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Assessing the usefulness of Land Surface Temperature spatial disaggregation for water stress mapping in the frame of the preparation of the Trishna mission

Serdar RAMA, Julien MICHEL, Vincent RIVALLAND (CESBIO), Aurélie MICHEL (ONERA-DOTA), Carlos GRANERO-BELINCHON (IMT Atlantique, Lab-STICC)

The french-indian Trishna Thermal Infra-Red remote sensing mission

Main characteristics

- French (CNES) and Indian (ISRO) satellite to be launched in 2025
- 4 Thermal Infra Red bands along 6 VISNIR bands, at 57 meter nadir
- Field of view $\pm 34^\circ$, 3 days revisit time (8 days with the same viewing angle)
- Design drivers:
 - Ecosystem stress and water use
 - Coastal and inland waters

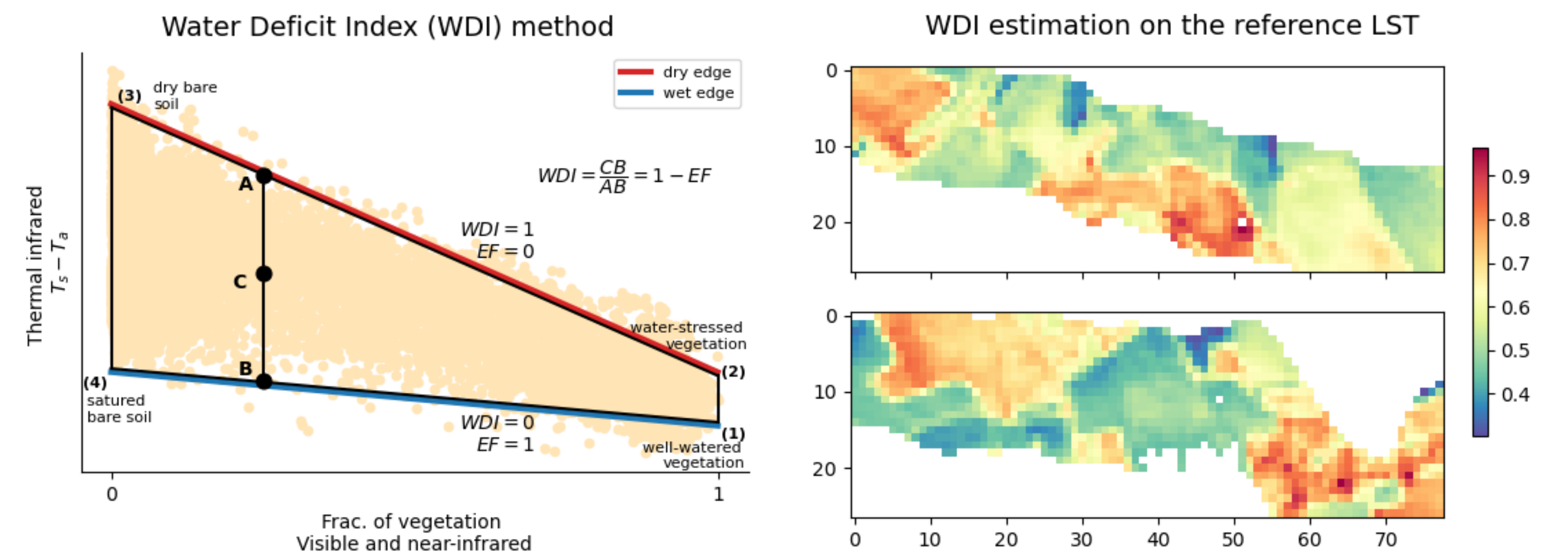
Spatial Disaggregation of future Trishna data

- Important for the monitoring of small crops (design driver)
- Spatial disaggregation of LST relies on higher resolution VISNIR bands: for Trishna, we could use Sentinel-2

This work

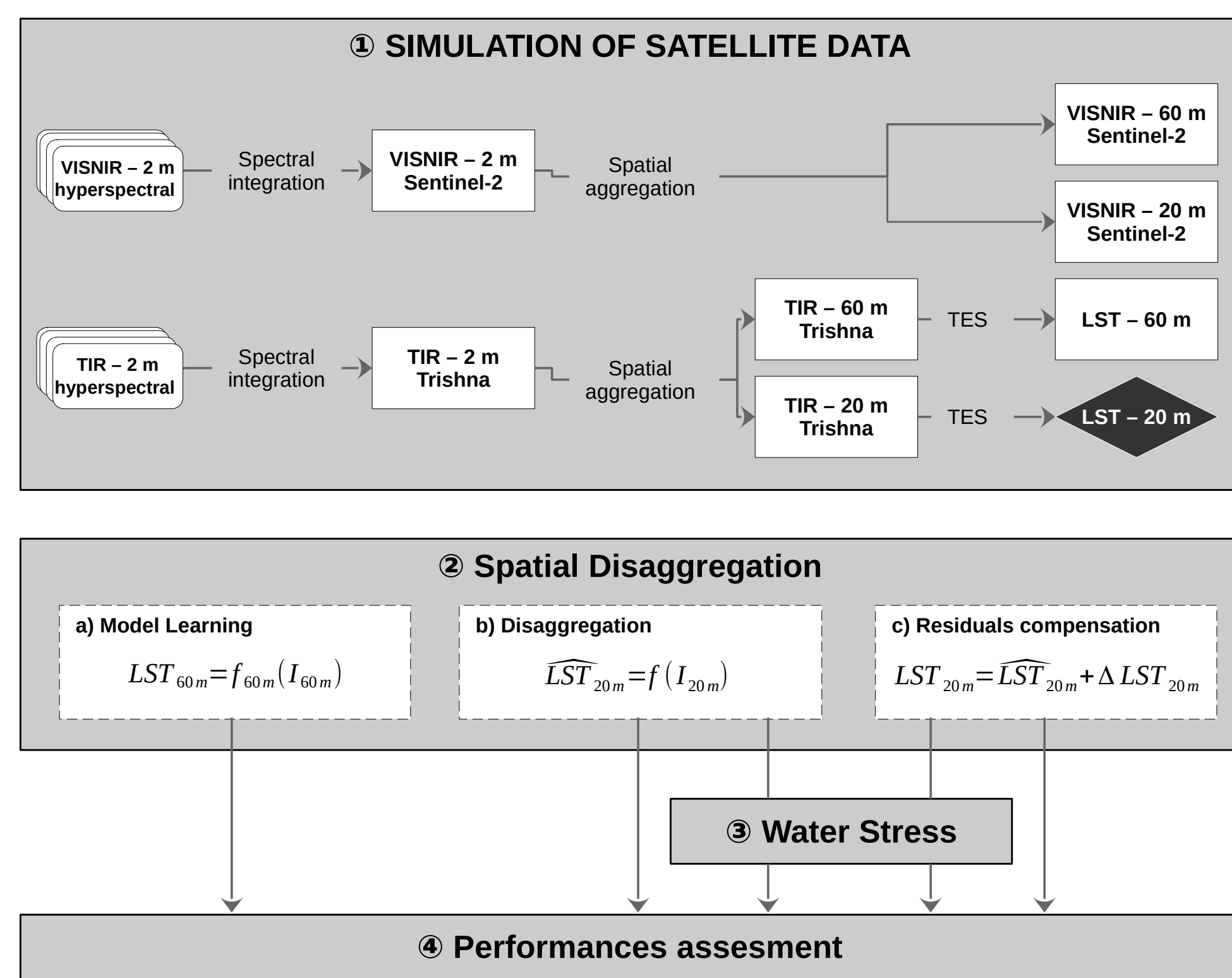
- Assess performances of spatial disaggregation of LST applied to Trishna / Sentinel-2 pairs
- Assess the benefits for spatial disaggregation of LST for evapo-transpiration and water stress

Water Stress estimation



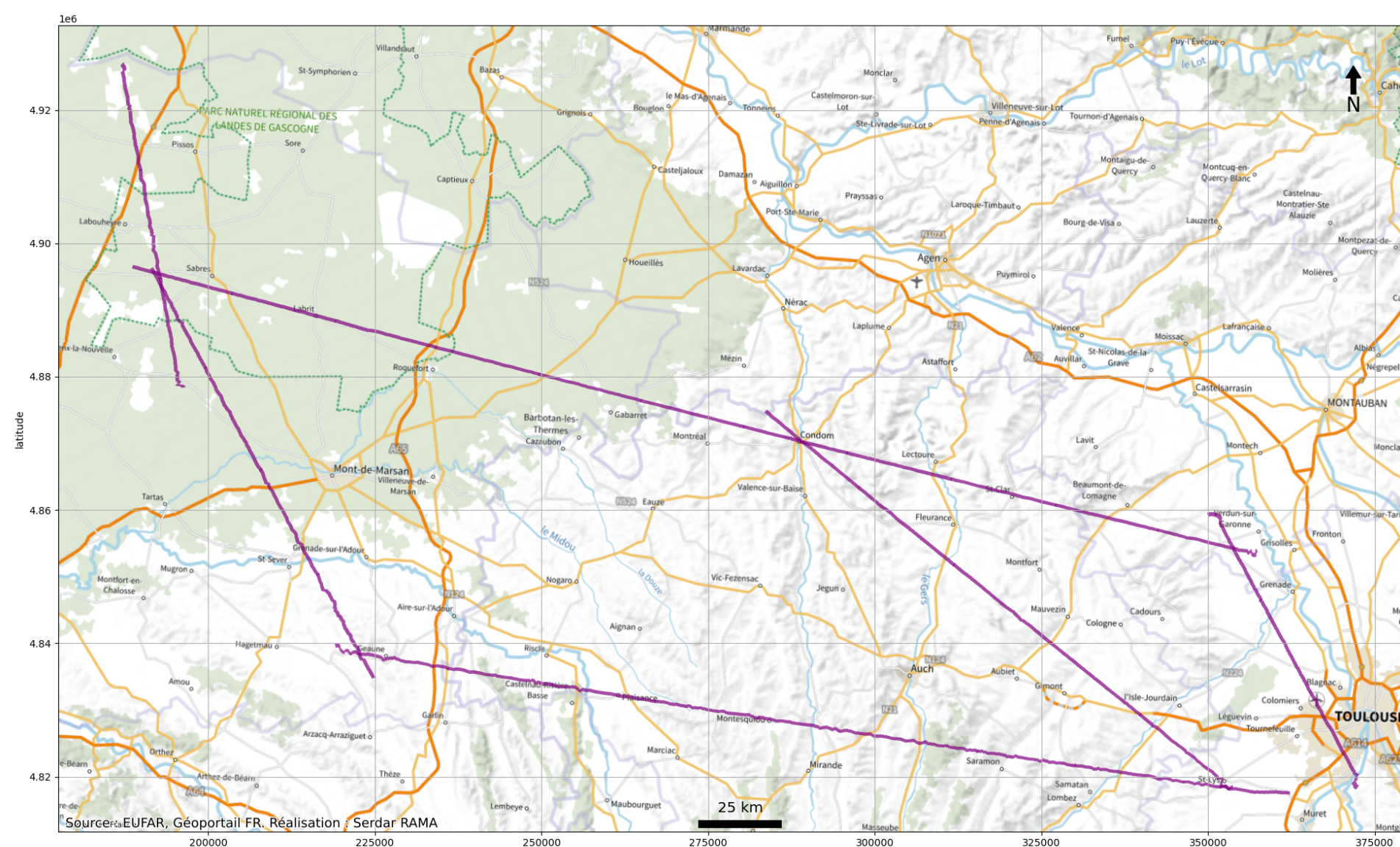
We use Water Deficiency Index as a proxy to measure impact of spatial disaggregation on evapo-transpiration and water stress estimation

Methodology



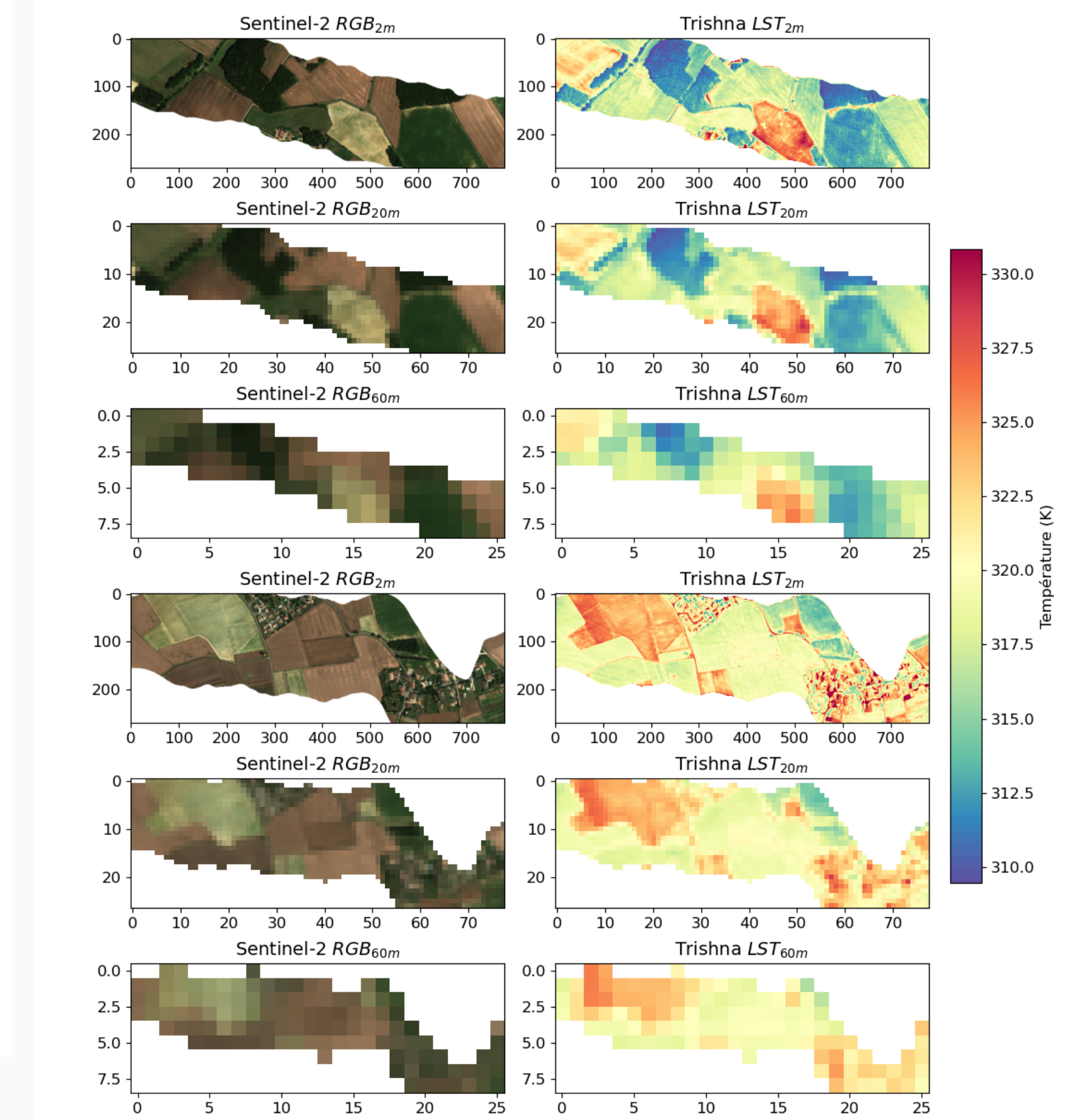
Data from hyperspectral airborne campaign (AHSPECT)

- AHSPECT flight of 2015.06.23, 6 tracks in south-west France
- Divided into 31 tiles for processing
- Resolution ≈ 2 meters, Swath width ≈ 300 meters



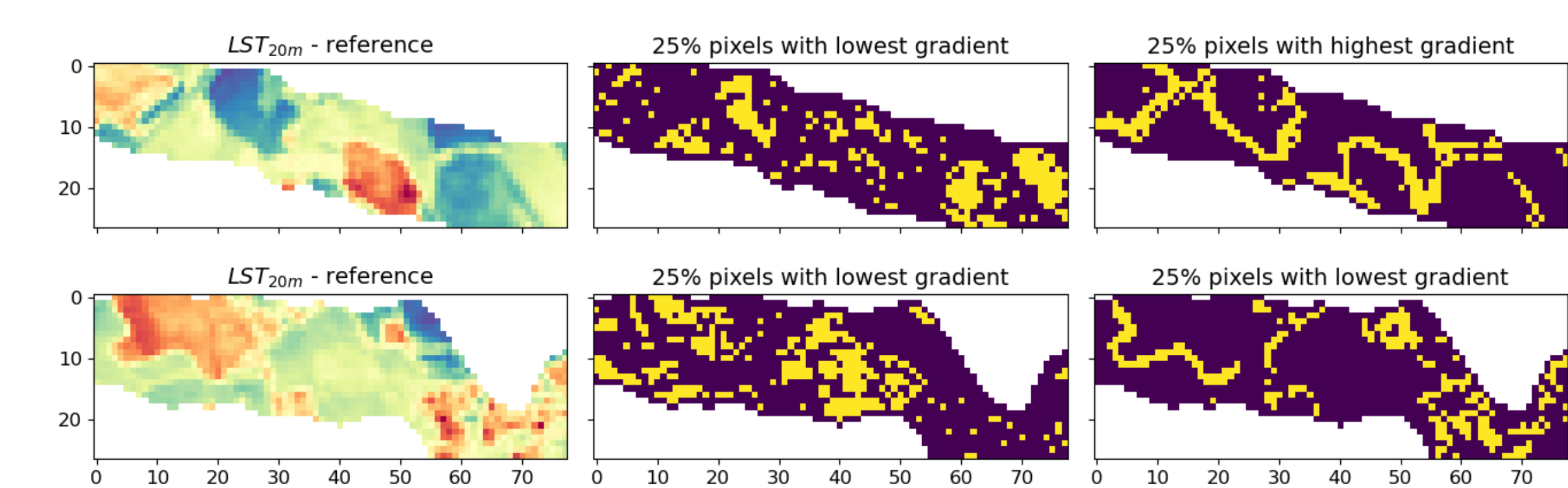
Sensor	N. bands	Wavelength range	Pre-processing
FENIX	448	381 - 2 502 nm	Ortho-rect., atm. corr.
OWL	102	7 584 - 12 593 nm	Ortho-rect.

Simulated data



Benchmarked methods: Bicubic Zoom (reference method), TsHARP [1], ATRPK [2], AATPRK [3], HUTS [4], Bilinear [5], Data Mining Sharpener [6] (Source code kindly provided by the authors of [7]: <https://github.com/cgranerob/Thumpy> except for DMS: <https://github.com/radosuav/pyDMS>)

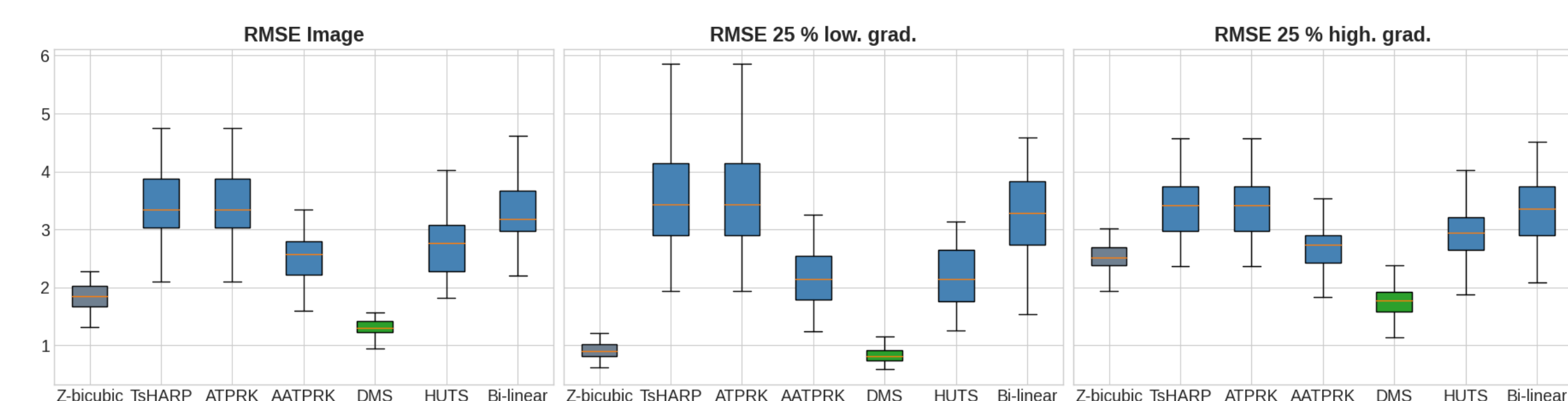
Pixels stratification by gradient class for performance evaluation



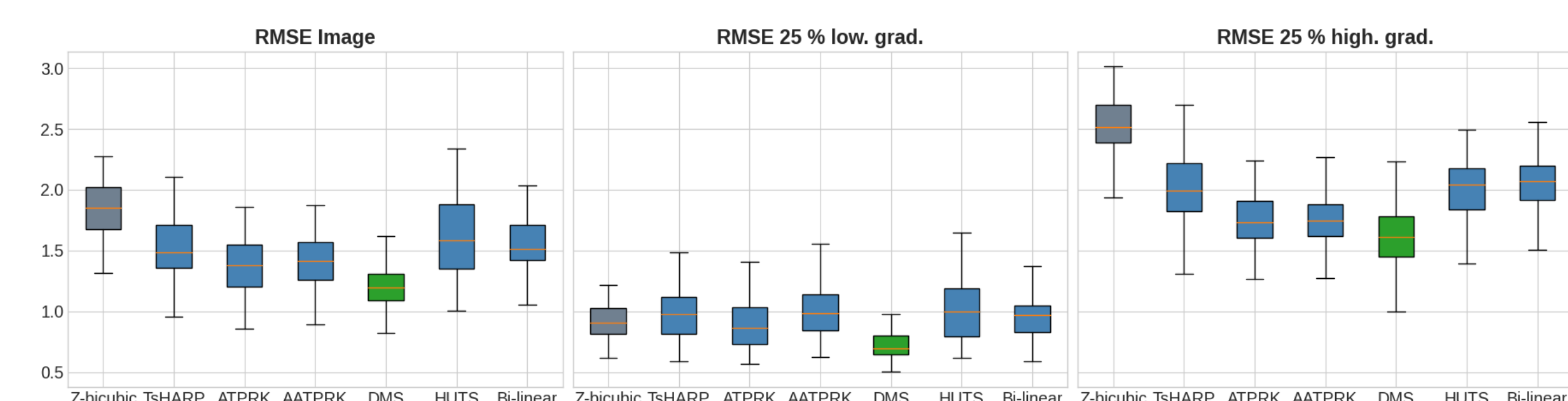
- 25% pixels with lowest gradient magnitude: low textures areas, no contours \rightarrow low spatial frequencies (should not be damaged by disaggregation)
- 25% with highest gradient magnitude: high texture, edges \rightarrow high spatial frequencies (= target for disaggregation)

Performances on Land Surface Temperature

Disaggregation, RMSE on 31 tiles (step b)



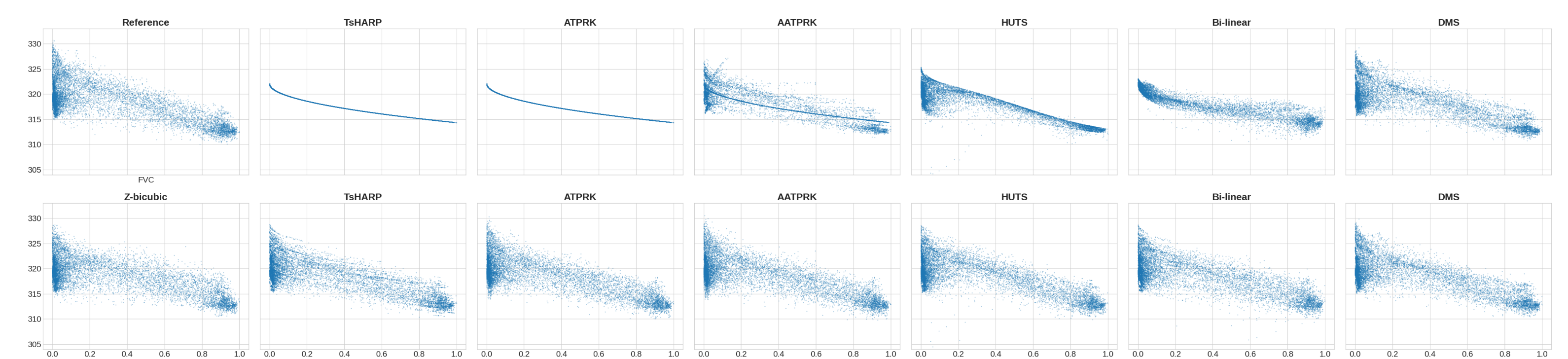
Residual compensation, RMSE on 31 tiles (step c)



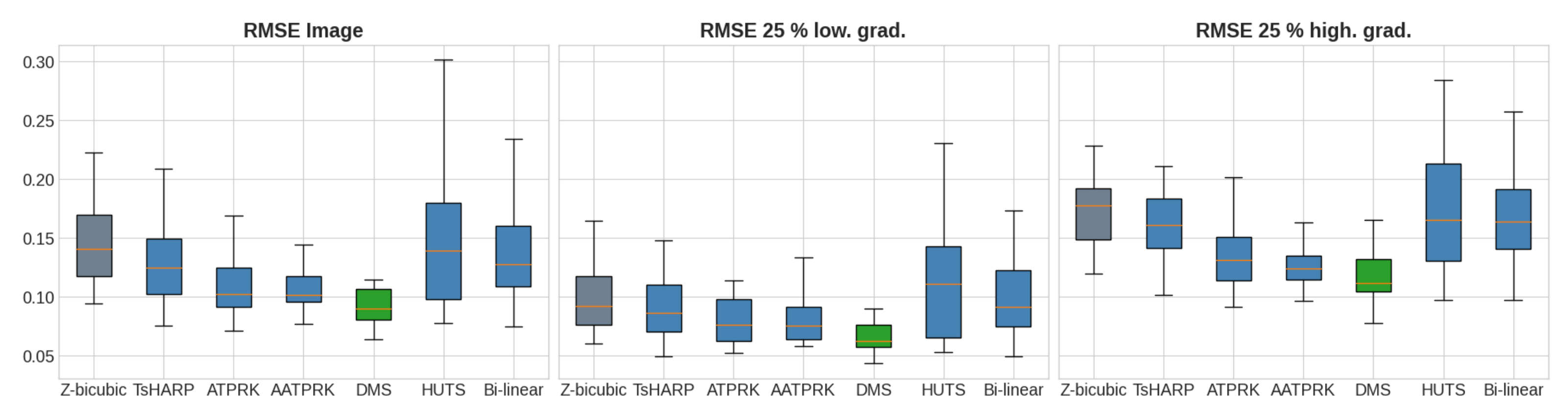
Performances on Water Deficiency Index

Scatter FVC - LST scatter plots without and with residual correction

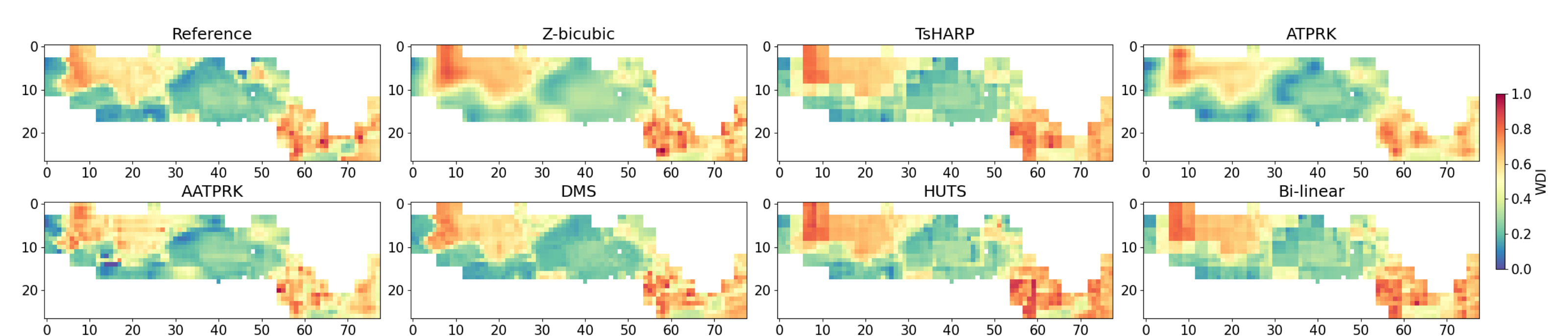
- Without residual corrections, scatter plots are damaged by all methods (except from DMS)
- Residual correction restores the scatter plots shape for most methods



WDI RMSE distributions for the 31 tiles with residual correction



WDI maps for all methods with residual correction



Conclusions and future work

Importance of residual compensation for all methods but DMS

- Performances on LST spatial disaggregation are essentially tied to residual compensation
- Without residual compensation, LST - FVC relation is not sufficiently preserved for WDI estimation

Interest of spatial disaggregation for water stress estimation in the Trishna case

- When compared to the 20m ground truth, when including residual compensations, all spatial disaggregation methods give a better estimate of WDI than a standard bicubic zoom
- Stratification on high gradient suggests that the performance gap with bicubic zoom is higher on high frequencies, and thus that faithful high resolution details are effectively generated
- DMS outperforms the other methods by 10% on WDI RMSE

Future work

- Process the October tracks of the AHSPECT campaign
- Input more features to DMS (especially MNT derived)
- Study the impact of temporal gap which will occur in operational case between Sentinel-2 and Trishna

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