

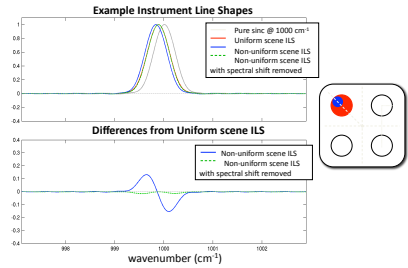
# Principle Component Analysis of IASI spectra with a focus on Non-uniform Scene Effects on the ILS



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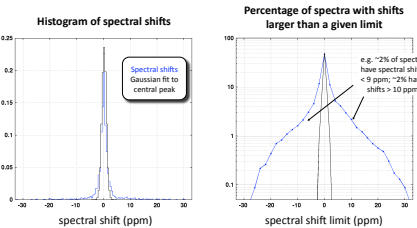
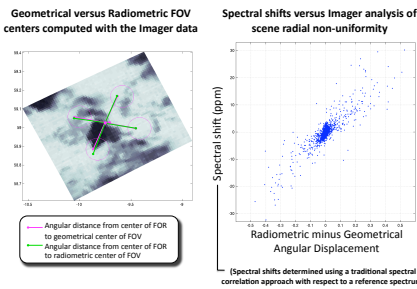
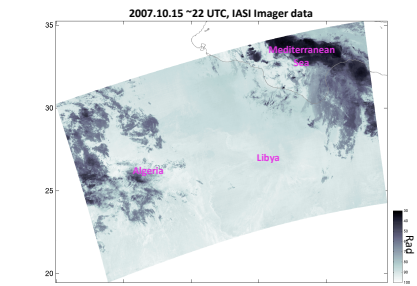


## Simulated impact of spatially non-uniform scenes on the Instrument Line Shape (ILS)



The primary effect of a non-uniform scene on the ILS is a spectral shift; ILS shape effects are secondary.

## Frequency and Magnitude of the Effects



The spectral shifts, which correlate well with analysis of the imager data, are as large as +/- 30 ppm for this typical granule.

## Summary

- Principle Component Analysis (PCA) is a useful tool for identifying and characterizing sensor characteristics. This investigation focuses on the effects of scene non-uniformity on the ILS.
- Scene non-uniformity within the IASI footprints manifests primarily in spectral shift artifacts, and these are found to be largely characterized by a single PC/eigenvector when using dependent set PCA.
- Preliminary results suggest that spectra reconstructed with this "spectral shift" PC excluded have a large portion of the non-uniform scene ILS effects removed. For the example granule shown here, ±30 ppm shifts are reduced to ±4 ppm.
- More work needs to be done to study the accuracy, robustness, and computational efficiency of this correction approach, including (a) the use of synthetic principle components, (b) comparison with physics-based corrections, and (c) the impact of the corrected data on retrievals.

## PCA of IASI Spectra

$$Y = N \text{ columns of differences from the mean spectrum, } y - \langle y \rangle$$

Singular Value Decomposition gives  $U$ ,  $\Lambda$ , and  $V$  such that  $Y = U \Lambda V^T$  where  $\Lambda$  is diagonal and  $U^T U = V^T V = I$

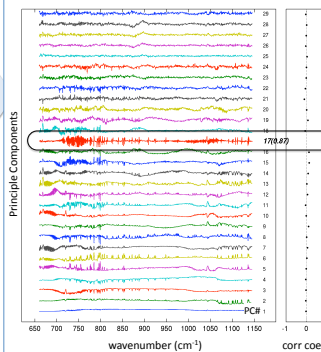
The  $j^{\text{th}}$  spectrum  $y_j$  can then be reconstructed as a sum of vectors (components)  $u_i$  with coefficients  $c_{ij} = \lambda_i v_{ij}^T = U^T (y_j - \langle y \rangle)$ :

$$y_j = \langle y \rangle + \sum_i c_{ij} u_i$$

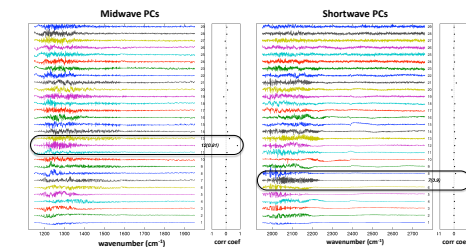
Considerations:

- The sample size
- Dependent vs. Independent set PCs
- Noise normalization ( $y/NEDN$  vs.  $y$ )
- The number of PCs to use in the reconstructions
- Entire spectrum or band by band

Longwave Principle Components ( $u_i$ ) for 2007.10.15 granule

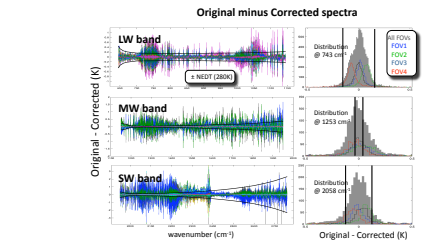
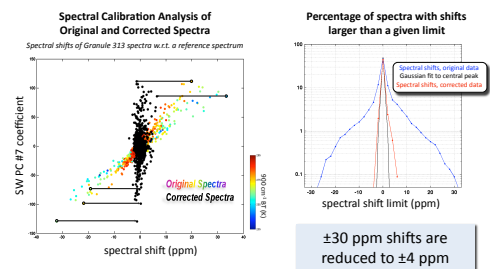
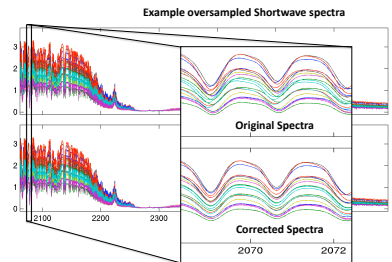


For each spectral band, individual PCs are found to have high correlation with a pure spectral shift signature, and to contain the primary signature associated with non-uniform scene ILS effects.



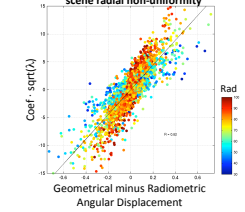
## Non-uniform scene ILS corrections

Involves reconstruction of the spectra with the "spectral shift" PC coefficients set to zero.



## PC coefficients versus Imager analysis of scene radial non-uniformity

The coefficients of the "spectral shift" component also display the spatial characteristics associated with non-uniform ILS effects.



IASI Imager data overlaid with LW Principle Component #17 Coefficients ( $c_{17j}$ )

