Parametrized observation operators and their application on illustrative 3D atmospheric chemical fields

T. Verhoelst (presenting); J.-C. Lambert; S. Vandenbussche

Belgian Institute for Space Aeronomy, Brussels, Belgium

The continuous enhancement of the resolution of atmospheric data assimilation systems poses new challenges for the ingestion of satellite observations which, in such systems, constrain the output of a chemical transport model. The common assumption that the information contributed by the satellite observation comes from the column over the ground footprint (for nadir sounders) or from the tangent point (for limb sounders), often lacks accuracy. Due to radiative transfer effects combining with scanning and orbital properties of the sounder, remote sensing by spectroscopic techniques yields only a smoothed perception of the atmospheric field. Horizontal smoothing properties can be characterised by the spread of the measured information and its geographic offset with respect to the footprint or tangent point. In some cases both the spread and the offset can be larger than the spatial resolution of the assimilation system. In such a situation, the classic observation operator consisting of a linear interpolation of the model at the footprint or tangent point may lead to non-negligible noise and bias.

In recent years we have developed parameterised observation operators for nadir, limb, and solar occultation satellite data. Here we use these operators on illustrative atmospheric fields to quantify the noise and bias introduced in model-observation comparisons when neglecting the actual sensitivity, spread and offset. We show that in the framework of data comparisons, like in data assimilation, scatter and bias can be reduced significantly when adjusting co-location criteria using the appropriate observation operators. With the drastic reduction in observational constraints for data assimilation anticipated in the 2nd half of this decade, and with the increased use of tracer-tracer correlations which also depend on co-location assumptions, the use of pragmatic observation operators at low computational cost in model-observation comparisons may be equally beneficial.