

## On the predictive behaviour of the Indian monsoon in June 2009

Francis and Gadgil<sup>1</sup> have made many interesting correlations of meteorological variables and events, and have proposed that unfavourable SST (sea surface temperature) gradient between the Bay of Bengal and EEIO (eastern equatorial Indian ocean) led to the large deficit of monsoon rainfall in 2009. In their own words, ‘... a drought was not expected from the predictions generated by the leading centres in the world using complex models of the coupled ocean-atmosphere system. Models had generally predicted above average rainfall for June–July–August (JJA) over most of the Indian region, which is almost the opposite to what was observed’.

The Flosolver Laboratory at National Aerospace Laboratories (NAL) has over the years developed various versions of the software called ‘Varsha’ for forecasting weather over the globe. The code has a special boundary layer parameterization scheme for the tropics and a refined scheme for handling the moist adiabat. During the monsoon season, a rainfall forecast for each month has been made in the first week of the month since 2006. Since 2007, these forecasts have been routinely sent to the Director General of Meteorology (DGM) of the India Meteorological Department (IMD).

For June 2009, a preliminary Varsha forecast of all-India rainfall was sent to

DGM on 29 May 2009 and an updated forecast (promised in this letter of 29 May) was sent on 8 June 2009. The figures sent are reproduced here, as Figures 1 and 2 respectively. There can be no doubt that the Varsha clearly forecast a substantial rainfall deficit. Figure 3 compares IMD-reported rainfall<sup>2</sup> for June 2009 with the five-day moving average of the Varsha forecast. The preliminary forecast clearly indicates a June rainfall well below the long-term mean. The updated forecast for the same month shows a 51% deficiency, and this prediction was clearly stated and highlighted in the correspondence with DGM of IMD. It is seen that the trend of observed rainfall is

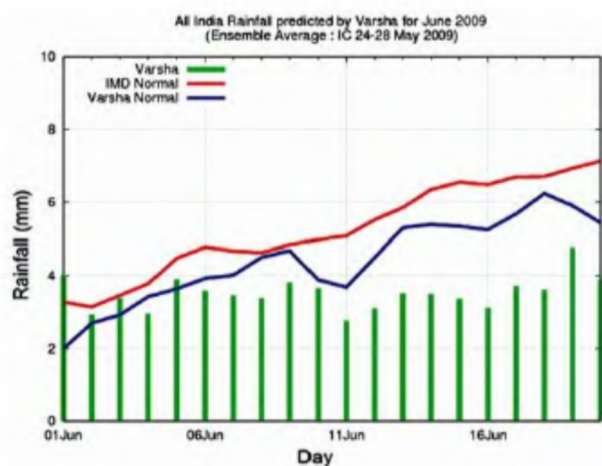


Figure 1. Preliminary Varsha prediction for June 2009.

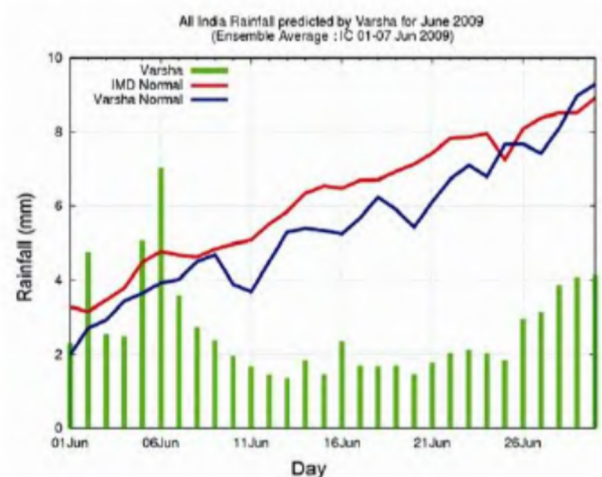


Figure 2. Updated Varsha prediction for June 2009.

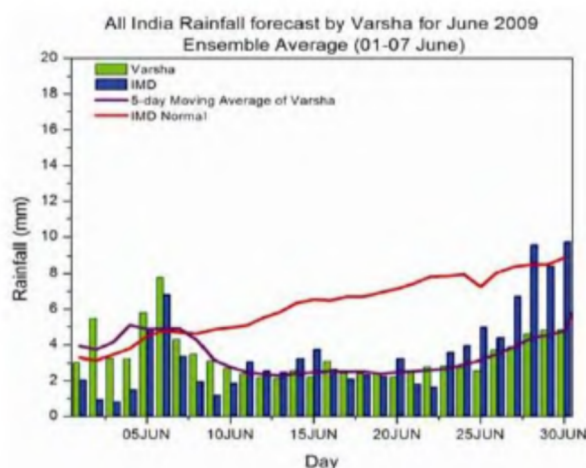


Figure 3. Comparison of Varsha rainfall forecast and IMD Observation, June 2009.

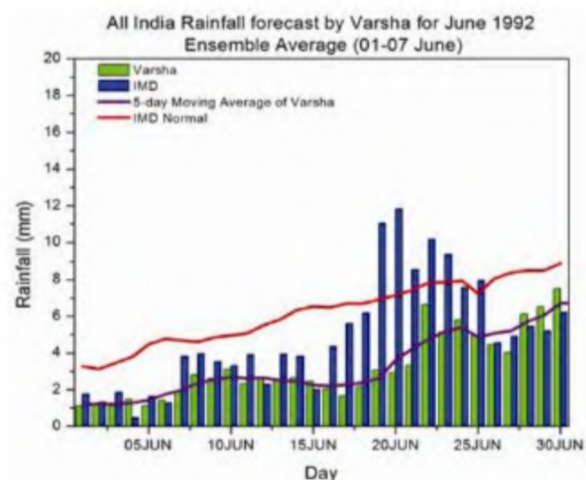
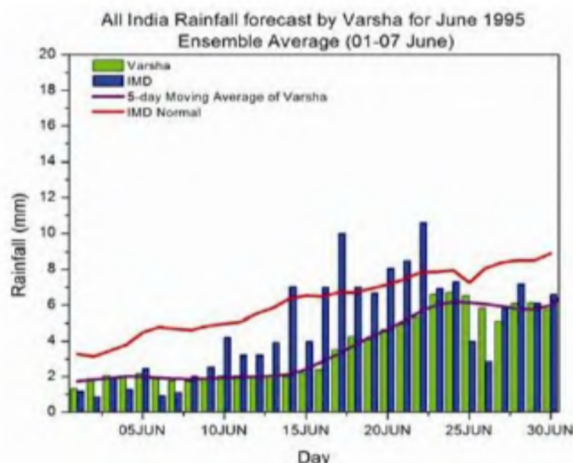
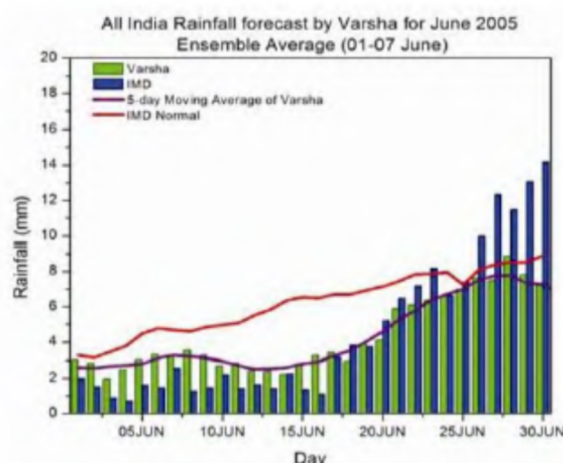


Figure 4. Comparison of Varsha forecast and IMD observation for June 1992.



**Figure 5.** Comparison of Varsha forecast and IMD observation for June 1995.



**Figure 6.** Comparison of Varsha forecast and IMD observation for June 2005.

reasonably well captured by Varsha; in particular there is no prediction of above-average rainfall.

Given the limitations of available data, various modelling constraints and long-standing scientific questions about predictability on longer time scales, we put on record that no claims are made for the spatial and temporal accuracy in the all India precipitation forecasts. But, given the long term of one month and the spatial extent of the Indian region, the observed trend is well captured not only for June 2009 but also for July–September 2009. Indeed, we find that in the last 20 years for which model forecasts have been made (and whose results have been presented in various fora sponsored by MoES), in all four cases where the deficit in June rainfall exceeded 20% the trends forecast by Varsha have been

qualitatively correct, as shown in Figures 4–6. For example, in all these cases the relatively low rainfall in the first half of the month, followed by higher rainfall in the second half is well depicted in the forecast.

Although NAL may not be a ‘leading centre of meteorological forecasting’ in the world, it so happens that its Varsha code picked up the deficit rainfall 3–4 weeks in advance and captured its severity three weeks in advance this June. Therefore, it would not be correct to conclude that atmospheric models in general do not have the skill of picking up the severe deficit of rainfall such as what was experienced in June 2009.

1. Francis, P. A. and Gadgil, S., *Curr. Sci.*, 2009, **97**, 1291–1295.

2. India Meteorological Department, <http://www.imd.gov.in>

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