A Microphysical Classification of Mixed-Phase Clouds in the Liquid-Ice Coexistence and Wegener-Bergeron-Findeisen Regime


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Mixed-phase clouds
- Temperature regime between 275K and 235K
- Supersaturated liquid water and ice can coexist
- Wegener-Bergeron-Findeisen process possible
- Precipitation building area

Motivation
- Highly dynamical system, many interactions: phase transitions, energy fluxes, mass changes, precipitation (not yet fully understood)
- Radiative effects depending on ice water content (see graph), will have to be implemented in climate models (IPCC 2013)

Cloud regimes
- Wegener-Bergeron-Findeisen-Regime (WBF)
- Coexistence Regime (CoEx)
- Radiative effects in the Arctic

WBF regime
- Study on the VERtical Distribution of Ice in Arctic clouds
- Inuvik, Canada
- Arctic campaign
- CAPS@Polar5

CoEx regime
- Combined Observation of the Atmospheric boundary Layer to study the Evolution of BruchCumulus
- Exeter, UK
- Mid-altitude campaign
- CAPS@BAE146
- Humidity measurement: ApCIT-TDL

Application of the cloud regime classification on field data: Size distributions for WBF and CoEx clouds

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CoEx regime:
- Regimes separated by size distributions
- Humidity measurement: ApCIT-TDL
  - WBF regime
  - CoEx regime
  - Size distributions are correlated very well to the humidity ranges that define the cloud regimes!

WBF cloud occurrence increases with altitude (=> with decreasing temperature)

Process visible: Cloud fraction grows with increasing altitude in the CoEx regime
*mean diameter of the cloud particle fraction with the highest concentration (calculated per flight second)

Correlations between size distribution and water saturation

Temperature and size trends of the spherical ice fraction in the WBF regime

References

Small ice crystals
- Small spherical and aspherical ice particles (3-50 μm) in WBF clouds: Not a result of shattering but frozen droplets or partly sublimated ice crystals
- Spherical ice fraction seems to increase with decreasing size.

Conclusions
- The cloud particle size distribution gives hints at the WBF or CoEx humidity regime
- Coexistence regime: more frequent than the Wegener-Bergeron-Findeisen regime
- The WBF cloud percentage increases with increasing altitude/decreasing temperature
- Similar particle numbers but growing particle sizes from the bottom to the top of the clouds