3</sub> dynamics well captured by both instruments

- Most spurious periods are identified from calibration and retrievals diagnostics

## CONCLUSIONS:

New harmonized ozone time series from 2010 to 2021:

- Fully harmonized but independent data series
- Large reduction of differences between Swiss ozone profiling instruments
- Improved averaging kernels (sensitivity) on GROMOS
- Enable identification and flagging of spurious periods
- Reduce anomalies in GROMOS measurements
- Compare well against Aura/MLS and SBUV

## OUTLOOK:

- Final validation and update the NDACC database
- Peer-reviewed publication in preparation
- Reprocessing of the pre-2010 data and harmonization of the full time series (1994-2021)
- Computation of new trends for GROMOS and SOMORA
- Diurnal cycles analysis

Any questions ?

eric.sauvageat@unibe.ch

