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Importance of interpolation and coincidence errors in data fusion

Simone Ceccherini (1), Bruno Carli (1), Cecilia Tirelli (1), Nicola Zoppetti (1), Samuele Del Bianco (1), Ugo Cortesi (1), Jukka Kujanpää (2), and Rossana Dragani (3)

(1) Istituto di Fisica Applicata “Nello Carrara” del Consiglio Nazionale delle Ricerche, Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy, (2) Finnish Meteorological Institute, Earth Observation Unit, P.O. Box 503, FI-00101 Helsinki, Finland, (3) European Centre for Medium-Range Weather Forecasts, Shinfield Park, Reading, RG2 9AX, United Kingdom

Many remote sensing observations of vertical profiles of atmospheric variables are obtained with instruments operating on space-borne and airborne platforms, as well as from ground-based stations. Recently, the Complete Data Fusion (CDF) method was proposed for use in the combination of independent measurements of the same profile in order to exploit all the available information and obtain a comprehensive and concise description of the atmospheric state. This is an a posteriori method that uses standard retrieval products. With simple implementation requirements, the CDF products are equivalent to those of the simultaneous retrieval, considered to be the most comprehensive way of exploiting different observations of the same quantity.
We apply the CDF method to ozone profiles obtained from simulated measurements in the ultraviolet and in the thermal infrared in the framework of the Sentinel 4 mission of the Copernicus programme. We observe that the quality of the fused products is degraded when the fusing profiles are either retrieved on different vertical grids or referred to different true profiles. To address this shortcoming, a generalization of the complete data fusion method, which takes into account interpolation and coincidence errors, is presented. This upgrade overcomes the encountered problems and provides products of good quality when the fusing profiles are both retrieved on different vertical grids and referred to different true profiles. The impact of the interpolation and coincidence errors on number of degrees of freedom and errors of the fused profile is also analyzed. The approach developed to account for the interpolation and coincidence errors can also be followed to include other error components, such as forward model errors.