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Assimilation of ENVISAT stratospheric trace gas observations into the new SACADA global chemistry circulation model

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Due to satellite data from space borne platforms such as ENVISAT and others the number of available observations of stratospheric trace gases has increased rapidly in recent years. To make optimal use of this data, that is scattered in time and space and that originates from different sensors, a data assimilation system with the ability to produce chemical consistent synoptic charts of stratospheric constituents is needed. Advanced spatio-temporal data assimilation methods provide a powerful technique to combine observations, statistical information, and three-dimensional chemistry circulation models delivering a "Best Linear Unbiased Estimate" (BLUE) of the stratosphere's chemical state.

A four-dimensional variational (4D-var) data assimilation system intended for operational application is being developed by the AFO-2000 project consortium SACADA. Kernel of this new system is a novel stratospheric global chemistry circulation model (GCCM) and its adjoint version. The German Weather Service global forecast model (GME) serves as an online meteorological driver for the GCCM, its icosahedral grid structure, the horizontal transport and the parallelisation strategy are adopted from GME. The stratospheric chemistry module accounts for 148 gas phase and 7 heterogenous reactions between 43 stratospheric constituents.

By application of the new system to ENVISAT stratospheric trace gas data, it can be shown that the assimilation procedure gains a considerable improvement over legacy model runs, as the discrepancies between observations and the model are significantly reduced, while chemical consistency is maintained by the computationally costly, but

efficient 4D var technique. At the same time it is possible to improve the knowledge of species which are not directly observed, as can be shown by means of experiments with artificially generated data sets or by excluding some observational data from the assimilation procedure for later validation of the analysis. A careful analysis of the systems performance with respect to the statistical quantities (errors and error-covariances) involved has been conducted to test the consistency with the assumptions of the underlying data assimilation theory. As will be demonstrated the numerical concept of the system -namely the icosahedral grid and the parallelisation that are adopted from GME- results in considerable efficency gain compared to systems of conventional design.