Global variability of aerosol optical properties retrieved from the network of GAW near-surface observatories

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Rationale

Atmospheric aerosols are known to play a key role in Earth's radiative budget, although the quantification of their climate forcing is still **highly uncertain**. In order to improve the scientific understanding of their climatic effect, the scientific community needs **in-situ near-surface** aerosol properties observations providing **worldwide long term homogeneous data.**

This work is part of the SARGAN initiative (see main and companion abstracts), presents an assessment of variability in absorption, scattering and single scattering albedo from the in-situ aerosol Global Atmopsheric Watch (GAW) network.

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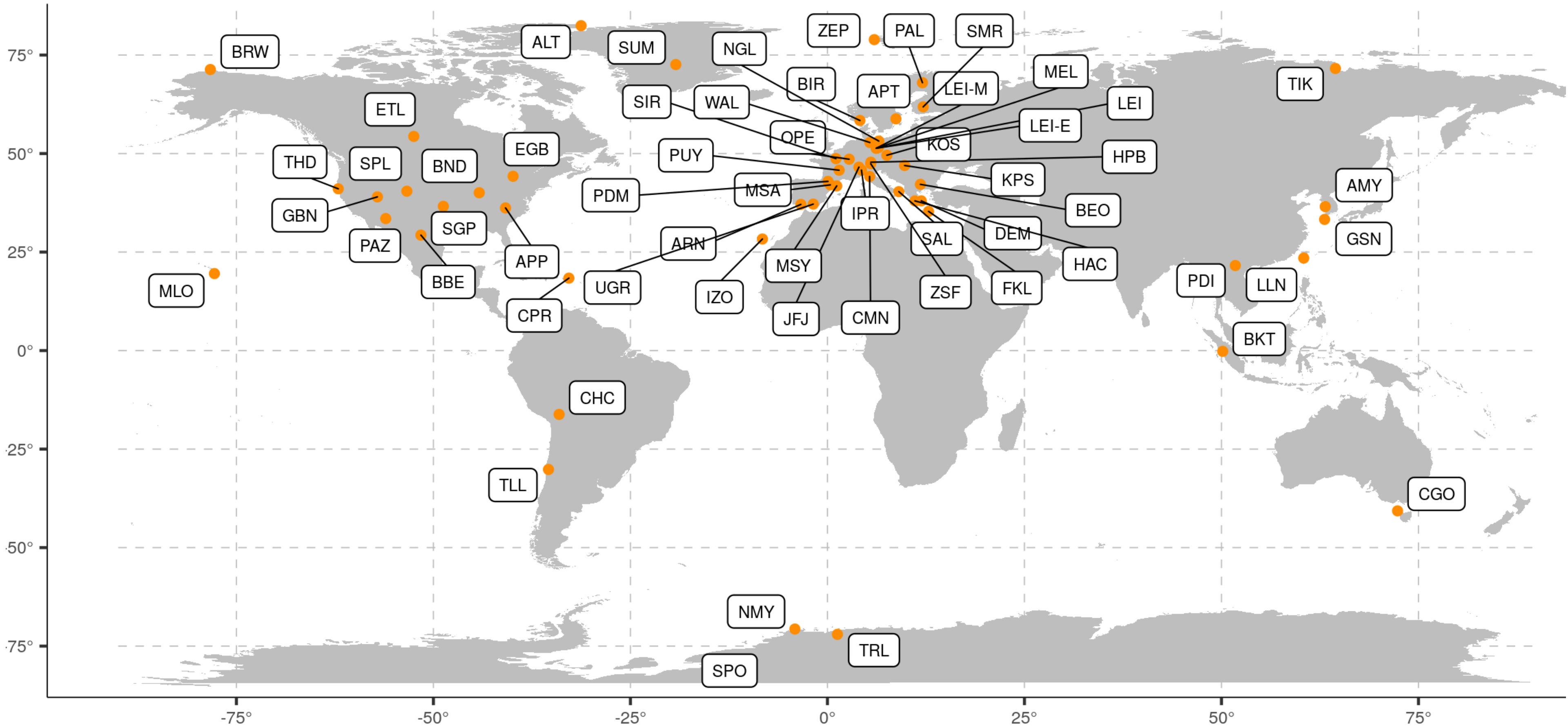
Goals and Methods

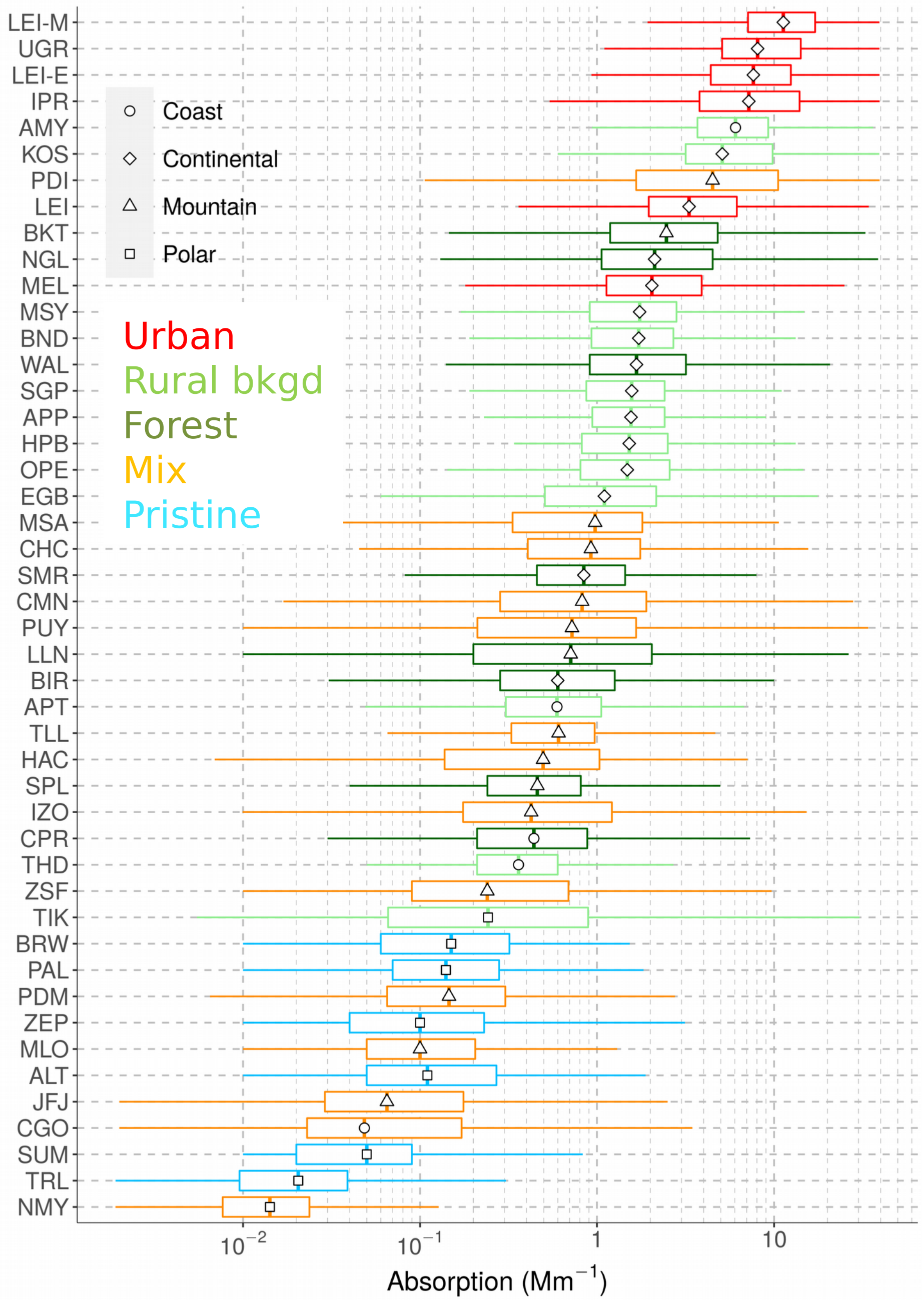
Investigate the spatial variability of aerosol optical properties based on in-situ near-surface worldwide harmonized measurements

- Analysis focussed on data for year 2017 proceeding from the **Global Atmosphere Watch (GAW) network** at
  - **53 sites** for particle light scattering coefficient (σ_{sp}) by integrating nephelometer
  - **55 sites** for particle light absorption coefficient (σ_{ap}) by filter absorption photometer
  - **31 sites** for single scattering albedo (ω_0)
- Light scattering for green wavelength was considered (550 nm or 525nm) at RH < 50%
- Light absorption for red wavelength was considered (637 nm, 653nm or 660nm)
- For each site, annual and seasonal statistics were computed and results were considered only if **75%** of the hourly data was available over the reference period (coverage constraint not applied to BRW, MLO and SPO)
- Results presented based on **site classification** as reported in Laj et al. (AMTD 2020), including both geographical and footprint criteria.

Spatial coverage of analysed sites



ABSORPTION VARIABILITY

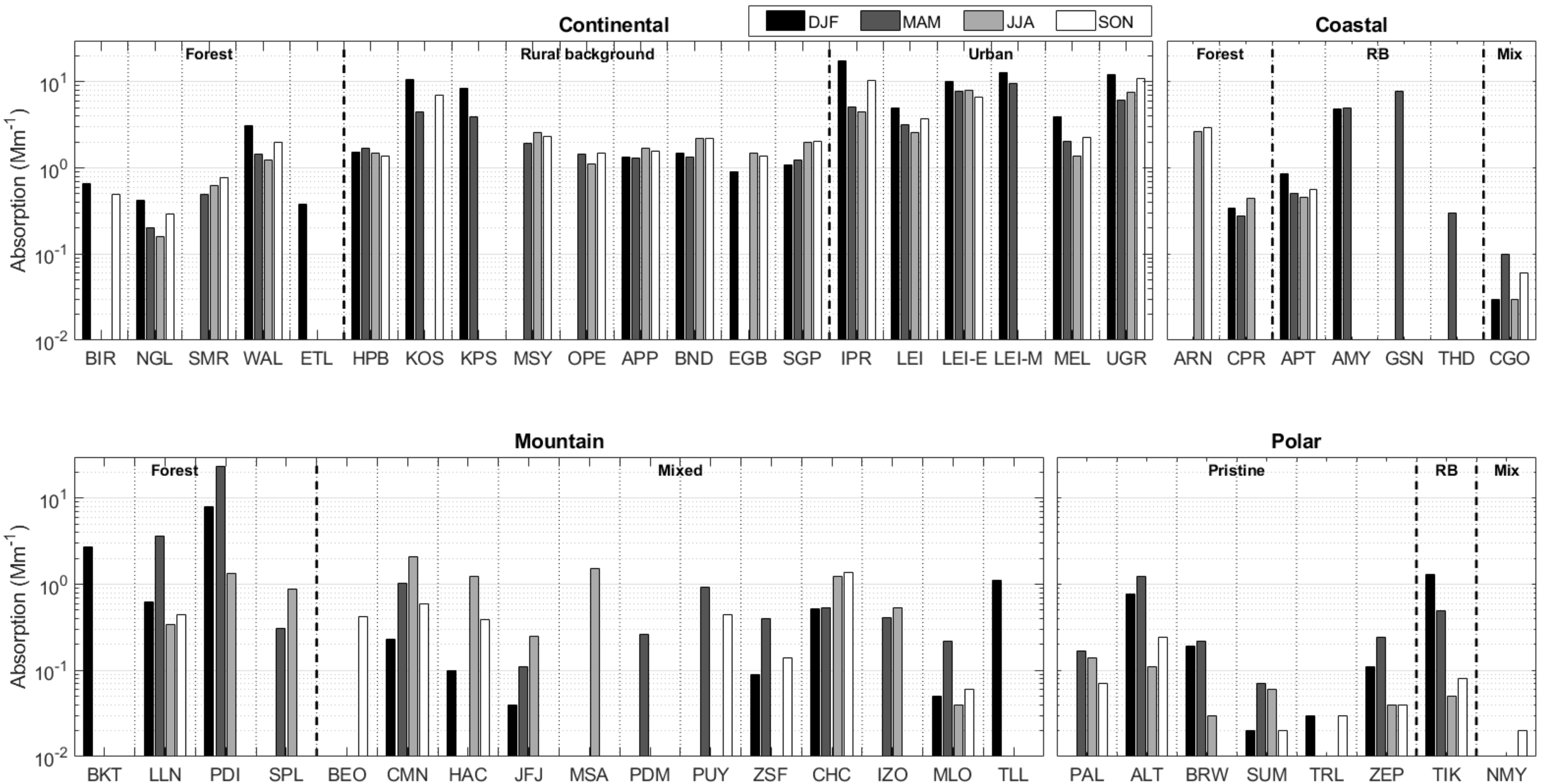


- several orders of magnitude in worldwide variability for σ_{ap}
- main drivers
  - latitude
  - geographic location/footprint
  - distance from main anthropogenic sources

- largest variability at mountain sites
- minimum variability at urban polluted sites (e.g. LEI, IPR)
- within the mid latitudes, increase from sites in rural/forest footprint towards those in mixed/urban
- polar sites, both in the Arctic and Antarctic, exhibits the lowest σ_{ap}
- second lowest σ_{ap} is at mountain sites, e.g. JFJ, ZSF and MLO + Pacific coastal background site of CGO.
- Significant impact of biomass burning at Asian sites AMY, BKT, LLN, PDI (SE Asia)

(Laj et al. AMTD 2020)

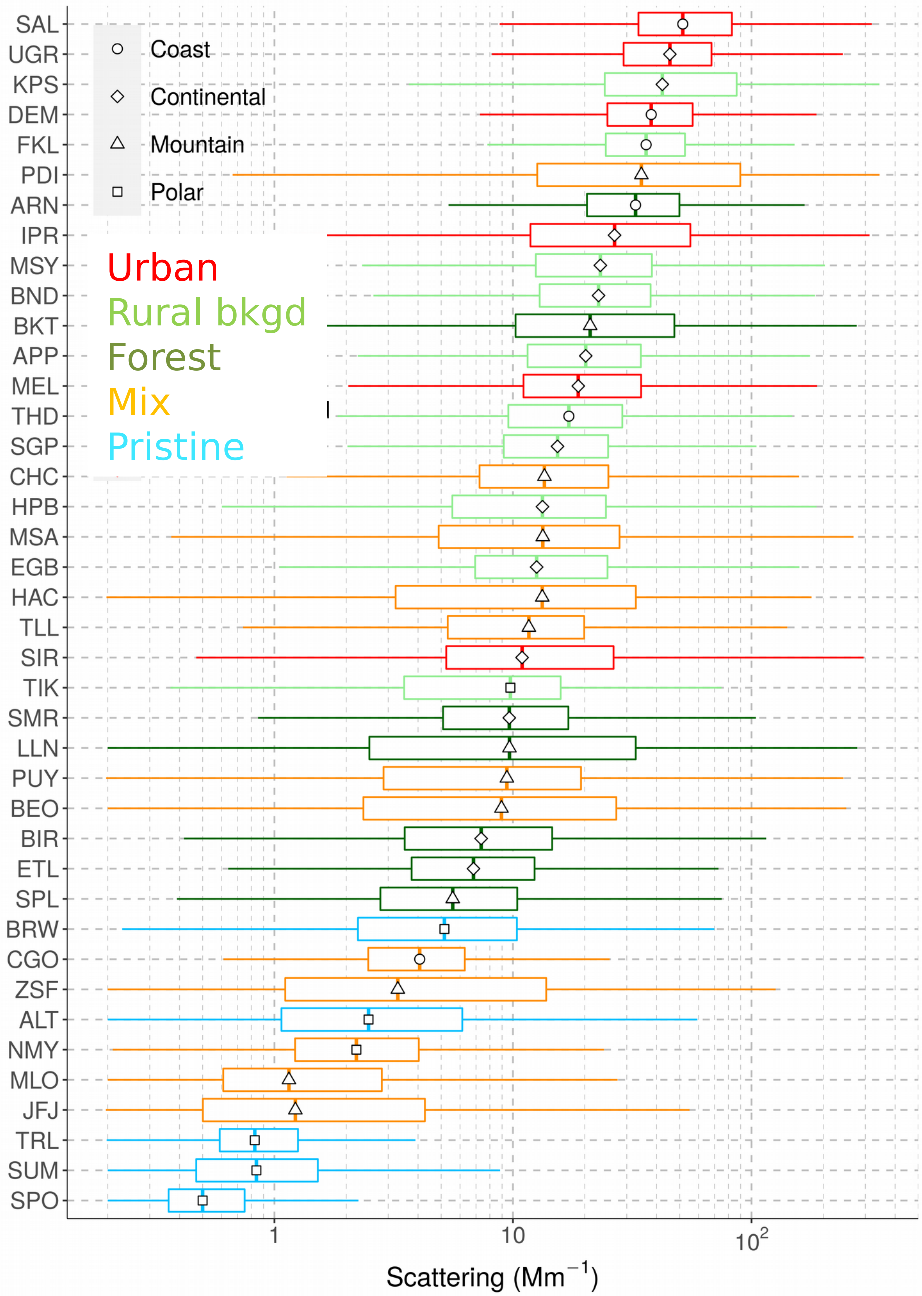
ABSORPTION SEASONALITY



- Seasonal variability much lower than yearly variability: transport is a key driver in variability
- At mountain sites the seasonality reflects the influence of boundary layer
- Largest seasonality at
  - urban sites (e.g. UGR, NOA, LEI-M)
  - sites with recurrent influence by transport of anthropogenic emissions (e.g. IPR, GSN)

(Laj et al. AMTD 2020)

SCATTERING VARIABILITY

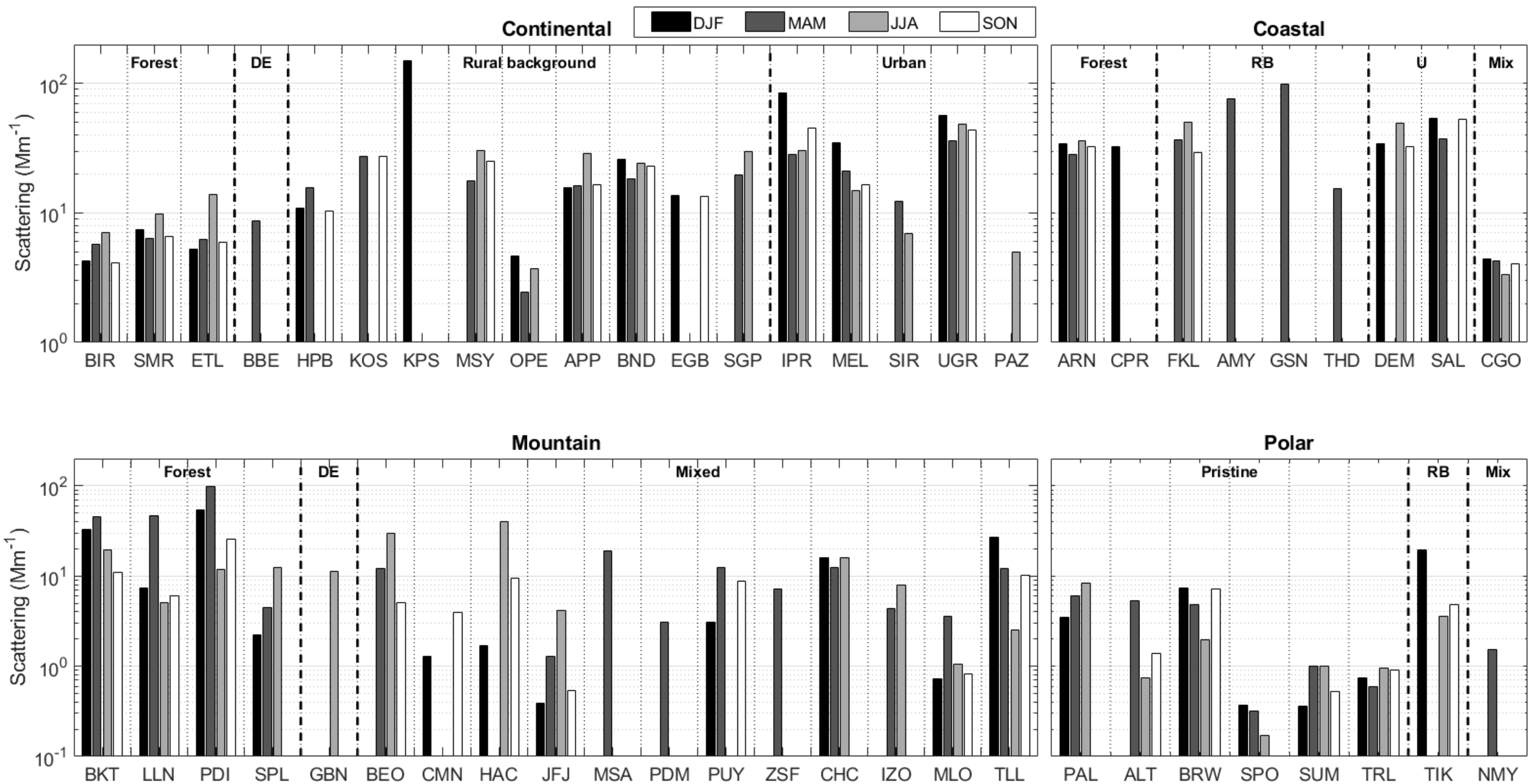


- Several orders of magnitude in worldwide variability
- Drivers similar to absorption
  - latitude
  - geographic location/footprint
  - distance from main anthropogenic sources

- large variability at cleaner sites, reflecting the contrasting transport, i.e. air masses from background areas and areas with larger emissions: seasonality/diurnal pattern in mountain sites, e.g. TIK the polar site with the largest median
- Significant impact of Saharan dust on variability at Mediterranean sites (e.g. DEM, FKL, SAL, UGR)
- JFJ (Switzerland) has median σ_{ap} and σ_{ap} lower than a few polar sites, i.e. ALT, BRW, PAL, ZEP

(Laj et al. AMTD 2020)

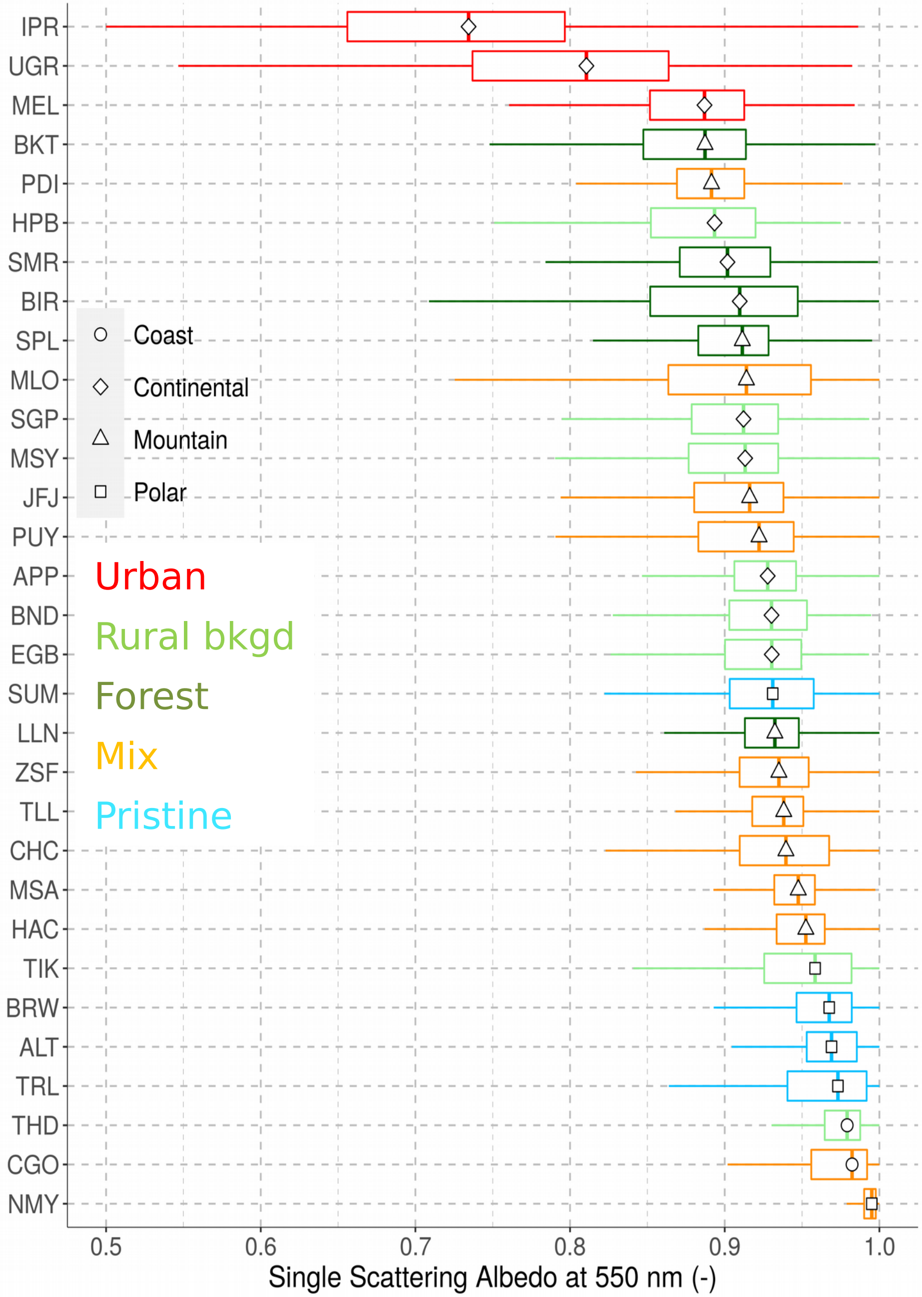
SCATTERING SEASONALITY



- Features similar to absorption
- seasonal variations evident at remote sites (ALT, TIK) due also to seasonality of air mass origin

(Laj et al. AMTD 2020)

SINGLE SCATTERING ALBEDO



- median ω_0 ranges [0.8, 1]
- highest ω_0 at coastal and polar sites clearly influenced by inorganic salts and sulfur-rich particles
- lowest ω_0 at IPR and UGR (Southern Europe) impacted by Saharan dust, biomass burning and local emissions

STUDY OUTLOOKS

- Variability in Angström Exponents
- Cluster analysis

(Laj et al. AMTD 2020)