What is this paper about?

Our primary interest in palaeoclimate rapid global warmings is their implication for twenty-first century climate change [p 1934].

This means they need to find processes operating within a century. I don't think they do. Statements like *we find no evidence of millennial lags between forcing and ice sheet response in palaeoclimate data [p1949]* aren't good enough.

Key arguments:

- (1) GHG feedbacks will substantially amplify warming
- (2) Climate Sensitivity is more like 6 oC for 2*CO2 than 3 oC
- (3) The palaeo record suggests that ice sheets respond quickly to change
- (4) 'albedo flip'

(1) GHG feedbacks

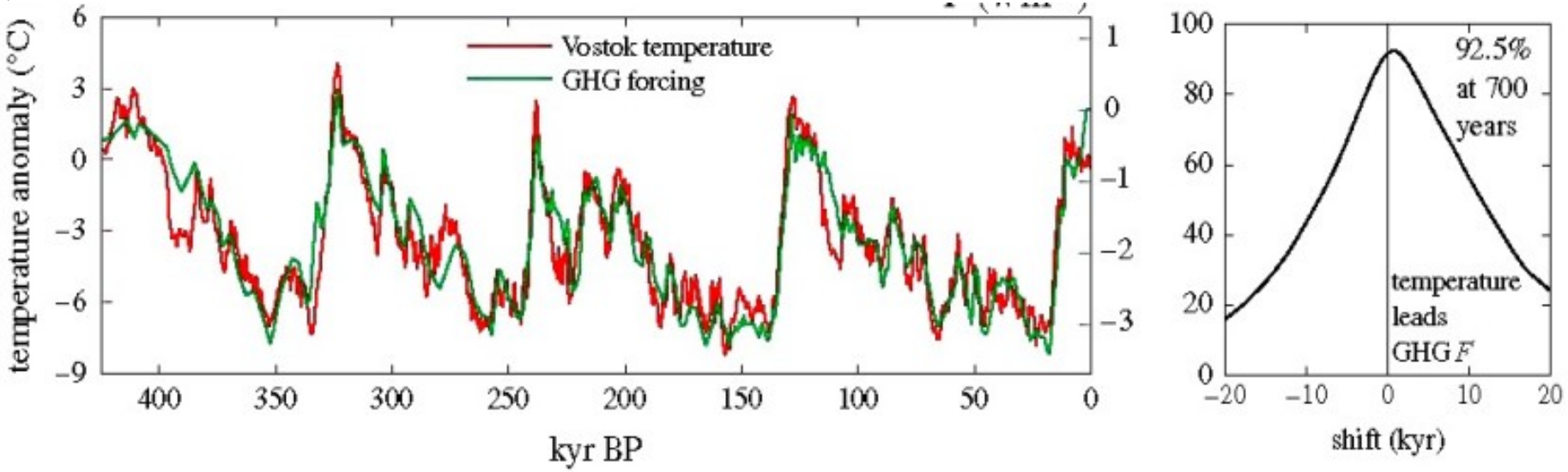


Figure 1a reveals remarkable correspondence of Vostok temperature and global GHG climate forcing. The temperature change appears to usually lead the gas changes by typically several hundred years, as discussed below and indicated in figure 1b. This suggests that warming climate causes a net release of these GHGs by the ocean, soils and biosphere. GHGs are thus a powerful amplifier of climate change, comparable to the surface albedo feedback, as quantified below [p1928].

An interesting point. In the case of the past, we're all agreed that GHG forcing amplifies the T feedback. In the case of now, we know that GHGs lead. Do we expect, on the basis of the palaeo stuff, substantial GHG feedback over the next few hundred years? Probably not: (a) the lag is more like 700 years (b) as the ice cores show, the GHG forcing tops out at 280 in interglacials - something (unknown) stops this feedback from venting more CO2. Why do we expect more in the future?

Various perfectly mainstream studies predict up to ~30% increase in atmos CO2 as a result of carbon cycle changes – do Hansens palaeo arguments add anything to this?

CO2, CH4 and N2O all seem to be positive feedbacks in palaeo records, with a lag of at most several hundred years, perhaps related to ocean mixing time. [p1946] – lag could easily be 1kyr; Hansen has 700. How did this morph into at most 100's?

(2) Climate sensitivity is twice what we think!?!

Surface albedo and GHG amounts are themselves feedbacks that respond to climate change, implying that actual climate sensitivity is much greater than that due to fast feedbacks. Realization that climate sensitivity is larger on longer time-scales is not new, but larger sensitivities are usually thought to apply to millennial time-scales. We will argue that 'slow' feedbacks (ice sheet, vegetation and GHG) substantially influence century, and perhaps shorter time-scales [p1931].

Hansen argues that Climate Sensitivty is 6 oC to 2*CO2. But this (which is nothing new) only applies if you have a Laurentide etc ice sheet. Without it, his argument collapses (more rapidly than an ice sheet...) and has no relevance to the future. Nor is it clear they could be relevant over a timespan as short as 100 years.

It might be argued that [6 oC for 2*CO2] *was derived from a (palaeoclimate) situation with large vulnerable ice sheets. True, but today further warming of even half the 5C warming since the last ice age will make West Antarctica and at least the South Dome of Greenland vulnerable [p1946].*

I don't think this rescues him. The Laurentide was bigger, and nearer the equator. If W Ant or Greenland collapsed there would be some albedo feedback (though less that the LGM) but this is a circular argument, and assumes the result. GCMs already include a temperature-dependent albedo for W Ant and Gr for the 21st century, and get the “standard” result.

(3) Ice sheet collapse timescale

It is difficult to predict time of collapse in such a nonlinear problem, but we find no evidence of millennial lags between forcing and ice sheet response in palaeoclimate data. An ice sheet response time of centuries seems probable, and we cannot rule out large changes on decadal time-scales once wide-scale surface melt is underway. [p1949]

Does this provide any useful information?

available data for the two terminations with near-absolute dating do not provide evidence for multi-millennial lag between insolation forcing and ice sheet response. If our interpretation of near synchroneity of forcing and ice sheet response is correct, implications for humanity are profound. [p1934]

morphs into...

Global warming of approximately 38C is predicted by practically all climate models for 'business-as-usual' (BAU) growth of GHGs (IPCC 2001, 2007). Yet IPCC (2001, 2007) foresees twenty-first century sea-level rise of only a fraction of a metre with BAU global warming. Their analysis assumes an inertia for ice sheets that, we argue, is incompatible with palaeoclimate data and inconsistent with observations of current ice sheet behaviour. [p1936]

So lack of a multi-millenial lag becomes evidence for change on a sub-century timescale. How?

Does the palaeo record really provide evidence for a fast (less than century; 1-2 centuries if you're pushing it) response from the ice sheets?

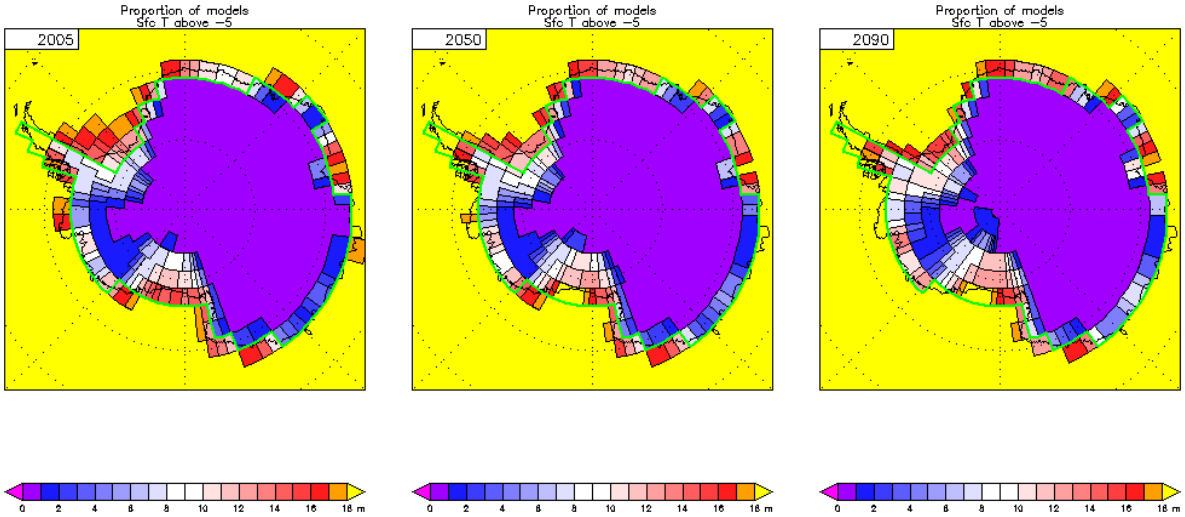
(4) 'Albedo Flip'

Or the ice-snow albedo feedback.

Thick ice sheets provide not only a positive feedback, but also the potential for cataclysmic collapse, and thus an explanation for the asymmetry of the ice ages. The albedo flip property of ice/water provides a trigger mechanism. If the trigger mechanism is engaged long enough, multiple dynamical feedbacks will cause ice sheet collapse (Hansen 2005). We argue that the required persistence for this trigger mechanism is at most a century, probably less. [p1935]

So the ice sheets are not going to disappear because they melt from the top, instead this will initiate ?basal? mechanisms leading to collapse.

What do GCMs say...?



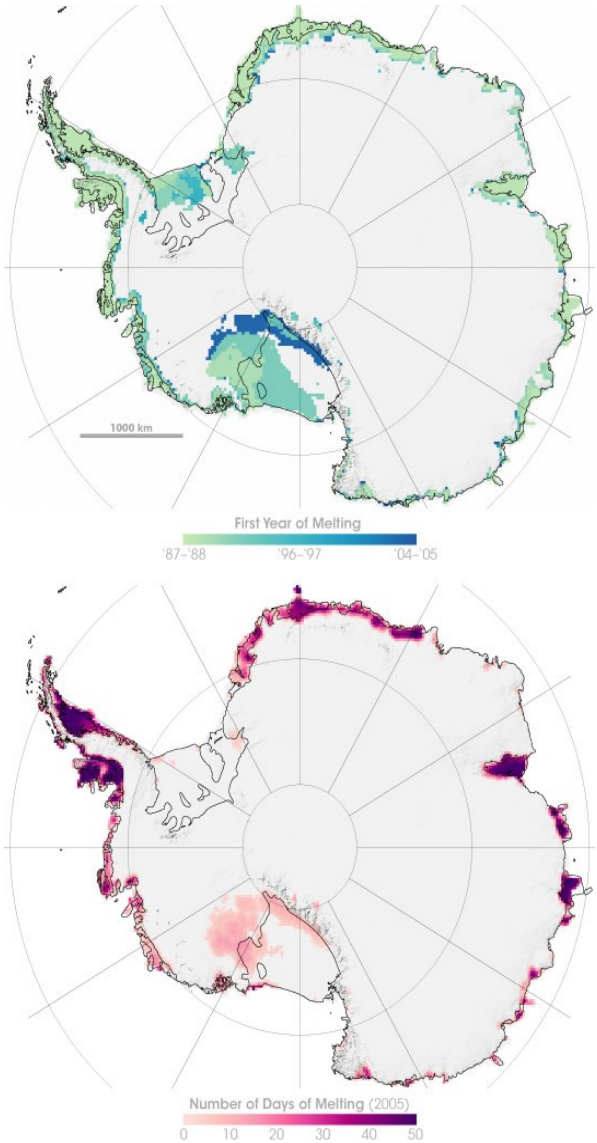


Illustration 1: http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=17780