Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00079, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00079
EGU General Assembly 2008

WRF Model Simulations of tropical Cloud Systems observed during TWP-ICE

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The Tropical Warm Pool-International Cloud Experiment (TWP-ICE) took place in Darwin, Australia during January and February 2006. It provides an outstanding data set describing tropical cloud systems, their evolution and interaction with the larger-scale environment. The experiment included a dense network of ground-based observational systems including a polarimetric weather radar, cloud radar, wind profilers, radiation measurements, a lightning network and a baloon-borne sounding network. Additionally, a fleet of five research aircraft was operated to measure cloud properties and the state of the atmosphere. During the experiment four different convective regimes were sampled. These include an active monsoon, a relatively suppressed monsoon, some clear days and a break period. During the active monsoon a great variety of convective organisation occurred including isolated storms as well as convective lines. This period showed the highest cloud occurrence of the TWP-ICE period. The area-averaged rain rate during the active monsoon period was around 17mm/day. Towards the end of this period a large mesoscale convective system developed, which produced an area-averaged accumulated rainfall of more than 70mm/day. The break period was characterized by intense afternoon thunderstorms as well as several squall lines passing the TWP-ICE domain during the evening and early morning. Due to the relatively transient and localized nature of the convection during the break period, the area-averaged rain rate was only 8 mm/day. The measurements of these different regimes during TWP-ICE provide a valuable resource for the validation of numerical simulations under different tropical meteorological situations.

The Weather Research and Forecasting (WRF) model has been used to simulate tropical cloud systems observed during TWP-ICE. Simulations for two different periods have been performed. The period from 20-24 January samples the active monsoon including the mesoscale convective system. The second simulation period, 6-8 February, is part of the break period. These periods enable the validation of model simulations for different convective regimes. The WRF simulations were performed with multi-nested domains with 4 different horizontal resolutions; the inner-most nest, which is centered on Darwin, has a horizontal grid spacing of 1.3km. The model initial and boundary conditions were derived from the NCEP reanalysis data. The overall model performance during the two convective regimes is evaluated. In particular, this study focusses on WRF‘s ability to reproduce the observed cloud structures as well as the model’s performance in terms of precipitation, which is evaluated using both gross measures (e.g., area-averaged accumulated precipitation) and localized rain rates. The comparisons utilize both surface rain gauges and radar observations, and highlight aspects of model performance that are regime dependent.