Role of Quasi-Biennial Oscillation in modulating Subseasonal variability of Indian Summer Monsoon

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Introduction

The stratosphere has been identified as an important source of predictability for a range of processes on subseasonal to seasonal (S2S) time scales by various pathways. One of them is an equatorial pathway in which the Quasi Biennial Oscillation (QBO) is a dominant phenomenon. The QBO has a downward propagating easterly and westerly zonal wind pattern dominant in the lower and middle stratosphere bounded vertically (between 100 hPa and 10 hPa) and meridionally (between 10° S and 10° N), which has approximately 28 months of periodicity (Baldwin et al., 2001). Westerly phase of the QBO in preceding winter is known to favour the deepening of monsoon trough over the Indo-Gangetic plains and weakening of convections over the equatorial Indian Ocean (Claud & Terray, 2007). Earlier studies have shown that the QBO phase influences the boreal wintertime convections associated with the Madden Julian Oscillation (MJO) and hence rainfall pattern of the underlying region (Yoo & Son, 2016). This study investigate the influence of QBO on the monsoon intraseasonal variability.

Objectives

- To identify the best definition of QBO index.
- To examine the concurrent relation of QBO phases and Monsoon Intraseasonal Oscillations (MISO).

Methodology & Study Area

Data: Wind observation from ERA5 reanalysis, Rainfall observations from IMD, MISO Index.

Methodology: In this study, the QBO indices are generated from zonal wind between (10°S – 10°N) from the lower stratospheric (100 hPa – 10 hPa) by EOF (John M. Wallace, 1993) and threshold (Yoo & Son, 2016) defined methods. Among the two methods, the EOF based method is identified to be more suitable as it considers all levels for defining phases. Then, the average picture of the Indian monsoon for the easterly and westerly phase of the QBO are studied. The EOF defined QBO are further classified into QBOEM/WM (Easterly Middle/Westerly Middle) and QBOEL/WL (Easterly Lower/ Westerly Lower). In the threshold method, three-monthly moving mean anomaly of zonal wind calculated by subtracting the monthly climatology at 50 hPa. The values greater (less) than half of its standard deviation called WQBO (EQBO) at particular levels.

Results

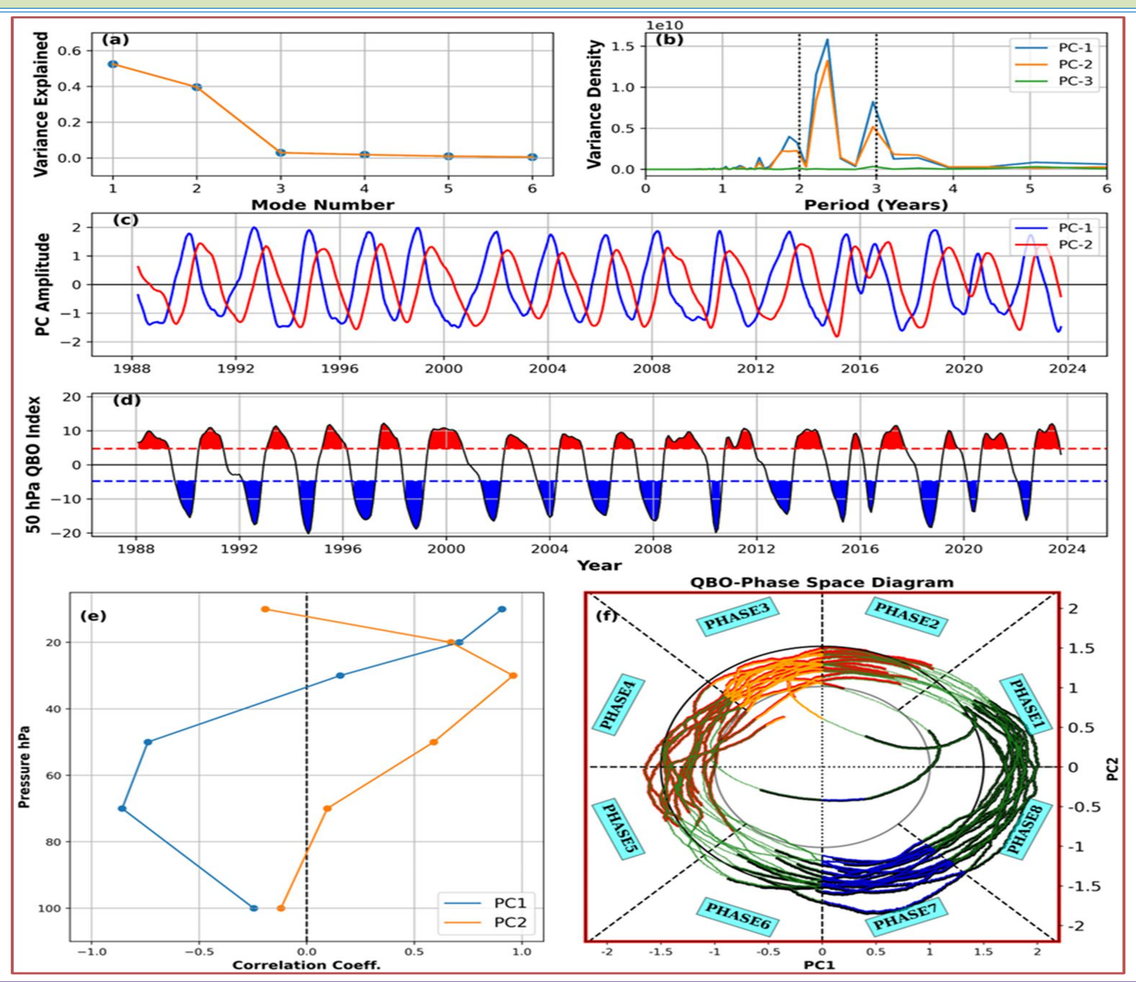

Fig. 1: (a) Variance (b) Power Spectrum (c) amplitudes of PC1 and PC2. (d) QBO Index defined at 50 hPa (e) The correlation coefficient with primary timeseries (f) QBO phase-space diagram.

Results

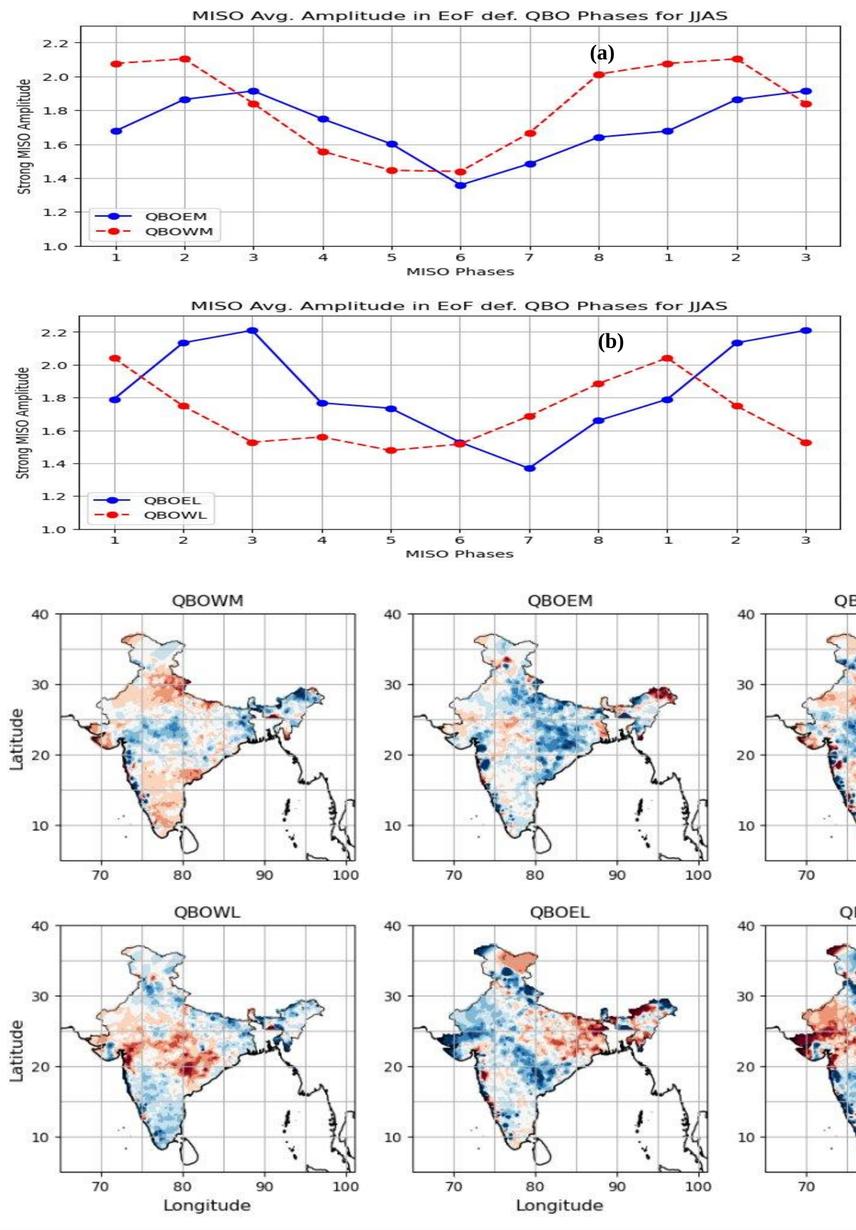

Fig.2 Average MISO amplitude in EOF defined QBO (a) Middle Phase (b) Lower Phase

Fig.3 Average Rainfall anomaly (mm) over Indian subcontinent for different phases of the QBO defined by EOF criteria and their difference.

Conclusions

- The QBO index defined based on the EOF method has advantage over the threshold method as it considers the whole vertical structure of the QBO with alternating pattern of zonal wind with height. On the other hand, in the threshold method the QBO is defined considering the zonal wind at a particular level.
- The first two EOF modes explained almost 92% variability implying that EOF defined methods explains majority of QBO varibility and can be used for to identify the QBO phases. It is further noted that the first two PCs exhibit dominant periodicity between 2-3 years which matches with QBO periodicity.
- In the QBOEM (QBOWM) phase, the average MISO amplitude remains high (low) for MISO phases 3,4 and 5 (7,8 and 1). It is noted that the rainfall pattern is shifted towards east of central India in QBOEM.
- In the QBOEL phase, the average MISO amplitude remains high for the MISO phases 3,4 and 5. It is seen that QBOWL phase supports break condition over central India, whereas QBOEL phase supports active monsoon conditions over central India.

Acknowledgments & References

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