Abstract of Doctoral Dissertation

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Interannual variability of precipitation over the Maritime Continent
（海洋大陸における降水の経年変動）

Understanding the relationship between El Niño and the interannual climate variability over the Maritime Continent region has important socio-economic implications. Given that El Niño has tremendous impacts, studying how it affects the precipitation would create better awareness and preparedness for the potential impacts if El Niño is predicted. This thesis describes a comprehensive understanding of the role of El Niño to the precipitation variability by analyzing a high-resolution gauge-based precipitation dataset as well as numerical experiments to investigate the precipitation responses to local and remote sea surface temperature (SST) anomalies during the El Niño events.

Regional-scale precipitation responses over Indonesia to major climate modes in the tropical Indo–Pacific Oceans, namely, canonical El Niño, El Niño Modoki, and the Indian Ocean Dipole (IOD), and how the responses are related to large-scale moisture convergences are investigated. The precipitation responses, analyzed using a high-spatial-resolution (0.5° × 0.5°) terrestrial precipitation dataset for the period 1960–2007, exhibit differences between the dry (July–September) and wet (November–April) seasons. Canonical El Niño strongly reduces precipitation in central to eastern Indonesia from the dry season to the early wet season and northern Indonesia in the wet season. El Niño Modoki also reduces precipitation in central to eastern Indonesia during the dry season, but conversely increases precipitation in western Indonesia in the wet season. Moisture flux analysis indicates that corresponding to the dry (wet) season precipitation reduction due to the canonical El Niño and El Niño Modoki anomalous divergence occurs around the southern (northern) edge of the convergence zone when one of the two edges is located near the equator (10°S–15°N) associated with their seasonal migration. This largely

explains the seasonality and regionality of precipitation responses to canonical El Niño and El Niño Modoki. IOD reduces precipitation in southwestern Indonesia in the dry season, associated with anomalous moisture flux divergence. The seasonality of precipitation response to IOD is likely to be controlled by the seasonality of local sea surface temperature anomalies in the eastern pole of the IOD.

The contribution of remote and local SST forcing during El Niño in shaping the interannual variations of large-scale precipitation over the Maritime Continent (MC) during July-October (JASO) and January-April (JFMA) season is investigated by using an atmospheric general circulation model (AGCM). Two idealized AGCM experiments are designed to isolate the effect of anomalous SST forcing from the tropical central-eastern Pacific (CEP) and tropical western Pacific (WP). In the first experiment climatological monthly mean SST is specified in the tropical CEP, while observed SST is specified elsewhere. In the second experiment, the climatological SST is specified in the tropical WP, while observed SST is specified elsewhere. Our numerical experiments indicate that, in the JASO season, the precipitation reduction over the southern hemisphere (SH) side of MC is likely explained as a direct influence of El Niño. In response to El Niño-related positive SST anomalies over the tropical CEP, twin Rossby wave cyclonic anomalies are generated to the tropical WP. The southern branch of the twin cyclonic anomalies advects dry air into the SH side of MC, which suppresses convection and precipitation there. In the JFMA season, the reduced precipitation over the northern hemisphere (NH) side of MC is likely induced by both the in-situ ocean surface cooling and remote warming forcing. The local cooling (remote warming) forcing promotes the generation of the Philippine Sea anticyclonic (Rossby wave cyclonic) anomalies in the NH. The combined eastern flank of the anomalous anticyclone and western flank of the anomalous cyclone transfer dry air into the NH side of MC, and reduce local precipitation.