



HOW UNUSUAL IS THE LATE 20TH CENTURY WARMING?

SUMMARY

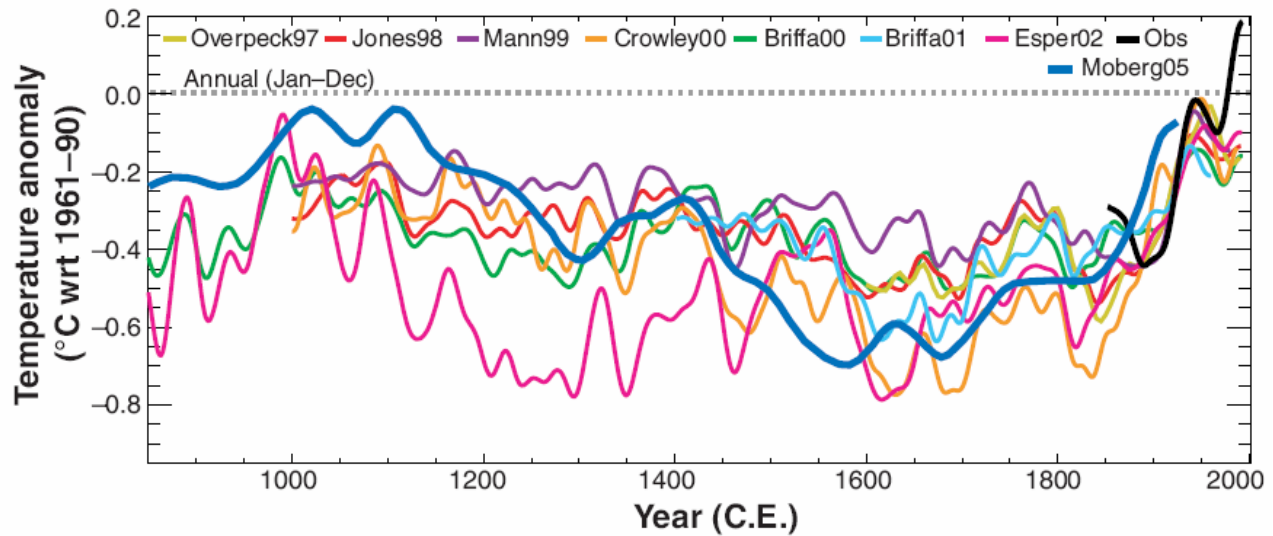
There is solid evidence for global warming in the 20th century, but is this warming unusual or just part of natural variability? Temperatures during the past 1,000 years can provide a measure of natural climate variability. While thermometer records are widely available for the past 140 years, earlier temperature records must be reconstructed from proxy data (tree-rings, sediments, ice cores and corals). Most proxy data are limited to the northern hemisphere.

Most scientists agreed in 2001 that the late 20th century warming in the northern hemisphere is likely to have been the largest of any century during the past 1,000 years. Recent research has extended this conclusion: late 20th century warming in the northern hemisphere is likely to have been the largest of any century during at least the past 1,800 years. The IPCC concludes that global warming over the past 50 years was mainly caused by human activities that have increased atmospheric concentrations of greenhouse gases.

There is solid evidence for global warming in the 20th century. In addition to the global-average surface warming of 0.6°C, the lower atmosphere and upper ocean have warmed, snow and ice cover have declined, global-average sea-level has risen 10 to 20 cm, high temperatures have increased, and frost seasons have become shorter (IPCC, 2001). Is the warming of the 20th century unusual or just part of natural variability?

Temperatures during the past 1,000 years can provide a measure of natural climate variability. While thermometer records are widely available for the last 140 years, earlier temperature records must be reconstructed from proxy data (tree-rings, sediments, ice cores and corals). Most proxy data are limited to the northern hemisphere.

Mann et al. (1998) found that the 1990s were likely to have been the warmest decade, and 1998 the warmest year, of the past millennium in the northern hemisphere. Jones et al. (1998) reached a similar conclusion from largely independent data and an independent methodology. Crowley and Lowery (2000) found that medieval temperatures (between the mid-12th and early 14th centuries) were no warmer than mid-20th century temperatures. These results, and those of two other reconstructions (Briffa et al., 2001), are shown in the diagram below. Independent borehole temperature reconstructions (Pollack and Smerdon, 2004) also indicate that the recent warming is unusual in the context of the last 500 years. More recent research has shown that the late 20th century warmth in the northern hemisphere is unprecedented for at least the past 1,800 years (Mann and Jones, 2003). A claim that the pre-1900 variability may be underestimated by a factor of two (von Storch, 2004) has been challenged (Wahl et al, 2006) Northern Hemisphere temperatures similar to those in the 20th century before 1990 may have occurred around 1000-1100 AD (Moberg et al, 2005). The robustness of multi-proxy reconstructions of temperature over the last millennium needs further investigation (Bürger and Cubasch 2005).



Eight Northern Hemisphere temperature reconstructions over the past 1150 years. The annual mean Northern Hemisphere temperature record from 1860 to 1999, based on thermometer observations (Obs), is also shown for comparison. The horizontal zero line denotes the 1961 to 1990 reference period mean temperature. Source: Kerr (2005: *Science* 307, page 828).

Some of these results have been questioned. A study by Soon and Baliunas (2003) challenged the unusual nature of the 20th century warming, but this study was found to be scientifically flawed (Mann et al., 2003a; Mann and Jones, 2003). Another study by McIntyre and McKittrick (2003) claimed that temperatures estimated by Mann et al. (1998) from 1400 to 1980 contained errors, and that corrections to the data showed that the early 15th century was warmer than any period in the 20th century. However, these claims were countered by Mann et al. (2003b) who found that McIntyre and McKittrick (2003) made errors in their analysis and omitted or truncated key proxy indicators from 1400-1600. Mann et al. (2004) acknowledge that their 1998 paper contained several errors that, when appropriately corrected, had no effect on previously published results. McIntyre and McKittrick (2005) claimed that the method of Mann et al. (1998) is biased toward producing a ‘hockey stick’ shaped curve and underestimates uncertainty in the 15th century. This assertion was tested by von Storch and Zorita (2005) and Huybers (2005) who found that the normalization used by Mann et al (1998) tends to bias results toward having a “hockey stick” shape, but the scope of this bias is exaggerated by the choice of normalization used by McIntyre and McKittrick (2005) and by an error in their estimation of significance levels.

The IPCC (2001) concludes that global warming over the past 50 years was mainly caused by human activities that have increased atmospheric concentrations of greenhouse gases.

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