Press Releases

October 11, 2016
JAMSTEC

Ocean–atmosphere Coupling Model Better Reproduces Madden–Julian Oscillation
- Towards more accurate climate prediction -

1. Overview

Dr. Wataru Sasaki and his team at Center for Earth Information Science and Technology, the Japan Agency for Marine-Earth Science and Technology (JAMSTEC: Asahiko Taira, President) demonstrated successful simulation of Madden–Julian Oscillation (MJO[*1]) using a cloud-system-resolving global ocean–atmosphere coupled model on the Earth Simulator supercomputer. It well reproduced climate phenomena such as rainfall and wind associated with the MJO.

The model, Multi-Scale Simulator for the Geoenvironment (MSGG) developed by JAMSTEC consists of an atmosphere component (MSSG-A) and an ocean component (MSSG-O). In this study, MSSG-A and MSSG-O were configured with 10 km x 10 km horizontal resolution mesh for longitude and latitude. As a result, it found significant impacts of ocean coupling on the representation of the MJO including the strength of the moisture convergence, and the timing and strength of westerly wind burst over the maritime continent. One major impact of atmosphere-ocean coupling was more adequate representation of the MJO decay in the western Pacific. In addition, their model experiments suggest that accurate simulation of sea surface temperature is also indispensable for better simulation of the MJO.

MJO is a tropical disturbance that affects weather worldwide and also triggers El Niño and typhoon. Because of its socioeconomic impacts, accurate and precise prediction is necessary. This study presented that MJO could be more accurately predicted by incorporating atmosphere-ocean interaction into simulation models. It is expected to contribute to making better seasonal prediction including sea surface temperature over a longer period than before and trends of average monthly temperature and precipitation.

The above results were published in the *Geophysical Research Letters* on September 29 (JST).

Title: MJO simulation in a cloud-system-resolving global ocean-atmosphere coupled model
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*1 Madden–Julian Oscillation (MJO)
It is a tropical convective activity discovered by Roland Madden and Paul Julian in 1971, having a traveling pattern that propagates eastward at approximately 18 km

per hour through the atmosphere above the warm parts of the Indian and Pacific oceans. It typically recurs every 30 to 60 days. MJO brings equatorial westerly winds and carries warm water from West Pacific to east, which can trigger El Niño events. Also, it is reported that active MJO convection generates tropical cyclone to develop typhoon.

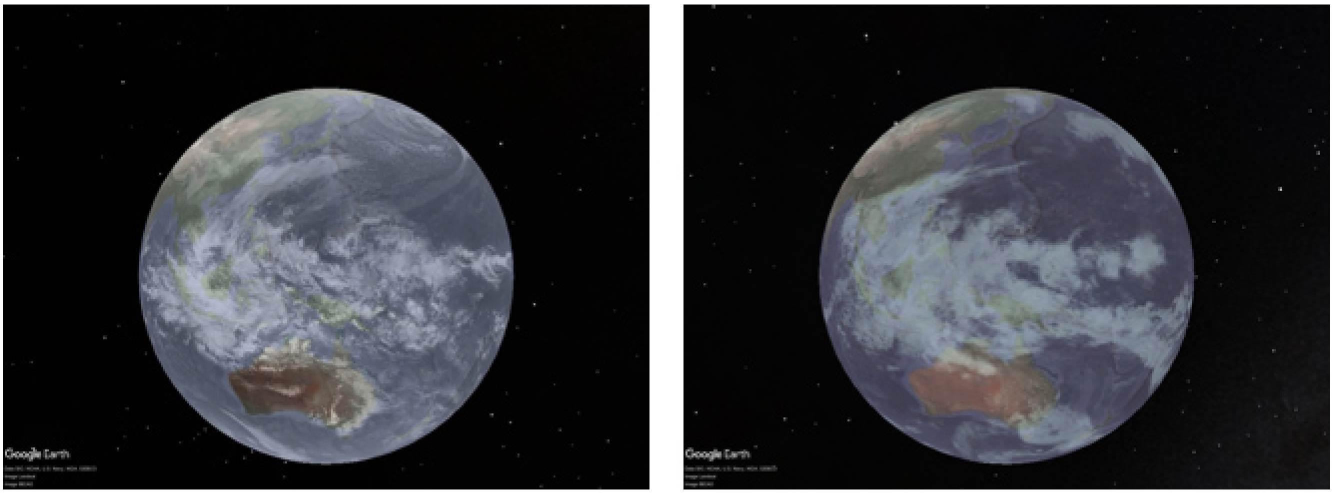

Figure 1. (Left) Cloud images by Himawari 6 weather satellite; (Right) Outgoing longwave radiation (one of indicators of convective activities) reproduced by MSGG. The white color areas show developed clouds.

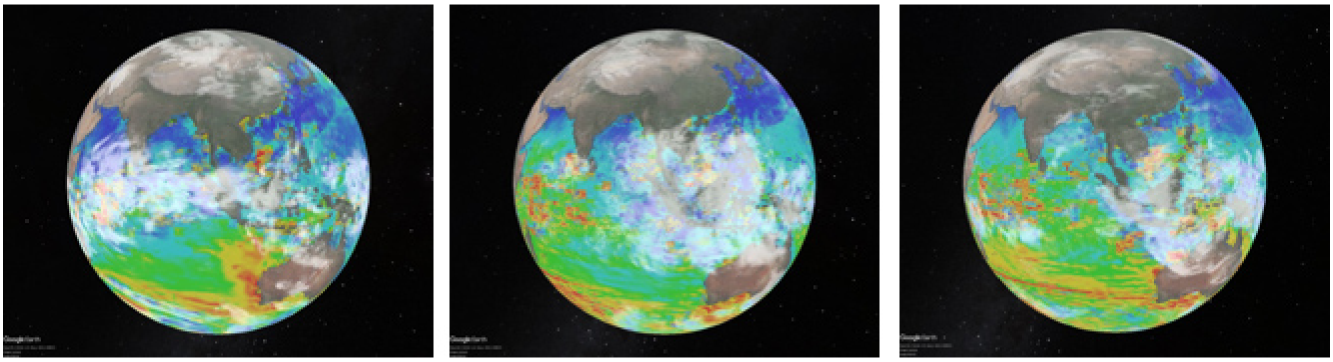

Figure 2. Outgoing longwave radiation (white shadows) and daily variation in sea surface temperature (gap between the highest and lowest temperatures as shown in colors) reproduced by the MSSG.
From the left: Observation on December 18, 2007; December 27, 2007 and January 5, 2008. These images show large clouds moving from the Indian Ocean to Pacific. Under clouds, daily variation in sea surface temperature becomes small because of less impacts of solar radiation.

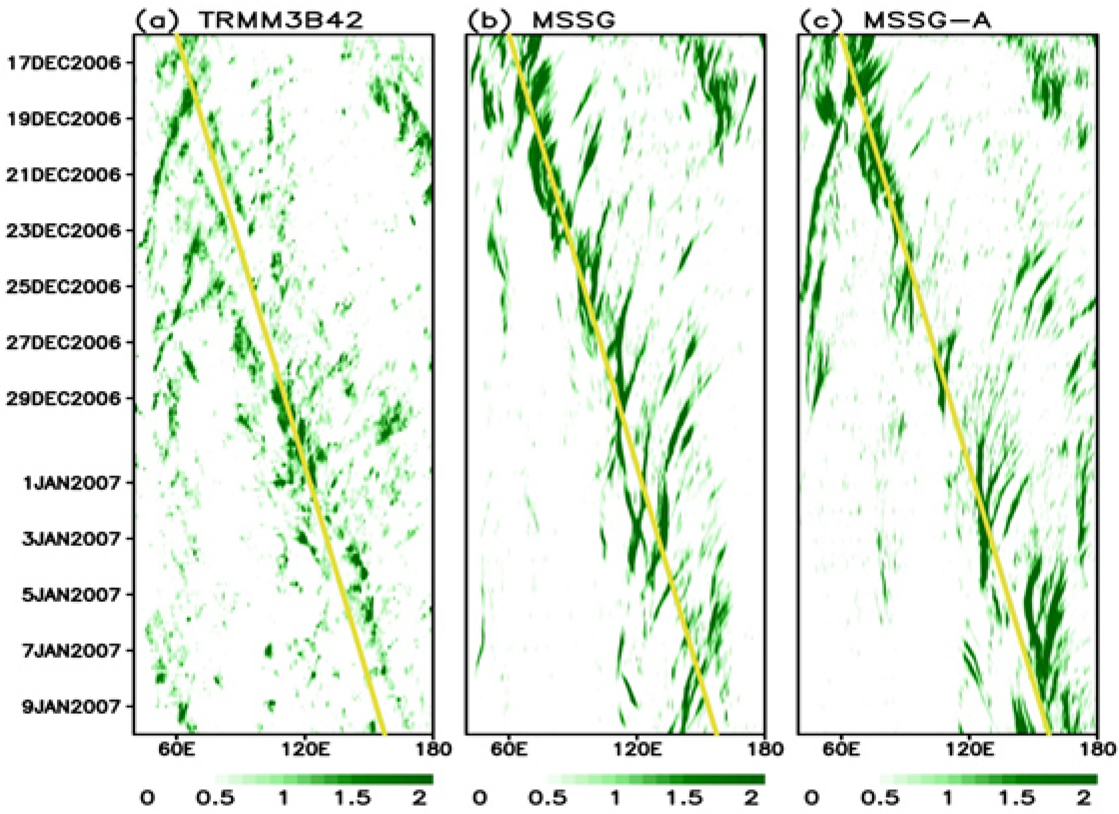

Figure 3. Temporal change of precipitation affected by MJO: a) satellite observation; b) simulation by MSSG; and c) simulation by MSSG-A. The darker green colors indicate higher precipitation (mm/h). The vertical axe indicates date and the horizontal axis longitude. These models reproduce heavy rainfall moving to east as time passes. The yellow solid line indicates the typical phase speed of MJO (18km/h). Based on satellite observation, rainfall caused by MJO is weakening in the western Pacific, though the atmospheric model predicts excessive rainfall. In the ocean-atmosphere coupled model, rainfall is more realistically reproduced as shown by observation.

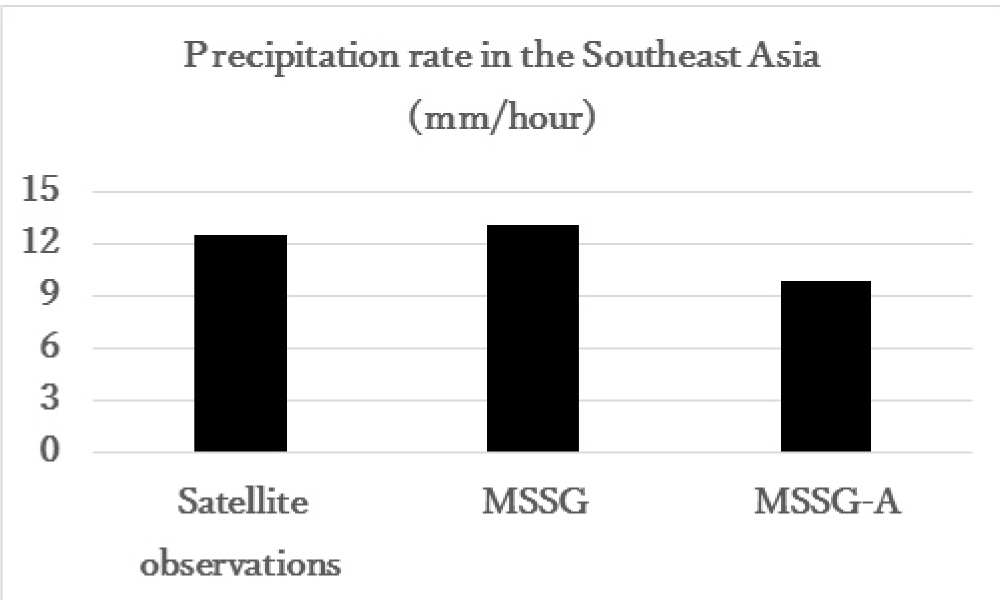

Figure 4. Comparison of precipitation by simulations (left: satellite observation; center: MSSG; right: MSSG-A) Coupled simulation of atmospheric and ocean models improves the margin of error for precipitation in Southeast Asian islands from 21% to 4%

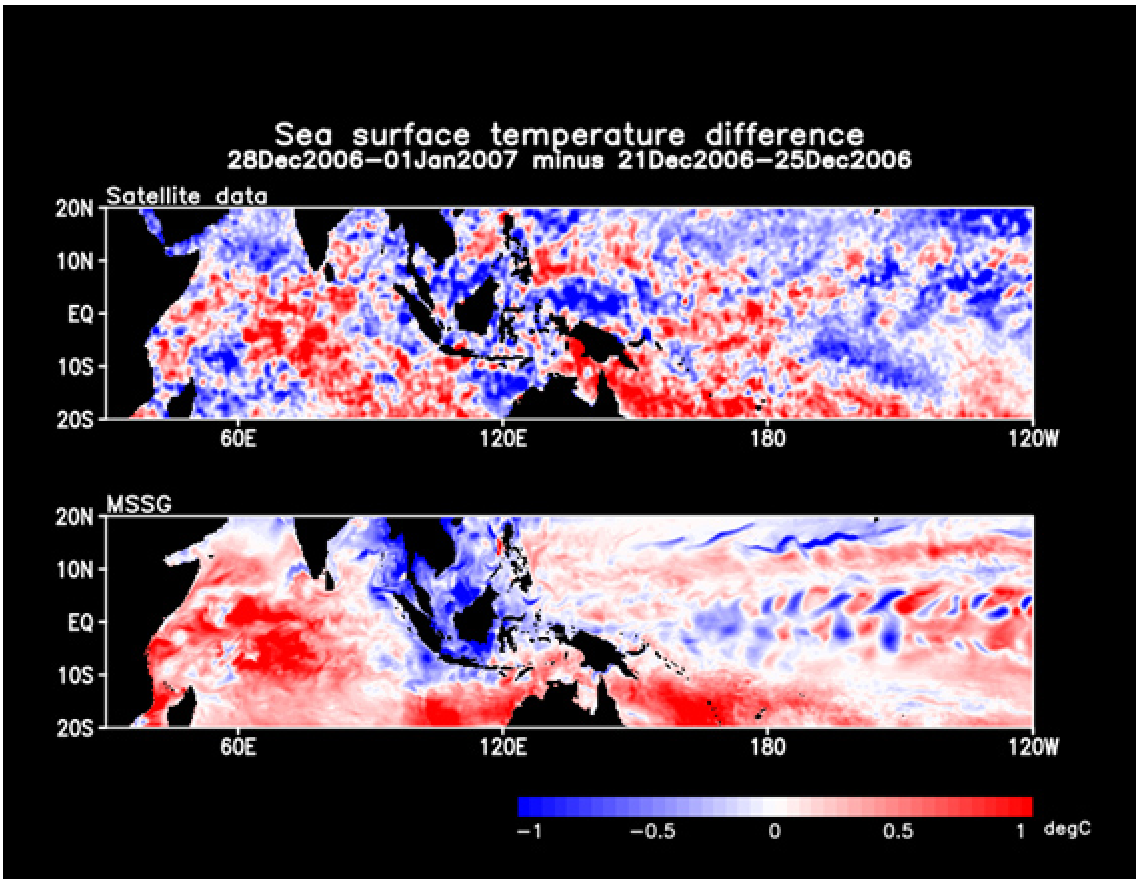

Figure 5. Sea surface temperature variation affected by MJO (top: satellite observation data; bottom: MSSG). It shows that cumulonimbus intercept solar insolation, which results in lower sea surface temperature.

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