Observational strategy for diurnal to intraseasonal rainfall variability study over Sumatera Island using the JEPP/GEOSS radar-profiler network

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Diurnal cycles of rainfall and cloudiness over Sumatera Island, Indonesian maritime continent, have been studied since FY2000 using satellites (TRMM, GMS, and GOES), GPS, intensive rawinsonde soundings, surface observations, and model simulations in term of dynamical and/or thermodynamical interactions between local circulations (e.g., Wu et al. 2003; Sasaki et al. 2004, Mori et al. 2004, Sakurai et al. 2005; Shibagaki et al. 2005). In particular, diurnal rainfall peak migrations observed by TRMM PR (Mori et al. 2004) showed a striking unique feature that a rainfall peak travels eastward (westward) into inland (offshore) region during the daytime (nighttime) from the southwestern coastline of Sumatera Island with a speed of 10-15 m/s. Sounding data showed local convergence (divergence) flow in the lower (upper) troposphere as the rainfall peak travels over the inland region, and the migrating speed was faster than background wind speed in the lower to middle troposphere.

Recently, Shibagaki et al. (2005) found multi-scale convective interactions over western Sumatera using a ground-based x-band weather radar, which interactions drive a rainfall peak migration eastward (into inland region) during the daytime. Sakurai et al. (2005) pointed out that the westward (into offshore region) rainfall peak migration are commonly seen though the year, whereas those moving eastward (into inland region) occur only in the rainy season based on GMS/GOES cloud data analysis. However, fundamental mechanisms driving the rainfall peak migration, especially which migrate westward (into the offshore region) in the nighttime, have not been well understood because the TRMM PR has a disadvantage of coarse temporal sampling resolution, the x-band radar is located in a mountainous area and cannot cover the offshore region, and the GMS/GOES watches only the cloud top temperature.

In order to investigate physical multiple mechanisms of diurnal migrating rainfall systems over western Sumatera, we plan to install two x-band Doppler radars and an L-band wind profiler at the southwestern coastline of Sumatera Island (0.4S, 99.3E - 0.9S, 100.4E) in 2006 as a part of “Japan Earth Observation System [EOS] Promotion Program (JEPP)/Global Earth Observation System of Systems (GEOSS) radar-profiler network over the maritime continent”. Although an original objective of JEPP/GEOSS radar-profiler network are monitoring the hydrological and energy cycles of atmospheric circulation over the maritime continent, we can utilize the network for studies on diurnal cycle mechanisms. We have successfully simulated the diurnal westward moving convective systems in the nighttime with a form of squall line system by using the MM5 cloud resolving model (Wu 2005), and cold surges near the surface in front of the old convective cells are suggested to play an important role for moving squall lines. Our observation intends to confirm the multiple mechanisms of diurnal cycles in terms of the cold surge effect on moving squall lines as well as effects of e.g., gravity waves generated by

coastal convections, radiative cooling at cloud tops in the nighttime, and cloud microphysics such as feeder-seeder process over the offshore region..

We set an intensive observation period of one month long from late October to November 2006. The dual Doppler radar observation captures three dimensional wind and reflectivity structures over the coastline to offshore region continuously, and the wind profiler monitors wind variations beneath the convections. Intensive soundings of 3-6 hours intervals at a coastal meteorological station provide fine atmospheric variations which well depict diurnal cycles. A network of automatic weather stations with high-sensitive barometer covers the coastal region to monitor local rainfalls, cold surges, and gravity waves. Additionally, aerosonde flights are proposed which observe three dimensional distributions of atmospheric parameters in and out sides of precipitating clouds captured by the dual Doppler radar observations, however, the budget of aerosonde flights depends on approval of grant-in-aid for scientific research submitted to the Japan Society for the Promotion of Science (JSPS).

The intensive observations are carried out in collaboration with R/V Mirai Indian Ocean cruise for the Study of the MJO-convection Onset (MISMO) planed by JAMSTEC, which consists of Doppler radars observations and intensive rawinsonde soundings for one month long from late October to November 2006 at the R/V Mirai (EQ, 80E) and Gan/Maldives (EQ, 73E), as well as those at Sumatera/Indonesia (EQ, 100E) of our study. Characteristics of diurnal variations over Sumatera Island must be greatly affected by intraseasonal variations including the MJO, which predominates in maximum over the central Indian Ocean, and the MISMO provide dataset of diurnal variations at three regions simultaneously over the Indian Ocean during onset and break phases (or windward, onset, and leeward) of the intraseasonal variation. Our data set are expected to reveal how the diurnal cycles affect on modulation of the intraseasonal variation, and vice versa, around Sumatera Island. Detailed strategy, schedule, and framework of international collaboration are presented at the workshop with schematics.

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