

Multiparametric monitoring of land surface state and anomalies in regional scale, with use of operational satellite products and ground observations

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Piotr Struzik, Małgorzata Kępinska-Kasprzak, Joanna Chmist-Sikorska – Team for Specialized Forecasts,IMGW-PIB 2021 SALGEE Workshop, 24-26/11/2021







- 1. Purpose of this project.
- 2. Selected parameters.
- 3. Retrieved maps and diagrams.
- 4. Constructed web page (actually only IMGW internal).
- 5. Conclusions.



Selected parameters:

- Land SAF DSSF Direct Surface Solar Flux,
- Land SAF DMET Actual Evapotranspiration,
- Land SAF METREF Reference Evapotranspiration,
- Land SAF GPP Gross Primary Production.
- H-SAF h14 Soil Moisture Index,
- CM-SAF Fractional Cloud Cover
- Sielyaninov's Hydrothermal Coefficient, retrieved by using Rain GRS (Precipitation) and T 2m from INCA Nowcasting Model (1 km spatial resolution).
- Climatic Water Balance calculated with use of RainGRS (Precipitation) and METREF (Reference Evapotranspiration),
- Additional parameters not based on remote sensing phenology, plant requirements for water.















Used Land SAF DSSF daily product operationally available since 2004

Generated products:

maps – daily, decadal, monthly and yearly amounts, decadal, monthly and yearly anomalies. diagrams for each administrative unit (16 provinces, 380 districts) – decadal, monthly values and anomalies



Mean yearly amount [kWh/m2] based on



Mean yearly amounts [kWh/m2] for the area of Poland



Direct Solar Surface Flux (Land-SAF DSSF) – monthly amount kWh/m² , year 2021 (different scales for each month)





Anomaly of Direct Solar Surface Flux vs. 2004-2018 mean, year 2021, scale ±30%





Diagram of decadal amount and anomaly (vs. 2004-2018 mean) of solar radiation in 2021 r.

Province: Zachodniopomorskie





Province: Małopolskie







Actual evapotranspiration – Land SAF MSG MET product.

- Generated maps of daily, decadal, monthly and yearly amounts for period 2010-now.
- Maps of anomalies generated until 2018. In March 2019 Land SAF completely changed MET products. Historical data not yet reprocessed.



Mean yearly amount [mm] based on 9 years period 2010-2018



Reference evapotranspiration based on Land SAF MSG METREF product.

Generated products:

maps – daily, decadal, monthly and yearly amounts, decadal, monthly and yearly anomalies.

diagrams for each administrative unit (16 provinces, 380 districts) – decadal, monthly values and anomalies

Mean yearly amount [mm] based on 15 years period 2004-2018



Mean yearly amounts [mm] for the area of Poland



Anomaly of Reference Evapotranspiration – decadal maps 2021, scale ±40%.







Gross Primary Production (GPP), informs about the efficiency of plant processes converting light into chemical energy by photosynthesis.

EUMETSAT Land-SAF GPP product on the base of solar radiation, actual evapotranspiration, reference evapotranspiration, Photosyntheticaly Absorbed Radiation, determines daily GPP using Monteith approach. Then decadal values are calculated as mean daily amounts from decade in g/m²*day.

It allows for identification of rapidly developing vegetation, as well as limited development due to stress related to lack of water or temperature.

The decadal values for period April-October 2018-2021 were generated for the area of Poland and presented in IMWM-NRI service.



Example od mean daily GPP in 1st decade of June



GPP during vegetation season 2018 – decadal values from April to September – scale 0-16 g/m2*day.





Soil Moisture Index – H-SAF h14 product (ECMWF) – daily values of SWI [%] for layers 0-7 cm, 7-28 cm, 28-100 cm and 100-289 cm.

Relation between Climatic Water Balance and SWI based on H-SAF product

Climatic Water Balance 1.VI. – 31.VII.2019





Anomalies of mean yearly Soil Moisture Index – yearly values vs. 2012-2018 mean [± 50 %]

Anomalie srednich rocznych wsakaznikow wilgotności gleby dla warstwy 7-28 cm, wzgledem wielolecia 2012-2018 [%]



Anomalie srednich rocznych wsakaznikow wilgotności gleby dla warstwy 28-100 cm, wzgledem wielolecia 2012-2018 [%]



Soil Moisture Index



Mean monthly values of SMI [%] in year 2021.

Layer 28-100 cm



22

23

20

July

14

15



August



May

19 20 21 22 23 24

September

18

16 17

15



June



October

19

15



45

40

15

10

Since 3.11.2021 operationally available new Soil Moisture product H26 with resolution 0.1 deg



3.11.2021

H26 – layer 28 - 100 cm





Sielyaninov's Hydrothermal Index - indicates areas with rainfall surplus or deficiency. Simple but efficient indicator of agroclimatic droughts.

	where
$\nu = \frac{10 * P}{10}$	P- amo
$K = \frac{1}{\sum t}$	t- deca
	-

where:

P- amount of rainfall in decade,

t- decadal sum of mean daily temperature measured on 2 m.



Rainfall

Used product RainGRS developed at IMWM-NR. Resolution 1x1 km,

Combining:

- G ground measurements from AWS,
- R radar estimations of rainfall,
- S experimental satellite rainfall product using NW-CSAF: PC, CRR, PCPh, CRRPh

Temperature

INCA nowcasting model analysis of temperature at 2 m from hours: 00, 03, 06, 09, 12, 15, 18, 21.

Good interpolation between AWS locations based on DEM. Removal of outliers.



Comparison of products based on: Synop data, AWS data, RainGRS/INCA data - third decade of June 2021





Hydrothermal Sielianinov Index – spatial distribution over Poland in year 2021 (decadal maps).





August



Climatic Water Balance – parameter used for evaluation of water deficit or surplus.

Official criteria in Poland for evaluation of agricultural loses and compensation from assurance. Monthly values less than -150 mm indicates drought, less than -200 mm indicates significant drought.

CWB = Σ Precipitation – Σ Evapotranspiration

Precipitation – used IMWM-NRI RainGRS product, Evapotranspiration – used Land SAF Reference Evapotranspiration.

Calculated decadal and monthly values. Example of July 2021 below.

Miesiąc Lipiec



22

Miesiac Marzec

18

Miesiac Kwiecień

Miesiąc Maj

15 16



3 dekada

15 16 17 18 19 20 21 22 23 24









18

19

17

20 21 22 23











August

July

Phenology



Phenological seasons related to plant observations:

- Early spring, -
- Spring,
- Late spring, -
- Early summer -



- Summer, -
- Early autumn, -



Średnie daty początku wczesnej wiosny (2007-2016)



Mean date 2007-2016

Early spring on different observation posts, based on phenological observations

>

Early Spring: 2021



Anomaly





- Autumn.

Optimal amount of precipitation was compared to actual amount in the period April – Septemeber. Results for selected types of agriculcure plants are presented as maps.





Year 2021



Created Web service (actually only intranet) contains over 90 000 maps and diagrams:

- Solar radiation 2004-now,
- Actual evapotranspiration 2010-now,
- Refrence evapotranspiration 2004-now,
- Soil Moisture Index 2012-now,
- Hydrothermal Sielianinow Index 2018-now,
- Climatic Water Balance 2018-now,
- Gross Primary Production 2018-now,
- Daily hours with clouds 2010-now,
- Phenological observations 2007-now,
- Water requirement by plants 2018-now.

The new ones (actual) are automatically generated and submitted to the service:

maps are generated by Golden Software Surfer scripts,
diagrams are generated by R scripts.



Web service







Reference evapotranspiration – comparison between Land SAF METREF Product and retrieval from ground observations using Penmann Monteith formula (yers 2018-2021, 23 Synop stations used)



■ Mikołajki ■ Mława ■ Płock ■ Poznań ■ Suwałki ■ Szczecin ■ Tarnów ■ Terespol ■ Wieluń ■ Wrocław ■ ZielonaG



Słupecki District located in Central Poland belongs to region of frequent droughts. Area 837,91 km², urbanization coefficient: 28,7% 71% of population outside of the cities.



52°18'N 17°52'E



Multimedia w Wikimedia Commons



Monitoring of agricultural areas – ground observations





Parameters based on satellite data or both satellite and ground observations – spatial distribution





Spatial distribution analysis (V.2018)





Temporal evolution (decadal steps)





From regional to local scale



Climatic Water Balance - May 2018.

Spatial distribution for:

- Country
- Province,
- District,
- Community.



Anomalies of current values vs. Multiannual mean - actual ewapotranspiration





Temporal variation of selected parameters for selected district





Precipitation — SM1 — SM2 — Etref — Solar rad. — Eta — CWB



- 1. Results of ongoing project concerning continous monitoring of actual state of environment over the multiannual means with selected parameters related to land monitoring and agrometeorology.
- 2. Unique possibilities of products generated operationally by EUMETSAT Land-SAF, H-SAF, NWC-SAF, CM-SAF and IMWM-NRI were presented.
- 3. Spatial and temporal resolution of satellite products based on MSG, as well as lenght of time series is sufficient for monitoring of actual state over climatology in spatial scale of small administrative units (provinces and districts of Poland).
- 4. Combining satellite and ground observations together, both at the web service and also for generation of individual products is useful and complimentary.
- 5. The results of project (all generated maps and diagrams) are available in form of web service, actually only IMWM-NRI internal, I hope in future also as public service.

Thank you

Piotr Struzik

