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Geoscientific
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Supplement of

Improving Madden–Julian oscillation simulation in atmospheric general circulation models by coupling with a one-dimensional snow–ice–thermocline ocean model

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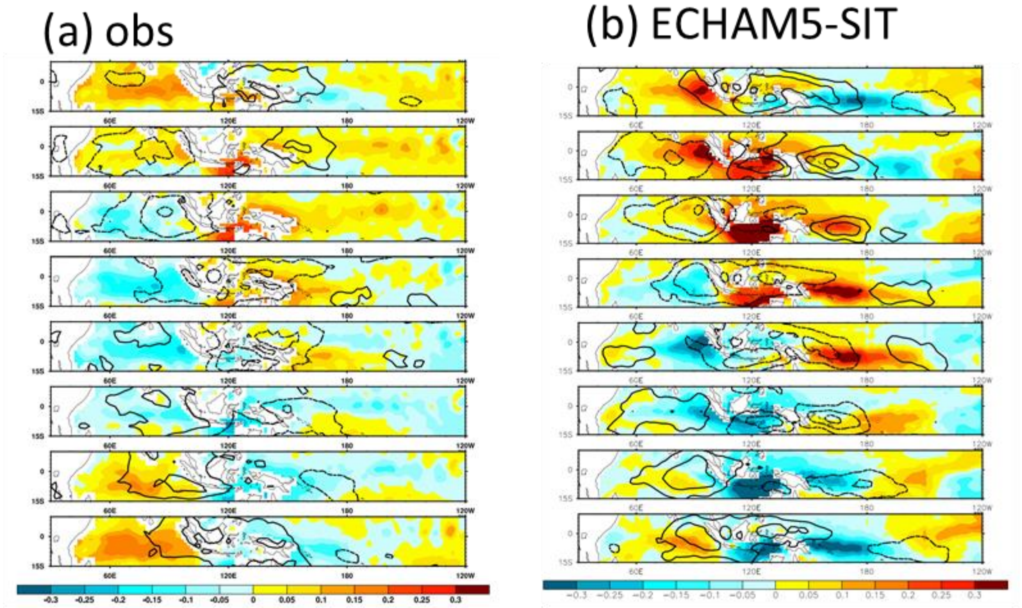
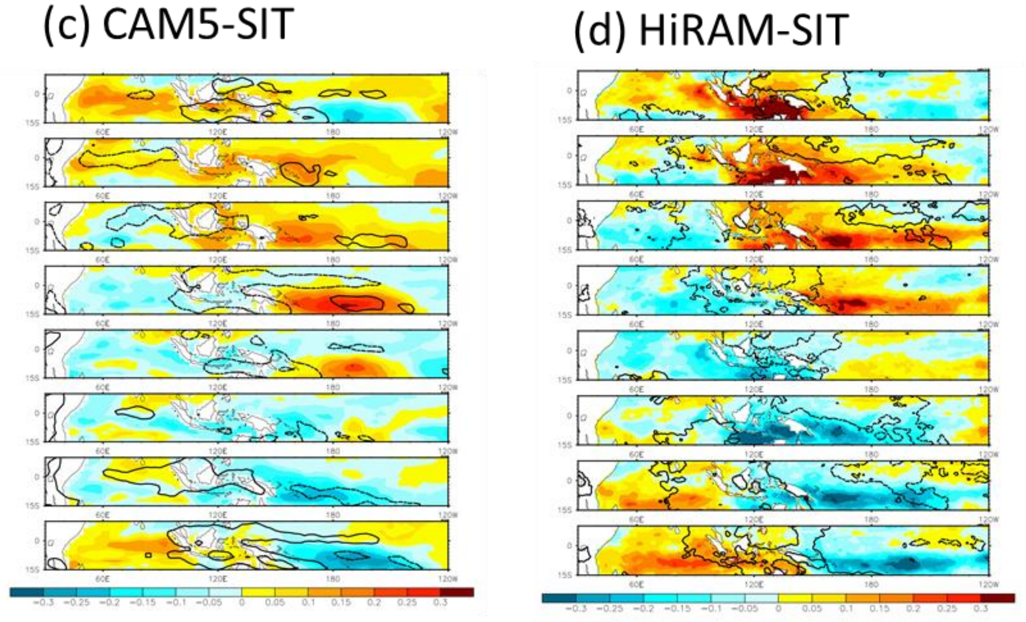


(a) obs

(b) ECHAM5-SIT



(c) CAM5-SIT

(d) HiRAM-SIT

Figure S1. Composite November–April 20–100-day filtering SST (°C; color) and OLR anomalies (W m^{-1}; vectors) as a function of the MJO phase based on (a) observations, (b) ECHAM5-SIT, (c) CAM5-SIT, and (d) HiRAM-SIT.

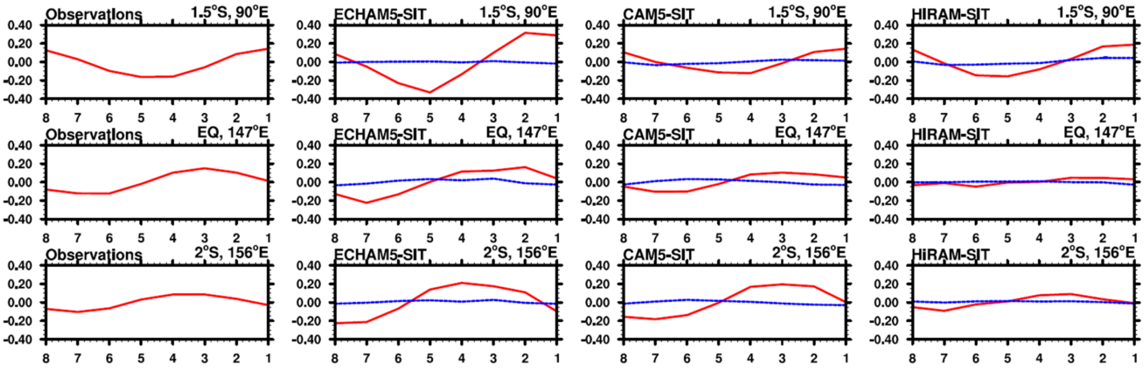


Figure S2. The SST (°C) with respect to MJO phases for intraseasonal anomalies (i.e., with 20–100-day filtering) in (a) observations and simulations by using the (b–d) coupled and (e–g) uncoupled AGCM. Observations are in suit with data from OISST.

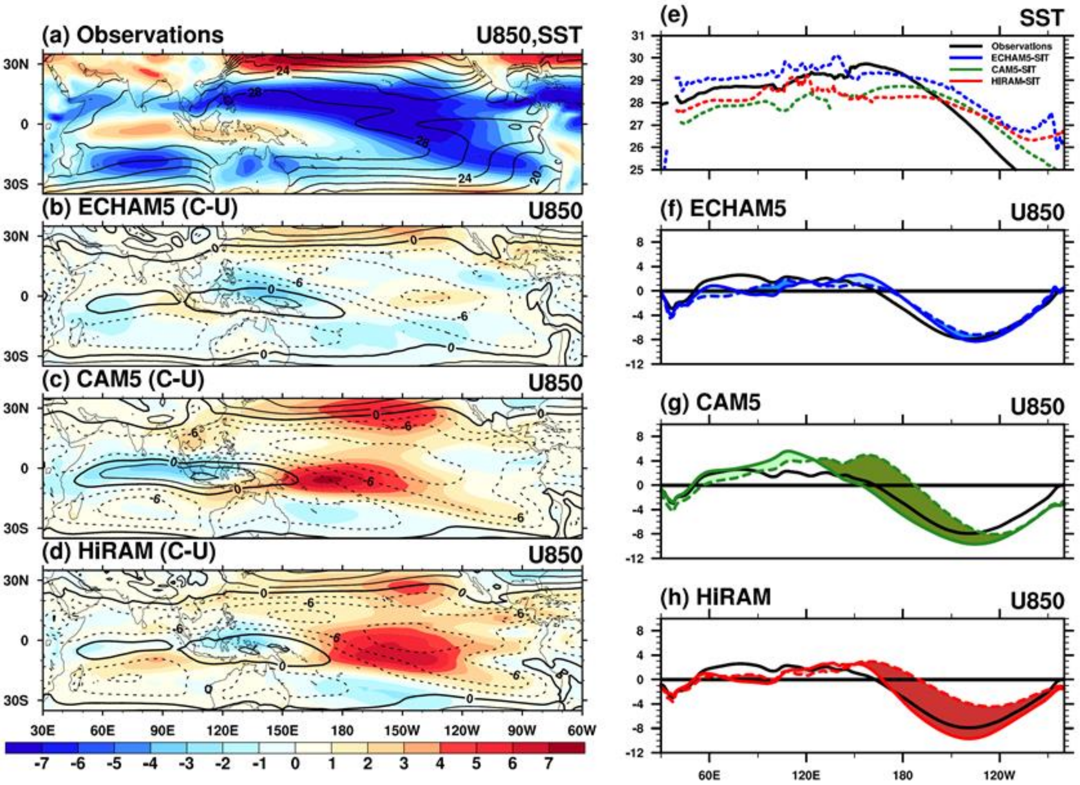


Figure S3. (a) The observational winter (November–April) averaged the mean state in 850 hPa zonal wind (m s^{-1}; shading) and SST (˚C; contours). (b–d) The winter averaged 850 hPa zonal wind difference of coupled and uncoupled simulations (m s^{-1}; shading) and uncoupled 850 hP zonal wind (m s^{-1}; contours) in ECHAM5, CAM5, and HiRAM. (e) The 10°S–EQ averaged winter SST (°C) in observation and simulations. (f–h) The 5°S–EQ averaged winter 850 hPa zonal wind (m s^{-1}) in ECHAM5, CAM5, and HiRAM. The solid line is uncoupled and the dashed line is a coupled model.

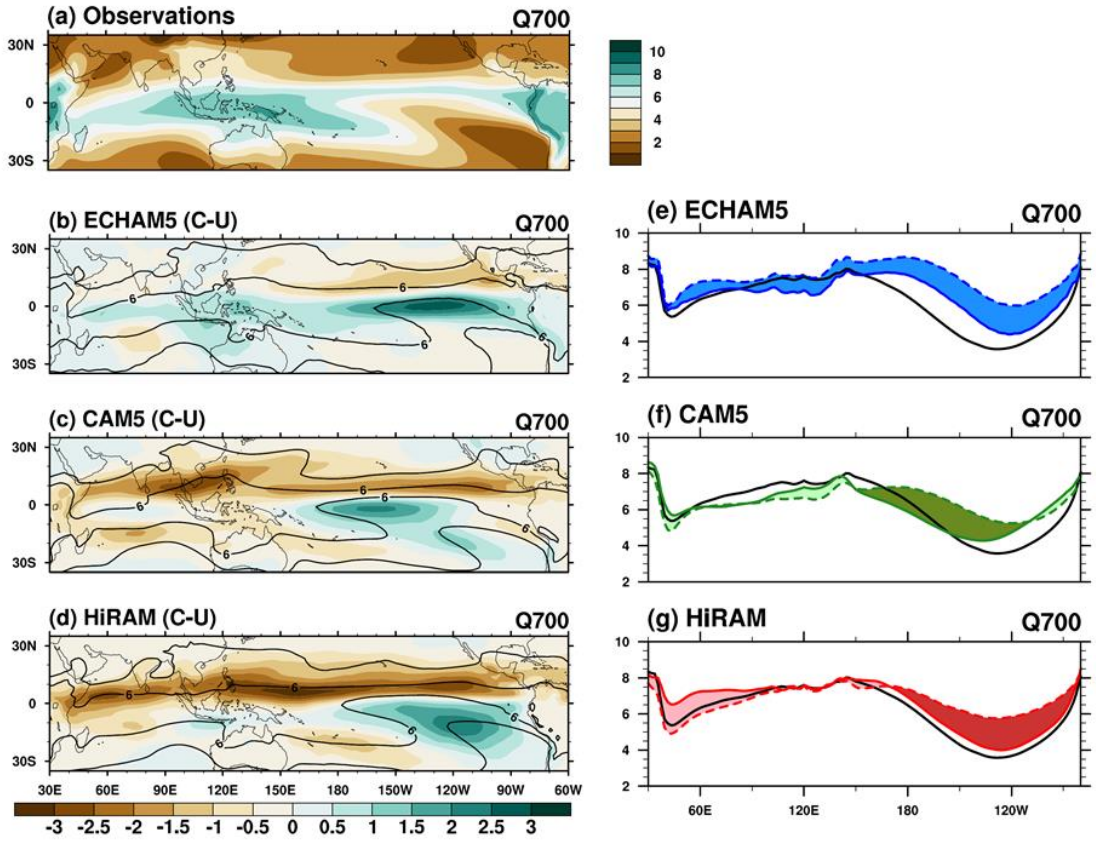


Figure S4. (a) The observational winter (November–April) averaged mean state in specific humidity at 700 hPa (Q700; kg s^{-1}; shading). (b–d) The winter averaged Q700 difference of coupled and uncoupled simulations (mm day^{-1}; shading) and uncoupled Q700 (kg s^{-1}; contours) in ECHAM5, CAM5, and HiRAM. (e–g) The 10°S–EQ averaged winter Q700 (kg s^{-1}) in ECHAM5, CAM5, and HiRAM. The solid and dashed lines indicate uncoupled and coupled models, respectively.

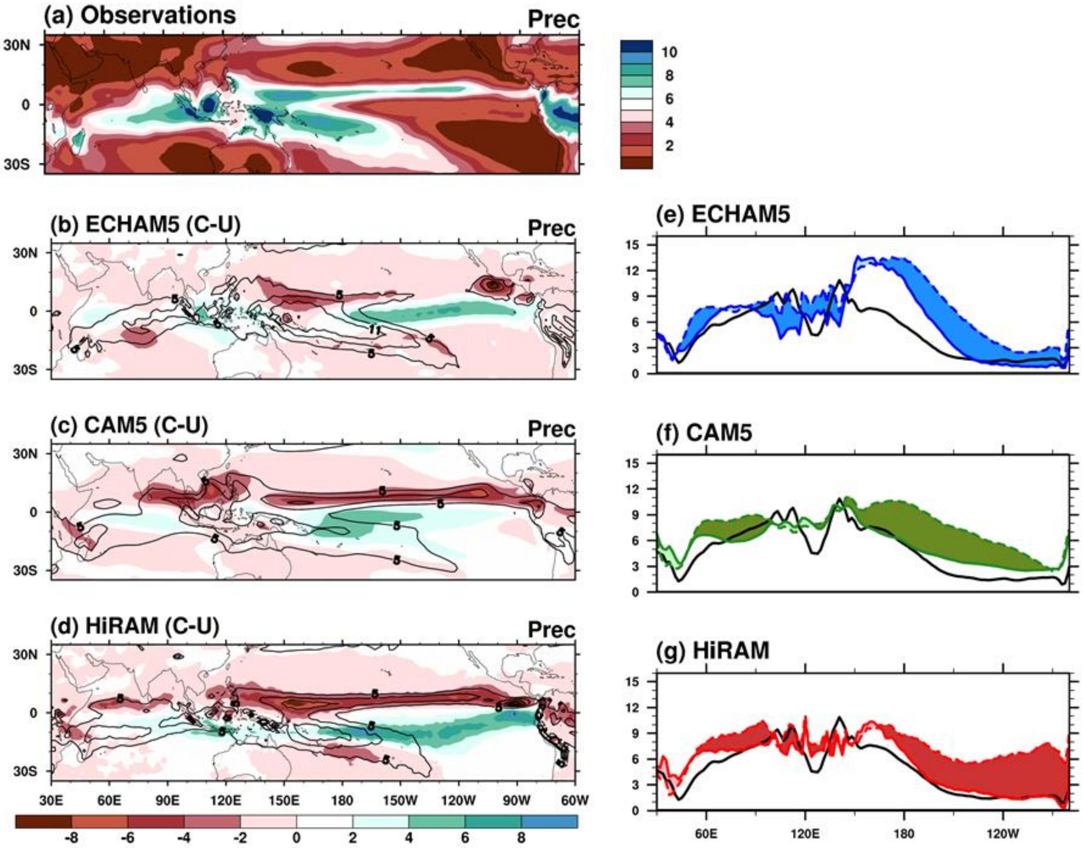


Figure S5. (a) Observational winter (November–April) averaged mean state in precipitation (mm day^{-1}; shading). (b–d) Winter averaged precipitation difference of coupled and uncoupled simulations (mm day^{-1}; shading) and uncoupled precipitation (mm day^{-1}; contours) in ECHAM5, CAM5, and HiRAM. (e–g) The 10°S–EQ averaged winter precipitation (mm day^{-1}) in ECHAM5, CAM5, and HiRAM. The solid and dashed lines indicate uncoupled and coupled models, respectively.

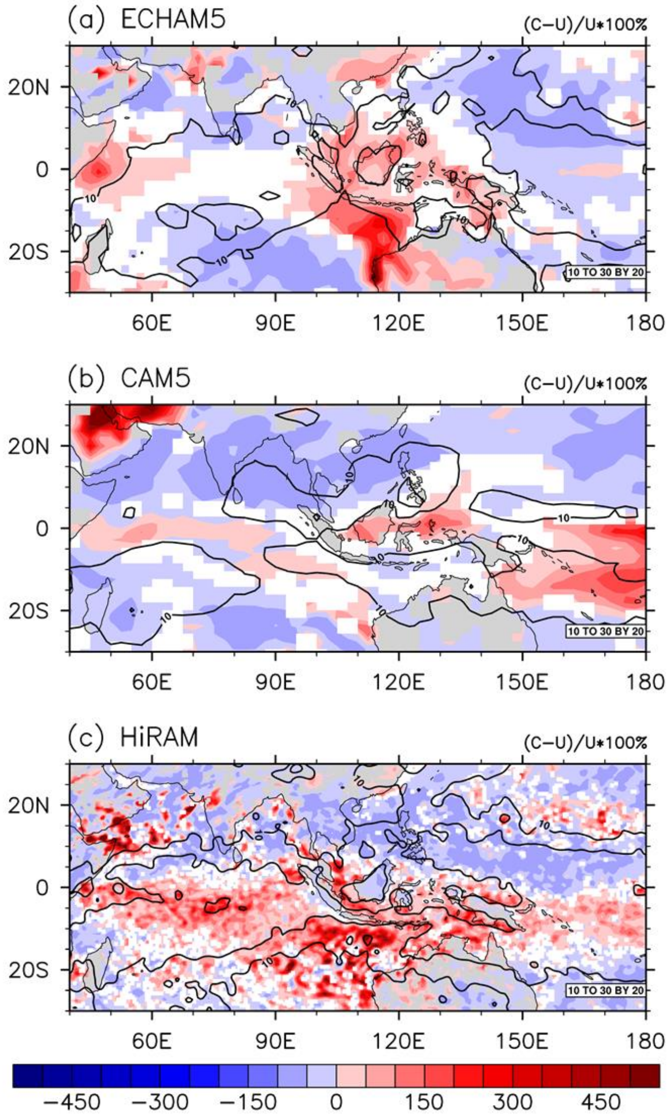


Figure S6. Ratio of the precipitation variance between the coupled and uncoupled models on intraseasonal time scales. The ratio is defined as (coupled – uncoupled) / uncoupled * 100%. The colored areas indicate where the ratio is statistically significant at 1% based on an F test. The contours show the intraseasonal precipitation variance (mm day^{-1})^2 in the uncoupled simulation. The 9-point local smoothing is applied in the intraseasonal precipitation variance of HiRAM here (contours only).