Atmospheric Chemistry and Physics
An Interactive Open Access Journal of the European Geosciences Union

Atmos. Chem. Phys., 8, 1231-1248, 2008
www.atmos-chem-phys.net/8/1231/2008/

Cloud type comparisons of AIRS, CloudSat, and CALIPSO cloud height and amount

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Abstract. The precision of the two-layer cloud height fields derived from the Atmospheric Infrared Sounder (AIRS) is explored and quantified for a five-day set of observations. Coincident profiles of vertical cloud structure by CloudSat, a 94 GHz profiling radar, and the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO), are compared to AIRS for a wide range of cloud types. Bias and variability in cloud height differences are shown to have dependence on cloud type, height, and amount, as well as whether CloudSat or CALIPSO is used as the comparison standard. The CloudSat-AIRS biases and variability range from −4.3 to 0.5±1.2–3.6 km for all cloud types. Likewise, the CALIPSO-AIRS biases range from 0.6–3.0±1.2–3.6 km (−5.8 to −0.2±0.5–2.7 km) for clouds ≥7 km (<7 km). The upper layer of AIRS has the greatest sensitivity to Altocumulus, Altostratus, Cirrus, Cumulonimbus, and Nimbostratus, whereas the lower layer has the greatest sensitivity to Cumulus and Stratocumulus. Although the bias and variability generally decrease with increasing cloud amount, the ability of AIRS to constrain cloud occurrence, height, and amount is demonstrated across all cloud types for many geophysical conditions. In particular, skill is demonstrated for thin Cirrus, as well as some Cumulus and Stratocumulus, cloud types infrared sounders typically struggle to quantify. Furthermore, some improvements in the AIRS Version 5 operational retrieval algorithm are demonstrated. However, limitations in AIRS cloud retrievals are also revealed, including the existence of spurious Cirrus near the tropopause and low cloud layers within Cumulonimbus and Nimbostratus clouds. Likely causes of spurious clouds are identified and the potential for further improvement is discussed.

Final Revised Paper (PDF, 2536 KB) Discussion Paper (ACPD)

Citation: Kahn, B. H., Chahine, M. T., Stephens, G. L., Mace, G. G., Marchand, R. T., Wang, Z., Barnet, C. D., Eldering, A., Holz, R. E.,

Kuehn, R. E., and Vane, D. G.: Cloud type comparisons of AIRS, CloudSat, and CALIPSO cloud height and amount, Atmos. Chem. Phys., 8, 1231-1248, 2008. Bibtex EndNote Reference Manager