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MAG: PSF bouncing effects

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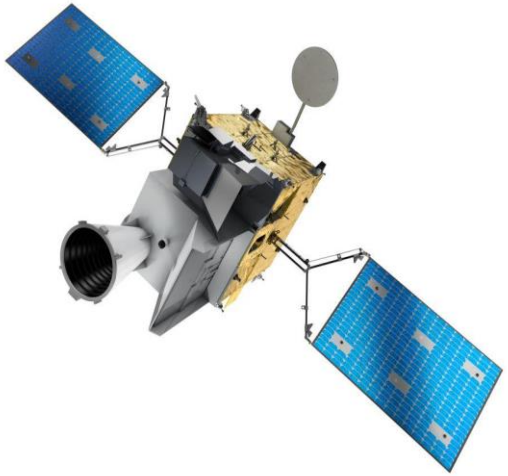
Introduction

- Optical ghosts (or signal bouncing) are expected on IRS, specially in MWIR,

- Development of a tool enabling to assess their impacts,

- Three possible impacts are discussed,

- Preliminary study, waiting for the PFM- PSFs.



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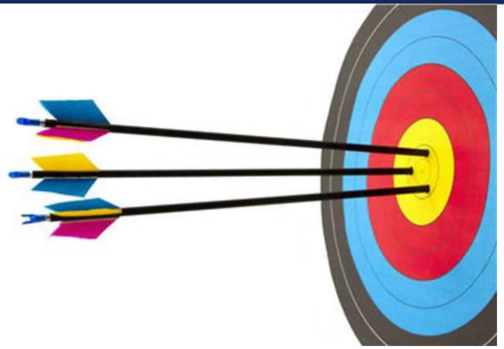
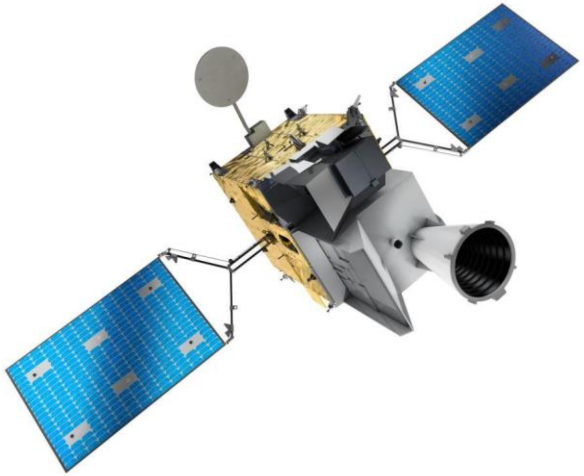
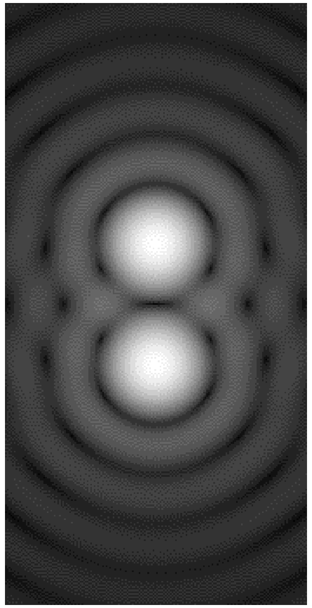
Outline

- Introduction
- Super-pixel PSF Description
- Spatial Resolution and Intra-band Co-registration
- Spectral calibration
- Conclusion





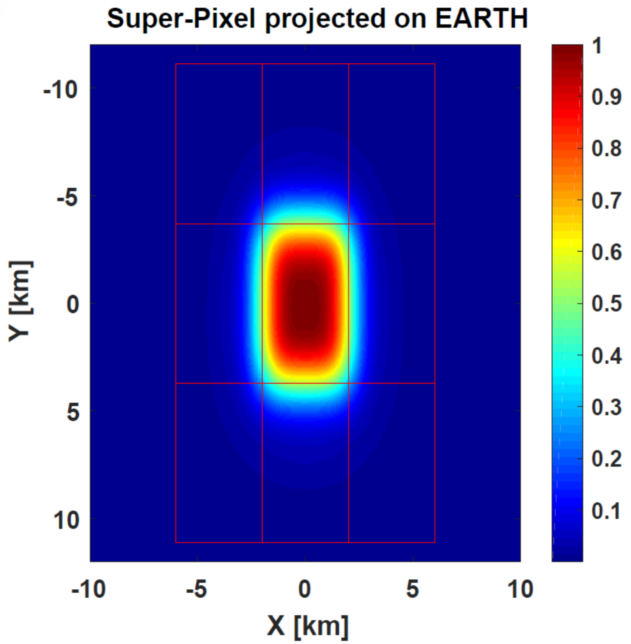


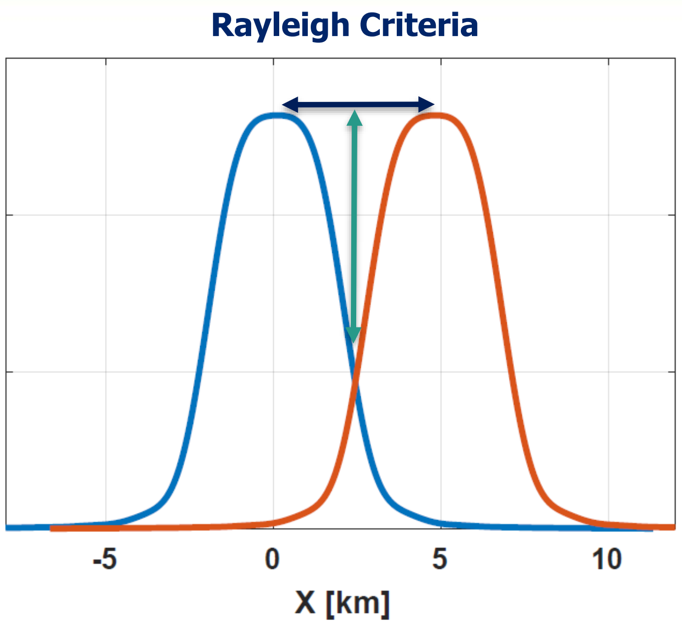
Super-pixel PSF Description without Straylight

- **From: MTG-KT-IR-MA-0001/ MTG-KT-IR-RP-0036 (CDR data-pack)**

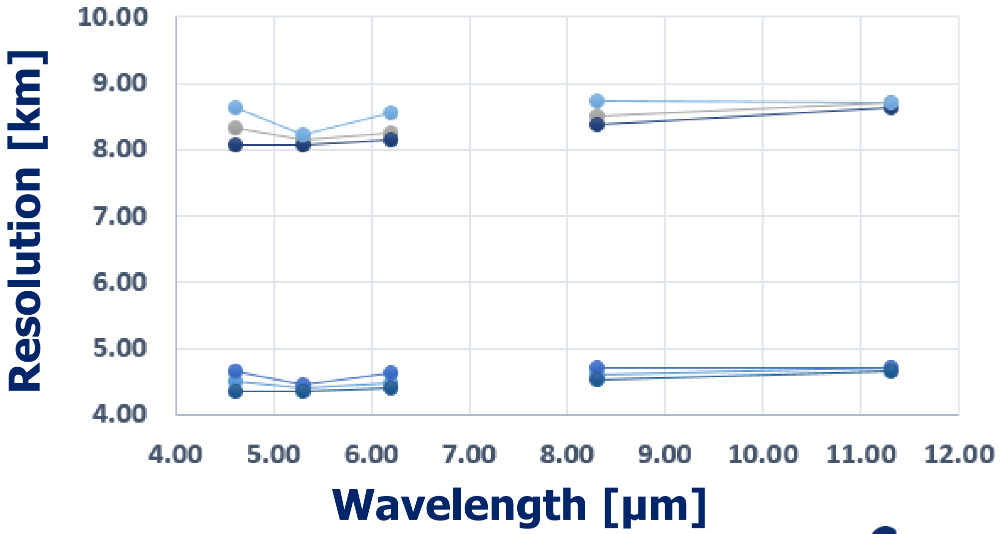
- **Focus on Europe (~Paris) @11.3µm:**
  - Pixel = 90 µm (4x4km)
  - Longitude = 0^o (X)
  - Latitude = 50^o (Y)

- **Low dependency on wavelength and FOV :**
  - Pixel size limited





Wavelength [µm]	4.60	5.30	6.20	8.30	11.30
Rayleigh X [km] (Min - Mean - Max)	4.67	4.45	4.63	4.72	4.72
	4.51	4.41	4.47	4.60	4.71
	4.36	4.36	4.41	4.54	4.67
Rayleigh Y [km] (Min - Mean - Max)	8.64	8.23	8.56	8.73	8.72
	8.34	8.16	8.26	8.50	8.71
	8.07	8.07	8.15	8.39	8.64



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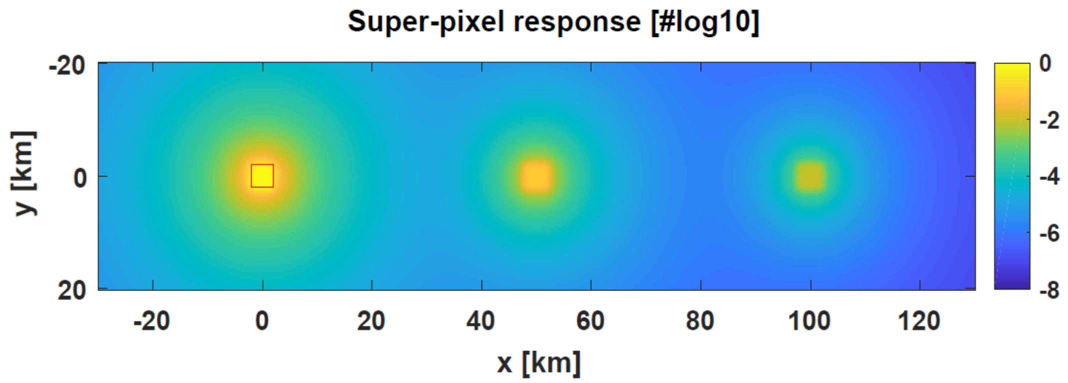
Super-pixel PSF with Bounding (ghosts)

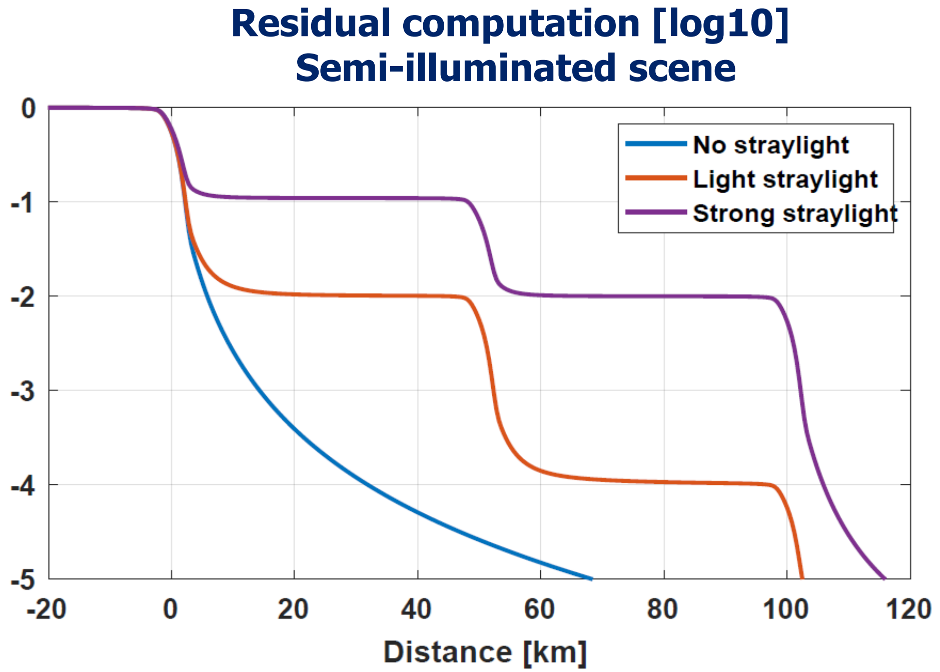
- **04/06/2020: No PSF available**

- **Requirements:**
  - Residual: 1% at 50km and 0.5% at 100km (IRS-URD_1017)

- **Information:**
  - 50km bouncing
  - 100km straylight requirement close to be fulfilled

- **Two scenarios have been considered:**
  - Light straylight: 1% bouncing signal, requirements ok
  - Strong straylight: 10% bouncing signal, requirement 50km, 100km ~x2 spec



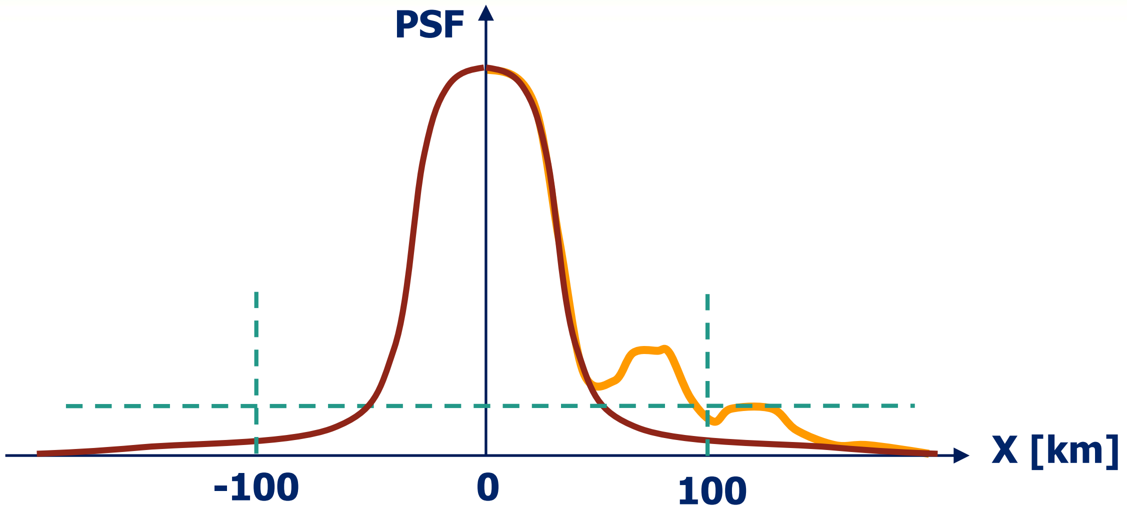


Spatial Resolution and Intra-band Co-registration

1) Spatial Localization

- Symmetry break = not usual straylight,
  -> Decreasing pedestal ≠ bouncing,
  ex: point source localization.

- Few % ghosts are expected to be visible in one Dwell for a single wavenumber (since SNR ≤ 100)



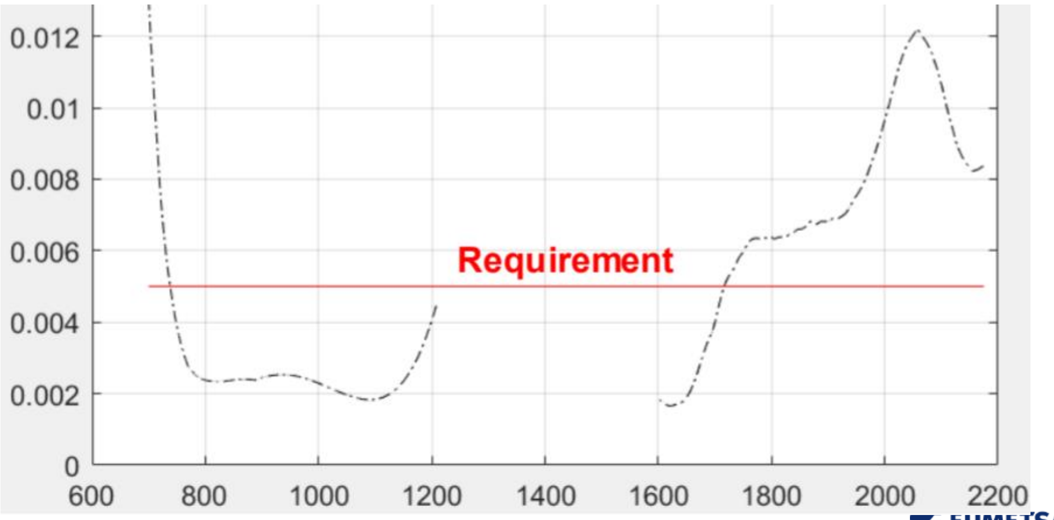
2) Intra-band co-registration

- Ghosts amplitude depends on the wavenumber !
  -> LOS = PSF barycentre function of the wavenumber endangering the intra-band co-registration:

  - Light straylight: Shift = 0.5km
  - Strong straylight: Shift = 6km

  Requirements (IRS-URD_1019) : <0.4km (1σ)

Residual computation @100km



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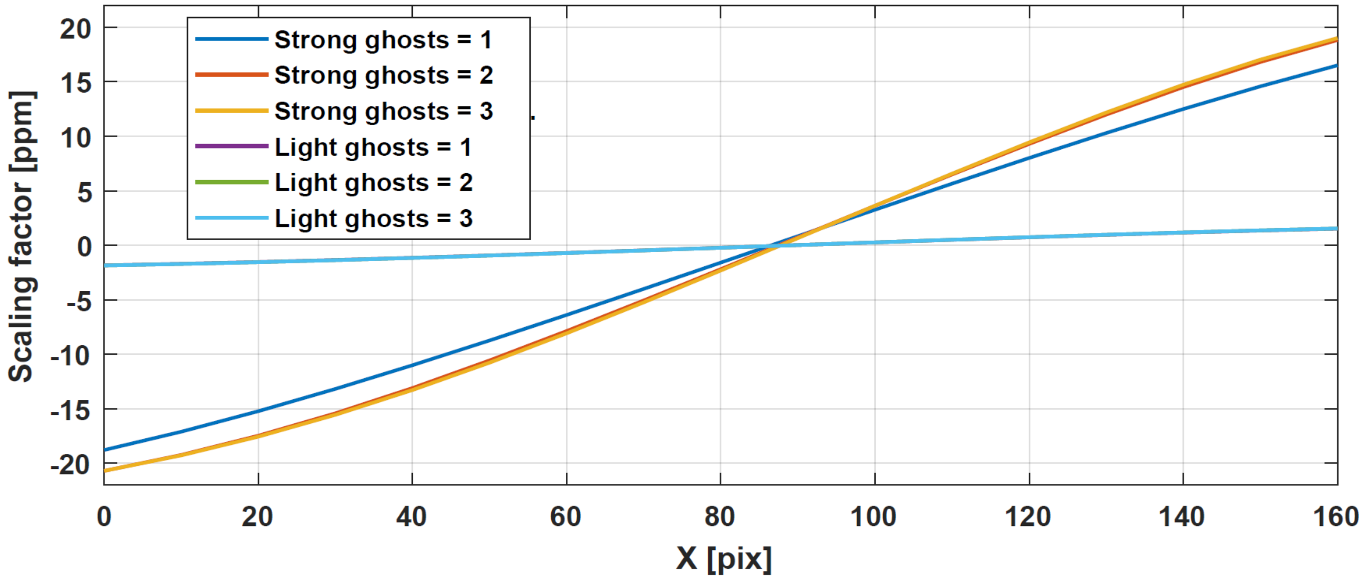
Spectral Calibration

1) Spectral calibration biais

$$Sp_{tot}(\nu) = Sp(\nu) + \sum_{g=\,ghosts} \alpha_g\, Sp\left(\nu \times \left[1 + SF_g\right]\right)$$

- Barycentre shift = wrong OPD correction = spectral rescaling
  -> **Mixing signal with different OPD on the same pixel:**
  (uniform scene)



- + Wavenumber dependency : $\alpha_g(\nu)$!   **But, can be measured and corrected (gas cells)!**

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Spectral Calibration

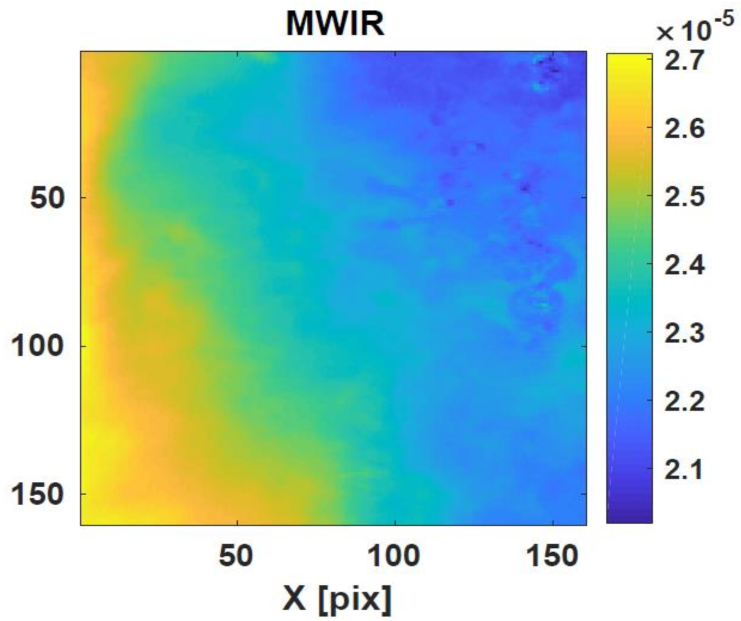
2) Spectral calibration jitter

- The ghost signal comes from a different position on earth than the main one.
  The spectral impact will be different for each pixel and scenes!

$$Sp_{tot}(\nu) = Sp_{nom}(\nu) + \sum_{g=\,ghosts} \alpha_g\, Sp_g(\nu \times [1 + SF_g])$$

  - Mixing hot main signal with cold ghost signal will have a low impact
  - Mixing cold main signal with hot main signal will have a greater impact.

- **Not corrected by the baseline spectral calibration scheme.**



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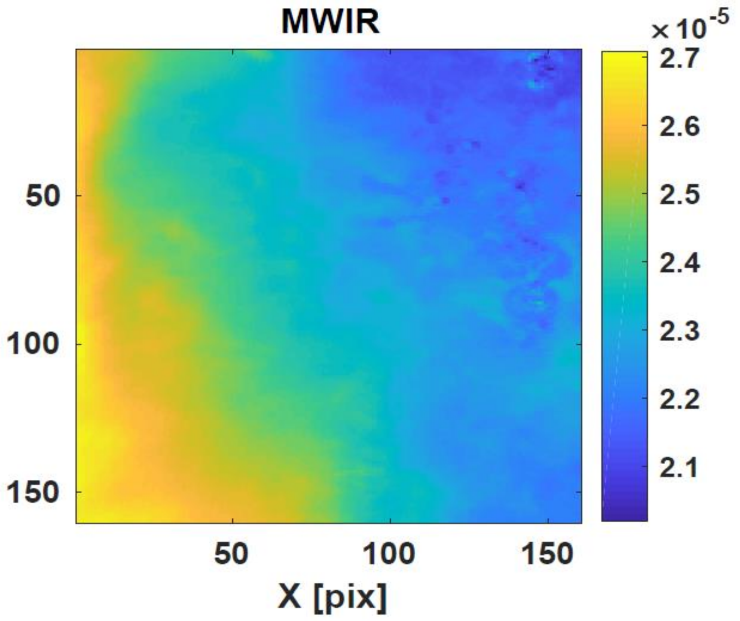
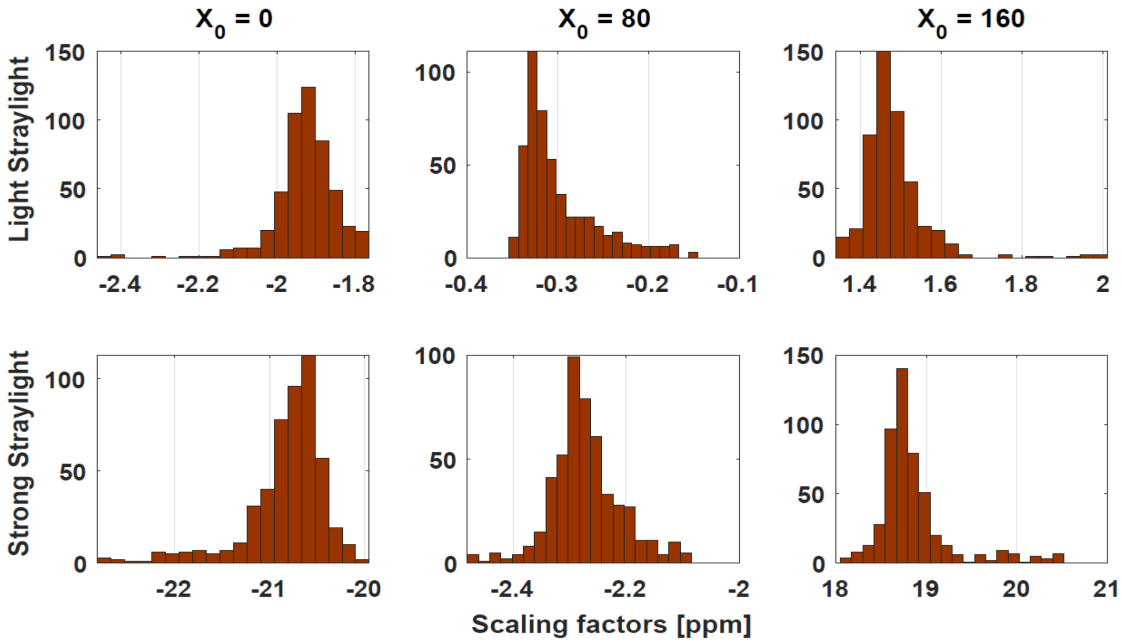
Spectral Calibration



Simulation

- Simulation on many sub-windows (with rotations) using ECMWF dwell processed to L1 level,
- With horizontal periodic limit conditions to simulate the worst cases = Nearby cold/hot scenes



Results

- Up to a few ppm jitter on detector edges for the strong straylight scenario.

  Requirement: <1ppm (1σ) MWIR (IRS-URD_478)

- \+ wavelength dependency = chromatism not simulated.

Conclusion

Bouncing impacts

- One direction ghosts with an amplitude ~ a single wave-number radiometric noise,
- Strong dependency with the wavenumber,
- Barycentre shifts function of wavenumber, threaten the intra-band co-registration,
- Spectral calibration jitter (up to a few ppm).

➔ Other requirements could be impacted by the in-field straylight,
<u>not only</u> the one specifically on the straylight itself.

Conclusion

Discussion

- Wait for the PFM PSFs + OHB assessment late June

- The strong wave-number dependency would make it really hard to correct (Timeliness issues, exact bouncing knowledge…)

- Adaptation of the spectral calibration strategy ?
  -> No more at pixel level to reduce the scene variability ?