Efficient Exploitation of the Information Content of Cloud-Affected IASI Radiances using an Ensemble of Data Assimilations

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The wealth of observations acquired by satellite-borne instruments is such that they provide the great majority of all data that are currently assimilated at operational meteorological centres. Whilst satellite data has a large and important impact on forecast skill there are still many observations not being used to constrain the model's forecast, owing to the difficulty of modelling every aspect (e.g. clouds, surface reflection) with sufficient accuracy. Particularly challenging is to simulate observations affected by water in its different phases, as the simulations critically depend on processes that are not always explicitly represented by the numerical weather prediction model (e.g., convection) or by the radiative transfer model (e.g., scattering).
Recent studies [1] [2] concerning the assimilation of remote sounding observations in the infrared when clouds are present in the instrument's field of view, confirm the findings of earlier investigations (e.g., [3] [4]) and show that the assimilation of a subset of the sounding channels assimilated in clear-sky conditions can reduce the mean analysis errors of the atmospheric temperature and water vapour profiles. There is also evidence of error reduction on cloud condensate variables [5].

These results provide a motivation to carry out a detailed investigation of the informative potential of high-spectral resolution infrared sounders in the presence of cloud and to assess possible implications on channel selection strategy. In this talk we will discuss the results of our work on quantification of the information content of all 8461 channels of the Infrared Atmospheric Sounding Interferometer (IASI) using the "scattering parametrization" configuration in RTTOV to account for cloud radiative effects. A case study during summer 2012 was considered and 11 "ensemble of data assimilations" (EDA) ECMWF forecast members over 137 model levels provided the short-range forecast ensemble used to simulate the emerging radiation from the atmosphere in all IASI channels over the whole globe. First, the information content in observation space was calculated, paying particular attention to the choice of the observation error covariance matrix as well as pre-screening strategies. Then, the analysis error reduction potential of the IASI radiance observations was evaluated both along the dry and the cloud-related components of the state vector using either the forecast ensemble or a full-rank "climatological" error covariance matrix. Finally, implications of our work on the operational 4DVAR assimilation of infrared sounders at ECMWF will be discussed.

References

[1] C. Prates, S. Migliorini, S. English and Ed Pavelin. "Assimilation of satellite infrared sounding measurements in the presence of clouds," *Q. J. R. Meteorol. Soc.*, 2013, under revision.

[2] M. Stengel, M. Lindskog, P. Undén and N. Gustafsson. "The impact of cloud-affected IR radiances on forecast accuracy of a limited-area NWP model," *Q. J. R. Meteorol. Soc.*, 2013, doi:10.1002/qj.2012.

[3] E. G. Pavelin, S. J. English and J. R. Eyre, "The assimilation of cloud-affected infrared satellite radiances for numerical weather prediction". *Q. J. R. Meteorol. Soc.*, 134: 737–749, 2008. doi: 10.1002/qj.243

[4] A. P. McNally. "The direct assimilation of cloud-affected satellite infrared radiances in the ECMWF 4D-Var". *Q. J. R. Meteorol. Soc.*, 135: 1214–1229, 2009. doi: 10.1002/qj.426

[5] P. Martinet, N. Fourrié, V. Guidard, F. Rabier, T. Montmerle and P. Brunel. "Towards the use of microphysical variables for the assimilation of cloud-affected infrared radiances". *Q. J. R. Meteorol. Soc.*, 2012, doi: 10.1002/qj.2046