

Update July 27, 2016

## Earliest Forecast of the Withdrawal Date of Indian Summer Monsoon - 2016 from the Eastern Ghats (20N, 80E).

The Indian Summer Monsoon (Southwest Monsoon) is likely (with a 84% probability) to withdraw from the Eastern Ghats region (20N, 80E, Gadchiroli Forest Reserve) around 5<sup>th</sup> October (+/- 5 days).

We estimate the date of monsoon withdrawal from the Eastern Ghats using our recently developed method for long-range forecasting (70 days in advance in 2016). Our prediction relies on observations of near-surface air temperature ( $T$ ) in the tipping elements of the monsoon: the Eastern Ghats (EG) and North Pakistan (NP).

The prediction scheme of the Withdrawal Date (WD) is based on the symmetry of temperature changes in NP during the year. Knowing the temperature of monsoon ( $T_{mon}$ ) in the EG from the training period, the trend of NP in the pre-monsoon period, and the maximum temperature in NP ( $T_{NP\ max}$ ), we can estimate the trend of the temperature decrease in the NP region. The withdrawal date is estimated as the intersection of the projected temperature decrease in NP and the temperature in the EG during the monsoon season ( $T_{mon}$ ) (see Figure 1). After the equalization of temperatures in the tipping elements the temperature in the EG decreases, indicating that season of monsoon is over in the region. However, after the monsoon withdrawal date, severe and devastating tropical cyclones originated in the Bay of Bengal may bring non-monsoon rainfall to the EG region.

The forecasting of the withdrawal date is crucial for the correct prediction of flooding events and for the adequate management of water and energy resources.

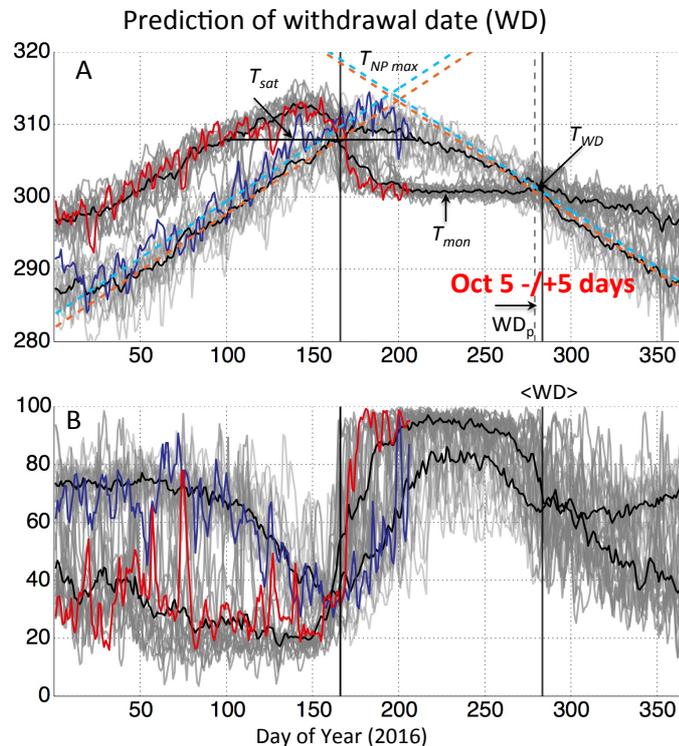


Figure 1. Prediction of the withdrawal date (WD) of monsoon in the EG. A: near-surface air temperature at 1000 hPa; B: relative humidity at 1000 hPa. Time series from the tipping elements of monsoon: 14-years mean (black) and 2016 values for NP (blue) and the EG (red). Grey lines show time series from the NP and EG for the training period of 14 years. Saturation temperature  $T_{sat}$  (A) is marked by horizontal black solid line. Orange lines indicate trends to the mean time series in the NP for the training period, light blue - trends for 2016. Black solid lines indicate mean value of the WD for the training period. Dotted grey line corresponds to the our predicted withdrawal date  $WD_p$  in 2016.