E n n er nne er on error corre on f

and the vertical. For IASI observations, the assumption of horizontal uncorrelation is supported by intelligent thinning of the data to avoid assimilating observations which are too close spatially.

Ensuring vertically independent observation errors is more difficult. A measurement in any IASI channel will be sensitive to the temperature and humidity profile over several atmospheric levels; the distribution being represented by the broad weighting functions of the instrument. Therefore the errors in channels spectrally close to each other are likely to be correlated if some mis-representation of the observation is common over several levels; for example, the sensitivity to a certain trace gas. Additionally, correlated errors of representation will be present between channels that observe spatial scales or features within the instrument's 12km field-of-view which the model does not represent well. Also, any errors in the forward model, such as those of spectroscopy, may be correlated between channels.

The current IASI channel selection procedure attempts to lessen the impact of vertically correlated errors by avoiding the assimilation of adjacent channels. But it is generally acknowledged that vertical correlation structure is still present among those channels chosen for assimilation. However, because of a lack of knowledge of the true error correlation structure and the perceived expense of including this structure in the assimilation, the observation errors are treated as uncorrelated between channels. To avoid mis-weighting the IASI observations in the data assimilation, the error variances are inflated to account for the lack of correlation. The level of inflation is determined by the wavelength band of the channels. This technique is not only used at the Met Office, but at the time the work was undertaken, was the technique Meteo-France and ECMWF applied to treat IASI observation error correlations.

Mis-treating observation errors as uncorrelated has been shown to be detrimental to the analysis accuracy and information content when using hyper-spectral satellite observations (

sources. As mentioned above, errors in the meteorology, the forward model, and resolution represen-

problem they were also able to iteratively tune observation error variances and recover observation error covariances, starting from a mis-specification of both. Stewart et al. (2009),Bormann and Bauer (2010a) and Bormann et al. (2010b) applied the estimation technique on a larger scale, estimating the error covariance structure for clear-sky sounder radiances used in the Met O□ce and ECMWF assimilation systems respectively. Results for IASI observations showed noticeable correlation structure in the surface-sensitive and short-wave temperature-sounding channels, and a significant degree of correlation between humidity-sounding channels.

2.2 Assimilation systems

2.4 Experimental set-up

The Desroziers diagnostic is calculated for two situations: firstly using the analysis output from the 1D-Var retrieval and secondly using the analysis output from the 4D-Var assimilation. The background and analysis increment statistics are generated from the assimilation of only clear-sky, sea surface IASI observations. Observations will be from both day and night time, with the exception of daytime observations from shortwave channels which will be eliminated. Using only IASI observations in the assimilation avoids the difficulties of attributing the diagnosed error structures to different observation types.

The 1D-Var results presented here are bat

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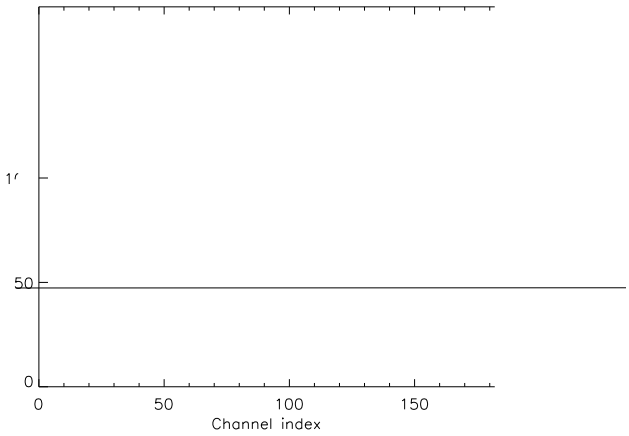
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Channel index


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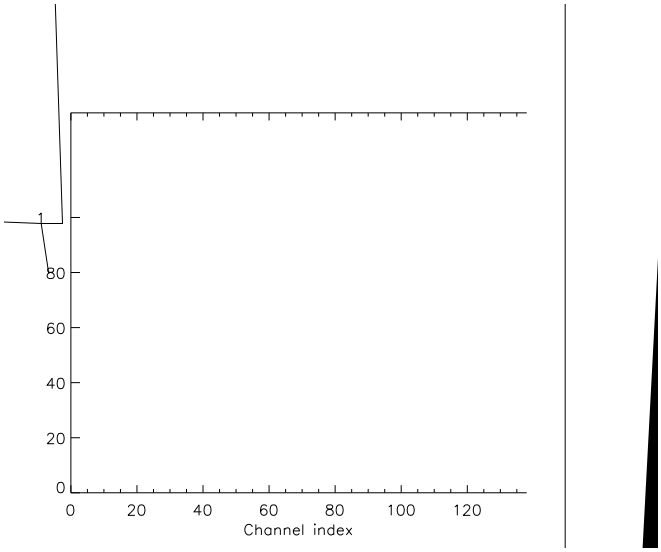
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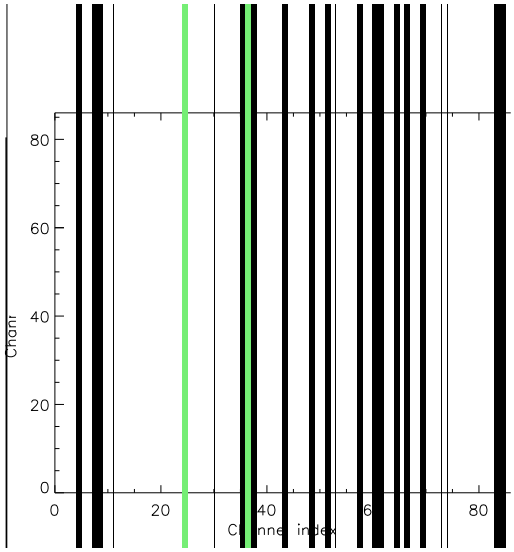
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80

In a 4D-Var assimilation, errors of representation in the horizontal also contribute to the observation error covariance matrix. When the IASI observations are processed in the 4D-Var retrieval, the diagnosed observation error variances were much larger than the instrument noise in channels sensitive to surface properties and water vapour (Figure 8). This suggests that instrument noise is no longer the main contributing factor to the errors in these channels, as in 1D-Var. We attribute most of the remaining error to horizontal errors of representation which contribute in a 4D-Var analysis but not in a 1D-Var retrieval.

Also, the diagnosed errors from 4D-Var were found to contain

Stewart L.M. 2010. 'Correlated observation errors in data assimilation'. PhD thesis, University of Reading. Available from http://www.reading.ac.uk/maths-and-stats/research/maths-phdtheses.aspx.

Stewart L.M, Dance S.L, English S, Eyre J, Nichols N.K. 2009. 'Observation error correlations in IASI radiance data'. Mathematical Report Series 1/2009. Univ.Reading:Reading, UK. Available from http://www.rdg.ac.uk.maths/research/maths-report-series.aspx.

Stewart L.M, Dance S.L, Nichols N.K. 2008. 'Correlated observation errors in data assimilation'. Int.J.Numer.Meth.Fluids. 56:1521-1527.

Stewart L.M, Dance S.L, Nichols N.K. 2012. 'Data assimilation with correlated observation errors: analysis acc0yy-0.33514(.n)-520.012(w)0.203603(i)-0.338178(t)-0.335133(a)-517.181(p)-0.4594874p0o-0.4429(tx)-0.3363