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]

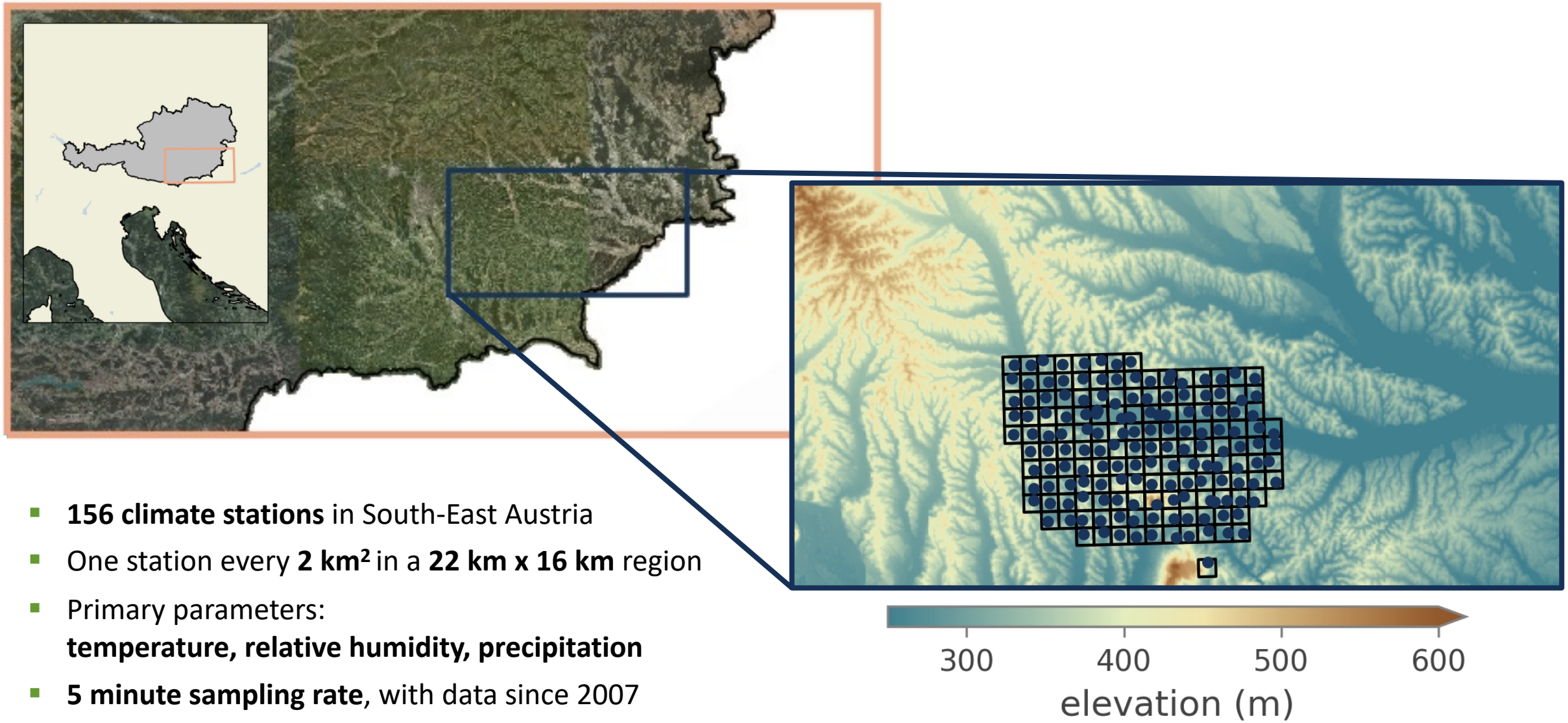
1) Wegener Center for Climate and Global Change (WEGC), University of Graz, Austria
2) Institute of Physics, University of Graz, Austria
3) Institute for Geography and Regional Science, University of Graz, Austria

EMS2023, 2023-09-06

WegenerNet 3D Open-Air Laboratory

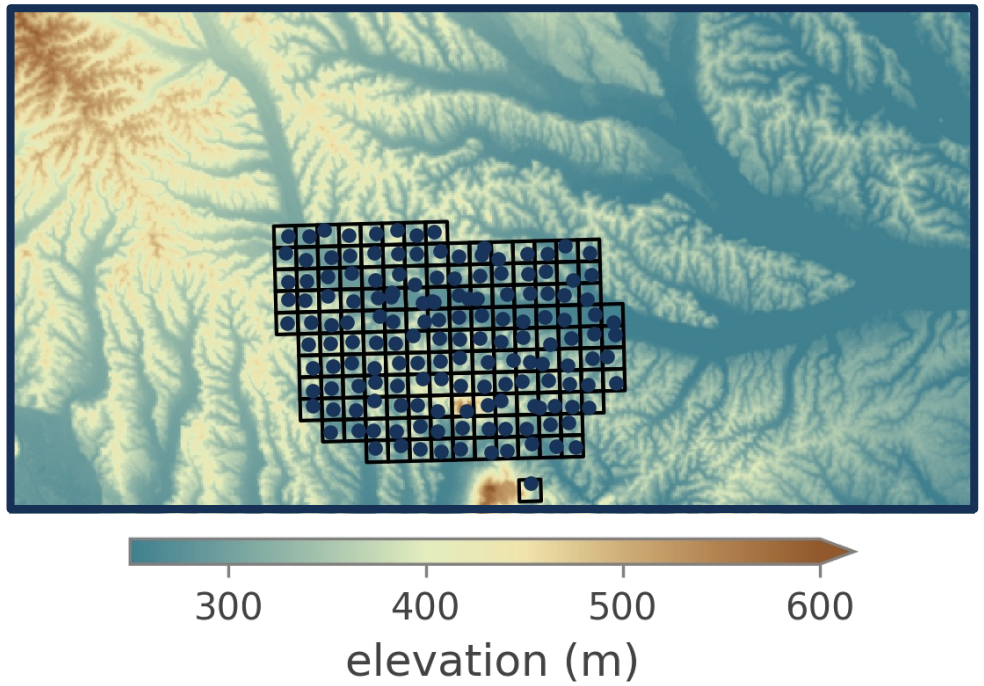
SCREEN CAPTURE
WELCOME

WegenerNet Feldbach Region Climate Station Network

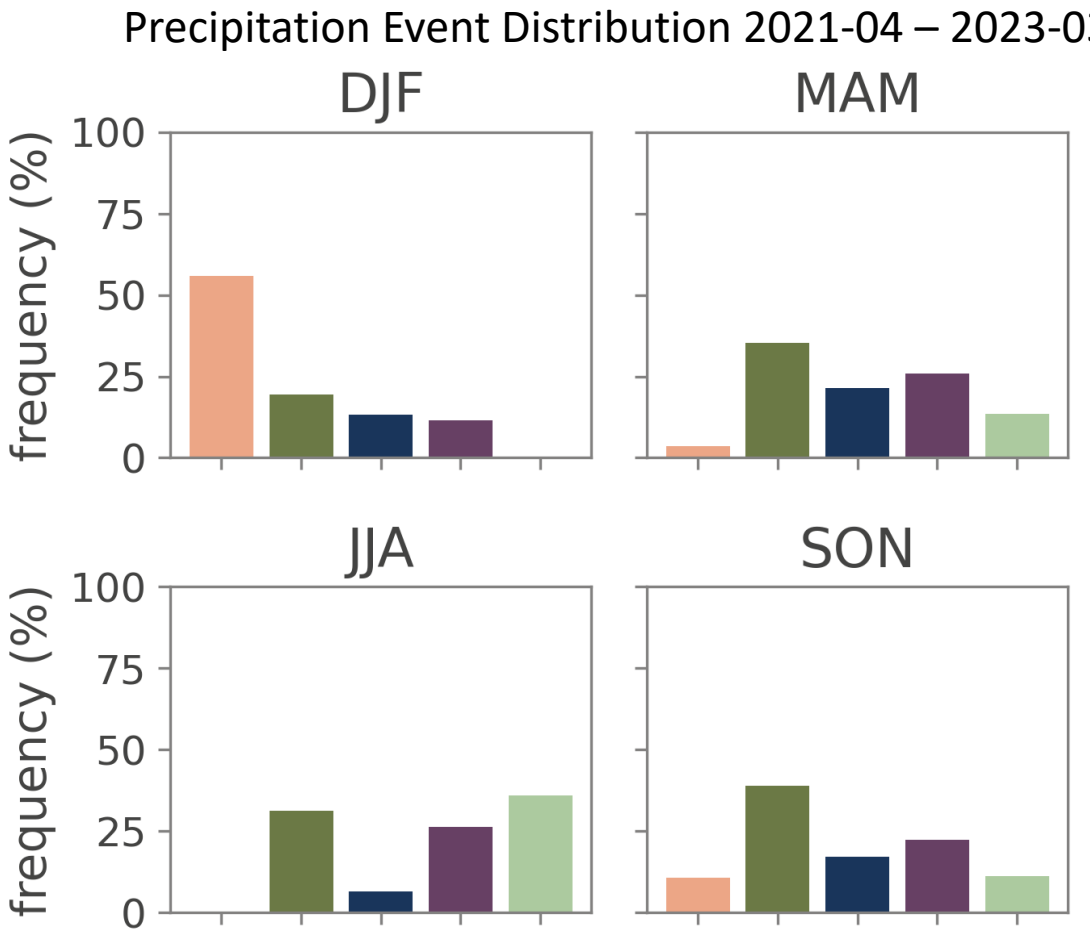


- **156 climate stations** in South-East Austria
- One station every **2 km²** in a **22 km x 16 km** region
- Primary parameters:
  temperature, relative humidity, precipitation
- **5 minute sampling rate**, with data since 2007

WegenerNet Feldbach Region Climate Station Network



- The Feldbach region (FBR) is located in the Alpine forelands and experiences a wide variety of precipitation events



WegenerNet 3D Open-Air Laboratory – WEGN 3D

- The WegenerNet 3D Open-Air Laboratory extends this climate station network with **atmospheric sounding capabilities**
- Sensors complement the existing 2D ground station infrastructure and offer rich synergies

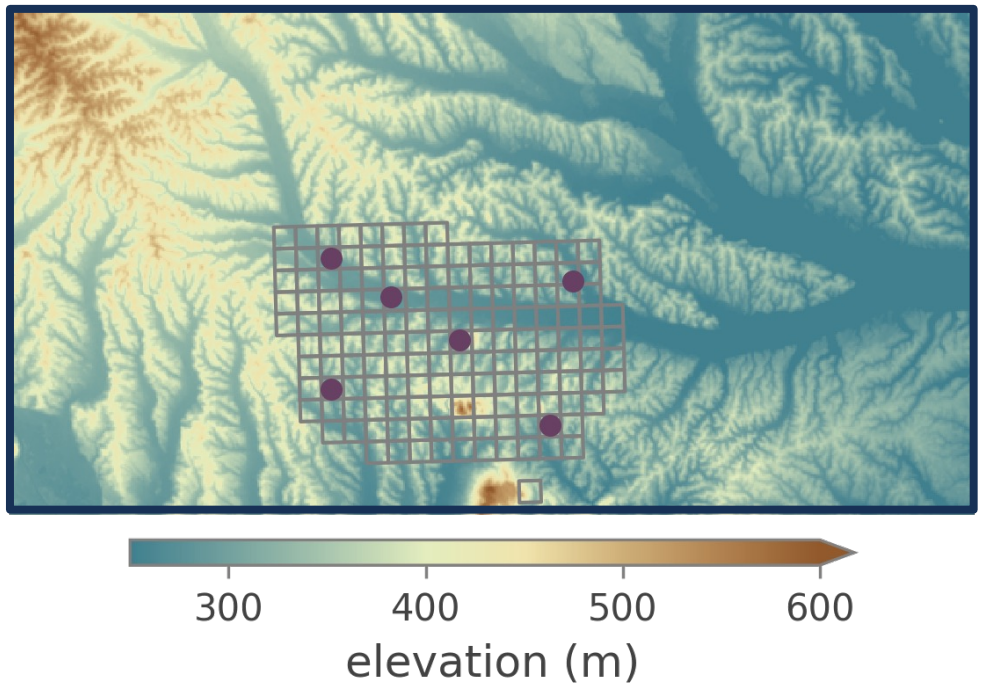
X-Band Precipitation Radar

GNSS Water Vapor Sounding Network GNSS-StarNet

Infrared Cloud Structure Radiometer

Microwave Tropospheric Profiling Radiometer

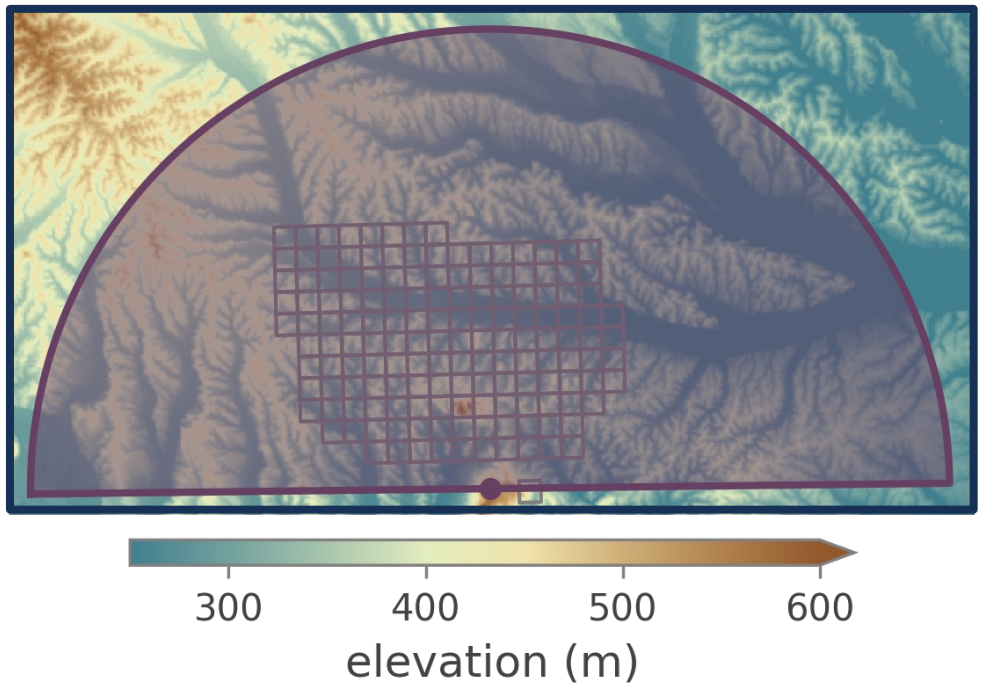
WegenerNet 3D Open-Air Laboratory: GNSS-StarNet



- **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 delay time series,
  15 minute sampling for zenith delay and IWV time series

Six-station GNSS-StarNet tracking data processed by GFZ German Research Centre for Geosciences

WegenerNet 3D Open-Air Laboratory: Precipitation Radar

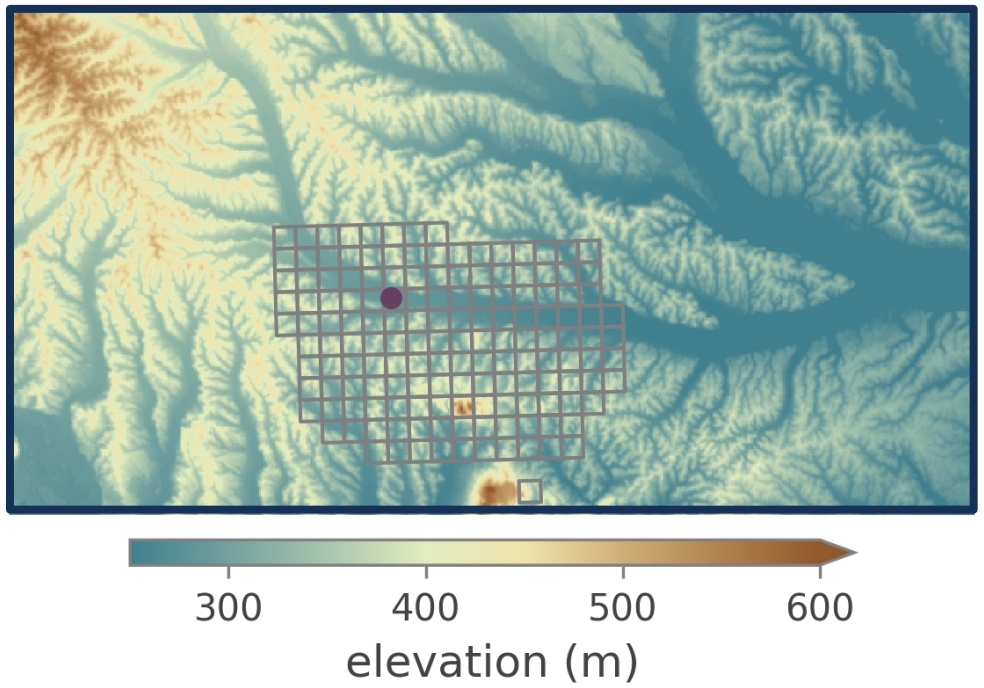


FURUNO WR2120 **X-Band Precipitation Radar**

- X-Band dual-polarization weather radar, focus precipitation
- Primary parameters: **precipitation rate, attenuation-corrected reflectivity, hydrometeor and precipitation type**
- **2.5 minute sampling** for full volume scan (3D field)

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

WegenerNet 3D Open-Air Laboratory: MW, IR Radiometers



RPG HATPRO G5 **Microwave Tropospheric Profiling Radiometer**

NubiScope **Infrared Cloud Structure Radiometer**

- **Temperature and humidity profiles** up to 10 km
- All-sky maps and zenith-direction measurements of **liquid water path, integrated water vapor, tropospheric path delay**
- **10 minute sampling** for profiles and all-sky maps

- Full all-sky map of infrared brightness temperature every **10 minutes**
- Combined with temperature profiles to determine **3D cloud structure** maps at several cloud levels

WEGN 3D – Primary Output Parameters

Water Vapor

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

Clouds

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

Precipitation

- Precipitation Amount
- Precipitation Classification

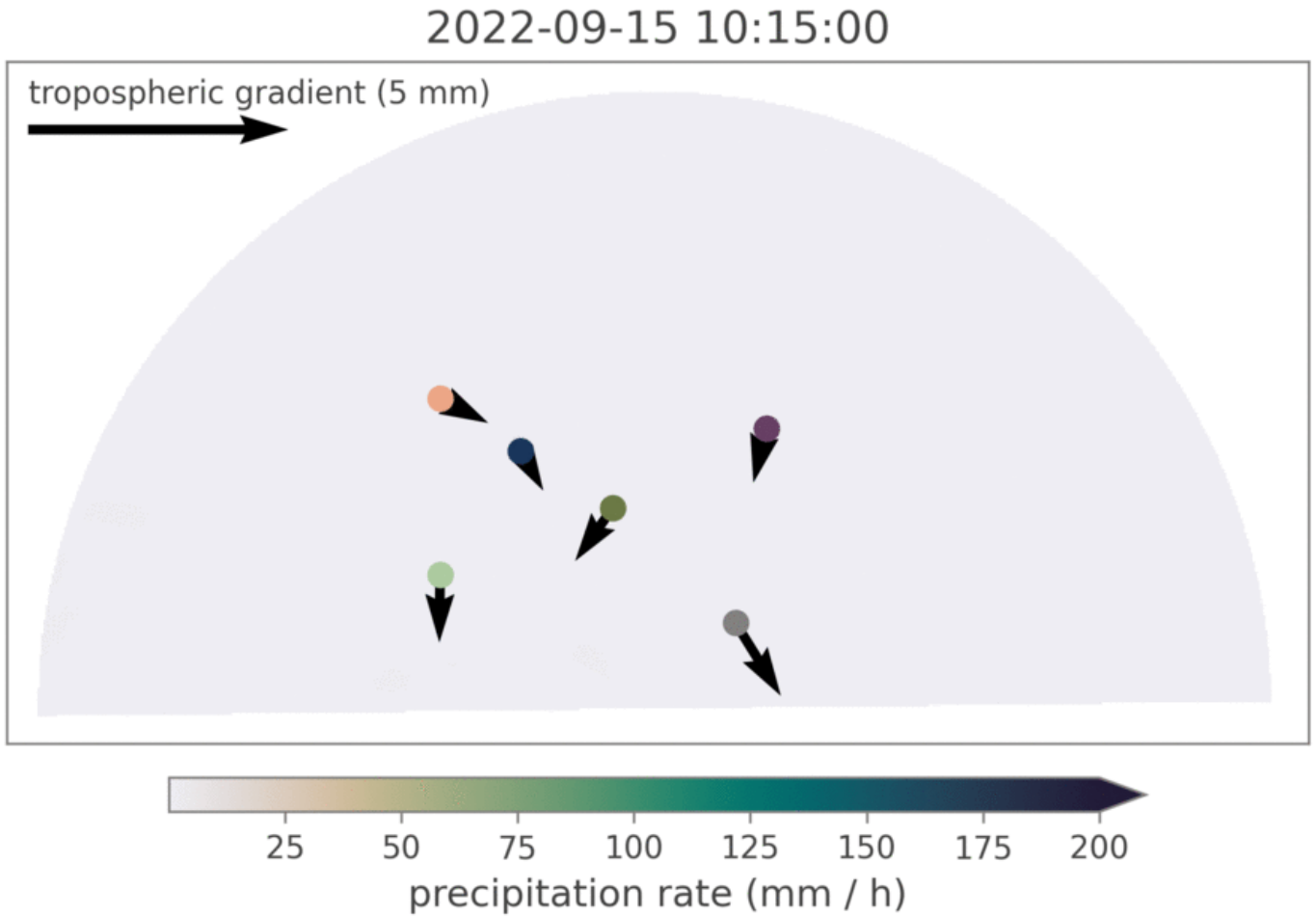
Atmospheric Properties

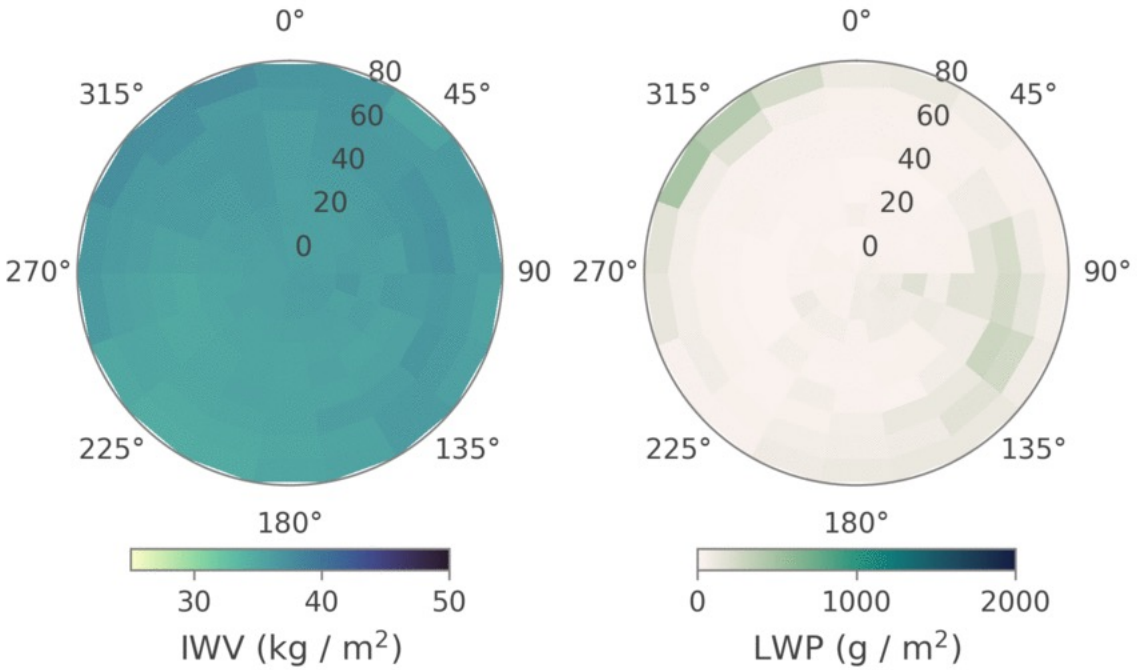
- Tropospheric Profiles
- Boundary Layer Depth
- Atmospheric Stability Indices

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

Precipitation Event Case Studies

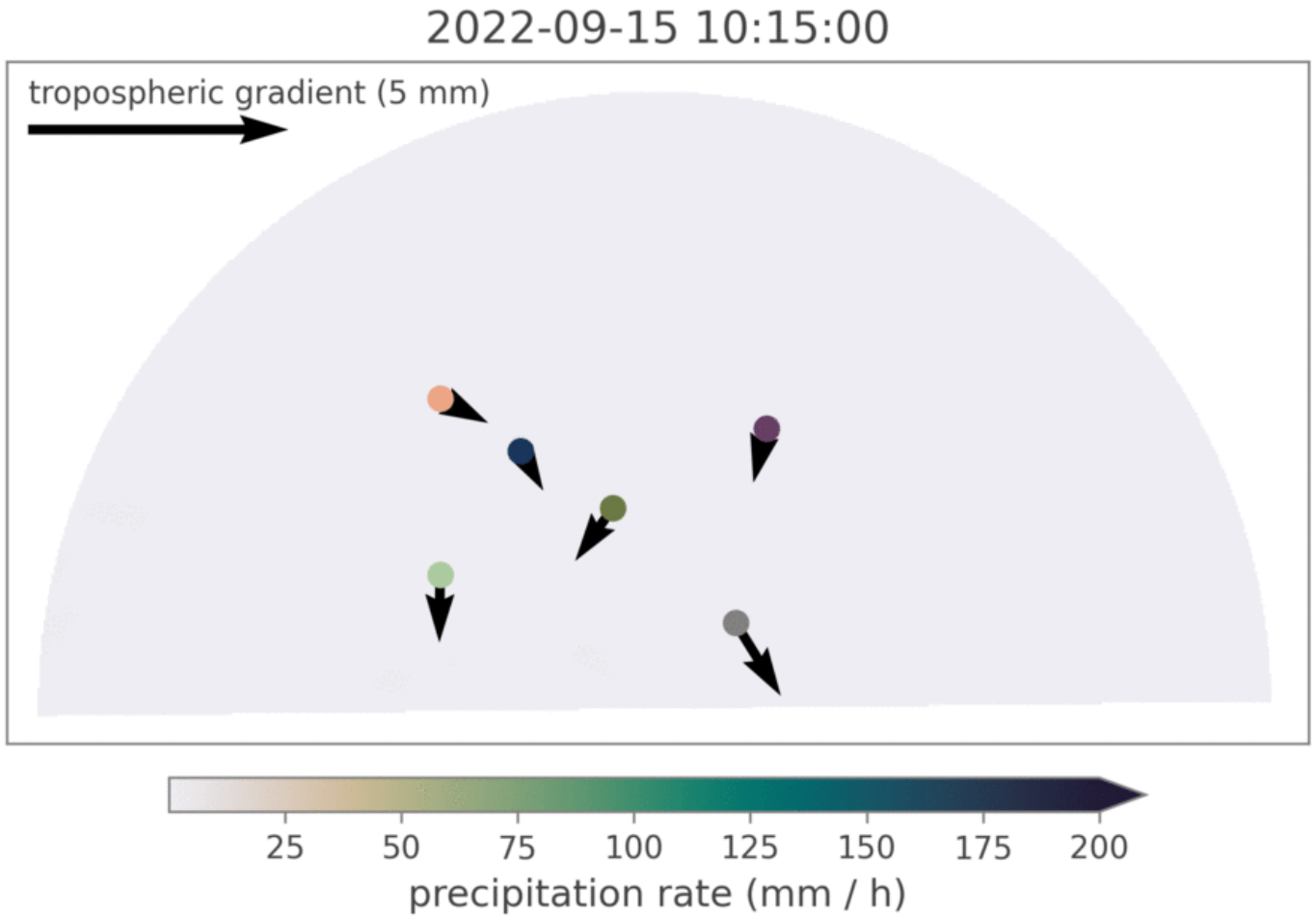
Precipitation Event Case Studies

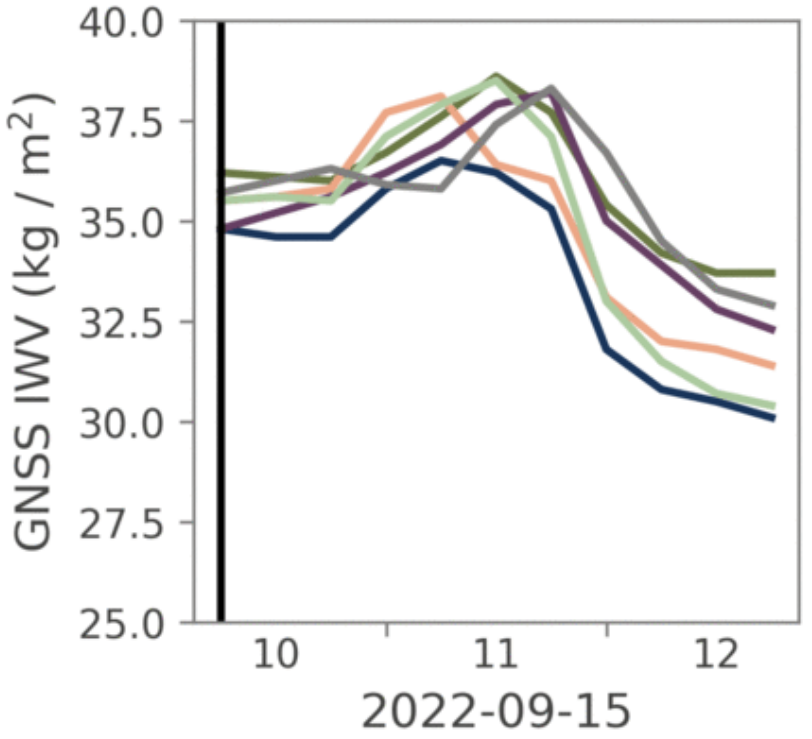




- Data products shown:
  - IWV and LWP all-sky maps (air mass corrected)
  - Tropospheric gradients
  - Radar-derived precipitation rate

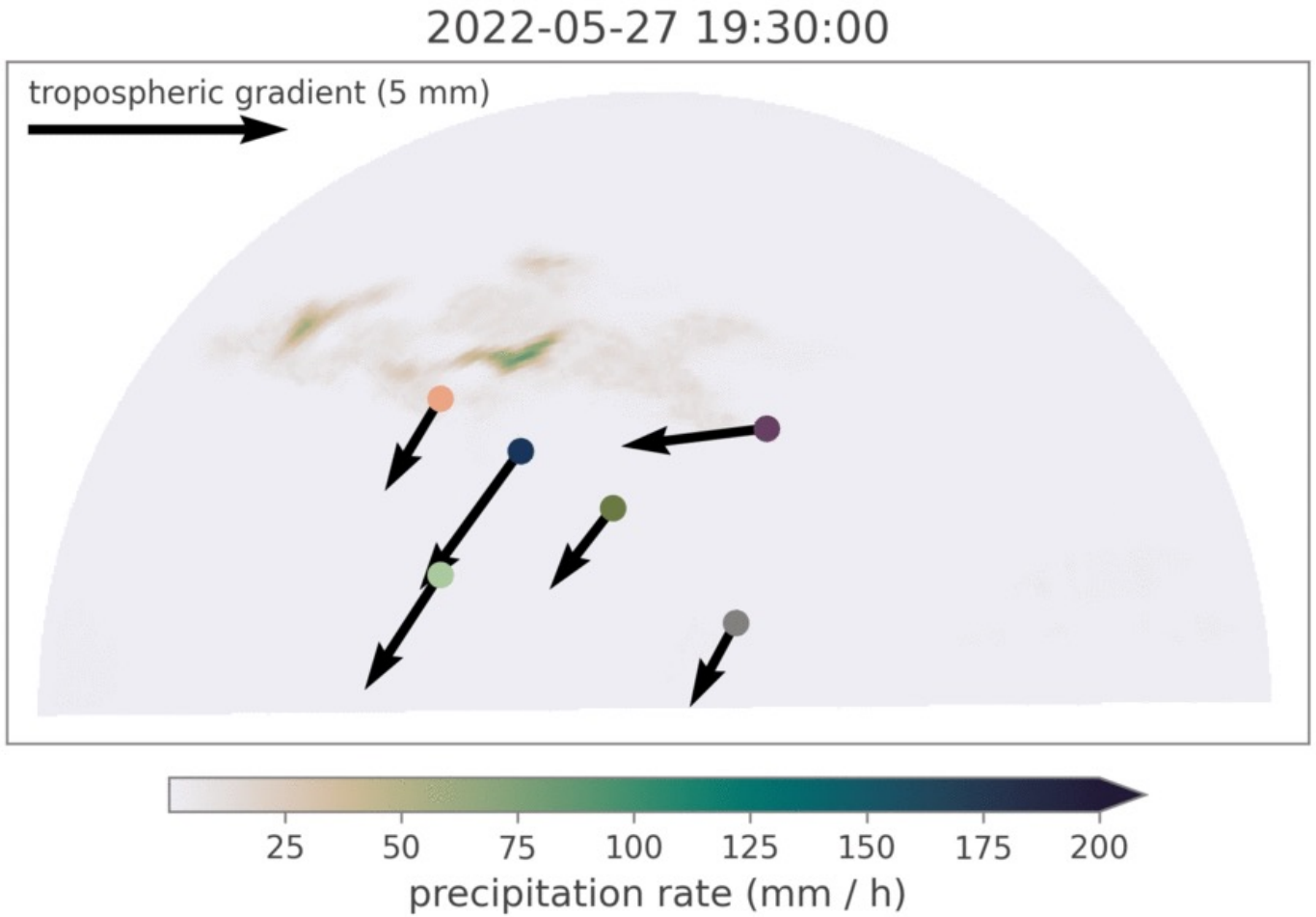
Precipitation Event Case Studies

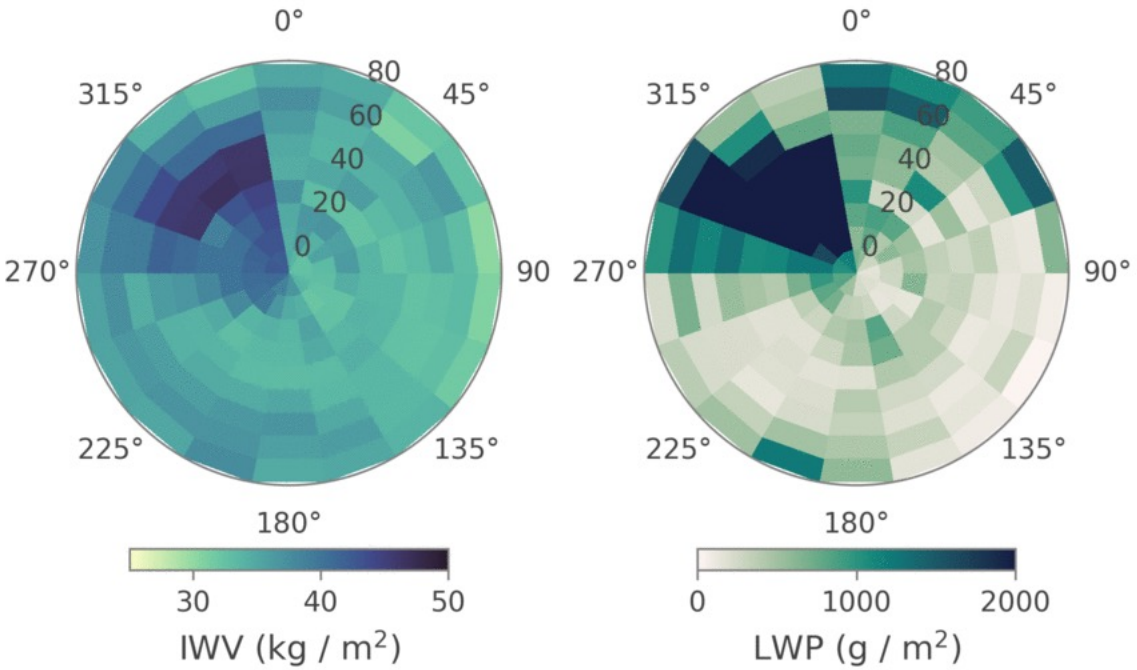




- Data products shown:
  - GNSS-derived water vapor
  - GNSS tropospheric gradients
  - Radar-derived precipitation rate

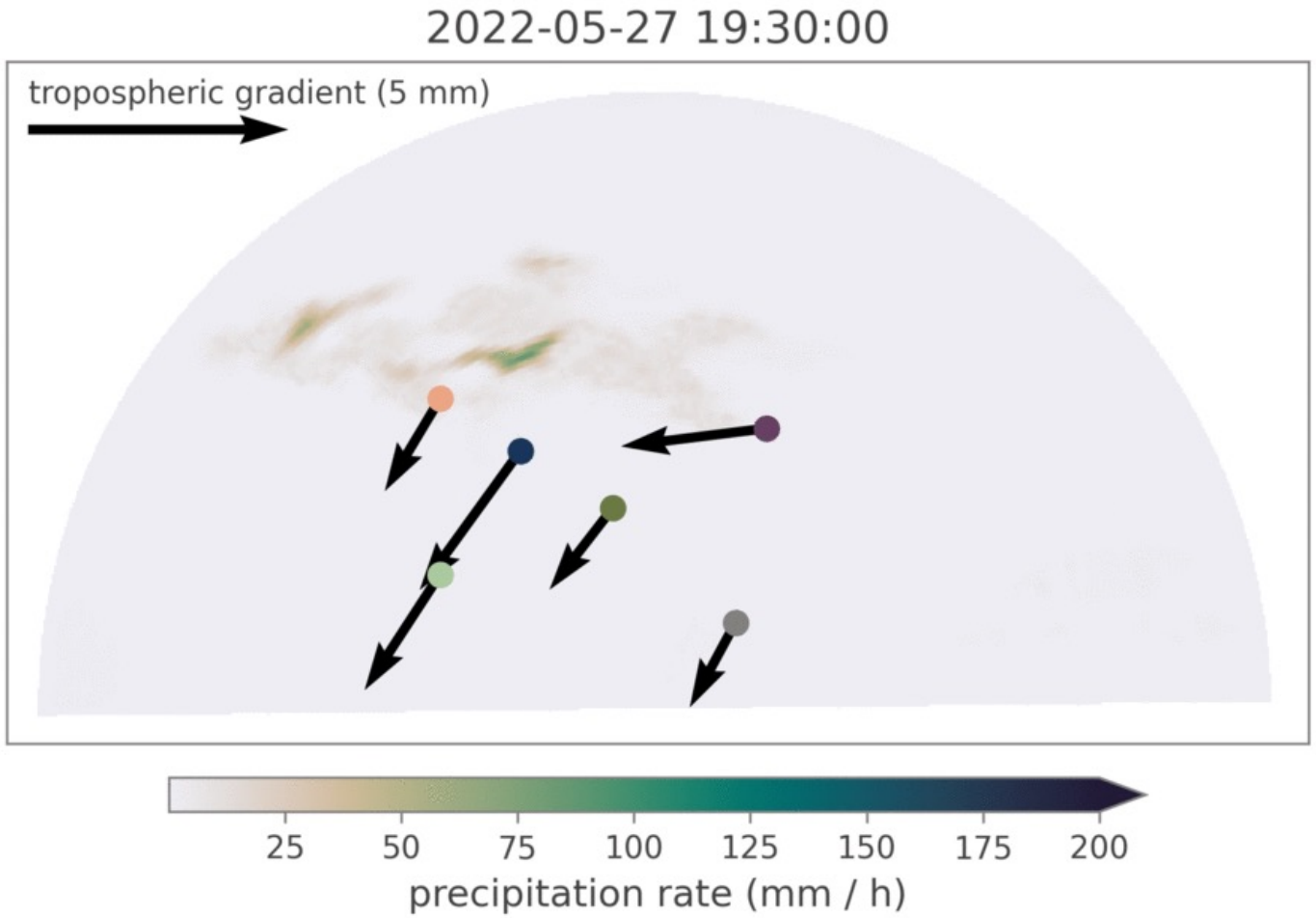
Precipitation Event Case Studies

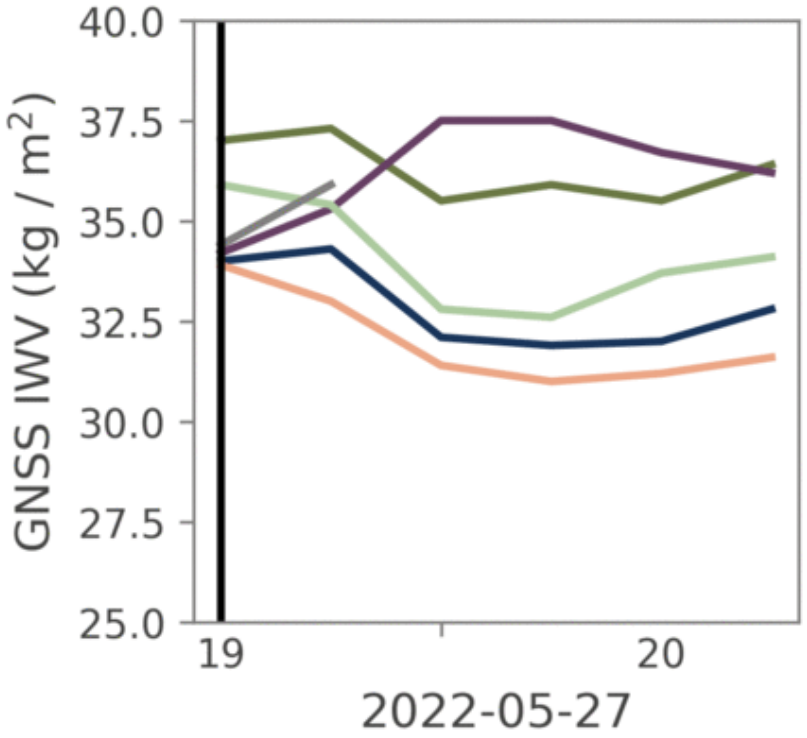




- Data products shown:
  - IWV and LWP all-sky maps (air mass corrected)
  - GNSS tropospheric gradients
  - Radar-derived precipitation rate

Precipitation Event Case Studies





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

Summary

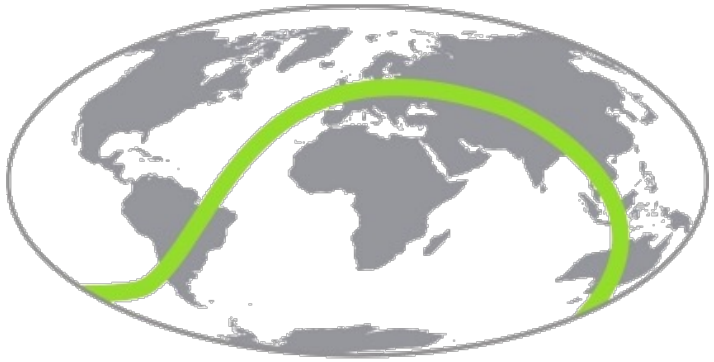
Summary

- The WegenerNet 3D Open-Air Laboratory (WEGN 3D) 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 WEGN 3D data record of over meanwhile more than two years

- Preliminary datacubes are in close-to-final preparation and will be made available on **wegenernet.org** as of **October 2023**

wegenernet.org



WegenerNet Data Portal