Comparing Cloudnet classification of mixed-phased clouds to high resolution cloud resolving model

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Motivation

Mixed phase clouds:

- play a decisive role in precipitation production
- represent crucial factor in global cloud radiative forcing
- are difficult to model and observe

  → however: new observational and modelling capabilities may lead to improved understanding

Observations

- Cloudnet (www.cloud-net.org)
  - – combines radar, lidar and microwave radiometer with a forecast model for a categorization product
- **6 years of observations** from Jülich Observatory for Cloud Evolution (JOYCE; www.joyce.cloud)

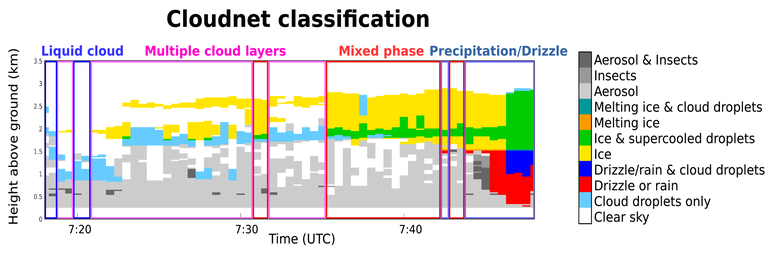

Fig. 1: Example of the Cloudnet target classification product (May 11th 2013) and illustrating how columns were classified for further analysis. Due to the attenuation of the lidar signal, cases with precipitation, drizzle or several cloud layers, are masked as precipitation and multiple cloud layers, respectively.

Seasonal Frequency

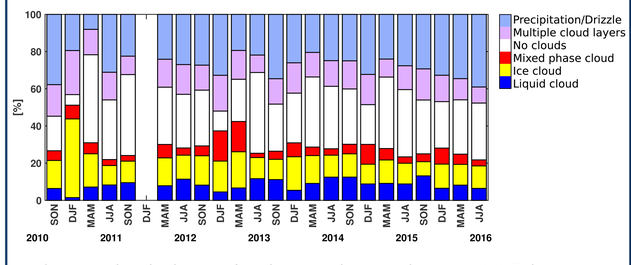

Fig. 2: Mixed phase clouds are observed over JOYCE in every season, with highest frequency in the winter. The same is true for ice clouds, whereas liquid clouds are most common in summer and autumn. Note, that blue and red bars indicate cases when only a single cloud layer of each cloud type was detected.

Model

- ICOsahedral Non-hydrostatic atmosphere model Large-Eddy Simulations (ICON-LEM)
  - – 156 m horizontal resolution, 150 vertical levels
  - – Domain: Germany
  - – **6 days in Spring** 2013 (HOPE campaign)
  - – Grid points closest to JOYCE site

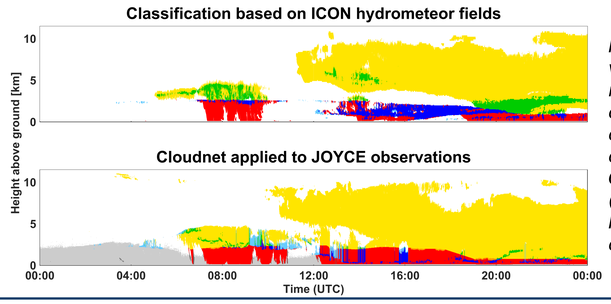

Fig. 3: Prognostic variables from the model were considered in categories corresponding to Cloudnet (26th April 2013). For meaning of colours, see Fig 1.

Comparison of cloud frequency

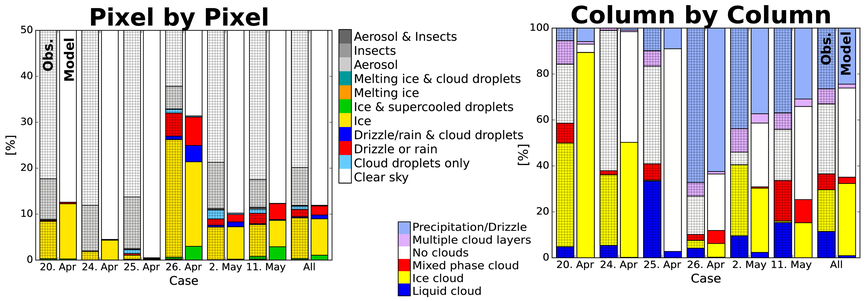

Fig 4. Frequency of each Cloudnet category in each case and for all 6 days.

- More 'drizzle/rain & cloud droplets' and less 'cloud droplets only' in the model
- Instrument limitations, e.g. lidar attenuation, not taken into account

Fig 5. Frequency of different columns (see Fig. 1) in each case and for all 6 days.

- Precipitation similar in model and obs.
- Non-precipitating liquid and mixed phase phase clouds underestimated by the model
- Ice clouds overestimated by the model

Phase in mixed phase clouds

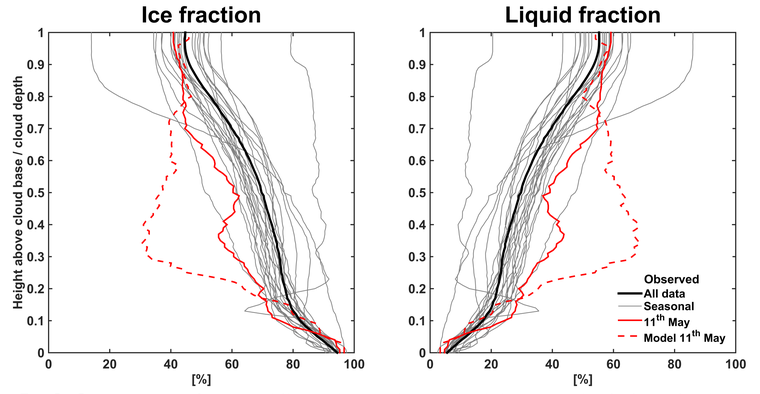

Fig 6. Occurrence of ice and liquid in the (non-precipitating, single layer) mixed phase clouds.

- Only half of the clouds contain liquid at cloud top
- Always ice at cloud base
- Small variability for different seasons

Conclusions

- 6 years of Cloudnet used for studying different kind of cloudy columns and the structure of mixed phase clouds, necessary to provide context for model case studies
- Fair agreement between model and observations on case by case comparison, but results are sensitive to instrument specifications and model output processing

References

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