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Comparison of ground-based remote sensing and in-situ observations of CO, CH_4 and O_3, accounting for representativeness uncertainty

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The EC project NORS (Demonstration Network Of ground-based Remote Sensing Observations in support of the GMES Atmospheric Service) aims at demonstrating the value of ground-based remote sensing data for quality assessment and improvement of the GMES products. As part of NORS CO, CH_4, O_3 and NO_2 tropospheric products as obtained by ground-based remote sensing within the Network for the Detection of Atmospheric Composition Change (NDACC) are compared to continuous surface in-situ measurements that are reported on common international reference scales within the Global Atmospheric Watch (GAW) Programme. However, a direct comparison between the different methods is hindered by different sampling volumes, introducing uncertainties due to representativeness.

Here we present a novel method that utilises high-resolution, backward Lagrangian particle dispersion modelling to characterise the transport history of different sampling volumes. Sampling volumes are defined as infinitesimally small point volumes for the in-situ observations and as separate profile segments with horizontal and vertical extent for the remote sensing observations. The characterisation is then used (a) to filter times for which a direct comparison between in-situ and remote sensing data is unfavourable (large representativeness uncertainty) and (b) to construct vertical profiles from the in-situ observations, taking additional information from large scale atmospheric composition models into account. These so called "in-situ" profiles are supposed to be more comparable to the remote sensing profile as the surface value itself, while conserving the high accuracy information of the latter and projecting it onto the profile. Therefore, these profiles allow for a more direct comparison and validation of the remotely sensed profiles.

The technique was first applied at two of the four NORS demonstration sites (Jungfraujoch, Switzerland and Izana, Spain) and to the comparison of remote sensing Fourier-transform infrared spectrometer (FTIR) measurements of CO, CH_4, and O_3 with the responding in-situ observations. While previous studies generally showed good agreement between the two kinds of observation, considerable amounts of scatter were evident. Selecting only situations with relatively small representativeness uncertainty reduces this scatter. Folding the "in-situ" profiles with the averaging kernels of the FTIR retrieval gives a more realistic comparison result that is not influenced by any a-priori assumptions. Results are also discussed with respect to season, time of day and weather type