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Improving UK Air Quality Modelling Through Exploitation of Satellite Observations

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In this work the applicability of satellite observations to evaluate the operational UK Met Office Air Quality in the Unified Model (AQUM) have been investigated. The main focus involved the AQUM validation against satellite observations, investigation of satellite retrieval error types and of synoptic meteorological-atmospheric chemistry relationships simulated/seen by the AQUM/satellite.

The AQUM is a short range forecast model of atmospheric chemistry and aerosols up to 5 days. It has been designed to predict potentially hazardous air pollution events, e.g. high concentrations of surface ozone. The AQUM has only been validated against UK atmospheric chemistry recording surface stations. Therefore, satellite observations of atmospheric chemistry have been used to further validate the model, taking advantage of better satellite spatial coverage.

Observations of summer and winter 2006 tropospheric column NO_2 from both OMI and SCIAMACHY show that the AQUM generally compares well with the observations. However, in northern England positive biases (AQUM – satellite) suggest that the AQUM overestimates column NO_2; we present results of sensitivity experiments on UK emissions datasets suspected to be the cause. In winter, the AQUM over predicts background column NO_2 when compared to both satellite instruments. We hypothesise that the cause is the AQUM winter night-time chemistry, where the NO_2 sinks are not substantially defined.

Satellite data are prone to errors/uncertainty such as random, systematic and smoothing errors. We have investigated these error types and developed an algorithm to calculate and reduce the random error component of DOAS NO_2 retrievals, giving more robust seasonal satellite composites.

The Lamb Weather Types (LWT), an objective method of classifying the daily synoptic weather over the UK, were used to create composite satellite maps of column NO_2 under different synoptic conditions. Under cyclonic conditions, satellite observed UK column NO_2 is reduced as the indicative south-westerly flow transports it away from the UK over the North Sea. However, under anticyclonic conditions, the satellite shows that the stable conditions enhance the build-up of column NO_2 over source regions. The influence of wind direction on column NO_2 can also be seen from space with transport leeward of the source regions.