

LSA SAF: Operational and reprocessed Evapotranspiration (ET) and surface energy fluxes products: examples of potential applications

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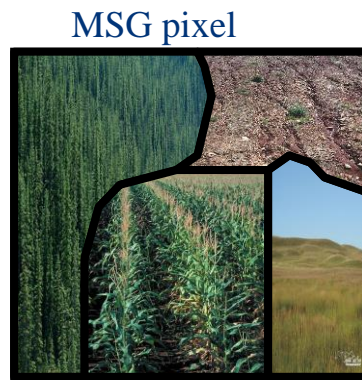
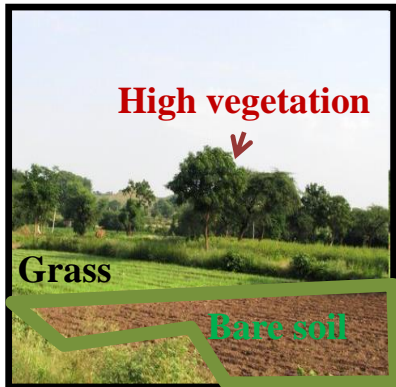
- Introduction
- Products examples and validation
- Reprocessed ET and surface fluxes (SF)
- Potential applications
- Summary

Approach philosophy

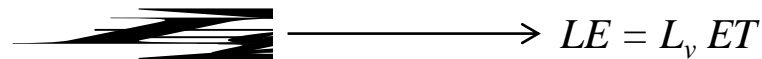
Simplified SVAT-based model, forced with satellite & NWP data, allowing to:

- Produce all-weather ET
- High repetition rate (one image every 30 minutes)
- Good spatial resolution for wide area coverage (~ 3km sub-satellite point)
- Flexible for model improvements
- Generate daily composites (based on instantaneous values)

In practice



Energy balance by land cover in MSG pixel → surface turbulent fluxes

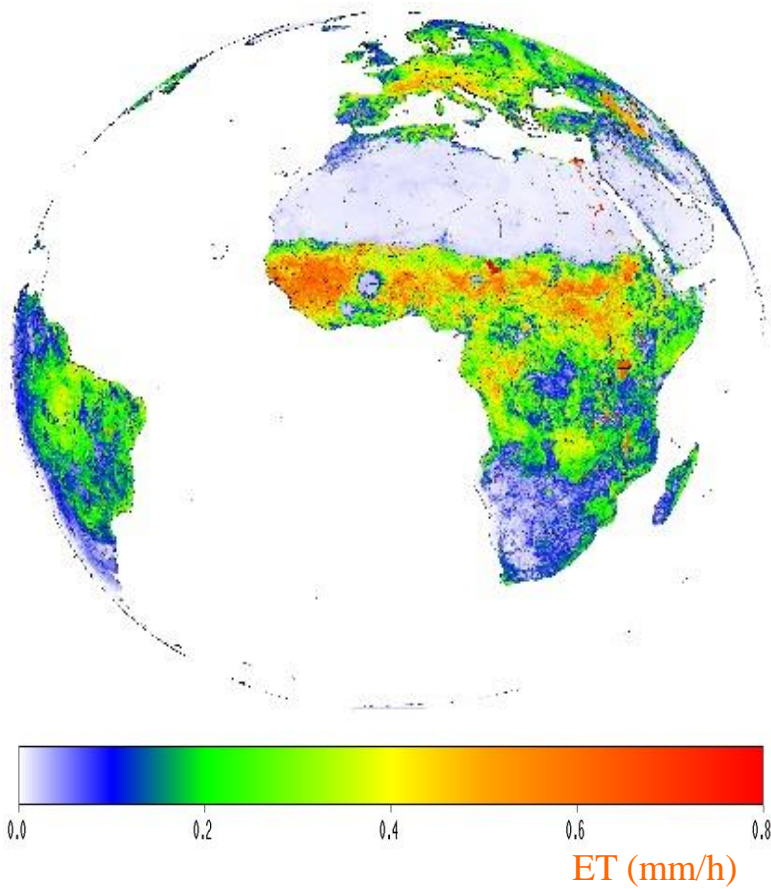


$$LE = L_v ET$$

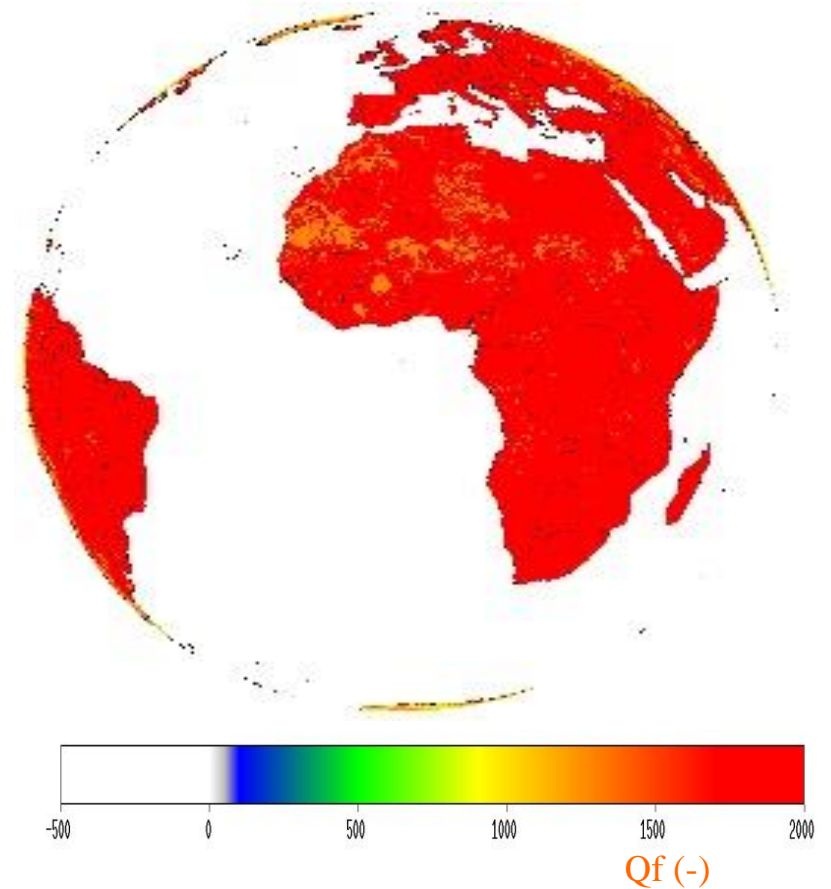
$$DMET = \sum_{i=1}^{48} MET_i \quad \text{Daily ET product}$$

Time between 00:30 and 24:00 UTC

Evapotranspiration

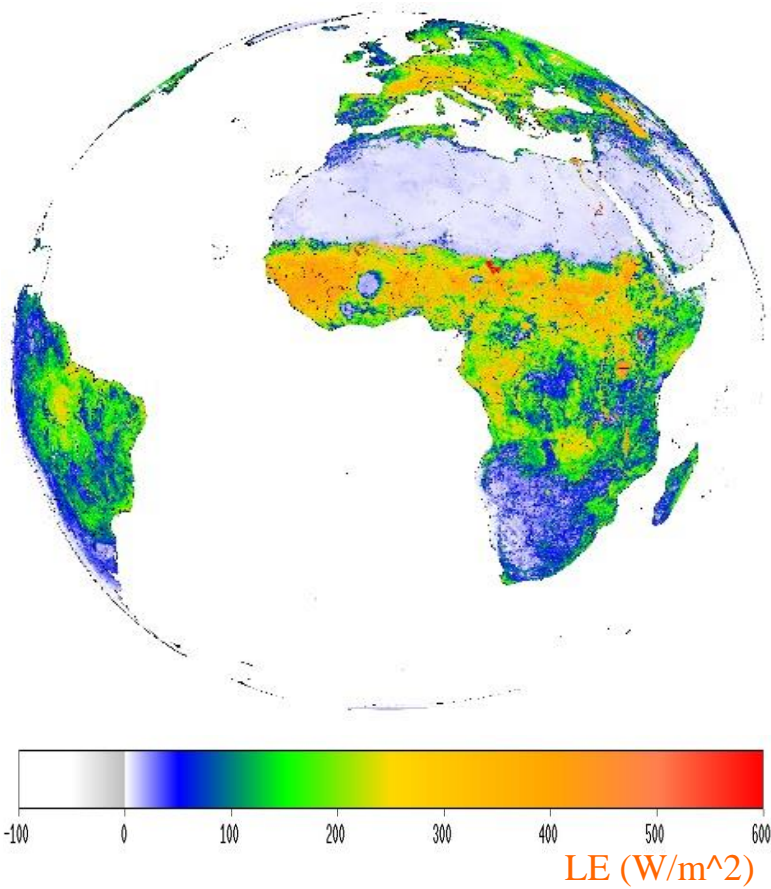


Quality flag

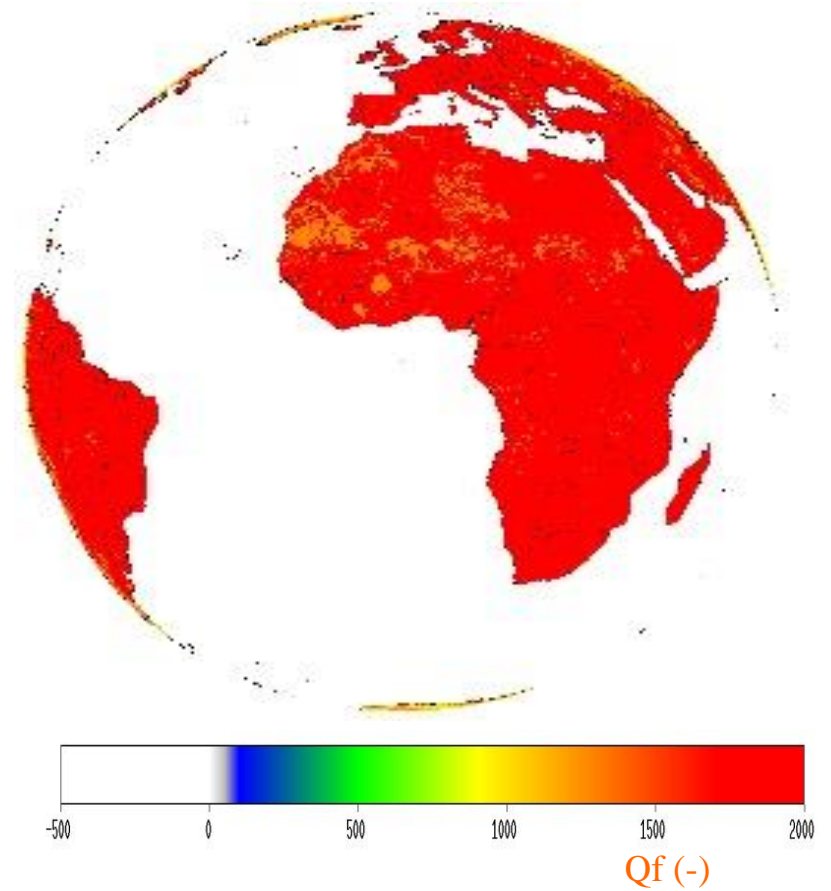


Estimation for 2021/08/21 at 12:00 UTC

Latent heat flux

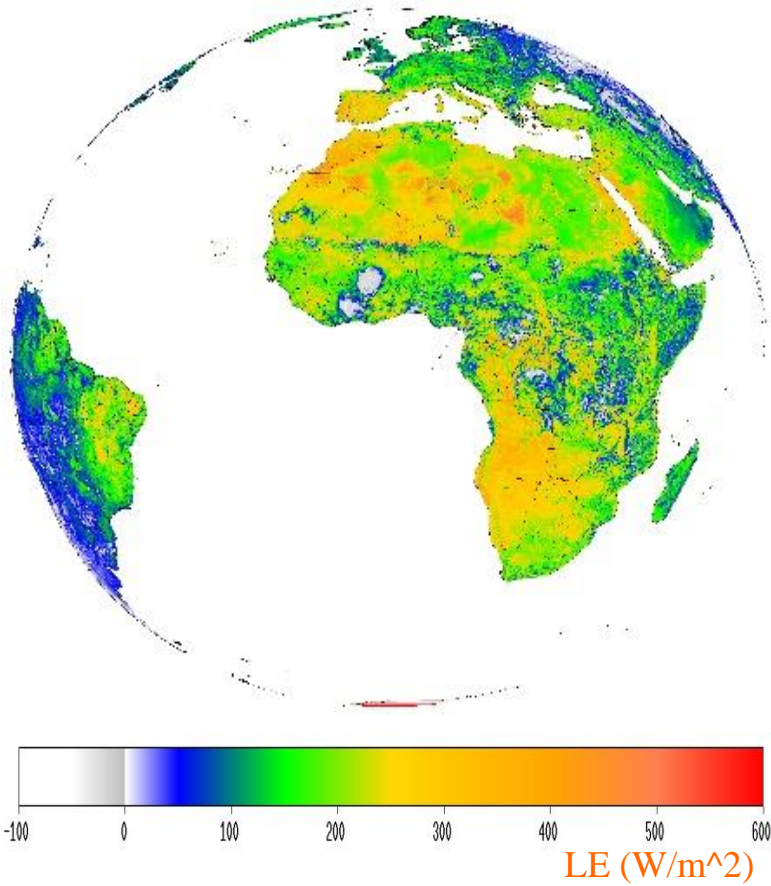


Quality flag

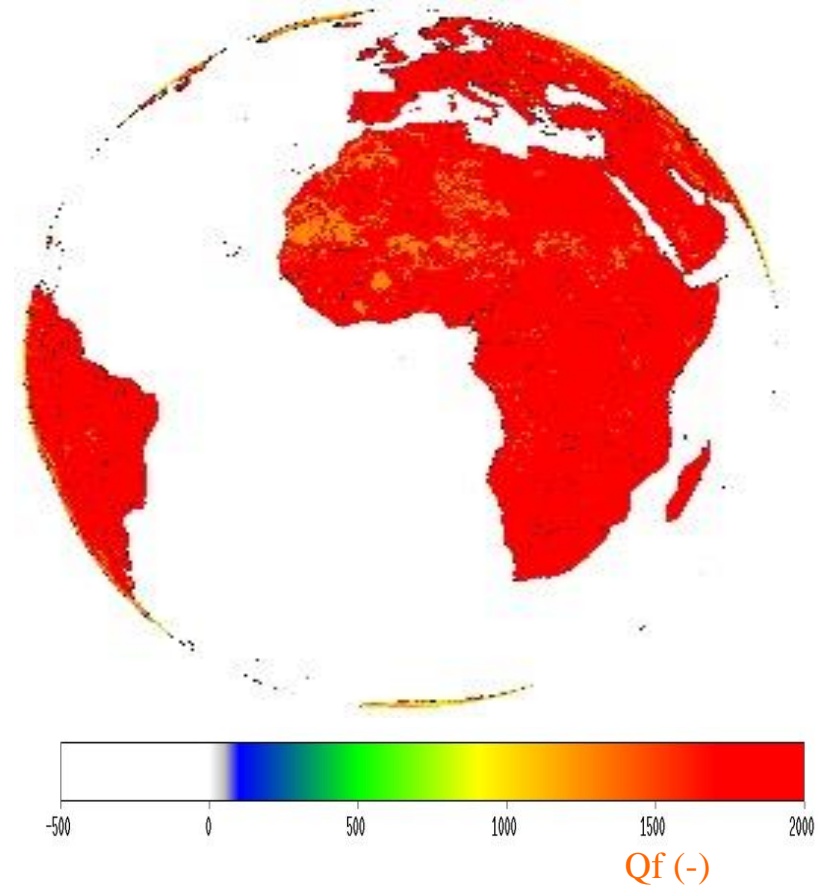


Estimation for 2021/08/21 at 12:00 UTC

Sensible heat flux

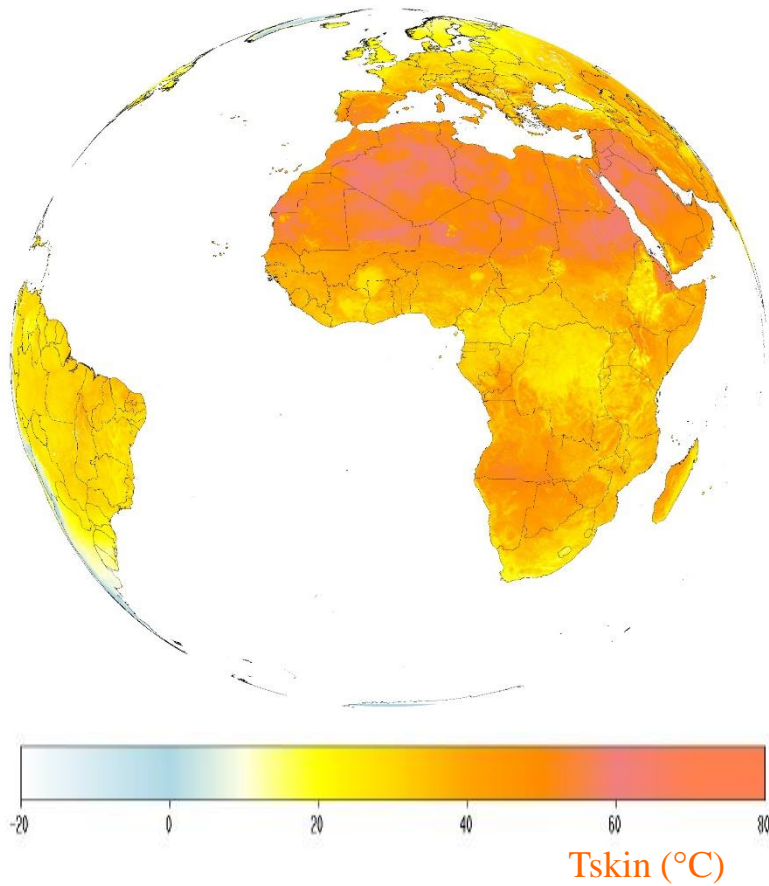


Quality flag

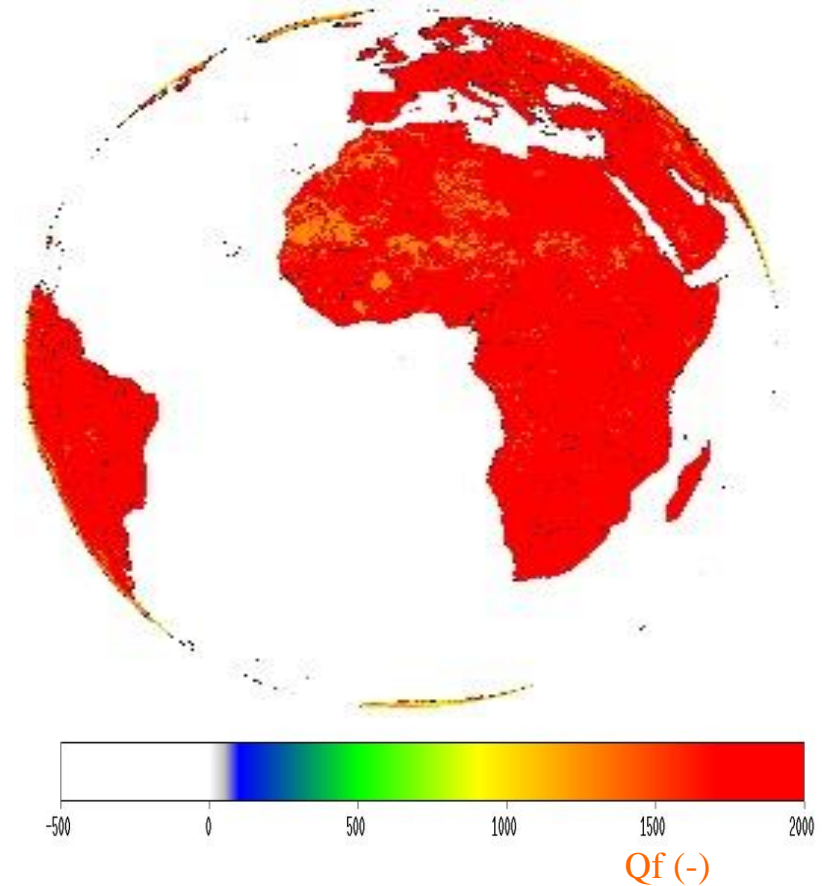


Estimation for 2021/08/21 at 12:00 UTC

Skin temperature (internal product)



Quality flag

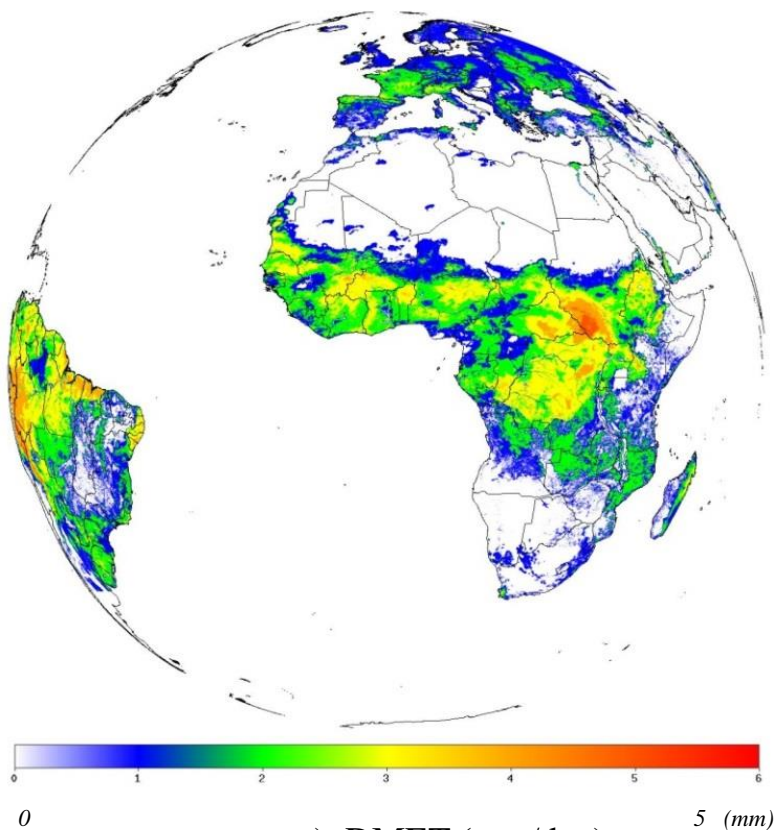


Estimation for 2021/08/21 at 12:00 UTC

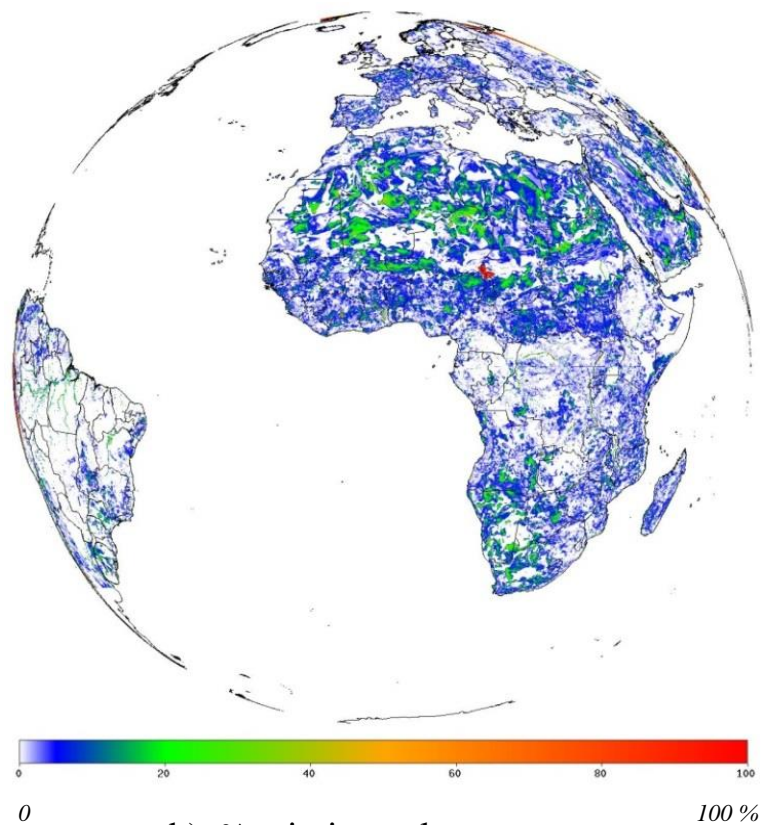
$$DMET = \sum_{t1=1}^{t2=48} MET_i$$

-MET_i: instantaneous ET

One file by day with three layers
of information:

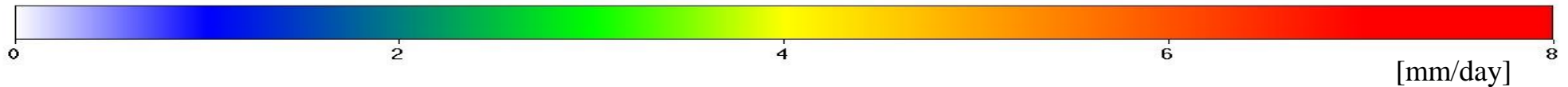
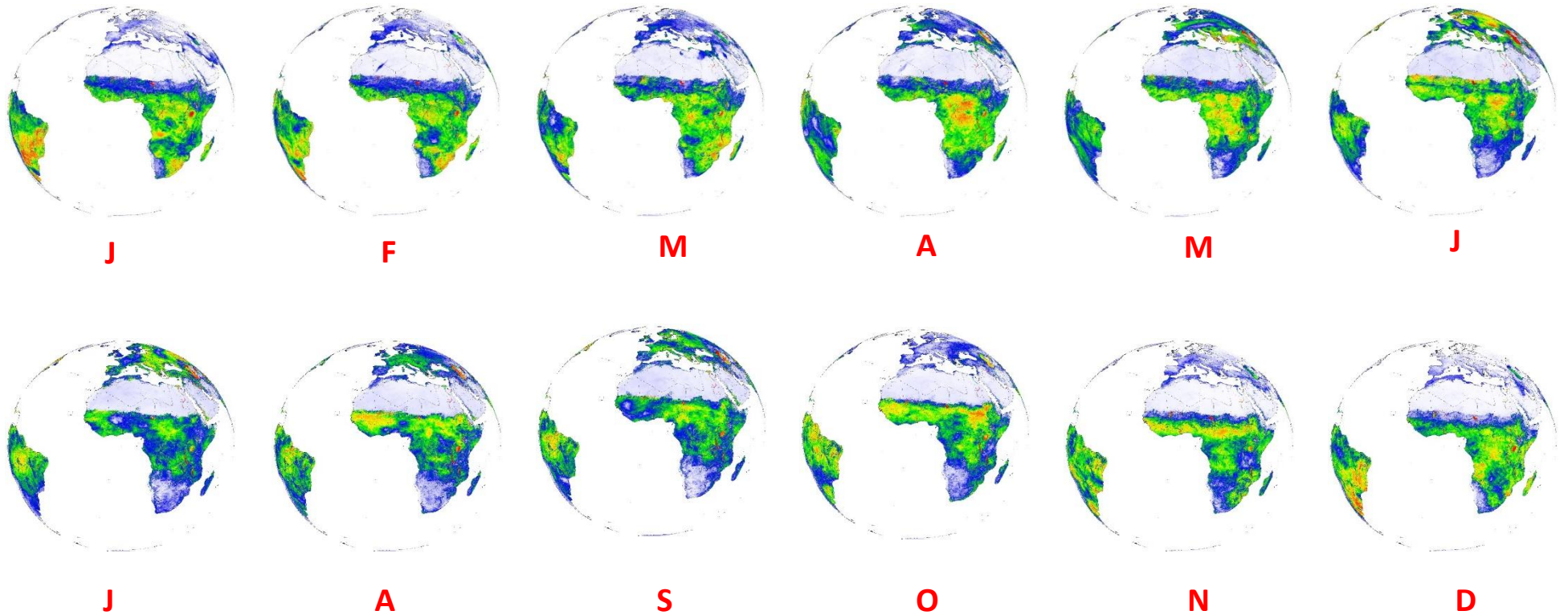


a) DMET (mm/day)



b) % missing values

Daily ET images for the 15th of every month in 2020



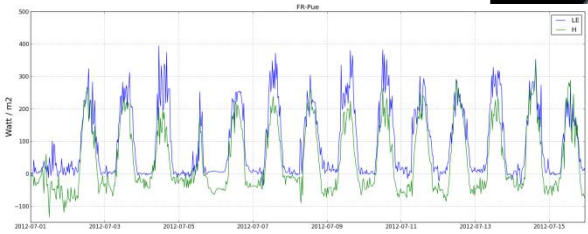
Validation (ET and SF products)

Diurnal cycle:

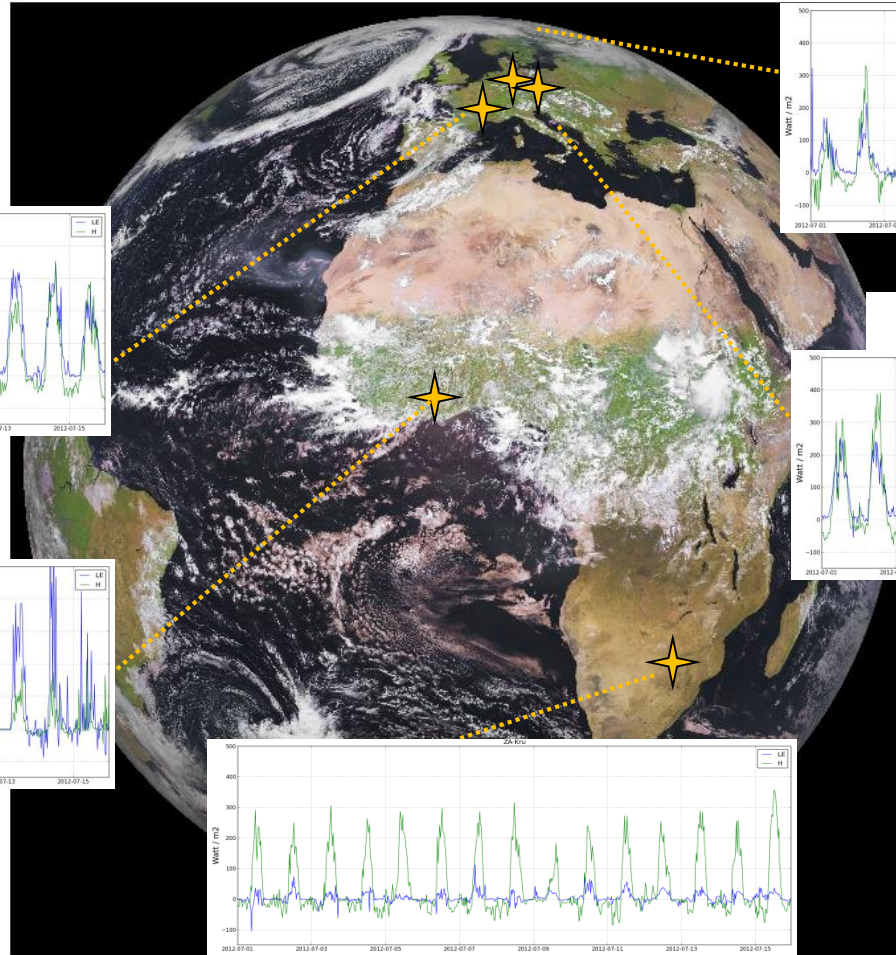
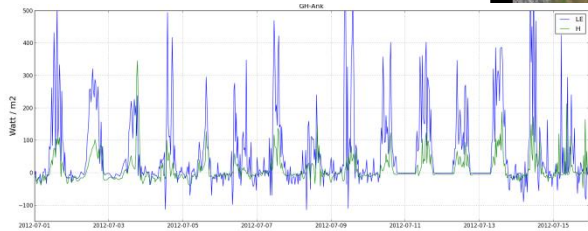
LE
H



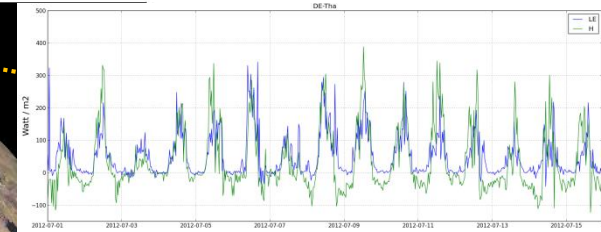
France: Puechabon (FR-Pue)



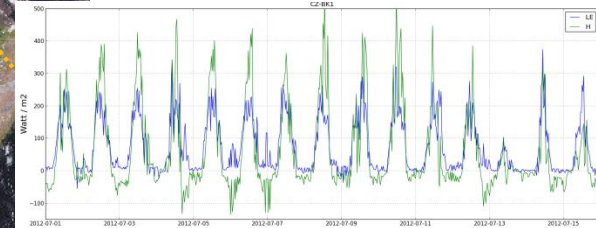
Ghana: Ankasa (GH-Ank)



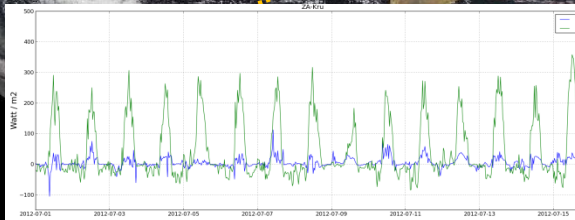
Germany: Tharandt (DE-Tha)



Czechia: Bily Kriz Forest (CZ-Bk1)



South Africa: Skukuza (ZA-KR)

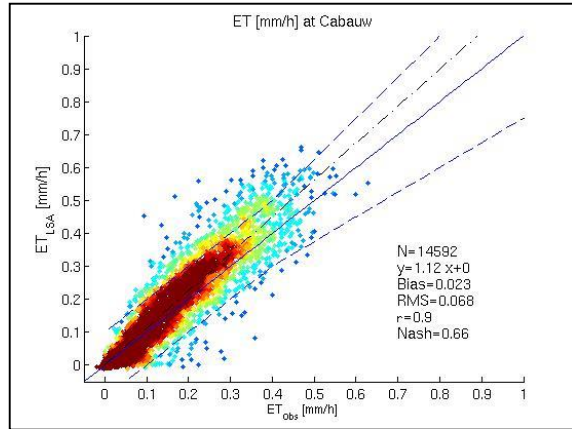


Fluxnet 2015 dataset;
30 minutes mean fluxes;
1-15 July 2012.

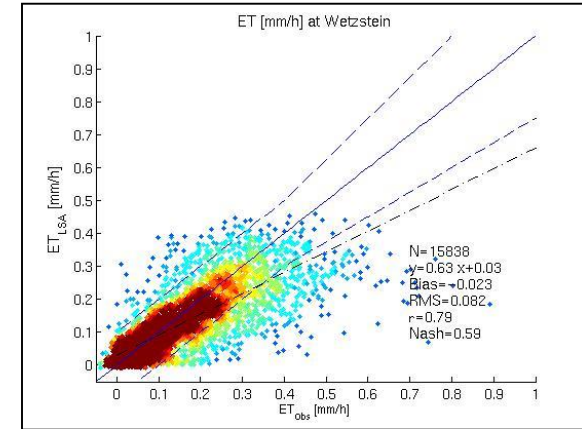
MK

IMETSAT

Cabauw (NL) - grassland

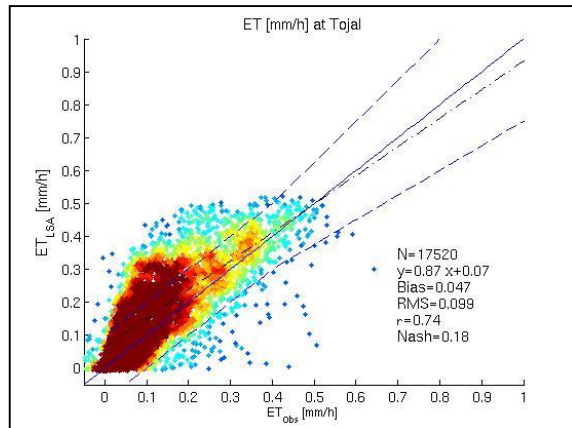


Wetzstein (GE) - coniferous forest

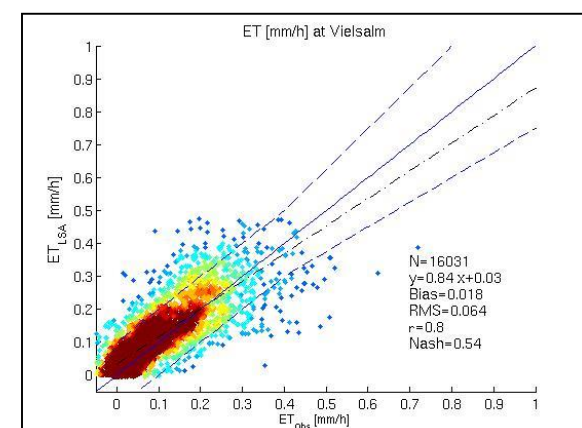


March – Nov
2007

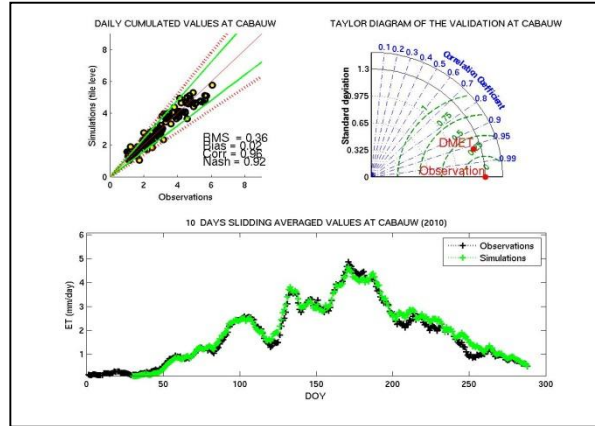
Tojal (PT) - grassland



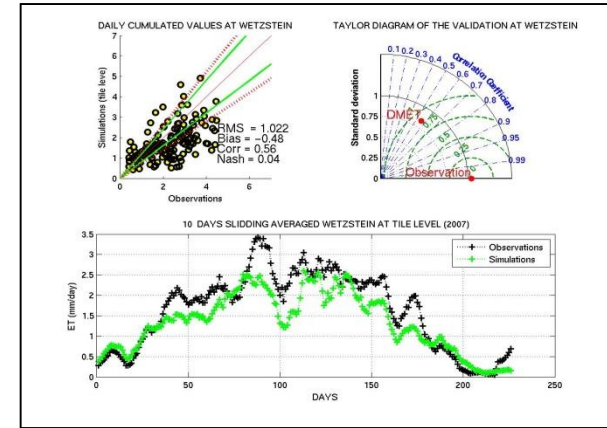
Vielsalm (BE) - mixed forest



Cabauw (NL) - grassland

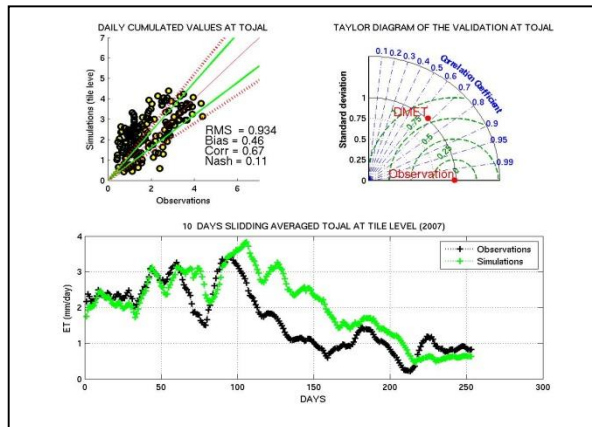


Wetzstein (GE) - coniferous forest

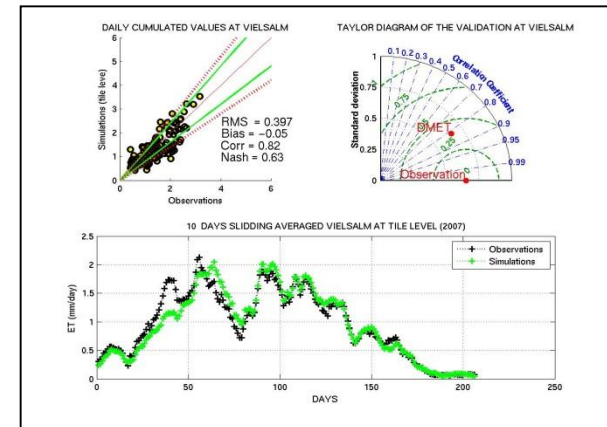


March – Nov.
2007

Tojal (PT) - grassland



Vielsalm (BE) - mixed forest



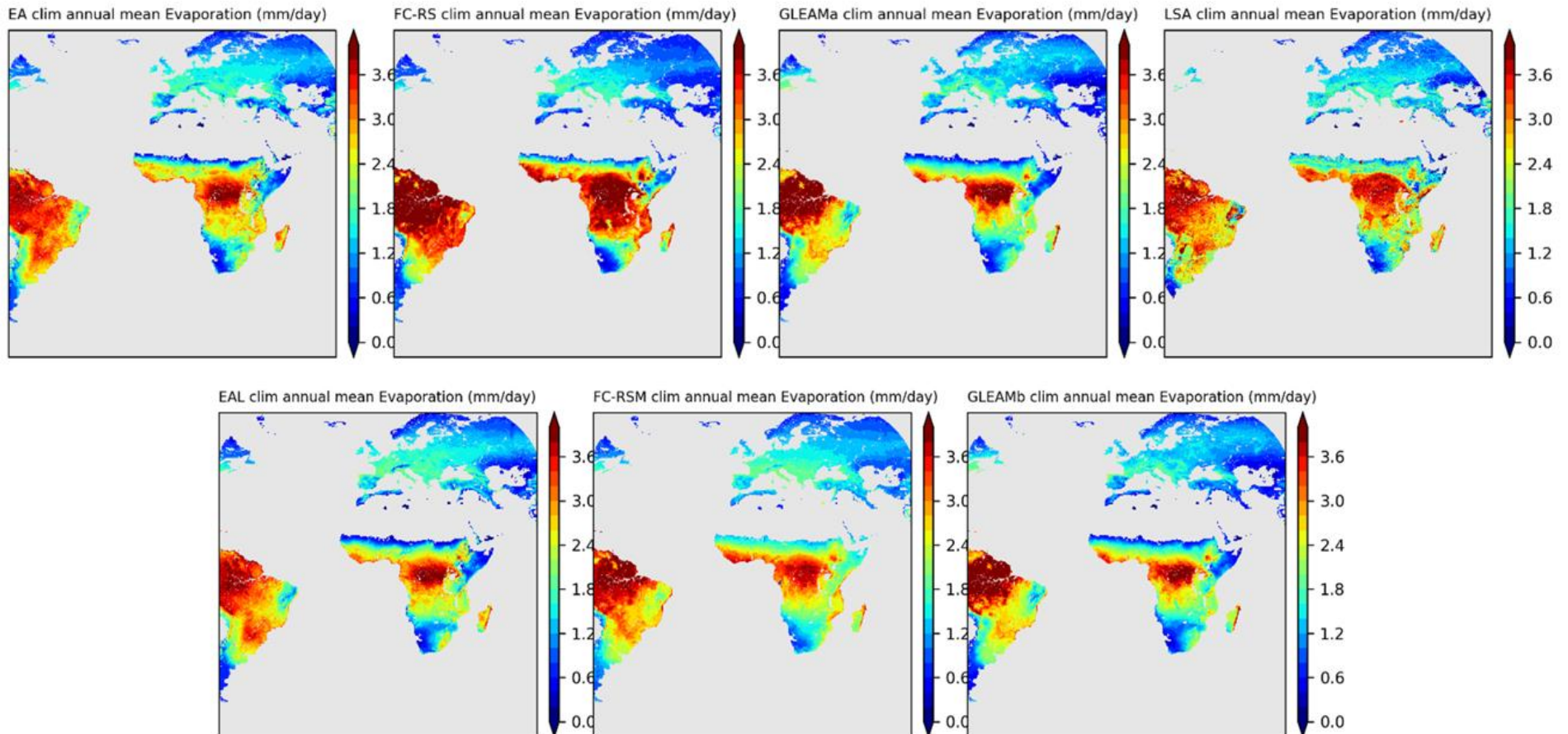
Objective:

To generate an ET and SF data record with the most recent version of the algorithm in order to provide an homogeneous data set covering the period 2004 => 2020

Methodology:

- ✓ Based on the methodology used operationally.
- ✓ The main differences are in the used forcing data.
 - Satellite products: Near real-time vs archived.
 - Meteorological forcing: forecasts vs reanalysis

Reprocessed ET and surface energy fluxes

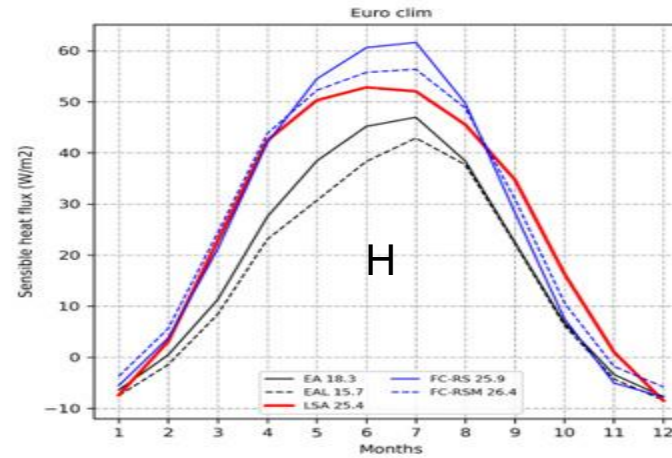
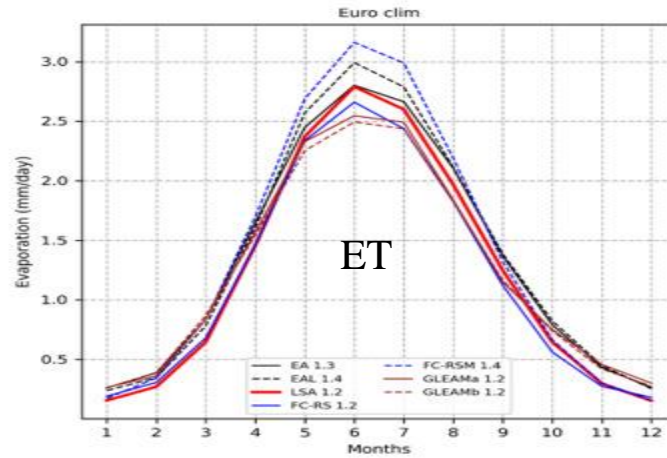


Mean ET for the period 2004-2013 (10 year) available in all datasets

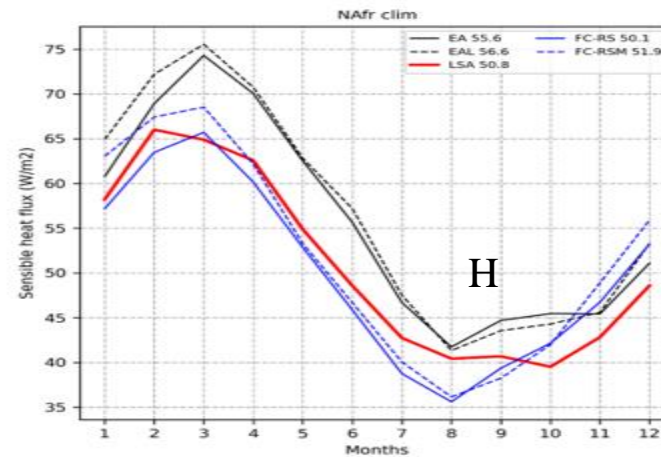
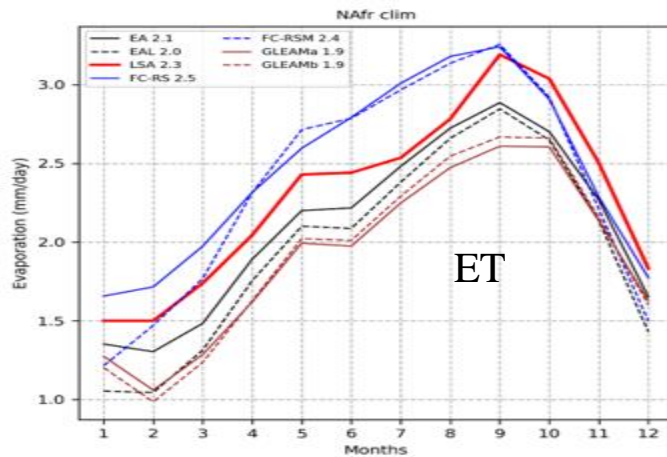
ERA5, ERA5-Land, FluxCom RS, FluxCom RS_Meteo, Gleam a, Gleam b

Courtesy: E. Dutra

Europe

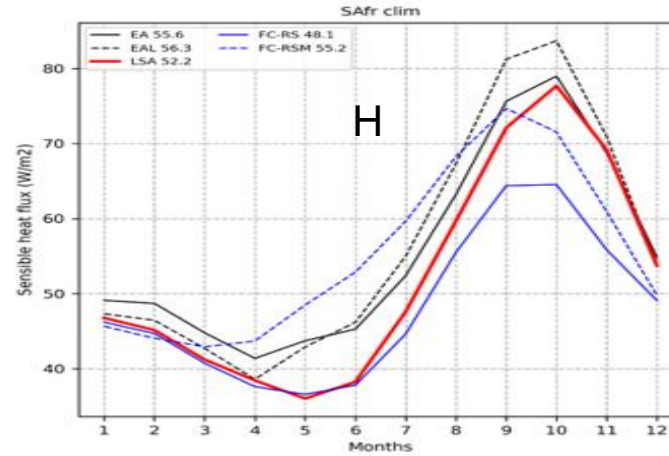
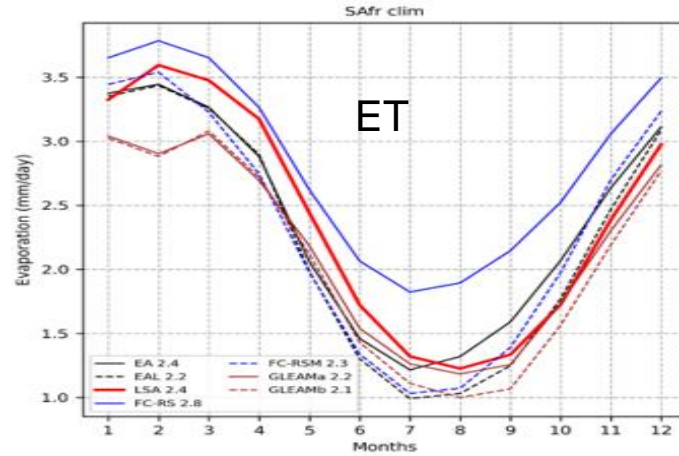


North Africa

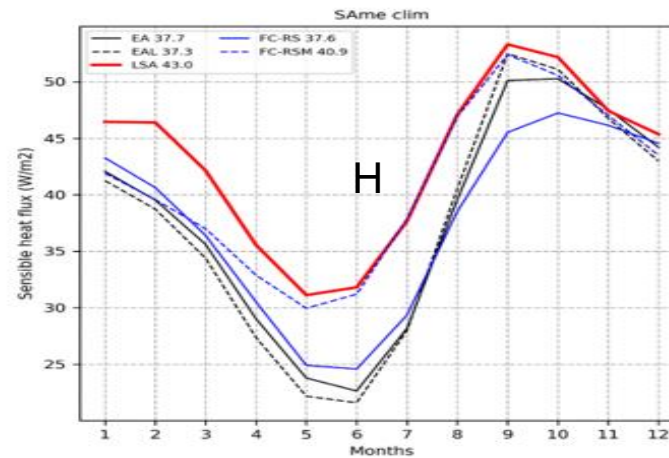
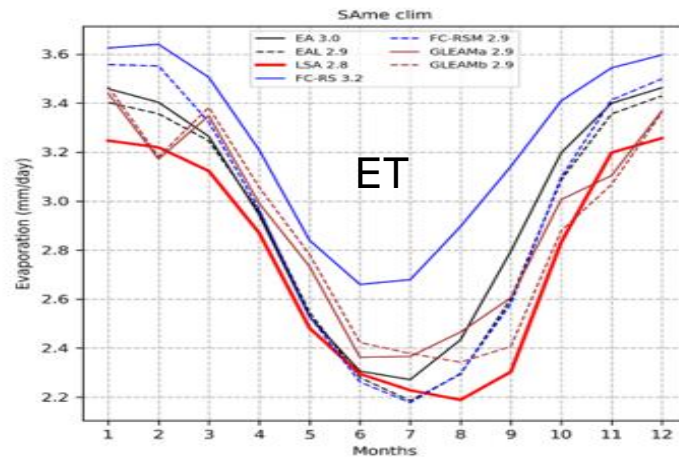


Courtesy: E. Dutra

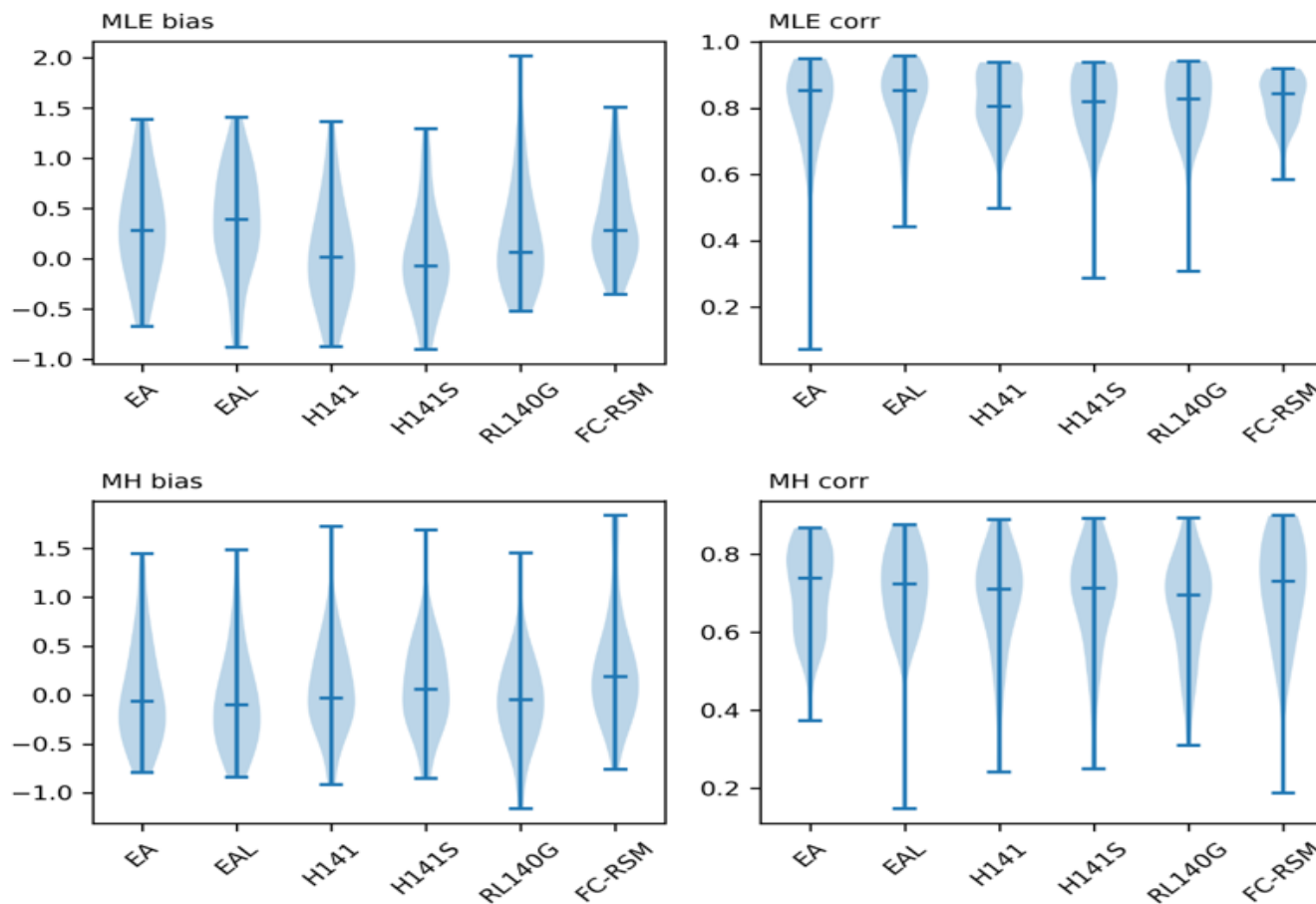
South Africa



South America



Courtesy: E. Dutra



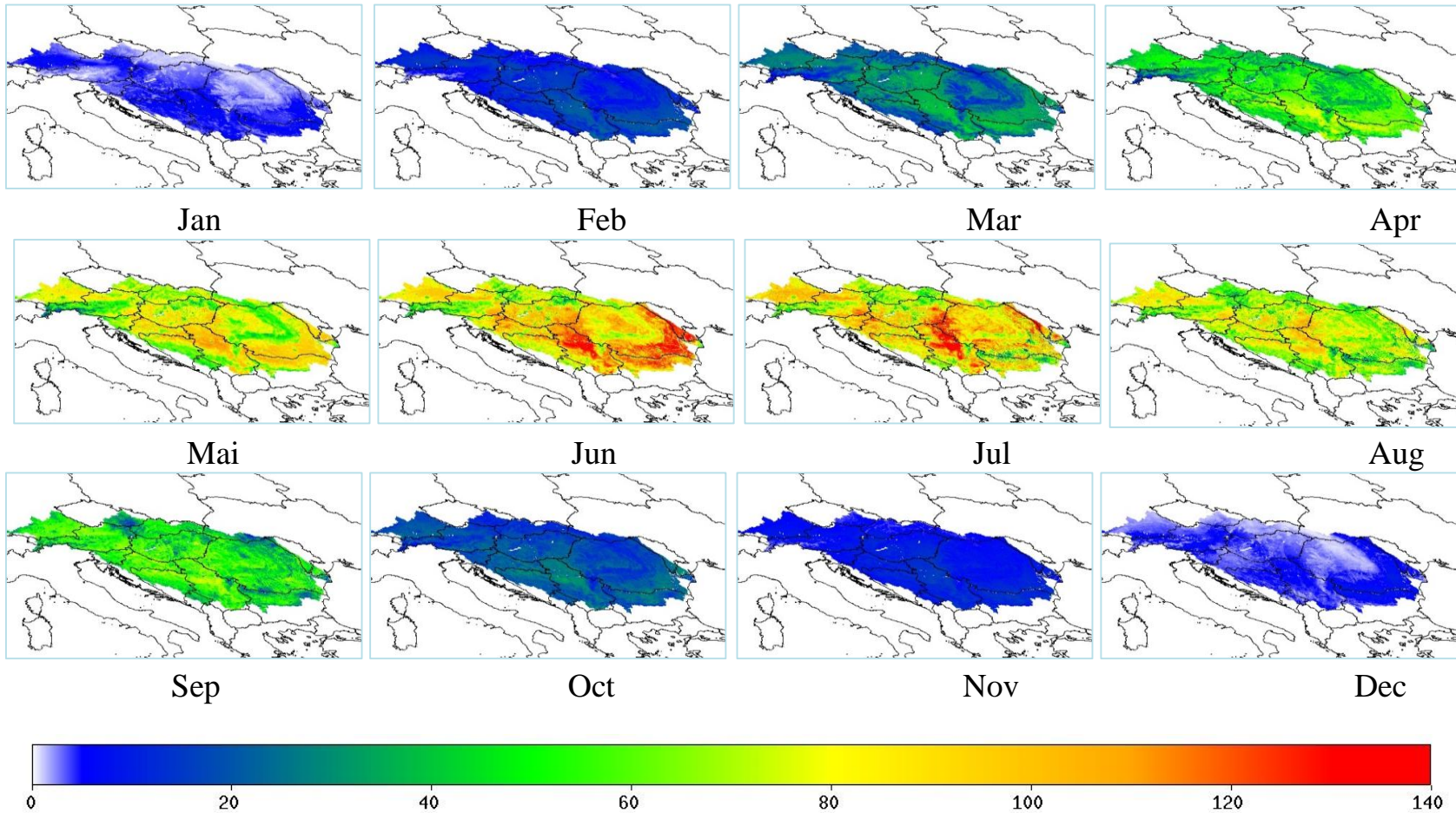
33 stations with at least 30 days of data from FLUXNET2015 in 2007.

Comparing ERA5 (EA) ERA5-Land (EAL), H141, H141S, RL140G and fluxcom RSM (only daily product available).

Courtesy: E. Dutra

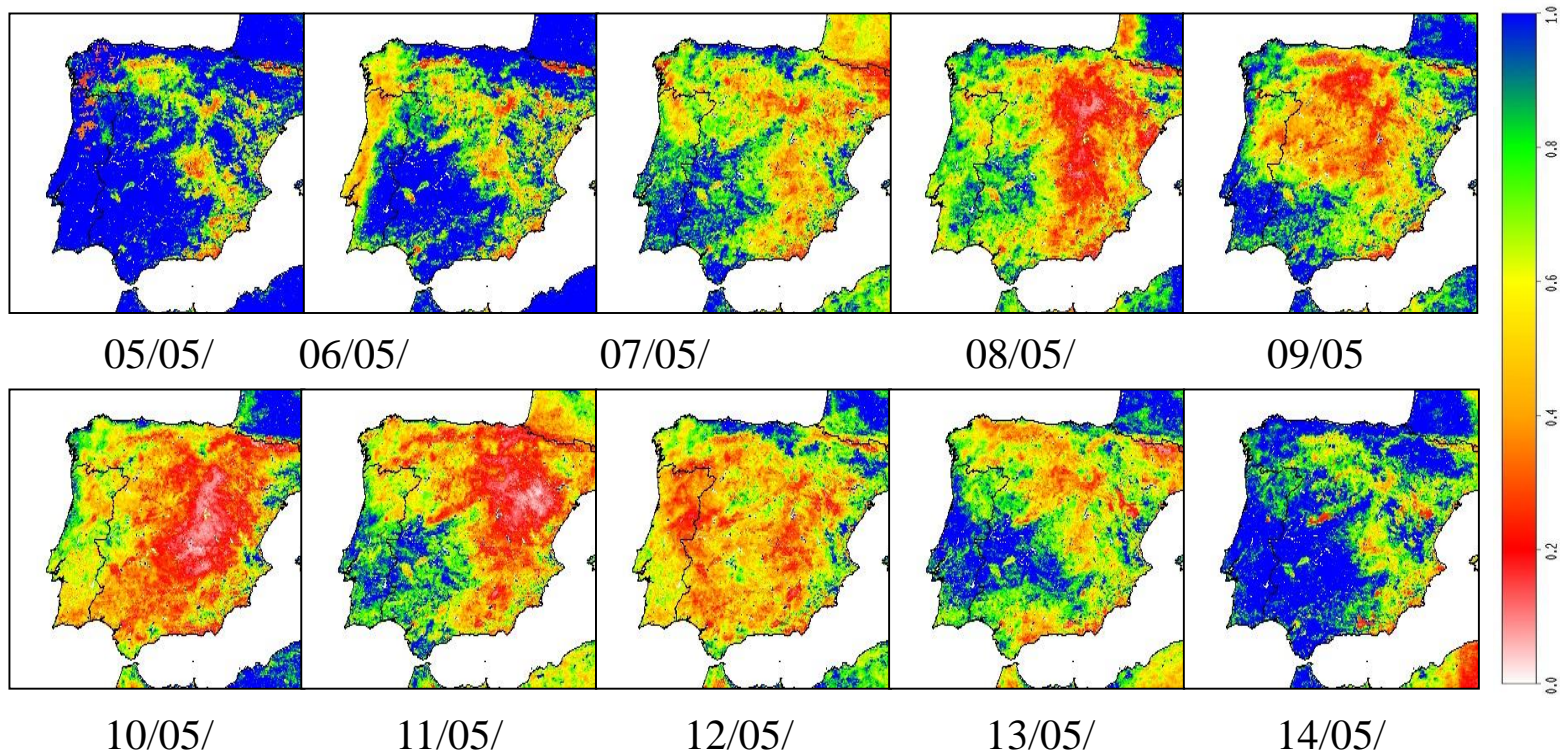
- **Hydrology and water management** (hydrological modeling, irrigation, hydro power generation)
- **Drought monitoring** (detect an approaching drought, extent, duration and severity)
- **Climate studies** (by analysing long-time series)

Potential ET & SF applications (hydrology)



Monthly cumulated ET (mm) over the Danube river basin for 2016.

ETA/ETref ratio evolution (very basic water stress indicator may be calculated as the ratio between real and potential /reference evapotranspiration)

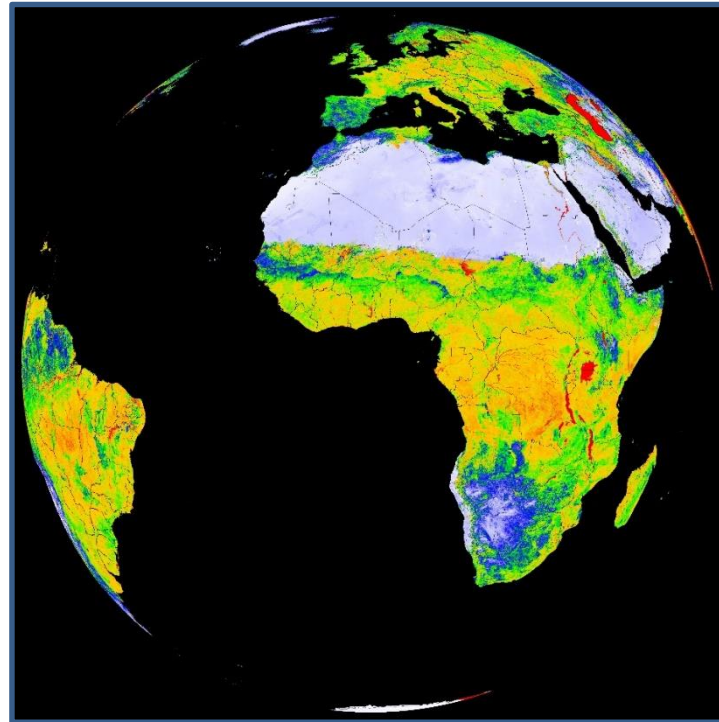


Daily ET and daily reference ET (also an LSA SAF product) were used to estimate water stress index over the Iberian peninsula from the 5 to the 14 of May 2018. Areas where the ratio MET/ETref is close to one (blue colour) indicate no water stress while values close to zero (white-red colour) represent zones affected by water shortage.

Average 1-10 June 2019

- 10-day evaporation fraction

$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H

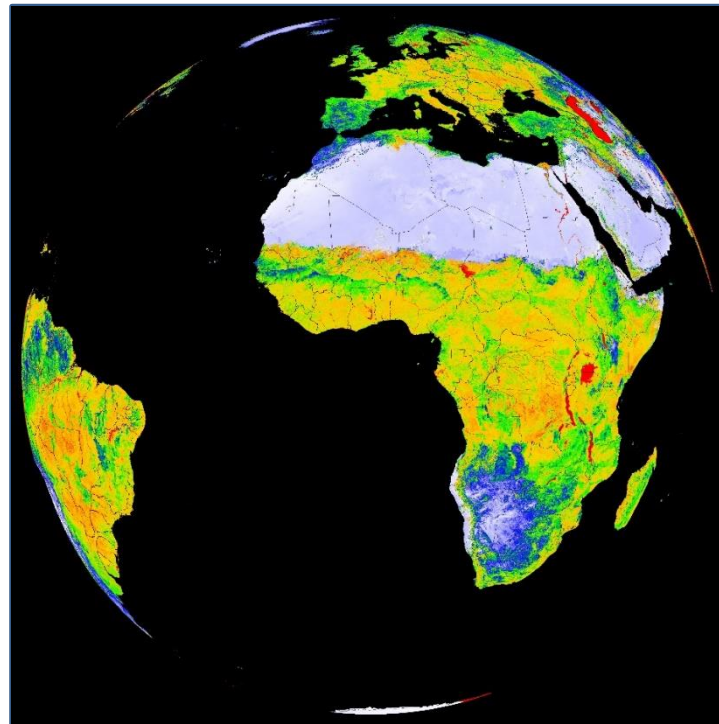


Low H
High LE

Average 11-20 June 2019

- 10-day evaporation fraction

$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H

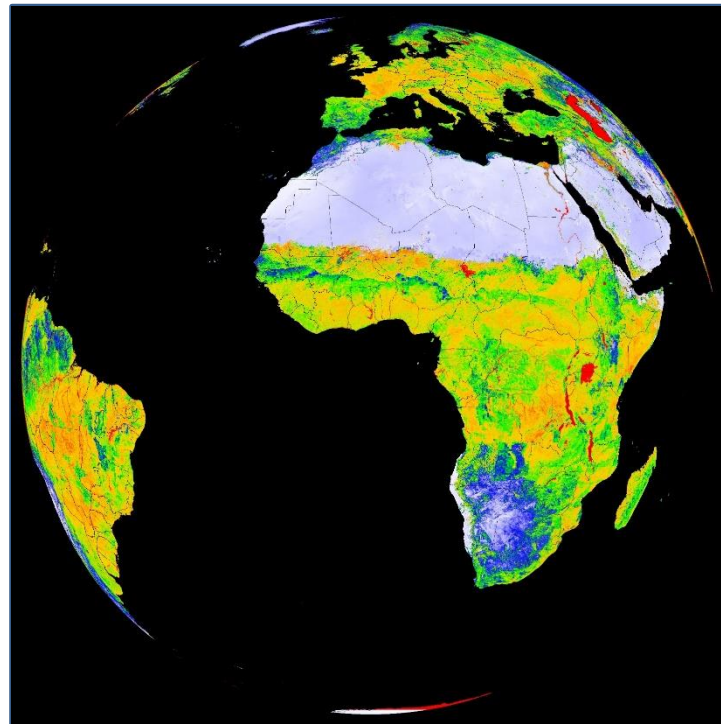


Low H
High LE

Average 21-30 June 2019

- 10-day evaporation fraction

$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H

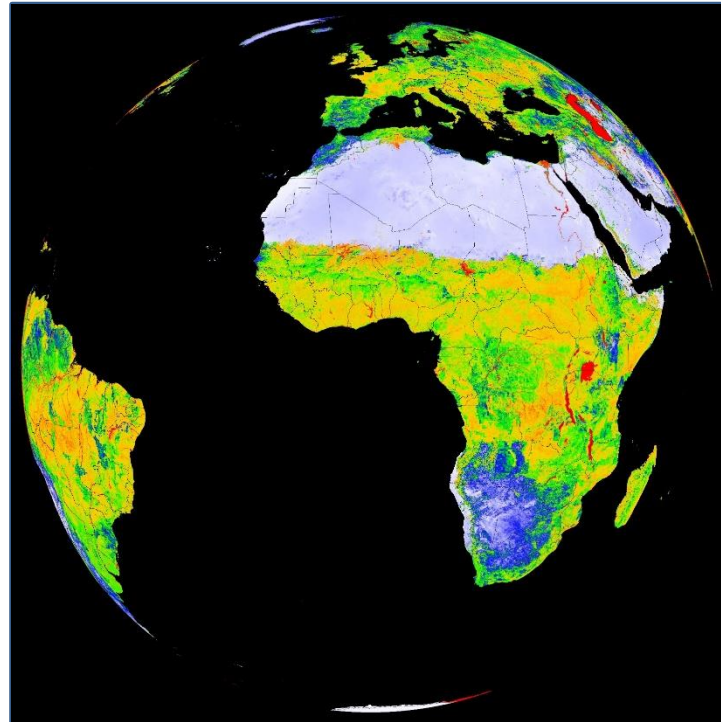


Low H
High LE

Average 1-10 July 2019

- 10-day evaporation fraction

$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H

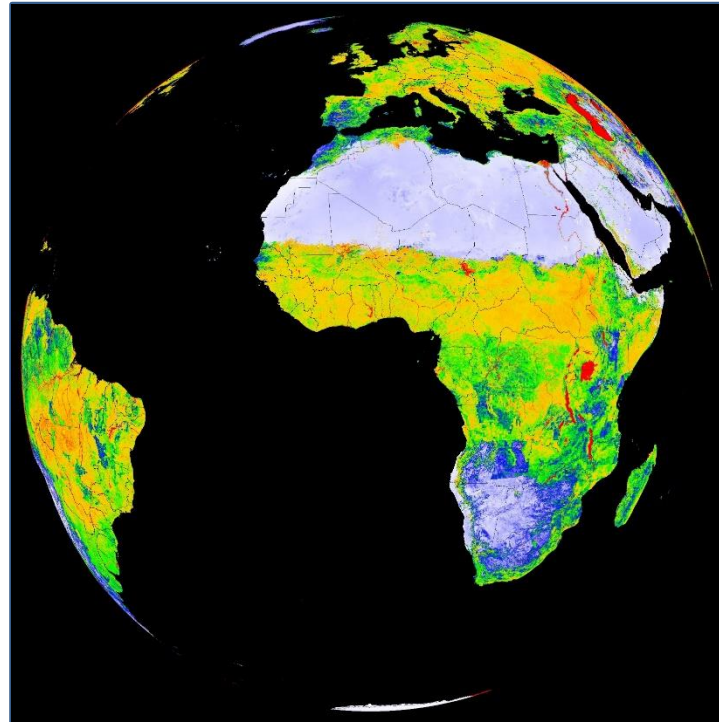


Low H
High LE

Average 11-20 July 2019

- 10-day evaporation fraction

$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H

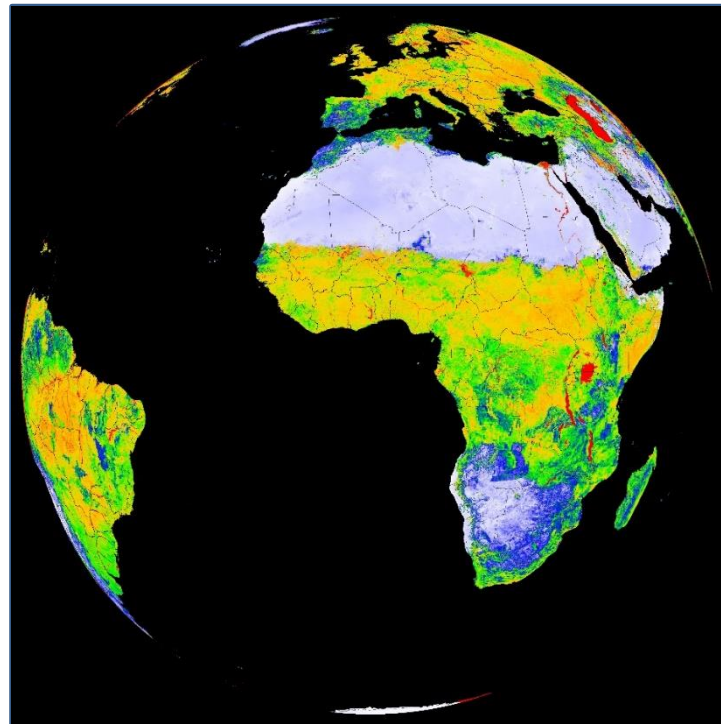


Low H
High LE

Average 21-31 July 2019

- 10-day evaporation fraction

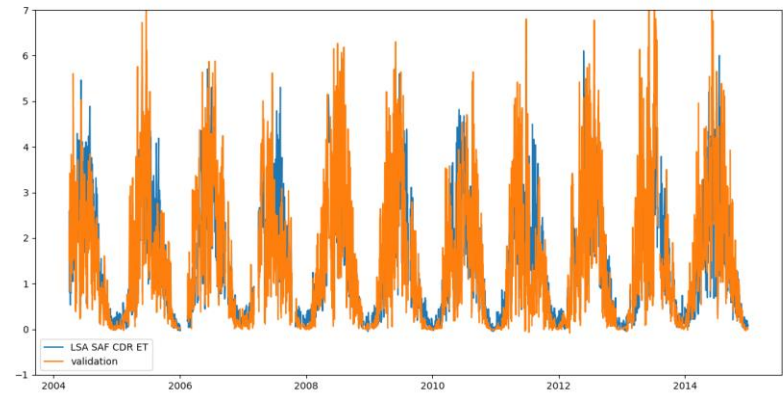
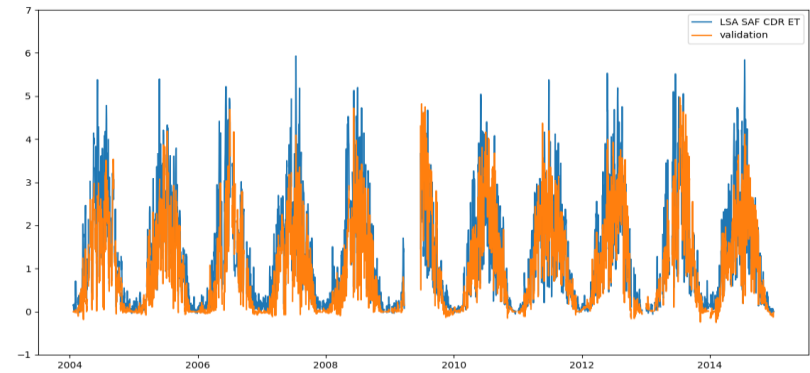
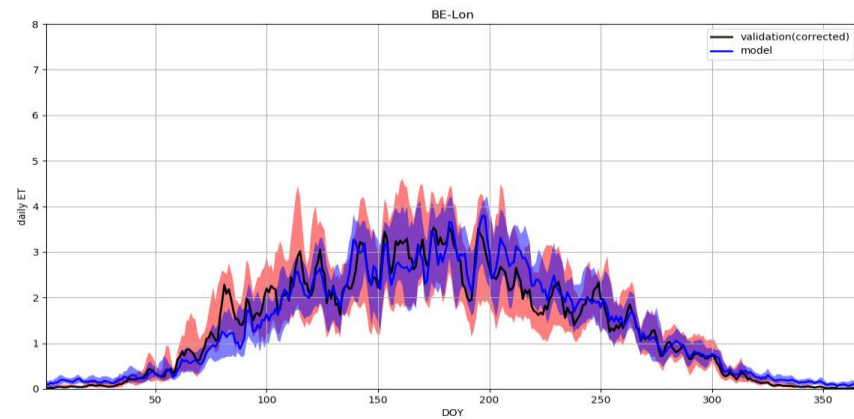
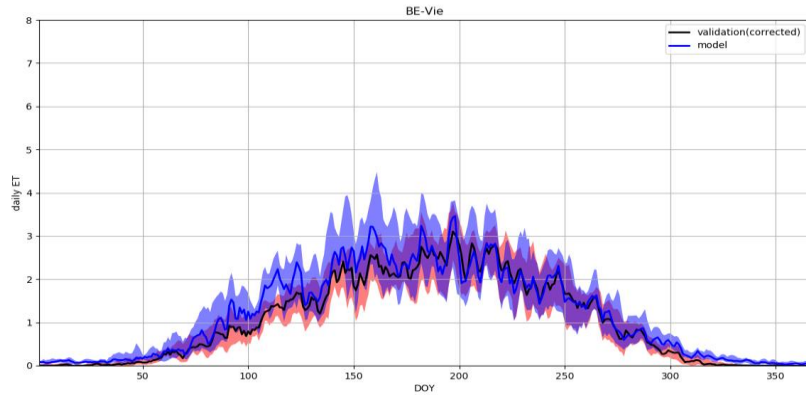
$$F_{ev} = \frac{LE_{10-day}}{(LE + H)_{10-day}}$$



Low LE
High H



Low H
High LE



Daily ET mean for observations (in black) and simulations (in blue) from 2004 to 2014)

Daily ET from observations (in orange) and simulations (in blue) from 2004 to 2014

LSA-SAF ET & SF products

- Extensively validated in different environments
- Suitable for different type of applications
- ET and surface energy fluxes reprocessed for 2004 - 2020
- Adaptation to MTG under development.
- Free for registered users

- ✓ Coverage: MSG SEVIRI FOV
- ✓ Spatial Resolution: MSG SEVIRI resolution (3km×3km at nadir)
- ✓ Frequency of generation: 30 min/Daily
- ✓ Sampling: pixel by pixel basis
- ✓ Units: mm/h / (mm/day)
- ✓ Available since: 2009
- ✓ Appended Data: Quality control information
Information about missing slots/values

- Visit the LSA web site: <http://lsa-saf.eumetsat.int>
 - => To obtain the products
 - => To read the documentation (ATBD, PUM, VR)

- Acknowledgments
 - => To all validation data providers
 - => EUMETSAT
 - => ESA / PRODEX Program / BELSPO

Thank you !