20 years of Aerosol optical depth trends from the GAW-PFR network and collocated measurements with AERONET

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Multi-wavelength aerosol optical depth (AOD) has been defined as an essential climate variable for the Global Climate Observing System (GCOS) and the Global Atmosphere Watch (GAW) Program of the World Meteorological Organization. It is the most important parameter related to aerosol radiative forcing studies. PMOD/WRC have developed the Precision Filter Radiometer (PFR) that has been used for long term AOD measurements under a GAW-PFR Network of sun-photometers started in 1995 at Davos Switzerland and from 1999 at other locations, worldwide.

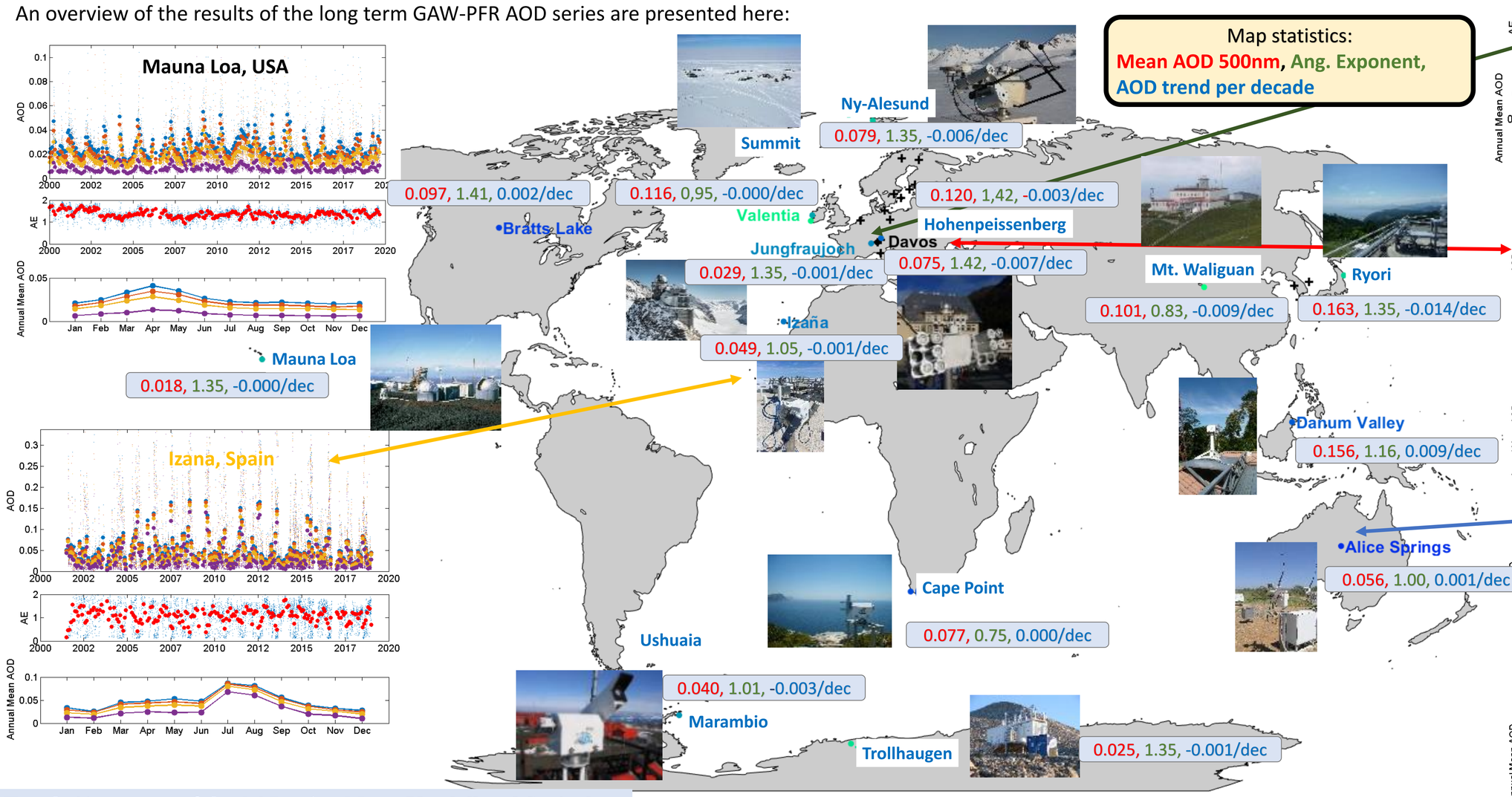
The World aerosol Optical Depth Research and Calibration Center (WORCC)

Based on a WMO resolution, the WORCC was established in 1996 at the PMOD/WRC in Davos, Switzerland. Two of the main goals of WORCC are :

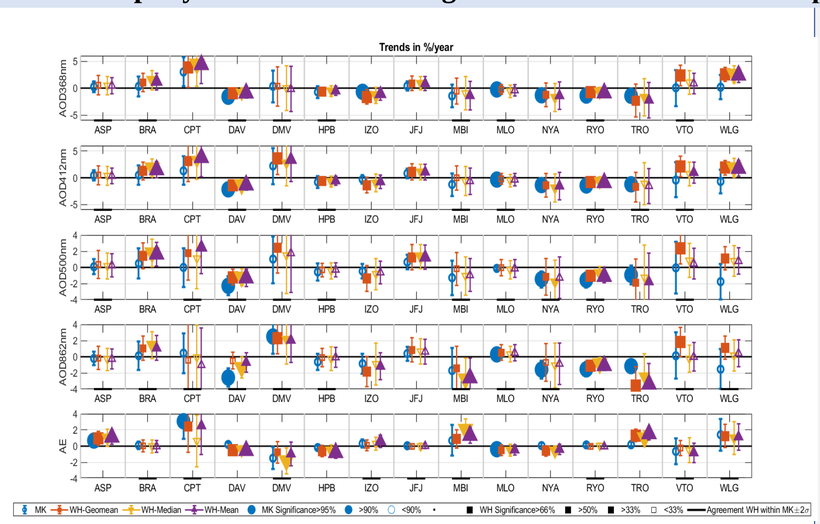
- to develop a radiometric reference for spectral radiometry to determine AOD

- to implement a long term AOD measuring network named GAW-PFR

The GAW-PFR network instruments calibration is based on a frequent comparison with a reference GAW-PFR Triad (3 PFR instr.) operating at Davos, Switzerland[1].
The reference AOD triad is stable within 0.5% (2σ) for the period 1995-2020.
In addition every five years WORCC organize the Filter Radiometer comparison that aims on the homogenization of all AOD global networks.
An overview of the results of the long term GAW-PFR AOD series are presented here:

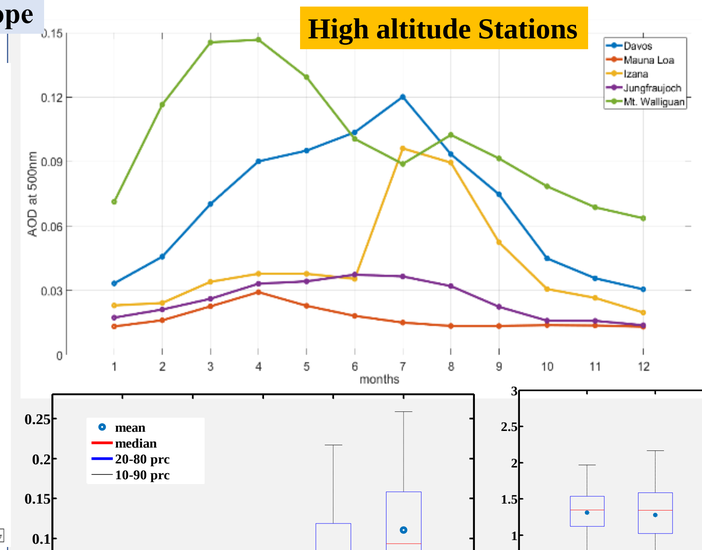


Trends % per year of the AOD using Mann-Kendall and Sen's slope



Trends in % per year for all stations. MK test (blue), WH test mean/median/geometrical mean (purple, yellow, red), filled large symbols stat. significant 95% (MK test), filed small symbols stat. significant 90% (MK test), filled squares stat. significant 33% (small),50% (moderate), 66% (large)(WH test).

High altitude Stations

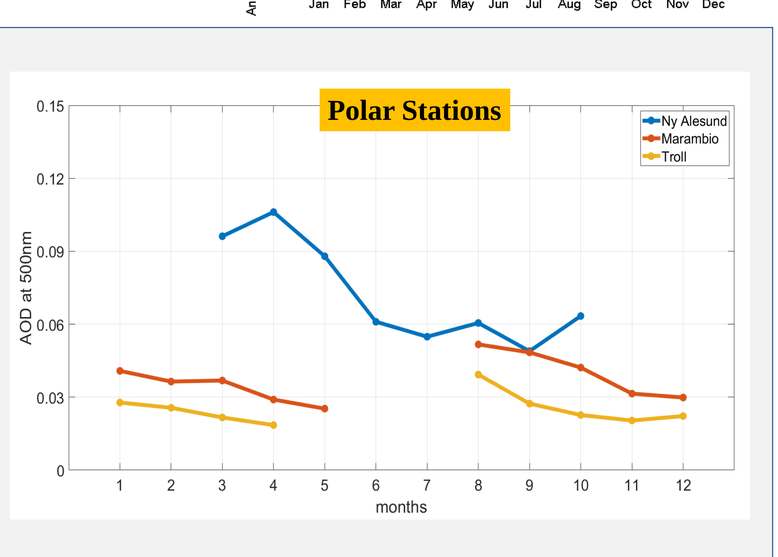


Intra-Annual monthly mean AOD500nm (left)/

AOD at 500 nm (down-right) and AE (down-right)
for 5 high altitude stations:

MLO - 3.4 Km
IZO - 2.3 Km
JFG - 3.5 Km
WLG - 3.8 Km
DAV - 1.6 Km

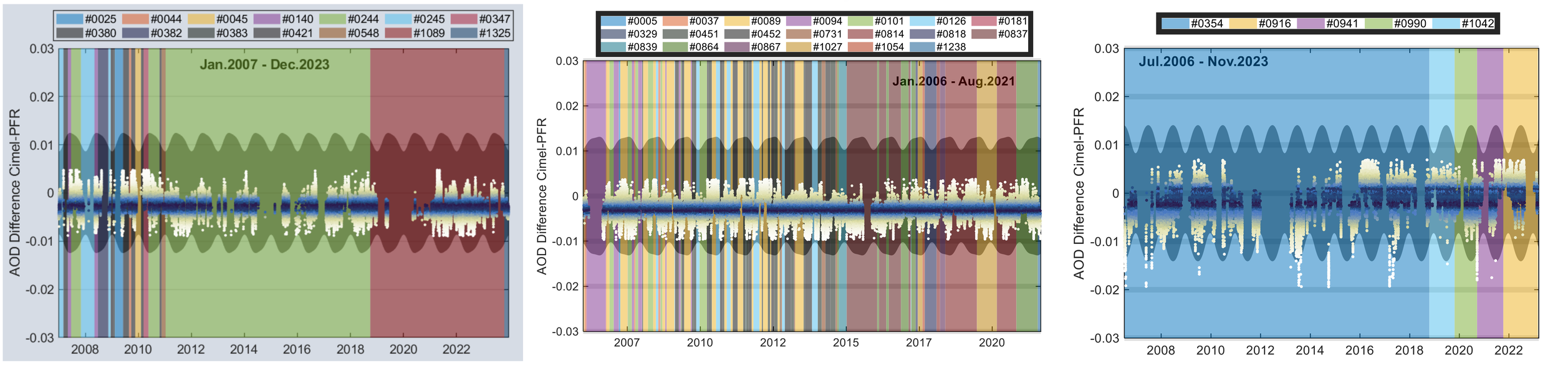
Polar Stations



Monthly long term average AOD at 500 nm over the three high-latitude stations.

Long term comparisons of AERONET and GAW-PFR

Figures: Long term comparisons of AOD at 500nm.
All comparisons are shown as CIMEL-PFR AODs. Shaded areas refer to the WMO limits for traceability and different shaded colors represent different CIMEL reference instruments operated at each of the stations. left (Izaña, Spain), middle (Mauna Loa, USA), Right (Davos, Switzerland).



Different colours represent different CIMEL instruments operating at the 3 sites.

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References:
Kazadzis, S., et al. : The WORCC quality assurance and quality control of GAW-PFR AOD measurements, Geosci. Instrum. Method. Data Syst., 7, 39-53, https://doi.org/10.5194/gi-7-39-2018.
Cuevas et al., Aerosol optical depth comparison between GAW-PFR and AERONET-Cimel radiometers from long-term (2005–2015) 1 min synchronous measurements, Atmos. Meas. Tech., 12, 4309–4337, https://doi.org/10.5194/amt-12-4309-2019, 2019
Karanikolas et al., Sensitivity of aerosol optical depth trends using long-term measurements of different sun photometers, Atmos. Meas. Tech., 15, 5667–5680, https://doi.org/10.5194/amt-15-5667-2022, 2022.

ACTRiS Centre for Aerosol Remote Sensing

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