

WegenerNet high density network as a tool to explore uncertainties in measured extreme rainfall events

Sungmin O^{(1),(2)}, U. Foelsche^{(1),(2),(3)}, G. Kirchengast^{(3),(1),(2)}, and J. Fuchsberger^{(3),(1)}

(1)Institute for Geophysics, Astrophysics, and Meteorology/Institute of Physics (IGAM/IP), NAWI Graz, University of Graz, Austria,

(2)FWF-DK Climate Change, University of Graz, Austria, (3) Wegener Center for Climate and Global Change (WEGC), University of Graz, Austria

How WegenerNet rain gauge measurements are used to quantify uncertainties in rainfall observations?

I. Climate Change and Extreme Rainfall

More intense and more localized rainfall events



Extreme weather and climate change.

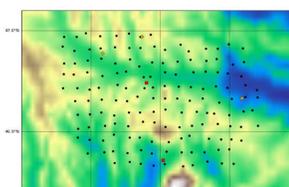
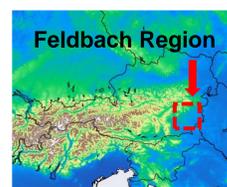
Source: Union of Concerned Scientists <http://www.ucsusa.org/>

• One of the well-known and most-agreed consequences of global warming is an increase in the intensity and frequency of heavy rainfall. Nevertheless, strong evidence linking extreme rainfall to global warming still remains challenging.

• Difficulties in rainfall ↔ climate studies are mainly due to the fact that many extreme rainfall events are very local events with high variability both in space and time, which requires high resolution observational data to minimize uncertainties in observations.

II. WegenerNet Network

Long-term monitoring facility for weather and climate



Precipitation data:

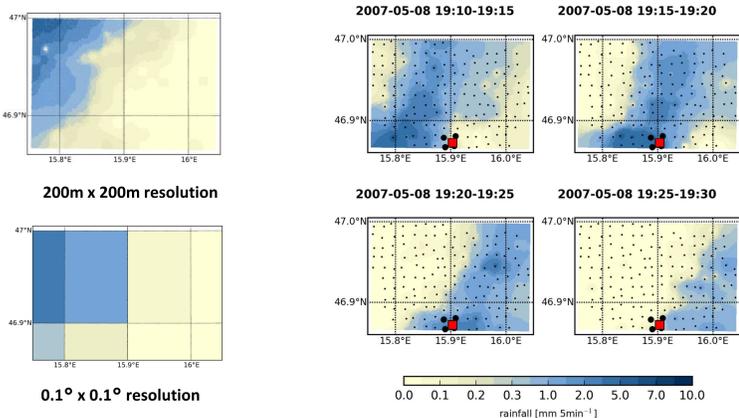
- 150 WegenerNet stations
- 3 AHYD stations
- 2 ZAMG stations

- area of ≈20 km x 15 km within the Feldbach Region, Southeastern Austria
- automatic near-real-time observation and quality control of parameters: temperature, humidity, precipitation, wind, pressure, and so on
- precipitation measurements by 150 stations at a resolution of ≈ 2 km²; only five 'normal' national weather stations - ZAMG and AHYD - in the same domain
- hilly Alpine forelands terrain with altitudes from 250 to 520 m.a.s.l.
- data available since January 2007 (WegenerNet data portal, www.wegenernet.org)

III. On-going Research with WegenerNet Rainfall Data

Rainfall measurements with high resolution

=> By how much has extreme rainfall been underestimated?



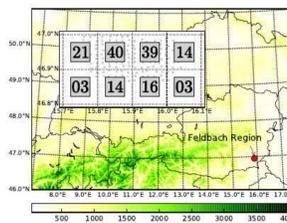
(LEFT) Different spatial resolution for the same rainfall event; top: WegenerNet gridded datasets, 200 m x 200 m, bottom: the same data but for a lower resolution, 0.1° x 0.1°;

(RIGHT) Rainfall events in the network during 20 minutes, May 2007; red and black symbols indicate ZAMG and WegenerNet stations, respectively.

The most distinguishable feature of the WegenerNet is its very high resolution; the network measures rainfall every 5 minutes at ≈2 km² resolution and produces 200 m x 200 m gridded datasets. As shown in the figures above, WegenerNet can provide more detailed information on rainfall structures and processes that can be missed when we are restricted by data only from satellite (left Fig.) or Austrian national stations (right). WegenerNet data will allow us to analyze a multitude of intense rainfall events, including those in summer 2009 which resulted in severe floods in Southeastern Austria.

'True' ground reference for rainfall datasets

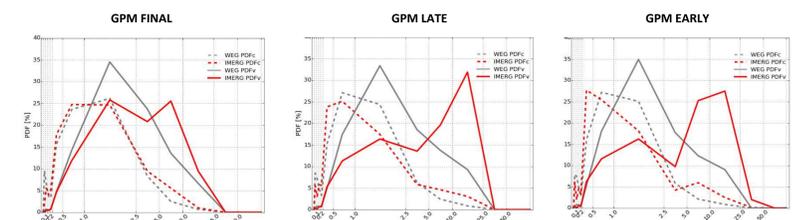
=> How accurate are satellite rainfall estimates?



The number of WegenerNet gauges for each GPM-IMERG satellite data grid cell

comparison can be conducted on average-points to pixel basis at both sub-daily and daily timescales.

The WegenerNet acts as "true" reference for the NASA Global Precipitation Mission (GPM) IMERG data to validate accuracy of the satellite data and finally to improve rainfall retrieval and calibration methodologies of the satellites; that is how the WegenerNet can actually contribute to improvements of global rainfall datasets beyond its own small domain. Since the WegenerNet has a flexibility to work with various spatial and temporal scales, the



Probability Density Functions by rainfall occurrence (dashed) and volume (solid) for GPM-IMERG rainfall (red) and WegenerNet rainfall (grey) during Apr-Oct 2015

Preliminary results on the comparison show that differences between GPM-IMERG and WegenerNet data decrease (GPM EARLY > LATE > FINAL processing products) as more retrieval or calibration processes are applied on the satellite data.

Applications of WegenerNet Rainfall Data

Decreases in uncertainties of rainfall measurements provided to

Users in hydro-meteorological communities

References
[1] Kirchengast, G., Kabas, T., Leuprecht, A., Bichler, C., Truhetz, H., Feb. 2014. WegenerNet: A Pioneering high-resolution network for monitoring weather and climate. Bull. Amer. Meteor. Soc. 95 (2), 227-242.
[2] Villarini, G., Mandapaka, P. V., Krajewski, W. F., Moore, R. J., Jun. 2008. Rainfall and sampling uncertainties: A rain gauge perspective. J. Geophys. Res. 113 (D11).
[3] Bidwell, S., Durning, J., Everett, D., Schwaller, M., Smith, E., Wol, D., 2004. Preparations for global precipitation measurement (GPM) ground validation. In: Geoscience and Remote Sensing Symposium, 2004. IGARSS 2004. Proceedings. Vol. 2. IEEE, pp. 921-924.

Acknowledgments
The study was funded by the Austrian Science Fund (FWF) under research grant W 1256-G15 (Doctoral Programme Climate 300 Change Uncertainties, Thresholds and Coping Strategies). WegenerNet funding is provided by the Austrian Ministry for Science and Research, the University of Graz, the state of Styria (which also included European Union regional development funds), and the city of Graz.