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Highly Over-Hyped: Greenland's and Antarctica's Impacts on Sea Level

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In the 24 March 2006 issue of *Science*, a number of commentaries heralded accelerating discharges of glacial ice from Greenland and Antarctica, while dispensing dire warnings of an imminent large, rapid and accelerating sea-level rise (Bindschadler, 2006; Joughin, 2006; Kerr, 2006; Kennedy and Hanson, 2006). This distressing news was based largely on three reports published in the same issue (Ekstrom *et al*., 2006; Otto-Bliesner *et al*., 2006; Overpeck *et al*., 2006), wherein the unnerving phenomena were attributed to anthropogenic-induced global warming, which is widely claimed to be due primarily to increases in the air's CO_2 content that are believed to be driven by the burning of ever increasing quantities of fossil fuels such as coal, gas and oil. But does all of this make any sense?
Consider the report of Ekstrom *et al*., who studied "glacial earthquakes" caused by sudden sliding motions of glaciers on Greenland. Over the period Jan 1993 to Oct 2005, they determined that (1) *all* of the best-recorded quakes were associated with major outlet glaciers on the east and west coasts of Greenland between approximately 65 and 76°N latitude, (2) "a clear increase in the number of events is seen starting in 2002," and (3) "to date in 2005, twice as many events have been detected as in any year before 2002." With respect to the *reason* for the recent increase in glacial activity on Greenland, Clayton Sandell of ABC News (23 March 2006) quotes Ekstrom as saying "I think it is very hard not to associate this with global warming," which sentiment appears to be shared by almost all of the authors of the seven *Science* articles. Unwilling to join in that conclusion, however, was Joughin, who in the very same issue presented histories of summer temperature at four Greenland coastal stations located within the same latitude range as the sites of the glacial earthquakes, which histories suggest that it was warmer in this region back in the 1930s than it was over the period of Ekstrom *et al*.'s analysis. Based on these data, Joughin concluded that "the recent warming is too short to determine whether it is an anthropogenic effect or natural variability," a position that is supported -- and in some cases even more rigorously -- by numerous scientists who have researched the issue, as noted in the following brief synopses of some of their

studies.
Hanna and Cappelen (2003), determined the air temperature history of coastal southern Greenland from 1958-2001, based on data from eight Danish Meteorological Institute stations in coastal and near-coastal southern Greenland, as well as the concomitant sea surface temperature (SST) history of the Labrador Sea off southwest Greenland, based on three previously published and subsequently extended SST data sets (Parker *et al*., 1995; Rayner *et al*., 1996; Kalnay *et al*., 1996). Their analyses revealed that the coastal temperature data showed a cooling of 1.29°C over the period of study, while two of the three SST databases also depicted cooling: by 0.44°C in one case and by 0.80°C in the other. In addition, it was determined that the cooling was "significantly inversely correlated with an increased phase of the North Atlantic Oscillation (NAO) over the past few decades."

In an even broader study based on mean monthly temperatures of 37 Arctic and 7 sub-Arctic stations, as well as temperature anomalies of 30 grid-boxes from the updated data set of Jones, Przybylak (2000) found that (1) "in the Arctic, the highest temperatures since the beginning of instrumental observation occurred clearly in the 1930s," (2) "even in the 1950s the temperature was higher than in the last 10 years," (3) "since the mid-1970s, the annual temperature shows no clear trend," and (4) "the level of temperature in Greenland in the last 10-20 years is similar to that observed in the 19th century." These findings led him to conclude that the meteorological record "shows that the observed variations in air temperature in the real Arctic are in many aspects not consistent with the projected climatic changes computed by climatic models for the enhanced greenhouse effect," because, in his words, "the temperature predictions produced by numerical climate models significantly differ from those actually observed."

In a study that utilized satellite imagery of the Odden ice tongue (a winter ice cover that occurs in the Greenland Sea with a length of about 1300 km and an aerial coverage of as much as 330,000 square kilometers) plus surface air temperature data from adjacent Jan Mayen Island, Comiso *et al*. (2001) determined that the ice phenomenon was "a relatively smaller feature several decades ago," due to the warmer temperatures that were prevalent at that time. In fact, they report that observational evidence from Jan Mayen Island indicates that temperatures there actually cooled at a rate of 0.15 ± 0.03°C per decade throughout the prior 75 years.

More recently, in a study of three coastal stations in southern and central Greenland that possess almost uninterrupted temperature records between 1950 and 2000, Chylek *et al*. (2004) discovered that "summer temperatures, which are most relevant to Greenland ice sheet melting rates, do not show any persistent increase during the last fifty years." In fact, working with the two stations with the longest records (both over a century in length), they determined that coastal Greenland's peak temperatures occurred between 1930 and 1940, and that the subsequent decrease in temperature was so substantial and sustained that then-current coastal temperatures were "about 1°C below their 1940 values." Furthermore, they note that "at the summit of the Greenland ice sheet the summer average temperature has decreased at the rate of 2.2°C per decade since the beginning of the measurements in 1987."

At the *start* of the 20th century, however, Greenland *was* warming, as it emerged, along with the rest of the world, from the depths of the Little Ice Age. What is more, between 1920 and 1930, when the atmosphere's CO_2 concentration rose by a mere 3 to 4 ppm, there was a *phenomenal* warming at all five coastal locations for which contemporary temperature records are available. In fact, in the words of Chylek *et al*., "average annual temperature rose between 2 and 4°C [and by as much as 6°C in the winter] in less than ten years." And this warming, as they note, "is also seen in the $^{18}O/^{16}O$ record of the Summit ice core (Steig *et al*., 1994; Stuiver *et al*., 1995; White *et al*., 1997)."

In commenting on this dramatic temperature rise, which they call the *great Greenland warming of the 1920s*, Chylek *et al*. conclude that "since there was no significant increase in the atmospheric greenhouse gas concentration during that time, the Greenland warming of the 1920s demonstrates that a large and rapid temperature increase can occur over Greenland, and perhaps in other regions of the Arctic, due to internal climate variability such as the NAM/NAO [Northern Annular Mode/North Atlantic Oscillation], without a significant anthropogenic influence."

In light of these several real-world observations, it is clear that the recent upswing in glacial activity on Greenland likely has had nothing to do with anthropogenic-induced global warming, as temperatures there have yet to rise either as *fast* or as *high* as they did during the great warming of the 1920s, which was clearly a *natural* phenomenon.

It is also important to recognize the fact that coastal glacial discharge represents only *half* of the equation relating to sea level change, the other half being inland ice accumulation derived from precipitation; and when the mass balance of the *entire* Greenland ice sheet was most recently assessed via satellite radar altimetry, quite a different result was obtained than that suggested by the seven *Science* papers of 24 March. Zwally *et al*. (2005), for example, found that although "the Greenland ice sheet is thinning at the margins," it is "growing inland with a small overall mass gain." In fact, for the 11-year period 1992-2003, Johannessen *et al*. (2005) found that "below 1500 meters, the elevation-change rate is -2.0 ± 0.9 cm/year, in qualitative agreement with reported thinning in the ice-sheet margins," but that "an increase of 6.4 ± 0.2 cm/year is found in the vast interior areas above 1500 meters." Spatially averaged over the bulk of the ice sheet, the net result, according to the latter researchers, was a mean increase of 5.4 ± 0.2 cm/year, "or ~60 cm over 11 years, or ~54 cm when corrected for isostatic uplift." Consequently, the Greenland ice sheet experienced no net loss of mass over the last decade for which data are available. Quite to the contrary, in fact, it was host to a net *accumulation* of ice, which Zwally *et al*. found to be producing a 0.03 ± 0.01 mm/year *decline* in sea-level.

In an attempt to downplay the significance of these inconvenient findings, Kerr quotes Zwally as saying he believes that "right now" the Greenland ice sheet is experiencing a net loss of mass. Why? Kerr says Zwally's belief is "based on his gut feeling about the most recent radar and laser observations." Fair enough. But *gut feelings* are a poor substitute for comprehensive real-world measurements; and even if the things that Zwally's intestines are telling him are ultimately proven to be correct, their confirmation would only demonstrate just how rapidly the Greenland environment can change. Also, we would have to wait and see how long the mass losses prevailed in order to assess their significance within the context of the CO_2-induced global warming debate. For the present and immediate future, therefore, we have no choice but to stick with what the existent data and analyses suggest, i.e., that *cumulatively since the early 1990s*, and *conservatively* (since the balance is likely still positive), there has been no net loss of mass from the Greenland ice sheet.

The set of *Science* papers and associated news reports also make much of recent ice discharges from Antarctica, particularly along the Antarctic Peninsula, which has warmed more than any other place on earth over the past fifty years. Little to nothing, however, is said about the fact that the great bulk of the continent has actually *cooled* over this period, which as in the case of Greenland has also been demonstrated by numerous researchers, as outlined below.

In a study of the entire continent, Comiso (2000) assembled and analyzed Antarctic temperature data from 21 surface stations and from infrared satellites operating from 1979 to 1998. The temperature trend derived from the satellite data was a cooling of 0.42°C per decade, while the trend derived from the station data was a cooling of 0.08°C per decade, which led Comiso to state that these negative temperature trends were "intriguing, since during the same time period a general warming is being observed globally," and to note that "the slight cooling detected in the entire Antarctic region is compatible with a slightly positive trend in the sea ice extent that has been observed from passive microwave data."

Doran *et al*. (2002) measured a number of meteorological parameters in the McMurdo Dry Valleys of Antarctica between 1986 and 2000, comparing what they learned with what happened concurrently over the rest of the continent, the climatic record of which stretches two additional decades back in time. Over the 14 years of their intensive measurements, the McMurdo Dry valleys cooled at the phenomenal rate of 0.7°C per decade. This dramatic cooling, in the researchers' words, "reflects longer term continental Antarctic cooling between 1966 and 2000." In addition to sharing the same cooling trend, most of the 14-year cooling in the dry valleys occurred in the summer and autumn, just as most of the 35-year cooling over the continent as a whole (which did not include any data from the dry valleys) also occurred in the summer and autumn; and Doran *et al*. note that this multi-faceted "compatibility with the dry valley data increases the validity of the analysis."

As for the significance of their findings, Doran *et al*. say that the continental Antarctic cooling documented in their paper "poses challenges to models of climate and ecosystem change." Climate models, as they note, not only predict that global warming should have been occurring over the period of their study, but that there should have been "amplified warming in polar regions." To instead find *dramatic cooling* (which is about as different from *amplified warming* as one can get) especially in one of the two places on earth where the climate models are thought to be most correct, represents about as clear-cut a refutation of the predictions of the climate models as one can imagine.

Taking a slightly longer view of the subject, Turner *et al*. (2005) used a "new and improved" set of Antarctic climate data -- which is described in detail by Turner *et al*. (2004) -- to examine "the temporal variability and change in some of the key meteorological parameters at Antarctic stations." In doing so, they found the warming at low elevations on the western coast of the Antarctic Peninsula to have been "as large as any increase observed on Earth over the last 50 years," which at the Faraday (now Vernadsky) station amounted to about 2.5°C. However, they say that "the region of marked warming is quite limited and is restricted to an arc from the southwestern part of the peninsula, through Faraday to a little beyond the tip of the peninsula."

With respect to the bigger picture of the vast bulk of the continent, the nine climate scientists remark that "of the 19 stations examined in this study for which annual trends could be computed, 11 stations have experienced warming over their whole length, seven stations have cooled, and one station had too little data to allow an annual trend to be computed." Considering that four of the stations that warmed are associated with the Antarctic Peninsula, however, there is little that can be said about the temperature trend of the entire continent, which issue they skillfully skirt. However, they do report "there has been a broad-scale change in the nature of the temperature trends between 1961-90 and 1971-2000." Specifically, they report that of the ten coastal stations that have long enough records to allow 30-year temperature trends to be computed for both of these periods, "eight had a larger warming trend (or a smaller cooling trend) in the *earlier* [our italics] period." In fact, four of them changed from warming to cooling, as did the interior Vostok site; and at the South Pole the rate of cooling intensified by a factor of six.

These observations reveal that over the latter part of the 20th century, i.e., the period of time that according to climate alarmists experienced the most dramatic global warming of the entire past two millennia, fully 80% of the Antarctic coastal stations with sufficiently long temperature records experienced either *an intensification of cooling* or *a reduced rate of warming*; while four coastal sites and one interior site actually *shifted from warming to cooling*.

In light of these facts, it is clear there is a serious disconnect between reality and the virtual world of climate modeling; and since everything else in the 24 March 2006 set of glacial ice *Science* papers pertains to climate modeling, there is not much else that need be said about them ... except, perhaps, to note that the modeling pertains primarily to the *prior interglacial*, which makes it essentially meaningless for two additional reasons. First, if the models can't replicate what happened in earth's polar regions over the past few decades, there's surely no reason to give any credence to what they tell us about something that occurred 130,000 years ago. And second, one can easily get the right answer to a computational problem for any number of compensating wrong reasons, so that even a "correct" replication does not imply that the mechanics of the modeled phenomenon are correctly understood.

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