The instrument noise covariance matrix of IASI

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ABSTRACT

The instrument noise covariance matrix (NCM) of the IASI instruments onboard the Metop satellites is an important characteristic of the corresponding infrared sounders. The definition and some historical background will first be recalled. The empirical determination of the matrix $\mathbf{S_y}$ characterizing the noise of the radiometrically and spectrally calibrated spectra **y** at level 1 (L1C) by viewing the onboard blackbody (BB) will be described as well as the instrument dependence (IASI-A,-B or -C), the pixel dependence and the number of BB spectra needed to reach a useful precision level. Smoothing and adjusting the diagonal and sub-diagonals of $\mathbf{S_y}$ can be used to reduce the determination noise.

The NWP centres are assimilating the IASI radiances in dedicated channels and have their own way to specify the noise in the context of assimilation. However, other users are interested in using reliable and convenient forms of $\mathbf{S_y}$ for their own purposes. Two examples will be given.

One can use the $\mathbf{S_y}$ matrix in parallel with an *a priori* covariance $\mathbf{S_a}$ of the state vector in the optimal estimation method (OEM) for retrieving geophysical parameters by inversion of the full or a limited portion of the IASI spectra. Simulated retrievals (where one can control the truth by simulation) with a noise consistent with the empirically determined NCM have been used to quantify the impact of various forms of the $\mathbf{S_y}$ (diagonal, band diagonal, full matrix, smoothed versions) on the retrieved parameters.

One needs also the appropriate form of the NCM in the IASI-PCA technique[1], which can use only the diagonal (to normalise the input L1C spectra) or a band-diagonal form of the matrix to account for the correlation between adjacent channels due to the Gaussian apodisation.

Recommendations for the use of robust forms of the NCM will be proposed for IASI. For the future instrument IASI-NG having different characteristics (with an improved noise in particular) a specific form of $\mathbf{S_y}$ will also be available.

As an outlook, we will insist on the importance of a good characterization of the possible correlations between spectral samples of spectra generated by remote sensing Fourier transform instruments.

[1] See the corresponding paper in this IASI 2024 conference.