Evapotranspiration and surface fluxes products

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with contribution of

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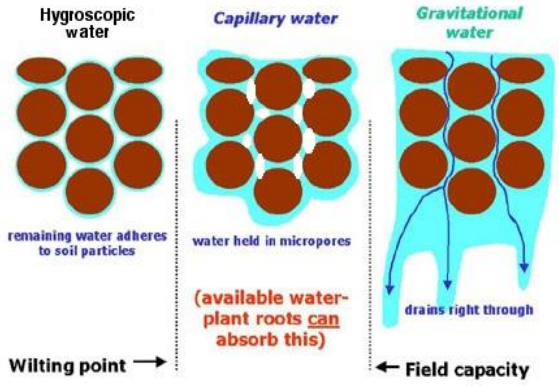
Outline

- Introduction
- Products
- Examples and applications
- Conclusion

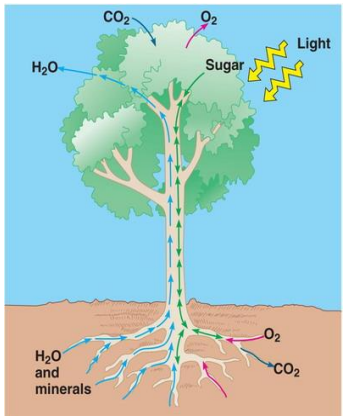
- Transpiration of vegetation

1. Root-zone water



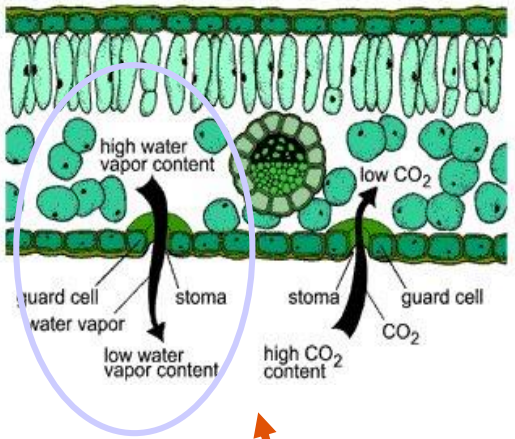
For transpiration to occur,
there must be water available !

2. Root water uptake



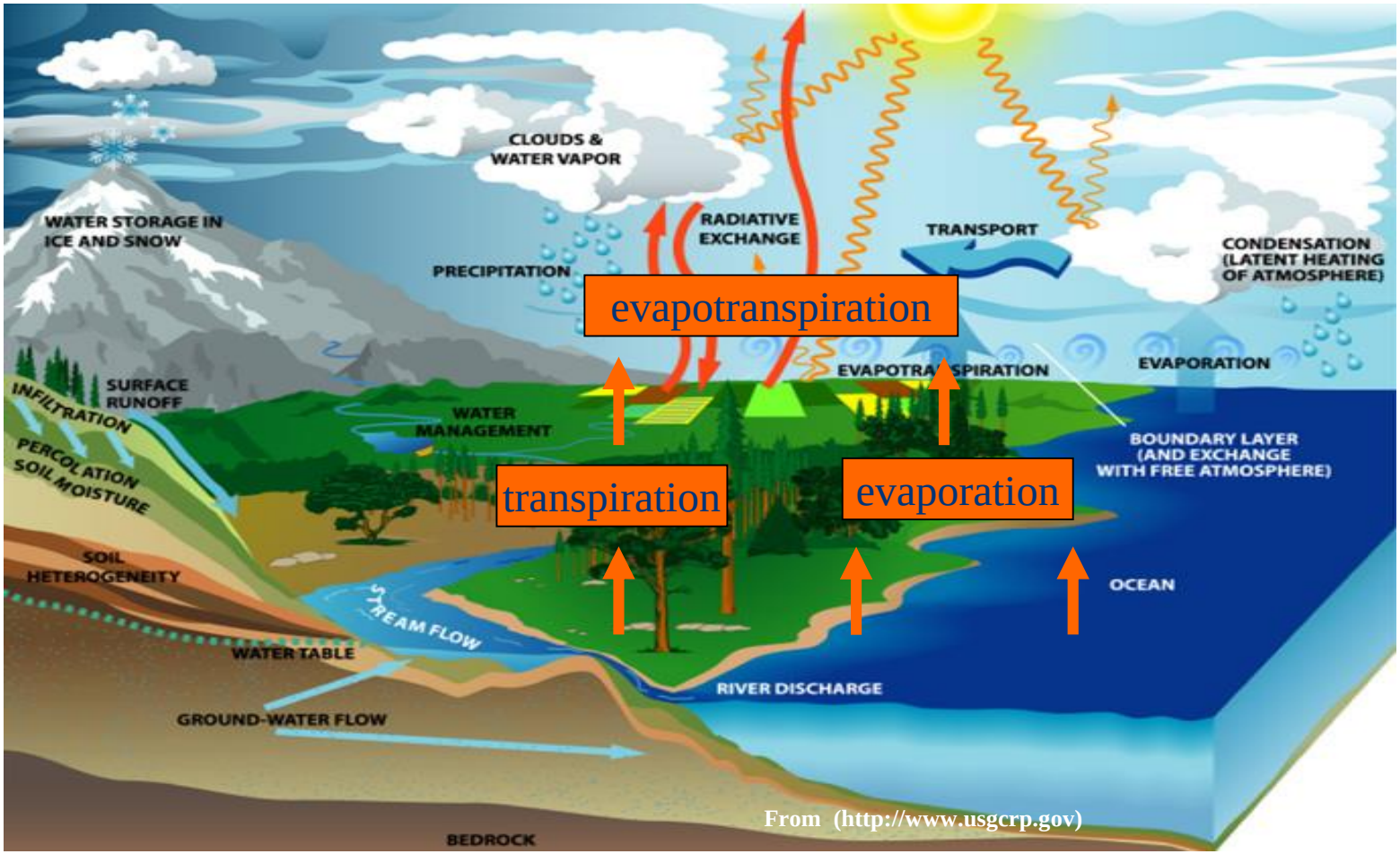
- Water taken to leaves through roots
- Light is necessary

3. Exchange plant-atmosphere

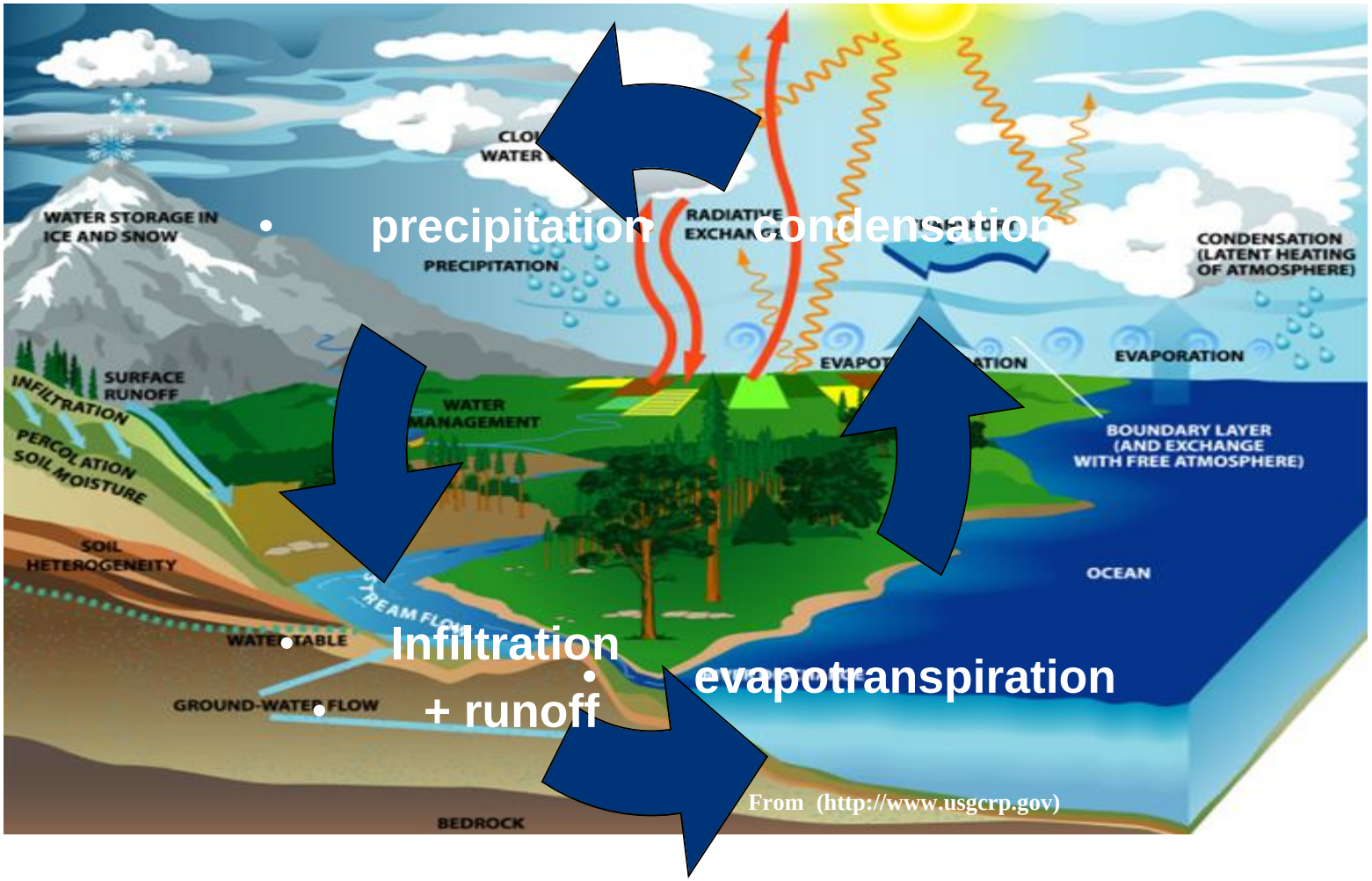


Water vapour is released into
the air through leaves stomata

Evapotranspiration



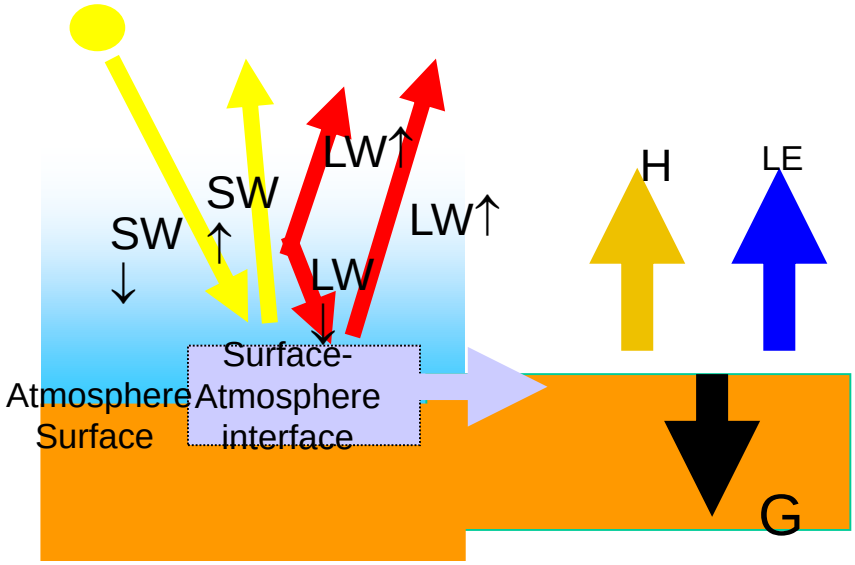
The water cycle



- precipitation
- condensation
- Infiltration + runoff
- evapotranspiration

- The energy balance

$$Rn = (1-\alpha)K\downarrow - \varepsilon\sigma T_s^4 + L\downarrow$$
$$Rn = H + LE - G$$



LE: **latent heat flux**

surface flux associated to evapotranspiration (ET).

H: **sensible heat flux**

exchanged energy flux between atmosphere and surface.

G: ground heat flux:

exchanged energy flux between surface and soil.

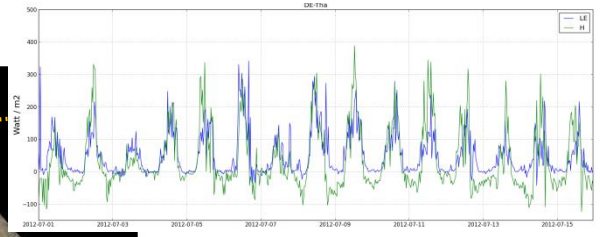
Variability in time and space

Diurnal cycle:

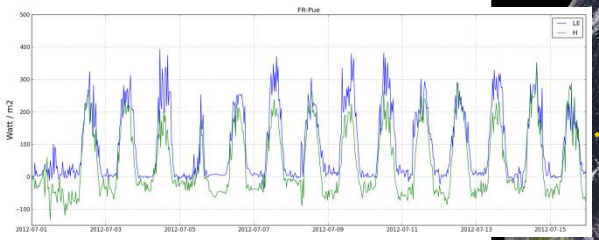
LE —

H —

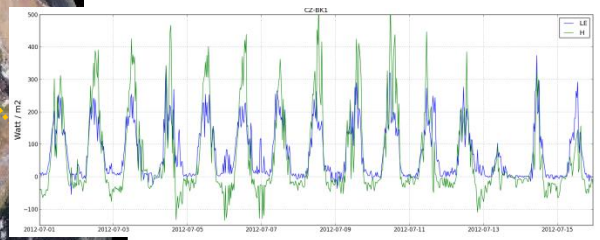
Germany: Tharandt (DE-Tha)



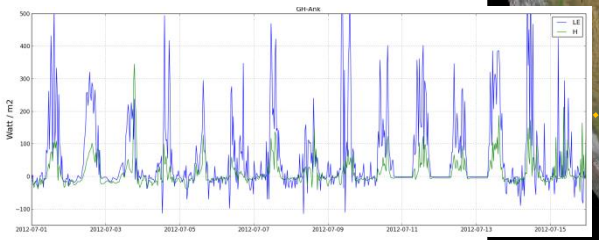
France: Puechabon (FR-Pue)

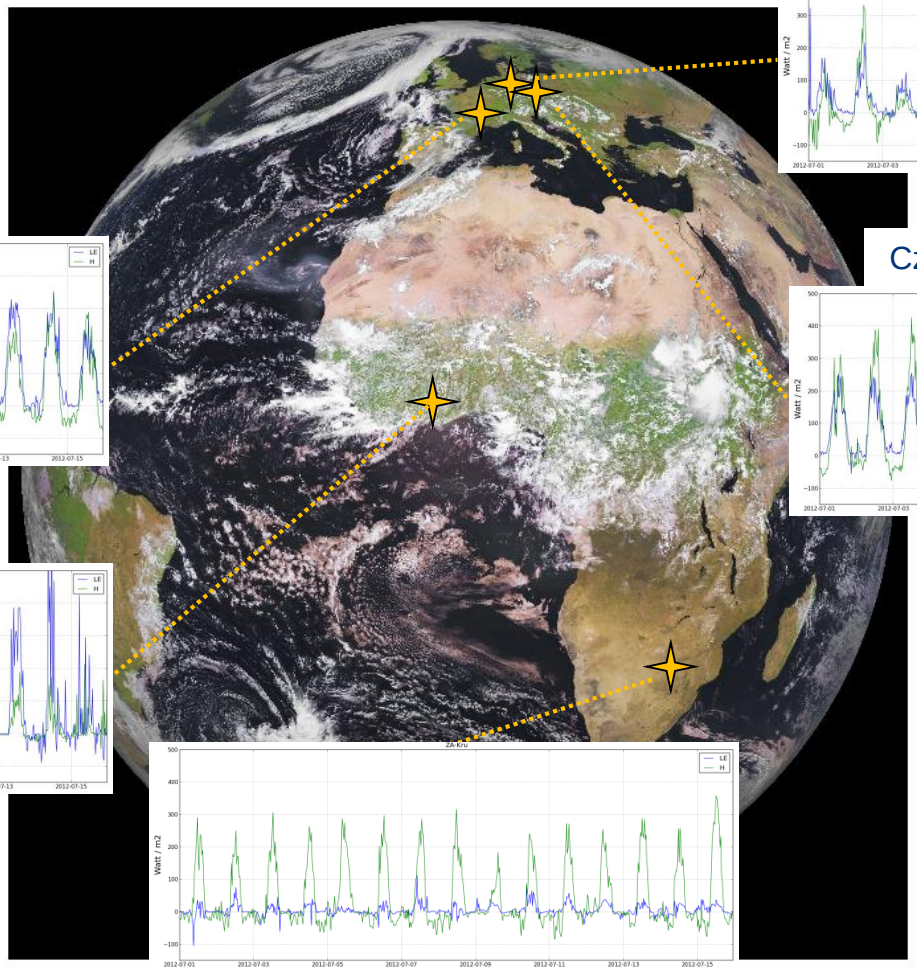


Czechia: Bily Kriz Forest (CZ-Bk1)



Ghana: Ankasa (GH-Ank)





South Africa: Skukuza (ZA-KR)

EUMETSAT

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

Introduction

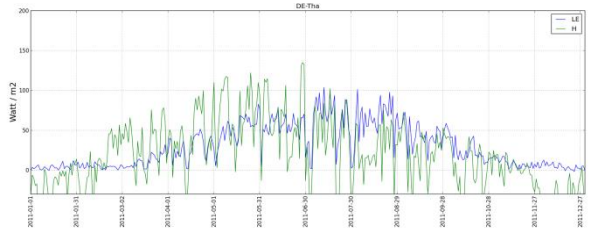
Variability in time and space

Annual cycle:

LE —

H —

Germany: Tharandt (DE-Tha)



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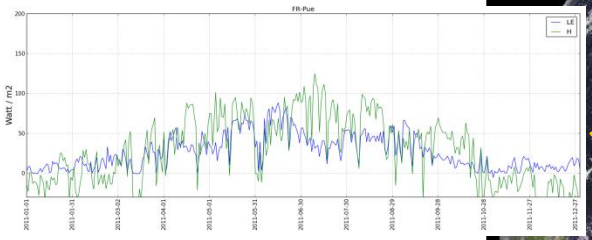

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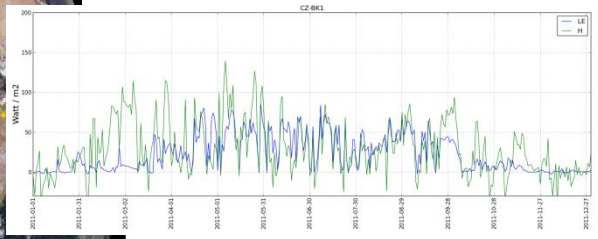

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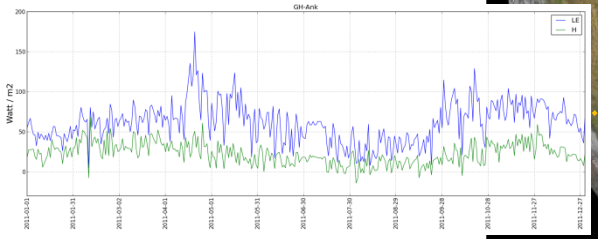
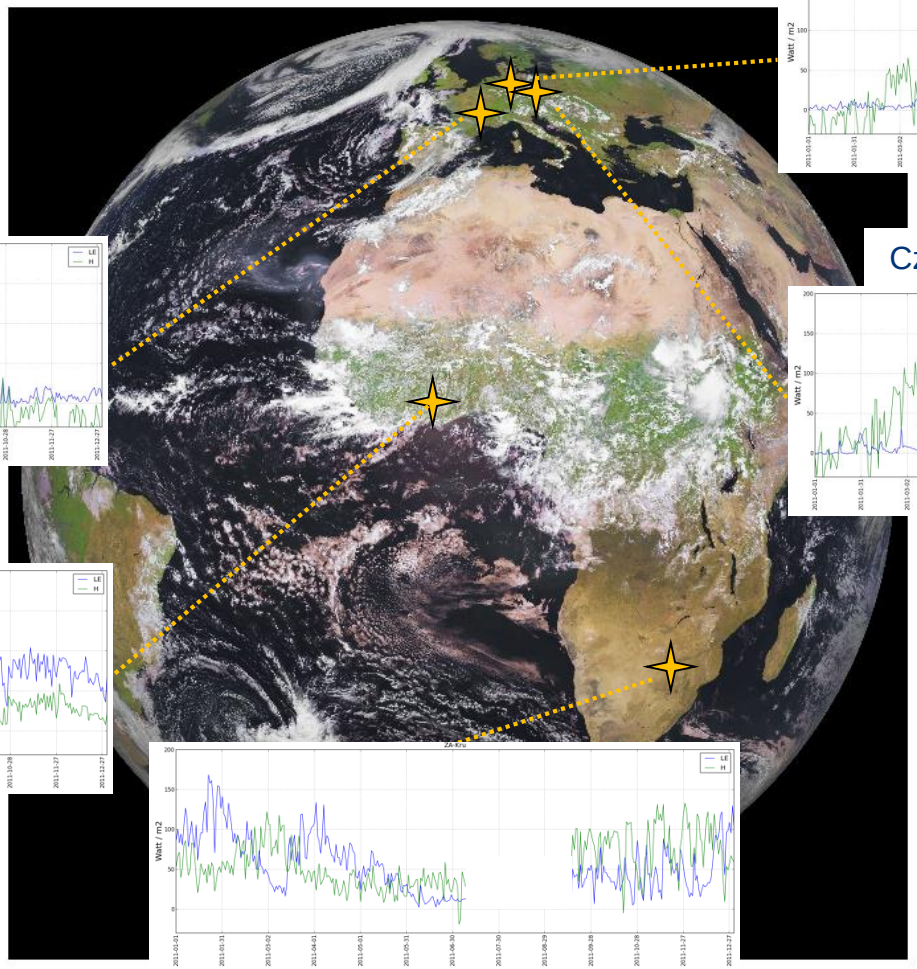




South Africa: Skukuza (ZA-KR)

Fluxnet 2015 dataset;
daily mean fluxes;
2011.

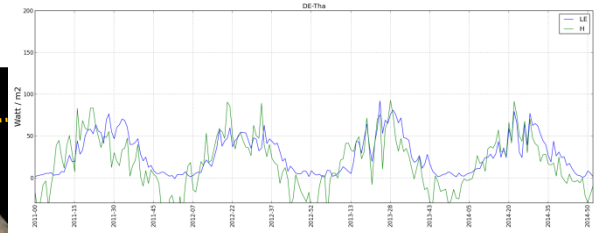
Variability in time and space

Multiple years:

LE —

H —

Germany: Tharandt (DE-Tha)



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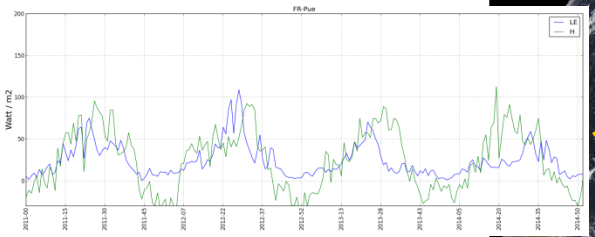

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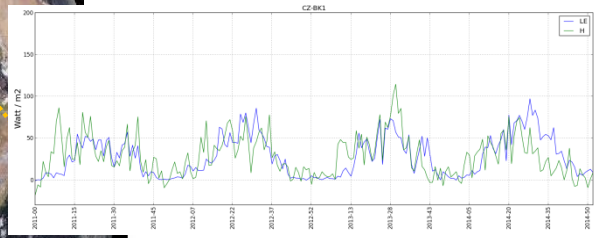

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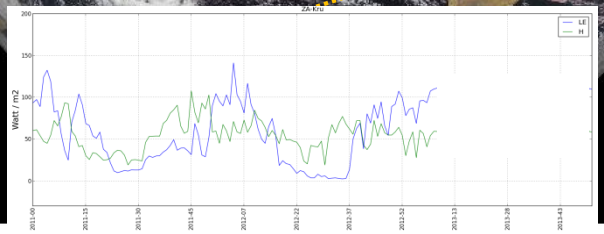
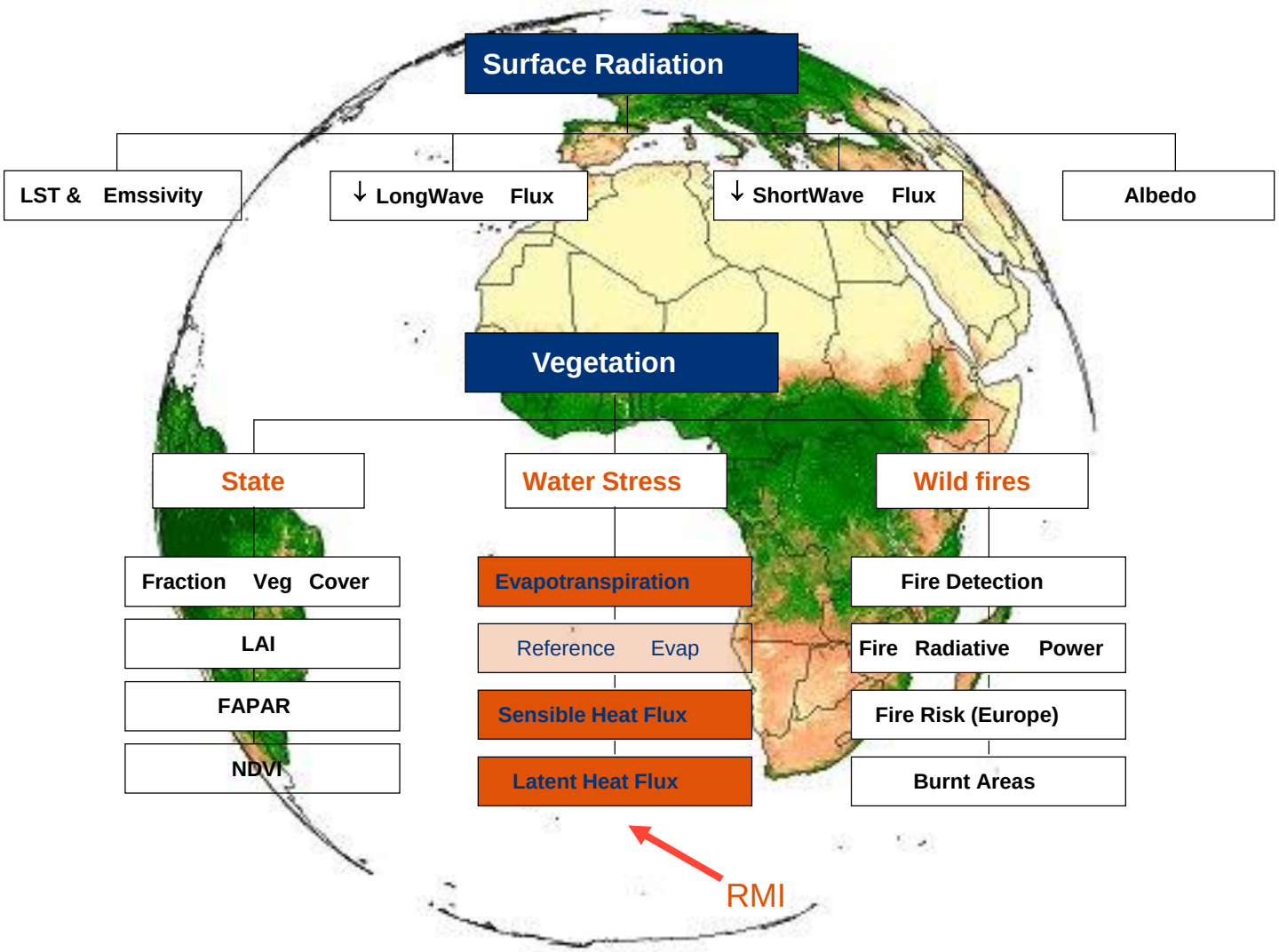


South Africa: Skukuza (ZA-KR)

Fluxnet 2015 dataset;
weekly mean fluxes;
2011-2014.

Products

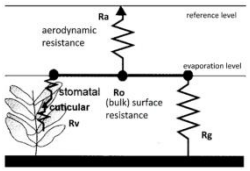
- LSA-SAF – products



Products

- Methodology

Tiles:
Bare soil
Forest
Crops
Grassland



Parameterization by resistance approach (Ghilain et al., 2011)

- For each tile i of

$$LE_i = \frac{L_v \rho_a}{(r_{a_i} + r_{c_i})}\left[q_{sat}(T_{sk,i}) - q_a(T_a)\right]$$

$$H_i = \frac{\rho_a}{r_{a\,i}}\left[c_p(T_{sk,i} - T_a) - g z_a\right]$$

$$G_i = \beta_i Rn_i \qquad \beta_i = f(LAI_i)$$

$$Rn_i - H_i - LE_i - G_i = 0$$

$$Rn_i = (1-\alpha)S_{\downarrow} + \varepsilon(L_{\downarrow} - \sigma T_{sk,i}^4)$$

- For each pixel of image k

$$LE_k = \sum_i \zeta_i LE_i$$

$$H_k = \sum_i \zeta_i H_i$$

Evapotranspiration [mm h^{-1}]

$ET_k = 3600\ LE_k / L_v$

MET, MLE, MH products

- For each pixel of day d

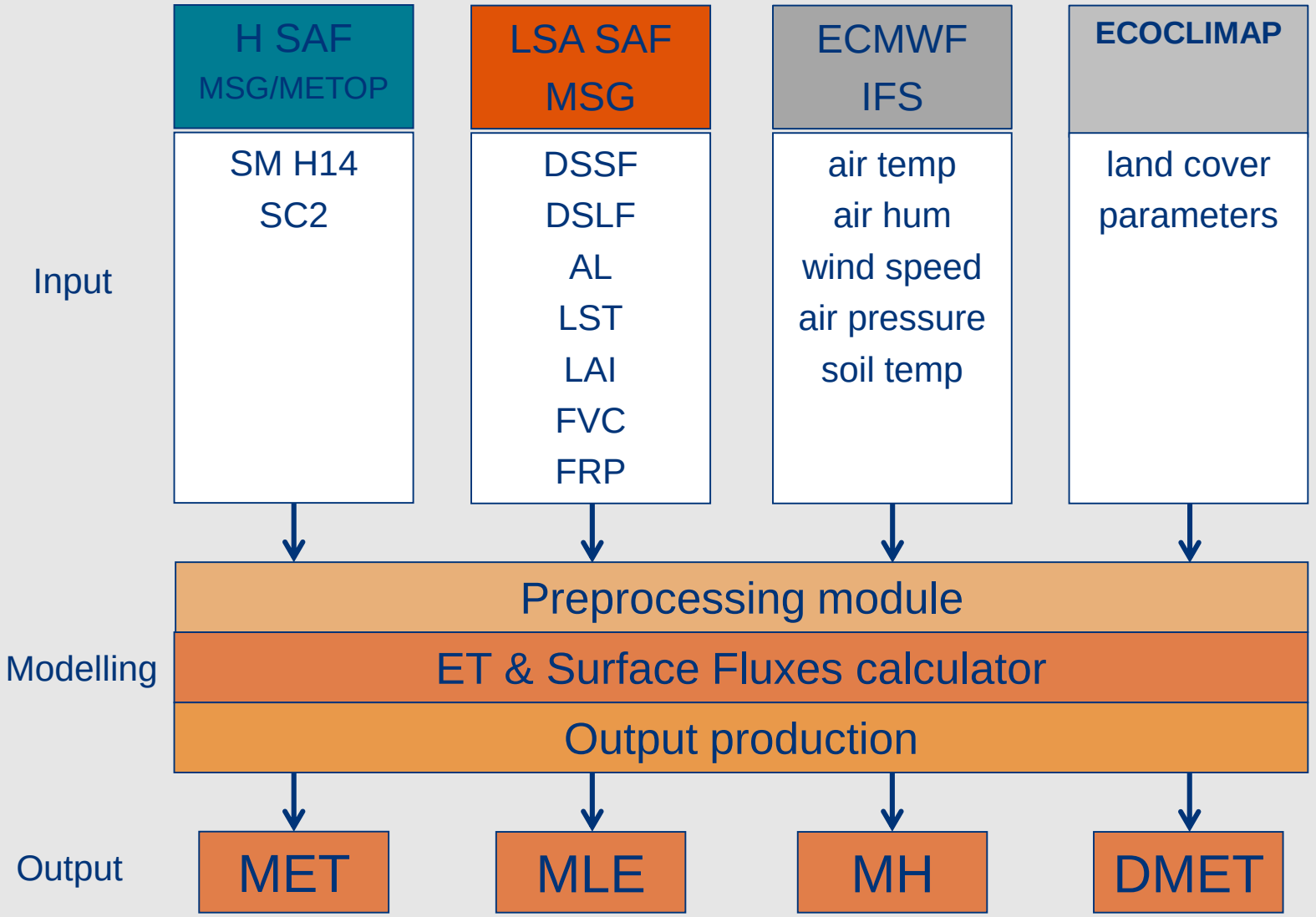
Evapotranspiration [mm d^{-1}]

$ET_d = \Sigma\ ET_k$

DMETv2 product

Products

- Methodology

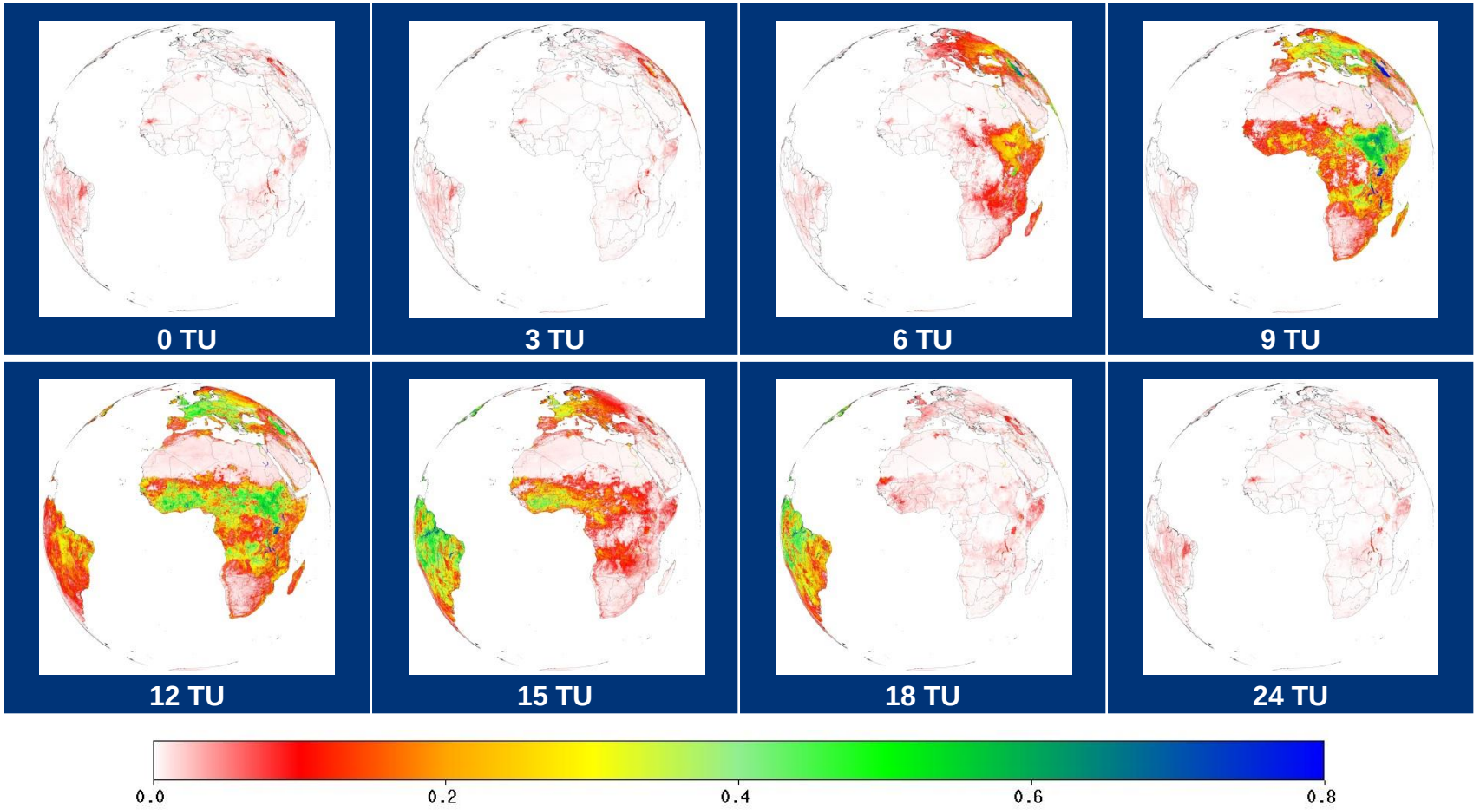


Products

- 30 min Evapotranspiration (mm h^{-1})

e.g. 3-hourly sampling on 25th August 2019.

MET



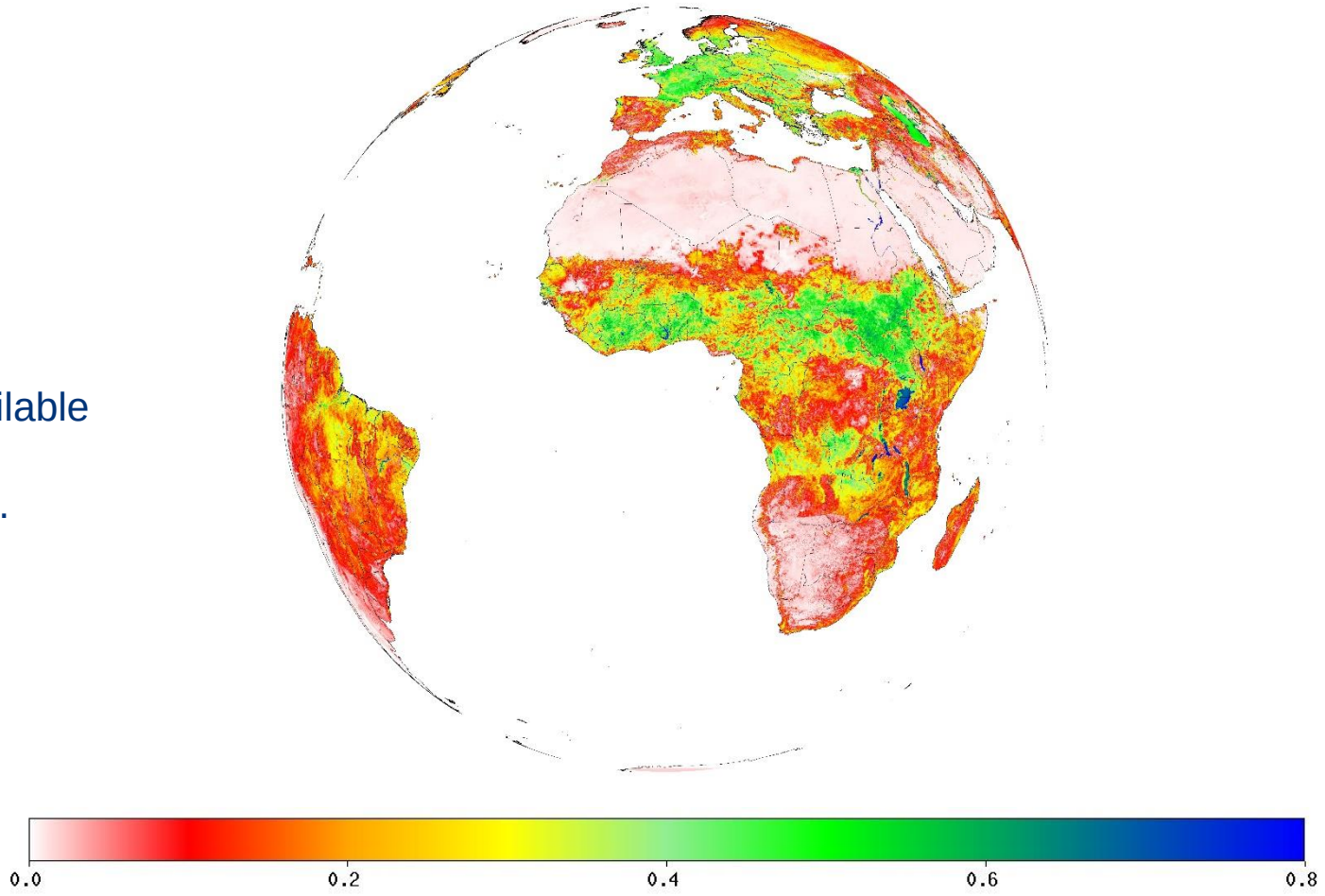
Products

- 30 min Evapotranspiration (mm h^{-1})

e.g. 25th August 2019 at 12 h UT.

MET

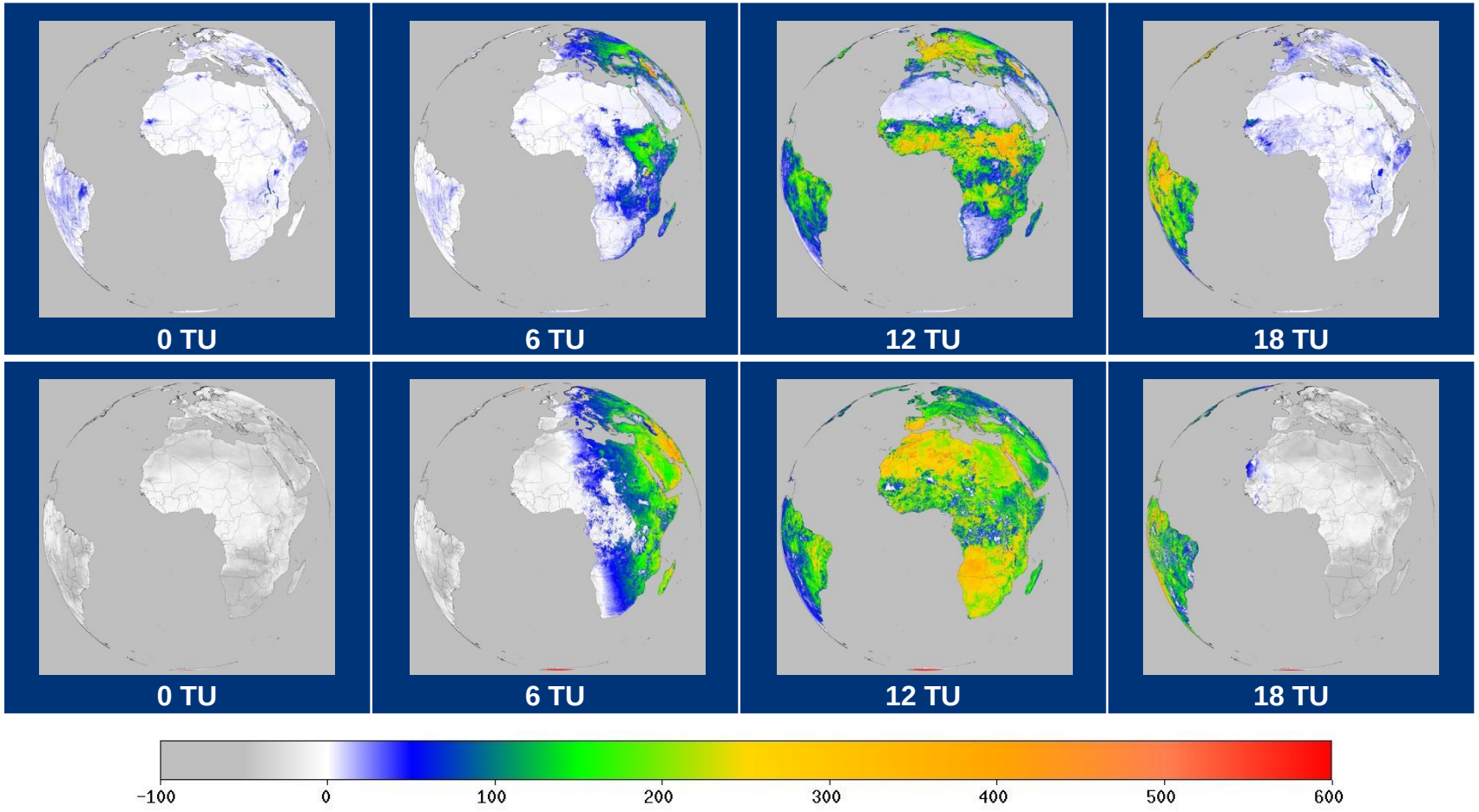
Data files available
each 30 min
+ quality flags.



Products

- 30 min Latent and Sensible Heat Fluxes (W m^{-2})

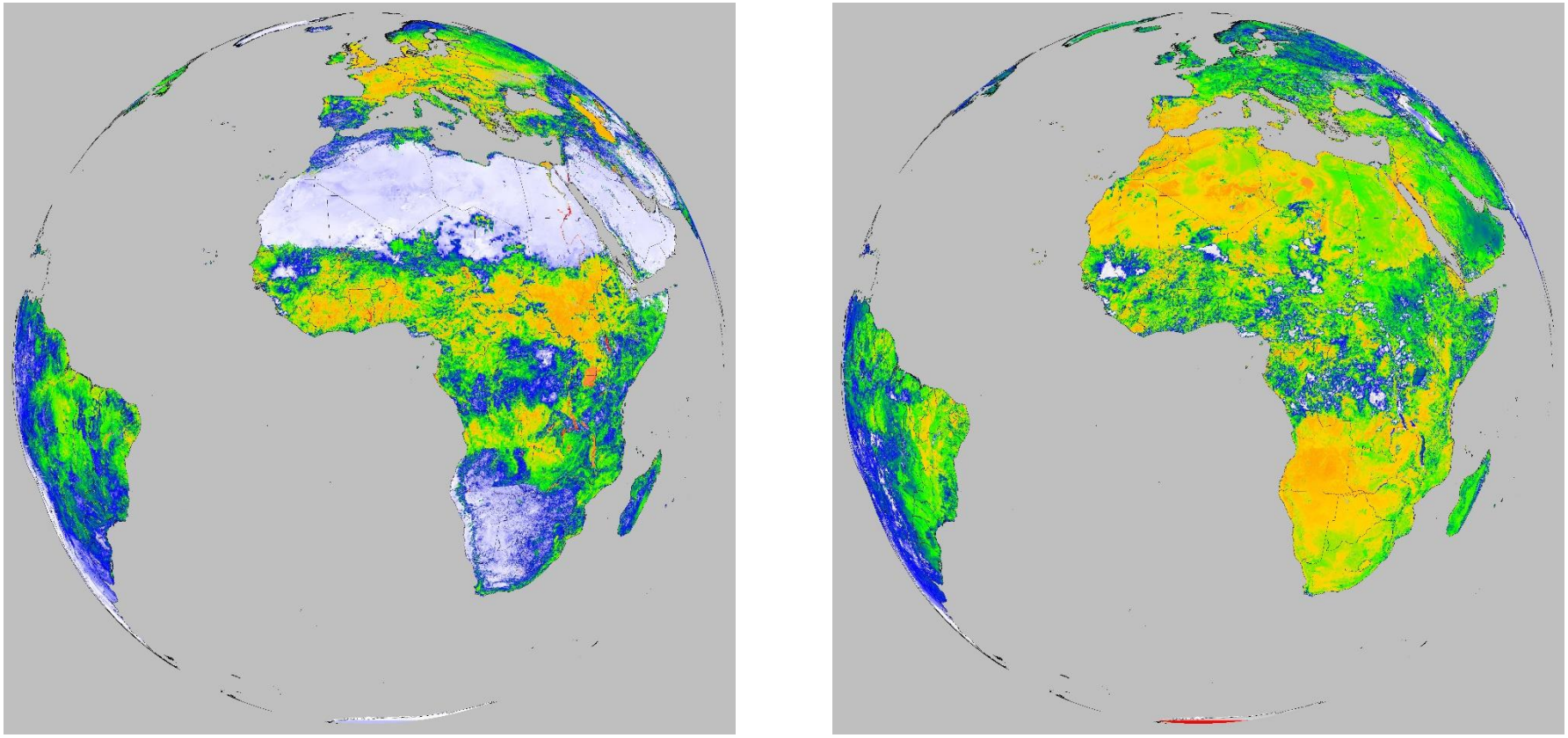
e.g. 6-hourly sampling on 25th August 2019.



Products

- 30 min Latent and Sensible Heat Fluxes (W m^{-2})

e.g. 25th August 2019 at 12 h UT.

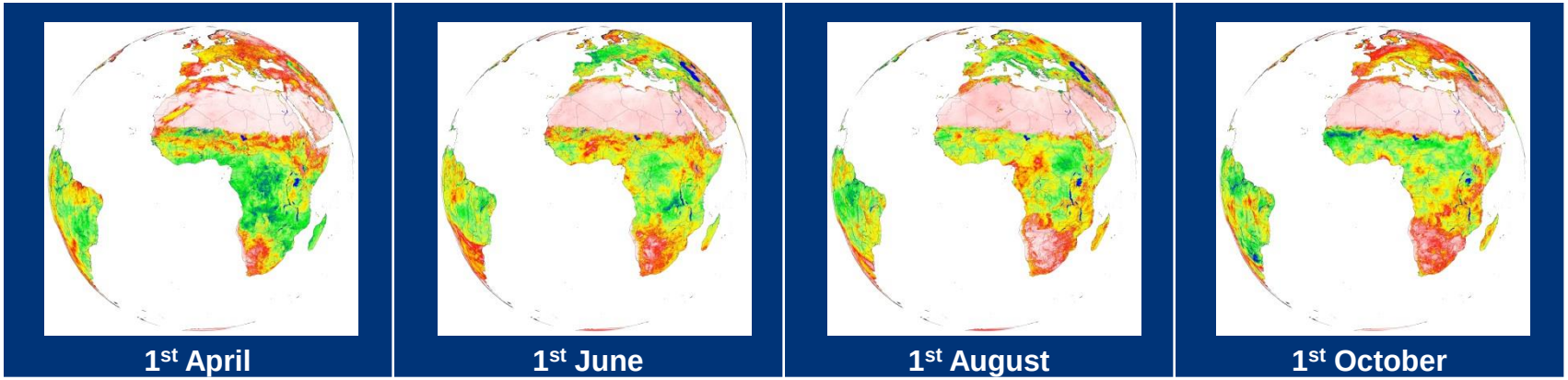


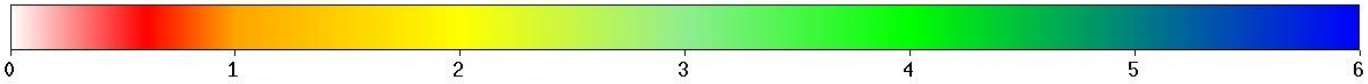
Products

- Daily Evapotranspiration (mm d^{-1})

  e.g. sampling a few days in 2019.

DMET





Products

- LSA web site: to get information

http://lsa-saf.eumetsat.int

go to

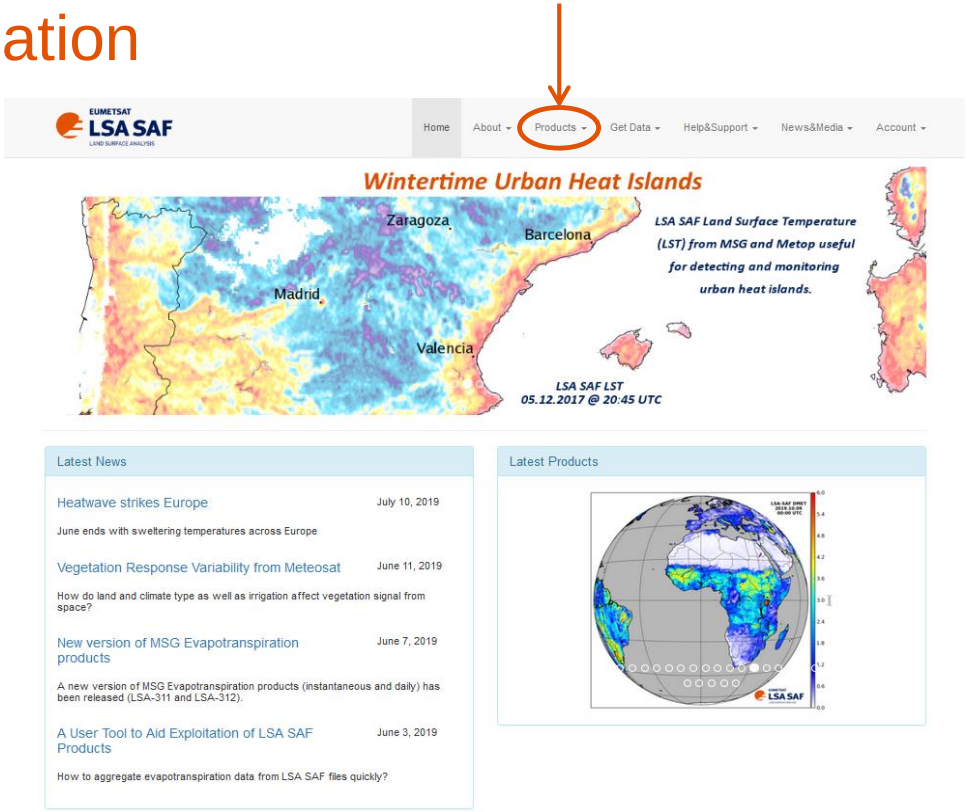
→ 'Products'

→ 'Evapotranspiration & Energy Fluxes'

to find

- a short description of the product

- documentation



- **Product User Manual** ('PUM') to help using the product;
- **Algorithm Theoretical Basis document** ('ATBD') to understand methodology;
- **Validation Report** ('VR') to know about data quality assessment.

Products

- LSA web site: LSA tool box

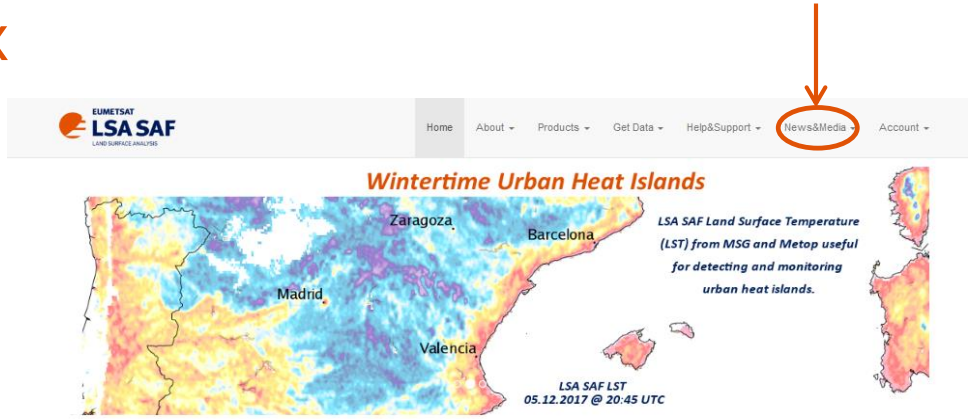
http://lsa-saf.eumetsat.int

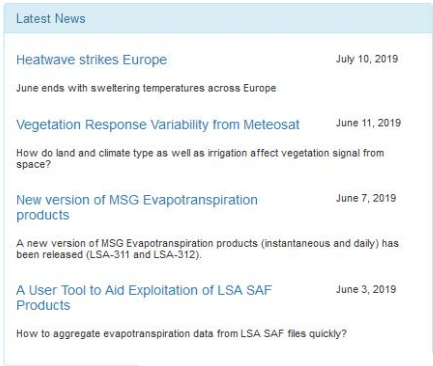
go to

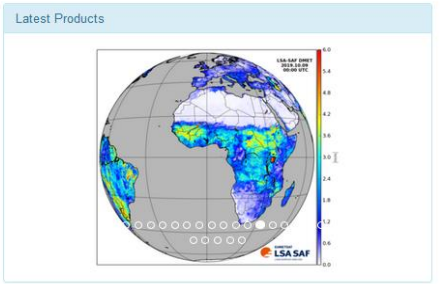
→ ‘News&Media’

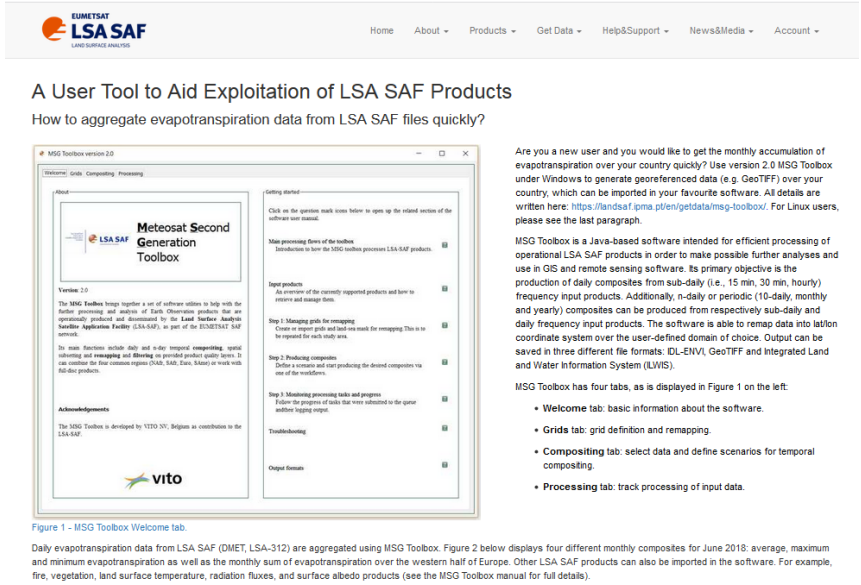
→ ‘News & showcases’

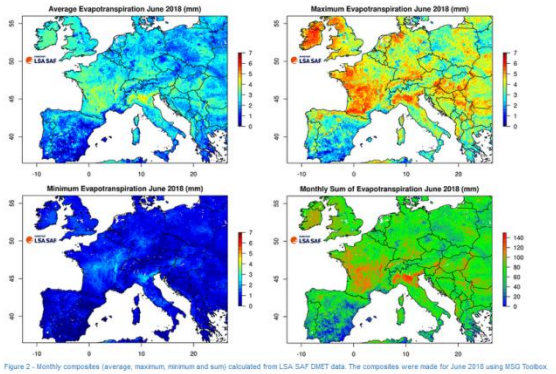
to find news and applications.











Products

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go to

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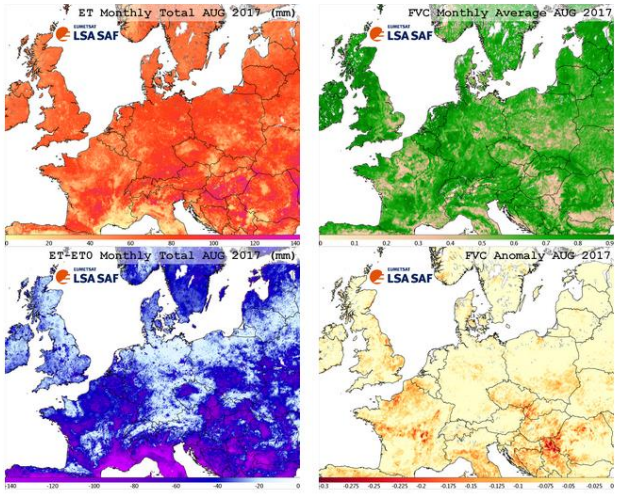
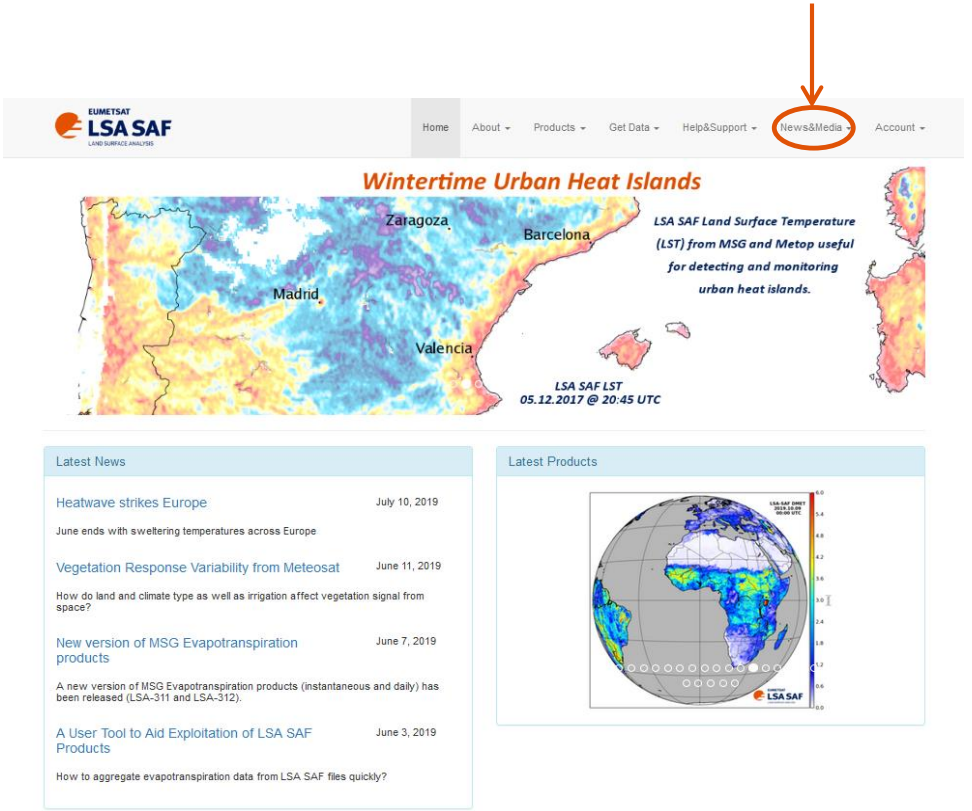


Evapotranspiration difference (ET – ET0) and FVC anomaly both highlight that mostly areas of S and SE Europe experienced strongest drought in August 2017. The local details might differ but the general picture is quite consistent for both evapotranspiration difference and FVC anomaly maps. Only negative anomaly is shown in FVC anomaly figures, i.e., positive anomaly is masked. Conclusions are similar for August 2018, but this time the vegetation and evapotranspiration drought signal is present in N, W and Central Europe.



Satellite Derived Evapotranspiration Is Advantageous for Drought Detection

Analysing Drought Impact by Combining Evapotranspiration and Vegetation Signal

A combination of satellite derived evapotranspiration and vegetation signal improves locating and analysing drought affected areas. In the scope of drought monitoring, satellite vegetation signal, e.g., fraction of vegetation cover is a very reliable indicator of vegetation health. However, for assessing drought stress (i.e. the current conditions vegetation is exposed to), evapotranspiration is also a very important variable. In this sense, the difference between reference and actual evapotranspiration can correlate with the drought stress as experienced by vegetation.

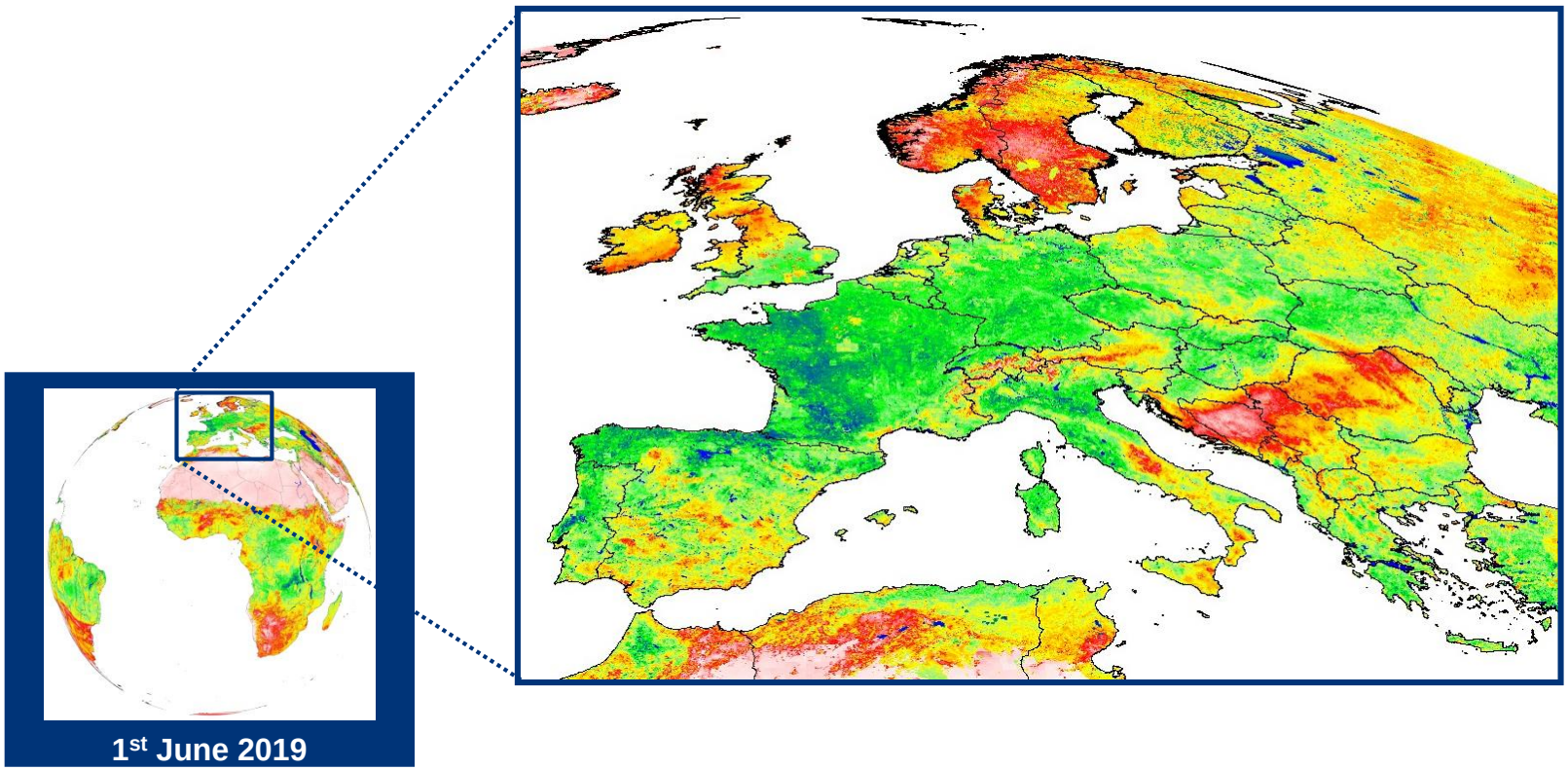
Next figures display satellite derived evapotranspiration (top) and vegetation (bottom) from LSA SAF; all products are prepared on a daily basis from Meteosat satellite. Actual evapotranspiration (MET, LSA-302), difference between reference (ET0, LSA-303) and actual evapotranspiration, fraction of vegetation cover (FVC, LSA-421) and FVC anomaly (difference between current vegetation and its long-term average in 2004-2016) are shown for August 2017 and 2018. ET0 and ET are calculated as monthly total in the same August periods. ET approaches ET0 when there is ample water. Therefore, a large difference between the two indicates a shortage of water, which could lead into drought when dry conditions are persistent.

Examples and applications

- Daily Evapotranspiration (mm d^{-1})

e.g. extraction of an area of interest.

DMET

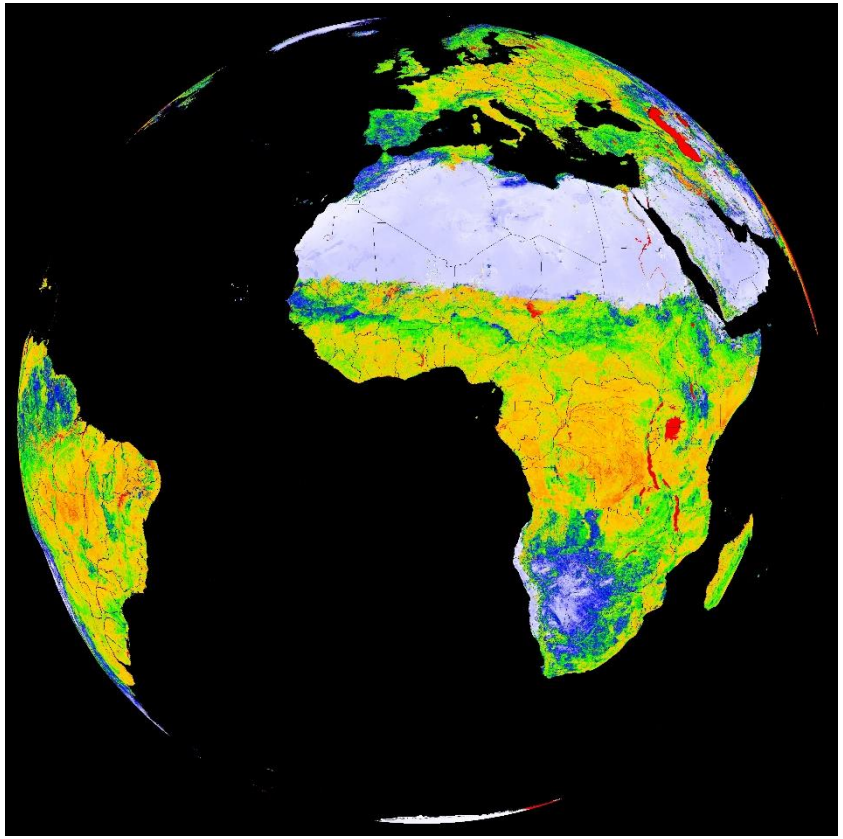


Examples and applications

- 10-day evaporation fraction

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

Average 1-10 June 2019



Low LE
High H

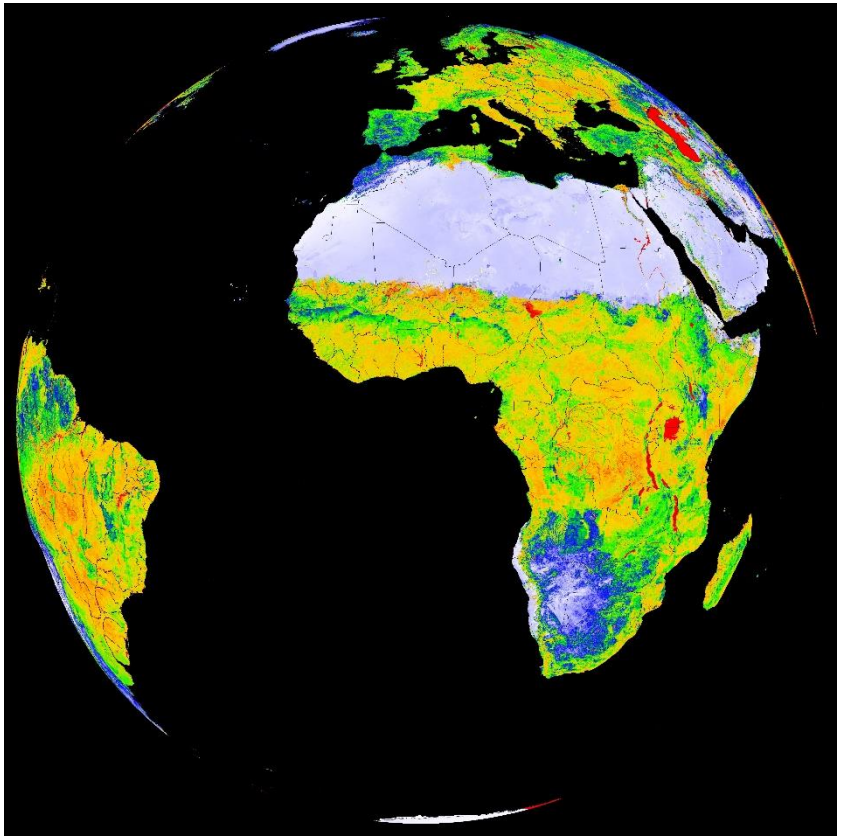
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 11-20 June 2019



Low LE
High H

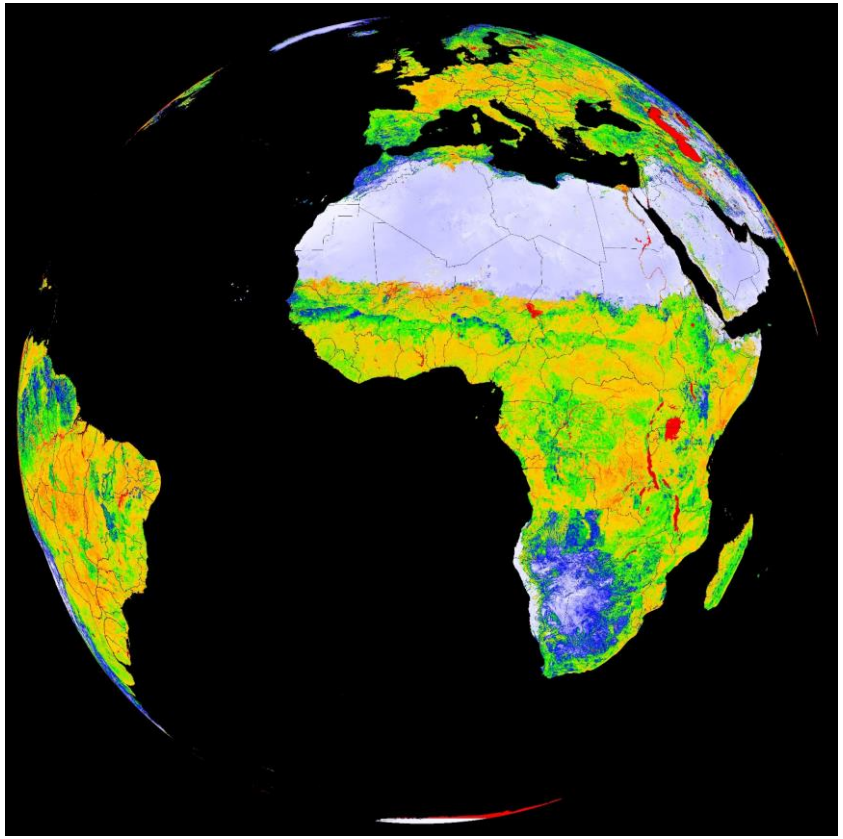
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 21-30 June 2019



Low LE
High H

Low H
High LE

Examples and applications

- 10-day evaporation fraction

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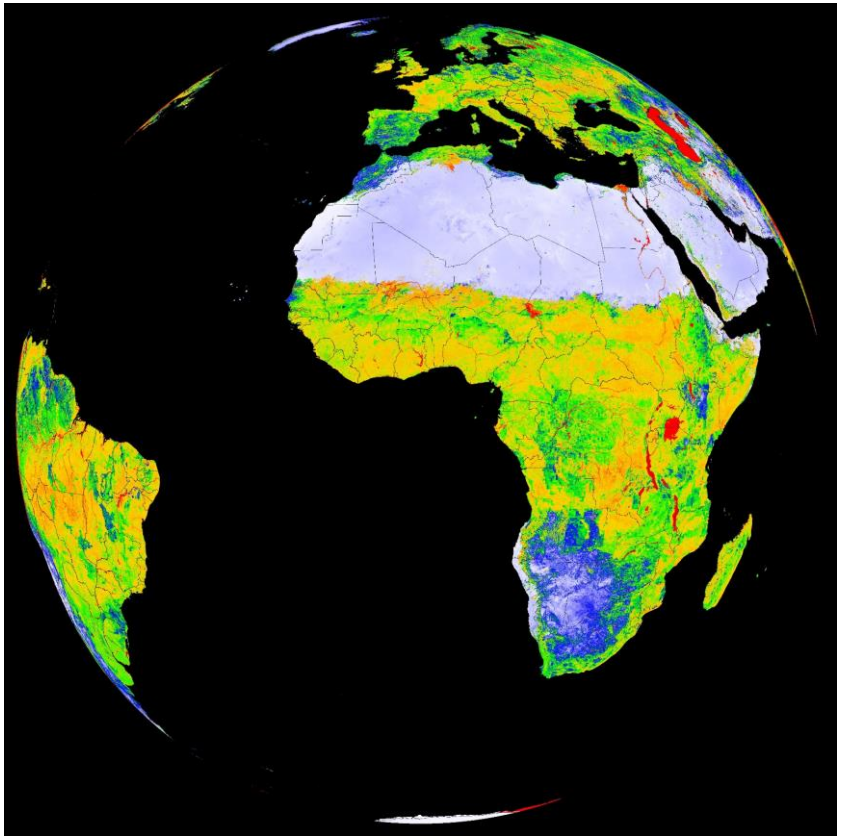
Average 1-10 July 2019



Low LE
High H

Low H
High LE

Examples and applications

- 10-day evaporation fraction

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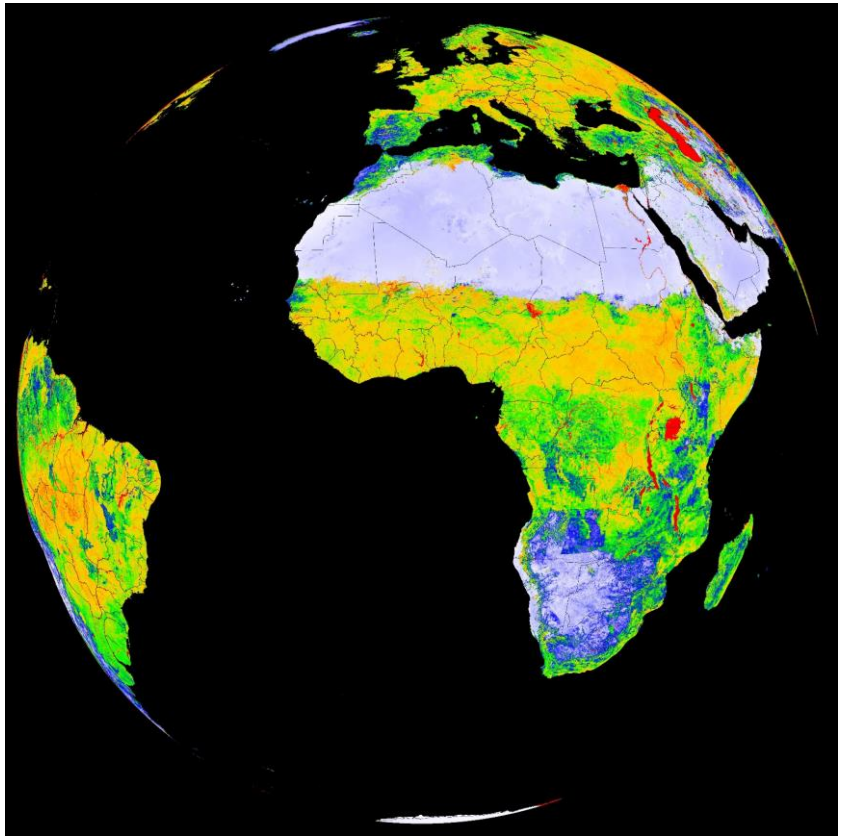
Average 11-20 July 2019



Low LE
High H

Low H
High LE

Examples and applications

- 10-day evaporation fraction

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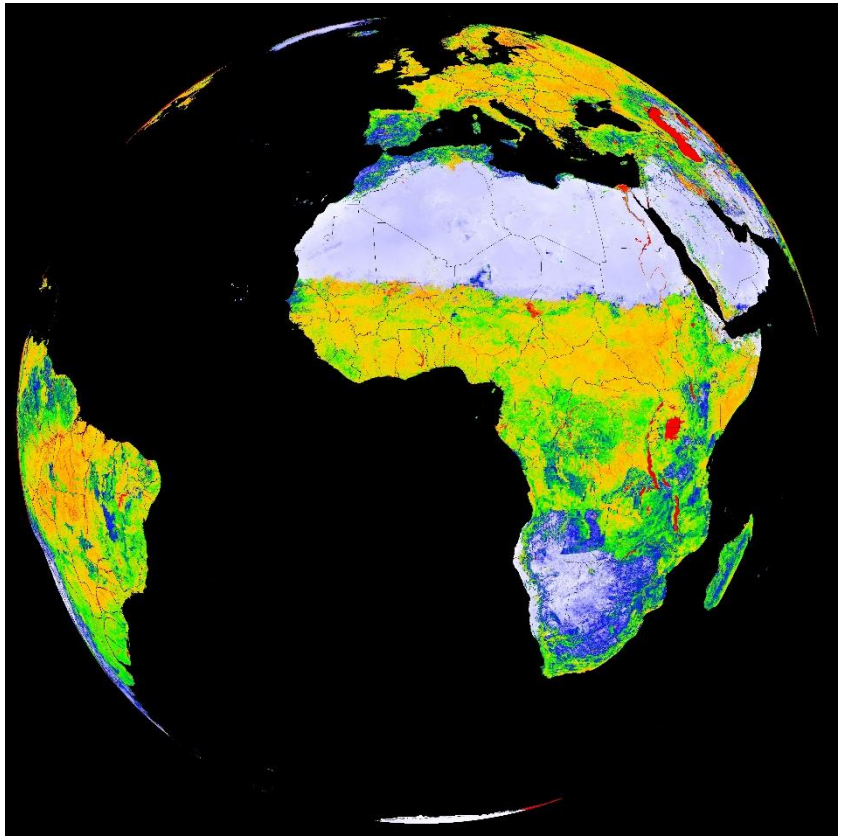
Average 21-31 July 2019



Low LE
High H

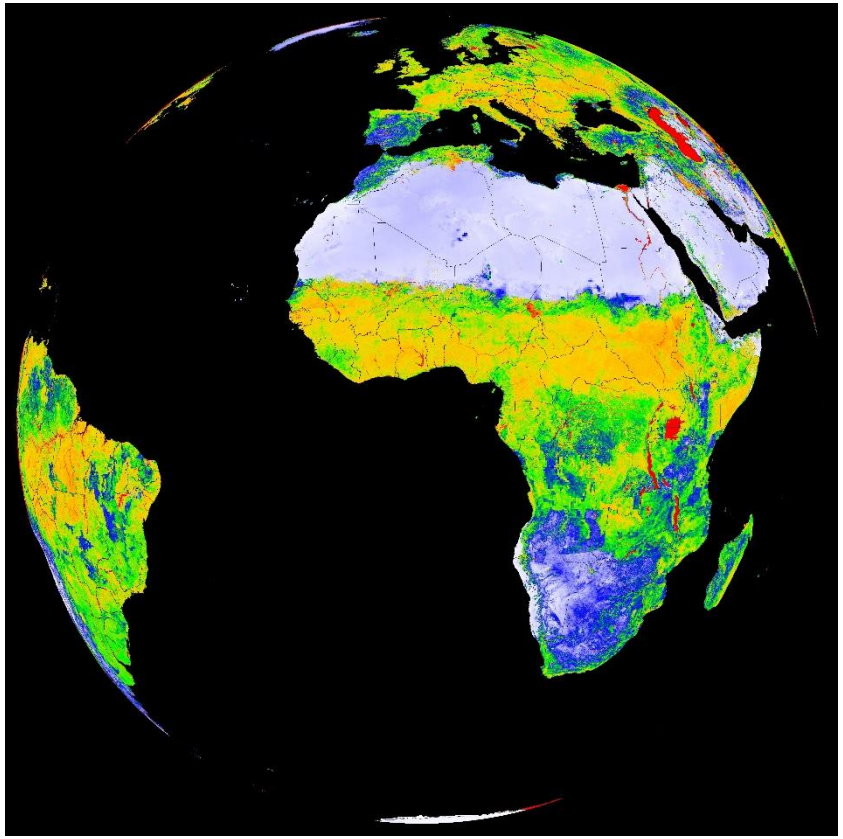
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 1-10 August 2019



Low LE
High H

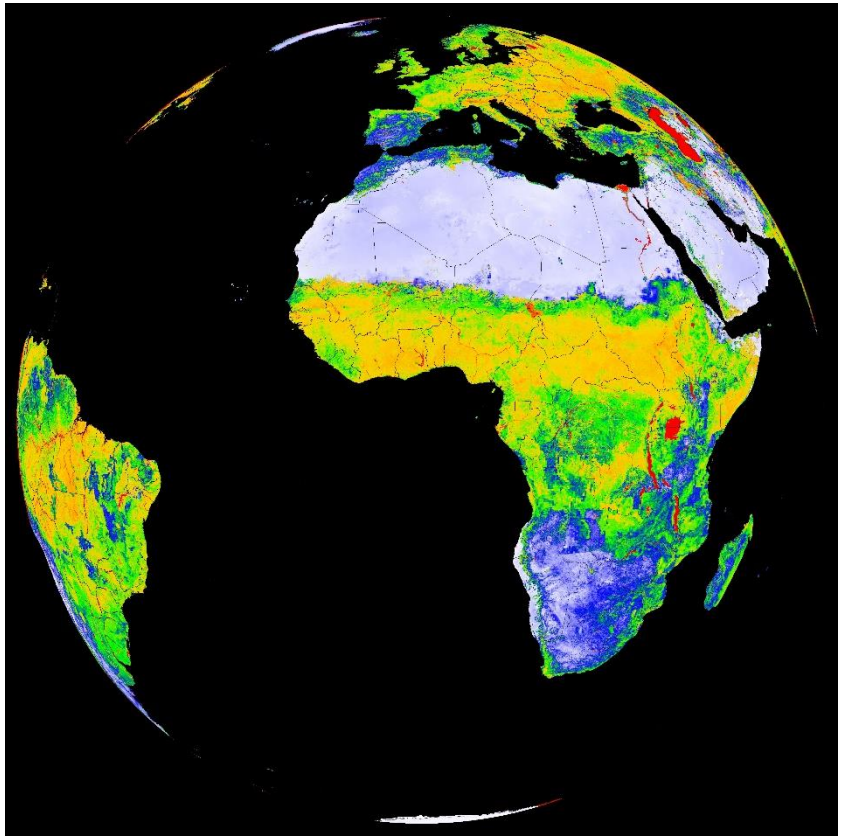
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 11-20 August 2019



Low LE
High H

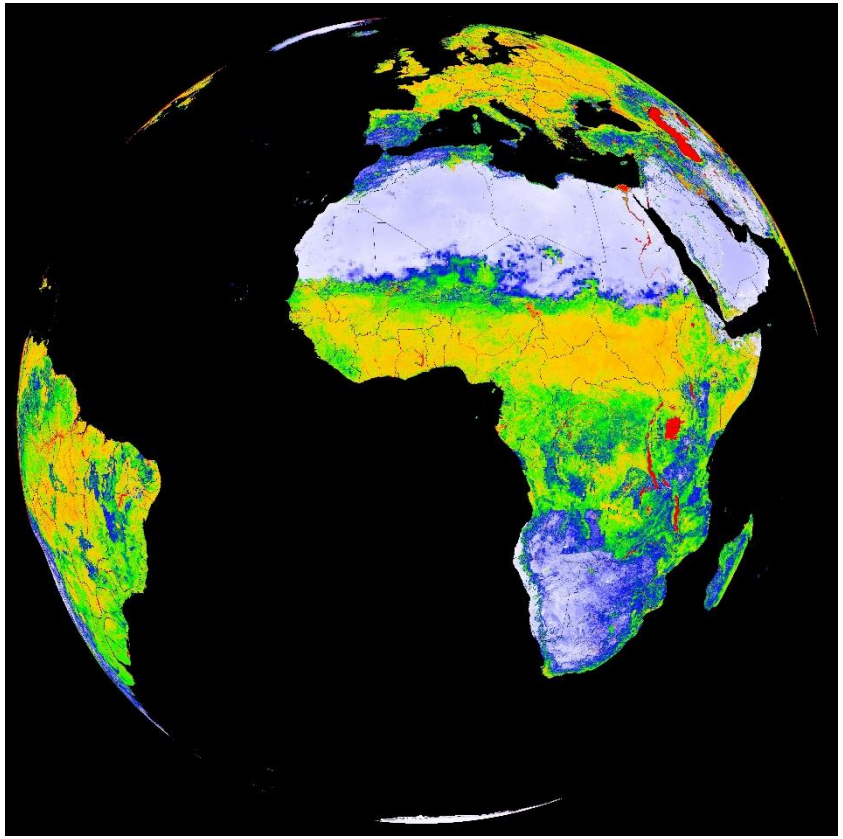
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 21-31 August 2019



Low LE
High H

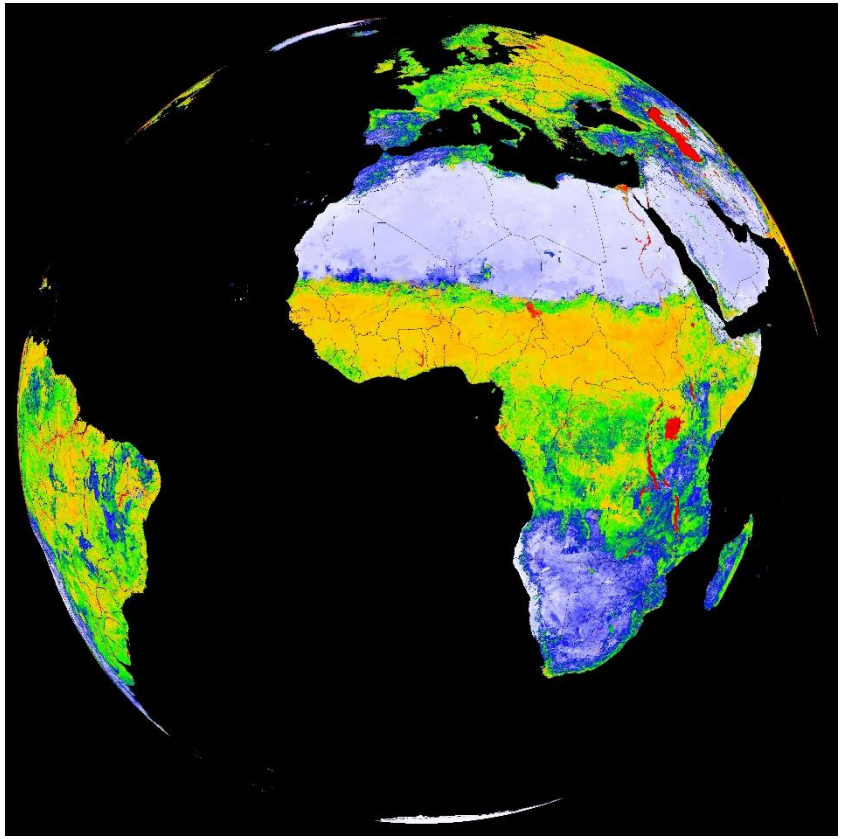
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 1-10 September 2019



Low LE
High H

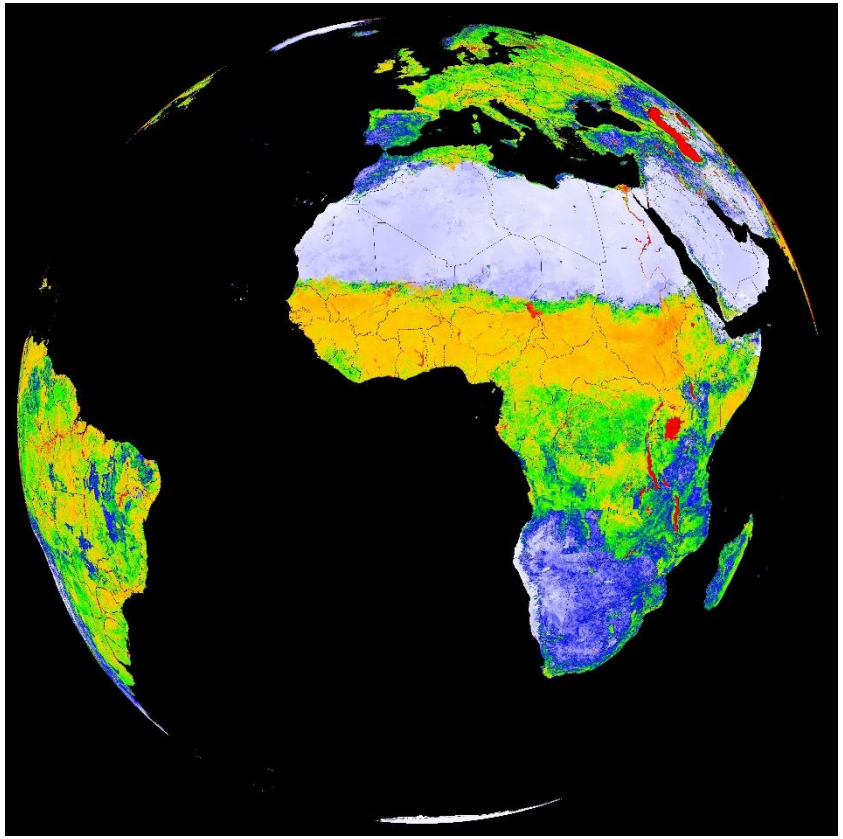
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 11-20 September 2019



Low LE
High H

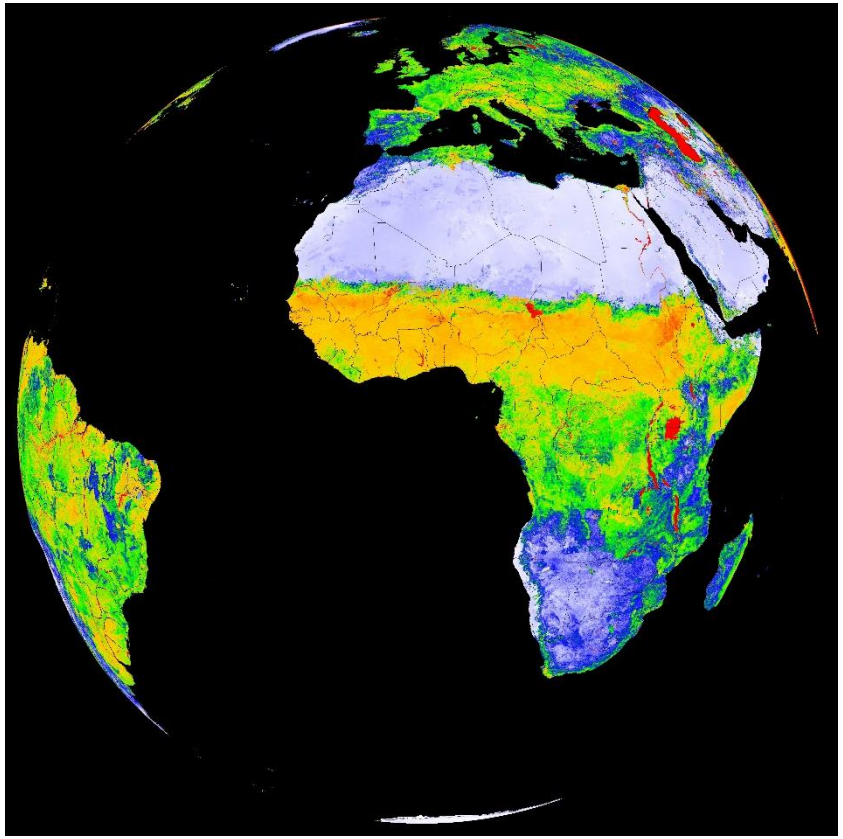
Low H
High LE

Examples and applications

- 10-day evaporation fraction

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

Average 21-30 September 2019



Low LE
High H

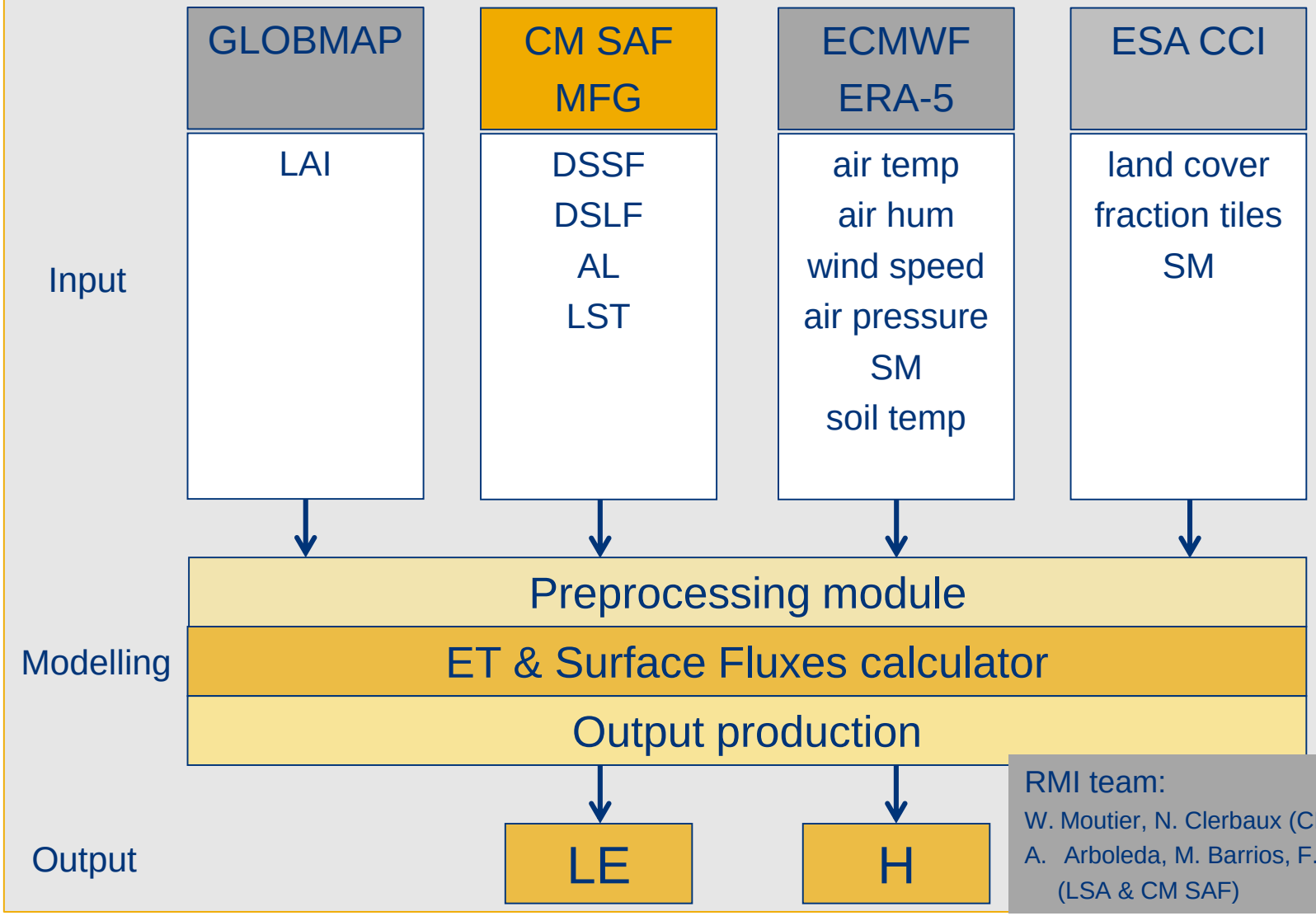
Low H
High LE

Next steps

- Reprocessing of MSG evapotranspiration and surface fluxes
  - Based on recent LSA Climate Data Records used as forcing
  - Period from 2004
- Adaptation to MTG
  - Continuity with MSG
  - Taking advantage of new opportunities (e.g. increased temporal and spatial resolution)
- New data record in collaboration with CM SAF
  - Compatibility with LSA SAF Climate Data Records on ET & SF
  - Adaptation to MFG

Next steps

- Adaptation of methodology to CM SAF



RMI team:
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A. Arboleda, M. Barrios, F. Meulenberghs (LSA & CM SAF)

Conclusions

- Summary

  - Evapotranspiration and surface heat fluxes (LE, H) have been developed in LSA SAF
  - Production done in NRT
  - On-going developments in view to build new data records
  - Adaptation foreseen to MTG.

- Users are invited to exploit available products

  - Documentation available from LSA SAF web site
  - Contact help desk for questions
  - Interaction welcome with development team to let us know about your experience and needs.

- Any questions ?

- Acknowledgments

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

- More information about our activities:

  - http://hydroland.meteo.be