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Elimination of hidden a priori information from remotely sensed profile data

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Abstract. Profiles of atmospheric state variables retrieved from remote measurements often contain a priori information which causes complication in the statistical use of data and in the comparison with other measured or modeled data. For such applications it often is desirable to remove the a priori information from the data product. If the retrieval involves an ill-posed inversion problem, formal removal of the a priori information requires resampling of the data on a coarser grid, which in some sense, however, is a prior constraint in itself. The fact that the trace of the averaging kernel matrix of a retrieval is equivalent to the number of degrees of freedom of the retrieval is used to define an appropriate information-centered representation of the data where each data point represents one degree of freedom. Since regridding implies further degradation of the data and thus causes additional loss of information, a re-regularization scheme has been developed which allows resampling without additional loss of information. For a typical ClONO₂ profile retrieved from spectra as measured by the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS), the constrained retrieval has 9.7 degrees of freedom. After application of the proposed transformation to a coarser information-centered altitude grid, there are exactly 9 degrees of freedom left, and the averaging kernel on the coarse grid is unity. Pure resampling on the information-centered grid without re-regularization would reduce the degrees of freedom to 7.1 (6.7) for a staircase (triangular) representation scheme.

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