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From a needle to the haystack: Aircraft cloud observations and radiative transfer simulation

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According to IPCC [2001], clouds and their interaction with radiation are one of the largest sources of uncertainty in our prediction of future climate. To improve the parameterisation of the cloud radiation interaction, detailed three-dimensional (3D) radiative transfer studies are required, to quantify the impact of cloud inhomogeneity on the radiation budget. A great remaining challenge in 3D radiative transfer is the generation of realistic clouds as input to the sophisticated radiative transfer models. Currently, it is not possible to derive the required distribution of liquid water content and droplet sizes from observations of a single instrument. Passive satellite remote sensing instruments may provide a detailed horizontal distribution but fail to give any information about vertical profiles. In-situ observations, on the other hand, may give data for any location but are usually restricted to only a few locations, e.g. along an aircraft flight track. Physical cloud-models (e.g. LES) on the other hand can provide the full 3D information of all needed microphysical properties but they do not necessarily represent real or even realistic cloud fields. CLABAUTAIR, a novel algorithm to derive 3D cloudfields (described by liquid water content and effective radius) from aircraft measurements is presented. The observations are scanned for characteristic spatial structures which are then used to extrapolate the data to create a complete 3D field. The capabilities of the algorithm are successfully demonstrated by deriving a cloud structure from simulated flights through an LES cloud. Results (cloud structure, statistical properties, and radiation) for real cases are shown for two field campaigns within the framework of the European INSPECTRO project (Influence of clouds on the spectral actinic flux in the lower troposphere); one took place in September 2002 in East Anglia, UK, the other in Mai 2004 in Bavaria, Germany. In one broken cloud case it was possible to combine these data with a high-resolution LandSat image, leading

an even more realistic cloud structure.