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## Critical transition to monsoon in outgoing long-wave radiation: prediction of the advance of Indian Summer Monsoon

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The Indian summer monsoon (ISM) dramatically transforms the weather from hot and dry conditions to abundant precipitation within four months. The high temperature in the summer creates a low-pressure monsoon trough. Subsequently, moist winds from the surrounding seas increase the humidity in the atmosphere. Both the temperature and humidity influence the cloud formation over the monsoon region. Outgoing longwave radiation (OLR) indicates convective activity, which is the basis for cloud formation. Thus, the OLR is a crucial characteristic in meteorology to define monsoon's arrival in the state of Kerala. However, certain values of OLR at monsoon onset for different locations remain unknown. That is a scientific challenge to characterize monsoon onset at every location. This study aims to quantify the advance of monsoon and then make predictions.

Recently, Stolbova et al. 2016 [1] showed temperature and relative humidity exhibit a critical transition from pre-monsoon to monsoon in central India, which allowed making a long-term prediction of monsoon onset and withdrawal in Central India [2]. In the current study, we reveal that OLR exhibits a critical transition from high OLR values during the pre-monsoon state to low OLR values in the rainy season state. We prove the existence of criticality by identifying the OLR-critical threshold. Moreover, we show the appearance of the critical phenomena on the eve of the monsoon onset. In particular, we observe a growth of autocorrelation and variance of fluctuations for different regions in temperature, relative humidity, and OLR.

We find that the abruptness of the transition varies along the direction of advance of the monsoon. More abrupt the transition higher the amount of precipitation. These findings allow us to predict the timing of the monsoon advance from South India to central India. Such a forecast provides crucial information for farmers to sow the appropriate crops before the monsoon begins.

[1] Stolbova, V., E. Surovyatkina, B. Bookhagen, and J. Kurths (2016). GRL 43, 1–9 [[doi:10.1002/2016GL068392](https://doi.org/10.1002/2016GL068392)]

[2] <https://www.pik-potsdam.de/en/output/infodesk/forecasting-indian-monsoon>

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