

## Representativity of AERONET observations of AOT and AAOT

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Every time atmospheric observations are used to evaluate models, or even compared against other observations, the question of observational representativeness arises. E.g., remotely sensed observations from the ground network AERONET are routinely used to evaluate global aerosol models. However, such observations are not possible during the night or under cloudy conditions. Even when they are possible, the AERONET sun photometer will observe a much smaller portion ( $\sim 5$  km horizontally) of the Earth's atmosphere than the gridbox of a global model ( $\sim 100$  km).

We use a new global high resolution ( $\sim 7$  km) simulation of the Earth's atmosphere (GEOS-5 Nature Run) to assess representativity of AERONET observations. Using these data, we simulate both global model data and AERONET observations and show that one of the most common protocols for model evaluation (using daily model data collocated to observations) allows for representation errors of more than 25 % in yearly Aerosol optical Thickness (AOT). Worse, we show that these representation errors are strongly correlated in space, e.g. all AERONET stations over northern Europe will show similar errors due to prevailing meteorological conditions.

Recently Wang et al. (GRL 2018) suggested that a globally systematic representation error might help explain why global models seem to underestimate Absorptive Aerosol Optical Thickness (AAOT), see Bond et al. 2013. However, we find no evidence for this in our dataset. We argue that the Wang et al. results are due to the construction of their high resolution dataset. We show that the GEOS-5 NR simulation itself compares favourably with real observations of AOT and AAOT.

This work is an extension of earlier work, which considered representativity in a few isolated regions on a monthly scale. The GEOS-5 NR simulation allows for the first time the analysis of representativity on a global and yearly scale.