DROUGHT MONITORING WITH HYPERSPECTRAL ENMAP AND PRISMA NARROWBANDS: INSIGHTS FROM THE ESA HYRELIEF PROJECT

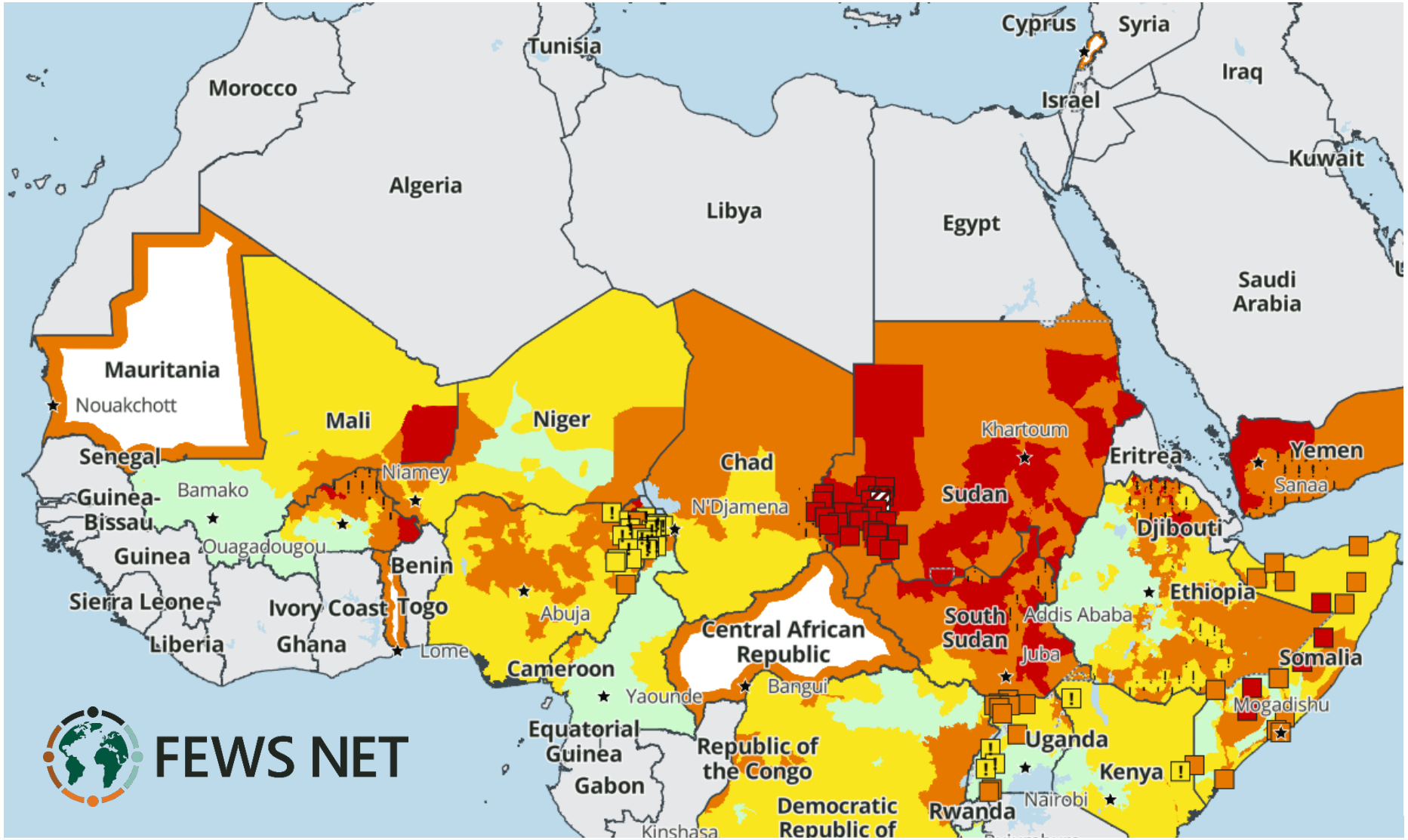
Team Members

Michael Marshall (ITC/University of Twente)
Monica Pepe (CNR-IREA)
Giulia Tagliabue (University of Milano-Bicocca)
Micol Rossini (University of Milano-Bicocca)
Cinzia Panigada (University of Milano-Bicocca)
Francesco Fava (University of Milano)
Sonja Leitner (International Livestock Research Institute)
Vincent Odongo (International Livestock Research Institute)
Chris Hecker (ITC/University of Twente)
Agnieszka Soszynska (University of Leicester)
Wim Timmermans (ITC/University of Twente)
Clement Atzberger (BOKU)
Micro Boschetti (CNR-IREA)

EO AFRICA

ESA HyRelief Project

Drought Induced Food Insecurity in Africa



IPC 3.1 ACUTE FOOD INSECURITY CLASSIFICATION

Click on a country for more information

The Integrated Phase Classification (IPC) acute food insecurity scale classifies areas according to a five-phase scale of increasing severity.

Presence Countries

- 1: Minimal
- 2: Stressed
- 3: Crisis
- 4: Emergency
- 5: Famine
- Not mapped
- National Parks/Reserves

Remote Monitoring Countries

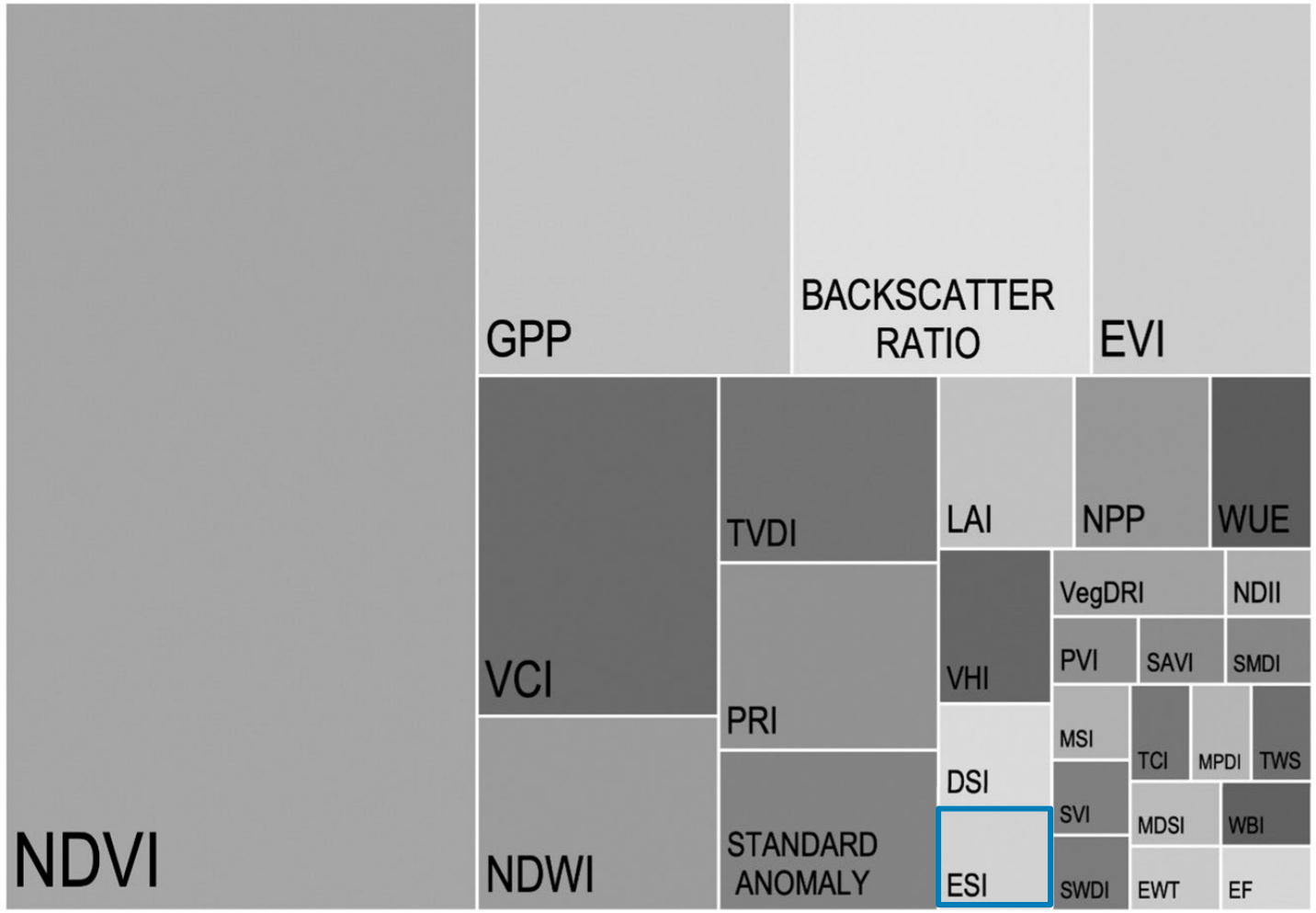
Highest IPC classification in areas of concern within the country

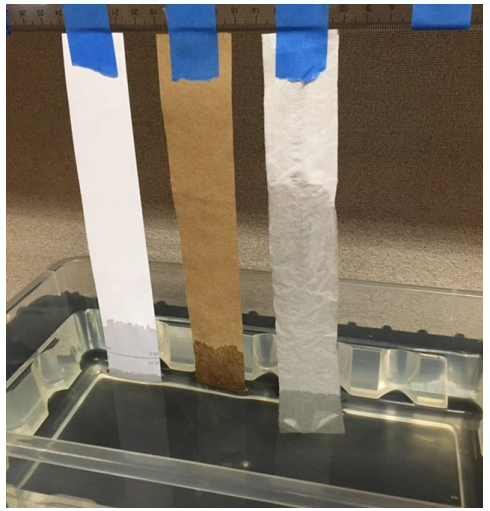
- 1: Minimal
- 2: Stressed
- 3+: Crisis or higher

Symbols

- ! Would likely be at least one phase worse without current or planned humanitarian food assistance
- Settlement of displaced populations

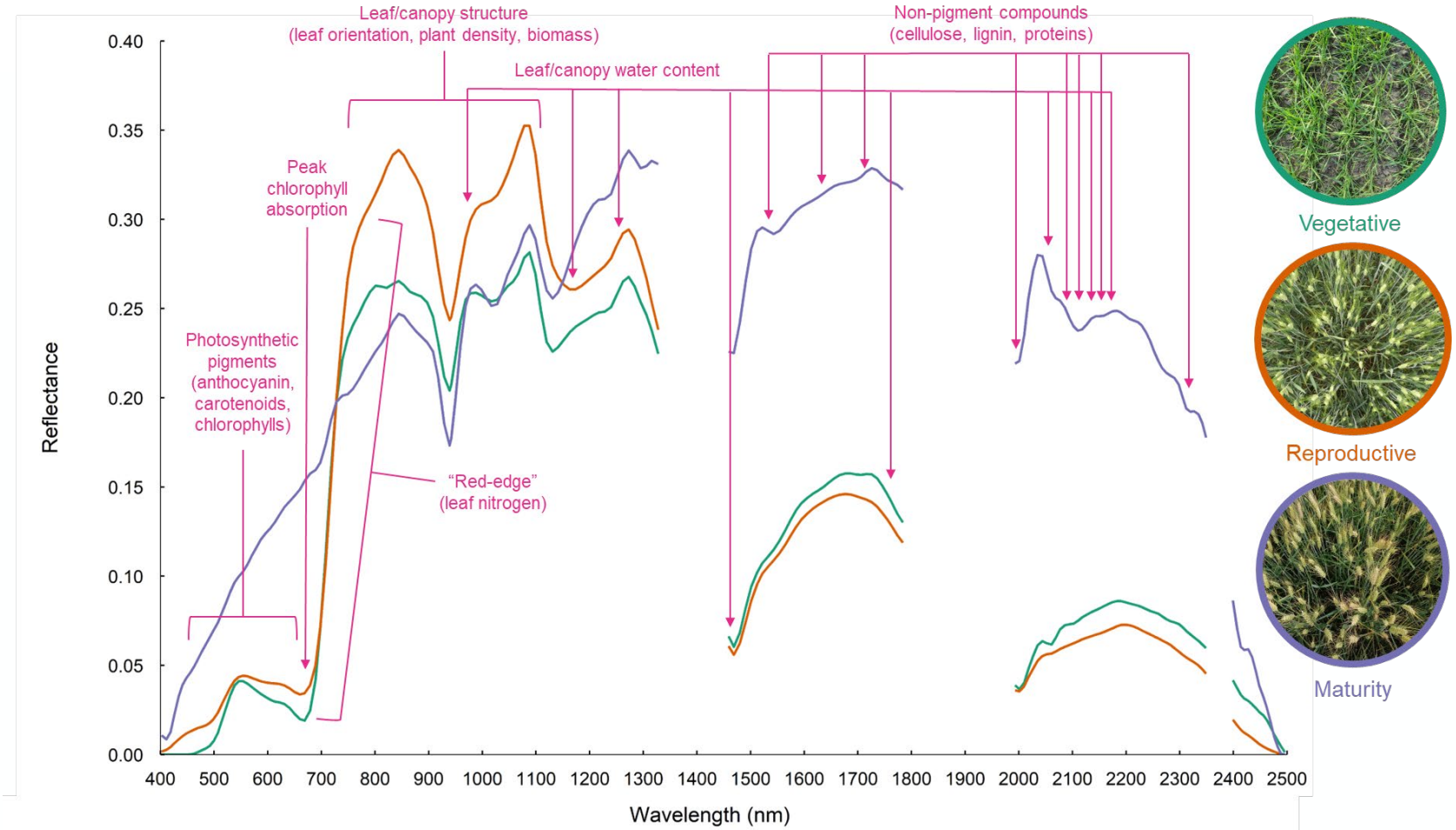
Evapotranspiration: Comprehensive Drought Indicator





West, H., Quinn, N., Horswell, M. 2019. Remote sensing for drought monitoring & impact assessment: Progress, past challenges and future opportunities. *Remote Sensing of Environment*, 232: 111291.

Opportunity in Hyperspectral Renaissance



Substitution of NDVI with hyperspectral vegetation indices (HVIs) with field spectroradiometers achieved:

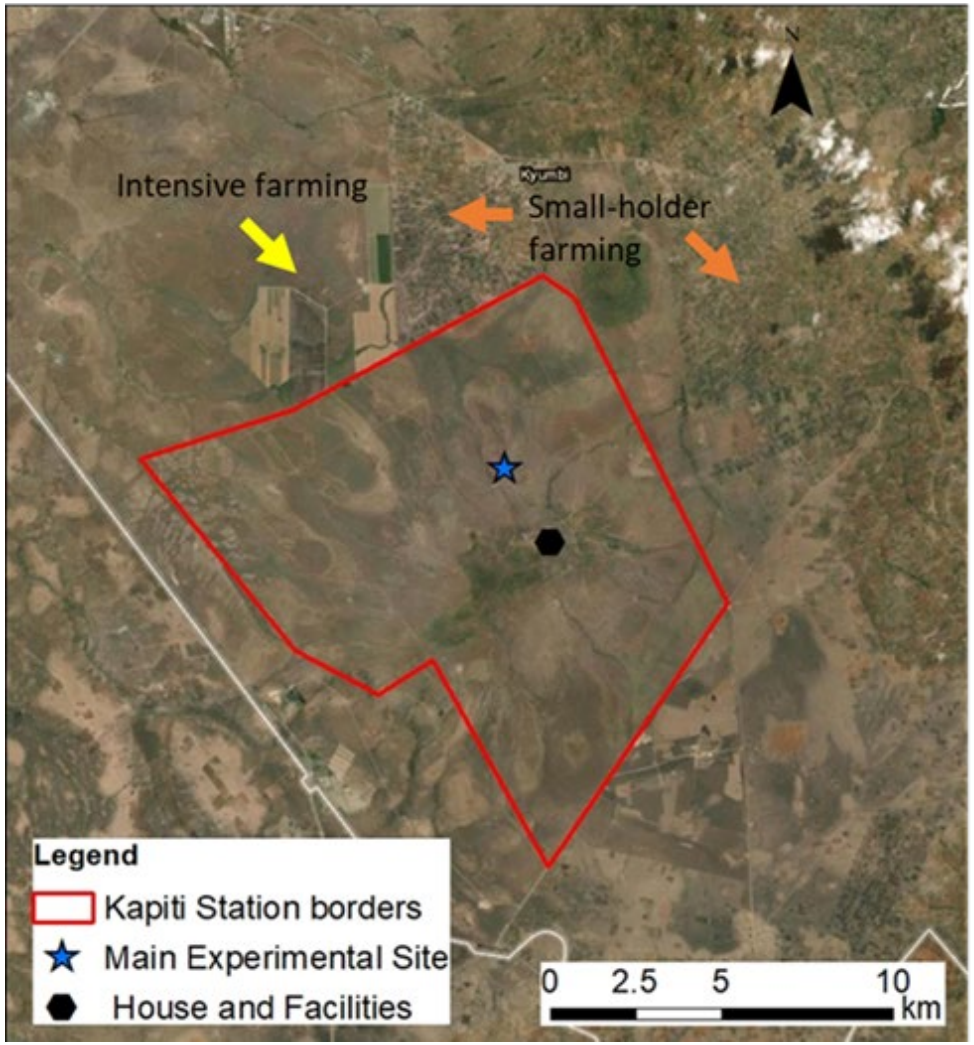
17% and 14% gains in transpiration and soil evaporation model performance

Marshall, M., Thenkabail, P., Biggs, T., Post, K. 2016. Hyperspectral narrowband and multispectral broadband indices for remote sensing of crop evapotranspiration and its components (transpiration and soil evaporation). *Agricultural and Forest Meteorology*, 218-19: 122-134.

ESA HyRelief Project Objectives

- Hyperspectral-enhancement of ECOSTRESS drought products
  - Evaluate the performance of HVIs in NASA PT-JPL
  - Assess RTM-inversion of HNBs in EEH TSEB
  - Compare the performance of PT-JPL and TSEB evapotranspiration
- Co-produce enhanced products with Agile
  - Analyze early adopter needs and prototype benefits
  - Create a first-user interface through iterative testing
  - Acceptance testing

Study Area


Intensive farming
Small-holder farming
Legend
Kapiti Station borders
Main Experimental Site
House and Facilities
0 2.5 5 10
km


km
0 500 1,000

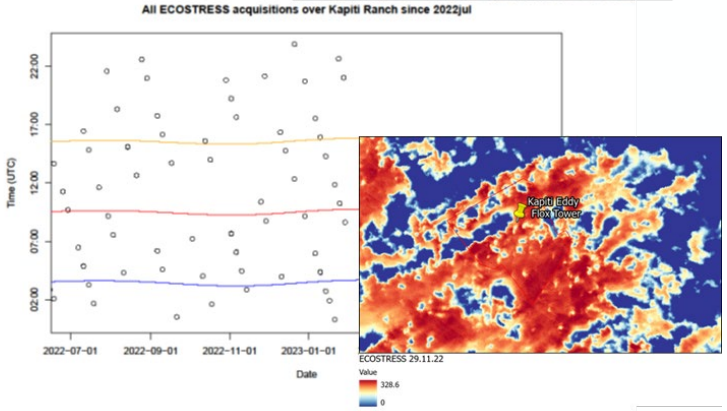

Nairobi
Machakos
Makueni
Kajiado
Makueni
km
0 25 50

Field Instrumentation

- Three Licor Eddy Covariance Systems
  - 2019
  - New installations 2022
  - Savannah and nearby dryland cropland
- FLOX hyperspectral instrument
  - 2020
  - Refit in 2023
- Phenological cameras

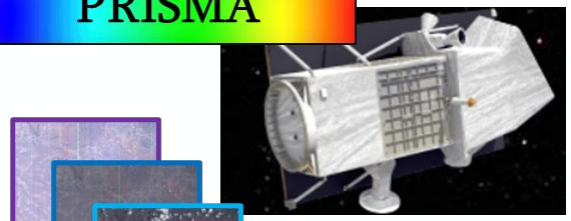
EO Data in Numbers

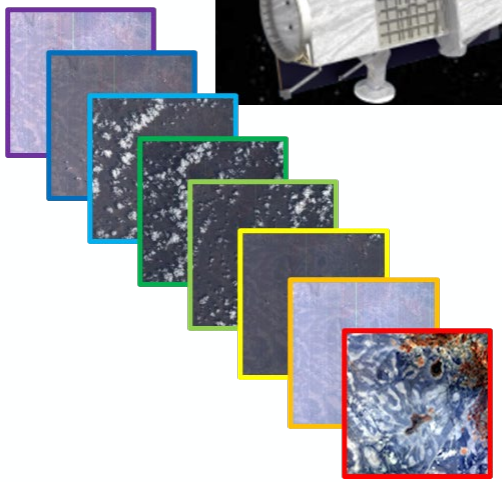
ECOSTRESS



- Since 2018 310
- Since 2022 July 57
  - Since 2022 July
  - 2h around noon 20

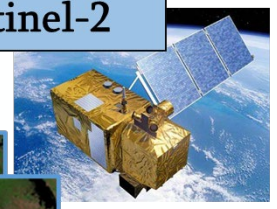
PRISMA

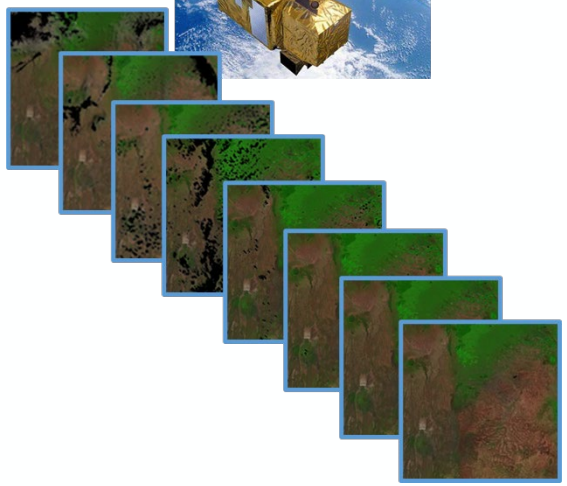




- Since 2019 64
- Since 2022 July 36
  - clouds <20% 22
  - clear AOI 15

Sentinel-2



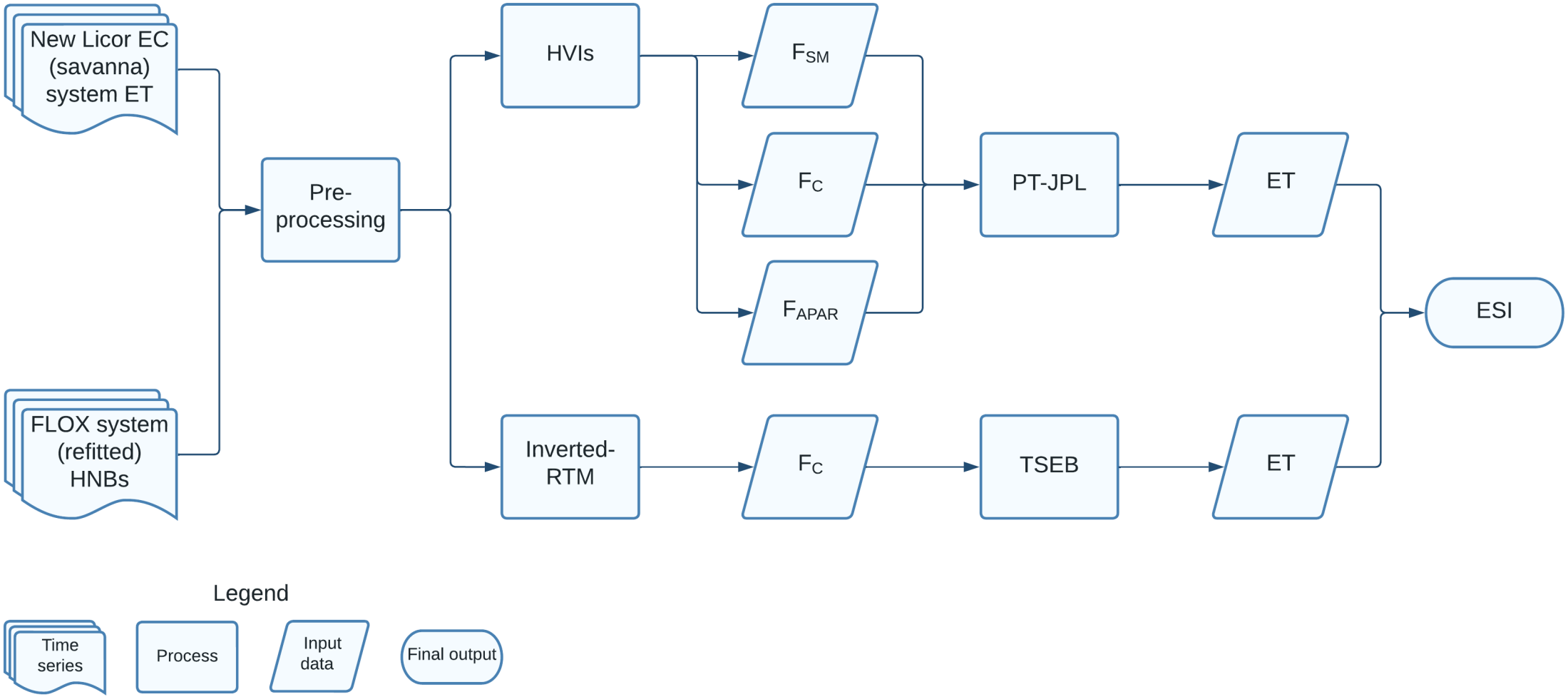


- Since 2022 July 49
  - clouds <20% 29
  - clear AOI 10

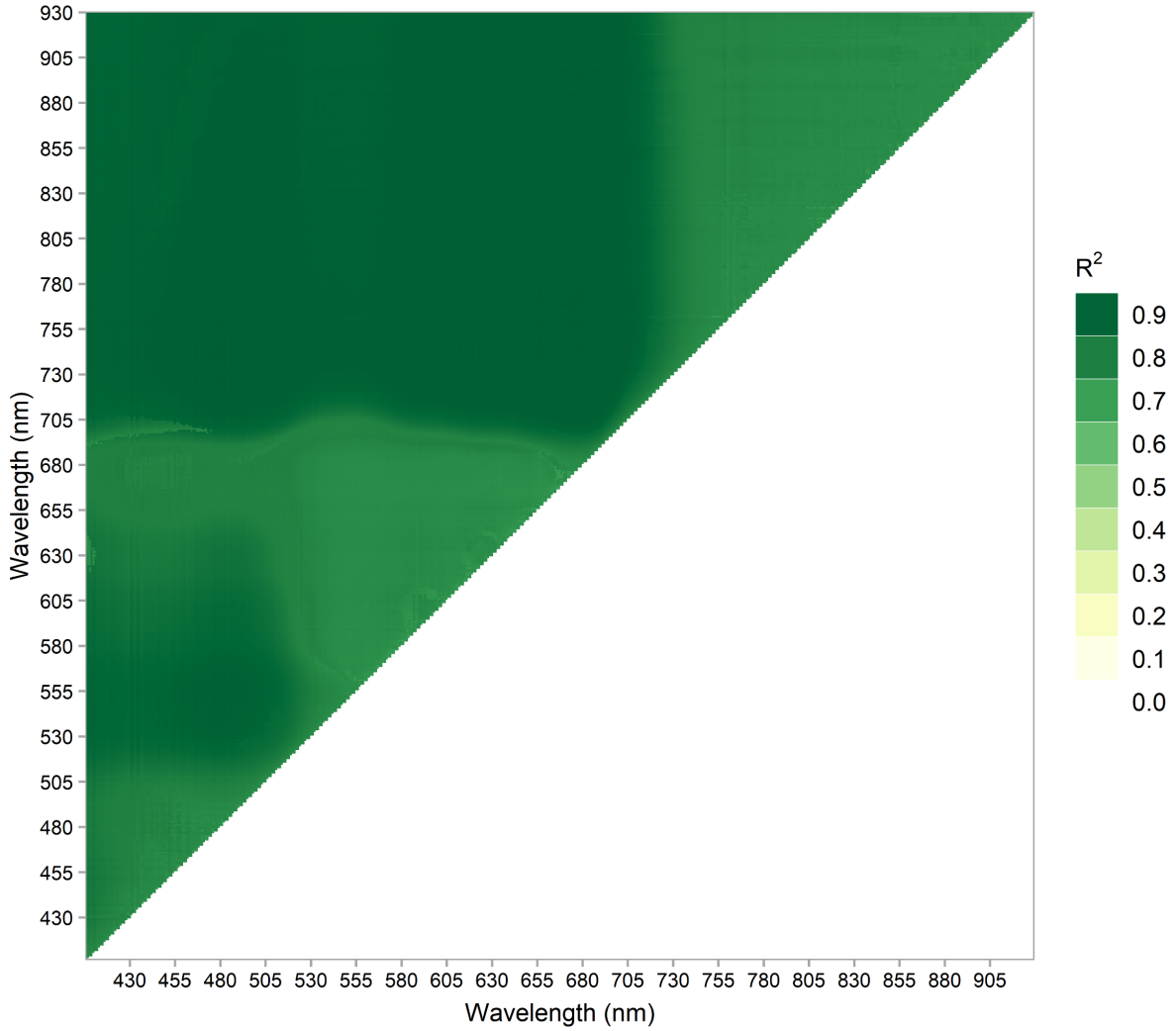
EnMAP

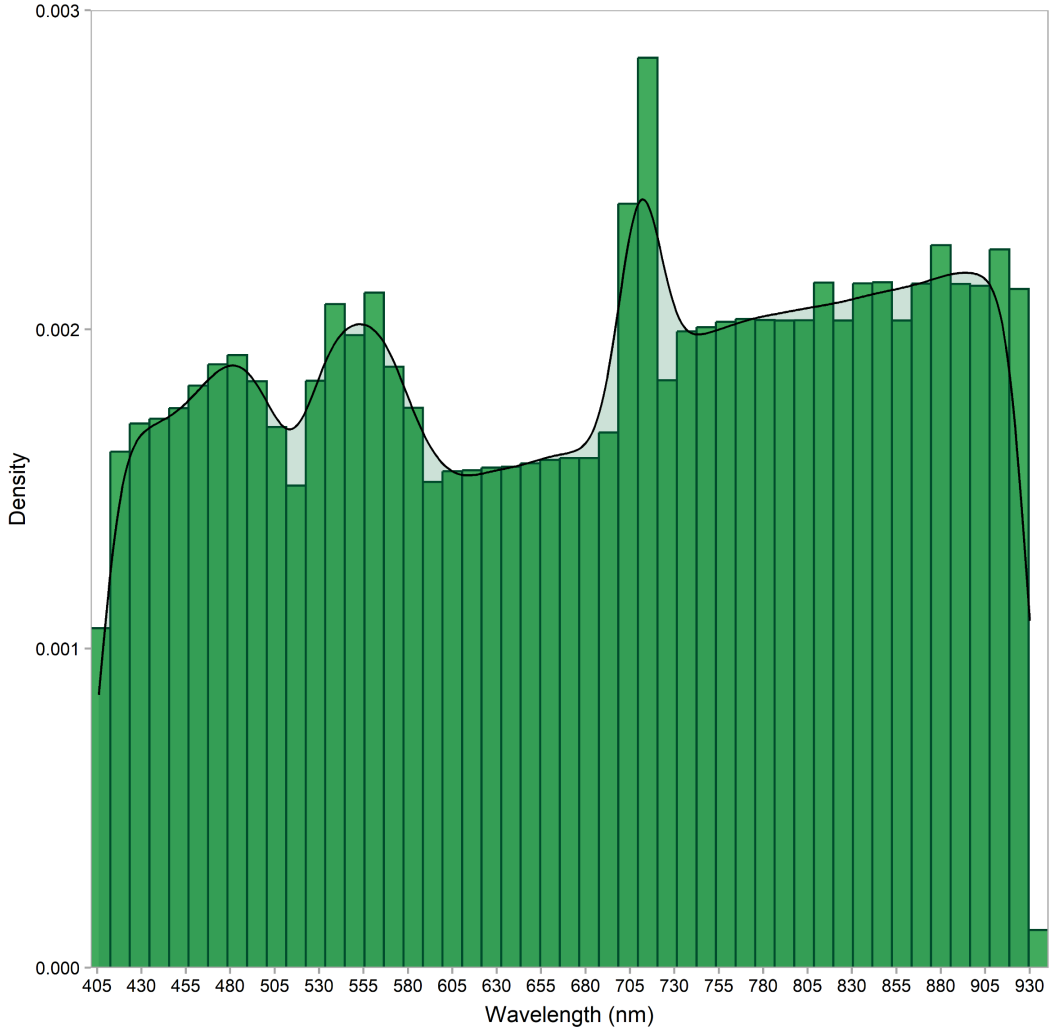
- Since 2022 July 7
  - clouds <20% 4
  - clear AOI 3

Technical Workflow

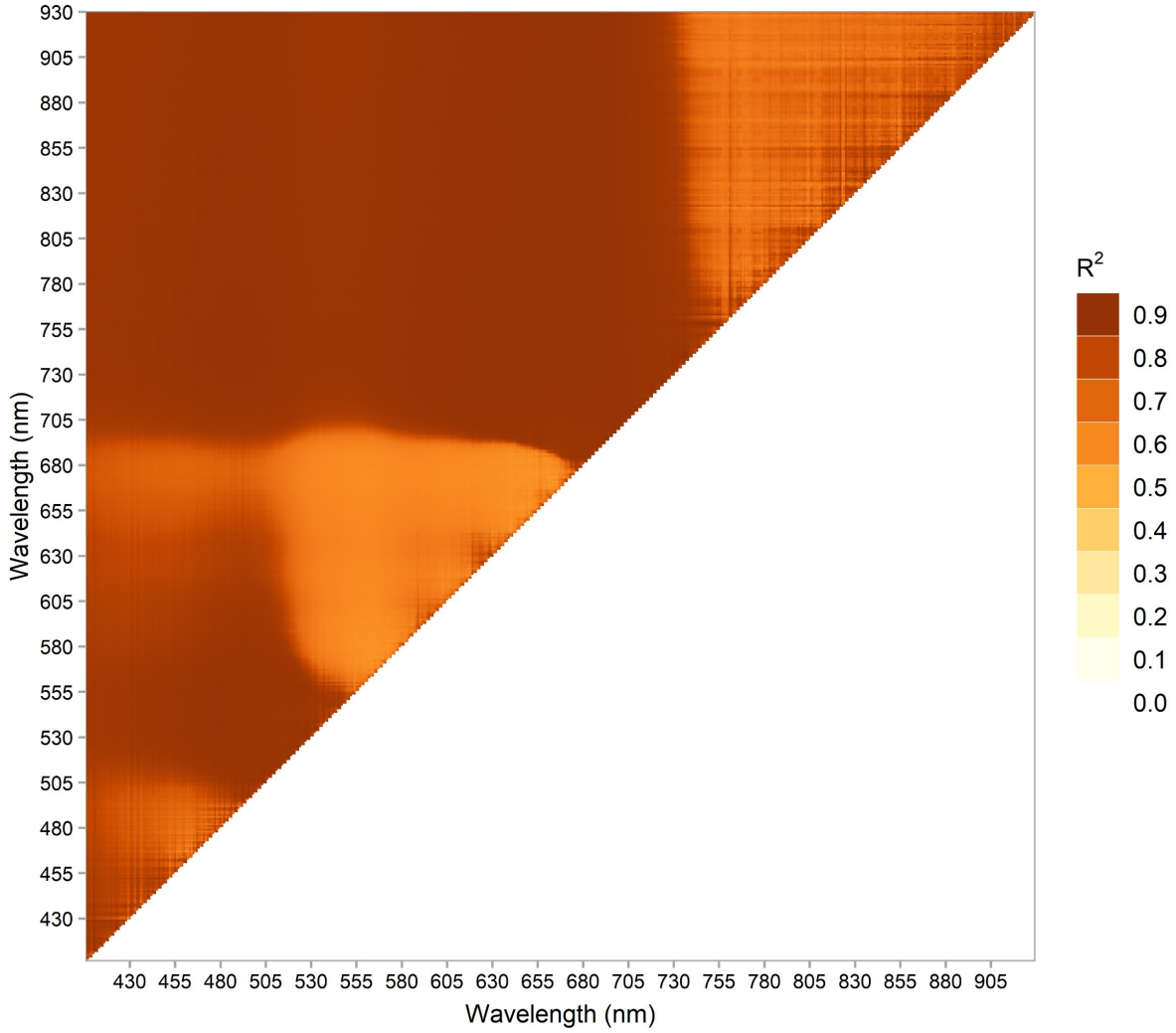


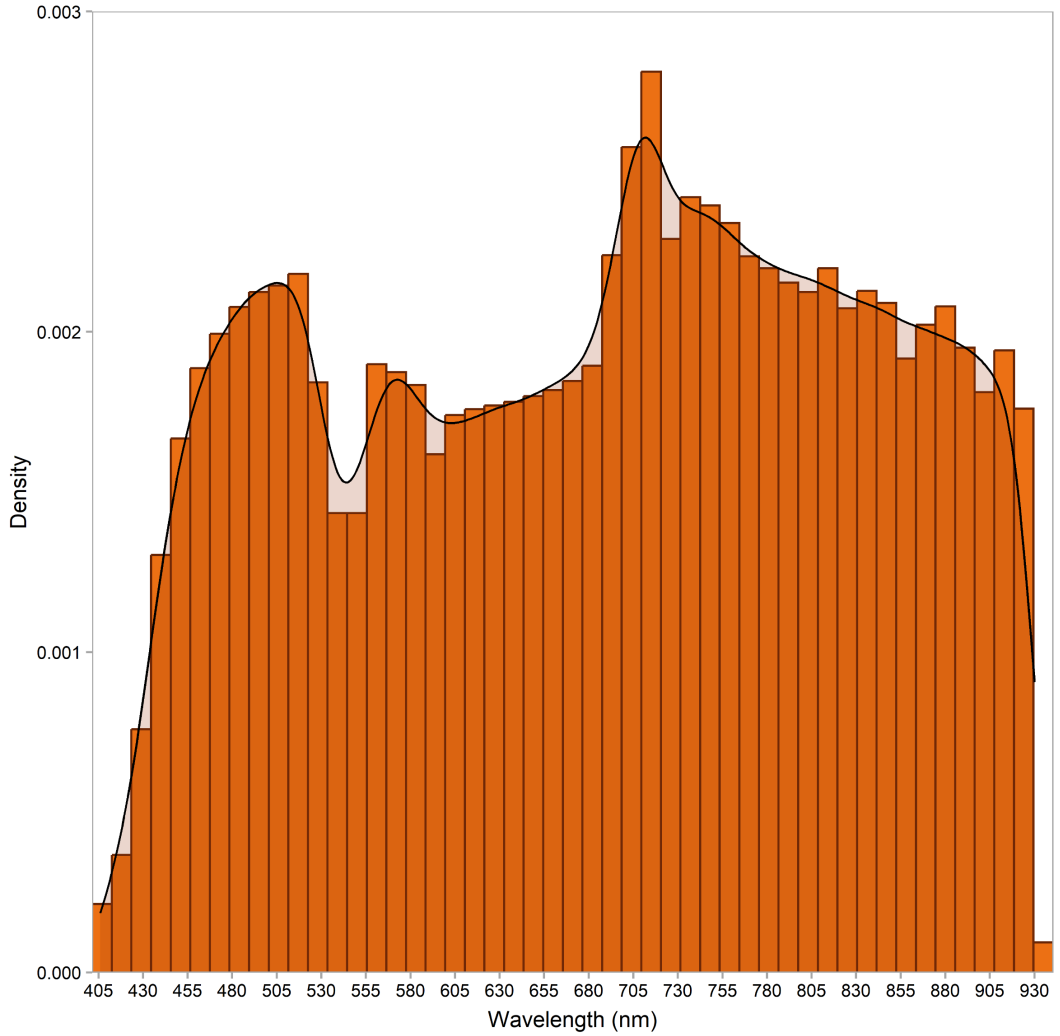
TBVIs (Canopy)



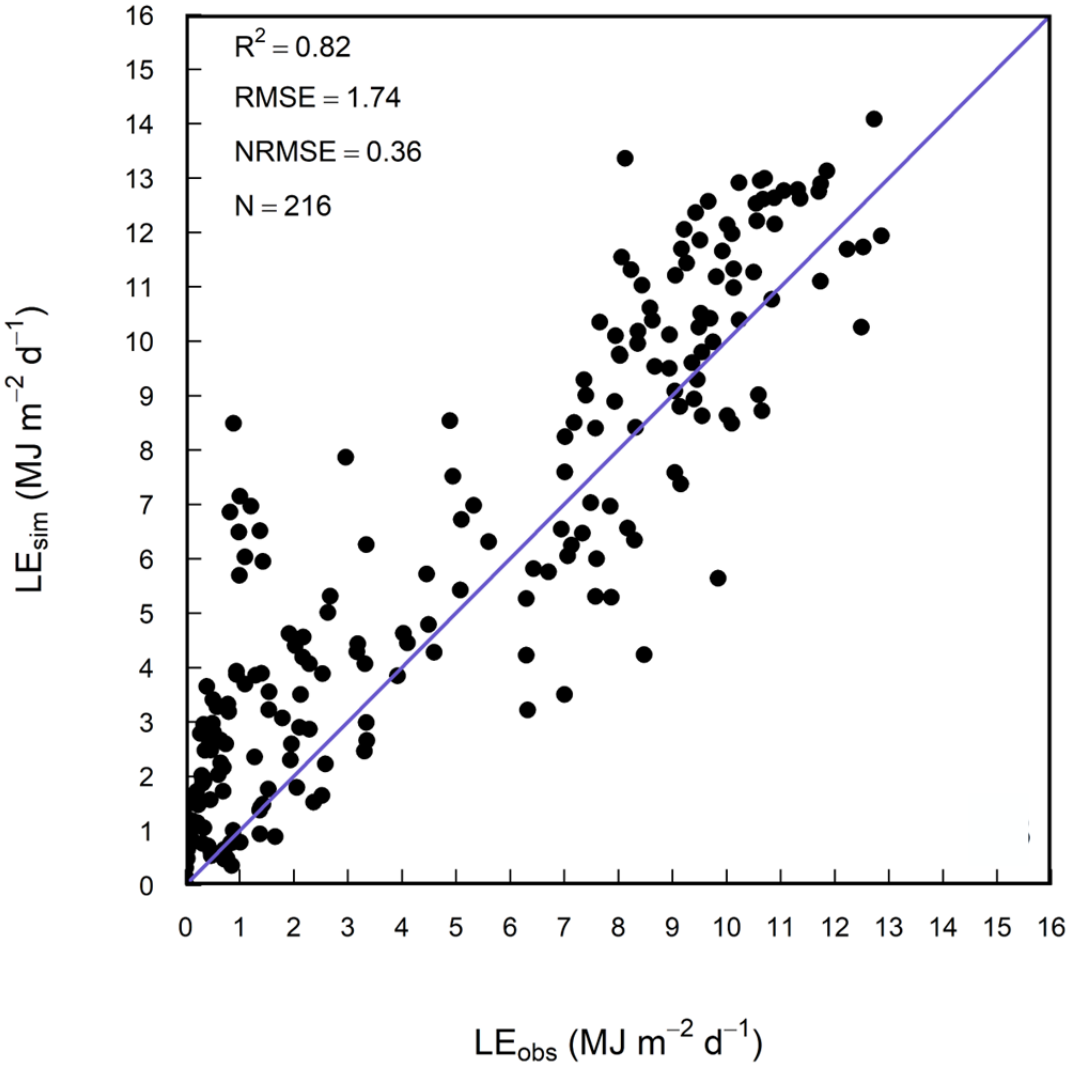


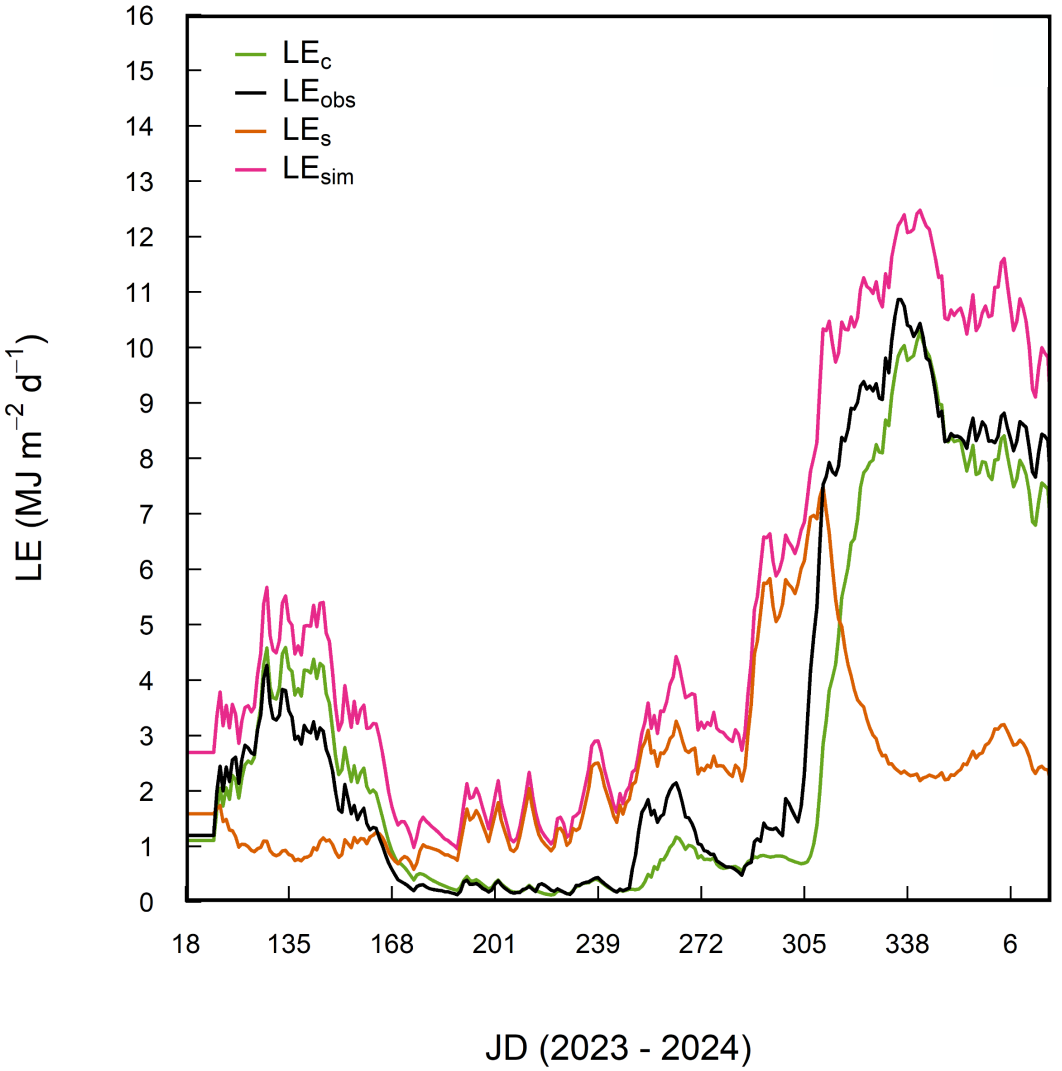
TBVIs (Soil)


Wavelength (nm)
930
905
880
855
830
805
780
755
730
705
680
655
630
605
580
555
530
505
480
455
430
430 455 480 505 530 555 580 605 630 655 680 705 730 755 780 805 830 855 880 905
Wavelength (nm)
R2
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

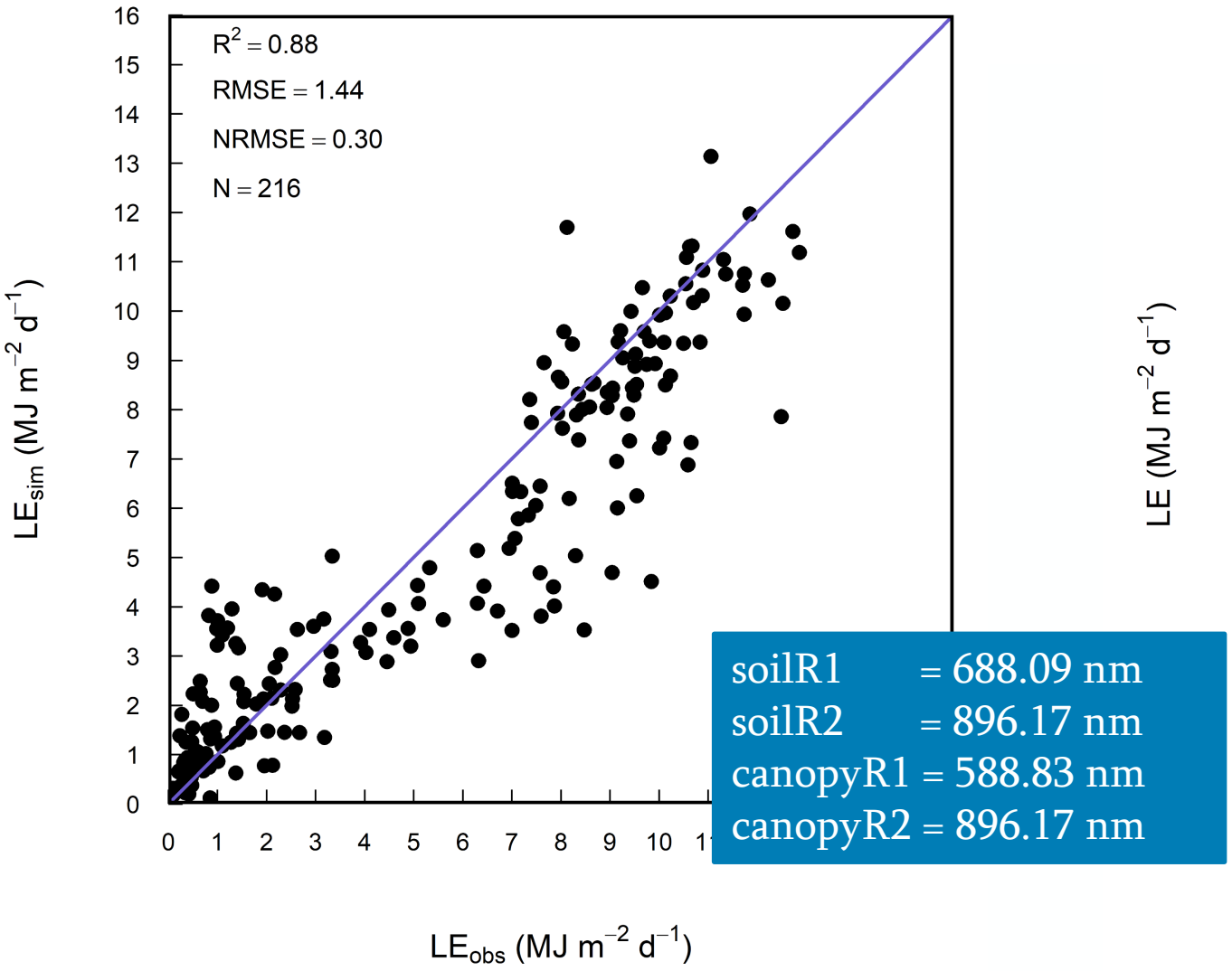

Density
0.003
0.002
0.001
0.000
405 430 455 480 505 530 555 580 605 630 655 680 705 730 755 780 805 830 855 880 905 930
Wavelength (nm)

PT-JPL without HVI Calibration

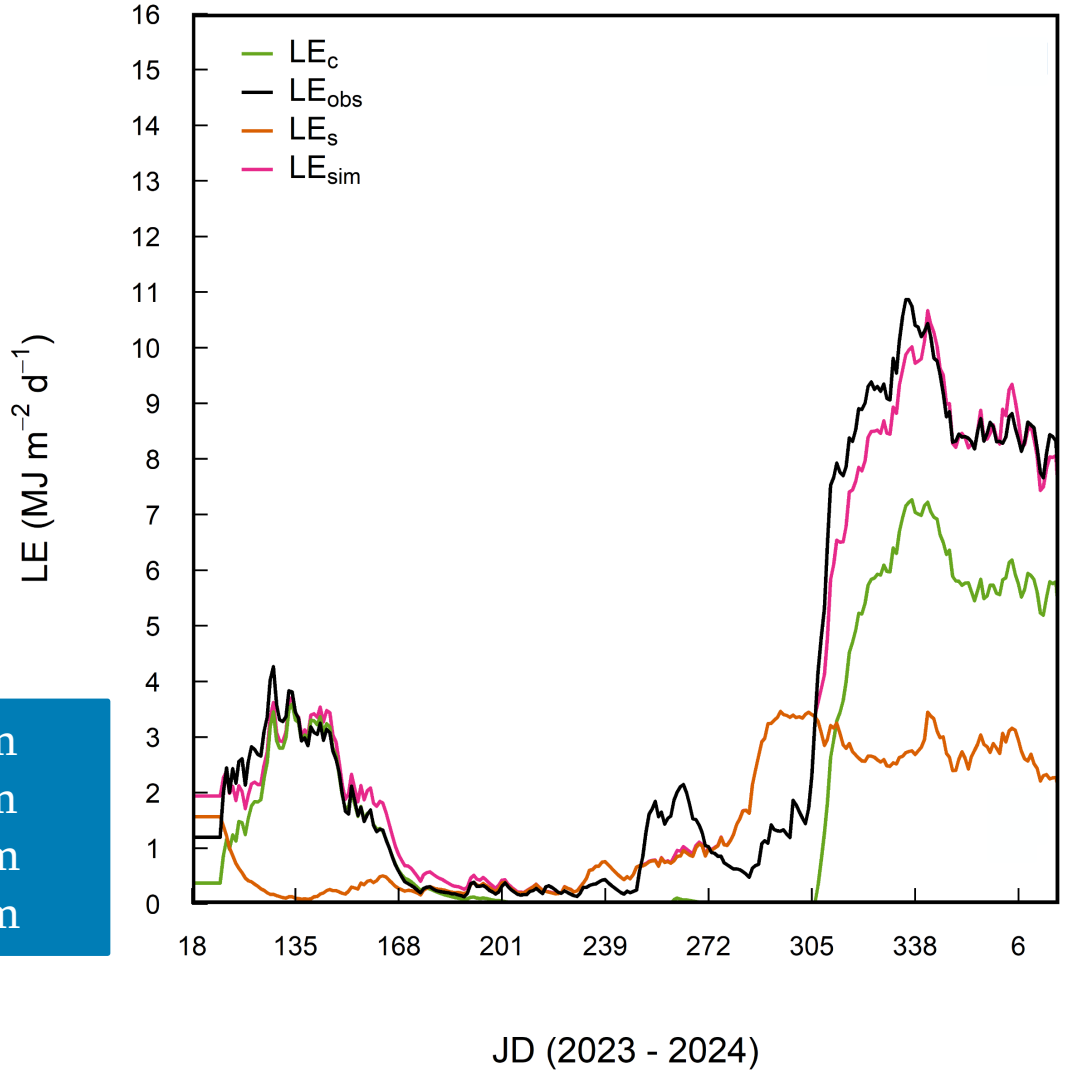




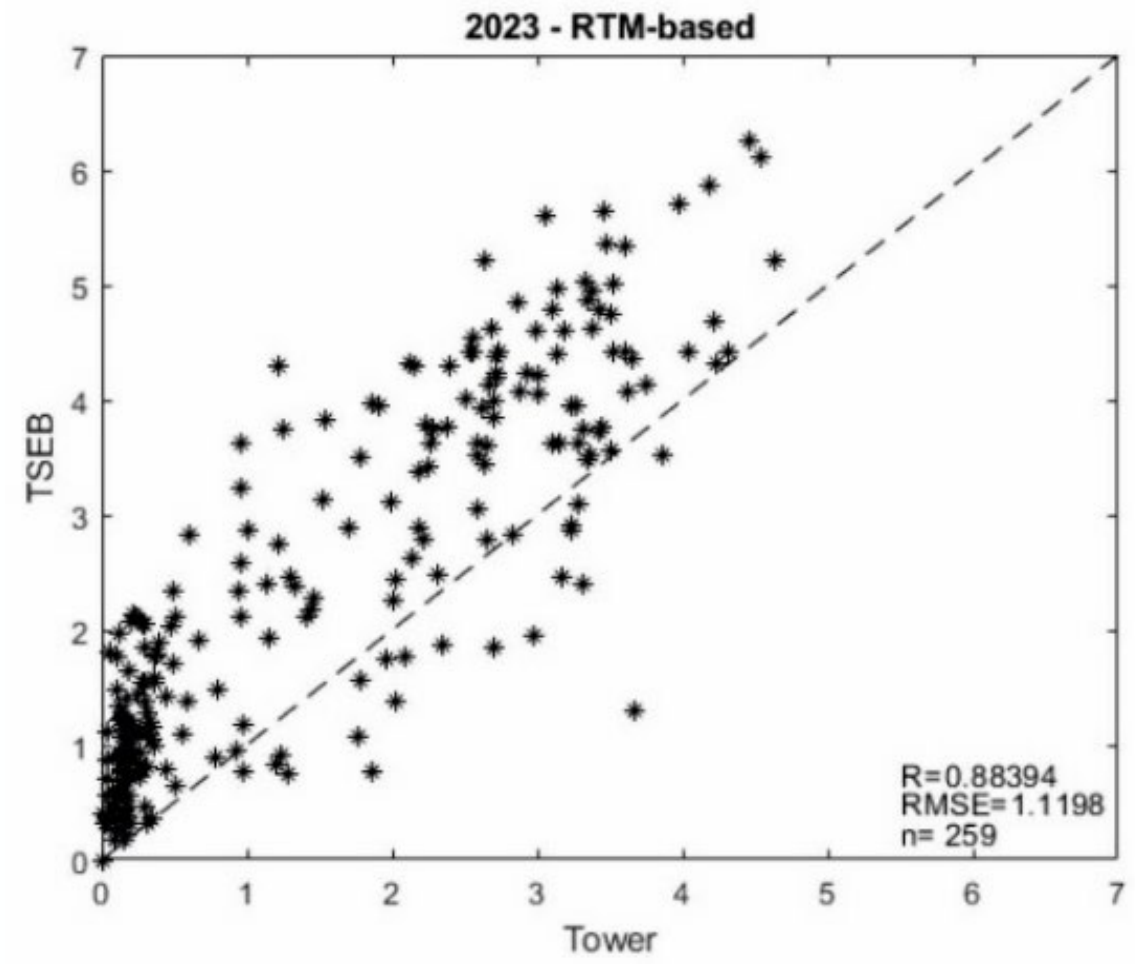
PT-JPL with HVI Canopy and Soil Calibration

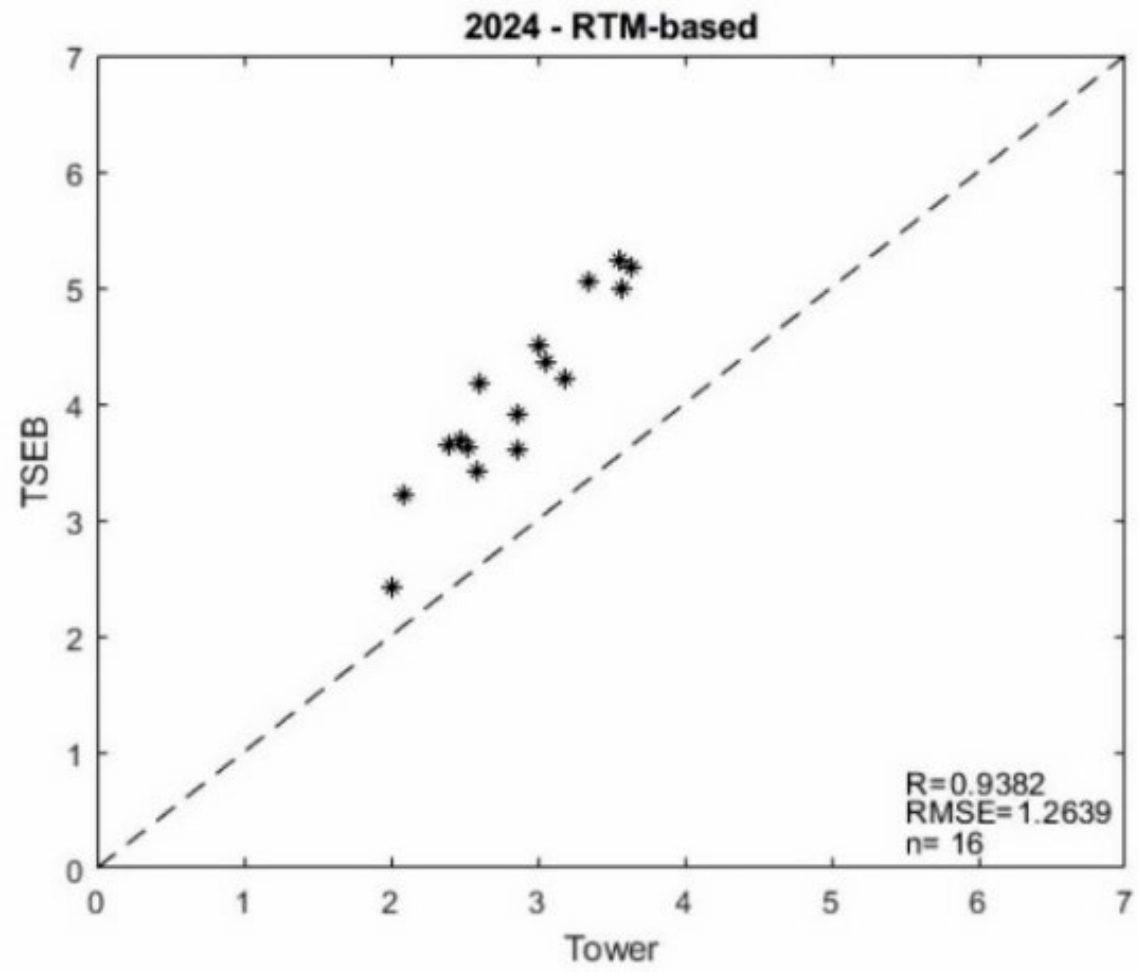


soilR1 = 688.09 nm
soilR2 = 896.17 nm
canopyR1 = 588.83 nm
canopyR2 = 896.17 nm



Comparison with RTM-inversion and TSEB





Concluding Remarks

- European ECOSTRESS Hub
  - ECOSTRESS (thermal), TSEB, SEBS
  - NASA PT-JPL over-estimation in water limited areas, but…
- Sentinel-2 Next Generation (S2NG) SWIR narrowbands and LE_S
- 11-day revisit time of CHIME mission remains too coarse for tropical areas with persistent cloud cover

Hu, T., Mallick, K., Hitzelberger, P., Didry, Y., Boulet, G., Szantoi, Z., Koetz, B., Alonso, I., Pascolini-Campbell, M., Halverson, G., Cawse-Nicholson, K., Hulley, G.C., Hook, S., Bhattarai, N., Olioso, A., Roujean, J-L., Gamet, P., Su, B.. 2023 Evaluating European ECOSTRESS Hub Evapotranspiration Products Across a Range of Soil-Atmospheric Aridity and Biomes Over Europe. *Water Resources Research*, 218-19: 122-134.