

Interactive comment on “Correlated observation error models for assimilating all-sky infrared radiances” by Alan J. Geer

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General comment:

This paper introduced an observation error model for correlated all-sky hyperspectral infrared sounders based on eigenvectors and corresponding eigenvalues, and presented methods to handle the problematic trailing eigenvalues that can cause unrealistic increments in the analysis when used as is. After reducing the sensitivity to the trailing eigenjacobians, the new error covariance matrix gives good results in all-sky infrared assimilation. This research is important as more potentially correlated observations are assimilated. The manuscript is well written and can be published after some minor modifications.

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Specific comments: Eigen value decomposition mathematically finds the directions of largest variances within a dataset. While the leading eigenvalues and eigenvectors represents the majority of variance related to strong physical constraints and can be stable, the trailing ones may be sensitive to the training dataset used. The value of the trailing eigenvalues may be small, but it does not necessarily mean the error in the channel combinations represented by the trailing eigenvectors are small. Firstly, eigenvalue decomposition is a linear operation but radiative transfer under all-sky condition is highly non-linear. Secondly, the eigenvalue decomposition is optimized for the entire training dataset, but the Jacobians used in data assimilation is respect to the current model state. Since the leading eigenvalues are orders of magnitude larger than the trailing eigenvalues, any error 'leaks' from the leading 'eigenchannels' during data assimilation due to the aforementioned reasons can overwhelm the trailing eigenvalues. As such, the trailing eigenvalues should be trust less and should not be used directly. Maybe that's why these trailing eigenvalues should be inflated. The author may overstate the value of the trailing eigenvalues too much in the conclusion section (e.g., Page 41, Line 5-7) and suggest modifications to address the possible uncertainties when using the trailing eigenvalues.

Minor correction: Page 39, line 11: an extra 'because'

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