Linking extreme precipitation in Southeast Asia and equatorial waves

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Equatorial Waves

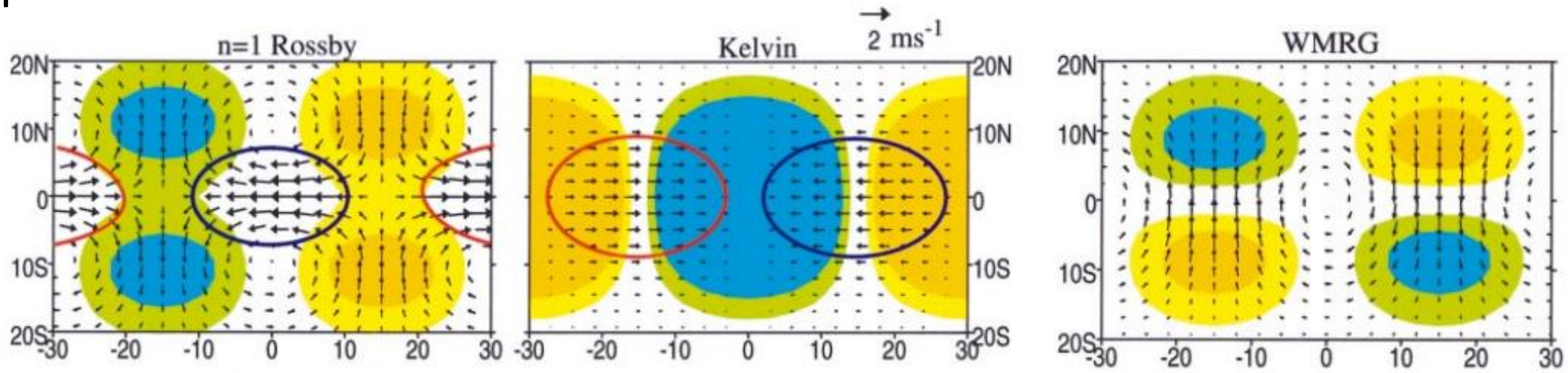
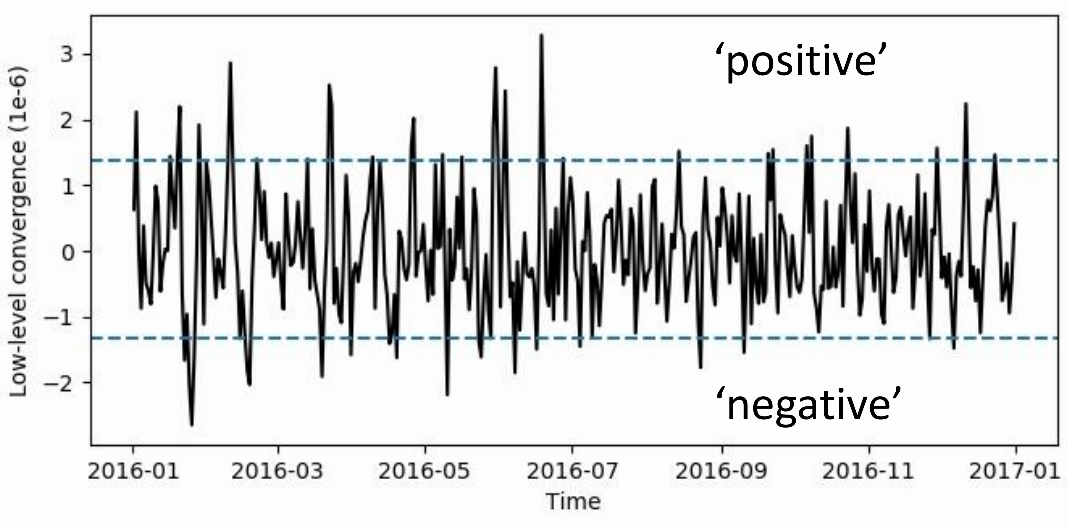


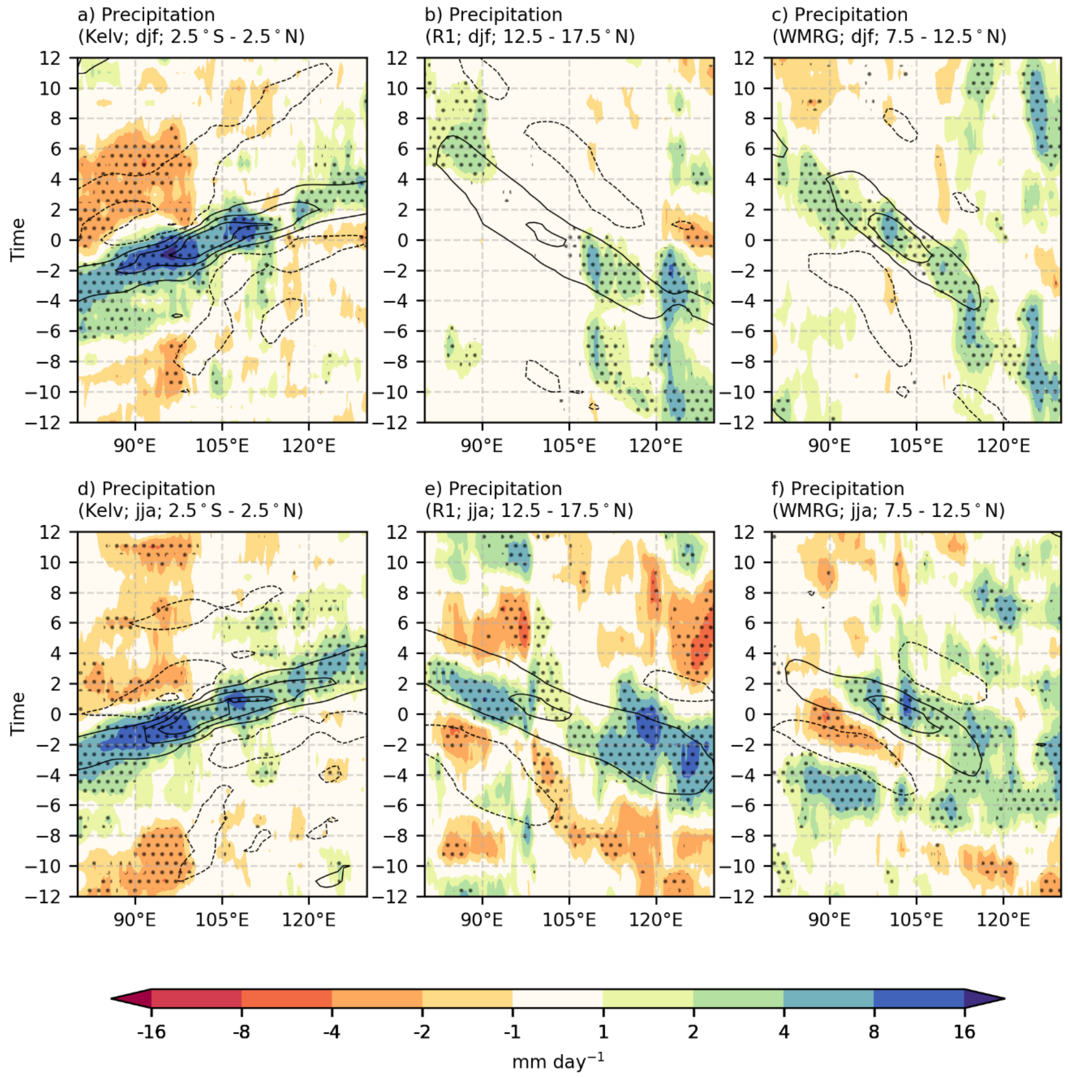
Figure from Yang et al. (2003)

Kelvin wave (110E-115E,0)



- Wave datasets, ERA-Interim and TRMM precipitation (1997-2016) are used to examine statistical relationship between high amplitude waves and mean and extreme precipitation in SE Asia
- Wave activity is found by averaging low-level convergence/divergence (or vorticity for R1) over longitude ranges in the region and a single latitude, depending on wave structure.
- 'high amplitude' >95th percentile/<5th percentile

Wave activity over SE Asia

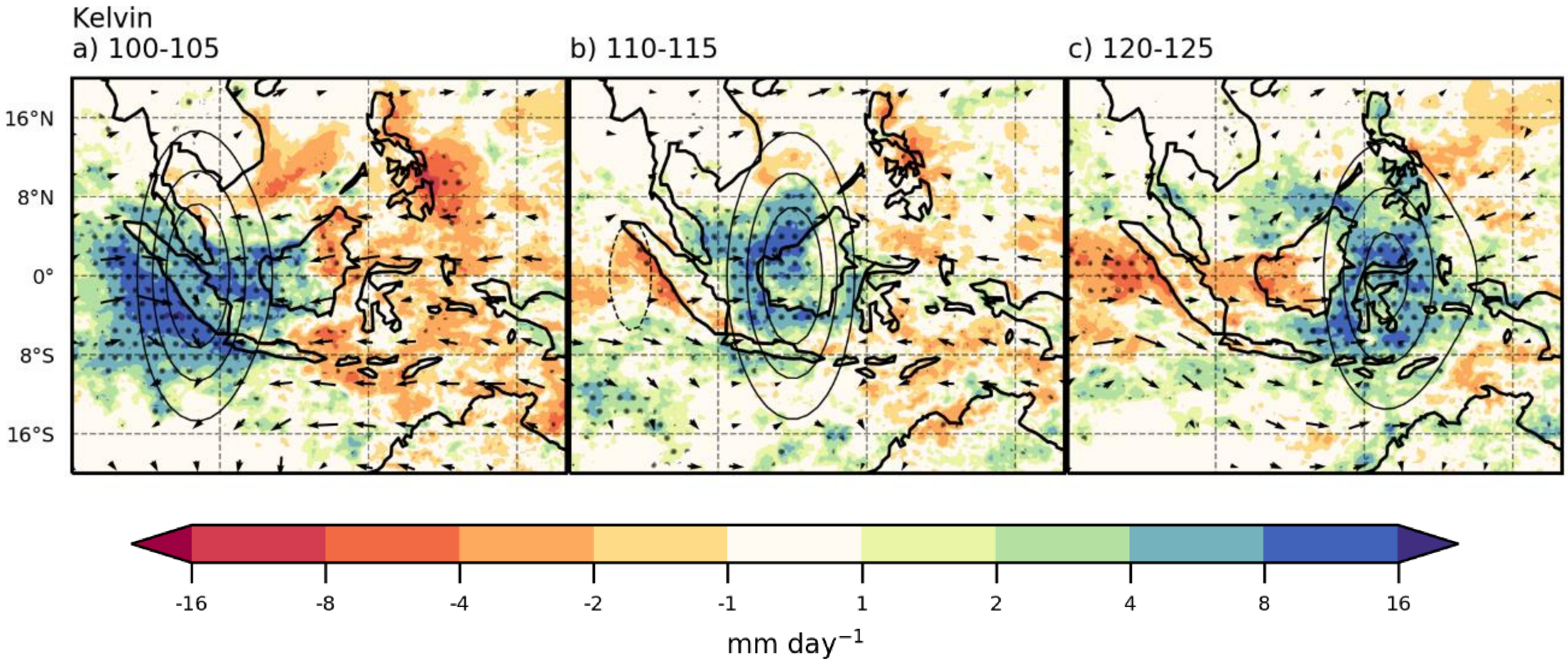


Hovmollers of composite precipitation anomaly (TRMM) and wave convergence (wave datasets) prior and following a high amplitude wave over longitude 100E-105E

- Increased mean precipitation coincident with wave convergence/positive vorticity
- Changes in precipitation associated with R1 waves much stronger in JJA

Ferrett et al. (submitted)
Linking Extreme Precipitation in Southeast Asia to Equatorial Waves.

Mean precipitation changes: Kelvin



Ferrett et al. (submitted)
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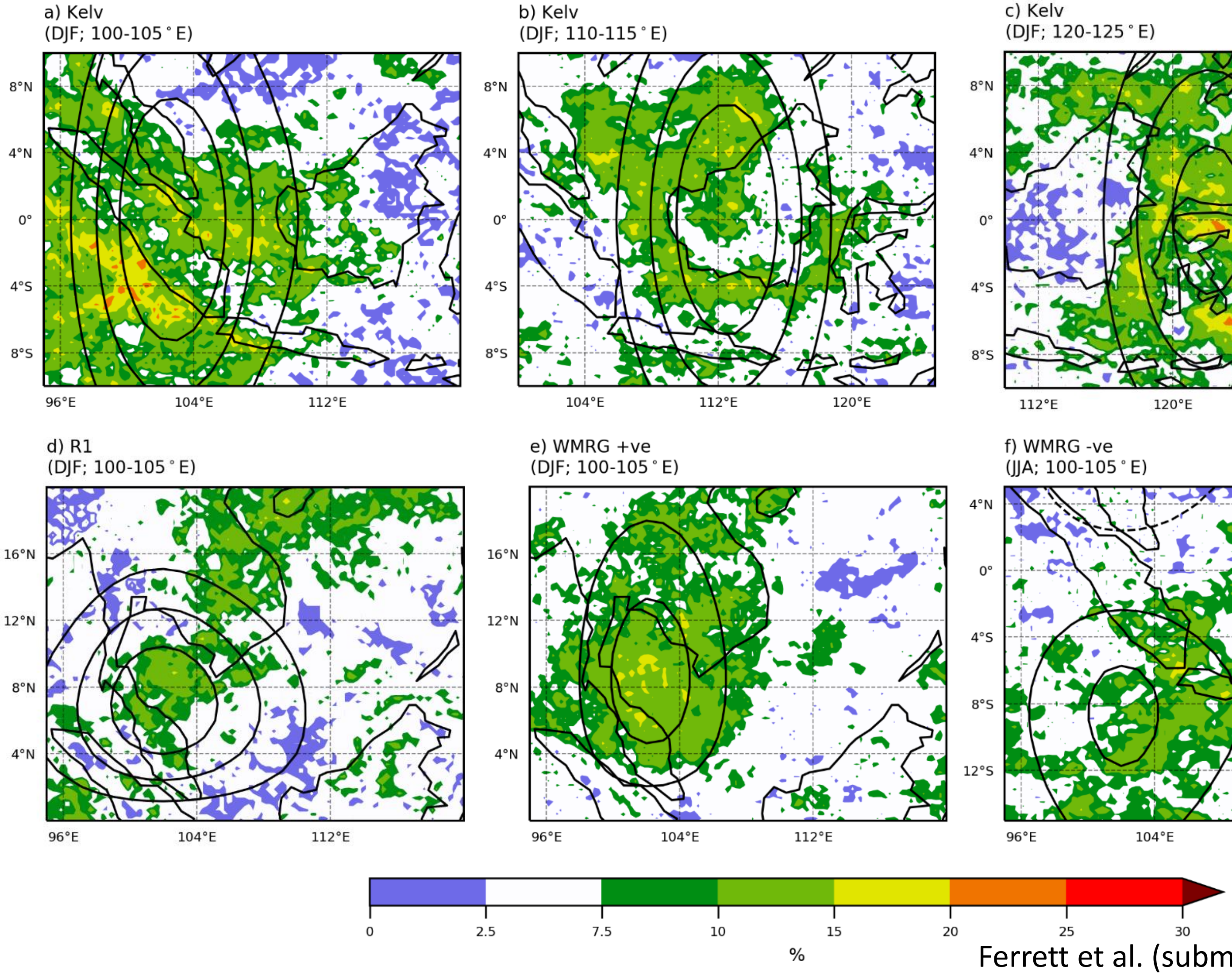
Extreme precipitation likelihood



- Examine likelihood of rainfall exceeding extreme rainfall threshold (95th percentile of 1998-2016 rainfall)
- 5% indicates no change from climatology
- Waves can be linked to increases in likelihood of extreme rainfall by 2-3 times

Ferrett et al. (submitted)
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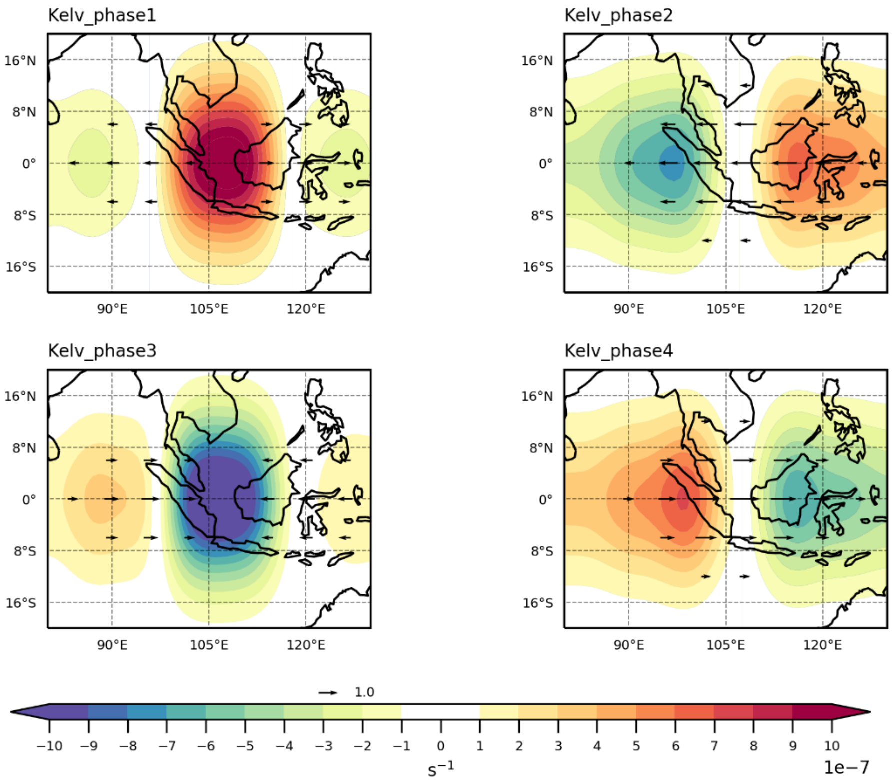
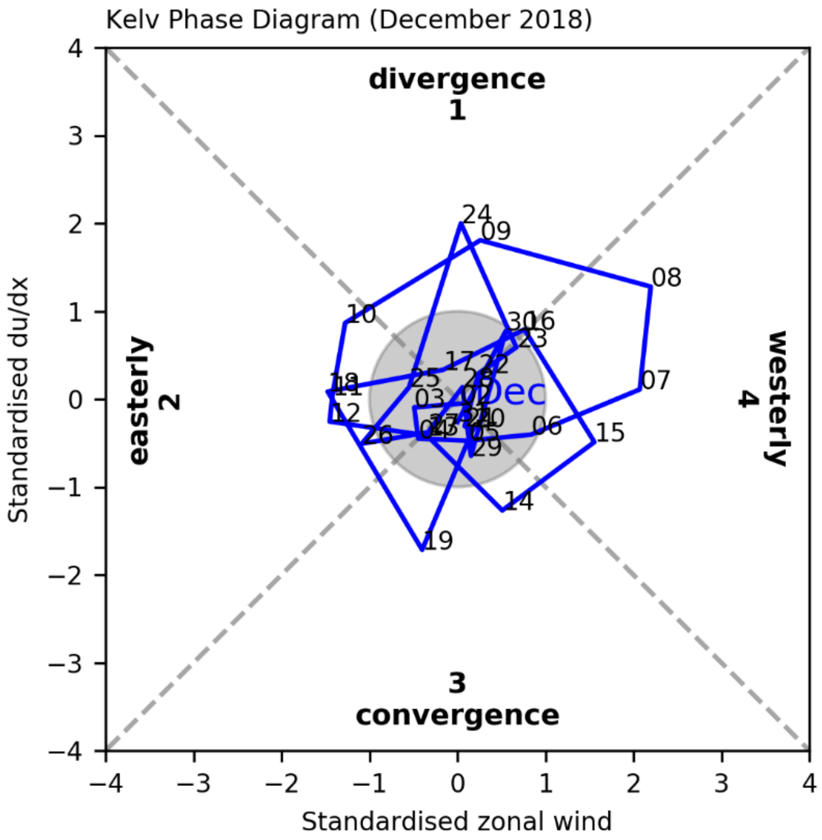
Wave phases: Kelvin

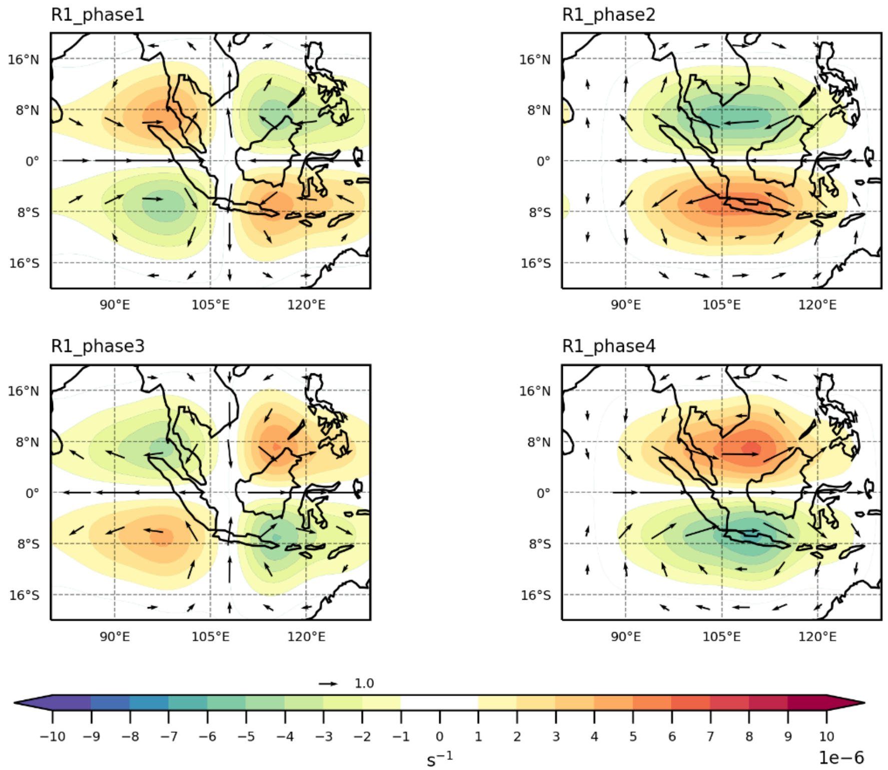


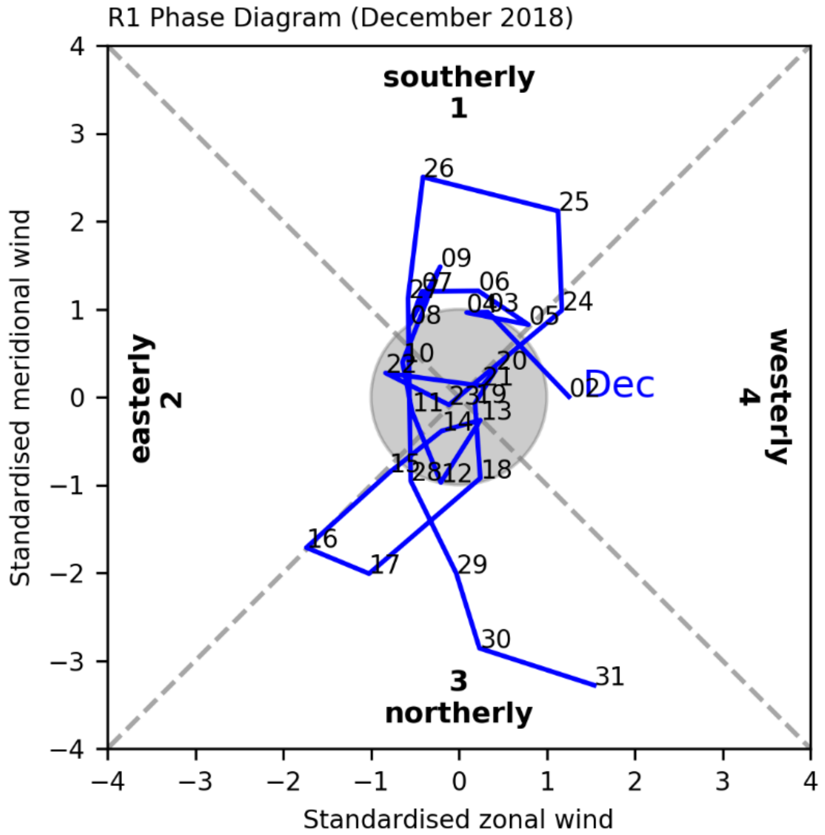
Kelvin wave phases (by divergence & zonal wind), filled contours show 850 hPa divergence



- For more detailed statistical analysis we expand on divergence metric by creating localised wave phases based on standardised convergence and zonal wind
- As waves propagate eastward moves through phases
- Distance from origin indicates amplitude of wave

Wave phases: R1

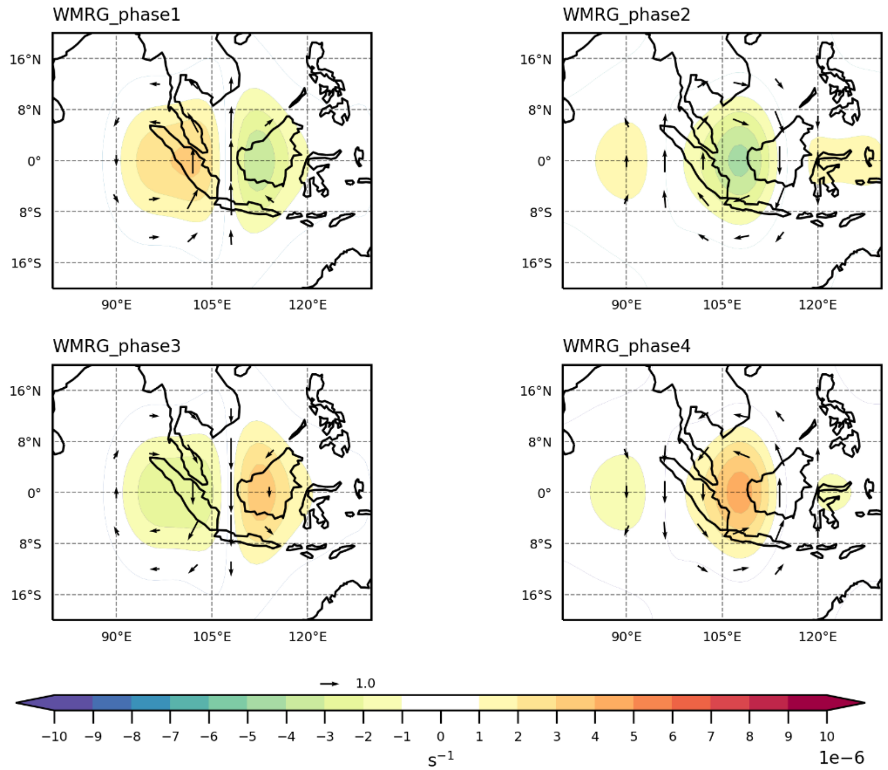


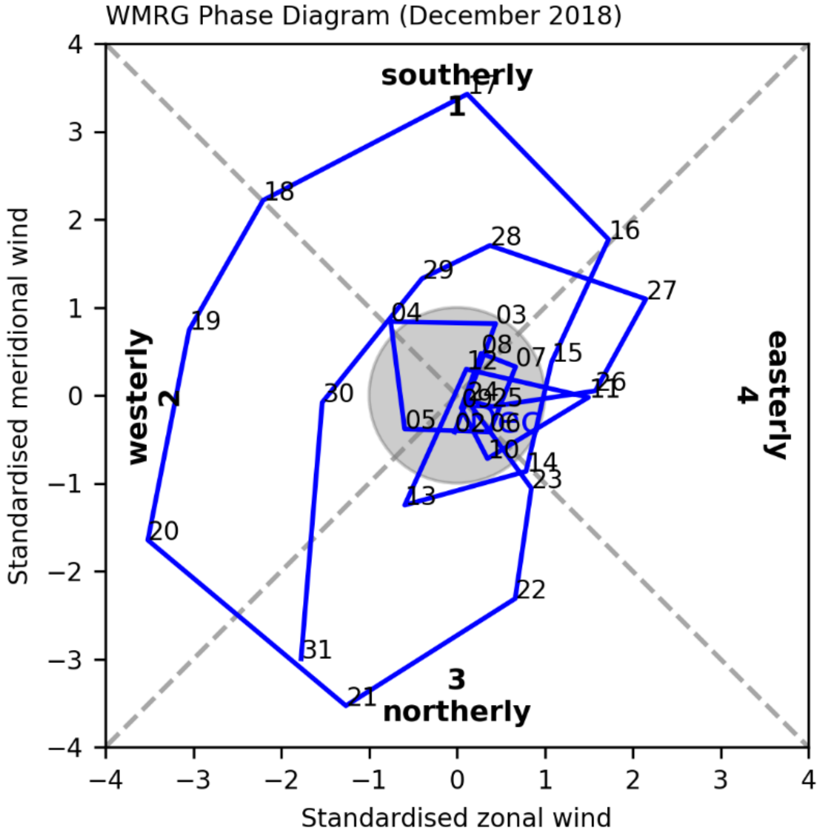


- For R1 and WMRG waves use zonal and meridional winds
- As waves propogate westward moves through phases

N=1 Rossby wave phases (by equ. zonal & NH meridional wind), filled contours show 850 hPa vorticity

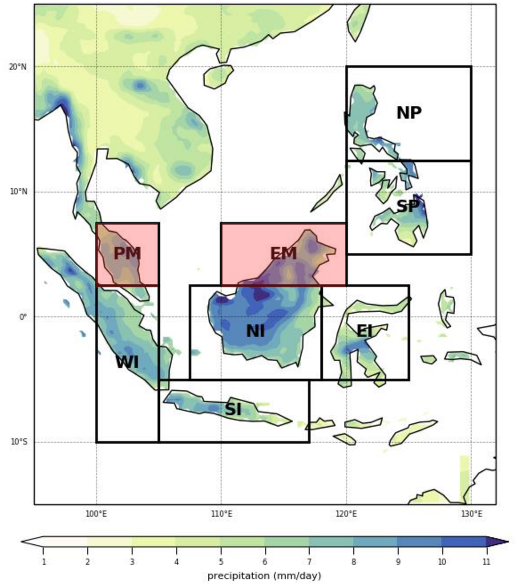
Wave phases: WMRG

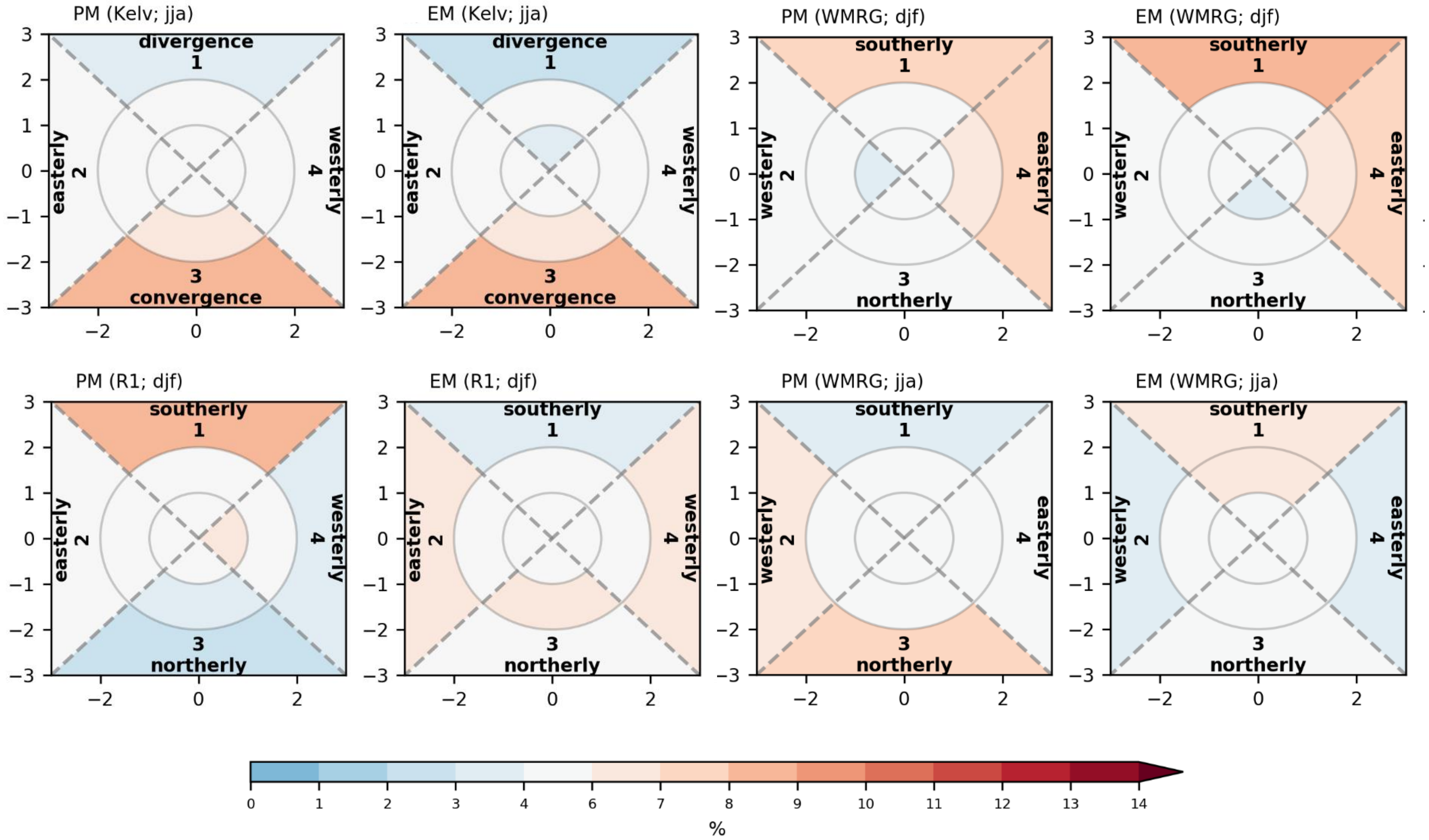




WMRG wave phases (by NH zonal & equ. meridional wind), filled contours show 850 hPa vorticity

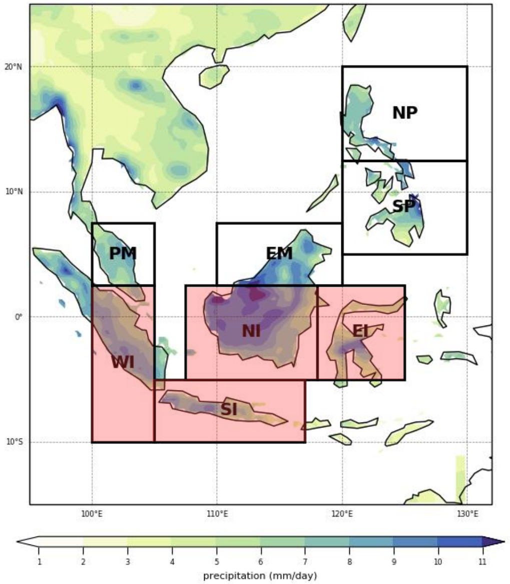
Extreme precipitation likelihood by wave phase: Malaysia

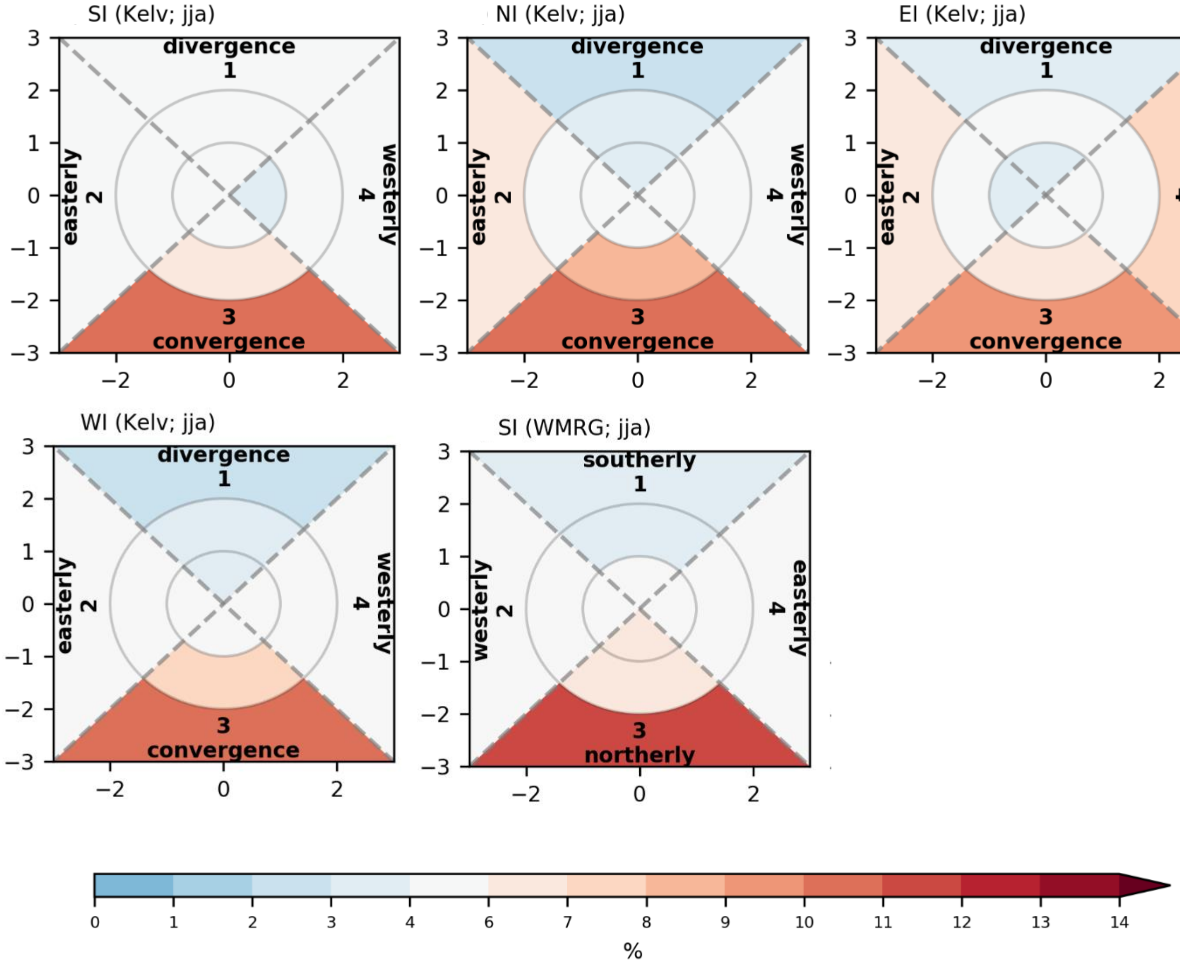




- Wave convergence linked to increased likelihood of extreme rainfall in PM
- WMRG and Kelvin waves linked to more frequent heavy rainfall in EM

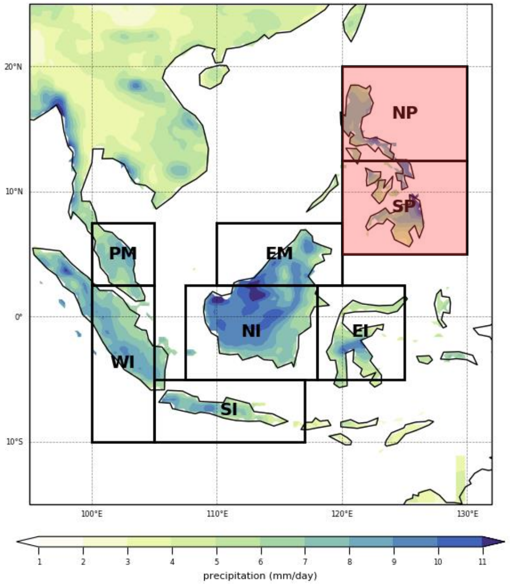
Extreme precipitation likelihood by wave phase: Indonesia

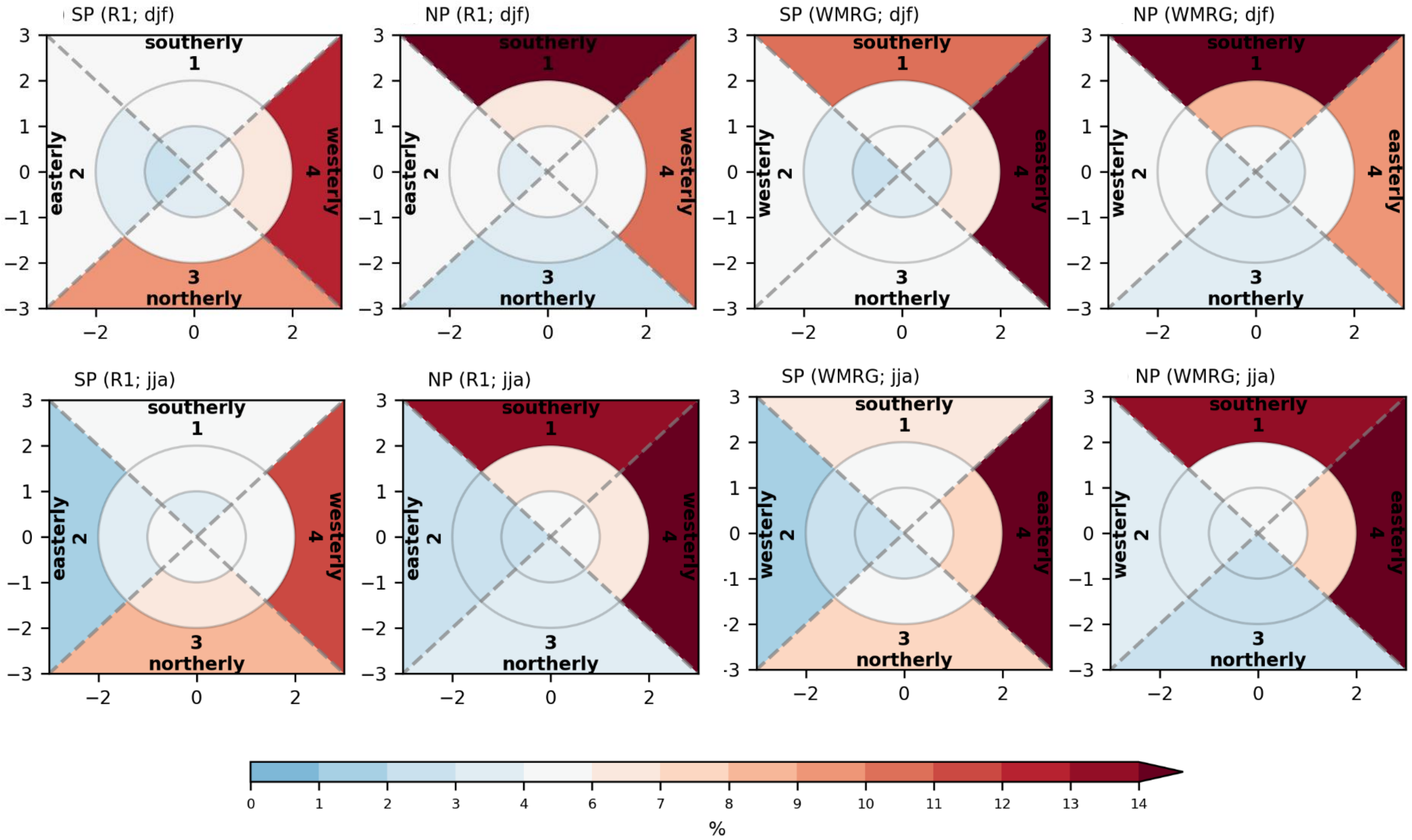




- Kelvin waves linked to increased likelihood of extreme rainfall in all areas of Indonesia (JJA)
- WMRG wave linked to increased occurrence of extreme rainfall in Java

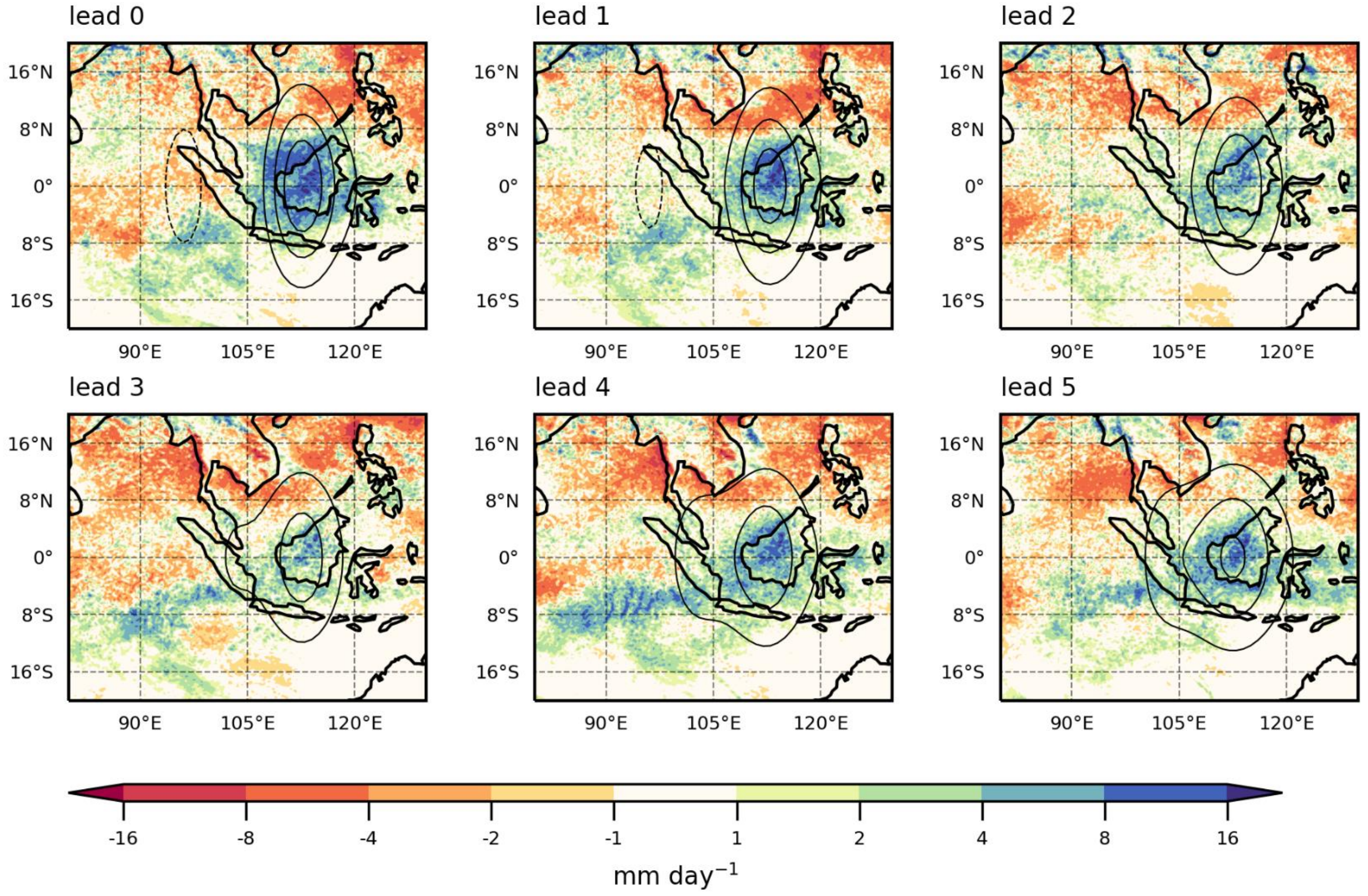
Extreme precipitation likelihood by wave phase: Philippines





- Large increases in likelihood of extreme precipitation in Philippines associated with R1 and WMRG waves
- A result of tropical cyclones in JJA.

Waves-precip relationship in UKMO global forecast



- Recently a method of identifying waves in ‘real-time’ has been developed.
- Future work will involve examination of the statistical relationship between waves and precipitation in UKMO forecasts.
- Initial results suggest weakening of observed wave-precip relationship with lead time.

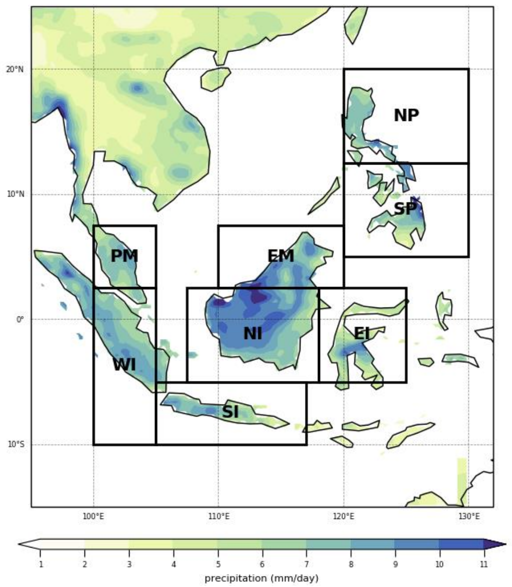
Summary

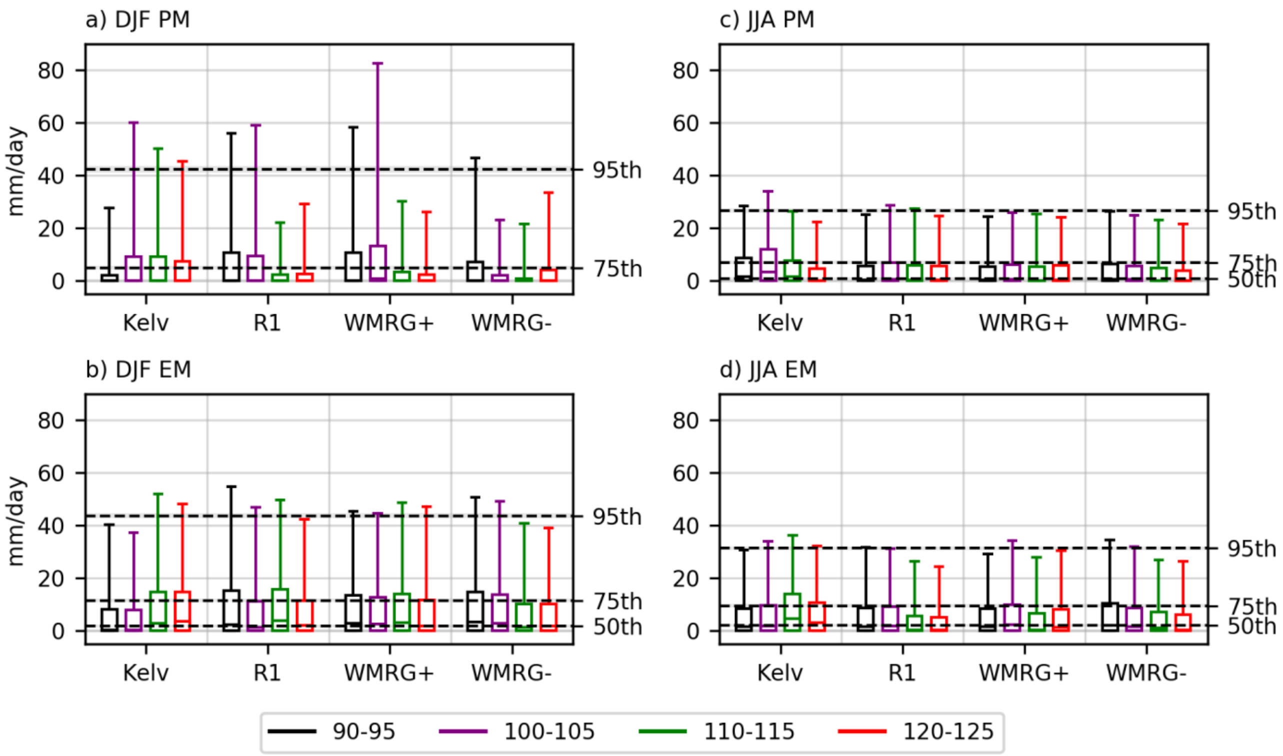
- High amplitude wave activity linked to increased mean and extreme precipitation in regions of SE Asia, including Malaysia, Indonesia and the Philippines

- Likelihood of extreme precipitation increases, and can be up to three times more likely, during high amplitude waves.

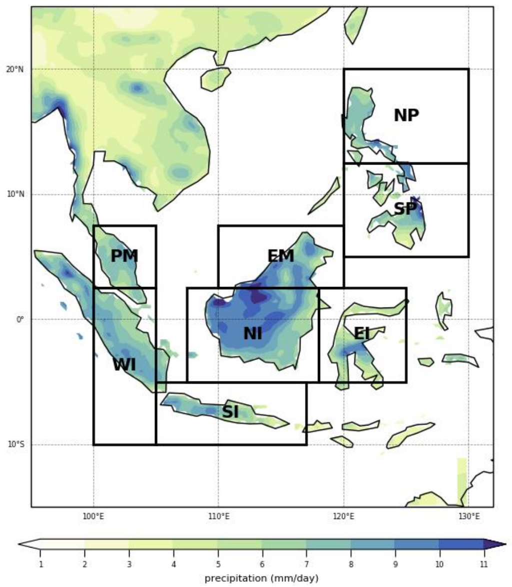
- Work has begun on assessing statistical relationship in global and regional UKMO forecasts

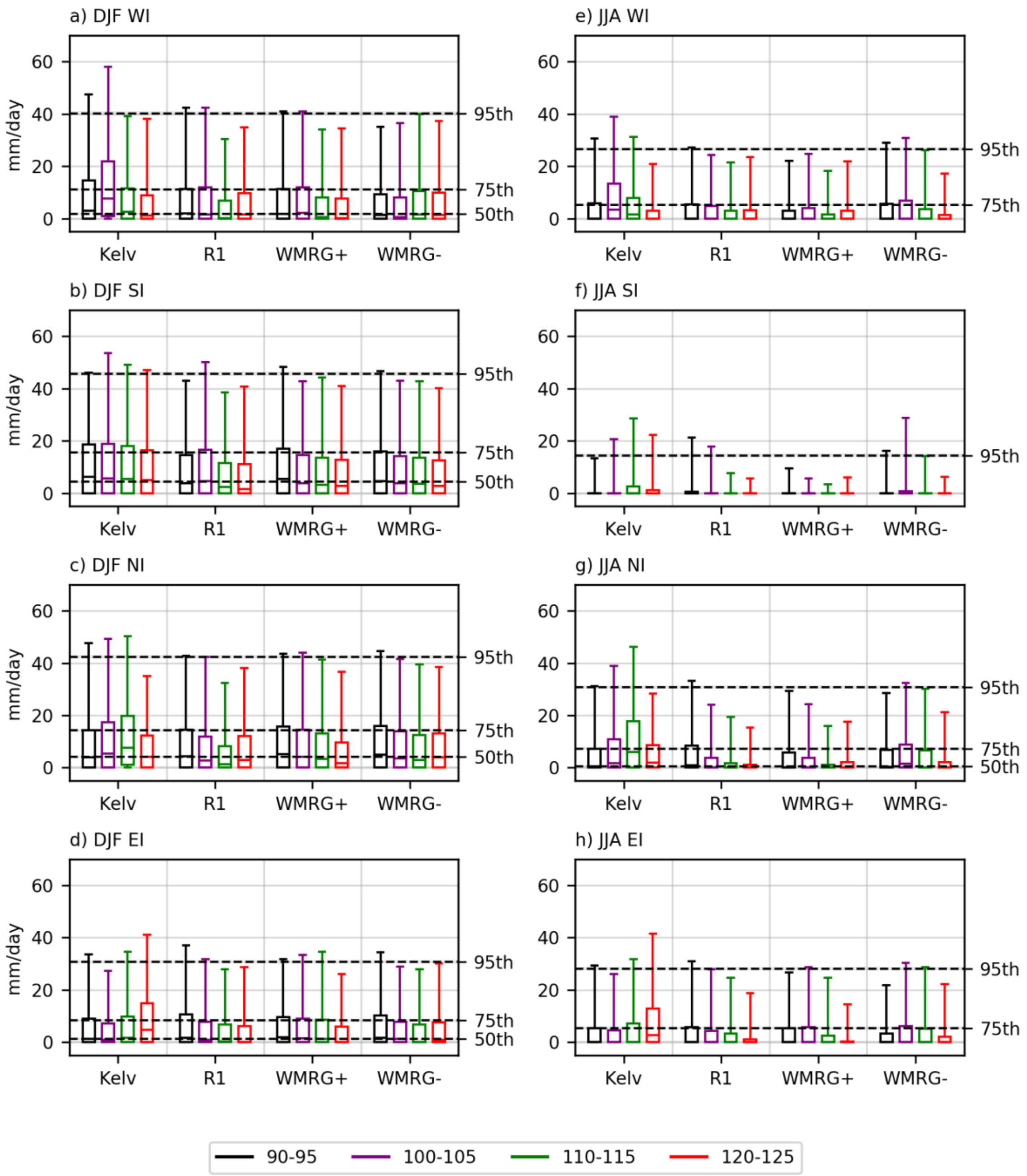
Regional precipitation changes





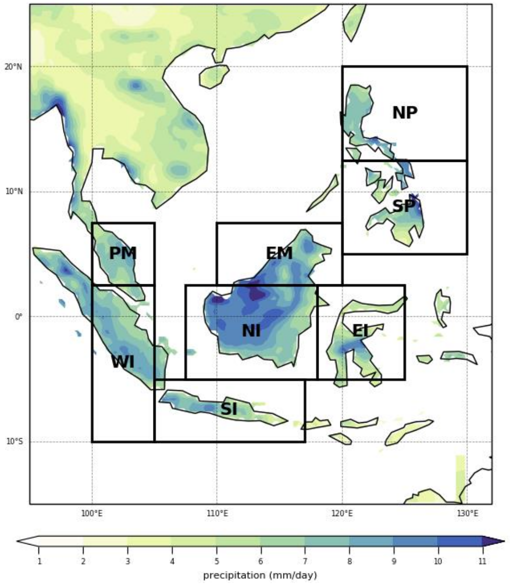
- All three waves linked to increased DJF precipitation in Malaysia
- WMRG has the strongest influence, in Peninsular Malaysia.

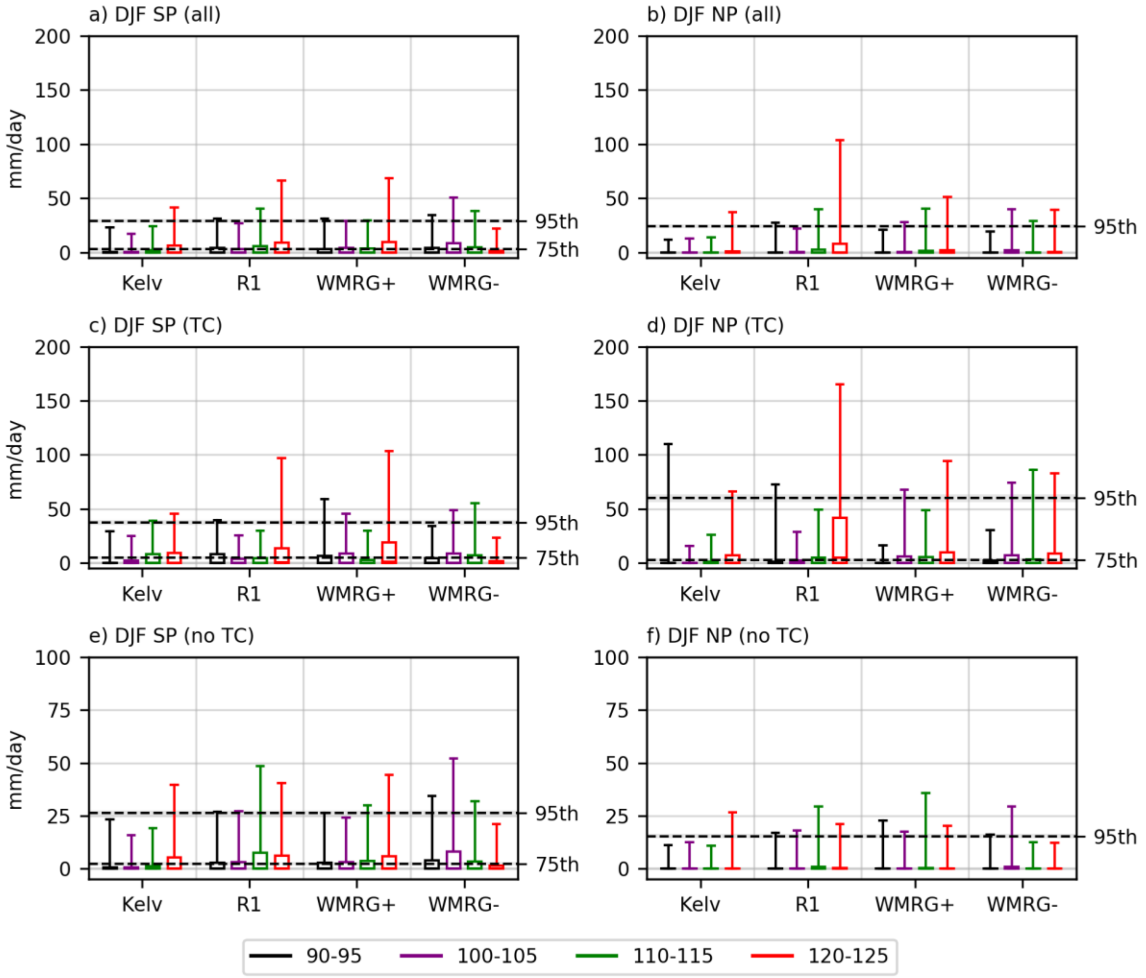




- Kelvin wave most influence Indonesia region rainfall, Sumatra when over 100-105E, Kalimantan and Java when over 110-115E, Sulawesi when over 120-120E
- Java rainfall also linked to negative phase of WMRG wave

Regional precipitation changes





- Tropical cyclones account for a portion of increased DJF rainfall during R1 and WMRG waves
- South Philippines rainfall may still be influenced by waves alone