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GUEST EDITORIAL

Why IMD got the seasonal forecast of 2015 southwest monsoon rainfall right

The 2015 southwest monsoon was the fourth deficient monsoon of this century with the season (June–September) rainfall over the country as a whole of 86% of its long period average (LPA). The season rainfall was also below normal over all the four broad geographical regions of the country, with 83% of its LPA over northwest India, 84% over Central India, 85% over the southern peninsula and 92% of its LPA over North east (NE) India. Month-wise, rainfall over the country as a whole was above normal in June (116% of LPA) and below normal during the remaining months (84% in July, 78% in August and 76% in September).

As the 2014 monsoon season had also received deficient rainfall, the prediction of monsoon rainfall this year was keenly followed by Government planners as well as water-dependent sectors such as agriculture, power generation, industries, etc. In fact, 2014 and 2015 were the fourth case of two consecutive all-India deficient monsoon years during the last 115 years (1901–2015). The fact that the climatological probability for two consecutive deficient monsoon years is very low (only about 3%) made it hard for India Meteorological Department (IMD) to issue forecast for deficient monsoon rainfall this year. The forecasting job was made further difficult as nobody in the country wanted to face another deficient monsoon year after last year's deficient monsoon rainfall, as that means further distress in the economy of the country in general and agriculture in particular. As a result, questions were raised on the scientific methodology and reliability of the monsoon forecast system of IMD. Perhaps, it was easier for everybody to accept the false hope offered by the normal forecast by private agencies. In view of the above, it is worth discussing some basic questions about the status of monsoon prediction in the country, and how IMD was able make accurate deficient monsoon forecast this year.

Early attempts for seasonal forecasting of Indian monsoon rainfall were started following a devastating famine in India during the late 1870s, for which a simple model based on the inverse relationship between preceding winter and spring snowfall over the Himalaya and subsequent monsoon rainfall was used. Since then, the seasonal forecasting system in India has undergone many changes with new knowledge being incorporated constantly. Currently, IMD issues operational seasonal forecast for nation-wide (country as a whole) southwest monsoon season (June–September) using a state-of-the-art statistical ensemble forecasting system based on parameters representing various physical mechanisms like ENSO, Indian Ocean dipole (IOD), northern hemispheric land heating, mid-latitude wave activity, etc. responsible for the year-to-year variation of monsoon rainfall over the country as a whole. These models were developed under in-house research activities. However, the predictors set was obtained by stringent screening process of several existing and new predictors identified by in-house research as well as by other researchers, both from India and abroad. The science part and methodology of the present forecasting system were discussed in several scientific fora both in India and abroad and peer-reviewed by an international journal before being implemented for operational forecasting. Use of this new operational statistical forecasting system has shown significant improvement in the skill of monsoon forecasting in India. For example, the average absolute error in the forecast of country-averaged season rainfall during the last 8 years (2007–2014) was about 6% of LPA compared to about 9% of LPA during the 8 years (1999–2006) just prior to this. This improved performance of the present forecasting system in recent years helped IMD to be more confident in this year's forecast.

It is recognized since long that ENSO is one of the main factors behind the year-to-year variation of the Indian summer monsoon rainfall. ENSO has two phases: warm phase or El Niño and cold phase or La Nina. El Niño (La Nina) is generally associated with above (below) normal sea surface temperatures over equatorial central and east Pacific, and below (above) normal Indian monsoon rainfall. Climatologically, it has been observed that either of the ENSO phases matures during the middle of the monsoon season resulting in stronger impact on the rainfall during the second half of the season. This year, however, weak El Niño conditions were set up in the month of March itself, which subsequently strengthened

by the middle of the season. As a result, the impact of El Niño on monsoon circulation was seen from the start of the season itself. If it were not for the favourable Madden Julian Oscillation (MJO) activity (a strong global intraseasonal variability pattern) over the Indian Ocean during the middle of June, the June rainfall would have also been affected. It may be mentioned that prior to 2015, there were four deficient monsoon years (2002, 2004, 2009 and 2014) during the ongoing century (2001–2014) and first three of them were all associated with El Niño. Even in 2014, El Niño-like conditions prevailed during the early part of the monsoon season causing large June rainfall deficiency. This clearly shows that El Niño was definitely a major factor for deficient monsoon rainfall over India in recent years as well as this year. The present seasonal forecasting system of IMD has appropriate representation of ENSO-related predictors. Most of the other predictors used in the models did not show much strength this year resulting in deficient monsoon forecast.

In spite of negligibly small climatological probability for two consecutive deficient all-India monsoon season rainfall as mentioned earlier, many other factors contributed to the confidence of IMD to go for deficient monsoon forecast. The first factor is that currently all-India monsoon season rainfall is passing through a below normal epoch (that started in early 1990s), which is likely to continue for the next 5–10 years. Similarly, in recent years, the skill of models (both statistical and dynamical) to predict El Niño phenomena has substantially improved. From early this year, several models predicted moderate to strong El Niño conditions to persist during the monsoon season and this turned out to be true in the end. Another factor is that the experimental/operational global forecasts from several reputed international centres suggested below-normal monsoon season rainfall over India prior to June itself. However, the most important factor that helped IMD to go for the second consecutive deficient monsoon forecast was the confidence showed by the administration in managing possible deficient monsoon situation. If the country comes out successful, at least partially, in managing the impact of this year's deficient monsoon rainfall on agriculture and other sectors, this will be a case study for all the developing countries in managing seasonal climate risks.

It may be worth mentioning that IMD has a long experience in the seasonal prediction. IMD has been wrong on some occasions due to inherent limitations/uncertainty in the seasonal prediction. But if one evaluates the performance of the forecasting system of IMD during the last several years, there have been significant improvements in the skill of the forecasts in all the scales (whether it is in short range or long range). The improvement in the forecast skill was the result of concentrated efforts/support from Government to improve the overall weather and climate services in India. IMD as well as other sister organizations from the Ministry of Earth Sciences (MoES), Government of India (GoI) have been working for the last several years to develop infrastructure necessary for better weather/climate monitoring and prediction. Now it is paying back. This has definitely increased the credibility of the met community in India in general and IMD in particular. MoES has launched the 'National Monsoon Mission' (NMM) with a vision to develop a state-of-the-art dynamical prediction system for monsoon rainfall on different timescales. For the last 4–5 years, Indian scientists have been working to improve the skill of the dynamical model for the seasonal forecast. For this purpose, many collaborative works are also underway among international scientists from various countries such as USA, UK, etc. The Indian Institute of Tropical Meteorology (IITM), Pune is coordinating these efforts. This year, it may be mentioned that the coupled dynamical forecasting system developed under NMM also consistently indicated deficient monsoon rainfall over the country.

Finally, it is essential to understand that the predictability of a climate system such as the Indian monsoon depends upon our ability to understand and model the mechanisms causing its variability. Whereas mechanisms like ENSO, IOD, anomalous snow cover, etc. that represent the changes in the slowly varying boundary conditions of the atmosphere provide potential monsoon predictability, the fast varying day-to-day weather or intra-seasonal variations (ISVs) form the non-predictable component of the monsoon variability. The predictable component of the monsoon variability is often strong in the extreme years (i.e. wet or dry) that are also the years of interest for society at large. This year, the ISVs consisted of MJO activity in June and activity of 11 monsoon low-pressure systems such as low-pressure areas, depressions, cyclones, etc. formed during the season. One of the important recent developments in the coupled models has been the improvement in forecasting the monsoon ISVs, which were thought to be nearly unpredictable till recently. As the ISVs form a significant part of monsoon seasonal variance, the improvement in the skill of ISV prediction should help in further improving the skill of seasonal monsoon prediction in India. This should help in generating better forecasts of monsoon on smaller spatial and temporal scales. On the other hand, the possible projected impacts of global warming on the mean monsoon circulation and rainfall patterns, and on the monsoon teleconnections throw up new challenges in monsoon prediction and these call for continued efforts in improving the global observational networks and the models as well.

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