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Impact of spatio-temporal sampling on the evaluation of models with observations

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Global models and observations differ strongly in their spatio-temporal sampling. First, Model results are typical of large gridboxes (100 km), while observations are made over much smaller areas (1 to 10 km). Second, model results are always available in contrast to observations that are intermittent due to sampling strategies, retrieval limitations and instrument failure/maintenance. We investigate the consequences of spatio-temporal sampling for the evaluation of models with observations and find them to be significant (differences up to 100% in monthly or yearly averages due to sampling alone).

Using high resolution WRF-Chem and EMEP simulations, we study the impact of evaluating low resolution global models with highly localised observations. Results suggest that significant differences due to the spatial aggregation alone will exist between models and observations, even after averaging data over e.g. a month. When using realistic observational sampling, these differences will be even bigger. Results depend on the concerned observable: a column-integrated property like AOT, easily advected by the flow, will exhibit smaller differences than a surface property like PM2.5, especially if that surface property shows little advection (e.g. number density). We explain these results qualitatively as a consequence of flow structure and aerosol source length-scales.

Furthermore, we show that proper temporal collocation of model data with the observations and further spatial aggregation of the observations can reduce (but not entirely remove!) these sampling-induced differences. We point out that even temporal collocation is by no means a standard procedure for researchers and often it is simply assumed that 'over time' issues due to sampling will average out (we show they will not).