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Characteristics of diurnal precipitation cycle over Indonesia using 1.3-GHz wind profiling radar network

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Variations in the diurnal precipitation cycle over equatorial Indonesia were investigated using 1.3-GHz wind profiling radars (WPRs) and rain gauges located at Pontianak (109.37E, 0.00S), Manado (124.92E, 1.55N), and Biak (136.10E, 1.18S). These WPRs were installed in the project of Hydrometeorological ARray for ISV-Monsoon AUtomonitoring (HARIMAU) on February 22, 2007, Setptember 18, 2009, and March 11, 2007, respectively.

Since 1.3-GHz WPR is high-sensitive to hydrometeor, the precipitation cloud type can be classified from vertical profile of vertical beam Doppler velocity and spectral width observed by WPRs for each precipitation observed by rain gauges. At all three WPR sites, peak rain rate was detected during 1300-1500 LT by rain gauges. WPR observations showed that deep convective clouds were predominant during that period. There was a clear difference in the afternoon-to-evening precipitation among the three WPR sites. At Pontianak, there was a clear transition from the convective-type clouds to the stratiform-type clouds during 1500-2000 LT. The afternoon-to-evening precipitation has the characteristics of a mesoscale convective system (MCS). At Manado and Biak, the peak rain rate in the early afternoon was characterized by a short period (within 3 h), and the precipitation after the convective precipitation was not clear.

Tbb data showed that the horizontal scale of cloud systems differs from Pontianak to Manado and Biak. The horizontal scale of the landmass around Pontianak is more than 100 km, while that of Manado and Biak is 10-100 km. The diurnal precipitation cycle was also investigated using 11 years of Tropical Rainfall Measuring Mission (TRMM) data. TRMM data showed that the midnight to morning precipitation at Biak was caused by northward propagation of cloud system from northern coastal region of New Guinea Island. The rain rate peak was distributed in the land region of peninsula in Sulawesi Island, and the whole region in Biak Island.

At Pontianak, zonal wind variation was dominant below 1.5 km, which can be explained by sea-land breeze of Borneo (Kalimantan) Island. At Manado, zonal and meridional wind variation below 1 km can be explained by the sea-land breeze of Sulawesi Island, and the wind variation of meridional component in 1-3 km can be explained by return flow of sea-land breeze. At Biak, meridional wind variation below 2 km altitude was dominant, which can be explained by sea-land breeze of New Guinea (Papua) Island, not of Biak Island itself. At Biak, the diurnal variation of meridional wind was suggested to make a convergence in the lower troposphere, and acts an important role in northward propagation of precipitation system from northern coastal region of New Guinea Island. At Manado and Biak, upward atmospheric motion clearly increased in the daytime, which suggest that upward atmospheric motion plays an important role in the daytime precipitation.

The relationship between horizontal scale of landmass and precipitation feature from afternoon-to-evening was discussed based on this study and previous studies. In the case of landmass with a horizontal scale of less than 10 km, afternoon precipitation is not predominant. In the case of landmass with a horizontal scale of 10-100 km (like Manado and Biak), even though afternoon precipitation caused by localized convection occurs, cumulus convection is not well organized enough to produce a stratiform region after the peak of the deep convective rain rate. In the case of landmass with a horizontal scale of more than 100 km (like Pontianak), cumulus convection is well organized enough to produce a stratiform region of MCS in the afternoon to evening precipitation.

Keywords: Maritime Continent, Precipitation, Diurnal variation, Wind Profiler