MEDIEVAL WARM PERIOD IN SOUTHERN 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, new and important data from Southern Europe that support their *original* belief are described and discussed.

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.

Working with a core of 2.5 meters length, which they sampled at intervals of 2 cm in the upper 1 meter and at intervals of 5 cm below that depth, Martinez-Cortizas *et al*. (1999)[1] derived a record of *mercury deposition* in the peat bog of Penido Vello in northwest Spain (43°32'N, 7°34'W) that extends to 4000 radiocarbon years before the present, which they analyzed for a number of parameters. This work revealed, in their words, "that cold climates promoted an enhanced accumulation and the preservation of mercury with low thermal stability, and warm climates were characterized by a lower accumulation and the predominance of mercury with moderate to high thermal stability." And based on these findings and further analyses, they derived a temperature history for the region that they standardized to the mean temperature of the most recent 30 years of their record.

This work revealed that the mean temperature of the Medieval Warm Period in northwest Spain was 1.5°C warmer than it was over the 30 years leading up to the time of their study, and that the mean temperature of the Roman Warm Period was 2°C warmer. Even more impressive was their finding that several decadal-scale intervals during the Roman Warm Period were more than 2.5°C warmer than the 1968-98 period, while an interval in excess of 80 years during the Medieval Warm Period was more than 3°C warmer.

In light of these findings, Martinez-Cortizas *et al*. concluded, and rightly so, that "for the past 4000 years ... the Roman Warm Period and the Medieval Warm Period were the most important warming periods." And, of course, these conclusions *totally repudiate* (for this small part of the world, at least) the drastically differing claims of Mann *et al*. (1998, 1999) and Mann

[1] http://www.co2science.org/articles/V8/N44/C2.php.

and Jones (2003), as well as the "consensus" judgment of the Intergovernmental Panel on Climate Change.

Four years later, Desprat *et al*. (2003)[2] studied the climatic variability of the last three millennia in northwest Iberia via a high-resolution pollen analysis of a sediment core retrieved from the central axis of the Ria de Vigo (42°14.07'N, 8°47.37'W) in the south of Galicia. This project yielded results that suggested that over the past 3000 years there was, in the words of the three researchers, "an alternation of three relatively cold periods with three relatively warm episodes." In order of their occurrence, these periods are described by Desprat *et al*. as the "first cold phase of the Subatlantic period (975-250 BC)," which was "followed by the Roman Warm Period (250 BC-450 AD)," which was followed by "a successive cold period (450-950 AD), the Dark Ages," which "was terminated by the onset of the Medieval Warm Period (950-1400 AD)," which was followed by "the Little Ice Age (1400-1850 AD), including the Maunder Minimum (at around 1700 AD)," which "was succeeded by the recent warming (1850 AD to the present)." In addition, they concluded that the "solar radiative budget and oceanic circulation seem to be the main mechanisms forcing this cyclicity in NW Iberia." And in this regard, they make special mention of the fact that "a millennial-scale climatic cyclicity over the last 3000 years is detected for the first time in NW Iberia paralleling global climatic changes recorded in North Atlantic marine records (Bond *et al*., 1997; Bianchi and McCave, 1999; Chapman and Shackelton, 2000)," which further suggests that the establishment of the Current Warm Period over the course of the past century is nothing more than the most recent manifestation of this ever-recurring phenomenon and, hence, is likely totally unrelated to the concurrent historical increase in the air's CO_2 content.

One year later, working at a site on the northwest coast of Sicily near Capo Gallo promontory, Silenzi *et al*. (2004)[3] acquired new oxygen isotopic data on sea climate trend fluctuations on Vermetid (*Dendropoma petraeum*) reefs that could be interpreted as *sea surface temperature* (SST) variations. These data clearly depicted the existence of the Little Ice Age (LIA), with a "temperature variation of about $\Delta T = 1.99 \pm 0.37$ °C between the LIA and present day." Of this period, they write that "Watanabe *et al*. (2001) report that 'seawater temperature records from marine biogenic carbonate including coral and foraminifera all indicate that tropical ocean temperatures were lower by anywhere from 0.5° to 5°C during the LIA (Druffel, 1982; Glynn *et al*., 1983; Dunbar *et al*., 1994; Linsley *et al*., 1994; Keigwin, 1996; Winter *et al*., 2000) with the vast majority of studies indicating a 1-2°C change'."

Following the LIA, the data of Silenzi *et al*. reveal what they call "the warming trend that characterized the last century." However, they note that "this rise in temperature ended around the years 1930-1940 AD, and was followed by a relatively cold period between the years 1940 and 1995." Their data also indicate that in the early to mid-1500s, SSTs were warmer than they are currently, as has also been found to be the case by Keigwin (1996) and McIntyre and McKitrick (2003). And so it is that the results of this study disagree with the flawed Northern Hemispheric temperature history of Mann *et al*. (1998, 1999) in three major ways. First, they indicate that the Little Ice Age was significantly colder than what Mann *et al*.

[2] http://www.co2science.org/articles/V6/N43/C2.php
[3] http://www.co2science.org/articles/V7/N5/C2.php.

suggest. Second, they do not show any sign of the dramatic late-20th century warming claimed by Mann *et al*. Third, they indicate that temperatures in the early to mid-1500s were warmer than they are currently, whereas Mann *et al*. claim it is currently warmer than it has been at any time over the past millennium or two (Mann and Jones, 2003). Hence, this study takes its place as one of the many comprising the *mountain of evidence* that will one day result in the unequivocal rejection of the false temperature history of the IPCC.

Close on the heels of Silenzi *et al*.'s study came that of Kvavadze and Connor (2005)[4], who in a review and analysis of the scientific literature, presented "some observations on the ecology, pollen productivity and Holocene history of *Zelkova carpinifolias*," a warmth-loving tree whose pollen "is almost always accompanied by elevated proportions of thermophilous taxa," in order to further refine our understanding of Quaternary climatic trends. Indeed, they write that the discovery of the tree's fossil remains in Holocene sediments "can be a good indicator of optimal climatic conditions." So what did they find?

The two researchers note that "Western Georgian pollen spectra of the Subatlantic period show that the period began [about 2580 cal yr BP] in a cold phase, but, by 2200 cal yr BP, climatic amelioration commenced," and "the maximum phase of warming [was] observed in spectra from 1900 cal yr BP," which interval of warmth was Georgia's contribution to the Roman Warm Period. Thereafter, a cooler phase of climate, during the Dark Ages Cold Period, "occurred in Western Georgia about 1500-1400 cal yr BP," according to the two scientists, but it too was followed by another warm period "from 1350 to 800 years ago," which, of course, was the Medieval Warm Period. During portions of this time interval, they also report that tree lines "migrated upwards and the distribution of *Zelkova* broadened." What is more, they present a history of Holocene oscillations of the upper tree-line in Abkhasia - derived by Kvavadze *et al*. (1992) - that depicts slightly greater-than-1950 elevations during a portion of the Medieval Warm Period and *much* greater extensions above the 1950 tree-line during parts of the Roman Warm Period. And finally, following the Medieval Warm Period, Kvavadze and Connor note that "subsequent phases of climatic deterioration (including the Little Ice Age) ... saw an almost complete disappearance of *Zelkova* from Georgian forests."

In a nutshell, then, both the Roman and Medieval Warm Periods have been identified in various parts of European Georgia via studies of *Zelkova carpinifolia* pollen found in local sediments; and portions of these warm climatic intervals were likely even warmer than what it was there during ~ AD 1950, which is the "present" of Kvavadze and Connor's study.

Contemporaneously, Pla and Catalan (2005)[5] analyzed chrysophyte cyst data collected from 105 lakes in the Central and Eastern Pyrenees of northeast Spain to produce a history of winter/spring temperatures in this region throughout the Holocene. And in doing so, they found there was a significant oscillation in the winter/spring temperature reconstruction in which the region's climate alternated between warm and cold phases over the past several thousand years. Of particular note were the Little Ice Age, Medieval Warm Period, Dark Ages

[4] http://www.co2science.org/articles/V8/N19/C3.php.
[5] http://www.co2science.org/articles/V8/N30/C2.php.

Cold Period and Roman Warm Period, the warmest of which intervals was the Medieval Warm Period, which started around AD 900 and was about 0.25°C warmer than it is currently.

Following the Medieval Warm Period, temperatures fell to their lowest values of the entire record (about 1.0°C below present), whereupon they began to warm, but remained below present-day values until the early 19th and 20th centuries, with one exception. A significant warming was observed between 1350 and 1400, when temperatures rose a full degree Celsius to a value about 0.15°C warmer than the present. And further examination of Pla and Catalan's data reveals that the Modern Warm Period is not yet (and may never be) as warm as the Medieval Warm Period, for modern temperatures peaked in the 1970s-80s and then declined throughout the 1990s.

About the same time, Giraudi (2005)[6] was studying various properties of alternating layers of organic-matter-rich soils and alluvial, glacial and periglacial sediments on higher Apennine massifs in Italy, located at approximately 42°23'N, 13°31'E, reconstructing a history of relative changes in temperature for this region over the past 6000 years. This effort led to the determination that organic-matter-rich soils formed on slopes currently subject to periglacial and glacial processes around 5740-5590, 1560-1370 and 1300-970 cal yr BP. And based on current relationships between elevation and soil periglacial and glacial processes, Giraudi estimated that the mean *annual* temperature during these three periods "must therefore have been higher than at present," and that *winter* temperatures were at least 0.9-1.2°C higher than those of today.

Working concurrently on a project off the coast of Italy in the Gulf of Taranto (39°45'53"N, 17°53'33"E), Cini Castagnoli *et al*. (2005)[7] extracted a $\delta^{13}C$ profile of *Globigerinoides rubber* from a shallow-water core that they used to produce a high-precision record of climate variability over the past two millennia. This high-precision record was then statistically analyzed, together with a second two-millennia-long tree-ring record obtained from Japanese cedars (Kitagawa and Matsumoto, 1995), for evidence of recurring cycles using Singular Spectrum Analysis and Wavelet Transform, after which both records were compared with a 300-year record of sunspots.

Plots of the pair of two-thousand-year series revealed the existence of the Dark Ages Cold Period (~400-800 AD), the Medieval Warm Period (~800-1200 AD), the Little Ice Age (~1500-1800 AD), and the Current Warm Period, the roots of which latter period can be traced to an upswing in temperature that began in the depths of the Little Ice Age "about 1700 AD." In addition, results of the statistical analyses showed a common 11-year oscillation in phase with the Schwabe cycle of solar activity, plus a second multi-decadal oscillation (of about 93 years for the shallow-water *G. rubber* series and 87 years for the tree-ring series) in phase with the amplitude modulation of the sunspot number series over the last 300 years.

According to the three researchers, the overall phase agreement between the two climate reconstructions and the variations in the sunspot number series "favors the hypothesis that the

[6] http://www.co2science.org/articles/V8/N51/C3.php.
[7] http://www.co2science.org/articles/V9/N2/C1.php.

[multi-decadal] oscillation revealed in $\delta^{13}C$ from the two different environments is connected to the solar activity," which further suggests that a solar forcing was at work in both terrestrial and oceanic domains over the past two millennia. Thus, and once again, we have more evidence for the solar forcing of climate at decadal and multi-decadal time scales, as well as for the millennial-scale oscillation of climate that likely has been responsible for the 20th-century warming of the globe that led to the demise of the Little Ice Age and ushered in the Current Warm Period.

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Also reporting in the same year were Frisia *et al*. (2005)[8], who working with stalagmite SV1 from Grotta Savi - a cave located at the southeast margin of the European Alps in Italy (45°37'05" N, 13°53'10" E) - developed a 17,000-year record of speleothem calcite $\delta^{18}O$ data, which they calibrated against "a reconstruction of temperature anomalies in the Alps" that was developed by Luterbacher *et al*. (2004) for the last quarter of the past millennium. This work revealed - among several other things (due to the great length of time involved) - the occurrence of the Roman Warm Period and a Medieval Warm Period that was broken into two parts by an intervening central cold period. And with respect to *both* parts of the Medieval Warm Period, the five researchers said that they were "characterized by temperatures that were similar to the present," while with respect to the Roman Warm Period, they said that its temperatures "were similar to those of today or even slightly warmer."

Two years closer to the present, Garcia *et al*. (2007)[9] noted that "despite many studies that have pointed to ... the validity of the classical climatic oscillations described for the Late Holocene (Medieval Warm Period, Little Ice Age, etc.), there is a research line that suggests the non-global signature of these periods (IPCC, 2001; Jones and Mann, 2004)." And noting that "the best way to solve this controversy would be to increase the number of high-resolution records covering the last millennia and to increase the spatial coverage of these records," they proceeded to do just that. And in doing so, they were able to identify five distinct climatic stages: "a cold and arid phase during the Subatlantic (Late Iron Cold Period, < B.C. 150), a warmer and wetter phase (Roman Warm Period, B.C. 150-A.D. 270), a new colder and drier

[8] http://www.co2science.org/articles/V13/N36/C3.php.
[9] http://www.co2science.org/articles/V10/N43/C2.php.

period coinciding with the Dark Ages (A.D. 270-900), the warmer and wetter Medieval Warm Period (A.D. 900-1400), and finally a cooling phase (Little Ice Age, >A.D. 1400)."

Noting that "the Iberian Peninsula is unique, as it is located at the intersection between the Mediterranean and the Atlantic, Europe and Africa, and is consequently affected by all of them," Garcia *et al*. significantly advanced the *likelihood* that "the classical climatic oscillations described for the Late Holocene (Medieval Warm Period, Little Ice Age, etc.)" were indeed both real and global in scope, as is becoming ever more evident. In addition, the six scientists stated that the Medieval Warm Period "is identified at about a similar date all around the world (China: Chu *et al*., 2002; Arabia, Fleitmann *et al*., 2004; Africa: Filippi and Talbot, 2005; Iceland: Doner, 2003; central Europe: Filippi *et al*., 1999; New Guinea: Haberle and David, 2004; USA: Cabaniss Pederson *et al*., 2005: Argentina: Mauquoy *et al*., 2004; etc.," and that "comparable changes are described by Desprat *et al*. (2003), Julia *et al*. (1998) and Riera *et al*. (2004) in northwest, central and northeast Spain." Truly, the evidence for the global scope of the Medieval Warm Period is *overwhelming*.

Moving forward another two years, Giraudi (2009)[10] examined "long-term relations among glacial activity, periglacial activity, soil development in northwestern Italy's alpine River Orco headwaters, and down-valley floods on the River Po," based on "studies carried out by means of geological and geomorphologic surveys on the glacial and periglacial features," including a sampling of soils involved in periglacial processes that "provided a basis for development of a chronological framework of late Holocene environmental change" and an analysis of "a stratigraphic sequence exposed in a peat bog along the Rio del Nel" about 1 km from the front edge of the Eastern Nel Glacier.

Among a number of other interesting findings resulting from these efforts, Giraudi determined that between about 200 BC and AD 100 - i.e., during the Roman Warm Period - "soils developed in areas at present devoid of vegetation and with permafrost," indicative of the likelihood that temperatures at that time "probably reached higher values than those of the present." He also concluded that "analogous conditions likely occurred during the period of [the] 11th-12th centuries AD, when a soil developed on a slope presently characterized by periglacial debris," while noting that "in the 11th-12th centuries AD, frost weathering processes were not active and, due to the higher temperatures than at present or the longer duration of a period with high temperatures, vegetation succeeded in colonizing the slope." He also determined that "the phase of greatest glacial expansion (Little Ice Age) coincides with a period characterized by a large number of floods in the River Po basin," and that "phases of glacial retreat [such as occurred during the Roman and Medieval Warm Periods] correlate with periods with relatively few floods in the River Po basin." This study thus provides a *double refutation* of the climate-alarmist claim that late 20th-century temperatures were the warmest of the past two millennia. And it demonstrates that in this part of Europe, cooler periods have generally experienced less flooding than have warmer periods.

Jumping ahead two years, and based on $\delta^{13}C$ data that they obtained from stalagmites recovered from three different caves in the northern part of Castilla-Leon in northern Spain -

[10] http://www.co2science.org/articles/V12/N14/C2.php.

each of which was situated approximately 50 km from a common central point (~42°40'N, 4°W) - and with the help of a good correlation between the mean annual temperatures of the past 125 years (from a site located 14 km from one of the caves) and corresponding $\delta^{13}C$ data, Martin-Chivelet *et al.* (2011)[11] developed a 4000-year history of the temperature of the region. And what did they find?

> There is nothing unusual about the current level of warmth of northern Iberia, of Europe, or of the globe as a whole, especially when it is realized that the atmosphere's CO_2 concentration is about 40% greater today than it was during the prior three warm periods of the last four millennia.

The five researchers report that their $\delta^{13}C$ record began with "an initial interval of broad warm conditions between 4000 and 3000 yr BP." Then came "a prolonged time during which thermal conditions become permanently cold," with the coldest conditions occurring between 2850 and 2550 yr BP, an interval that they describe as "the 'first cold phase' of the Subatlantic period, also called in Europe the Iron Age Cold Period." Next came another warm period when "maximum temperatures were probably reached in the three hundred years interval between 2150 and 1750 yr BP," which corresponds, in their words, "to the well-known Roman Warm Period, an interval which has been correlated with a phase of relatively high solar flux."

Thereafter came "another relatively cold episode, which lasted about 250 years and reached its minimum at ~1500 yr BP," which "correlated with the Dark Ages Cold Period described in other areas of Europe." Then, "a rapid trend of warming led to a new, prolonged interval of warmth" that lasted from 1400 to 700 yr BP. Known as the Medieval Warm Period, Martin-Chivelet *et al*. say that it is "probably the most robust climatic feature in our records, perfectly outlined in the series of the three stalagmites." And they state that "the end of the Medieval Warm Period was marked by a progressive and rapid ... transition into the Little Ice Age, a relatively cold period broadly reported from all Europe and also from other areas in the world as far as South Africa or South America."

Last of all, a graph of the researchers' data portrays the development of the Current Warm Period; and it suggests that temperatures at the end of the 20th century were about a quarter of a degree Centigrade *warmer* than the peak warmth of the Medieval Warm Period. However, they note that studies in Northern Spain based on peat bog proxies "suggest that the temperatures during both the Roman Warm Period and the Medieval Warm Period were higher than present-day ones," citing the work of Martinez-Cortizas *et al*. (1999)." In any event, it is clear that there is nothing unusual about the current level of warmth of northern Iberia, of

[11] http://www.co2science.org/articles/V14/N29/C2.php.

Europe, or of the globe as a whole, especially when it is realized that the atmosphere's CO_2 concentration is about 40% greater today than it was during the prior three warm periods of the last four millennia.

In a similarly timed and located study, Andrade *et al*. (2011)[12] worked with a 2.5-m gravity core and an 18-cm box core taken from the outer area of the Ria de Muros (42°44'N, 9°02'W) on the northwestern coast of the Iberian Peninsula in June 2004, in order to establish a climatic history of the region through "the combined use of textural analysis, magnetic properties and geochemical parameters (total concentrations of diagenetically stable and mobile elements in sediment and pore water)," which "allowed the identification of a current redox front and two palaeosedimentary redox fronts in the sediment record."

These three redox fronts, as the team of Spanish scientists described them, "originated during periods of high marine/terrestrial organic matter ratio (as inferred from the ratio of total organic carbon to total nitrogen and $\delta^{13}C$)." And they say that "sedimentation rates calculated from ^{14}C dating results identify these periods as known periods of increased upwelling and reduced continental input due to colder, drier climate in the NW Iberian Peninsula, namely the Little Ice Age, the Dark Ages, and the first cold period of the Upper Holocene." They also add that the lesser proportion of oceanic influence observed between 1250 and 560 cal. yr BP "coincides with the Medieval Warm Period, during which there was an increase in continental input to both the continental shelf (Mohamed *et al*., 2010) and the Rias of Vigo and Muros (Alvarez *et al*., 2005; Lebreiro *et al*., 2006)." And they add that the colder Dark Ages period was preceded by the "Roman Warm Period."

Once again, therefore, we find documentation for the millennial-scale oscillation of climate that has alternately brought the earth both into and out of the Roman Warm Period, the Dark Ages Cold Period, the Medieval Warm Period, the Little Ice Age, and - most recently - *into* the Current Warm Period. And during all of these climatic transitions, except for the most recent one, there have been no significant changes in the atmosphere's CO_2 concentration, which suggests that the transition out of the Little Ice Age and into the Current Warm Period likely had nothing at all to do with the concomitant increase in the air's CO_2 content.

Also with a paper published in the same year were Morellon *et al*. (2011)[13], who wrote that "in the context of present-day global warming, there is increased interest in documenting climate variability during the last millennium," since "it is crucial to reconstruct pre-industrial conditions to discriminate anthropogenic components (i.e., greenhouse gases, land-use changes) from natural forcings (i.e., solar variability, volcanic emissions)." And, therefore, they conducted a multi-proxy study of several short sediment cores they recovered from Lake Estanya (42°02'N, 0°32'E) in the Pre-Pyrenean Ranges of northeast Spain, which provide "a detailed record of the complex environmental, hydrological and anthropogenic interactions occurring in the area since medieval times." More specifically, they stated that "the integration of sedimentary facies, elemental and isotopic geochemistry, and biological proxies (diatoms, chironomids and pollen), together with a robust chronological control, provided by AMS radiocarbon dating

[12] http://www.co2science.org/articles/V14/N48/C2.php.
[13] http://www.co2science.org/articles/V15/N6/C2.php.

and ^{210}Pb and ^{137}Cs radiometric techniques, enabled precise reconstruction of the main phases of environmental change, associated with the Medieval Warm Period (MWP), the Little Ice Age (LIA) and the industrial era."

After all that was said by them was ultimately done, the thirteen researchers identified the MWP as occurring in their record from AD 1150 to 1300, noting that their pollen data reflect "warmer and drier conditions," in harmony with the higher temperatures of the Iberian Peninsula over the same time period that have been documented by Martinez-Cortizas *et al*. (1999), the higher temperatures of the Western Mediterranean region found by Taricco *et al*. (2008), and the global reconstructions of Crowley and Lowery (2000) and Osborn and Briffa (2006), which "clearly document warmer conditions from the twelfth to fourteenth centuries," which warmth, in the words of Morellon *et al*. is "likely related to increased solar irradiance (Bard *et al*., 2000), persistent La Niña-like tropical Pacific conditions, a warm phase of the Atlantic Multidecadal Oscillation, and a more frequent positive phase of the North Atlantic Oscillation (Seager *et al*., 2007)."

Following hard on the heels of the MWP was the LIA, which Morellon *et al*. recognized as occurring from AD 1300 to 1850. And here they report that, on the Iberian Peninsula, lower temperatures (Martinez-Cortizas *et al*., 1999) characterized this period, which "coincided with colder North Atlantic (Bond *et al*., 2001) and Mediterranean sea surface temperatures (Taricco*et al*., 2008) and a phase of mountain glacier advance (Wanner *et al*., 2008)." And following the LIA they identified the transition period of AD 1850-2004 that took the region into the Current Warm Period.

In discussing all three of these distinctive periods, Morellon *et al*. say that "a comparison of the main hydrological transitions during the last 800 years in Lake Estanya and solar irradiance (Bard *et al*., 2000) reveals that lower lake levels dominated during periods of enhanced solar activity (MWP and post-1850 AD) and higher lake levels during periods of diminished solar activity (LIA)." And *within* the LIA, they note that periods of higher lake levels or evidence of increased water balance occurred during the solar minima of Wolf (AD 1282-1342), Sporer (AD 1460-1550), Maunder (AD 1645-1715) and Dalton (AD 1790-1830).

In light of these several observations, it would appear that the multi-centennial climate oscillation uncovered by the thirteen researchers has been driven by a similar oscillation in solar activity, as well as by multi-decadal solar activity *fluctuations* superimposed upon that longer-period *oscillation*. And these relationships suggest that there is no compelling reason to attribute 20th-century global warming to the concomitant increase in the air's CO_2 content. Natural variability appears quite capable of explaining it all.

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