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The Madden-Julian Oscillation (MJO)-like structure obtained with a global cloud resolving model NICAM (Nonhydrostatic ICosahedral Atmospheric Model)

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Most of current atmospheric general circulation models (AGCMs) employ a cumulus parameterization to represent effect of sub-grid scale cloud convection. The cumulus parameterization, however, is widely known as one of the most uncertain components in AGCMs, since its formulation is based on an idealized statistical assumption. In order to avoid this ambiguity, we directly resolve cumulus convections in an AGCM named NICAM (Nonhydrostatic ICosahedral Atmospheric Model), which is effective for calculation with horizontally high resolution. In this cloud resolving model, the multi-scale and multi-physical interactions are treated explicitly. Using NICAM, we have performed global cloud-resolving simulations with horizontal grid intervals dx = 14km, 7km and 3.5km on an aqua planet setup.
In the tropics, Madden-Julian Oscillation (MJO)-like structure is obtained. A typical super cloud cluster spreads with extent of about 5000km in the longitudinal and 1500km in the latitudinal direction. Low and high pressure regions on the surface are located at east-side and west-side of the convective region, respectively, and a strong westerly wind region is associated with the west-side, illustrating a convectively-coupled Kelvin wave structure.
Distribution and propagation of these clouds are hierarchical. Cloud clusters move westward with lifetime of about 2 days and a few super cluod clusters as envelopes of these cloud clusters propagate eastward. As horizontal resolution increases, period of super cloud cluster becomes longer and period with dx = 7km and 3.5km is close to observations (30-50 days).

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