


RESEARCH ARTICLE

Objective determination of the winter monsoon onset dates and its interannual variability in Malaysia

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Funding information

Ministry of Higher Education, Malaysia, Grant/Award Numbers: LR001-2020, LRGS-MRUN 2016-1, LRGS/1/2016/UTM/01/1/3; FIO-UM Joint Center of Marine Science and Technology (JCMST); Met Office Weather and Climate Science for Service Partnership (WCSSP) Southeast Asia

Abstract

The northeast/winter monsoon over Malaysia often leads to extreme rainfall events and floods over the windward side of terrain due to the strong northeasterly winds. Comparatively, much less rain falls over the other are sheltered by the mountain ranges. Based on this consideration, the onset of monsoon in the region is best determined operationally using 925 hPa winds. Therefore, we propose the first, simple, single-variable-based method to determine the onset dates of winter monsoon is yet reliable and can be closely monitored for operational purposes. The onset date is defined in the third pentad when the average of three pentads of 925 hPa northerly wind speed is greater than $1 \text{ m}\cdot\text{s}^{-1}$, and at least one of three pentads must be greater than $2.5 \text{ m}\cdot\text{s}^{-1}$. The study also investigates the relationship between the interannual variability of onset date and El Niño–Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). Late-onset can be expected when La Niña develops in the boreal fall season. However, a similar association between monsoon onset and El Niño condition was not observed. The lead–lag correlation between the IOD and the onset dates shows that the onset is significantly negatively correlated with the IOD. During negative (positive) IOD events, a delay (early) onset is expected. Results also show that the relationship between the onset and IOD is more robust and linear than the ENSO.

KEYWORDS

Asian winter monsoon, ENSO and monsoon, IOD and monsoon, monsoon onset, monsoon onset date, monsoon season, northeast monsoon, northeast monsoon onset

1 | INTRODUCTION

The boreal winter monsoon over Southeast Asia is one of the most dynamic planetary-scale phenomena (Chang *et al.*, 2016; Chan and Li, 2019) characterized by strong baroclinic systems with an extensive meridional domain from the high latitude to low latitude. Intense middle latitude Siberian high- and low-pressure systems associated

with the Intertropical Convergence Zone (ITCZ) over the equatorial Maritime Continent and surrounding oceans are the significant features of the winter monsoon. Outbreaks of cold air from the Siberian high pressure to the intense low-pressure system over the Maritime Continent (Chang *et al.*, 2016) often leads to extreme rainfall and floods events over the region. The intense northeasterly cold surges not only influence the weather and climate of