High-resolution Precipitation Monitoring in the WegenerNet 3D Open-Air Laboratory for Climate Change Research

Andreas Kvas[1], Jürgen Fuchsberger[1], Gottfried Kirchengast[1,2], Robert Galovic[1,3], Daniel Scheidl[1], and Christoph Bichler[1,2]

1) Wegener Center for Climate and Global Change (WEGC), University of Graz, Austria
2) Institute of Physics, University of Graz, Austria
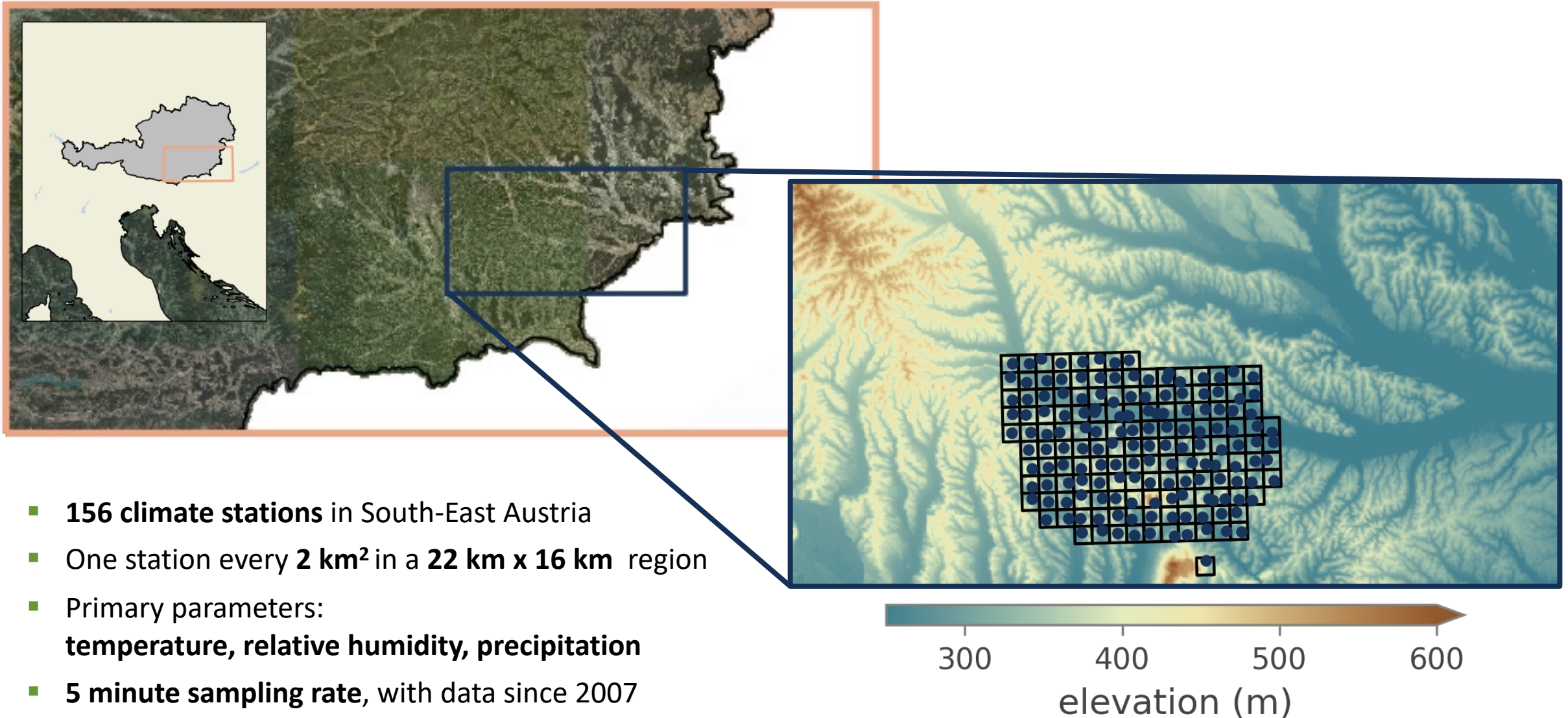3) Institute for Geography and Regional Science, University of Graz, Austria

EMS2023, 2023-09-06

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

WegenerNet 3D Open-Air Laboratory

WegenerNet Feldbach Region Climate Station Network

- **156 climate stations** in South-East Austria
- One station every **2 km²** in a **22 km x 16 km** region
- Primary parameters: **temperature, relative humidity, precipitation**
- **5 minute sampling rate**, with data since 2007

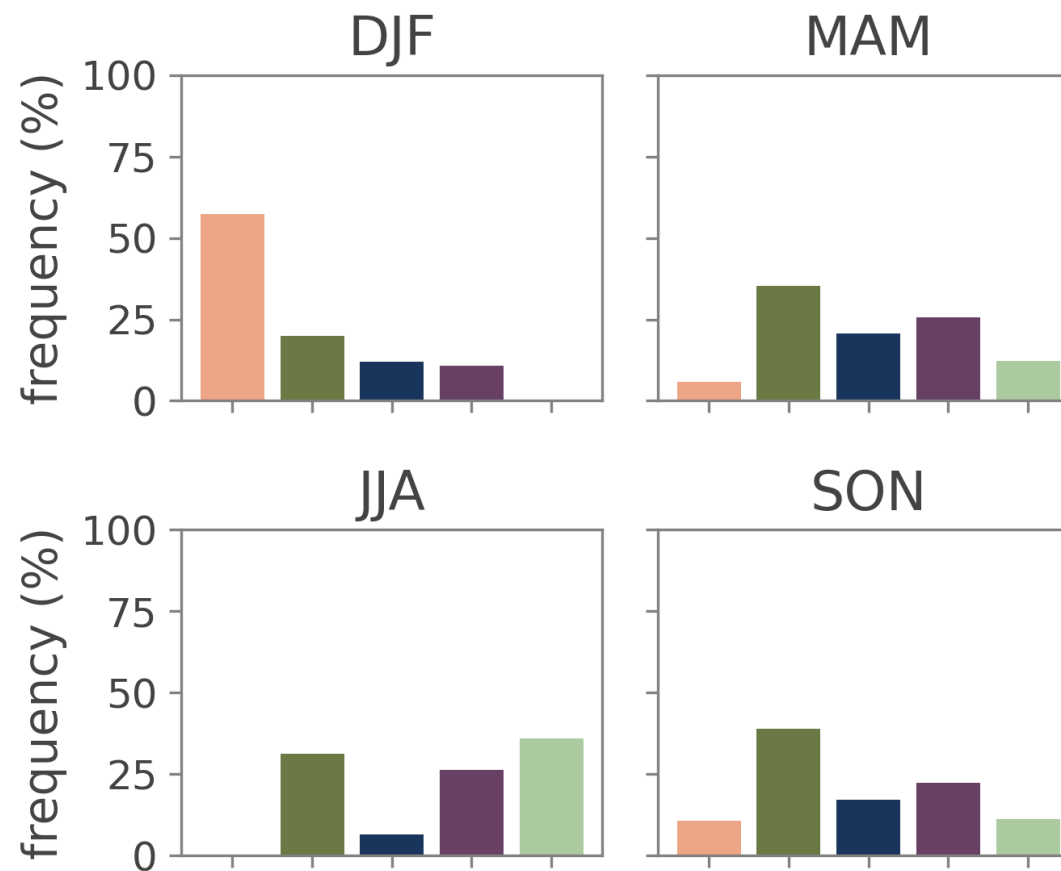elevation (m)
300   400   500   600

WegenerNet Feldbach Region Climate Station Network
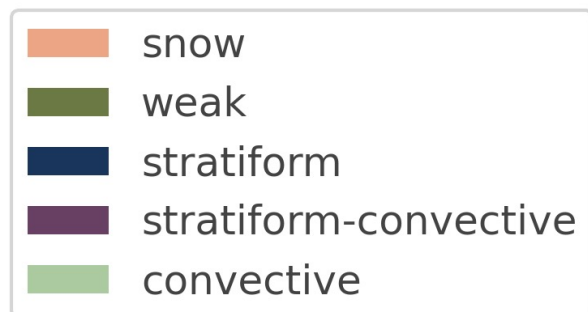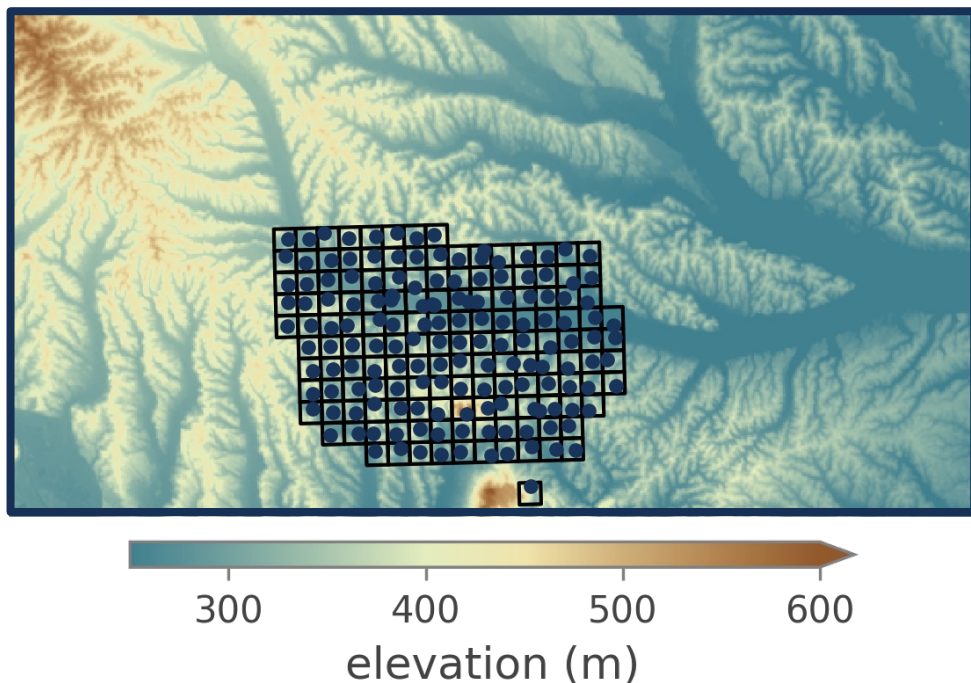
- The Feldbach region (FBR) is located in the Alpine forelands and experiences varied precipitation events

Precipitation Event Distribution 2021-03 – 2023-03

Legend:
- snow
- weak
- stratiform
- stratiform-convective
- convective

WegenerNet 3D Open-Air Laboratory

- The WegenerNet 3D Open-Air Laboratory extends this climate station network with **atmospheric sounding capabilities**

- Sensors complement the existing 2D infrastructure and offer rich synergies
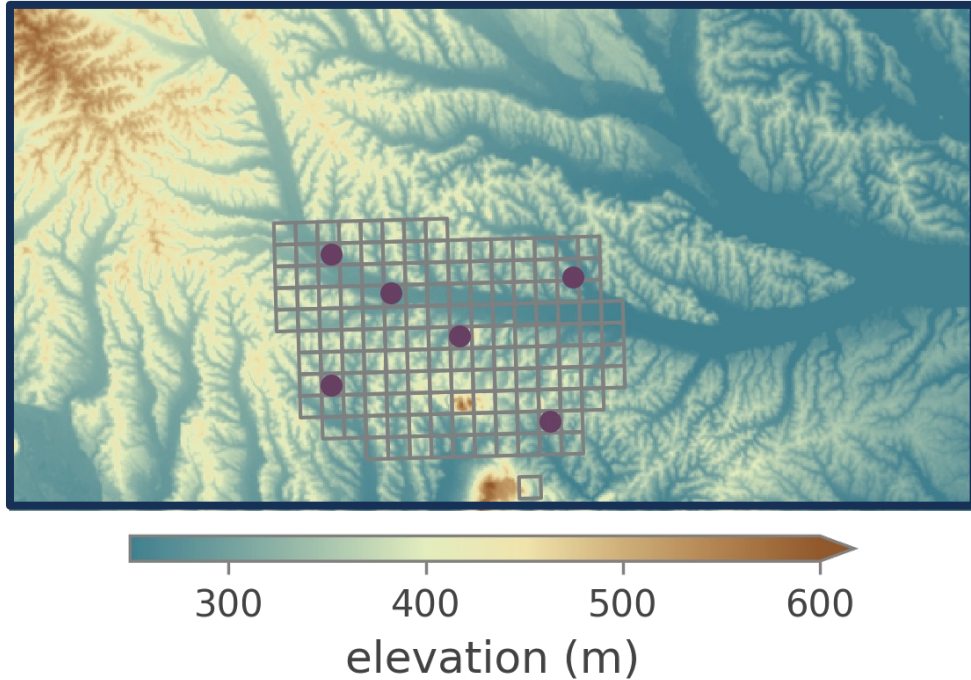
X-Band Weather Radar

Multi-GNSS Network

Infrared Cloud Structure Radiometer

Microwave Radiometer

WegenerNet 3D Open-Air Laboratory

elevation (m)

Multi-GNSS Network processed by
GFZ German Research Centre for Geosciences

- **6 multi-GNSS receivers** in (nested) star configuration

- Primary parameters: **tropospheric path delay in slant and zenith direction, integrated waper vapor (IWV), tropospheric gradients**

- **2.5 minute sampling** for slant delays,
  15 minute sampling for zenith delays and IWV

WegenerNet 3D Open-Air Laboratory

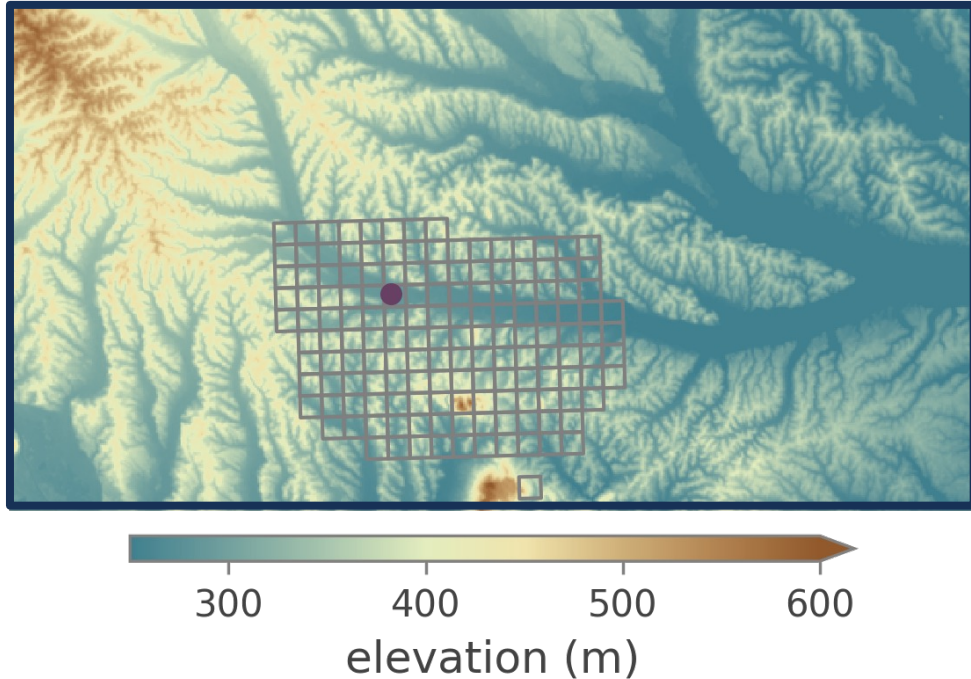FURUNO WR2120 X-Band Weather Radar
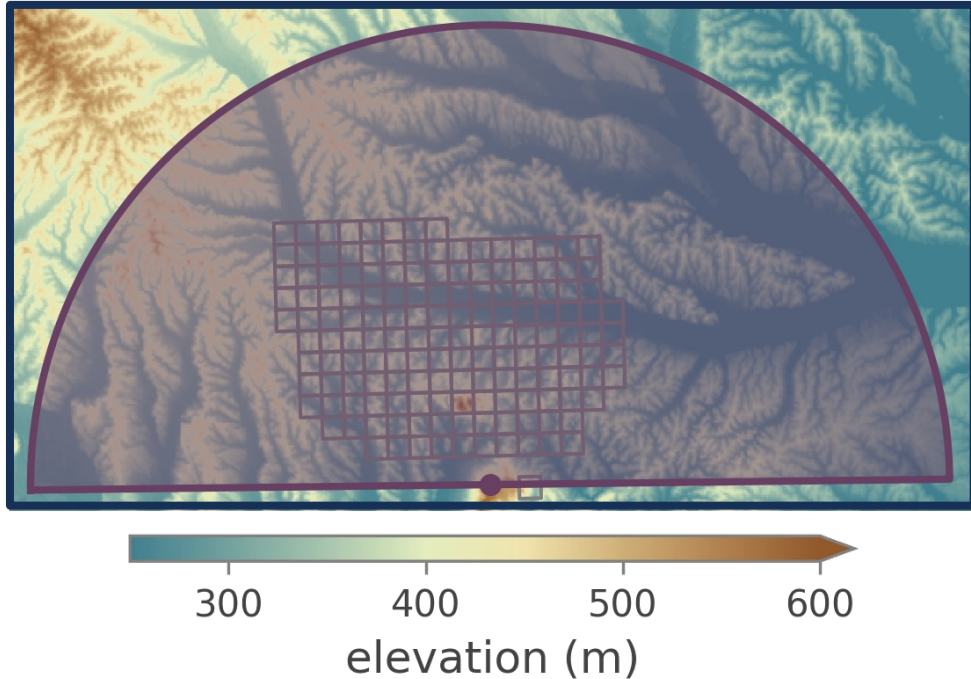
- X-Band dual-polarization weather radar
- Primary parameters: **precipitation rate, attenuation corrected reflectivity, hydrometeor and precipitation type**
- **2.5 minute sampling** for full volume scan

- The dense climate station network allows for a robust calibration of Z-R relations for different precipitation types and intensities

WegenerNet 3D Open-Air Laboratory

RPG HATPRO G5 Microwave Radiometer

NubiScope Infrared Cloud Structure Radiometer

elevation (m)
300   400   500   600

- All-sky scans and zenith direction measurements of **liquid water path, integrated water vapor, tropospheric path delay**

- **Temperature and humidity profiles** up to 10 km

- **10 minute sampling** for all-sky scans and profiles

- Full all-sky scan of infrared brightness temperature every **10 minutes**

- Combined with temperature profiles to determine **3D cloud structure**

WEGN3D – Primary Output Parameters

Water Vapor

- Integrated Water Vapor (IWV)
- Troposhperic Path Delay
- Troposhperic Gradients

Clouds

- 3D Cloud Structure
- Liquid Water Path (LWP)
- Liquid Water Content Maximum (LWC)

Precipitation

- Precipitation Amount
- Precipitation Classification

Atmosphere Properties

- Atmospheric Profiles
- Boundary Layer Depth
- Atmospheric Stability Indices

- Data products are provided as CF-compliant NetCDF data cubes
- Product types include time series, all-sky scans, and geolocated grids
- Each output variable is accompanied by **quality flags** and an **uncertainty estimate**

Precipitation Event Case Studies

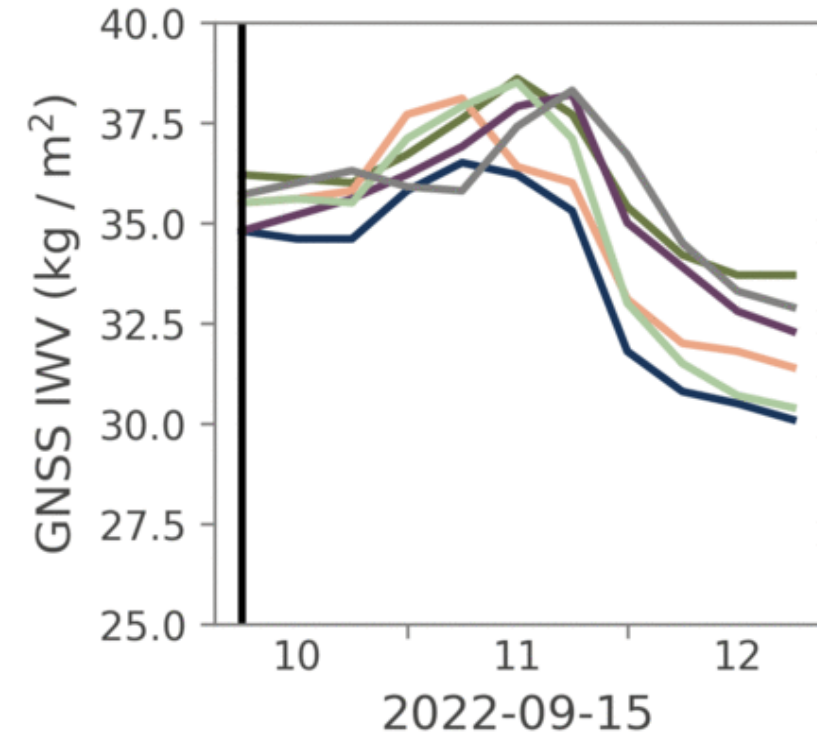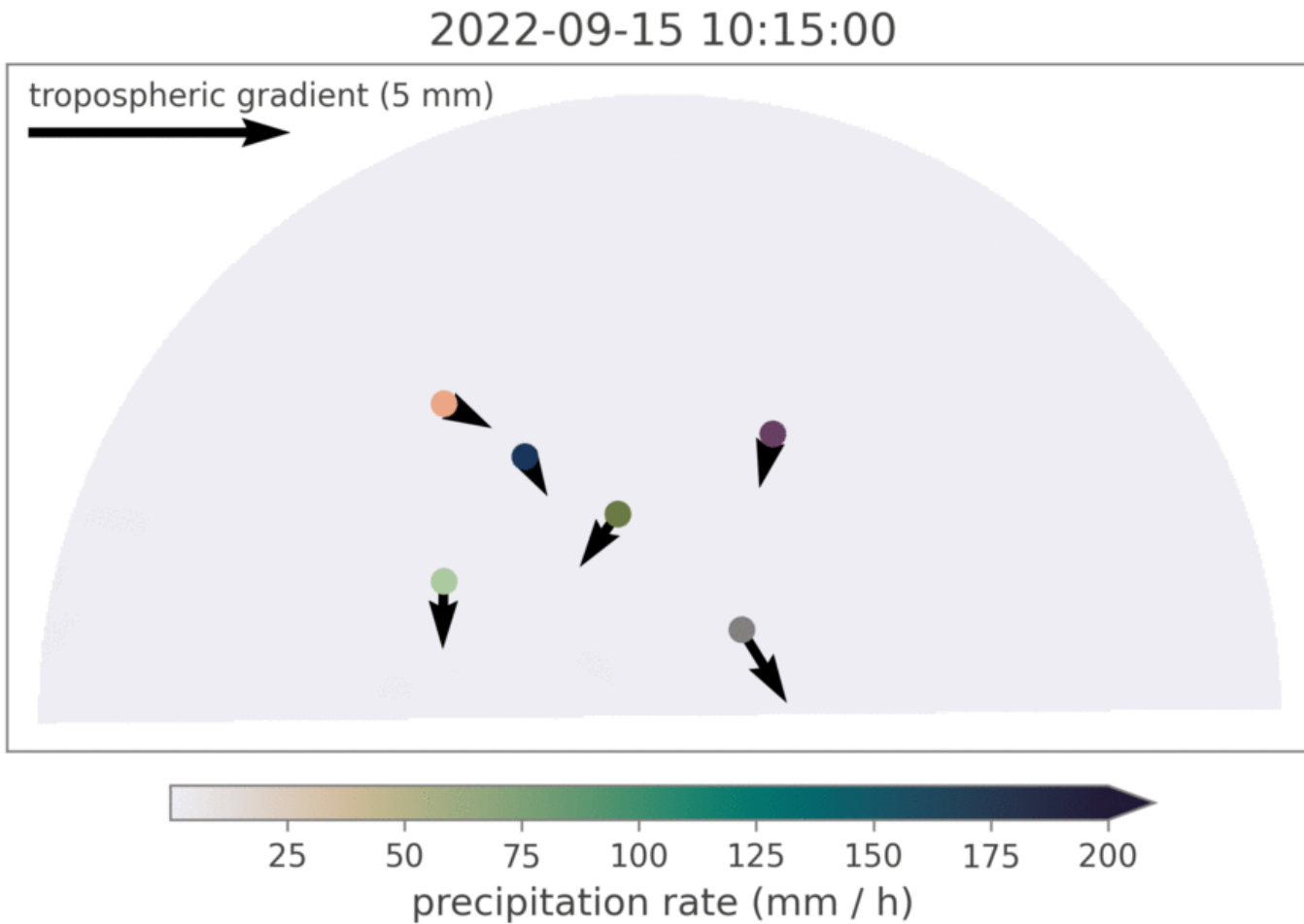# Precipitation Event Case Studies

2022-09-15 10:15:00

tropospheric gradient (5 mm)

precipitation rate (mm / h)
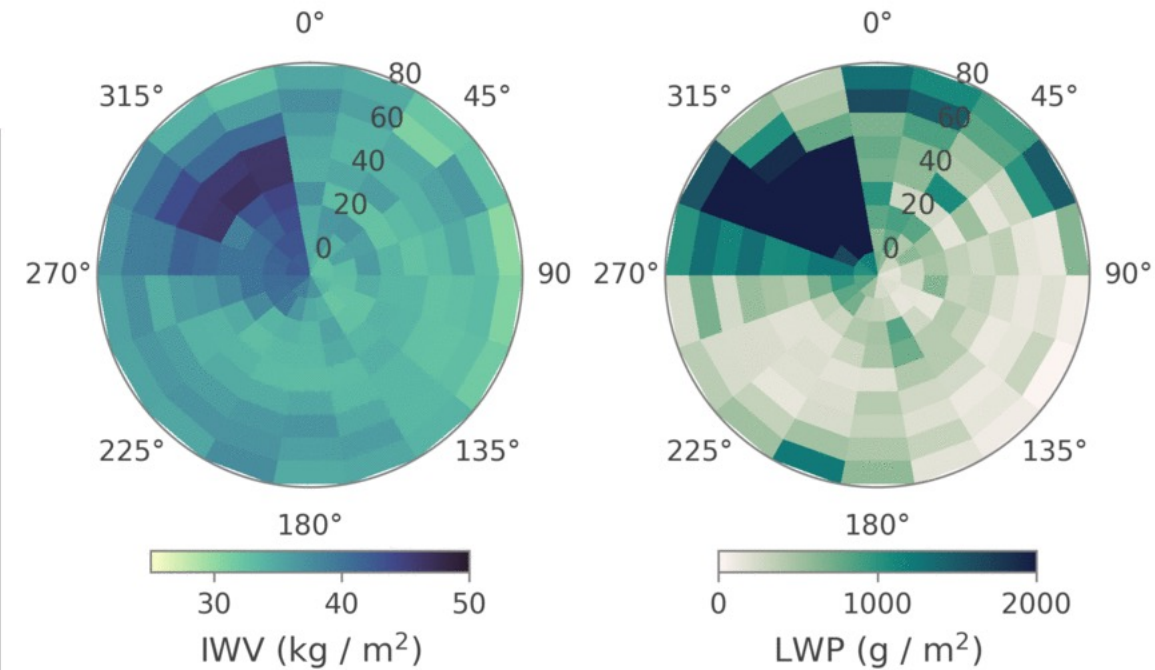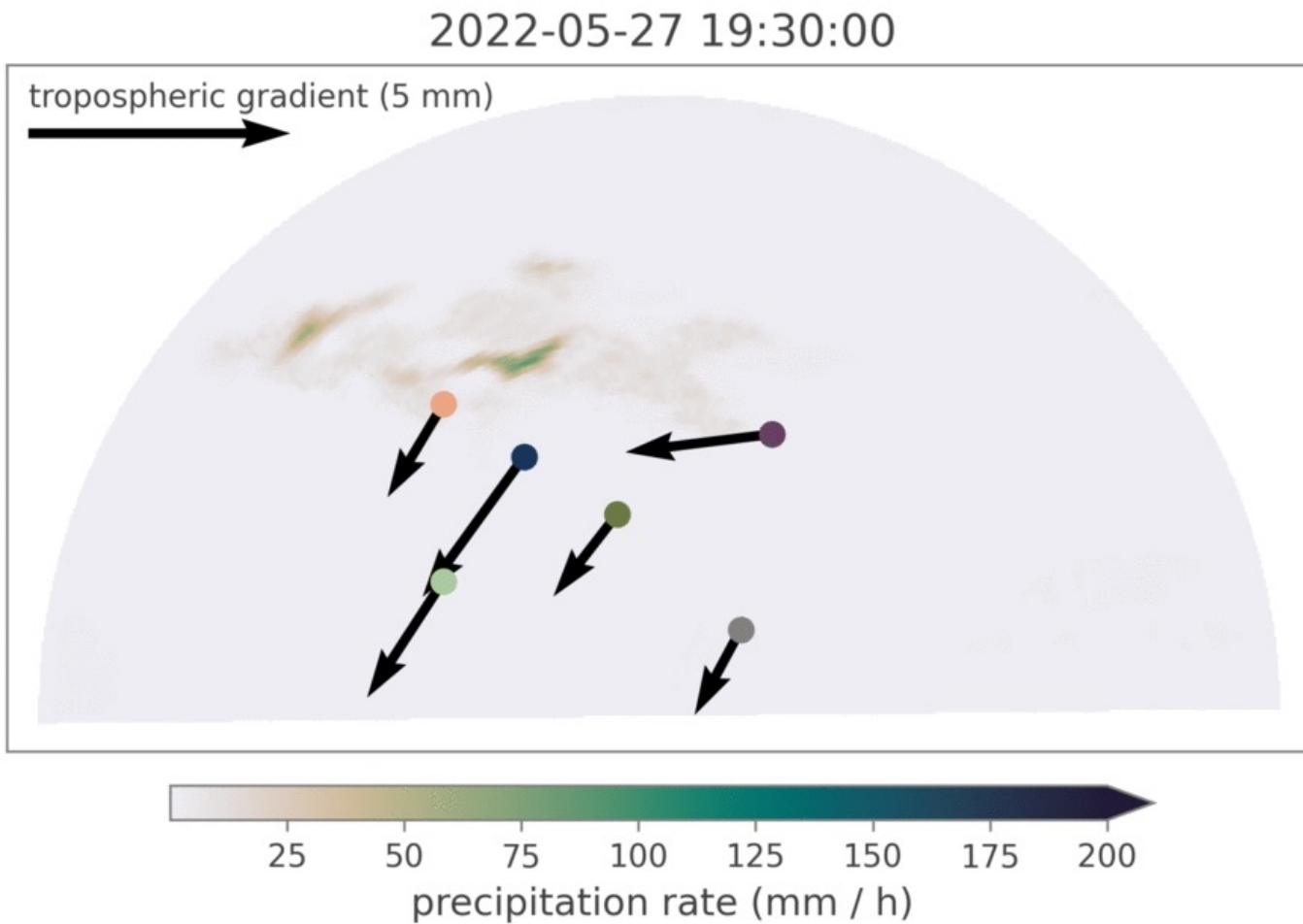
IWV (kg / m²)

LWP (g / m²)
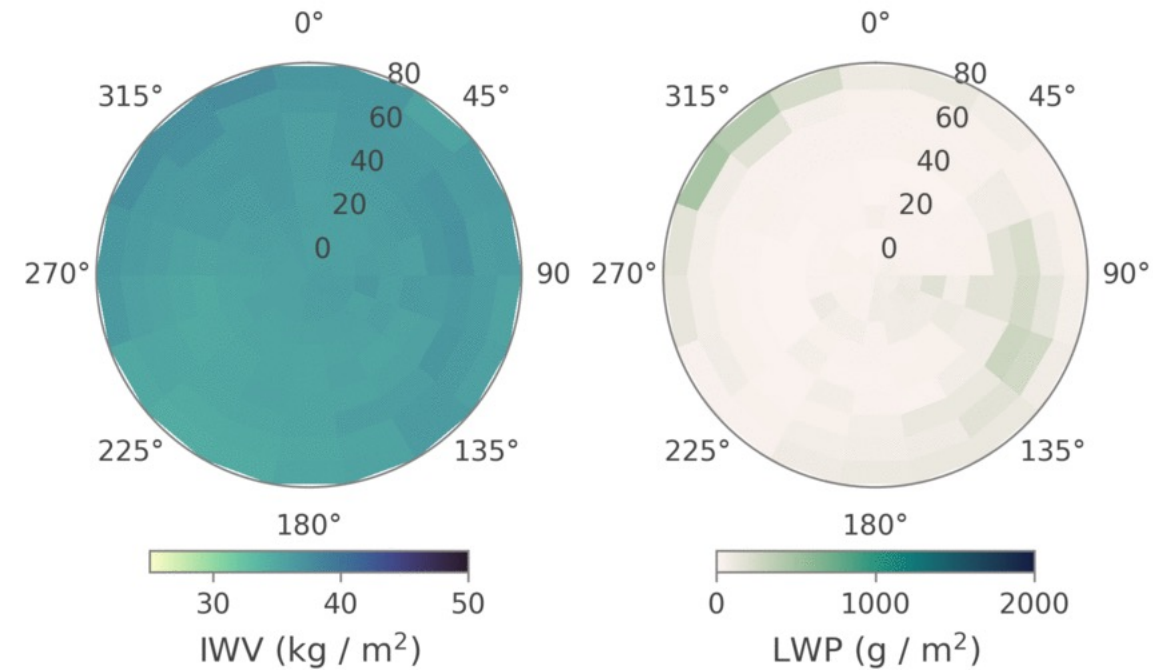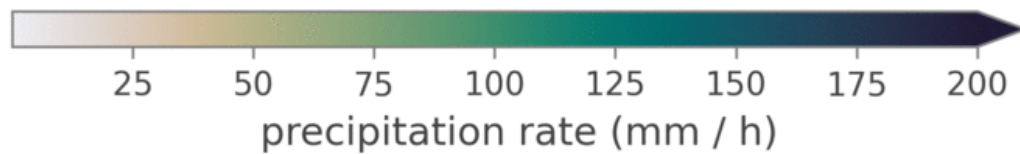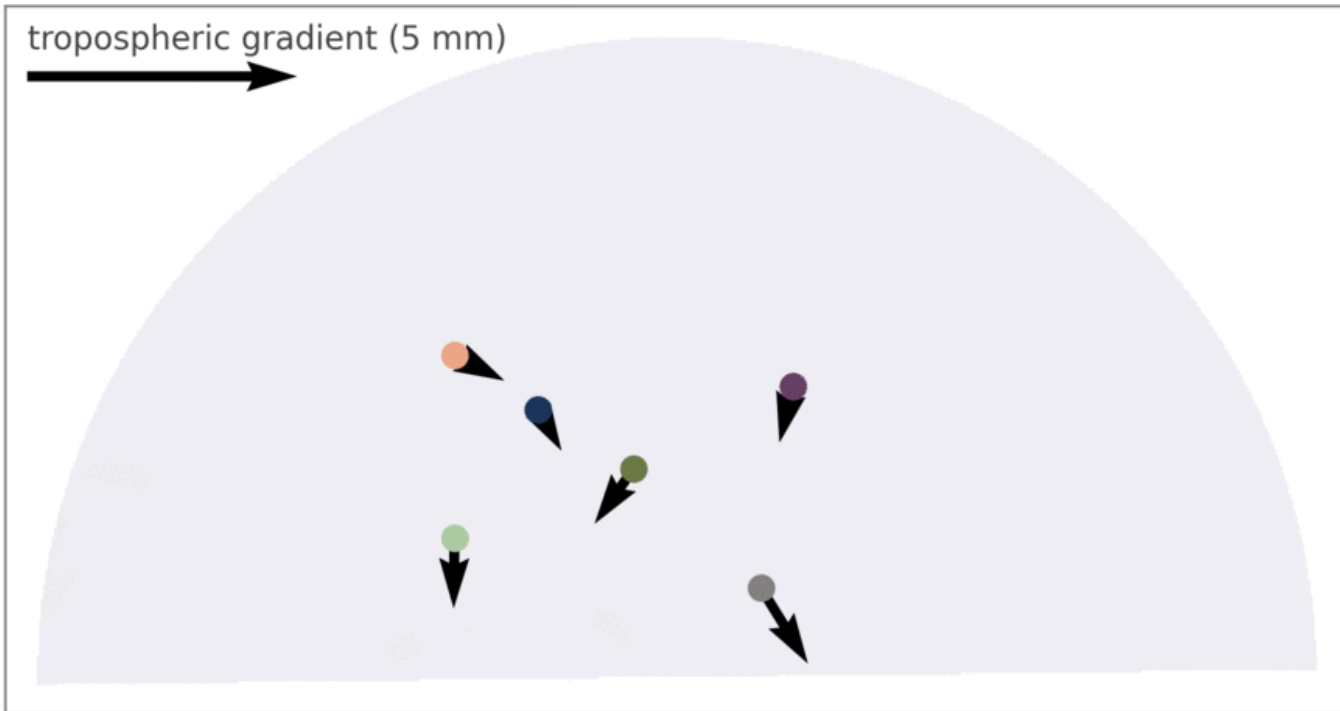
- Data products shown:
  - IWV and LWP all-sky scans (air mass corrected)
  - Tropospheric gradients
  - Radar-derived precipitation rate

Precipitation Event Case Studies

2022-09-15 10:15:00

tropospheric gradient (5 mm)

precipitation rate (mm / h)

- Data products shown:
  - GNSS-derived water vapor
  - GNSS tropospheric gradients
  - Radar-derived precipitation rate

- Data products shown:
  - IWV and LWP all-sky scans (air mass corrected)
  - GNSS tropospheric gradients
  - Radar-derived precipitation rate

2022-05-27 19:30:00

tropospheric gradient (5 mm)

precipitation rate (mm / h)

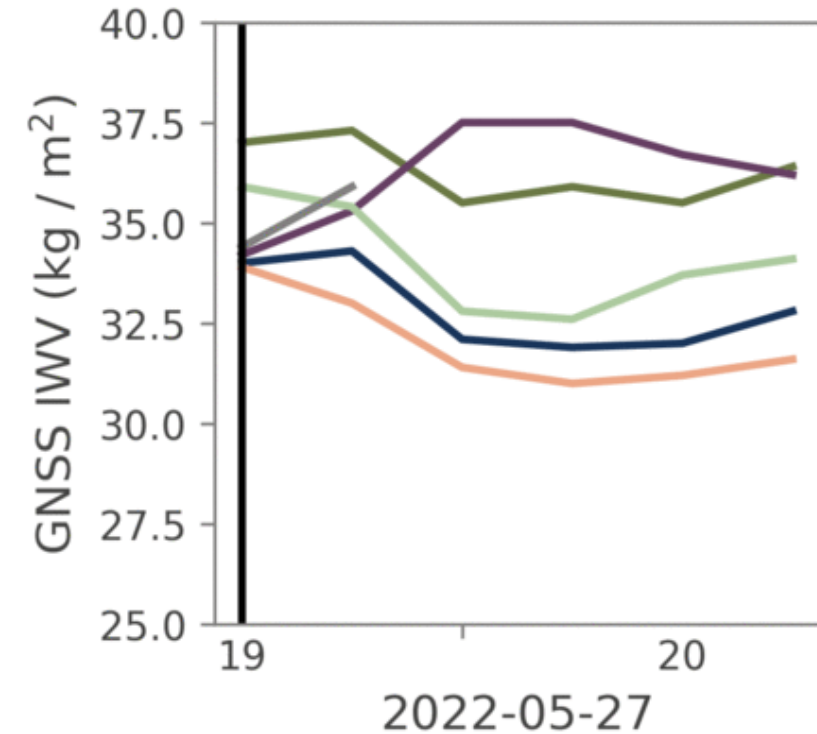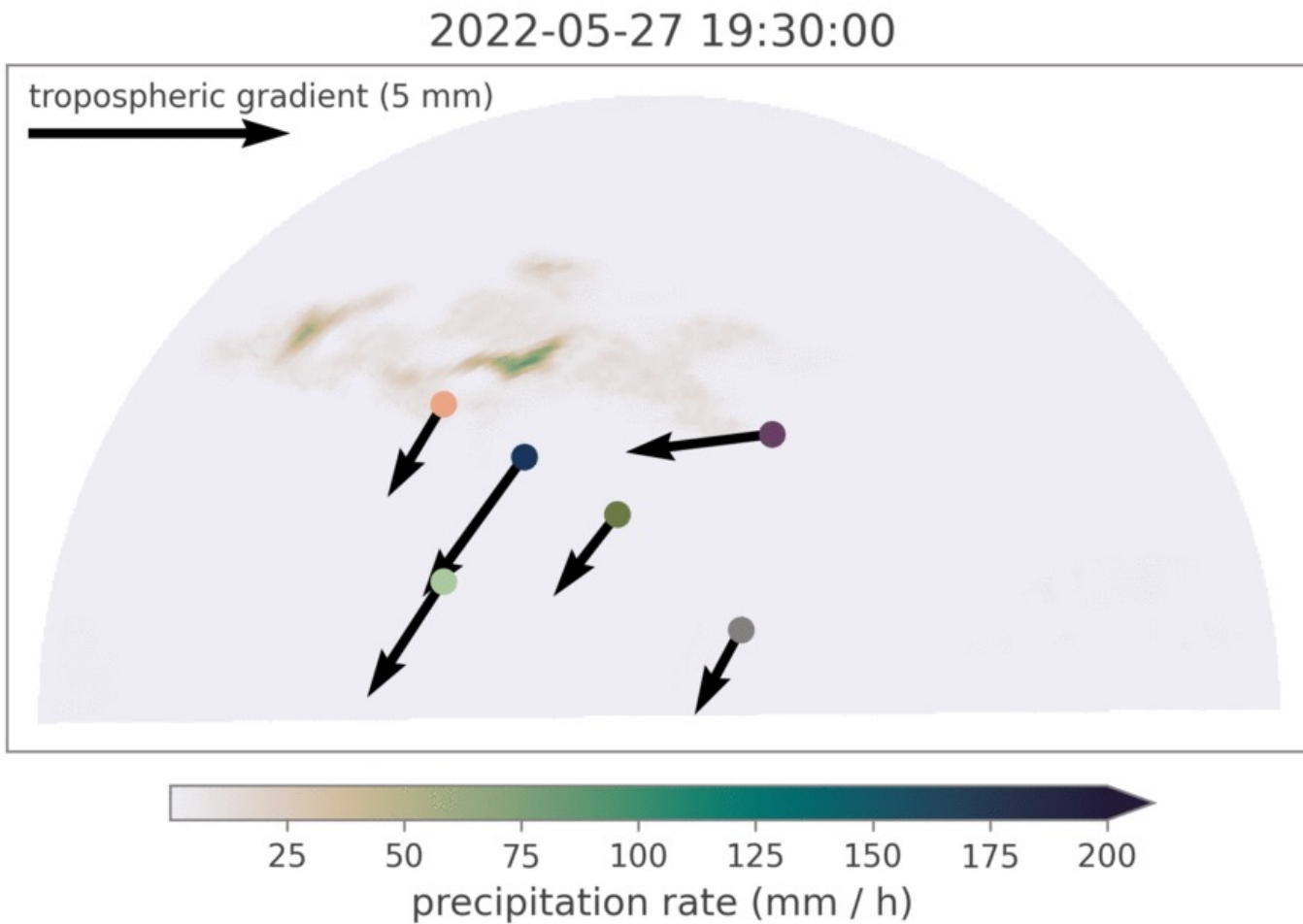GNSS IWV (kg / m²)

2022-05-27

- Data products shown:
    - GNSS-derived water vapor
    - GNSS tropospheric gradients
    - Radar-derived precipitation rate
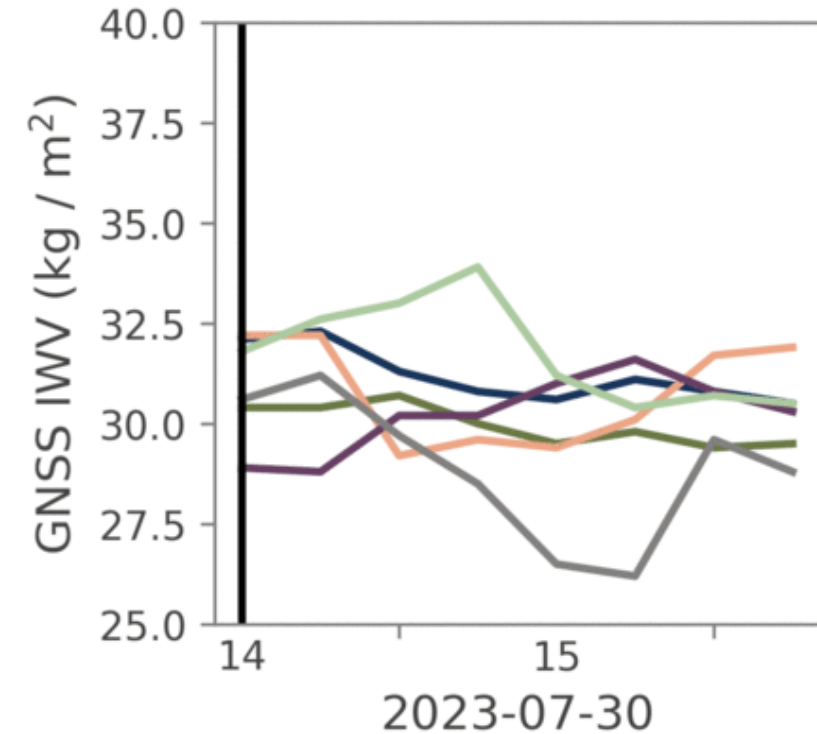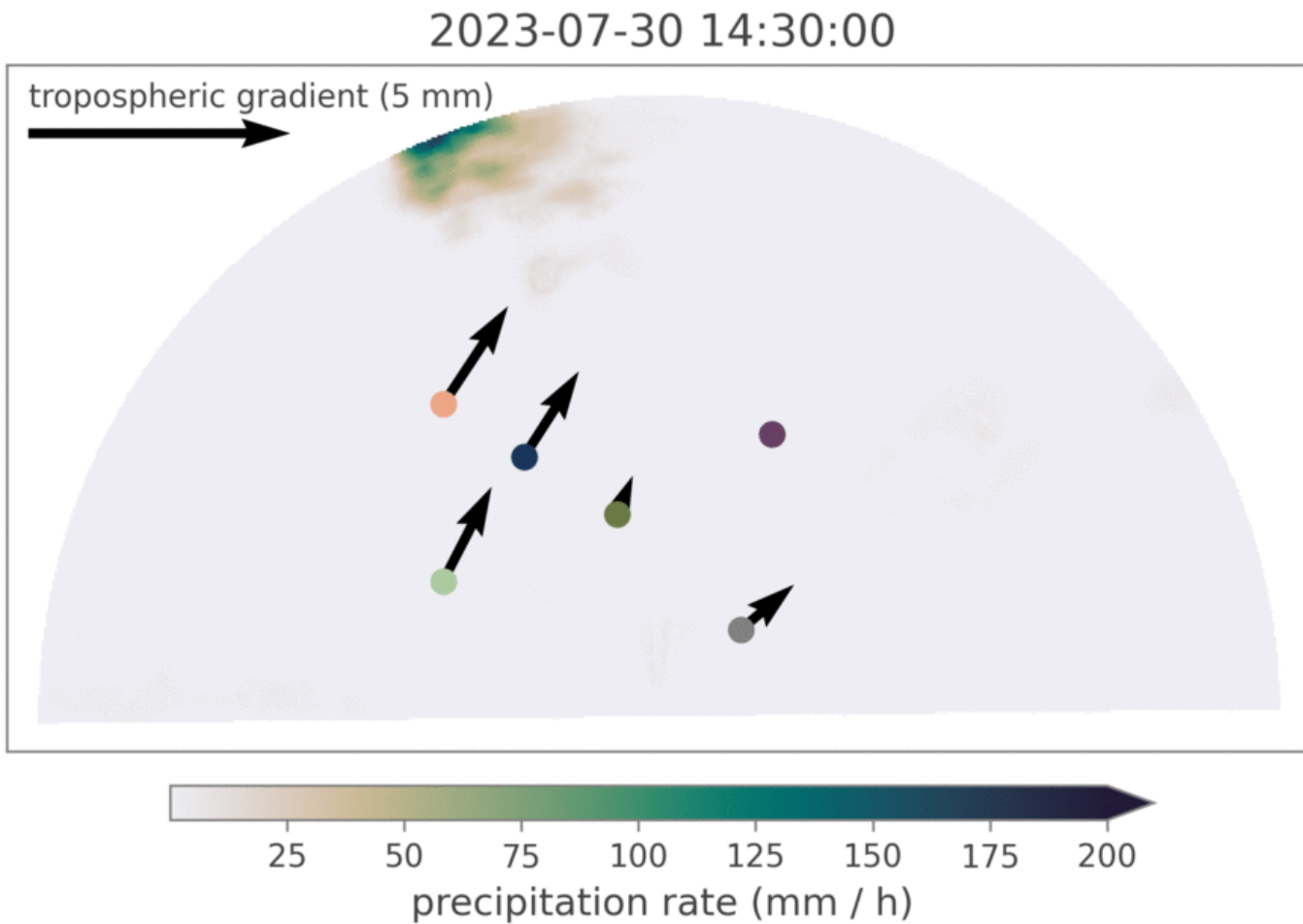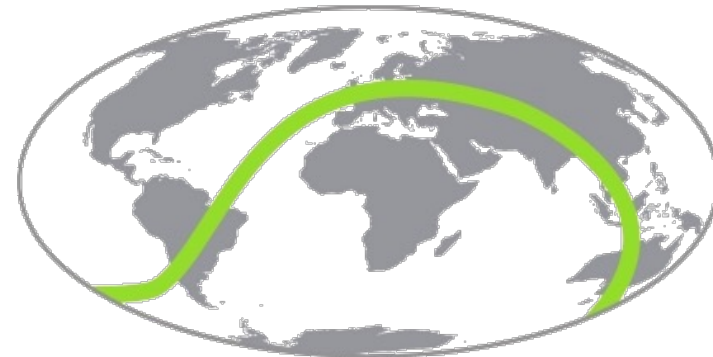
Precipitation Event Case Studies

2023-07-30 14:30:00

tropospheric gradient (5 mm)

precipitation rate (mm / h)

- Data products shown:
    - GNSS-derived water vapor
    - Tropospheric gradients
    - Radar-derived precipitation rate

Summary

Summary

- The WegenerNet 3D Open-Air Laboratory provides high-resolution, multi-sensor data for the study of precipitation events

- It has been operational in the current configuration since mid-2021, providing a consistent and growing data record of over two years

- Preliminary datacubes are in preparation and will be made available on **wegenernet.org** in **September/October 2023**

wegenernet.org

WegenerNet Data Portal