The Life-Cycle of Cloud and Precipitation Microphysics in Radar Observation and Numerical Model

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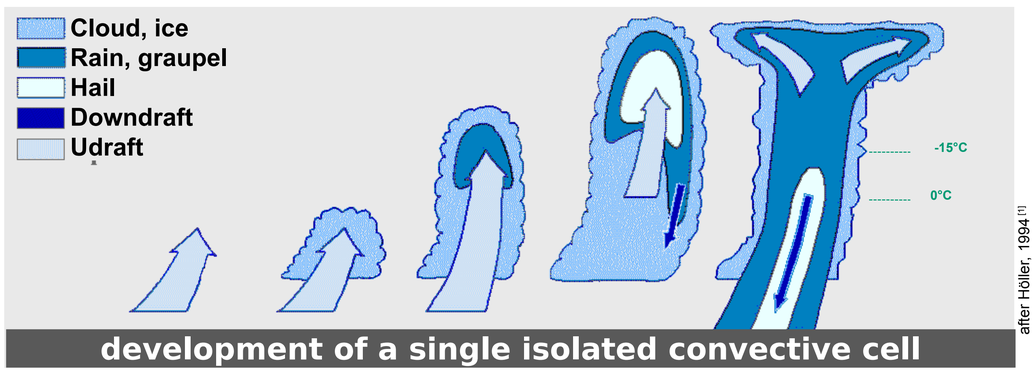
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IcePolCKa

Cloud and precipitation processes are the main source of uncertainties in numerical weather prediction:
- Oversimplified parameterizations
- Lack of observations that describe microphysical processes at necessary level of detail

1) Novel polarimetric and dual-wavelength (DWR) radar measurements to observe convective cloud systems over their lifetime:
   - Polarimetry: Provides information about hydrometeor shapes
   - DWR: Provides information about hydrometeor sizes

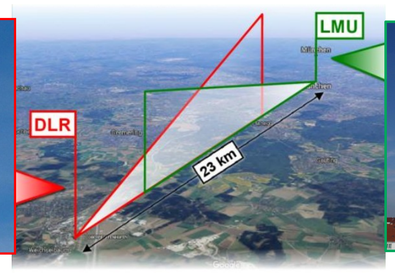
2) High resolution numerical weather model simulations with microphysical schemes of varying complexity to evaluate model microphysics against our observations.



Measurements

POLDIRAD (DLR)



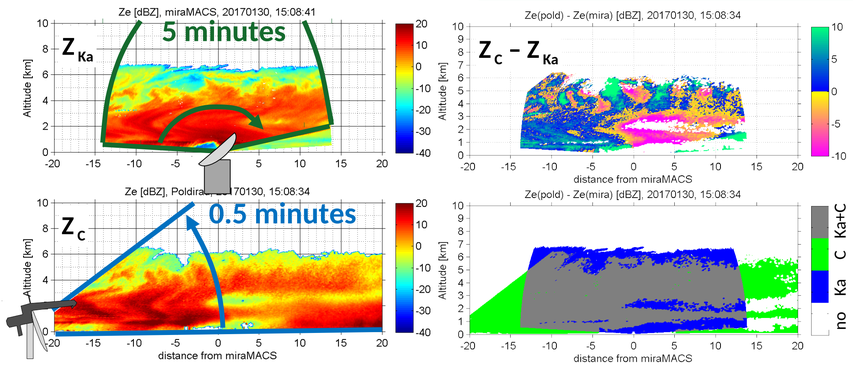


miraMACS (LMU)



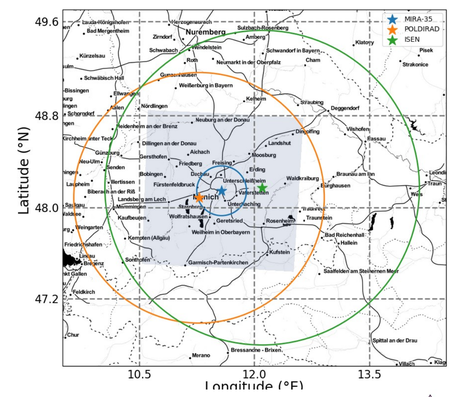
- C-band weather radar (5.5 GHz, 250 kW)
- Located at DLR Oberpfaffenhofen
- 4.5 m antenna, 1° beam-width
- range res. 150 m, max. 120 km
- full polarimetric (ZDR, LDR, KDP, rho_{HV})

- Ka-band cloud radar, scanning (35 GHz, 30 kW)
- Located at LMU Munich city
- 1 m antenna, 0.6° beam-width
- range res. 30 m, max. 30 km
- linear depolarization ratio LDR



High resolution numerical weather modeling

- Weather Research and Forecasting (WRF)
- Inner nested Munich domain at 400 m resolution
- Simulations with 5 microphysics schemes of varying complexity:
  - **2-moment Bulk:** Thompson2008[2], Morrison2009[3], Thompson2014[4]
  - **Spectral bin:** Shpund2019[5],
  - **P3:** Morrison2015[6]

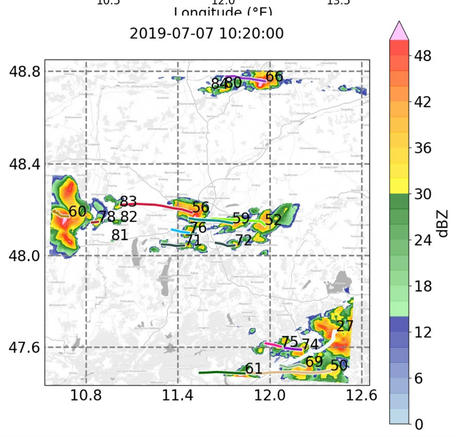


Radar forward operator

- CR-SIM (Oue2020[7])
- For comparison of model and radar

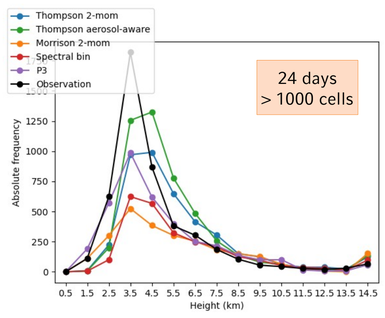
Cell Tracking

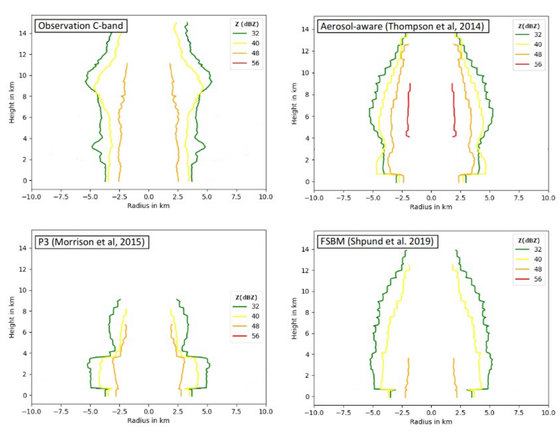
- TINT (Fridlind2019[8])



Statistical intercomparison of classical convective cell characteristics

- Number, extent, echo distribution, max reflectivity, lifetime, …
- ~50 days of DWR observations and simulations
- DWD Isen radar measurements as complementary data for larger spatial coverage



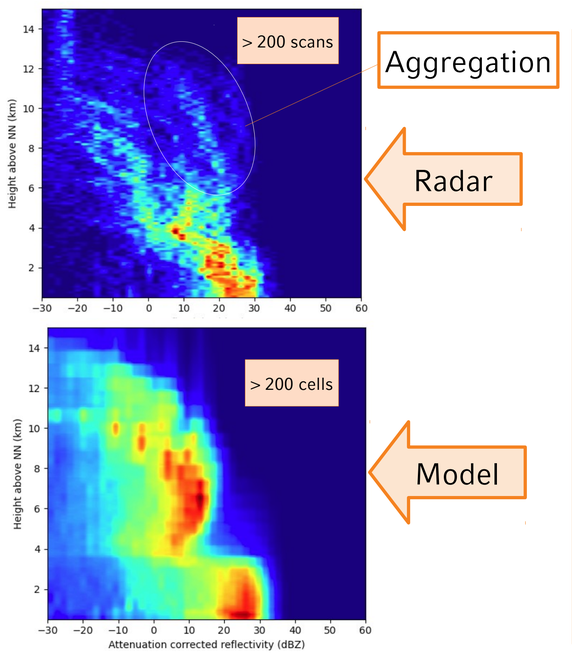


Preliminary results:

- Peak of most convective cells at lower heights and lower reflectivity in observations
- Morrison2009[3] and Sphund2019[5] simulate too few convective cells

Microphysical fingerprints and process understanding

- CFADs (model and radar) of polarimetric and dual-wavelength quantities to visualize microphysical processes within convectice cells



- Are simulations able to reproduce microphysical fingerprints visible in observations?
- Hydrometeor classification:
  - Hydrometeor abundances and distributions
- DWR and polarimetry:
  - particle size distributions and particle shapes
- Effect on convective initiation and precipitation development

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