

The Role of Local Orography on the Development of a Severe Rainfall Event over Western Peninsular Malaysia: A Case Study

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(Manuscript received 28 November 2018, in final form 27 February 2020)

ABSTRACT

Severe rainfall events are common in western Peninsular Malaysia. They are usually short and intense, and occasionally cause flash floods and landslides. Forecasting these local events is difficult and understanding the mechanisms of the rainfall events is vital for the advancement of tropical weather forecasting. This study investigates the mechanisms responsible for a local heavy rainfall event on 2 May 2012 that caused flash floods and landslides using both observations and simulations with the limited-area high-resolution Met Office Unified Model (MetUM). Results suggest that previous day rainfalls over Peninsular Malaysia and Sumatra Island influenced the development of overnight rainfall over the Strait of Malacca by low-level flow convergence. Afternoon convection over the Titiwangsa Mountains over Peninsular Malaysia then induced rainfall development and the combination of these two events influenced the development of severe convective storm over western Peninsular Malaysia. Additionally, anomalously strong low-level northwesterlies also contributed to this event. Sensitivity studies were carried out to investigate the influence of the local orography on this event. Flattened Peninsular Malaysia orography causes a lack of rainfall over the central part of Peninsular Malaysia and Sumatra Island and produces a weaker overnight rainfall over the Strait of Malacca. By removing Sumatra Island in the final experiment, the western and inland parts of Peninsular Malaysia would receive more rainfall, as this region is more influenced by the westerly wind from the Indian Ocean. These results suggest the importance of the interaction between landmasses, orography, low-level flow, and the diurnal cycle on the development of heavy rainfall events.

1. Introduction

Western Peninsular Malaysia is the most densely populated area of Peninsular Malaysia with at least 65% of the Malaysian population. The Strait of Malacca is adjacent to the western coast of Peninsular Malaysia and the eastern coast of Sumatra Island and is one of the busiest sea traffic lanes in the world. This area has interesting weather patterns mostly affected by the interaction between the atmosphere and local orography (Fig. 1). In Peninsular Malaysia, severe weather events such as flash floods, landslides, and strong wind storms are the main meteorological threats affecting the socioeconomic factors of the people in this region.

A better understanding of the processes affecting such events is essential for improving forecasts and minimizing loss.

Localized convective rainstorms usually develop from thermal convection aided by warm surface temperature and surface land heating due to solar insolation. Local orography, local weather circulations such as land–sea breezes, and large-scale weather patterns such as monsoons will influence and modify local weather. For cases in Peninsular Malaysia and nearby islands, the following mechanisms involved in the development of localized severe convection have been discussed in previous studies:

- 1) the interaction between the gravity waves produced by the orography and the gravity waves produced by the advancing westerly sea breeze front over the west coast (Joseph et al. 2008);

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DOI: 10.1175/MWR-D-18-0413.1

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