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「課程博士用」

学 位 論 文 の 要 旨

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学位論文題目	The Characteristics of Mesoscale Convective Complexes (MCCs) over the Indonesian Maritime Continent and their Relationships with Rainfall and the Large-scale Environment		

This study comprises an analysis of the climatology of mesoscale convective complexes (MCCs) over the Indonesian Maritime Continent (IMC), identified by infrared satellite imagery using an algorithm that combined information about cloud coverage, eccentricity, and the cloud lifetimes of MCCs, for the15-year period from 2001 to 2015. A case study and composite analysis were used to examine the environmental conditions during MCC events. The contribution of MCCs to the total rainfall was determined from the ratio of total rainfall accumulated during the MCC events to the total rainfall accumulated at each grid point over the 15-year period. The contribution of MCCs to the extreme rainfall was determined from the ratio of extreme rainfall accumulated during the MCC events to the extreme rainfall accumulated at each grid point over the 15-year period. Brightness temperature (T_{BB}) is obtained from the Himawari generation satellite data for the period from 2001 to 2015 which consist of Geostationary Meteorological Satellite (GMS-5), Multi-functional Satellite imagery Transport SATellite (MTSAT 1R and MTSAT 2), Himawari 8 and Geostationary Operational Environmental Satellites (GOES-9). Rainfall data from TRMM (Tropical Rainfall Measuring Mission) Multi-satellite Precipitation Analyses (TMPA-RT) 3B41RT v7 for the period from 2001 to 2015. Wind data from the Cross-Calibrated Multi-Platform (CCMP) for the period from 2001 to 2015. The environmental parameter data is obtained from The European Center for Medium-Range Weather Forecasts (ECMWF) ERA-Interim Reanalysis for the period from 2001 to 2015. A total of 1028 MCCs were identified and tracked during the 15-year period from 2001 to 2015. Most of these MCCs were over the continental area, mainly near the mountains and the high elevation areas. The oceanic MCCs, which lasted for more than 12 hours, were longer-lived than the continental and coastal MCCs. Small-sized and large-sized MCCs most frequently occurred over the continental area and the ocean, respectively. The MCCs over the IMC had an average cloud shield area of around 315,000 km^2. MCCs developed when several small clouds or orographic clouds merged and grew larger because of interactions between the convergent surface wind flows and the land-sea breeze. Those observed in this study were usually nocturnal and reached a maximum at midnight. Convergent wind flows allowed the clouds to grow to a maximum size, and land-sea breezes became stronger during the mature stage. The MCCs decayed and dissipated because of divergent

outflows from the cold pool, in conjunction with the land-sea breezes that generated and propagated new convective systems. These new convective systems migrated to areas surrounding the MCCs, helped by land-sea breezes and interactions between the cold pool outflow and the westerly/southerly/easterly/northerly winds. During propagation, the new convective systems induced convective clouds in the areas surrounding them, which also followed the propagation of advection and convergence fields. It triggered new growth of either convective systems or continuous heavy rainfall systems induced by the new convective systems. The results from this study showed that, in general, the initial stage of the MCC was characterized by strong low-level convergence and vertical convection and was largely driven by the convergence of the moisture flux in the lower troposphere. The mature stage of the MCC was characterized by weak surface convergence, strong upper-level divergence, and a shortwave ridge in the mid- and upper-levels. Where there was strong surface divergence, the decay and dissipation stages were very similar, and surface convergence left the system. Movement of most MCCs resulted from the combined contributions of advection and the propagation of surface convergence. Results from this research show that these large convective systems tended to form in the vicinity of the terminus of a low-level jet that transported moist and warm air to the originating regions of the MCCs. Shortwave troughs and baroclinic zones were associated with MCC development. Results from the composite analysis were consistent with the case study, which indicates that MCCs in the same area as the case study shared the characteristics of the case study. The MCCs that occurred over the western coastal of Sumatra influenced the convective activity over the island of Sumatra; those that occurred over the northern coastal area of Kalimantan triggered a diurnal cycle over the South China Sea, and those that occurred in the coastal region of Papua near Merauke were related to cloud development over the Arafura Sea. Over the 15-year period, MCCs accounted for up to 20% of the total rainfall. Seasonal and monthly increases meant that MCCs accounted for up to 24% and 30%, respectively, of the total rainfall and, except July, the increases in the seasonal and monthly contributions were greater over the continental area than over the oceans. MCCs contributed to rainfall in both MCC areas and the surrounding areas. They contributed to extreme rainfall events over the IMC, mainly when they had reached their maximum extent. Almost all of the MCCs over the IMC produced extreme rainfall because the contributions from the MCCs were up to 45% greater for type 3 extreme events than for the other types. In future studies, this information about the development of MCCs should be integrated into regional weather models to allow precise prediction of MCCs. For further long-term predictions, however, the effects of large-scale environments, i.e. the Madden-Julian Oscillation (MJO), El Niño-Southern Oscillation (ENSO), and Indian Ocean Dipole (IOD), on MCCs in the IMC need to be considered.

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