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Multi-instrumental data analysis of satellite tracer observations: challenges and perspectives

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This paper examines possible scenarios for analysis of multi-instrumental satellite observations in the chemical weather studies. The combination of nadir-viewing horizontally dense data (radiances and retrievals), limb-viewing retrievals from research satellites, and in-situ constituent data will be considered to characterize the biases of retrievals reported by different instruments. The analyzed differences in the retrieved profiles and partial columns (for example, MOPITT, TES and AIRS CO data) currently present the main issue for the multi-instrumental assimilation of constituents and inverse estimation of their surface emissions. This paper highlights that the scale-consistent projections of information between the forecast space (tracer concentrations) and the observation space (measured radiances) will be a key element for optimal use of the primary satellite data (radiances) from flying nadir-viewing sensors. Challenge to assimilate the rank-deficient retrieved tracer profiles (CO and O3) with a priori deviated significantly from the “today” constituent forecast will be discussed. The sequential three-step source-state estimation schemes for assimilation of tracers will be outlined to achieve unbiased analysis of chemical constituents in the presence of systematic model biases related to misspecification of surface emissions.