HD(CP)² Observational Prototype Experiment
HOPE for Clouds and Precipitation

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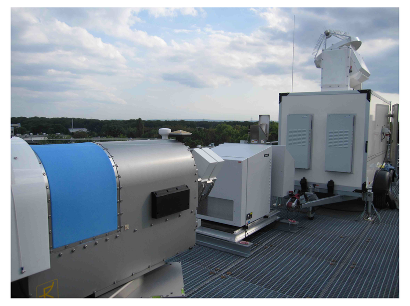
Three supersites within 5 km radius

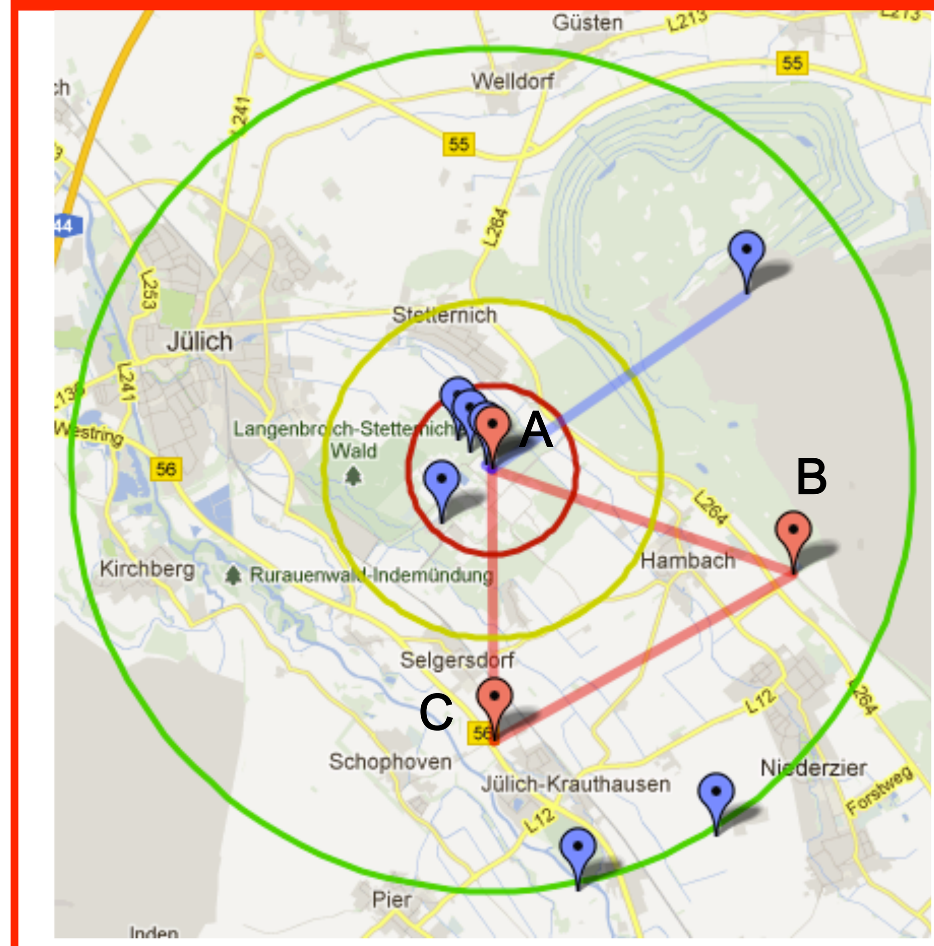
JOYCE: Jülich Observatory for Cloud Evolution (A)
- Scanning cloud radar MIRA
- Scanning MWR HATPRO
- WV Raman lidar MPI & BASIL
- Scanning Doppler lidar
- AERI system
- Ceilometers, MRR, all-sky imager
- Aeronet station, radiation sensors



KITcube & UHOH (B)
- Cloud radar MIRA
- Scanning MWR HATPRO
- Scanning WV DIAL
- Rotational Raman Lidar
- Doppler Lidar, ceilometer
- Mobile X-band radar, rain gauges, MRR
- 2 ceilometers, MRR, 30m tower
- Surface energy balance

LACROS: Leipzig Aerosol and Cloud Remote Observations System (C)
- Multi-wavelength Raman Lidar
- Scanning cloud radar MIRA
- MWR HATPRO
- Scanning Doppler lidar
- All-sky imager, ceilometer

HOPE: April-May 2013, Jülich, Germany



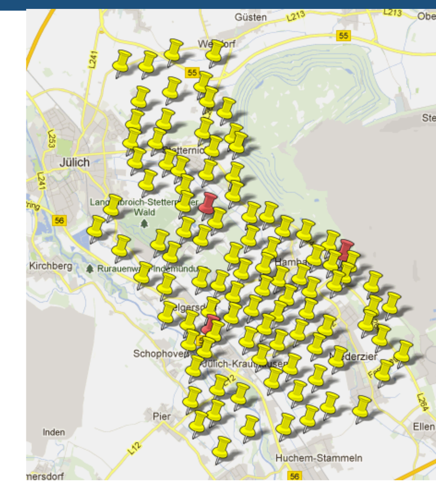
HOPE area 1, 2, 5 km radius (red, yellow, green) around the Research Centre Jülich (red circle)

Objectives
- Evaluate HD(CP)² cloud resolving model (dx=100m) over the full domain of Germany (1000 km)
- Provide information on sub grid variability

Focus
- 3D cloud and water vapor fields
- Clouds (activation) and precipitation (auto conversion) in the BL
- Cloud-overlap and 3D radiative effects
- Aerosol and cirrus cloud properties

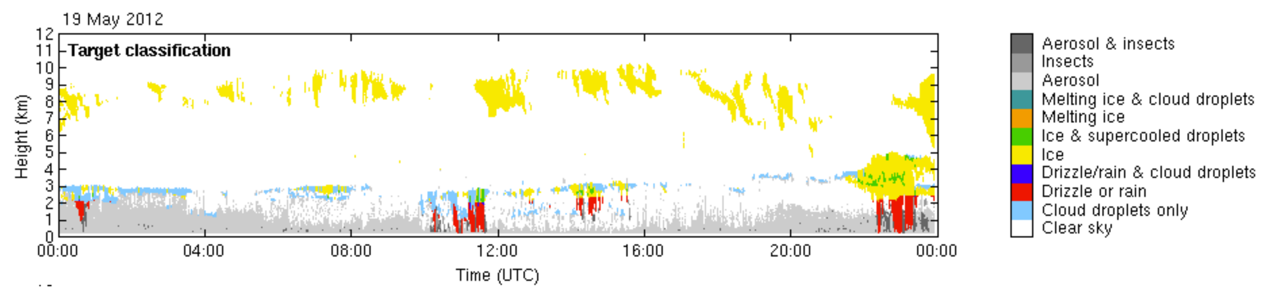
Additional measurements

- 0 and 12 UTC radiosondes
- Array of 100 surface solar irradiance stations
- MWR profiler for continuous BL temperature profiles
- 2 X-band Dual Polarization weather radars
- 3D cloudy reconstruction from all-sky cloud cameras
- EC stations and soil moisture measurements



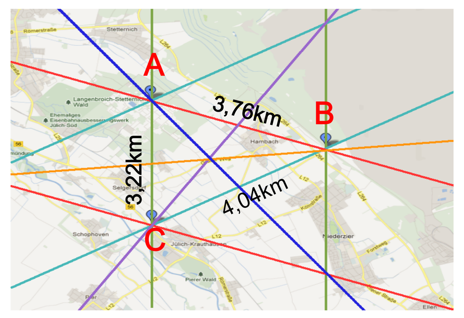
Measurement integration

- Cloudnet products: cloud classification, cloud cover, cloud microphysics
- 1DVAR retrieval of thermodynamic and cloud property profiles (IPT)
- 3D radar composites merged with satellite data

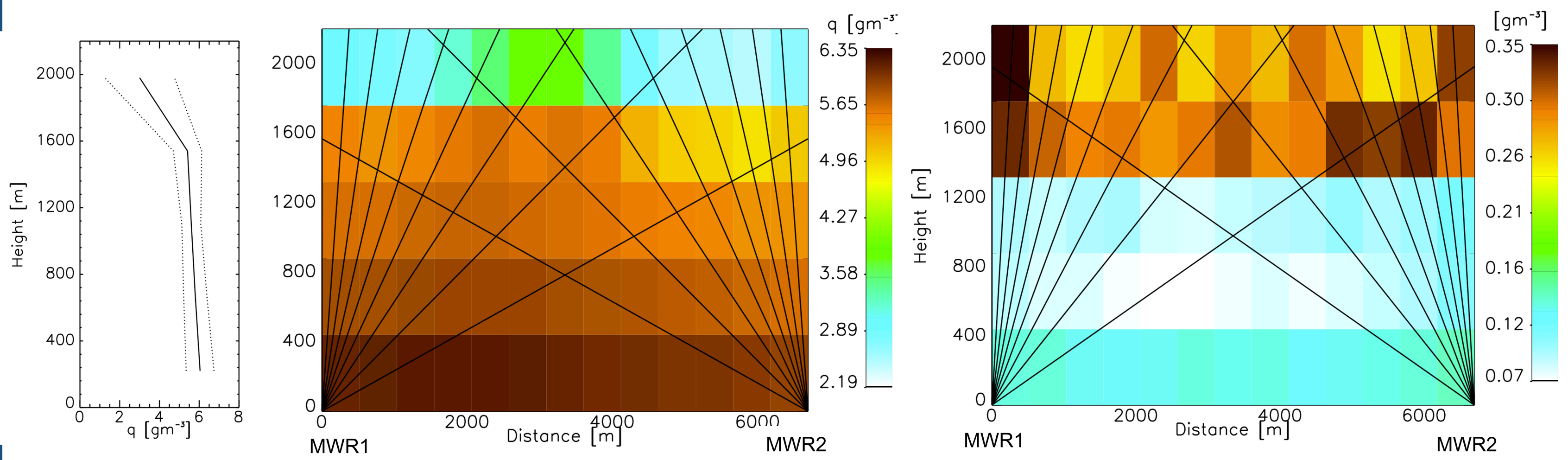


Cloudnet target categorization at JOYCE on 19 May, 2012 (www.cloud-net.org).

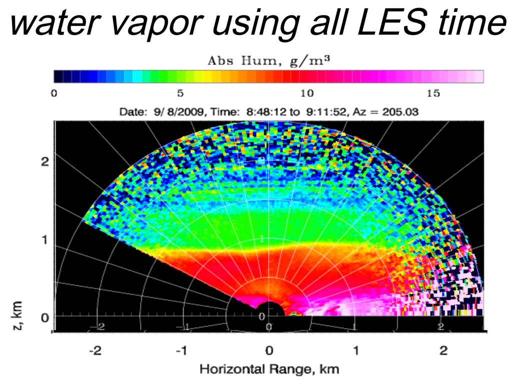
3D water vapor fields through tomography



3 MWR, each scanning at:
- 4 azimuth angles
- 17 Elevation angles: 13° - 167° (resolution 9.6°) continuously scanning during clear-sky cases
→ apply OE retrieval by Steinke et al. 2013



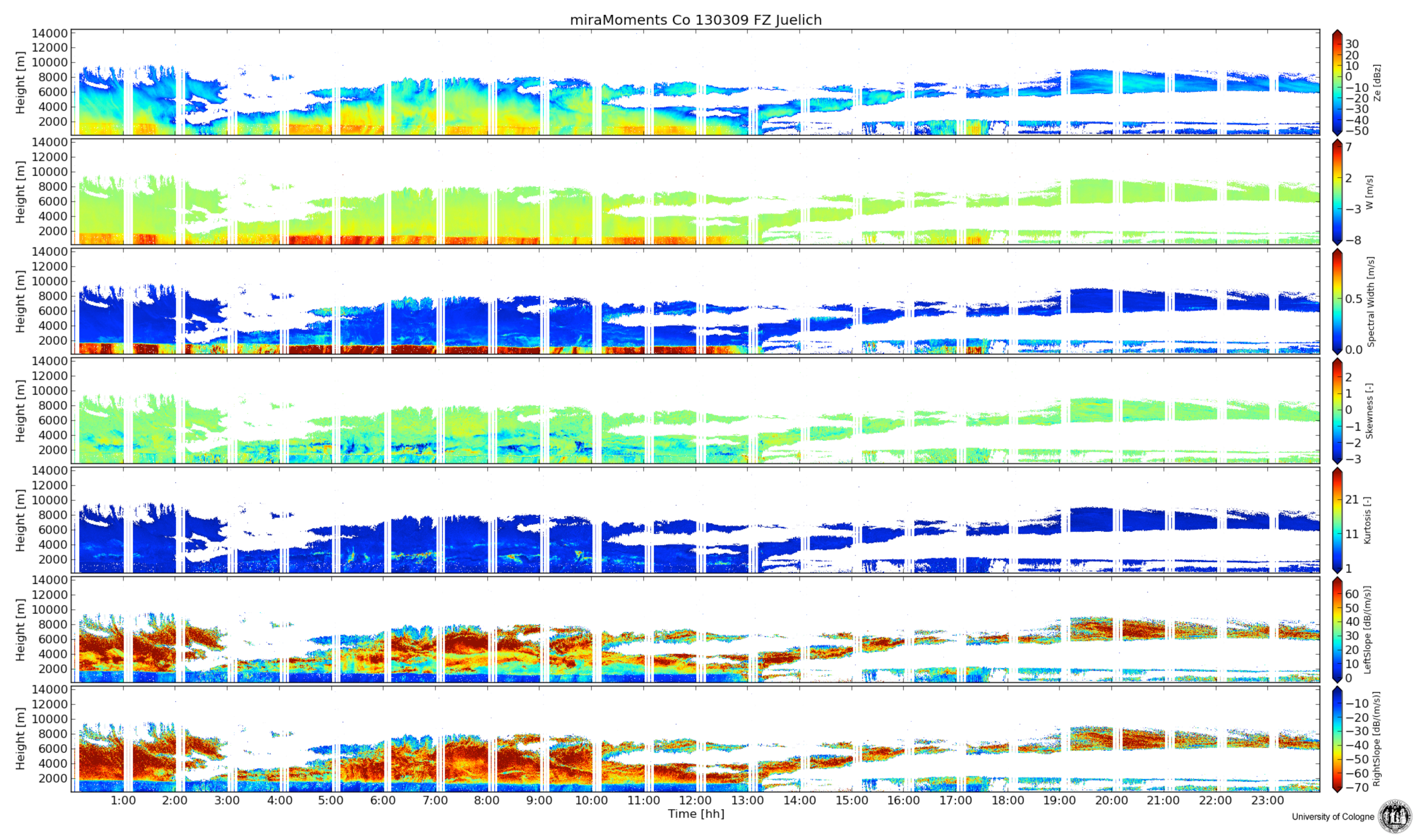
Left: mean water vapor profile (and standard deviation) from a LES simulation over the JOYCE area. Center: a retrieved 2D water vapor cross-section using the "LES truth" to simulate MWR measurements in the K-Band along the shown propagation directions. Right: accuracy of retrieved water vapor using all LES time steps (N=360).



Left: high resolution absolute humidity fields from scanning DIAL

Scanning DIAL
- Evaluate tomography retrieval
- Use as a prior constraint
- Include in OE retrieval

Clouds and precipitation



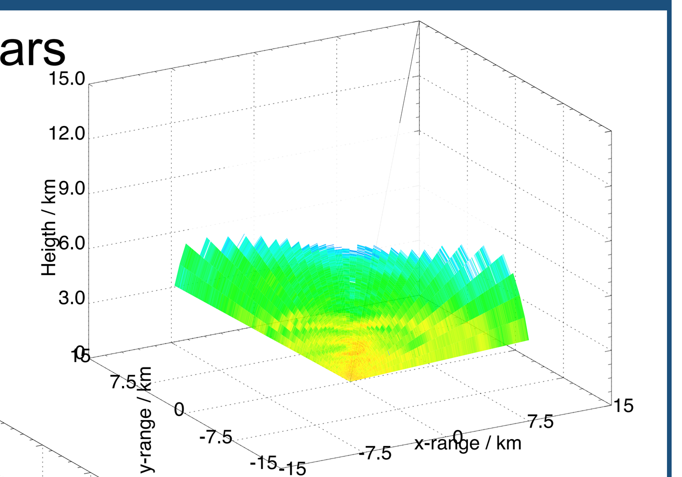
An updated data processing of the cloud radar MIRA@JOYCE now allows to retrieve higher spectral moments (kurtosis, panel 4 & skewness, panel 5) of the Doppler spectrum along with "usual" values of reflectivity (panel 1), Doppler velocity (panel 2) and Doppler velocity spectral width (panel 3). In precipitation, the left (panel 6) and right (panel 7) slope of the most significant peak in the Doppler spectrum shows potential to infer extended information on the particle size spectrum microphysics. Additionally, the full velocity co- and cross-specta are stored using an optimized compression.

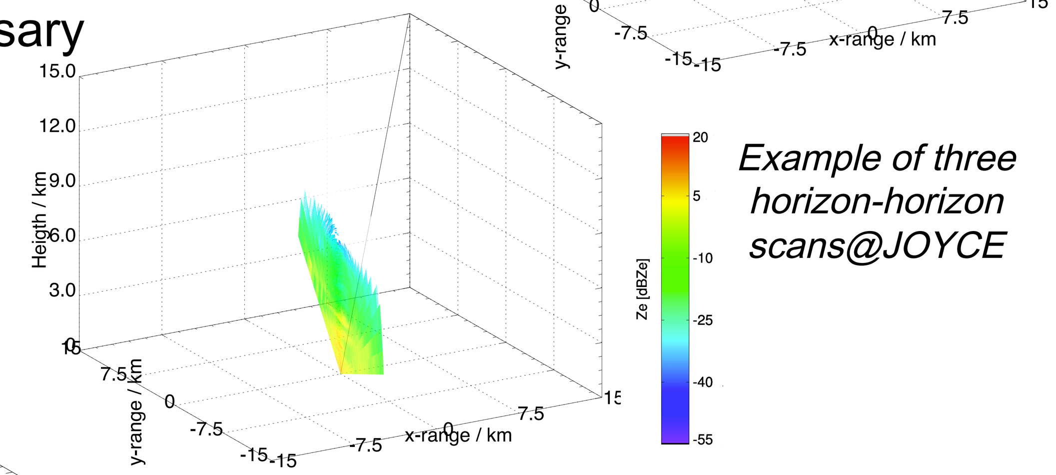
Scanning cloud radar

Coordinated scan patterns of HOPE cloud radars

JOYCE scanning cloud radar

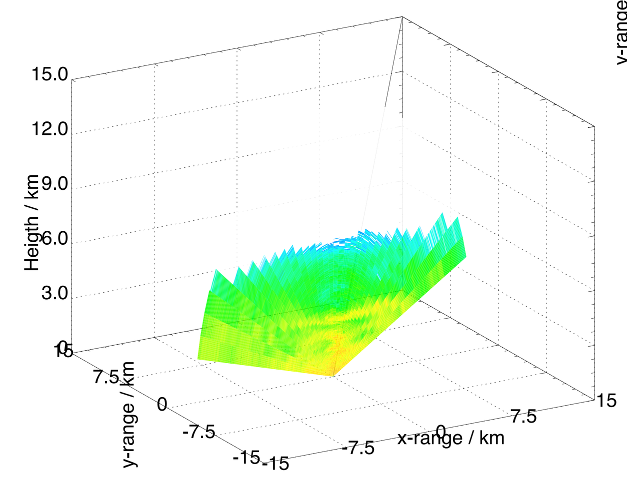
- Combine different radars at distinct azimuth angles → enhance effective scan speed
- Temporal coordination necessary





Example of three horizon-horizon scans@JOYCE

Horizon-horizon: 3D "snap shot"



other planned scan patterns
- *BL wind parallel:* capture life cycle of single BL cloud with 2 radars
- *Cross wind:* extend standard vertical viewing to two dimensions