The influences of large scale forcing on the diurnal cycle of rainfall over Darwin

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Global circulation models (GCMs) have difficulty in properly simulating convective systems due, in part, to the physics being highly parameterized. Furthermore, these simulations have difficulties in generating a realistic Madden Julian Oscillation (MJO) which can greatly impact occurrence and intensity of convection over the tropics with ramifications for global impacts including atmospheric rivers. The C-band dual Polarization Radar (CPOL) collected 17 seasons of full volume scans documenting the macro, microphysical and kinematic properties of precipitating systems over Darwin, Australia. Darwin is a region with a large scale forcing that is quantifiable in terms of the MJO and the Northern Australian Monsoon. This, in combination with the size of the dataset provides an opportunity for the diagnosis and improvement of the macrophysical and microphysical properties of convection simulated by GCMs. This study will, in particular focus on the rainfall rates retrieved from carefully calibrated CPOL data over the 17 year time period. A comparison of rainfall rates retrieval using various methods against disdrometer observations shows that the CSU-blended technique for tropical oceans provided the best agreement with the disdrometer observations and the lowest statistical uncertainty.

As the accurate representation of the diurnal cycle of precipitation is a key diagnostic of model performance a 17 year data set is ideal for examining the daily mean and diurnal cycle of rainfall as an observational target for GCMs. In general, daily rainfall accumulations are much higher during active monsoon conditions. Two distinct peaks in the diurnal cycle are present in the data. One is a stronger peak over the afternoon over mainland Australia and the Tiwi Islands that is attributable to diurnal heating and Hector that is more prevalent during the suppressed phase of the MJO. The other is a weaker peak over the oceans during the early morning hours more prevalent during an active MJO and monsoon. Finally, the diurnal cycle of rainfall over Darwin shows that the presence of the monsoon creates for an earlier onset to the afternoon peak of the diurnal cycle.

To investigate the performance of the Energy Exascale Earth System Model (E3SM) the model was run at a one degree resolution with three hourly output over a set of grid cells over Darwin. Initial comparisons show that this configuration of E3SM does not properly resolve this diurnal cycle of precipitation over Darwin, Australia highlighting a key area for future parameterization and convective trigger development.