

The relationship between intraseasonal precipitation of Iran and combined effects of MJO and NAO

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- **Introduction**

Because of low precipitation and its severe fluctuations in Iran, understanding the dynamics of large scale climate modes and probability of annual and intraseasonal precipitation variation is essential for water management.

Many studies have also demonstrated that the MJO influences precipitation variability and atmospheric circulation both in the Tropics and extratropical regions, through atmospheric Rossby wave propagation (Zhang 2005; Wheeler et al. 2009; Pai et al. 2011; Julia et al. 2012).

This study investigates the characteristics of the combined effects of Madden-Julian Oscillation (MJO) and North Atlantic Oscillation (NAO) on precipitation over Iran.

- **Data**

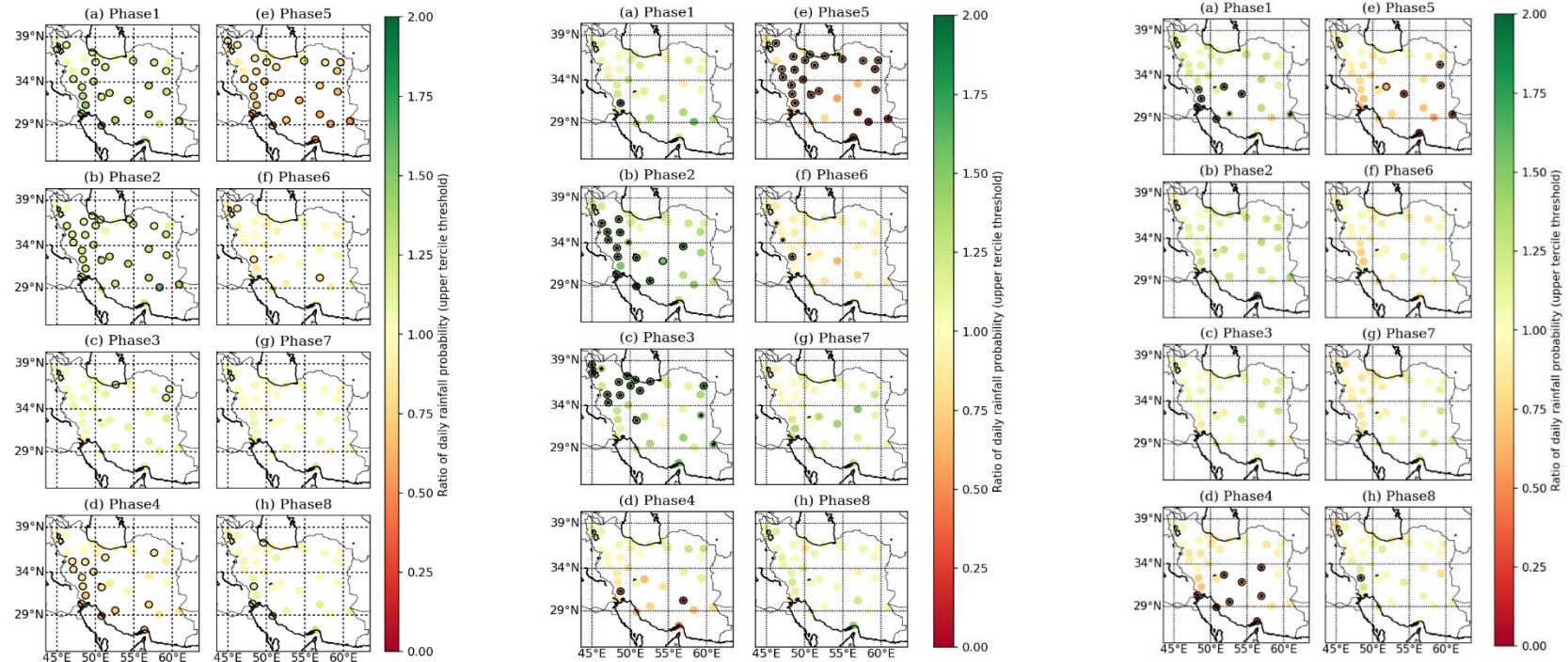
Daily precipitation and atmospheric data (relative humidity and vertical velocity) were analysed over Iran during wet season (October to May) for the period 1961 to 2018.

- **Method**

The upper tercile (i.e., upper 33%) of daily rainfall during the wet season is used as the minimum critical level (threshold) for identifying wet conditions, with the threshold value (mm/day) of the tercile varying from station to station. We calculated the probability of the daily rainfall rate exceeding the upper tercile conditioned on the phases of the MJO (amplitude >1), both positive and negative phases of the NAO.

• Results

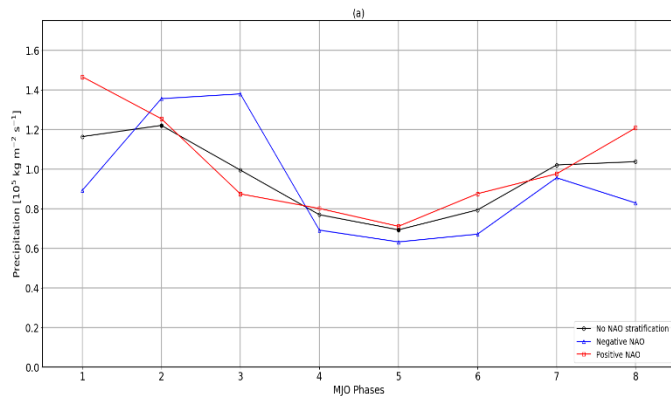
The results indicated that: 1) Distinct difference can be observed in spatial distribution of the probability of daily precipitation above upper tercile for MJO phases, phase 1 and 2 wetter while 4 and 5 are drier. (a) (b) (c)



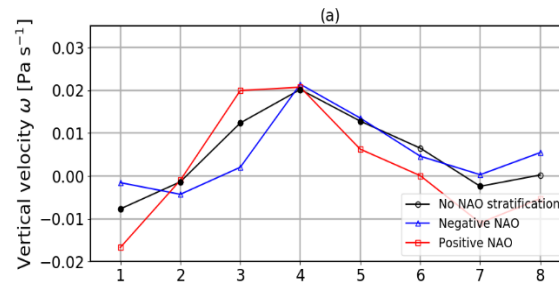
Probability of daily wet season rainfall above the upper tercile for MJO phase 1-8 during a) no NAO stratification b) negative NAO c) positive NAO state, expressed as a ratio to the climatological probability

The relative humidity is higher in phases (1-3 and 7-8) and lower in phases (4-6). The vertical velocity shows upward (downward) motion in phases 1-2 and 7-8 (3-6).

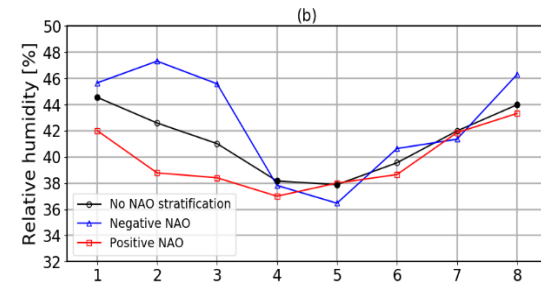
2) Response of rainy season precipitation over Iran to MJO is more affected by the large-scale atmospheric variation associated with negative NAO as compared to positive NAO.



Composite of precipitation rate over Iran for MJO phases in all years (black line), negative NAO (blue line), positive NAO (red line)



a) Composites of relative humidity at 600 hpa and b) composite vertical velocity at 300 hpa over Iran for MJO phases during all years (black line), negative NAO (blue line), positive NAO (red line)



- **Summary**

In the negative NAO, the MJO increase (decrease) the probability of upper tercile precipitation 1.2 (0.7) times in phases 2-3 (4-6) and significant tests show a significantly large response for west and North west of Iran. In contrast of positive NAO, the relative humidity and vertical velocity is more affected by negative NAO state. The more (less) humidity and upward (downward) motions increase (decrease) precipitation in phases 2-3 (4-6).

- **Referencess**

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- Zhang, C. (2005). Madden-Julian Oscillation. *Reviews of Geophysics*, 43, 1-36. <https://doi.org/10.1029/2004RG000158>