Variational schemes allow observations ($y$) to be used for which model equivalents ($Hx_b$) can be computed. The optimal analysis increment is given by

$$x_a - x_b = BH^T(H BH^T + R)^{-1}(y - H x_b)$$

where $H BH^T$ is the background error in observation space and $R$ holds the observation error covariances.

**Monte Carlo**

$$B = E\{e_{\delta}e_{\delta}^T\} \approx B = \frac{1}{N} \sum \eta_i \eta_i^T U^T$$

where $\eta$ is $N(0, I)$ and $U$ is the transform from control to model space.
The diagonal bg error $\sigma_b = \sqrt{\text{diag}(B H H^T)}$ (white bars) with respect to AMSU-A channel number.

Error contribution of uncertainties in $q$ (light blue) and $T$ (dark blue) if assumed independent.

**View Angle**

The spatial error variation in the northern Atlantic is negligible. However, there is a zenith view angle dependence for the channels sensitive to the surface (ch 1-4 & 15).

Background errors as a function of zenith view angles from 0 (light) to 50 (dark) degrees.

**Surface temperature**

The background error variation with respect to the standard deviation of the surface temperature (0-5 K).

**Background departure**

Here the NE\Delta T (1) together with $\sigma_b$ (2) and std($y - H x_b$) (3) are shown.

With $d = y - H x_b$, note that we have

$$E\{dd^T\} = R + H BH^T$$