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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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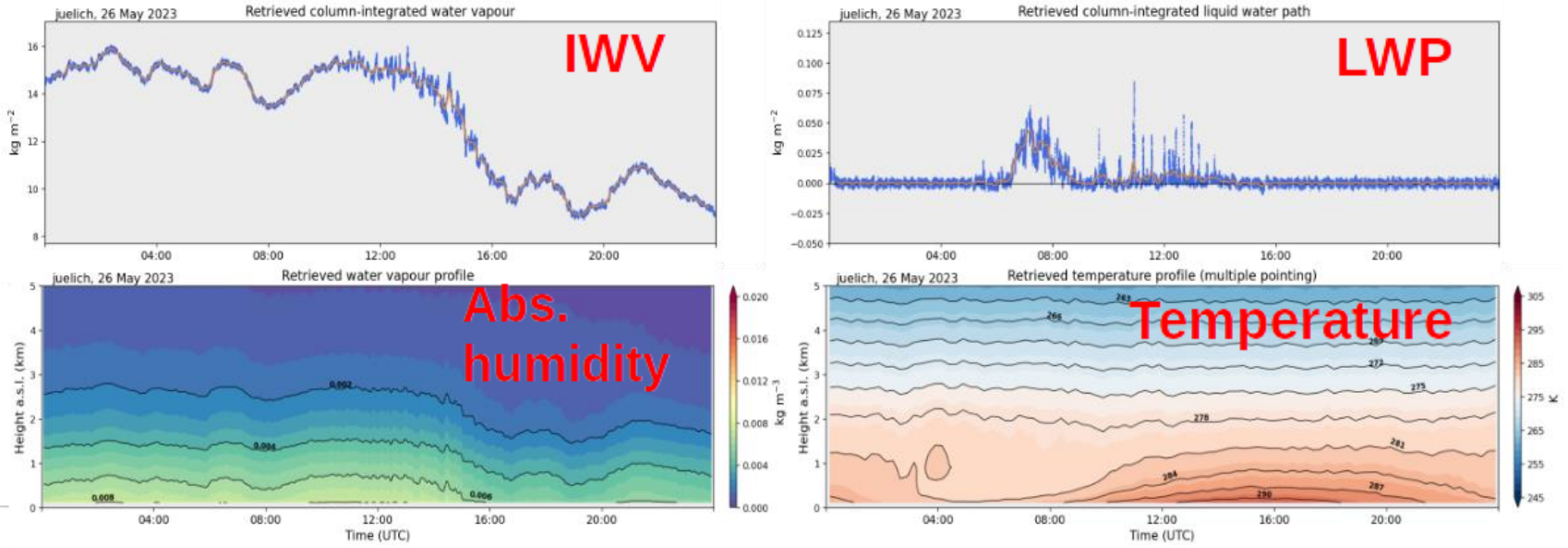
Motivation

- Ground-based microwave radiometer (MWR) observations provide informations 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



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Ground-based Microwave radiometer networks in Europe

- More and more stations from various operators are running continuously throughout Europe
- Two initiatives aim for coordinated networks:
  - EUMETNET / E-Profile (operational met services)
  - ACTRIS-CCRES
- Challenges for network operation (calibration, data processing, retrievals, quality control, etc.)

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EUMETNET

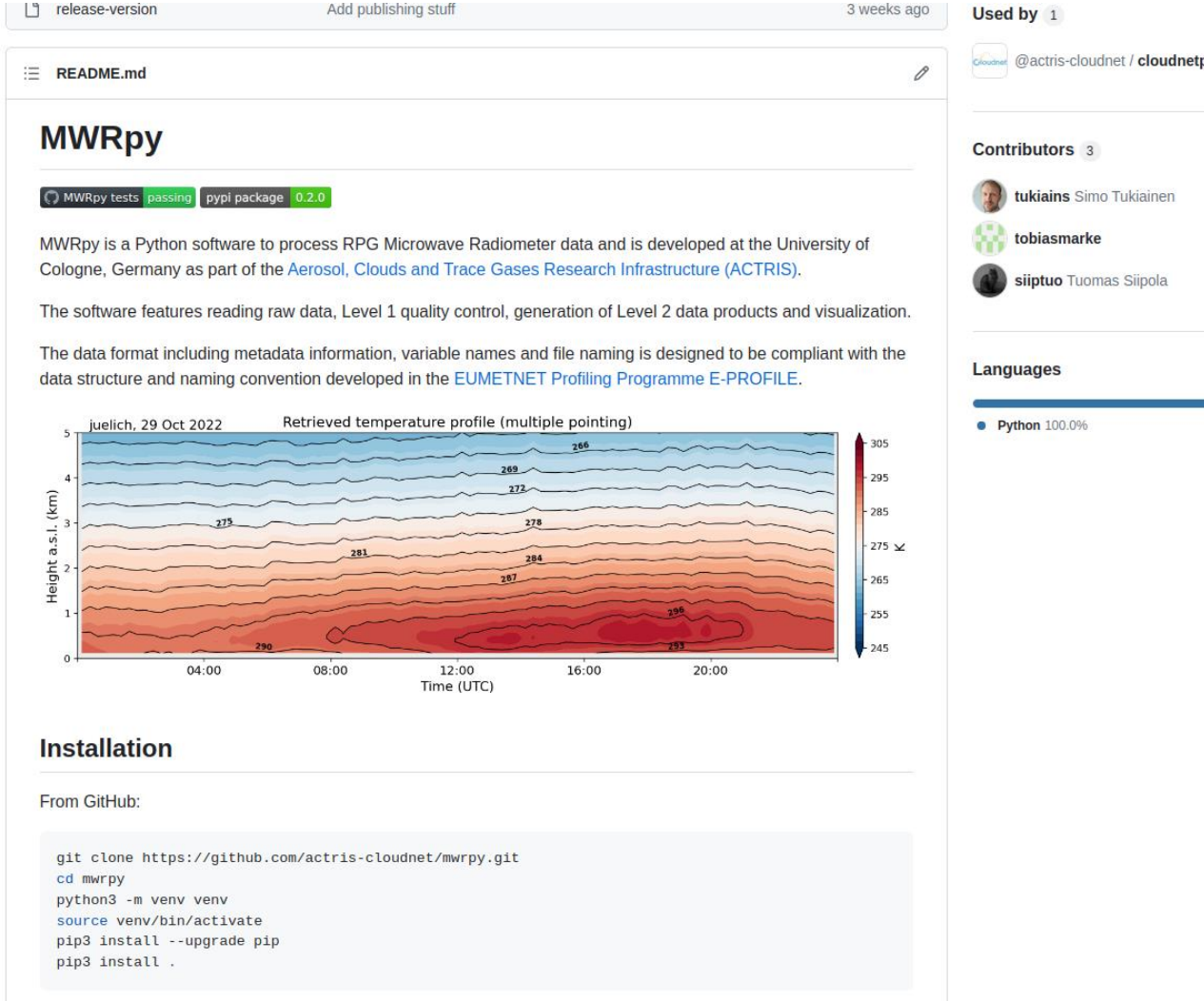
Challenges / ACTRIS efforts

- 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

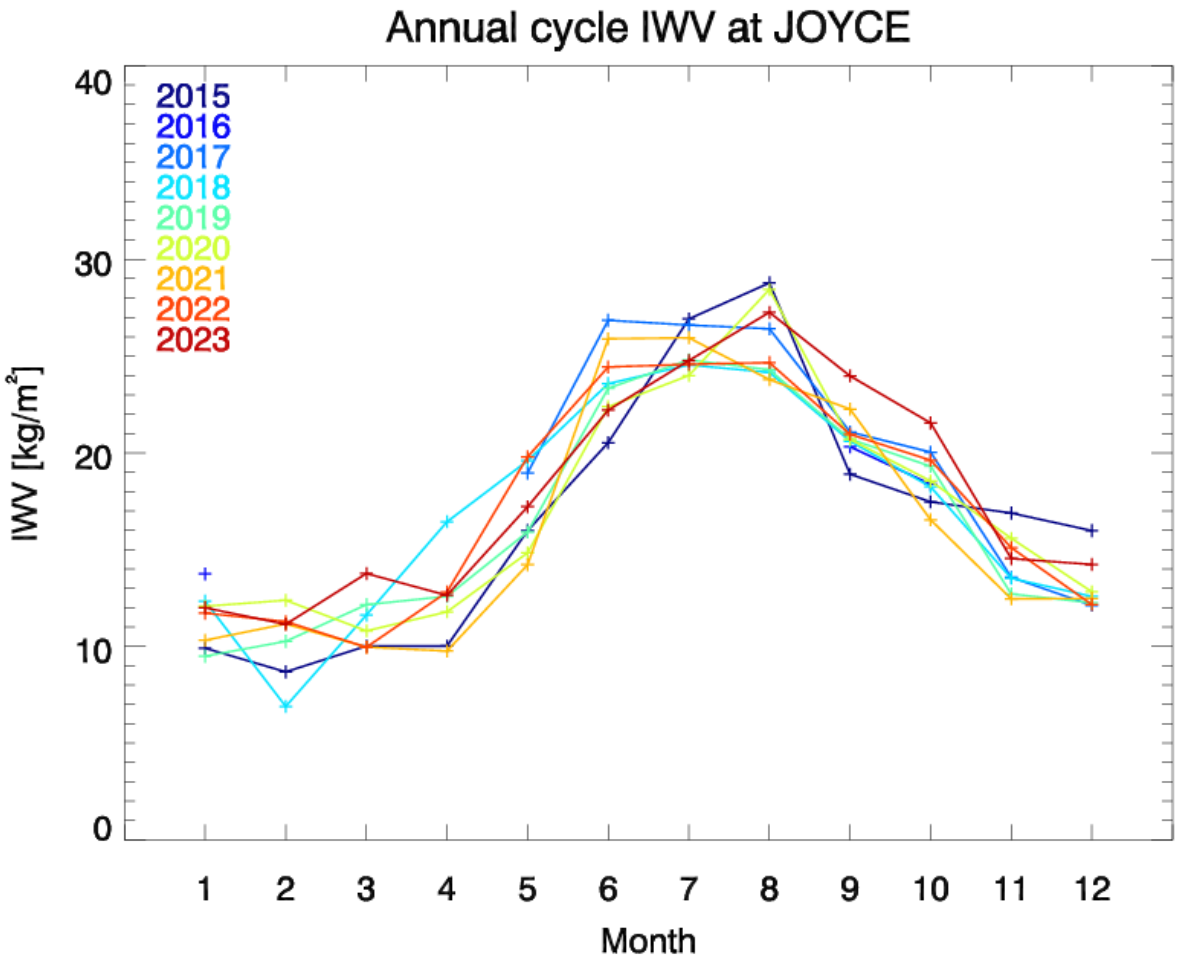
> MWRpy already implemented at Cloudnet data portal for 8 stations

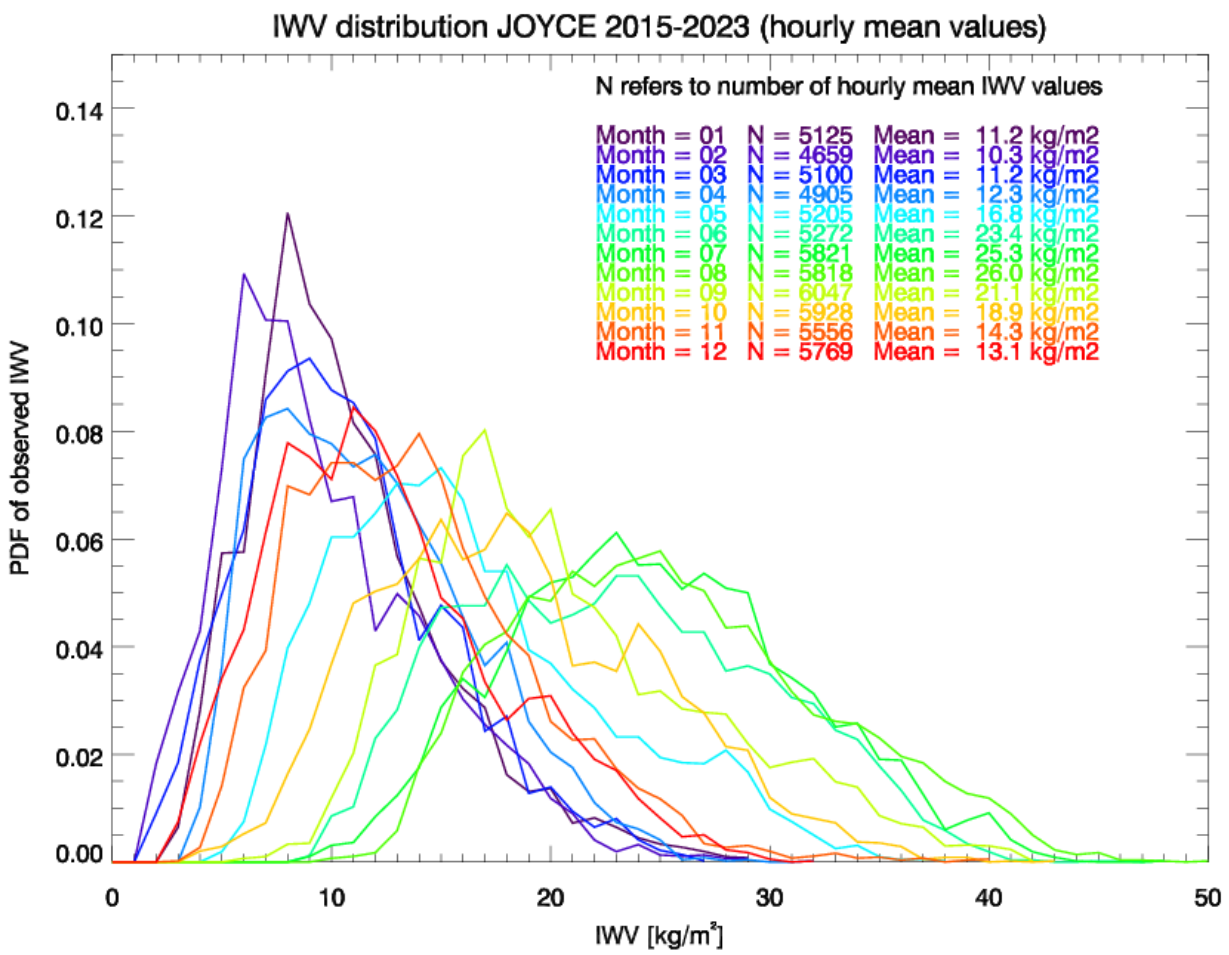


Datasets in this study

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

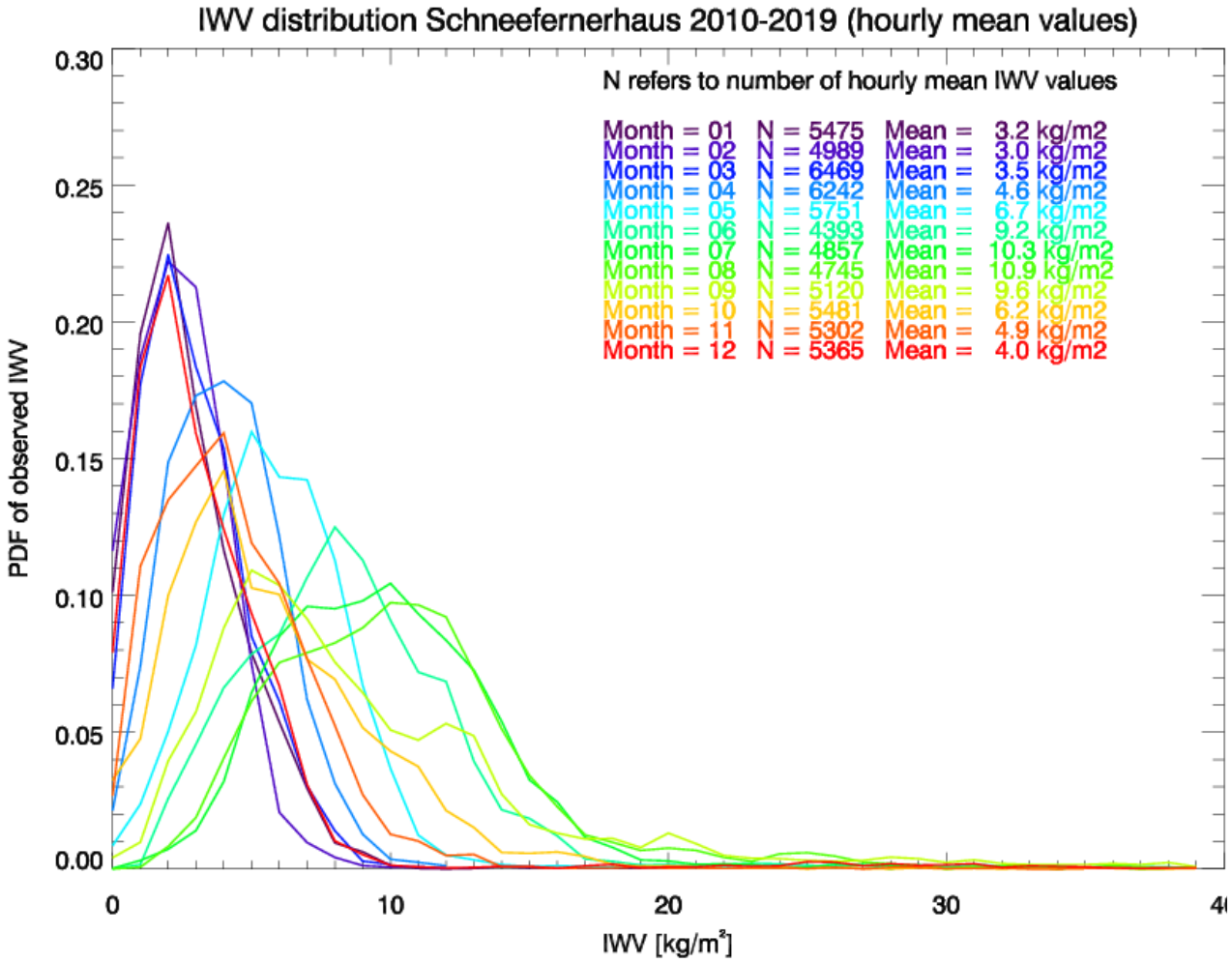
Integrated water vapor at JOYCE

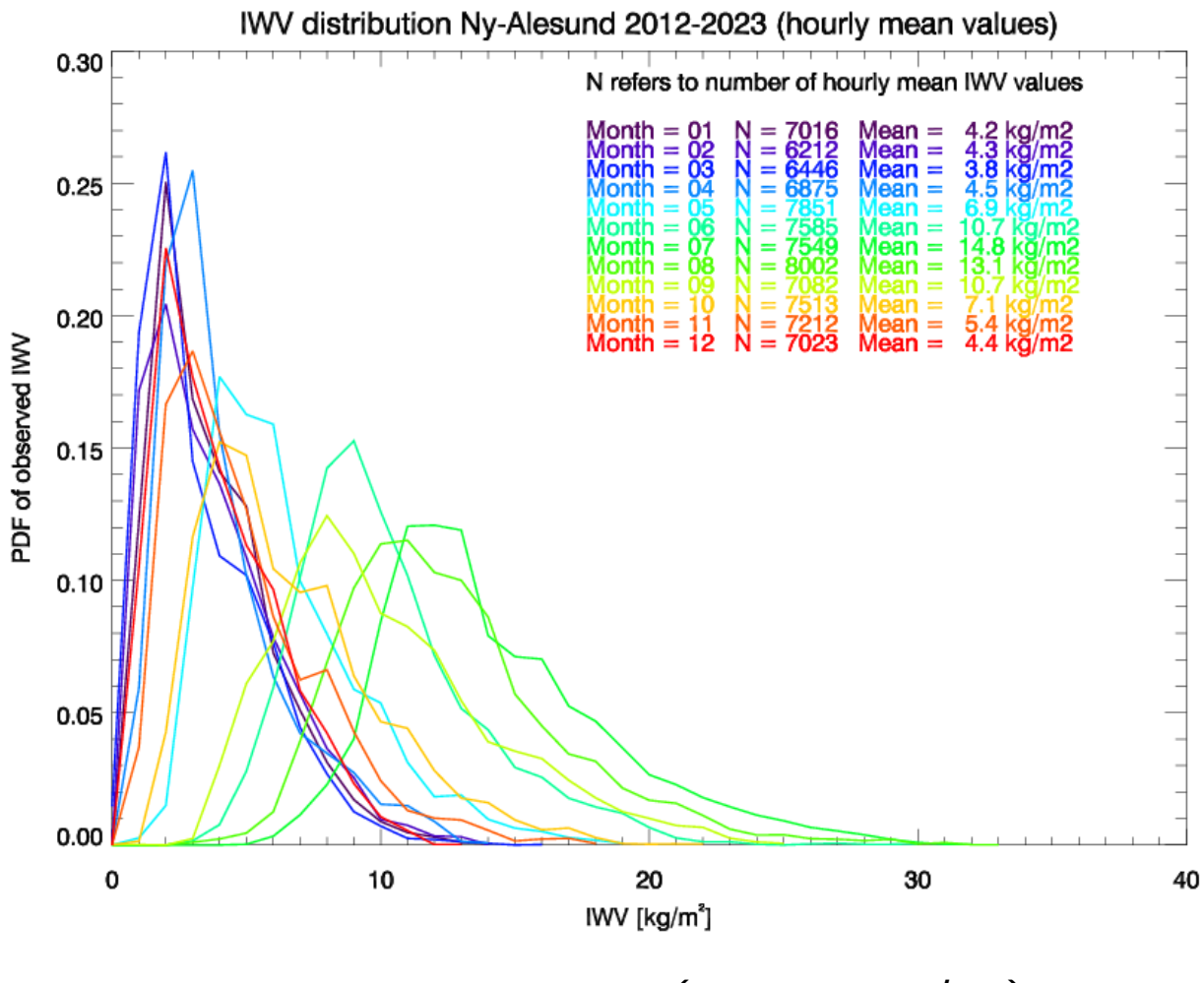




Annual cycle (humid months correspond to warm months)

IWV distributions at different sites





Very narrow distribution between December and April in Ny-Alesund, few humid cases (up to 30 kg/m²)

Broader distribution at Schneefernerhaus in spring/autumn

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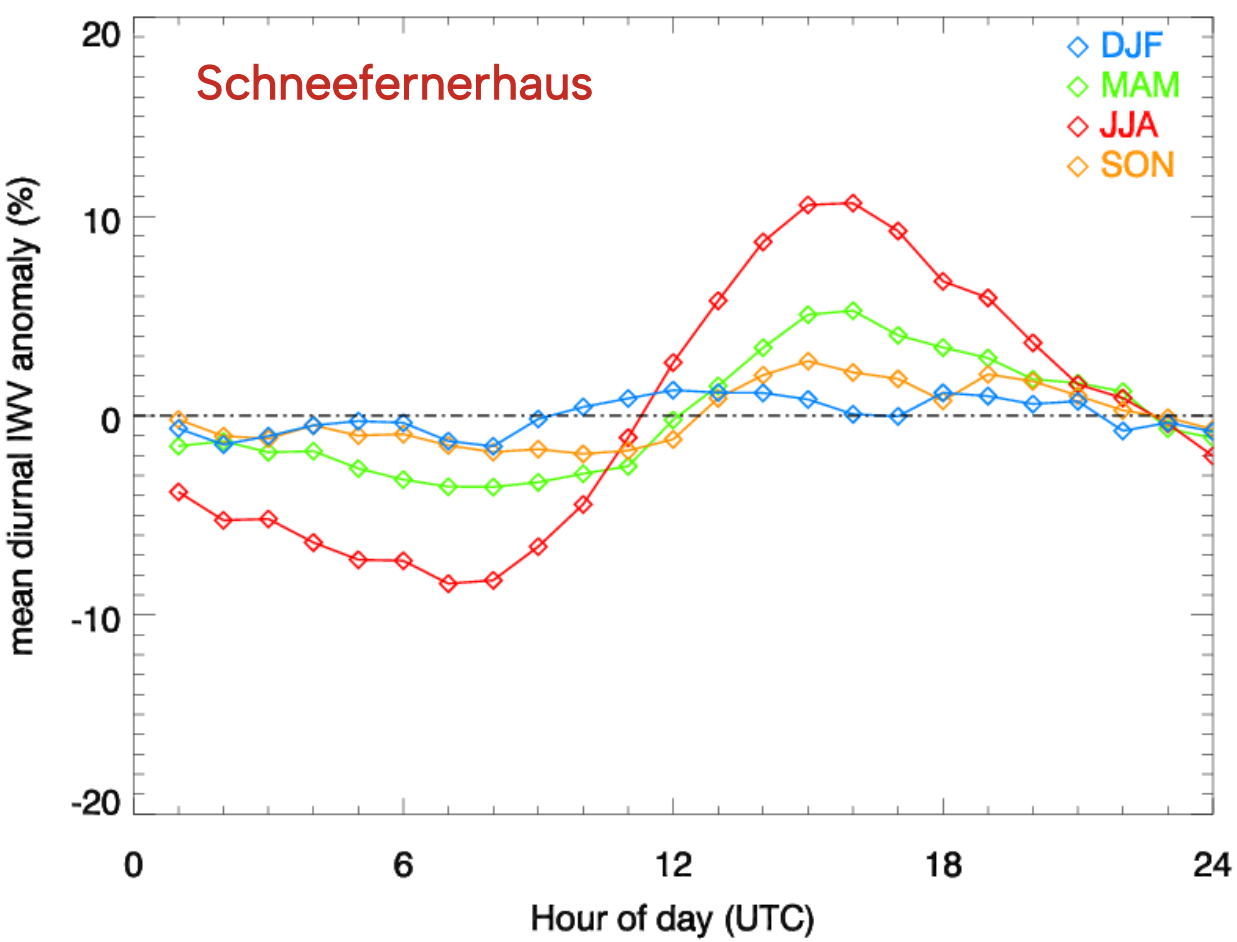
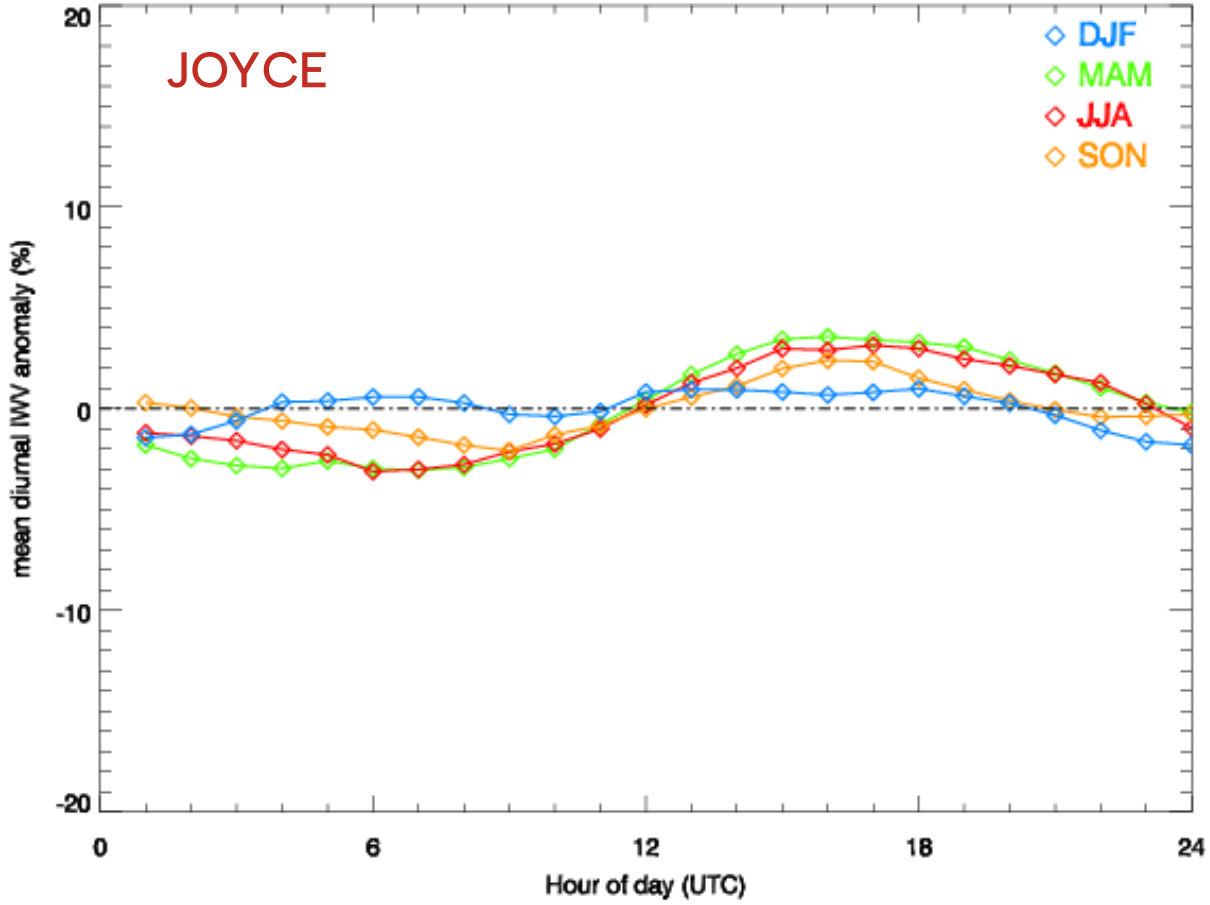
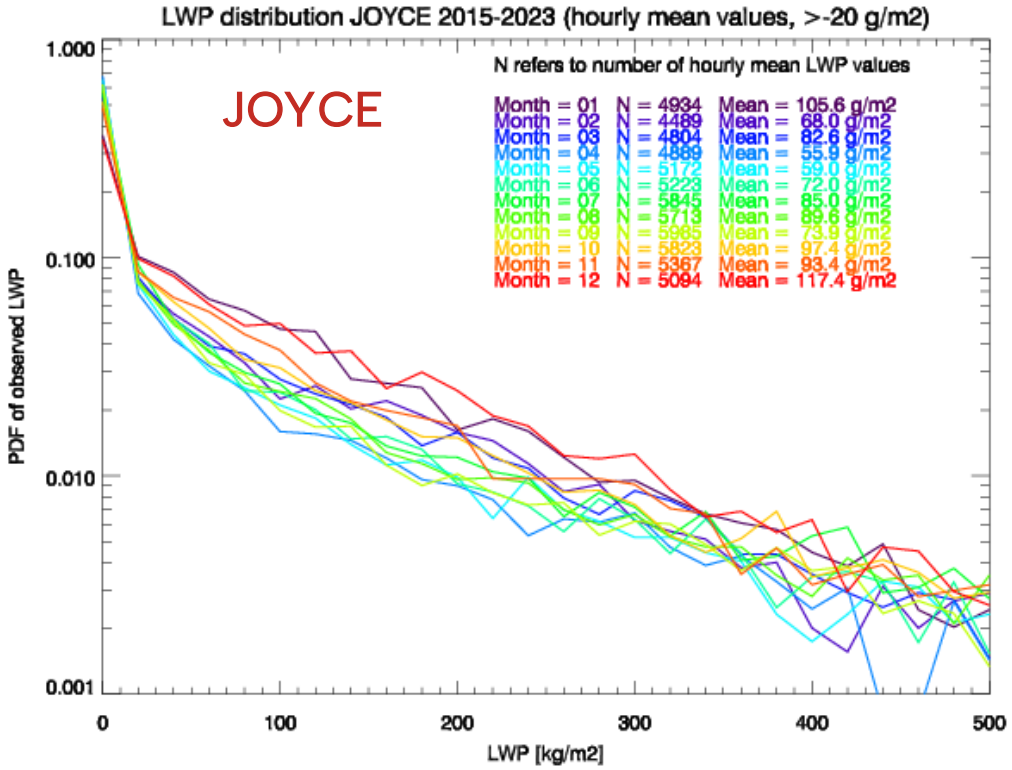
IWV diurnal cycle (seasonal)

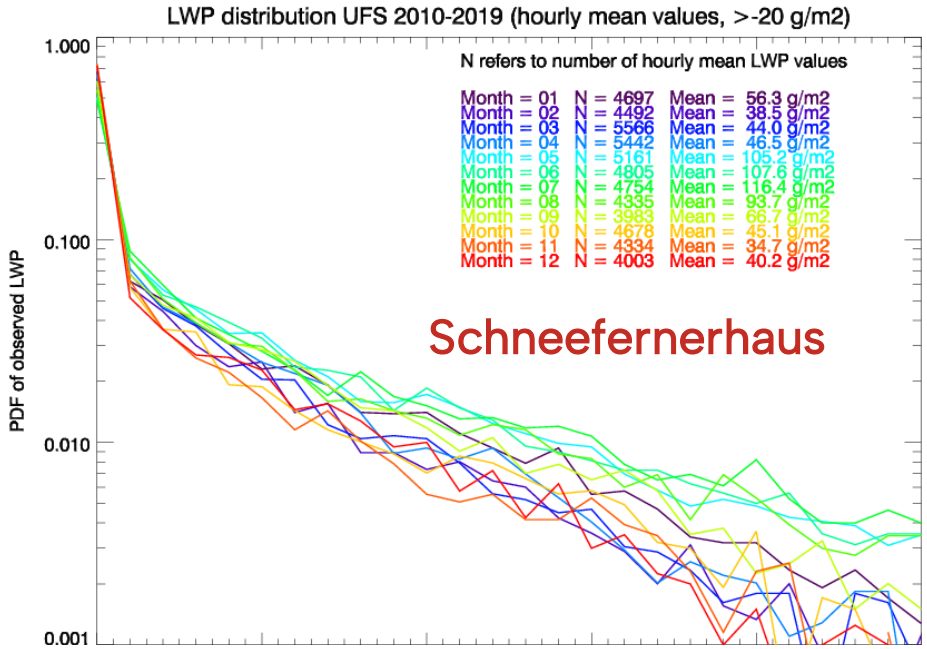


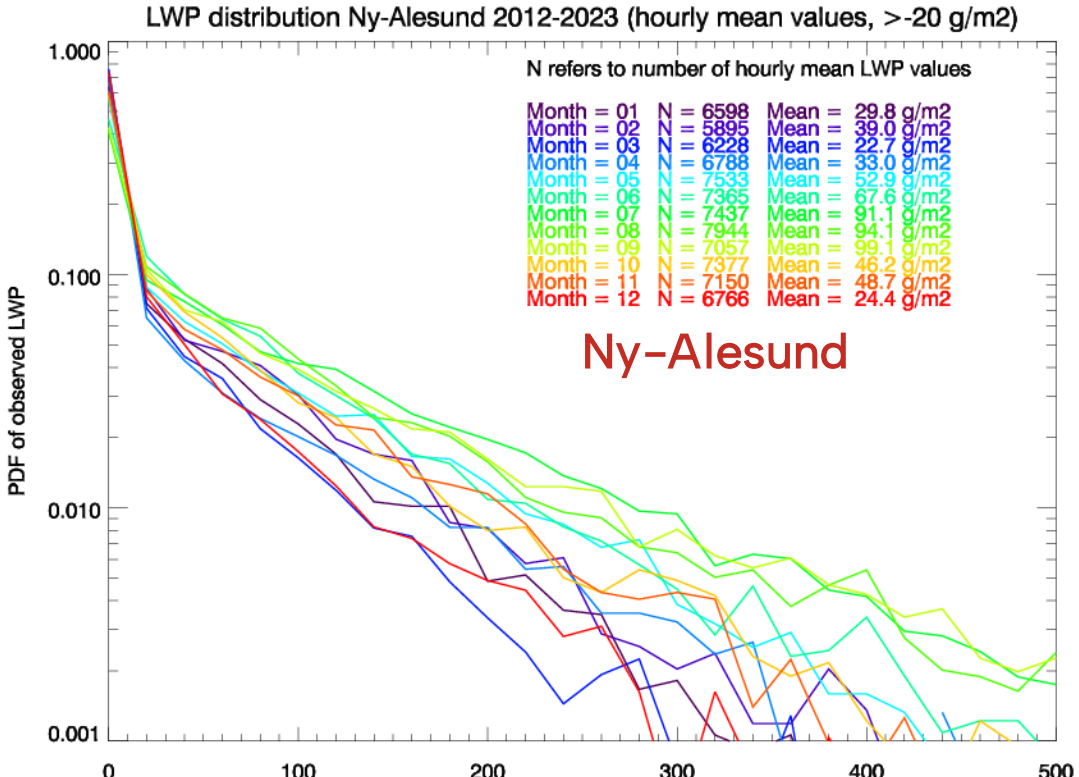


More pronounced diurnal cycle in summer at Schneefernerhaus, no significant signal in Ny-Alesund

Cloud liquid water path distribution per month

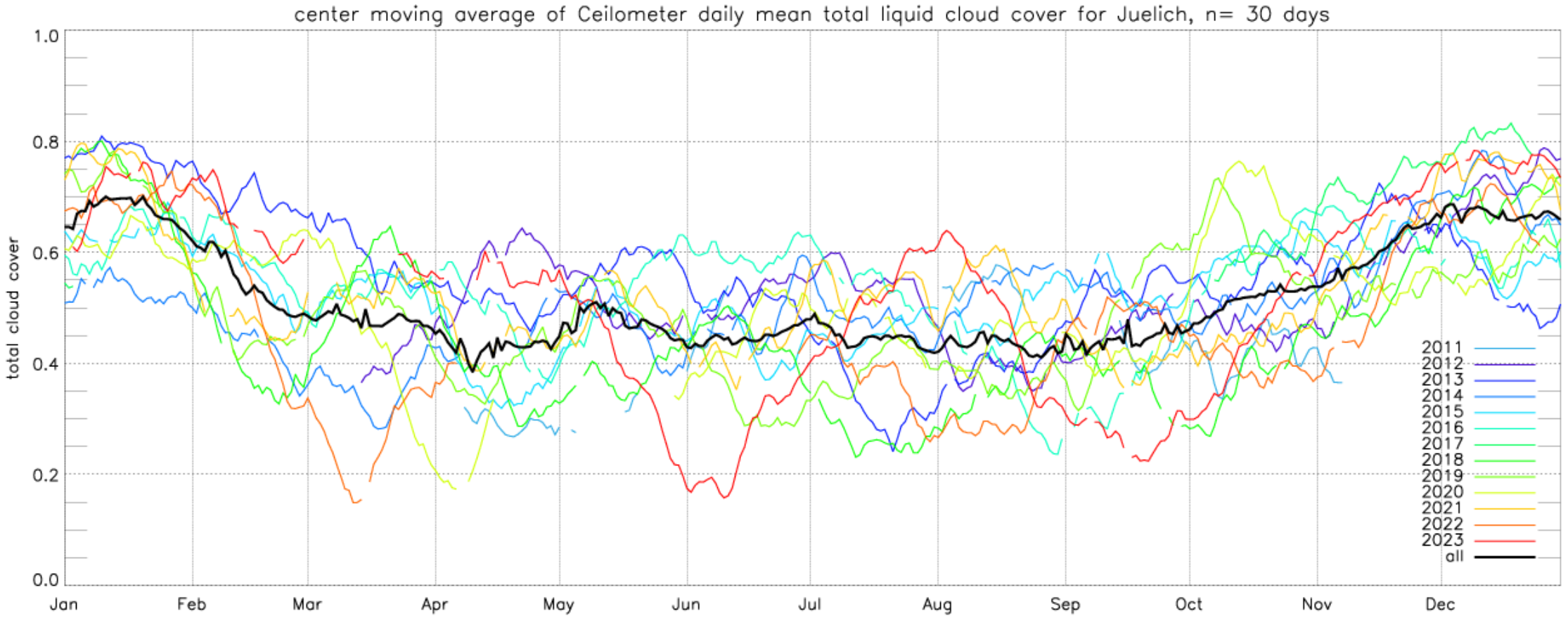






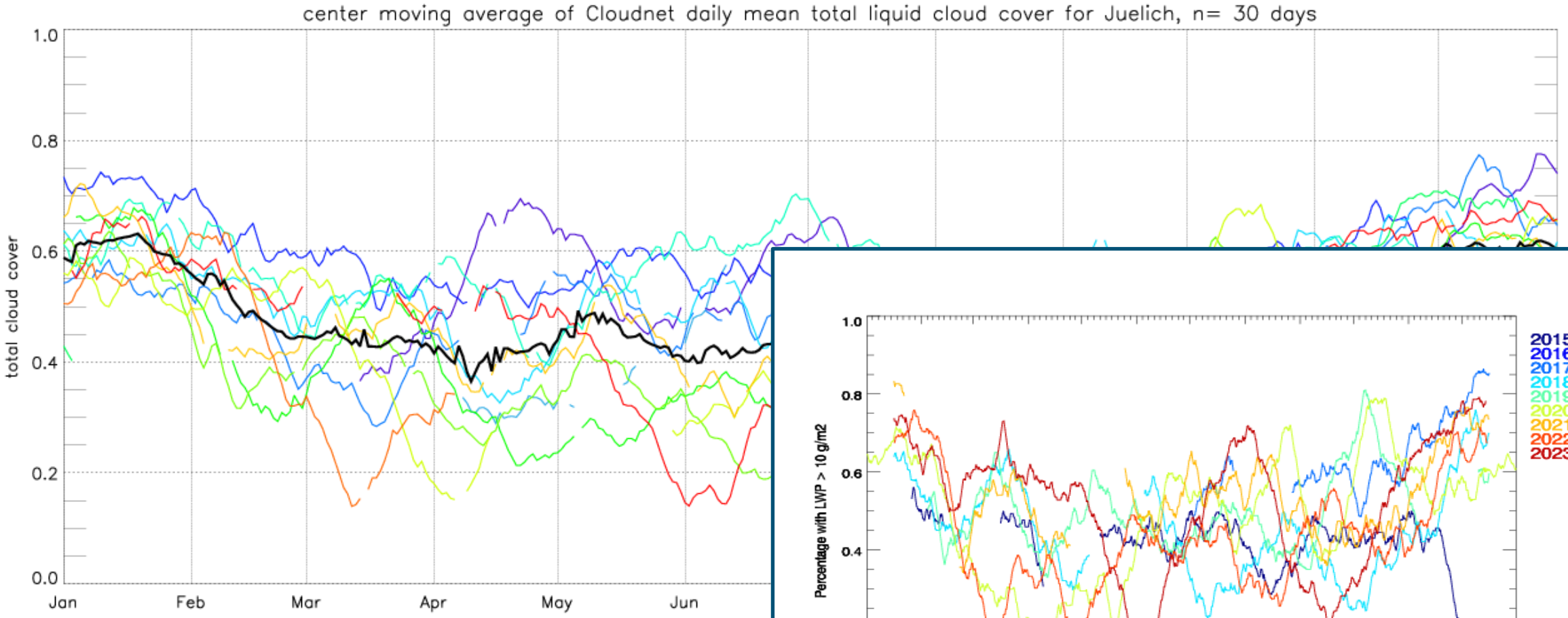
JOYCE: Max cloud LWP (<300 g/m²) in winter
Schneefernernhaus: Summer LWP dominant, smallest LWP in autumn
Ny-Alesund: Very low LWP frequency in winter

Cloud cover Ceilometer / MWR (yearly variation)



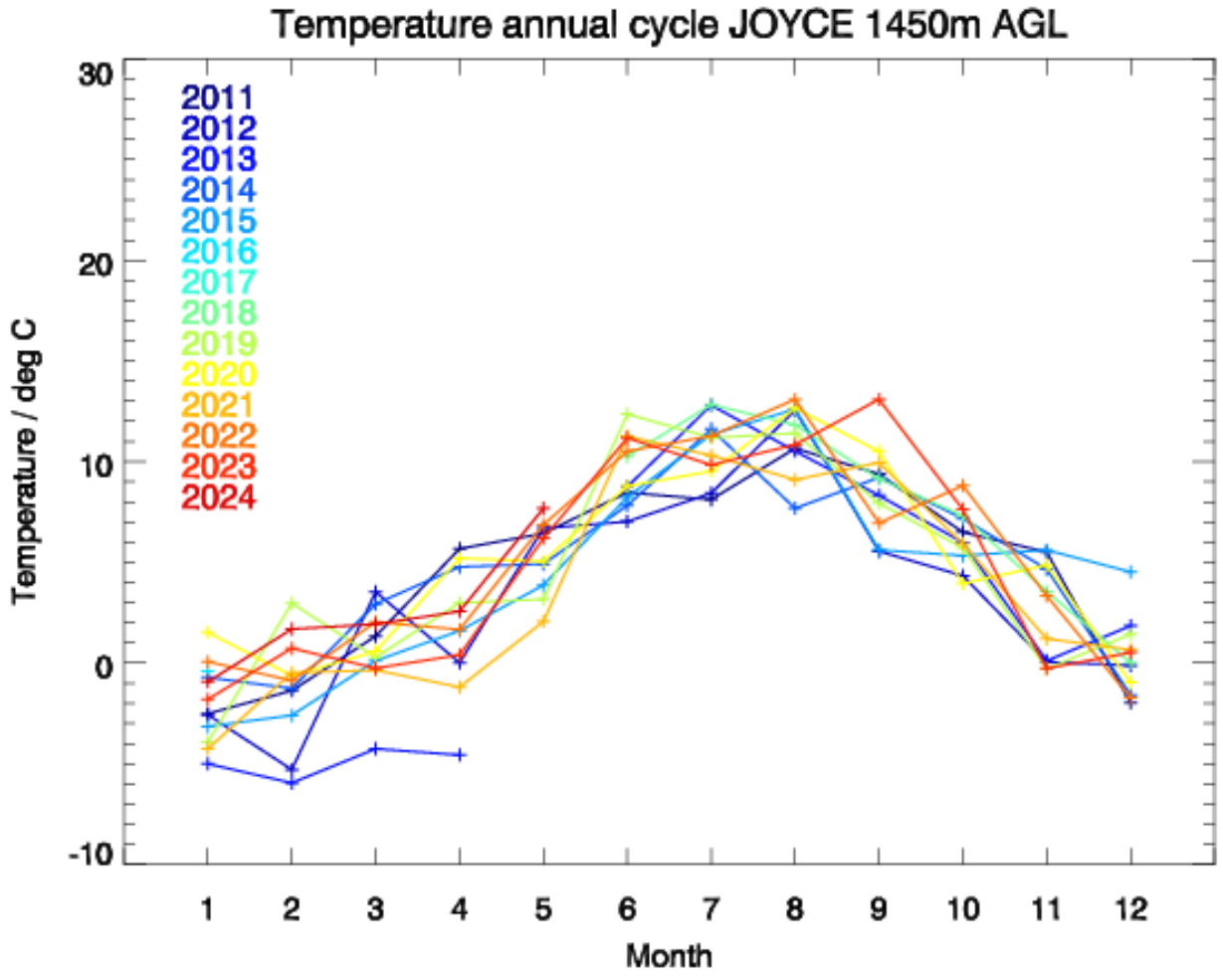
Ceilometer cloud occurrence vs. LWP occurrence in Jülich

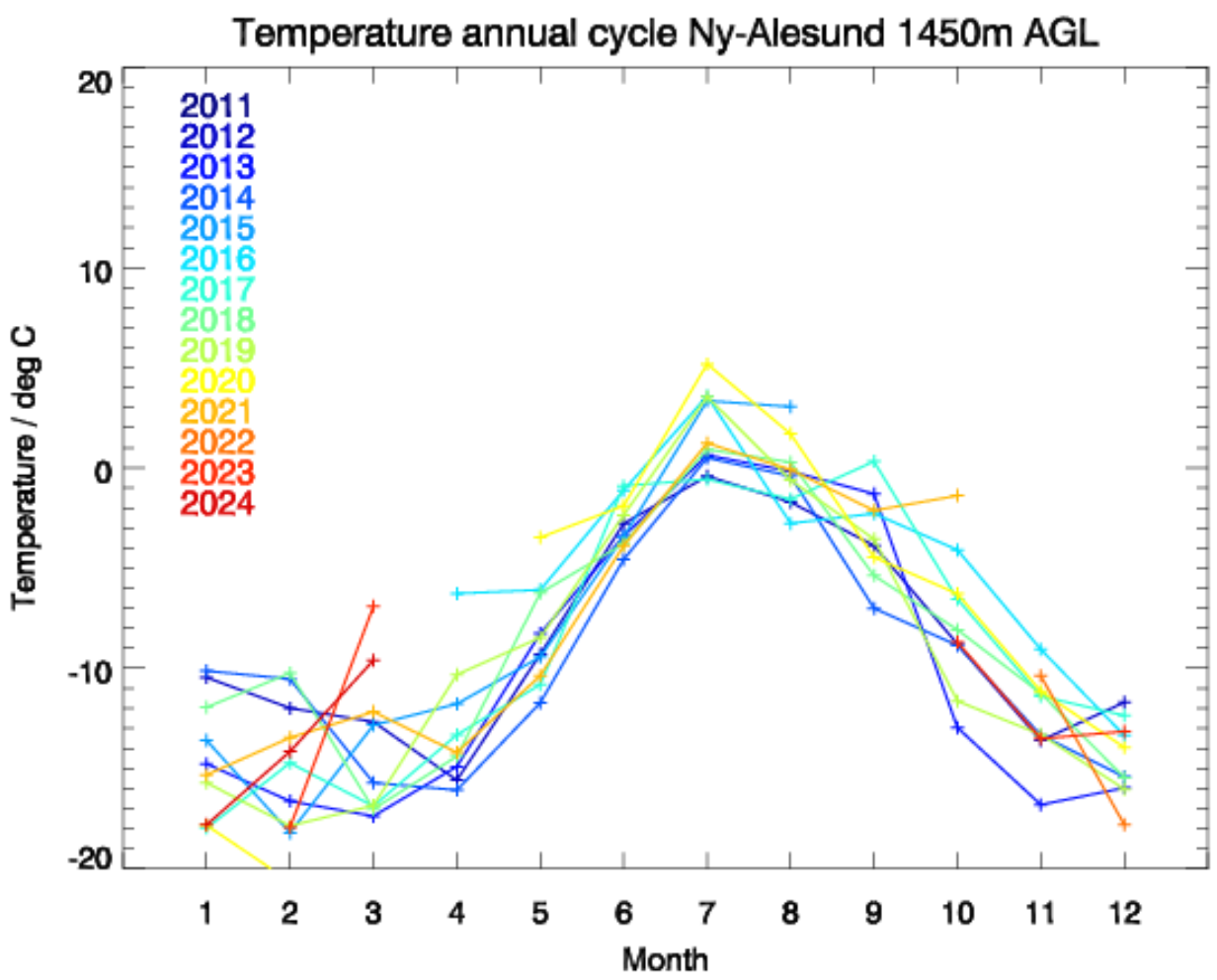
Cloudnet liquid cloud cover / MWR



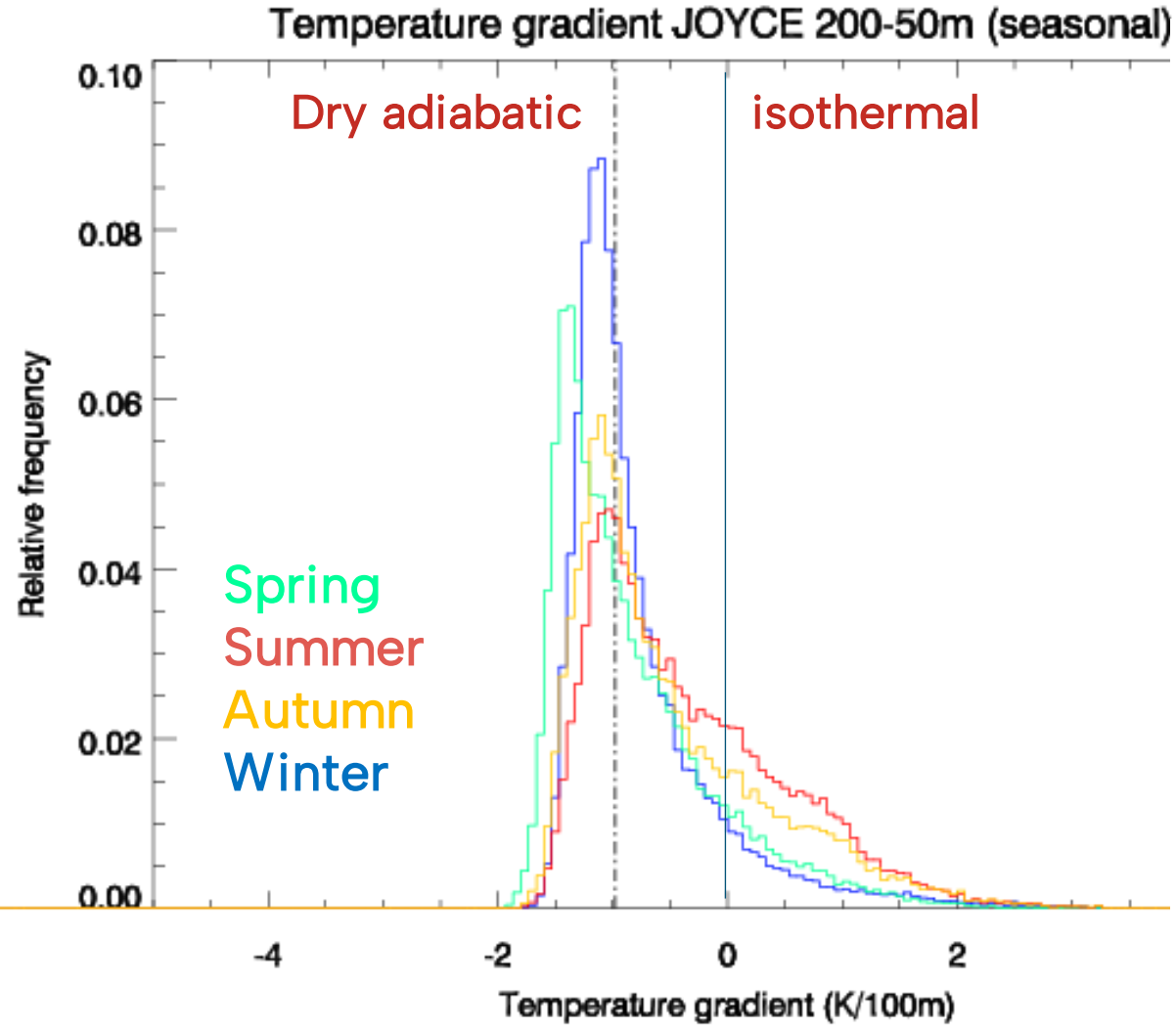
Same for Cloudnet liquid water

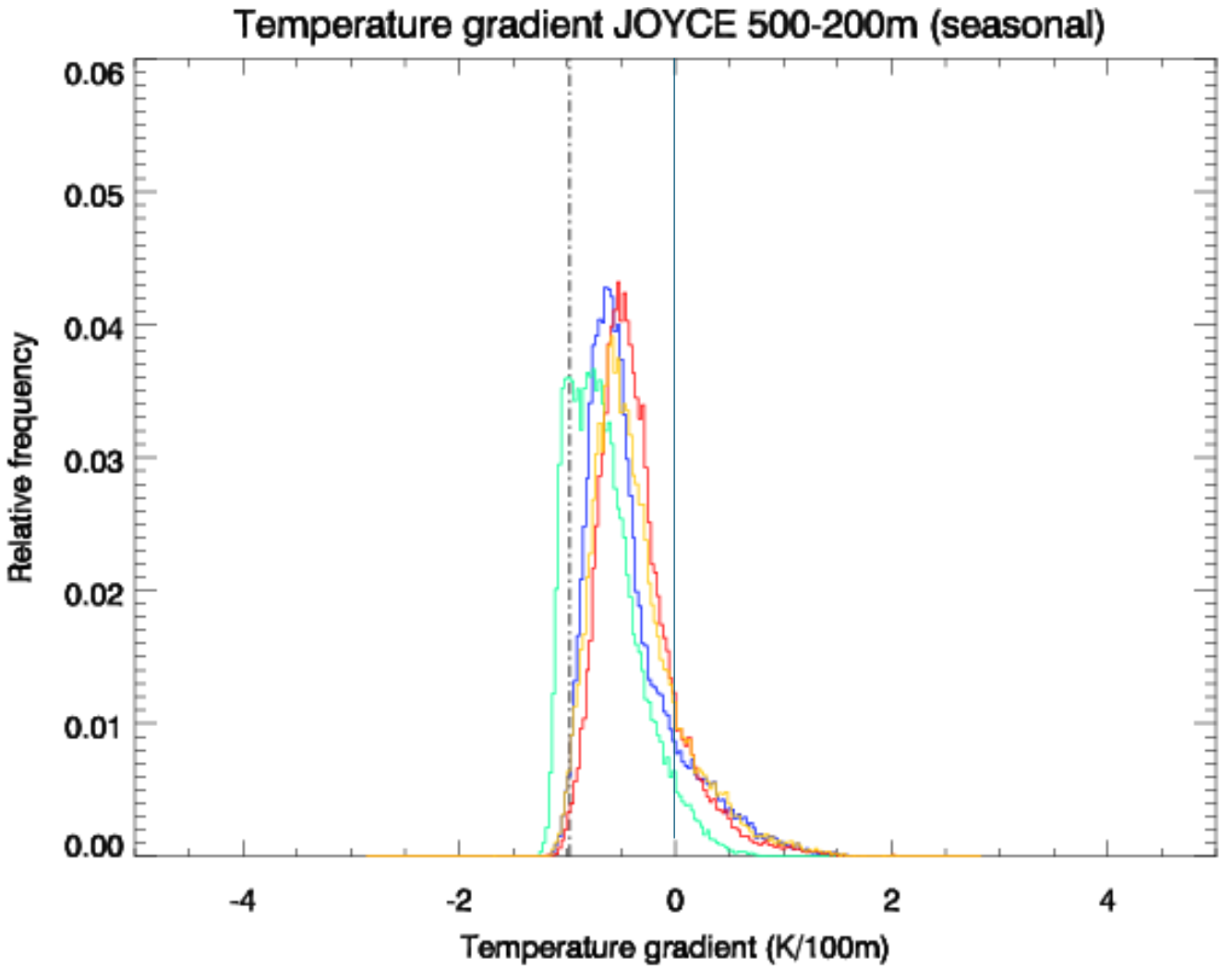
Temperature annual cycle



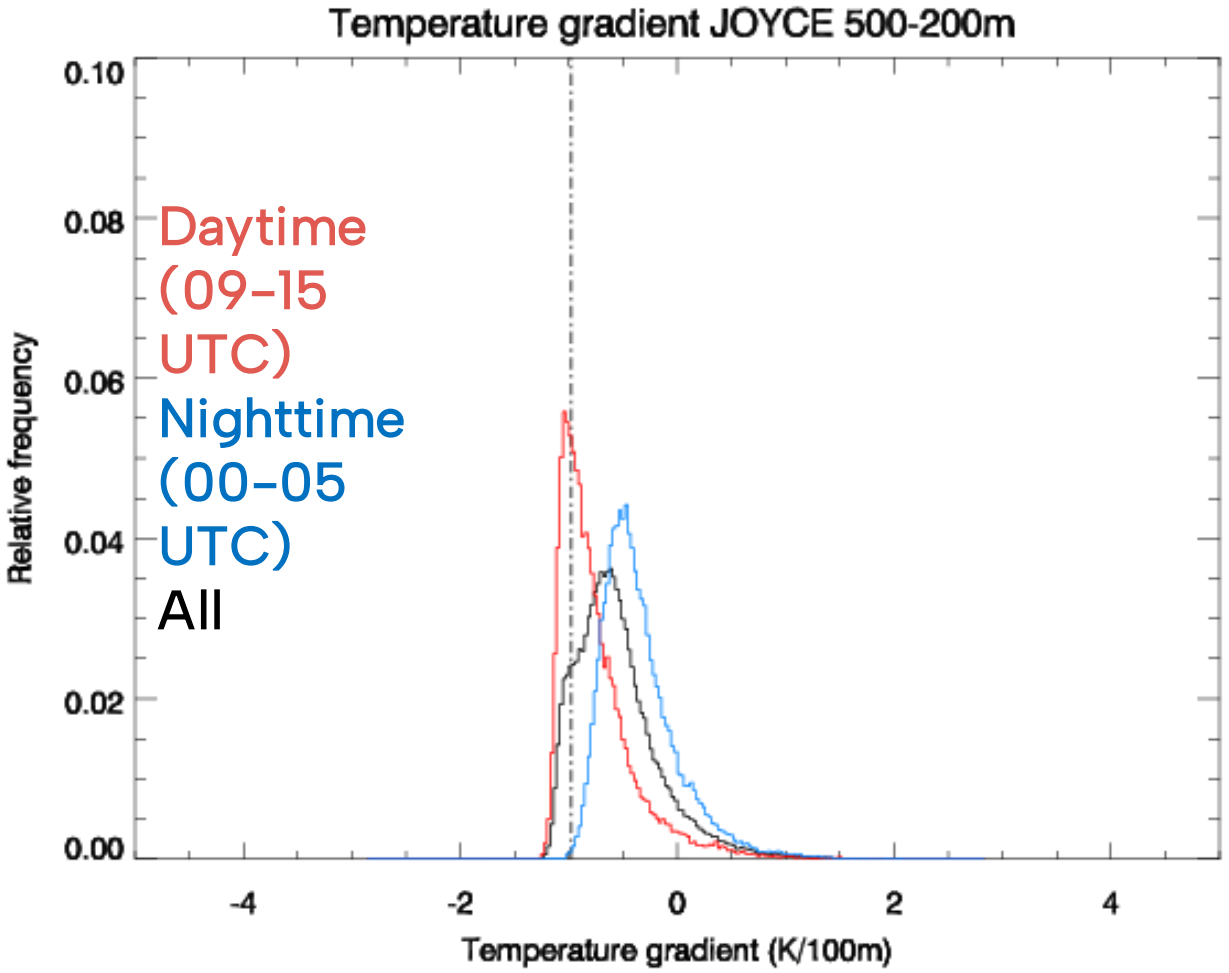


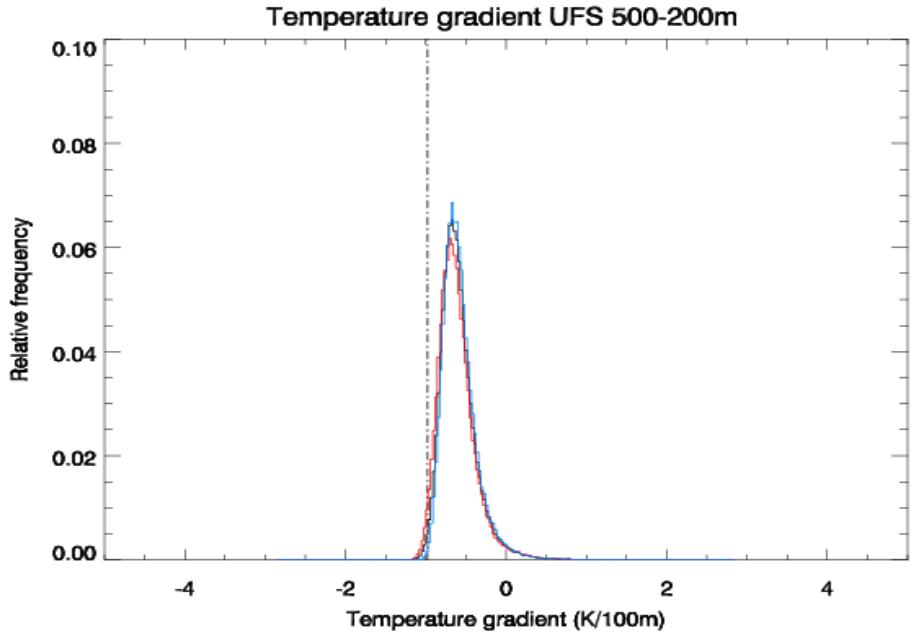
Temperature gradient / inversions (seasonal)

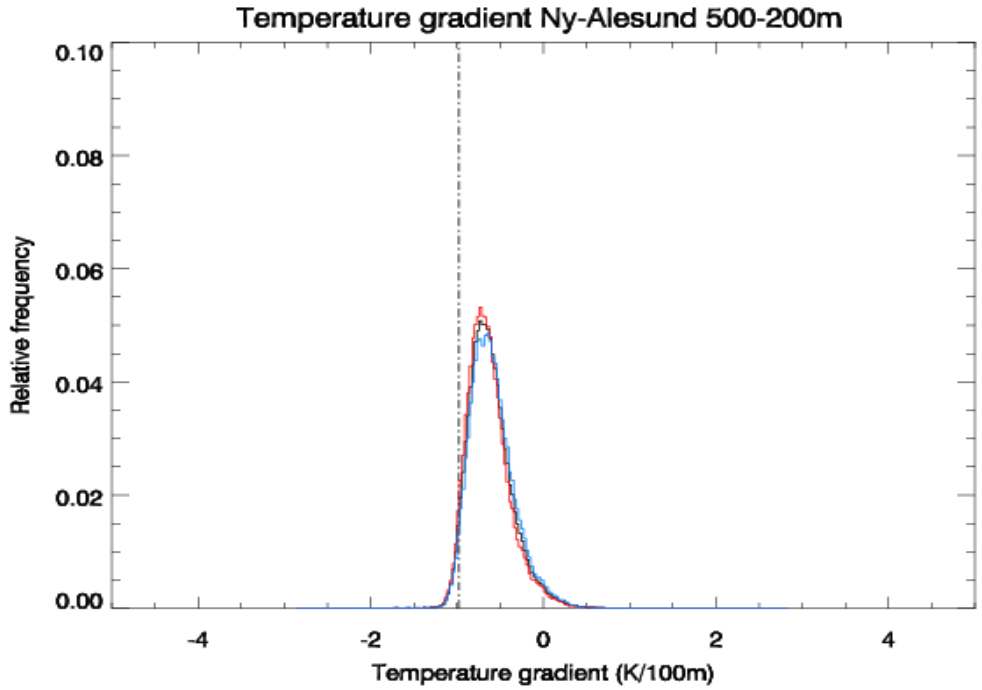




Temperature gradient (diurnal variations)







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