Evaluating the critical relative humidity as a measure of subgrid-scale variability of humidity cloud cover parameterizations

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Cloud cover parameterisations in general circulation models (GCMs) rely on assumptions about the subgrid-scale variability of humidity. Unfortunately, little options exist to evaluate these assumptions using observational data at a large scale. A relatively simple parameterisation assumes a "critical relative humidity", or a threshold value of the grid-box mean relative humidity, above which partial cloudiness in a GCM grid box is diagnosed. The critical relative humidity is thus a measure of the subgrid-scale variablity, diagnosing clouds even for grid-box mean relative humidities less than 100%.

Analysing the model parameterisation, it is found that for a given fractional cloudiness, and a given grid-box mean relative humidity, this critical relative humidity can be inferred. While high-resolved observations of humidity, from which a probability density distribution could be inferred, are scarce, large-scale mean obserations exist from satellite data and from meteorological re-analyses. In the presentation, the profiles and geographical distributions of the critical relative humidity as inferred from Atmospheric Infrared Sounder (AIRS) satellite retrievals and from a combination of relative humidity from the ECMWF Re-Analyses (ERA- Interim) and cloud fraction CALIPSO lidar satellite data are analysed. The observations-based results are applied to revise the parameterisation in the ECHAM general circulation model, and some conclusions for the cloud-climate feedback are presented.