Quality Control and Creation of Grids of Meteorological Variables for the Copernicus Emergency Management Services

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1 Deutscher Wetterdienst

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Background CEMS-MDCC

- Copernicus Emergency Management Services (CEMS)– Meteorological Data Collection Centre (MDCC):
  - Collects near-real time meteorological observations for Europe and neighboring areas
  - Stores them in a data bank
  - Controls the quality of the data
  - Post-processes data (aggregation, minimum/maximum/mean calculation, etc.)
  - Creates tailored analyses for CEMS components EFAS, EDO and EFFIS
- Established in 2003 at JRC Ispra, operated since 2016 by a consortium of KISTERS AG and German Meteorological Service

Real-time Data Provider

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32 currently active data providers

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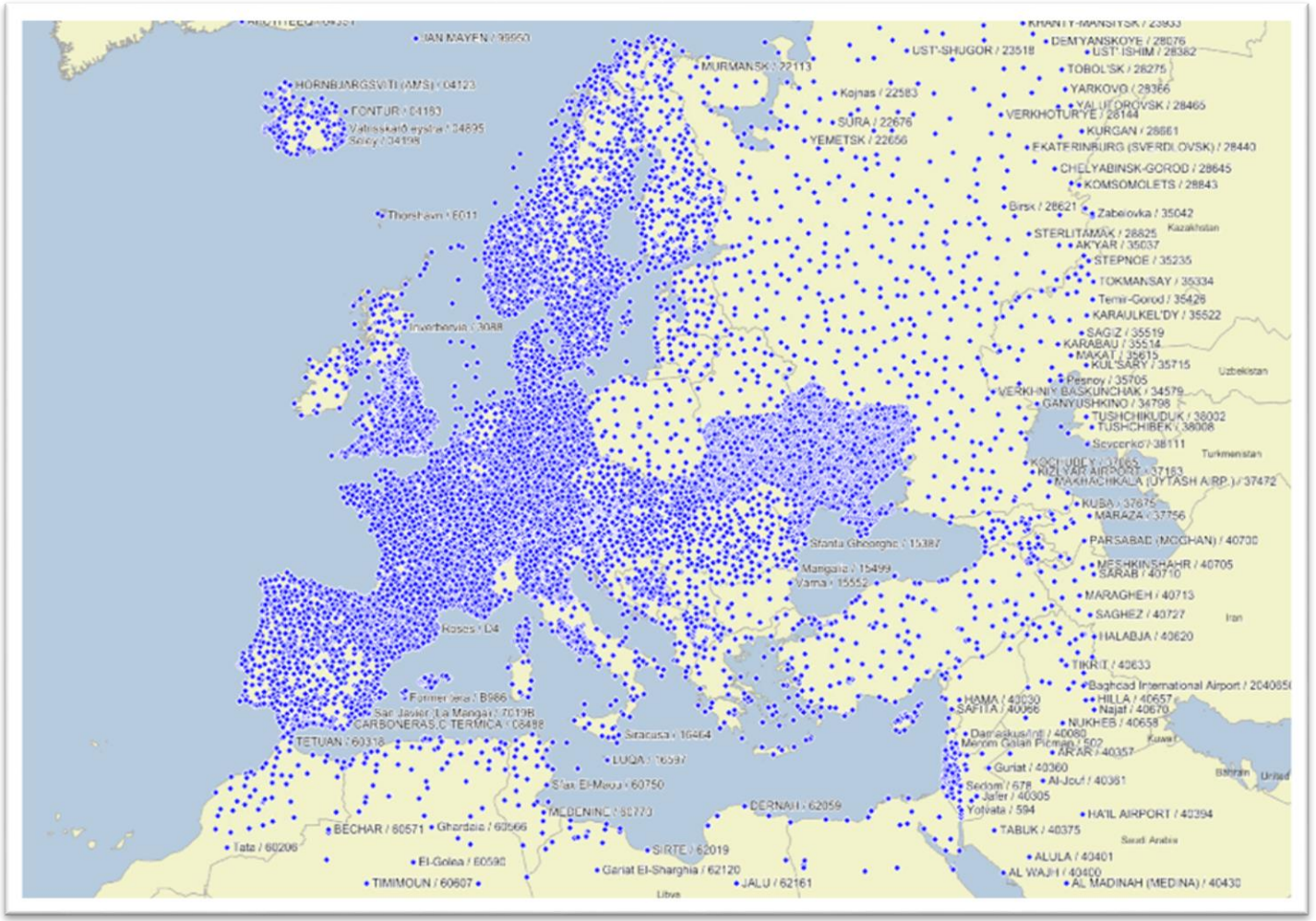
Station Distribution

Active stations in CEMS-MDCC database (EFAS domain)



Number of stations:

- Total: >54.500
- Active: ~22.000
  - thereof 4695 virtual stations
- Inactive: >31.500
  - thereof 9310 virtual stations

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Some numbers

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- > 70,246 stations in database
- > 9,000,000 data records to process each day (to be QC'ed)
- > 1300 GB disc space of database

Parameter description	Active stations in EFAS domain
Precipitation	~ 17300
Relative Air humidity	~ 8600
Solar radiation	~ 5800
Air temperature	~ 16800
Water vapor pressure	~ 4170
Wind speed	~ 13300

Quality Control at the MDCC

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- Data are QC‘ed:
  - When they are imported to the data bank system WISKI (Water Information System KISTERS; agent or synchronous validation)
  - External data validation framework outside WISKI (asynchronous data validation)
  - Defined QC-flags: good, estimated, suspect, rejected, missing
- Synchronous validation:
  - \+ Triggered by the import into WISKI
  - \+ Post-processed data always QC‘ed
  - \- Can only compare with existing data (‚order of import‘ matters)
  - \- No spatial validation possible
  - \- Rely on implemented validation agents
- Asynchronous Validation:
  - \+ Run of QC scheduled by user
  - \+ Applies pre-defined and user-defined rules
  - \+ Applicable for within time series and spatial validation
  - \+ Uses delayed data for comparison
  - \+ Data are extracted from data base and QC-flags written back

Synchronous Data Validation

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- Comparison against thresholds, other time series (parameters), temporal consistency and rate of change
  - Temporal consistency: checks reporting frequency and adds missings in data gaps -> needed to get correct temporal coverage for post-processing
  - Rate of change: detects abrupt changes in time series, e.g. wrong sign in air temperature
  - Cross-validation: Consistency between parameters, e.g. air temperature and dew point temperature
  - Thresholds: checks exceedance of minimum and maximum limits
- Current setting: one threshold for whole EFAS-domain (Northern Africa to Arctic) and no annual cycle (except air temperature)

Synchronous Data Validation

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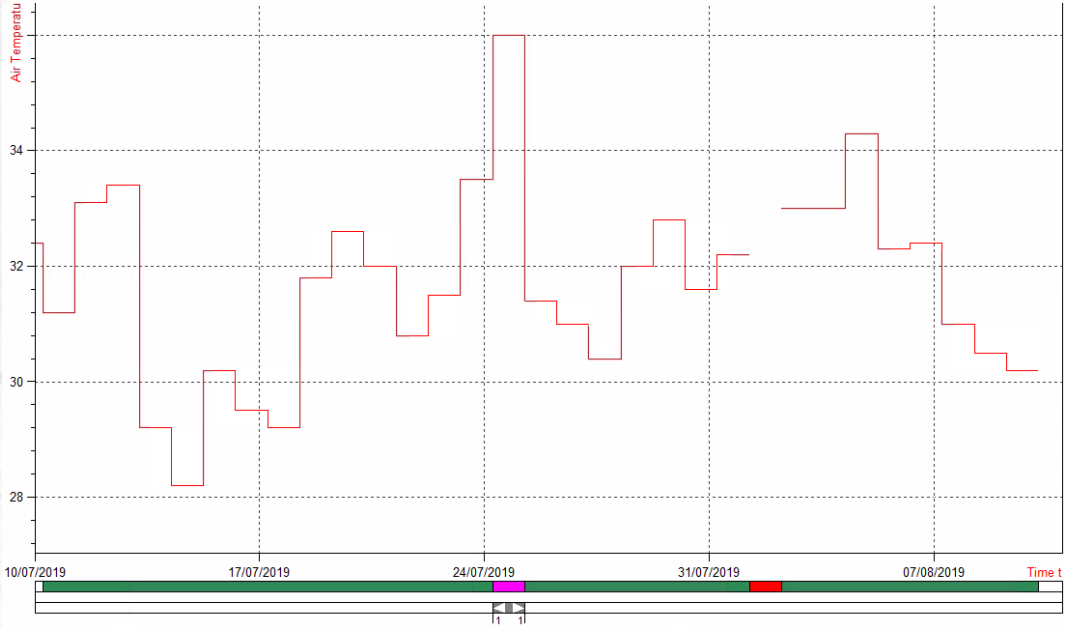
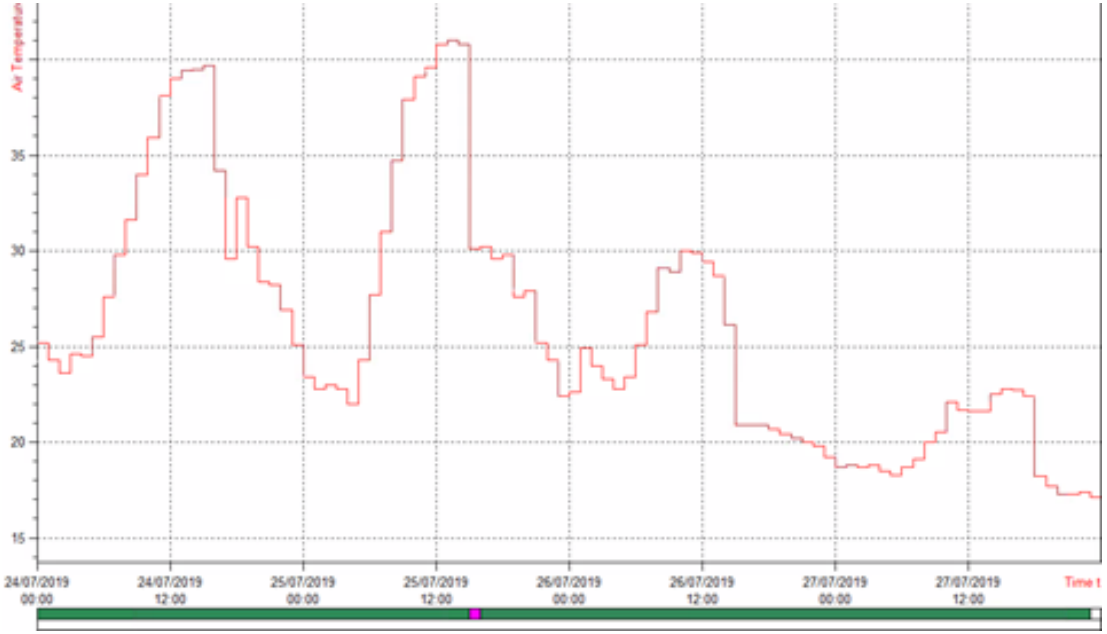
- Real (extreme) values can be outside the thresholds:



Minimum temperature above threshold during heat wave



Value ok, difference to previous due to cold front

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Synchronous Data Validation

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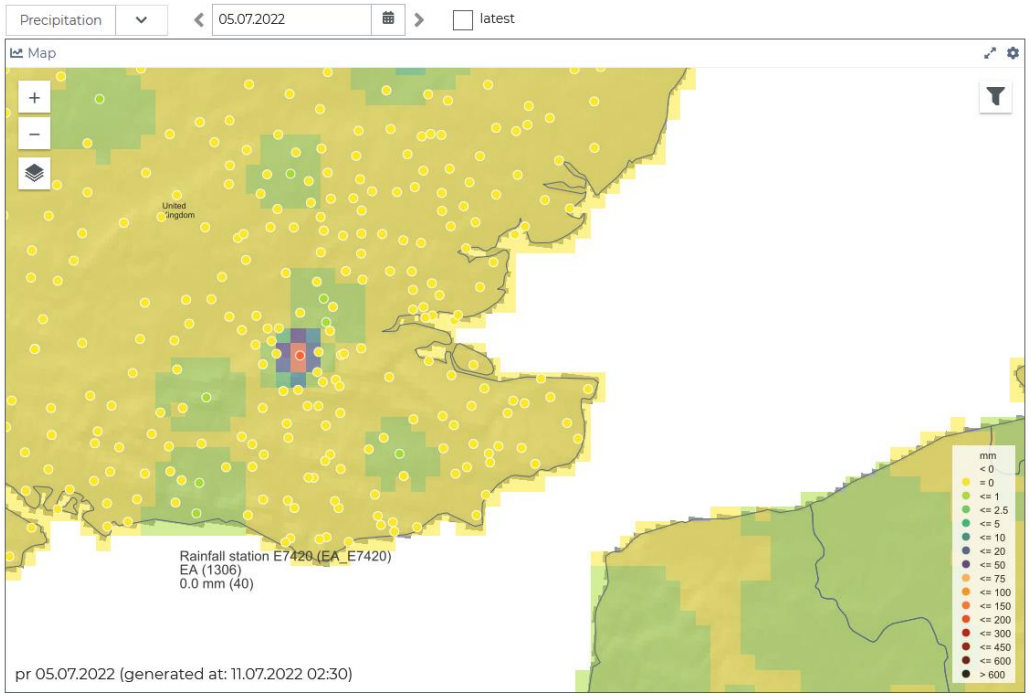
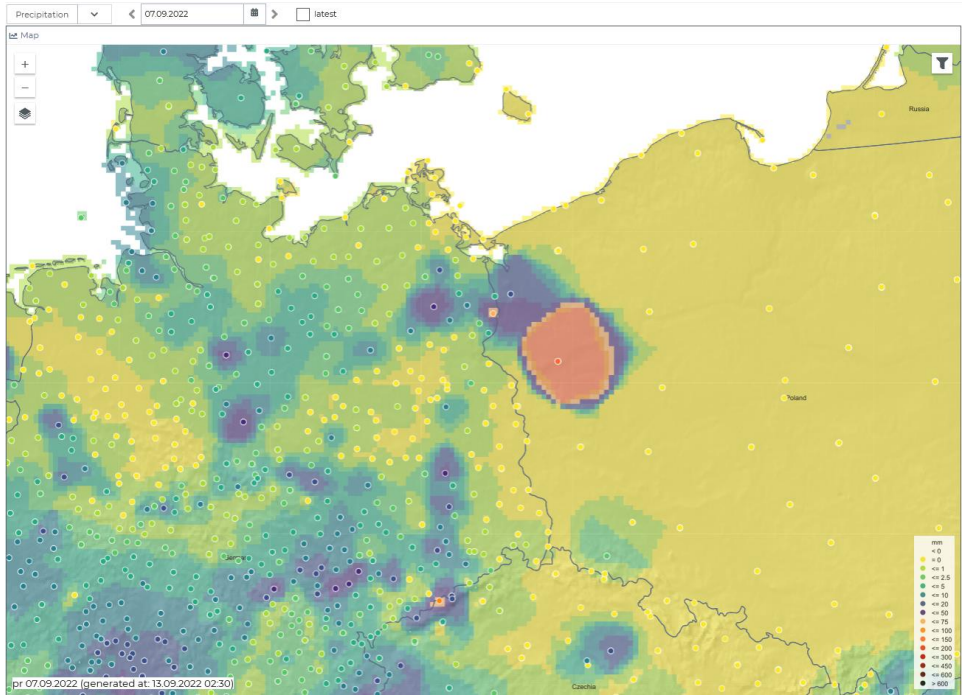
- Erroneous values can be inside the thresholds:
  - not all errors were detected (left), but real extremes have to pass (right)



144 mm for 6 July 2022 in England

Yellow: 0.0 mm

Dark blue: > 50 mm



130 mm for 9 September 2022 in Poland

Orange: > 130 mm

Confirmed by Radar data

Synchronous Data Validation

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- Improvement: define seasonal and geographical thresholds
  - Use existing data in data base to calculate thresholds
  - Group stations by climate zone according to Köppen-Geiger climate classification
  - Calculate various percentiles
  - Visual inspection to define which percentile in which climate zone and offset is applied
- Turned out that this approach is not applicable to all parameters
  - Wind speed: low seasonal and geographical dependency, no improvement with new approach, but adjusted existing threshold (45 m/s -> 50 m/s)
  - Precipitation: too noisy in real extremes for calculation of reliable seasonal thresholds
  - Wind direction and cloud cover have neither a geographical nor a seasonal dependency

Synchronous Data Validation

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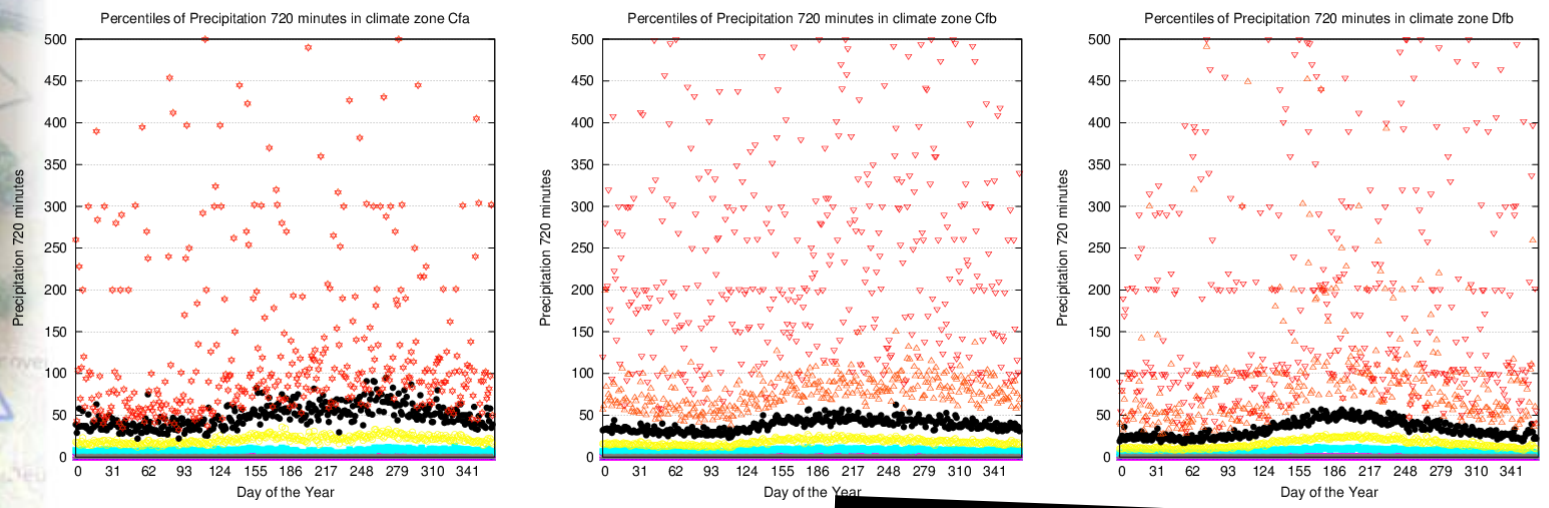
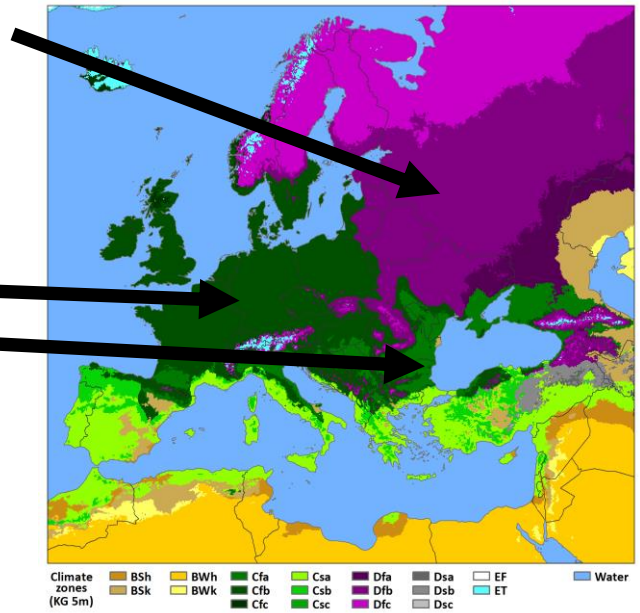
- 12-hourly precipitation data





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Synchronous Data Validation

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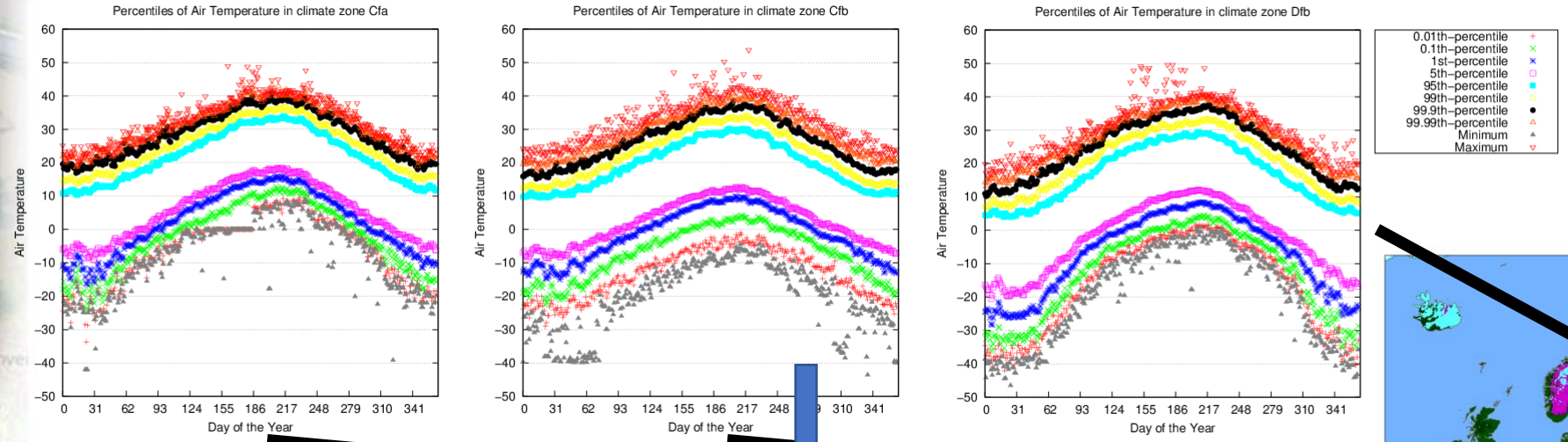
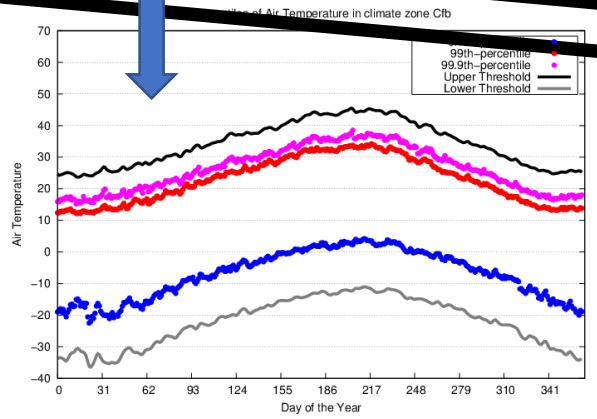
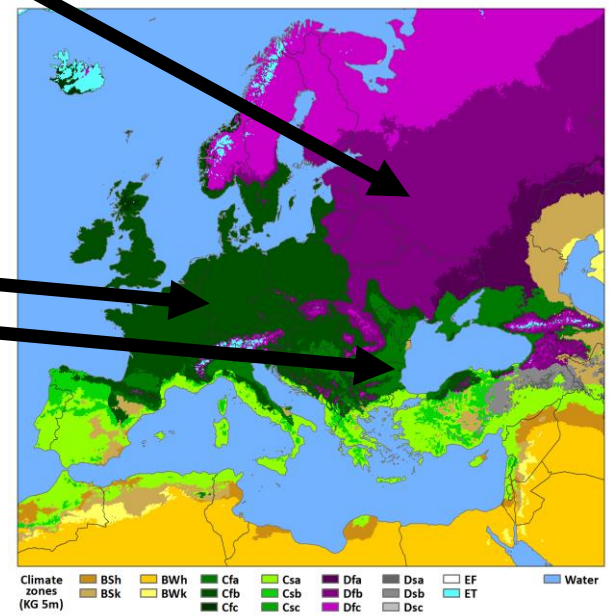
- Air temperature



- Added 7-days low-pass filter
- Upper limit: 99.9% + 5K offset
- Lower limit: 0.1% - 10K offset





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Synchronous Data Validation

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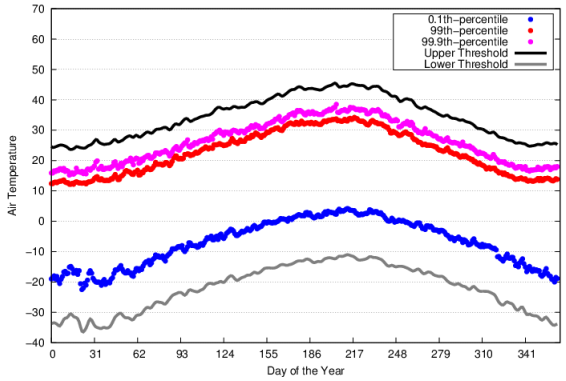
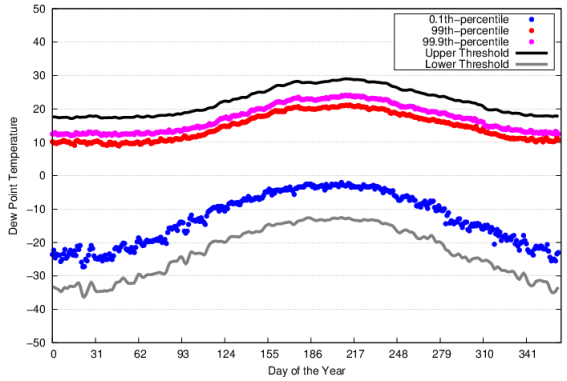
- Expect elimination of more outliers by the seasonal and geographical thresholds (examples for Cfb)

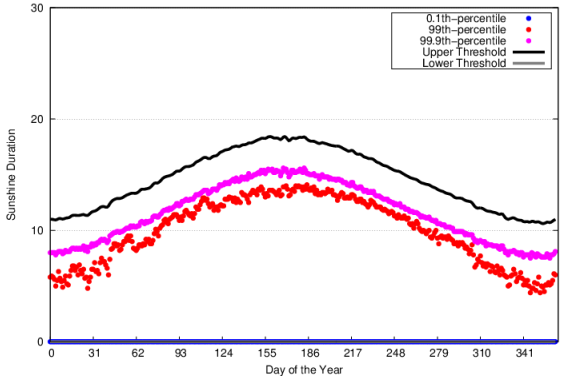
Air temperature



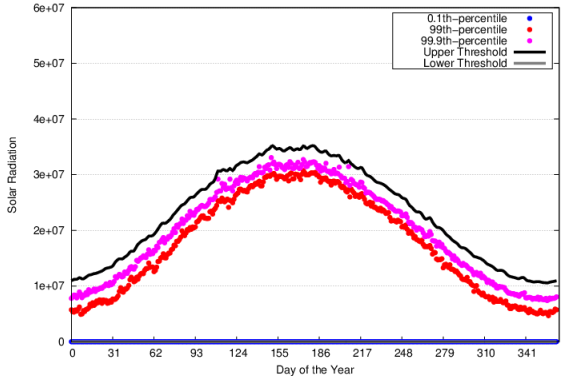
Dew point temperature



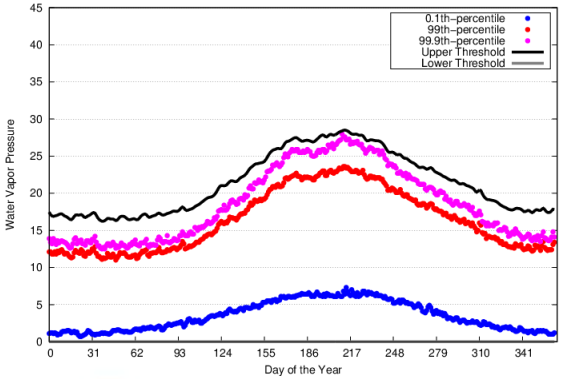
Sunshine duration



Solar radiation



Water vapor pressure



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Asynchronous Data Validation

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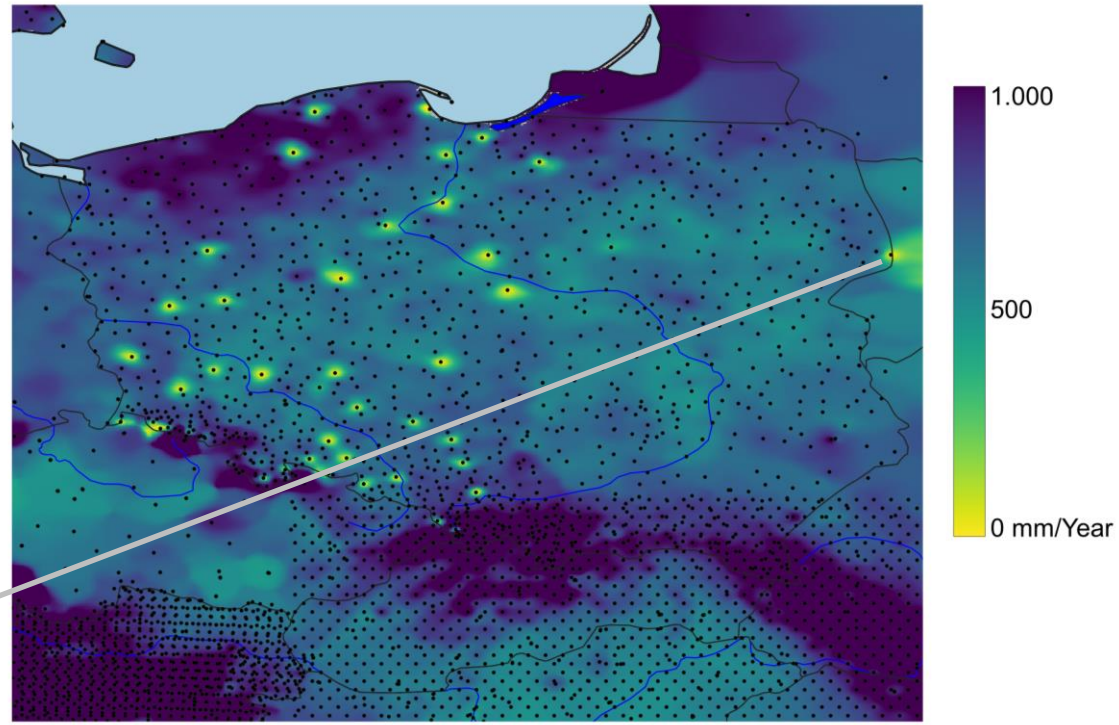
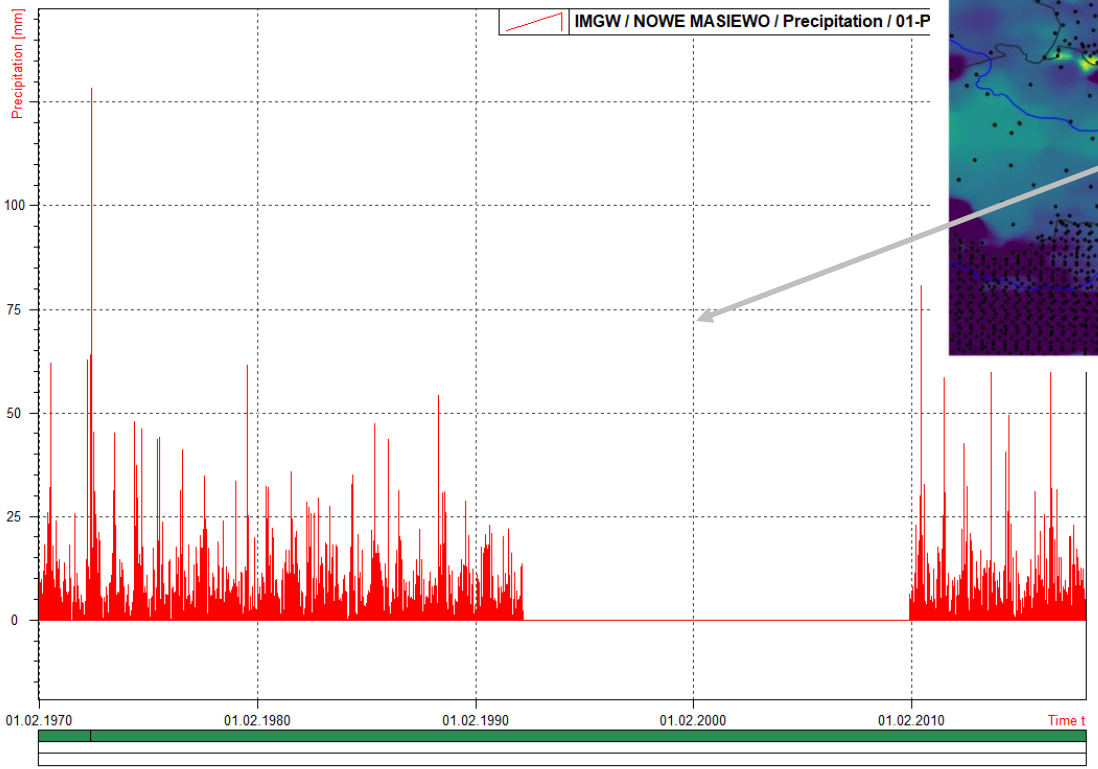
- Many predefined rules available:
  - Flatliner detection (value sequence)
  - Completeness
  - Range
  - Rate of change
  - Spatial comparison / spatial zero comparison
  - As well as user developed rules (Python interface)
- Currently best settings for rules under investigation, e.g. zero precipitation flatliner (missing data were filled with zeros)

Asynchronous Data Validation

Emergency Management

- Use case: flatliner detection





Note: Zeros may have been introduced by mishandling gaps during data preparation - they are unlikely to be in your copy of the record!

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Asynchronous Data Validation

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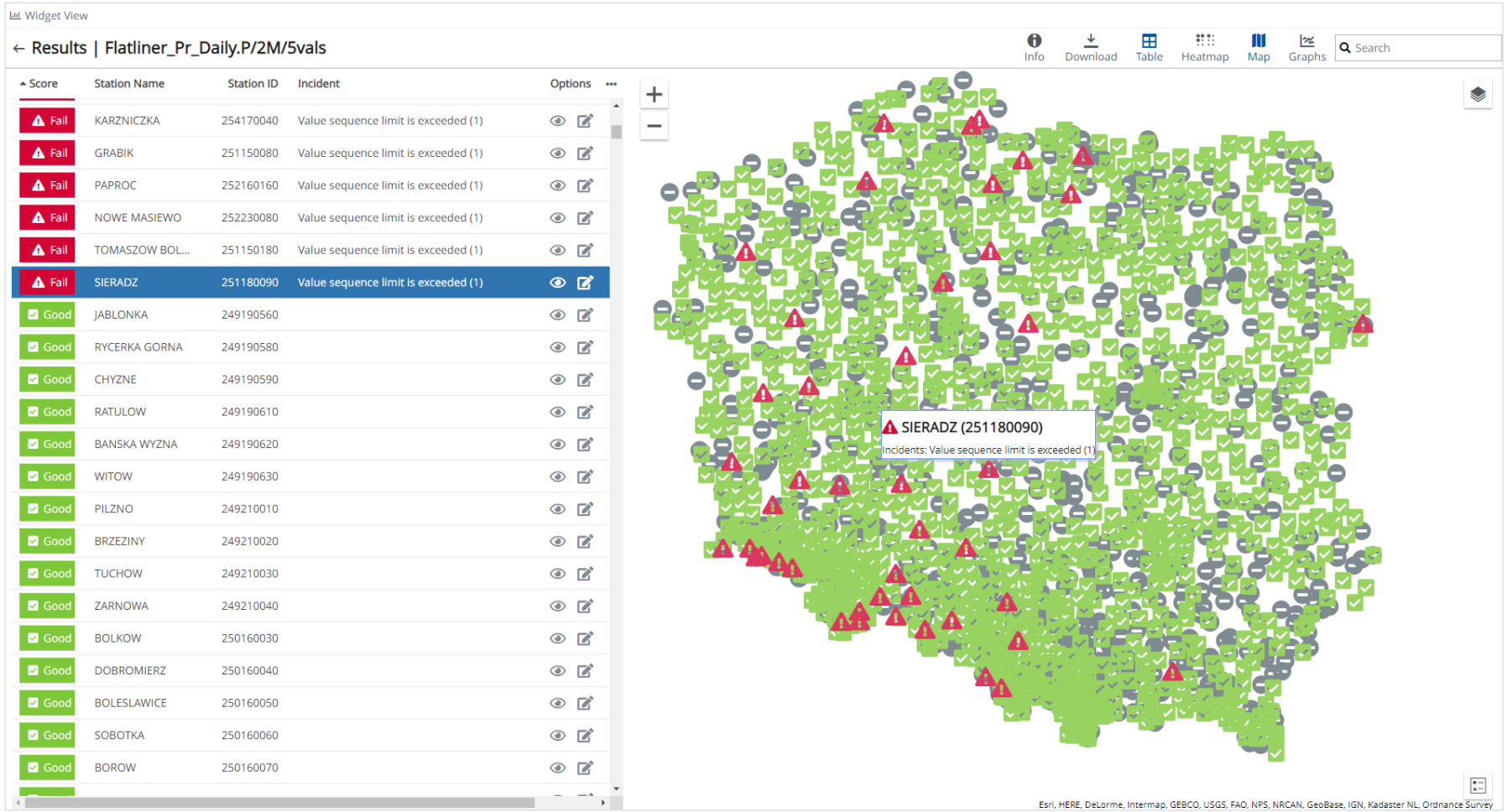
- Use case: flatliner detection



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Asynchronous Data Validation

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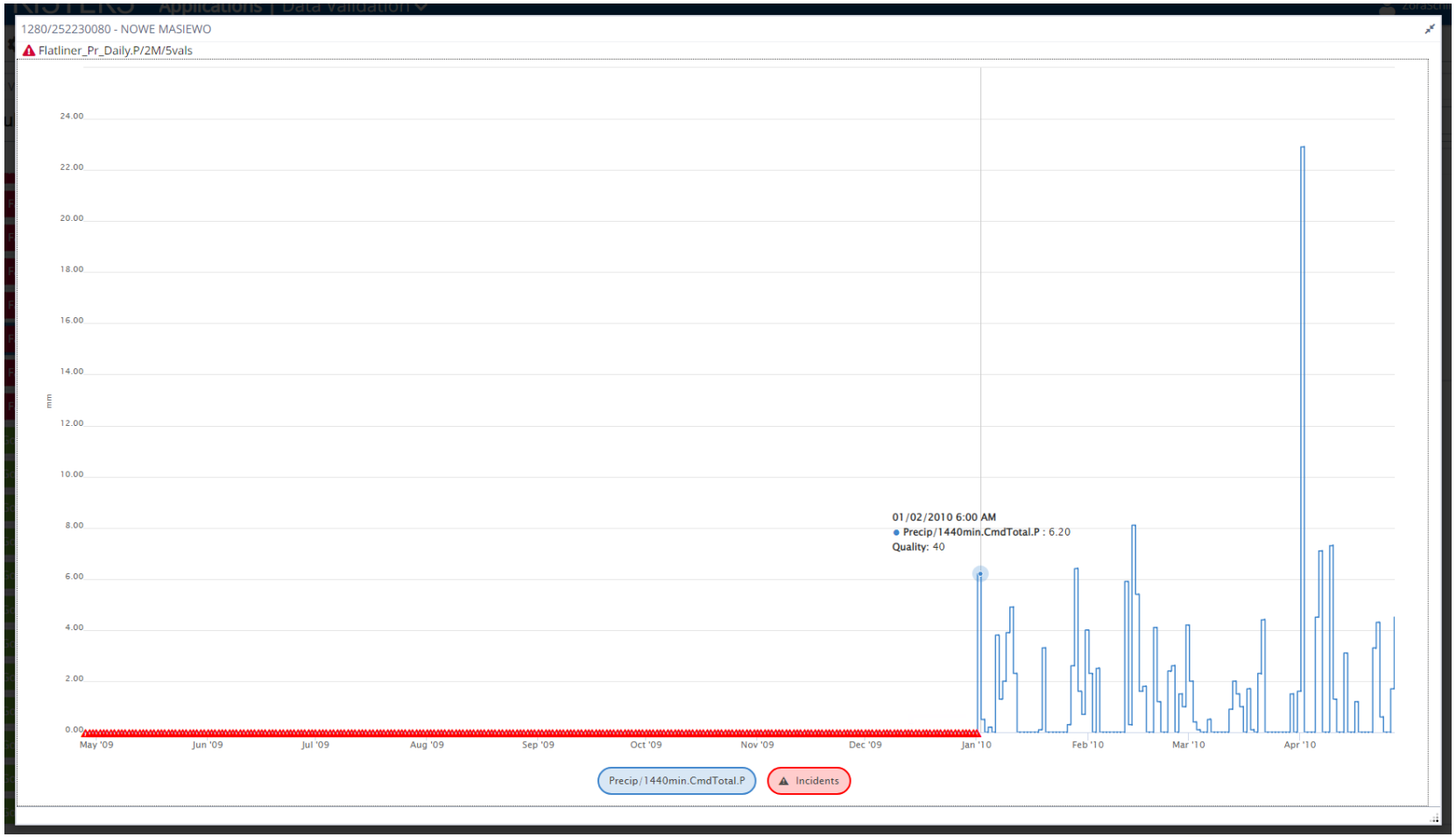
- Use case: flatliner detection



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MDCC Grid Creation

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- Only data with quality good, estimated or suspect are used for gridding
- Gridding by means of a modified SPHEREMAP scheme (4 – 10 station per grid point)
- Calculate an uncertainty estimation for each grid, depending on data availability and variance between input data
- Spatial resolution: 5 x 5 km² (950.000 cells), soon 1 x 1 arcmin² (13.454.100 cells)
- Gridded parameters:
  - Precipitation (6-hourly and daily)
  - Air temperature (6-hourly mean, daily minimum and maximum)
  - Wind speed
  - Solar radiation
  - Water vapour pressure

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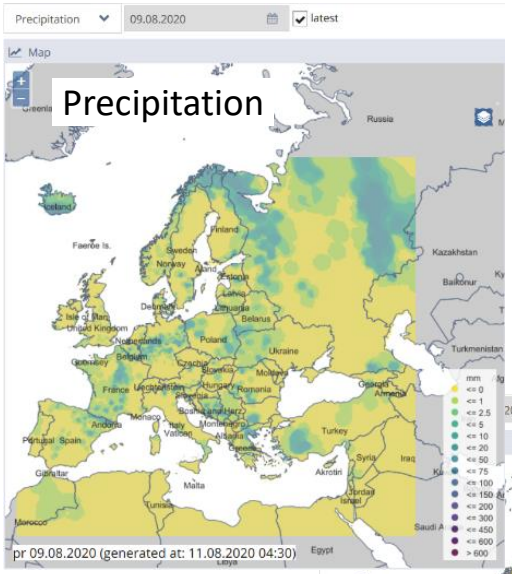
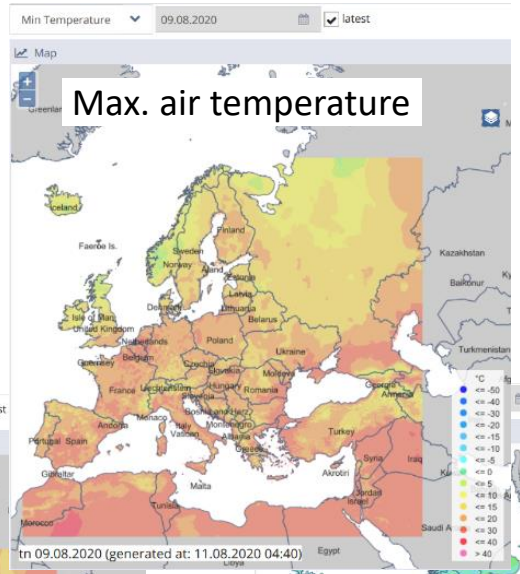
Interpolated grids for LISFLOOD model

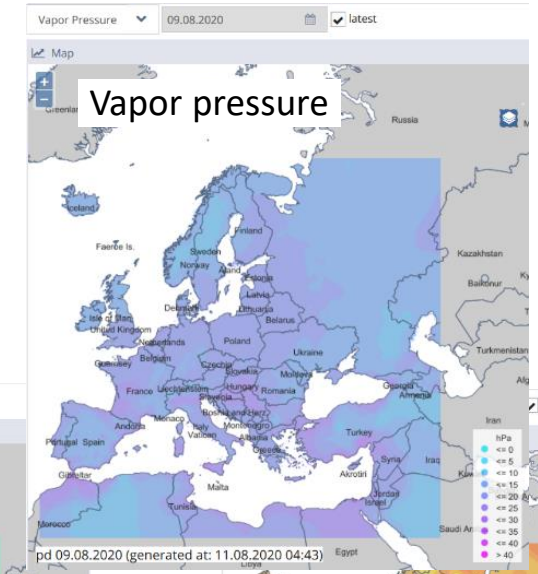
- Daily grids produced by CEMS-MDCC



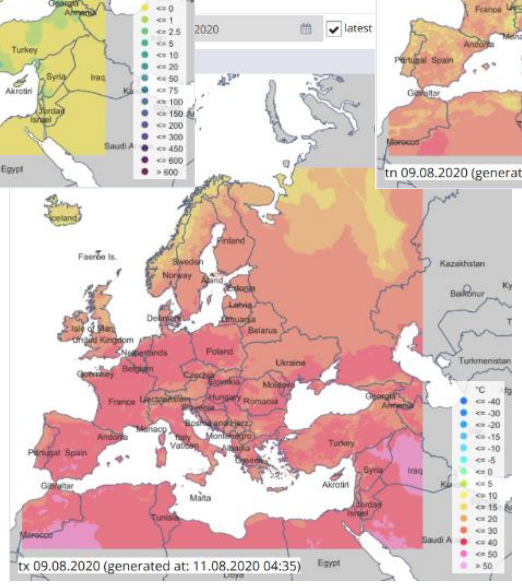
Precipitation



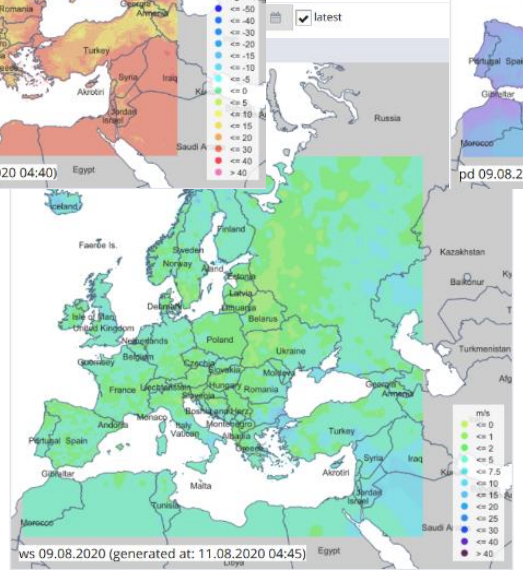
Max. air temperature



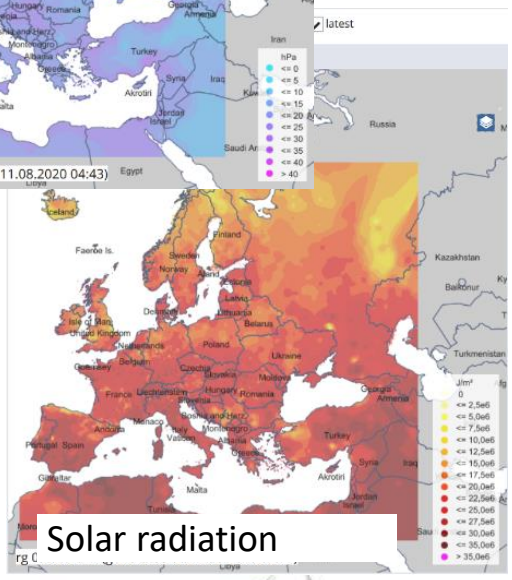
Vapor pressure



Min. air temperature



Wind speed



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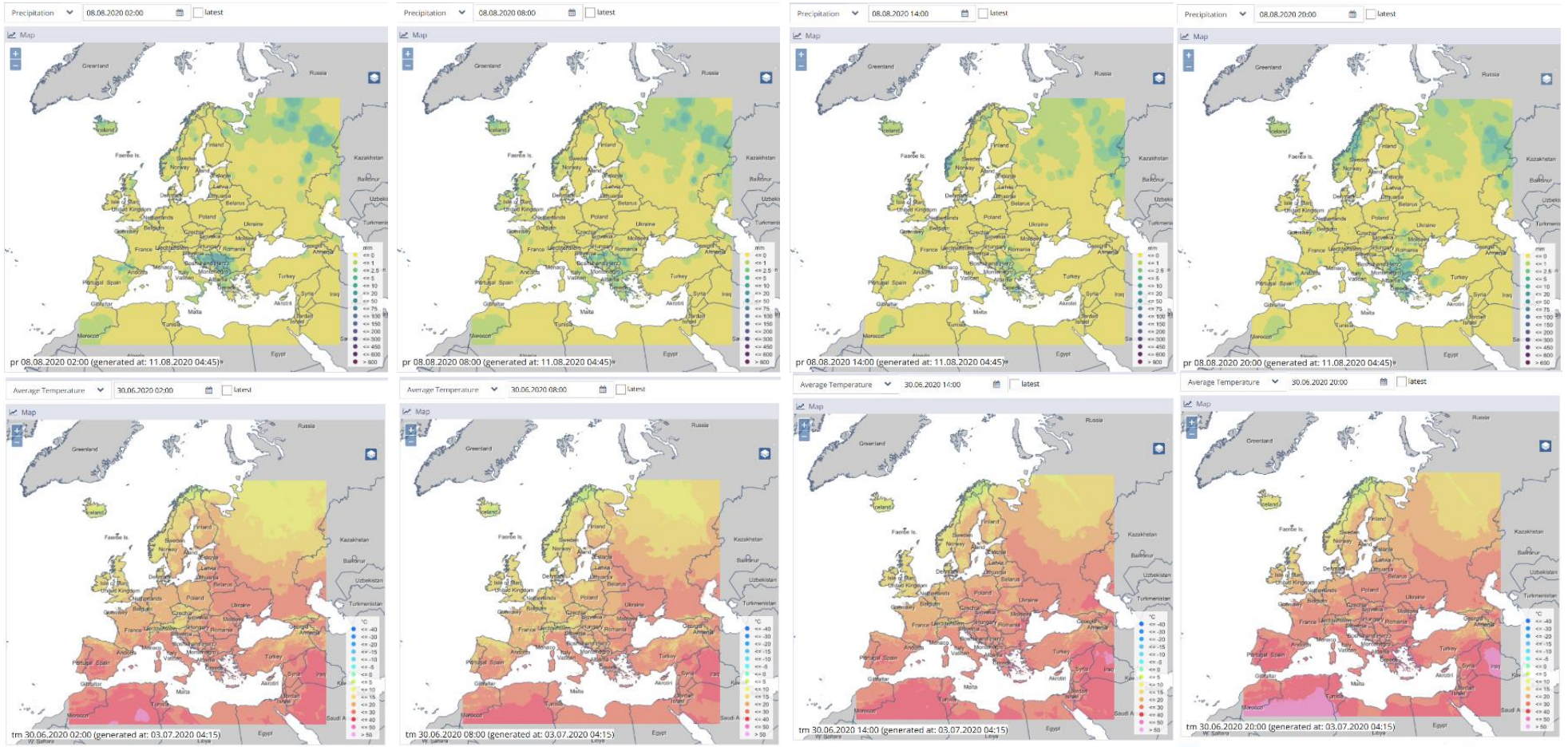
Interpolated grids for LISFLOOD model

- 6-hourly precipitation and average temperature grids produced by CEMS-MDCC



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Additional MDCC Products

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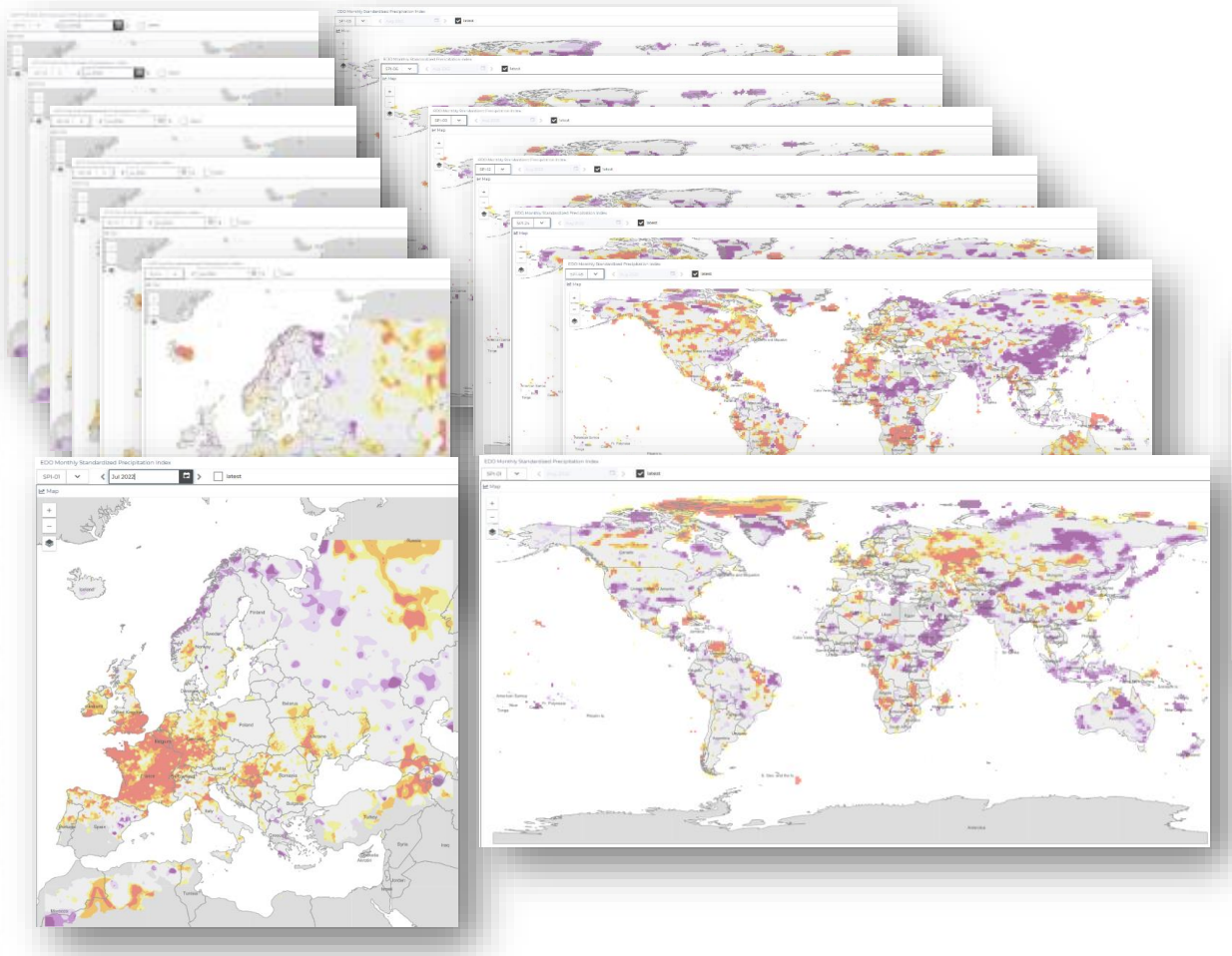
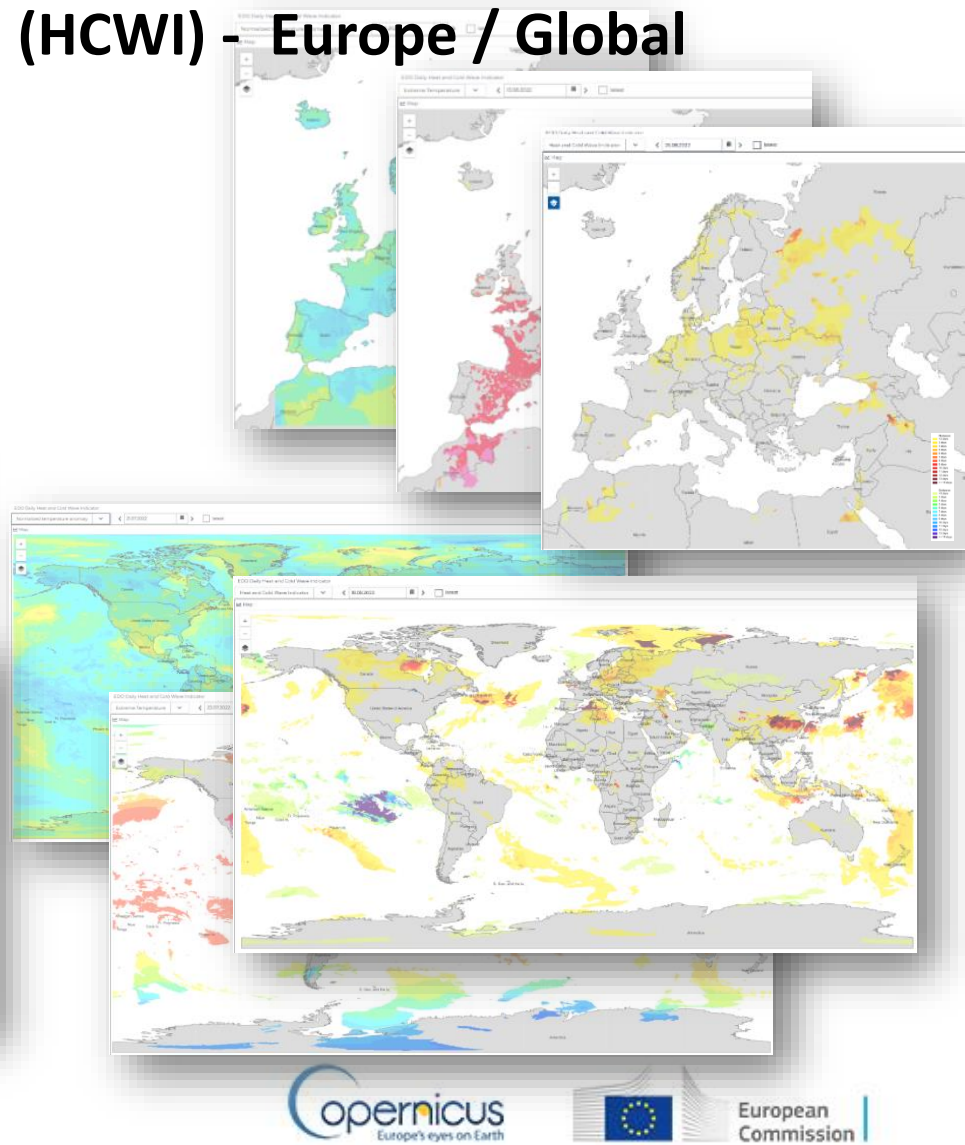
Standardized Precipitation Index (SPI) - Europe / Global



Heat and Cold Wave Indicator (HCWI) - Europe / Global



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How to contribute to CEMS-MDCC?

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Meteorological station data

- As many parameters as possible:
  - **Precipitation**
  - **Relative humidity**
  - **Solar radiation**
  - **Temperature (including min/max)**
  - **Water vapour pressure**
  - **Wind speed**
  - Cloud cover
  - Dew-point temperature
  - Evaporation
  - Sunshine duration
  - Wind direction
- Time-period: near real-time but also historic data from 1 January 1970 to present (if available)
- Time-resolution: at least 6-hourly, if possible hourly or better
- **Station metadata**: number/ID, name, coordinates, elevation, instrument type (optional)
- Usage in accordance to EUMETNET-Copernicus data license

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Contact details

Email: efas.mdcc@dwd.de

Markus Ziese (CEMS-MDCC/DWD), phone: +49 69 8062 2973

For questions in relation to the data license:

Peter Salamon (JRC Ispra), phone: +39 0332786013,

email: peter.salamon@ec.europa.eu

We are looking forward to work with you and your data!

Further Information

- LISFLOOD (hydrological model):
  - https://github.com/ec-jrc/lisflood-code

- Gridded data:
  - https://data.jrc.ec.europa.eu/dataset/0bd84be4-cec8-4180-97a6-8b3adaac4d26#dataaccess


Preparedness
Response
Recovery
Rapid Mapping
Risk & Recovery Mapping
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Fires
Droughts
Population
Built-up areas