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► To cite this version:

Albert Olioso, Gilles Boulet, Jérôme Demarty, Hugo Desrutins, Jordi Etchanchu, et al.. TRISHNA Level-2 products: Daily evapotranspiration and water stress. International Workshop on High-Resolution Thermal EO 2023, May 2023, ESRIN, Frascati, Italy. 2023. hal-04154762

HAL Id: hal-04154762

<https://hal.inrae.fr/hal-04154762v1>

Submitted on 2 Oct 2023

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TRISHNA Level-2 products: Daily evapotranspiration and water stress



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Trishna Products

TRISHNA products will include evapotranspiration and water stress index products to be delivered within 12 hours after acquisition:

At level 2:

- Latent heat flux (LE) at the time of satellite clear-sky acquisition
- Evaporative fraction (EF) as a water stress index

At higher levels:

- daily evapotranspiration (ETd) for days with acquisition
- reconstructed daily evapotranspiration for days with no acquisition (revisit, clouds...)

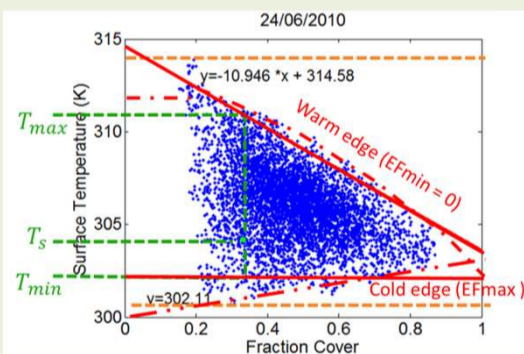
Models

EVASPA

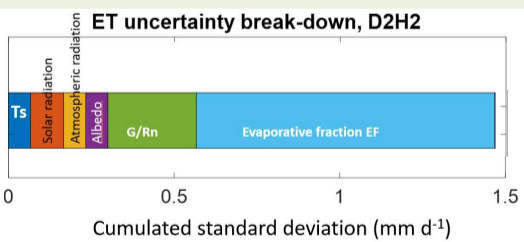
(EVApotranspiration from SPACE)
Gallego-Elvira et al. 2013 ; Allies et al. 2020

Contextual models:

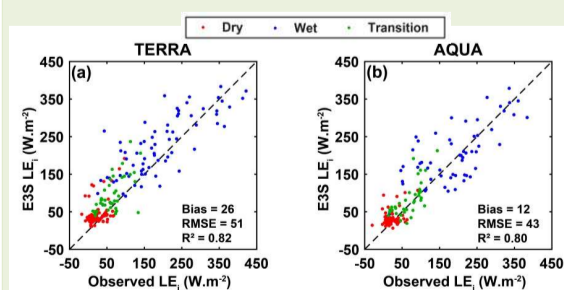
triangle (fraction cover-Ts) and S-SEBI (albedo-Ts) methods;
LE derived from the Evaporative Fraction:
EF=(Ts-Tmax)/(Tmin-Tmax)



Multi-data multi-model framework
=> uncertainty assessment:



Example of results over Niger using MODIS data (Allies et al. 2020):



Allies A., J. Demarty, A. Olioso, I. Bouzou Moussa, H. B.-A. Issoufou, C. Velluet, M. Bahir, I. Mainassara, M. OI, J.-P. Chazarin, B. Cappelerae. (2020). Evapotranspiration Estimation in the Sahel Using a New Ensemble-Contextual Method. *Remote Sensing*, 12, 380. doi:10.3390/rs12030380

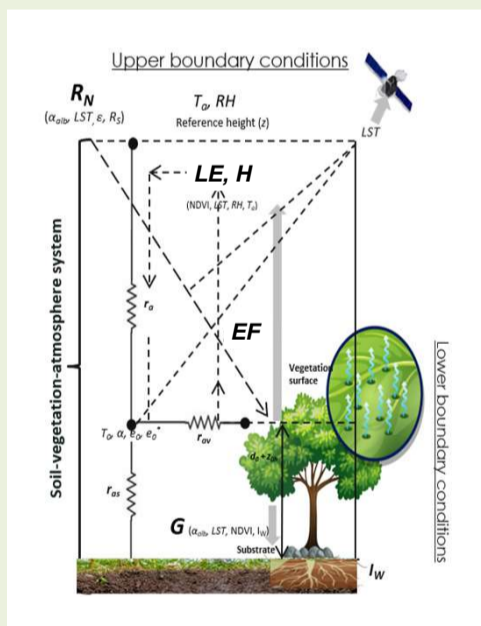
Gallego-Elvira B., Olioso A., Mira M., Reyes Castillo S., Boulet G., Marloie O., Garrigues S., Courault D., Weiss M., Chauvelon P., Boutron O., (2013). EVASPA (Evapotranspiration Assessment from SPACE) tool: an overview. *Procedia Environmental Sciences*, 19, 303-310

STIC

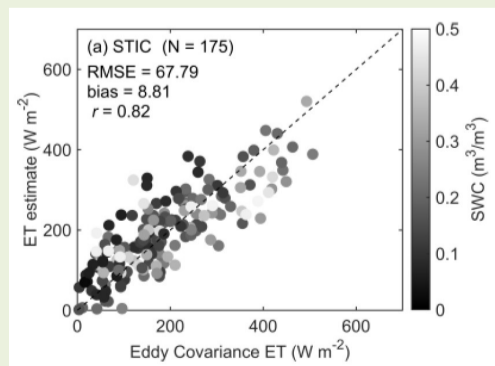
(Surface Temperature Initiated Closure)
Mallick et al., 2014, 2016

Single pixel model:

Penman-Monteith equation for the vegetation layer, Shuttleworth-Walace resistance network



Example of results over various sites using ECOSTRESS data (Hu et al. 2023):



Mallick, K., Jarvis, A.J., Boegh, E., Fisher, J.B., Drewry, D.T., Tu, K.P., Hook, S.J., Hulley, G., Ardo, J., & Beringer, J. (2014). A Surface Temperature Initiated Closure (STIC) for surface energy balance fluxes. *Remote sensing of Environment*, 141, 243-261

Mallick, K., Trebs, I., Boegh, E., Giustarini, L., Schlerf, M., Drewry, D.T., Hoffmann, L., Randow, C.V., Kruijt, B., & Araujo, A. (2016). Canopy-scale biophysical controls of transpiration and evaporation in the Amazon Basin. *Hydrology and Earth System Sciences*, 20, 4237-4264

Hu T., K. Mallick, P. Hitzelberger, Y. Didry, G. Boulet, Z. Szantoi, B. Koetz, I. Alonso, M. Pascolini-Campbell, G. Halverson, K. Cawse-Nicholson, G.C. Hulley, S. Hook, N. Bhattarai, A. Olioso, J.-L. Roujean, P. Gamet, Z. Su. (2023). Evaluating European ECOSTRESS Hub Evapotranspiration Products Retrieved from Three Structurally Contrasting SEB Models over Europe. To be published in *Water Resources Research*. (preprint. doi: 10.1002/essoar.10512884.1)

General scheme

TRISHNA Level 1 & 2 Products

Ts, albedo, ε, fC, LAI, ρr, ρnir

Meteorological Analysis

Ta, ea

Radiation products

Rg, Ra

Models

EVASPA

STIC

LE_EVASPA
Rn-G_EVASPA

LE_STIC
Rn-G_STIC

EF_EVASPA

EF_STIC

Ts: surface temperature
ε: surface emissivity
fC: fraction cover
LAI: leaf area index
ρr: red reflectance
ρnir: near infrared reflectance
Ta: air temperature
ea: air vapour pressure
Rg: solar radiation
Ra: atmospheric radiation
LE: latent heat flux
Rn: net radiation
G: ground heat flux
EF: evaporative fraction

Daily ET

The instantaneous latent heat flux LE is scaled to ETd, the daily evapotranspiration, by assuming a constant ratio LE / Rg along the day (following Delogu et al. 2021, Guillevic et al. 2019).

Instantaneous solar radiation at the time of TRISHNA acquisition is obtained from TRISHNA data (Champion et al. 2022). Daily value of solar radiation can be computed as a theoretical value or obtained from geostationary satellite products.

Champion, J., J.-L. Roujean, J. Auclair, O. Hagolle, J. Michel, X. Ceamanos (2022). Estimate of short- and long-wave downwelling surface radiation fluxes at high resolution. *TRISHNA Days*, Toulouse, March 2022.

Delogu, E., Olioso, A., Allès, A., Demarty, J., Boulet, G., (2021). Evaluation of Multiple Methods for the Production of Continuous Evapotranspiration Estimates from TIR Remote Sensing. *Remote Sensing*, 13, no. 6, 1086. DOI: 10.3390/rs13061086

Guillevic, P.C.; Olioso, A.; Hook, S.J.; Fisher, J.B.; Lagouarde, J.-P.; Vermote, E.F., (2019). Impact of the Revisit of Thermal Infrared Remote Sensing Observations on Evapotranspiration Uncertainty—A Sensitivity Study Using AmeriFlux Data. *Remote Sensing*, 2019, 11, 573.

Tiling

TRISHNA data will be projected on to a UTM grid and made available on 100x100 km² tiles following the system used for Sentinel 2. Some tiles, in particular on coast, will be grouped to increase the number of available pixels to run EVASPA.

