The assimilation of AIRS radiance data at ECMWF

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The NASA-AQUA satellite was launched in May 2002 and a subset of the measured radiance data from the Atmospheric Infrared Sounder (AIRS) has been made available to NWP centres since November 2002. The AIRS is a high spectral resolution sounder that potentially provides atmospheric temperature and composition information at a much higher vertical resolution than has been available before. The ECMWF 4DVAR analysis system has been adapted to assimilate the AIRS radiance data. A key element of the assimilation system is a cloud detection scheme that identifies which of the AIRS channels at a particular location are cloud-free and which are contaminated. This approach (rather than the identification of completely clear locations) was chosen to maximize the use of information from the AIRS instrument above the cloud top (e.g. in situations were the scene is covered by low or mid-level cloud with many of the upper sounding channels being unaffected by its presence). The details of the cloud detection scheme are described in *McNally and Watts 2003*. Other elements of the assimilation system (such as bias correction and quality control) are similar to those developed to assimilate radiance data from the operational (low spectral resolution) sensors (i.e. HIRS, AMSUA, AMSUB and SSM/I).

The assimilation system has initially been tuned to be conservative in its use of AIRS data, by assigning relatively large observation errors to the radiances (ranging from 0.6K to 2.0K) and avoiding parts of the spectrum affected by solar radiation and ozone (the latter has significant RT model problems). Despite this conservative approach, the use of AIRS data showed a modest, but consistent positive impact upon the quality of the analysis and forecasting system (figure 1). On the basis of these results the AIRS data were incorporated into the ECMWF operational assimilation system at the end of September 2003. Future development is aimed towards making more extensive use of the AIRS data. For example, the cloud detection scheme is currently rather stringent and could be relaxed to allow more data into the analysis (but may have to be coupled with an estimation of the contribution of the cloud to the radiance signal). Another area where improvement is expected is using more of the information provided by the AIRS spectra. Currently it is not practical to distribute all of the 2378 AIRS channels in near-real-time to NWP centres. However, there are principal component (eigenvector) representations of the full spectra that could convey the information in a very efficient manner (with additional de-noising properties). These are being investigated.

The use of AIRS data to estimate trace gas concentrations is also an active area of research with the initial focus on CO2. Column values (shown in figure 2) are estimated simultaneously within the main 4DVAR analysis system (taking advantage of other observations to constrain temperature and humidity that would otherwise confuse the CO2 signal). Early results are very promising, showing some significant departures from

background (climatological) knowledge when and where the atmosphere is clear sufficiently often to allow a meaningful averaging of individual point CO2 estimates.

References
McNally and Watts, 2003 A cloud detection algorithm for high-spectral-resolution IR sounders *QJRMS* **129** pp3411-3423

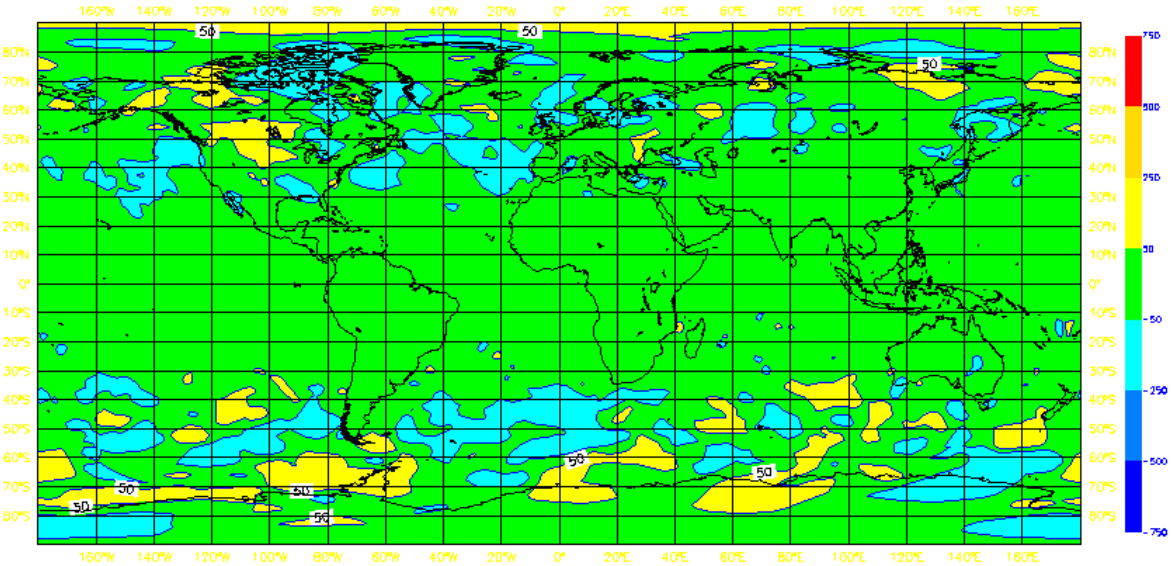

Figure 1 RMS error of day-5 forecasts of 500hPa geopotential , CONTROL system (no AIRS) minus the AIRS system averaged over 40 days (blue shading indicates the use of AIRS reducing forecast errors)

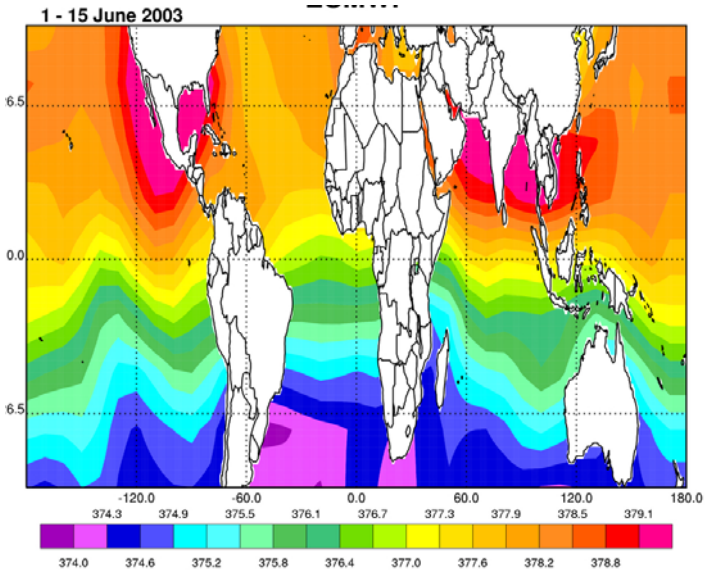

Figure 2 Tropospheric column CO2 estimated within the AIRS assimilation system, averaged over 15 days in June 2003.