Scale interaction between the Madden-Julian Oscillation and the diurnal cycle of precipitation over the Maritime Continent

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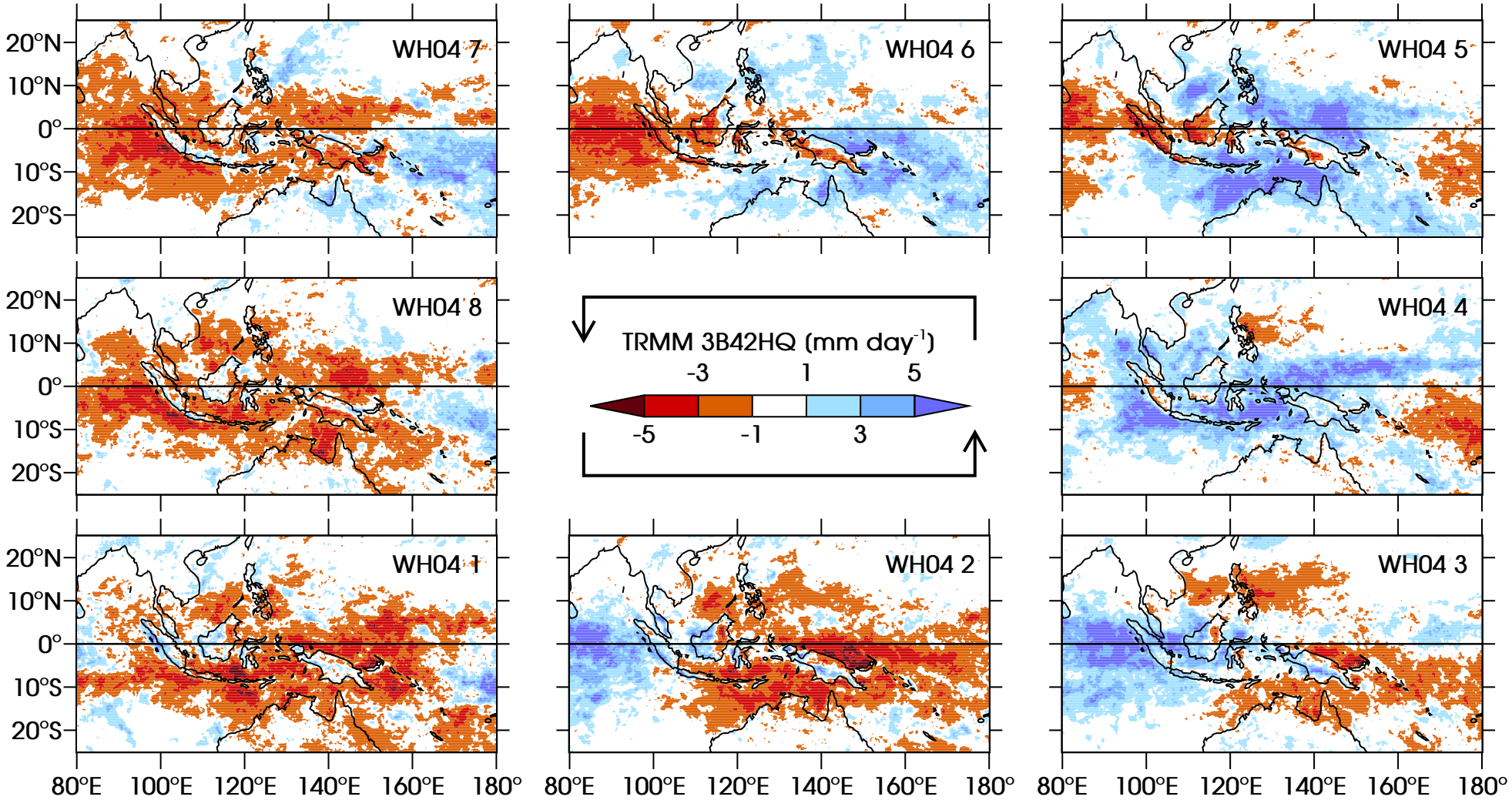
Peatman SC, Matthews AJ, Stevens DP. 2013. Propagation of the Madden-Julian Oscillation through the Maritime Continent and scale interaction with the diurnal cycle of precipitation. *Q. J. R. Meteorol. Soc.* **139**. DOI: 10.1002/qj.2161

NATURAL ENVIRONMENT RESEARCH COUNCIL

MJO anomaly of daily mean precipitation

Typical cycle:
~50 days



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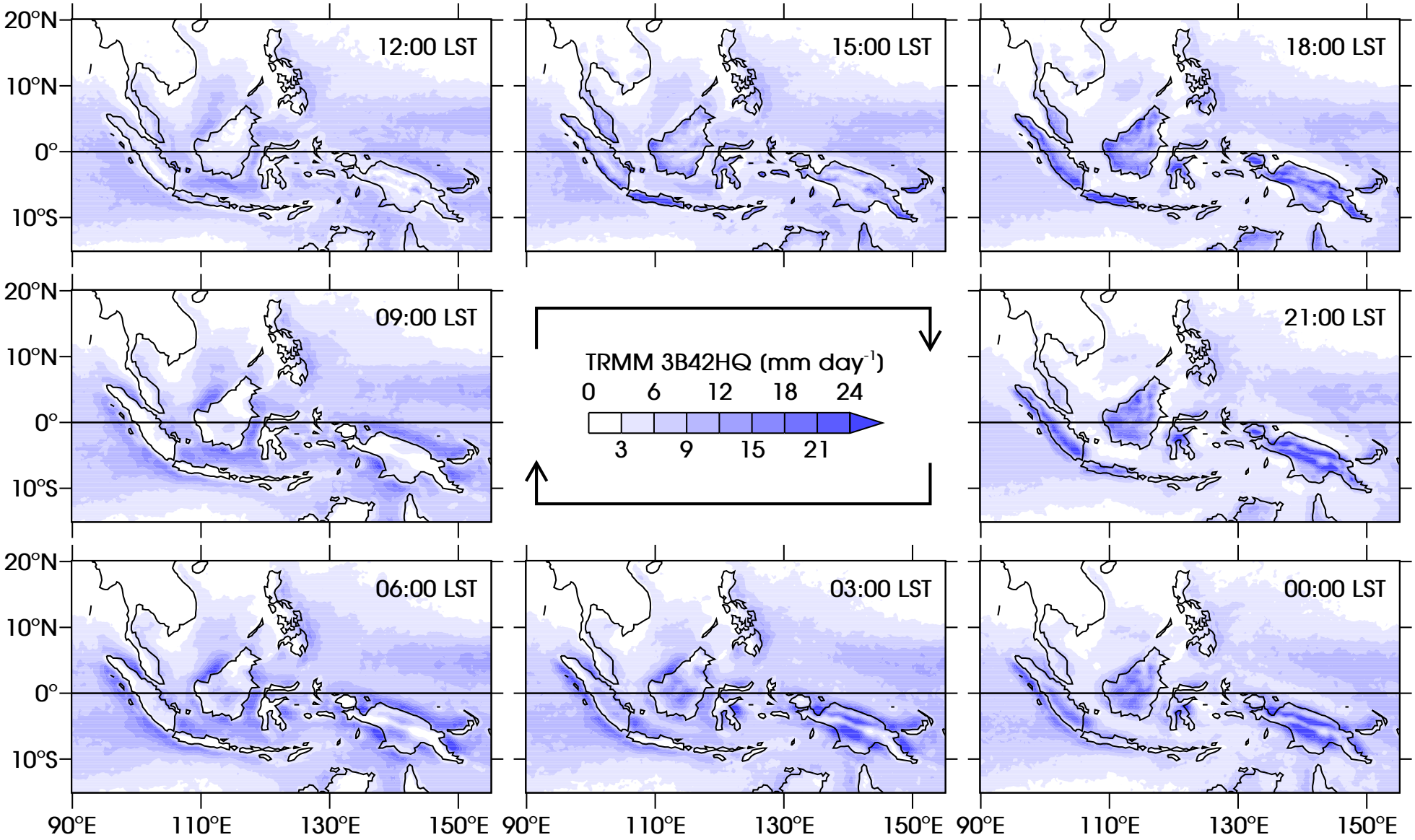
Diurnal cycle of precipitation over the Maritime Continent



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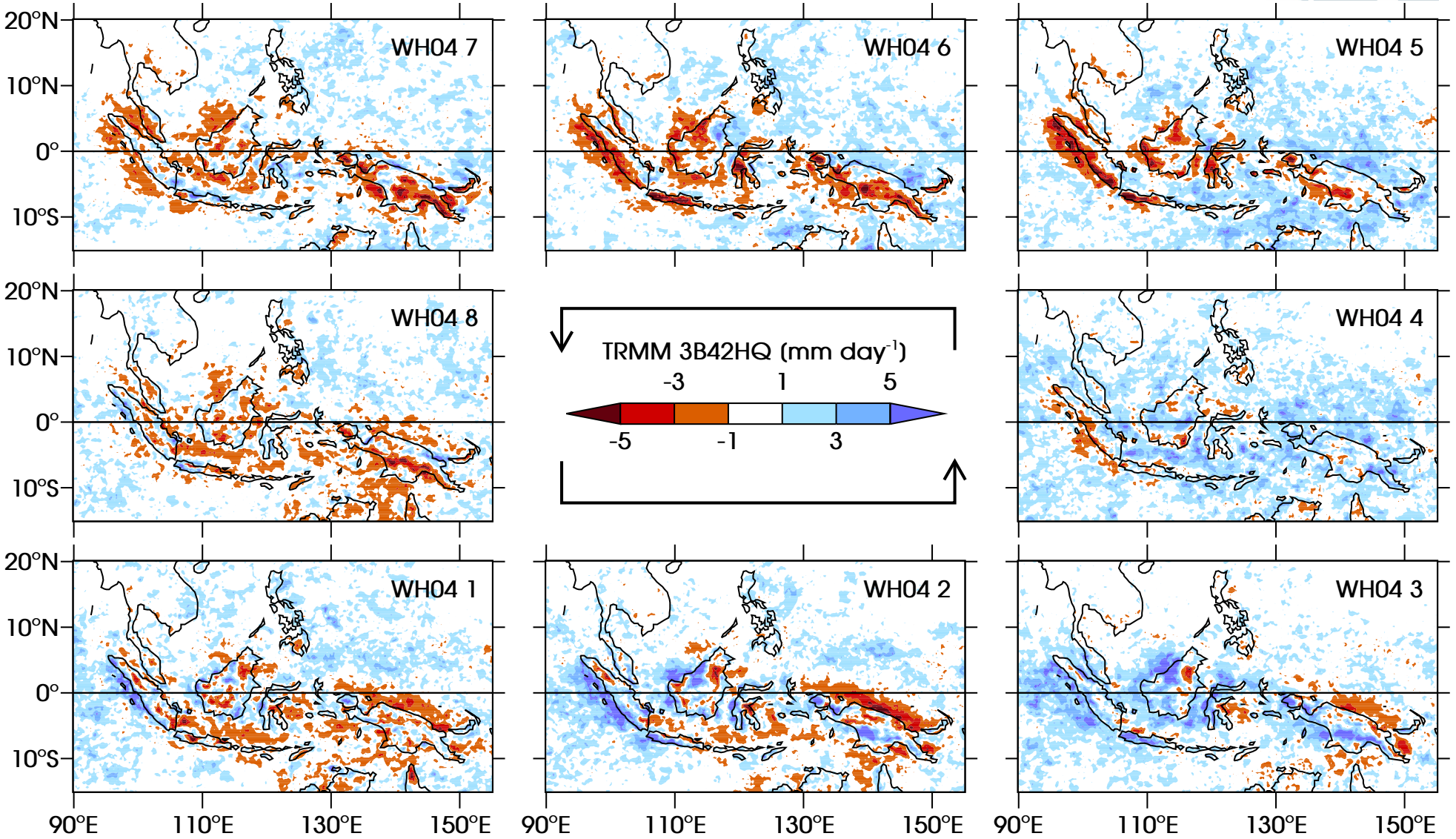
MJO anomaly of the amplitude of the diurnal cycle

Typical cycle:
~50 days



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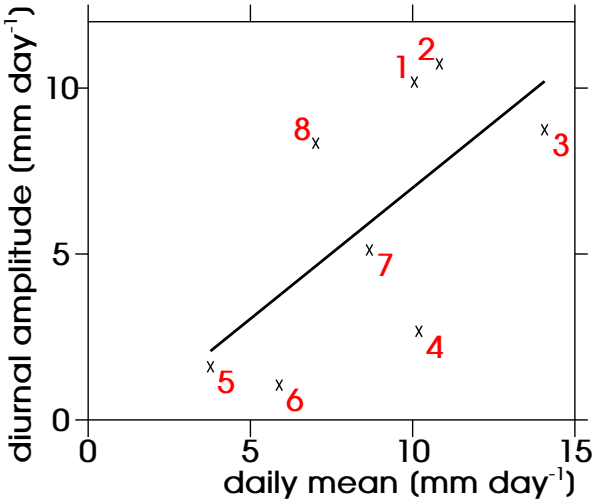
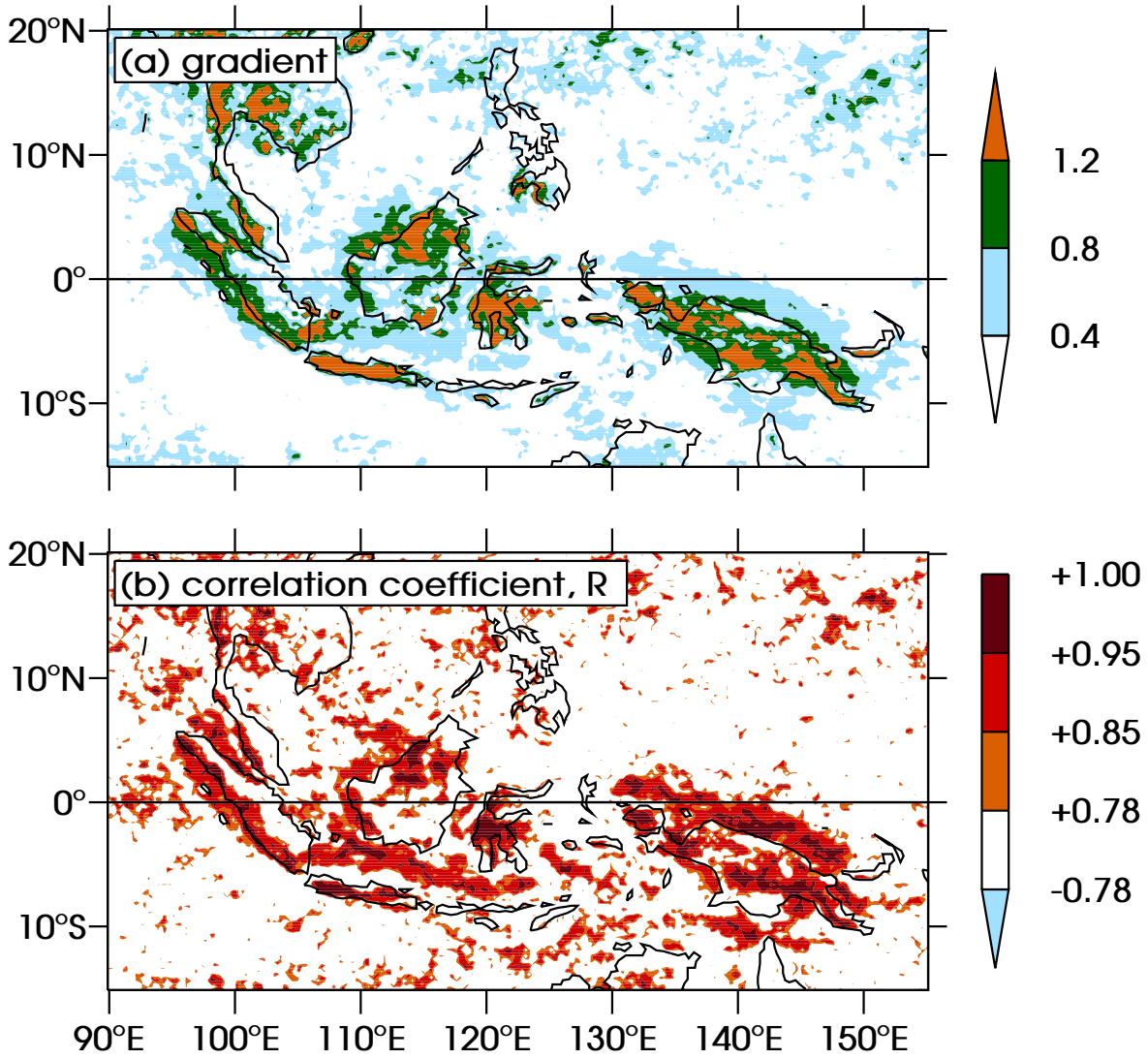
Correlation between daily mean precip and diurnal amplitude



- Above: scatterplot for grid point 0.125°N, 103.125°E (Sumatra)
  gradient = 0.79
  correlation coefficient = 0.64

- Right: gradient and correlation coefficient computed from linear regression for all grid points
- Correlation is significant (95% confidence) for $|R| > 0.78$



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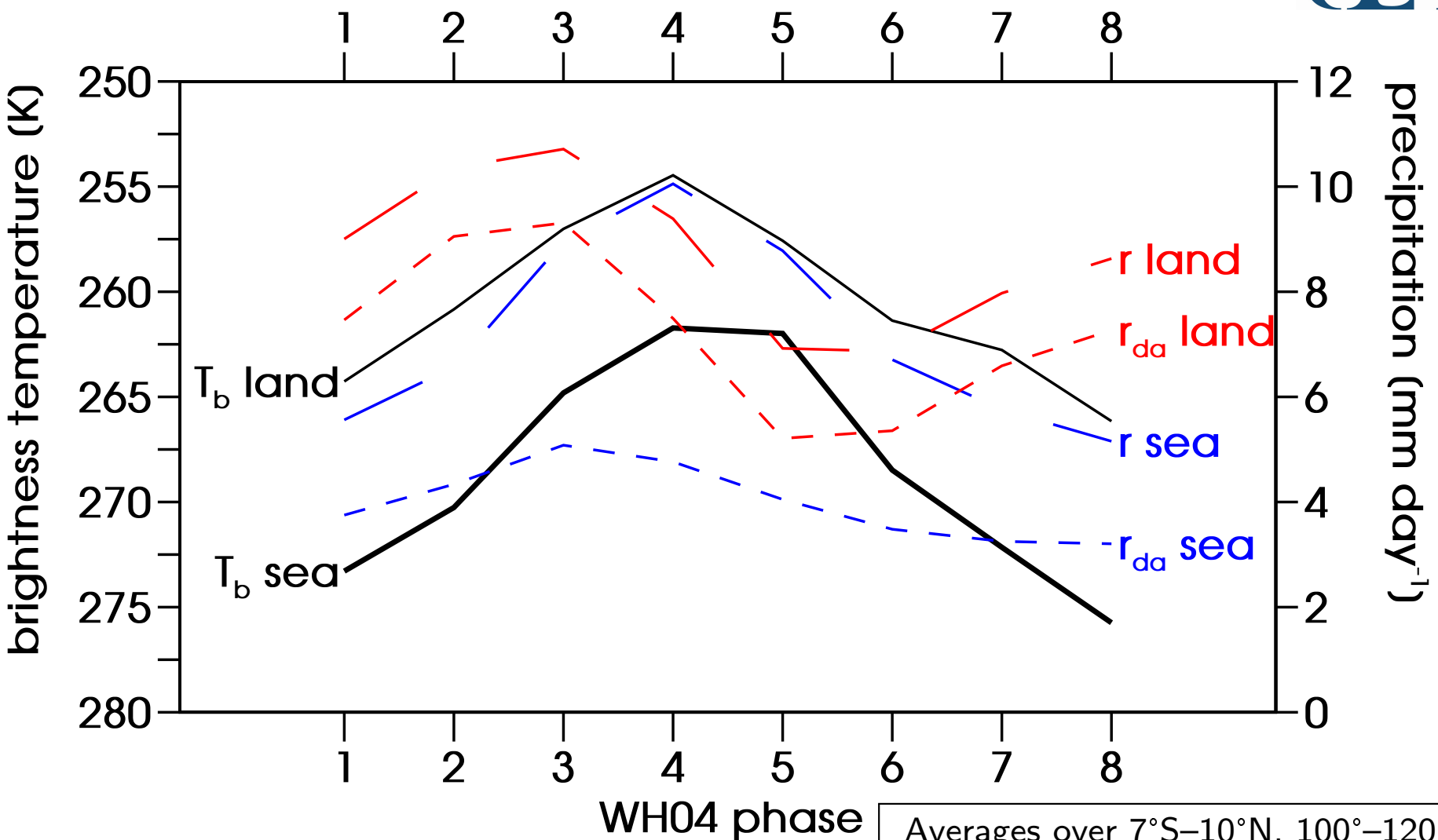
Lag between brightness temperature and precip over land/sea



Averages over 7°S–10°N, 100°–120°E
(Borneo and most of Sumatra)

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Conclusions

- Wet and dry anomalies of daily mean precipitation "leap ahead" of the main envelope of the MJO over the Maritime Continent islands, creating "gaps" in the large-scale spatial structure.
- This is attributed to a triggering of the diurnal cycle ahead (to the east) of the advancing MJO envelope.
- Over ocean the diurnal cycle is not strong enough to affect the daily mean signal, but over land it is strong enough to be the dominant contributor to the daily mean precipitation anomaly.
- Thus there is a two-way scale interaction: the large-scale MJO triggers the smaller-scale diurnal cycle, which rectifies back onto the MJO, altering its spatial structure over the islands.
- Therefore, for accurate simulation of the MJO and forecasting of precipitation over the heavily populated Maritime Continent region, this scale interaction needs to be modelled correctly.

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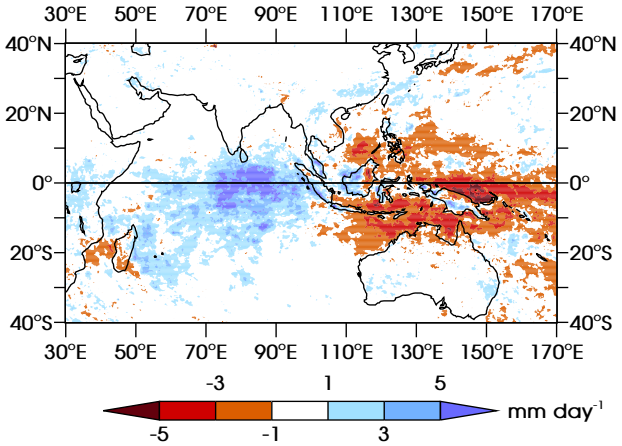
Consistency with Matthews (2000) MJO propagation mechanism



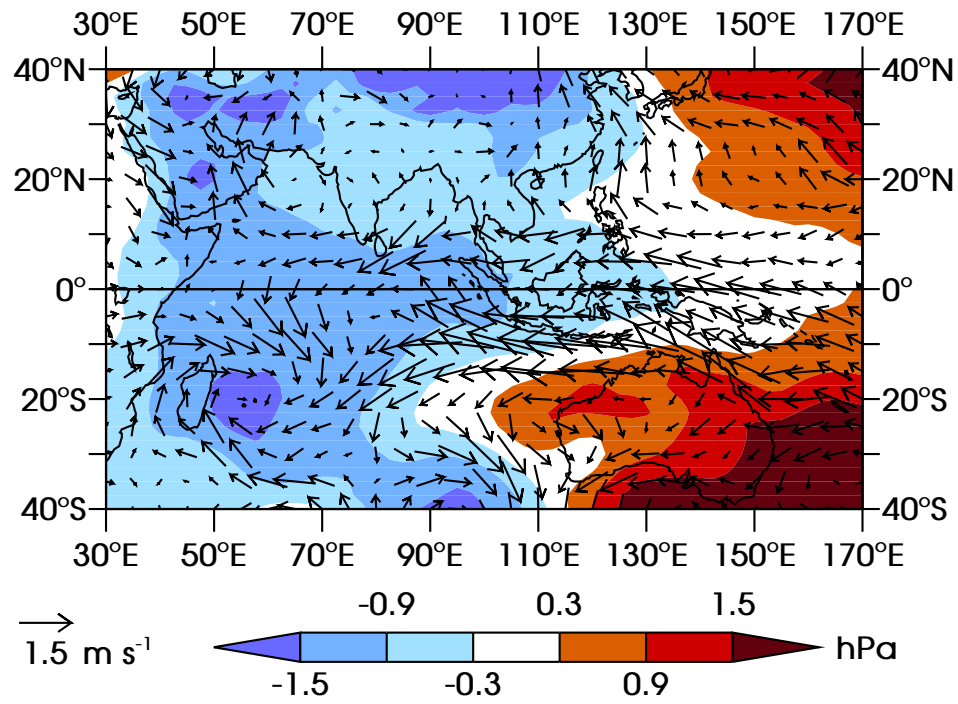
Anomalies for WH04 phase 2

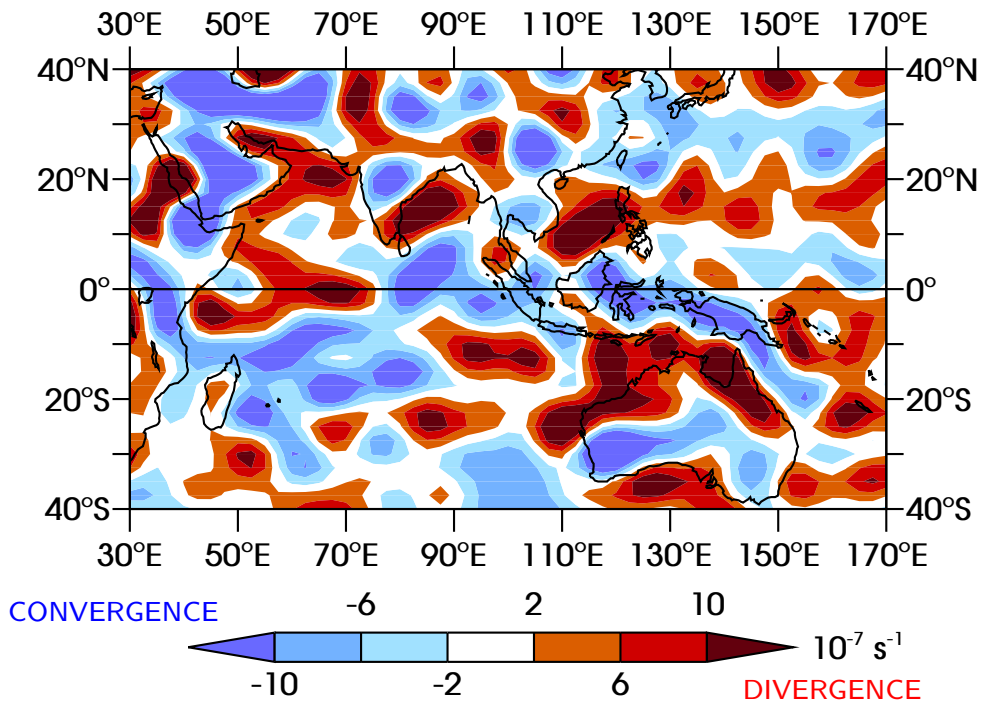
Left: daily mean precipitation (TRMM 3B42HQ)

Bottom left: mean sea level pressure and 1000hPa wind field (NCEP/DOE)

Bottom right: 1000hPa divergence

- The wind field associated with the active MJO envelope enhances convection to the east through divergence of moist air
- Over the Maritime Continent, this enhanced divergence sustains the land-based diurnal cycle, causing a strong diurnal cycle ahead of the main envelope





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