

SI-TRACEABLE SURFACE-BASED OBSERVATIONS FOR OZONE AND AEROSOL PROPERTIES RETRIEVAL

Julian Gröbner, Natalia Kouremeti, Luca Egli, Gregor
Hülsen, Stelios Kazadzis

Physikalisch-Meteorologisches Observatorium Davos, World Radiation
Center, PMOD/WRC

QA4EO Phase 1 (2019/11-2022/4)

- 1) Operate solar spectroradiometers & filter radiometers at PMOD/WRC to retrieve:
 - 1) Traceable total column ozone from direct spectral solar UV irradiance measurements.
 - 2) Traceable aerosol optical depth from direct solar irradiance measurements.

- 2) Characterise and calibrate solar filter radiometers (PFR & CIMEL):
 - 1) Angular response (Field of view)
 - 2) Normalised spectral filter response
 - 3) Responsivity calibration traceable to SI

- 3) Participation at a field campaign organised by LOA at the Aeronet-Europe calibration site at Observatoire de haute Provence (OHP).

Supplementary tasks:

- Support validation of CAL/VAL sensors measuring solar UV radiation and ozone.
- Characterisation & Calibration of CAL/VAL sensors in the optical laboratory of PMOD/WRC or via cross-calibrations at field campaigns.

Outlook for 2020

Done

❖ April-June

Installation of one reference PFR at OHP.

**Postponed
to 2021**

❖ 14-24 July

RBCC-E OZONE Campaign at PMOD/WRC

**Postponed
to 2021**

❖ 14-18 September

SORBETTO-2 Summer School, Rome

**Postponed
to 2021**

❖ 28 Sep. - 16 Oct.

FRC-V Filter Radiometer Comparison at PMOD/WRC

On schedule

❖ Nov- Dec

PFR laboratory characterisation.

Total Column ozone measurements at PMOD/WRC

QASUME



KOHERENT

Dobson D101



D051

D062

Brewer B156



B040

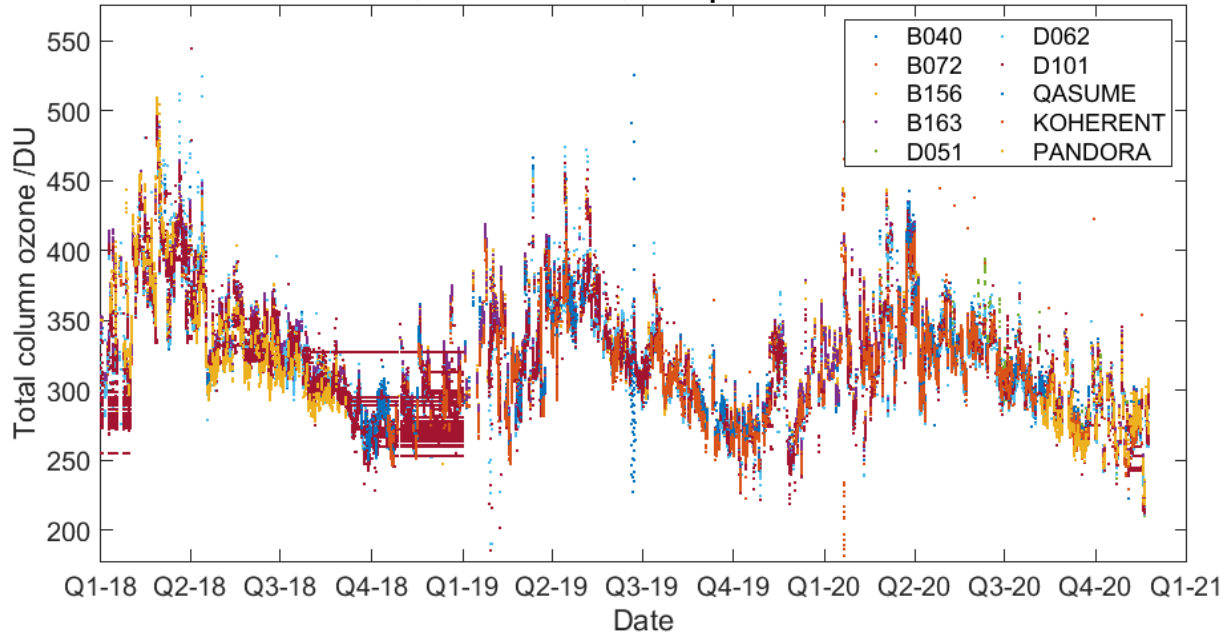
B072

B163

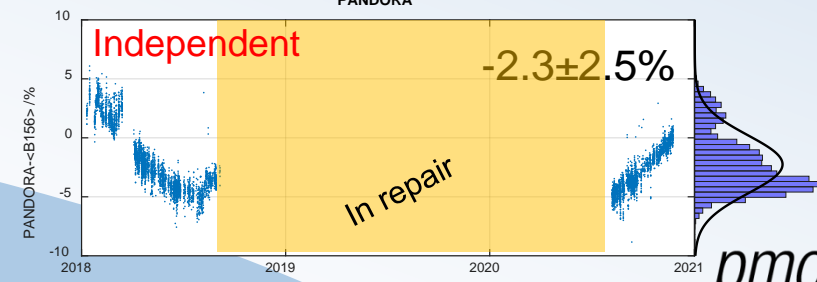
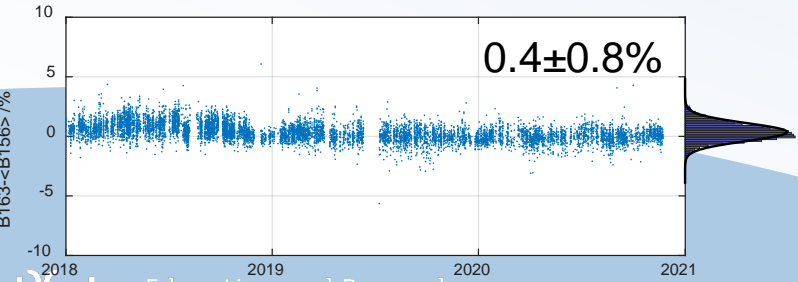
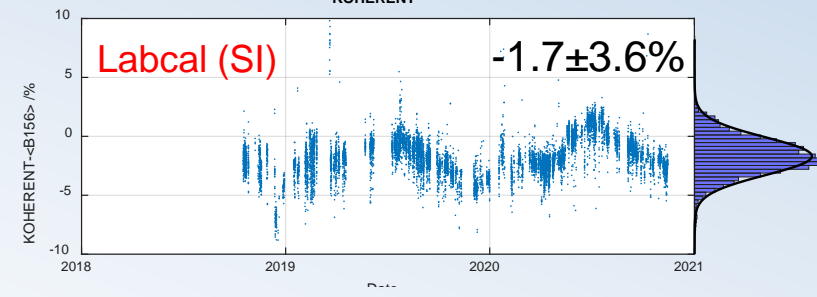
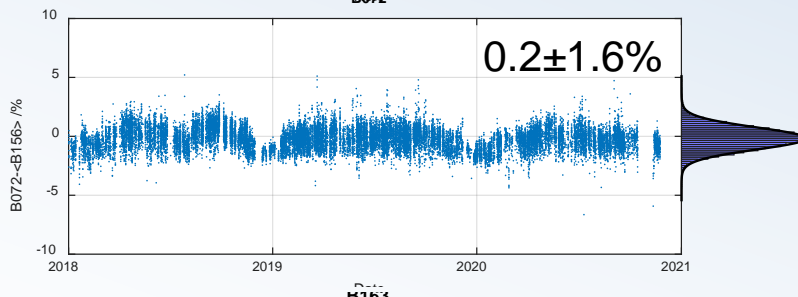
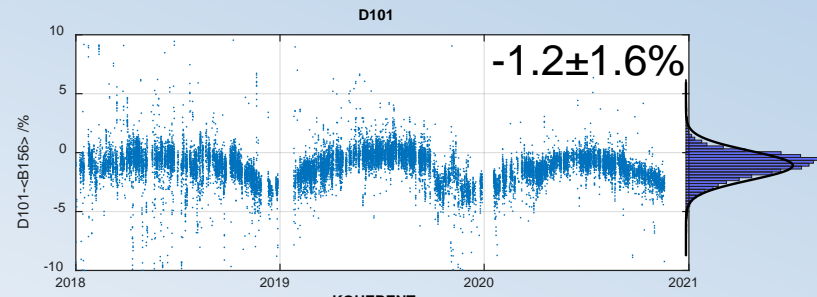
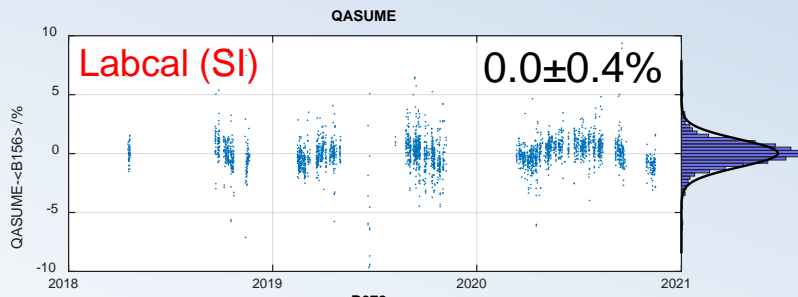


Pandora P120

10 Instruments: 4 Brewer, 3 Dobson, 3 Spectroradiometers

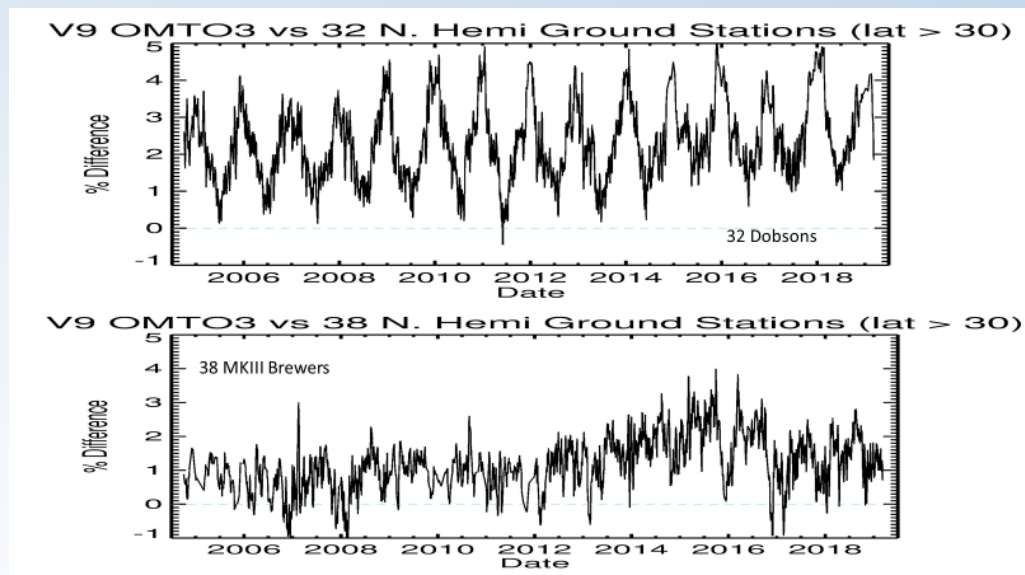
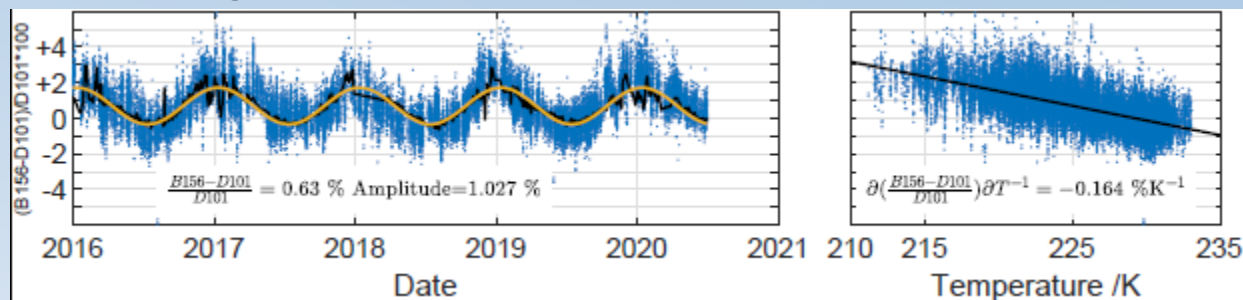


Total Column ozone measurements at PMOD/WRC



Finding consistency between Brewer and Dobson

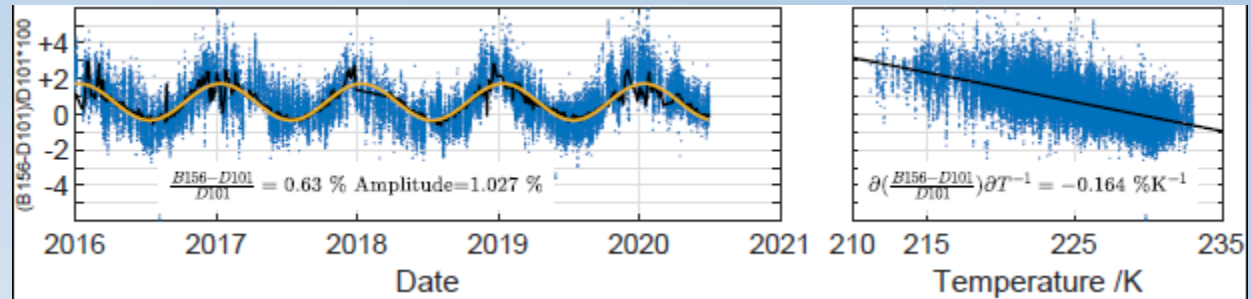
Using the operational methodology



From Gordon Labow, SAG O3UV, 2020

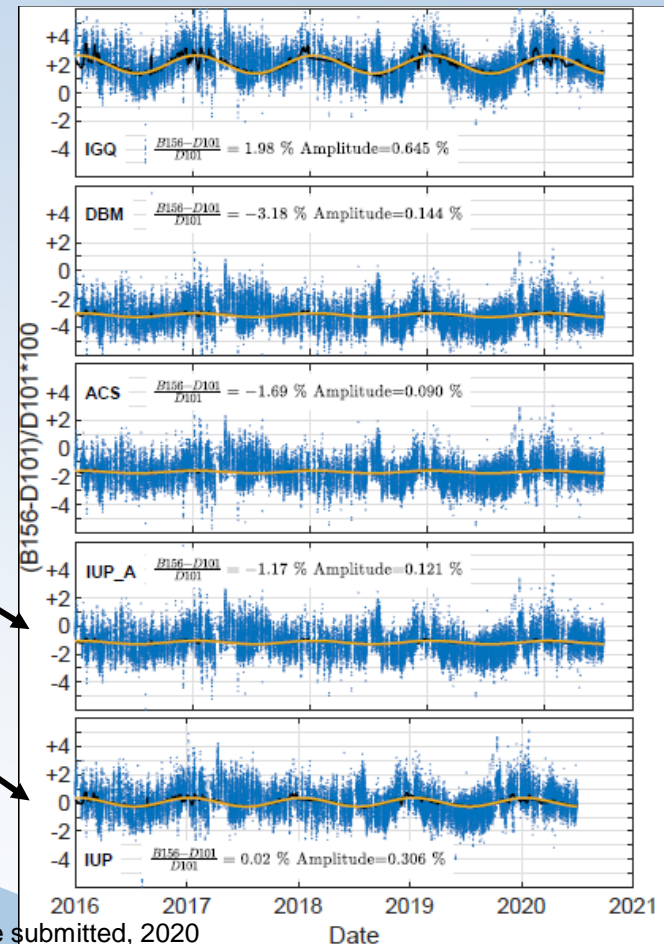
Finding consistency between Brewer and Dobson

Using the operational methodology



Reprocessing using:

- Ozone absorption cross-sections
 - Bass&Paur, 1985 (IGQ)
 - Daumont, Brion, Malicet, 1993 (DBM)
 - ESA SEOM-IAS, 2020 (ACS)
 - Univ. Bremen, 2017 (IUP_ATMOZ)
 - Univ. Bremen, 2013 (IUP)
- Effective ozone temperature
 - Ozone sondes
 - ECMWF reanalysis
- Measured slit functions of Brewer/Dobson
- Rayleigh scattering coefficients



AOD measurements at PMOD/WRC

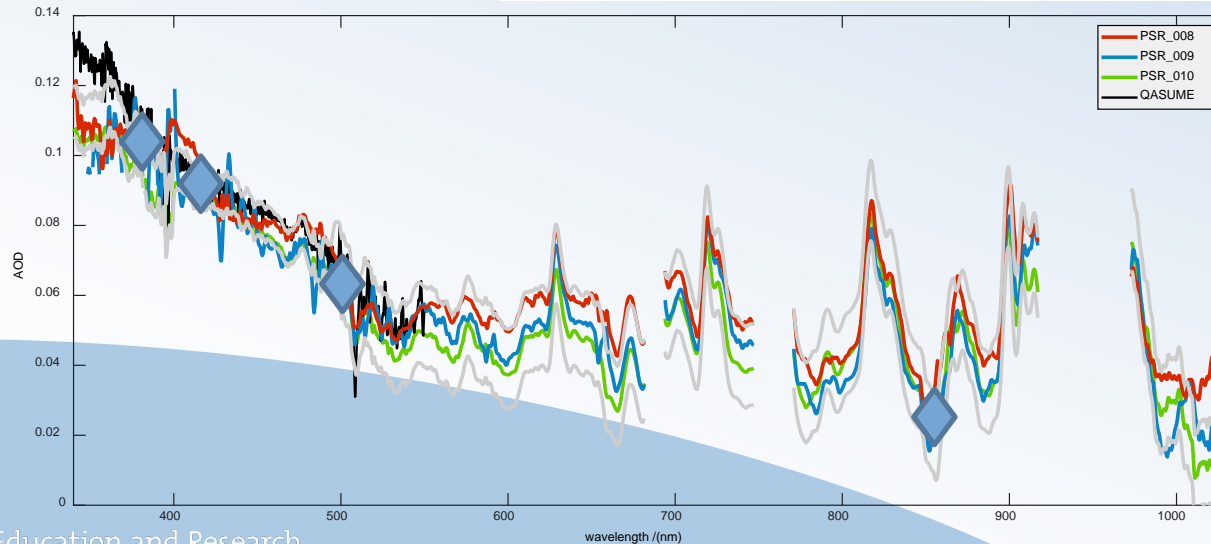


- PFR: 368, 412, 500, 862 nm
- CIMEL: 340, 380, 440, 500, 675, 870, 1020, 1640 nm
- PSR : 310 -1040 nm
- QASUME: 300-550 nm

Based on Langley cal

Traceable to SI

Spectral optical depth from filter radiometers and spectroradiometers



◆ PFR Wavelengths

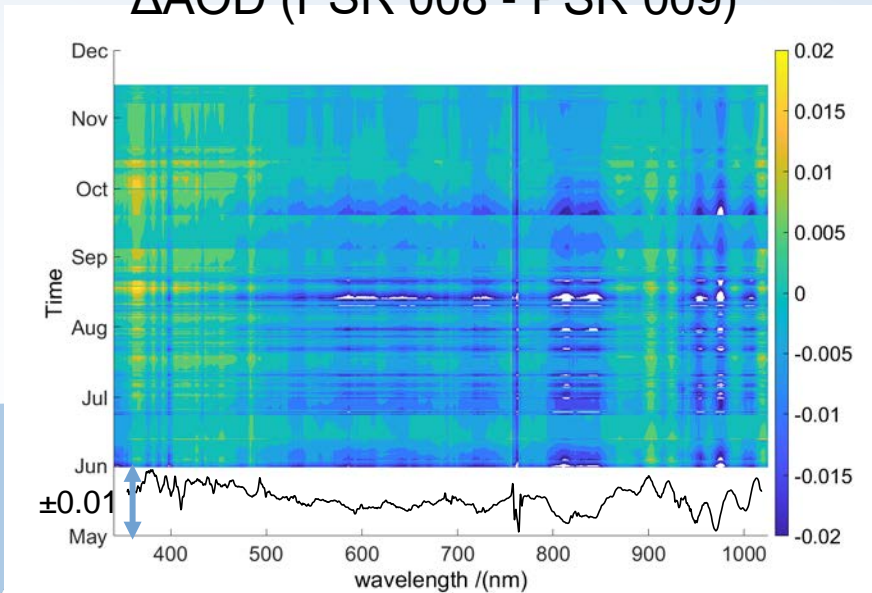
AOD measurements at PMOD/WRC

Performance of the PSRs during 2020



- PFR: 368, 412, 500, 862 nm
- CIMEL: 340, 380, 440, 500, 675, 870, 1020, 1640 nm
- PSR : 310 -1040 nm
- QASUME: 300-550 nm

Δ AOD (PSR 008 - PSR 009)

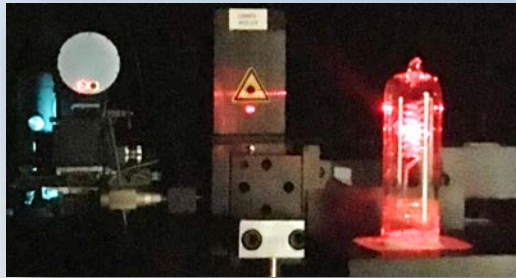


N=8008 (Nb. of spectra)
 MM Var(95%)=-0.0023±0.014

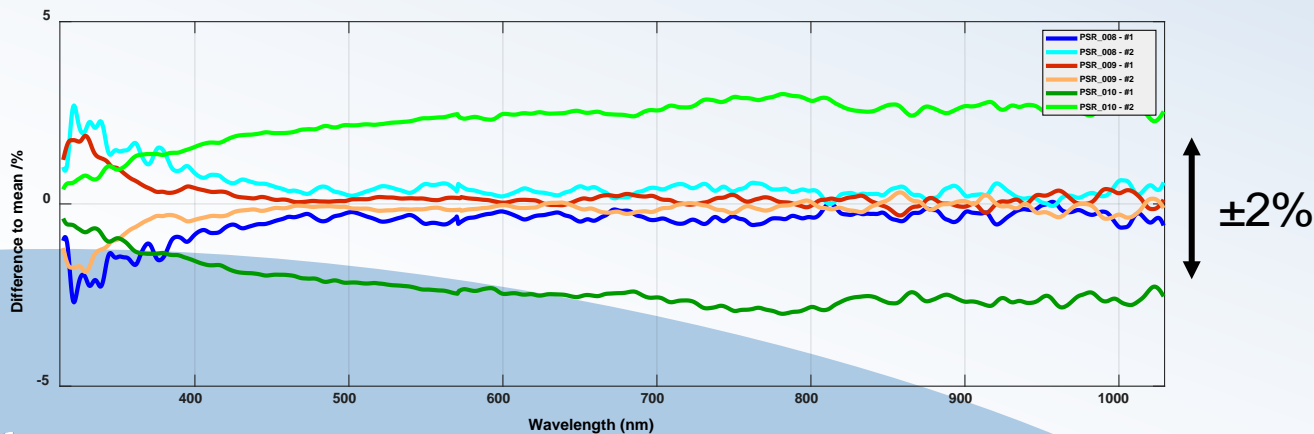
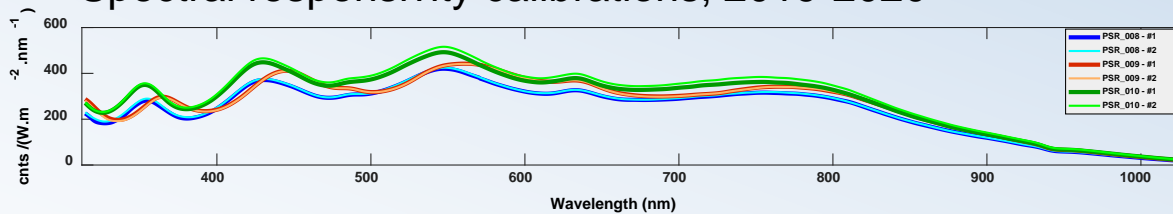
Aerosol optical depth @ 500 nm (PSR-PFR)		
	MEAN	STD
PSR 008	0.006	0.009
PSR 009	0.005	0.005
PSR 010	0.006	0.009

AOD measurements at PMOD/WRC

PSR AOD is based on laboratory calibrations



Spectral responsivity calibrations, 2019-2020



Characterisation and Calibration of filter radiometers

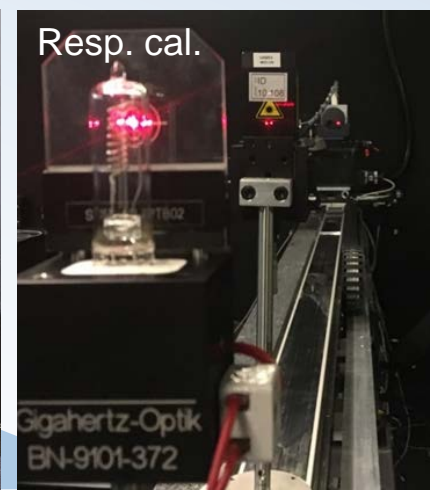
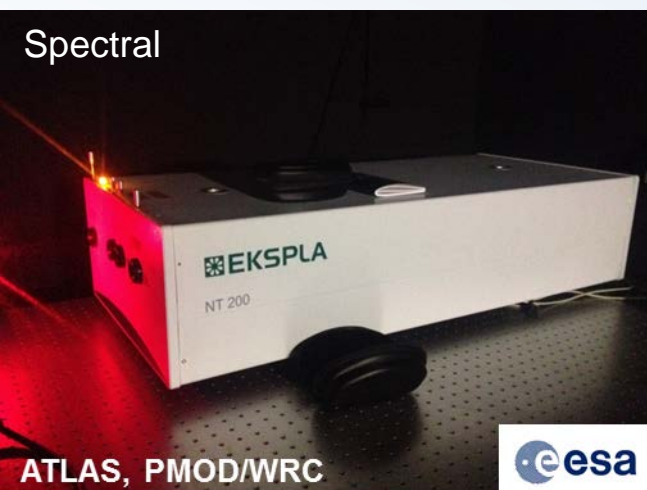
Collaboration with LOA

April-June 2020 Install a Precision Filter Radiometer at AERONET-EUROPE Calibration site OHP.

➔ Provide traceability of AERONET-EUROPE to WMO PFR Triad

Next activities:

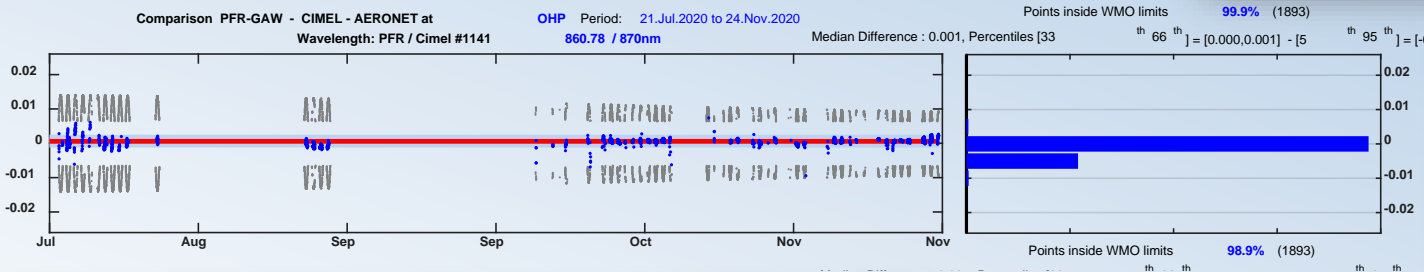
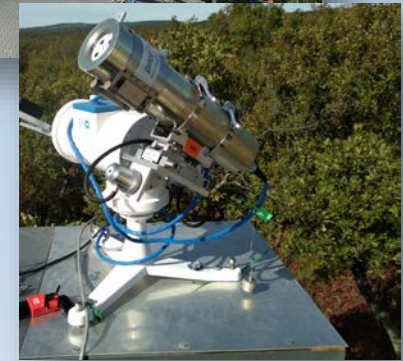
- Characterisation of CIMEL radiometer at PMOD/WRC
 - Waiting for new operating firmware from CIMEL (support to MAPP project)



COMPARISON CAMPAIGN AT OHP AERONET-EUROPE, WMO GAWPFR

The PFR instrument (PFR-98-N-014) was installed at the AERONET-Europe calibration site of OHP on 21 July 2020 to provide traceability to the WMO PFR Triad

<https://www.pmodwrc.ch/en/world-radiation-center-2/worcc/gaw-pfr/ohp/>



Data in realtime on the Internet:

Wavelength PFR/CIMEL in nm	AOD Difference			% in WMO limits
	median	5th prcntile	95th prcntile	
861/870	0.001	-0.001	0.002	99.9
500/500	0.005	0.001	0.008	98.9
411/440*	0.004	-0.001	0.010	97.9
367/380*	0.006	-0.003	0.011	90.4

*extrapolated with Angstrom exponent
Number of measurements = 1893

19ENV04 MAPP Metrology for aerosol optical properties

Providing SI-traceability to atmospheric remote sensing of aerosol optical properties.

Project objectives

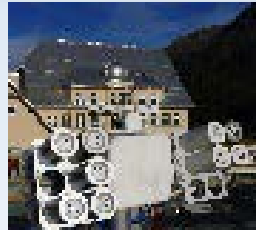
- Spectral irradiance and radiance calibrations in the spectral range 310 nm to 1700 nm with U=1%.
- Derive top-of-the-atmosphere solar and lunar spectra.
- Develop an uncertainty budget for columnar aerosol optical properties (ECVs) and assess its impact on radiative forcing of aerosols in Global Climate Models.
- Create impact by knowledge transfer, training, and uptake and exploitation.



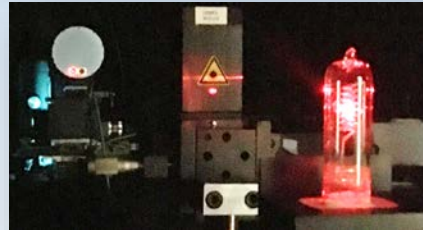
From field calibrations...



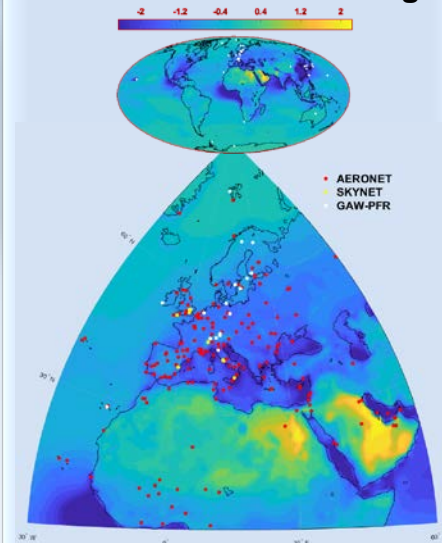
transfer



... to SI traceability



Aerosol radiative forcing



Based on CAMS reanalysis data.

- **Project coordination:** *pmod wrc* J. Gröbner
- **Duration:** 3 years, 2020/6 - 2023/6 Budget: 2.2 M€
- **Particip. Networks:** GAW-PFR, AERONET Europe, SkyNET Europe
- **Consortium:** 13 Partners 6 NMI/DI & 7 External partners

Outlook for 2021

- ❖ June RBCC-E OZONE Campaign at PMOD/WRC.
- ❖ September SORBETTO-2 Summer School, Rome.
- ❖ 28 Sep. - 16 Oct. FRC-V Filter Radiometer Comparison at PMOD/WRC.
 - ❖ Suggestion to perform AOD campaign with PSR & QASUME at PMOD/WRC during FRC-V due to COVID situation.
- ❖ Development of CIMEL firmware for operation of CIMEL radiometers in the laboratory.
 - CIMEL Filter radiometer calibration with traceability to SI.