A consecutive development of MJO events reproduced by three-month SST-forced experiments with NICAM

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Simulation of the Madden-Julian Oscillation (MJO) has been notoriously difficult in atmospheric models. This is partly due to the fact that the reproducibility of the MJO is highly sensitive to parameters that are difficult to fix from observation or theory, and require empirical tuning based on model behaviors. Moreover, model settings fine-tuned for MJO simulations are not necessarily compatible with longer simulations due to biases in the long-term mean.

To address this problem, we first conducted 46-days parameter sweep experiments on a convection-permitting model, NICAM (Nonhydrostatic ICosahedral Atmospheric Model) at 14 km horizontal resolution. Combinations of different microphysics and surface flux parameters were tested with the target of improving the reproducibility of an MJO event in December 2018. We then selected a model setting that best reproduced the MJO (MJO-tuned setting) to conduct longer integrations to test whether MJO can be reproduced by NICAM not only as a solution to an initial value problem but also as one of the modes of internal variability of the atmosphere reproduced by the model.

For this, we employed the MJO-tuned setting and conducted an ensemble of eight 90-day simulations initiated at 6-hour intervals from UTC-00h 1 October 2018. The sea surface temperatures were given from the observations and the simulations do not include air-sea interactions. Analyses of the ensemble indicated that of the three MJO events (MJO1 –3), which were included in the integration period, the first event in November 2018 (MJO1) was well represented in most of the ensemble simulations. Moreover, as an ensemble mean, another MJO event was consecutively reproduced after the MJO1 at a timing close to the MJO2 in observation. The results of the experiments imply that NICAM has the potential to reproduce the MJO as a mode of internal variability of the model reproduced atmosphere when realistic bottom boundary conditions are given.

Keywords: Madden-Julian Oscillation, NICAM , convective-permitting model

