Medieval Warm Period in Northern Europe

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MEDIEVAL WARM PERIOD IN NORTHERN EUROPE

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Was there really a *global* Medieval Warm Period? The IPCC used to acknowledge there was; but they have long since changed their view on the subject. Mounting evidence, however, suggests they were wrong to do so; and in this summary, both old and new important data from Northern Europe that support their *original* belief are described and discussed.

Studying "four well-preserved continuous sediment sequences from the southern flank of the Skagerrak [58.2-58.6°N, 7.6-8.2°E]," which he described as "a current-controlled sedimentary basin between the North and Baltic Seas," Hass (1996)[1] carried out "granulometric and stable oxygen isotope analyses ... in order to reconstruct climate fluctuations and to evaluate climate impact during the upper Holocene." These data and his analyses of them led him to conclude that the "Modern Climate Optimum was reached between 1940 and 1950, when temperatures exceeded the present day mean by 0.5°C." Prior to that was the Little Ice Age, which he placed at about AD 1350-1900, while before that the Medieval Warm Period (AD 800/1000-1350) held sway, the climate of which, in his words, "was characterized by warm summers, mild winters and little storm activity." Preceding this interval was what has been called the Dark Ages Cold Period, which Hass did not name but placed between AD 400 and 700, while preceding that cold spell was the Roman Warm Period, running from approximately 400 BC to AD 400. And preceding these climatic epochs was another pair of cold and warm periods.

Was there really a global Medieval Warm Period? The IPCC used to acknowledge there was; but they have long since changed their view on the subject.

Mounting evidence, however, suggests they were wrong to do so; and in this summary, both old and new important data from Northern Europe that support their original belief are described and discussed.

As so many other studies have revealed, both before and after 1996, Hass' work adds to the mountain of evidence supporting the reality of a repetitive worldwide cycling of climate between Medieval Warm Period- and Little Ice Age-like conditions. In addition, he notes that "at the onset of the Modern Climate Optimum ... conditions change again to a level comparable

[1] http://www.co2science.org/articles/V12/N16/C3.php.

to the Medieval Warm Period," even though there was not nearly as much CO_2 in the air back then as there was at the time of his study.

Two years later, Kullman (1998)[2] reviewed the many findings of his personal investigations of "past positional, structural and compositional shifts of tree-limits and upper boreal forests, mainly in the southern Scandes Mountains of Sweden," based on studies of the elevational location of well-dated subfossil wood remains and the known change in air temperature with change in elevation. Among other things, he discovered that "some exceptionally warm and stable centuries, with high tree-limits and dense montane forests, occurred during the Medieval period." He also found "an episode of warmer climate during the first half of the [20th] century," but notes that tree-limits and high-elevation forests at that time "were far from restored to their medieval levels," which by AD 900-1100 "were situated 80-100 meters higher" than they were about a century ago, i.e., ~1900. And he also reported that "during the past few decades," i.e., during the latter part of the 20th century, there was widespread "rapid cold-induced dieback."

In discussing his findings, the Swedish scientist stated that "the slight cooling and associated tree-limit and forest responses since the climate optimum in the late 1930s fit a more general pattern, common to the entire North Atlantic seaboard and adjacent continental areas." And what was that pattern? He said "there appear to have been no detectable regional or global tree-limit progression trends over the past 2-3 decades matching the GCM climate projections based on increasing CO_2 levels." And he thus concluded that "since tree-limits in Scandinavia or elsewhere in the world have not reestablished at their Medieval levels, it is still possible that today's climate, despite centennial net warming, is within its natural limits."

At the start of the new millennium, Andren *et al*. (2000)[3] conducted an extensive analysis of changes in siliceous microfossil assemblages and chemical characteristics of various materials found in a well-dated sediment core that was obtained from the Bornholm Basin in the southwestern Baltic Sea. The data they thereby obtained revealed the existence of a period of high primary production at approximately AD 1050, as well as the fact that contemporaneous diatoms were warm water species such as *Pseudosolenia calcar-avis*, which they indicate is "a common tropical and subtropical marine planktonic species" that "cannot be found in the present Baltic Sea." They also note that what they call the Recent Baltic Sea Stage, which began about AD 1200, starts "at a point where there is a major decrease in warm water taxa in the diatom assemblage and an increase in cold water taxa, indicating a shift towards a colder climate," which they associate with the Little Ice Age.

Andren *et al*.'s data clearly indicate there was a period of time in the early part of the past millennium when the climate in the area of the southwestern Baltic Sea was warmer than it is today, as the sediment record of that time and vicinity contained several warm water species of diatoms, some of which can no longer be found there. This period of higher temperatures, as they describe it, falls within "a period of early Medieval warmth dated to AD 1000-1100," which

[2] http://www.co2science.org/articles/V12/N18/C2.php.
[3] http://www.co2science.org/articles/V4/N3/C2.php.

they make a point of noting "corresponds to the time when the Vikings succeeded in colonizing Iceland and Greenland."

One year later, [Hiller *et al*. (2001)][4] analyzed subfossil wood samples from the Khibiny mountains in the Kola Peninsula, (67-68°N, 33-34°E) in an effort to reconstruct climate change there over the past 1500 years. And based upon dating methods used on the subfossil wood samples, it was determined that between AD 1000 and 1300 the tree-line was located at least 100-140 m *above* its current elevation, which elevation advance is described by the three researchers as suggesting that mean summer temperatures during this "Medieval climatic optimum" were "at least 0.8°C higher than today." In fact, they describe this time interval as hosting "the most pronounced warm climate phase on the Kola Peninsula during the last 1500 years,"

Publishing contemporaneously, [Nesje *et al*. (2001)][5] described how they analyzed a 572-cm-long sediment core retrieved from Norway's Lake Atnsjoen in an effort to determine the frequency and magnitude of pre-historic floods in the southern part of that country. These efforts revealed the presence of several pronounced floods that occurred throughout the 4500-year period. The more recent portion of the record, however, revealed (1) a time "of little flood activity around the Medieval period (AD 1000-1400)," which was correlated with reduced regional glacier activity, as well as (2) a subsequent period of the most extensive flood activity in the Atnsjoen catchment," which resulted from the "post-Medieval climate deterioration characterized by lower air temperature, thicker and more long-lasting snow cover, and more frequent storms associated with the 'Little Ice Age'."

Close to simultaneously, [Mikalsen *et al*. (2001)][6] conducted detailed analyses of benthic foraminifera, stable isotopes and other sedimentary material obtained from a core extracted from a fjord in western Norway, from which they derived a relative temperature history of the region that spanned the last 5500 years. This work revealed the occurrence of four cold periods characterized by 1.5-2°C reductions in bottom-water temperature: 2150 to 1800 BC, 850 to 600 BC, 150 BC to AD 150, AD 500 to 600, and "a cooling that may correspond to the 'Little Ice Age' (AD 1625)." The three researchers also note "there is a good correlation between the cold periods and cold events recorded in other studies," which finding helps to strengthen their conclusions. Perhaps of even more importance, however, was their identification of a warm period from AD 1330 to 1600 that "had the highest bottom-water temperatures in Sulafjorden during the last 5000 years," which sure sounds a lot like the Medieval Warm Period.

About this same time, [Brooks and Birks (2001)][7] were deeply involved in refining protocols for using the larval-stage head capsules of midges to reconstruct temperature histories of various locations; and in this particular paper they reported their progress and illustrated the application of their techniques to certain locations in Scotland and Norway. Of particular interest to the CO_2-climate debate, were their findings for Lochan Uaine, in the Cairngorms region of the Scottish Highlands, which lake, in their words, "is remote from human habitation

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4 http://www.co2science.org/articles/V4/N30/C1.php.
5 http://www.co2science.org/articles/V4/N32/C2.php.
6 http://www.co2science.org/articles/V4/N44/C2.php.
7 http://www.co2science.org/articles/V5/N4/C1.php.

and therefore any response of proxy indicators to climatic change [is] unlikely to be masked by the effects of anthropogenic environmental change in its catchment."

Reconstructed temperatures for this region peaked at about 11°C, during what they refer to as the "Little Climatic Optimum" - which is more typically called the Medieval Warm Period - "before cooling by about 1.5°C which may coincide with the 'Little Ice Age'." These results, say the two scientists, "are in good agreement with a chironomid stratigraphy from Finse, western Norway (Velle, 1998)," where summer temperatures were "about 0.4°C warmer than the present day" during the Medieval Warm Period. This latter observation also appears to hold for Brooks and Birks' study, since the upper sample of the Lochan Uaine core, which was collected in 1993, "reconstructs the modern temperature at about 10.5°C" which is 0.5°C less than the 11°C value they obtained from the Medieval Warm Period.

Also working contemporaneously, McDermott *et al*. (2001)[8] derived a $\delta^{18}O$ record from a stalagmite discovered in Crag Cave in southwestern Ireland, after which they compared this record with the $\delta^{18}O$ records from the GRIP and GISP2 ice cores from Greenland. This comparison provided evidence for "centennial-scale $\delta^{18}O$ variations that correlate with subtle $\delta^{18}O$ changes in the Greenland ice cores, indicating regionally coherent variability in the early Holocene." They also reported that the Crag Cave data "exhibit variations that are broadly consistent with a Medieval Warm Period at ~1000 ± 200 years ago and a two-stage Little Ice Age, as reconstructed by inverse modeling of temperature profiles in the Greenland Ice Sheet." Also evident in the Crag Cave data were the $\delta^{18}O$ signatures of the earlier Roman Warm Period and Dark Ages Cold Period that comprised the prior such cycle of climate in that region. As for the significance of these findings, the three researchers state that the coherent $\delta^{18}O$ variations in the records from both sides of the North Atlantic "indicate that many of the subtle multicentury $\delta^{18}O$ variations in the Greenland ice cores reflect regional North Atlantic margin climate signals rather than local effects." And, of course, their data confirmed the reality of the Medieval Warm Period/Little Ice Age cycle, as well as the prior and even-more-strongly-expressed Roman Warm Period/Dark Ages Cold Period cycle, demonstrating there is nothing unusual, unnatural or unprecedented about the global warming of the past century or so.

Working concurrently, Voronina *et al*. (2001)[9] analyzed dinoflagellate cyst assemblages in two sediment cores from the southeastern Barents Sea - one spanning a period of 8300 years and one spanning a period of 4400 years - obtaining information about sea-surface salinity, temperature and ice cover throughout the mid- to late-Holocene. The longer of the two cores indicated a warm interval from about 8000 to 3000 years before present, followed by *cooling pulses* coincident with lowered salinity and extended ice cover in the vicinity of 5000, 3500 and 2500 years ago. The shorter of the two cores additionally revealed cooling pulses at tentative dates of 1400, 300 and 100 years before present. For the bulk of the past 4400 years, however, ice cover lasted only two to three months per year, as opposed to the modern mean of 4.3 months per year, while August temperatures ranged between 6 and 8°C, significantly warmer than the present mean of 4.6°C.

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8 http://www.co2science.org/articles/V4/N50/C1.php.

9 http://www.co2science.org/articles/V5/N5/C2.php.

Once again, therefore, we have evidence of considerably warmer temperatures than those of today over much of the past few thousand years - including a period of time coeval with the Medieval Warm Period - in the southeastern Barents Sea, which conditions are said by Voronina *et al*. to be reflective of conditions throughout northwestern Eurasia. So yet once *again* we have the testimony of the *very-real world* refuting the *climate-model-inspired contention* that it is currently warmer than it has been at any time during the past millennium or two.

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Still stuck in the same year, McDermott *et al*. (2001)[10] derived a $\delta^{18}O$ record from a stalagmite discovered in Crag Cave in southwestern Ireland, after which they compared this record with the $\delta^{18}O$ records from the GRIP and GISP2 ice cores from Greenland. This comparison provided evidence for "centennial-scale $\delta^{18}O$ variations that correlate with subtle $\delta^{18}O$ changes in the Greenland ice cores, indicating regionally coherent variability in the early Holocene." They also reported that the Crag Cave data "exhibit variations that are broadly consistent with a Medieval Warm Period at ~1000 ± 200 years ago and a two-stage Little Ice Age, as reconstructed by inverse modeling of temperature profiles in the Greenland Ice Sheet." Also evident in the Crag Cave data were the $\delta^{18}O$ signatures of the earlier Roman Warm Period and Dark Ages Cold Period that comprised the prior such cycle of climate in that region. As for the significance of these findings, the three researchers state that the coherent $\delta^{18}O$ variations in the records from both sides of the North Atlantic "indicate that many of the subtle multi-century $\delta^{18}O$ variations in the Greenland ice cores reflect regional North Atlantic margin climate signals rather than local effects." And, of course, their data confirmed the reality of the Medieval Warm Period/Little Ice Age cycle, as well as the prior and even-more-strongly-expressed Roman Warm Period/Dark Ages Cold Period cycle, demonstrating yet again that there is nothing unusual, unnatural or unprecedented about the global warming of the past century or so.

[10] http://www.co2science.org/articles/V4/N50/C1.php.

Finally moving ahead one year, Gunnarson and Linderholm (2002)[11], while working with living and subfossil Scots pine (*Pinus sylvestris* L.) sampled close to the present tree-line in the central Scandinavian Mountains, developed a continuous 1,091-year tree-ring width chronology running from AD 909 to 1998, which they determined to be a good regional proxy for summer temperatures in the region of their study. And they report that their data "support evidence for a 'Medieval Warm Period,' where growth conditions were favorable in the tenth and early eleventh centuries." In addition, their data show that the warmth of the Medieval Warm Period was both *greater* and *longer-lasting* than that of the Current Warm Period, which their data depict as having peaked around 1950.

In further discussing their findings, the two Swedish scientists state that their chronology "does not show the continuous temperature decrease from AD 1000 to 1900 followed by a distinct increase during the twentieth century" that the hockeystick temperature history of Mann *et al*. (1998, 1999) does. "On the contrary," as they put it, their chronology "displays a positive trend from the middle of the seventeenth century, culminating around 1950, followed by strongly decreasing growth." Hence, not only has the Current Warm Period in the Scandinavian Mountains not been as warm as the earlier Medieval Warm Period, the way in which it developed is also different from the way in which the hockeystick record implies it developed. And these two discrepancies thus add up to a significant *double strike* against the ill-supported claims of the world's climate alarmists in this particular part of the planet, which, though but a small part of the entire globe, joins many other such "particular parts of the planet" in revealing the same things.

Advancing another year, Berglund (2003)[12] identified several periods of expansion and decline of human cultures in Northwest Europe and compared them with a history of reconstructed climate "based on insolation, glacier activity, lake and sea levels, bog growth, tree line, and tree growth." And in doing so, he learned there was "a positive correlation between human impact/land-use and climate change." More specifically, in the latter part of the record, where both cultural and climate changes were best defined, there was, in his words, a great "retreat of agriculture" centered on about AD 500, which led to "reforestation in large areas of central Europe and Scandinavia." He additionally notes that "this period was one of rapid cooling indicated from tree-ring data (Eronen *et al*., 1999) as well as sea surface temperatures based on diatom stratigraphy in [the] Norwegian Sea (Jansen and Koc, 2000), which can be correlated with Bond's event 1 in North Atlantic sediments (Bond *et al*., 1997)."

Next came what Berglund called a "boom period" that covered "several centuries from AD 700 to 1100." This interval of time proved to be "a favorable period for agriculture in marginal areas of Northwest Europe, leading into the so-called Medieval Warm Epoch," when "the climate was warm and dry, with high treelines, glacier retreat, and reduced lake catchment erosion." This period "lasted until around AD 1200, when there was a gradual change to cool/moist climate, the beginning of the Little Ice Age ... with severe consequences for the agrarian society."

[11] http://www.co2science.org/articles/V7/N40/C2.php.
[12] http://www.co2science.org/articles/V6/N21/C2.php.

And so it can be understood that even human enterprise bears witness to the reality and great significance of the natural*non-CO_2*-induced millennial-scale oscillation of climate that, within the bounds of the historical record just described, has been responsible for producing the Dark Ages Cold Period, the Medieval Warm Period and the Little Ice Age, and which has most recently *blessed* the earth with the Current Warm Period.

Also with a paper appearing the same year were Andersson *et al*. (2003)[13], who inferred surface conditions of the eastern Norwegian Sea (Voring Plateau) from planktic stable isotopes and planktic foraminiferal assemblage concentrations in two seabed sediment cores obtained in the vicinity of 66.97°N, 7.64°W that covered the period of the last three thousand years. The climate history derived from this study was remarkably similar to that derived by McDermott *et al*. (2001) from a high-resolution speleothem $\delta^{18}O$ record obtained from a stalagmite discovered in a cave in southwestern Ireland. At the beginning of the 3000-year-long Voring Plateau record, for example, both regions were clearly in the end-stage of the long cold period that preceded the Roman Warm Period. Hence, both records depicted warming from that point in time to the peak of the Roman Warm Period, which occurred about 2000 years BP. Then, both regions began their descent into the Dark Ages Cold Period, which held sway until the increase in temperature that produced the Medieval Warm Period, which in both records prevailed from about 800 to 550 years BP. Last of all, the Little Ice Age was evident, with cold periods centered at approximately 400 and 100 years BP, again in both records.

Two other points of interest are the *facts* that (1) neither record indicates the existence of what has come to be called the Current Warm Period, and (2) Andersson *et al*. report that "surface ocean conditions warmer than present were common during the past 3000 years." As time has passed, therefore, evidence for the reality of the solar-induced millennial-scale cycling of climate described by Bond *et al*. (1997, 2001) has continued to mount, while evidence for the so-called "unprecedented" temperature claimed for the present by the IPCC continues to be sought ... but not found.

In another concurrent study, Tiljander *et al*. (2003)[14] conducted a number of high-resolution analyses - including varve thickness, relative X-ray density, pollen and diatom assessments, and organic matter loss-on-ignition (LOI) - on a 3000-year varved sediment sequence obtained from Lake Korttajarvi in central Finland, after which they compared their results with those of other palaeo-environmental studies conducted in Finland. This work led to their discovery of "an organic rich period from AD 980 to 1250" that they say "is chronologically comparable with the well-known 'Medieval Warm Period'." During this time interval, they report that "the sediment structure changes" and "less mineral material accumulates on the lake bottom than at any other time in the 3000 years sequence analyzed and the sediment is quite organic rich (LOI ~20%)." And from these observations they concluded that "the winter snow cover must have been negligible, if it existed at all, and spring floods must have been of considerably lower magnitude than during the instrumental period (since AD 1881)," which conditions they equate with a winter temperature approximately *2°C warmer than at present*.

[13] http://www.co2science.org/articles/V6/N34/C3.php.
[14] http://www.co2science.org/articles/V7/N2/C2.php.

In support of this conclusion, Tiljander *et al*. cite much corroborative evidence. They note, for example, that "the relative lack of mineral matter accumulation and high proportion of organic material between AD 950 and 1200 was also noticed in two varved lakes in eastern Finland (Saarinen *et al*., 2001) as well as in varves of Lake Nautajarvi in central Finland c. AD 1000-1200 (Ojala, 2001)." They additionally note that "a study based on oak barrels, which were used to pay taxes in AD 1250-1300, indicates that oak forests grew 150 km north of their present distribution in SW Finland and this latitudinal extension implies a summer temperature 1-2°C higher than today (Hulden, 2001)." And they report that "a pollen reconstruction from northern Finland suggests that the July mean temperature was c. 0.8°C warmer than today during the Medieval Climate Anomaly (Seppa, 2001)." In these several studies, therefore, the scientists involved in them concluded that both summer and winter temperatures over much of the Medieval Warm Period throughout many parts of Finland were significantly warmer than they are currently, so that in this part of the world, the climate-alarmist claim that current temperatures are unprecedented over the past one to two millennia rings rather hollow.

Moving ahead one year, Roncaglia (2004)[15] analyzed variations in organic matter deposition from approximately 6350 cal yr BC to AD 1430 in a sediment core extracted from the Skalafjord, southern Eysturoy, Faroe Islands in an attempt to assess climatic conditions in that part of the North Atlantic from the mid- to late-Holocene. In doing so, she discovered that an increase in "structured brown phytoclasts, plant tissue and sporomorphs in the sediments dating to ca. AD 830-1090 indicate increased terrestrial influx and inland vegetation supporting the idea of improved climatic conditions" during that time period, while similarly noting in another place that "the increase in the amount of structured brown phytoclasts, leaf and membranous tissue and sporomorphs indicated increased inland vegetation probably related to improved climatic conditions and/or the presence of cultivated crops on the islands." In addition, she found that high "total dinoflagellate cyst concentration and increased absolute amount of loricae of tintinnid and planktonic crustacean eggs occurred at ca. AD 830-1090," concluding that these observations "may suggest increased primary productivity in the waters of the fjord," citing Lewis *et al*. (1990) and Sangiorgi *et al*. (2002).

In commenting further on these findings, Roncaglia wrote that the "amelioration of climate conditions," which promoted the enhanced productivity of both land and sea at this time, "may encompass the Medieval Warm Period in the Faroe region." And indeed it does, for the data of Esper *et al*. (2002) show, in *their* words, that the warmest portion of the Medieval Warm Period "covers the interval 950-1045, with the peak occurring around 990."

Thereafter, Roncaglia reported an increased concentration of certain other organisms at about AD 1090-1260 that she says "suggests a cooling, which may reflect the beginning of the Little Ice Age." This finding, too, is in complete harmony with the findings of Esper *et al*., which show a dramatic drop in temperature over this period. And thus it is that evidences for both the Medieval Warm Period and Little Ice Age show up strong and clear in the sediments of a Faroe Island fjord, demonstrating that *even at sea*, these major recurring extremes of cyclical Holocene climate make their presence felt to such a degree that they significantly influence

[15] http://www.co2science.org/articles/V7/N37/C2.php.

both aquatic and terrestrial primary production (the latter in places where small areas of land rise above the ocean surface).

Contemporaneously, Hormes *et al*. (2004)[16] identified and dated periods of soil formation in moraines in the Kebnekaise mountain region of Swedish Lapland in the foreground of the Nipalsglaciaren (67°58'N, 18°33'E), after which they compared the climatic implications of their results with those of other proxy climate records derived throughout other areas of northern and central Scandinavia. And in doing so, two main periods of soil formation were identified (2750-2000 and 1170-740 cal yr BP), which spans of time coincide nearly perfectly with the Roman and Medieval Warm Periods delineated by McDermott *et al*. (2001) in the high-resolution $\delta^{18}O$ record they developed from a stalagmite in southwestern Ireland's Crag Cave.

Hormes *et al*. also report that the periods during which the soil formation processes they discovered took place "represent periods where the Nipalsglacier did not reach the position of the moraine," and that "the glacier was most likely in a position similar to today, and climate conditions were also similar to today." And comparing their findings with those of other investigators, they noted the following, the first set of which observations apply to the Medieval Warm Period.

(1) Pollen profiles derived from sediments of Lake Tibetanus in Lapland (Hammarlund *et al*., 2002) "infer increased mean July temperatures ... peaking around 1000 cal yr BP."

(2) Oxygen isotope studies in nearby Lake 850 "record changes around 1000 cal yr BP towards favorable climate conditions (Shemesh *et al*., 2001)."

(3) At Lake Laihalampi in southern Finland, "pollen-based reconstructions of mean temperatures indicate 0.5°C higher values between 1200 and 1100 cal yr BP (Heikkila and Seppa, 2003)."

(4) Radiocarbon ages of mosses in front of Arjep Ruotesjekna in the Sarek Mountains of Swedish Lapland "support the conclusion that between 1170 and 920 cal yr BP the glaciers had not reached the 1970s limit (Karlen and Denton, 1975)."

(5) Reconstructed temperatures of a pine dendrochronology from northern Fennoscandia "show temperatures between 1100 and 750 cal yr BP to have been around 0.8°C higher than today (Grudd *et al*., 2002)."

(6, 7) At Haugabreen glacier (Matthews, 1980) and Storbreen glacier (Griffey and Matthews, 1978) in southern maritime Norway, "soil formation on moraines was dated between 1060 and 790 cal yr BP."

(8) Alder trees were melted out from Engabreen glacier (Worsley and Alexander, 1976), "suggesting a smaller extension of this Norwegian glacier between 1180 and 790 cal yr BP supporting warm/dry conditions during that time in central Norway."

[16] http://www.co2science.org/articles/V8/N13/C3.php.

(9) Jostedalsbreen glacier "receded between 1000 and 900 cal yr BP (Nesje *et al*., 2001)."

Then, with respect to their identification of the Roman Warm Period, Hormes *et al*. reported prior findings of soil formation at (1) Svartisen glacier between 2350 and 1990 cal yr BP by Karlen (1979), (2) Austre Okstindbreen glacier between 2350 and 1800 cal yr BP by Griffey and Worsley (1978), and (3) Austre Okstindbreen glacier between 2750 and 2150 by Karlen (1979). In addition, they noted the following:

(4) The pine tree-based temperature history of northern Fennoscandia developed by Grudd *et al*. (2002) "discloses a spike +2°C higher than today's around 2300 cal yr BP."

(5, 6, 7, 8, 9) "The lacustrine records in Lapland and Finland are also consistent with supposition of a warmer climate than at present before 2000 cal yr BP and cooler temperatures before 2450 cal yr BP (Rosen *et al*., 2001; Seppa and Birks, 2001; Shemesh *et al*., 2001; Hammarlund *et al*., 2002; Heikkila and Seppa, 2003)."

In view of these many research findings, it is clear that both the Medieval and Roman Warm Periods were very real features of Scandinavian climatic history, and that they were likely even warmer than the Current Warm Period has been to date, all without any help from elevated atmospheric CO_2 concentrations, which were a full 100 ppm *less* than today's concentration during those earlier high-temperature periods. And, hence, there is no compelling reason to believe that the modest warmth of today has anything at all to do with the air's CO_2 content.

Concurrently providing more evidence for this conclusion in a special issue of *Palaeogeography, Palaeoclimatology, Palaeoecology*, Solomina and Alverson (2004)[17] reviewed and synthesized the findings of a number of papers presented at a conference held in Moscow in May of

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[17] http://www.co2science.org/articles/V9/N23/EDIT.php.

2002, which brought together more than 100 local paleoenvironmental researchers from Bellarussia, Estonia, Georgia, Kyrgyzstan, Russia, Ukraine and Uzbekistan, plus another 30 scientists from 18 additional countries. And in doing so, the two researchers summarized the meeting's overall findings for five distinct regions: The Arctic and Sub-Arctic, The Russian Plain and Caucasus, Central Asia and the Caspian Region, Eastern and Southern Siberia, and The Far East.

The Arctic and Sub-Arctic. "The 9th-14th centuries were relatively warm, though at least two colder periods probably occurred in the 11th and 13th centuries," after which "the 15th-early 20th centuries were generally cold," while "subsequent warming is recorded with almost all proxies."

The Russian Plain and Caucasus. "The climate of the Russian plain was relatively warm from the 11th to 14th centuries, with the exception of the late 12th-early 13th centuries, and colder from the 15th to 19th centuries, except for a warm interval in the first half of the 16th century." In the Central Caucasus, they also report the existence of a "relatively warm climate around the end of the first to the beginning of the second millennium AD," followed by "numerous glacier advances...during the 14th-19th centuries," the timing of which correlates well with those in the European Alps.

Central Asia and the Caspian Region. "A milder, less continental climate with more precipitation approximately from the 9th to 12th centuries" was indicated by most of the available data, while "cold conditions dominated from the 13th to 19th centuries, though interrupted by a brief warm period from the end of the 14th-early 15th century," after which "the coldest conditions were probably in the 17th and 19th centuries, when glaciers advanced several times, lake level was high, and permafrost depth increased."

Eastern and Southern Siberia. "Two periods of warmer and drier climate can be roughly identified in this huge area as having occurred from the 9th to 11th centuries and in the 14th century," while "the 15th-19th centuries were clearly cold and the 20th century has seen a return to warm conditions."

The Far East. "There is some evidence suggesting moderately warm conditions in the North Pacific region from the end of the first to the beginning of the second millennium," with "a subsequent cooling after the 14th century."

In summarizing their findings for the bulk of the Northern Eurasia region, Solomina and Alverson wrote that "a number of records allow one to distinguish the climatic pattern of the 9th-13th centuries [i.e., the Medieval Warm Period] from earlier and later colder conditions [i.e., the Dark Ages Cold Period and Little Ice Age, respectively]." They also said that "the spatial pattern of temperature anomalies ca. 1000 years ago is similar to the earlier mid-Holocene 'optimum'." Last of all, they remark that "the warming of the 14th century in several regions, including the Russian plain, Altai and Central Asia, was at least as intense as the earlier one at ca. 1000 years before present or even warmer." This latter widely-detected event might possibly correspond to what some have called the *Little* Medieval Warm Period. Just as easily, it may well be what one could call "the 'last hurrah' of the Medieval Warm Period before it relinquished control of earth's climate to the Little Ice Age."

Taken together, the many observations summarized by Solomina and Alverson bear strong testimony to the reality of the *natural*, as opposed to *anthropogenic-induced*, millennial-scale oscillation of earth's climate that has most recently resulted in the development of the Current Warm Period.

One year later, utilizing plant macrofossils, testate amoebae and degree of humification as proxies for environmental moisture conditions, Blundell and Barber (2005)[18] developed a 2800-year "wetness history" from a peat core extracted from Tore Hill Moss, a raised bog in the Strathspey region of Scotland; and based on the results they obtained from the three proxies they studied, they derived a relative wetness history that began 2800 years ago and extended all the way to AD 2000.

The most clearly defined and longest interval of sustained dryness of this entire history stretched from about AD 850 to AD 1080, coincident with the well-known Medieval Warm Period, while the most extreme wetness interval occurred during the depths of the last stage of the Little Ice Age. Also evident in the two scientists' wetness history was a period of relative dryness centered on about AD 1550, which corresponded to a period of relative warmth that has previously been documented by several other studies. And preceding the Medieval Warm Period, their hydro-climate reconstruction revealed a highly chaotic period of generally greater wetness that corresponded to the Dark Ages Cold Period, while also evident were dryness peaks representing the Roman Warm Period and two other periods of relative dryness located about 500 years on either side of its center.

Consequently, and in *local* contradiction of the climate-alarmist claim that the late 20th century was the warmest period experienced by the earth over the past two millennia, the correlation this study demonstrates to exist between relative wetness and warmth in Scotland strongly suggests that the temperature of the late 20th century was nowhere near the highest of the past two millennia in that particular part of the world. In fact, it suggests there were five other periods over the past 2800 years that were considerably warmer. In addition, Blundell and Barber cite many studies that report findings similar to theirs throughout much of the rest of Europe and the North Atlantic Ocean. And as a result, the *regional* challenge this group of studies provides to the IPCC-endorsed hockeystick temperature history of the world is substantial.

About this same time, Linderholm and Gunnarson (2005)[19] developed what they called the Jämtland multi-millennial tree-ring width chronology, which was derived from living and subfossil Scots pines (*Pinus sylvestris* L.) sampled close to the present tree-line in the central Scandinavian Mountains. This record spanned the time interval from 2893 BC to AD 2002, with minor gaps at 1633-1650 BC and AD 887-907. And in the study discussed here, the two

[18] http://www.co2science.org/articles/V8/N22/C2.php.
[19] http://www.co2science.org/articles/V8/N40/C2.php.

researchers focused their analysis on the well replicated period of 1632 BC to AD 2000, utilizing it as a proxy for summer temperatures. So what did they find?

Several periods of anomalously warm and cold summers were noted throughout the record: (1) 550 to 450 BC (Roman Warm Period), when summer temperatures were the warmest of the entire record, exceeding the 1961-1990 mean by more than 6°C, (2) AD 300 to 400 (Dark Ages Cold Period), which was "the longest period of consecutive cold summers," averaging 1.5°C less than the 1961-1990 mean, (3) AD 900 to 1000, a warm era corresponding to the Medieval Warm Period, and (4) AD 1550 to 1900, a cold period known as the Little Ice Age. And with respect to the latter portion of the tree-ring record, which encompasses the period of *modern global warming*, Linderholm and Gunnarson declare that this phenomenon "does not stand out as an anomalous feature in the 3600-year record," noting, in fact, that "other periods show more rapid warming and also higher summer temperatures." What should be even more embarrassing to the world's climate alarmists, however, is the fact that the last *half* of the 20th century actually experienced *cooling* in the central Scandinavian Mountains.

The results of this analysis thus suggest that there is nothing unusual or unprecedented about the Current Warm Period in the Scandinavian Mountains, as it has not been anywhere near as warm there in modern times as it was some 2500 years ago during the Roman Warm Period; nor has it been as warm there recently as it was during the less-extreme Medieval Warm Period of a thousand years ago. In fact, the so-called *unprecedented global warmth*, which climate alarmists claim to have been present during the last two decades of the 20th century, is actually *nowhere to be seen* in the Scandinavian Mountains, nor is it detectable at a whole host of other places on earth.

Working concurrently, Berge *et al*. (2005)[20] described and discussed the significance of what they refer to as "the first observations of settled blue mussels *Mytilus edulis* L. in the high Arctic Archipelago of Svalbard for the first time since the Viking Age." This discovery of the established blue mussel colony was made by SCUBA divers in August and September of 2004 at Sagaskjaeret, Isfjorden, Svalbard (78°13'N, 14°E); and subsequent inferences of the five researchers with regard to pertinent regional climatic and oceanographic conditions over the prior few years led them to conclude that "the majority of blue mussels were transported as larvae in unusually warm water by the West Spitsbergen Current from the mainland of Norway to Spitsbergen during the summer of 2002," and that "it is highly probable that the newly established blue mussel population is a direct response to a recent increase in sea surface temperatures," although the mussels would still appear to have a long way to go before they can match the foothold their ancestors had on the region back at the time of the Vikings.

More specifically, Berge *et al*. write that the "distribution patterns of blue mussels *Mytilus edulis* L. in the high Arctic indicate that this thermophilous mollusk was abundant along the west coast of Svalbard during warm intervals (Salvigsen *et al*., 1992; Salvigsen, 2002) in the Holocene," but that mussels of this species "have not been present at Svalbard for the last 1000 years (Salvigsen, 2002)." And in light of these well-documented real-world observations, including the fact that blue mussels had only recently begun to reestablish themselves in this

[20] http://www.co2science.org/articles/V9/N1/C3.php.

part of the world, they opine that water temperatures there were only *beginning* to "approach those of the mediaeval warm period."

One year later, Eiriksson *et al*. (2006)[21] reconstructed the near-shore thermal history of the North Atlantic Current along the western coast of Europe over the last two millennia, based on measurements of stable isotopes, benthic and planktonic foraminifera, diatoms and dinoflagellates, as well as geochemical and sedimentological parameters, which they acquired on the Iberian margin, the West Scotland margin, the Norwegian margin and the North Icelandic shelf.

In addition to identifying the Roman Warm Period (nominally 50 BC- AD 400), which exhibited the *warmest sea surface temperatures of the last two millennia* on both the Iberian margin and the North Icelandic shelf) and the following Dark Ages Cold Period (AD 400-800), Eiriksson *et al*. reported detecting the Medieval Warm Period (AD 800-1300) and the Little Ice Age (AD 1300-1900), which was followed in some records by a strong warming to the present. However, they made a point of stating that this latter warming "does not appear to be unusual when the proxy records spanning the last two millennia are examined."

The results of Eiriksson *et al*.'s research once again reveal the presence of the millennial-scale climatic oscillation that has been responsible for periodically producing centennial-scale warm and cold periods throughout earth's history. It also reveals there is nothing unusual or unnatural about the Current Warm Period, which in the case of two of their four sites was found to be somewhat *cooler* than it was during the Roman Warm Period of 2000 years ago, when the atmosphere's CO_2concentration was over 100 ppm *less* than it is today. And in light of these several observations, there should be *no compelling reason* to believe the climate-alarmist claims that (1) the earth has experienced unprecedented warming over the past several decades, and that (2) that warming was driven by the historical increase in the atmosphere's CO_2concentration. In fact, there is much compelling evidence to ***dis**believe* their contentions.

Another year later, Haltia-Hovi *et al*. (2007)[22] extracted sediment cores from beneath the 0.7-m-thick ice platform on Lake Lehmilampi (63°37'N, 29°06'E) in North Karelia, eastern Finland, in the springs of 2004 and 2005, after which they identified and counted the approximately 2000 annual varves contained in the cores and measured their individual thicknesses and mineral and organic matter contents. Then, they compared these climate-related data with residual $\Delta^{14}C$ data derived from tree rings, which serve as a proxy for solar activity. And in doing so, they report that their "comparison of varve parameters (varve thickness, mineral and organic matter accumulation) and the activity of the sun, as reflected in residual $\Delta^{14}C$ [data] appears to coincide remarkably well in Lake Lehmilampi during the last 2000 years, suggesting solar forcing of the climate."

In addition, the Finnish researchers say that "the low deposition rate of mineral matter in AD 1060-1280 possibly implies mild winters with a short ice cover period during that time with

21 http://www.co2science.org/articles/V10/N29/C3.php.
22 http://www.co2science.org/articles/V10/N25/C2.php.

minor snow accumulation interrupted by thawing periods." Likewise, they state that the low accumulation of organic matter during this period "suggests a long open water season and a high decomposition rate of organic matter." Consequently, since the AD 1060-1280 period shows *by far* the lowest levels of both mineral and organic matter content, and since "the thinnest varves of the last 2000 years were deposited during [the] solar activity maxima in the Middle Ages," it is difficult not to conclude that that period was likely the warmest of the past two millennia in the part of the world studied by the three scientists.

Concomitantly, Allen *et al.* (2007)[23] analyzed pollen characteristics within sediment cores retrieved from a small unnamed lake located at 71°02'18"N, 28°10'6.6"E near the coast of Nordkinnhalvoya, Finnmark, Norway, after which they used the results of this effort to construct a climatic history of the area over the course of the Holocene. In doing so, they found that "regional vegetation responded to Holocene climatic variability at centennial-millennial time scales." And within the timeframe that is of most significance for evaluating the nature of modern global warming, they report that "the most recent widely documented cooling event, the Little Ice Age of ca 450-100 cal BP, also is reflected in our data by a minimum in *Pinus:Betula* [pollen] ratio beginning ca 300 cal BP and ending only in the recent past," and they add that "the Dark Ages cool interval, a period during which various other proxies indicate cooling in Fennoscandia and beyond, is evident too, corresponding to lower values of *Pinus:Betula* [pollen] ratio ca 1600-1100 cal BP." In addition, they state that "the Medieval Warm Period that separated the latter two cool intervals also is strongly reflected in our data, as is the warm period around two millennia ago during which the the Roman Empire reached its peak."

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These findings are but another common example of an important aspect of earth's climate and how it operates: it oscillates back and forth between centennial-scale intervals of relative cold and warmth with a full-period temporal mean of approximately 1500 years.

Viewed in this light, the development of the Current Warm Period over the past century or so is readily recognized to be nothing more than the most recent – and expected – manifestation of this natural cycling of earth's climate.

23 http://www.co2science.org/articles/V10/N34/C2.php.

and warmth with a full-period temporal mean of approximately 1500 years. And viewed in this light, the development of the Current Warm Period over the past century or so is readily recognized to be nothing more than the most recent - and *expected* - manifestation of this natural cycling of earth's climate; and this knowledge suggests that the planet's current relative warmth is likely *not* a response to the historical increase in the atmosphere's CO_2 concentration. It is a totally independent phenomenon.

Also appearing in print in the same year was the report of the study of Jiang *et al*. (2007)[24], who analyzed diatom data they obtained from core MD992271 (66°30'05"N, 19°30'20"W) on the North Icelandic shelf to derive summer sea surface temperatures (SSTs) for that location based on relative abundances of warm and cold water species, after which they compared the results they obtained with results derived by Jiang *et al*. (2002, 2005) via similar analyses of nearby cores HM107-03 (66°30'N, 19°04'W) and MD992275 (66°33"N, 17°42'W), as well as results derived from GISP2 $\delta^{18}O$ data and other marine sediment records obtained from still other regions of the North Atlantic.

The data from the new sediment core revealed a gradually decreasing temperature trend over the entire expanse of the reconstructed 3000-year SST record, with superimposed centennial- and millennial-scale summer SST fluctuations. In addition, Jiang *et al*. wrote that "the Medieval Warm Period and the Little Ice Age are identified in the record," the former of which periods appears to have prevailed between approximately AD 950 and 1250. Unfortunately, the MD992271 record ended in the midst of the Little Ice Age and therefore did not reveal any 19th- or 20th-century warming. The HM107-03 record, on the other hand, extended to within about 50 years of the present; but it too showed no evidence of any warming at its end. Core MD992275 did extend to the nominal present, however; and it suggested that the end of the 20th century was at least three-quarters of a degree Centigrade *cooler* than the peak temperature of the Medieval Warm Period, which is about the same qualitative and quantitative difference suggested by the GISP2 $\delta^{18}O$ data.

Jiang *et al*. further stated that "comparison of the data from core MD992271 with those from two other cores, HM107-03 and MD992275, on the North Icelandic shelf shows coherent late Holocene changes in reconstructed summer SST values ... reflecting regional changes in the summer SSTs on the North Icelandic shelf." In addition, they concluded that "the consistency between changes in the late Holocene summer SSTs on the North Icelandic shelf and in GISP2 $\delta^{18}O$ data, as well as in other marine sediment records from the North Atlantic, further suggests synchronous North Atlantic-wide climate fluctuations." And the consistency among *all* of these records and the many similar records from *other parts of the world* ultimately suggests the existence of synchronous *global* climate fluctuations that are beginning to also reveal a warmer-than-present Medieval Warm Period (when there was fully 100 ppm *less* CO_2 in the air than there is today).

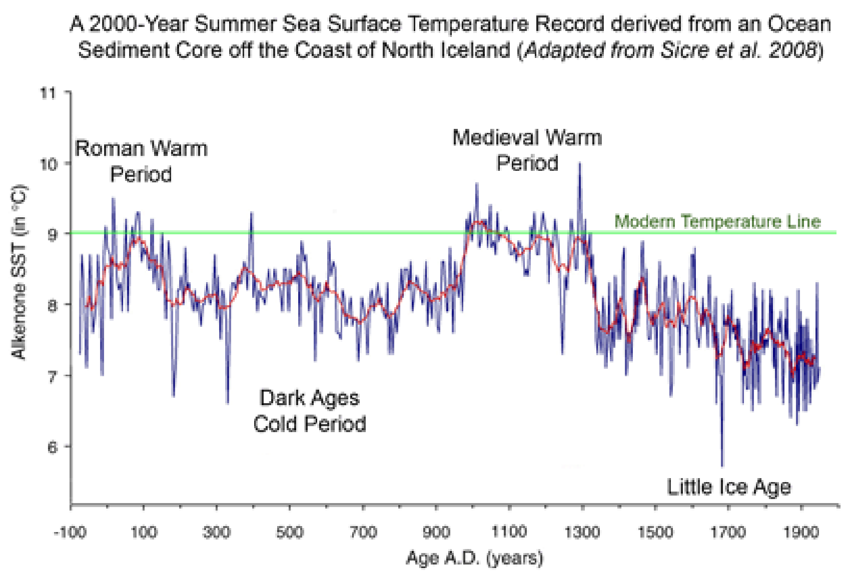
One year later, Leipe *et al*. (2008)[25] described what they learned from five 60-cm sediment cores they retrieved from the eastern Gotland Basin in the central Baltic Sea (~56°55'-57°15'N,

24 http://www.co2science.org/articles/V10/N41/C3.php.
25 http://www.co2science.org/articles/V11/N22/C2.php.

19°20'-20°00'E) after analyzing them for a variety of physical, chemical and biological properties. And at the top of the list was the fact that "during the Medieval Warm Period, from about AD 900 to 1250, the hydrographic and environmental conditions were similar to those of the present time." But they added that analyses of lignin compounds in the sediment cores - which "can be used to characterize terrigenous organic matter from plants" - pointed to the Medieval Warm Period possibly being warmer than the Current Warm Period.

Also working at sea and reporting in the same year were Sicre *et al*. (2008)[26], who developed a unique 2000-year-long summer sea surface temperature (SST) record with unprecedented temporal resolution (2-5 years) from a sediment core retrieved off North Iceland (66°33'N, 17°42W), based on their analyses of alkenones synthesized primarily in the summer by the marine alga *Emiliania huxleyi* that grew in the overlying ocean's surface waters, while dating of the SST data was provided by tephrochronology.

The graph below is adapted from the temperature history they derived. Of particular interest is the fact that it clearly reveals the millennial-scale oscillation of climate that produced the Roman Warm Period, Dark Ages Cold Period, Medieval Warm Period, Little Ice Age and Current Warm Period.



Sea surface temperature vs. time. Adapted from Sicre et al. (2008).

In comparing prior temperatures to those of the near-present, it can be seen from the graph that the SST record peaks at about 8.3°C *somewhere in the vicinity of 1940*, which was a particularly warm time in earth's modern history. However, the researchers show a "modern temperature" of 9°C that they determined from a box-core of nearby surface sediment, which they say "is consistent with the recent compilation produced by Hanna *et al*. (2006)," who reported that "since 1874, July and August SSTs measured at Grimsey Island have varied

[26] http://www.co2science.org/articles/V11/N25/C2.php.

between 6.7 and 9°C," which ultimately suggests that Sicre *et al*.'s 9°C value is the *peak* modern temperature observed to the time of Hanna *et al*.'s analysis.

In light of the above observations, it can be concluded that the peak temperature of the Medieval Warm Period was fully 1°C warmer than the peak temperature of the Current Warm Period, and that the peak temperature of the Roman Warm Period was about 0.5°C warmer than that of the Current Warm Period. And since the air's CO_2 concentration at those two earlier times was at least 100 ppm *less* than it is today, whatever caused the much higher-than-current temperatures of those earlier warm periods may well be what has caused the more *modest* high temperatures the earth has experienced in our day and age.

Contemporaneously, MacDonald *et al*. (2008)[27] conducted an analysis of past changes in the northern Russian treeline - as reconstructed from tree-ring data and radiocarbon-dated subfossil wood - in an attempt to answer the question: "Has the pattern of recent warming over the late nineteenth and the twentieth centuries caused significant changes in the density of trees at the treeline and/or an extension of the geographical location of the treeline?" In doing so, they indeed found that "temperature increases over the past century are already producing demonstrable changes in the population density of trees," but they added that "these changes have not yet generated an extension of conifer species' limits to or beyond the former positions occupied during the Medieval Warm Period (MWP: *ca* AD 800-1300)."

Of the Khibiny uplands of the central Kola Peninsula, for example, they write that "the treeline was located 100-140 m higher in elevation than today during the MWP," and that "forest has yet to recolonize these elevations (Kremenetski *et al*., 2004[28])." Likewise, of the northern Polar Urals they say "the treeline was at its highest elevation during the MWP between *ca* AD 900 and 1300 when it reached 340 m," after which it "descended to approximately 270 m during the Little Ice Age and then ascended to its present elevation of approximately 310 m during the recent warming of the late nineteenth and twentieth centuries."

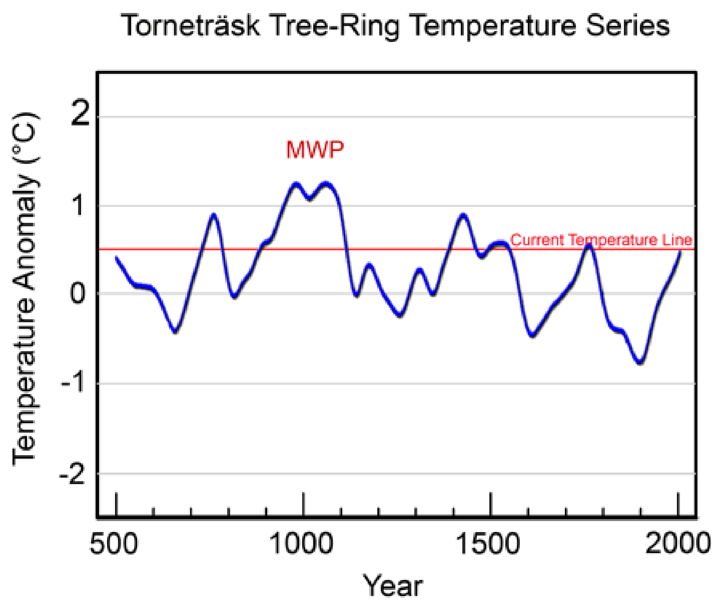
The three researchers thus concluded that at the sites studied, "the impact of twentieth century warming has not yet compensated fully for the mortality and range constriction caused by the cold temperatures of the Little Ice Age," and they note that "these results are similar to observations in some other northern treeline regions such as uplands in eastern Quebec and interior Labrador where *Picea mariana* (P. Mill.) B.S.P. and *Picea glauca* (Moench) Voss trees remain below their pre-Little Ice Age limits despite recent warming (Gamache and Payette,2005; Payette, 2007)," which warming has likely not yet equaled that of the MWP in either magnitude or duration ... or possibly even both.

Also with a paper appearing in the same year was Grudd (2008)[29], who noted that many tree-ring-based climate histories terminate far short of the end of the 20th century, and who stated there thus was "an urgent need to update existing tree-ring collections throughout the northern hemisphere," especially (as his results vividly demonstrate) to make valid comparisons

[27] http://www.co2science.org/articles/V11/N32/C2.php.
[28] http://www.co2science.org/articles/V7/N33/C2.php.
[29] http://www.co2science.org/articles/V11/N37/C3.php.

of past high-temperature periods, such as the Medieval Warm Period, with those the present, i.e., the Current Warm Period.

Working with an extensive set of Scots pine (*Pinus sylvestris* L.) tree-ring *maximum density* (MXD) data from the Tornetrask area of northern Sweden, which were originally compiled by Schweingruber *et al*. (1988) and covered the period AD 441-1980, Grudd extended the record an additional 24 years to 2004 using new samples obtained from 35 relatively young trees, which had the effect of reducing the mean cambial age of the MXD data in the 20th century and thus *eliminating* a disturbing "loss of sensitivity to temperature, apparent in earlier versions of the Tornetrask MXD chronology (Briffa, 2000)." And these efforts resulted in the following figure.



Annual April-August temperatures. Adapted from Grudd (2008).

Grudd concluded, as is readily evident from the results presented in the figure above, that "the late-twentieth century is not exceptionally warm in the new Tornetrask record," since "on decadal-to-century timescales, periods around AD 750, 1000, 1400 and 1750 were all equally warm, or warmer." More specifically, he stated that "the warmest summers in this new reconstruction occur in a 200-year period centered on AD 1000," leading him to declare that "Fennoscandia seems to have been significantly warmer during medieval times as compared to the late-twentieth century," and that this period "was much warmer than previously recognized." In addition, he notes that "a warm period around AD 1000 is in line with evidence from other proxy indicators from northern Fennoscandia," writing that "pine tree-limit (Shemesh *et al*., 2001; Helama *et al*., 2004; Kulti *et al*., 2006) [and] pollen and diatoms (Korhola *et al*., 2000; Seppa and Birks, 2002; Bigler *et al*., 2006) show indisputable evidence of a 'Medieval Warm Period' that was warmer than the twentieth century climate."

One year later, based on data obtained from hundreds of moisture-sensitive Scots pine tree-ring records originating in Finland, and using *regional curve standardization* (RCS) procedures, Helama *et al.* (2009)[30] developed what they describe as "the first European dendroclimatic precipitation reconstruction," which "covers the classical climatic periods of the Little Ice Age (LIA), the Medieval Climate Anomaly (MCA), and the Dark Ages Cold Period (DACP)," running all the way from AD 670 to AD 1993. And these data, in their words, indicate that "the special feature of this period in climate history is the distinct and persistent drought, from the early ninth century AD to the early thirteenth century AD," which interval "precisely overlaps the period commonly referred to as the MCA, due to its geographically widespread climatic anomalies both in temperature and moisture." In addition, they report that "the reconstruction also agrees well with the general picture of wetter conditions prevailing during the cool periods of the LIA (here, AD 1220-1650) and the DACP (here, AD 720-930)."

In further discussing their findings, the three Finnish scientists note that "the global medieval drought that we found occurred in striking temporal synchrony with the multicentennial droughts previously described for North America (Stine, 1994; Cook *et al*., 2004, 2007), eastern South America (Stine, 1994; Rein *et al*., 2004), and equatorial East Africa (Verschuren *et al*., 2000; Russell and Johnson, 2005, 2007; Stager *et al*., 2005) between AD 900 and 1300." Noting further that "the global evidence argues for a common force behind the hydrological component of the MCA," they also reported that "previous studies have associated coeval megadroughts during the MCA in various parts of the globe with either solar forcing (Verschuren *et al*., 2000; Stager *et al*., 2005) or the ENSO (Cook *et al*., 2004, 2007; Rein *et al*., 2004; Herweijer *et al*., 2006, 2007; Graham *et al*., 2007, Seager *et al*., 2007)," stating that "the evidence so far points to the medieval solar activity maximum (AD 1100-1250), because it is observed in the $\Delta^{14}C$ and ^{10}Be series recovered from the chemistry of tree rings and ice cores, respectively (Solanki *et al*., 2004)."

And so the evidence continues to mount for a *global* and *solar-induced* Medieval Warm (and Dry!) Period, which likely eclipsed (in both categories) what the world has so far experienced during the Current Warm Period.

Contemporaneously, Axford *et al*. (2009)[31] wrote that "the idea of a widespread and spatially coherent 'Medieval Warm Period' (MWP) has come under scrutiny in recent years," but that "it remains a viable hypothesis that a period of relative warmth in northwestern Europe and the northern North Atlantic region helped facilitate Norse expansion across the North Atlantic from the ninth to thirteenth centuries, including settlement of Iceland and Greenland," and that "subsequent cooling contributed to the demise of the Norse settlements on Greenland." And in further exploring this subject, they developed a regional climatic record from a sediment core retrieved from lake Stora Vioarvatn in northeast Iceland (66°14.232'N, 15°50.083'W) in the summer of 2005, based on chironomid assemblage data - which were well correlated with nearby measured temperatures over the 170-year instrumental record - and total organic carbon, nitrogen and biogenic silica content.

With respect to the Medieval Warm Period, the four researchers report that their data indicated "warm temperatures in the tenth and eleventh centuries, with one data point

30 http://www.co2science.org/articles/V12/N14/C3.php.
31 http://www.co2science.org/articles/V12/N16/C2.php.

suggesting temperatures slightly warmer than present." But even more striking in this regard, they found that "temperatures were higher overall and more consistently high through much of the first millennium AD."

In discussing these findings, the Icelandic, UK and US scientists said "the historical perception of a significant medieval climate anomaly in Iceland may be primarily a reflection of the human perspective," in that "Iceland was settled ca. AD 870, during a period of relative warmth that was followed by many centuries of progressively colder and less hospitable climate," and that "had the Norse settled Iceland 1000 years earlier, the MWP might be viewed only as a brief period of climatic amelioration, a respite from a shift to colder temperatures that began in the eighth century," near the end of several centuries of even greater warmth. In any event, and viewed from either perspective, it is clear there is nothing unusual or unnatural about the region's present-day temperatures, which the researchers say "do not show much recent warming."

Also looking at climate from the "human perspective" - and in the very same year - were Stancikaite *et al*. (2009)[32], who carried out interdisciplinary research at the Impiltis hill fort and settlement area of Northwest Lithuania in order "to study the climate and the human impact on the landscape, the development of the settlement and the hill fort, the types of agriculture employed there, and changes in the local economy." And in doing so, they determined that "the transition from the first to the second millennium AD, also the onset of the 'Medieval Warm Period,' coincided with a period of intensive human activity at the Impiltis hill fort and settlement area."

There was at that time, as they discovered, "a high intensity of farming activities, which were supported by favorable climatic conditions and included the existence of permanent agricultural fields as well as the earliest record of rye cultivation in NW Lithuania." And the "period of most prominent human activity in the Impiltis," as the eight researchers described it, "was dated back to about 1050-1250 AD," when they suggested that "the favorable climatic conditions of [this] 'Medieval Warm Period' may have supported human activity during its maximum phase," which inference, in their words, "correlates well with the chronology of the hill fort and settlement prosperity as represented in data collected from the site." Thereafter, they further suggested that "it is possible that the ensuing gradual regression of human activity was caused, in part, by the climatic deterioration known as the 'Little Ice Age'."

Once again, we have a treasure trove of real-world evidence for what Stancikaite *et al*. describe as "remarkable changes" in Northwest Lithuania's "environment and population history" that "took place in the context of worldwide climatic fluctuations," which were, of course, *totally independent* of any fluctuations in the atmosphere's CO_2 concentration (since there were no signification CO_2 fluctuations over this period). And *these* observations suggest that the *reverse* of that "worldwide climatic fluctuation" - earth's *recovery* from the global chill of the Little Ice Age (which led to the creation of the *Current* Warm Period) - has *also* had nothing to do with concomitant changes in the atmosphere's CO_2 concentration, revealing the weakness of climate-alarmist claims to the contrary.

[32] http://www.co2science.org/articles/V13/N12/C2.php.

Finally reaching 2010, Bonnet *et al*. (2010)[33] developed a high-resolution record of ocean and climate variations during the late Holocene in the Fram Strait (the major gateway between the Arctic and North Atlantic Oceans, located north of the Greenland Sea), based on detailed analyses of a sediment core recovered from a location (78°54.931'N, 6°46.005'E) on the slope of the western continental margin of Svalbard, based on analyses of organic-walled dinoflagellate cysts that permit the reconstruction of sea-surface conditions in both summer and winter. These latter reconstructions, in their words, "were made using two different approaches for comparison and to insure the robustness of estimates." These were "the modern analogue technique, which is based on the similarity degree between fossil and modern spectra" and "the artificial neural network technique, which relies on calibration between hydrographical parameters and assemblages."

Employing these procedures, Bonnet *et al*. discovered that the *sea surface temperature* (SST) histories they developed were "nearly identical and show oscillations between -1°C and 5.5°C in winter and between 2.4°C and 10.0°C in summer," and their graphical results indicate that between 2500 and 250 years *before present* (BP), the mean SSTs of summers were warmer than those of the present about 80% of the time, while the mean SSTs of winters exceeded those of current winters approximately 75% of the time, with the long-term (2250-year) means of both seasonal periods averaging about 2°C more than current means. In addition, the highest temperatures of all were recorded in the vicinity of 1320 cal. years BP, during a warm interval that persisted from about AD 500 to 720 during the very earliest stages of the Medieval Warm Period (MWP), when the peak summer and winter temperatures of the MWP both exceeded the peak summer and winter temperatures of the first several years of the 21st century by about 3°C.

About this same time, Haltia-Hovi *et al*. (2010)[34] wrote that "lacustrine sediment magnetic assemblages respond sensitively to environmental changes," and that "characteristics of magnetic minerals, i.e. their concentration, mineralogy and grain size in sediments, can be studied by making mineral magnetic measurements, which yield large quantities of environmental data rapidly and non-destructively," citing Evans and Heller (2003). And so it was that working with two sediment cores taken from Finland's Lake Lehmilampi (63°37'N, 29°06'E), they constructed detailed chronological histories of several magnetic properties of the sediments, as well as a history their total organic carbon content.

Based on their several analyses, the four researchers discovered a "conspicuous occurrence of fine magnetic particles *and* high organic concentration" that was evident around 4,700-4,300 Cal. yrs BP, which time interval, in their words, "is broadly coincident with glacier contraction and treelines higher than present in the Scandinavian mountains according to Denton and Karlen (1973) and Karlen and Kuylenstierna (1996)." And they further report that from that time on towards the present, there was a "decreasing trend of magnetic concentration, except for the slight localized enhancement in the upper part of the sediment column at ~1,100-900 Cal. yrs BP," where the year zero BP = AD 1950.

[33] http://www.co2science.org/articles/V13/N27/C2.php.

[34] http://www.co2science.org/articles/V13/N43/C2.php.

Changes of these types in prior studies have been attributed to magnetotactic bacteria (e.g. *Magnetospirillum* spp.), which Haltia-Hovi *et al*. describe as "aquatic organisms that produce internal, small magnetite or greigite grains" that are used "to navigate along the geomagnetic field lines in search of micro or anaerobic conditions in the lake bottom," as described by Blakemore (1982) and Bazylinski and Williams (2007). And they further state that the studies of Snowball (1994), Kim *et al*. (2005) and Paasche *et al*. (2004) "showed magnetic concentration enhancement, pointing to greater metabolic activity of these aquatic organisms in the presence of abundant organic matter," which is also what Haltia-Hovi *et al*. found in their study, where they report that the "concentration of organic matter in the sediment is highest, together with fine magnetic grain sizes, in the time period 1,100-900 Cal. years BP," which time interval they say "is associated with warmer temperatures during the Medieval Climate Anomaly according to the varve parameters of Lake Lehmilampi," citing the precise core-dating by varve-counting work of Haltia-Hovi *et al*. (2007). And *all* of these observations, *taken together*, strongly suggest that the peak warmth of the Medieval Warm Period (about AD 850-1050) was very likely somewhat *greater* than that of the Current Warm Period.

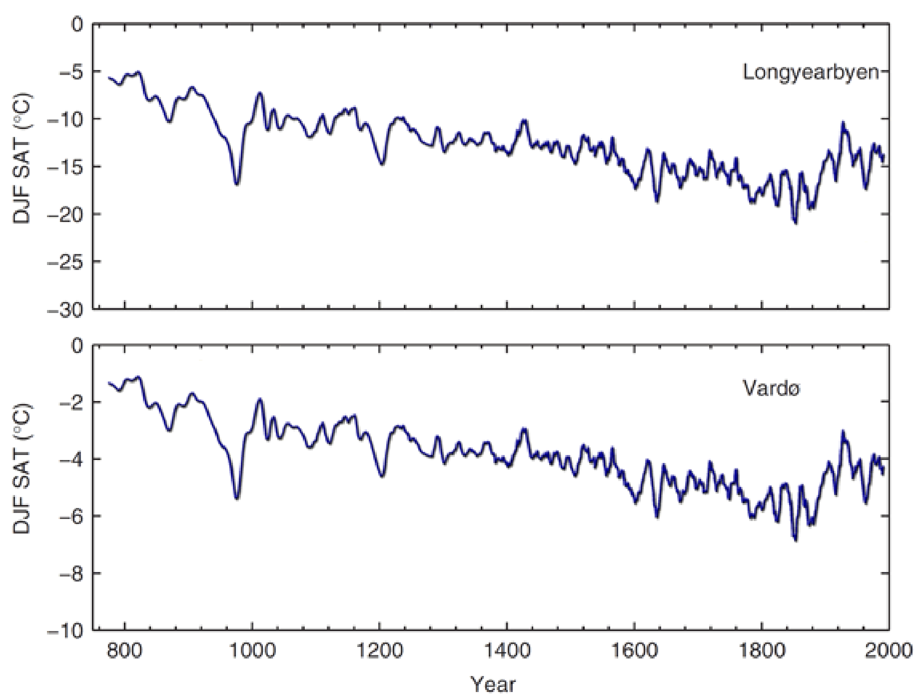
Moving up another year, Gunnarson *et al*. (2011)[35] wrote that "dendroclimatological sampling of Scots pine (*Pinus sylvestris* L.) has been made in the province of Jamtland, in the west-central Scandinavian mountains, since the 1970s," and they say that "a maximum latewood density (MXD) dataset, covering the period AD 1107-1827 (with gap 1292-1315) was presented in the 1980s by Fritz Schweingruber." And, therefore, working in the same general area, Gunnarson *et al*. combined these older historical MXD data with "recently collected MXD data covering AD 1292-2006 into a single reconstruction of April-September temperatures for the period AD 1107-2006," using regional curve standardization (RCS), which "provides more low-frequency variability than 'non-RCS' and stronger correlation with local seasonal temperatures."

As a result of this effort, the three researchers found there was "a steep increase in inferred temperatures at the beginning of the twelfth century, followed by a century of warm temperatures (ca. 1150-1250)," which falls within the temporal confines of the Medieval Warm Period; and they state that "the record ends with a sharp increase in temperatures from around 1910 to the 1940s, followed by decreasing temperatures for a few decades," after which they indicate that "another sharp increase in April-September temperature commenced in the late 1990s," during what is commonly known as the Current Warm Period. And they thus concluded that "the two warmest periods are the mid to late twentieth century and the period from AD 1150-1250," emphasizing that the temperatures of both of these periods have been *so similar* that "it is not possible to conclude whether the present and relatively recent past are warmer than the 1150-1250 period." Consequently, and contrary to the worn-out claim of the world's climate alarmists that the high temperatures of the past couple of decades have been *unprecedented* relative to those of the past couple of *millennia*, this impressive April-September temperature reconstruction from west-central Scandinavia tells a much different story for this particular part of the world, which now joins a host of other "particular parts of the world" that reflect the same fact.

[35] http://www.co2science.org/articles/V14/N14/C3.php.

In a contemporary paper, Divine *et al*. (2011)[36] wrote that "the recent rapid climate and environmental changes in the Arctic, for instance, sea-ice retreat (e.g., Comiso *et al*., 2008) and ice-sheet melting (e.g., van den Broeke *et al*., 2009), require a focus on long-term variability in this area in order to view these recent changes in the long-term context," which is truly essential if one desires to know just how unusual, unnatural or unprecedented the recent warming of the Arctic has been. And, therefore, working with ice cores extracted from Svalbard at Lomonosovfonna in 1997 (Isaksson *et al*., 2001) and at Holtedahlfonna in 2005 (Sjorgren *et al*., 2007), Divine *et al*. used the $\delta^{18}O$ data derived from them to reconstruct 1200-year winter (DecJanFeb) surface air temperature histories for nearby Longyearbyen (78.25°N, 15.47°E) and farther-afield Vardo (70.54°N, 30.61°E, in northern Norway), by calibrating (scaling) the $\delta^{18}O$ data to corresponding historically-observed temperatures at the two locations, which for Longyearbyen were first collected in 1911 and for Vardo have been extended back to 1840 as a result of the work of Polyakov *et al*. (2003).

These efforts resulted in the winter surface air temperature reconstructions that are depicted in the figure below, which begin at the peak warmth of the Medieval Warm Period at a little before AD 800; and they decline fairly steadily to the coldest period of the Little Ice Age at about AD 1830, after which they rise into the 1930s, decline, and then rise again, to terminate just slightly lower than their 1930s' peaks near the end of the 1990s.



Reconstructed winter surface air temperature (SAT) for Longyearbyen (top) and Vardo (bottom) vs. time. Adapted from Divine et al. (2011).

As may readily be determined from Divine *et al*.'s results, the 11-year running-mean peak winter temperature of the Medieval Warm Period was approximately 9°C greater than the end-

[36] http://www.co2science.org/articles/V15/N31/C3.php.

of-record 11-year running-mean peak winter temperature at Longyearbyen, while it was about 3.3°C warmer at Vardo. And thus it can readily be realized that not only is there nothing unusual, unnatural or unprecedented about the most recent surface air temperatures at these two sites, it is pretty clear that it was *significantly* warmer at both locations during the peak warmth of the Medieval Warm Period, when there was *way* less CO_2 in the atmosphere than there is today. And this observation suggests - as do many others from all around the world - that anthropogenic CO_2 emissions are *not* the great threat to humanity and the biosphere that climate alarmists claim them to be; for something in the environment appears to be effectively *counteracting* whatever "greenhouse effect" they may produce.

Finally advancing one more year, Esper *et al*. (2012)[37] introduced their most recent study of the subject by stating that millennial-length temperature reconstructions have become "an important source of information to benchmark climate models, detect and attribute the role of natural and anthropogenic forcing agents, and quantify the feedback strength of the global carbon cycle." And, therefore, the four researchers dedicated themselves and their talents to developing the most reliable long-term regional temperature reconstructions possible, focusing their attention most recently on parts of northern Sweden and Finland.

What they did was develop 587 high-resolution wood density profiles (Frank and Esper, 2005) from living and sub-fossil *Pinus sylvestris* trees of northern Sweden and Finland to form a long-term *maximum latewood density* (MXD) record stretching from 138 BC to AD 2006, wherein all MXD measurements were derived from high-precision X-ray radiodensitometry, as described by Schweingruber *et al*. (1978), and where biological age trends inherent to the MXD data were removed using *regional curve standardization* (RCS), as described by Esper *et al*. (2003), after which the new MXD record was calibrated against mean June-August temperatures obtained from the long-term (1876-2006) instrumental records of Haparanda, Karasjok and Sodankyla. And in comparing their results with the earlier temperature reconstructions of others, they say that their MXD-based summer temperature reconstruction "sets a new standard in high-resolution palaeoclimatology," as "the record explains about 60% of the variance of regional temperature data, and is based on more high-precision density series than any other previous reconstruction."

As for what was learned from this monumental effort, the four researchers say that their new temperature history "provides evidence for substantial warmth during Roman and Medieval times, larger in extent and longer in duration than 20th century warmth." And it would thus appear to be the case that as ever more data-inclusive and carefully-analyzed studies of palaeo-temperature proxies are conducted, it is becoming ever more evident that there has not been anything *unusual*, *unnatural* or *unprecedented* about either the *rate of warming* or the *level of warmth achieved* during the 20th century throughout the whole of Northern Europe, which further suggests that there is likely no real-world empirical evidence for CO_2-induced warming anywhere else on the planet either, which suggestion is pretty much verified by similar studies that have been conducted on other continents.

[37] http://www.co2science.org/articles/V15/N39/C3.php.

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