The influence of atmospheric and oceanic forcings on the Southwest and Northeast Monsoon over India: A paleoclimate perspective

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Abstract.

The Indian Monsoon is the primary source of water for approximately one-fourth of the world's population. There are two distinct monsoon seasons in India. The first is the southwest monsoon (SWM) and the rainfall associated with it is known as the Indian Summer Monsoon Rainfall (ISMR), and it brings rainfall to the majority of the Indian subcontinent between June and September (Simpson 1921; Gadgil 2003). The second is the northeast monsoon (NEM), which primarily influences peninsular India and Sri Lanka between October and December (Bamford 1922; Gadgil 2003). We propose to develop two monsoon-sensitive tree ring records that seek to reconstruct each of these two monsoons. Two sites from the Western Ghats in southwestern India and another from along the Eastern Ghats in southeastern India will be used to reconstruct the SWM and NEM, respectively. The locations of the proposed sites can be found in Figure 1. These reconstructions will enable us to examine the natural variability of both monsoons, and to explore their relationships to two key forcing effects – the El Niño-Southern Oscillation (ENSO- Ihara & Kushnir 2007), and the North Atlantic Oscillation (NAO- Chang et al. 2001). Baguinon et al. (2010) revealed multiple Indian species with annual ring formation, and Borgaonkar et al. (2010) showed that teak from the study region may exceed 700 years in age. We therefore propose that we can examine precipitation trends on centennial timescales, and that information may be used to project future variations in monsoonal rainfall due to natural and anthropogenic climate forcings.

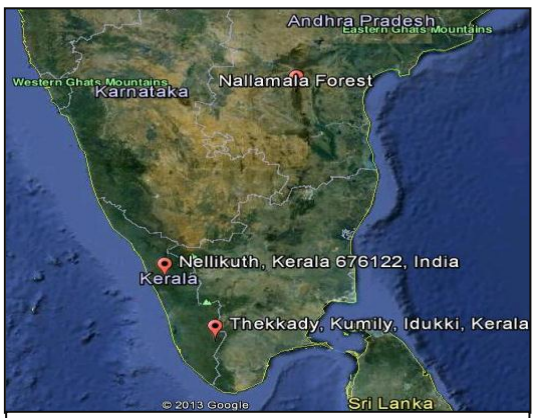

Figure 1 Proposed Sites (courtesy Google Maps)
Western Ghats: Nellikuth (11.104589N, 76.178763S) (Kerala) Thekkedy (9.625461N,77.158985S)
Eastern Ghats: Nallamala (15.601875N, 78.760071S) (Andhra Pradesh)

The Indian state of Kerala receives most of its rain from the SWM whereas the region along the Eastern Ghats in Andhra Pradesh receives a majority of its rainfall from the NEM. The selected sites are along mountain ranges hence, both receive high rainfall due to orographic lifting. Figure 2[1] depicts the surface level winds during both monsoon seasons. The figure demonstrates that the sites are on different sides of the two mountain ranges, and that each site receives a majority of its rainfall from only one of the two monsoon seasons. Because the moisture sources for the two monsoons are different (Arabian Sea for SWM and Bay of Bengal for NWM), an oxygen ($\delta^{18}O$) isotopic analysis can be used to compare the samples from Kerala and Andhra Pradesh. The oxygen isotope theory states that trees deposit isotopes during the transfer of source water to cellulose in the cambium (McCarroll & Loader 2004). Gupta et al.

[1] Figure 2 form http://wps.prenhall.com/wps/media/objects/442/453483/FG12_07Monsoon.JPG

(2005) have shown that the isotope compositions of the Bay of Bengal (the moisture source for NEM) and the Arabian Sea (source for SWM) are different. They observed that regions receiving precipitation from the Bay of Bengal are depleted in heavy isotopes ($\delta^{18}O$, δD)[2] as compared to regions that receive precipitation from the Arabian Sea. Therefore, by taking isotopic fractionation effects like evaporative enrichment into consideration, the analysis of oxygen isotopes might be used to develop temperature and relative humidity reconstructions (Waterhouse et al. 2002).

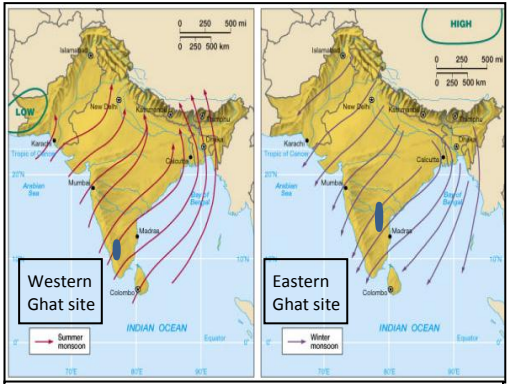

Figure 2 Surface winds associated with monsoon season (Left: SWM, Right: NEM)