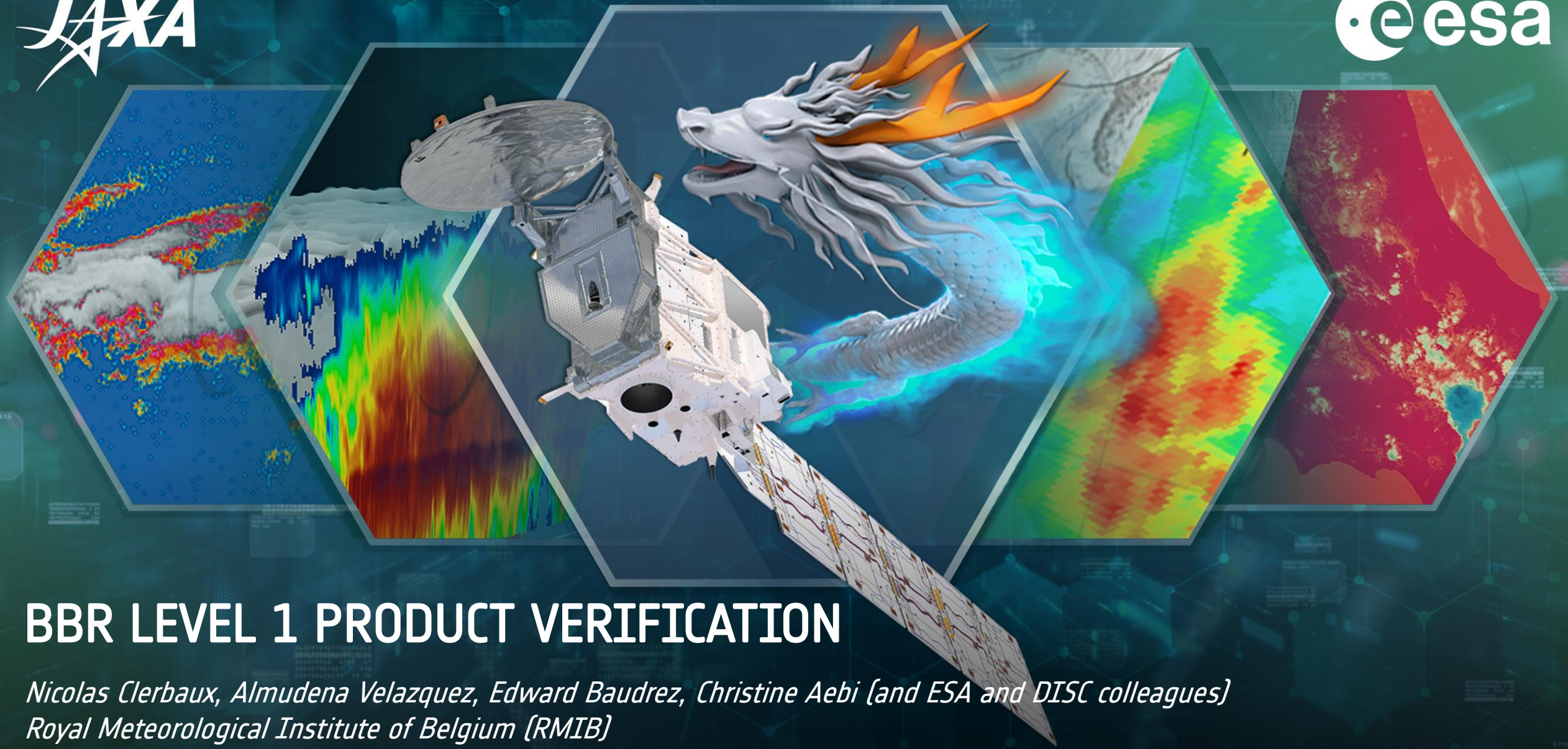

BBR LEVEL 1 PRODUCT VERIFICATION

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Royal Meteorological Institute of Belgium (RMIB)

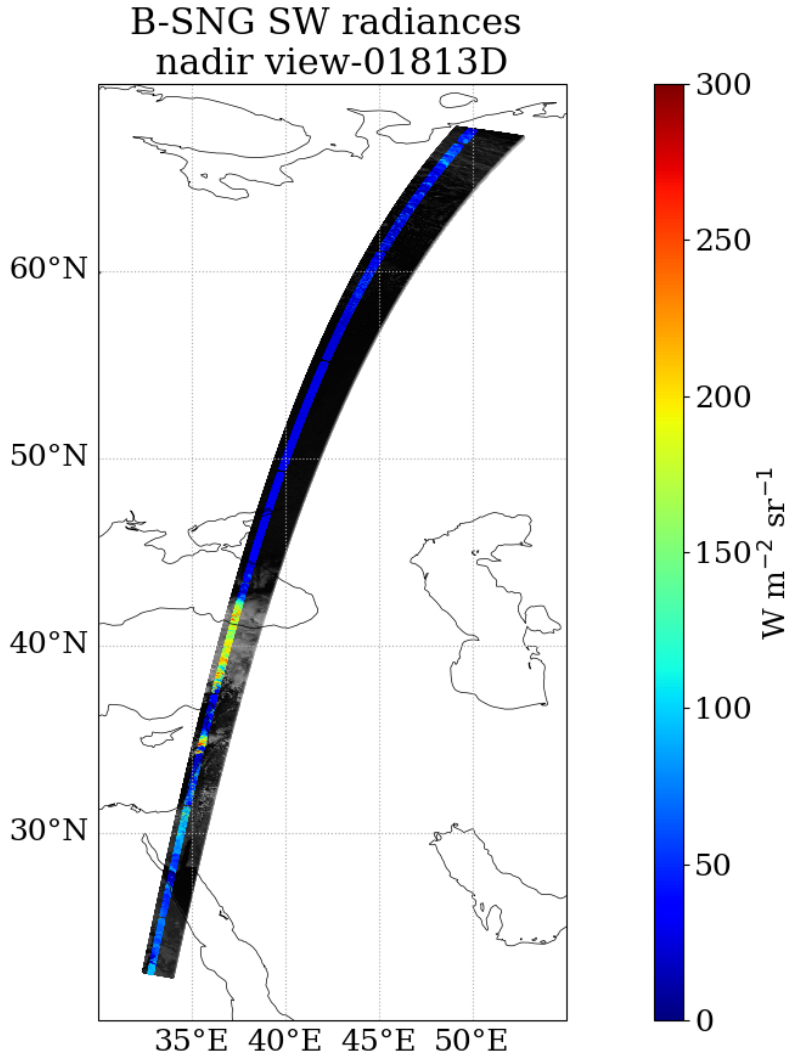
1st ESA-JAXA EarthCARE In-Orbit Validation Workshop
14 – 17 January 2025 | VIRTUAL EVENT

Content : B-SNG PRODUCT VERIFICATION

- Overview B-SNG product
- BBR sampling
- BBR calibration strategy
- B-SNG detector noise analysis
- B-SNG detector radiometric consistency analysis
- B-SNG comparison with CERES FLASHflux
- Summary

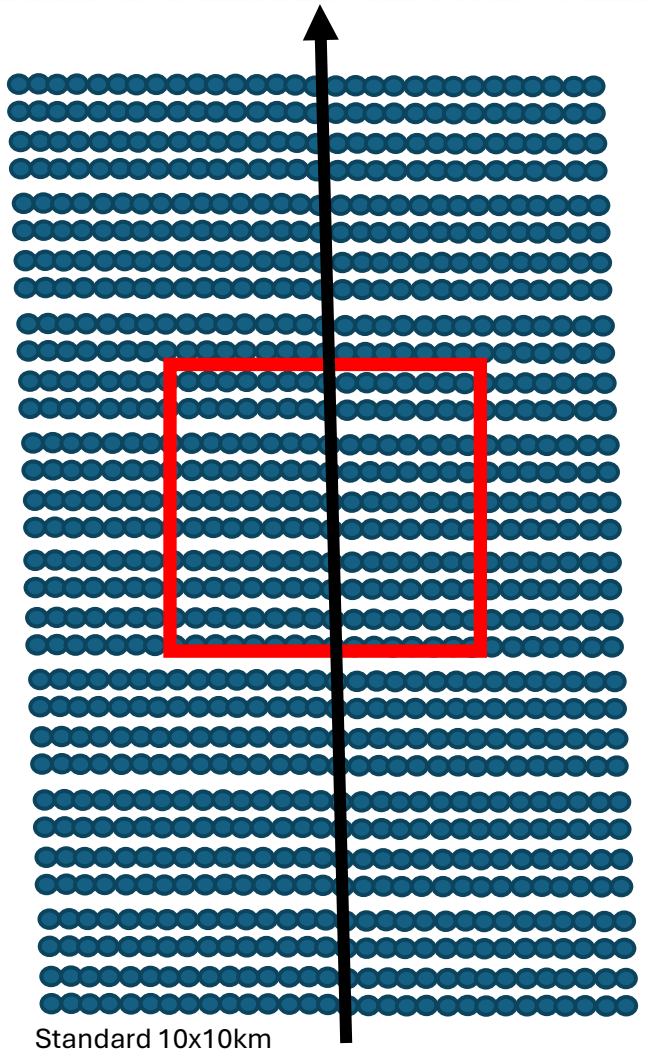
Note : next talks on

- BBR geolocation evaluation
- B-NOM level 1 product evaluation
- BM-RAD and BMA-FLX products evaluation



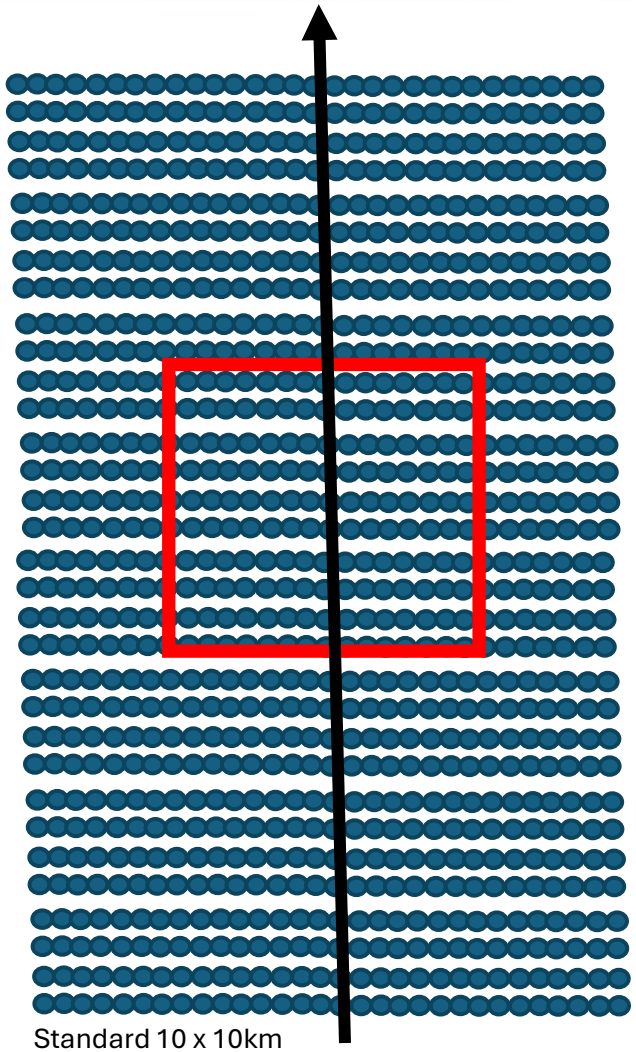
Overview B-SNG Product

- 3 views along-track: aft, nadir, fore
- 30 detectors for each view
- 2 interleaved spectral bands: TW, SW (quartz filter)
- BBR instrument operated at 70% of the CDM speed (configurable). For a same band (TW or SW):
  - dt = 0.1532 sec
  - along track sampling ~1113m
- Initially B-SNG was not foreseen to be released as a product (only B-NOM).
- B-SNG interesting for integration over other domains (e.g. the elongated assessment domain)
- B-SNG provides filtered TW and SW radiances



Standard 10x10km
nadir : 16 * 9 pixels
Aft/fore : 10 * 9 pixels

B-SNG Sampling distance (CDM of 70%)



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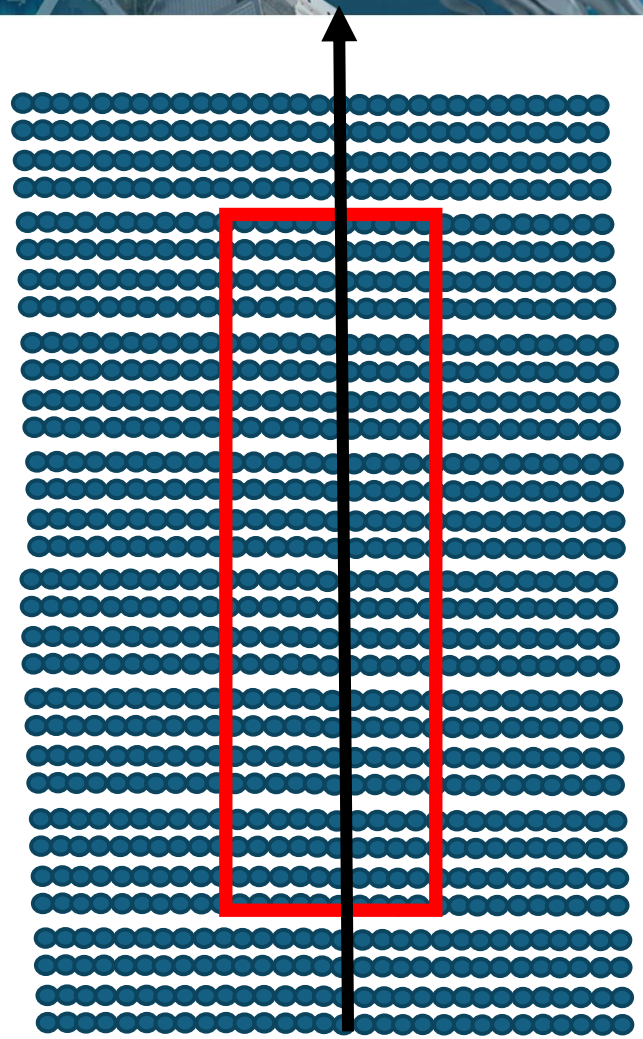
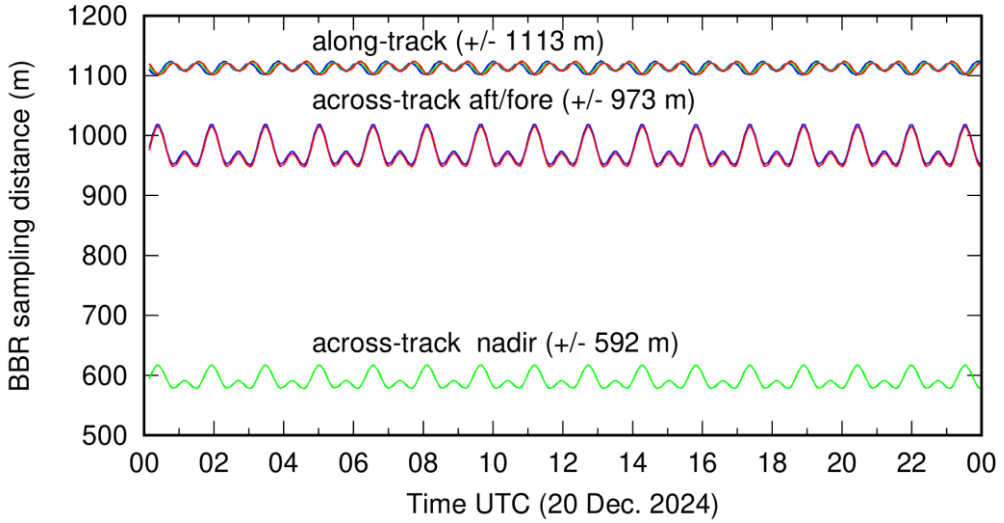


Assessment Domain 5 x 21 JSG pixels(~km)
nadir : 8 * 19 pixels
Aft/fore : 5 * 19 pixels



View	Across-track	Along track
Aft	975m ± 21m [950m:1020m]	1113m ± 7m [1101m:1124m]
Nadir	592m ± 12m [577m:618m]	1113m ± 6m [1102:1122m]
Fore	971m ± 21m [946m:1016m]	1113m ± 7m [1101m:1124m]

BBR Calibration strategy

Longwave calibration each 88s

- Observation of 2 blackbodies -> gain and offset for each of the 3 x 30 detectors

Shortwave calibration, each 88s

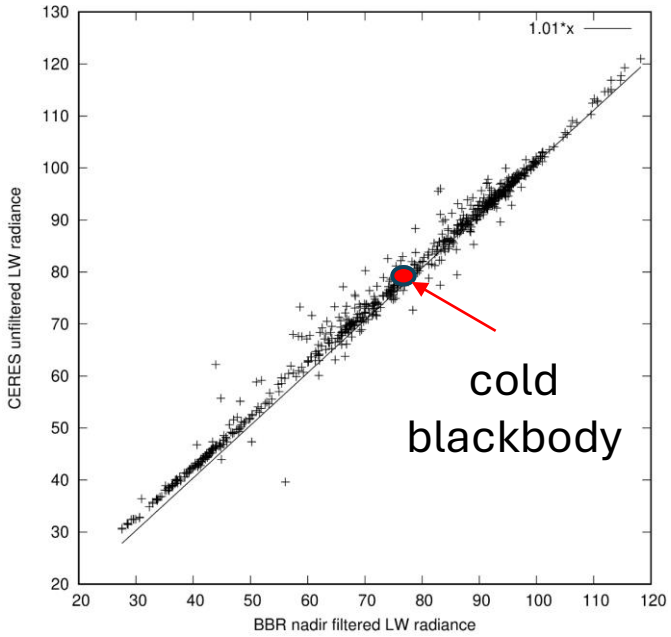
- Gain $G_{SW} = B * G_{LW}$ via 'constant' factors *B*
- Offset via observation of the cold blackbody

Shortwave calibration, every 2 months

- Monitoring using the sun NDM
- Spectral degradation via MPDs

-> Done but results not yet analyzed

warm blackbody



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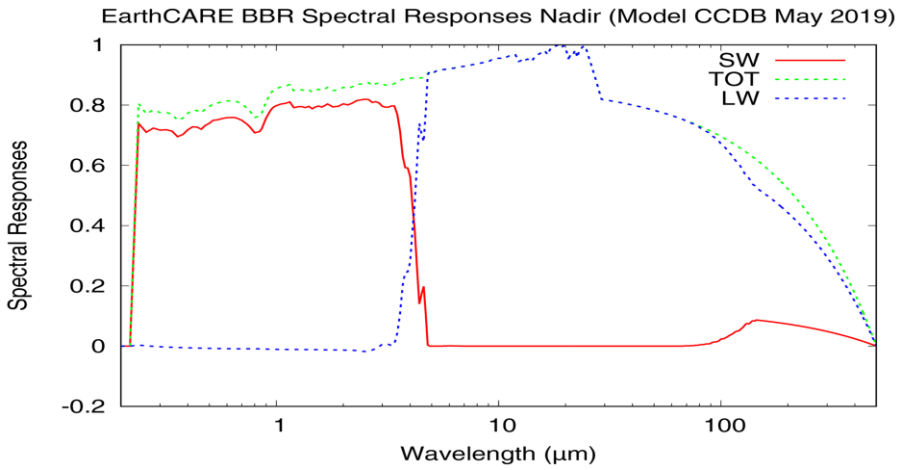
BBR Ground characterization

- "Relative" spectral responses (SW/TW, per view) R(λ)
- 'B' factors for each 30 nadir detectors

BBR filtered radiances definition for "normalized" spectral responses r(λ)!

- Not yet fully clear yet how the T_K have been calculated



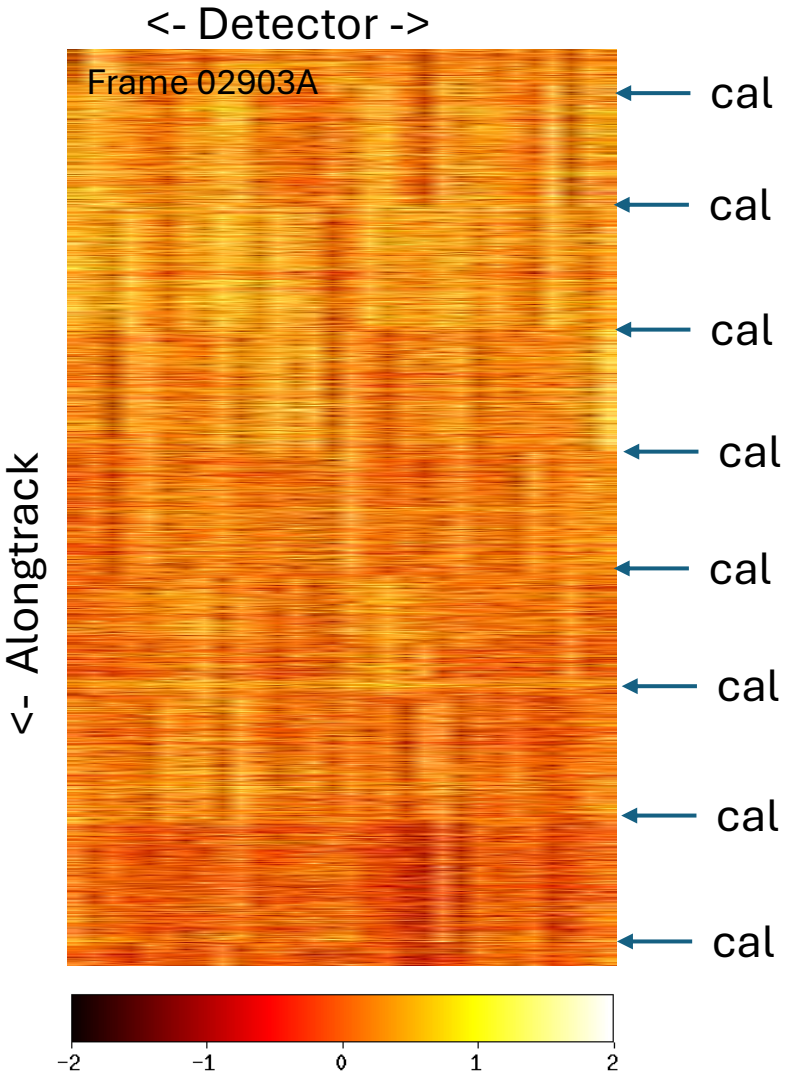
$$L^{f}_{\mathrm{TW}}(\mathrm{BB}) = \int_0^{\infty} L_{\mathrm{Planck}}(\lambda, t) r_{\mathrm{TW}}(\lambda)\, d\lambda,$$

$$r_K(\lambda) = \frac{1}{T_K} R_K(\lambda),$$

$$T_K = \frac{\int_0^{\infty} L_{ref}(\lambda) R_K(\lambda)\, d\lambda}{\int_0^{\infty} L_{ref}(\lambda)\, d\lambda}.$$

B-SNG detector noise

- Using nighttime SW images (frame ‘A’)
- Small overall bias due to thermal contamination (~0.15 $W/m^2/sr$)
- About $\varepsilon \sim 0.8\ W/m^2/sr$
  -> $\varepsilon \sim 0.75\ W/m^2/sr$ det. noise
  -> $\varepsilon \sim 0.30\ W/m^2/sr$ cal. noise



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  -> $\varepsilon \sim 0.75$ W/m^2/sr det. noise
  -> $\varepsilon \sim 0.30$ W/m^2/sr cal. noise
- Similar between the detector and stable, except:
  - Fore/det6 : "broken"
  - Nadir/det20 : bias low.
- Noise reduction in domains:
  - Standard domain (10x10km, i.e. 10/16 x 9 pix):

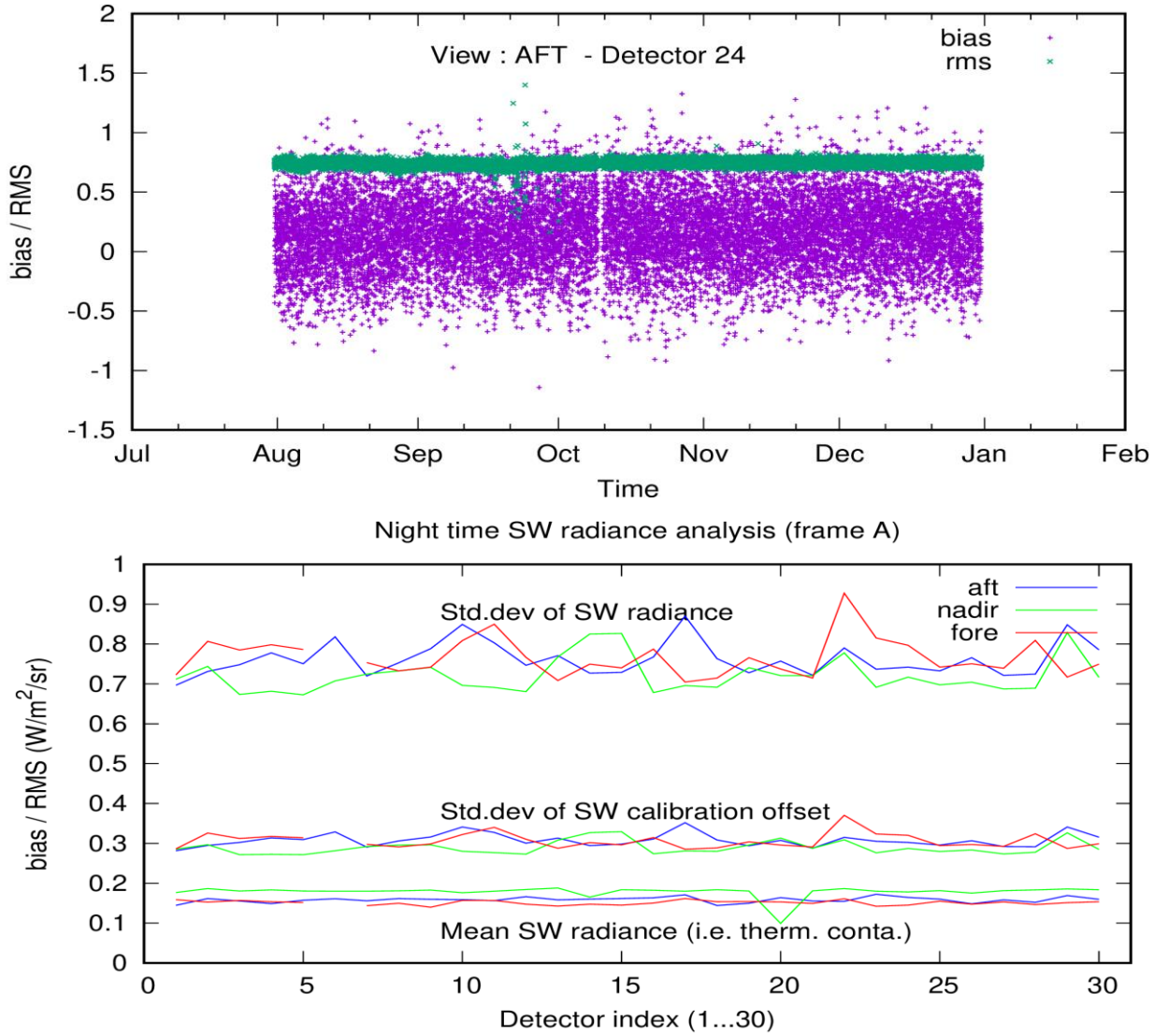
$$\varepsilon = \frac{0.75}{\sqrt{90}} + \frac{0.30}{\sqrt{10}} = 0.17 \text{ W/m}^2\text{/sr (aft/fore)}$$

$$\varepsilon = \frac{0.75}{\sqrt{154}} + \frac{0.30}{\sqrt{16}} = 0.14 \text{ W/m}^2\text{/sr} \quad \text{(nadir)}$$

  - Assessment domain (21x5km, i.e. 5/8 x 19 pix)

$$\varepsilon = \frac{0.75}{\sqrt{95}} + \frac{0.30}{\sqrt{5}} = 0.21 \text{ W/m}^2\text{/sr(aft/fore)}$$

$$\varepsilon = \frac{0.75}{\sqrt{152}} + \frac{0.30}{\sqrt{8}} = 0.17 \text{ W/m}^2\text{/sr} \quad \text{(nadir)}$$



B-SNG detector radiometric consistency

Input files: TW/SW over 19953 files (26 July 2024 to 5 Jan. 2025)

TW night :

- consistent detector LW calibration
- Consistent fore/aft views

SW day:

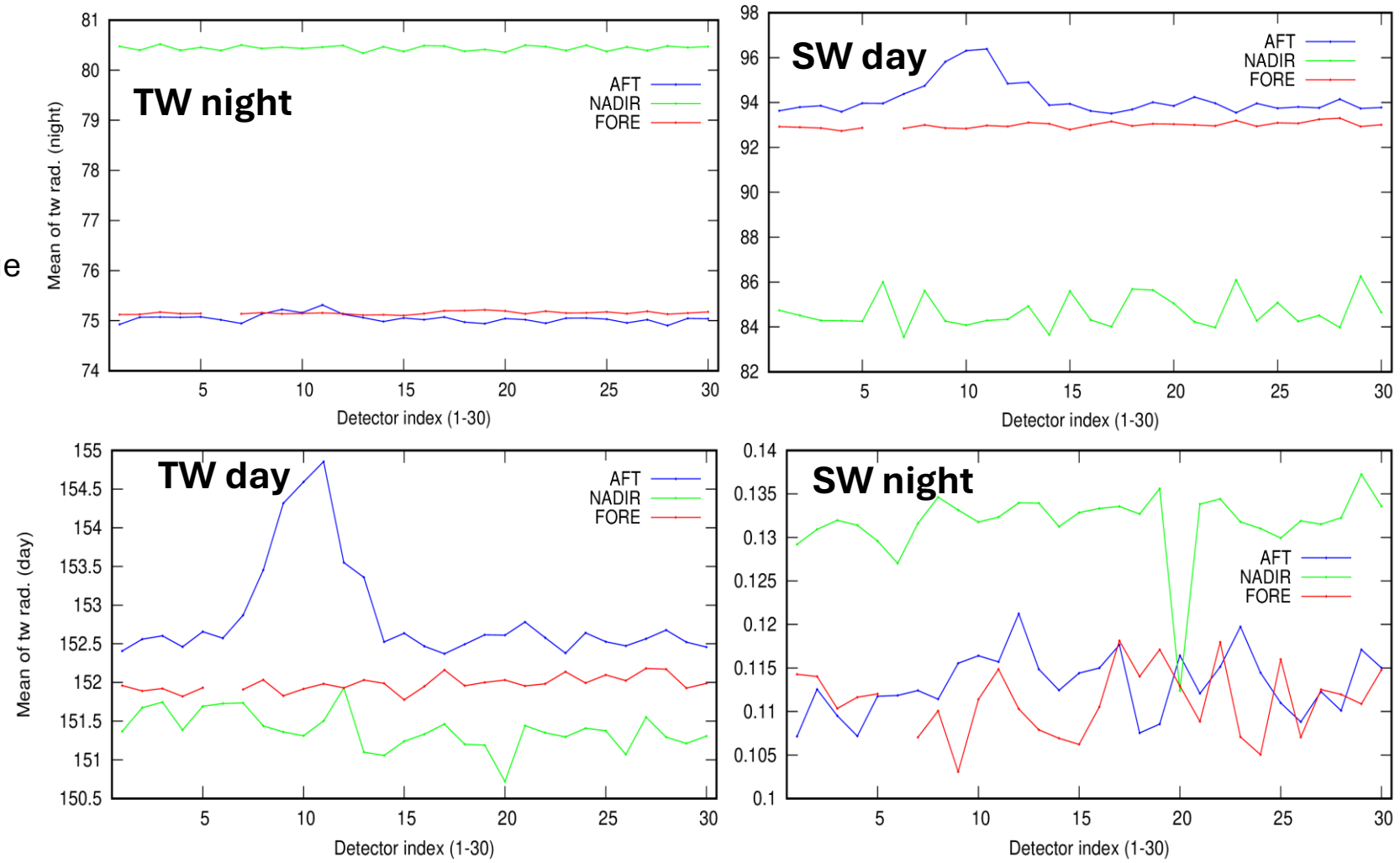
- Aft/det.8-13 too sensitive to SW
- Det-to-det variability for the nadir view (due to B factors)

TW day :

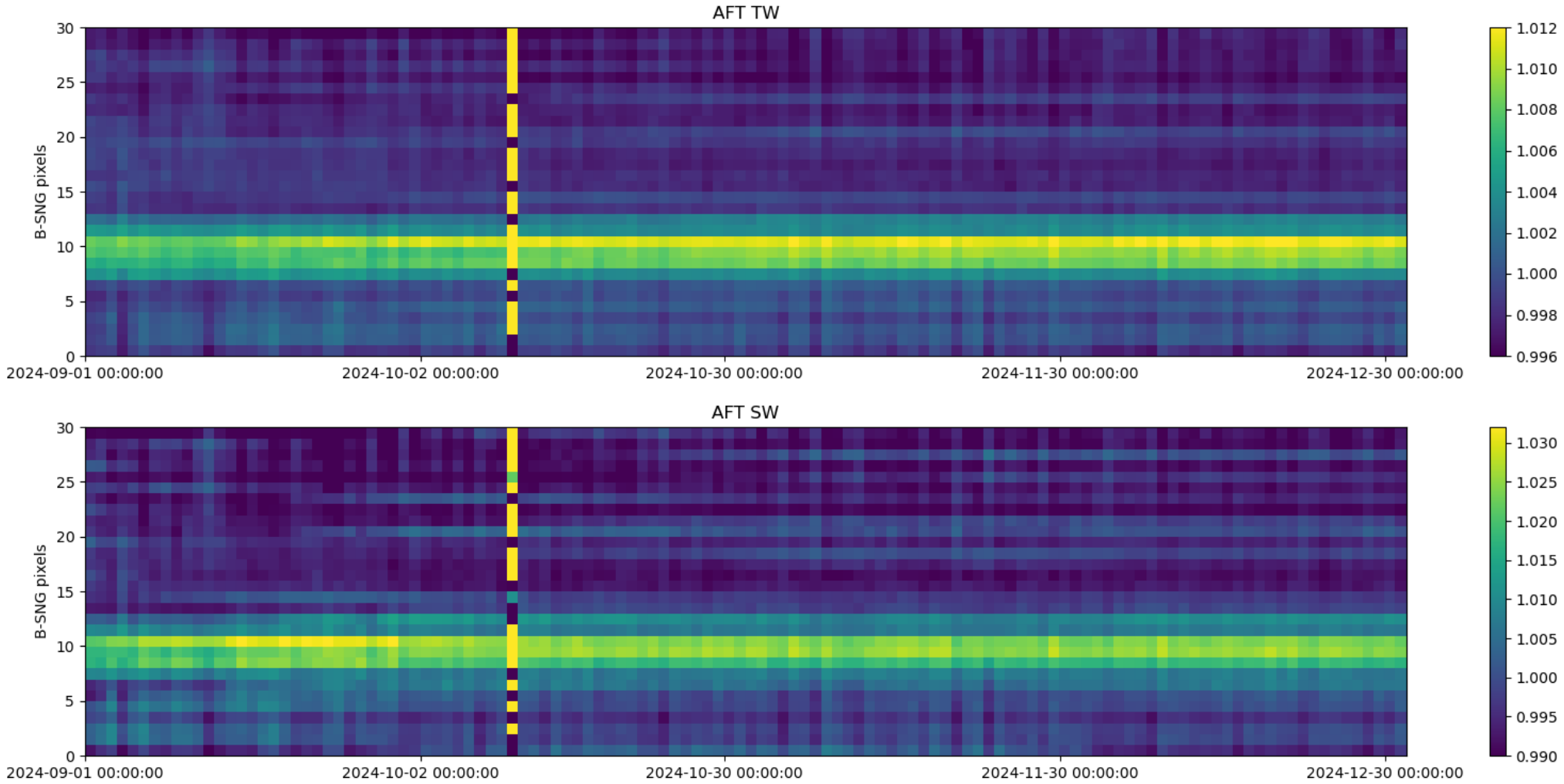
- Aft det. 8-13 too sensitive to SW
- Nadir variability (to be investigated)

SW night :

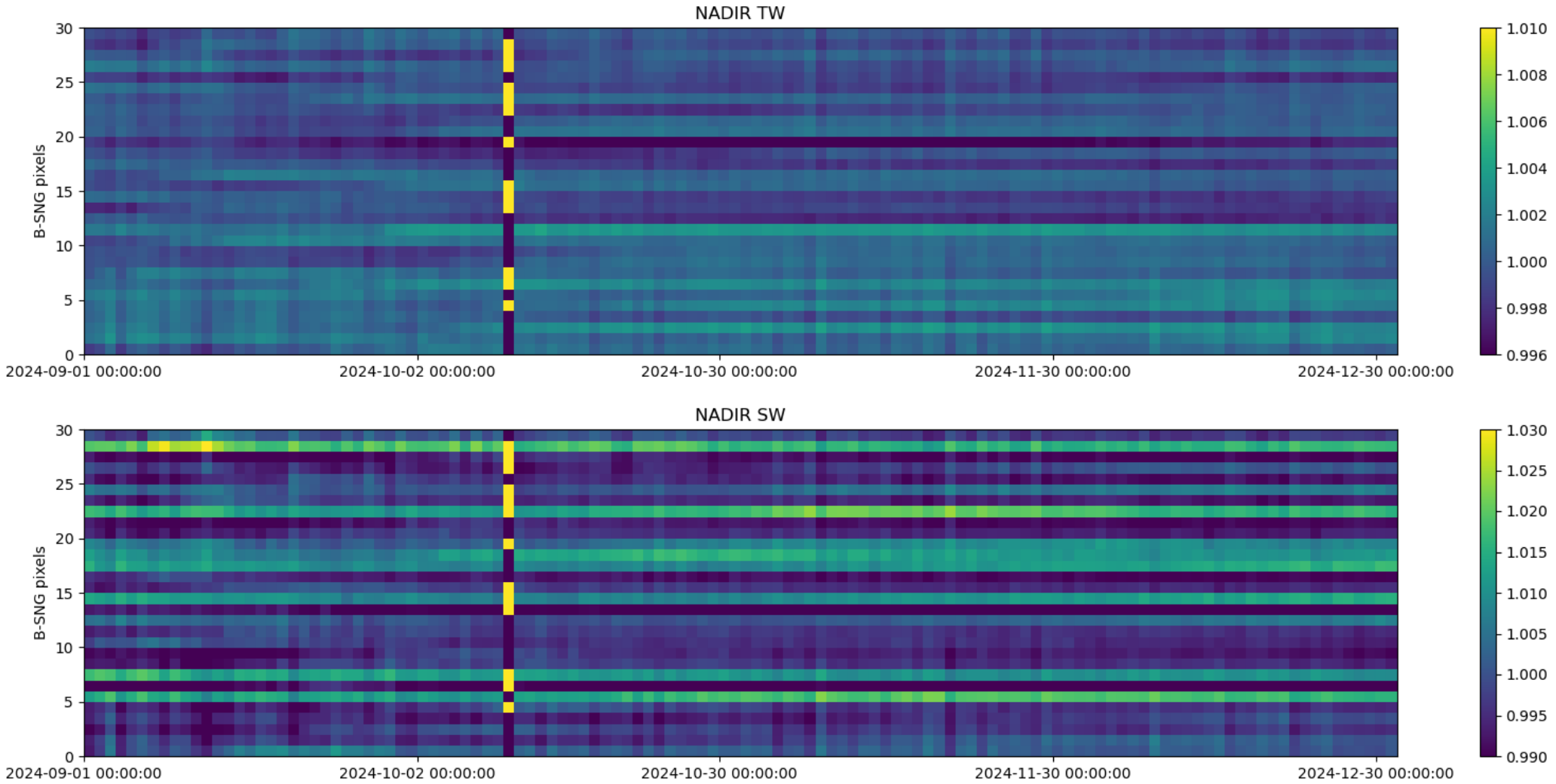
- Consistent with expected thermal contamination.
- Nadir/det20 to be investigated.



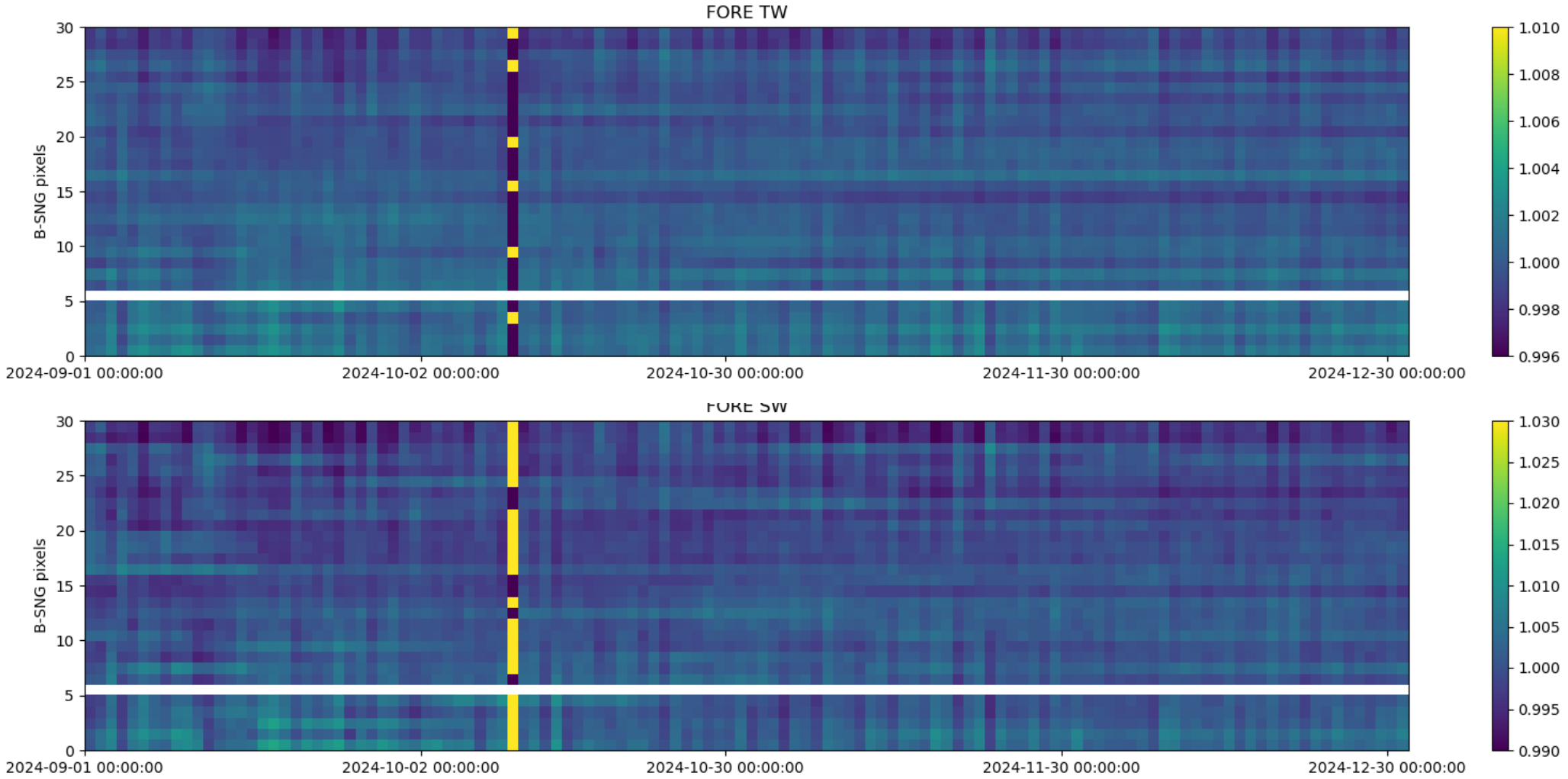
B_SNG detector radiometric consistency : daily analysis - AFT



B_SNG detector radiometric consistency : daily analysis - NADIR

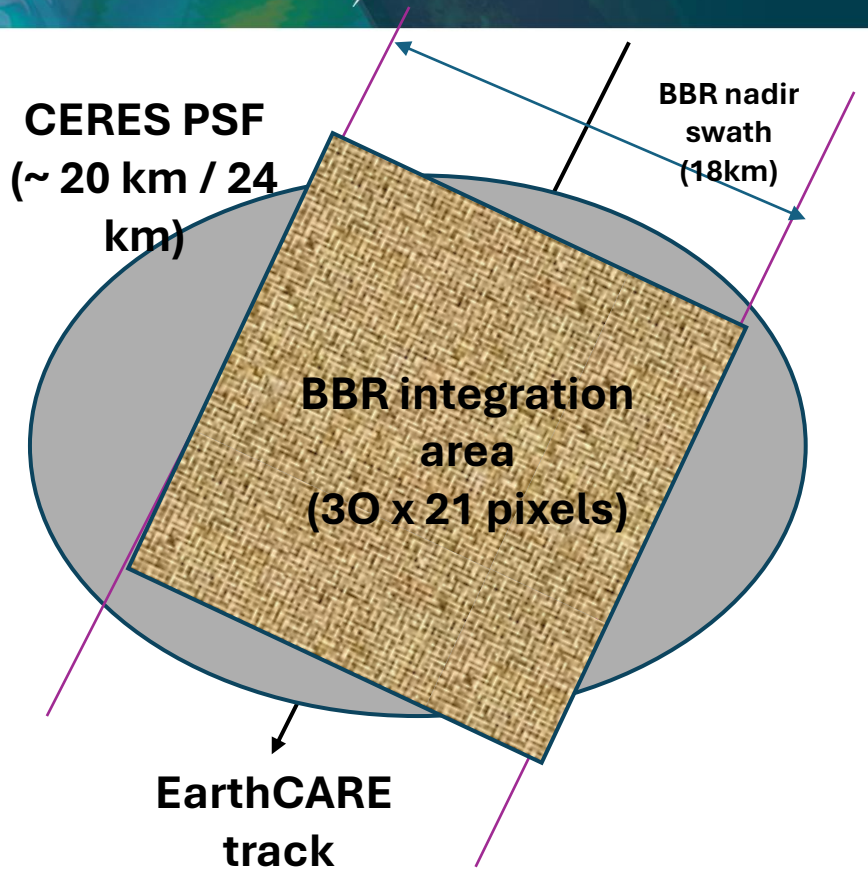


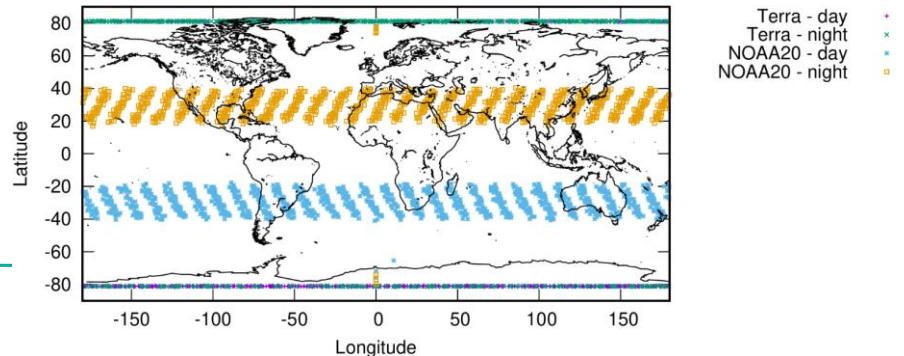
B_SNG detector radiometric consistency : daily analysis - FORE



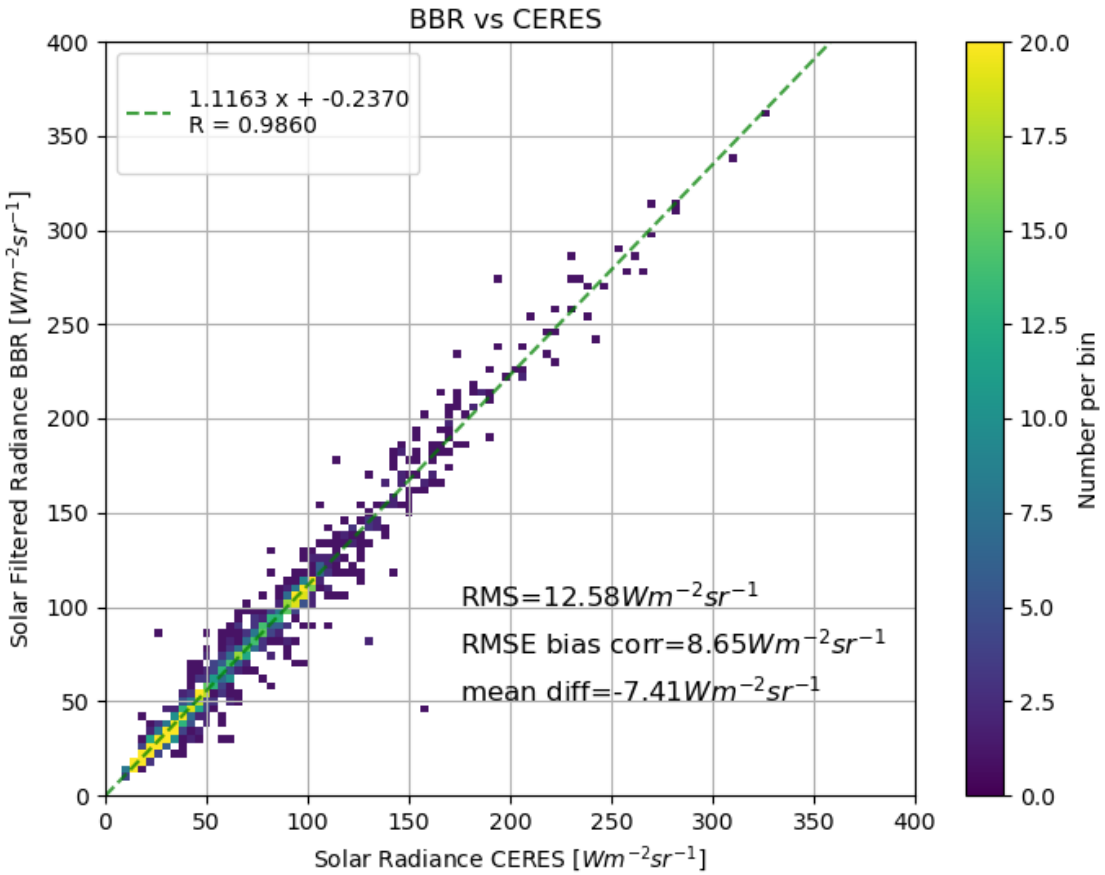
BBR-SNG Comparison with CERES FLASHflux - method

- CERES : Cloud and Earth Radiant Energy System
- Level 2 SSF (Single Scanner Footprint) product
- Currently only FLASHFlux (Fast Longwave And SHortwave Flux) products available from across-track instruments on:
  - FM1 on Terra (morning)
  - FM6 on NOAA20 (afternoon)
- CERES PSF of ~20 km (Terra, Aqua) or ~ 24 km (SNPP, NOAA20) -> larger than the BBR swath (~18km)
- B-SNG integration area : 30 (across track) x 21 (along-track)
- Collocation criteria
  - Time difference < 300 seconds
  - distance between PSF centers < 3km
  - Angle between viewing directions < 3°
- Dates : 10 Aug. 2024 – 04 Jan. 2025

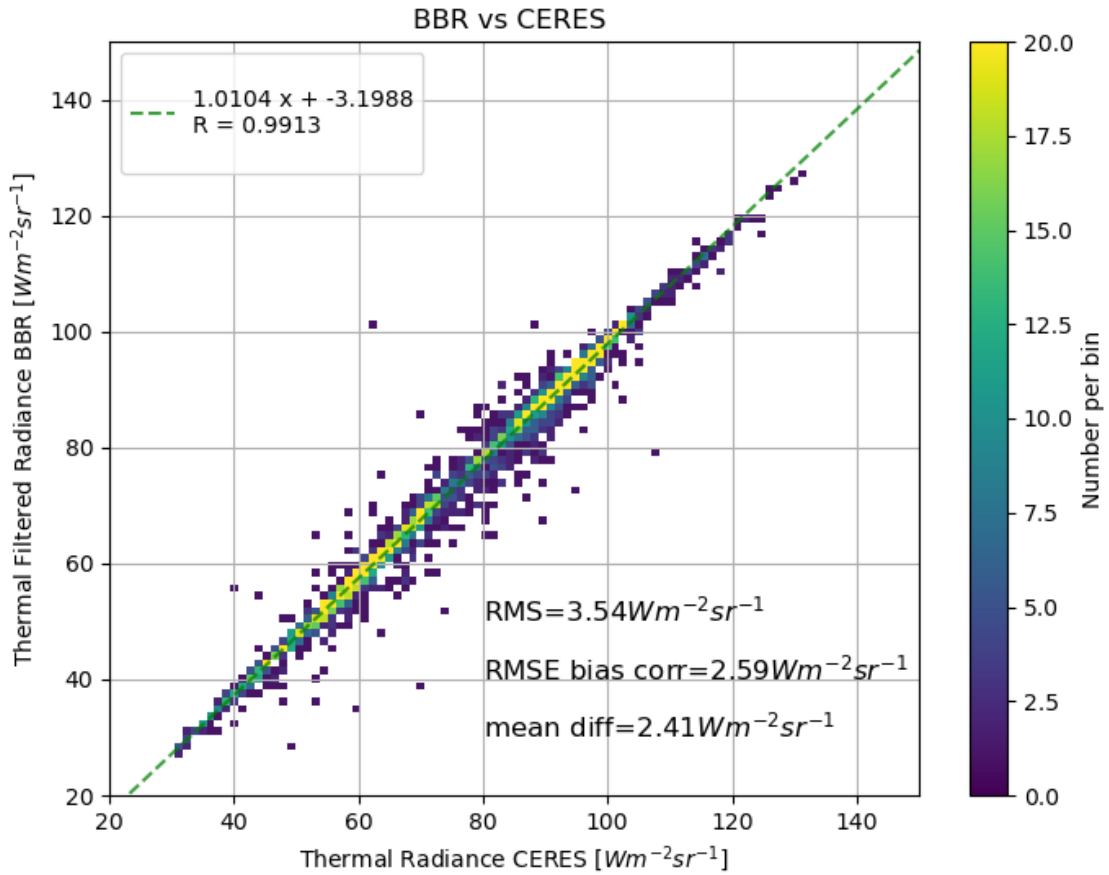




B-SNG Comparison with CERES FLASHflux - Results



SW brighter ~9%



LW lower ~ 2.4 W/m^2/sr

Summary - B-SNG L1 product

- Overall good quality and excellent availability since 26/06/2024, main interruptions are for calibration:
  - LW calibration during ~4s each 88s
  - SW calibration each 2 months (at high latitude)
- Important detector noise level but reduced in domain integration
- Detectors radiometric consistency: recommend to unpated the ‘B’ factors to improve the consistency
- Aft and fore views look consistent, no evidence of problem with the nadir view
- Significant difference wrt CERES FLASH flux:
  - SW too bright -> likely due to the ‘B’ characterization
  - LW too low and scene type dependency -> investigations needed.