

The Future Pulse of the Indian Monsoon¹

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ABSTRACT

The subsistence of India's burgeoning population and the health of its emergent economy are intricately tied to the pulse of its monsoonal climate. Variability in agricultural output (about 22% of GDP) is largely driven by the year-to-year fluctuations in strength of the summer monsoon rains (June to September), accounting for the historical binding of Indian economic and social fabric to climate. We are thus compelled with more than academic interest to determine how human emissions of greenhouse gases may affect the future pulse of Indian monsoon rains. At issue is not only the overall volume of rains during the summer monsoon season, but also the length of the monsoon season, the manner in which those rains are delivered (such as the number of rainy days and their intensity which affects agronomic stress and yields), and the frequency of severe rains (especially tropical storms which have property and life implications). We present lines of evidence and offer physical explanations to support a view that the seasonal mean Indian monsoon rains in the latter half of the 20th century may not be materially different in *abundance* to that experienced today, although their *intensity and duration of wet/dry spells* may change appreciably.

The matter of temperature is rarely considered when assessing the historical vulnerability of India to climate, owing to the fact that India's subtropical geography has ensured great stability of its yearly temperatures - interannual swings are mostly less than 1°C. As such, rain rather than temperature has exposed underlying risks to Indian societal and agricultural concerns to date. With regard to temperature, however, history may prove to be a poor yardstick for potential impacts of anticipated future change on India. We present results that show Indian temperatures during the late 21st Century will very likely exceed the highest values experienced in the 130-year instrumental record of Indian data. This assessment comes with higher confidence than for rainfall because of the large spatial scale driving the thermal response of climate to greenhouse gas forcing.

Tipping points, whose exceedence could trigger heighten human and crop mortality are explored. Indications of the response of human health and agricultural productivities to the late 21st century temperatures in the vicinity of such tipping points form a basis for discussion of the potentially large and detrimental effect that increases in greenhouse gases may have on the social and economic health of India.

¹ Based on the paper

The Once and Future Pulse of Indian Monsoon Climate, 2008; K. Kumar, K. Kamala, B. Rajagopalan, M. Hoerling, J. Eischeid, S. Patwardhan, G. Srinivasan, B. Goswami, and R. Nemani, *Proceedings of the National Academy of Science*, in review.