Singular vector based uncertainties of initial values and emissions for the ZEPTER-2 campaign

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Measurements of the earth's environment provide only sparse snapshots of the state of the system due to their insufficient temporal and spatial density. In face of these limitations, the measurement configurations need to be optimized to get a best possible state estimate. One possibility to optimize the state estimate is provided by targeted observations of sensitive system states, where measurements are of great value for forecast improvements.

In the recent years, numerical weather prediction adapted singular vector analysis with respect to initial values as a novel method to identify sensitive locations. In the present work, this technique was transferred from meteorological to chemical forecast. Besides initial values, emissions were introduced as controlling variables. Since time-variant amounts of emissions continuously act on the chemical evolution, targeting observations of emissions is a challenging task. Alternatively, uncertainties in the amplitude of the diurnal profile of emissions are analyzed, yielding emission factors as target variables.

The concept of adaptive observations was implemented in a chemical transport model to determine ranking lists of measurement priorities for different compounds as well as optimal placements of measurements. Results show large differences in sensitivities of different compounds. Consequently, an optimal measurement configuration benefits from omitting measurements of compounds of low sensitivity. It is demonstrated how targeted observations of chemical compounds depend on the considered simulation interval, meteorological conditions, and the underlying chemical composition. Accomplished studies identify visible differences between meteorological and chemical target areas. These differences reveal the importance of the chemical composition and underline the significance of chemical singular vectors for effective campaign planing.