WEGN4CARE - Validation of EarthCARE cloud and precipitation products by the WegenerNet 3D Open-Air Laboratory for Climate Change Research in Southeastern Austria (EVID34)

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**Online presentation @ 2nd ESA EarthCARE Validation Workshop, 25 May 2021**

Further info on partners & sponsors: www.wegcenter.at/wegenernet

The WegenerNet 3D Open-Air Laboratory for Climate Change Research (WEGN 3D) – Ground Station Network (WEGN 2D part)
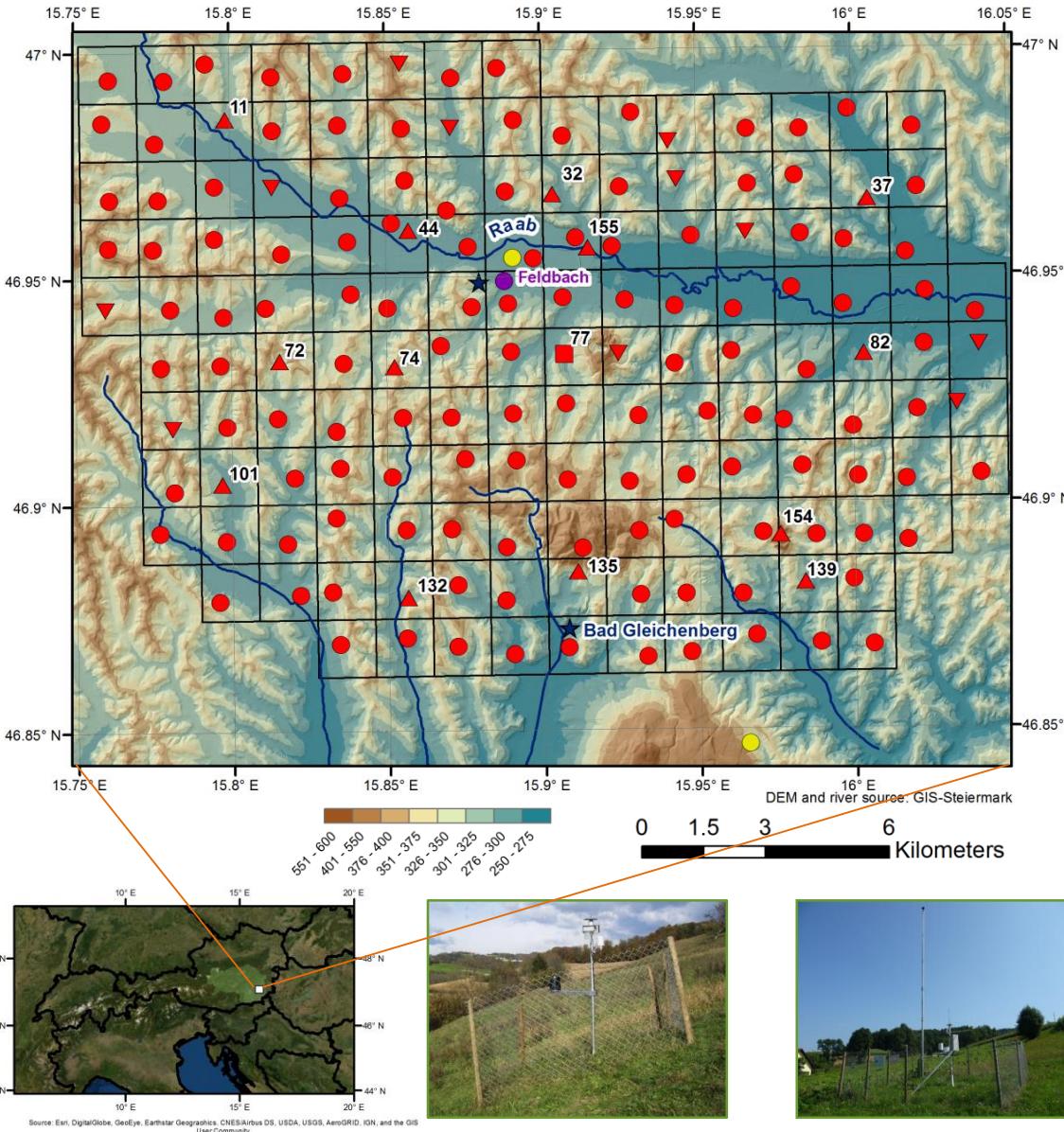
**Key features of the WegenerNet ground station network:**

- Pioneering high-resolution network for long-term monitoring of weather and climate

- **156 climate stations** (red symbols in map) located in the southeastern Alpine foreland in Austria

- **~22 km x 16 km region**

- Station grid with a station every about 2 km²

- Elevation range ~250 m to 600 m,

- Highest station elevation: 520 m

- More than 13 years of data (start: 1st January 2007)

- Main parameters: **Temperature, relative humidity, and precipitation**, measured at all stations

- At 13 stations additional measurements of wind and solid precipitation (heated rain gauges)

- At 12 Stations soil moisture and soil temperature measurements

- Reference station additionally measures air pressure and net radiation balance

- Measurement **sampling rate 1 min to 5 min**

- Data available at www.wegenernet.org

WEGN 3D: Polarimetric X-Band precipitation radar Stradnerkogel

Location: Mount Stradnerkogel at 609 m above mean sea level.

WegCenter
ORS-Mast Stradnerkogel

Radar - ATU/SPU/DPU
mounting overview

ATU

(Radar Dome, on Dome Mount Platform)

SPU

(within Dome Mount Platform)

41m / ~ 650m ü.d.M

Data line
(optical fiber)

MM, 1GBs min, OM3 ok, outdoor, LC connectors confected (beware/secure when installing cable on mast the LC connectors)

Power Line
(5x 1,5 mm², NYCY)

Helukabel 32220-100 Erdkabel NYCY
5 x 1.50 mm² Schwarz 100 m

1x 2 power for adapters/switch/converter (durable)
1x 2 power for SPU unit only (variable operation, ground controlled)
1x 1 ground (replaces green/yellow)

DPU & further equipment

(within 19" rack within ORS-shelter)

0m / ~ 609m ü.d.M

- Output products: **Rainfall intensity R** (mm/h), **Reflectivity Zh and Zv** (dBZ), etc.

- **1 km x 1 km horizontal, 500 m vertical**

- **2.5-min time sampling**

Mounted on a 81 m tall radio mast, about half-level, at 41 m height.

WEGN 3D: Atmospheric profiling and cloud structure microwave/IR radiometers

Location "Central Station Raabtal" (156): Rooftop (~27 m above ground) of an office building in the central valley of the region
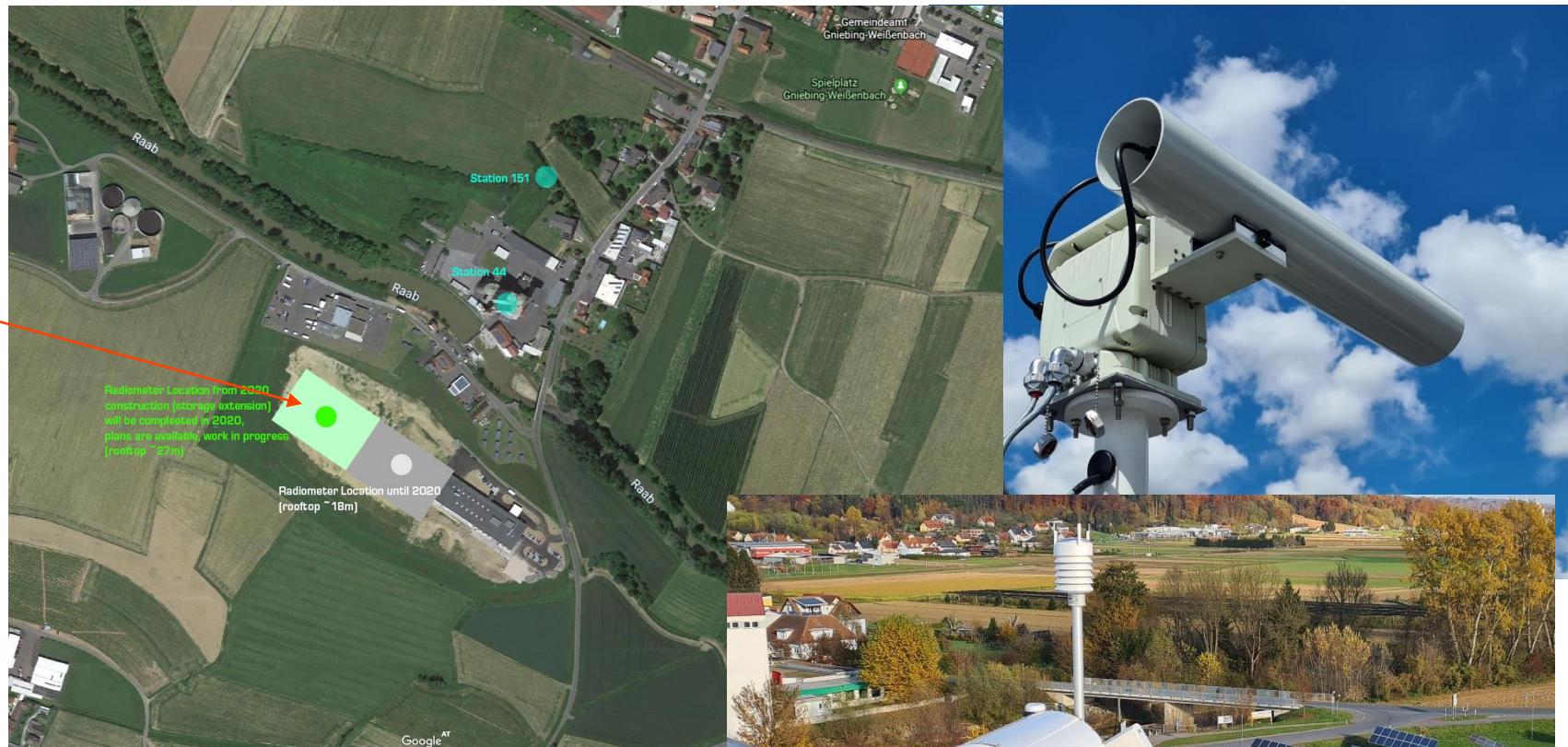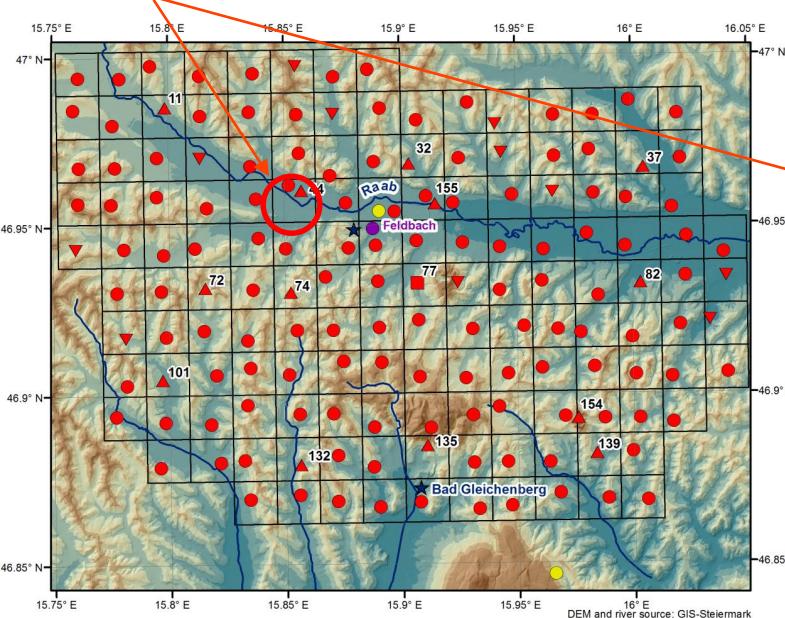
- Output products: temperature, humidity, and **cloud liquid water** profiles; integrated water vapor, **liquid water path**, **cloud base height**, for full sky above the radiometer pair (angular resolution: 10° elev., 20° azim.)

- **10 min time sampling**

- Vertical grid resolution of <= 60 m in boundary layer (at < 1.5 km altitude) and <= 300 m in free troposphere (1.5 km to 10 km)

Station locations:
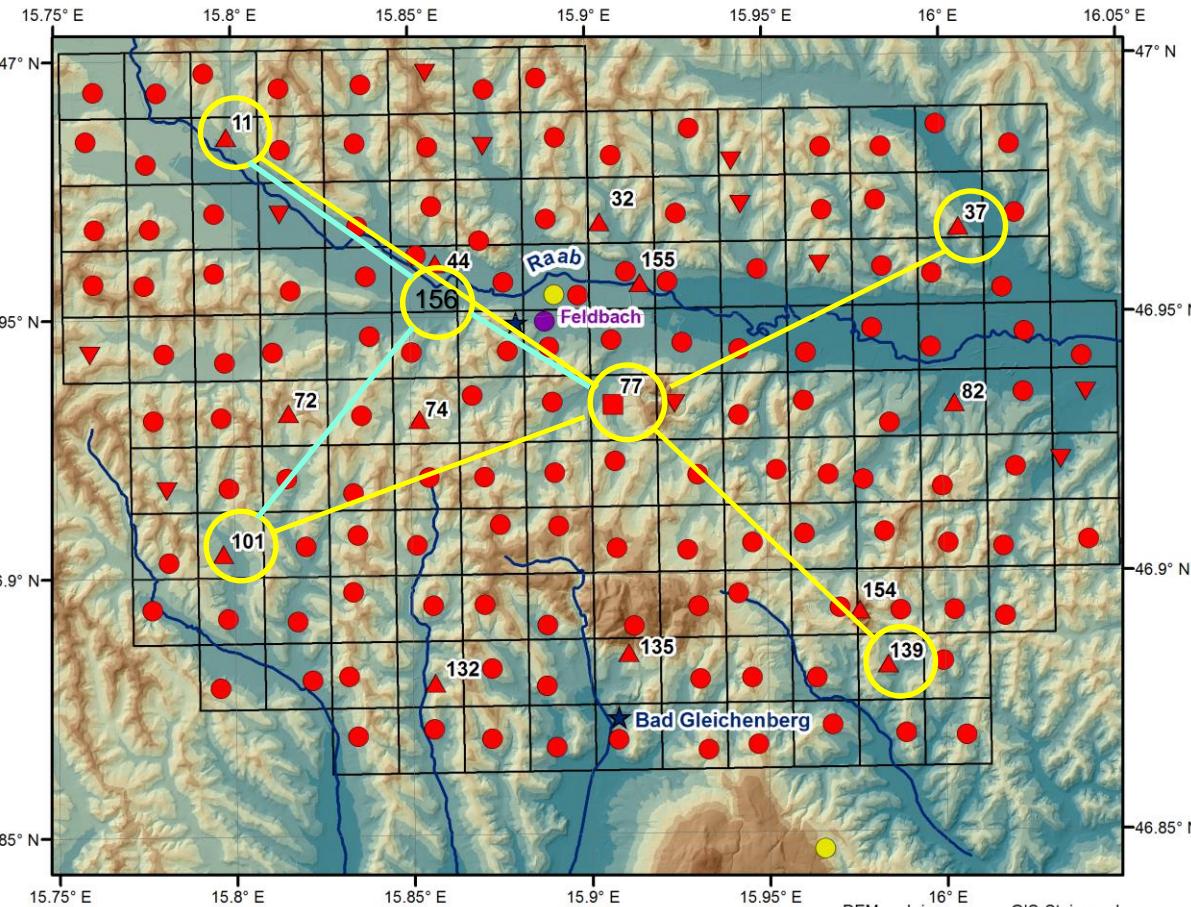
GNSS-StarNet "Main Star"

GNSS-StarNet "Embedded Star"

- 6 Multi-GNSS stations within WegenerNet region (at WegenerNet station no.s 11, 37, 77, 101, 139, 156), built and operated jointly with the GFZ Potsdam (Prof. J. Wickert & Team)

- Measuring slant and vertically **integrated water vapor (IWV) columns** above the WegenerNet area, with 2.5 min to 15 min time resolution

L2a, C-TC (Cloud Radar - Target Classification):

- validate **cloud base height** against WEGN IR-radiometer data (sufficient accuracy of 50 to 400 m available up to 3000 m altitude)

- validate **simplified convective classification** using WEGN X-band weather radar data

- validate **melting layer base and top heights** in a campaign-like setup of the WEGN X-band radar

L2b, ACM-CAP (Cloud and Aerosol properties):

- validation using WEGN radiometer data
  - **liquid water content** (LWC) (threshold: 50 g/m² LWP)
  - **liquid water path** (LWP) (threshold: 67 g/m² for +-15 % accuracy)

- validation using WEGN X-band weather radar and ground precipitation data
  - **rain rate** (threshold: 0.1 mm/5 min)
  - **rain water content**
  - **raindrop** normalized **number** concentration(*)
  - median **raindrop diameter**(*)
  - **rain classification**
  - **convective classification**

  *for moderate to heavy precipitation;

Temporal collocation possible within < 1 min (campaign-wise) and **< 5 min** (operational).

WegenerNet references and further information

Data portal: www.wegenernet.org

Homepage: www.wegcenter.at/wegenernet

Fuchsberger, J., G. Kirchengast, and T. Kabas (2021):
WegenerNet high-resolution weather and climate data from 2007 to 2020, *Earth Syst. Sci. Data*, 13, 1307–1334.
https://doi.org/10.5194/essd-13-1307-2021

O, S., U. Foelsche, G. Kirchengast, J. Fuchsberger, J. Tan, and W. A. Petersen (2017):
Evaluation of GPM IMERG Early, Late, and Final rainfall estimates using WegenerNet gauge data in southeastern Austria, *Hydrol. Earth Syst. Sci.*, 21, 6559–6572
https://doi.org/10.5194/hess-21-6559-2017

Kirchengast, G., T. Kabas, A. Leuprecht, C. Bichler, and H. Truhetz (2014):
WegenerNet: A pioneering high-resolution network for monitoring weather and climate. *Bull. Amer. Meteor. Soc.*, 95, 227-242.
https://doi.org/10.1175/BAMS-D-11-00161.1

WegenerNet Data DOI:

Fuchsberger J., G. Kirchengast, C. Bichler, A. Leuprecht, and T. Kabas (2021):
WegenerNet climate station network Level 2 data version 7.1 (2007–2020), University of Graz, Wegener Center for Climate and Global Change, Graz, Austria.
https://doi.org/10.25364/WEGC/WPS7.1:2021.1

Instrument provider information:
Precipitation radar: https://furuno-weather-radar.com

MW/IR Radiometer: https://www.radiometer-physics.de

IR Cloud Structure Radiometer: http://www.nubiscope.de

GNSS-StarNet infrastructure ops: https://www.gfz-potsdam.de/en/section/space-geodetic-techniques/projects/gnss-infrastructure/
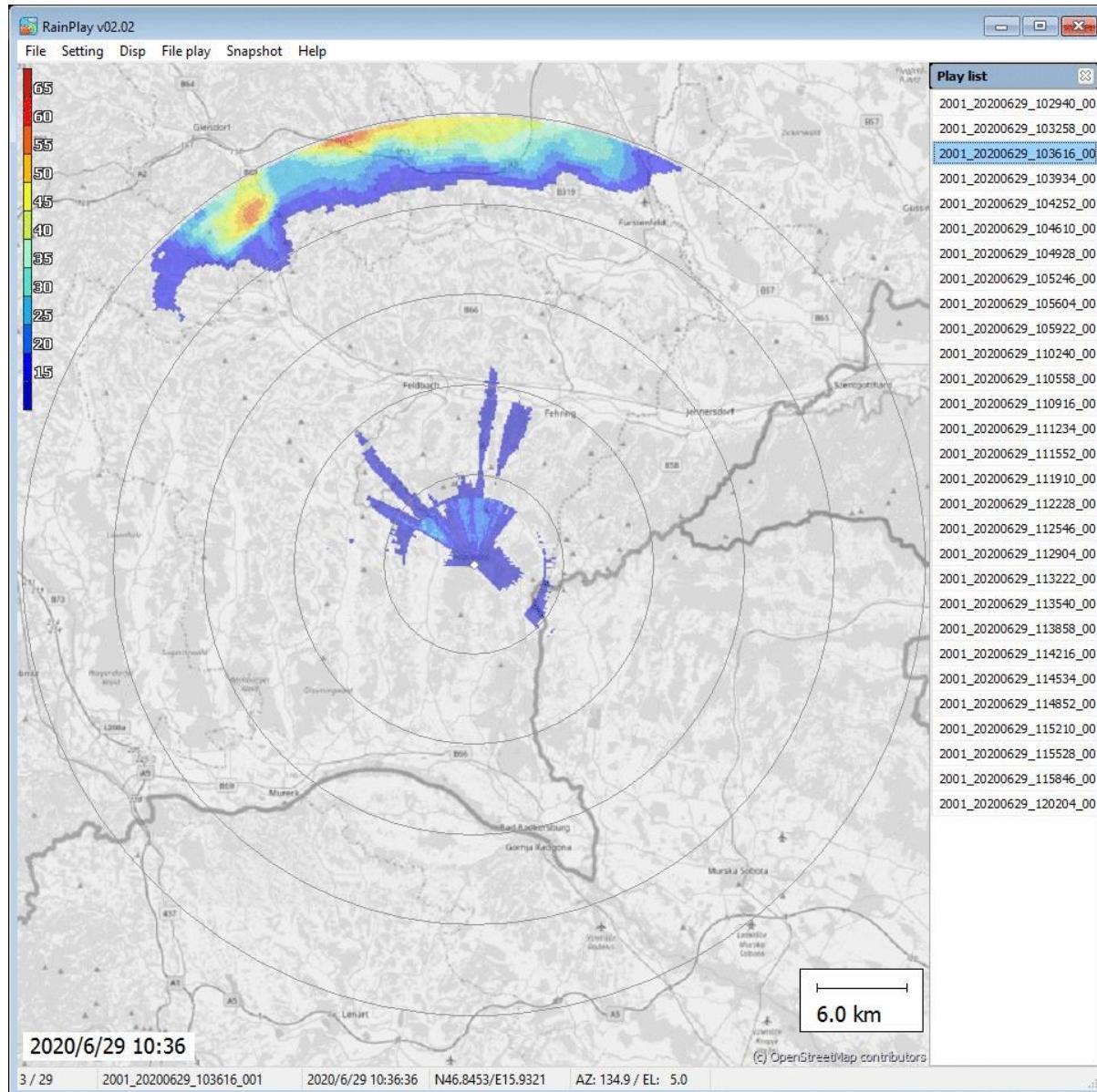
- Animation of radar images (2020-06-29 10:29 – 12:02 UTC)

WEGN X-band radar (top)
WEGN station gauges (bottom)
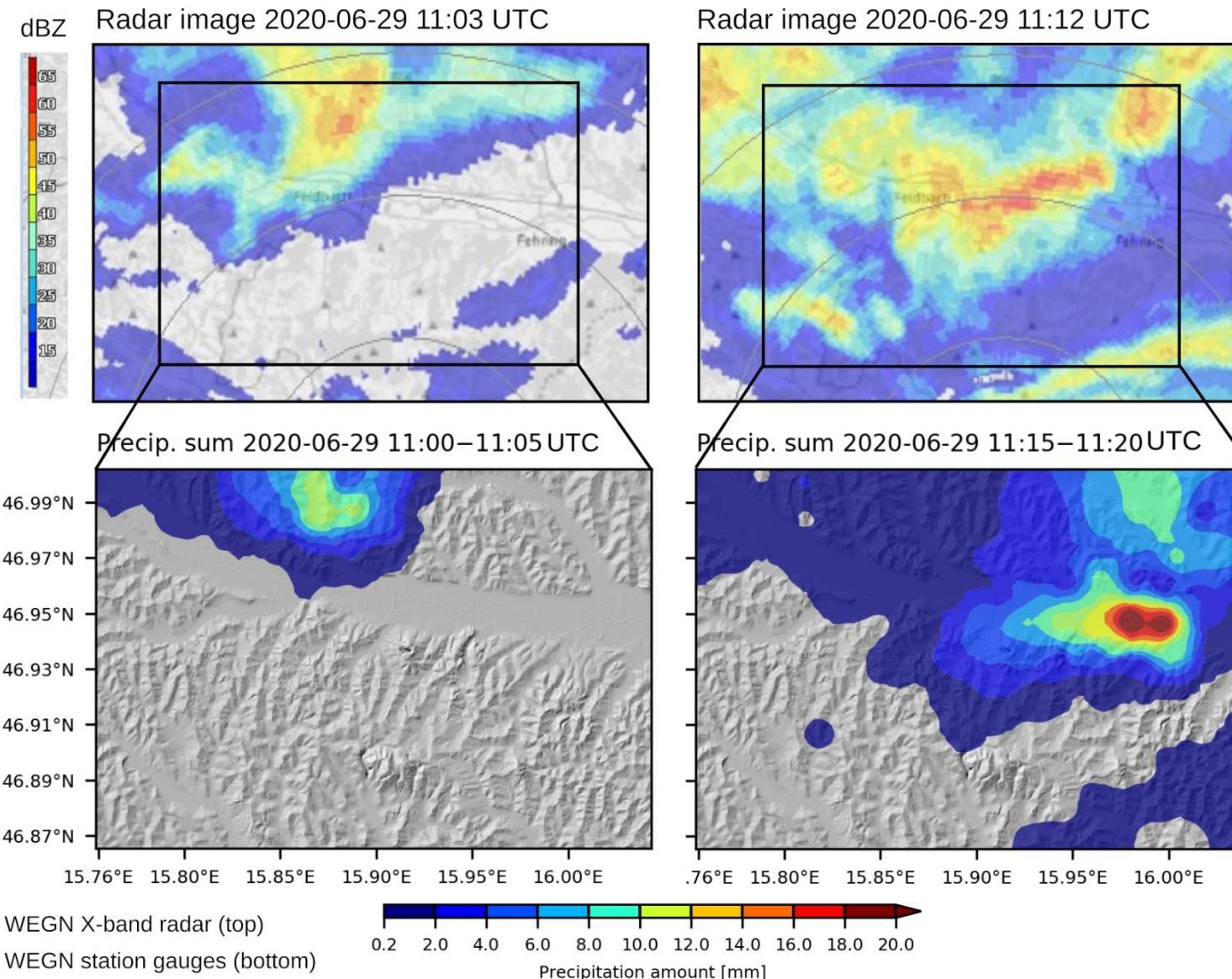
- **2nd highest 5-min precipitation rate on WegenerNet record (since 2007):**
- **20.6 mm/5 min** at Station 66
- 42.0 mm/30 min, 58.2 mm/60 min, and 76.8 mm/day

Precip. sum 2020-06-29 10:45–10:50
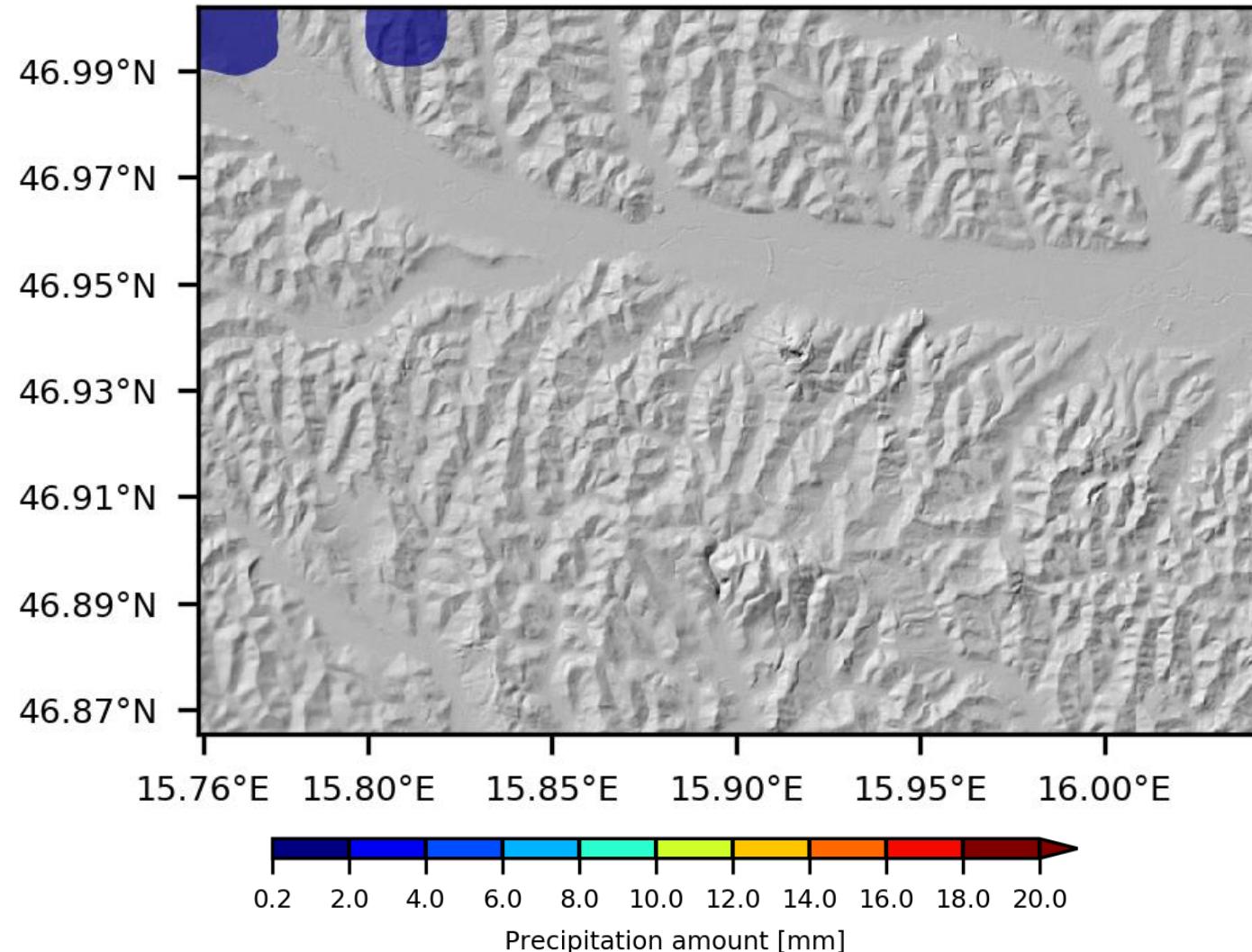
- Animation of WegenerNet gridded precipitation data:
  June 29, 2020 10:45 – 12:00 UTC

X-Band precipitation radar: Specifications and data products
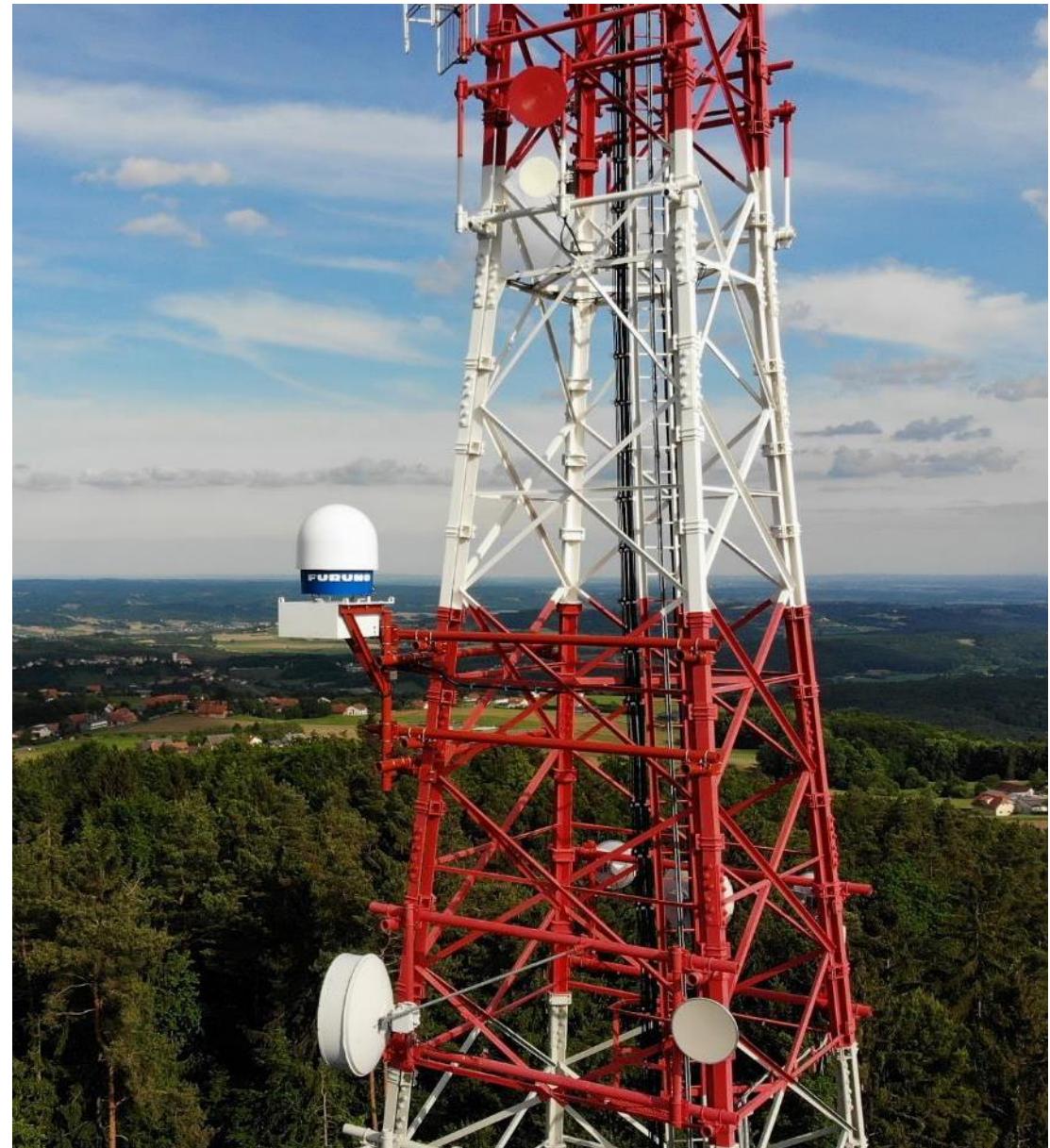
- Type Furuno WR-2120

- Polarimetric X-band weather radar operating at ~9.4 GHz

- Output products: **Rainfall intensity R** (mm/h), **Reflectivity Zh and Zv** (dBZ), Doppler velocity V (m/s), Doppler velocity width W (m/s), Cross polarization difference phase φdp (deg), Specific differential phase KDP (deg/km), Correlation coefficient between the two polarizations, Horizontal and Vertical Differential reflectivity ZDR (dB)

- Further derived products: Hydrometeor classification, drop size distribution

- Native resolution: 2.7° angular, 300 m radial

- Resolution of processed 3D volume data: **1 km x 1 km horizontal, 500 m vertical**

- Observation range: 30 km (up to 70 km for case studies)

- **2.5-min time sampling** (180° 3D volume; down to 30 s for case studies)

- Peak output power: 100 W

- Advanced pulse compression techniques

- Operating since May 2020

Atmospheric profiling and infrared radiometer: Specifications and data products

- Type: RPG-HATPRO-G5

- **Relative humidity and temperature profiling** microwave/IR radiometer

- Multi-directional azimuth and elevation scanning

- Output products: temperature, humidity, and cloud liquid water profiles; integrated water vapor, **liquid water path**, **cloud base height**

- 14 microwave channels (22 GHz to 31 GHz and 51 GHz to 58 GHz)

- IR radiometer at 9.6-11.5 µm band

- **Vertical grid resolution of <= 60 m in boundary layer (at < 1.5 km altitude) and <= 300 m in free troposphere (1.5 km to 10 km)**

- Observation range: 0 m to 10000 m

- **10-min time sampling** (for full 3D scene for chosen ops mode)

- Capable of GNSS satellite tracking for GNSS-line-of-sight integrated water vapor (IWV) observations

- temperature profiling with an accuracy of ~0.5 K or better in boundary layer and ~1 K or better in free troposphere

- relative humidity profiling with an accuracy of ~5 % or better in the lower troposphere (< 5 km altitude);

Cloud structure infrared radiometer: Specifications and data products

- Type: NubiScope infrared cloud scanning radiometer
- Enabling multi-layer cloud-field reconstruction over the WegenerNet area
- Multi-directional azimuth and elevation scanning
- IR radiometer at 8-14 µm band
- Output products: **IR temperature of cloudless sky, cloud cover percentage, cloud type, cloud base height and temperature**
- **10-min time sampling** (for full 3D scene)

- Receiver type: Septentrio PolaRx5 FULL

- Mapping of **water vapor columns**

- **15-min time sampling** (slant total delays 2.5 min)

- Main data products: Vertically Integrated Water Vapor [kg m^2], Zenith Wet Delay [mm], Zenith Total Delay [mm], Slant Total Delay [mm]

- Operated in cooperation with GFZ Potsdam, providing station monitoring and processing towards the main data products