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Quantitative constraints on the surface uplift history of Tibet and its climatic implications

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The Indian monsoon is driven both by the physical barrier of the Himalaya to air masses flowing northwards and by the heating effect of an uplifted plateau on the troposphere, generating a low-pressure system over central Asia. In order to provide empirical constraints on climate models that relate orographic evolution to monsoonal intensity and hence climate change it is critical to determine not only the changing elevation of the plateau but also to chart the changing area of the uplifted region through time. Whilst the exhumation history of an orogen can be determined from cooling ages or fission-track studies of surface bedrock, or its erosional history obtained from sedimentological studies, the palaeoaltitude of the surface is more difficult to determine and is often inferred from proxy observations that are usually model-dependent. Contrasting tectonic models for the behaviour of the lithosphere during continental collision, for example the thin-viscous sheet or the channel-flow models, have differing implications for the elevation of the plateau. In contrast, two techniques recently employed for determining palaeo-elevation are independent of such tectonic models, the first exploiting the change of leaf morphology with moist static energy of the atmosphere and the second involving the variation with altitude of oxygen isotopes in precipitation. Each technique carries its own uncertainties that can be quantified, but independent studies from a Neogene basin in southern Tibet suggest that the altitude of the southern plateau has not significantly changed since at least the mid Miocene (*ca.* 15 Ma) arguing for an onset of the monsoon system during or before the early Miocene. Tectonic and geochemical studies suggest that the northern plateau is a younger geomorphological feature, but there is no quantitative estimate of the timing of its elevation.