



## **Distinctive atmospheric vertical structures in the regional Asian summer monsoons: Q1 and Q2**

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The start timing of the Asian summer monsoon is one of critical factor of monsoon prediction. Understanding of monsoon onset is utmost important but remains a challenging issue. We attempted to investigate individual characteristics the three sub-regional monsoons by the South Asian (SA), East Asian (EA), and Western North Pacific (WNP) monsoons according to the different atmosphere-ocean-land interaction and land-ocean configurations. In this presentation, we examine the onset of three regional monsoons using the apparent heat source (Q1) and apparent moisture sink (Q2), representing the hydrological cycle. Approaching integrated Q1 and Q2 is incomplete to understand the underlying physical processes of the monsoon onset, the characteristics of atmospheric vertical structure in the regional Asian summer monsoon are investigated. This study demonstrates how individual monsoons have distinct vertical features in causality and source before and after the summer monsoon onset. In particular, the vertical structure of Q1-Q2 relation from the surface to tropopause in three regions is examined. It indicates the contribution to the heat source is distinctive between the components including radiational heating and condensation. In addition, the role of radiative heating and eddy flux occupies a significant portion of the heat source in the EA with condensation. By investigating the causality for distribution of heat source in level and the affecting factor modulating heat intensity, this study sheds light on the internal process of monsoon onset.