Overview of MSI Level 1 validation by ECVT (AO PIs) - Discussion

EarthCARE Status – May 2021

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MSI Level 1 validation proposals

- **MMP : Monitoring MSI/EarthCARE L1 performances using concomitant intercalibration and stand-alone approaches (Noelle SCOTT, LMD, Palaiseau, France)**

- **GIVE : German Initiative for the Validation of EarthCARE (Ulla Wandinger, Tropos, Leipzig, FUB, Germany)**

- Validation of EarthCARE Product in China (Xiuqing He, National Satellite Meteorological Center, Beijing, China)

- Evaluation of EarthCARE Radiances and Fluxes with CERES Data Products (Normen Loeb, NASA Langley Research Center, USA)

- EarthCARE BBR L1 and L2 Products Assessment (Nicolas Clerbaux, Royal Meteorological Institute of Belgium)

MSI Level 1 validation proposals

MMP : Monitoring MSI/EarthCARE L1 performances using concomitant intercalibration and stand-alone approaches (Noelle SCOTT, LMD, Palaiseau, France)

The method relies upon two concomitant approaches:
(i) a relative (sometimes referred to as inter-calibration) approach and
(ii) a "stand alone" approach.

They combine **observations to observations** and **simulations to observations** comparisons, respectively:

- All geographical regions and seasons, as well as land/sea/day/night scenes, clear/cloudy/aerosols scenes, thus encompassing a broad range of brightness temperatures.
- Simulations will be performed with the 4A/OP model fed with adequate descriptions of the atmospheric and surface state.

MSI Level 1 validation proposals

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- Inter-comparison of different satellite aerosol products and additional radiative transfer simulations are further used to interpret the MSI Level 1 radiance measurements.

- Comparisons of validated aerosol products from OLCI and SLSTR (long operational perspective of the European Sentinel-3 series).

- The EarthCARE BMA-FLX product will also be compared to fluxes that are estimated from MSG-SEVIRI radiance measurements

MSI – L1 Calibration – Discussion

MSI – L1 Calibration – what is needed ?

- VNS is calibrated against reflectance standard (not radiance)! Selection of solar spectrum: Continuous analysis !
  - radiometric diffusers ageing
  - instrument sensitivity evolution
  - Spectral characterisation of VNS bands (not explicitly addressed so far)

- TIR calibration
  - Analysis of housekeeping data: Black-body evolution.
  - Stray-light correction/orbit dependent ?

- Access to instrument data to analyse with respect to calibration procedures: Who is doing it ?

- Geo-location accuracy for VNS and TIR (by bands)

Inflight absolute and relative radiometric

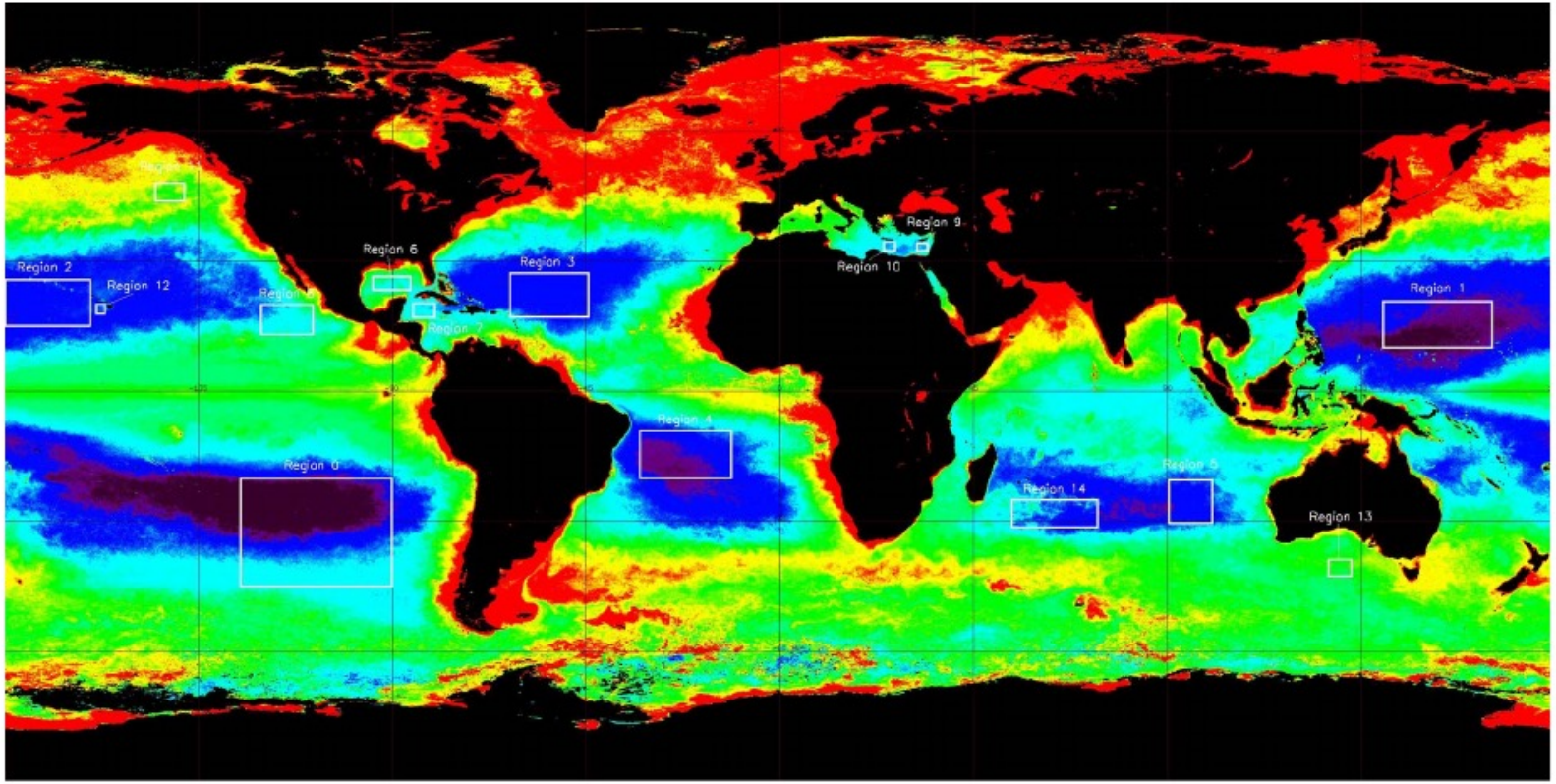
1. **Invariant Calibration Targets**: Precise **RTM** simulations, ideally accompanied with ground-based atmosphere characterisation. **Use of established sites allows inter-satellite comparisons.**
   - **Rayleigh Calibration** oceanic sites, offglint geometry, no clouds, only background aerosol. Applicable only for wavelengths/geometry with significant Rayleigh signal : **VIS 1**.
   - **DCC** (Deep Convective Clouds): nearly perfect solar diffusers (adequate for inter-band: relative radiometric calibration). Worldwide distributed, mainly +- 10°.
   - **LWC** (liquid water clouds, trade wind zones): good for intermediate intensities, non-linearities vs bright
   - **Sun Glint** Reflectance follows refractive index: Good for inter-band, but MSI is slightly tilted to off-glint:-(
   - **SST:** relatively stable, monitored by many ground based and satellite missions. Needs good RTM (water vapour)
   - **(Pseudo) Invariant Calibration Sites** (PICS): mostly deserts, DOME-C…

Inflight absolute and relative radiometric

2. **SNO** (Simultaneous Nadir Observations): Inter-satellite. RSR must be as similar as possible (or RTM based transfer). Spatial variability should be low. Eventually, radiometric consistency (closures) between instruments on one platform (BBR ←→MSI) should be used.

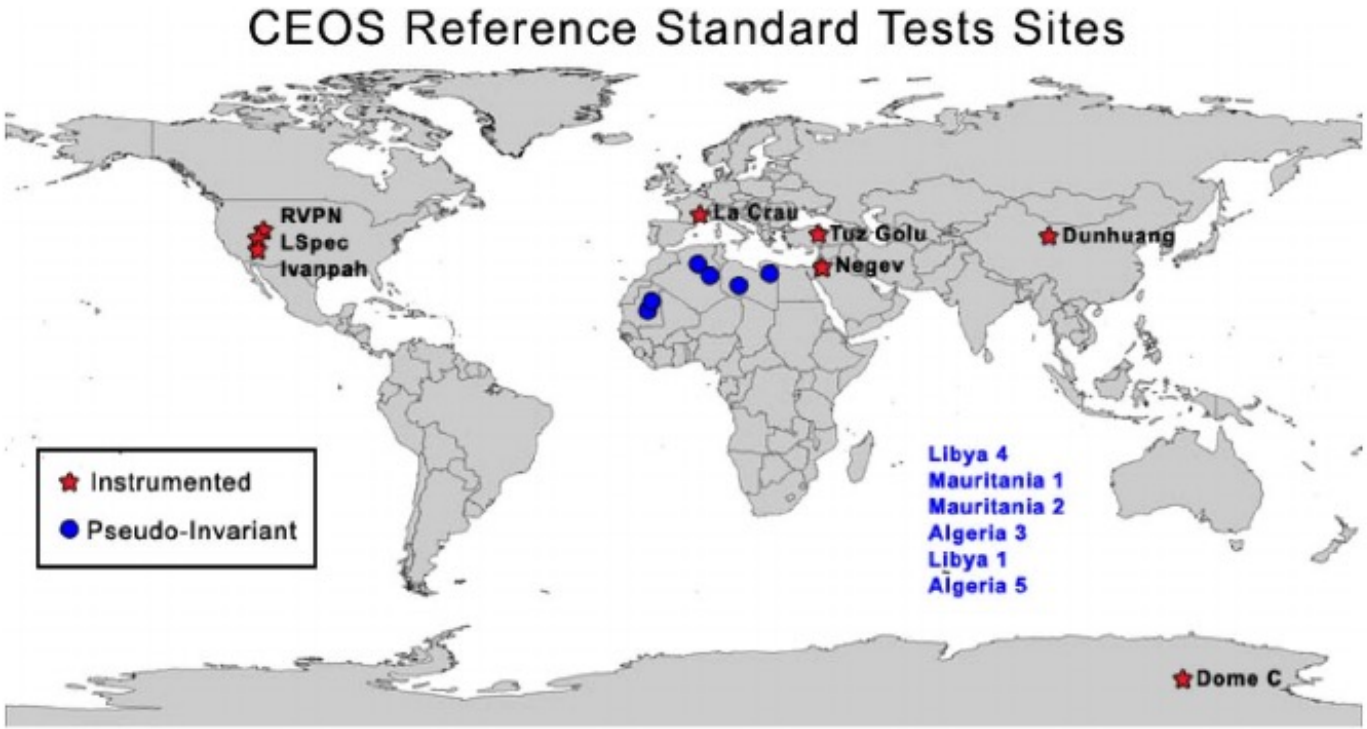
3. **Statistical Inter-comparisons** (look also on higher moments of pdf's)

Rayleigh



Chander et al 2013

Fig. 5. Distribution of the recommended Raleigh scattering calibration test sites [211] (courtesy: Bertrand Fougnie, CNES). Based on the measurements from the SeaWiFs ocean color data, six spatially homogeneous ocean sites were recommended in the Pacific, Atlantic, and Indian Ocean.



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Lessons learned from previous missions

1. Effort and budget should be allocated to instrument **pre-launch characterization** and knowledge transfer. *Some instrument features observed during operations are usually extremely difficult to be characterized and to be disentangled from each-other in-flight!!* House-keeping data can support instrument characterisation (we will never use 99.5 % of the HK data, but we don't want to miss any!)

2. "… **the calibration is a never-ending process and a dedicated effort should be allocated throughout the full mission lifetime (and beyond), this entails the need for regular reprocessing campaigns for the continuous improvements of the level 1 dataset …"**

3. Multi-sensor radiometric inter-comparison over *Pseudo-Invariant Calibration Sites* (PICS) is an invaluable source, however, the uncertainty of the methods requires **meticulous work** to incorporate, BRDF, atmospheric, spatial averaging and spectral effects. (RadCalNet, spectral HR sensors to establish transfer functions, community agreed RTM, protocols, …) It is always a **cooperative approach**: (**CEOS, GSICS**)

4. **Option:** Orbital maneuverer provide view on moon for stability monitoring and diffusor BRDF investigations