Impact of Thermal Scene Inhomogeneities on IASI Spectral Response and its Correction

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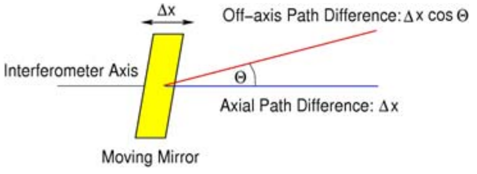
EUMETSAT

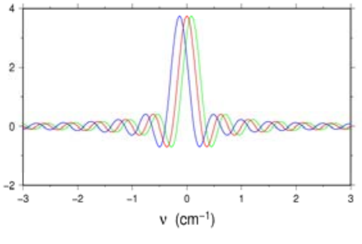
Off-axis Path Difference



The off-axis path difference is less than the axial one, implying two effects:

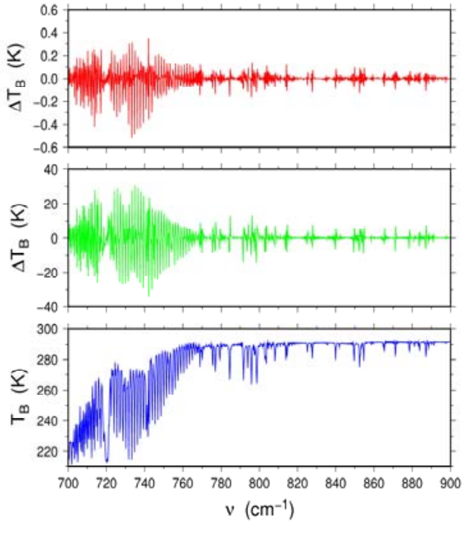
- Broadening of the spectral response function due to the reduced maximum optical path difference: factor 1/cos Θ
- Shift of spectral response function from ν_0 to $\nu_0 \cos \Theta$ due to linearity of Fourier transform

Shift of Spectral Response Function



Three response functions are shown for the centre of an IFOV (red), the IFOV border closest to the interferometer axis (blue), and the IFOV border farthest from The interferometer axis (green).

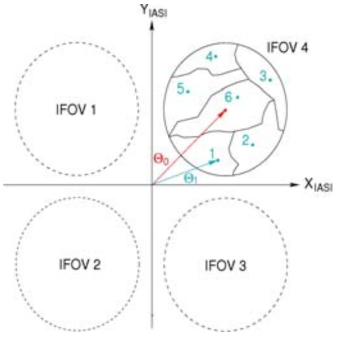
Variation of Measured Spectra across IFOV



Homogeneous scene:

- Brightness temperature spectrum at IFOV centre
- Difference between spectra measured at inner and outer border of IFOV
- Difference between spectra at IFOV centre and average over IFOV

Scene Inhomogeneity



IFOV 4 contains 6 different homogeneous scenes, with an indication of their centres of gravity. The interferometer axis is in the centre of the X_{IASI},Y_{IASI} -plane.

Correction of Spectra

Radiance in channel i for $n=1,\ldots,N$ cloud/surface formations within IFOV:

$$R_i = \sum_{n=1}^{N} \int_{\nu=0}^{\infty} d\nu \iint_{IFOV} R_{\nu,n}(x,y)\Phi(\nu,\nu_0,x,y)dxdy$$

Fractional cloud/surface formations within FOV:

$$\alpha_n = \iint_{FOV(n)} dxdy \Big/ \iint_{IFOV} dxdy$$

ISRF of cloud/surface fraction f_n:

$$f_n = f(\bar{\theta}) + \frac{\partial f}{\partial \nu}\frac{\partial \nu}{\partial \cos\theta}\Delta\theta$$

Correction for radiance in channel i:

$$\varepsilon_i = \sum_{n=1}^{N} \alpha_n (\cos\theta_n - \cos\bar{\theta}) \int_{\nu_i-\Delta\nu/2}^{\nu_i+\Delta\nu/2} R_n(\nu')\frac{\partial\Phi(\nu'-\nu_i)}{\partial\nu'}d\nu'$$

Discretisation:

$$\varepsilon_i \approx \sum_{n=1}^{N} \alpha_n (\cos\theta_n - \cos\bar{\theta}) \sum_{l=i-30}^{i+30} R_{n,l}\frac{\partial\Phi_i(l)}{\partial\nu}\Delta\nu$$

Approximation using AVHRR Ch.4 mean cluster radiance:

$$R_{n,l} \approx B_l(T_{AVHRR,n}) \quad \text{if} \quad T_{b,l} > \min(T_{AVHRR,n}, n=1,\ldots,N)$$

$$R_{n,l} \approx 0 \quad \text{else.}$$

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