Evaluation and Process-oriented Diagnosis of the GEFSv12 Reforecasts

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***Acknowledgements**: Jiacheng Ye, Fanglin Yang, Lucas Harris, Tara Jensen, Douglas E. Miller, Christina Kalb, Daniel Adriaansen, Weiwei Li*
Supported by NOAA Round 3 R2O Initiative and MAPP Program

JCLI 2023: https://doi.org/10.1175/JCLI-D-22-0772.1

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Three-level Diagnostics

Level 1: Evaluation of Model Systematic Errors

- Moisture-Precipitation
- Cloud microphysics

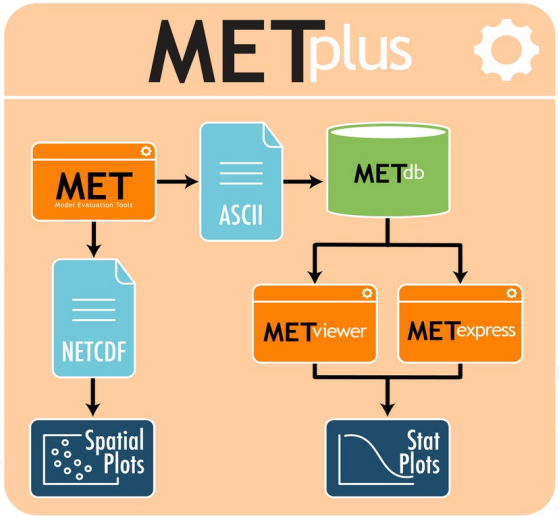
Level 2: Evaluation of the Sources of Predictability for Extended-range Forecasts

- MJO
- NAO
- weather regimes

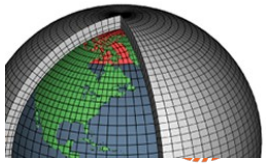
Level 3: Evaluation of High-Impact Weather and Climate Phenomena

- Blocking
- Tropical cyclones

Integration into METplus



MDTF Github



Model Diagnostics

Data

Model data:

- The GEFSv12 retrospective forecasts span from 1 Jan 2000 to 31 Dec 2019
- Only the control run is evaluated

Evaluation datasets

- ERA5 reanalysis
- Global Precipitation Climatology Project (GPCP)
- Outgoing longwave radiation (OLR) from the Clouds and the Earth's Radiant Energy System (CERES)
- International Best Track Archive for Climate Stewardship (IBTrACS) dataset Version 4

Level 1: Model Systematic Errors

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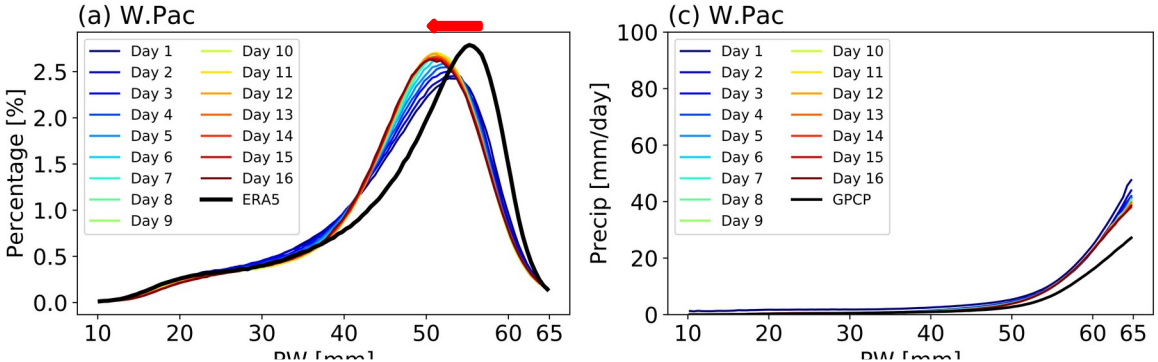
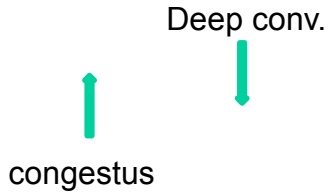
Moisture-Precipitation Relationships





- A single prominent peak of PW over WPac corresponding to deep convection and a high precipitation rate – dry biases in the GEFS
- a bimodal distribution over EPac not well represented in the GEFS
- Early onset of precipitation

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Column Water Vapor and Precipitation

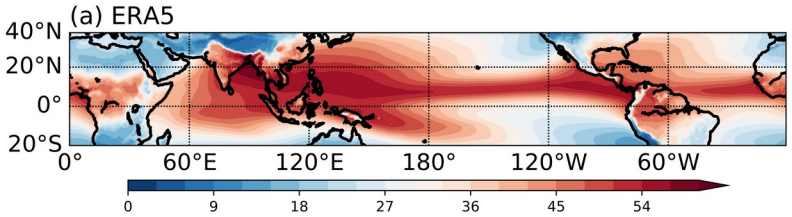
Column Water Vapor

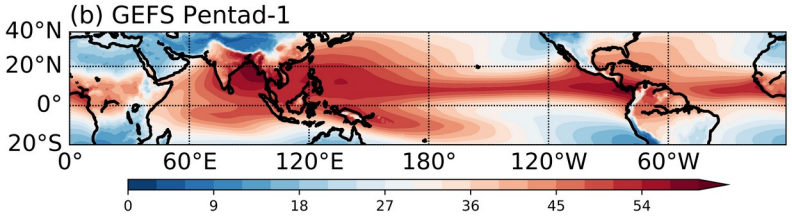
Precipitation

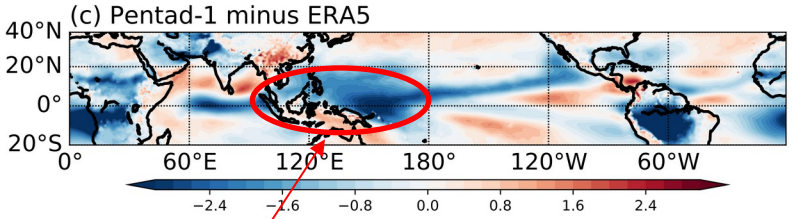
ERA5

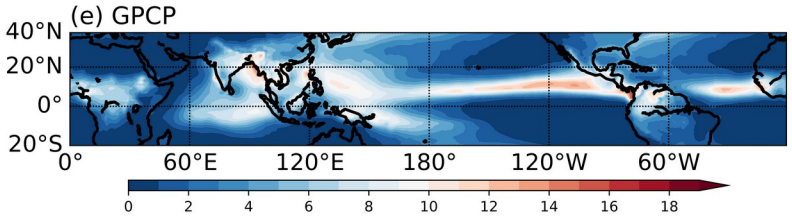
GEFS

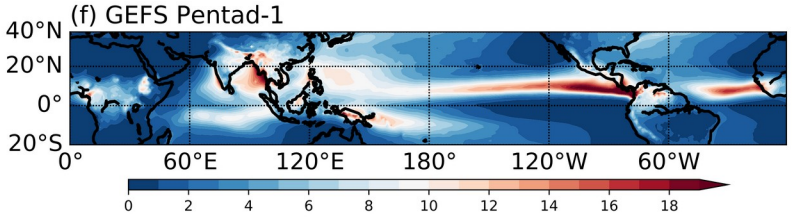
Biases

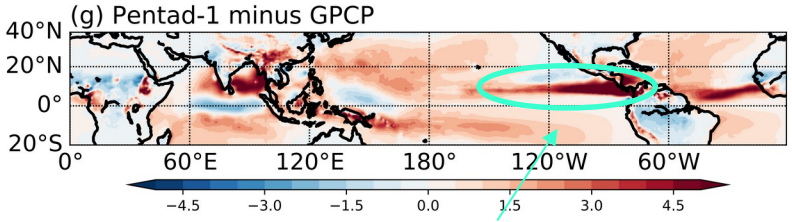










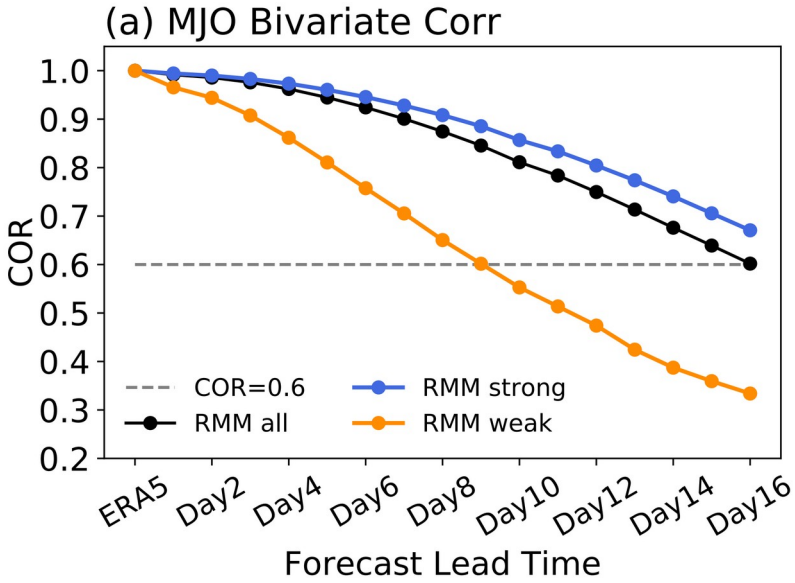


Dry biases over the Maritime Continent

ITCZ too strong in the GEFS

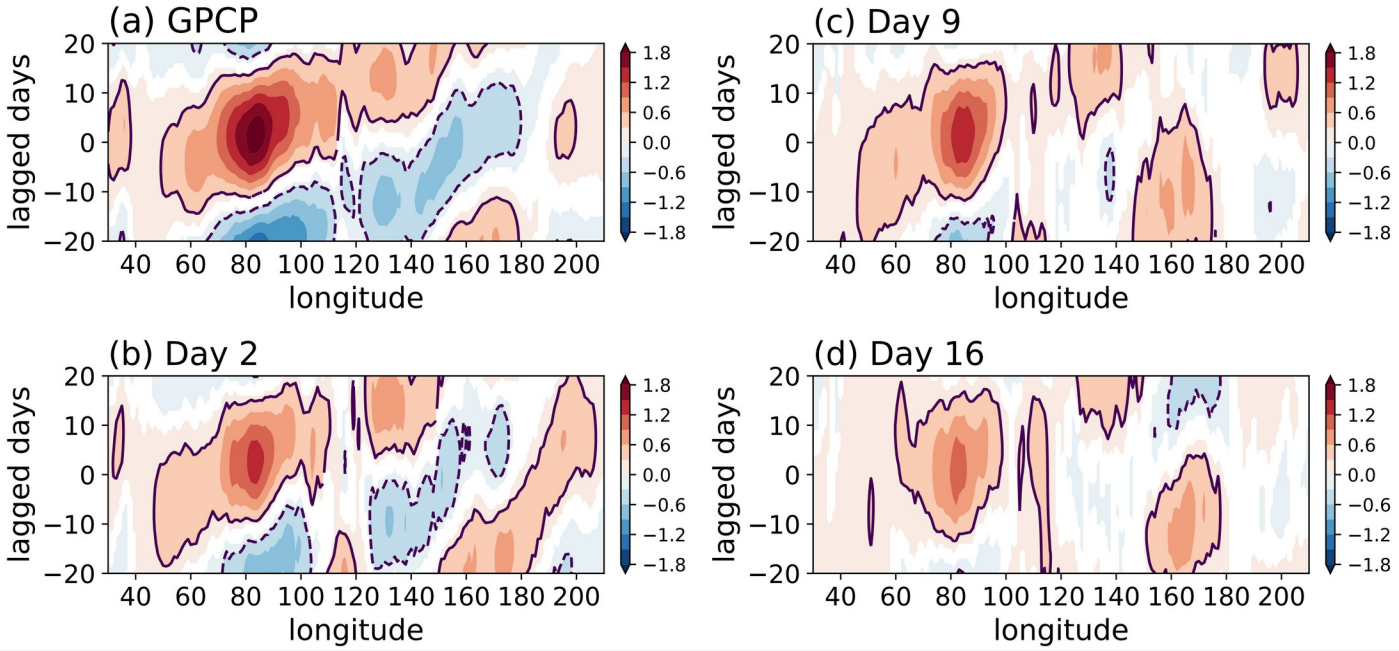
Level 2: Sources of Predictability for Extended-range Forecasts

MJO Skill in the GEFS



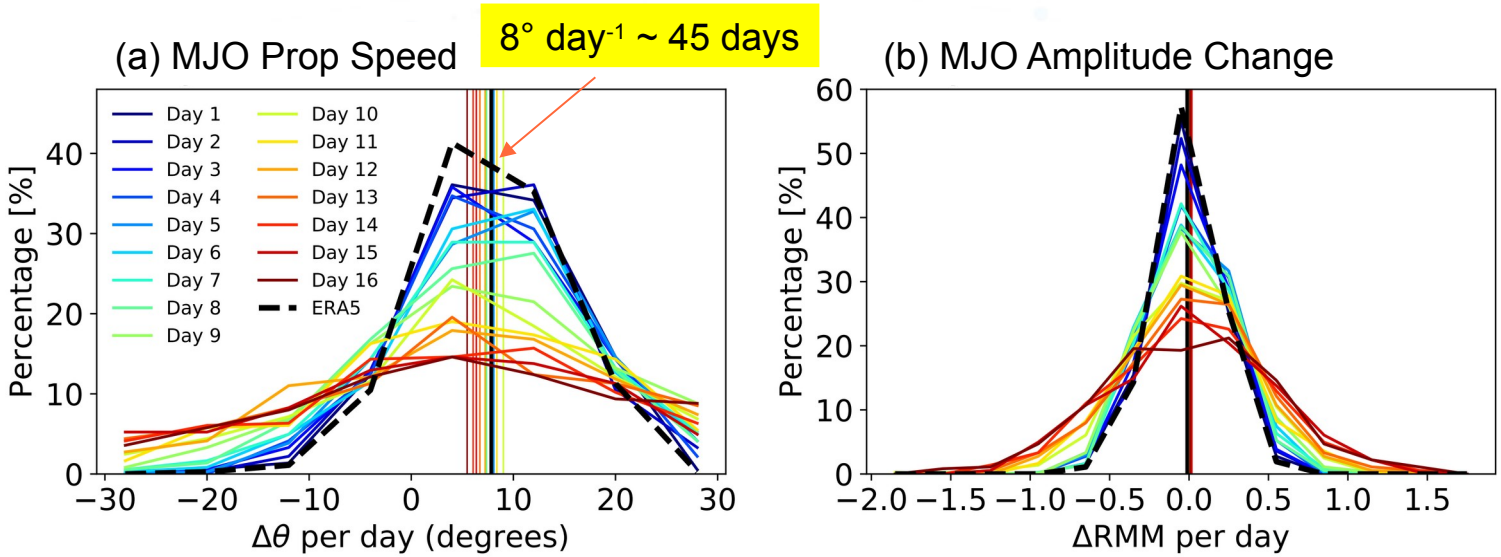
- The bivariate correlation remains above 0.6 up to 16 days.
- Increasing ensemble size is expected to improve the model prediction skill.
- The skill is higher for strong MJO days.

Hovmöller diagrams of band-pass filtered precip



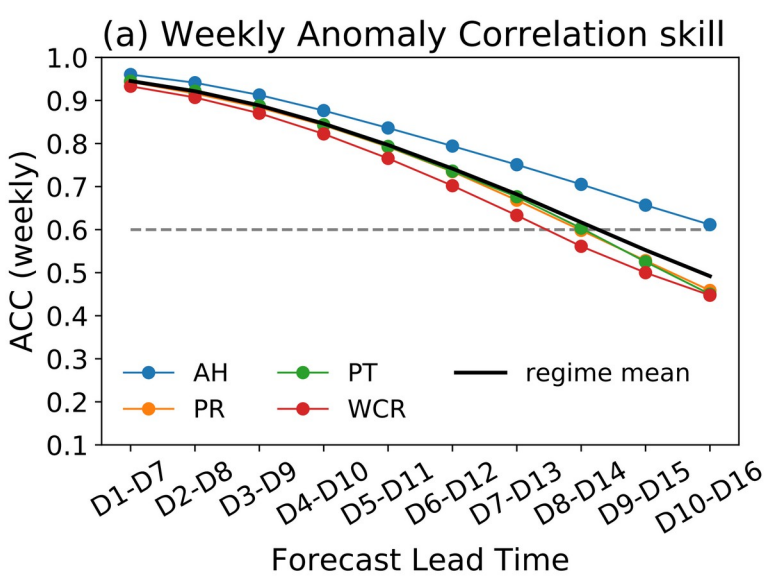
The eastward propagation of enhanced precipitation across the maritime continent remains robust even in the Day-16 reforecasts, although the signals weaken with increasing forecast lead time

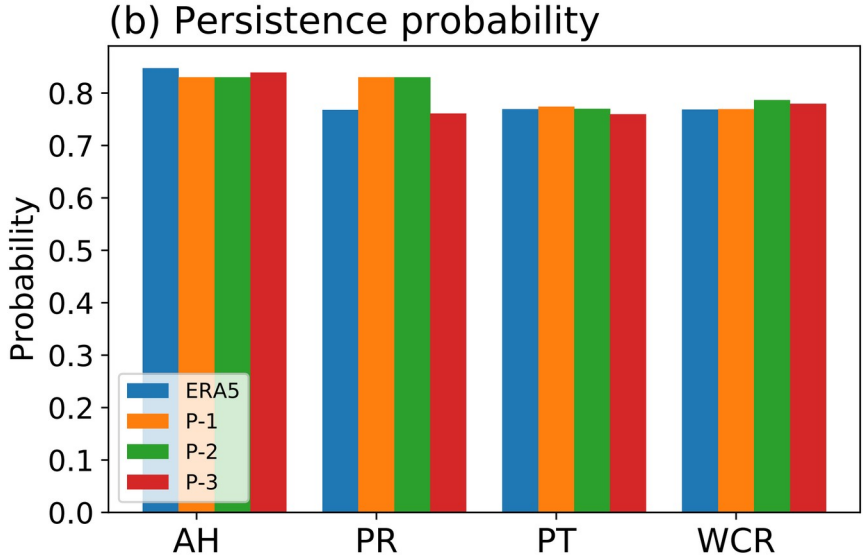
Probability distributions of the MJO phase speed and daily change of RMM magnitude



- The MJO propagation slows down progressively with increasing forecast lead time.
- The model has difficulty maintaining the steady state of the MJO with increasing forecast lead time.
- The weakened and less coherent MJO signals with increasing forecast lead-times may be attributed to humidity biases over the Indo-Pacific warm pool region.

North American Weather Regimes





- The ACC remains above 0.6 up to 12 days, which is comparable to the performance of the ECMWF S2S reforecasts.
- The persistence probability is well reproduced for all regimes and for all pentads in the GEFS

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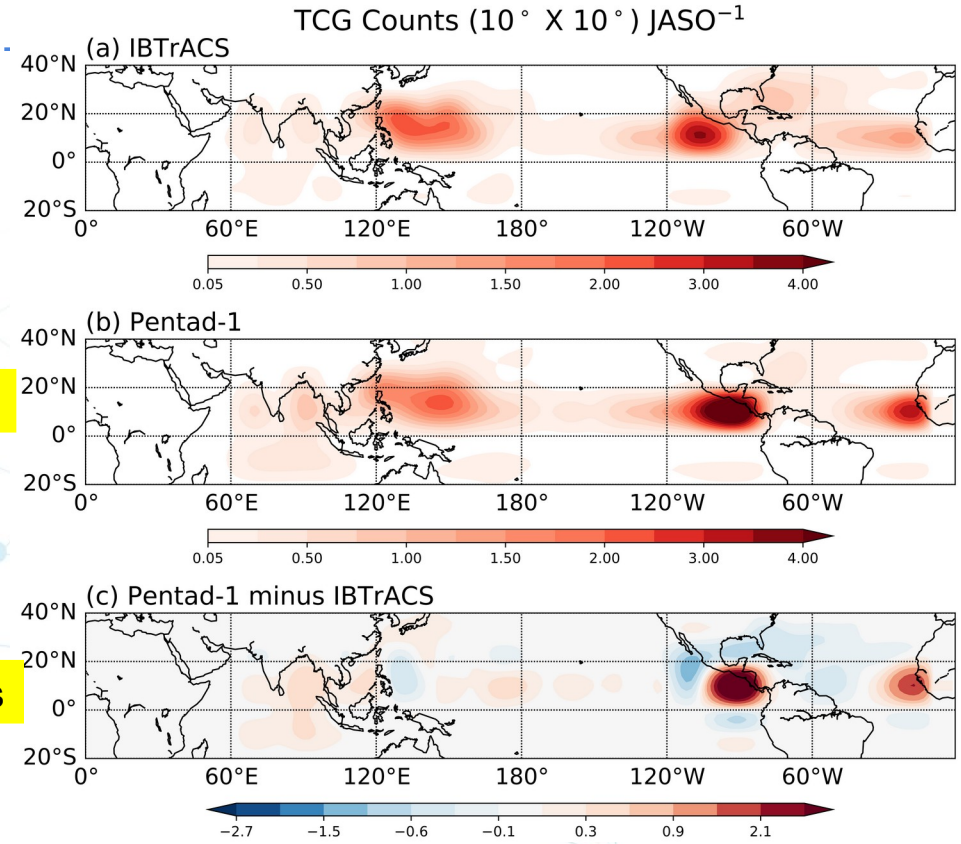
Level 3: High-Impact Weather and Climate Phenomena

Tropical Cyclone Genesis Density Function

Obs

GEFS

Biases



- TCG in the WPac is improved substantially compared to an earlier version.
- The positive biases over the EPac can be attributed to the overestimated ITCZ.

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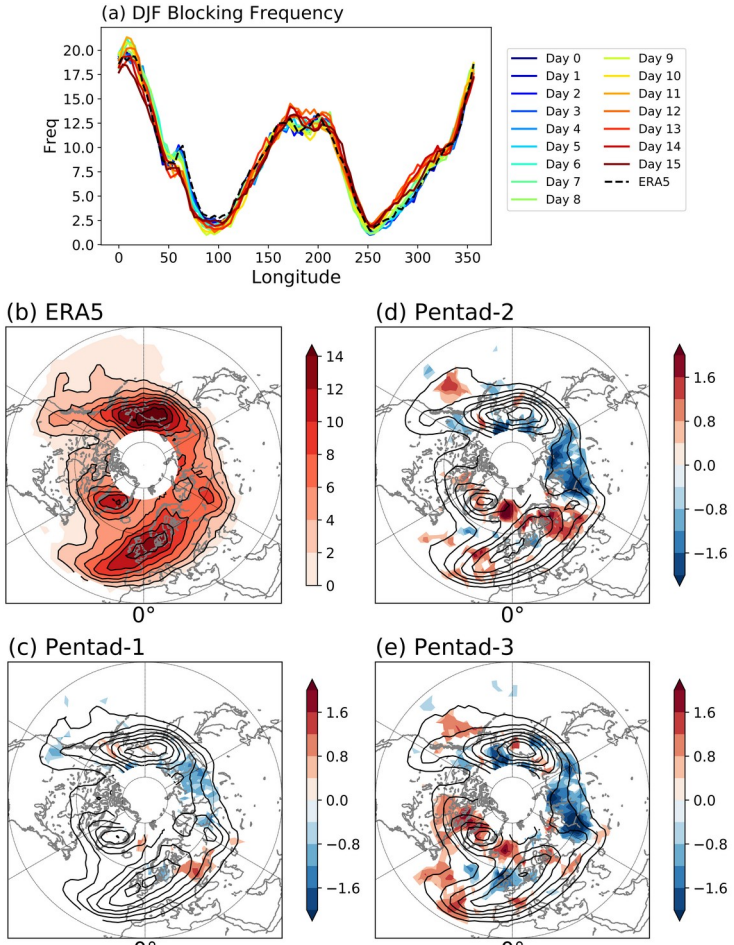

Blocking

- The long-term mean longitudinal distribution of blocking frequency is well represented in the GEFSv12 from Day 1 to Day 15.
- Positive blocking frequency biases prevail over the subpolar North Atlantic, and negative biases downstream of the Ural Mountain, which increase with the forecast leadtime.

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Summary

- Three levels of model diagnostics are applied to evaluate the GEFSv12 reforecasts.
- The level-1 diagnostics reveal that precipitation onset over tropical oceans occurs too early in terms of CWV accumulation, leading to prevailing dry biases in the tropics.
- The level-2 diagnostics show that the GEFSv12 can skillfully forecast the MJO up to 16 days ahead and can reasonably represent the MJO propagation across the MC.
- It is also found that the weather regimes can be skillfully predicted up to 12 days ahead with persistence comparable to the observation.
- The GEFSv12 shows reduced mean biases in TC genesis distribution, and blocking climatology in the GEFSv12 also shows an overall good agreement with the observations.