Release Notes for Version 7 of the WegenerNet Processing System (WPS Level-2 data v7)

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Contents

1 Version Details

This document describes major changes and new features for version 7.9 of the WegenerNet Processing System (WPS), producing Level-1 data version 5 and Level-2 data version 7.

WPS Version:

7.9.7 released March 22, 2018

Update to 7.9.7.r2 on Sep. 12, 2018: Rounded coverage factors of wind spike check to .5 and improved description of this check (Chapter 3.1.1)

Level-1 Data Version:

5

Level-2 Data Version:

7 (used to assign the general name of the version: WPS v7)

2 Major Changes

2.1 Level-2 Data Quality Indicators

2.1.1 Station Time Series Data

Basis Data

In common with previous versions of the WPS, data quality for Level-2 basis data is indicated by a Data Product Flag (DP-Flag) ranging from 0 to 4 (Table 2.1). Measurements that have passed the Level-1 Quality Control procedure with a Quality-Flag (Q-Flag) of 0 get a DP-Flag of 0, all other data are either temporally or spatially interpolated (Kirchengast et al. 2014, Ebner 2017).

Level-2 basis data have a temporal resolution of 5 minutes for the WegenerNet Feldbach Region (FBR), and 10 minutes for the WegenerNet Johnsbachtal (JBT).

Table 2.1: Data Product Flags for Level-2 basis data and corresponding properties (adapted from Ebner 2017, p. 9).

DP-Flag	Property of parameter value
0	Measured value at station that has passed Level-1 Quality Control
1	Temporally interpolated value
2	Spatially interpolated value (by surrounding stations)
3	Spatially interpolated value (by gridded data)
4	NaN value (no interpolation possible due to lack of data)

Weather and Climate Data

For Weather and Climate data, the DP-Flag's approach and meaning has changed: Instead of a value between 0 and 4 it now gets a percentage value between 0 % and 100 % which represents the flagged percentage of data (FP-of-Data), *FP*.

FP is defined as

a) for continuous data, like temperature and humidity:

$$FP_c = \frac{N[DP\text{-}Flag > 0]}{N_{total}} \cdot 100\ [\%], \tag{2.1}$$

where $N[DP\text{-}Flag > 0]$ is the number of flagged basis data values, and N_{total} is the total number of basis data values within the given timespan of a weather or climate data product.

So, for example, if half of the temperature values of a given hour ($N_{total} = 12$) are flagged, the resulting FP for this hour would be $\frac{6}{12} = 50$ %. For the given day ($N_{total} = 288$), if only this single half hour was flagged, FP would be $\frac{6}{288} = \frac{1}{48} = 2.1$ %;

b) for precipitation data:

$$FP_P = \frac{P_{flagged}\ [\text{mm}]}{P_{total}\ [\text{mm}]} \cdot 100\ [\%], \tag{2.2}$$

where $P_{flagged}$ is the precipitation sum over all flagged basis data values, and P_{total} is the total precipitation sum for a given timespan (T) of a weather or climate data product,

$$P_{flagged} = \sum_{i=1}^{N_T} \{P_i | DP\text{-}Flag(P_i) > 0\}, \tag{2.3}$$

$$P_{total} = \sum_{i=1}^{N_T} P_i\ , \tag{2.4}$$

where index i runs over the timespan T up to final value N_T.

In order to ensure that only "wet data" (data with a reasonable minimum precipitation) are flagged, FP_P is set to zero if the flagged precipitation sum is 0, or the maximum precipitation is below a certain low limit, i.e.,

$$\text{if } P_{flagged} \equiv 0 \text{ or } \max(P_i) < 0.21 \text{ mm then } FP_P = 0; \tag{2.5}$$

For instance, if the precipitation sum of a given hour is 2 mm and half of this sum (1 mm) originates from flagged data, FP_P for this hour would be 50 %. If the precipitation sum for the given day would be 4 mm, and the flagged data remains the same (1 mm), FP_P for this day would be exactly 25 % ($\frac{1}{4}$), regardless of the timespan of the flagged precipitation data. This way of computation guarantees that precipitation flags are always properly weighted to the amount of precipitation.

2.1.2 Gridded Data

Basis Data

As of WPS v7, gridded DP-Flag fields are generated out of the station's DP-Flags, serving as spatially resolved quality indicators. The DP-Flags of the individual stations are interpolated onto the grid using the same algorithm as used for the corresponding measurement values (inverse-distance weighted interpolation for temperature and humidity, and inverse-distance-squared interpolation for precipitation data).

Fig. 2.1 shows two examples of DP-Flag fields for precipitation data, one on Aug. 27, 2017, 18:50-18:55 UTC (upper panel), the other on Feb. 13, 2018, 16:55-17:00 UTC (lower panel). On 27th Aug. 2017, all but two stations got a DP-Flag of 0 so that the respective DP-Flag field is essentially zero everywhere except for the two locations. On 13th Feb. 2018, as the temperature was below 2 °C at all stations (the implemented criteria to distinguish between liquid and solid precipitation), only stations with heated precipitation gauges got a DP-Flag of 0. All other data have been spatially interpolated from the surrounding heated stations and thus got a DP-Flag of 2.

Weather and Climate Data

Weather and Climate data quality grids likewise use the flagged percentage of data (FP-of-Data), *FP*, as described in section 2.1.1. However, instead of a calculation per station, *FP* is now calculated per grid point. The same equations (Eq. 2.1 to 2.4) are used for this purpose, just with the threshold *DP-Flag* > 0.5 instead of *DP-Flag* > 0 in Eqs. 2.1 and 2.3 now, in order to allow moderate deviations from zero for these interpolated grid point DP-Flag values.

In order to make sure on the grid that only "wet data" (data with a reasonable minimum precipitation) are flagged, FP_P is set to zero if the areal mean precipitation is below a certain low limit, i.e.,

$$\text{if } \overline{P_{total}(x,y)} < 0.21 \text{ mm then } FP_P = 0 \ , \tag{2.6}$$

where $\overline{P_{total}(x,y)}$ denotes the average precipitation over all grid points (x, y).

Fig. 2.2 shows two examples of daily FP-of-Data fields for precipitation, one for 27th Aug. 2017 (upper panel) and the other for 12th Feb. 2018 (lower panel). Since on 27th Aug. 2017 the majority of stations had a FP-of-Data at or close to zero, the daily field also shows very low FP-of-Data over almost the entire region. On 12th Feb. 2018, as the temperature was below 2 °C at most stations, only the heated ones have a FP-of-Data of 0. All other data have a percentage of 100 %, except a few stations where temperature exceeded 2 °C for a short period. Fig. 2.3 shows the corresponding precipitation data for both examples.

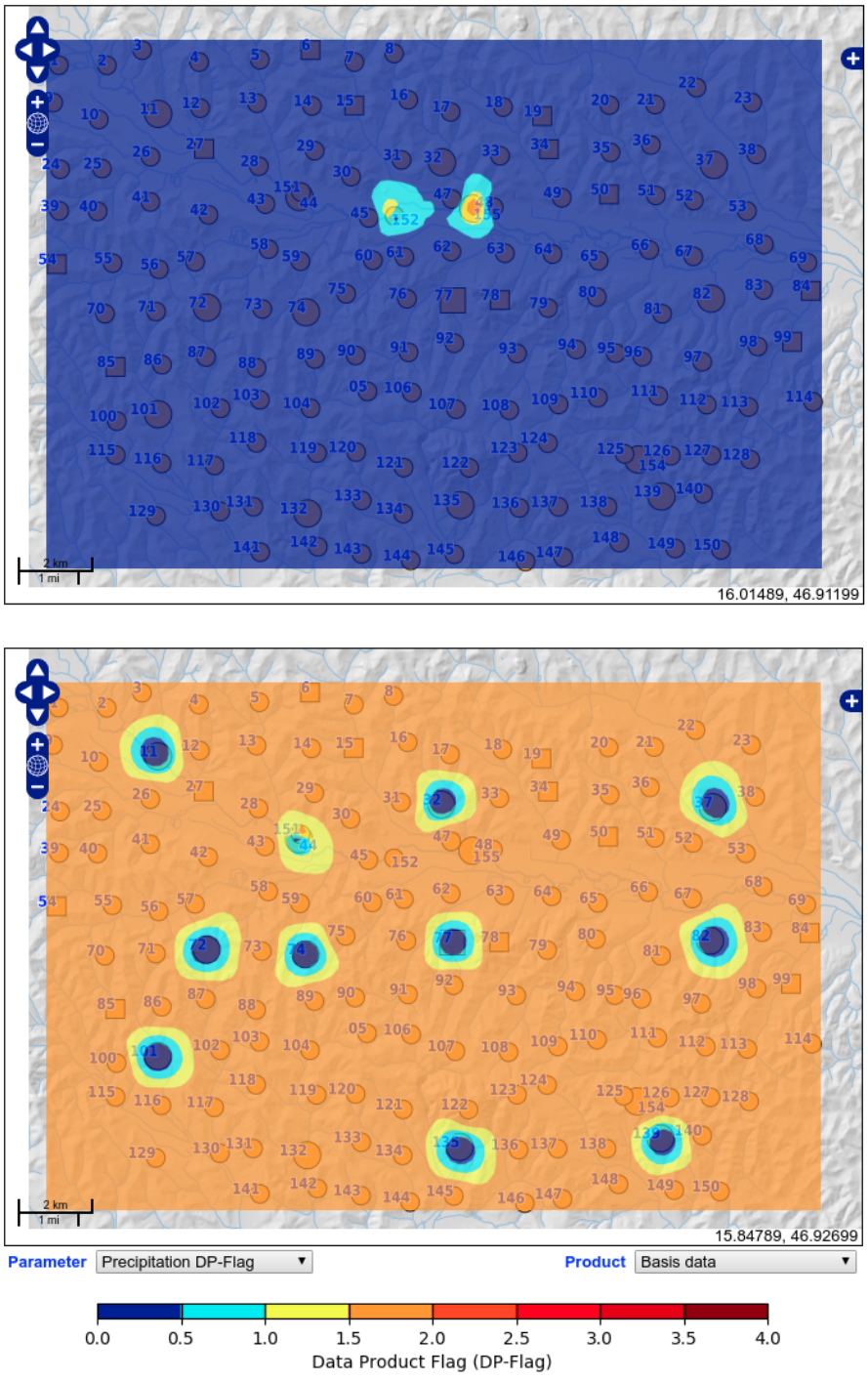

Figure 2.1: Gridded DP-Flag data for precipitation on 2017-08-27 18:50-18:55 UTC (upper panel) and on 2018-02-12 16:55-17:00 UTC (lower panel).

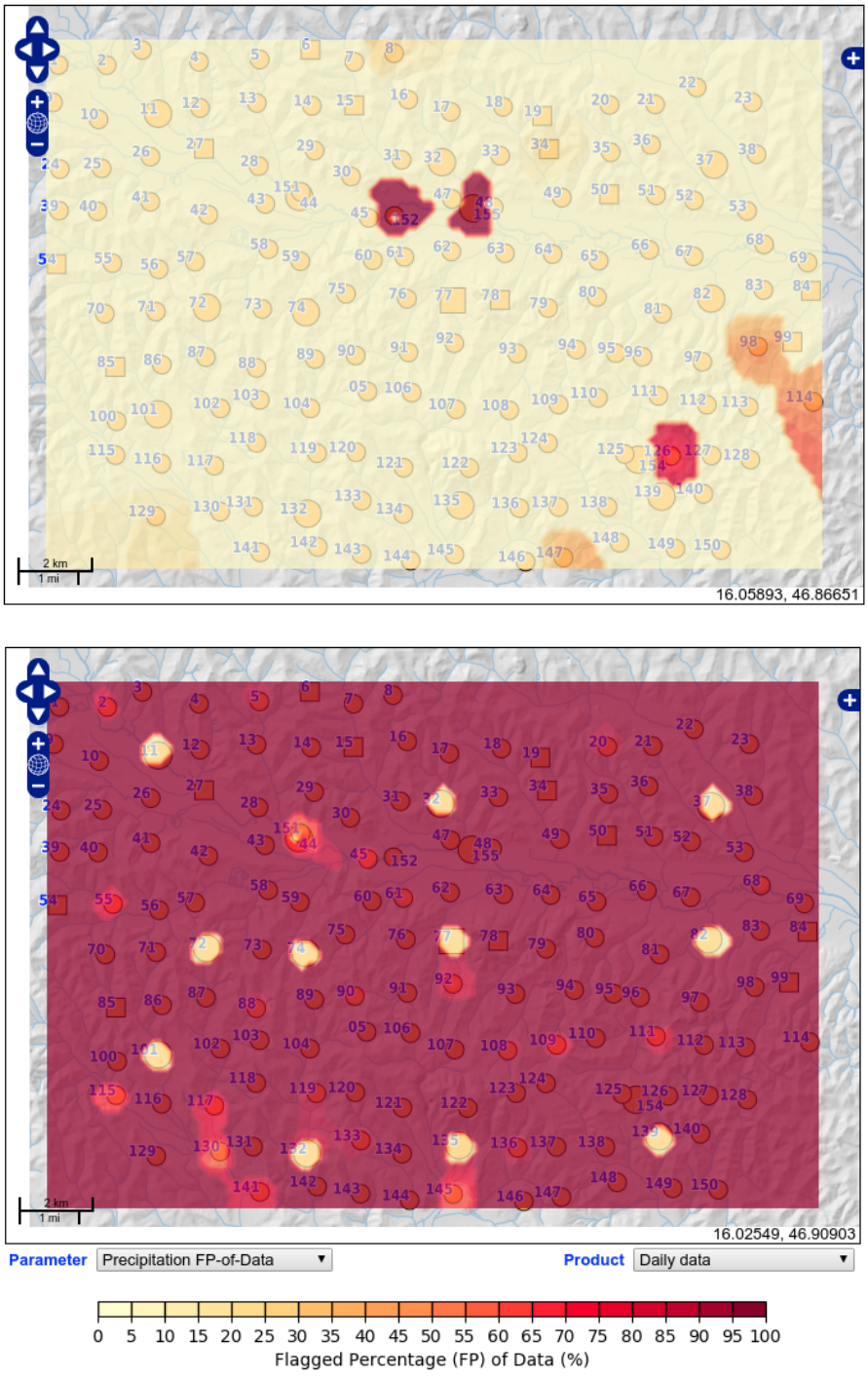

Figure 2.2: Map of flagged percentage (*FP*) of data for daily precipitation on 2017-08-27 (upper panel) and on 2018-02-12 (lower panel).

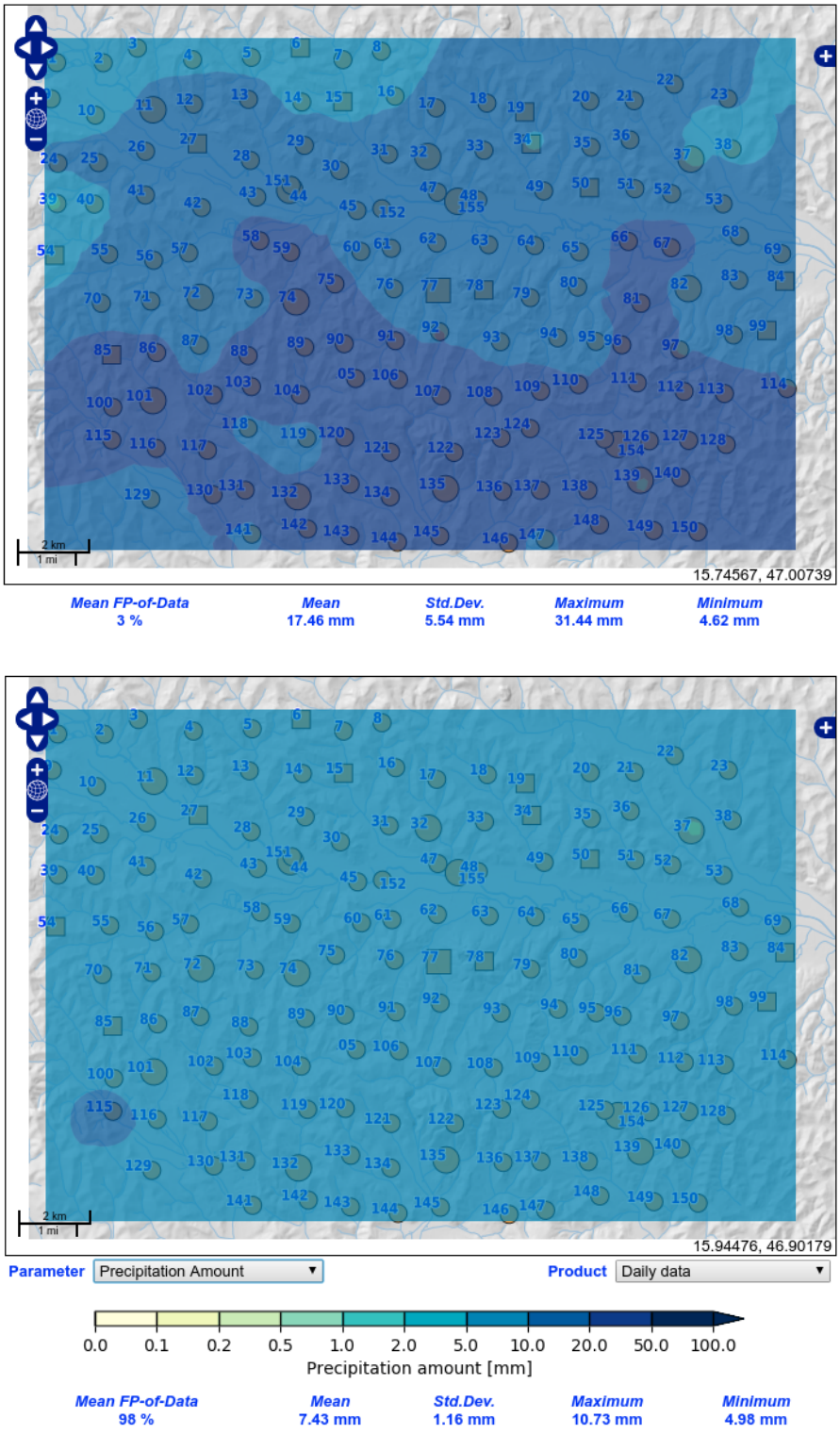

Figure 2.3: Daily precipitation data for 2017-08-27 (upper panel) and for 2018-02-12 (lower panel).

2.2 NetCDF files

2.2.1 NetCDF version

The netCDF (Unidata, 2018) format version for all gridded data changed from 3.0 (classic) to 4.4. Version 4 NetCDF data are encoded using new compression options which led to a reduction in storage size by about a factor of four.

2.2.2 Coordinates

UTM coordinates and projection information are now written directly into the netCDF files, making it easier to import them into GIS programs. Nevertheless, UTM and latitude/longitude coordinates are still available in a separate file for convenience, downloadable at `https://wegenernet.org/downloads/WN_L2_Grid_v2_coordinates.nc`.

3 New Features and Products

3.1 Level-1 data processing — Quality Control System (QCS)

3.1.1 Wind spike check

Because some wind sensors show unrealistic wind speed spikes (Fig. 3.1 illustrates an example), an additional QCS check has been implemented in QCS layer 4 (time variability checks), for generating the Level-1 data as basis for the WPS v7 Level-2 data. This so called wind spike check looks for anomalous spikes in the wind speed or gust data and compares their magnitude to the median and standard deviation of the data before the spike occurred.

It is defined that any wind speed or gust value $v_{s,i}$ is flagged if

$$v_{s,i} > F_m \cdot \text{median}(v_j) \vee v_{s,i} > F_s \cdot \text{stddev}(v_j), \tag{3.1}$$

where v_s is the spike magnitude, v_j the (non-flagged) wind speed or peak gust values of the last 120 minutes (nominally 24 data values), and F_m, F_s are constant coverage factors, depending on the parameter type and status of the sensor as summarized in Table 3.1. Note that for each parameter two sensor statuses are available: "Normal" sensors – sensors without known problems – are checked with less rigorous coverage factors than "problem" sensors – sensors that regularly show erroneous spikes in their data, currently (Aug. 3, 2018) these are wind speed at station 501 (Oberkainz), and wind speed and peak gust at station 503 (Schröckalm), both located in the Johnsbachtal.

Table 3.1: Values for coverage factors F_m and F_s of the wind spike check.

Parameter	**Sensor status**	F_m	F_s
Wind speed	Normal	4.5	5.5
Wind speed	Problem	2.5	4.5
Peak gust	Normal	6.0	6.0
Peak gust	Problem	2.5	4.5

See Scheidl (2014) and Scheidl et al. (2017) for further details on the QCS.

3.1.2 Relative humidity problem detection

Since the first generation of relative humidity sensors in the WegenerNet are known to suffer from problems above humidity values of about 70 %RH, an elaborated special

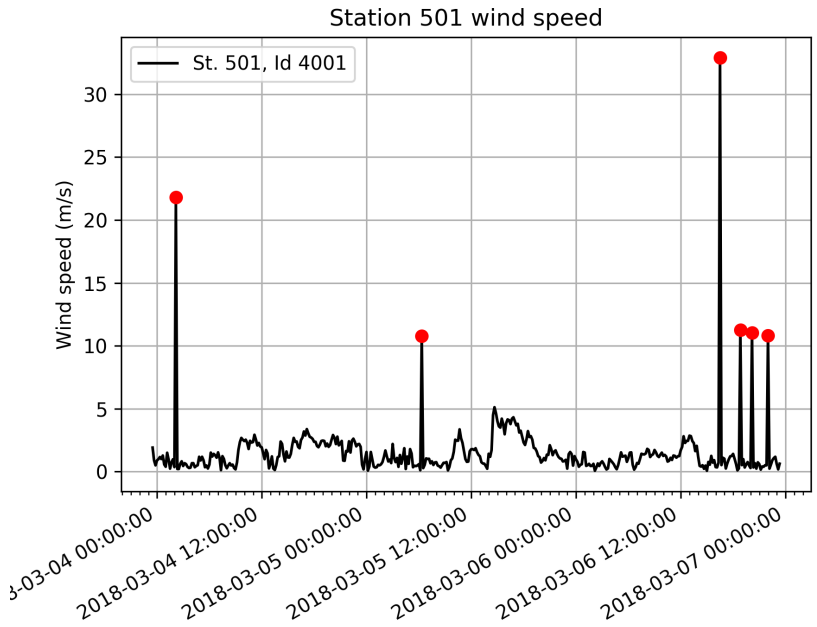

Figure 3.1: Wind speed data from station 501 with false-data spikes marked in red.

algorithm has been developed to detect problematic behavior and mark those values with a quality flag. The algorithm has been implemented into the QCS for the Level-1 data version 5 processing. Details can be found in Scheidl et al. (2017).

3.1.3 1-minute data

As all 13 main stations in the FBR network have been recently changed to a native resolution of 1-minute, done while installing a new generation of data loggers, the QCS has been adapted for also processing these higher-resolved Level-1 data. However, for continuity and consistency reasons, the data are aggregated to 5-minutes in the Level-2 processing. For access to the Level-1 1-minute data, expert users can manually choose the Level-1 Version 5 data in the data selection dialog of the WegenerNet web portal.

3.2 Level-2 data processing — Data Product Generator (DPG)

3.2.1 Homogenization of temperature and humidity data

Temperature and humidity data have been homogenized according to Ebner (2017). The correction factors reported in this study were applied in Level-2 basis data processing of WPS v7. They therefore automatically apply also to the derived weather and climate data.

3.2.2 Correction of precipitation data

Implementation of correction curve for Meteoservis MR3 sensors

Current precipitation sensors in the WegenerNet, Meteoservis MR3 and MR3H (Wegener Center, 2018) came shipped with a correction curve (METEOSERVIS, 2008), which can be used for compensation of undercatchment at high rain rates, typical for tipping-bucket sensors.

The correction curve is applied during Level-2 basis data processing of WPS v7. For example, the network's record rain rate (by March 22, 2018) was observed on July 8, 2015, 13:25-13:30 UTC at station 11 with a rain rate of 20.1 mm/5 min (∼241 mm/h). Without correction, this event would be observed at 17.3 mm/5 min (∼208 mm/h).

Implementation of correction factors for Friedrichs and Young sensors

General correction factors of 1.10 for Friedrichs and 1.13 for Young sensors, operational from year 2007 until fall 2016 in the FBR network, have been implemented into the Level-2 processing of WPS v7 according to O et al. (2018).

3.2.3 Johnsbachtal Level-2 data processing

As of Level-2 version 7, station time series data for the WegenerNet JBT network are also available as basis data and weather and climate data products. Due to the mountainous topography and the sparser station density (11 JBT stations in comparison to the 154 FBR stations by March 22, 2018), gridded data products for the main parameters temperature, relative humidity, and precipitation are not available for the JBT.

3.2.4 High-resolution gridded wind fields

High-resolution wind fields and peak gust fields with a temporal resolution of 30 minutes and a spatial resolution of 100 m × 100 m are generated every hour for both regions, the FBR and JBT, in the Level-2 processing of WPS v7. Also the complete FBR data record since 2007 and the JBT data since 2012 have been re-processed to produce these fields. As the other Level-2 data, the wind fields are aggregated to weather and climate data products. For details on data preparation see Schlager et al. (2017) and Schlager et al. (2018).

3.3 Data portal

3.3.1 Image export of plots

As a new feature, all plots generated at the data portal can be exported as png images using the button *Export plots as .png images* at the bottom of the screen.

3.3.2 Digital elevation model and land use/land cover data download

In the grid data download section, digital elevation data in 10 m × 10 m, 100 m × 100 m, and 200 m × 200 m resolution, covering the FBR and JBT regions (Land Steiermark, 2018), and land use/land cover data in 100 m × 100 m resolution, covering the Styrian Raab catchment and WegenerNet FBR region (Klebinder et al., 2017), are now available for download.

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