Geophysical Research Abstracts, Vol. 8, 09508, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09508

Integrated analyses of microphysical, radar and radiometric observations from TRMM/KWAJEX

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Precipitation measurement from space is becoming increasingly important for understanding the Earth's climate as well as monitoring and predicting the Earth's weather. Recognizing the importance of this measurement capability, the Tropical Rainfall Measurement Mission (TRMM) was initiated by NASA (USA) and JAXA (Japan) in the late 1980s. In November 1997, the TRMM program launched a satellite with active and passive microwave remote sensors onboard to make measurements of precipitation. This satellite is still in operation and current plans call for continued operation into the early part of the next decade. Validation is a critical component of spaceborne precipitation retrieval. One approach to validation involves examination of the physical assumptions that are central to the satellite precipitation retrieval algorithms. Assumptions regarding the microphysical character of precipitating clouds, particularly the horizontal and vertical distribution of hydrometeor size, shape, phase, mass and growth mode, are one of the largest uncertainties in these algorithms. In recognition of the fact that new observational datasets were required to validate and improve their precipitation retrieval algorithms, the TRMM program planned and executed several field campaigns in the tropics and sub-tropics during 1998 and 1999. One of these projects occurred over the central Pacific Ocean, in the vicinity of Kwajalein Atoll. A primary emphasis in the Kwajalein Experiment (KWAJEX) was the collection of in situ microphysical datasets for the purpose of evaluating assumptions in precipitation retrieval algorithms. Three aircraft were employed in the project to collect these data (NASA DC8, University of North Dakota Citation and University of Washington Convair). In addition, one of these aircraft (NASA DC8) was equipped with a radar (ARMAR) and radiometer (AMPR) similar to those used on the TRMM

satellite. This facilitated algorithm evaluation and also provided a broader context for the microphysical observations.

Microphysics datasets from KWAJEX were integrated with associated radar and radiometer datasets in the KWJAEX Kitchen Sink Dataset (KKSD). The reference geometry for the KKSD is based on the DC8 AMPR radiometer dataset. Native resolution AMPR data have been combined into 5 scan by 4 elevation superpixels. Microphysics datasets were mapped onto this coordinate system along with airborne radar data from the ARMAR radar flown on the DC8 and ground-based radar data from the ground validation radar on Kwajalein Island (KPOL). A total of 40140 superpixels were classified as sampling precipitation. CMP microphysics data from the Citation (DC8) could be mapped into 2087 (2281) of these superpixels. Statistical distributions of sampling temperatures and microphysical parameters are similar between the overall CMP dataset and the KKSD subset of the CMP dataset. Distributions of ice water content in regions of KPOL stratiform and convective echo do not show fundamental differences except in frequency of occurrence. Profiles of ARMAR reflectivity in KPOL convective regions show a distinct bright band and are not appreciably different from profiles in KPOL stratiform regions. AMPR 85 GHz brightness temperature depressions from scattering become more prominent as ice water content increases. AMPR 10.7 GHz brightness temperature enhancements from emission become more prominent as Citation ice water content increases; a trend with DC8 ice water content is not as clear. The KKSD radiometric data is also being applied to the passive microwave Goddard Profiling Algorithm (GPROF). Intercomparison of output from GPROF with KWAJEX microphysics datasets shows that the observed range of ice water content is not accounted for in the GPROF model output. The GPROF output also produces far too much graupel, especially in stratiform precipitation regions.