Ichikawa, Y., and M. Inatsu, 2016: Methods to evaluate prediction skill in the Madden-Julian oscillation phase space. *J. Meteor. Soc. Japan*, **94**, 257-267.
https://doi.org/10.2151/jmsj.2016-014

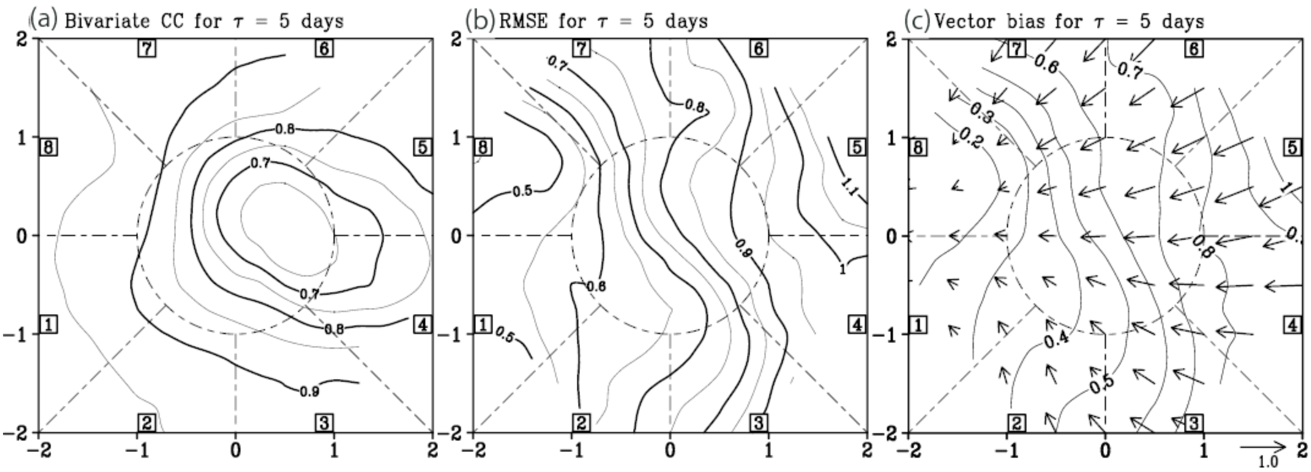

Figure 1: (a) Bivariate anomaly correlation coefficient and (b) root-mean-square error with their contour interval of 0.5. The value is calculated for the 5-day lead time and plotted at the initial position of the forecast. The area where the probability density function (PDF) is less than 0.02 is masked out. (c) Mean error vector field with, 0.5 and 0.1 respectively. For the mean error the reference vector of 1.0 day^{-1} is shown in the bottom right.

Indices of prediction skill over the Madden-Julian oscillation (MJO) phase space are examined with reanalysis and forecast data provided by the Japan Meteorological Agency (JMA). Conventionally, the root-mean-square error (RMSE) and anomaly correlation coefficient (ACC) have been used, although this approach misses information on the model bias for MJO events. Moreover, the ACC is not suitable for models in which the MJO signal tends to damp in some phases, because the ACC strongly depends on the MJO amplitude. As is shown above, both ACC (Fig. 1a) and RMSE (Fig. 1b) indicate a better skill in Phases 4-5 and a worse skill in Phases 8 and 1. The ACC is rather axisymmetric around the origin, so that this index unintendedly shows a bad skill solely with small MJO amplitude. The RMSE, in contrast, is obviously asymmetry. This discrepancy between ACC and RMSE is a problem when one evaluates the MJO forecast. The mean-error vector (Fig. 1c) compensates this drawback by associating a model's erroneous mean tendency with RMSE. The leftward mean error vector field uniformly distributed over the MJO phase space with its amplitude related to RMSE. We recommend that the mean error vector together with RMSE should be used for evaluating MJO prediction skill.