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Validation of trajectory statistical methods

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The statistical analysis of a great number of back trajectories from receptor sites has turned out to be a valuable tool to identify sources and sinks of atmospheric trace substances or to reconstruct their average spatial distribution. Up to now a number of works have been trying to validate various trajectory statistical methods (TSMs), mostly through subjective comparison with known sources. Here in a more comprehensive and quantitative approach 3 trajectory statistical methods (potential source contribution function, PSCF, concentration field method, CF and redistributed concentration field method, RCF) were subjected to 2 validation approaches: validation with virtual sources under idealised conditions, where the effects of dispersion and removal of the trace substance are excluded, and comparisons with the EMEP SO_2 emission inventory under realistic conditions.

The ideal and real world experiments span a range between 2 brackets of extreme cases. A theoretically maximum possible performance was achieved in an idealised situation with about 78% common spatial variance between the EMEP emission inventory and the trajectory statistical reconstruction of the EMEP emission inventory with the RCF method at a spatial coverage of 90%, whereas the real world experiments for SO_2 on an European scale resulted in a much lower performance with 33% common spatial variance between the EMEP emission inventory and the trajectory statistical reconstruction with the PSCF method at a spatial coverage of about 68%.

The experiments reported in the discussion section suggest that the limitation of the accuracy and spatial extent of TSMs are rooted in the simplified transport process described just by trajectory paths. If one links these limitations with the concept of the mean residence time of the considered trace substance, temporal and spatial brackets can be deduced, within which the effect of the simplification of the transport process is restricted and useful information can be expected from TSMs. The lower numbers

of the mean residence time for SO_2 were deduced from the decay approach of the discussion section and range from 9 to 17 hours, whereas the numbers derived from the optimum real world validation experiment place the upper bracket of the mean residence time to about 60 +- 6 hours or 2.5 days. Both figures move within the range of mean residence times for SO_2 cited in literature. Through the validation experiments of this work the rule of thumb, not to trust TSMs beyond the mean residence time of the substance, has become palpable. From the above work we conclude that TSMs and related methods are computationally fast procedures, which deliver first hints on potential source areas, if applied within the frame of the mean residence time of the considered substance.