Noise reduction by Principal Component Truncation and Image Re-transformation:

An important aspect of PC compression

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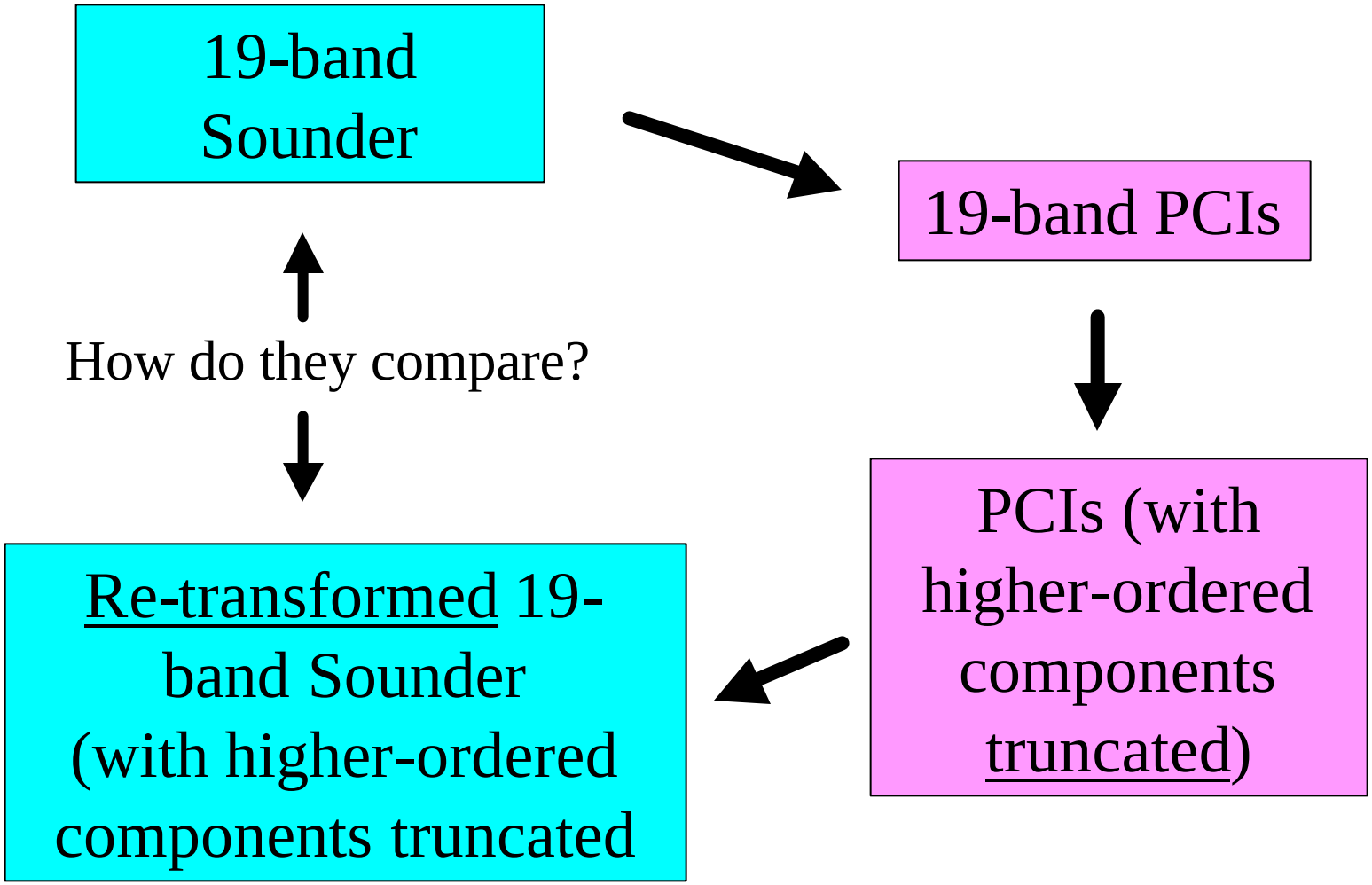
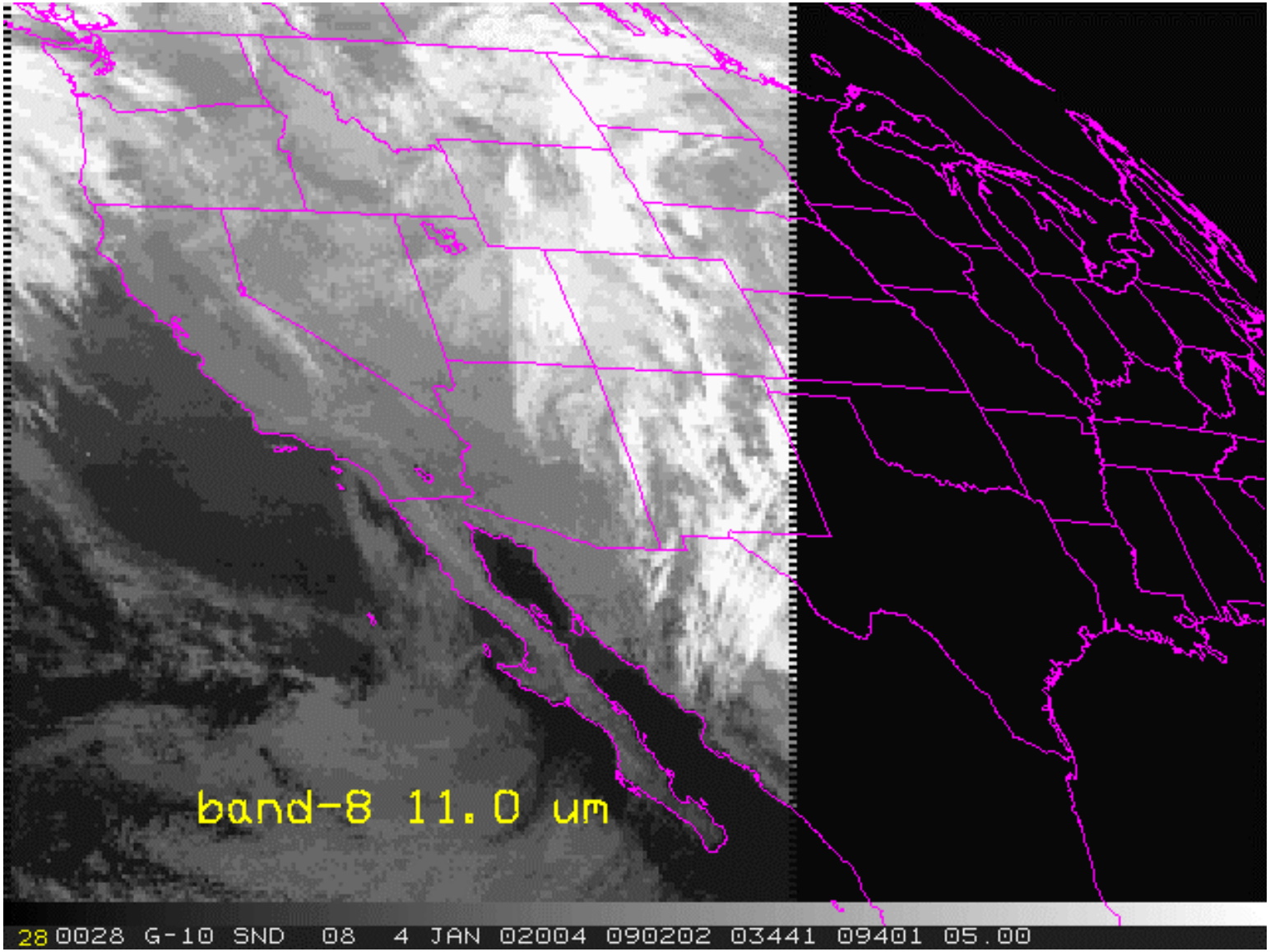
Noise reduction by example on GOES-10 Sounder imagery

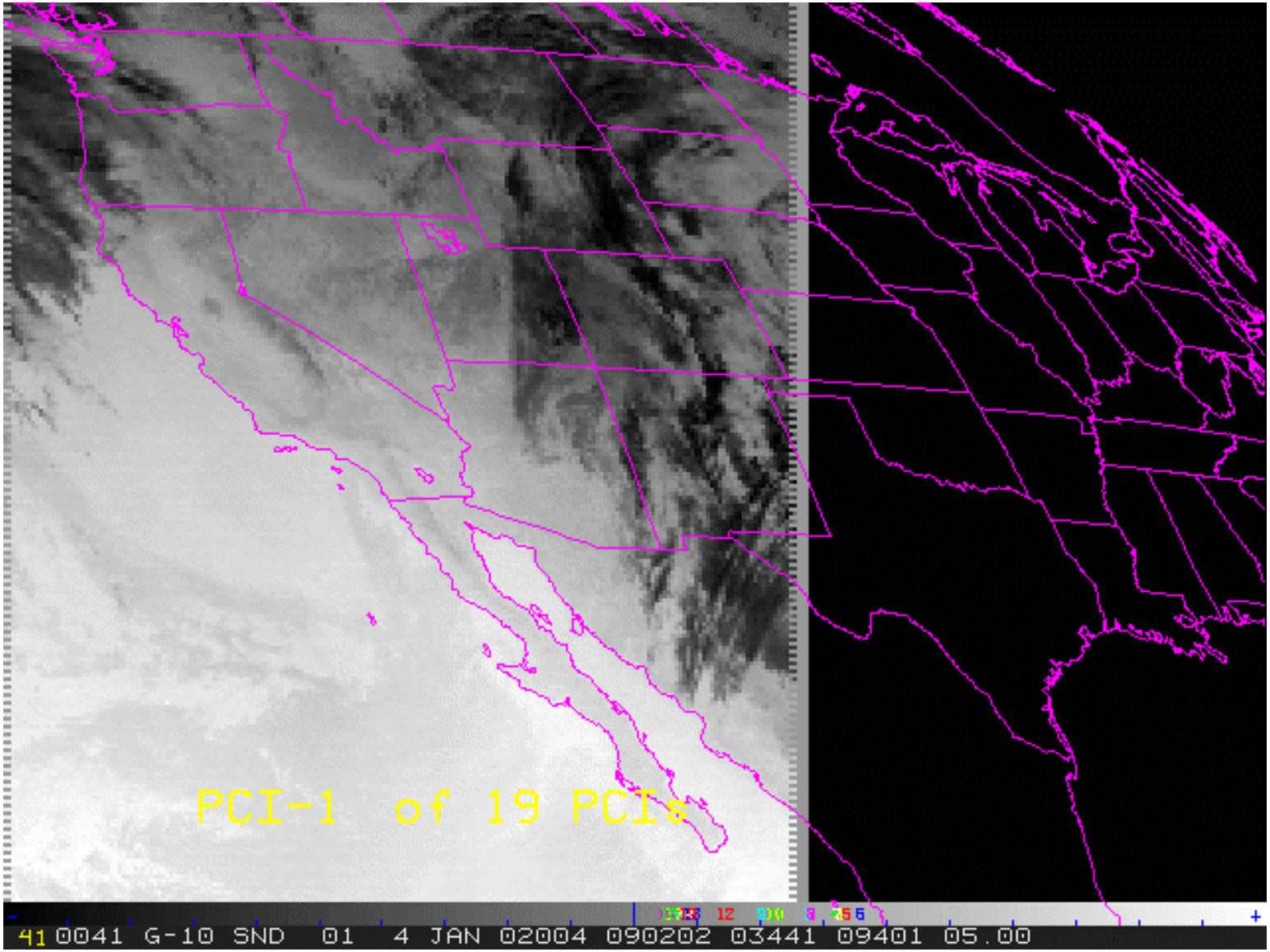
- **PCI = Principal Component Image** (eigenvector / eigenvalue transformation of original spectral bands)
- PCI transformation is can be used to view more subtle features in imagery, features such as volcanic ash, dust, fires and smoke.
- Re-transform after truncation of higher-order PCIs can **reduce noise** in GOES Sounder imagery. (Suggested by *AMS Satellite Conference* paper from 1994.) But what is the effect on the signal?
- Tested here with GOES-10 imagery.


19-band Sounder
19-band PCIs
PCIs (with higher-ordered components truncated)
Re-transformed 19-band Sounder (with higher-ordered components truncated
How do they compare?



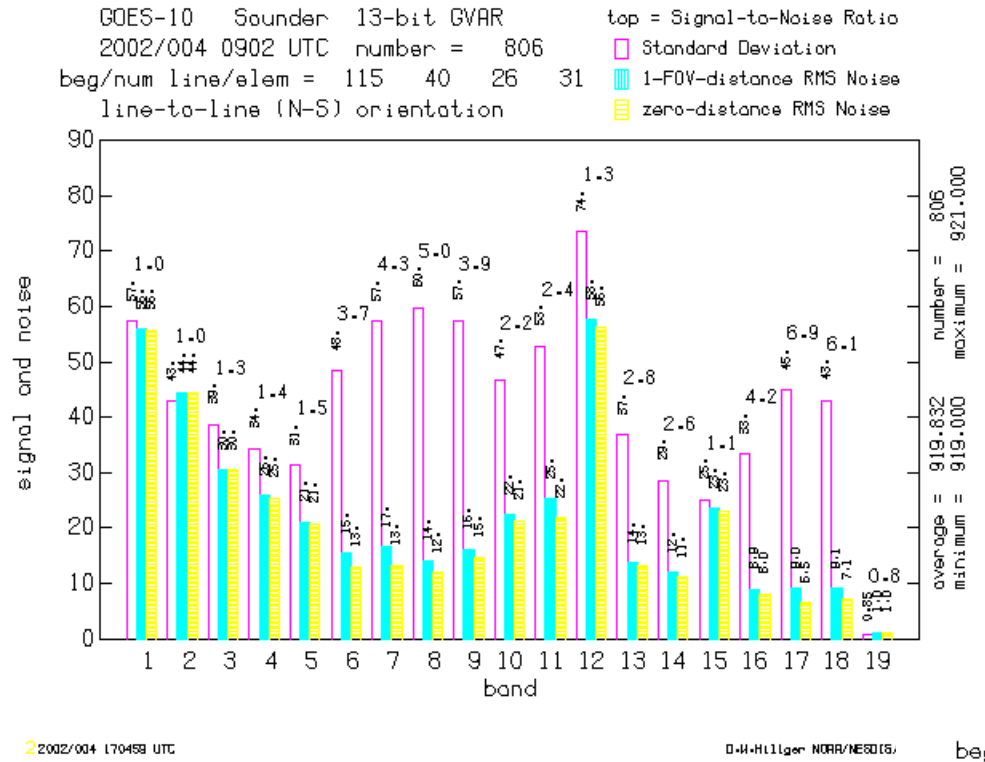
19-band Sounder imagery – stretched

(Click on image to see all bands)

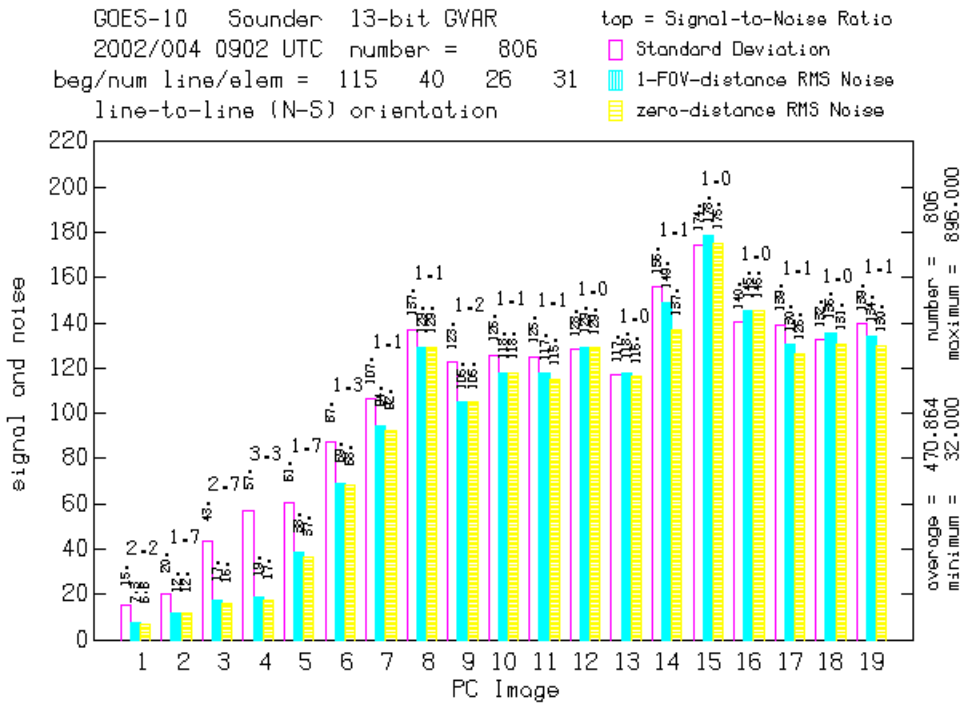


19-band PCIs

(Click on image to see all components)



Transform 19-band Sounder into 19-band PCIs

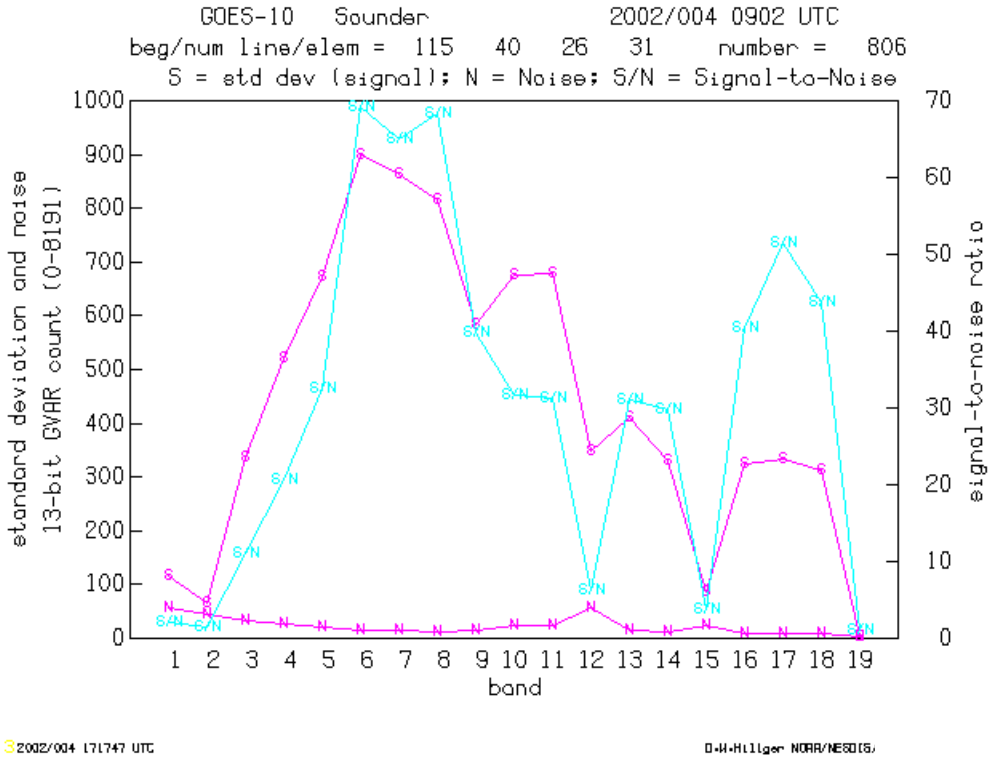


Legend:

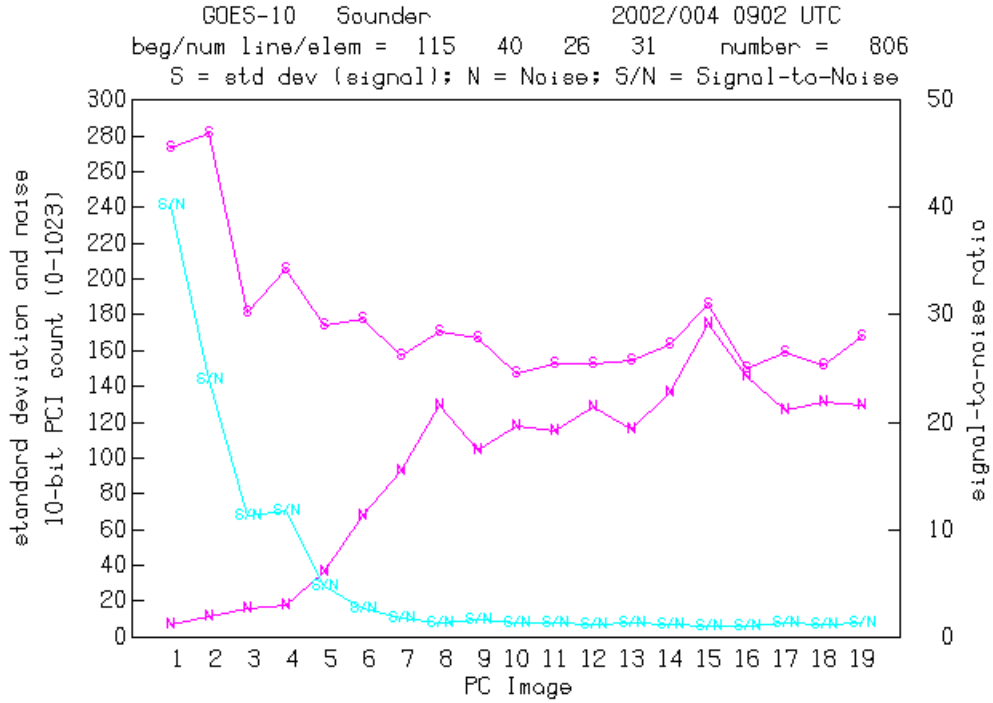
Two values for Noise:

Noise and Noise

Small-sample Signal



Transform 19-band Sounder into 19-band PCIs

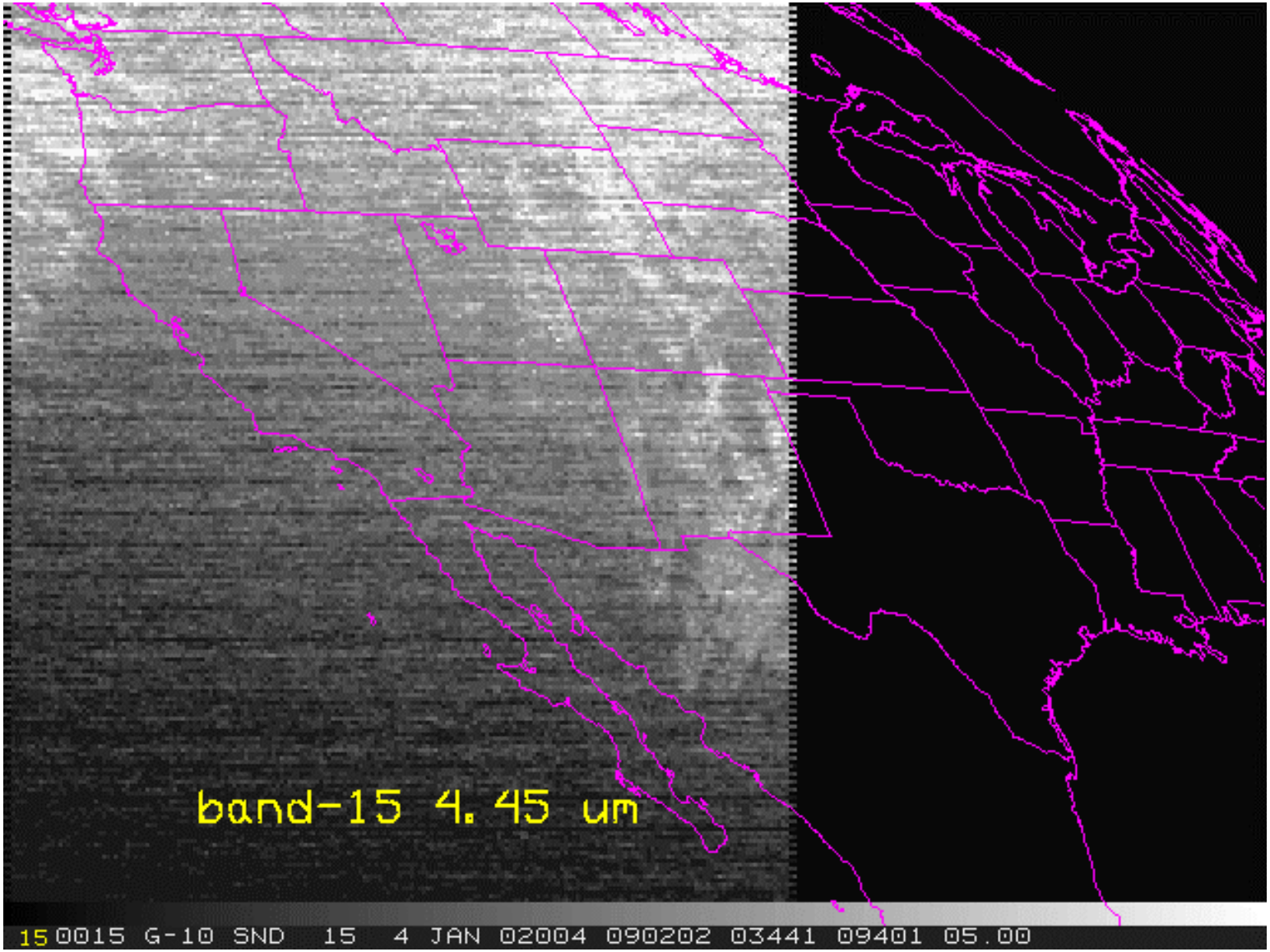


Legend:

Signal and noise

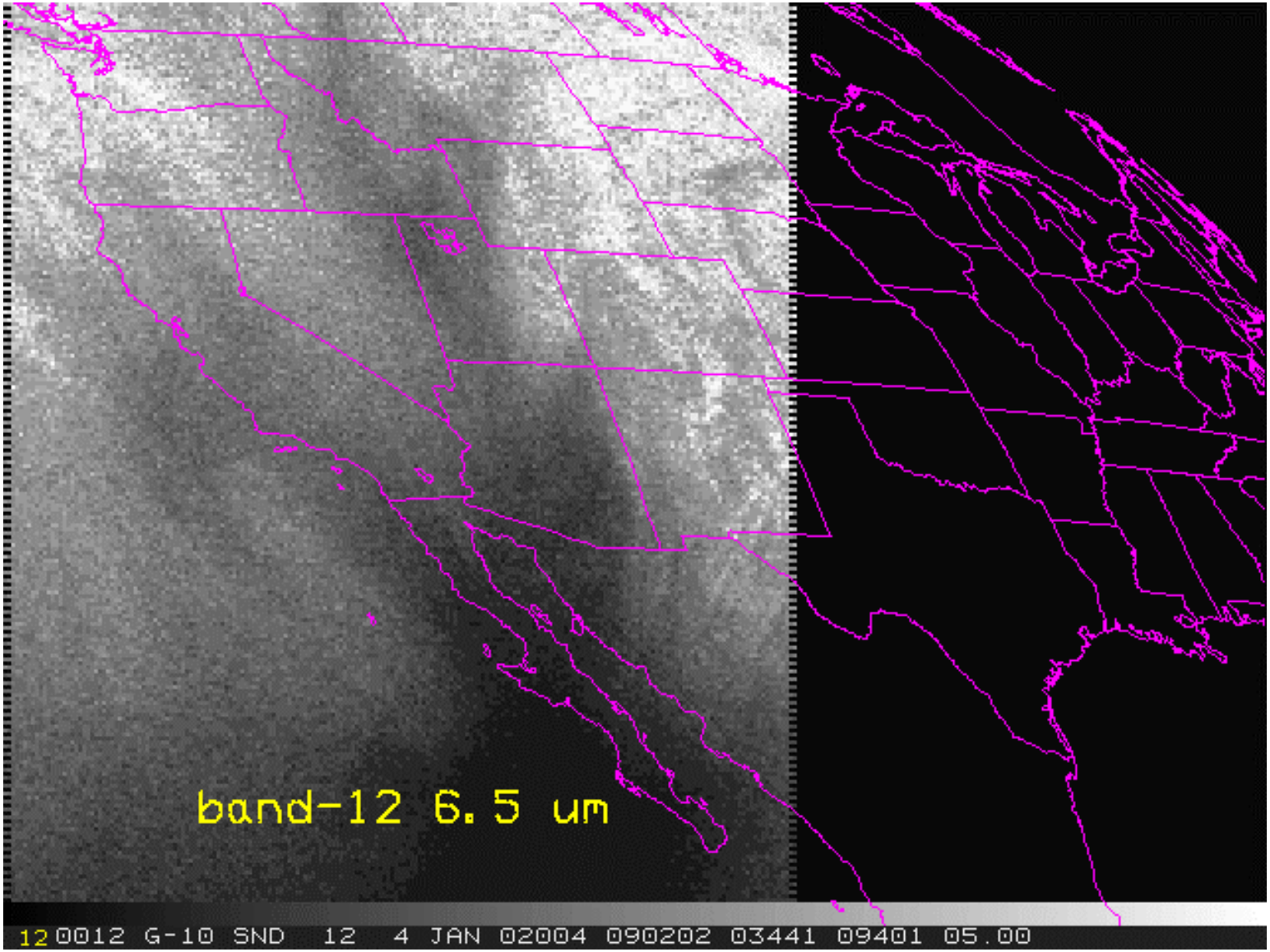
and

Signal/Noise



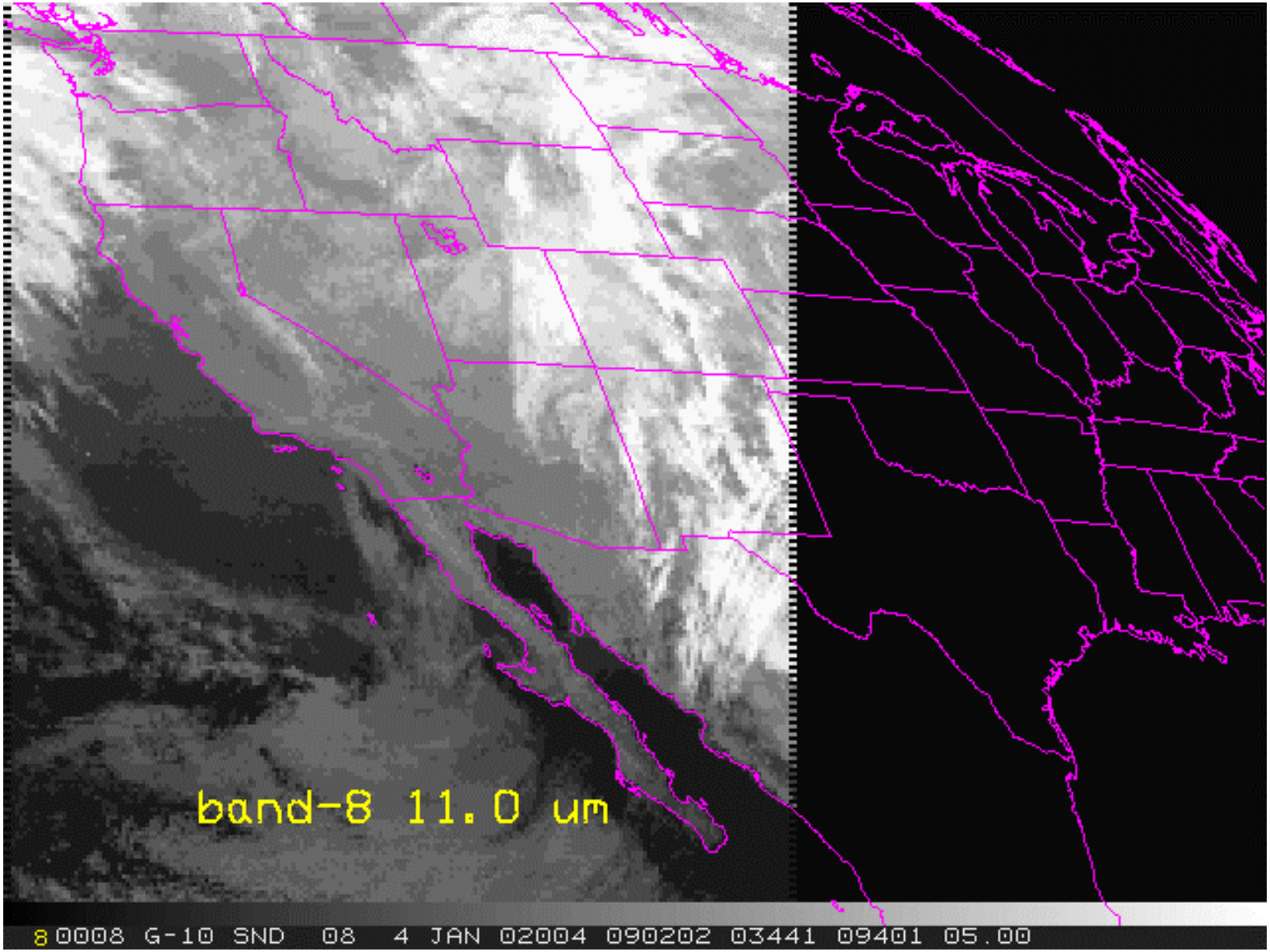
Sounder band-15 – original

(Click on image to see various re-transformations)



Sounder band-12 – original

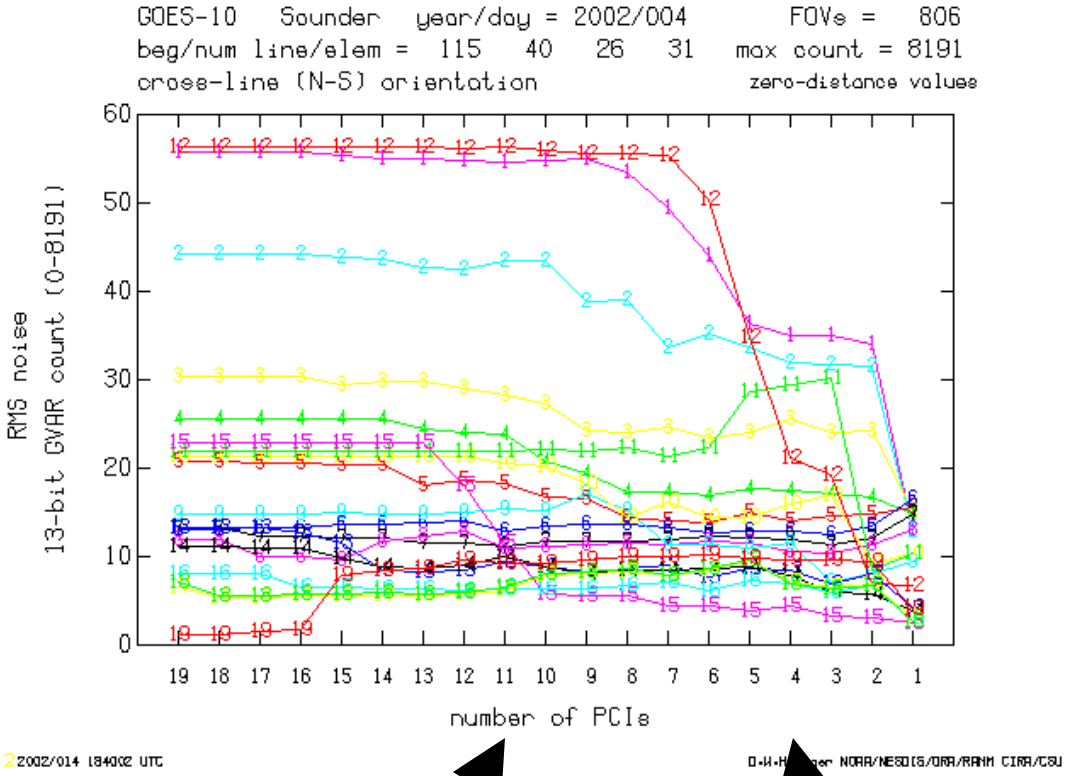
(Click on image to see various re-transformations)



Sounder band-8 – original

(Click on image to see various re-transformations)

All 19 Bands: <u>**Noise**</u> as a function of the number of components in the re-transform

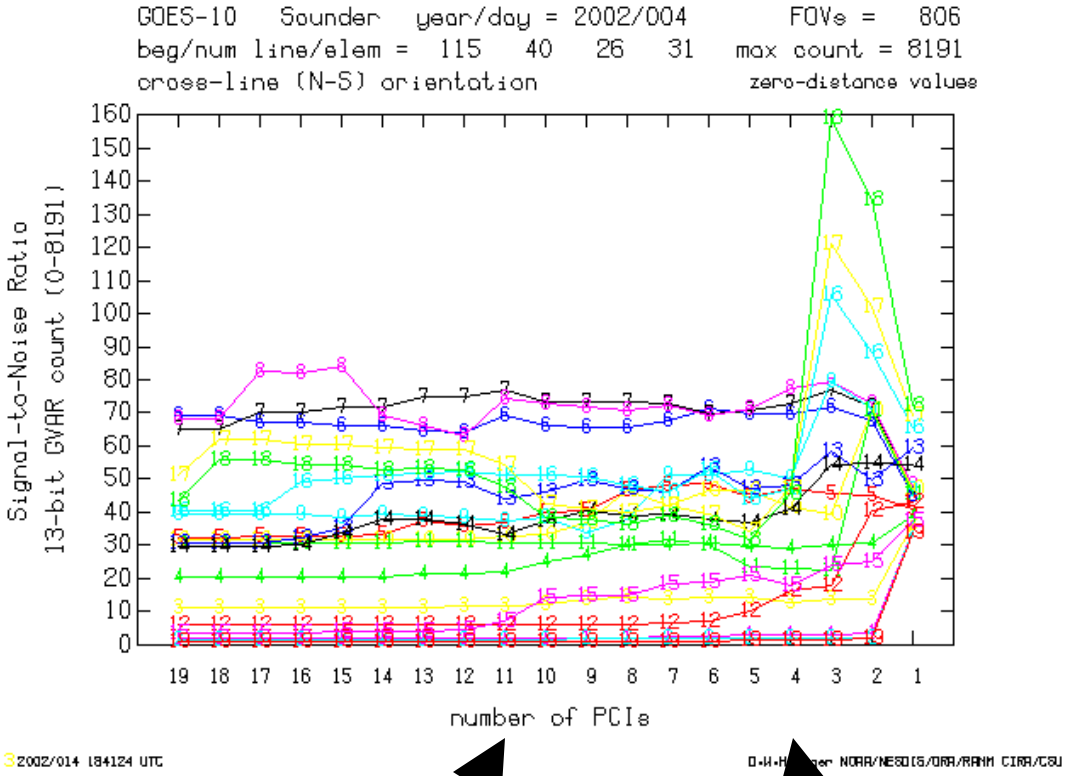


Legend: Line color and number = Sounder band number

As components decrease, <u>noise</u> is reduced

Beyond what point is the <u>signal</u> corrupted?

All 19 Bands: **Signal-to-Noise** as a function of the number of components in the re-transform



Legend: Line color and number = Sounder band number

As components decrease, noise is reduced

Beyond what point is the signal corrupted?

Conclusions

- Truncation of higher-ordered Principal Components can reduce noise and increase signal-to-noise of re-transformed Sounder imagery.
- But at what point is noise reduced at the expense of the signal? Have not answered this question.
- The truncation level is a compromise between:
  - **Maximizing** truncated components (Noise reduction)
  - **Minimizing** truncated components (Reducing the dimensionality of the data, masking more subtle features in imagery)