Monsoon Indices: Onset, Strength and Withdrawal

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Precipitation in India has clear seasonal variation and the onset of the Indian summer monsoon is of great interest as not only a research target but also a socioeconomic factor for water resources in India. Since the need of referring to monsoon variability with reference to specific features and the time of their occurrence, many monsoon indices have been developed and used in research. The onset and withdrawal of the broad scale Asian monsoon occur in many stages and represent significant transitions in the large-scale atmospheric and ocean circulations. Useful indices provide a simple characterization of the state of the monsoon during different epochs and also the inter-annual variability. While there is no widely accepted definition of these monsoon transitions at the surface, the onset is recognized as a rapid, substantial increase in rainfall with in a large scale. The arrival of the summer monsoon over the Kerala coast is found to be reasonably regular either towards the end of May or beginning of June.

This migration and location of the heat source has important implications for the withdrawal of monsoon over South Asia. However, to date there has been no systematic investigation of the retreat of the monsoon system despite its key contribution to total rainfall variability. In this study the following four dynamical indices are undertaken with data from the present NCMRWF high resolution T254L64 analysis and forecast (up to 12 hrs) for the period May - September 2008 and 2009 system. Some of the frequently used monsoon dynamical indices of the South Asian summer monsoon are shown in the table with their corresponding brief definition. These monsoon indices are based on circulation features associated with convection centers related with rainfall during the summer for the Indian region. The analysis forecasts systems have been used to compute various monsoon indices to monitor onset, strength and the withdrawal of the monsoon during 2008 and 2009.

The presentations shows the objective circulation indices calculated by Wang and Ding (2009) for the analysis and forecast for the length of 24 hr, 72 hr and 120 hr. From this figure it is seen that the apparent onset date-bogus onset is noticed as 23 May, by the sustained westerly (U) exceeding 6.2 m/sec and persisting for more than six days i.e. up to 28 May. This high value of U did not persist beyond 28 May. From this study it is seen

that another onset date is noticed around 30 May, by the sustained westerly (*U*) exceeding 6.2 m/sec and persisting for more than six days. This high value of *U* did persist beyond 05 Jun also. Hence the authors strongly write that the real onset occurred on 30 May only. The bogus onset date 23 May can be omitted safely by quoting these monsoon onset criteria. Another figure shows the circulation indices calculated by Syroka and Toumi (2002, 2004) for the onset phase. From this we infer that the onset date around 29 May 2009, because on that day onwards the daily index is changing it's sign from negative to positive and maintained there after. In this case also the bogus onset date 23 May is clearly brought out. The analysis and the 24 hr forecast, 72hr forecast, 120hr forecast also shows the change of sign, but with lag of few days. One more figure shows the circulation indices/vertical shear calculated by Goswami et al., (1999) for the onset phase. This is popularly known as Hadley cell circulation index. From this figure we infer that the onset date is seen around 2 Jun only but not on the day 23 May, because on that day onwards the daily index is changing it's sign from negative to positive and maintained the positive sign there after. The analysis and the 24 hr forecast, 72 hr forecast, 120 hr forecast also having the same trend and are able to change the sign from negative to positive with a lag of 2-3 days.

The study is proposed to examine these monsoon indices for the year 2010 with T254L64, JRA25 reanalysis data sets.