EGU22-10781
https://doi.org/10.5194/egusphere-egu22-10781
EGU General Assembly 2022

MJO impacts on South America monsoon season and their modulation by ENSO in MetUM-GOML3 model

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The impacts of the Madden-Julian Oscillation (MJO) on the South American monsoon season (December, January, and February – DJF) and their possible changes during positive (El Niño – EN) and negative (La Niña – LN) phases of the El Niño-Southern Oscillation (ENSO) are analyzed in the UK Met Office Unified Model Global Ocean Mixed Layer configuration (MetUM-GOML3). Experiments sixty years long, with and without ENSO cycle, considering lower (200 km) and higher (90 km) spatial resolution, are performed to assess if the ENSO influences MJO characteristics such as the phase distribution, propagation, convection, and teleconnections to South America (SA). The analyzes use daily continental precipitation data, daily global outgoing longwave radiation (OLR), and zonally asymmetric streamfunction computed with daily wind data. Composites of daily filtered anomalies in the 20-90 day band are assessed. Simulations without ENSO show (1) an established MJO extratropical teleconnection triggered by enhanced convection in the central-east subtropical South Pacific (SP) (source region), and its strongest impact on precipitation over SA in phase 8, earlier than in observations (phase 1); (2) an extratropical teleconnection via Rossby wave train, triggered by suppressed convection over the same region, with strongest impact on precipitation over SA in phase 4, with opposite sign; (3) increased horizontal resolution enhances the MJO convection and the anomalous circulation-precipitation dipole over SA, mainly over subtropical SA. However, the extratropical teleconnections via Rossby wave train at upper levels are slightly shifted east at higher resolution due to an enhanced SA westerly jet with respect to the lower resolution. The ENSO affects the basic state and the MJO convective anomalies, which modulate the MJO teleconnections and their impacts on SA in simulations with ENSO cycles. The EN (LN) basic state improves (worsens) MJO eastward propagation and its convection. However, both EN and LN states produce enhanced convection over the source region in phases 8+1, while suppressed convection over the same region in phase 4 is simulated only in EN. The extratropical teleconnections via Rossby wave train (phases 8+1, 4) and their impacts are stronger under ENSO with respect to those in simulations without ENSO. Hence, both ENSO states in the model generate forcing in the central-east subtropical SP that more efficiently triggers teleconnections than simulations without ENSO, indicating nonlinear ENSO effects on MJO anomalies over SA. As the MJO and its teleconnections improve during ENSO, other coupled global climate models (CGCMs) may reproduce these features, and subseasonal to seasonal (S2S) predictions to SA may be better forecast when ENSO and MJO peak in DJF, though the MJO impacts in phase 1 remain challenging.

Keywords: Coupled global models; ENSO-MJO Interaction; South American monsoon; Teleconnections.