Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 9, 1883-1897, 2009
www.atmos-chem-phys.net/9/1883/2009/

A self-adapting and altitude-dependent regularization method for atmospheric profile retrievals

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Abstract. MIPAS is a Fourier transform spectrometer, operating onboard of the ENVISAT satellite since July 2002. The online retrieval algorithm produces geolocated profiles of temperature and of volume mixing ratios of six key atmospheric constituents: H_2O, O_3, HNO_3, CH_4, N_2O and NO_2. In the validation phase, oscillations beyond the error bars were observed in several profiles, particularly in CH_4 and N_2O.

To tackle this problem, a Tikhonov regularization scheme has been implemented in the retrieval algorithm. The applied regularization is however rather weak in order to preserve the vertical resolution of the profiles.

In this paper we present a self-adapting and altitude-dependent regularization approach that detects whether the analyzed observations contain information about small-scale profile features, and determines the strength of the regularization accordingly. The objective of the method is to smooth out artificial oscillations as much as possible, while preserving the fine detail features of the profile when related information is detected in the observations.

The proposed method is checked for self consistency, its performance is tested on MIPAS observations and compared with that of some other regularization schemes available in the literature. In all the considered cases the proposed scheme achieves a good performance, thanks to its altitude dependence and to the constraints employed, which are specific of the inversion problem under consideration. The proposed method is generally applicable to iterative Gauss-Newton algorithms for the retrieval of vertical distribution profiles from atmospheric remote sounding measurements.

Final Revised Paper (PDF, 525 KB) Discussion Paper (ACPD)

Citation: Ridolfi, M. and Sgheri, L.: A self-adapting and altitude-dependent regularization method for atmospheric profile retrievals, Atmos. Chem. Phys., 9, 1883-1897, 2009. Bibtex EndNote Reference Manager