Evaluation of INCA precipitation analysis using a very dense rain gauge network in southeast Austria

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Introduction 1

The evaluation of precipitation measurements is essential to increase the reliability of flood warning systems and also for better understanding of uncertainties in climate models. The goal of this study is to compare the Integrated Nowcasting through Comprehensive Analysis (INCA) precipitation analysis product using a dense weather station network (WegenerNet) in southeast Austria.

WegenerNet Feldbach Region (FBR):

- Area of the network: about 22 km × 16 km.
- 153 tipping bucket rain gauges (about one station per 2 km^2) measure weather parameters every 5 minutes since 2007 [1].
- WegenerNet gridded data were aggregated to 15 minutes and upscaled to 1 km.

INCA:

Precipitation analysis product in entire Austria by combining national ground stations (ZAMG), Austrian hydrological network (AHYD) stations, 5 radars, and high-resolution topographic data with 1 km spatial and 15 minutes temporal resolution.

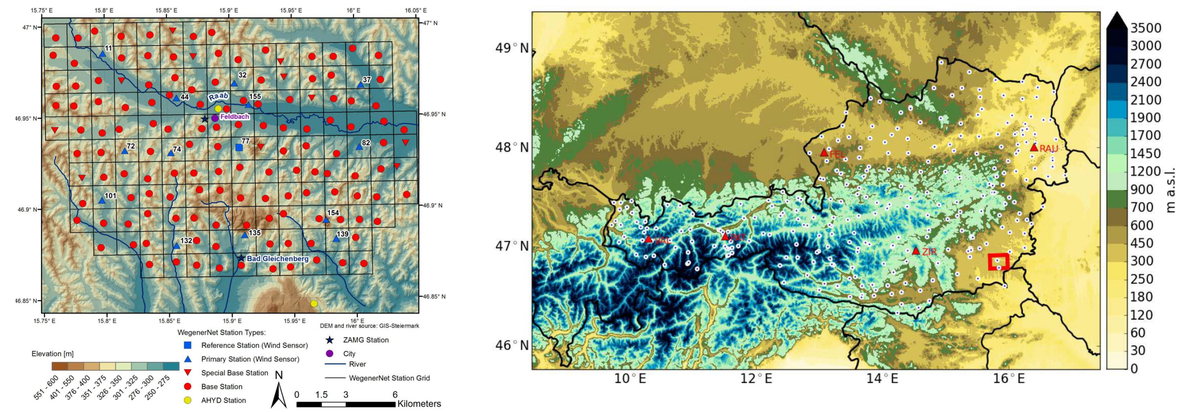

Figure 1. The locations of WegenerNet stations (left) and ZAMG rain gauge stations (white/blue dots) five radars (red triangles), and WegenerNet Feldbach region (red rectangle) (right). The map is taken from [3].

Categorical Verification 2

Probability of Detection (POD), False Alarm Ration (FAR), and Critical Success Index (CSI) is used for evaluating the ability of INCA to detect rainfall. These indices were calculated for each pixel using 12 years of data.

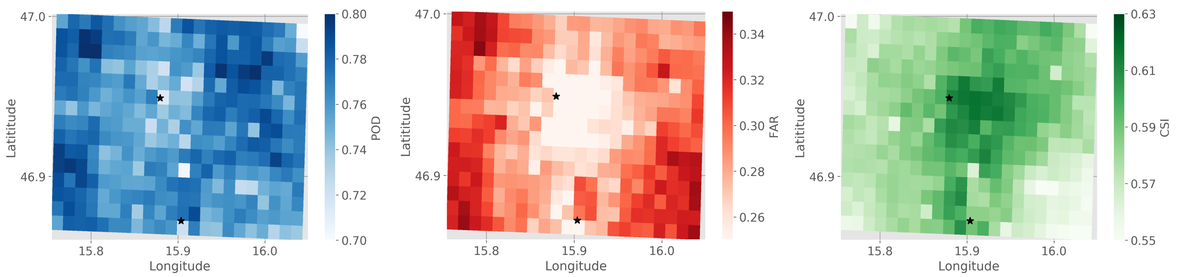

Figure 2. POD (left), FAR (middle), and CSI (right) for 15 minutes INCA rainfall with 0.2 mm threshold. The two black stars represent the two ZAMG stations in the study area

Based on FAR and CSI indices, INCA performs better near the two ZAMG stations. Based on the INCA algorithm, the weight of the radar estimate is higher with increasing distance from the ZAMG stations [3]. So, we can conclude that radar detected some rainfall events which were not observed by ground stations. This might be due to the presence of non-precipitating phenomena.

Annual Comparison 3

Based on the figure 3, INCA tends to overestimate precipitation - in particular from 2012 until 2014.
Since there was a replacement process for the Austrian radars (starting from October 2011), another radar estimation product was used to generate INCA precipitation analysis products during this time. This can explain the different behavior of INCA in this period.

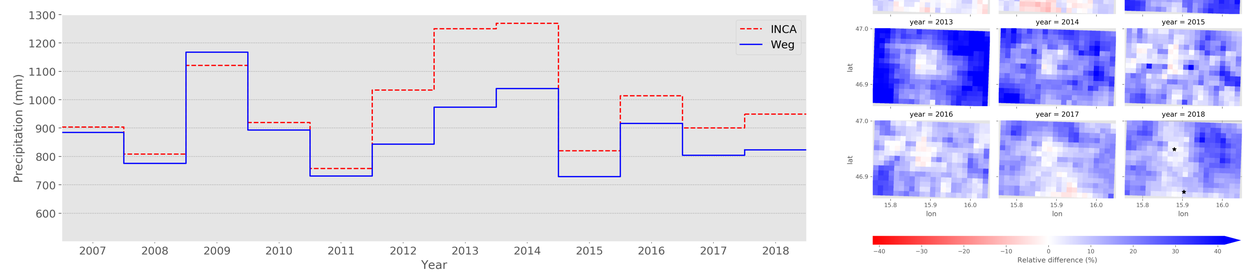

Figure 3. Annual area-mean precipitation (left) and the annual relative difference between INCA and WegenerNet (right)

Comparison for extreme precipitation 4

After excluding all the data from 2012 to 2014 and also events lower than 0.2 mm per 15 min, we calculated quantile 99 for wet (May to September) and dry (October to April) seasons for each pixel.
In those pixels which are not close to the two ZAMG stations, INCA underestimates extremes. A reason for this underestimation is the distance of the radar from the study area (~100 km).

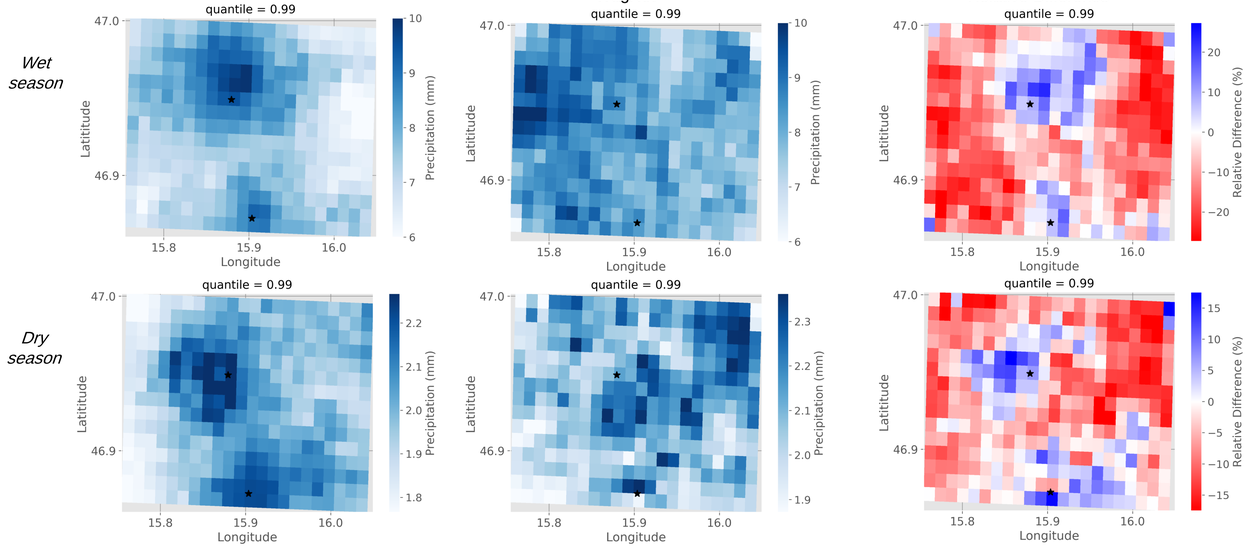

Figure 4. Quantile 99 for both INCA and WegenerNet in wet (May to September) and dry (October to April) seasons

References:

[1] Kirchengast, G., Kabas, T., Leuprecht, A., Bichler, C., & Truhetz, H. (2014). WegenerNet: A pioneering high-resolution network for monitoring weather and climate. Bulletin of the American Meteorological Society, 95(2), 227-242.
[2] O, S. and Foelsche, U.: Assessment of spatial uncertainty of heavy rainfall at catchment scale using a dense gauge network, Hydrol. Earth Syst. Sci., 23, 2863–2875, 2019.
[3] Kann, A., Meirold-Mautner, I., Schmid, F., Kirchengast, G., Fuchsberger, J., Meyer, V.,& Bica, B. (2015). Evaluation of high-resolution precipitation analyses using a dense station network. Hydrology and Earth System Sciences, 19(3), 1547-1559.

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