

Interactive comment on “Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous” by J. Hansen et al.

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Response to SC C5549: ‘Interactive comment on “ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2°C global warming is highly dangerous” by J. Hansen et al.’, William Ruddiman, 03 Aug 2015.

Here I (JEH) respond in first person to this discussion by Bill Ruddiman. I suspect that Bill is responding to the portion of our paper that discusses his hypothesis that the An-

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thropocene began several millennia ago, without carefully reading our entire paper and discerning its implications for his hypothesis. My inclination has always been (without a great deal of study, however) to suspect that he is basically correct – the human climate forcing did become significant several thousand years ago. Furthermore, I believe that our paper provides a way out of the conundrums that he has faced in trying to defend his hypothesis.

The basic problems he has faced are (1) the extremely large deforestation source that he has hypothesized, which most people would dismiss as unrealistic, and (2) such a huge anthropogenic source would have left a clear signal in ^{13}C data, which is not there.

What can be inferred from our paper is that he does not need a human-made source nearly as large as he has assumed (40 ppm CO_2) to explain the observed changes of CO_2 . We conclude, based on a huge body of research by the scientific community, that the Southern Ocean is the key regulator of atmospheric CO_2 and CO_2 is the control knob for global climate. Furthermore, the system is quite sensitive on millennial time scales: weak persistent paleo forcings are able to elicit a substantial CO_2 change via variations of the upwelling of deep ocean carbon.

The Holocene, like the Eemian, had peak CO_2 early in the interglacial period and then a very slow decline of atmospheric CO_2 . However, the slow Holocene decline of atmospheric CO_2 , which had peaked at ~ 12 ky BP (12 thousand years before present), came to an end at ~ 7500 ky BP and then a slow CO_2 increase ensued. I believe that Ruddiman is right that the reason for the reversal of the CO_2 trend is anthropogenic emissions. However, most of the increase of atmospheric CO_2 during the next several thousand years would have been from the Southern Ocean. The amount of human CO_2 emission required to prime this Southern Ocean CO_2 pump, given the demonstrated sensitivity of that pump to weak persistent forcing, was at most the magnitude needed to stem the natural decline. There would be no need for a CO_2 forcing greater than ~ 10 ppm CO_2 , surely not 40 ppm. With a requirement of only ~ 10 ppm of an-

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thropogenic CO₂, both the unrealistic source problem and the ¹³C problem disappear.

My conclusion is that the Anthropocene began ~7500 years ago, as Ruddiman proposed, and the Hyper-anthropocene began with the coal burning of the industrial revolution.

By the way, I do agree that there is no need to get into the merits or demerits of the modeling of Kleinen – it would only detract from the need to see the forest for the trees.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 20059, 2015.

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