The MJO and global warming: A CCSM-4 study

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**Motivation**

- To diagnose MJOs in CCSM4
- To understand the behavior of MJOs concomitantly with different climate phenomena

**CCSM4 Diagnostics**

Spatial and temporal intraseasonal variability

- CCSM4 has 26 levels in the vertical, 0.9x1.25° horizontal atmosphere and land resolution, 1° ocean and sea ice resolution
- The structure of the ISV pattern in CCSM4 is consistent with MJO characteristics (minima in zonal wind variance along the equator in both the Indian and Pacific Oceans and a max variance over the Maritime Continent).
- Dominant peak at 60 days is somewhat stronger and more broadband in CCSM4 than observations.

**MJO Diagnostics**

Coupling between dynamics and convection

- CCSM4 exhibits strong coherence in this low-wavenumber band, with lags similar to observations.
- The model’s spread of coherency into higher frequencies at wavenumber 1 suggests that more linear Kelvin wave activity, with a convective signature, is present in CCSM4 than in observations (Roundy 2008).
- Faster phase speed of MJO in CCSM4 is also evident in the lag correlation between the convection and the dynamic winds for observations and model.

**Summary**

- Increased precipitation variance in the 21st century in the intraseasonal time period
- Model MJO is stronger in the 21st century simulation and the tail of the distribution rises!

**Combined EOFs of U and OLR. Composite maps**

- Mode 2 from 21st C corresponds to Mode 1 of the 20th C.
- This pair of leading EOFs represents coherent eastward propagation of MJO.
- The lag correlation between PC-1 and PC-2 indicates that the dominant period is roughly 32 days in the 20th C run and 40 days in the 21st C run.
- The composite is constructed by selecting full fields of U850, U200 and OLR during the time intervals when MJO is strongly excited.
- The convection in phase 7 and 8 in the 21st C composite is stronger than in the 20th C case indicating a longer propagation of the MJO into the Pacific.

**MJO - Climate**

Will global warming modify the activity of the Madden - Julian Oscillation?

- Global warming (RCP 8.5 pathway) increases intraseasonal precipitation by >40% and the MJO is amplified with more persistent extreme events and it propagates farther into the Pacific ocean.

**Obs. NCEP U850**

- 21st Century (2050-2100)
- 20th Century (1950-2000)

- Variance in Intraseasonal Precip.

**CCSM4 Variations**

- Increased precipitation variance in the 21st century in the intraseasonal time period
- Model MJO is stronger in the 21st century simulation and the tail of the distribution rises!

**MJO Index for the 20th and 21st Century**

- 20th Century Variance: 0.18
- 21st Century Variance: 1.17

**CCSM-4 was run for 20th century greenhouse gas forcing and 21st century projected greenhouse gas forcing with a net change of 8.5 Wm^-2 in earth’s heat balance by the end of 2100.**