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# LONG-TERM STATISTICS OF WATER VAPOUR AND CLOUDS FROM MICROWAVE RADIOMETER OBSERVATIONS IN JÜLICH WITH FOCUS ON CLOUD PROPERTIES

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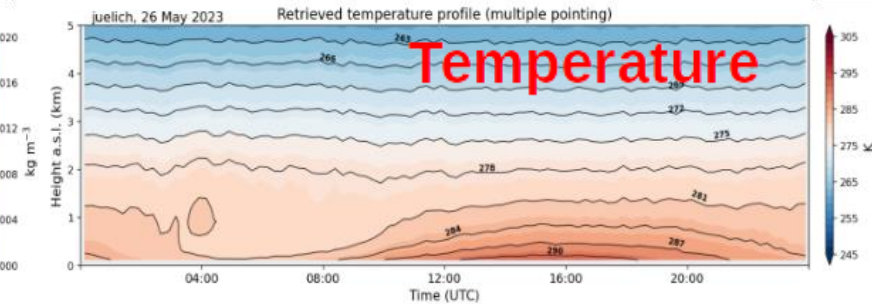
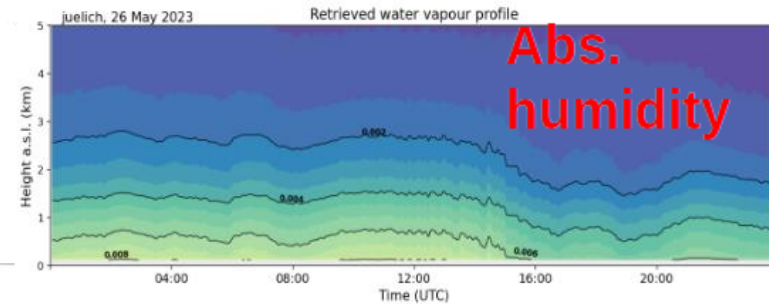
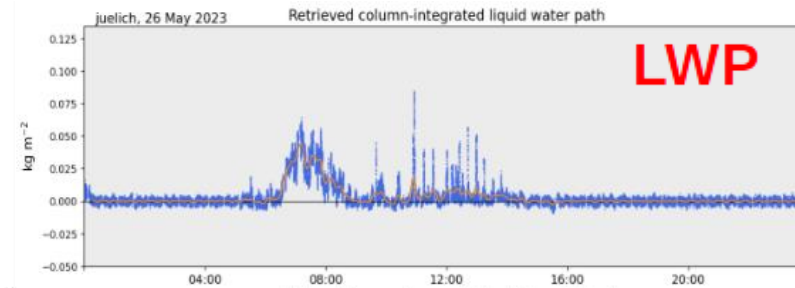
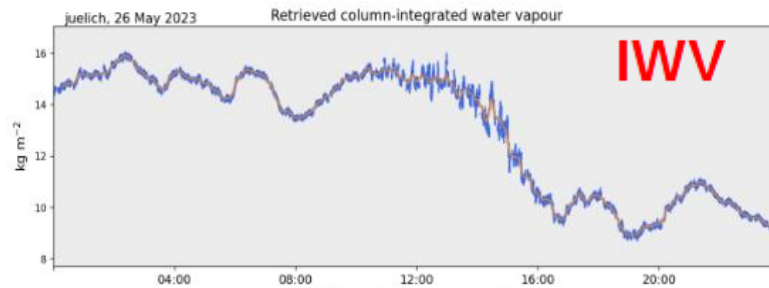
# Motivation

- Ground-based microwave radiometer (MWR) observations provide information on water vapour, cloud liquid as well as temperature profiles in the lower troposphere
- MWR are a mandatory instrument at ACTRIS-Cloud remote sensing stations (NF)
- Some instruments have been operated for > 15 years
- What do these data provide?
- Can we see trends with these observations?



# Microwave Radiometer (MWR) Observations

- MWRs measure radiances in two frequency ranges along absorption lines of water vapor and oxygen, as well as in window regions for clouds.
- Products:
  - Cloud liquid water path (LWP) > only instrument to provide this!
  - Integrated water vapor (IWV)
  - Profiles of atmospheric humidity and temperature





# Challenges / ACTRIS efforts

- Long time series need thorough data quality control
- Breaks in timeseries due to faulty calibrations or instrument changes
- Retrieval inhomogeneities

We developed MWRpy data processing suite including quality control,

further updates concerning retrieval development will follow

> MWRpy already implemented at Cloudnet data portal for 8 stations

release-version Add publishing stuff 3 weeks ago

Used by 1

Contributors 3

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tobiasmarke

siiptuo Tuomas Siipola

Languages

Python 100.0%

## MWRpy

MWRpy tests passing pypi package 0.2.0

MWRpy is a Python software to process RPG Microwave Radiometer data and is developed at the University of Cologne, Germany as part of the [Aerosol, Clouds and Trace Gases Research Infrastructure \(ACTRIS\)](#).

The software features reading raw data, Level 1 quality control, generation of Level 2 data products and visualization.

The data format including metadata information, variable names and file naming is designed to be compliant with the data structure and naming convention developed in the [EUMETNET Profiling Programme E-PROFILE](#).

juelich, 29 Oct 2022 Retrieved temperature profile (multiple pointing)

Height a.s.l. (km)

Time (UTC)

### Installation

From GitHub:

```
git clone https://github.com/actris-cloudnet/mwrpy.git
cd mwrpy
python3 -m venv venv
source venv/bin/activate
pip3 install --upgrade pip
pip3 install .
```

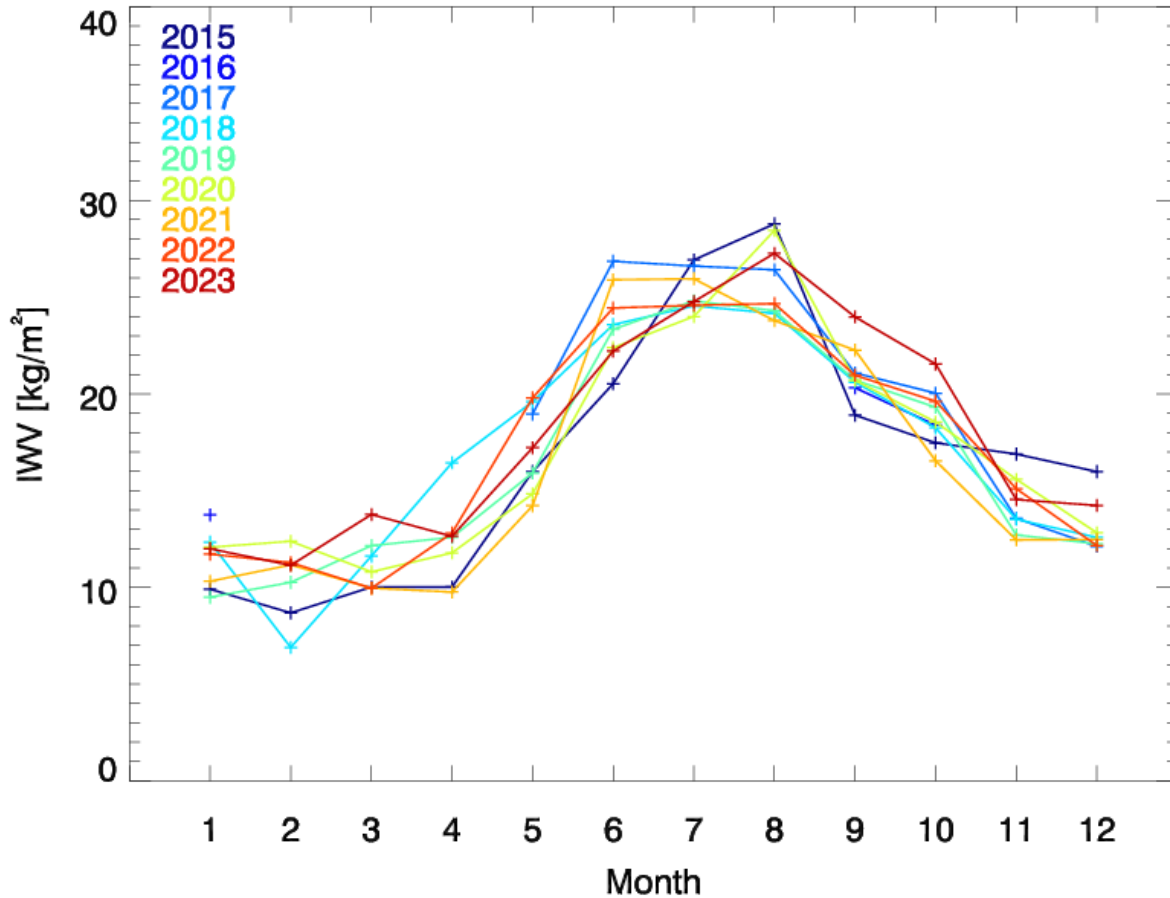
# Datasets in this study

- JOYCE data from 2011- now
- AWIPEV data from 2012-now
- UFS data from 2010-2022

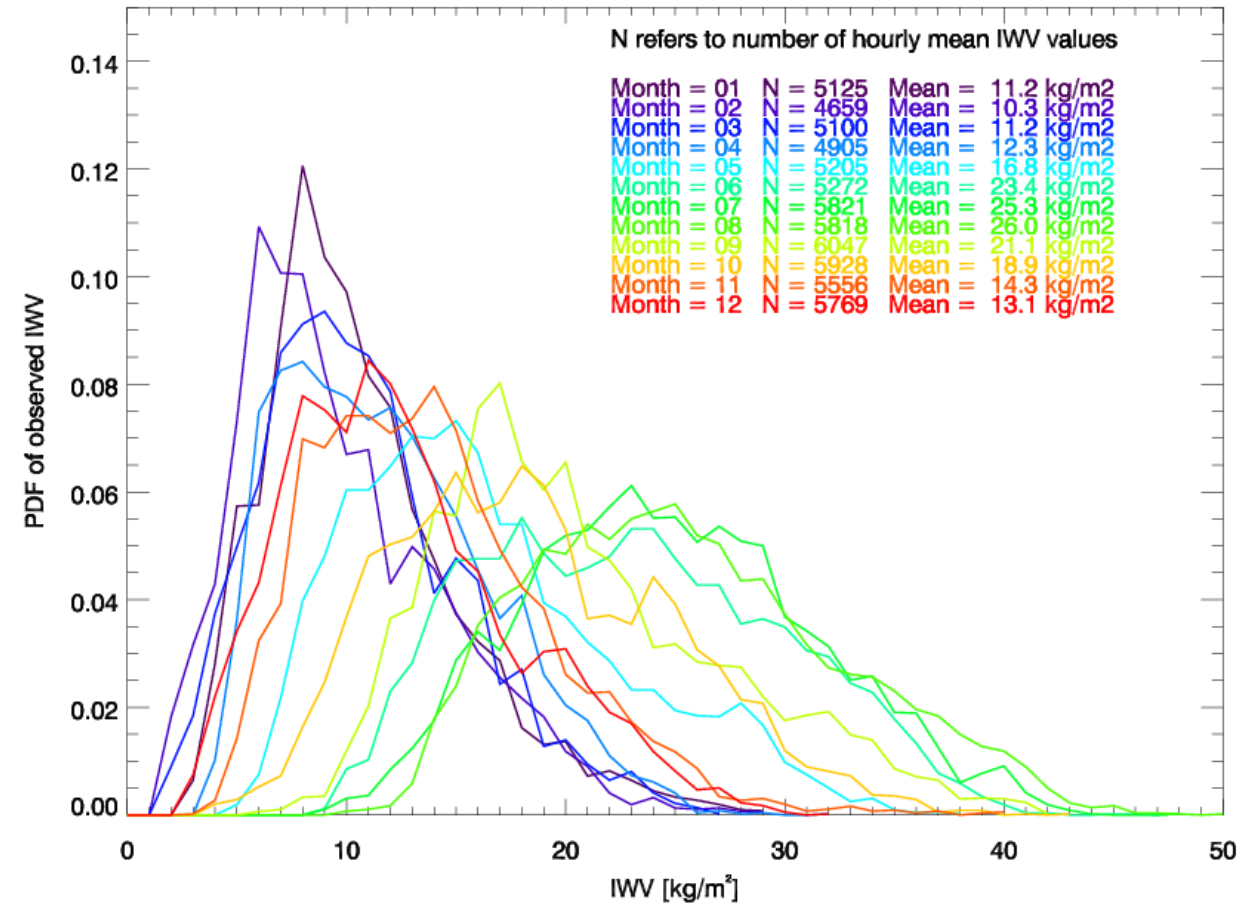


# Integrated water vapor at JOYCE

Annual cycle IWW at JOYCE



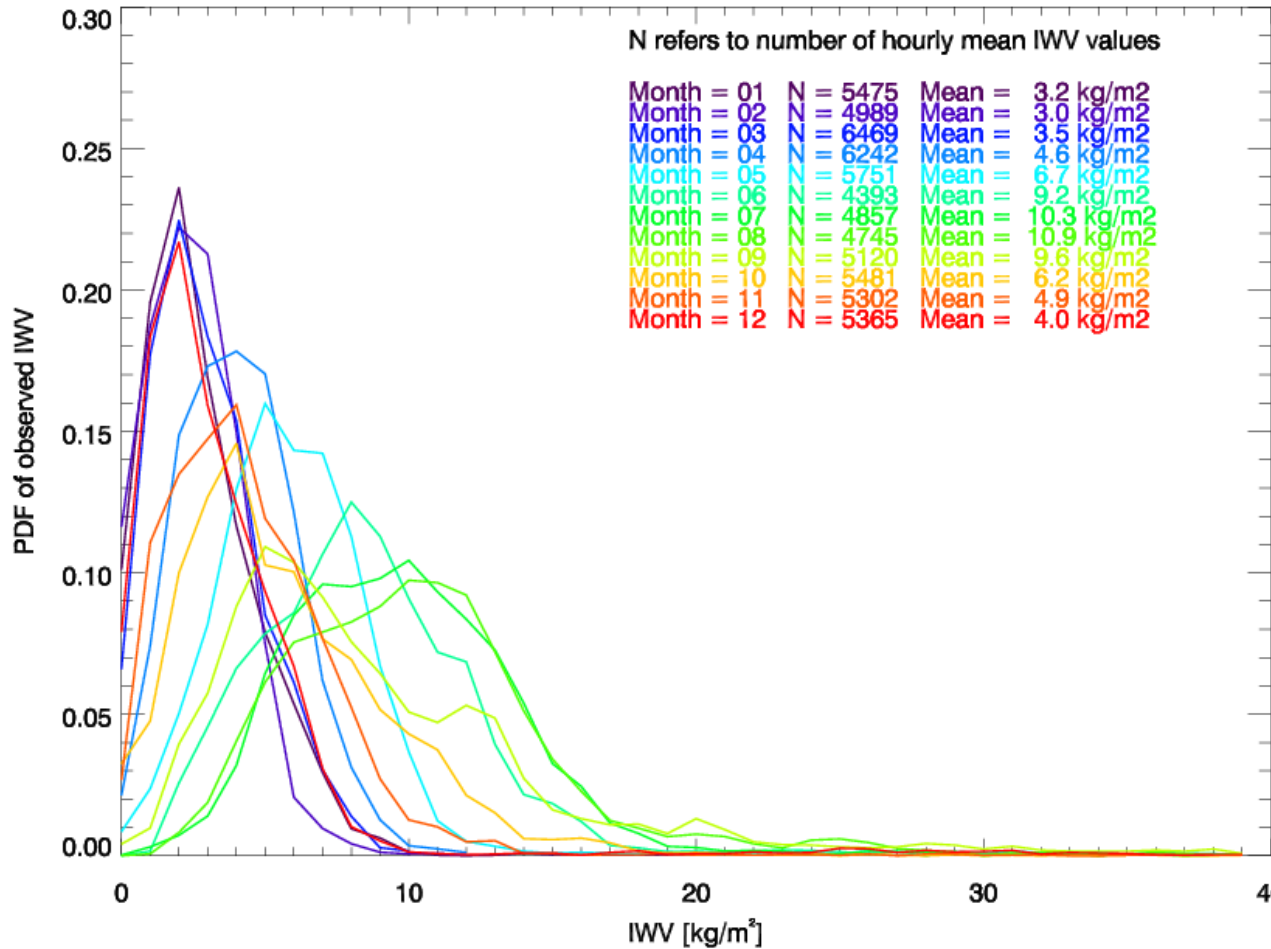
IWW distribution JOYCE 2015-2023 (hourly mean values)



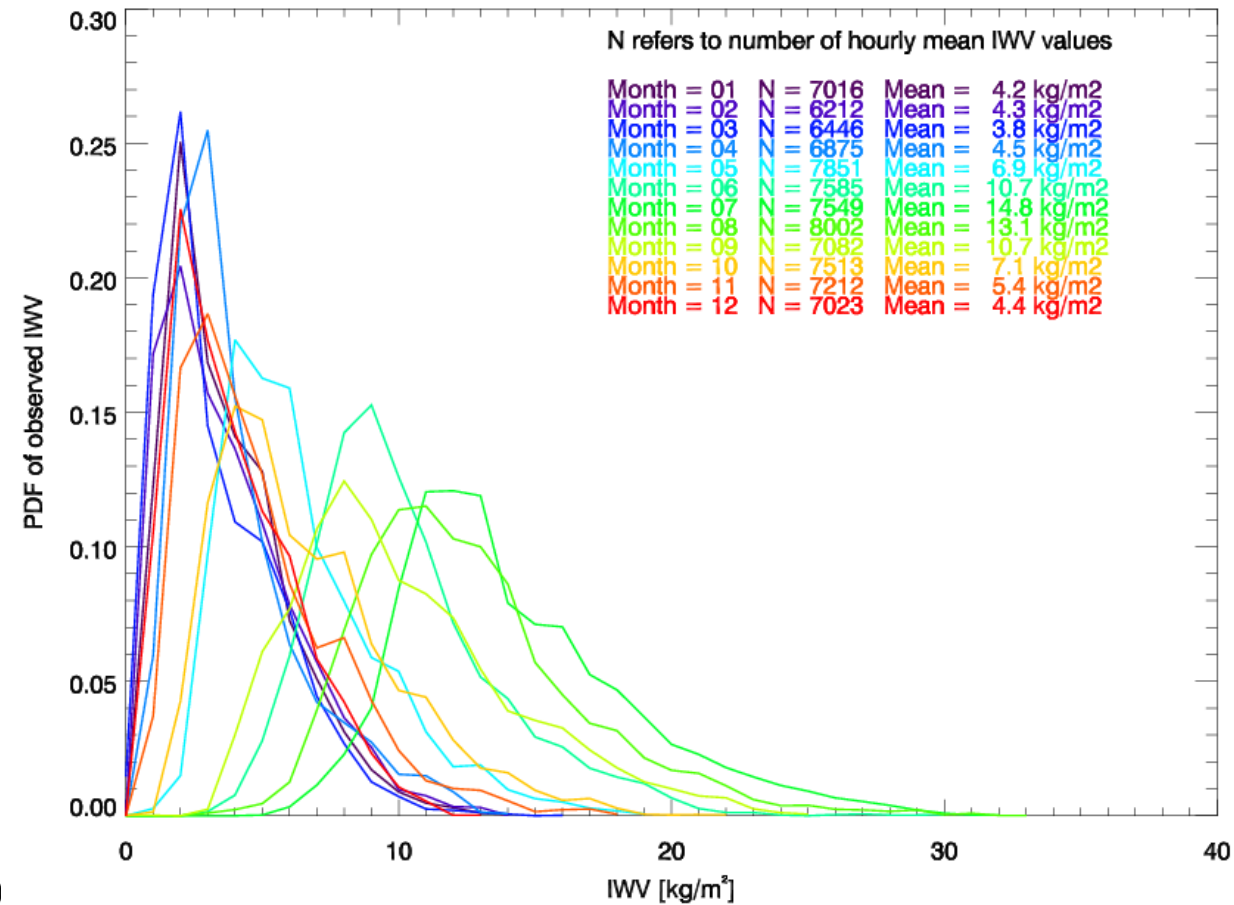
Annual cycle (humid months correspond to warm months)

# IWV distributions at different sites

IWV distribution Schneefernerhaus 2010-2019 (hourly mean values)



IWV distribution Ny-Alesund 2012-2023 (hourly mean values)



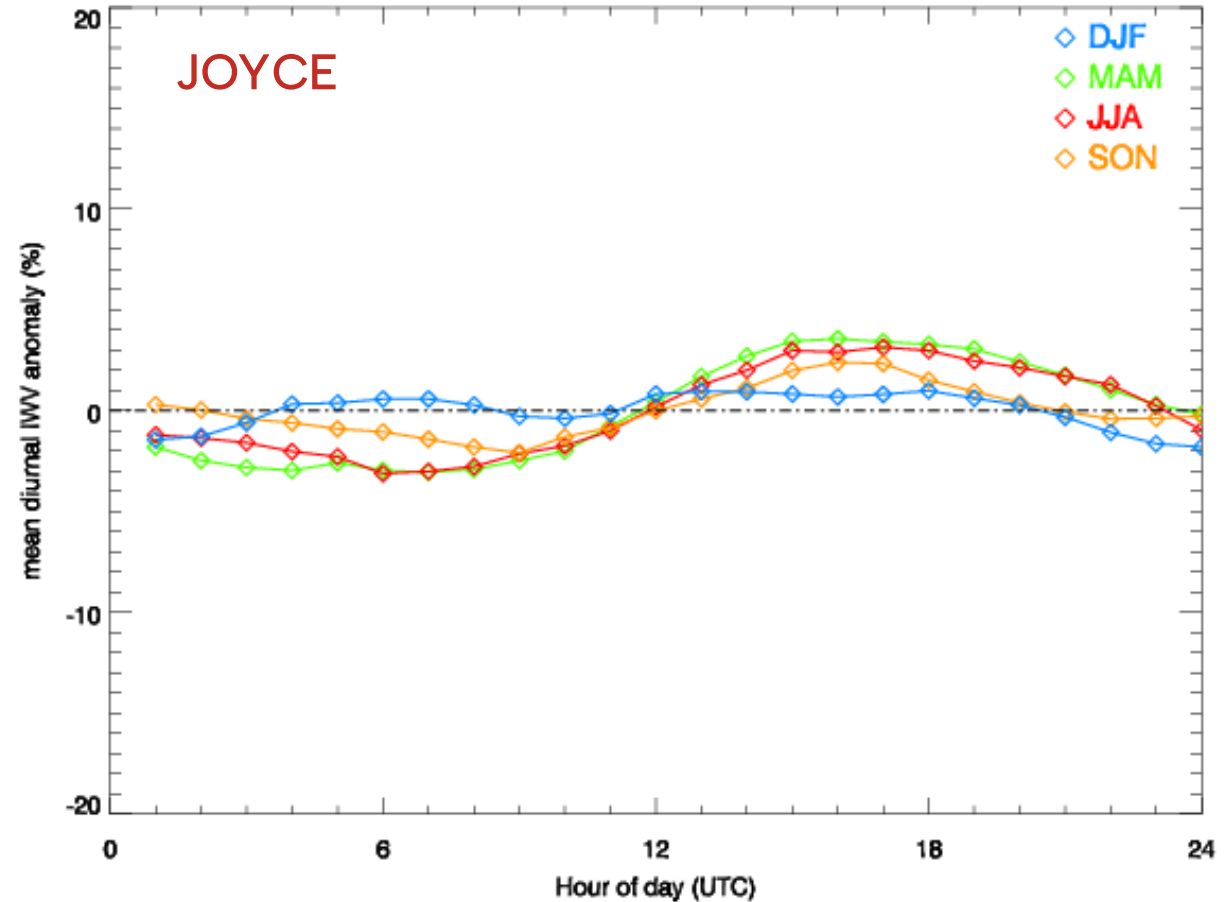
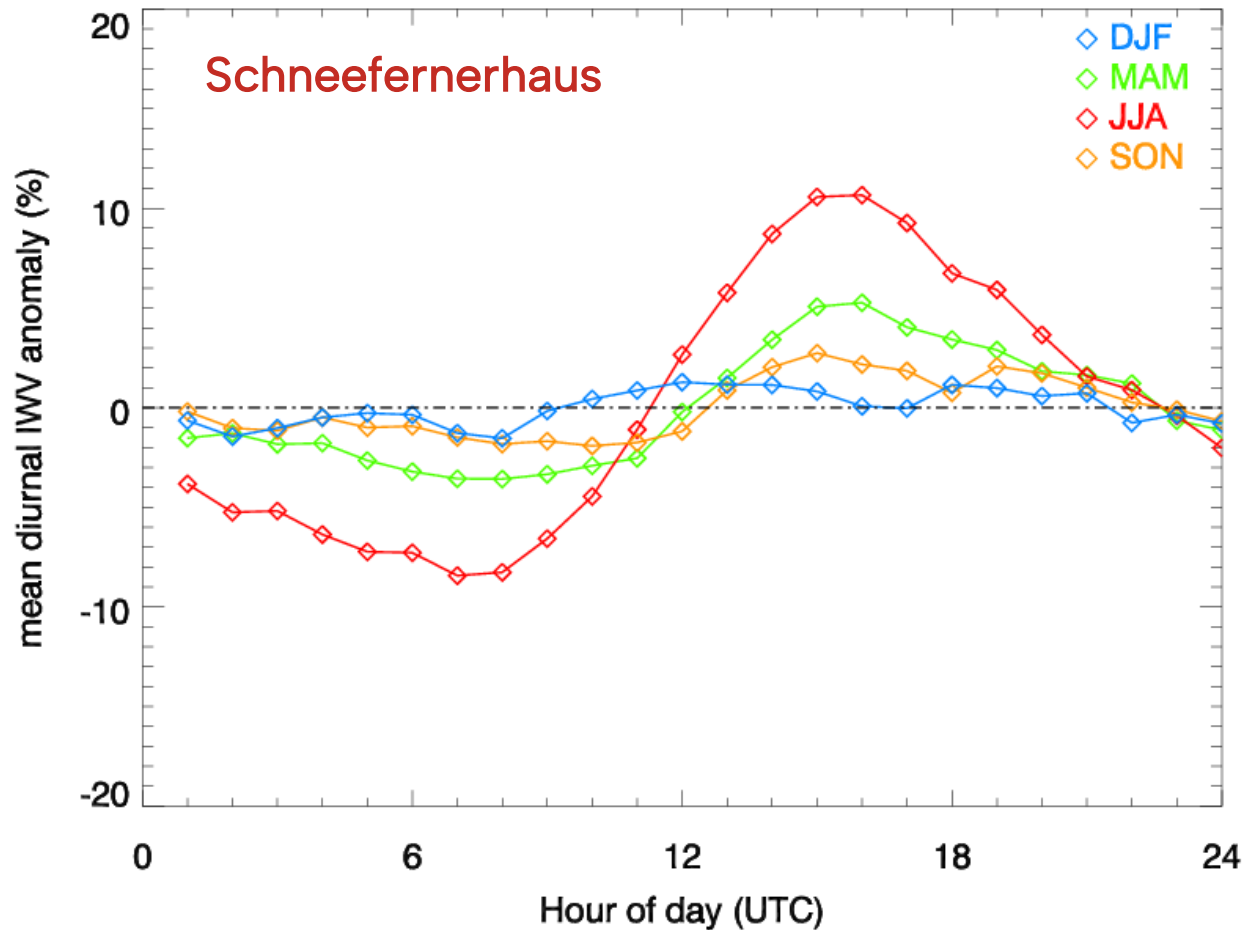
Very narrow distribution between December and April in Ny-Alesund, few humid cases (up to 30 kg/m<sup>2</sup>)

Broader distribution at Schneefernerhaus in spring/autumn

19.06.2024

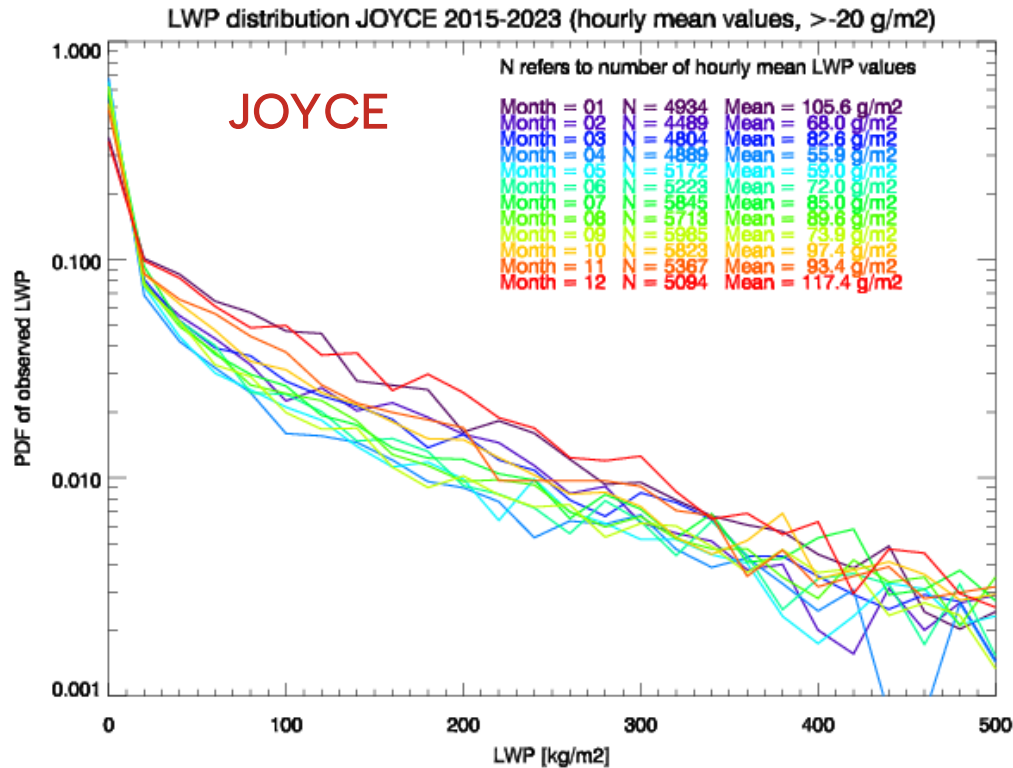


# IWV diurnal cycle (seasonal)



More pronounced diurnal cycle in summer at Schneefernerhaus, no significant signal in Ny-Alesund

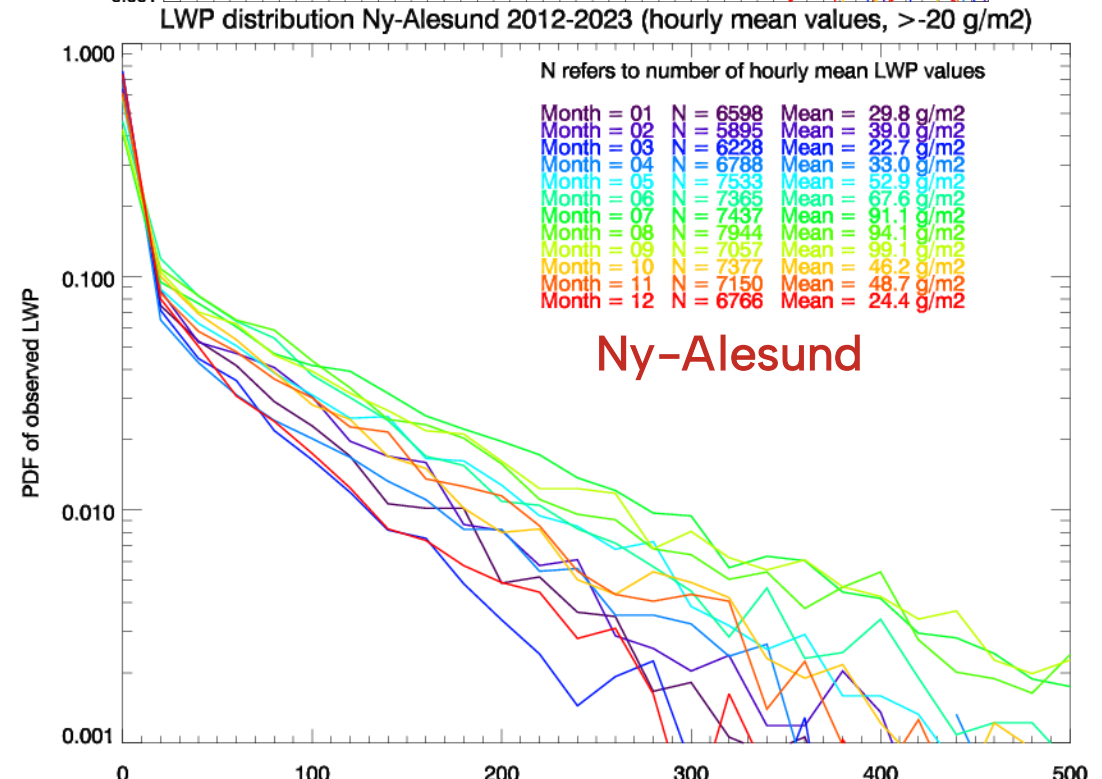
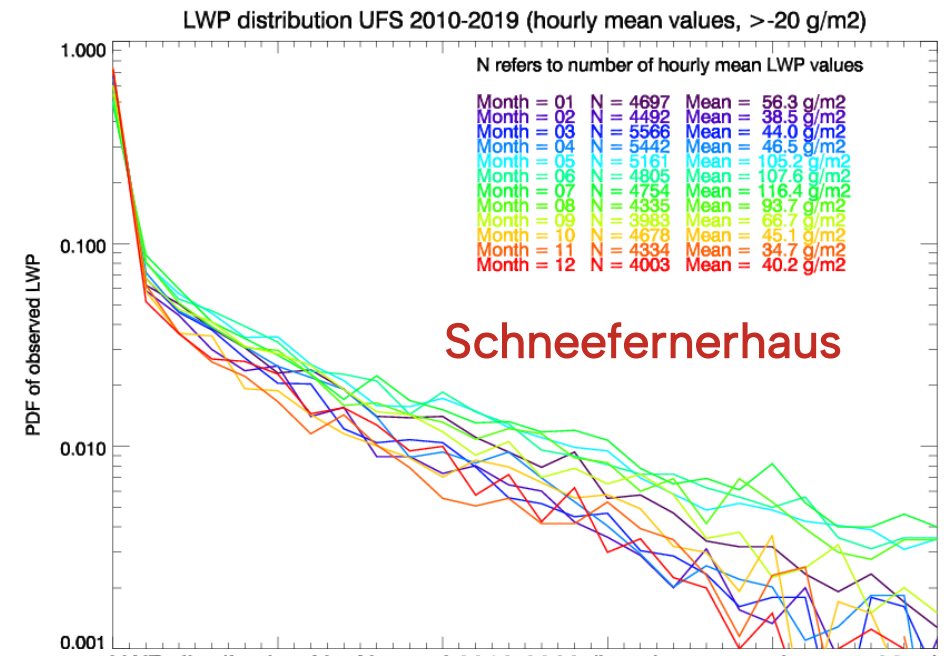
# Cloud liquid water path distribution per month



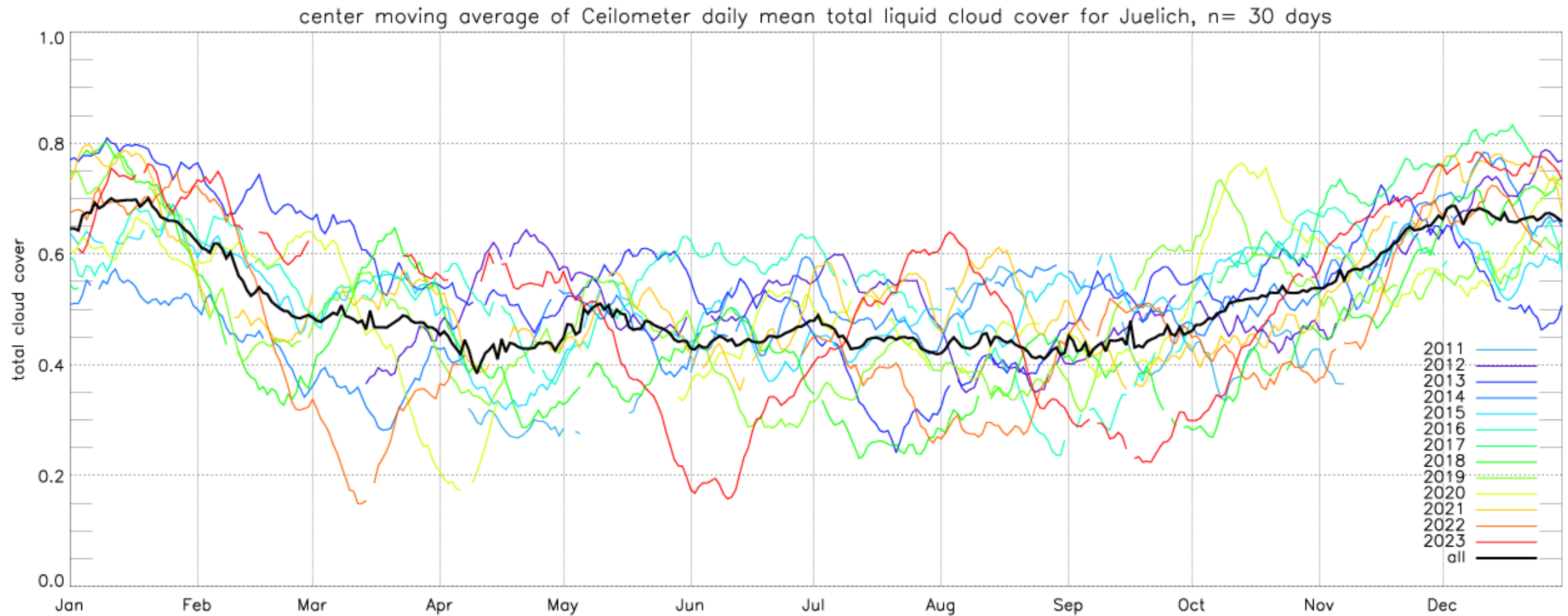
JOYCE: Max cloud LWP (<300 g/m<sup>2</sup>) in winter

Schneefernerhaus: Summer LWP dominant, smallest LWP in autumn

Ny-Alesund: Very low LWP frequency in winter



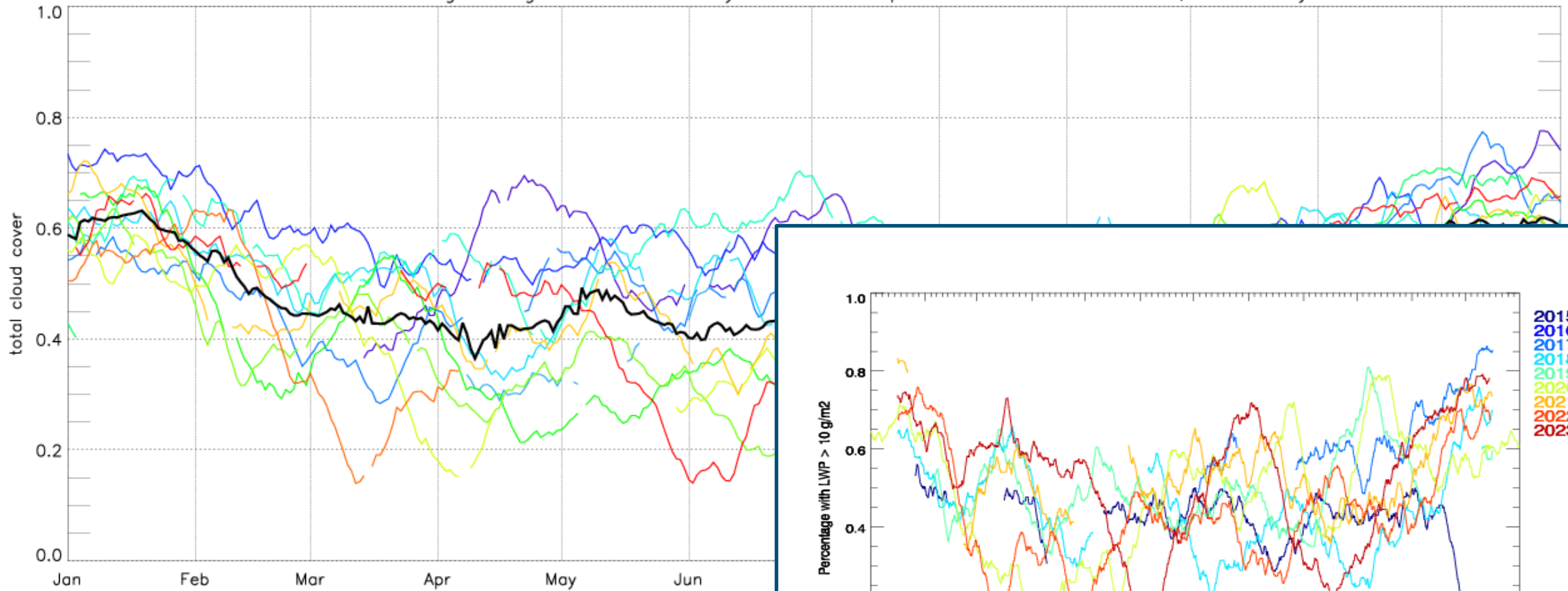
# Cloud cover Ceilometer / MWR (yearly variation)



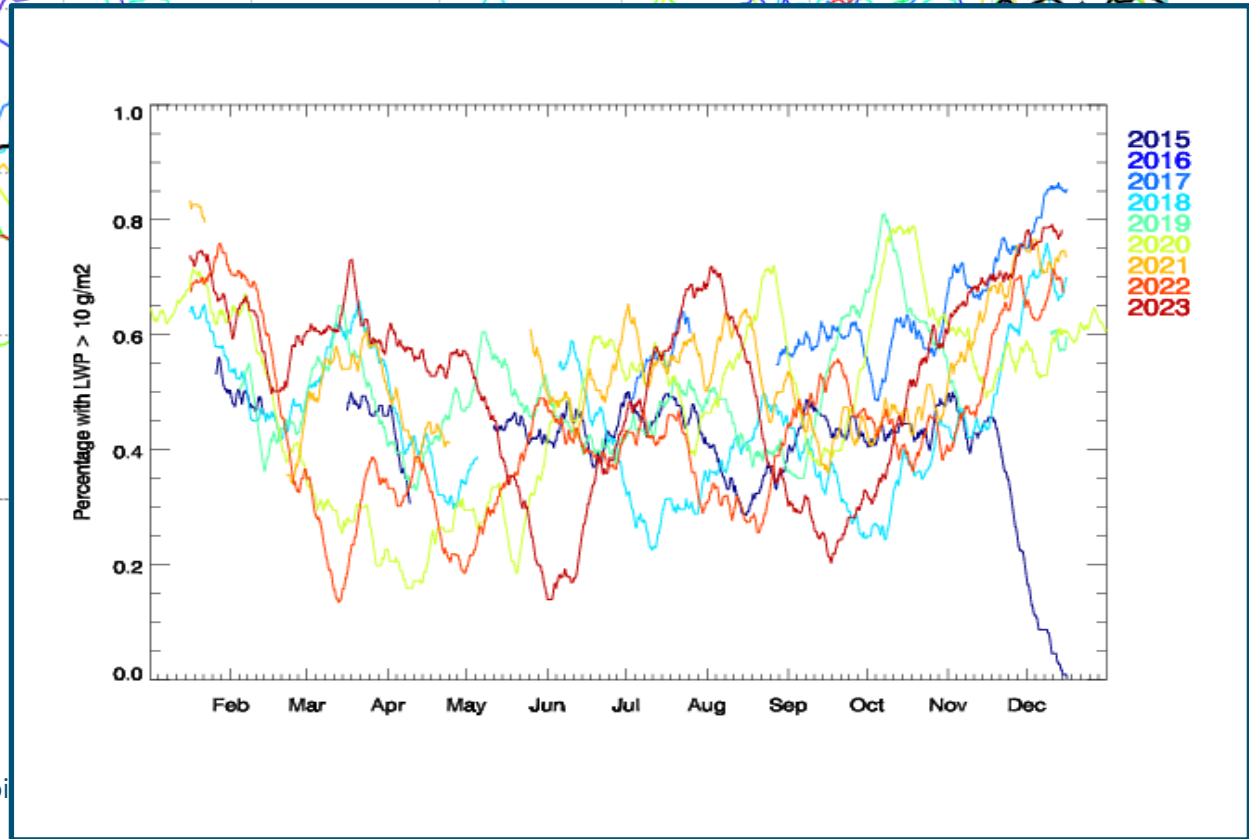
Ceilometer cloud occurrence vs. LWP occurrence in Jülich

# Cloudnet liquid cloud cover / MWR

center moving average of Cloudnet daily mean total liquid cloud cover for Juelich, n= 30 days

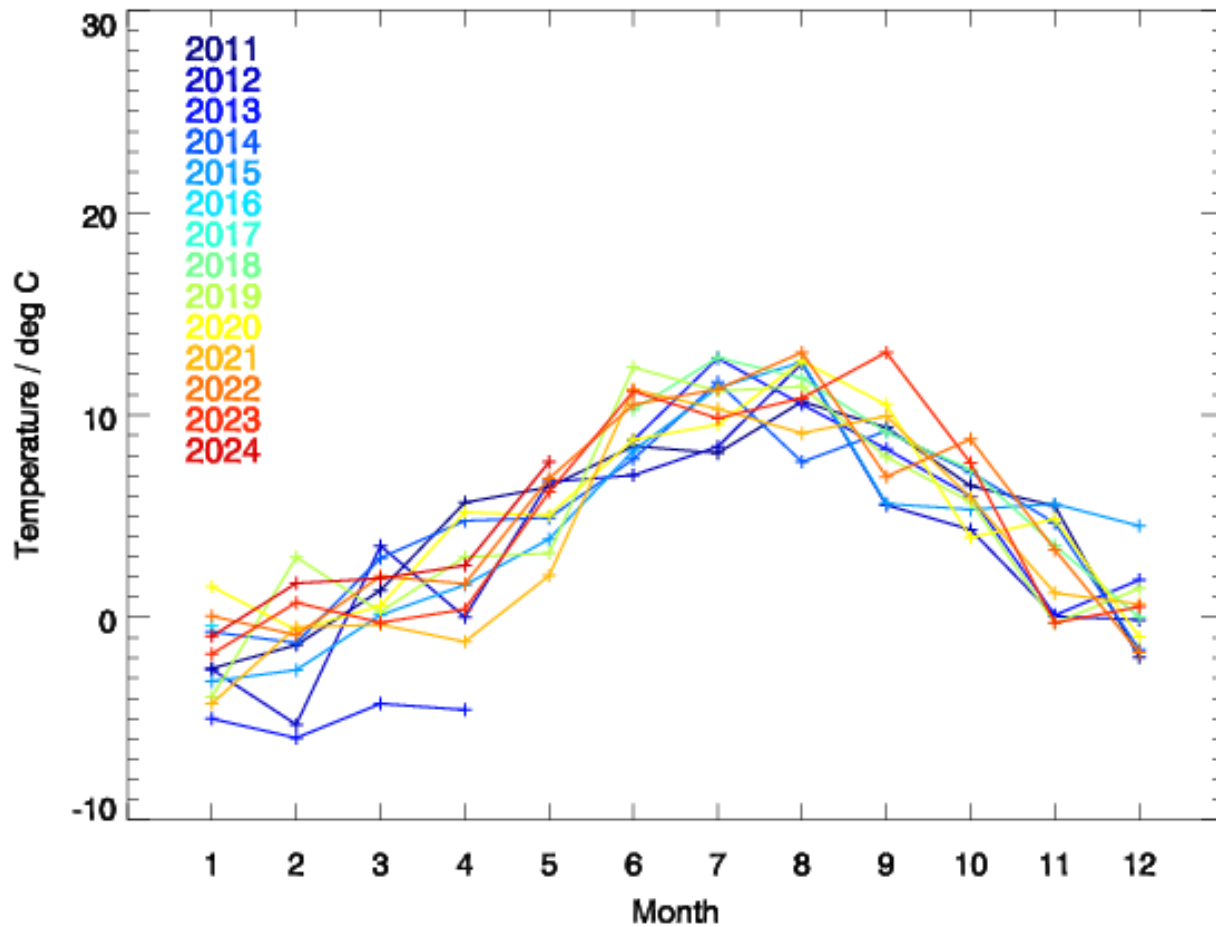


Same for Cloudnet liquid water

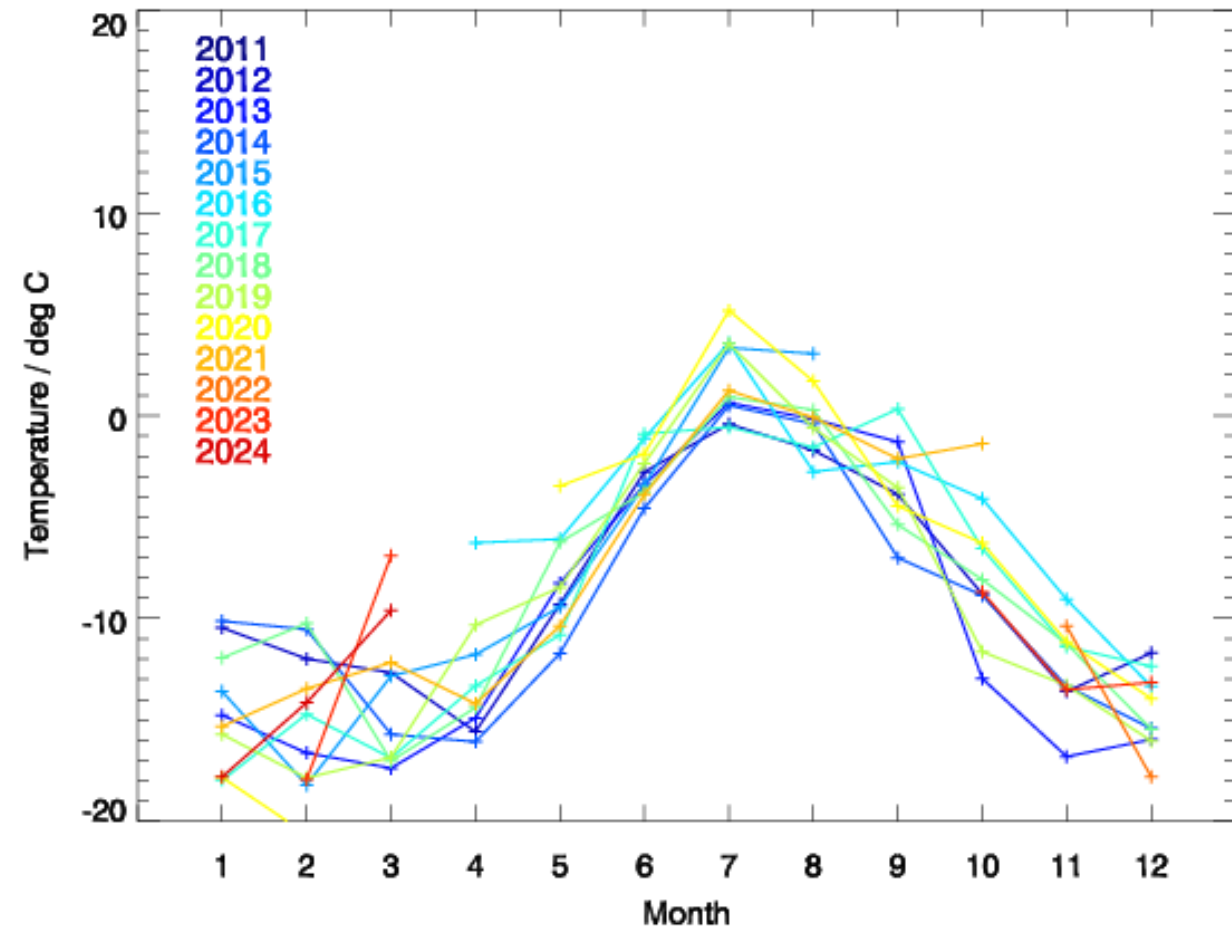


# Temperature annual cycle

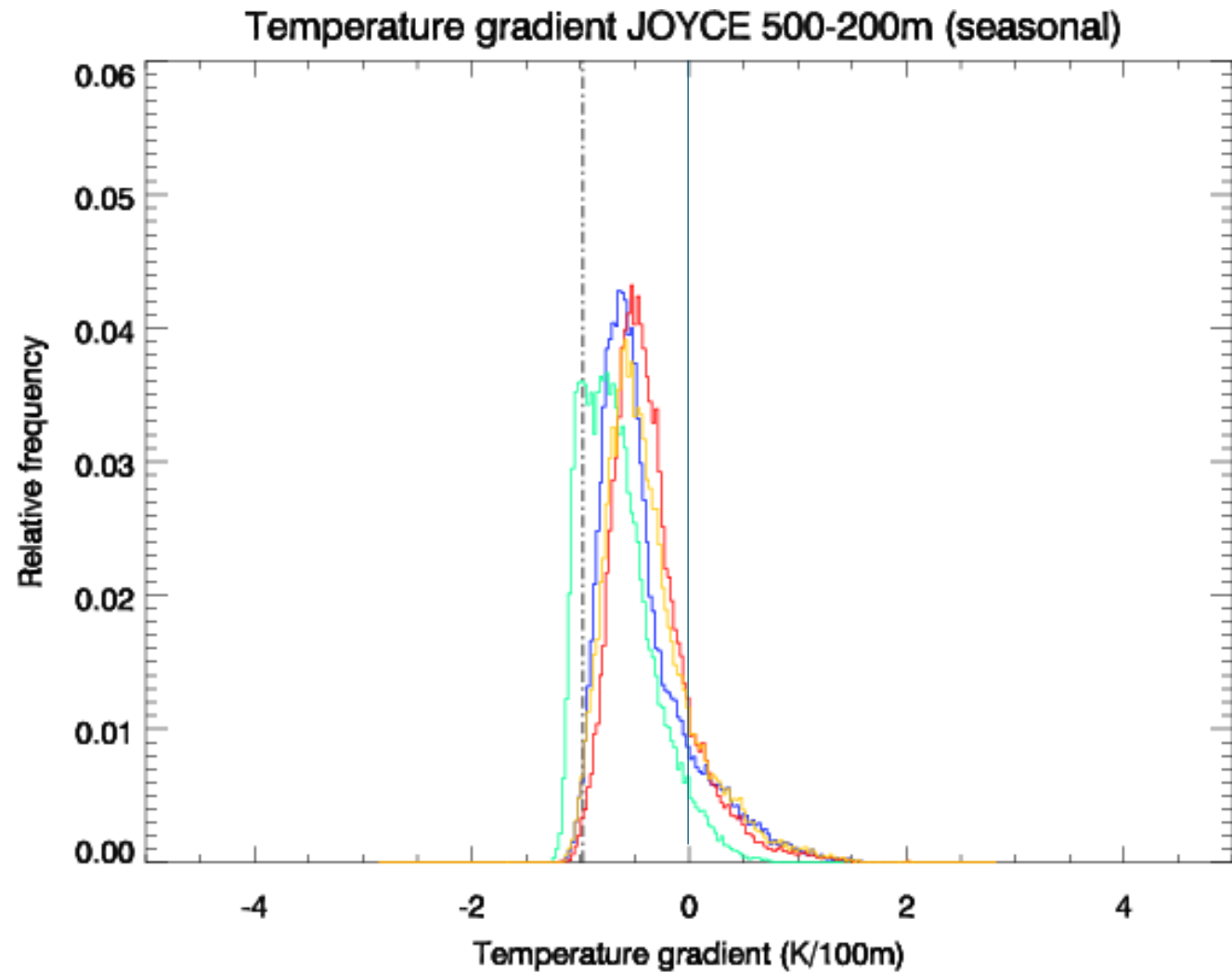
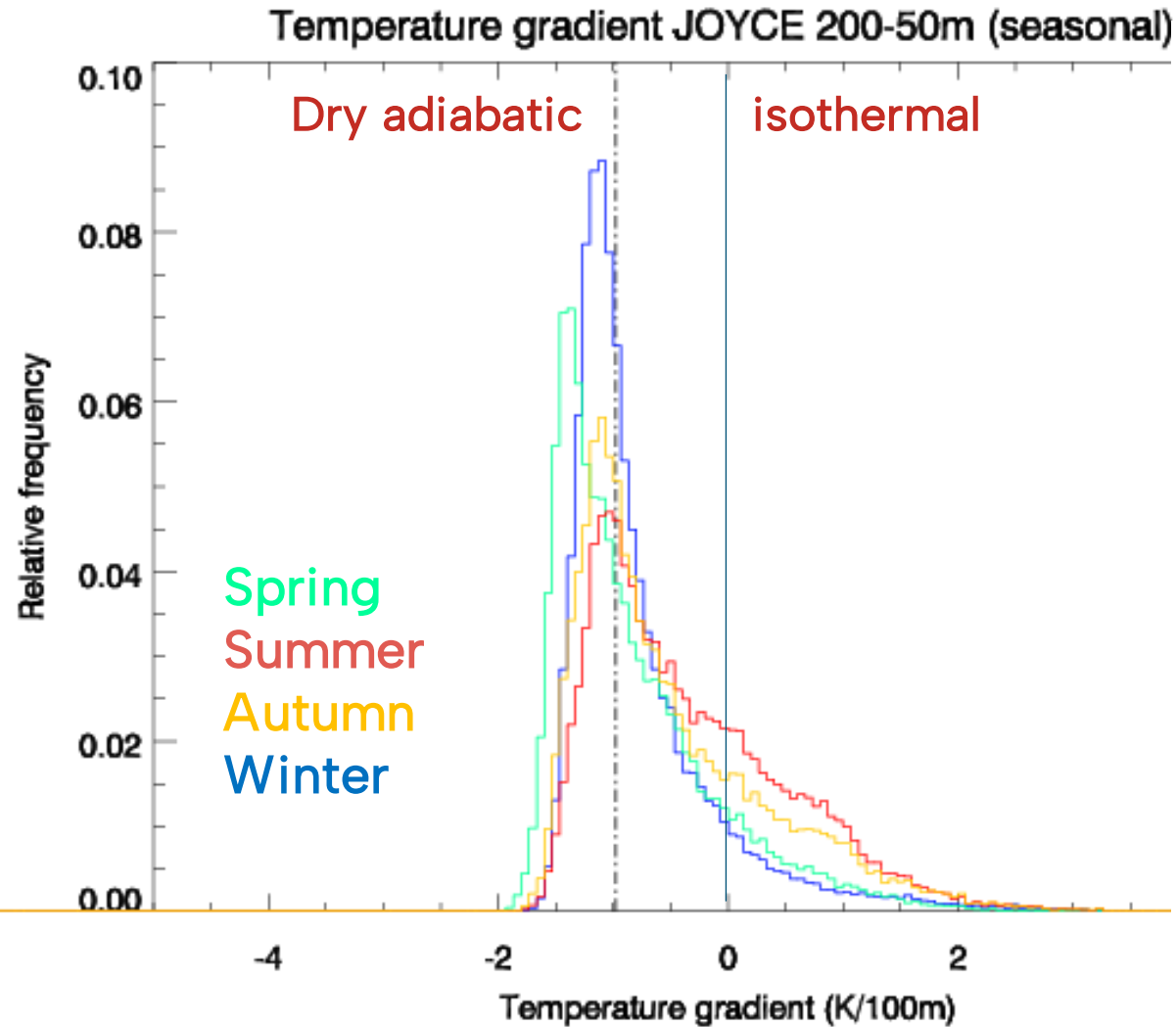
Temperature annual cycle JOYCE 1450m AGL



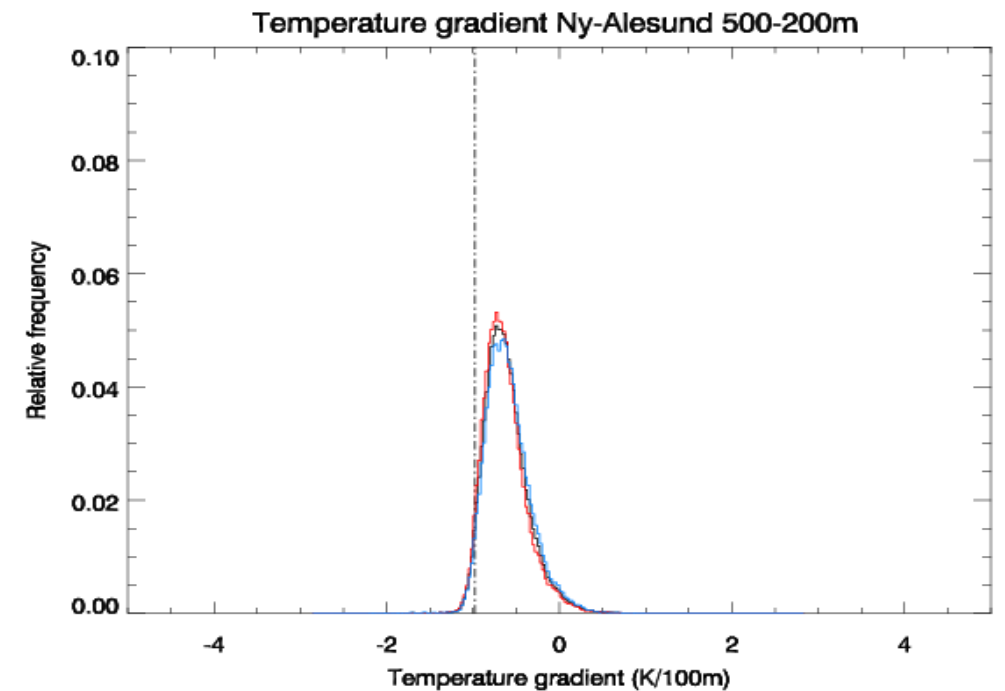
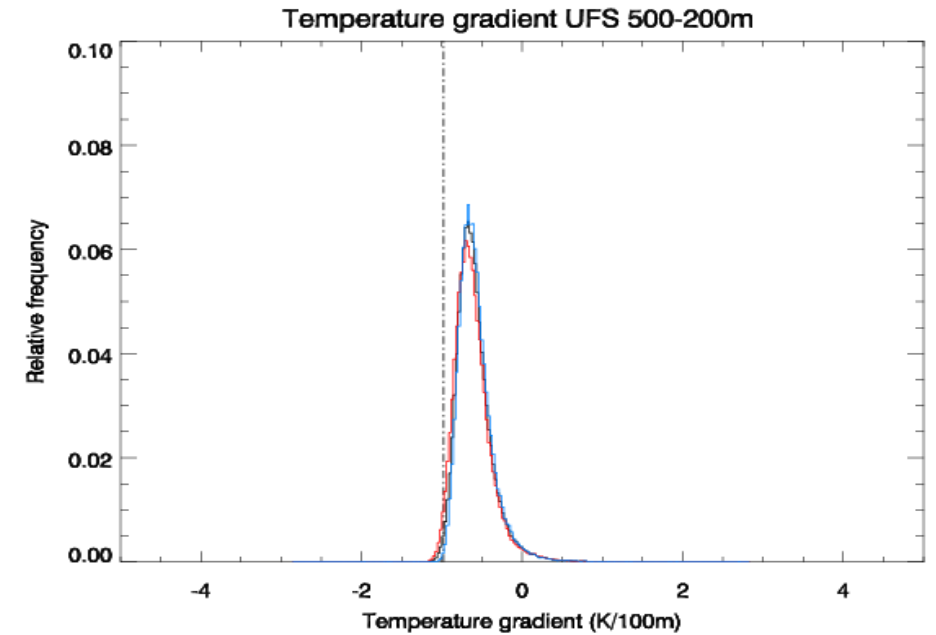
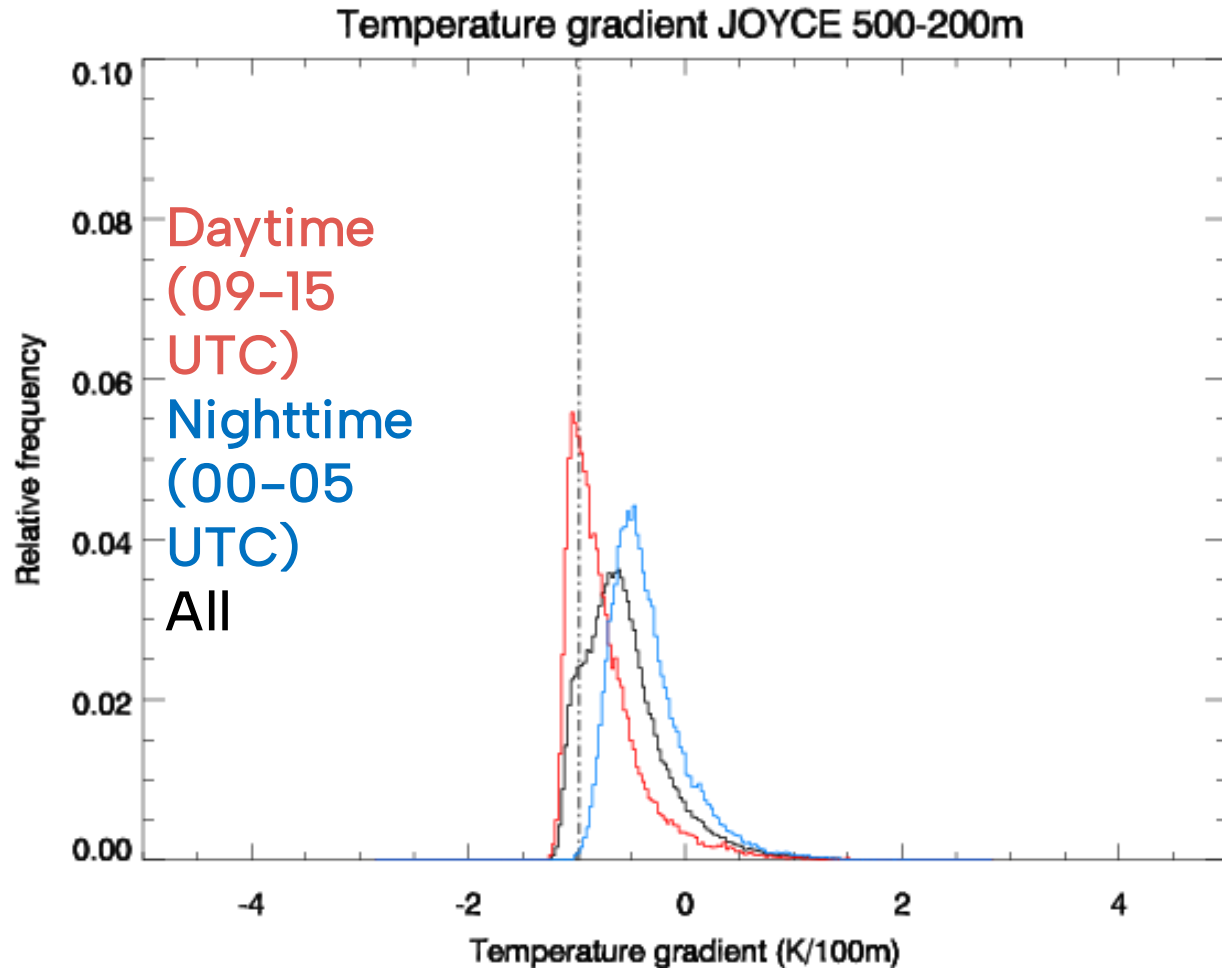
Temperature annual cycle Ny-Alesund 1450m AGL



# Temperature gradient / inversions (seasonal)



# Temperature gradient (diurnal variations)



# Summary

- Long time-series of MWR provide climatologies and inter-annual variation of cloud liquid water, water vapour as well as temperature profiles (inversions)
- Temperature and water vapour profiles also allow to monitor atmospheric stability
- Thorough data quality control is mandatory
- ACTRIS-Cloudnet will provide these data for the whole CRS network
- MWR timeseries are valuable for cal/val and combined products with satellites