Impacts of Tibetan uplift history on palaeoclimate proxies

D.J. Lunt (1,2), R. Flecker (1)

(1) BRIDGE (Bristol Research Initiative for the Dynamic Global Environment, University of Bristol, UK
(2) British Antarctic Survey, UK

d.j.lunt@bristol.ac.uk
www.bridge.bris.ac.uk
XY222

(1) THE QUESTION

"Did Tibetan uplift result in climatic changes which are measurable in proxies today?"

or are observed changes usually assumed to be related to uplift, actually caused by something else....?

(2) EXPERIMENTAL DESIGN

We configured 4 climate model simulations, with various degrees of uplift:

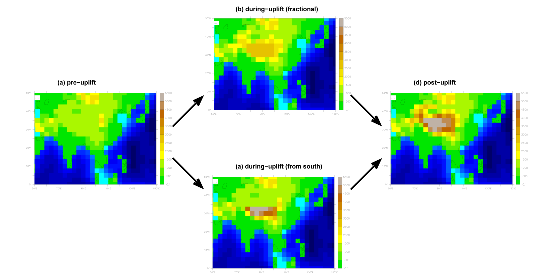

Figure 1: **East Asian orographic and bathymetric boundary conditions applied in the 4 simulations in this study (a) E_{flat}, (b) E_{frac}, (c) E_{south}, and (d) E_{mod}. Black arrows show the direction of geological time. The mean orography over the East Asian region in configurations (b) E_{frac} and (c) E_{south} is the same.**

We used the UK Met Office model, HadCM3, and carried out simulations to quasi-equilibrium.

(3) RESULTS - SSTs

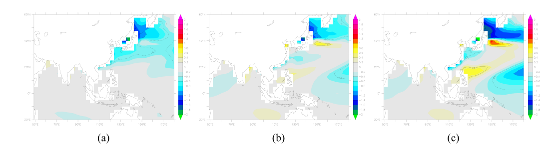

Figure 2: **(a,b,c) Annual mean SST change [°C] (a) E_{frac}-E_{flat}, (b) E_{south}-E_{flat}, and (c) E_{mod}-E_{flat}.**

It appears that SST is not a good indicator for climate change caused by Tibetan uplift or the nature of that uplift history. There are isolated regions which would show a signal, but these would be hard to interpret because of their relatively small magnitude and limited spatial extent, making any observed changes very hard to attribute to uplift directly. In addition, no change in SSTs is predicted as a result of Tibetan uplift and associated monsoonal variability in localities such as the South China Sea, a classic region for monsoon studies and where Holocene changes to monsoon intensity have been documented (e.g. Huang et al., 1997).

(4) RESULTS - vegetation

Vegetation changes in the region of the Tibetan Plateau should be a very good indicator of uplift and the uplift history. However, outside of the plateau itself, the vegetation signal associated with uplift is very weak. There are some latitudinal shifts in vegetation type, but these are relatively small and would be almost impossible to ascribe to uplift as opposed to other possible forcing factors.

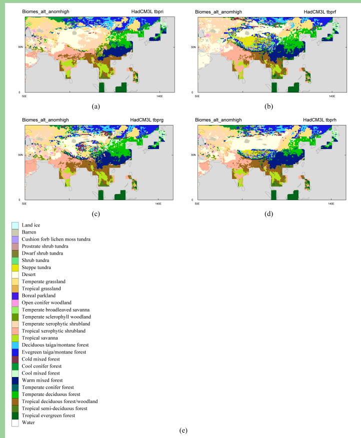

Figure 3: **Vegetation biome types predicted by the BIOME4 model for the four simulations (a) E_{flat}, (b) E_{mod}, (c) E_{frac}, and (d) E_{south}.**

(5) RESULTS - river discharge

Run-off can be used a good indicator of both uplift and uplift history, provided that the correct river basin is examined. Specifically, our results indicate that discharge from the Ganges/Brahmaputra would be the best indicator of uplift history, and that the Pearl and Yangtze would also show significant uplift signals.

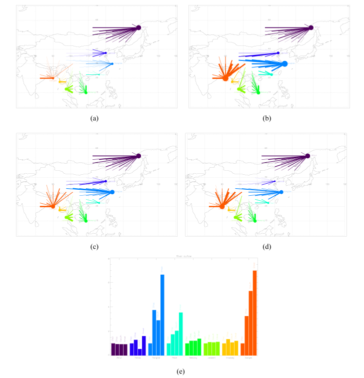

Figure 4: **(a-d) Major river runoff in the four simulations. The straight lines join the model continental gridcells with their corresponding river mouth. The thickness of the straight lines indicates the amount of runoff from that gridcell. The area of the filled circles at each river mouth represents the total runoff which enters the ocean at that point. Only the major rivers are shown. (a) E_{flat}, (b) E_{mod}, (c) E_{frac}, and (d) E_{south}. (e) shows the total outflow for the major rivers, normalized so that each river is given a value of 1 for the E_{flat} case.**

(6) CONCLUSIONS

We have shown that the SST changes associated directly with uplift are very small, and are unlikely to be detectable using current methods of palaeo SST reconstruction. An exception is in the subtropical western Pacific, but the area of cooling there is still relatively small. SST shows little possibility of distinguishing between different uplift histories. Vegetation-based proxies unsurprisingly show a large sensitivity over the plateau itself, where temperature and precipitation changes are both relatively large. They also show potential for distinguishing the history over the plateau. However, outside of the plateau, the vegetation is relatively insensitive to the temperature and precipitation changes associated with uplift. There are some shifts in vegetation boundaries, but these would be hard to interpret in the proxies as directly due to uplift, as opposed to other drivers. River discharge also shows some sensitivity to uplift. However, it is important to use the most sensitive river systems, which the model indicates to be the Ganges/Brahmaputra, the Yangtze, and the Pearl. In particular, the Ganges/Brahmaputra discharge appears to be a good proxy for distinguishing different uplift histories.