Improving the prediction skill of the Madden-Julian Oscillation of the ECMWF model by post-processing

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CAFE
Climate Advanced Forecasting of sub-seasonal Extremes

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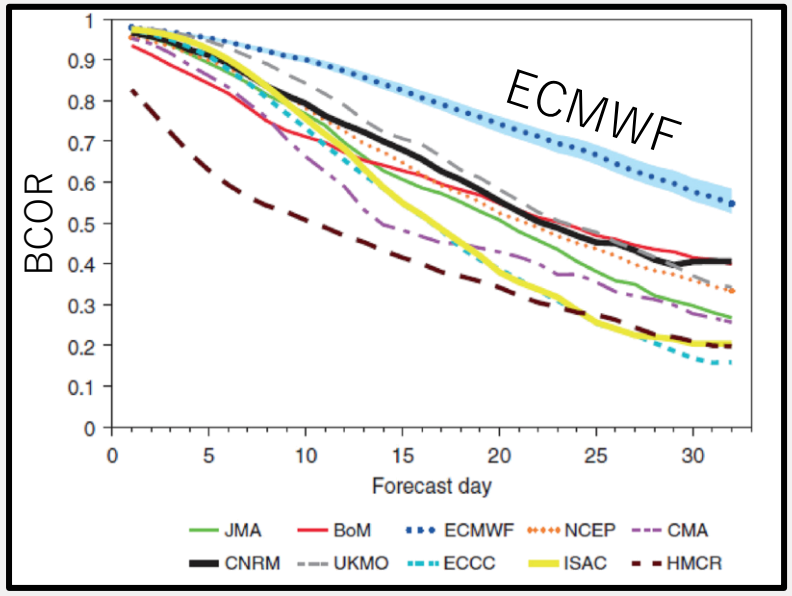
Madden-Julian Oscillation prediction

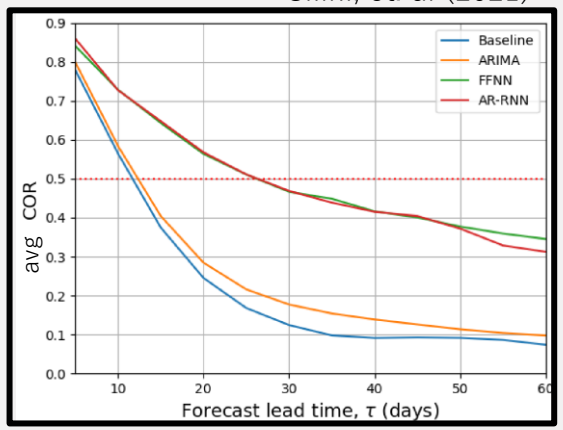
Madden-Julian Oscillation prediction

Vitart (2017)

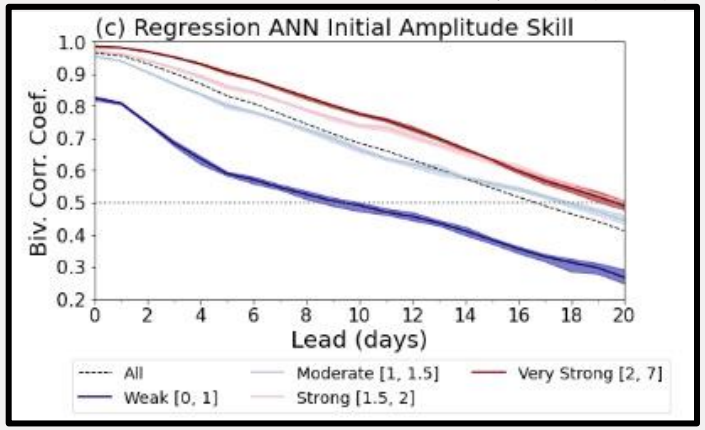


Numerical models
Prediction skill: ~5 weeks

Silini, et. al (2021)



Martin, et. al (2021)



Machine Learning models
Prediction skill: ~2-3 weeks

Issues

Issues

Numerical models

- Didn’t yet reach the theoretical predictability
- Maritime Continent Barrier

Machine Learning

- Lower prediction skill compared to numerical models

Idea

Idea

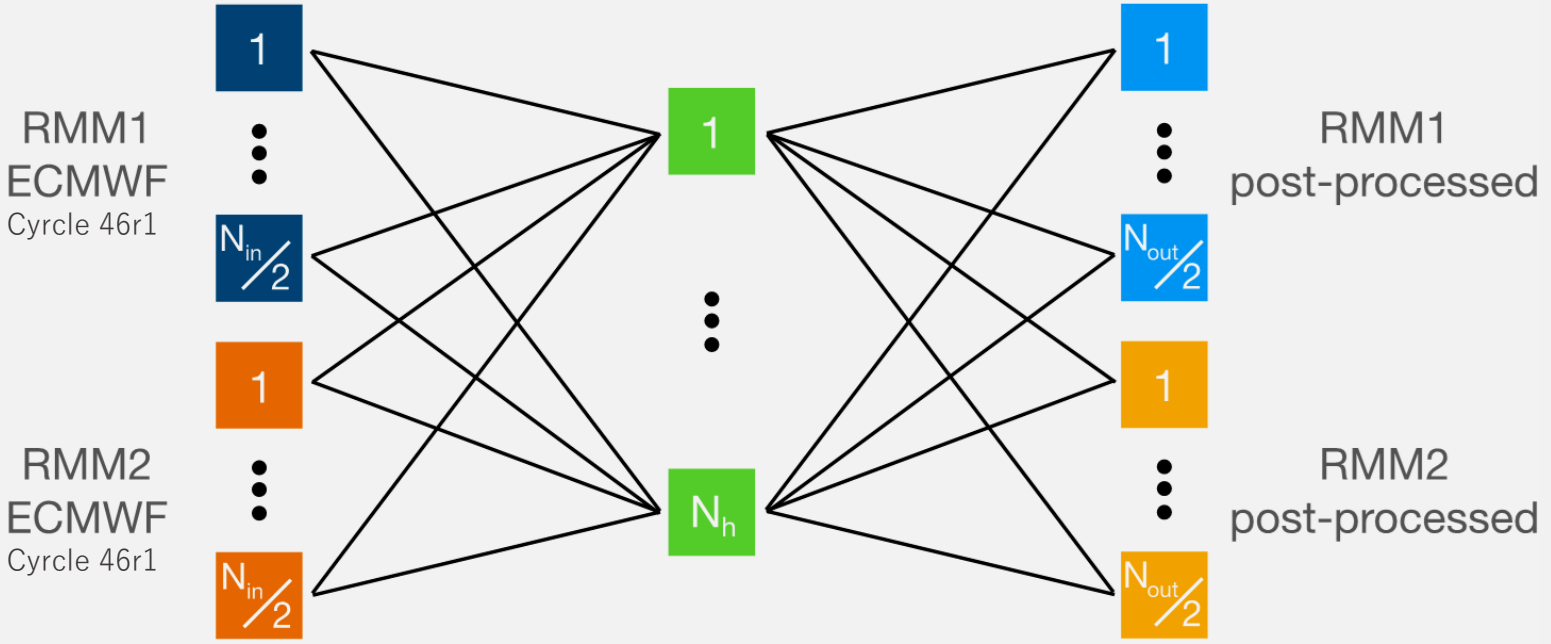
Combine Machine Learning with numerical models.

→ Machine learning post-processing of the ECMWF model predictions

Neural network architecture

Feedforward neural network

Data: June 1999 - June 2019



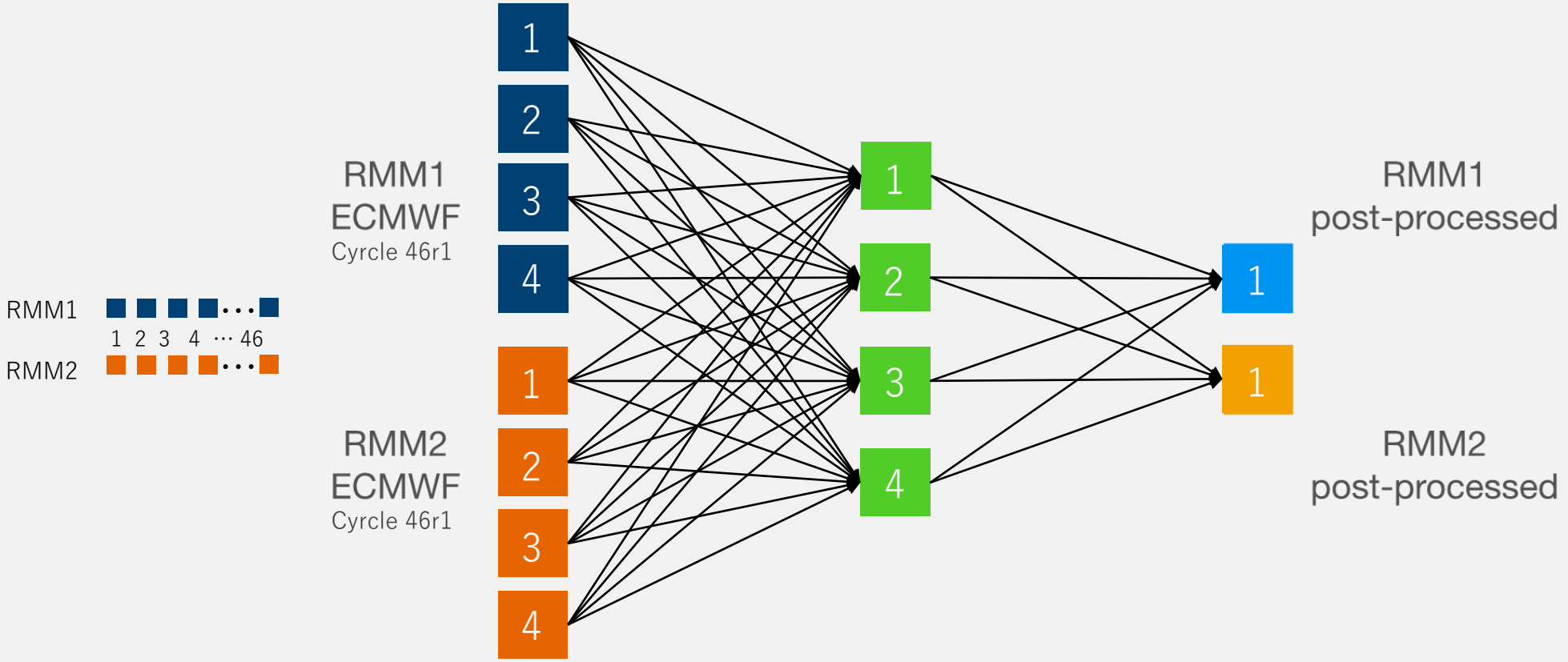
Nin = Nout + 6

Nh = Nin/2

Nout = 2 * lead time

Feedforward neural network

Lead time: 1 day



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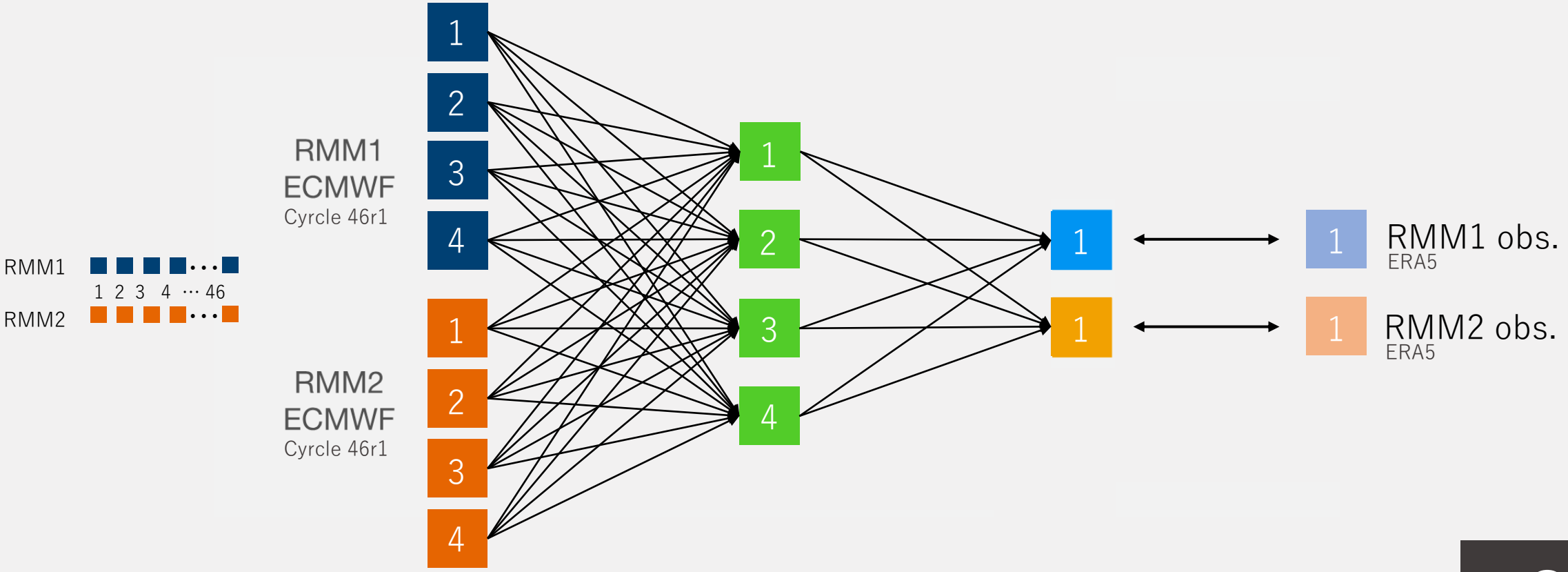


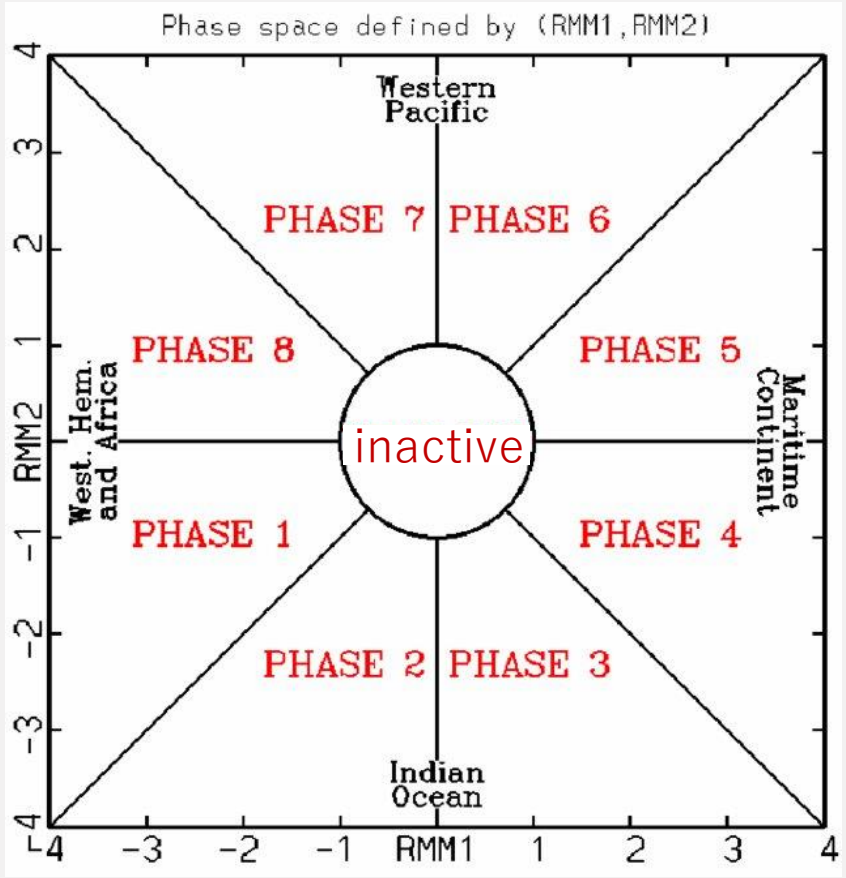
Amplitude and phase

Amplitude and phase

RMM1
RMM2 → (polar transform.) → amplitude
phase

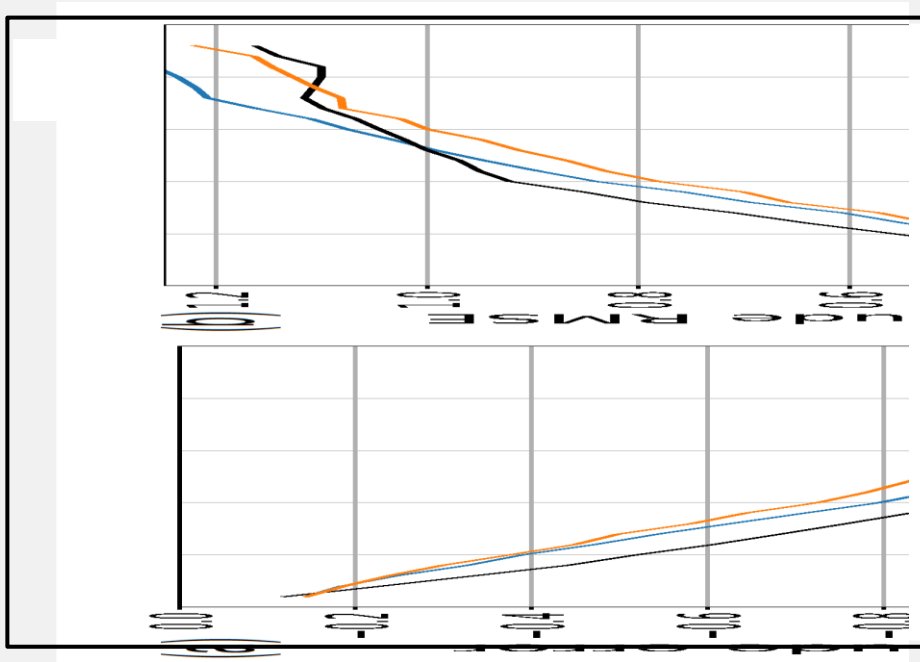
Amplitude: event intensity

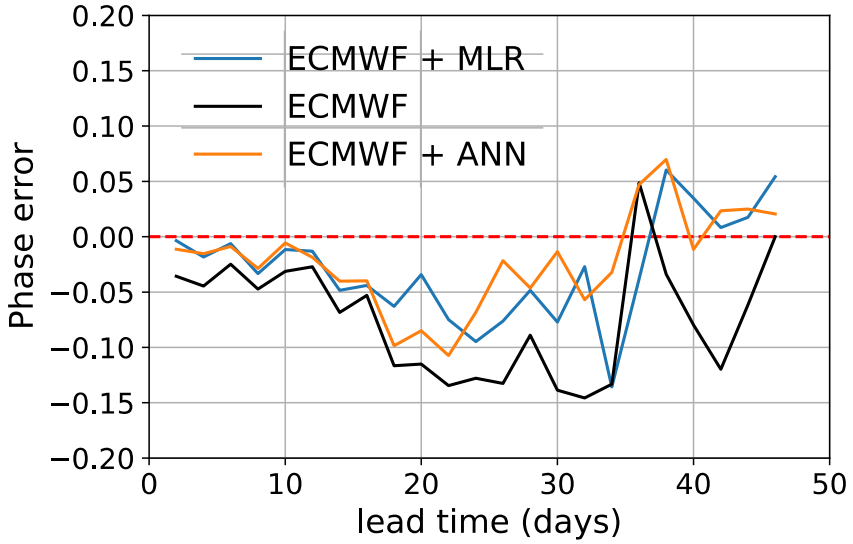
Phase: geographical location



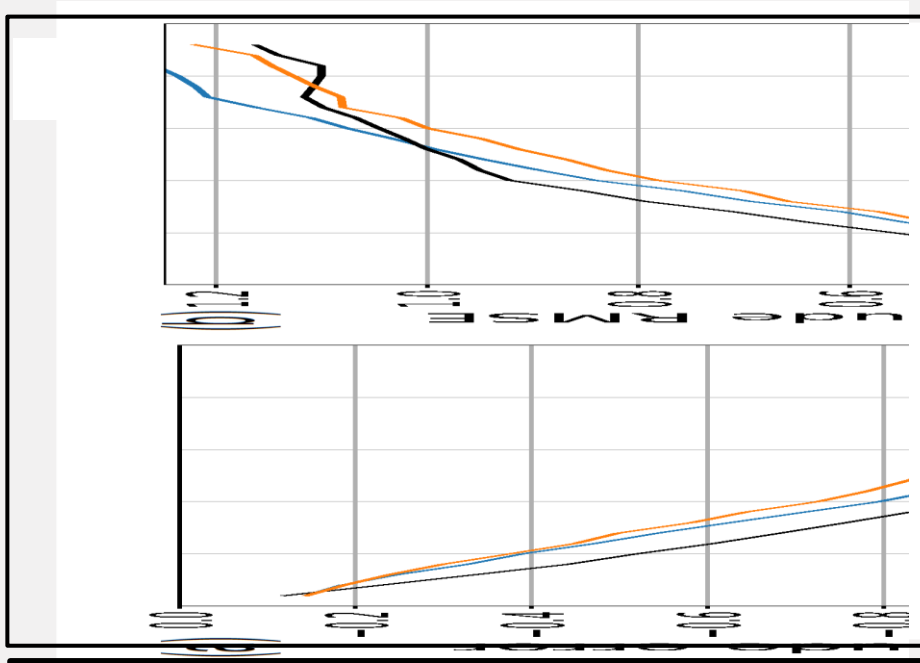
Results

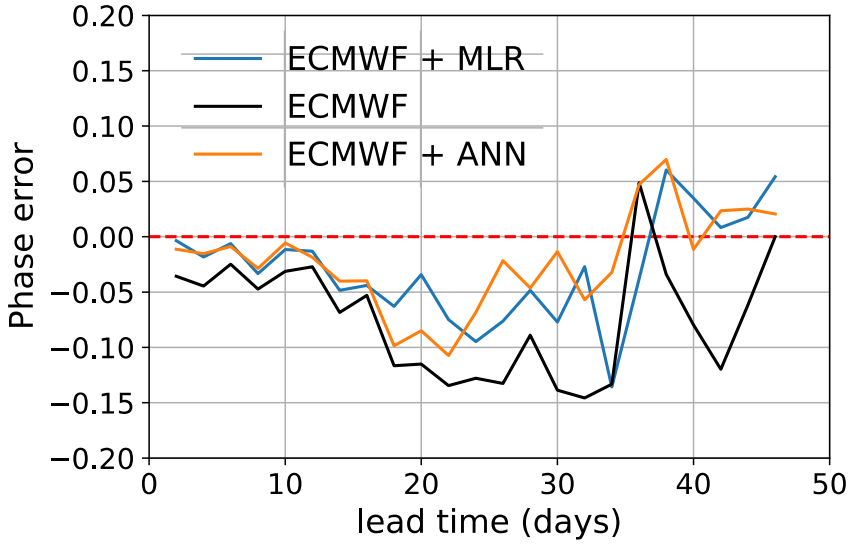
Amplitude and phase error





Amplitude and phase error

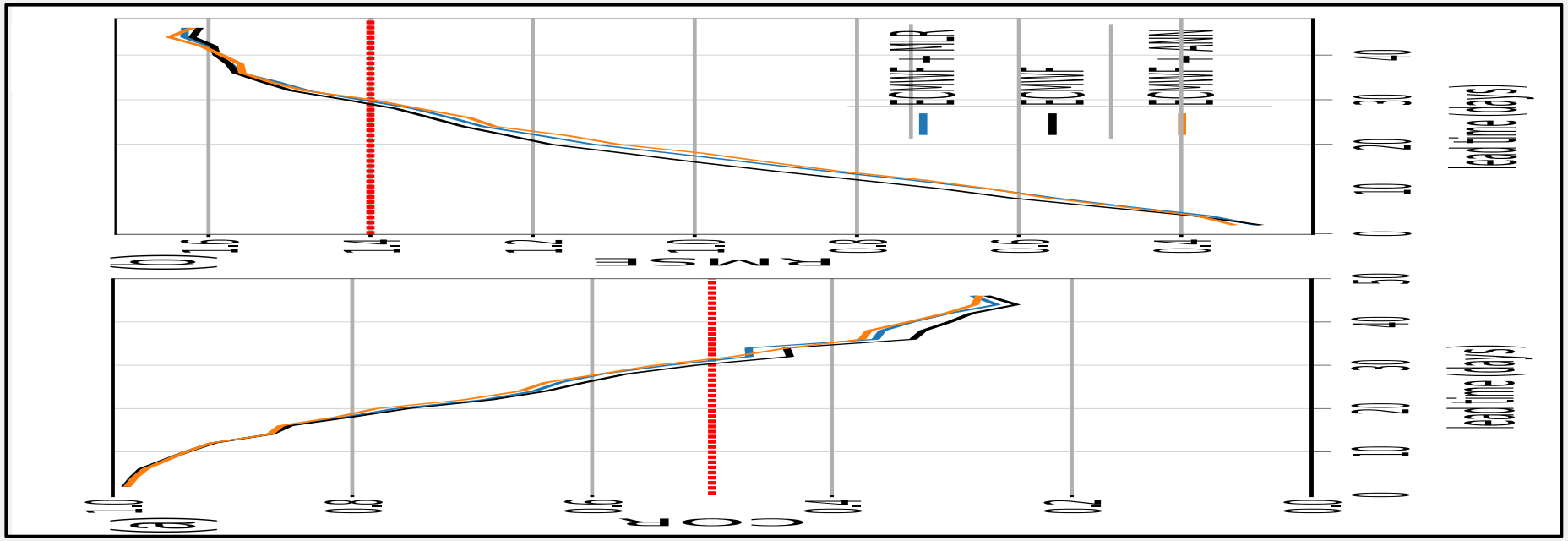




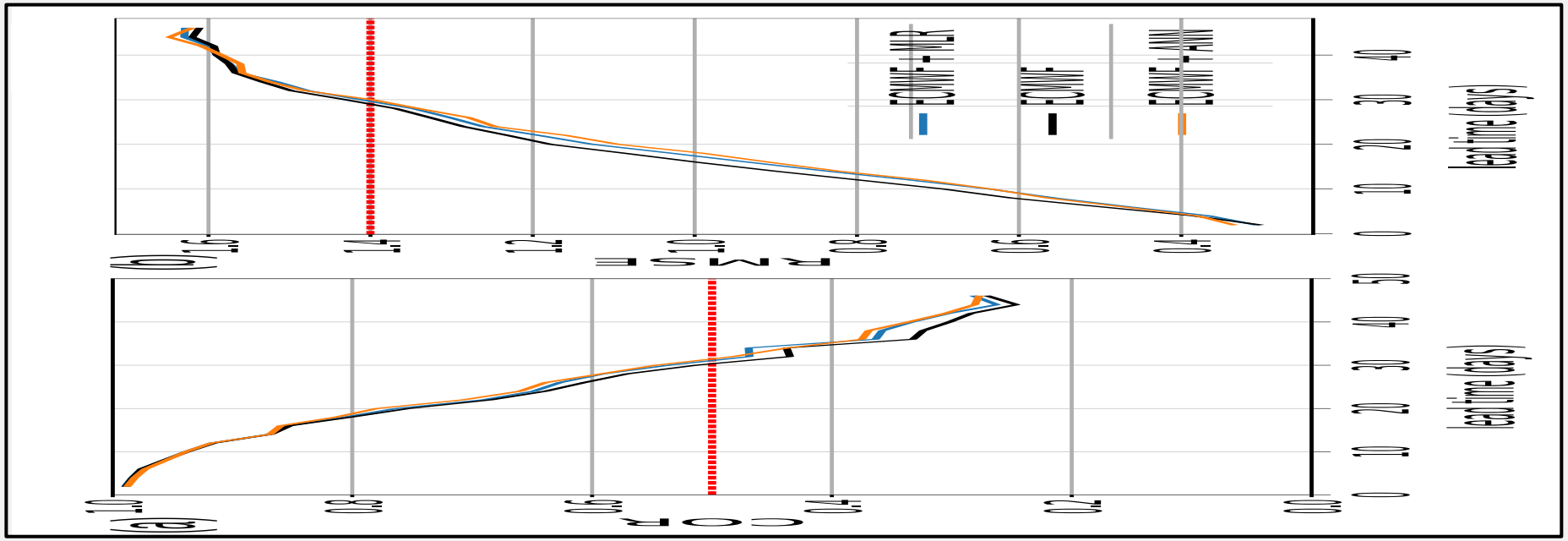
Improved amplitude prediction
up to ~5 weeks
Best Model: ANN

Improved phase prediction
up to ~5 weeks
Best Models: ANN and MLR

Bivariate correlation and RMSE



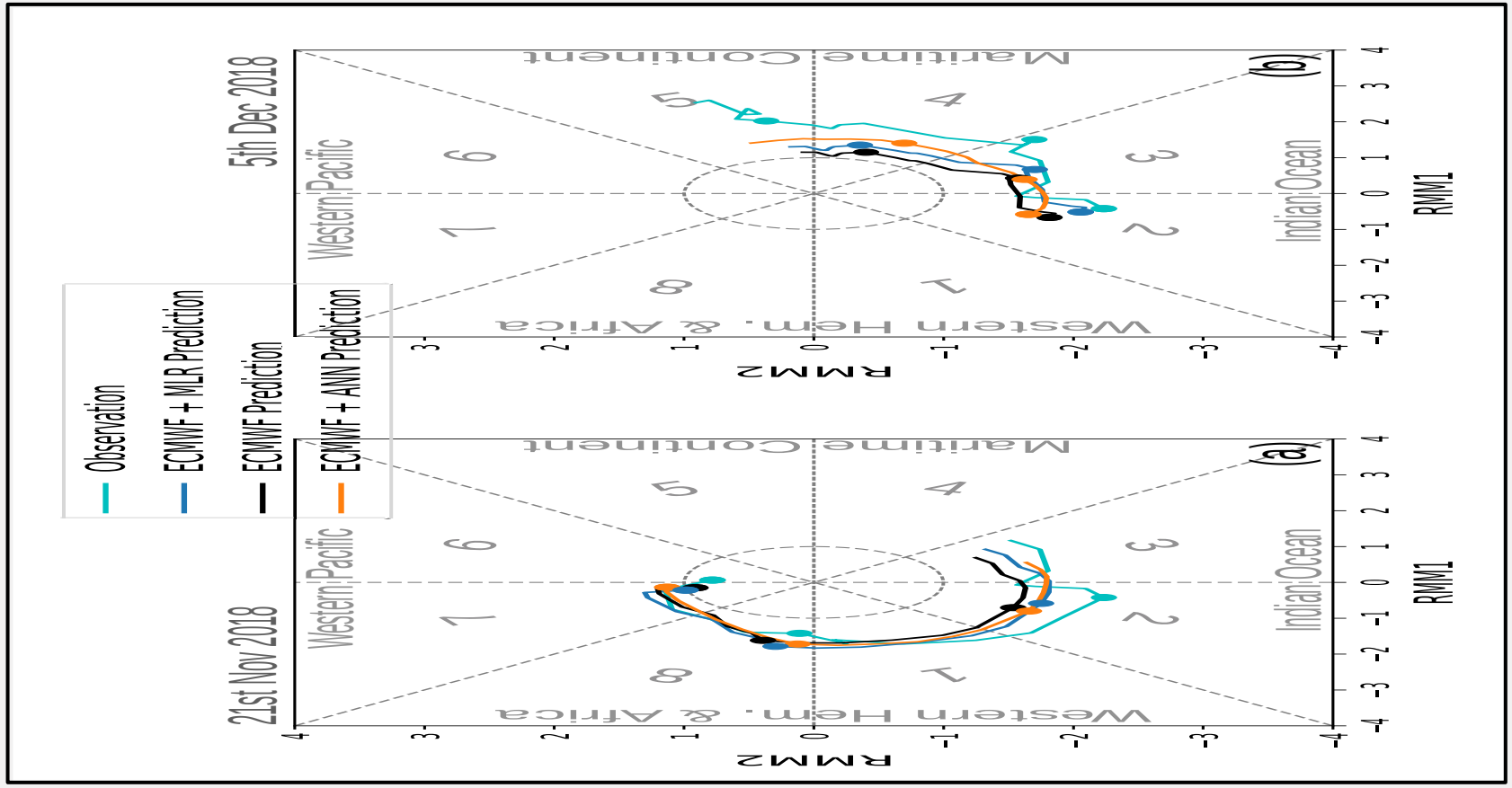
Bivariate correlation and RMSE



Improved prediction skill of about 1-2 days
Best Models: ANN and MLR

Wheeler-Hendon phase diagrams

3 weeks prediction



Conclusions

A cost-effective artificial neural network used as post-processing tool, can improve the current best model for MJO forecast (ECMWF), better than linear models

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A cost-effective artificial neural network used as post-processing tool, can improve the current best model for MJO forecast (ECMWF), better than linear models

- Improved *amplitude* prediction up to 5 weeks
  Best Model: ANN

- Improved *phase* prediction up to 5 weeks
  Best Models: ANN and MLR

- Improved prediction skill of about 1-2 days
  Best Models: ANN and MLR

- Improved prediction entering the Maritime Continent (*MC barrier*) using ANN

But there's more!

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