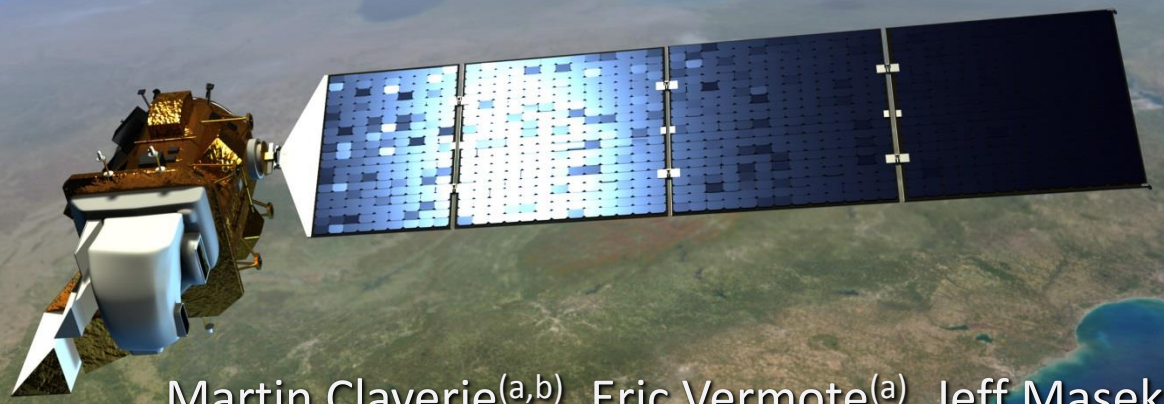
An update on the Landsat / Sentinel-2 merged Surface Reflectance product project



Martin Claverie[a,b], Eric Vermote[a], Jeff Masek[a]

(a) NASA - Goddard Space Flight Center

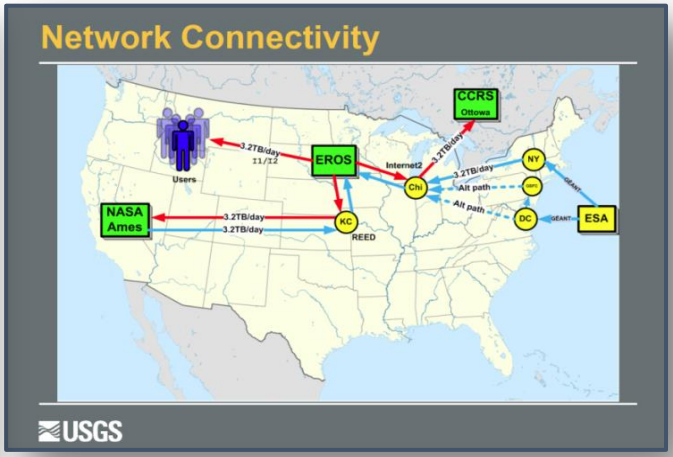
(b) UMD - Department of Geographical Sciences

martin.claverie@nasa.gov

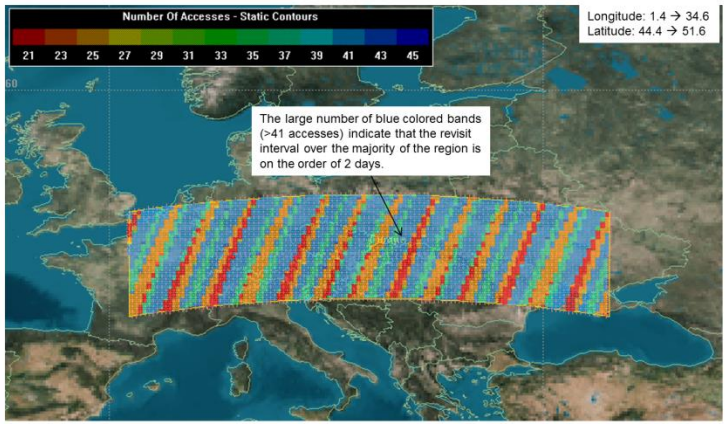
Picture: Landsat-8 (USGS copyright)

Landsat – Sentinel-2 fusion project

- ❑Merging Sentinel-2 and Landsat data streams could provide < 5-day coverage
- Goal is “seamless” near-daily 30m surface reflectance record
- ❑Cross-calibration, atmospheric corrections, spectral and BRDF adjustments, regridding



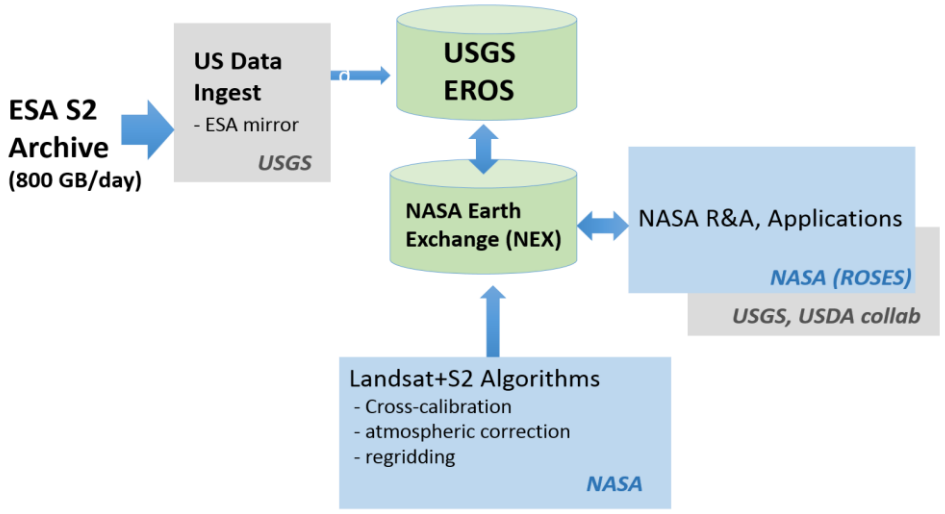
Sentinel 2A and B - LDCM Europe

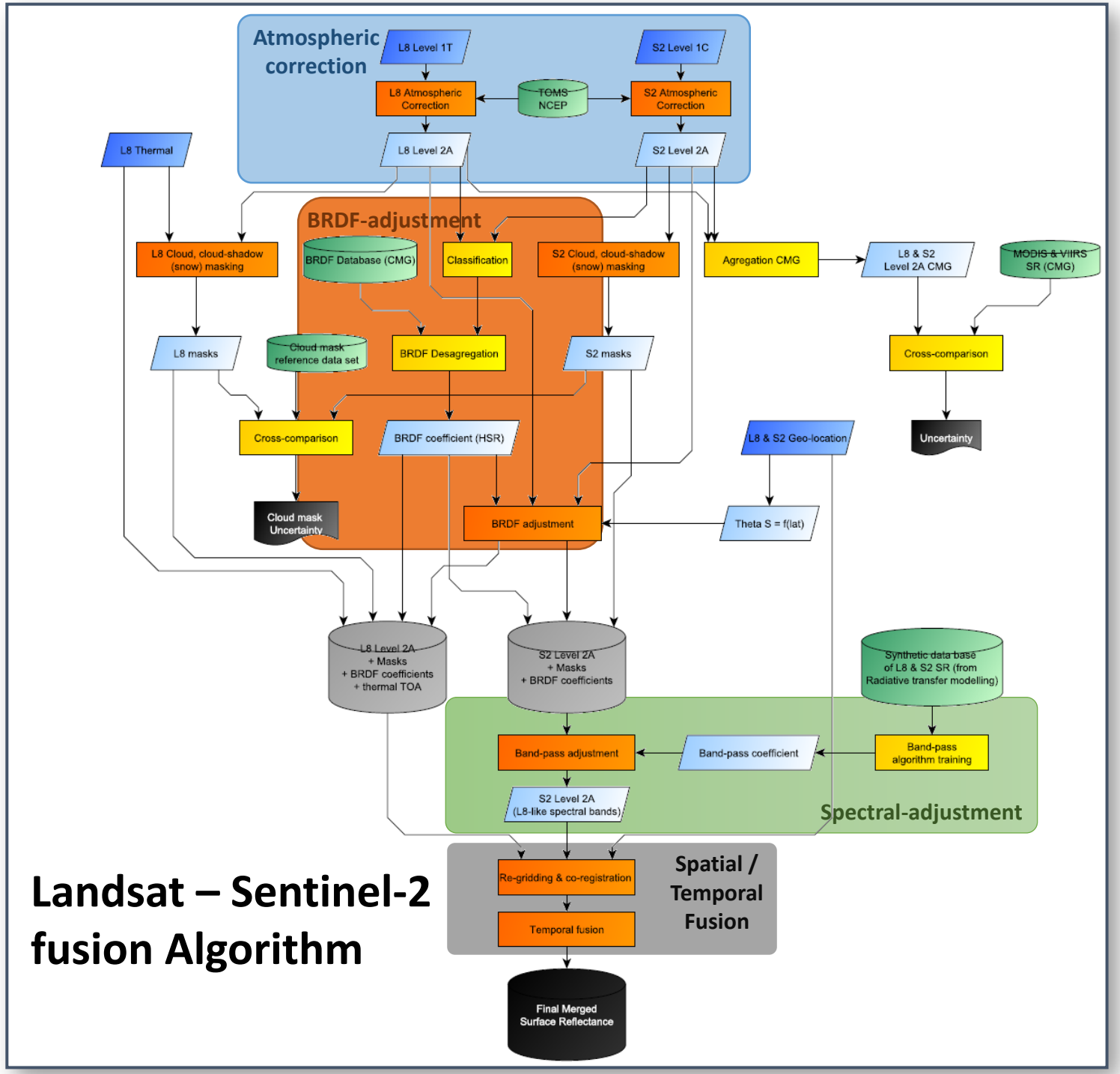


- The picture shows the number of times LDCM and the Sentinel 2 satellites accessed areas on the ground over an 80 day period of time.
  - 21 accesses indicates a maximum revisit interval of ~3 days 19 hours
  - 46 accesses indicates a minimum revisit interval of ~1 day 18 hours

Courtesy Brian Killough, NASA LARC

Proposed Architecture

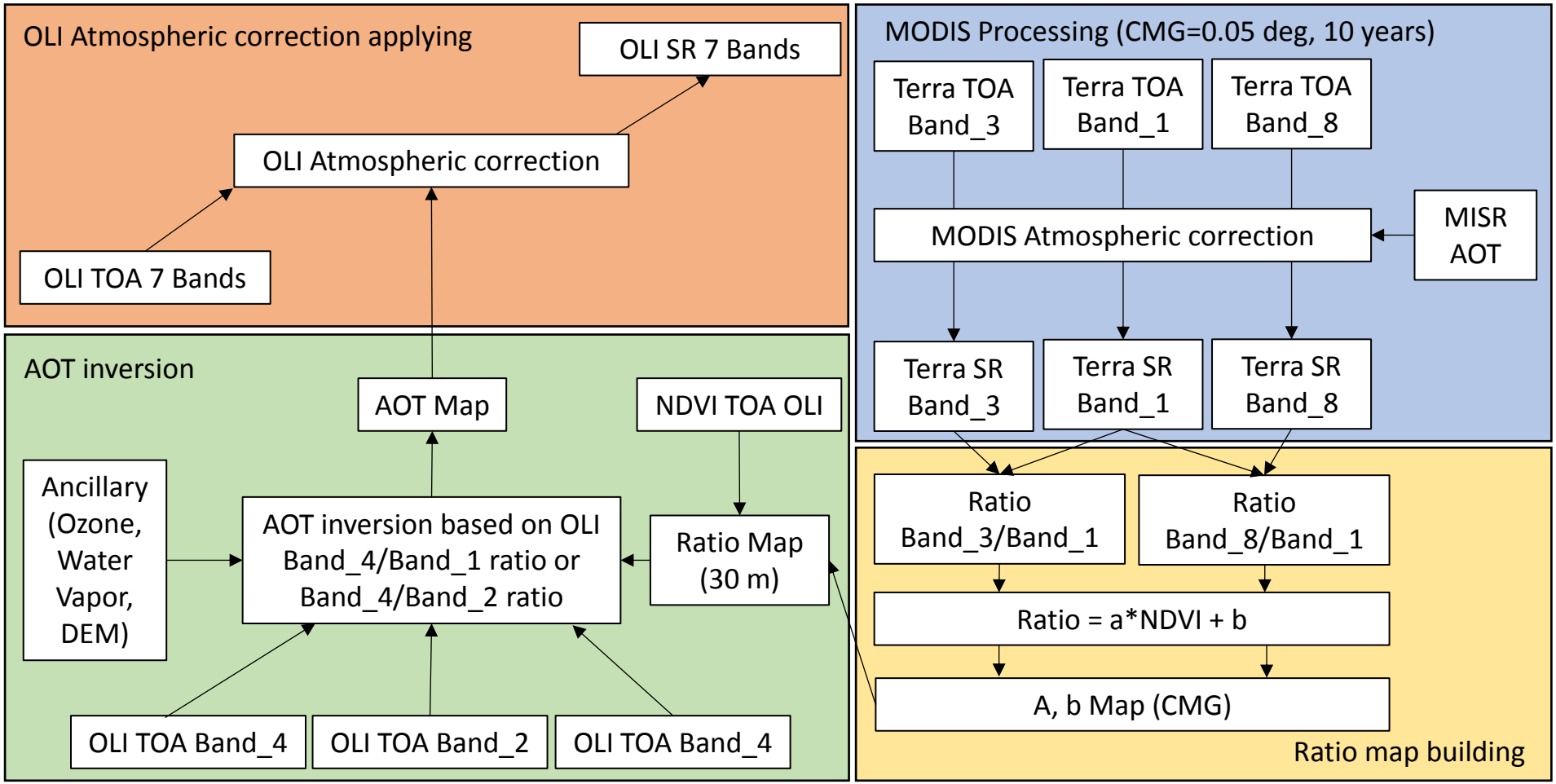




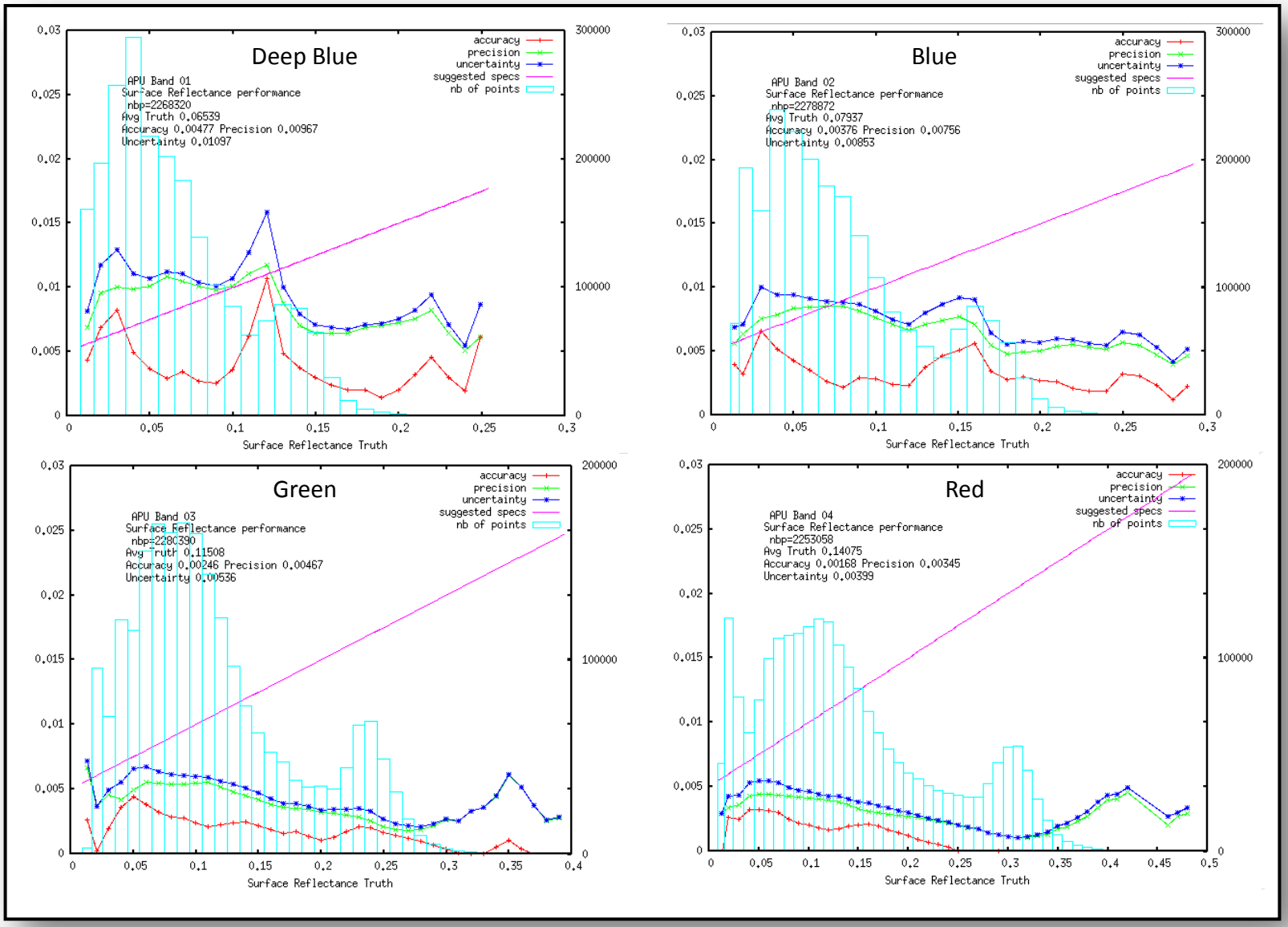
Landsat – Sentinel-2 fusion Algorithm

Landsat-8 OLI Atmospheric correction

Landsat-8 OLI Atmospheric correction Chain



validation over Aeronet sites Landsat 8 SR (71 matchups)



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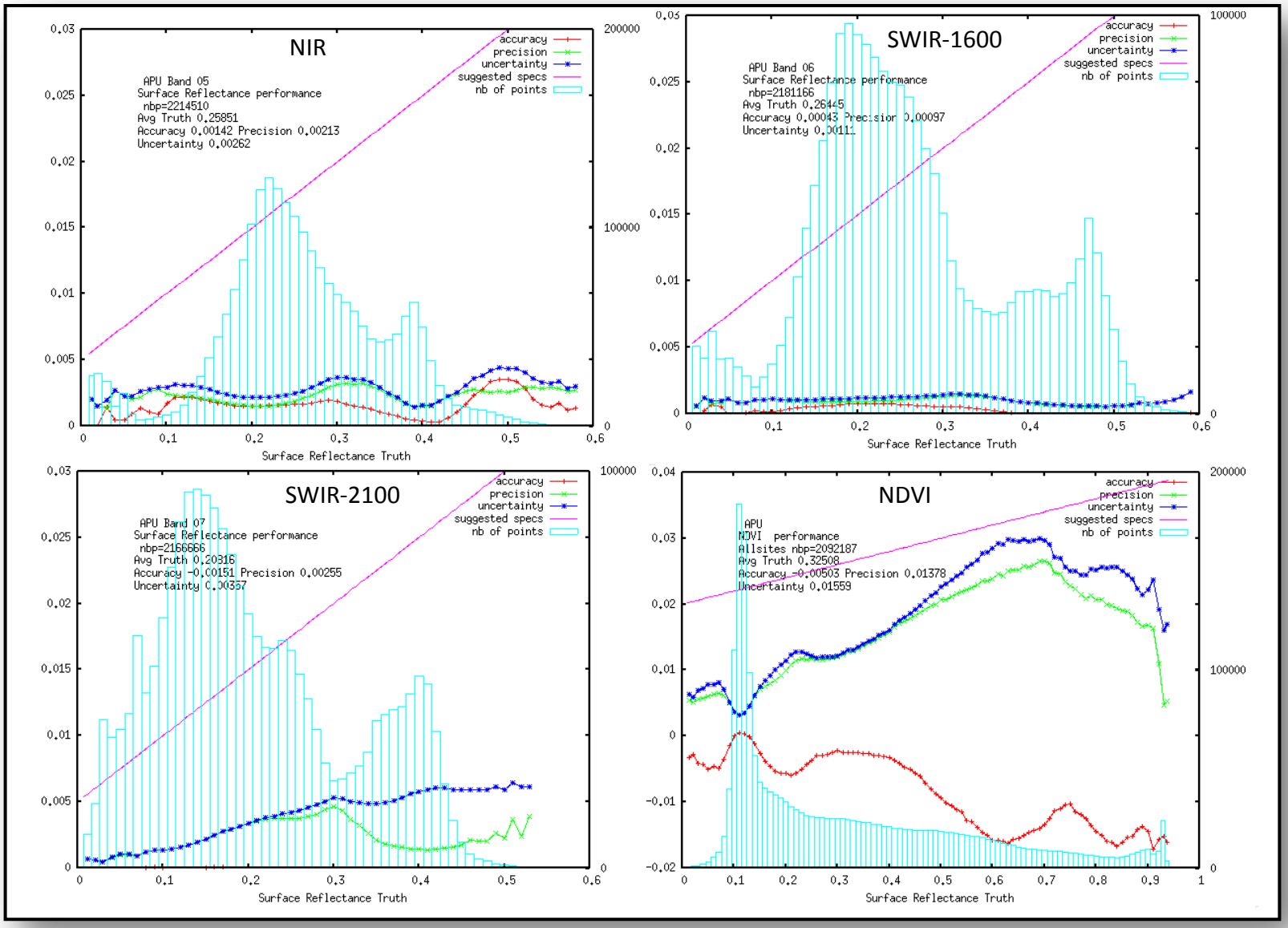
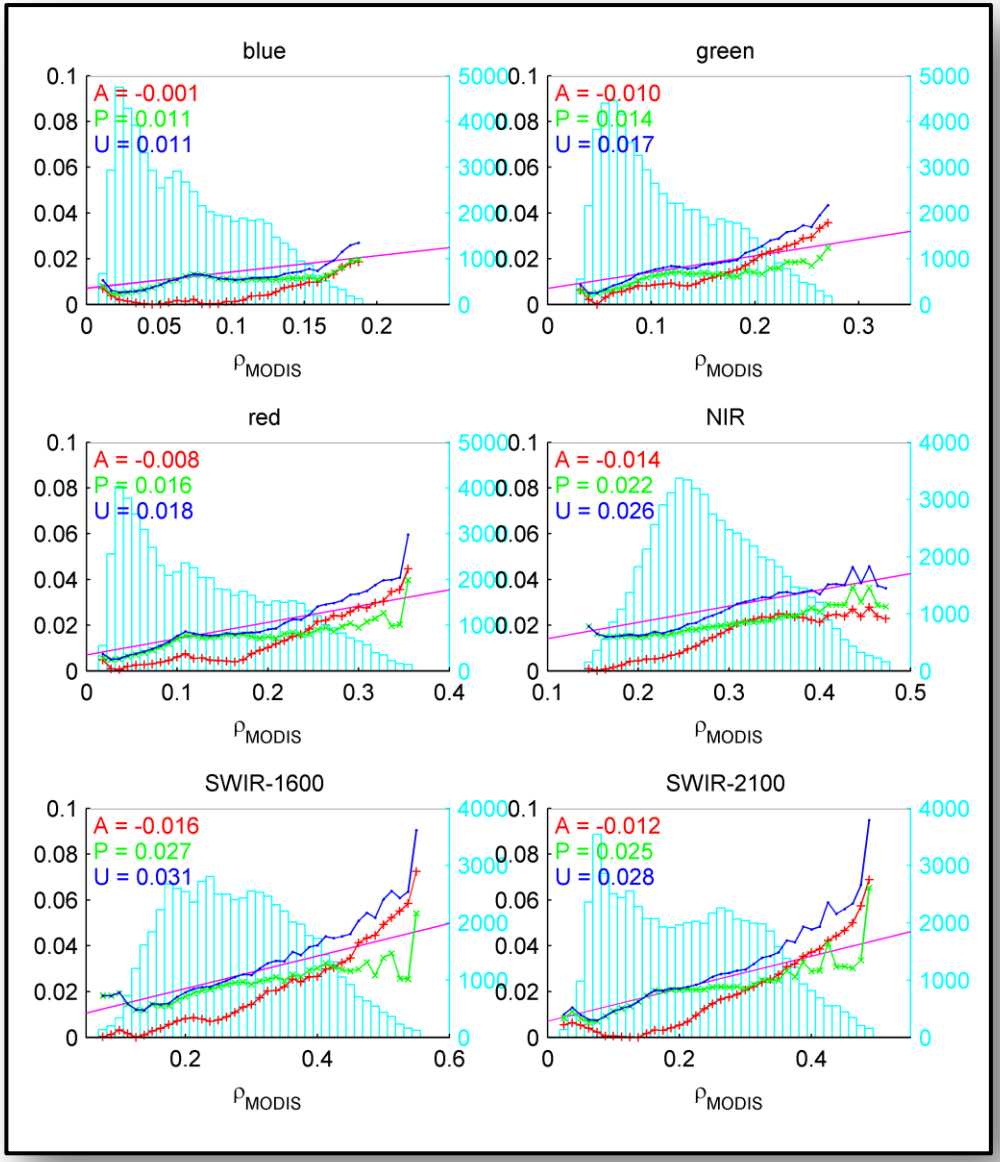
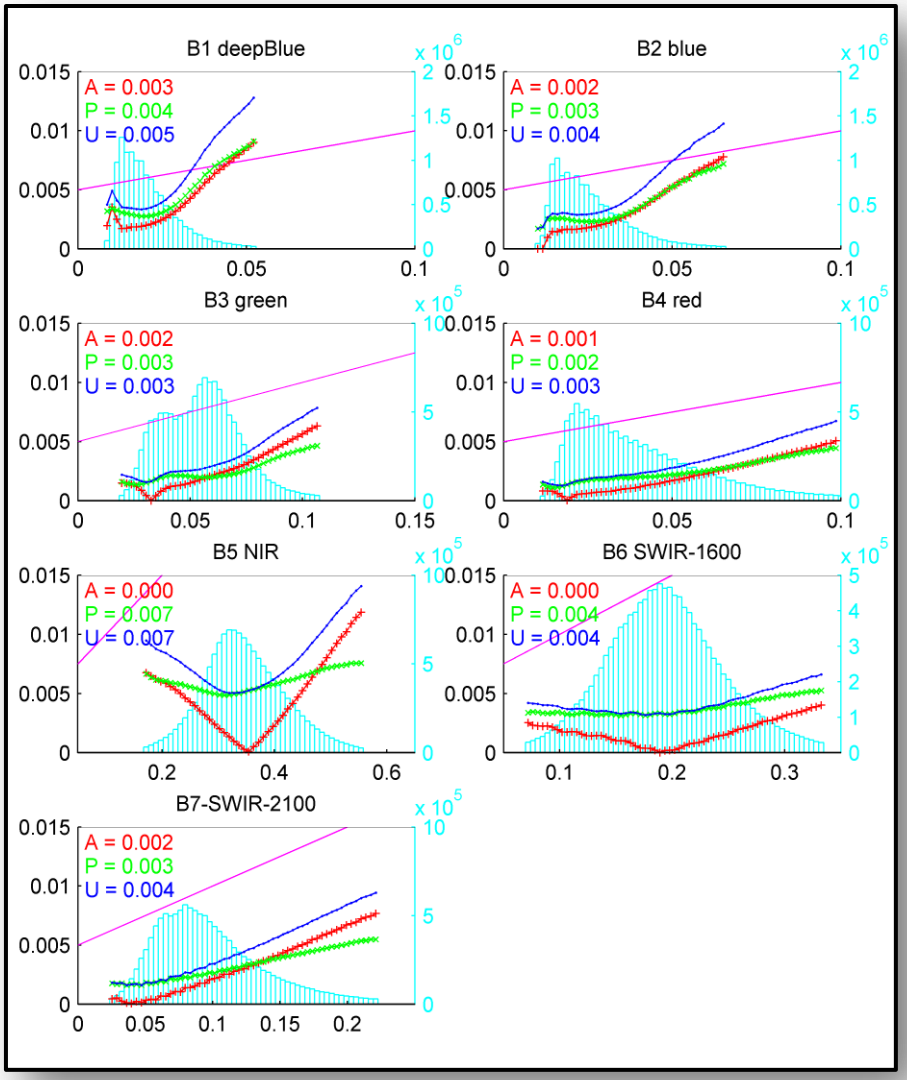


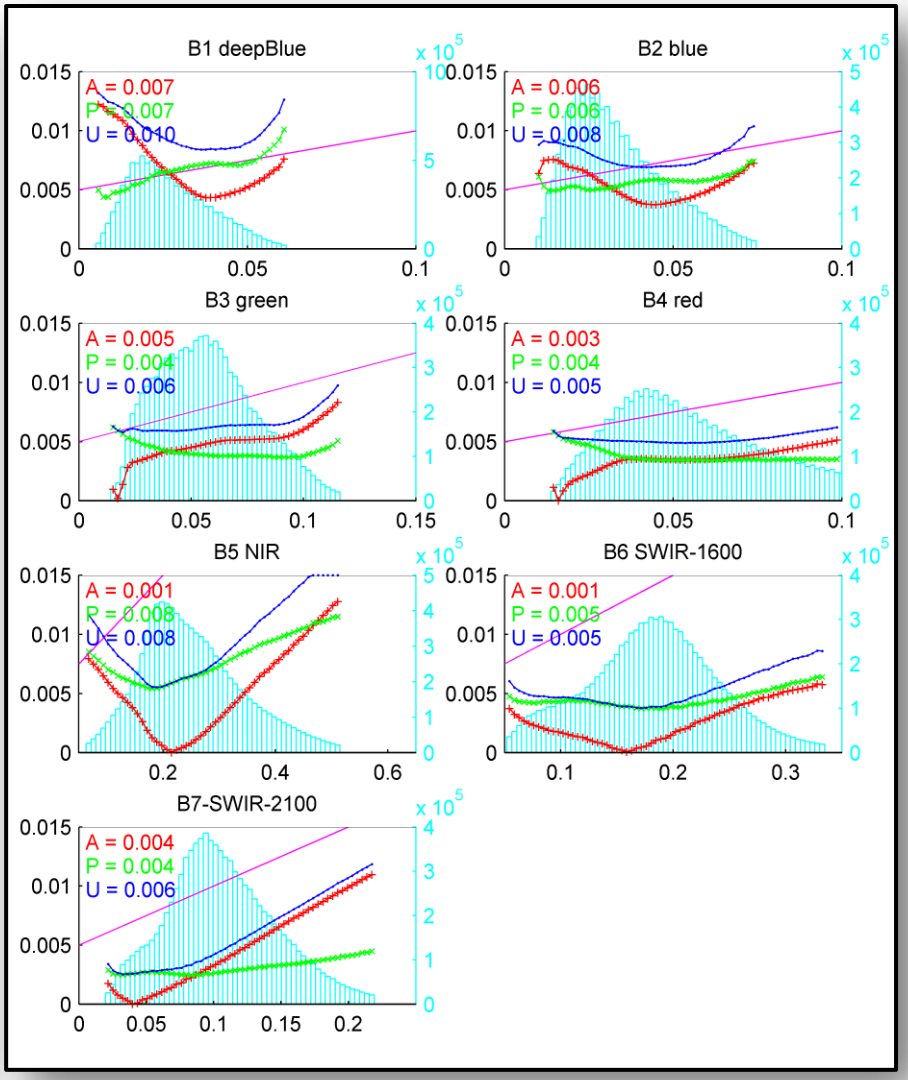
Cross-comparison with MODIS: Landsat 8 APU (~200 scenes)



Comparison NASA / CNES (1)

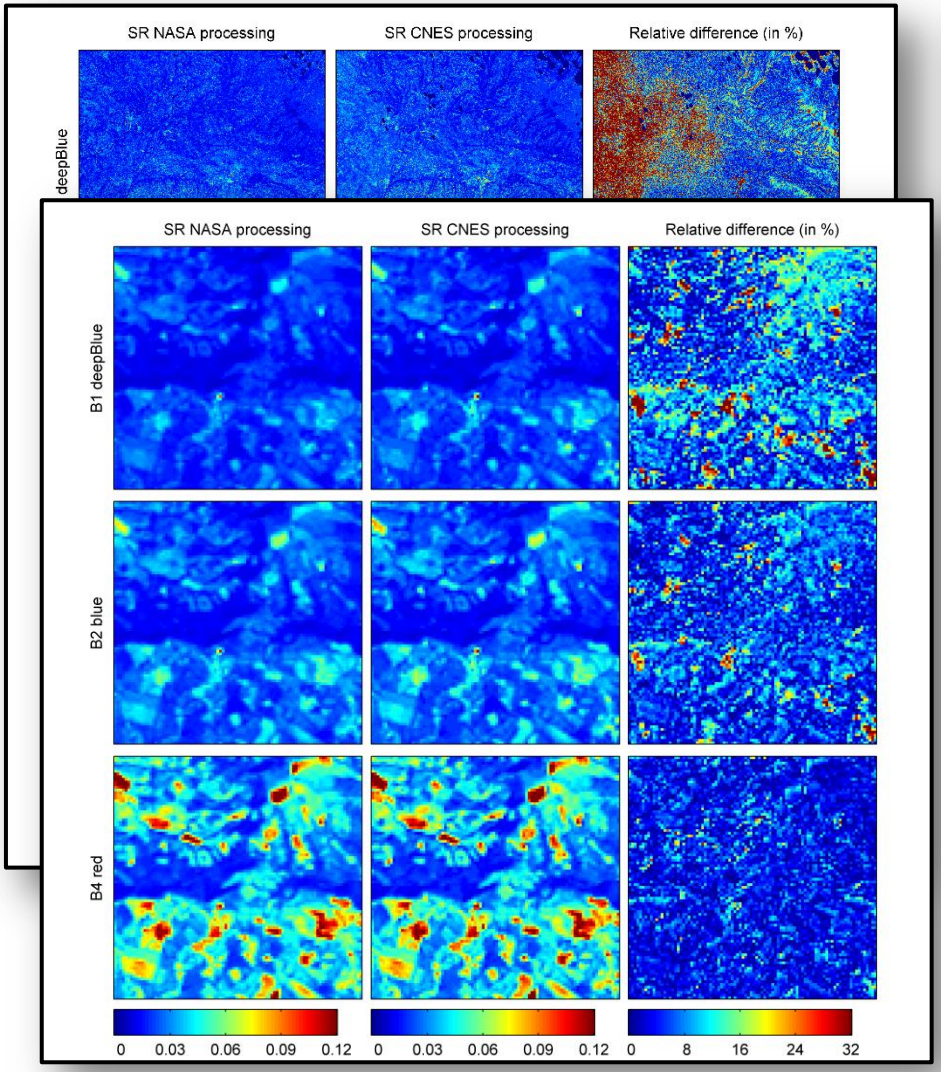
processing (2 100*100 km THEIA tiles)

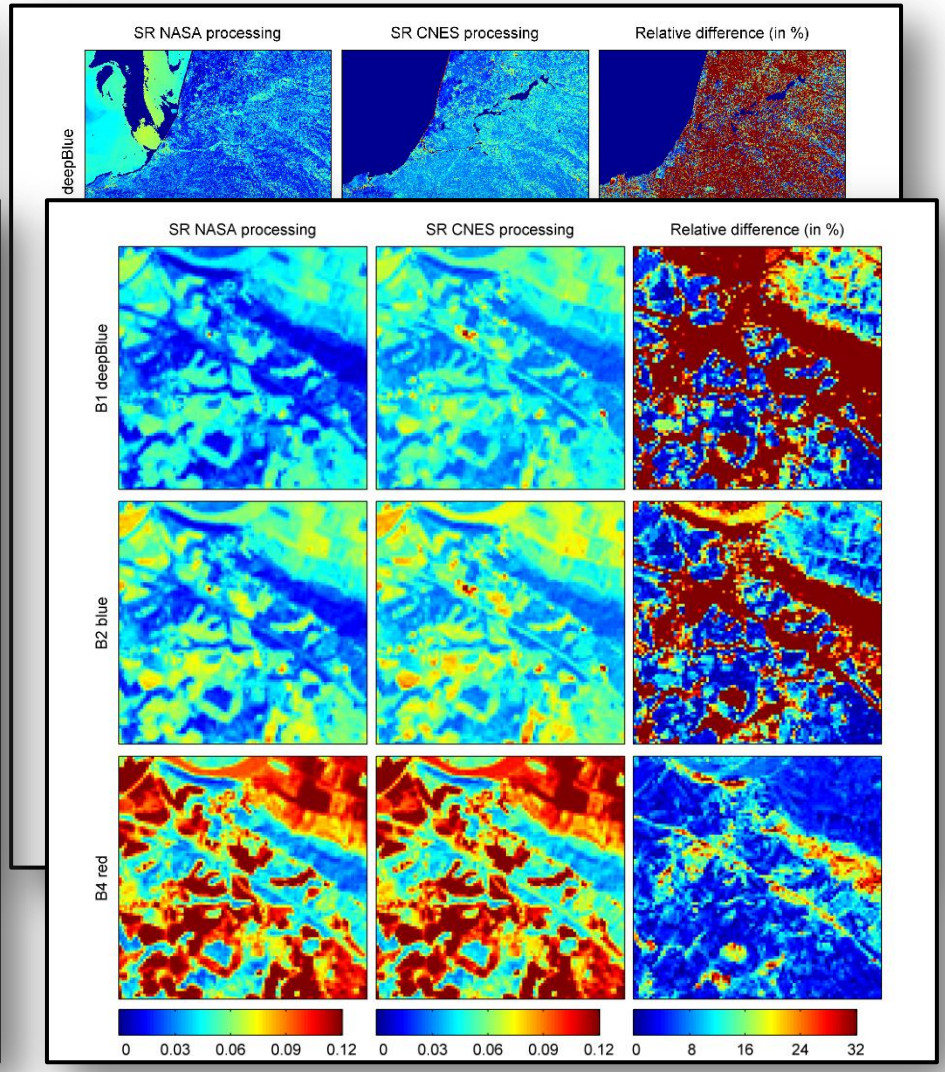




Comparison NASA / CNES (2)

processing (2 100*100 km THEIA tiles)



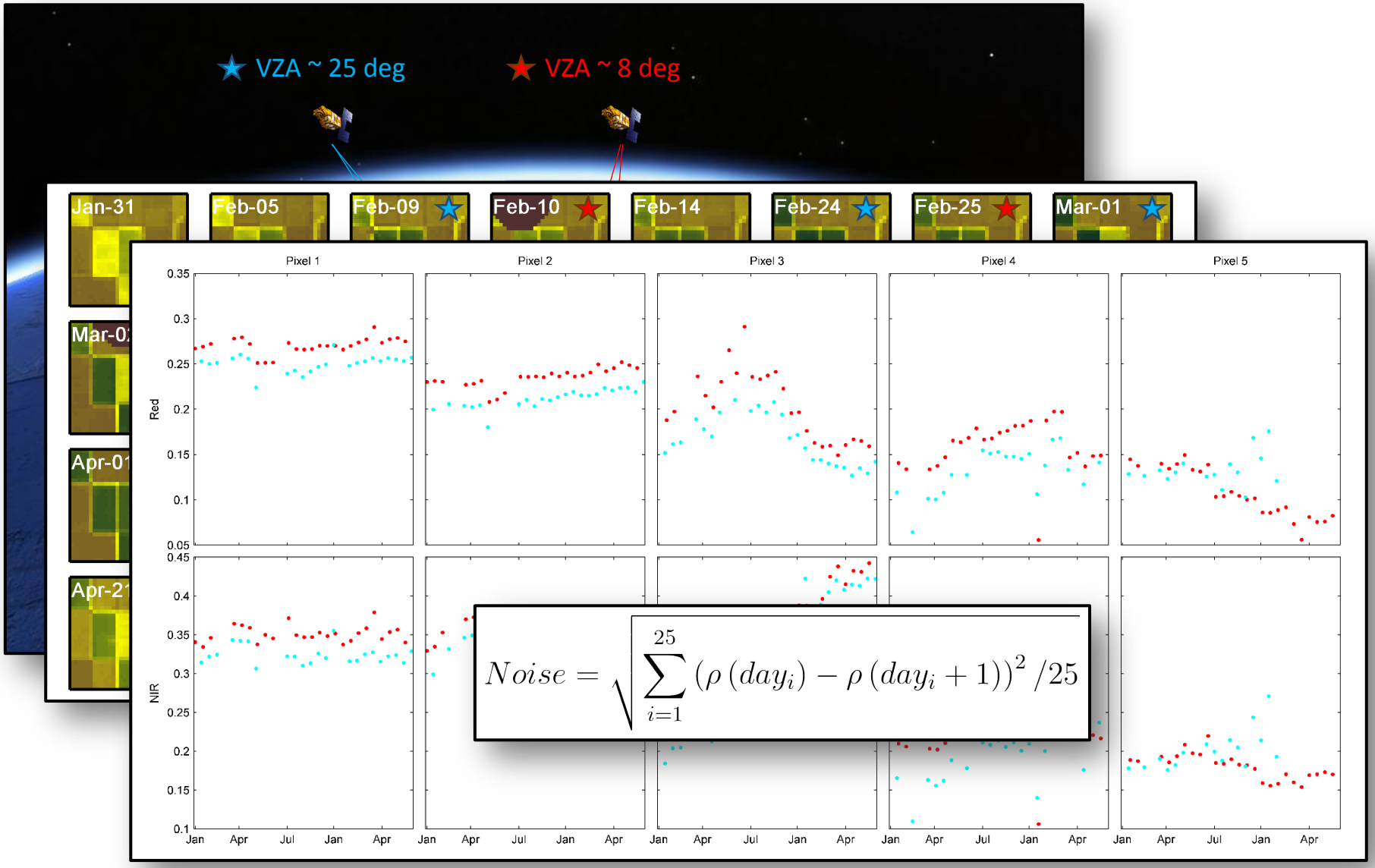


BRDF adjustments

What is the issue?

- Landsat-8 and Sentinel-2 will have distinct orbit and sun/view geometry.
- To reduce time series noise, it is required to account for the sun/view geometry differences
- sun/view geometry:
  - Landsat-8 : VZA = +/- 7 deg, Aq. Time ~ 10:00 a.m
  - Sentinel-2: VZA = +/- 12 deg, Aq. Time ~ 10:30 a.m
- Spot 4 Take 5 – Maricopa Site
  - Two sets of images with two distinct VZA (~8 deg vs ~25 deg)

Spot 4 Take 5 – Maricopa Site

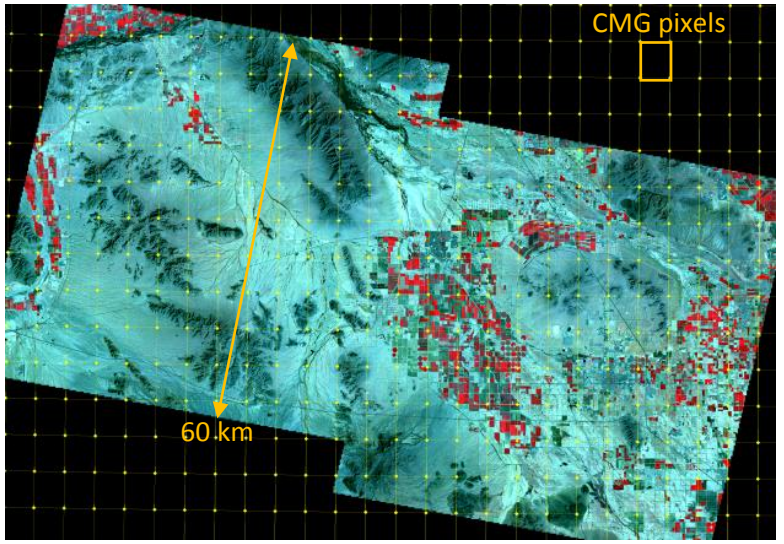


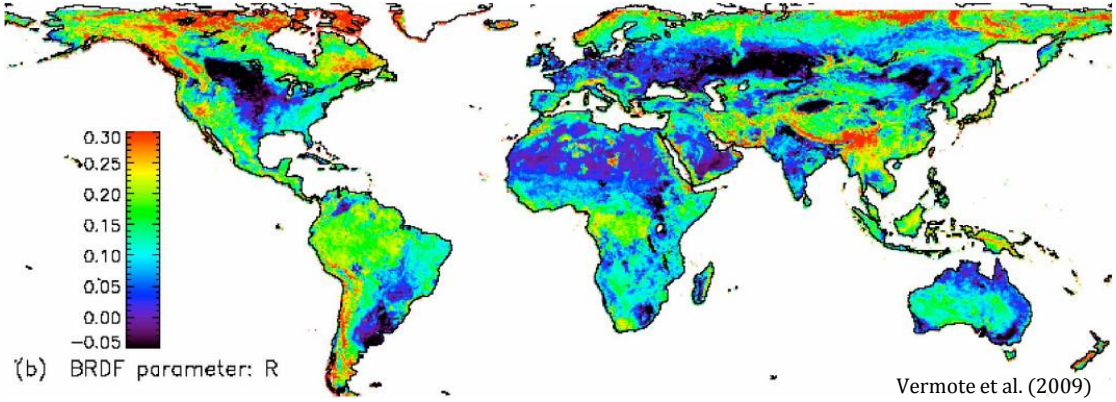
$$Noise = \sqrt{\sum_{i=1}^{25} \left(\rho\left(day_i\right) - \rho\left(day_i + 1\right)\right)^2 / 25}$$

VJB model to correct BRDF

(Bidirectional Reflectance Distribution Function)

- VJB Model (Vermote et al. 2009)
  - Relate BRDF parameter to NDVI
  - Simplification of BRDF Kernels using 2 proxy: R & V
  - $\rho(\theta\_out) = \rho(\theta\_in) \times K(\theta\_in, \theta\_out, R, V)$ & θ stands for θs, θv, Δδ
  - using MODIS CMG (0.05°), R & V were found well-correlated to NDVI
    - $R = a_1 \times NDVI + b_1$
    - $V = a_2 \times NDVI + b_2$
  - a_1, b_1, a_2, b_2 parameters were retrieved at global scale (at 0.05°) for each MODIS band, but can be retrieved at better resolution





Vermote et al. (2009)

HiRes BRDF adjustment Methods

- Four approaches based on the VJB model
  - Constant Model (from CESBIO analysis)
    - One unique set of R and V
  - Average Model (Breon et al. 2012)
    - One unique set of a_1,b_1,a_2,b_2 parameters
    - Use of HR NDVI (temporal dynamic)
  - LR disaggregation of V and R through the NDVI
    - Use of LR a_1,b_1,a_2,b_2 parameters without disaggregation
    - Use of HR NDVI (temporal dynamic)
  - LR disaggregation of V and R through land cover (Franch et al. 2014)
    - Use of Land cover to set V and R

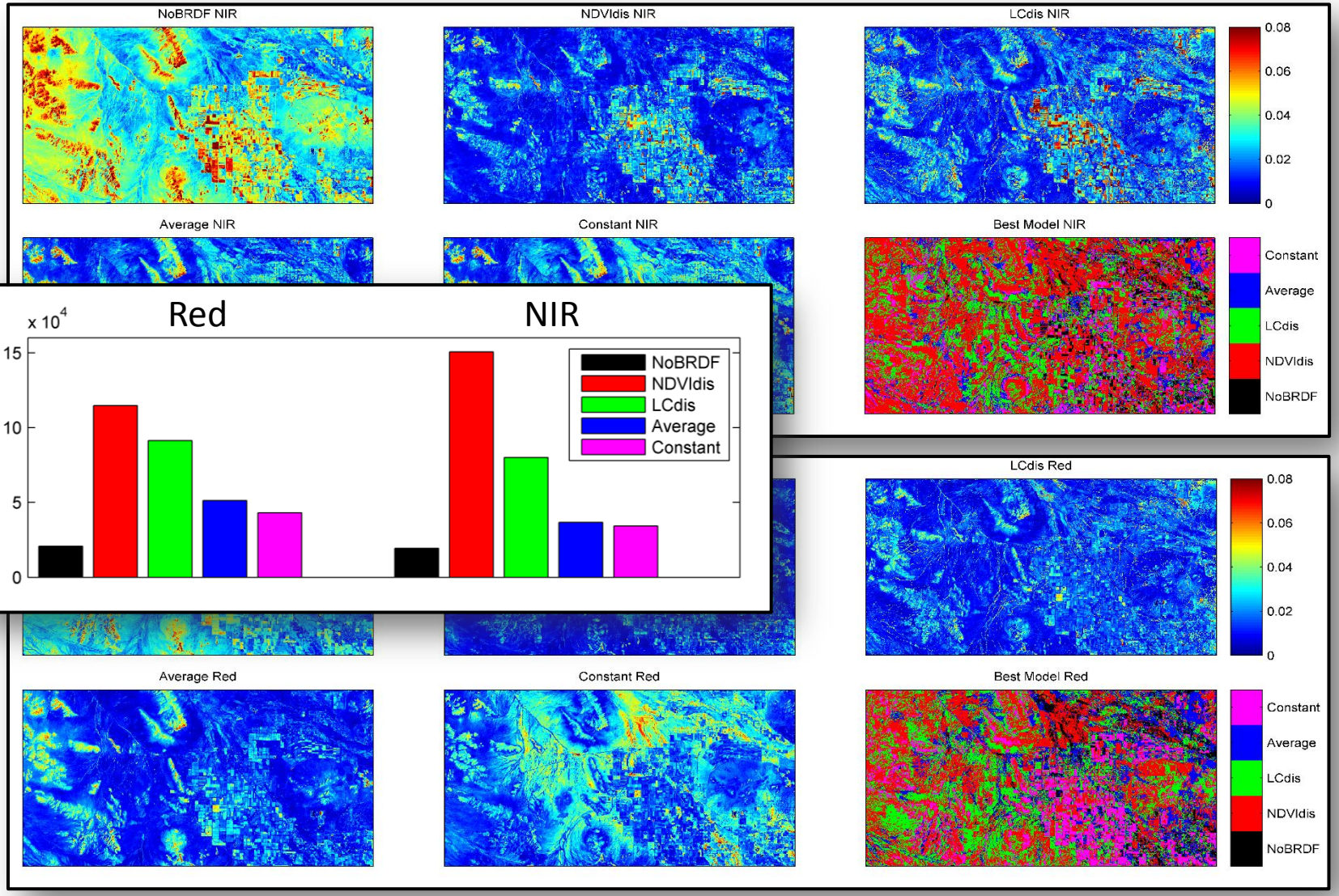
Constant

Average

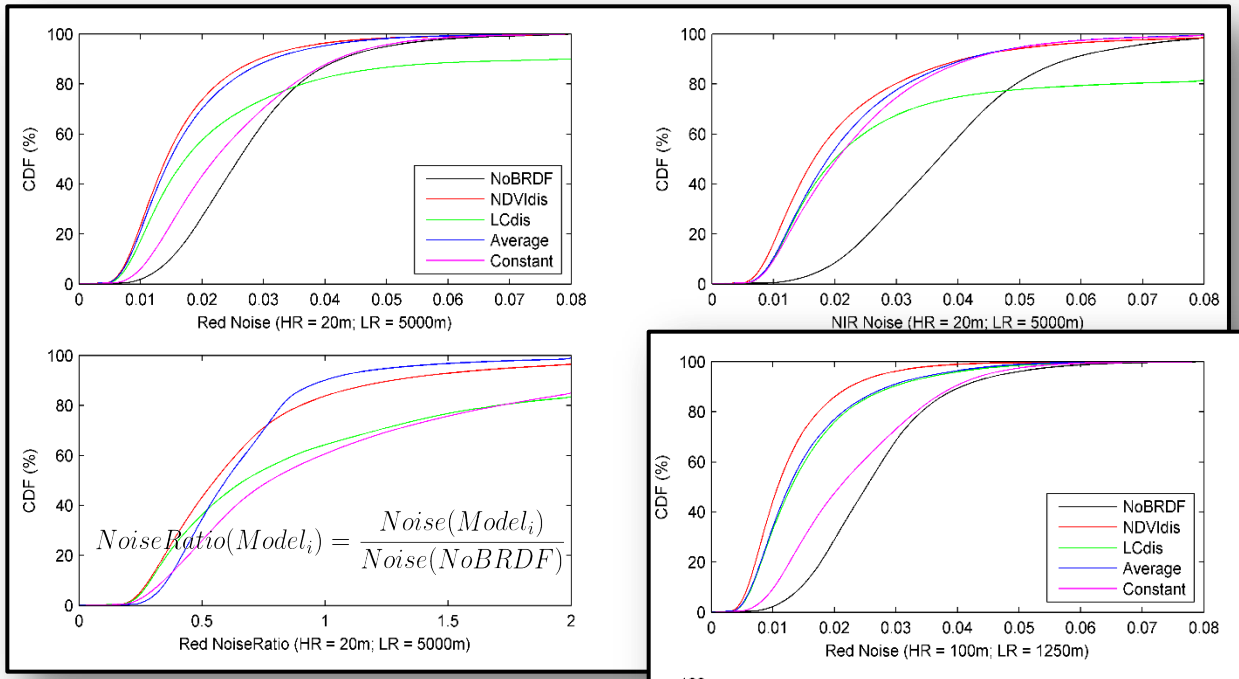
NDVIdisag

LCdisag

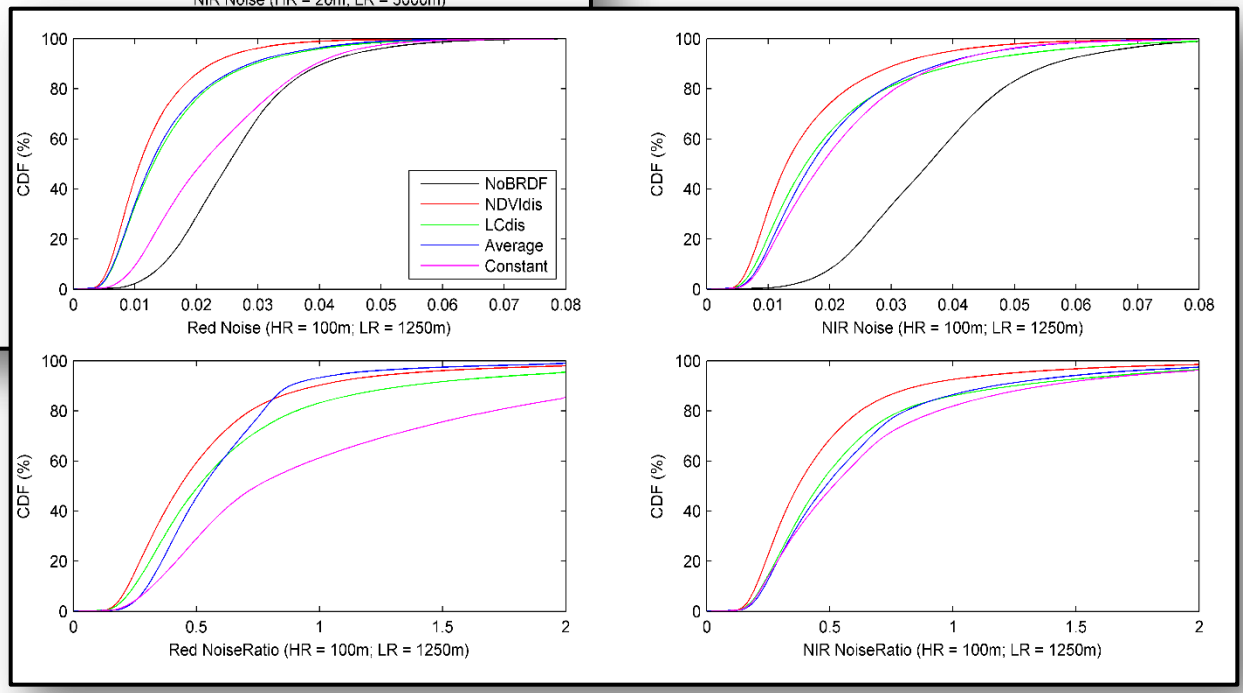
HiRes BRDF adjustment Results (1)



HiRes BRDF adjustment Results (1)

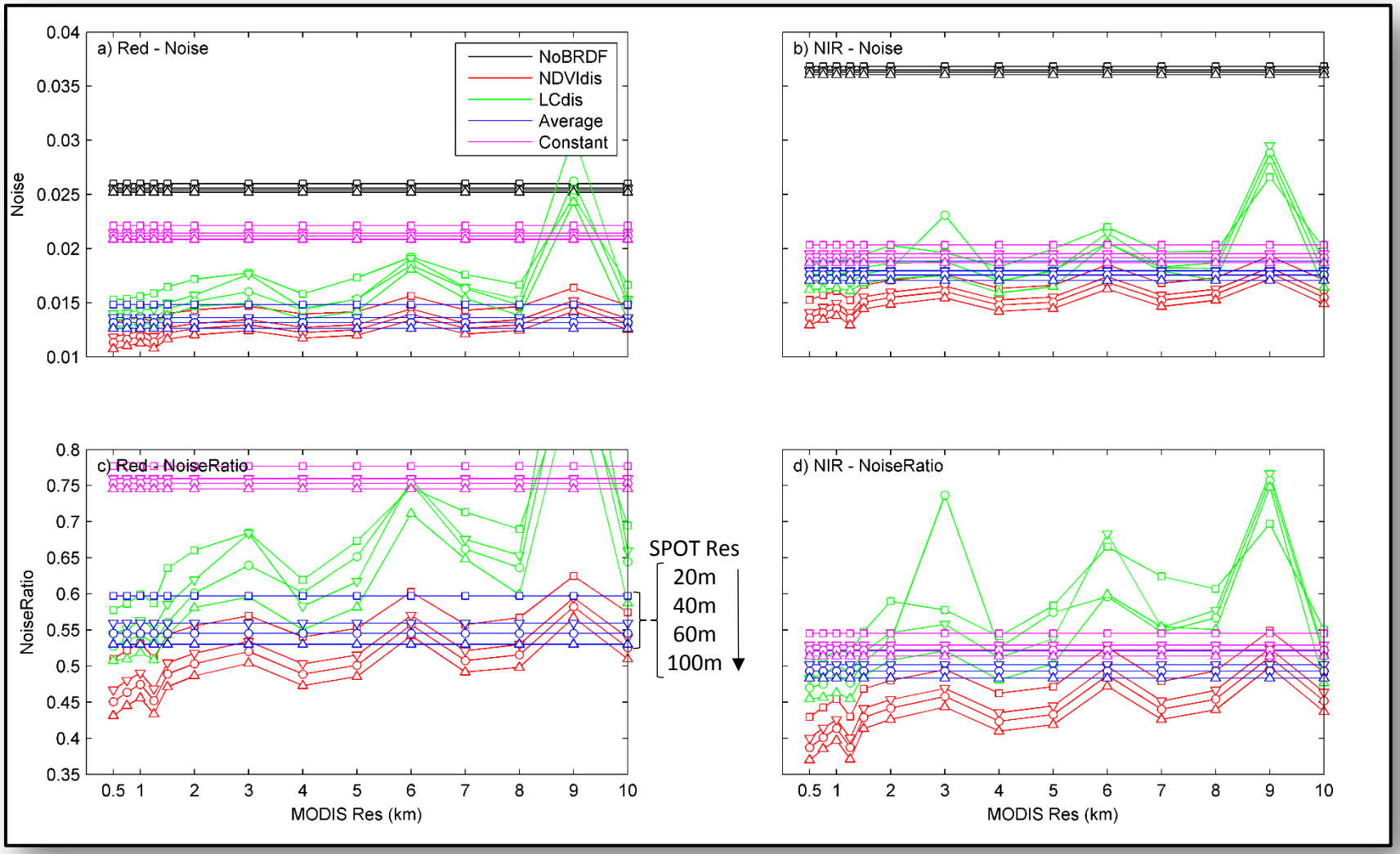


SPOT = 20m
MODIS = 5km (~CMG)

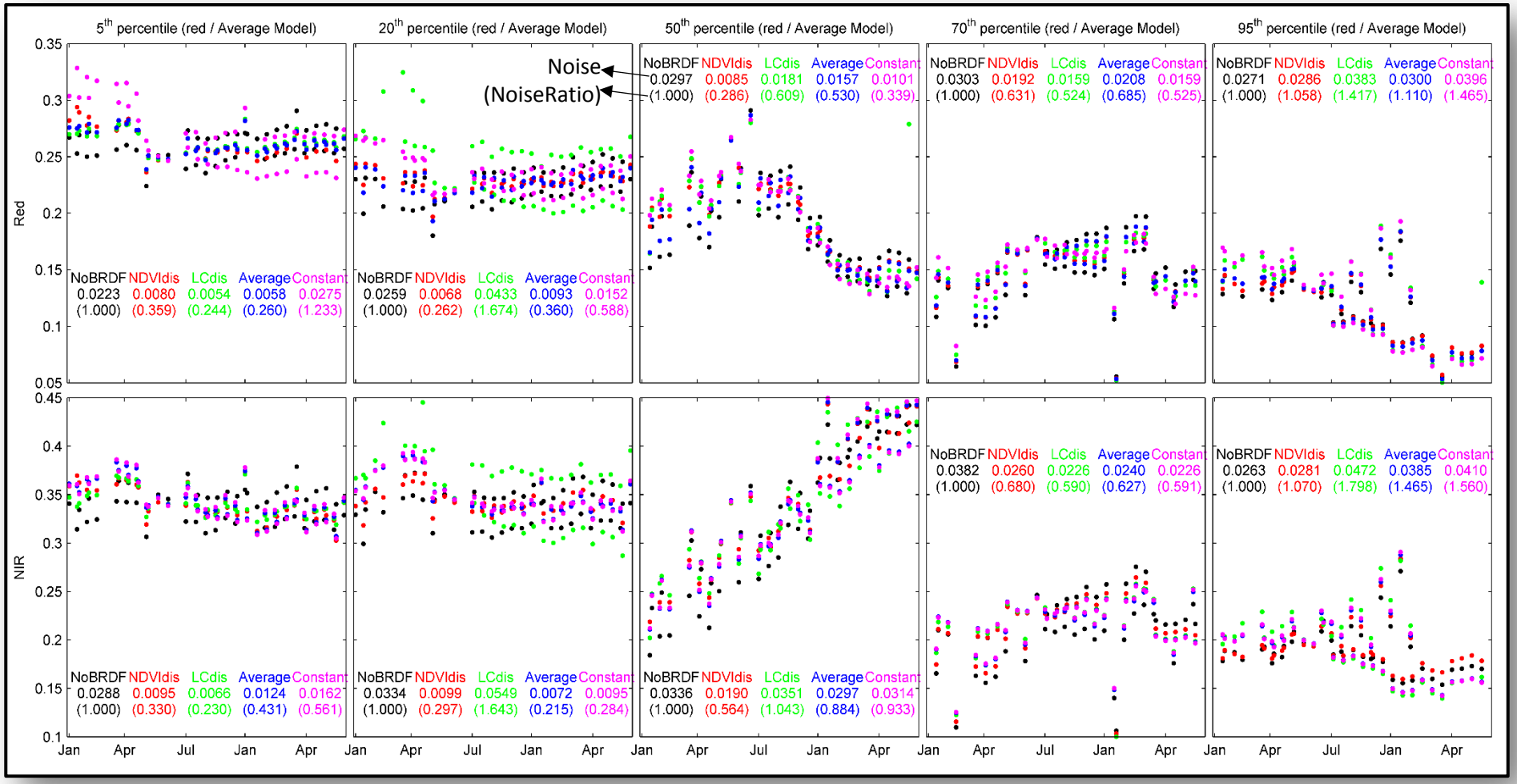


SPOT = 40m
MODIS = 1250m (5*250)

HiRes BRDF adjustment Results (2)



HiRes BRDF adjustment Results (3)



Conclusion

- Landsat / Sentinel Fusion Project is on track!
- On-going activities: BRDF / Spectral adjustments
- Next step: adapt the Atmospheric correction chain to Sentinel-2 (similar approach except no thermal band for Cloud masking)
- BRDF adjustments
  - Analyze deeper the results of Maricopa
  - … but we have to keep in mind that L8/S2 sun-view geometry will be less important
  - Next step: perform similar analysis with Landsat overpass (mostly in high latitude)
  - Continue a similar experiment with SPOT-5 Take-5 (Maricopa, Boreal Forest)

Picture: Landsat-8 (USGS copyright)

Thank you!

Picture: Landsat-8 (USGS copyright)