EUMETSAT
H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

# Case study:

# H05 - Raingauge 10-years precipitation normals for estimation dry/wet periods over Slovakia and central European region (July 2012 - June 2022)

**Ján Kaňák[1], Ľuboslav Okon[1], Peter Kajaba[2]**
**[1] Remote Service Department**
**[2] Climatological Service**
**Slovak Hydrometeorological Institute**
**November 2022**

# This case study is about:

## H05-RG 10 years of data for estimation dry/wet periods over Slovakia and central Europe (July 2012 - June 2022)

**Index**

# This case study is about:

## H05-RG 10 years of data for estimation dry/wet periods over Slovakia and central Europe (July 2012 - June 2022)

**Index (continue)**

# Introduction

In the frame of HSAF validation cluster the evaluation of precipitation products is very important task. Validation is based on comparison of satellite data against ground truth (raingauge or radar measurements).

Mainly statistical comparisons of instantaneous precipitation or 24 hour accumulations were performed until nowadays to evaluate HSAF precipitation products quality and performance.

**Aim of this case study is to use long-term accumulated data on monthly basis.**

Maximum 10 years of H05A/B HSAF products is available for this kind of work – operationally generated and archived data are covering the period from July 2012 until nowadays.

**What we need to estimate is DRY/NORMAL/WET period in following way:**

- Monthly accumulated precipitation (monthly totals) in mm per month (120 months)
- Monthly long-term normals, e.g. 10-years averaged accumulated precipitation for each month of the year
- Calculation of monthly anomalies (difference between monthly accumulated precipitation and monthly long-term normal
- Evaluation of monthly anomalies according DRY/NORMAL/WET classification table

# Definition of monthly rain characteristics

We re-used the table routinely used by the Climatological Service of SHMÚ.
This table defines 7 classes of rain characteristics:

| Definition: | *for month* | *for the season* |
|---|---|---|
| EXTREMELY DRY | below 10 % | below 60 % |
| VERY DRY | 10 - 49 % | 60 - 79 % |
| DRY | 50 - 79 % | 80 - 89 % |
| NORMAL | 80 - 120 % | 90 - 110 % |
| WET | 121 - 150 % | 111 - 120 % |
| VERY MOIST | 151 - 190 % | 121 - 140 % |
| EXTREMELY MOIST | above 190 % | above 140 % |

For our purposes in final evaluation we reduced number of classes to simplify our results:

DRY (includes EXTREMELY DRY and VERY DRY classes)
NORMAL (includes DRY, NORMAL and WET classes)
WET (includes VERY MOIST and EXTREMELY MOIST classes)

**NOTE: In this case study we evaluate rain characteristics only on monthly basis. For evaluation of the seasons we need to prepare more general processing software and we plan to do it in near future.**

# Processing and preparation of H05A/B data

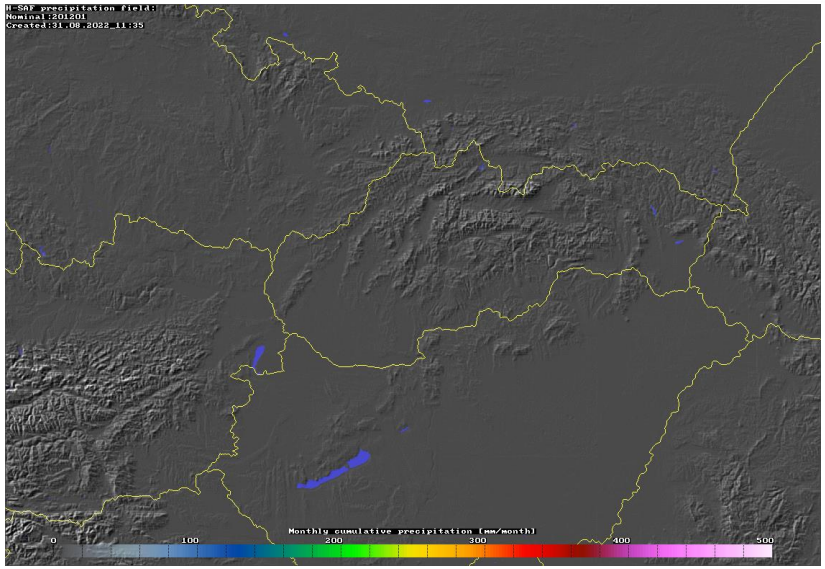
H05A/B data we downloaded from HSAF FTP-server, where all precipitation products are archived:

- H05A is covering the period from July 2012 to May 2015
- H05B is covering the period from June 2015 to July 2022

**In overlapping period after May 2015 we used merging principle of H05A/B with priority set to B product.**
**In this way we reached availability of data 100% for 102 months from overall 120 months and averaged availability 96.75% for this 2012-2022 10-years period.**
This availability is in compliance with EUMETSAT standards of overall satellite data availability.

# Processing and preparation of SHMÚ raingauge data

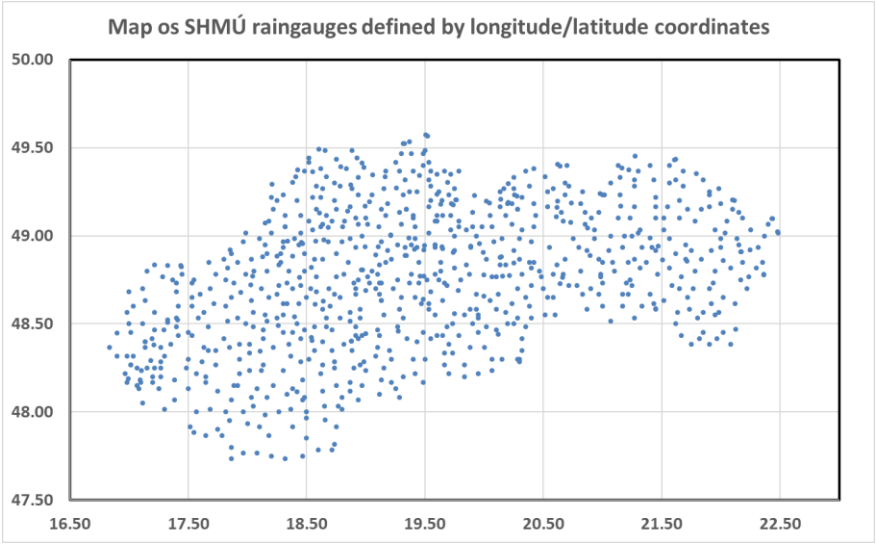
Raingauge data are collected at SHMÚ and controlled by our Climatological department on monthly basis. We received and worked with quality checked and interpolated raingauge data over Slovak territory as monthly totals in mm/month.
Interpolation method includes the influence of 500m orography to rain distribution.
**NOTE: H05 product does not contain such kind of correction.**



Orography of Slovakia: lowlands and mountains

Raingauge data stored in GIS system were extracted together with lat/lon coordinates and re-projected/upscaled to common grid (Mercator projection) with satellite and raingauge data in resolution of 1x1km$^2$.

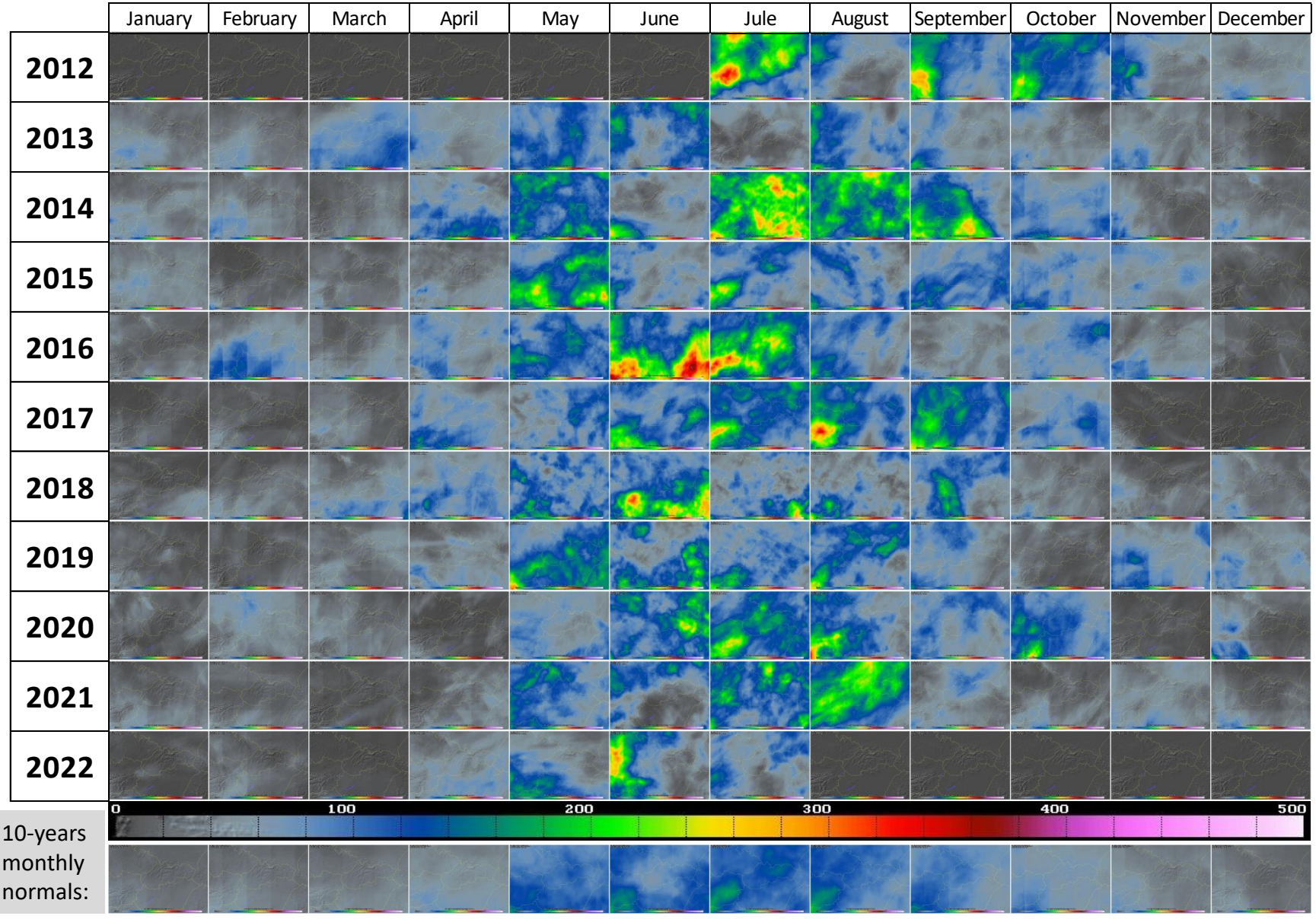
Database of SHMÚ raingauge data contains 830 single measurement points.



# Monthly precipitation totals in [mm/month] H05:

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

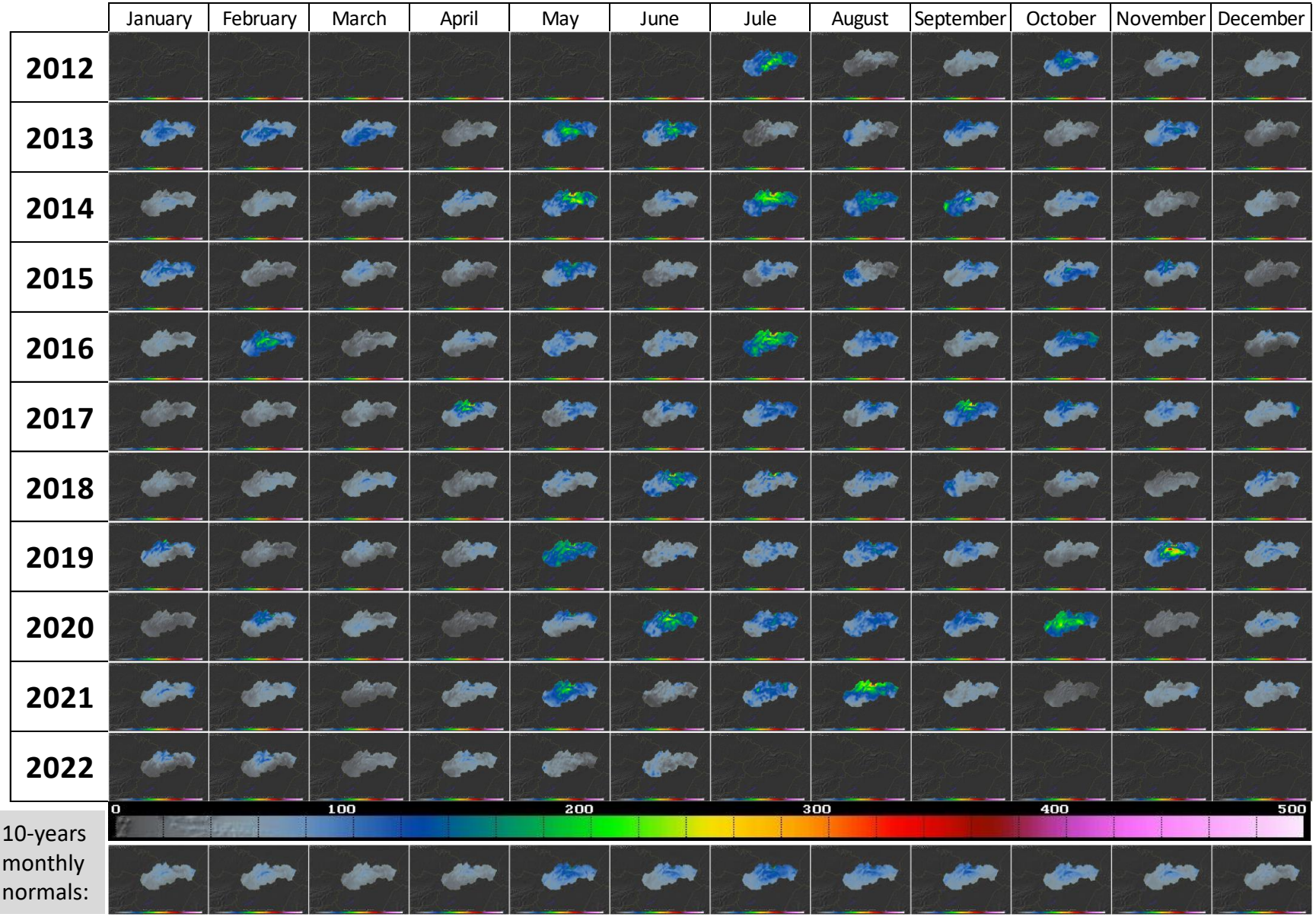
Summing 24h H05 accumulations to obtain monthly sums; summing single months 2012+…+2022 and calculating the average we received monthly normals (last line):



# Monthly precipitation totals in [mm/month] RG:

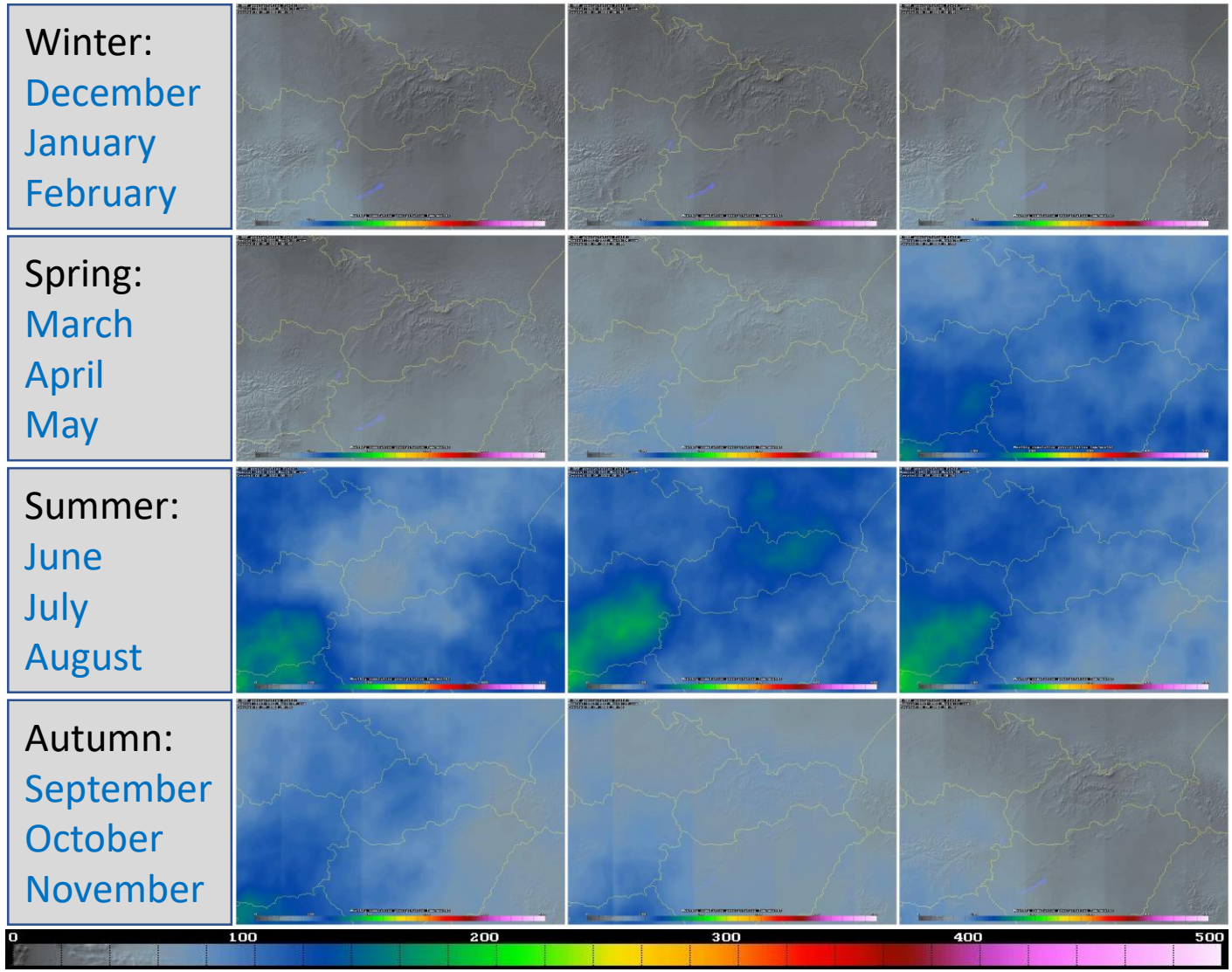
EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Summing 24h RG accumulations to obtain monthly sums; summing single months 2012+…+2022 and calculating the average we received similar monthly normals:



# Monthly precipitation 10-years normals in [mm/month] for H05:

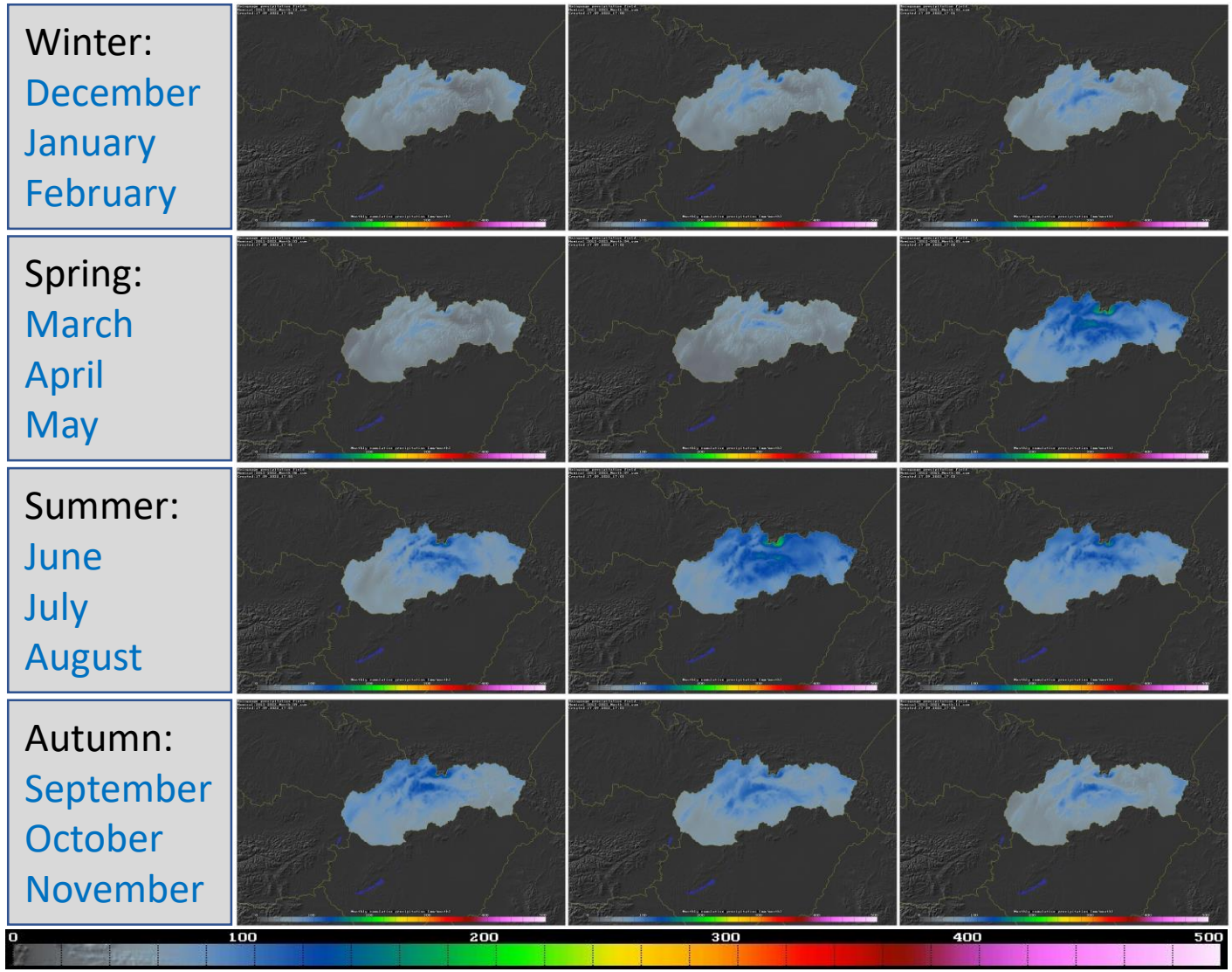
EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT




Summing single months 2012+…+2022 and calculating the average we received 10-years monthly normals. **NOTE: All area is covered by satellite data.**

# Monthly precipitation 10-years normals in [mm/month] for RAINGAUGES:

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

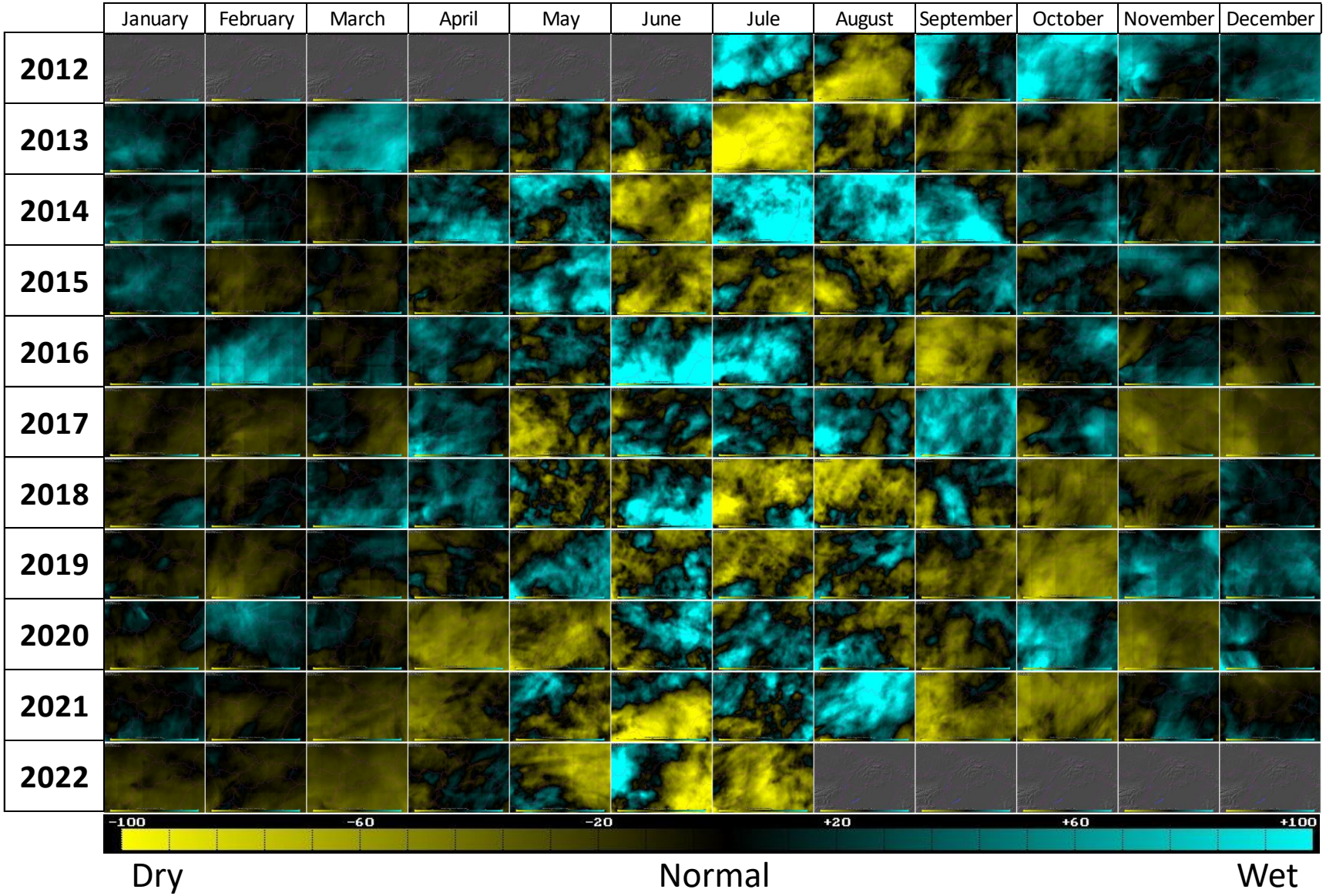



Summing single months 2012+…+2022 and calculating the average we received 10-years monthly normals. **NOTE: Only area of Slovakia is covered by RG data.**

# Monthly precipitation anomalies according H05:

## Absolute differences in [mm/month] of monthly sums

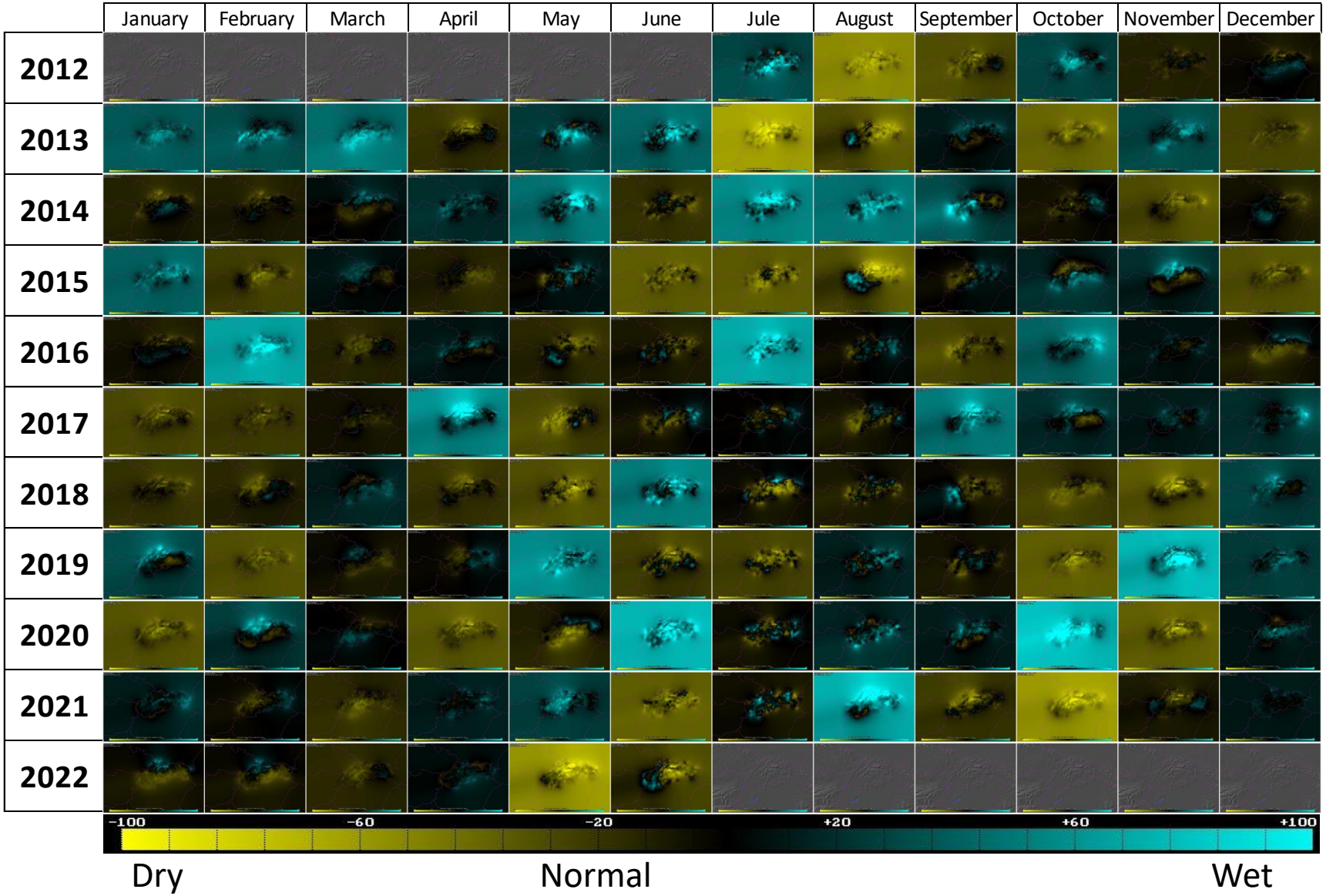
EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT



# Monthly precipitation anomalies according RG:

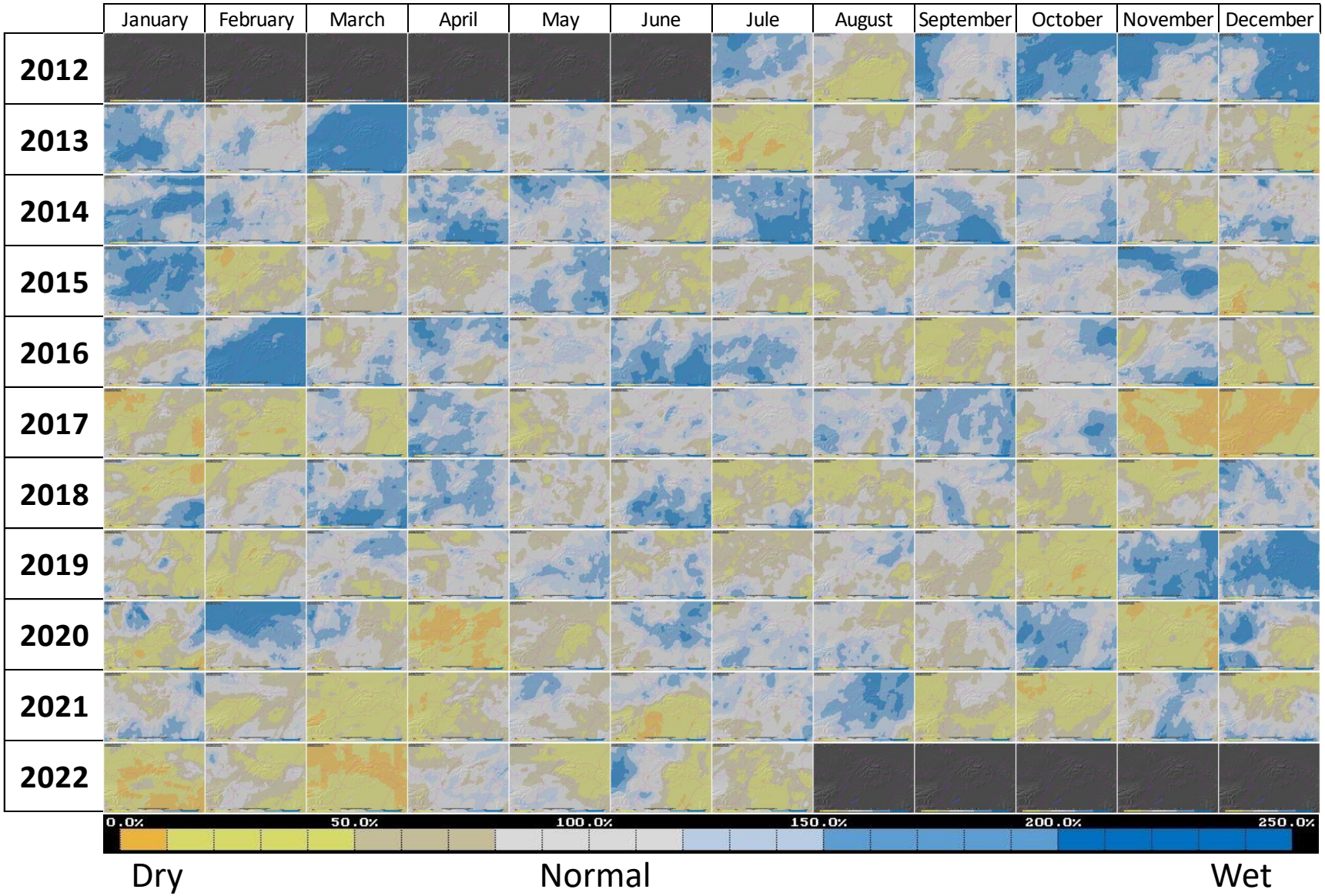
## Absolute differences in [mm/month] of monthly sums

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT



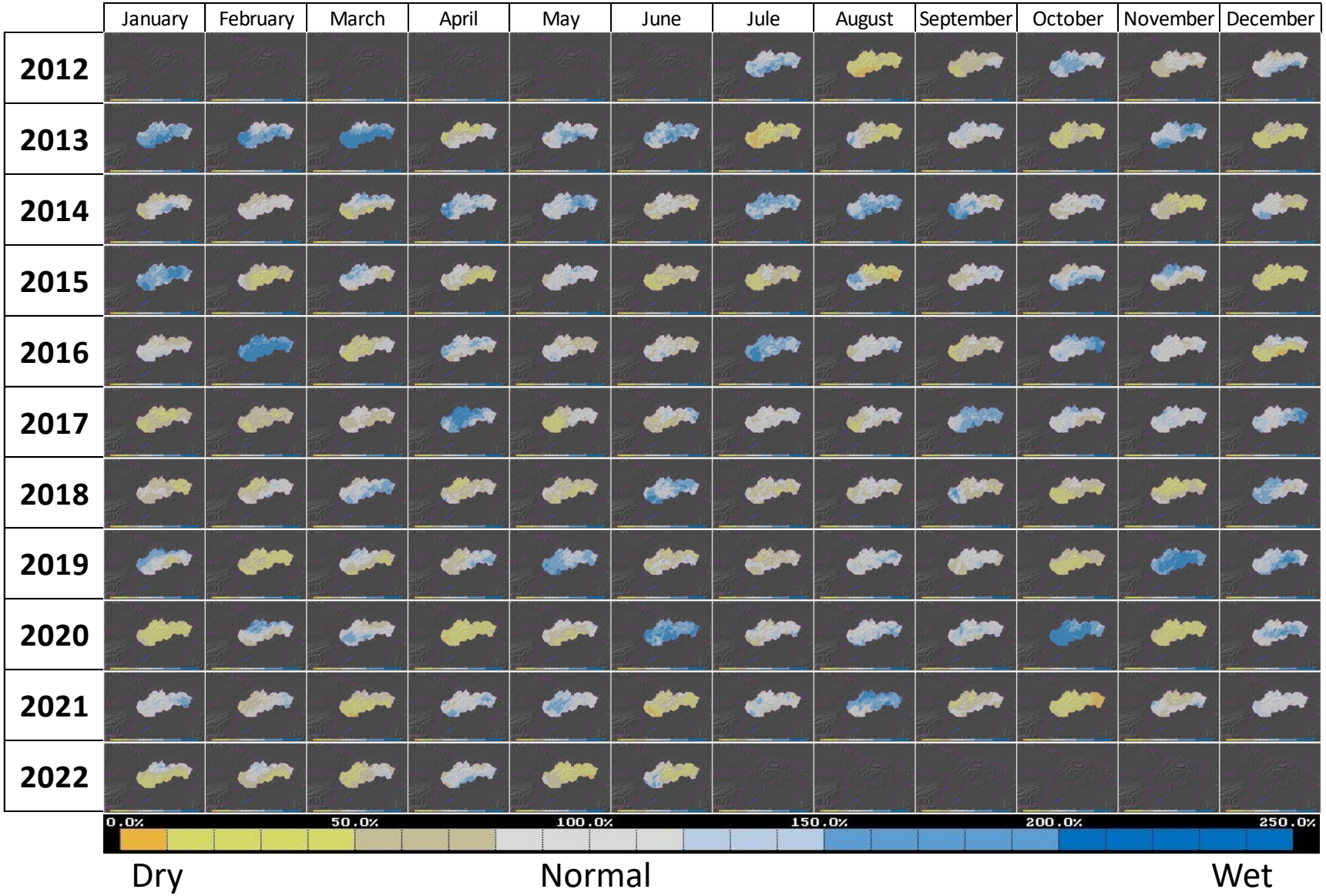
# Monthly precipitation anomalies according H05: Relative differences in [%] of monthly sums

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT



# Monthly precipitation anomalies according RG: Relative differences in [%] of monthly sums

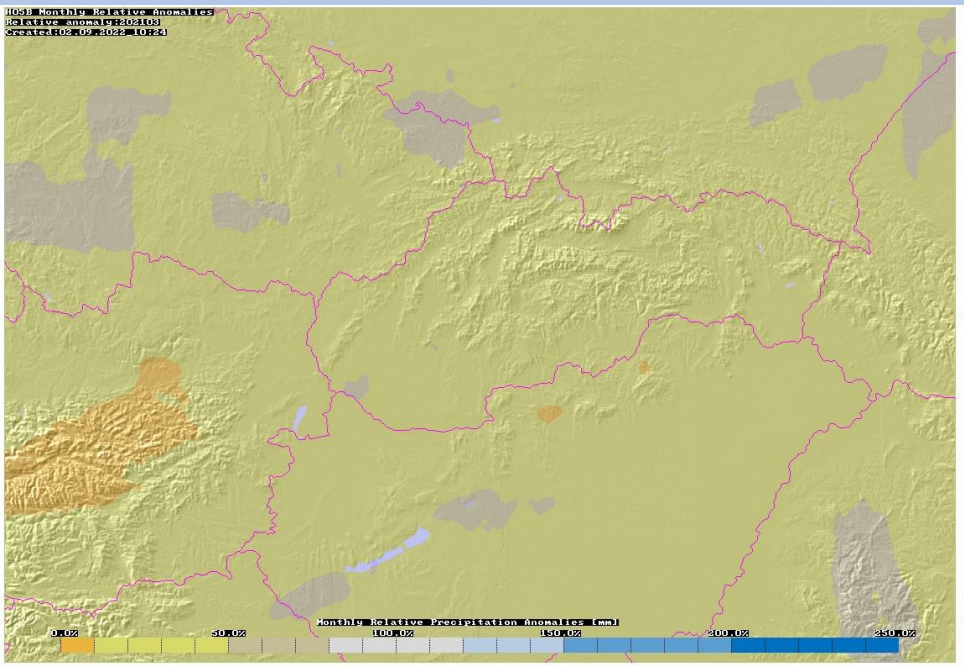
EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT



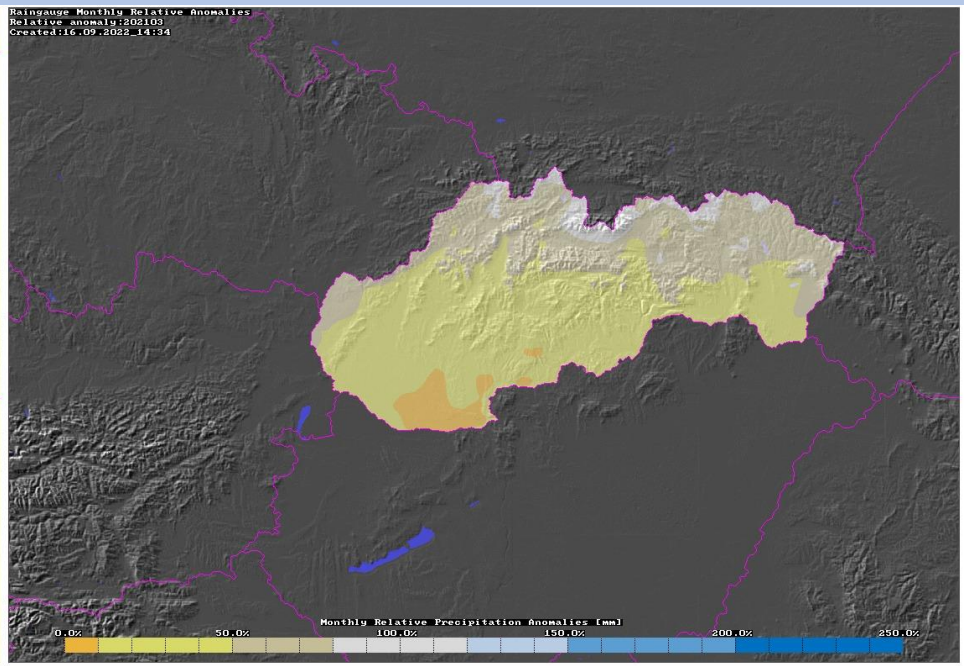
# Comparison of H05 vs RG:
# March 2021 Example of dry month

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:




Results of comparison:

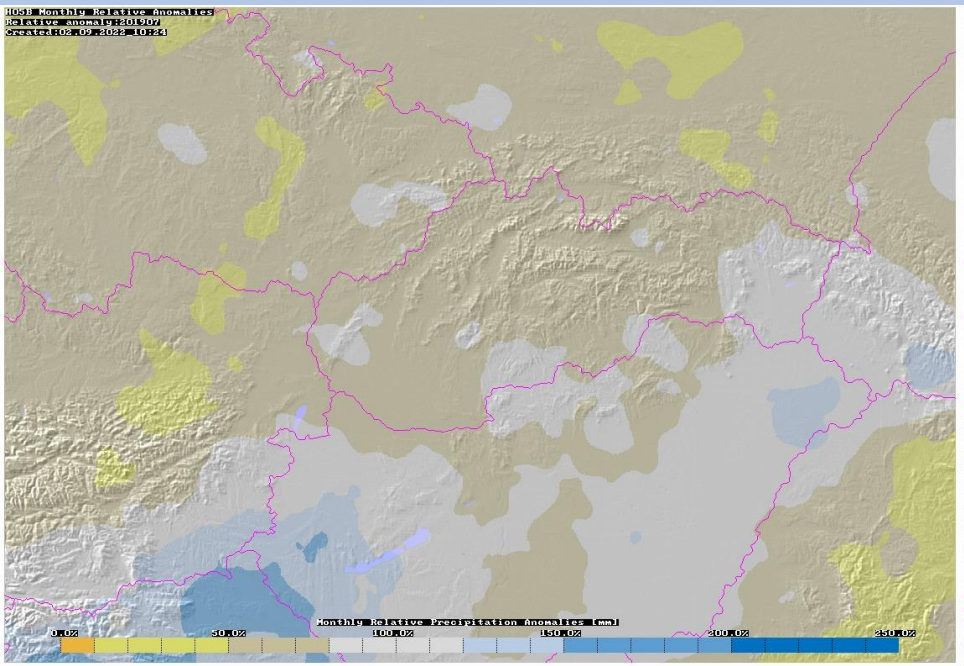
| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 202103 | H05 | 99.4% | 0.6% | 0.0% |
| | RG | 60.5% | 39.5% | 0.0% |

Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

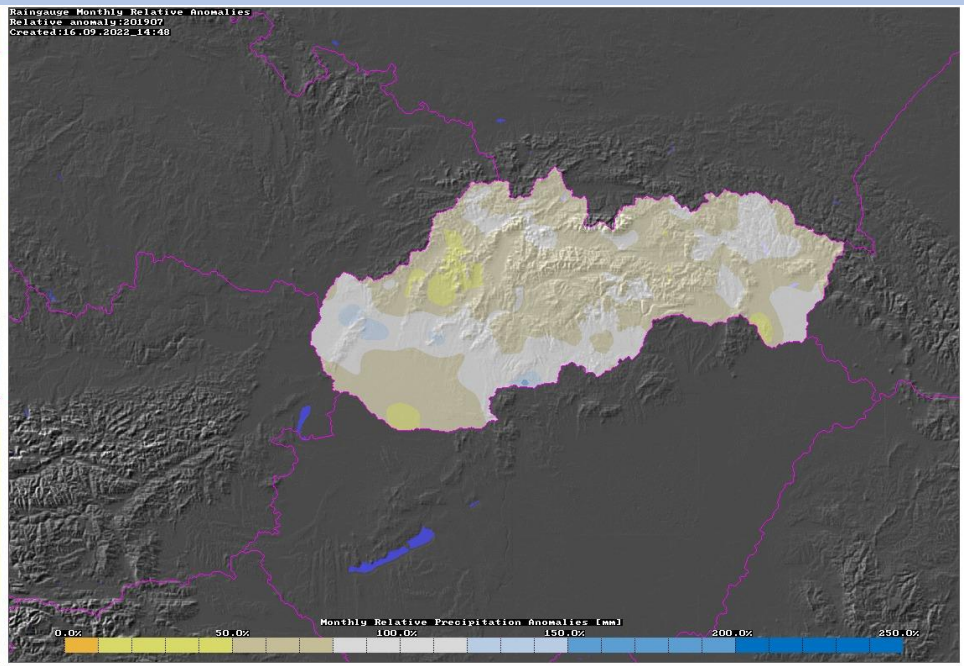
# Comparison of H05 vs RG:
# July 2019 Example of normal month

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:



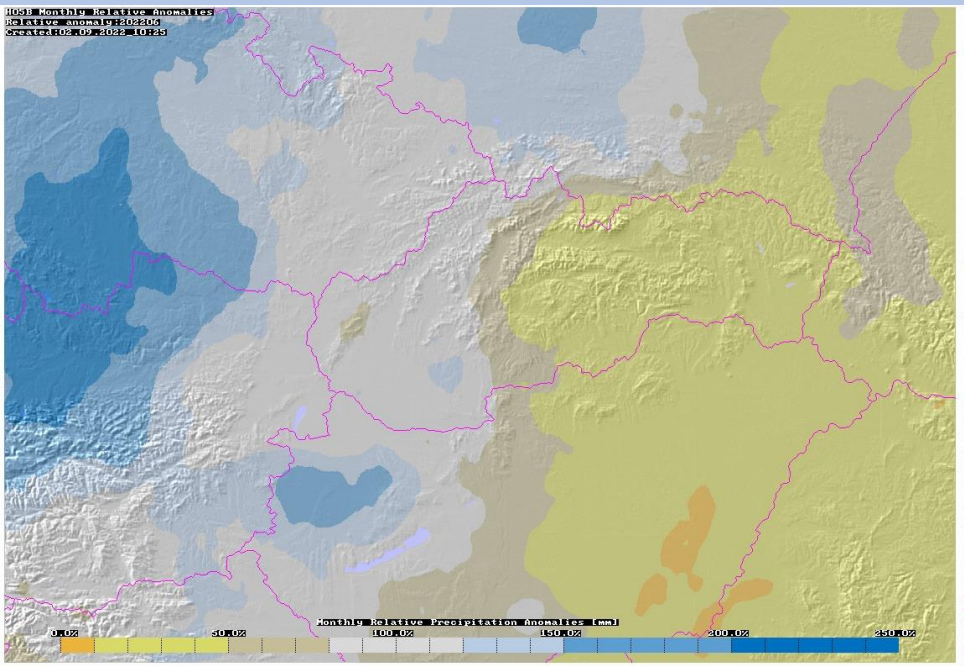

Results of comparison:

| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 201907 | H05 | 0.0% | 100.0% | 0.0% |
| | RG | 4.4% | 95.5% | 0.0% |

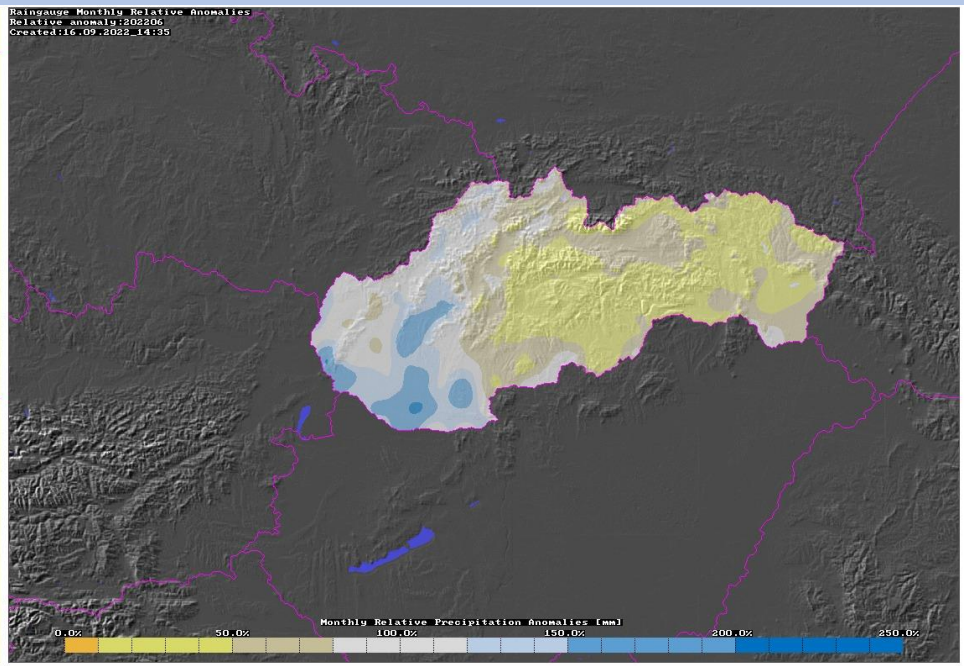
Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

# Comparison of H05 vs RG:
# June 2022 Example of dry month
# (normal in west, dry in east Slovakia

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:




Results of comparison:

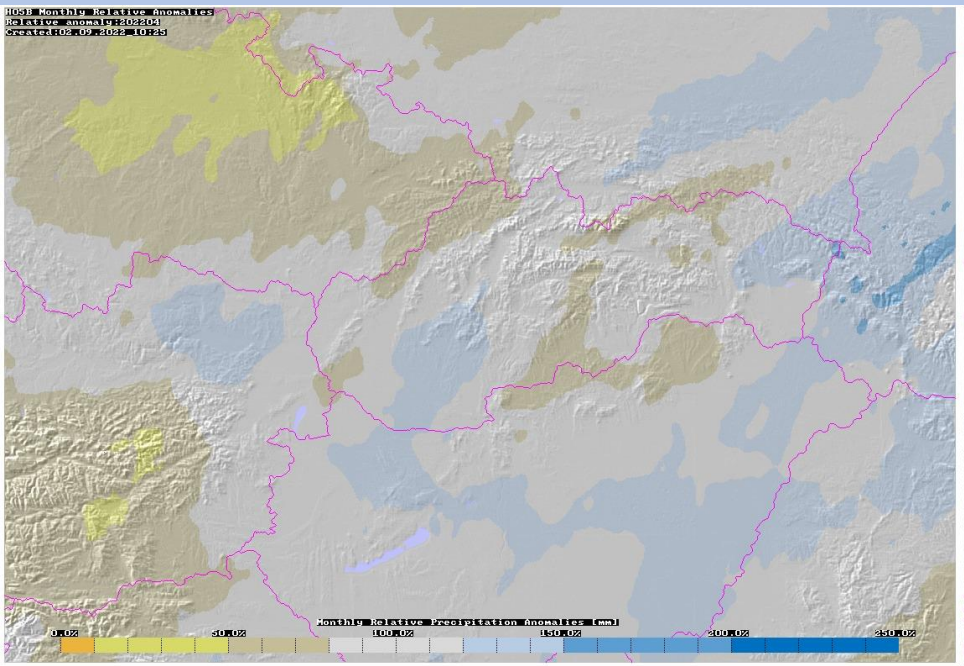
| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 202206 | H05 | 50.2% | 49.8% | 0.0% |
| | RG | 74.9% | 25.1% | 0.0% |

Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

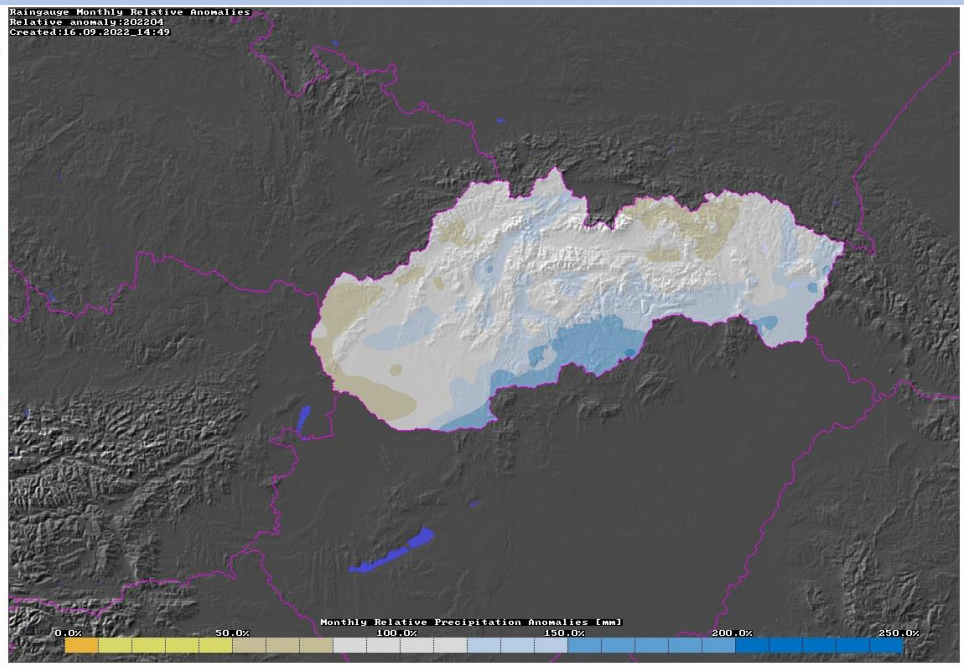
# Comparison of H05 vs RG:
# April 2022 Example of normal month

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:




Results of comparison:

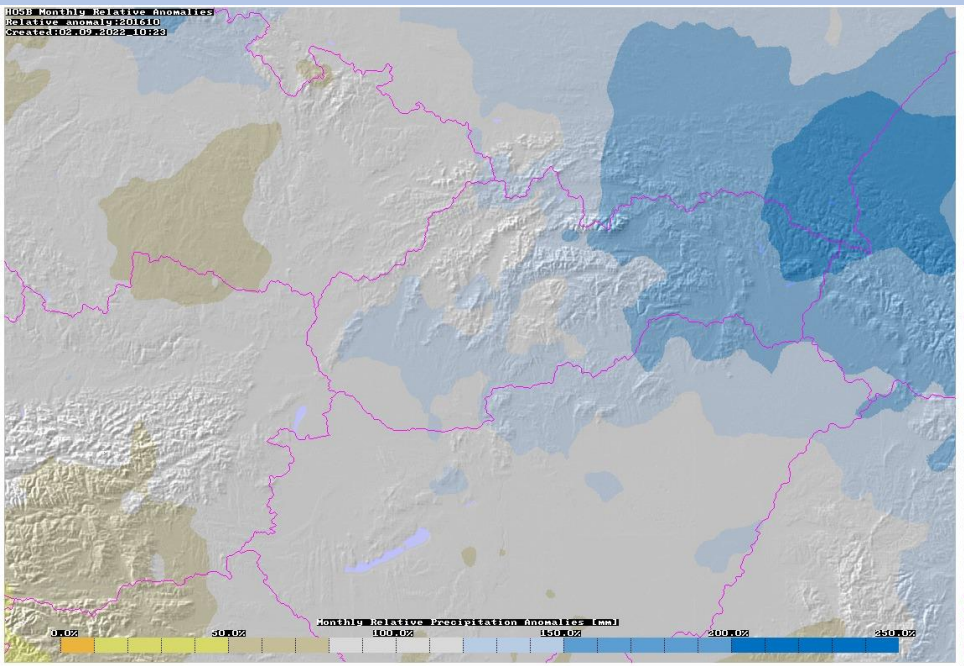
| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 202204 | H05 | 0.0% | 99.9% | 0.1% |
| | RG | 0.0% | 92.1% | 7.9% |

Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

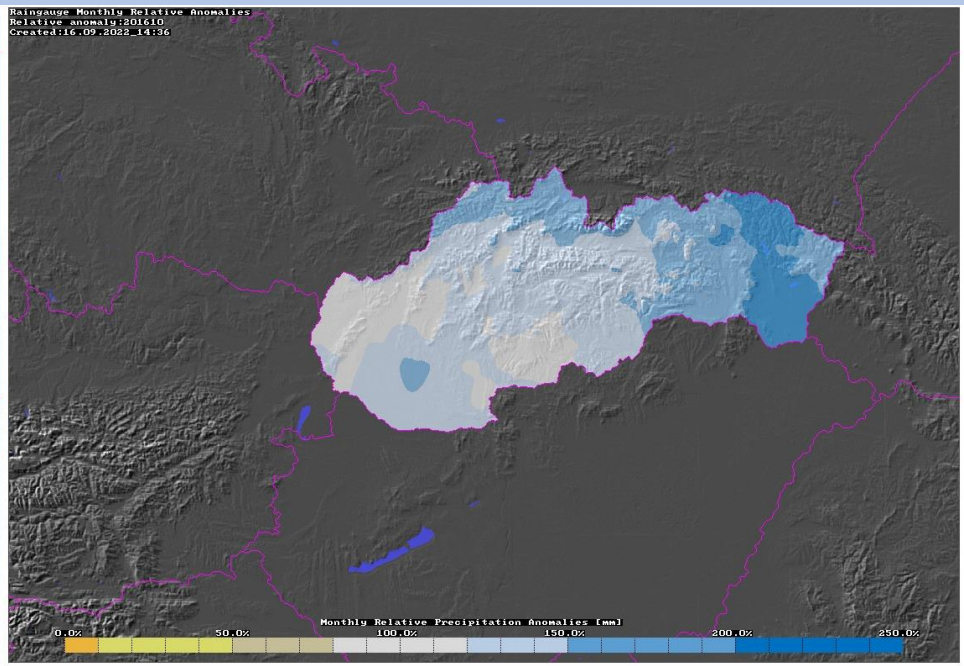
# Comparison of H05 vs RG:
# October 2016 Example of wet month

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:




Results of comparison:

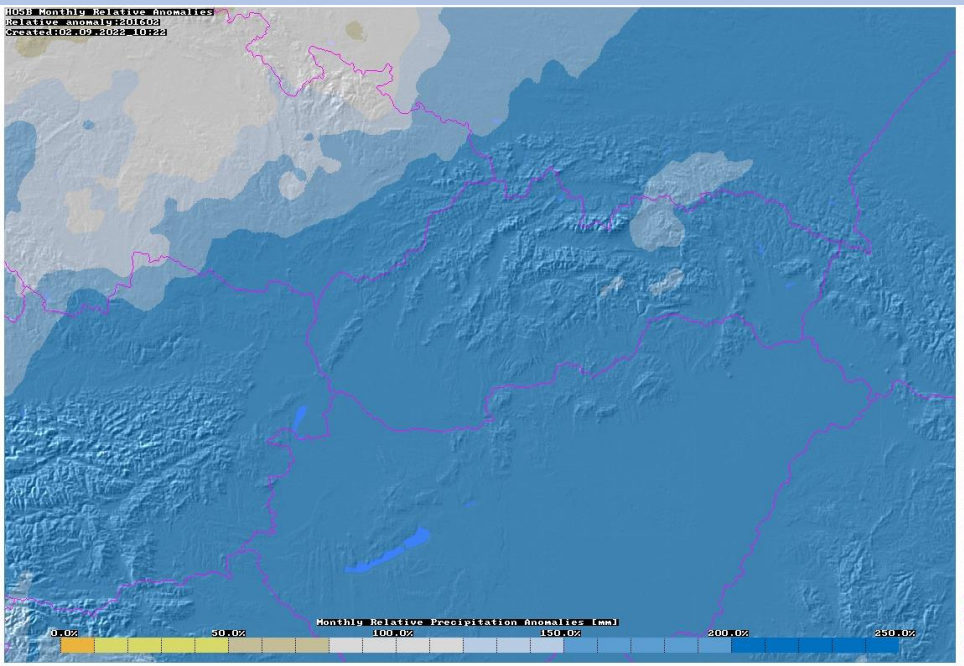
| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 201610 | H05 | 0.0% | 68.9% | 31.1% |
| | RG | 0.0% | 63.8% | 36.2% |

Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

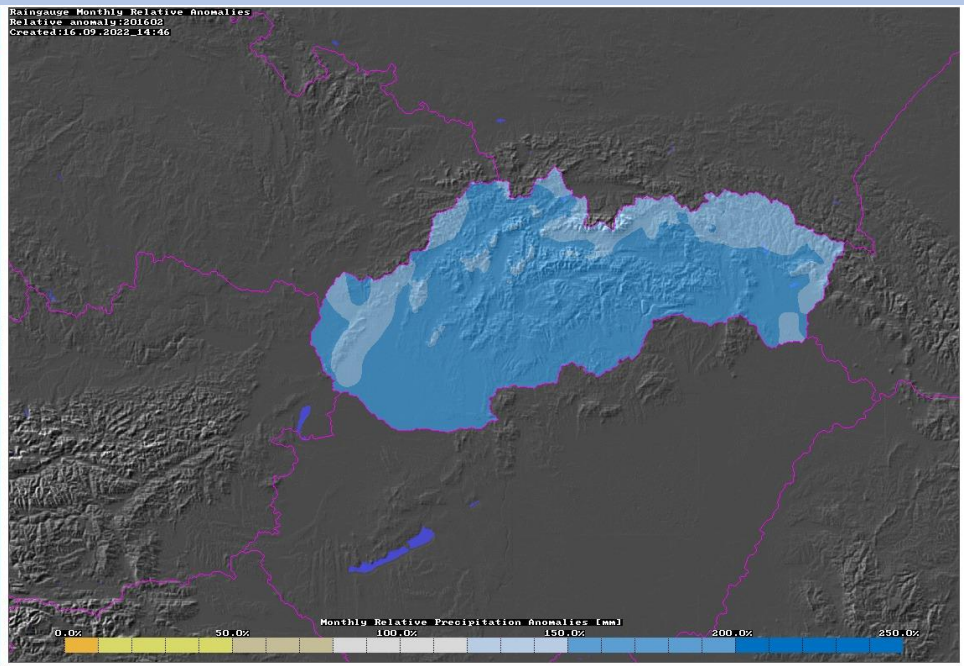
# Comparison of H05 vs RG:
# February 2016 Example of wet month

EUMETSAT H SAF
SUPPORT TO OPERATIONAL HYDROLOGY AND WATER MANAGEMENT

Anomalies derived from H05 product:




Anomalies derived from Raingauge network:




Results of comparison:

| Month | Source | DRY | NORMAL | WET |
|---|---|---|---|---|
| 201602 | H05 | 0.0% | 0.0% | 100.0% |
| | RG | 0.0% | 0.0% | 100.0% |

Table shows the percentage of DRY, NORMAL and WET pixels over Slovak territory

# Evaluation of dry/normal/wet months in 2012-2022 period

Evaluation according H05 processed data:

| Month/Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | nodata | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 |
| February | nodata | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 3 | 2 | 1 |
| March | nodata | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| April | nodata | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 1 | 2 | 2 |
| May | nodata | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| June | | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 1 | 1 |
| July | 3 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| August | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | nodata |
| September | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | nodata |
| October | 3 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 3 | 1 | nodata |
| November | 2 | 2 | 2 | 3 | 2 | 1 | 1 | 3 | 1 | 2 | nodata |
| December | 3 | 1 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 2 | nodata |

Legend:

| | | |
|---|---|---|
| DRY | 1 | 0 to 50% |
| NORMAL | 2 | 50 to 150% |
| WET | 3 | Above 150% |

Table shows DRY, NORMAL or WET rain character according H05 data for each month in 2012-2022 period.

# Evaluation of dry/normal/wet months in 2012-2022 period

Evaluation according RAINGAUGE processed data:

| Month/Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | nodata | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| February | nodata | 3 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 | 2 |
| March | nodata | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 2 |
| April | nodata | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 2 |
| May | nodata | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 1 |
| June | nodata | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 1 | 2 |
| July | 2 | 1 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | nodata |
| August | 1 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | 3 | nodata |
| September | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | nodata |
| October | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | nodata |
| November | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 1 | 2 | nodata |
| December | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | nodata |

Legend:

| | | |
|---|---|---|
| DRY | 1 | 0 to 50% |
| NORMAL | 2 | 50 to 150% |
| WET | 3 | Above 150% |

Table shows DRY, NORMAL or WET rain character according RG data for each month in 2012-2022 period.

# Evaluation of differences between H05 and RG for each month in 2012-2022 period

Comparison table for H05 versus RG estimation of rain characteristics:

| Month/Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| January | nodata | 0 | 1 | 0 | 0 | 0 | -1 | 0 | 1 | 0 | 0 |
| February | nodata | -1 | 0 | 0 | 0 | -1 | 0 | 0 | 1 | 0 | -1 |
| March | nodata | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -1 |
| April | nodata | 0 | 0 | 0 | 0 | -1 | 1 | 0 | 0 | 0 | 0 |
| May | nodata | 0 | 0 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 |
| June | nodata | -1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | -1 |
| July | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | nodata |
| August | 0 | 0 | -1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | nodata |
| September | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | nodata |
| October | 1 | 1 | 0 | 0 | 0 | 0 | -1 | 0 | 0 | 0 | nodata |
| November | 0 | 0 | 0 | 1 | 0 | -1 | 0 | 0 | 0 | 0 | nodata |
| December | 1 | 0 | 0 | 1 | 1 | -1 | 0 | 1 | 0 | 0 | nodata |

Legend:

| | |
|---|---|
| Under estimation | -1 |
| Agreement | 0 |
| Overestimation | 1 |

**Table shows underestimation (yellow) and overestimation (light red) of rain for H05 against RG measurements for each month in 2012-2022 period.**

# Summary and Conclusions

**From 120 evaluated months we found out**:

- 13 months with underestimated precipitation monthly totals by H05 against RG
- 93 months with agreement of precipitation monthly totals by H05 against RG
- 14 months with overestimated precipitation monthly totals by H05 against RG

While coverage of raingauge data is limited only to the territory of Slovakia, HSAF H05 products cover much bigger areas.

HSAF H05 product can be therefore used to evaluate long-term rain characteristics over non-limited regions in Europe and Africa, if we consider not only European H05A domain, but also H05B (full disk) product coverage.

For regions outside H05A domain we have not data available for 10 years , as production of the product H05B started only from June 2015. Therefore in such case we can calculate maximum 8-years long-term normals until now.
**For future developments during CDOP-4 phase this is promising vision.**