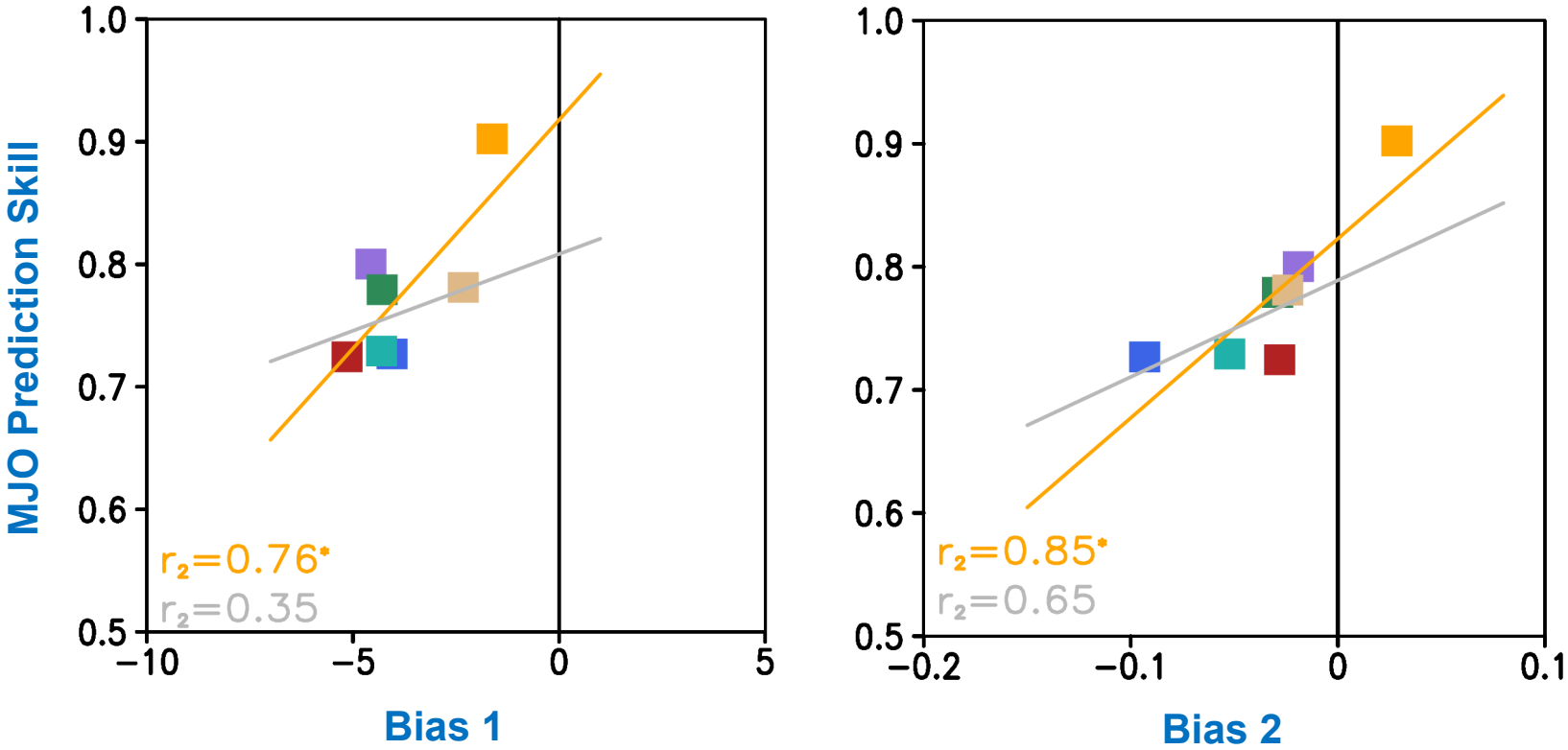

Mean state bias, cloud-radiation feedbacks, and MJO prediction skill in the S2S models

Daehyun Kim[1], Yuna Lim[2] and Seok-Woo Son[2]

[1]University of Washington, [1]Seoul National University

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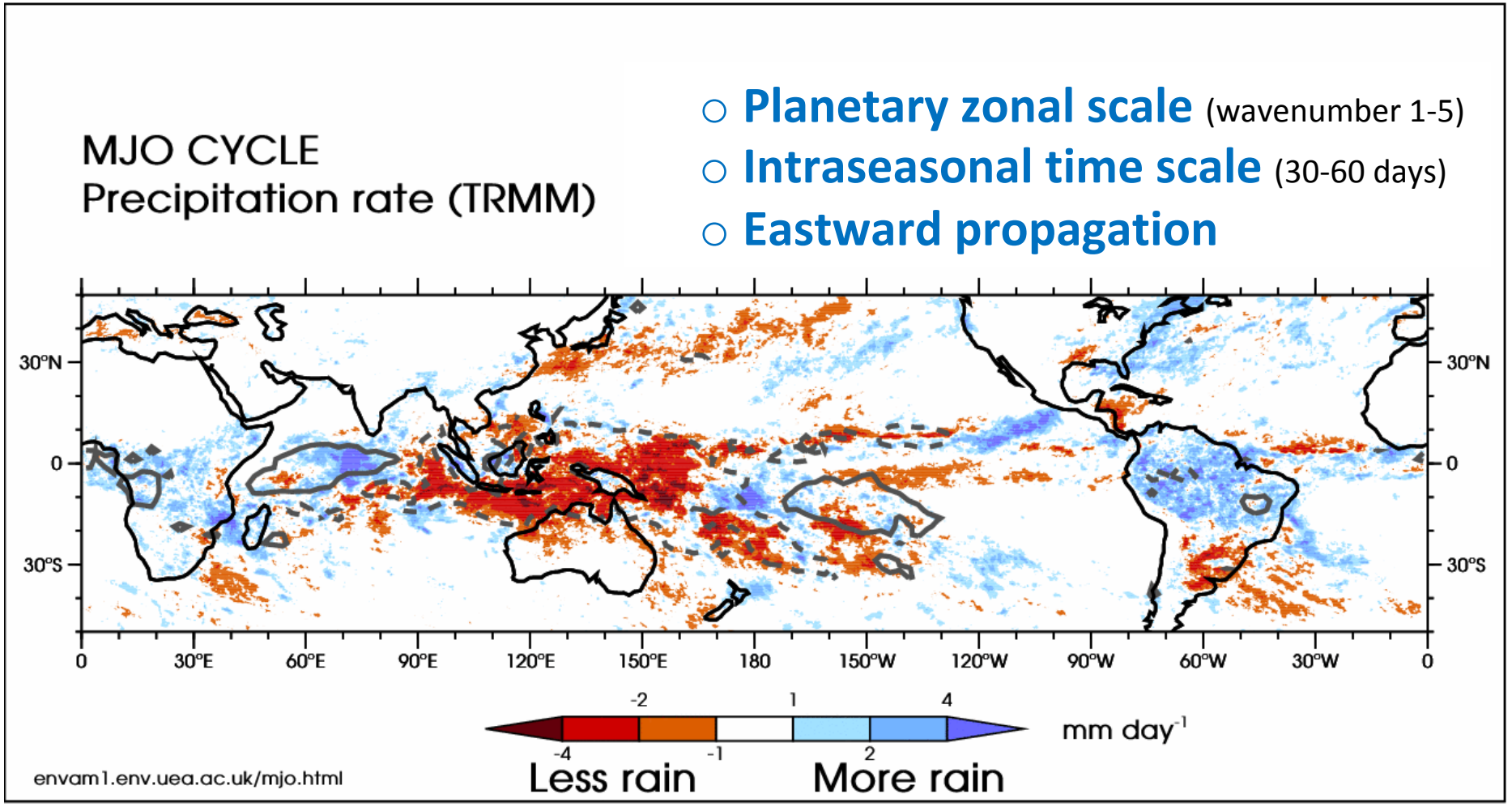
Madden-Julian oscillation

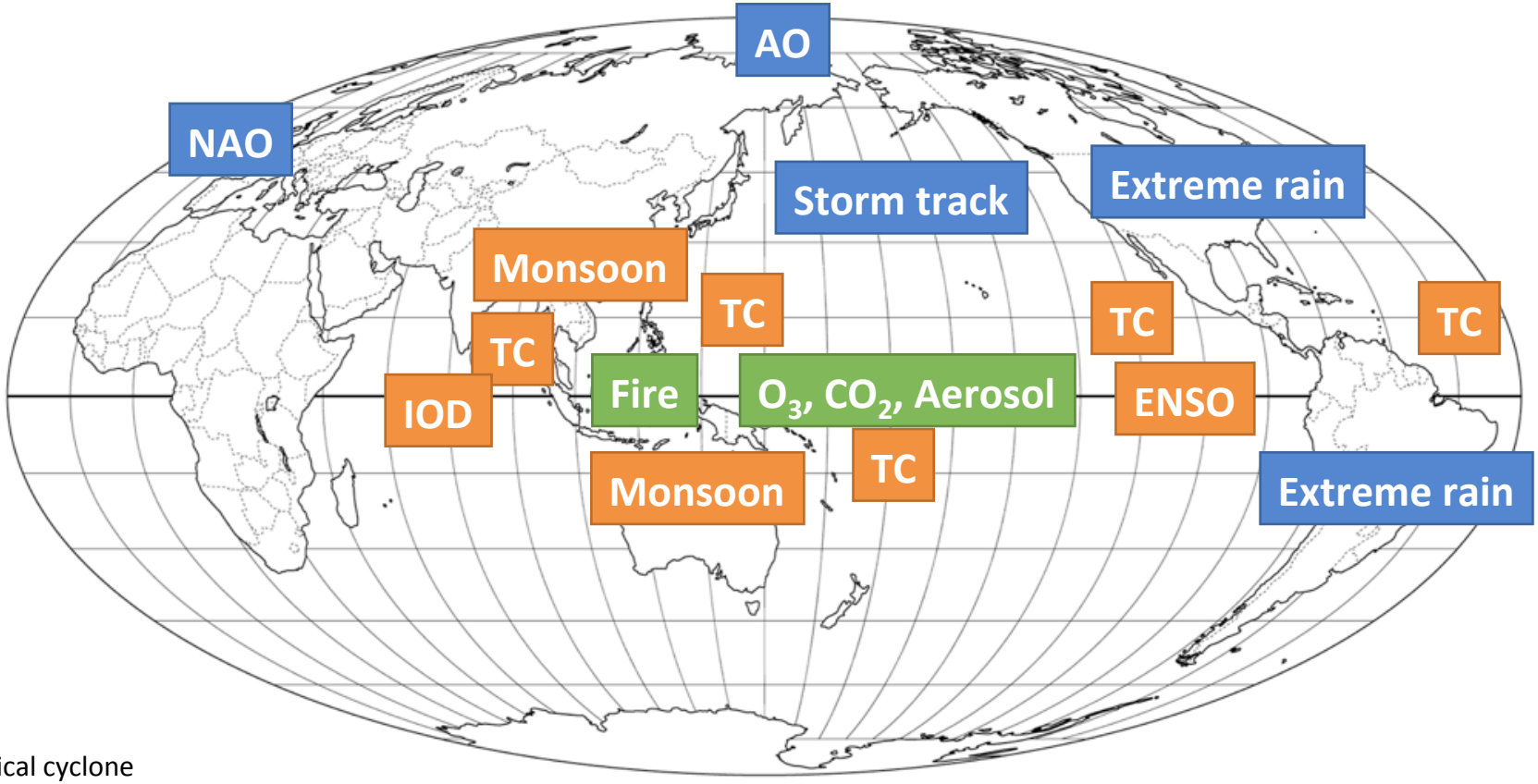
A unique type of organized tropical convection



envam1.env.uea.ac.uk/mjo.html

MJO impacts

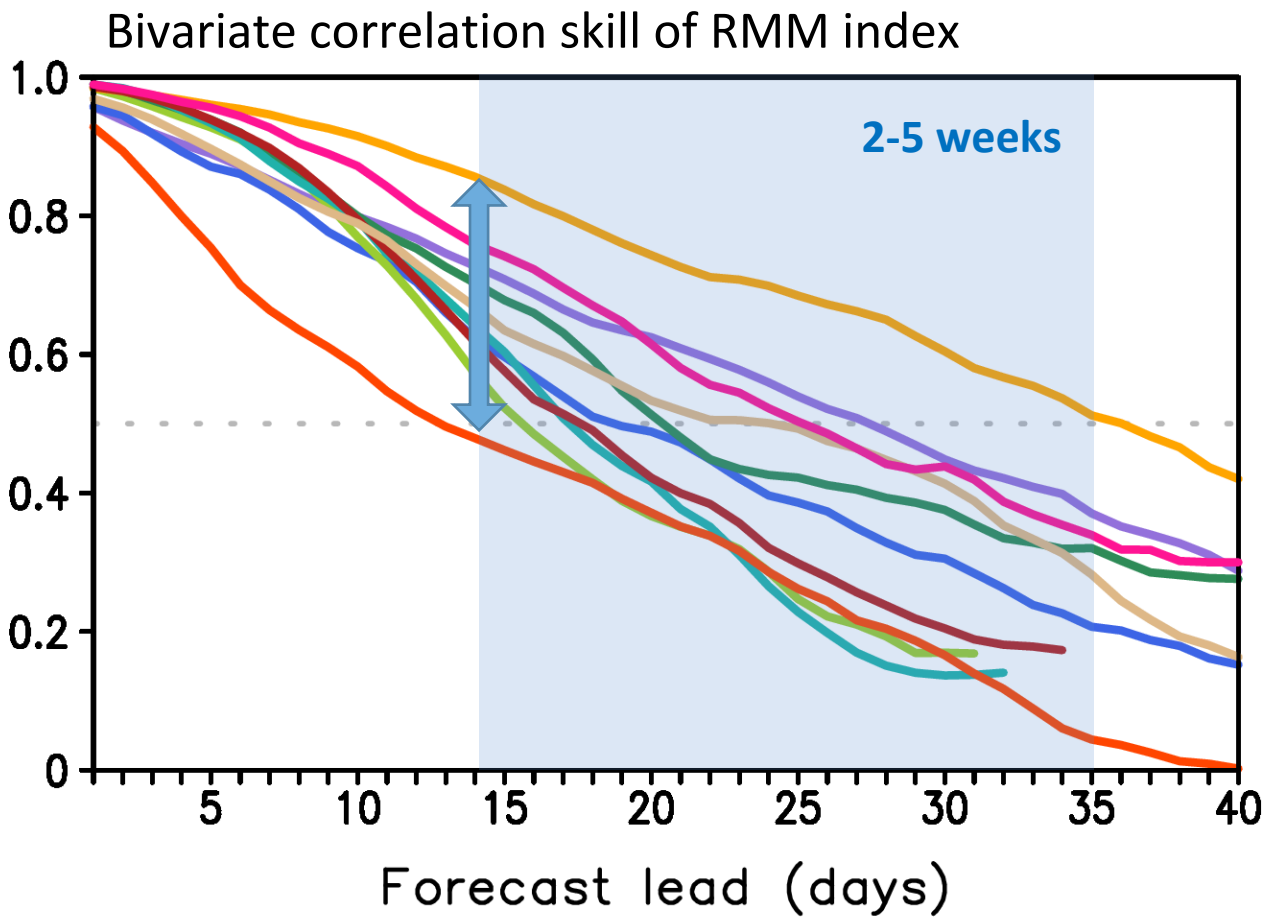
The dominant source of predictability in the intraseasonal timescale



TC: tropical cyclone
ENSO: El-Nino Southern oscillation
IOD: Indian ocean dipole
AO: Arctic oscillation
NAO: North Atlantic oscillation

MJO prediction skill in S2S models

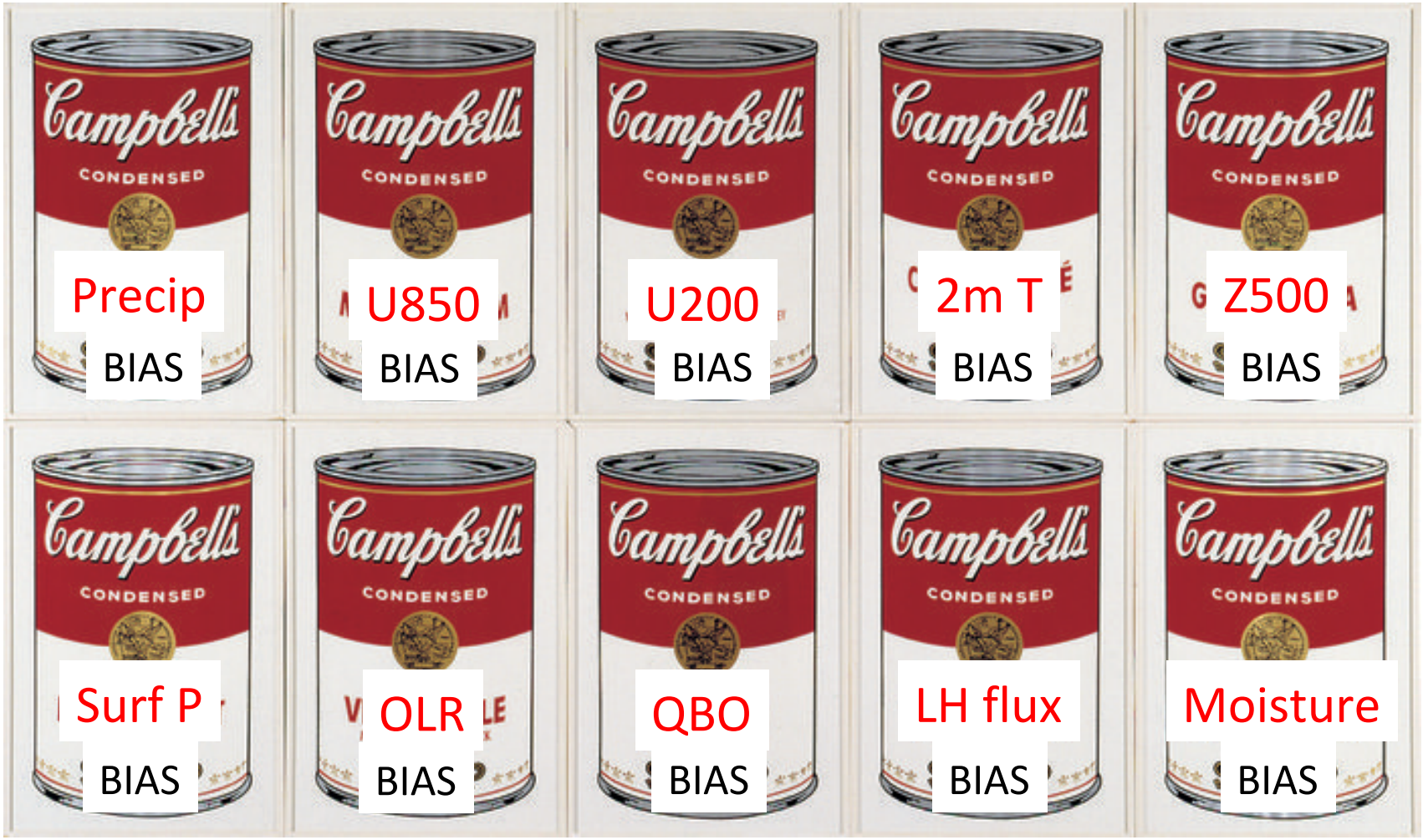
S2S models exhibit 2-5 weeks of prediction skill



What can we learn from the spread?

To what degree this spread is due to model bias?

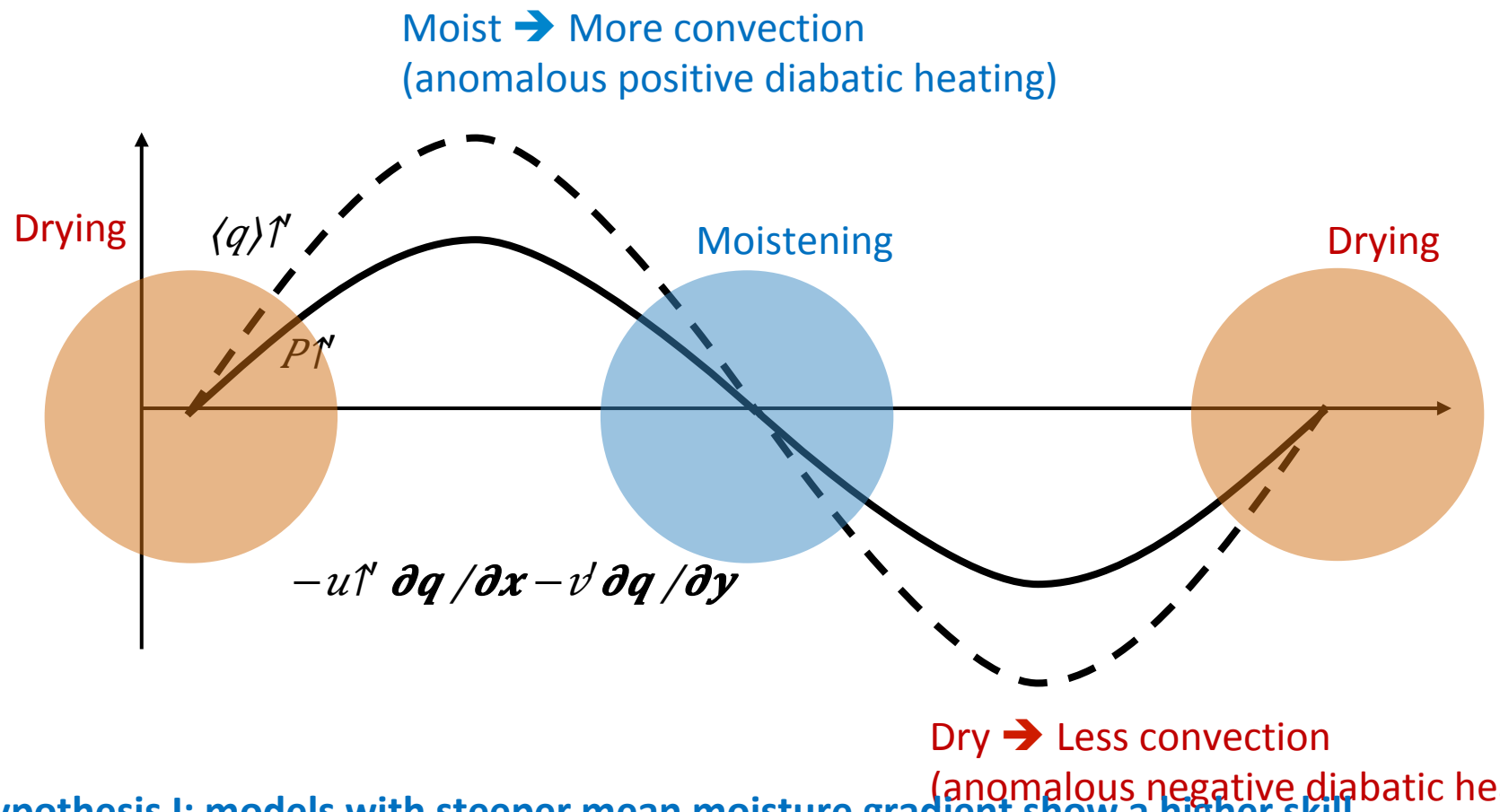
Model bias? Which one?



Andy Warhol

Madden-Julian oscillation as a Moisture Mode

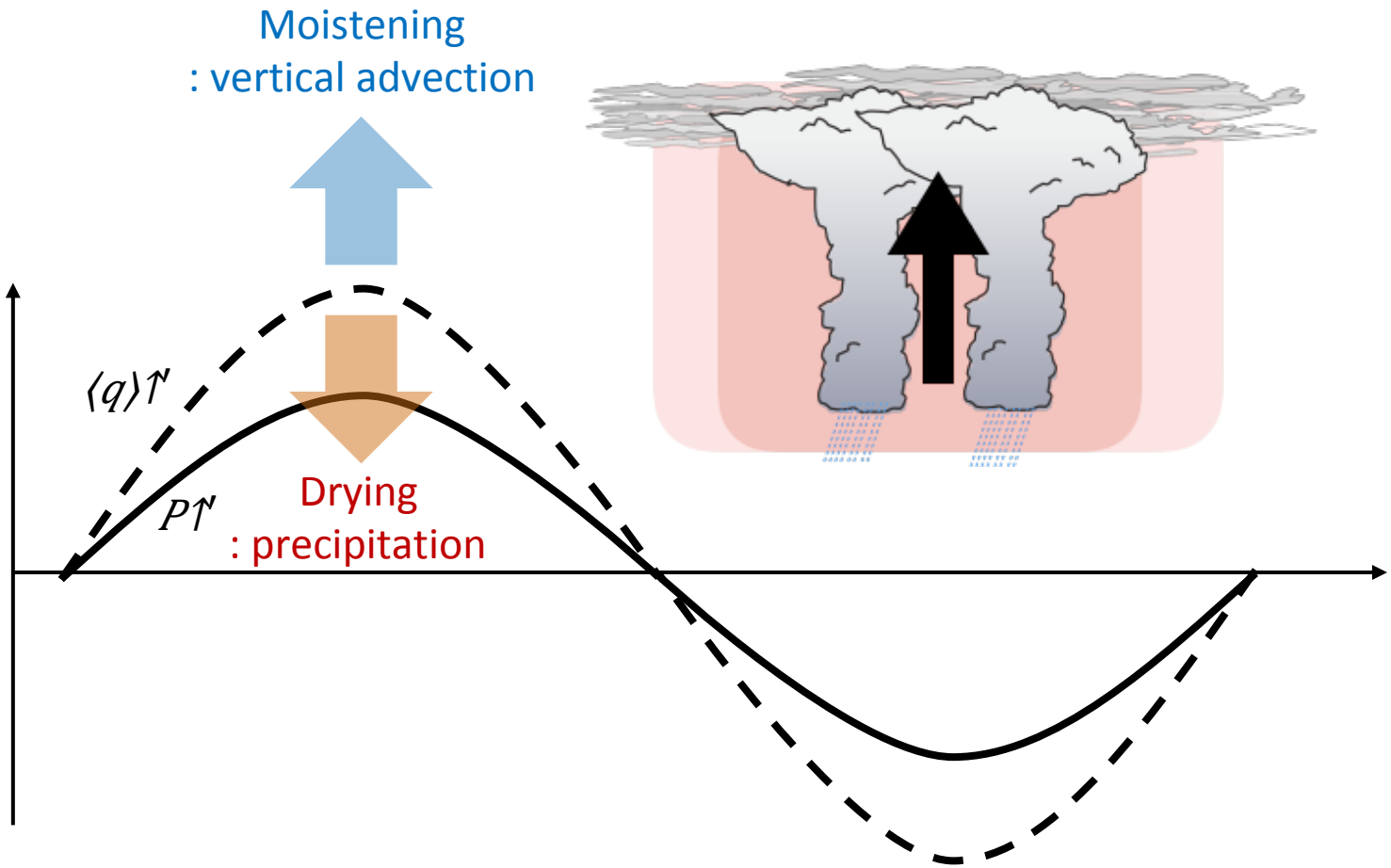
Advection of mean moisture by anomalous circulation explains eastward propagation of the moisture wave



Hypothesis I: models with steeper mean moisture gradient show a higher skill

Madden-Julian oscillation as a Moisture Mode

The longwave cloud-radiation feedbacks is key to the maintenance of the moisture wave



Hypothesis II: models with stronger longwave cloud-radiation feedback show a higher skill

Mean state bias – Column Water Vapor (CWV)

Dry bias near the MC ➔ weakens horizontal gradient

Observation (SSM/I-TMI, NDJFMA)

Mean state bias – Column Water Vapor (CWV)

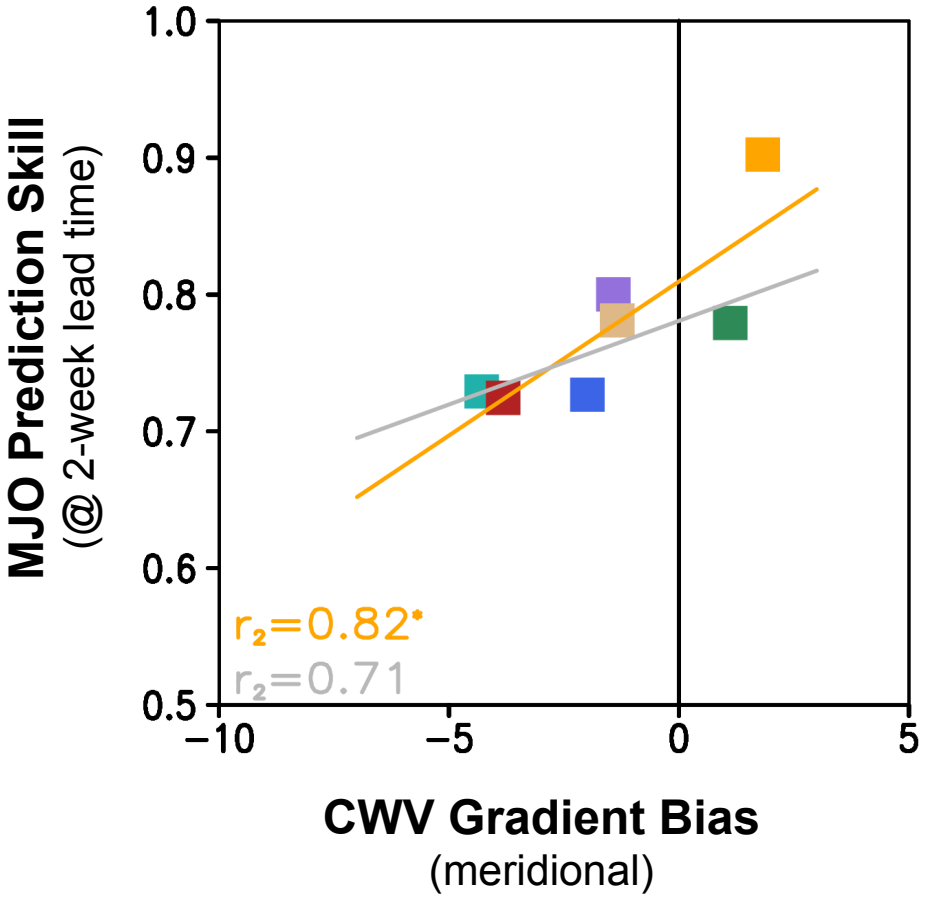
The dry bias is independent of the MJO

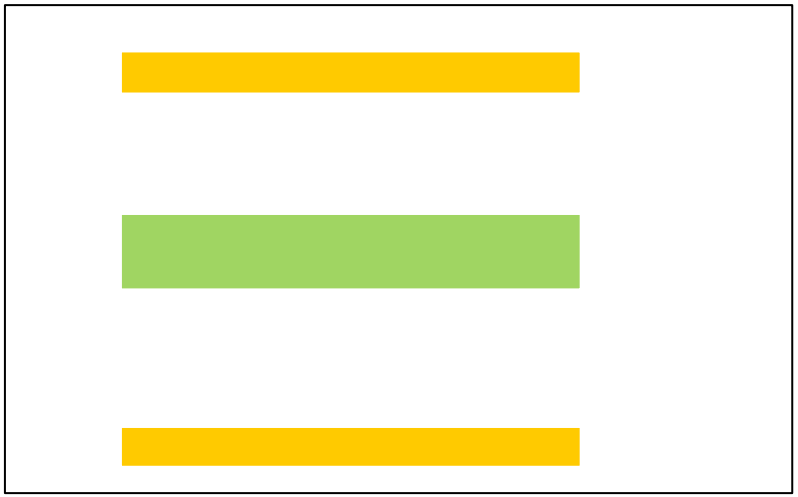
Model bias – all initial conditions (7 models)

Mean state bias vs. MJO prediction skill

Steeper mean CWV gradient → higher MJO skill

*Initial MJO phase 2-3





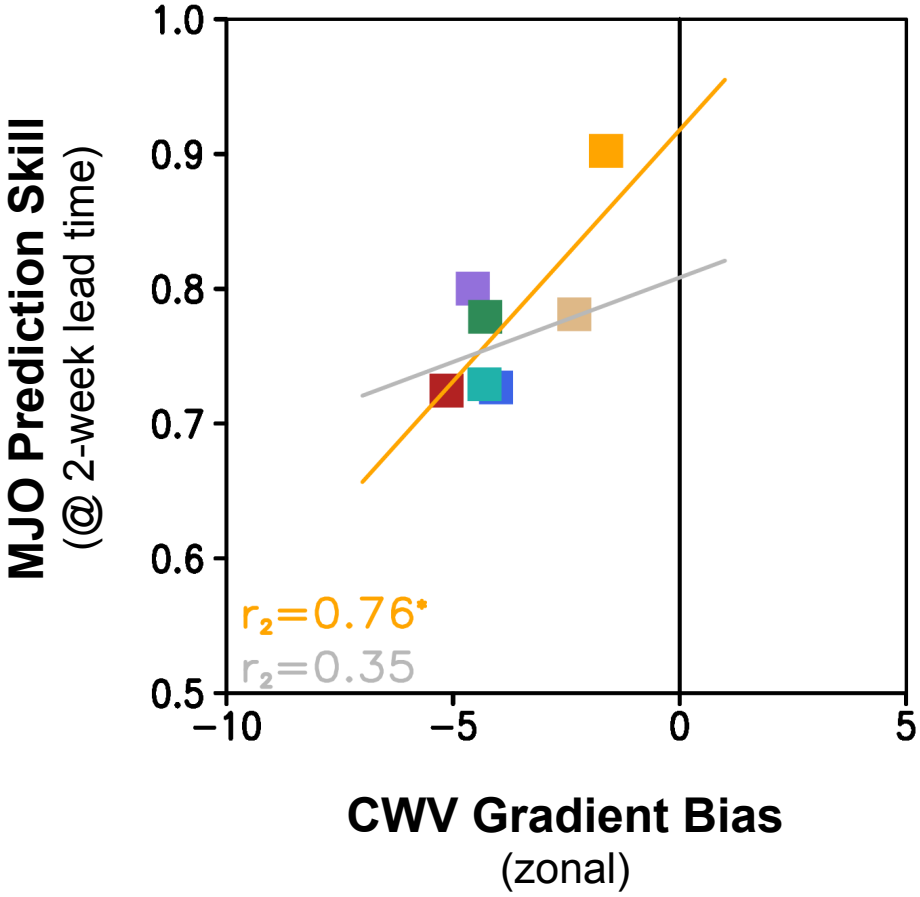
(Near Equator minus subtropics over IO
$=CWV_{(60\text{-}120E,\ 5S\text{-}5N)}-$
$\{CWV_{(60\text{-}120E,\ 15\text{-}20N)}+CWV_{(60\text{-}120E,\ 25\text{-}20S)}\}/2)$

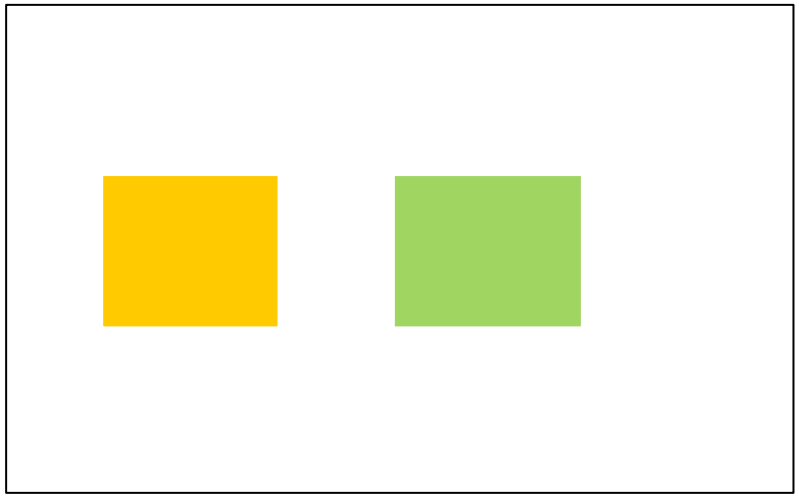
Hypothesis I: models with steeper mean moisture gradient show a higher skill

Mean state bias vs. MJO prediction skill

Steeper mean CWV gradient (less bias) → higher MJO skill

*Initial MJO phase 2-3





(Eastern IO minus Western IO
$=CWV_{(100\text{-}120E,\ 10S\text{-}10N)}\text{-}CWV_{(60\text{-}80E,\ 10S\text{-}10N)}$)

Hypothesis I: models with steeper mean moisture gradient show a higher skill

Longwave cloud-radiation feedback

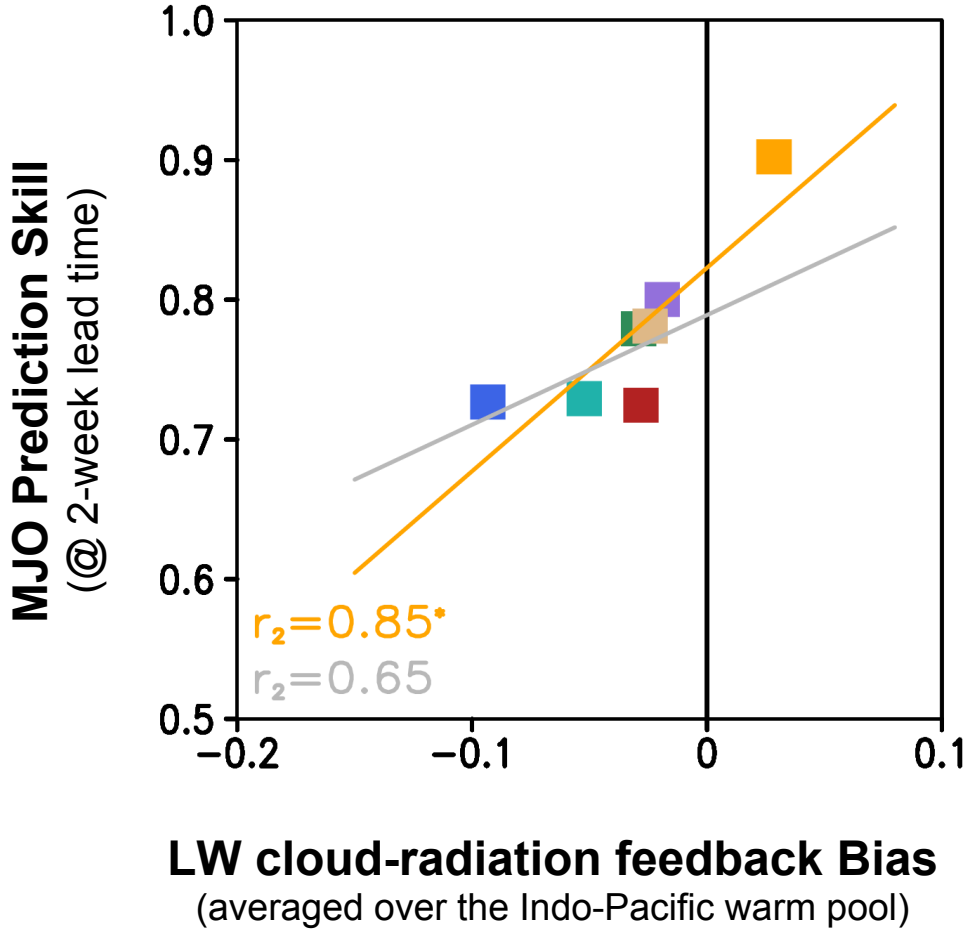
S2S Models tend to underestimate the feedback

Observation (TRMM precip/AVHRR OLR)

$$OLR' = -rP'$$

LW cloud-radiation feedback vs. MJO prediction skill

Stronger feedback ➔ higher MJO prediction skill



Hypothesis II: models with stronger longwave cloud-radiation feedback show a higher skill

Summary

- We examined the relationship between model bias and MJO prediction skill among the S2S models. Two specific biases – those in the mean column water vapor and longwave cloud-radiation feedbacks – are chosen based on the moisture mode theory for the MJO and data availability.

- The results show that the S2S models tend to underestimate horizontal gradient of the mean CWV due to the common dry bias around the Maritime Continent region. The models also underestimate the longwave cloud-radiation feedbacks.

- Models with weaker biases in the mean column water vapor and longwave cloud-radiation feedbacks tend to show a higher MJO prediction skill. Our results might suggest that MJO prediction skill can be enhanced by reducing the model biases.

Lim, Y., S.-W. Son, and D. Kim, 2018: MJO Prediction Skill of the Subseasonal-to-Seasonal Prediction Models. *J. Clim.*, **31**, 4075–4094.

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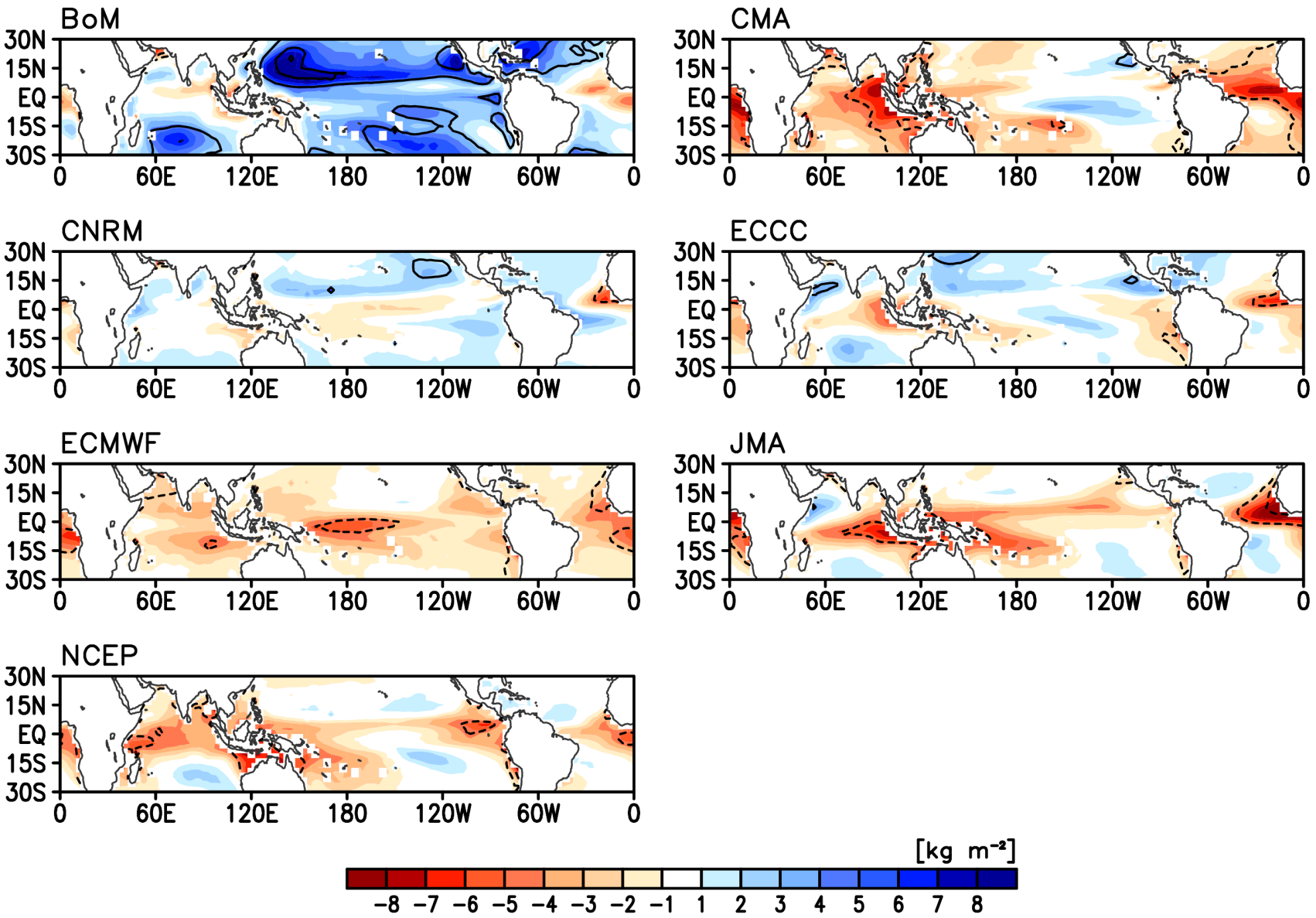
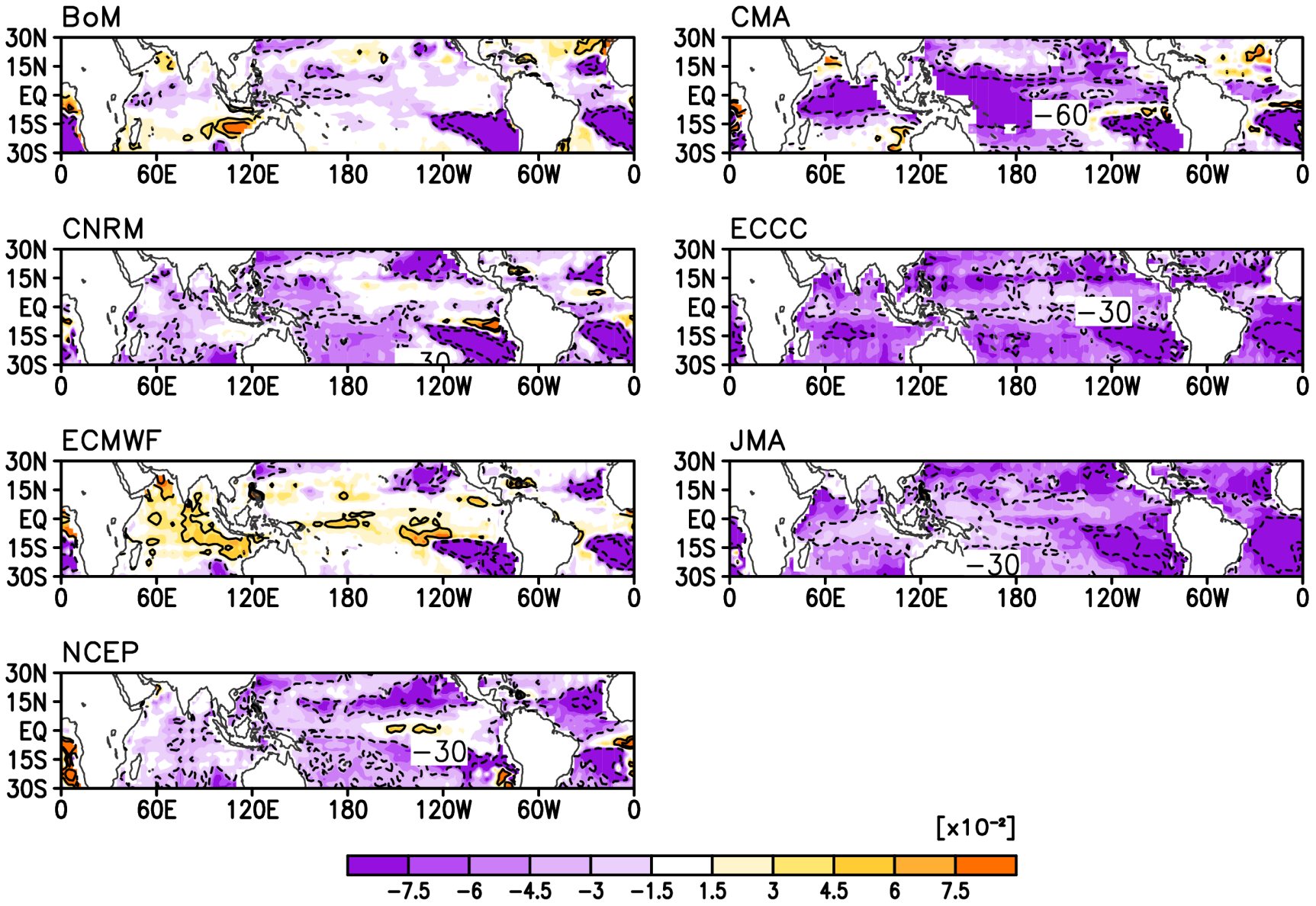
Korea Meteorological Administration

CWV mean bias – individual models



LW CLF bias – individual models



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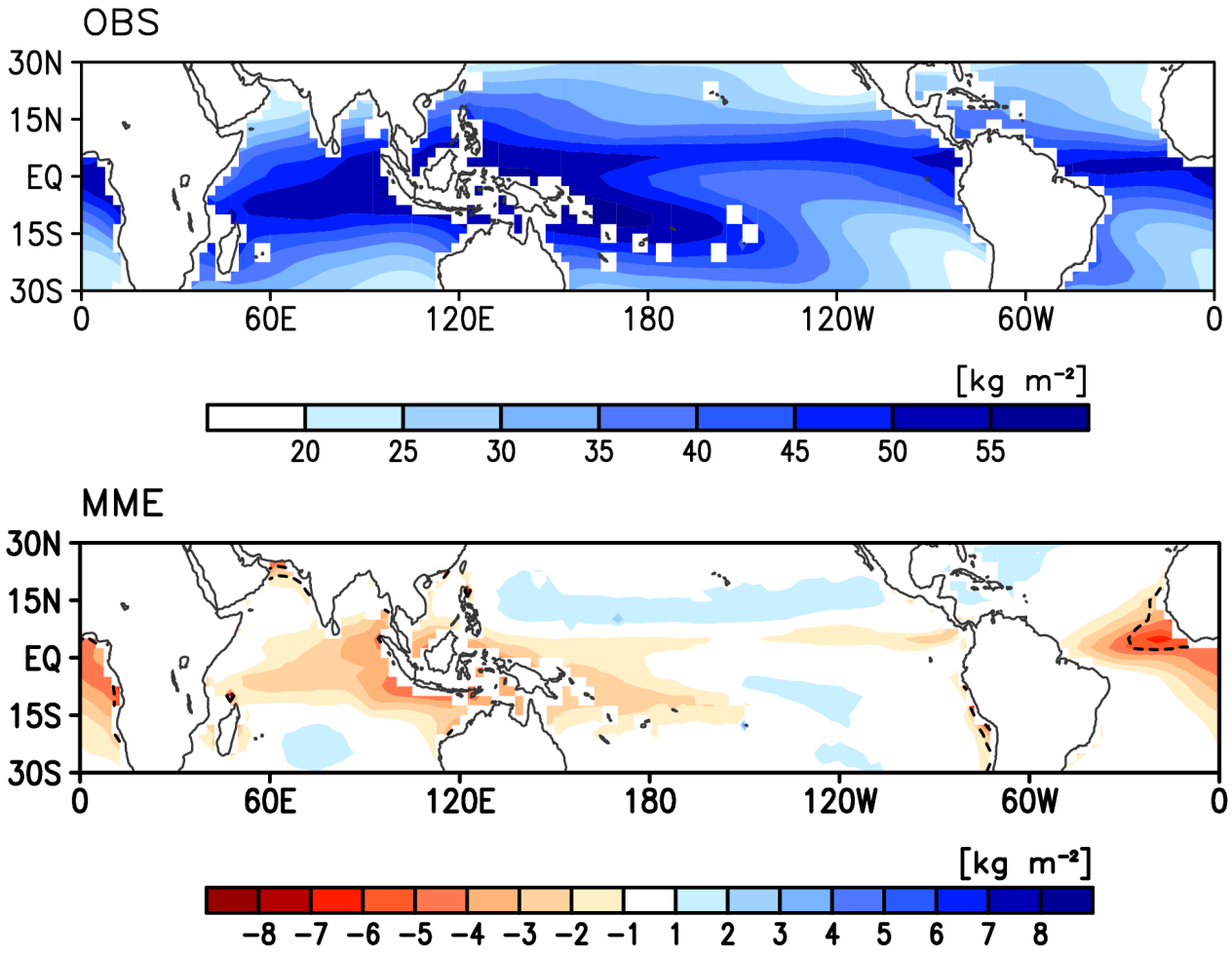
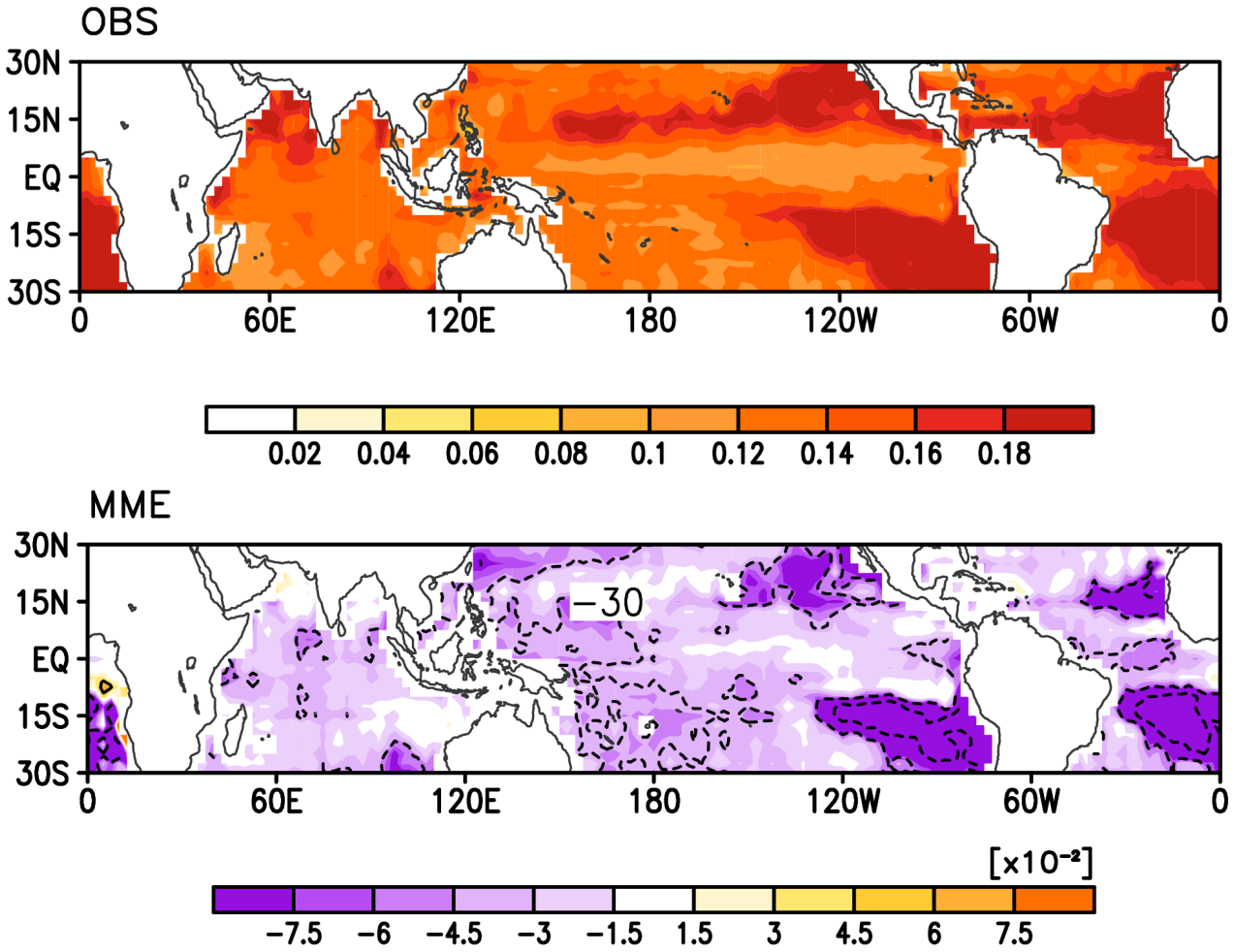


Hypothesis I: models with steeper mean moisture gradient show a higher skill

Longwave cloud-radiation feedback

Models tend to underestimate the feedback



Hypothesis II: models with stronger longwave cloud-radiation feedback show a higher skill

Longwave cloud-radiation feedback

S2S Models tend to underestimate the feedback

Observation (SSM/I-TMI)

Model mean – all initial conditions

Hypothesis II: models with stronger longwave cloud-radiation feedback show a higher skill