likely position of the pre-glacial landscape. The data set also provides important insight into other aspects of landscape history. Notably, the findings do not support a second phase of rifting that is thought to have further elevated the Gamburtsev Mountains during the Cretaceous period⁷. This underscores both the mountain range's remarkable age and the extraordinary degree of subglacial landscape preservation.

The impressive data set of mineral grain ages presented by Thomson *et al.*¹ leads to as many questions as answers. Because incursions of ice into Prydz Bay have removed sediments deposited between approximately 3 and 33 million years ago, the

precise timing of glacial incision cannot be known. Thus, it remains unclear whether the transition from warmer to colder ice sheet conditions occurred later than 14 million years ago, as has been proposed¹⁰. The source of uplift in the Lambert region since 34 million years ago¹⁰ — and its influence on the timing and depth of incision — also remains enigmatic.

Despite the questions that remain, Thomson and colleagues¹ provide strong evidence for an early EAIS that was locally very erosive and may have undergone significant fluctuations in volume before transitioning to the stable, cold ice sheet of today¹⁰.

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CLIMATE SCIENCE

Tropical carbon constraint

The species-rich land-based ecosystems of the tropics store vast quantities of carbon. Climate change could lead to the release of much of this carbon into the atmosphere. Future droughts have been projected to trigger forest die-off and suppress productivity, and warming is expected to speed up the degradation of organic matter. How much carbon will be lost from these tropical ecosystems is, however, highly uncertain — projections differ by around 330 gigatonnes over the twenty-first century.

Equally uncertain are the knock-on effects for climate. Carbon that escapes tropical ecosystems and enters the atmosphere will cause further warming. Without a tighter constraint on the amount of carbon released, it is hard to put exact numbers on this positive feedback, but warming-induced carbon release in the tropics is considered to be one of the largest carbon-cycle–climate feedbacks on the planet.

Peter Cox and colleagues devise a way to quantify the amount of carbon transferred from tropical land to the atmosphere by 2099 as a result of climate warming, starting from 1960 (*Nature* <http://doi.org/khh>; 2013). They use a collection of climate models in which the land and ocean carbon cycles are fully coupled to changes in climate. As expected, they find large inter-model differences in tropical carbon loss — anywhere between 29 and 133 Gt of carbon are released per Kelvin rise in temperature over this period. However, they find systematic variations in the amount of carbon released: most carbon

is lost in those models that simulate the largest changes in atmospheric CO₂ levels in response to year-to-year variations in tropical temperature. Importantly, the relationship between carbon loss and the sensitivity of atmospheric carbon dioxide concentrations to temperature variations is linear across all the models.

They then use atmospheric observations to pin down the sensitivity of atmospheric carbon dioxide concentrations to past variations in tropical temperatures, and so determine how close individual models are to observations. Applying this constraint, they show that the reduction in terrestrial carbon storage expected from the tropics over the coming century falls at 53 ± 17 Gt

of carbon per Kelvin rise in temperature, a more moderate carbon–climate feedback than some climate models suggest.

Cox *et al.* quantify the effect of climate warming on tropical carbon loss. Unfortunately, the real world is more complicated still: rising concentrations of carbon dioxide are expected to fertilize tropical ecosystems, therefore offsetting potential carbon losses, and other factors (such as aerosols and non-CO₂ greenhouse gases) also play a role. The net effect of all these changes on tropical carbon release and climate remains to be seen.

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