Investigating the impact of the IASI ILS shift in presence of non uniform scenes

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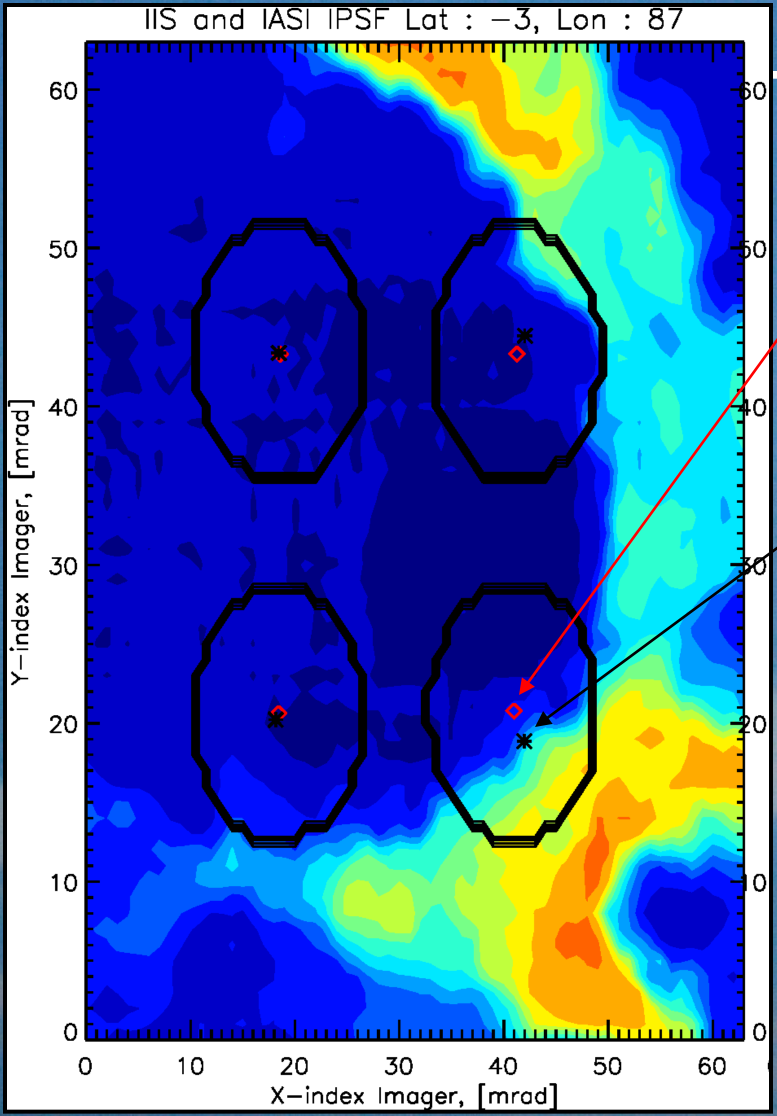
Introduction

- **The precise knowledge of the Instrument Line Shape (ILS) is critical for measurements with a hyper spectral sounder: any error $\delta\upsilon$ in the knowledge of the ILS centroid will introduce an error δR on the radiance spectrum.**
- **Non-uniformly illuminated scenes are responsible of a distortion of the theoretical ILS, which is mainly a frequency shift effect, $\delta\upsilon$, of the ILS centroid.**

- ***1) What is the magnitude of the radiance error introduced by the ILS shift?***
- ***2) What is its impact on the retrievals?***

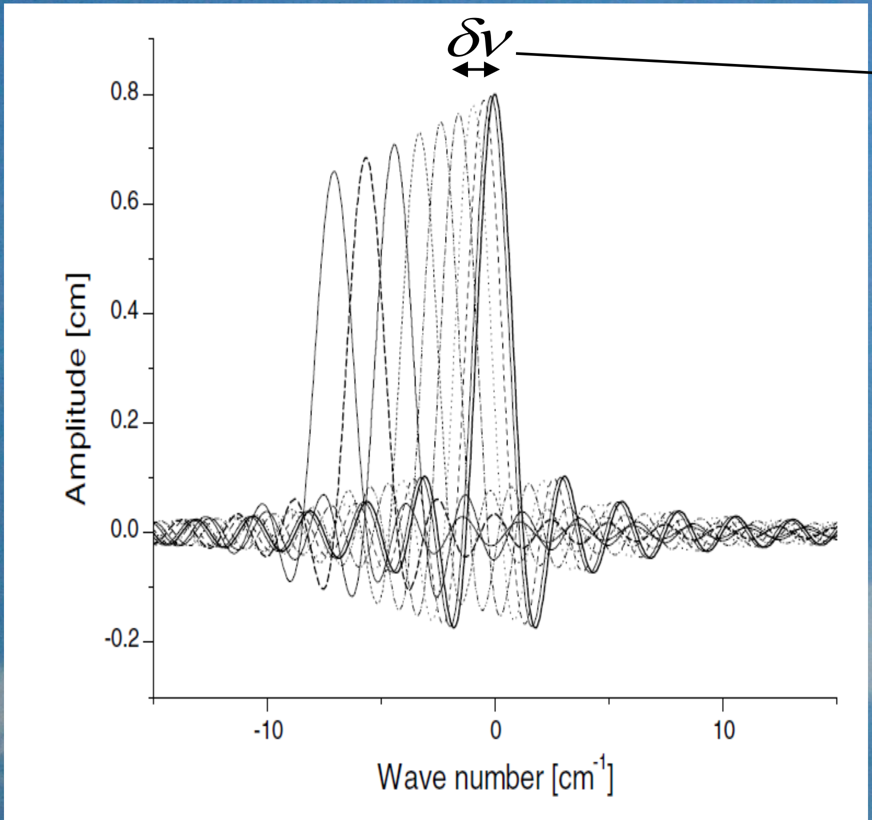
Nominal Geometric Centroids (◊) versus *Radiometric* Centroids (*) :



IIS Imager (64x64 pixels) and IASI FOVs (black contour)

- **Nominal Geometric Centroids obtained from the IASI Instrument Point Source Function (IPSF)**
- **Radiometric Centroids obtained from the IIS measurement and the IASI IPSF**
- **Spatial inhomogeneities introduce a shift between the geometric and radiometric centroids**
- **The higher the spatial inhomogeneity, the largest the radiometric centroid shift**

ILS dependence on radiometric centroid shift $(\delta\vartheta)$



simplified case of an ideal monochromatic source

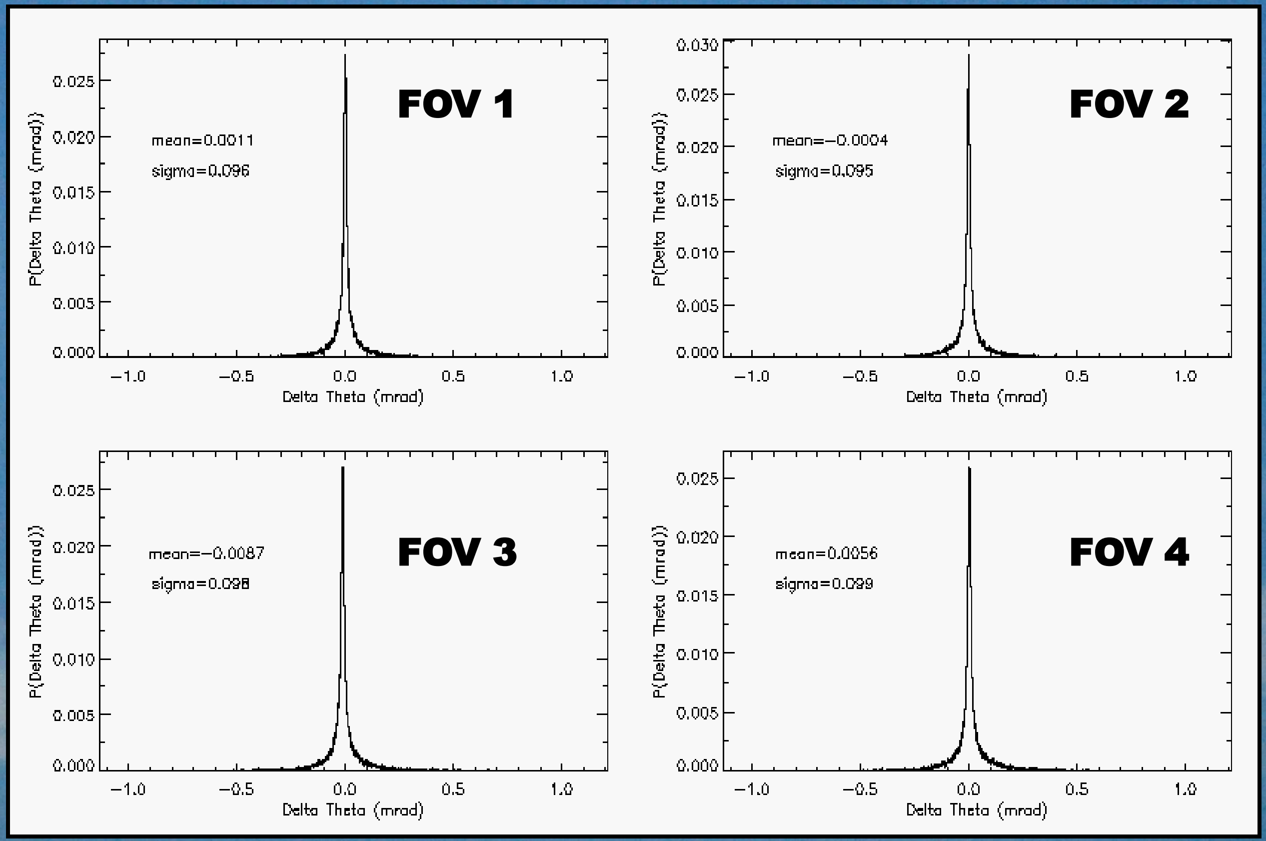
$$\boxed{\frac{\delta\upsilon}{\upsilon} \sim \vartheta_{FOV}\,\delta\vartheta}$$

Radiometric centroid shift

Geometric centroid angular position

- **In general a non uniform light source introduces a distortion in the pixel ILS. The frequency shift $\delta\nu$ of the peak is the dominant effect.**
- **This frequency shift is a source of error in the radiance spectrum that we try to quantify (next slides).**

Centroid shift ($\delta\theta$) distributions (*units in mrad*)
(mid lat ocean night cases, clear & cloudy, October 19th, 2007)

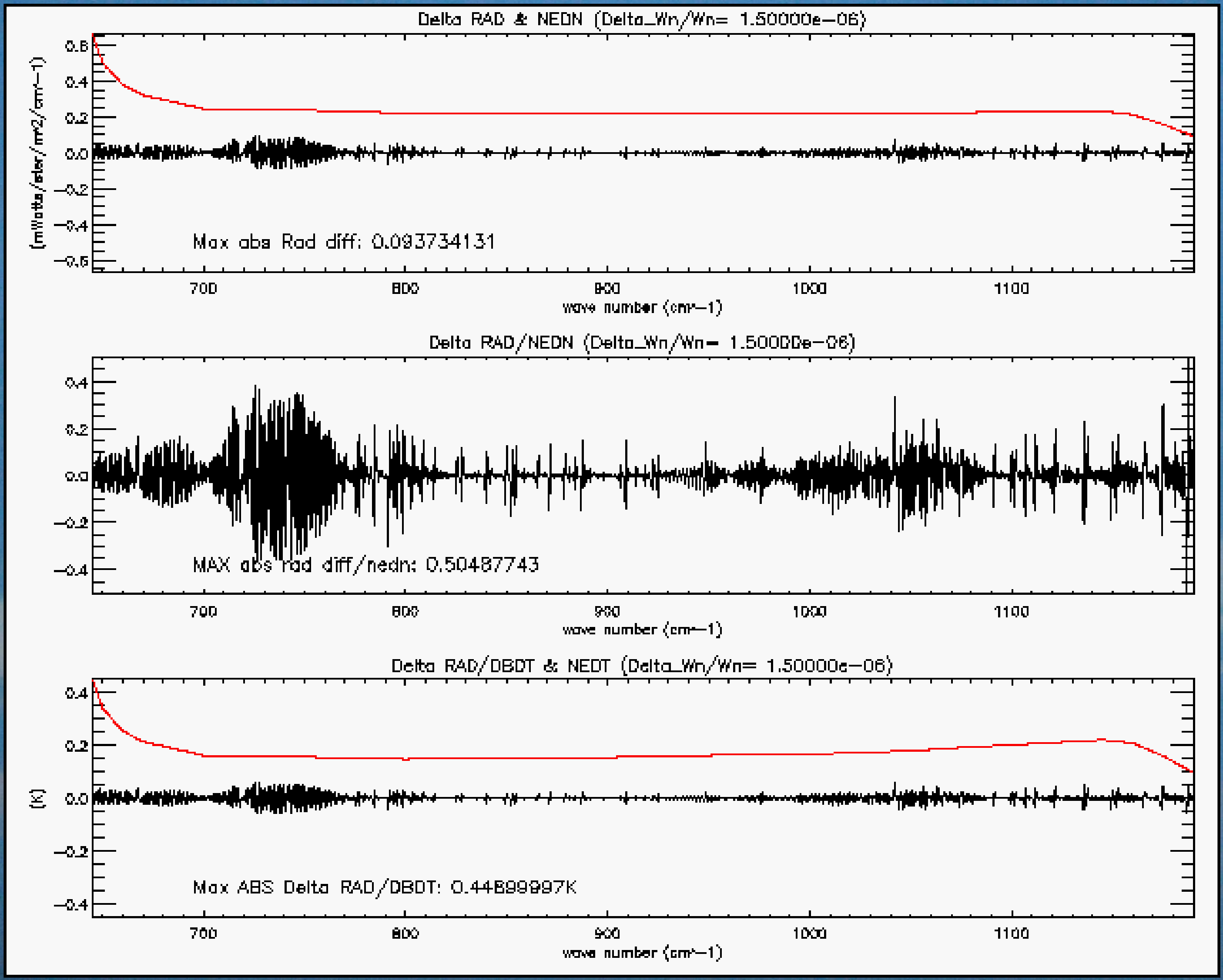


In the next slides we compute the radiance error derived from:

$$\frac{\delta\nu}{\nu} \sim \langle\theta_{fov}\rangle\delta\theta = \begin{cases} \text{1.5e-06} & (\delta\theta = 1 sigma \sim 0.1 mrad) \\ \text{3.0e-06} & (\delta\theta = 2 sigmas \sim 0.2 mrad) \\ \text{4.5e-06} & (\delta\theta = 3 sigmas \sim 0.3 mrad) \end{cases}$$

Radiance Error - **BAND 1 (Gran # 393)**

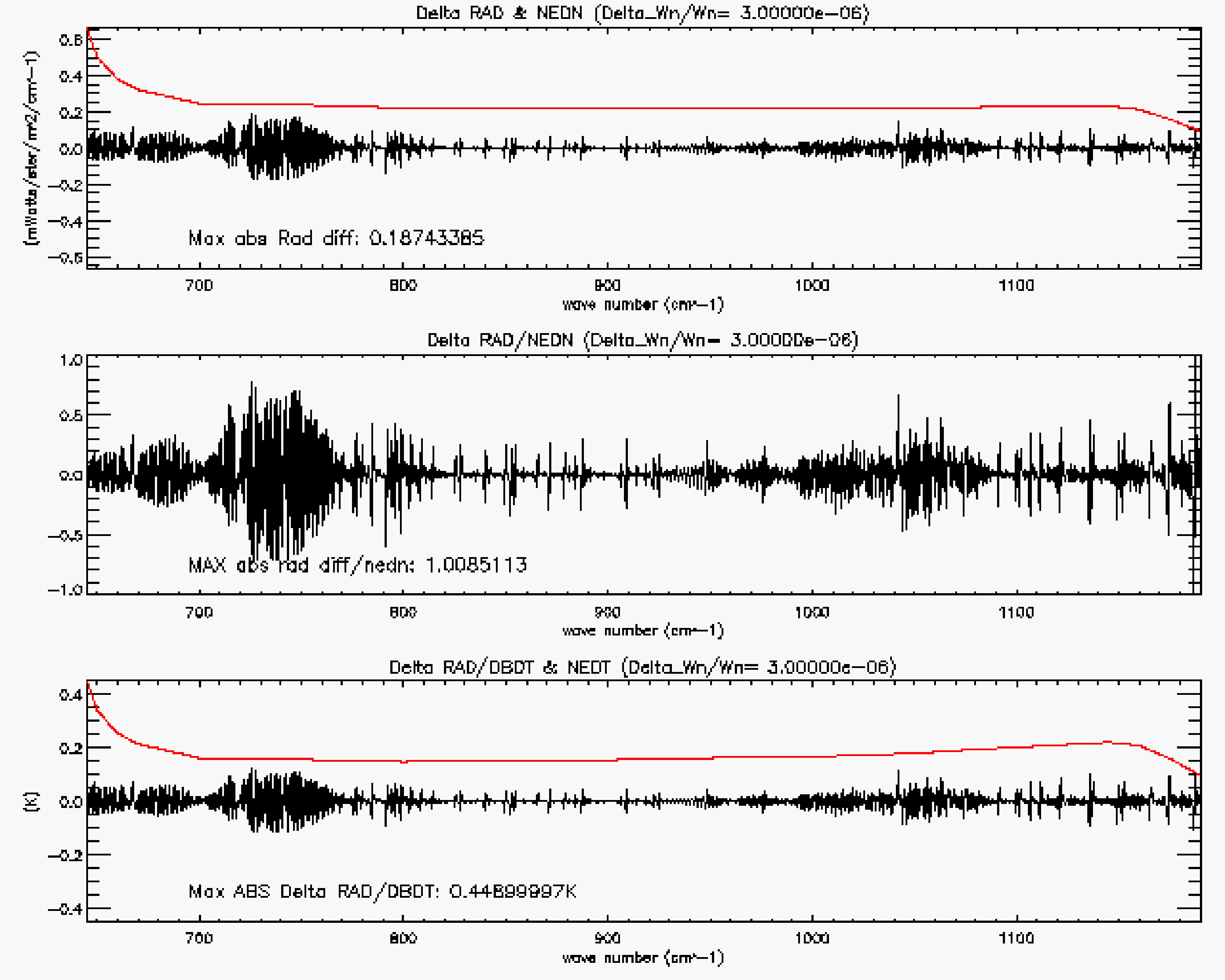
dθ=1 sigma (0.1mrad): dv/v~1.5e-06



Radiance error
<<
Instrument noise

Radiance Error - BAND 1 (Gran # 393)

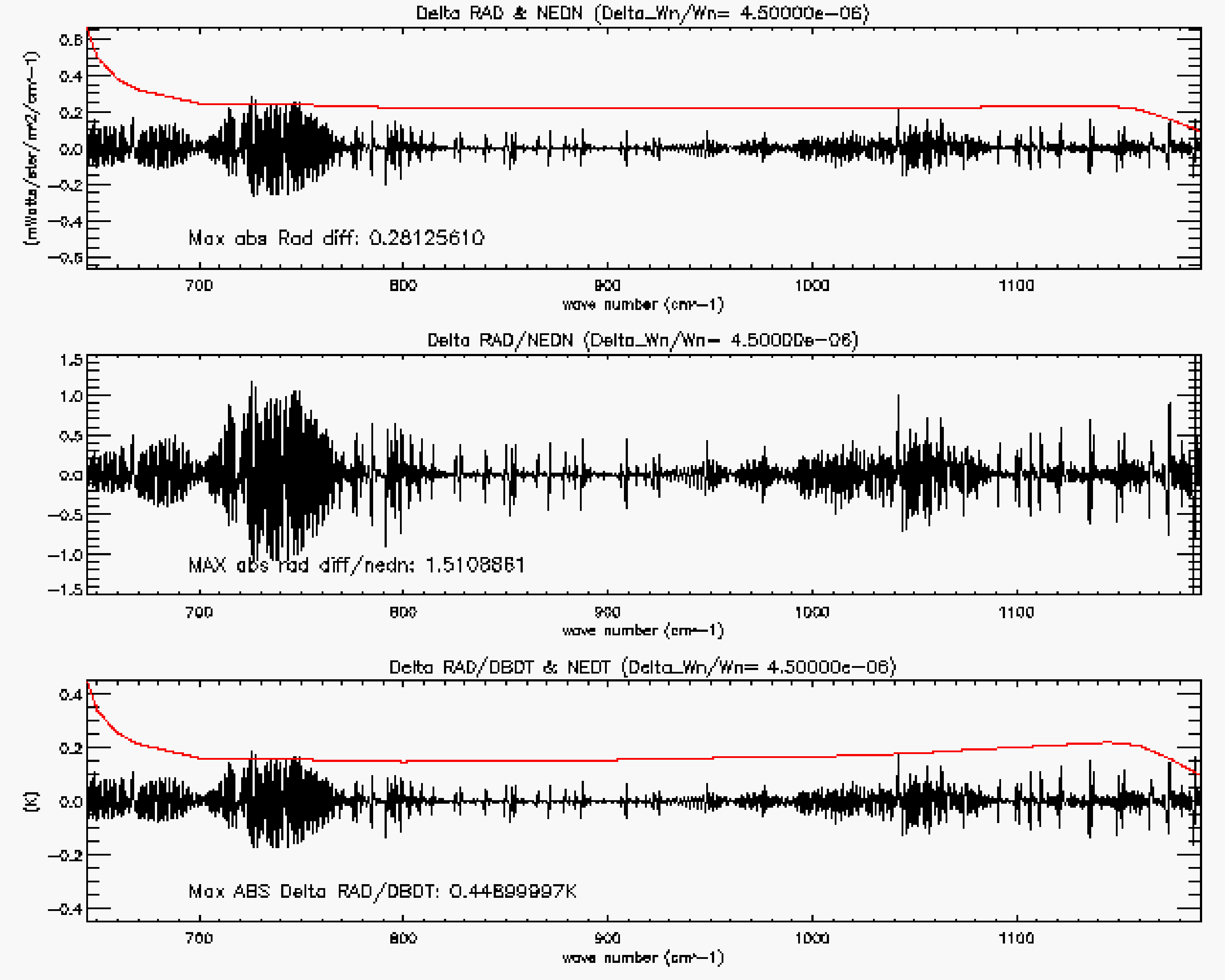
<u>dθ = 2 sigma</u> (0.2mrad): dv/v~3e-06



Radiance error
<<
Instrument noise

Radiance Error - BAND 1 (Gran # 393)

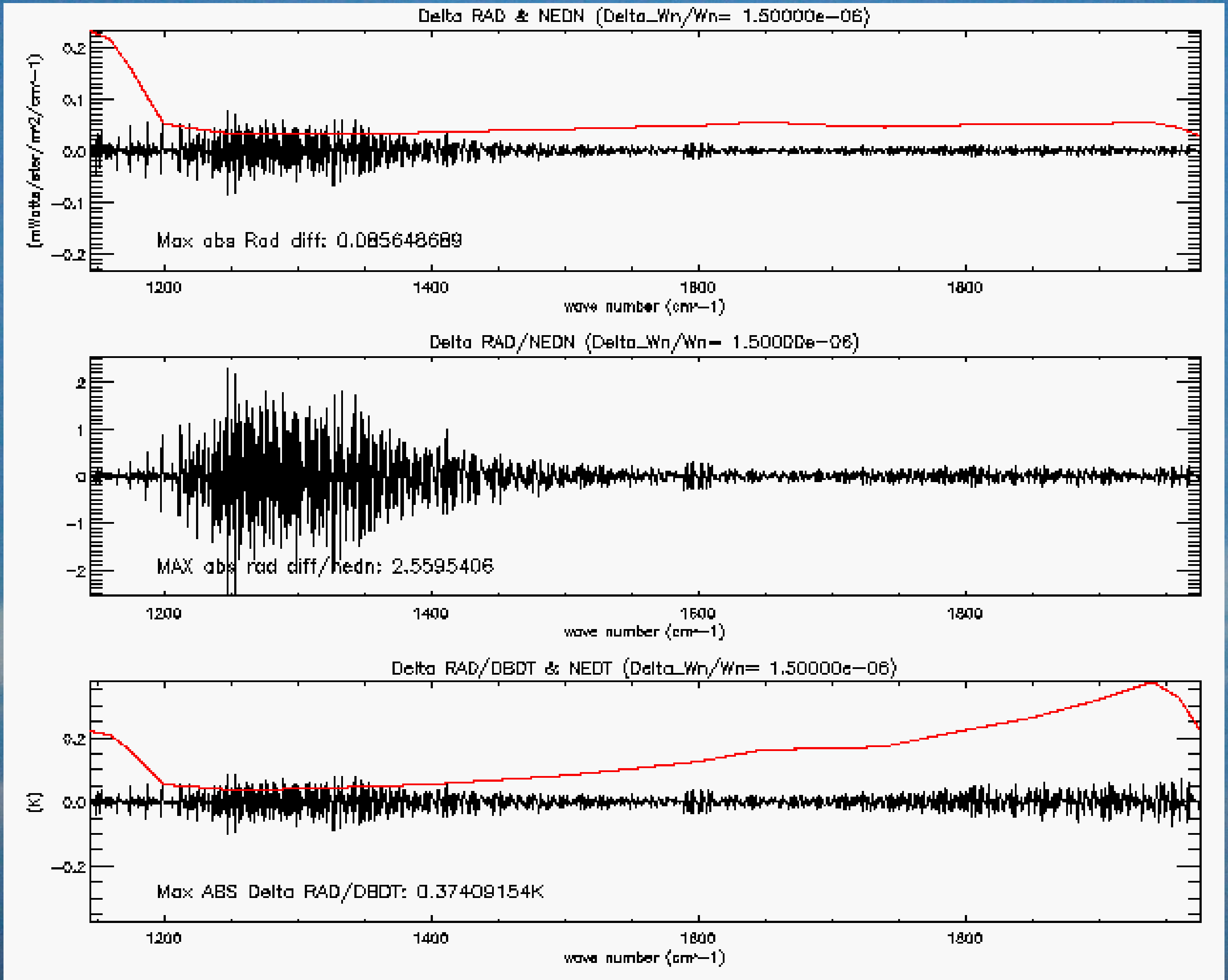
dθ = 3 sigma (0.3mrad): dv/v~4.5e-06



the radiance error becomes comparable to the instrument noise

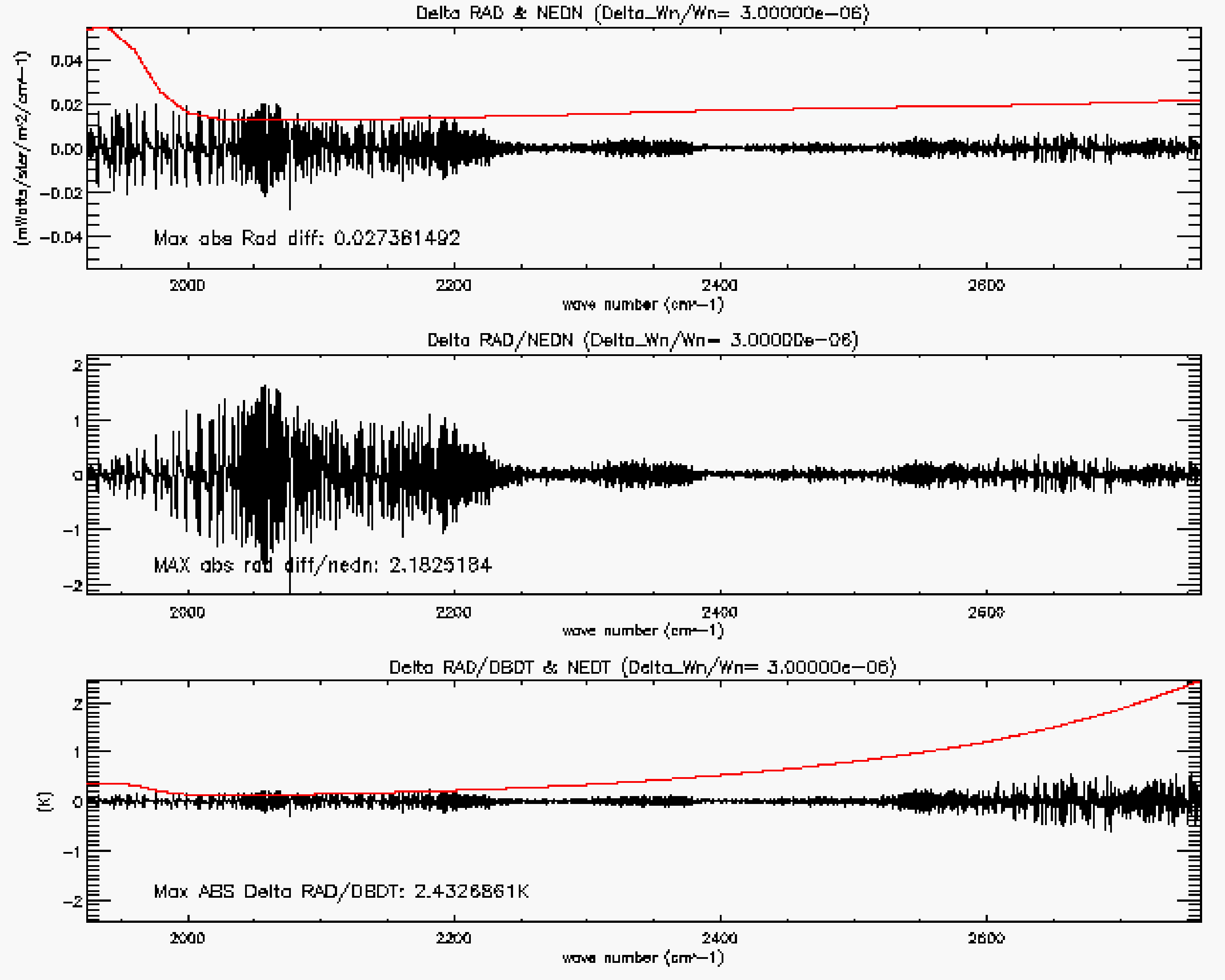
Radiance Error - BAND 2 (Gran # 393)

dθ=1 sigma (0.1mrad): dv/v~1.5e-06



the radiance error becomes comparable to the instrument noise

Radiance Error - BAND 3 (Gran # 393)
dθ=2 sigma (0.1mrad): dv/v~3e-06



the radiance error becomes comparable to the instrument noise

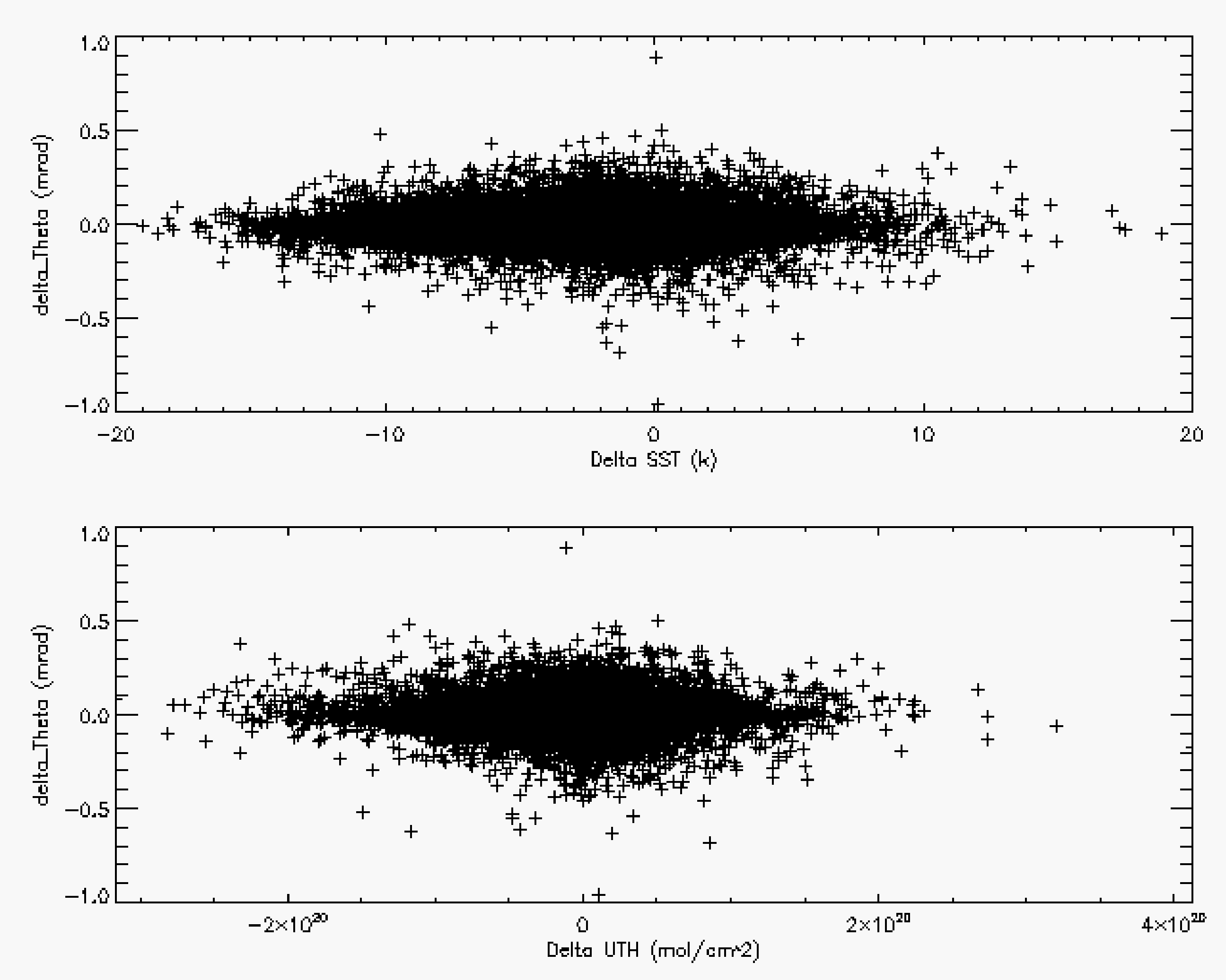
Part I first conclusions:

The radiance error introduced by the ILS shift is generally negligible wrt the instrument error. Only 5% of the full day ensemble is seen to undergo a shift ~ 1 sigma or higher.

Part II (next slides):

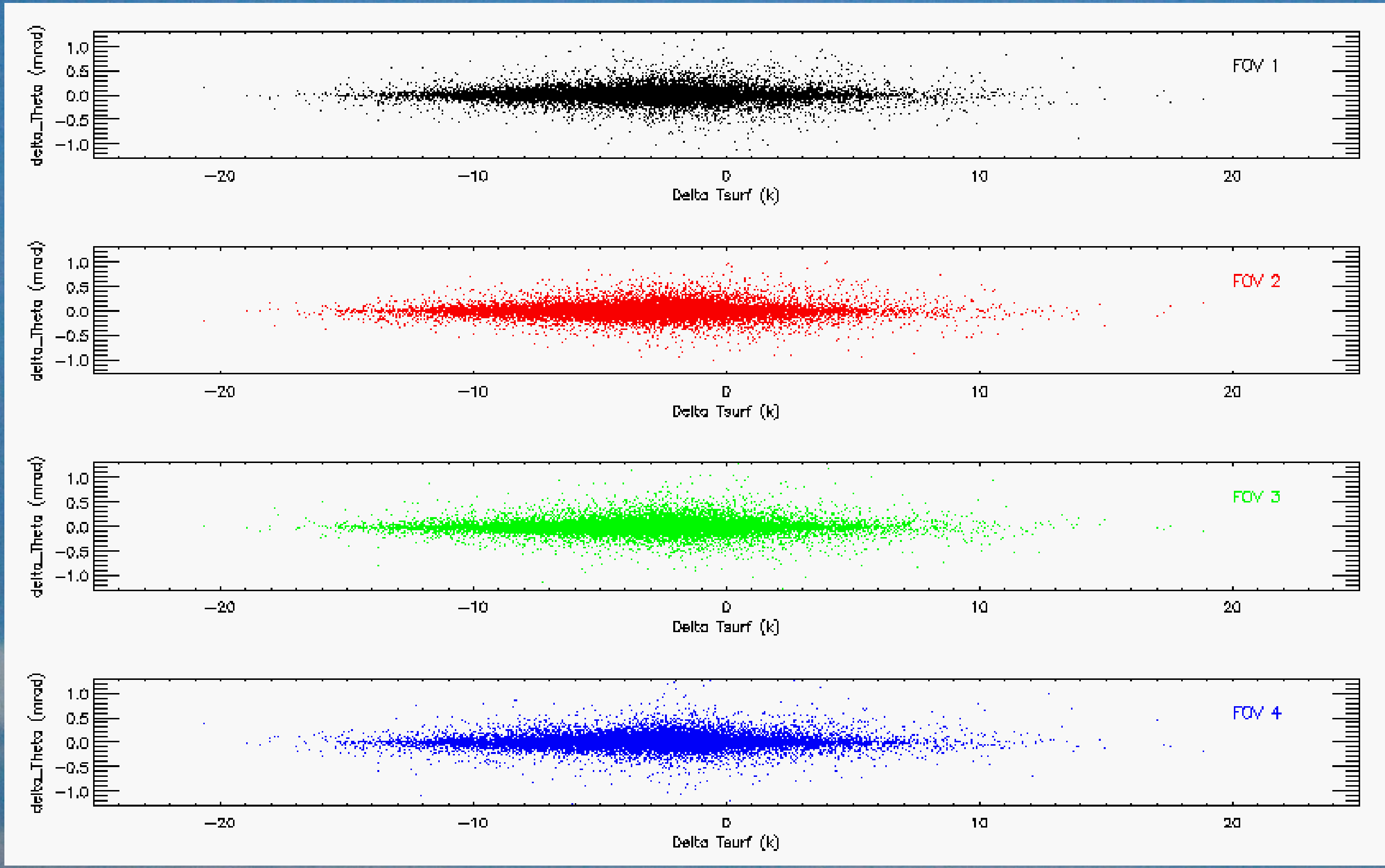
Impact of the ILS shift on level 2 products

4 FOV MEAN Centroid Shift vs SST & UTH bias (ocean night mid lat Oct 19 2007)



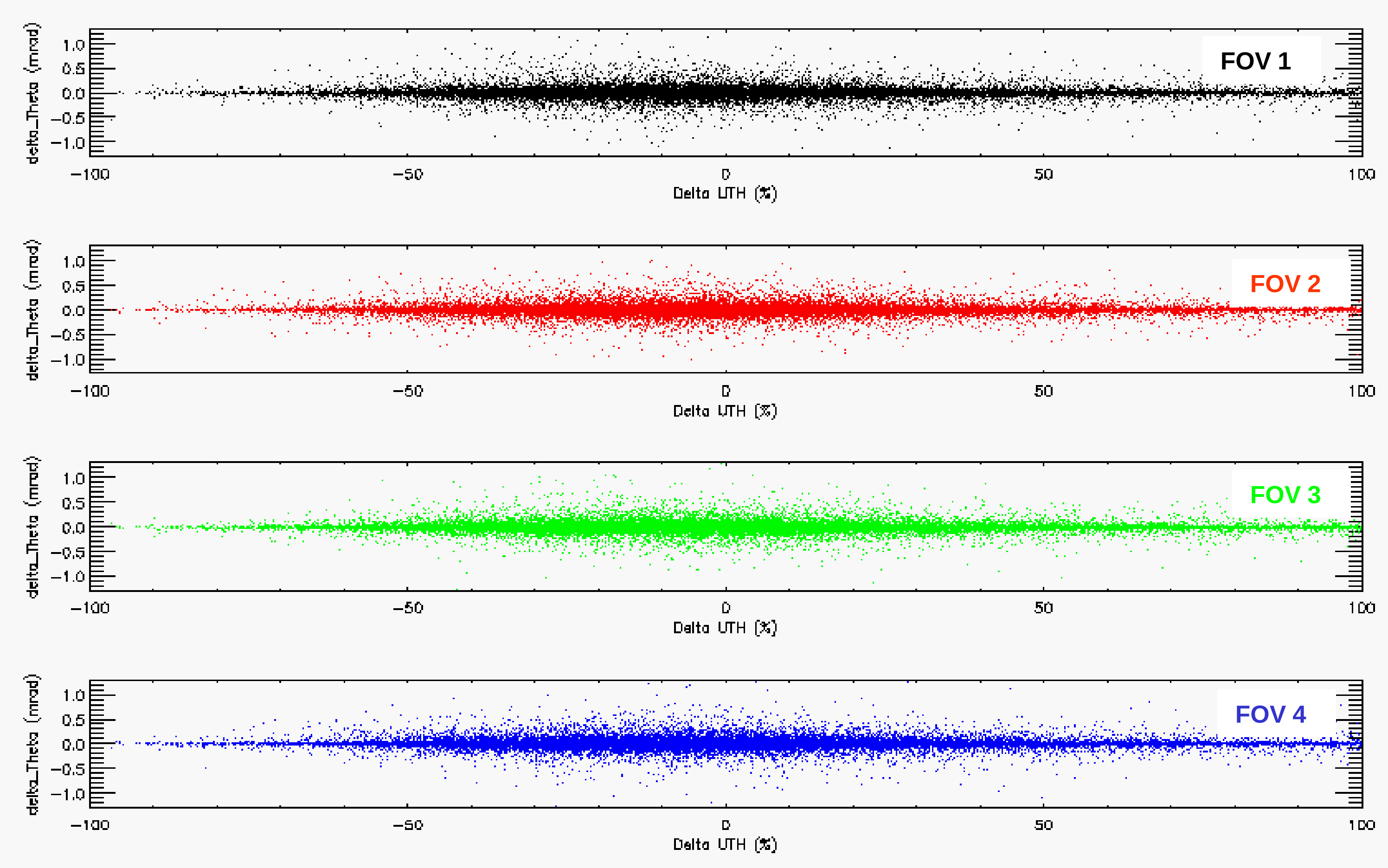
No significant correlation is seen to stand out

Centroid Shift vs Tsurf bias (ret- ecmwf) (ocean night mid lat Oct 19 2007)



No significant correlation is seen to stand out

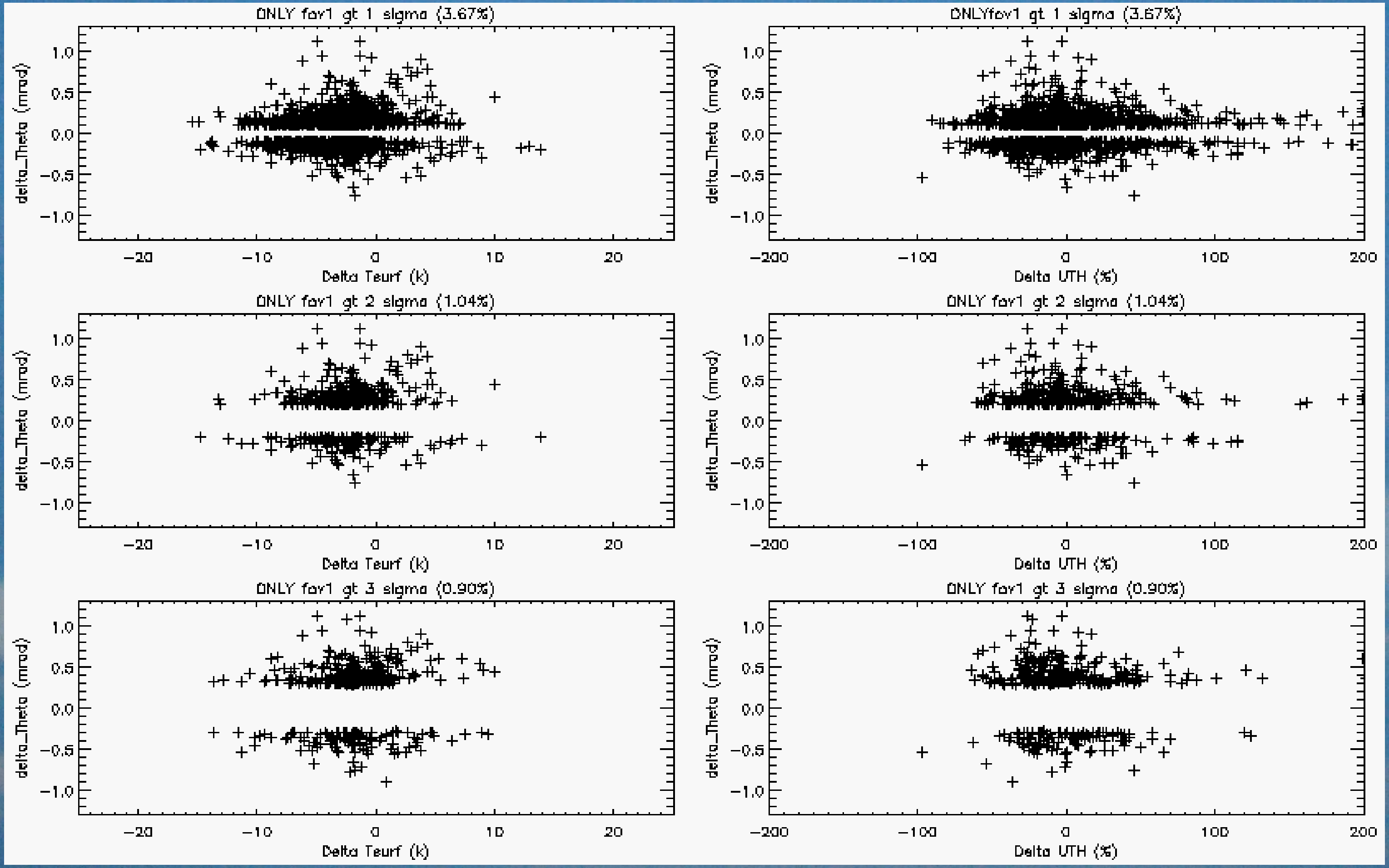
Centroid Shift vs UTH bias (ret- ecmwf) (ocean night mid lat Oct 19 2007)



No significant correlation is seen to stand out

Examples of cases that are likely to pass Radiance Cloud Clearing QAs (high cloud contrast)

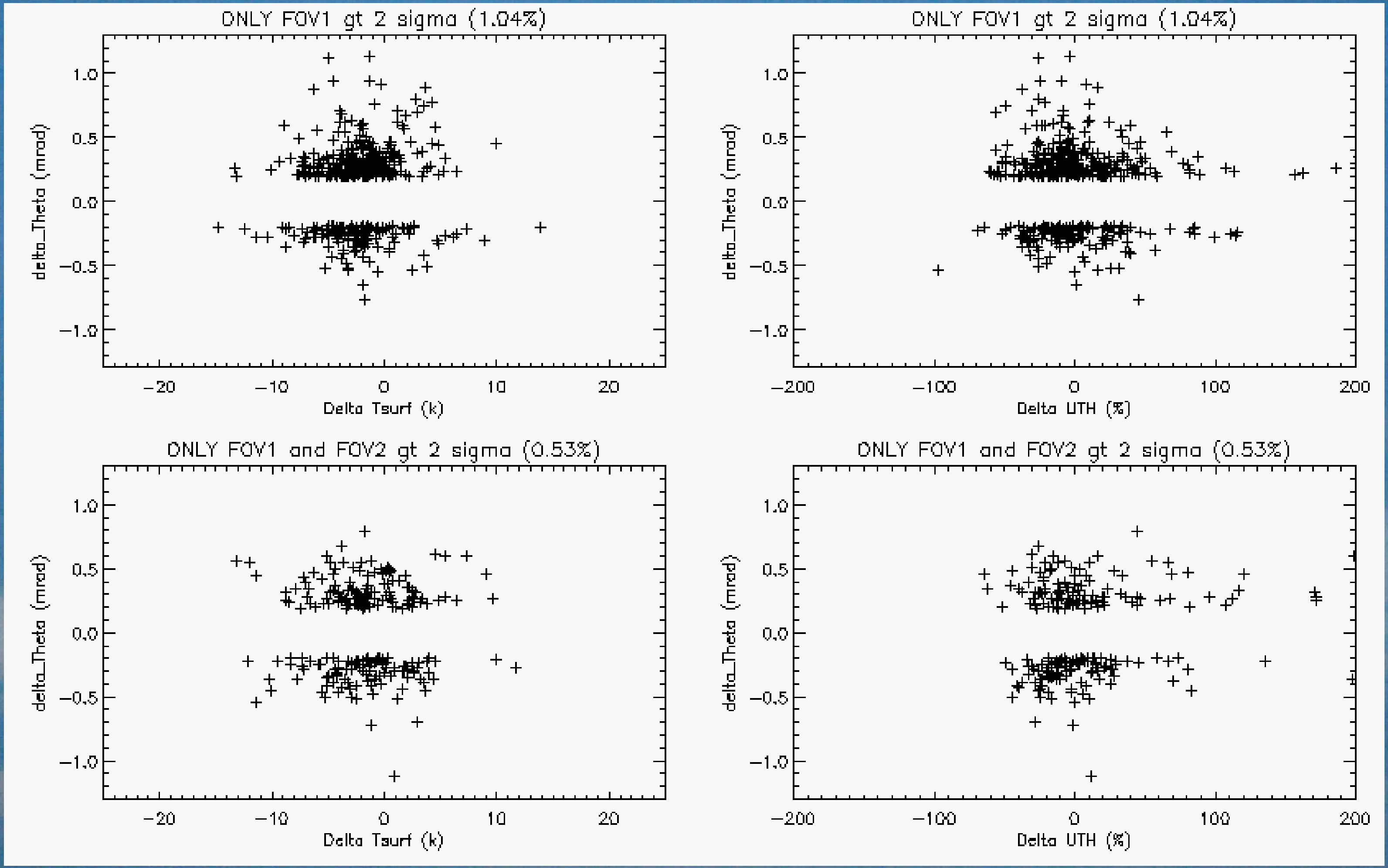
1) ONLY FOV 1 has dθ gt 1, all others lt 1 sigma
2) ONLY FOV 1 has dθ gt 2, all others lt 1 sigma
3) ONLY FOV 1 has dθ gt 3, all others lt 3 sigma



No significant correlation is seen to stand out

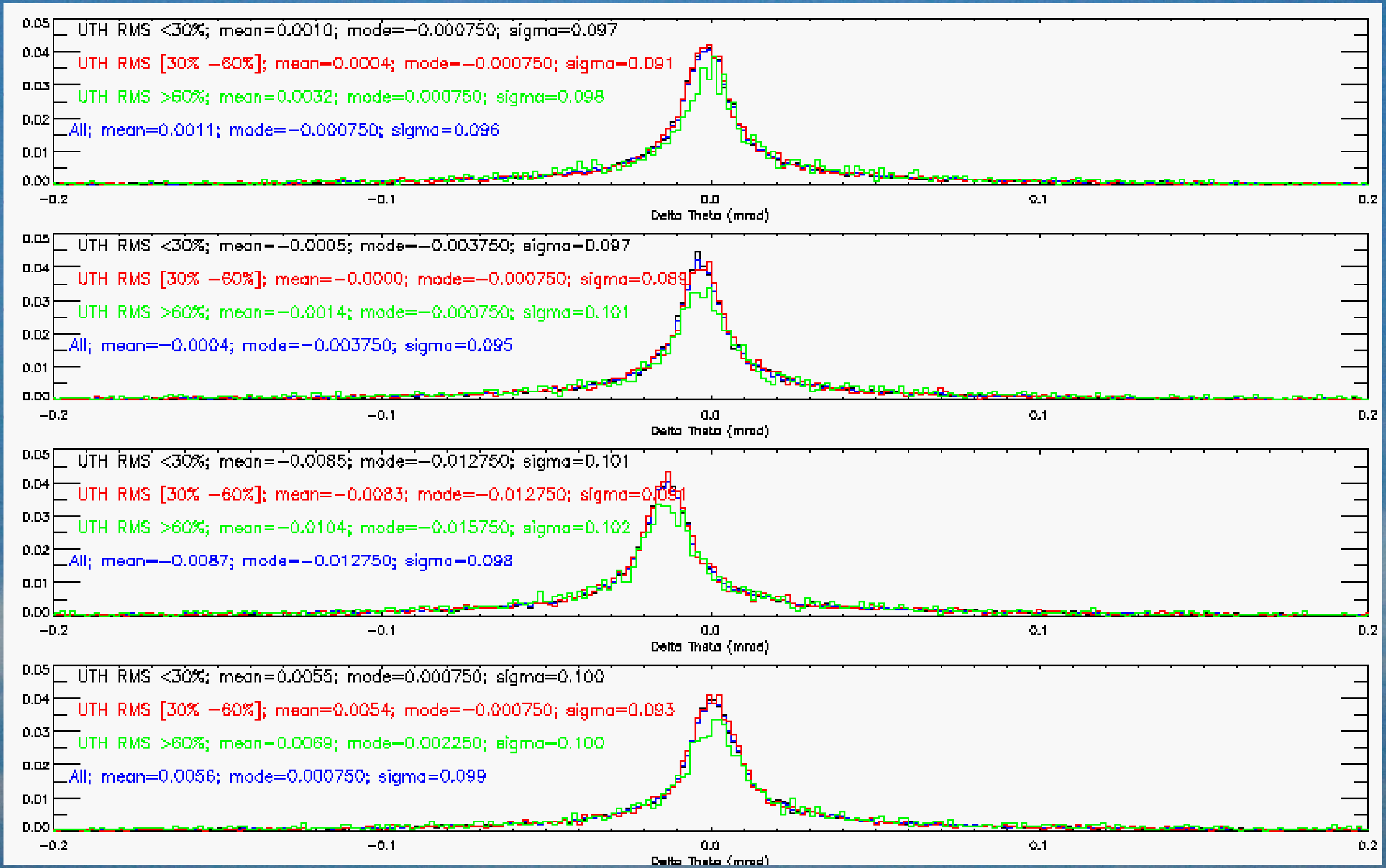
Examples of cases that are likely to pass Radiance Cloud Clearing QAs (high cloud contrast)

1) ONLY FOV 1 dθ gt 2, all others lt 1 sigma
2) ONLY FOV1 and FOV2 gt 2 sigma, all others lt 1 sigma



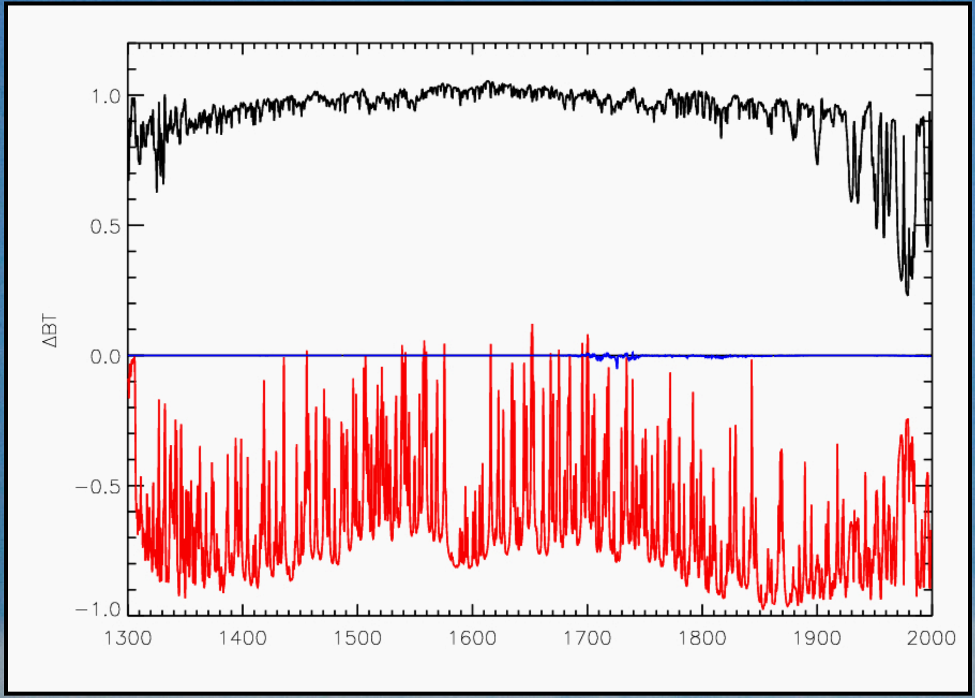
No significant correlation is seen to stand out

Centroids distribution conditioned by UTH statistics



No significant correlation is seen to stand out

Comparison with the sensitivity to temperature and water Vapor perturbations in 6.7 μm Band



1K temperature perturbation

10% water perturbation

10% ozone perturbation

- The retrieval uncertainty appears to be dominated by other sources of error
- The main assumption of the cloud clearing algorithm is that besides clouds, everything in the FOR scene is homogeneous. This is a much broader assumption than the unperturbed ILS one; i.e. water vapor in the FOR can vary up to 10% and more.

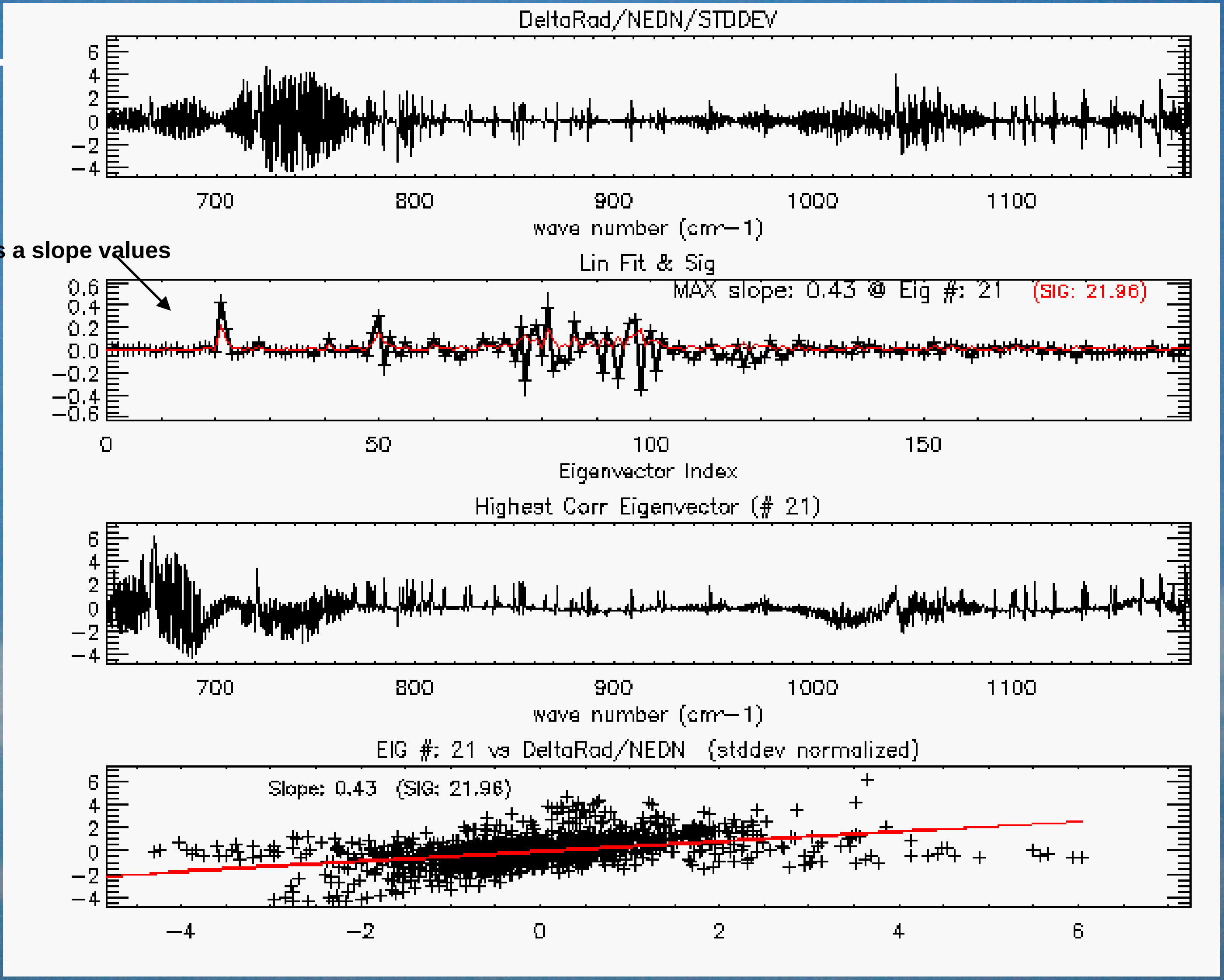
Final conclusions

- **<u>The analysis above indicates that the radiance error induced by the ILS shift in presence of clouds is negligible:</u>**
  - **The radiance error is by far smaller than the instrument noise for radiometric center offset values up to 3 sigma (band 1), 2 sigma (band 3) and 1 sigma (band2) of the overall offsets distributions.**
  - **In retrieval space, there does not appear to exist any correlation among angular offsets and retrieval biases of SST, UTH, CH4, etc (not shown) wrt ECMWF or climatology. This is possibly due to:**
    - **the presence of other factors dominating the uncertainty in the retrievals**
    - **no preferential distribution in angular offsets across the 4 FOVs (all 4 are centered around zero angular offset) such that the effect is likely to be averaged to zero during cloud clearing.**
  - **Angular offsets can still be monitored off line in order to build an ad hoc rejection flag (under study).**

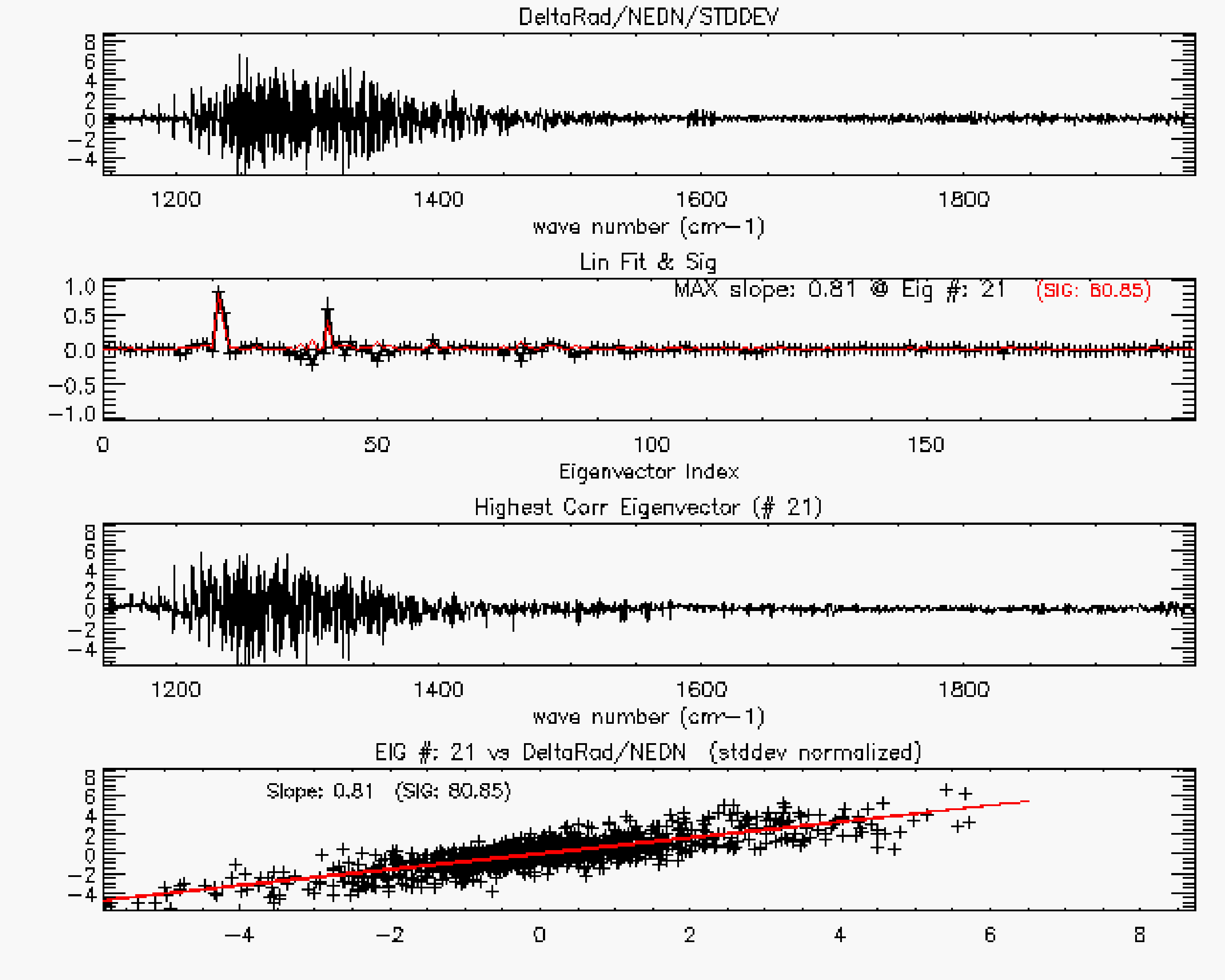
BACK UP SLIDES

Band 1, Gran # 393

Each black point is a slope values



Band 2, Gran # 393



Band 3, Gran # 393