Arctic Temperature Change – Over the Past 100 years

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This note has been prepared in response to questions and comments that have arisen since the publication of the Arctic Climate Impact Assessment overview document – "*Impacts of a Warming Arctic*". It is intended to provide clarity regarding some aspects relative to the material from Chapter 2 *Arctic Climate - Past and Present* that will appear in full with the publication of the ACIA scientific report in 2005 and has now been posted on the ACIA website.

There are several possible definitions of the Arctic depending on, for example, tree line, continuous permafrost, and other factors. It was decided for purposes of this analysis that the latitude 60^{o}N would be defined as the southern boundary. Although somewhat arbitrary, this is no more arbitrary than choosing 62 ^{o}N, 67 ^{o}N or any other latitude. Since the marine data in the Arctic are very limited in geographical and temporal coverage, it was decided, for consistency, to only use data from land stations. The Global Historical Climatology Network (GHCN) database (updated from Peterson and Vose, 1997) and the Climatic Research Unit (CRU) database (Jones and Moberg, 2003) were selected for this analysis.

The analysis showed that the annual land-surface air temperature variations in the Arctic (north of 60º N) from 1900 to 2002 using the GHCN and the CRU datasets led to virtually identical time series, and both documented a statistically significant warming trend of 0.09 ºC/decade during that period (Figure 1). In view of the high correlation between the GHCN and CRU datasets, it was decided to focus the presentation in Chapter 2 on analyses of the GHCN dataset.

It needs to be stressed that the spatial coverage of the region north of 60º N is quite varied. During the period (1900–1945), there were few observing stations in the Alaska/Canadian Arctic/West Greenland sector and more in the North Atlantic (East Greenland/Iceland/Scandinavia) and Russian sectors. The coverage for periods since 1945 is more uniform. Based on the analyses of the GHCN and CRU datasets, the annual land-surface air temperature from 60–90^{o}N, smoothed with a 21-point binomial filter giving near decadal averages, was warmer in the most recent decade (1990s) than it was in the 1930–1940s period. It should be noted that other analyses (e.g., Przybylak 2000; Polyakov et al. 2002; and Lugina et al. 2004) give comparable estimates of Arctic warming for these two decades that, however, lay within the error margins of possible accuracy of the zonal mean estimates (Vinnikov et al. 1990;

Vinnikov et al.,1987). The major source of this uncertainty is the data deficiency in the North American sector prior to 1950s in all databases.

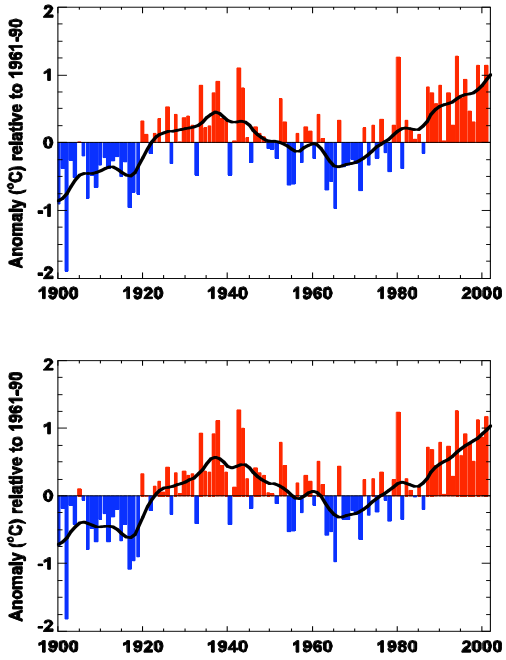

Figure 1. Annual anomalies of land-surface air temperature (°C) from 60–90°N for the period 1900–2002. Anomalies are relative to a 1961–1990 base period. The smoothed curve was created using a 21-point binomial filter giving near decadal averages. Panel (a)(upper) depicts the GHCN time series (updated from Peterson and Vose, 1997), and panel (b)(lower) depicts the CRU time series (Jones and Moberg, 2003).

Least-squares linear trends in annual anomalies of Arctic (60º to 90º N) land-surface air temperature from the GHCN (updated from Peterson and Vose, 1997) and CRU (Jones and Moberg, 2003) datasets for the period 1966–2003 both gave warming rates of 0.38 (ºC/decade). This is consistent with the analysis of Polyakov et al. (2002) and confirmed with satellite observations over the whole Arctic, for the past 2 decades (Comiso, 2003).

Chapter 3 of the ACIA report, entitled "The Changing Arctic: Indigenous Perspectives" documents the traditional knowledge of Arctic residents and indicates that substantial changes have already occurred in the Arctic and supports the evidence that the most recent decade is different from those of earlier in the 20th century

The modeling studies of Johannessen et al. (2004) showed the importance of anthropogenic forcing over the past half century for modeling the arctic climate. "It is suggested strongly that whereas the earlier warming was natural internal climate-system variability, the recent SAT (surface air temperature) changes are a response to anthropogenic forcing".

In the context of this report, the authors agreed on the following terminology. A conclusion termed as "very probable" is to be interpreted that the authors were 90–99% confident in the conclusion. The term "probable" conveys a 66–90% confidence.

The conclusions of Chapter 2 were that:

"Based on the analysis of the climate of the 20th century, it is very probable that the Arctic has warmed over the past century, although the warming has not been uniform. Land stations north of 60º N indicate that the average surface temperature increased by approximately 0.09 ºC/decade during the past century, which is greater than the 0.06 ºC/decade increase averaged over the Northern Hemisphere. It is not possible to be certain of the variation in mean land-station temperature over the first half of the 20th century because of a scarcity of observations across the Arctic before about 1950. However, it is probable that the past decade was warmer than any other in the period of the instrumental record."

Polar amplification refers to the relative rates of warming in the Arctic versus other latitude bands. The conclusions of Chapter 2 were that:

"Evidence of polar amplification depends on the timescale of examination. Over the past 100 years, it is possible that there has been polar amplification, however, over the past 50 years it is probable that polar amplification has occurred."

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