

## The Notoriously Unpredictable Monsoon<sup>1</sup>

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The Indian Monsoon and by extension the Asian Monsoon which impact about 4 billion people (70% of world's humanity) today is perhaps the most complex feature of the earth's climate system. Climate models have achieved only a limited success so far in simulating many features of this complex system.

Normally the Indian monsoon arrives at the southern tip of Indian Peninsula (about 8°N) by May 25 and by June 7/8, the Monsoon begins over Mumbai (largest Indian city, pop: ~20 million) and progresses further into central India. By about June 25 to June 30 the Monsoon generally spreads over most of India. Despite year-to-year variations in these dates, the onset dates over a 150-yr database (one of the best datasets) shows Monsoon arrival dates to be remarkably robust. Delay in Monsoon arrival is often associated with anxiety about water shortage, impact on agriculture and of course an increased hype about "*global warming, climate change and possible adverse impact*". A careful examination of past data, however, shows such "*fears*" about adverse global warming impact are without any merit.

Despite significant advances in Monsoon meteorology, predicting onset and overall intensity and distribution of Monsoon rainfall during the four summer months (June-September) is still a daunting task and considerable research efforts are needed at present to improve predictability of Indian/Asian Monsoon. Since the Indian/Asian Monsoon system transfers sufficient energy across the entire climate system, any future projection of earth's climate must include an improved modelling of the Monsoon system than what is available at present.

This year's (2009) Monsoon was predicted to be about normal (96% of normal) by the India Meteorological Department (IMD) as early as 18 April 2009. The first burst of Monsoon rains during the second week of May at the southern tip of India suggested an early (but possibly normal overall) Monsoon season. However, further progress of Monsoon was stalled for reasons that meteorologists do not fully understand and this stalling and later creating acute shortage of water in Mumbai and New Delhi (India's capital

city with a pop, ~14 M) evoked comments like "*Monsoon gamble, looming spectre of a drought etc*" from many, including a scientist working with *Greenpeace* in India.

It must be remembered that such delays in Monsoon arrival have occurred in the past and have affected India's agricultural output, but such delays and irregular Monsoon progression are all part of natural variability, quite possibly linked to large-scale atmospheric circulation systems like the ENSO (El Niño-Southern Oscillation) phase in equatorial Pacific, Eurasian and Himalayan winter snow cover, QBO (Quasi-Biennial equatorial stratospheric wind Oscillation) phase and perhaps a host of other regional features (see Khandekar 1996). This is what makes the Indian/Asian Monsoon so very complex and a challenging scientific problem.

In 1972 the Indian Monsoon was delayed, especially in Peninsular India, by almost six weeks and that year proved to be one of severest drought years for the Monsoon (most certainly the delay and the overall 'drought Monsoon' was attributed to the 1972 strong El Niño) which resulted in sharply reduced rice yield that year. Earlier, in 1961, Monsoon rains were heaviest during the four months with extensive flooding over many parts of India. Such floods and droughts have occurred irregularly and are still not fully understood. The worst ever drought was in 1877 which sparked a paper by Henry Blanford (1884) who was the British Meteorological Reporter for the Government of India then. In his paper, Blanford hypothesized a linkage between extensive snow cover over the Himalayas during the preceding winter and a weak subsequent Monsoon.

Climate modelers almost 100 years later were able to simulate this inverse relationship (Barnett et al 1989). However much remains to be understood about how winter Eurasian snow cover impacts Monsoon circulation a few months down the road and how the tropical easterly jet (TEJ) stream that emanates from east of Bangkok to Saudi Arabia at about 12 km level over Peninsular India (~12N) during the summer Monsoon months, evolves and influences Monsoon rains.

<sup>1</sup> A shorter version of this commentary first appeared in the Benny Peiser internet news letter CCNet 103/2009 July 2<sup>nd</sup> 2009.

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Per an IMD communication (issued on June 25 2009), Monsoon rains were eventually spreading over most of India and this season's rains were projected to be only about 93% of normal. The month of July is the most critical month with regular rains (~ 1cm/day under) over most of eastern & western Gangetic Plains (with a total population of over 250 M) during normal Monsoon. The ENSO phase was about normal during this year's Monsoon, so no adverse impact from equatorial Pacific was expected. Winter Eurasian snow cover during the 2008/09 winter was heavier than normal; however, the continued westerly phase of the QBO would help make up the Monsoon rains over the remainder of the season. As the season was drawing to a close, there were heavy rains leading to some flooding in the southern Peninsular region during the second and third week of September. The end-of-season summary issued by the IMD in mid-October estimated the season's rains over the country as a whole to be only 77% of normal, thus making summer 2009 as one of the major drought years in the Indian Monsoon. Only in the Peninsular region, the summer Monsoon was close to normal, as predicted early in the season.

Accurate simulation and prediction of Monsoon rains with a lead time of few weeks to few months still remains an intractable problem in climate science.

#### **References;**

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