foraminifera were assembled from sediments representing different periods throughout the past 4 million years (Fig. 1). The sampling site is located in the centre of the present-day east Pacific cold tongue, the region where variations in sea surface temperature are largest during modern El Niño events. A high degree of variance in the stable isotopes of individual foraminifers provides strong evidence for persistent interannual temperature variability during the mid-Pliocene. This variability is most reasonably interpreted as ENSO variability, which occurred around a mean climate state that more closely resembles an El Niño event in the present-day Pacific Ocean than its present-day mean conditions.

The accompanying climate model simulations with the HadCM3 model confirm this scenario. The simulations suggest that in the Pliocene, ENSO variability was characterized by a more steady and regular amplitude, with slightly stronger El Niño events, than seen in the pre-industrial simulations.

This is in line with previous climate modelling studies, which mostly showed persistent ENSO variability for the Pliocene[4,10]. Indeed, a theoretical model has demonstrated that it is very difficult to create a mean climate state with a weak zonal temperature gradient and also that ENSO variability persists under a broad range of mean climate states[11]. Intriguingly, these simulations indicate that under conditions of elevated global mean temperatures and weaker trade winds — as may have prevailed during the Pliocene — the cold tongue shifts westwards from its present location. The movement of the centre of cooler waters may mean that temperature-gradient reconstructions based on sites in the present cold tongue may not capture the true east–west temperature gradient. Changes in the location of the cold tongue could reconcile proxy estimates of a low temperature gradient during the Pliocene with the model simulations that suggest that such a climate state is not dynamically viable.

The results[6] of Scroxton and colleagues show that interannual ENSO variability persisted throughout the warm Pliocene climate. Future work should explore ENSO variability in other warm episodes in Earth's history, in conjunction with efforts to understand the physical controls of the mean state of the tropical Pacific Ocean under a range of climatic conditions. ❐

Anna S. von der Heydt and Henk A. Dijkstra are in the Department of Physics and Astronomy, Institute for Marine and Atmospheric Research, Utrecht University, Princetonplein 5, 3584CC Utrecht, The Netherlands.
e-mail: A.S.vonderHeydt@uu.nl

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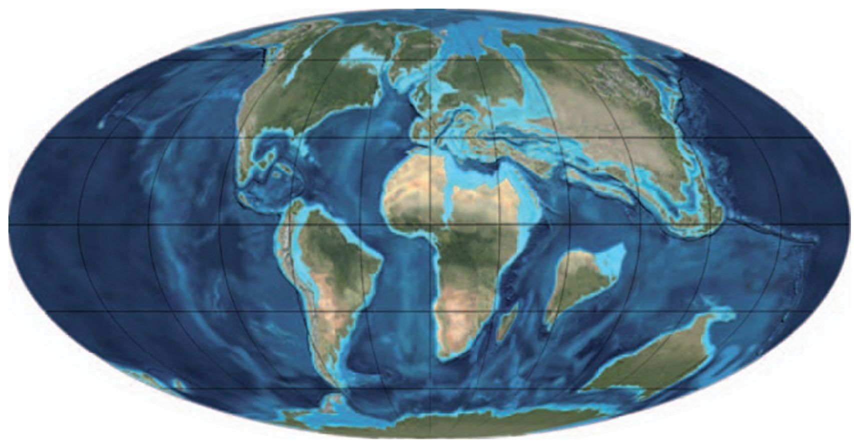
PLATE TECTONICS

Pushy plume

The migration speed of tectonic plates across the globe is largely controlled by the pull of old, dense oceanic lithosphere. As this lithosphere sinks into the mantle beneath the more buoyant continents, it gradually drags the surface part of the oceanic plate, as well as any adjoining continents, toward the subduction trench. This slab-pull force can move plates at a maximum rate of about 8 cm yr^{-1}. Yet, around 67 million years ago, India began charging towards Asia more than twice as fast, by up to 18 cm yr^{-1}.

To reassess the precise timing of India's movements, Steven Cande and Dave Stegman (*Nature* **475,** 47–52; 2011) analysed magnetic anomalies in basaltic rocks on the Indian Ocean floor. They found that India's motion accelerated precisely when the Réunion plume, rising up through the mantle beneath India, reached the surface. The power of the upwelling mantle plume may have given India an extra push, they suggest. And, because the plume nudged India towards the subduction zone that was already dragging the continent towards Asia, the two forces — plume push and slab pull — combined to catapult India on its journey northwards.



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The plate reconstructions also reveal that the motion of the African plate slowed down at about the same time. This retardation of Africa's movement could also be due to the influence of the Réunion plume: the plume is positioned in a way that the plume-push and slab-pull forces would have counteracted each other.

Between 15 and 22 million years later, the movements of both the Indian and African plates returned to normal. It could be that the Réunion plume, and its push, began to wane at this time.

AMY WHITCHURCH

Correction

In the print version of the News & Views 'Pushy plume' (*Nature Geosci.* **4**, 503; 2011), the reference in the second paragraph was incorrect and should have been '*Nature* **475**, 47–52; 2011'. This error is correct online.