Press Releases

May 14, 2013
JAMSTEC
Japan Science and Technology Agency
Japan International Cooperation Agency

Using Meteorological Monitoring Data to Clarify the Causes and Mechanisms of Torrential Rainfall in Jakarta

1. Overview

Senior Scientist Wu Peiming and colleagues from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) Research Institute for Global Change have used field meteorological monitoring data to clarify the causes and mechanisms of the torrential rains from January 17 to 18 of this year that caused widespread flooding in the center of Jakarta, the capital of Indonesia. Specifically, analyses of Doppler meteorological radar (*1) monitoring data as the foundation and satellite data revealed that the torrential rains occurred because convection caused by superimposition of the Asian winter monsoon cross-equatorial northerly surge from the northern hemisphere; an active phase of the Madden-Julian Oscillation (MJO) (*2); and the sea land breezes circulation for the island of Java (*3).

This finding clarifies the causes of torrential equatorial rainfalls that have traditionally been difficult to forecast, and contributes to improving the accuracy of forecasts for torrential rainfall events in the low latitude tropics. It provides the basis for sound and effective measures for controlling flooding and fundamental information for effectively preventing and mitigating the socio-economic impacts of these disasters. Application across a wide range of fields is expected.

This research was conducted by JAMSTEC as part of the Climate Variability Study and Social Application through Indonesia-Japan "Maritime Continent COE" – Radar-Buoy Network Optimization for Rainfall Prediction project under the SATREPS (Science and Technology Research Partnership for Sustainable Development) program (*4) supported by the Japan Science and Technology Agency (Michiharu Nakamura, President) and the Japan International Cooperation Agency (Akihiko Tanaka, President). These findings were also a product of collaborative research with the Agency for the Assessment and Application of Technology (BPPT) (Marzan A. Iskandar, Chairman) of Indonesia.

These findings are the first verification results in which continuous meteorological radar monitoring data were used to scientifically explain the mechanisms of torrential rainfall in this region. Following the presentation of these findings at the Meteorological Society of Japan Spring Meeting held from May 15 to 18 and the Japan Geoscience Union Meeting 2013 held from May 19 to 24, the findings are

scheduled to be published in the Meteorological Society of Japan online letters journal SOLA on May 27.

*1 With meteorological radar, the position of raindrops is measured from the direction and time of the transmitted electromagnetic waves reflected by the raindrops; the strength of the returning radar echo is used to observe the intensity of the rainfall. In addition to the position and intensity of the precipitation, with Doppler meteorological radar, the change in frequency of returning radar echoes (the Doppler effect) can be used to detect the motion of rain droplets.

*2 The Madden-Julian Oscillation (MJO) is a phenomenon in which regions of active convection (atmospheric circulation) of the tropical equatorial atmosphere move eastward over an approximately 1 to 2 month period. This occurs repeatedly like an oscillation at intervals of about 30 to 60 days. This is also called the 30–60 day oscillation, or tropical intraseasonal oscillation, but is usually referred to by the names of Madden and Julian, who first reported the phenomenon in 1972.

*3 If the land and ocean are compared, land, which has a lower heat capacity than ocean, is easier to warm or cool. In coastal regions, air rises over land when the temperature rises during the day and winds blow toward the land (sea breeze) near the surface to fill the space vacated by the rising air, while higher in the atmosphere, a countercurrent to the sea breeze blows from the land to the ocean. During the night, the air over the ocean warms near the surface and winds blow from the land to ocean (land breeze). This daily cycle of alternating sea and land breezes is called the sea¬–land breeze circulation.

*4 SATREPS (Science and Technology Research Partnership for Sustainable? Development) has the objectives of acquiring new knowledge linked to resolving global scale issues and raising science and technology levels based on the needs of developing countries, by promoting, in collaboration with Official Development Assistance (ODA), international joint research that envisions actual implementation in future society. In addition, through these international collaborations, the program seeks to build a foundation for sustainable activity to contribute to resolving issues by the raising the capacity of developing nations for independent research and development.

Figure 1. Jakarta, the capital of Indonesia, experienced large-scale flooding due the torrential rains from January 15 to 18 of this year. Transportation in the center of the city was paralyzed on January 17 to 18 owing to waist-deep flooding. Photographs taken by Chiaki Fukuda, JICA SATREPS Project Coordinator, show the flooding on January 17, 2013 on the left and normal conditions on the right.

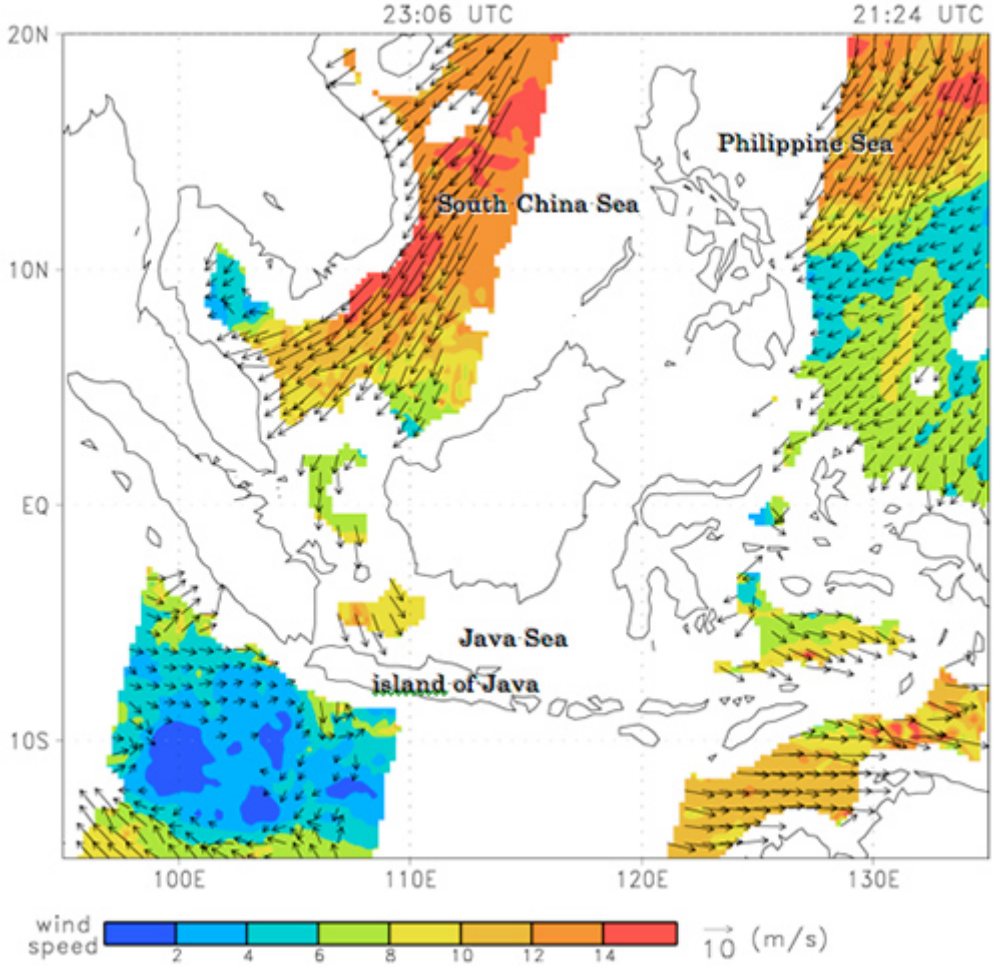

Figure 2. Ocean surface wind distribution measured on January 17, 2013 by the ocean surface wind observation satellite (WindSat). There were strong northeast winds from the Philippine Sea to the South China Sea while north winds were observed over the Java Sea. North winds accompanying the Asian winter Monsoon crossed the equator and reached the island of Java in the Southern Hemisphere.

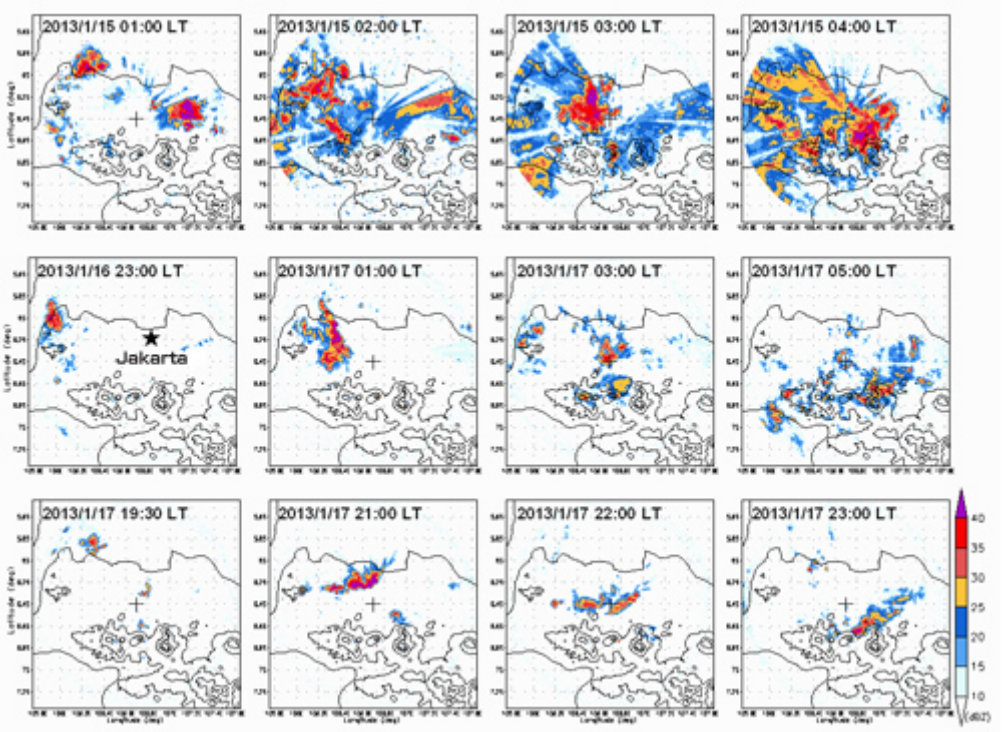

Figure 3. Change with time from January 15 to 17, 2013 of rainfall distribution observed using the Doppler meteorological radar sited in Jakarta. The cross mark in the center of the figures indicates the location of radar installation. In addition, the terrain of Java is shown by the contour lines drawn at 500-m intervals.

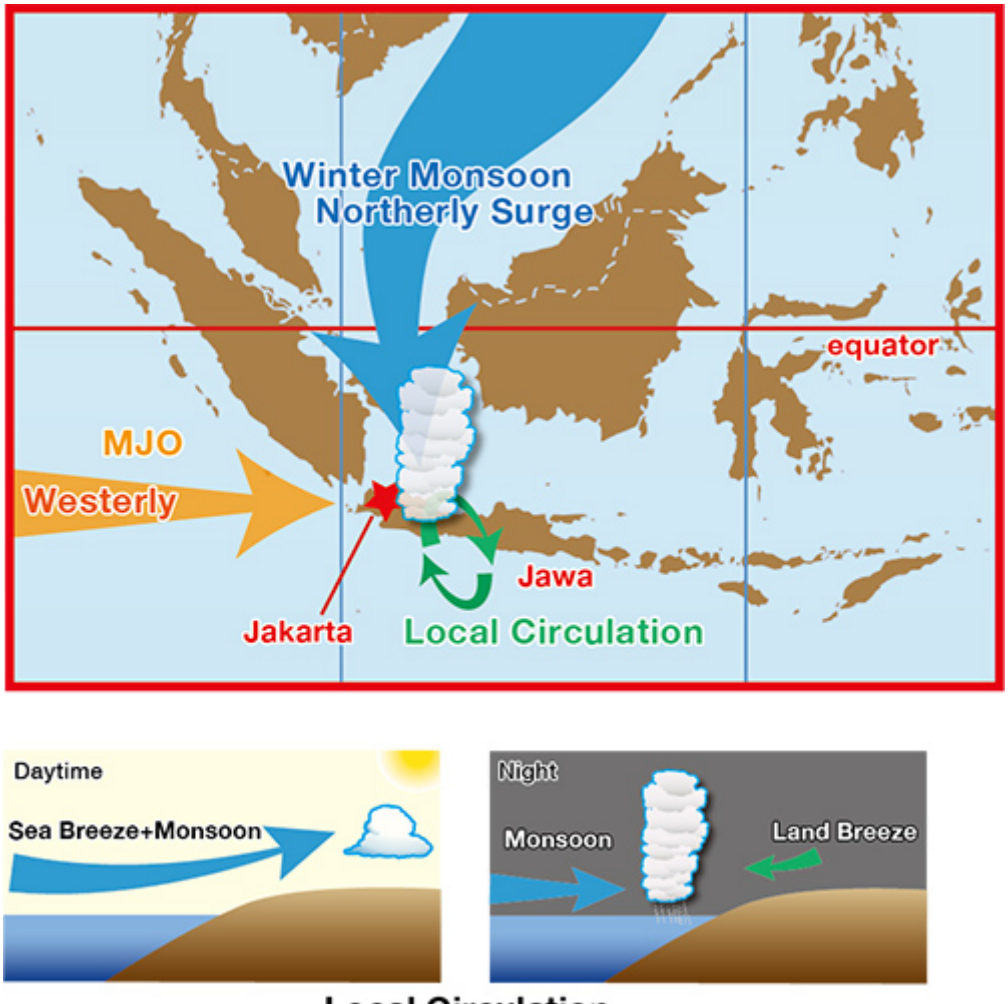

Figure 4. Schematic diagram of the mechanism of torrential rain generation by the equator-crossing Asian winter Monsoon and the MJO. The superimposition of a

cross-equatorial northerly surge, strong westerly wind caused by the active phase of the MJO, and the nighttime land breeze circulation caused the torrential rains.

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