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Outcomes of the Aerosol Radiance Assimilation Study

Angela Benedetti[1], Samuel Quesada Ruiz[1], Julie Letertre Danczak[1], Marco Matricardi[1], and Gareth Thomas[2]
[1]European Center for Medium-Range Weather Forecasts, Research/Atmospheric Composition Team, Reading, United Kingdom of Great Britain – England, Scotland, Wales (angela.benedetti@ecmwf.int)
[2]Rutherford Appleton Laboratory - SPACE

The ESA-funded Aerosol Radiance Assimilation Study (ARAS) has provided ground-breaking research in using visible radiance data from satellite to estimate the concentration of aerosols.

Satellite observations in the infrared and microwave parts of the spectrum have long been assimilated into forecasting systems to help estimate the best possible initial conditions for global weather predictions. Assimilating radiances in the visible part of the spectrum, on the other hand, continues to pose many challenges.The reason lies in the complex interactions of cloud and aerosol particles with radiation at those wavelengths and in the complex characteristics of the surface as a reflector of visible light. These factors make it difficult to develop an observation operator, which converts model values into satellite observation equivalents.

One of the key achievements of ARAS is to have developed an observation operator for aerosol reflectances in the visible part of the spectrum. This operator was comprised of two elements: a fast radiative transfer code based on a Look-Up-Table approach developed by RAL Space for aerosol retrievals (Thomas et al, 2009) and adapted to the ECMWF's Integrated Forecast System as well as a surface reflectance model for ocean and land.

This enabled the first-ever experimental assimilation of reflectances into the 4D-Var assimilation system of ECMWF's Integrated Forecasting System (IFS) to help estimate aerosol concentrations. The assimilation experiments were very successful. The performance was remarkable considering that this was a new development rolled out over the course of just two years. The observations used in the ARAS project were cloud-cleated aerosol reflectances from the MODIS instrument on board the Aqua and Terra satellites. Experiments were carried out to compare the impact of assimilating these observations with the impact of assimilating traditional satellite-derived AOD observations. The results show that the performance of reflectance assimilation is broadly comparable to that of satellite AOD assimilation. However, it varies depending on the metrics used and the period analysed.

While assimilating aerosol reflectances is still experimental, the results show great potential for future operational implementation in atmospheric composition forecasts. Such forecasts are routinely produced by the EU□funded Copernicus Atmosphere Monitoring Service (CAMS) implemented by ECMWF. However, the scope for future applications is much wider than that.

Many of the tools developed in ARAS for aerosol visible reflectance assimilation could be adapted to clouds. This could open the way towards a fuller exploitation of visible radiances to improve numerical weather prediction.

References

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