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

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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, in-situ ground-based aerosol properties observations are needed by the research community. Such data would also allow the global assessment of the effect of environmental policies over both the short and the long term.

To develop a robust and consistent view over time of the worldwide variability of aerosol properties, data resulting from a fully-characterized value chain, including uncertainty estimation, is needed.

The present work is part of a wider project, having among its goals the investigation of the variability of climate-relevant aerosol properties observed at all sites connected to the Global Atmospheric Watch network, whose data are publicly available from the World Data Centre for

Aerosols and follow the aforementioned specifications.

This work focuses on aerosol optical proprieties, i.e. the aerosol light scattering coefficient (σ_{sp}), the aerosol light absorption coefficient (σ_{ap}), single scattering albedo (ω_o) and both scattering and absorption Ångström exponents ($å_{sp}$ and $å_{ap}$).

The analysis includes 108 yearly datasets collected either during 2016 or 2017 at different sites: 53 for absorption and 55 for scattering coefficient datasets, respectively. For 29 of these sites it was also possible to compute single scattering albedo.

The spatial variability in extensive and intensive optical properties was analysed in terms of each site's geographical location (either polar, continental, coastal or mountain) and its footprint (from pristine to urban, representing increasing levels of anthropogenic influence).

The results highlight the impact of anthropogenic emissions and biomass burning on absolute levels and annual variability. The effect of sea spray or long range transport of dust is also evident for several sites, along with the influence of regional emissions. The largest seasonality in aerosol loading was observed at mountain sites under mixed footprint conditions, while the lowest seasonality occurred at urban sites. Urban sites also exhibited the highest σsp and σap values. The lowest levels in σ_{sp} and σ_{ap} were observed at some polar sites, along with few coastal and mountain sites, despite their typically mixed footprint.

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