Evaluation of the Madden-Julian oscillation in KIM

Hye-Jin Park (hjpark@kiaps.org) and Eun-Hee Lee
Korea Institute of Atmospheric Prediction Systems (KIAPS), Seoul, Korea

1 Background and Objectives

- The Korean Institute of Atmospheric Prediction System (KIAPS) is making various efforts to extend the forecast range to 30 days based on the Korean Integrated Model (KIM), which is developed by KIAPS and is the operational global numerical weather prediction model of the Korean Meteorological Administration (KMA) for the medium-range forecasting.
- In this study, the characteristic of the Madden-Julian oscillation (MJO) forecast are evaluated from the operational medium-range forecast of KIM. We estimate the forecast skill of the MJO using Real-time Multivariate MJO (RMM) index through the comparison with UM (Unified Model operated by KMA), and then evaluate the propagation of MJO and mean state bias, and examine the impact of systematic bias on the MJO forecast in the KIM.

2 Model configuration and Analysis methods

Configuration of KIM (Korean Integrated Model) (Hong et al., 2018)		
Dynamic Core	Equation	Non-hydrostatic
	Spherical grid	Cubed-sphere
	Horizontal resolution	ne360np3 (~12km)
	Vertical levels	L91 (~80km)
	Temporal approximation	Split-explicit, 3th Runge-Kutta
Physics	Moist process	Scale-aware mass-flux deep/shallow convection, WSM5 microphysics
	Radiation	Revised RRTMG
	PBL	Scale-aware non-Local PBL
	Gravity waves	Sub-grid orographic and non-orographic GWD
	Land	Revised land-surface module based on Noah LSM
	Data assimilation	Hybrid-4D EnVar

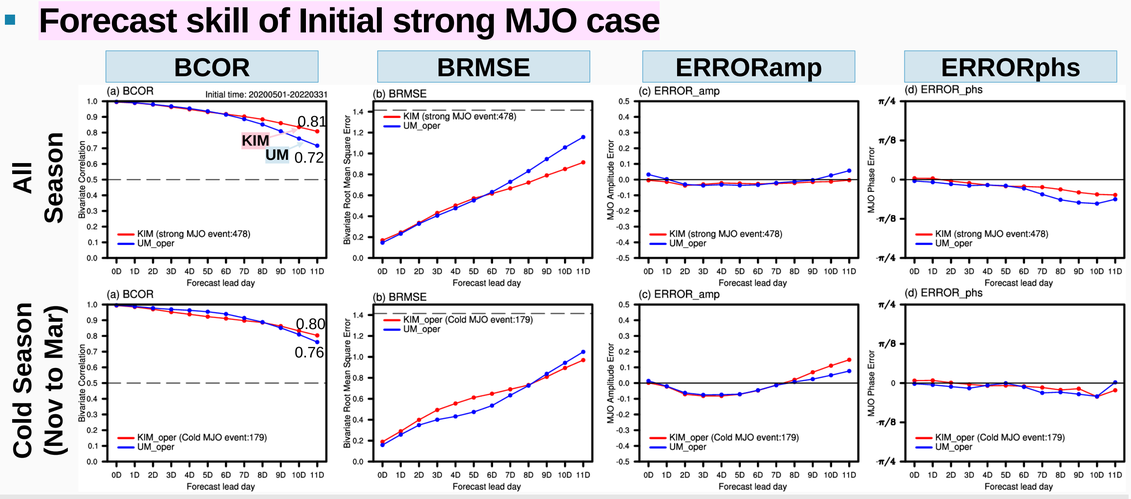
- **Analysis period : 2022.05.01 – 2022.03.31 (based on initial time)**

- **Observational proxies**
  - ERA5 reanalysis data (6hourly to 1-day)
  - NOAA HIRS OLR daily data
- **RMM index (Wheeler and Hendon, 2004, Lin et al., 2008)**
  - Indices based on the combined EOF 1 & 2 structure of intraseasonal anomalies of OLR, U850 and U200 in the equatorial region (15°S-15°N)
  - Calculation RMM index from forecast data from NWP model (Lin et al., 2008)
  - Climatology period: 1981 – 2020 (40years)
- **Verification materials (Rashied et al, 2011)**
  - Bivariate Correlation skill (BCOR)
  - Bivariate Root Mean Square Error (BRMSE)
  - MJO Amplitude and Phase Error (ERRORamp & ERRORphs)
- **Calculation of instraseasonal Anomaly (Lin et al., 2008)**
  - Removing the daily climatology and previous 120-day mean from RAW data

4 Results

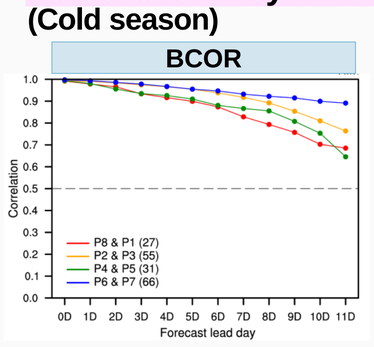
Forecast performance based on RMM index

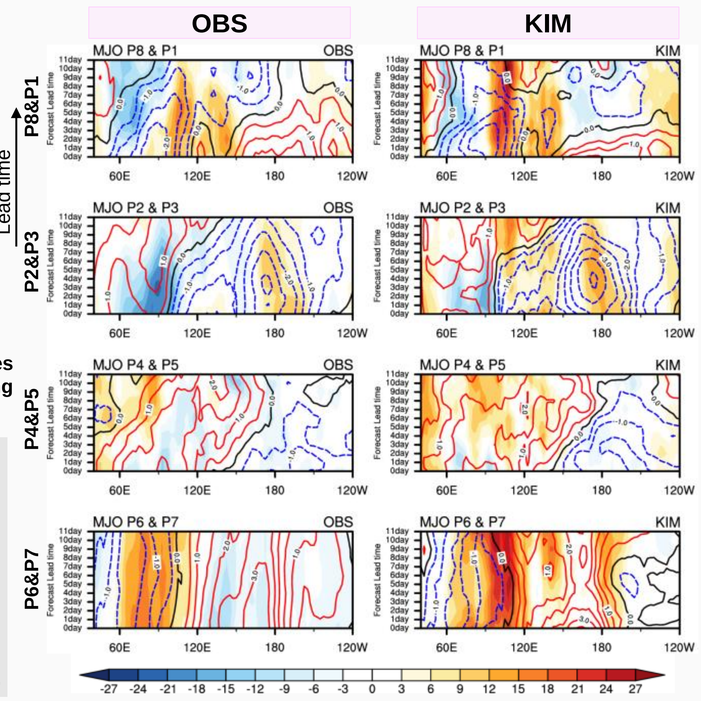
- **Forecast skill of Initial strong MJO case**



- KIM shows the better performance in prediction the initially strong MJO than UM.
- For the cold season, KIM predicts a weaker MJO than the reanalysis up to 7-day lead time, and a stronger MJO thereafter. The MJO phase gradually slows down as the lead time increases.

- **Forecast skill by initial MJO phase of KIM and propagation pattern (Cold season)**



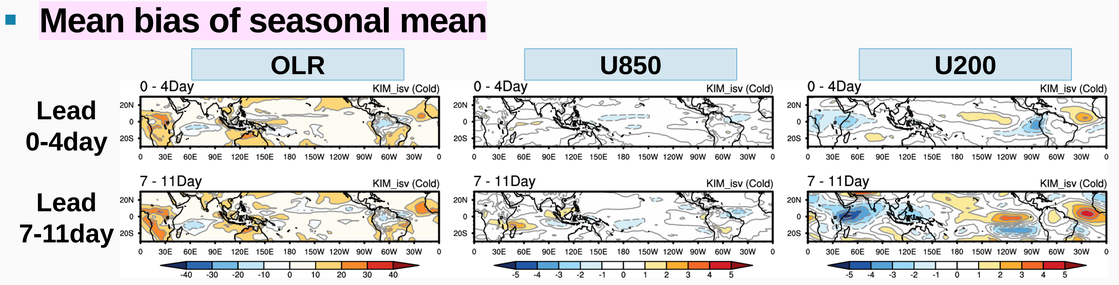


▶ **Lead time-longitude distribution of composite of tropical intraseasonal anomalies of OLR(shading) and U850(contour) according to each initial MJO phases (Cold season)**

- P6&P7 initiation shows good predictive performance for a longer lead time than other phases.
- KIM shows an similar MJO propagation pattern with the observation. The pattern is gradually deviates from the observation as lead time increases.

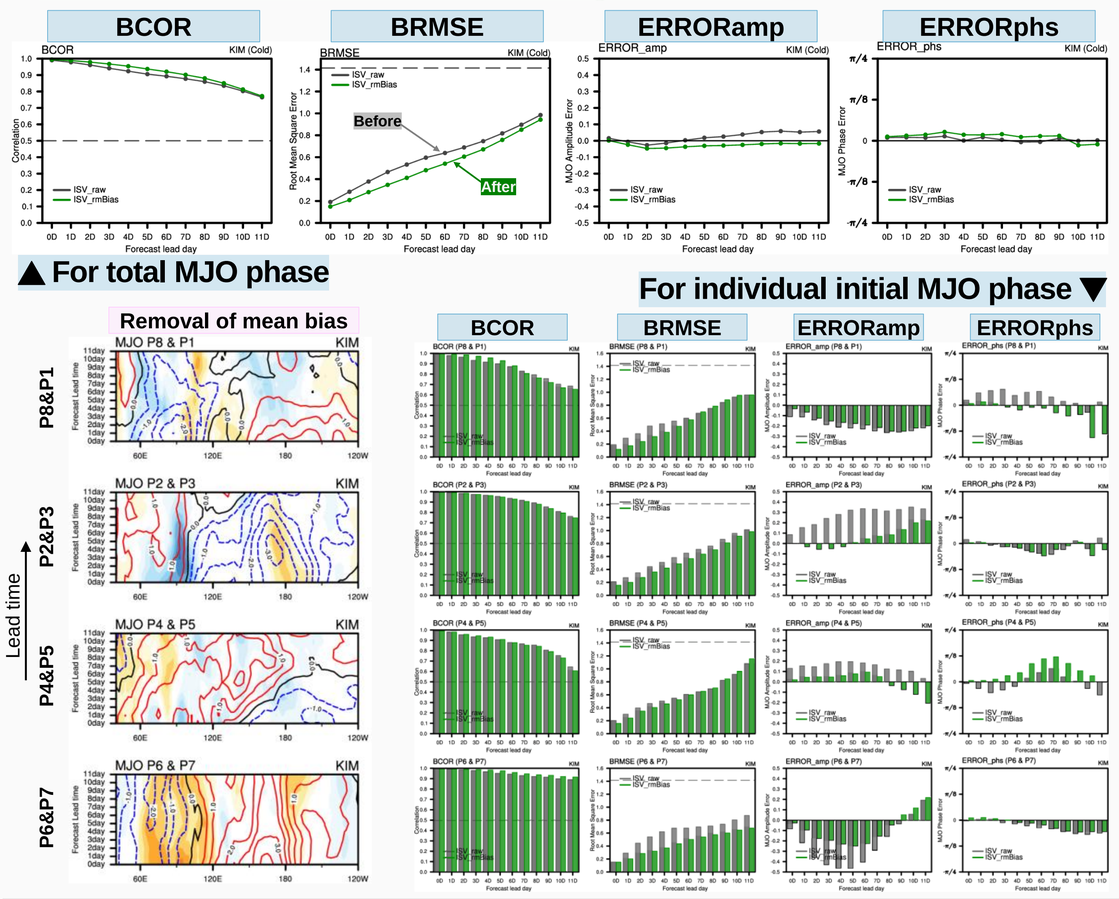
Impact of mean state bias (Cold season)

- **Mean bias of seasonal mean**



- Some bias over Indian Ocean and Maritime Continent appears regardless of MJO phase (now sown).
- The biases are increasing as the lead time increase.

- **Forecast skill of MJO after removing mean bias**



- When the seasonal mean bias of KIM, the MJO prediction performances are improved.
- The extent of improvement in MJO prediction performance is different for each initial MJO phase.

5 Summary and Conclusions

- As a preceding step to provide feedback on the development of the extended medium-range forecasting in KIAPS, the MJO prediction performance was evaluated in operational medium-range forecast of KIM for the past two years to understand the characteristics of KIM.
- In this study, it was conformed that the seasonal mean bias of KIM can affect the MJO prediction performance, and therefore the MJO forecast skill can be improved through the improvement of the seasonal mean bias.
- It is necessary to evaluate the prediction performance of the KIM for a longer period and analyze the dynamical and physical diagnosis related to the MJO.

6th WGNE workshop on systematic errors in weather and climate models, 21 Oct-4 Nov 2022 (Virtual attendance)