

A Critical Review of the Draft U.S. Climate Change Report

by Zbigniew Jaworowski, M.D., Ph.D., D.Sc.

Aug. 11, 2008

Editor's Note: *The report Dr. Jaworowski discusses here was released in draft form in July by the U.S. Climate Change Science Program (CCSP), a governmental group established in 2002 "to coordinate climate and global change research conducted in the United States and to support decision-making on climate-related issues." This "Unified Synthesis Product," or USP, was charged with synthesizing the information from 21 CCSP reports, along with the report of the Intergovernmental Panel on Climate Change (IPCC) and other "recent results that have appeared in the scientific literature." The stated aim of the report is "to provide a single coherent analysis of the current understanding of climate change science, summarize the contributions of the CCSP Program, and identify important gaps in the science."*

The draft report, complete with graphics, is available at www.climate.noaa.gov/index.jsp?pg=/.ccsp/unified_synthesis.jsp. The CCSP asked for public comment, and Dr. Jaworowski replied with this document. The report's graphics are not reproduced here, as the CCSP authors have requested that they not be reproduced at this stage.

Dr. Jaworowski is a multidisciplinary scientist, now a senior advisor at the Central Laboratory for Radiological Protection in Warsaw. In the Winter of 1957-58,

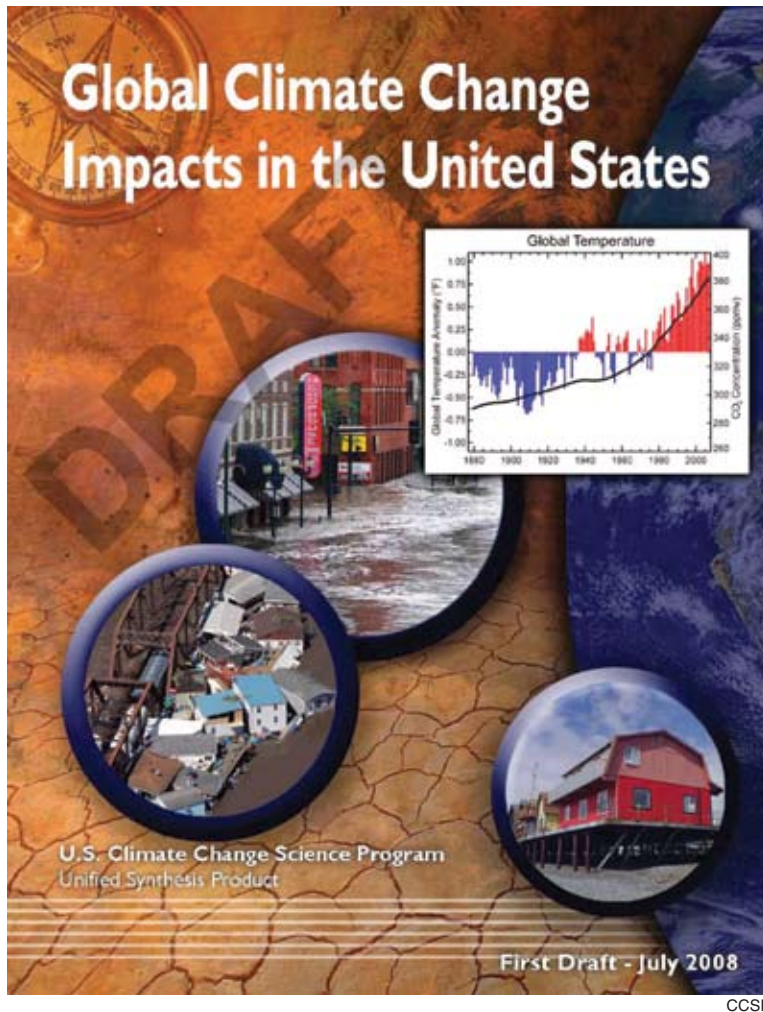
he measured the concentration of CO₂ in the atmospheric air at Spitsbergen. From 1972 to 1991, he investigated the history of the pollution of the global atmosphere, measuring the dust preserved in 17 glaciers: in the Tatra Mountains in Poland, in the Arctic, Antarctic, Alaska, Norway, the Alps, the Himalayas, the Ruwenzori Mountains in Uganda, and the Peruvian Andes. He has published many papers on climate, most of them concerning CO₂ measurement in ice cores.

Some of his papers on climate are available on the website of 21st Century Science & Technology magazine, www.21stcenturysciencetech.com, and on the EIR website, www.larouchepub.com. His response to the CCSP has been slightly edited for a general audience, and subheads have been added.

A striking feature of the CCSP-USP Report is a unilateral presentation of information, with an almost exclusive concentration on greenhouse gases, and particularly on man-made emissions of carbon dioxide, as the dominant cause of the Modern Warm Period.¹ The Report totally ignores studies which disagree with the man-made warming hypothesis.

An example of this neglect, one from among many, is a lack of information on cosmo-climatologic re-

1. The Modern Warm Period refers to the long recovery from the Little Ice Age, which occurred from 1650 to the early 20th Century.



The cover of the draft report, "Global Climate Change Impacts in the United States," gives an graphic idea of its bias: that industrial emissions are responsible for high temperatures, floods, and severe weather. Actually, global temperatures have been cooling in the last decade.

search. Recent studies demonstrate a powerful influence on climate of fluctuations of the muon fraction of cosmic rays, caused by variations of the Sun's activity. In the lower troposphere, muons create condensation nuclei for water particles, which are indispensable for cloud formation. Cloudiness, which is directly related to the flux of muons, determines temperature at the surface of the Earth and in the lower troposphere. Short-term fluctuations of muon flux change the cloudiness by 3 to 4% (Svensmark and Calder 2008).

The Report does not discuss this at all. But the relationship between climate and cosmic ray fluctuation, on the time scales from decades to centuries to millennia, is much stronger than between climate and human emissions of CO₂ (Svensmark 2007; Svensmark and Calder

2008). Only a 2% increase in cloudiness is sufficient to cancel any climatic effect of man-made emissions of CO₂ (Veizer 2005). The activity of the Sun, which was stronger during the last 60 years than for the past 1,100 years (Usoskin et al. 2004; Usoskin et al. 2003), is a much more plausible cause of the Modern Warm Period [since coming out of the Little Ice Age] than the human emission of CO₂.

The extremely strong correlation between temperature (estimated from the change of oxygen-18 in stalagmites) and radioactive carbon-14 (produced by cosmic rays in the atmosphere) indicates that the influence of the Sun (modulating the cosmic ray flux) on the Earth's temperature was about 280 times stronger than the influence of atmospheric CO₂ (Mangini et al. 2005).

These fundamental studies are ignored in the CCSP-USP Report, making its claim that CO₂ man-made emissions are the main cause of the Modern Warming Period unsupported.

Misleading Characterizations

The phrase "climate change is now upon us," repeated in various versions in pages 1 to 9 of the Report, and then throughout the document, is incorrect and misleading. It implies that the climate was formerly "stable," and that it is only now that it is changing. This, however, is not true, and is not in agreement with other statements in the document. Without human intervention and without the influence of CO₂, climate was changing constantly over the past several billion years, sometimes much more, and much faster, than now (Veizer 2005).

The Dansgaard-Oeschger events (D-Os), extremely rapid changes of climate, occurred about 20 times during the past 100,000 years. One of them, the so called "Younger Dryas," happened 12,800 years ago, when the warm climate switched rapidly to a cold one, and then after 1,300 years, almost immediately returned back into a warm phase. Both times, the switch took one decade, or just a few years; that is, much less time than the recovery from the Little Ice Age after 1900 A.D., "which is now upon us."

The current Modern Warm Period is one of innumerable former natural warm climatic phases; it is less

warm than four such former phases, which the planet has seen over the past 1,500 years (Grudd 2008). This information is ignored in the Report, and the influence of man-made CO₂ is utterly exaggerated. The key requirement of objectivity does not hold in this Report, not only in presenting the facts, but also in its style.

The figure on page 19 of the Report suggests that there is a relationship between trends in atmospheric CO₂ concentration, man-made CO₂ emissions, and temperature. The only true data in this figure are the carbon emissions. The temperature and CO₂ concentration curves are false. The temperature curve is the infamous hockey stick curve of Mann et al. (1999), used as a flagship in the Intergovernmental Panel on Climate Change's "Working Group I: The Scientific Basis, Chapter 2" (IPCC 2001). In this curve, both the Medieval Warming and the Little Ice Age disappeared altogether, although hundreds of peer-reviewed publications by more than 560 authors from more than 300 institutions in about 40 countries demonstrated that both these warm and cold climatic phases had a global range (Broecker 2001; CO₂science 2008; Cole-Dai and Zhou 2003; de Menocal et al. 2000; Hall 2007; Kreutz et al. 1997; Loehle 2007; Loehle and McCulloch 2008; Mosley-Thompson and Thompson 1992; Tyson et al. 2000).

A crushing criticism by several groups of authors (Legates 2003; McIntyre and McKittrick 2003; Muller 2003; Soon 2003; Soon and Baliunas 2003; Soon et al. 2003) demonstrated that the temperature hockey stick curve represented wishful thinking, and flawed and probably fraudulent methods, rather than the climatic reality. After this criticism, the hockey stick curve disappeared in the 2007 IPCC report. Its reappearance in this CCSP-USP Draft Report, and a complete ignoring in this Report of the existence of the Holocene Warming, Medieval Warming, and Little Ice Age, disqualifies the Report as an objective source of scientific information.

The CO₂ atmospheric concentration curves on pages 17 and 19 of the Report also have the shape of a "hockey stick." They are the very foundations of the man-made greenhouse warming hypothesis. The figure on page 17 suggests that during the past 800,000 years, the atmospheric concentration of CO₂ was always 170 to 300 parts per million (ppm), and never before the 20th Century reached the level of about 380 ppm. The figure on page 19 suggests that between 1000 and approximately 1800 A.D., the CO₂ concentration in the atmosphere was about 180 ppm, and that in the second



The author (right) on one of his glacier missions, working with ion exchange columns in a laboratory tent at Kahiltna Glacier, Alaska, 1977.

half of the 19th Century it started to increase rapidly, up to the current level, allegedly some 30% higher than before the Industrial Revolution. Both these CO₂ curves are false.

The Unreliability of Polar Ice Cores

The CO₂ hockey stick curves are made from proxy estimates of CO₂ atmospheric levels, based on analysis of air bubbles from the Antarctic and Greenland cores of old ice, combined with direct measurements of this gas in samples of modern atmospheric air, collected near the summit of an active, CO₂ emitting Mauna Loa volcano in Hawaii.

There are two problems with these curves. The first problem with the CO₂ hockey stick curves on pages 17 and 19 is the unreliability of proxy CO₂ determinations in old polar ice. Ice cores do not fulfill the essential closed-system criteria, indispensable for reliable reconstruction of the pre-industrial and ancient atmosphere.

One of these criteria is a lack of liquid water in ice.

This criterion is not met, as there is ample evidence that even the coldest Antarctic ice contains liquid water, in which solubility of CO_2 is about 73 times and 26 times higher than that of N_2 (nitrogen gas) and O_2 (oxygen gas), respectively. This dramatically changes the chemical composition of the gas inclusions in polar ice in comparison to atmospheric air. More than 20 physical and chemical processes, mostly related to the presence of liquid water, contribute to CO_2 depletion from the original air inclusions (see review in Jaworowski et al. 1992).

One of these processes is the formation of clathrates, which are solid crystals formed at high pressure and low temperature by the interaction of gas with water molecules. In the ice sheets, CO_2 , O_2 , and N_2 start to form clathrates at about 5 bars, 75 bars, and 100 bars of pressure, respectively. Because of this process, CO_2 starts to leave air bubbles at a depth of about 200 meters (650 feet), and the air bubbles themselves disappear completely at a depth of about 1,000 meters (3,280 feet).

Drilling, which is an extremely brutal procedure, decompresses the deep ice cores, in which the solid clathrates now decompose into gas form, exploding in the process as if they were microscopic grenades. In the decompressed, bubble-free ice, the explosions form new gas cavities and mini-cracks. The ice cores, however, are earlier exposed to a more coarse cracking by vibrations in the drilling barrel, and by the sheeting phenomenon at the bottom of the borehole, induced by the pressure difference between the drilling fluid and the ice.

Before the cracks heal by regelation, they open the gate for the escape of gas inclusions, and for an extreme pollution of the ice cores with heavy metals from drilling fluid. Pollution of the inner parts of ice cores with lead and zinc is thousands of times higher than the levels of these elements in the surface snow (Boutron et al. 1990; Boutron et al. 1987). This clearly shows that these cores are not a closed system.

Glaciological CO_2 records are thus strongly influenced by natural processes in the ice sheets and man-made artifacts in the ice cores, which lead to depletion



Mauna Loa, Hawaii, the active volcano site that the National Oceanic and Atmospheric Administration chose, to take measurements of CO_2 and other “greenhouse gases” in the atmosphere. As for the gases the volcano spews out, NOAA applies a “correction” to the data. Here, NOAA engineer Paul Fukumura-Sawada captures air near NOAA’s Mauna Loa Observatory.

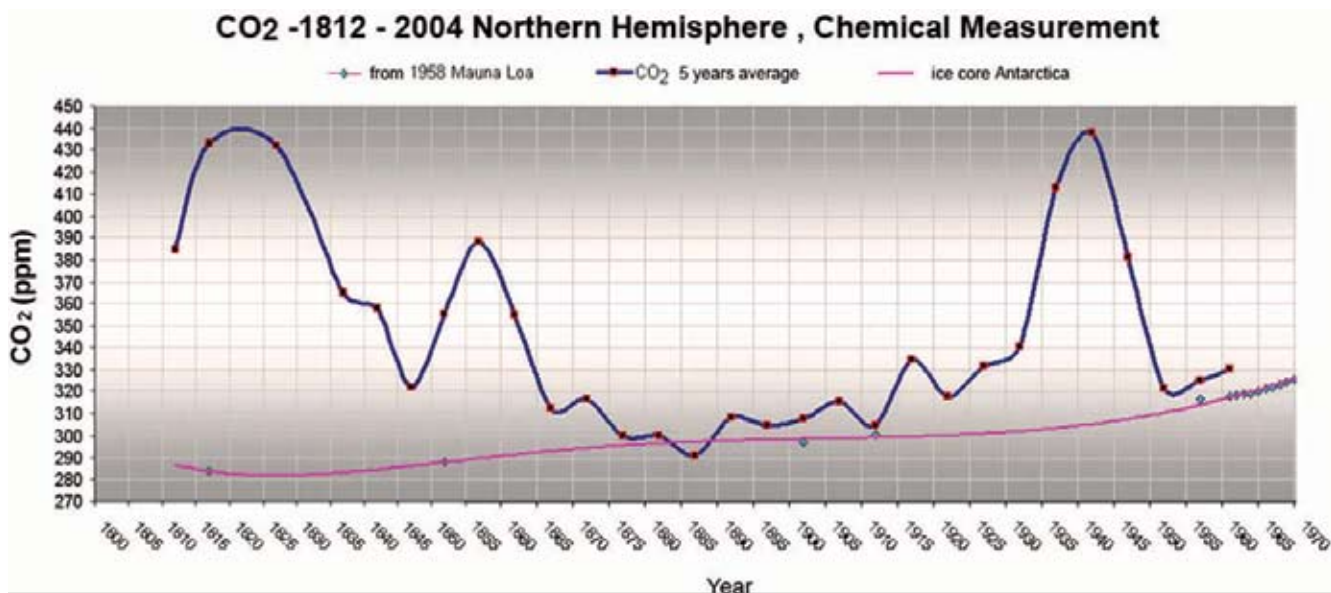
of CO_2 by 30% to 50%.

In addition, the records presented in the figures on pages 17 and 19 of the report, are beset with an arbitrary selection of data, with experimentally unfounded assumptions on gas age, and with one-sided interpretations ascribing the observed concentration trends to human factors, ignoring other more plausible explanations (Jaworowski 1994).

It was never experimentally demonstrated that ice core studies reliably reconstruct the original composition of the past atmosphere. Perusal of these studies indicates that polar ice and the ice cores are an improper medium for this task, and that glaciological studies are not capable of such reconstruction (Jaworowski 1994; Jaworowski et al. 1990; Jaworowski et al. 1992).

The assumption of a low and stable level of CO_2 in the pre-industrial atmosphere, and of its recent increase of about 30% as a result of fossil-fuel burning (IPCC 2007), was posed by Callendar (1958) and From and Keeling (1986), after their arbitrary rejection of most of the more than 90,000 technically excellent, direct measurements of CO_2 in the atmosphere, carried out in America, Asia, and Europe, during 149 years between 1812 and 1961 (**Figure 1**). These measurements showed that the 5-year average CO_2 concentrations fluctuated widely,

FIGURE 1
Chemical Measurements of CO₂ in the Northern Hemisphere (1812-2005)



Source: Adapted from Beck 2007.

Reconstruction of CO₂ concentration trends in the Northern Hemisphere based on more than 90,000 direct chemical measurements in the surface atmosphere at 43 stations between 1812 and 1961. The lower line is the proxy estimates from Antarctic ice core artifacts. The diamonds on the lower line (after 1958) are infrared direct CO₂ measurements in air samples taken at an active volcano, Mauna Loa in Hawaii.

with a minimum of 290 parts per million by volume (ppmv) in 1885, and peaking up to 440 ppmv around 1820, to about 390 ppmv around 1855, and to about 440 ppmv around 1940 (Beck 2007)—a pattern completely different from a flat and low ice-core record.

The ice core proxy estimates disagree also with other proxy CO₂ determinations for the past 10,000 years, which fluctuated up to 459 ppmv (Kurschner et al. 1996; Royer et al. 2001; Wagner et al. 1999; Wagner et al. 2002) (Figure 2). The low CO₂ ice-core concentrations during the six former interglacials, when the global temperature was warmer than now, suggest that either atmospheric CO₂ levels have no discernible influence on climate, or that the proxy ice core reconstructions of the chemical composition of the ancient atmosphere are false. Both these propositions are probably true.

The uncritical acceptance in the CCSP-USP Report of the low CO₂ ice core records from old polar ice as the only basis for estimation of the pre-industrial levels of atmospheric CO₂, ignorance of the high direct CO₂ measurements in the 19th- and 20th-Century atmosphere, and of the high proxy measurements in leaf stomata, demonstrates a lack of impartiality of this Report.

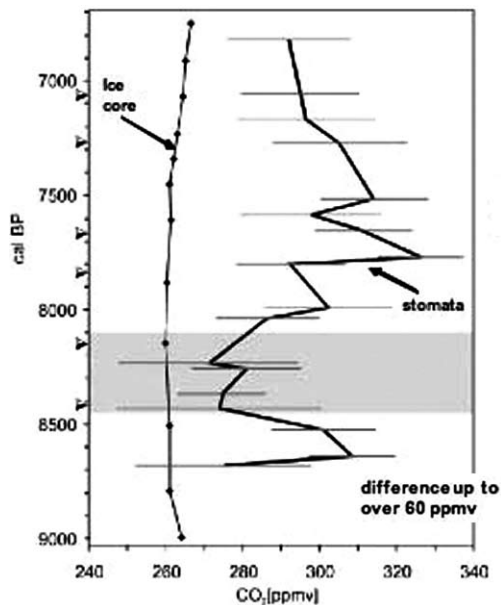
Doctored Data

The second problem with the CO₂ hockey curves on pages 17 and 19 of the report is the doctored of the proxy ice core data from the 19th Century and earlier (most of which are artifacts), so that they could overlay the direct CO₂ measurements in the atmosphere carried out in the second half of the 20th Century.

The data from 19th Century and earlier ice cores, such as those from Siple, Antarctica (Friedli et al. 1986; Neftel et al. 1985), are regarded both in the CCSP-USP Report, and in all IPCC reports, including the “Summary for Policy Makers, 2007” (IPCC 2007), as the strongest proof that man increased the CO₂ content of the global atmosphere. However, these data show a clear *inverse* correlation between the decreasing CO₂ concentrations, and the load-pressure increasing with depth. This correlation indicates a depletion of CO₂ from the air inclusions in ice, caused by the formation of crystalline CO₂ clathrates, rather than changes in the original atmospheric concentration of this gas.

The problem with the Siple data (they are included in curves on pages 17 and 19 of the Report) is that the

FIGURE 2
CO₂ Measurements from Fossil Leaves Compared to False Readings from Ice Cores



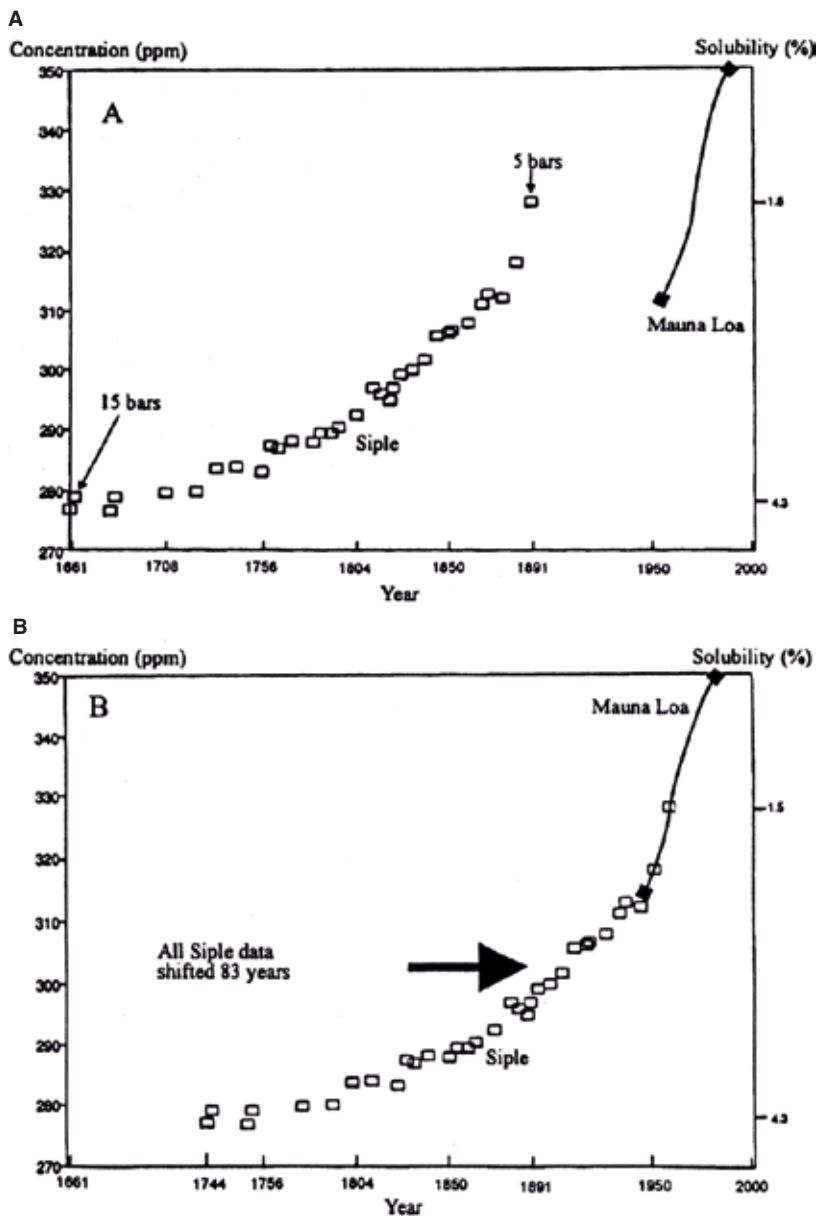
Source: Adapted from Wagner et al. 2002.

Atmospheric CO₂ concentrations between 6800 and 8700 Years Before Present, based on stomata of fossil birch leaves from Denmark (right line), and on ice core samples from Taylor Dome, Antarctica (left line).

CO₂ concentration found in this Antarctic locality in pre-industrial ice from a depth of 68 meters (that is, above the depth of clathrate formation), was too high to fit the man-made warming hypothesis. This ice was deposited in 1890 A.D., and the CO₂ concentration was 328 ppmv, not about 290 ppmv, as needed by the man-made warming hypothesis. The CO₂ atmospheric concentration of about 328 ppmv was measured at Mauna Loa, Hawaii, in 1973 (Boden et al. 1990); that is, 83 years after the ice was deposited at Siple. Instead of rejecting their assumption of a low pre-industrial concentration of CO₂ in the atmosphere, the glaciologists found another solution:

An *ad hoc* assumption, not supported by any factual evidence, solved the problem: The average age of air was arbitrarily decreed to be exactly 83 years

FIGURES 3 (a) and (b)
The Mother of all CO₂ Hockey Stick Curves



CO₂ concentration in air bubbles from pre-industrial ice from Siple, Antarctica (open squares), and from 1958-86 atmosphere measurements at Mauna Loa, Hawaii (solid line at right).

In A, the original Siple data are given without assuming that the air is 83 years younger than the age of the enclosing ice (Jaworowski 1994).

In B, the same data are shown after an arbitrary correction of the age of the air, as published by Neftel et al. 1985 and Friedli et al. 1986.

younger than the ice in which it was trapped (Jaworowski 1994; Jaworowski et al. 1992). The “corrected” ice core data were then made to smoothly overlay the recent Mauna Loa record (Figure 3), and then

were reproduced in countless publications as the famous “Siple curve.”

In 1993, eight years after the first publication of the Siple curve, glaciologists attempted to prove the age assumption experimentally (Schwander et al. 1993), but they failed (Jaworowski 1994). A similar manipulation of data was applied also to ice cores from other polar sites, to make the “CO₂ hockey stick curves” covering the past 1,000 and even 400,000 years (IPCC 2001; Wolff 2003). For some of these curves, a much longer air/ice age difference was arbitrarily assumed, without any experimental support, reaching up to 5,500 years. The apparent aim of these manipulations, and of ignoring other proxy CO₂ determinations, and of ignoring approximately 90,000 direct determinations in the pre-industrial and 20th-Century atmosphere, was to induce in the public a false conviction that the 20th-Century level of CO₂ was unprecedented over the past hundreds of thousands of years.

Thus, manipulated data were used as “*an indicator of human influence on the atmosphere during the Industrial Era*” (IPCC 2001). These data are also used to show “human influences” and the human “fingerprint” in the text on page 26 of the Report, and in the figure therein, titled “Separating Human and Natural Influences on Climate,” to argue that the “*observed [current] warming could not have been caused by natural forces alone.*” In fact, this is the *only* proof of human causation of the Modern Warm Period presented in the Report. This proof is false.

Violating Objectivity

The foundations of the CCSP-USP Report, its “fingerprints” and “human influences,” are based on ice core studies of CO₂. However, ice cores are a wrong matrix for reconstruction of chemical composition of the ancient atmosphere. No effort dedicated to improving analytical techniques can change the imperative pattern of polar ice as a non-closed system matrix.

Because of this pattern of ice, the CO₂ ice core data will always be artifacts caused by processes in the ice sheets and in the ice cores, with CO₂ concentration values about 30% to 50% lower than in the original atmosphere.

The low CO₂ ice-core concentrations during the past interglacials, when the global temperature was warmer than now, suggest that either atmospheric CO₂ levels have no discernible influence on climate, or that proxy ice core reconstructions of the chemical compo-

sition of the ancient atmosphere are false. Both propositions are probably true.

The scenarios in the CCSP-USP Draft Report are based on unreliable ice core data and on an incorrect presentation of the past climatic changes. They should not be used for global economic planning. Under the Information Quality Act’s terms, this document is not permissibly disseminated so long as it continues to reproduce these false scenarios with the apparent imprimatur of the Federal government.

The requested changes are:

(1) to drop all the references to “human influences” and “fingerprints,” as they cannot be credibly validated and are in fact empty notions;

(2) to present the veritable fluctuation of climatic cold and warm phases over the past millennium;

(3) to review the recent cosmo-climatologic studies, and to reflect them in the conclusions and recommendations of the Report.

Without such corrections, the statements in this document fail to meet the authors’ claim of representing “the best available information” (p. 14), and “the best available evidence” (p. 15), and otherwise violate applicable objectivity requirements.

References

- Beck, E.-G. 2007. “180 Years of CO₂ gas analysis by chemical methods.” *Energy & Environment*, Vol. 18, No. 2, pp. 259-282.
- Boden, T.A., Kanciruk, P., and Farrel, M.P., 1990. *TRENDS '90—A Compendium of Data on Global Change*, pp. 1-257. Oak Ridge National Laboratory.
- Boutron, C.F., Patterson, C.C., and Barkov, N.J., 1990. “The occurrence of zinc in Antarctic ancient ice and recent snow.” *Earth Planet. Sci. Lett.*, Vol. 101, pp. 248-259.
- Boutron, C. F., Patterson C.C., Petrov V.N., and Barkov N.I., 1987. “Preliminary data on changes of lead concentrations in Antarctic ice from 155,000 to 26,000 years BP.” *Atmospheric Environment*, Vol. 21, No. 5, pp. 1197-1202.
- Broecker, W.S., 2001. “Was the Medieval Warm Period Global?” *Science*, Vol. 291, pp. 1497-1499.
- Callendar, G.S., 1958. “On the amount of carbon dioxide in the atmosphere.” *Tellus*, Vol. 10, pp. 243-248.
- CO₂Science, 2008. Medieval Warm Period Project. <http://www.CO2science.org/data/mwp/description.php>.
- Cole-Dai, J. and Zhou, L., 2003. “Evidence of Little Ice Age in an East Antarctica ice core.” American Geophysical Union, Fall Meeting 2003, Vol. Abstract No. PP51A-08. <http://adsabs.harvard.edu/abs/2003AGUFMPP51A.08C>.
- deMenocal, P., Ortiz, J., Guilderson, T., and Sarnthein, M., 2000. “Coherent high- and low-latitude climate variability during the Holocene warm period.” *Science*, Vol. 288, pp. 2198-2202.
- Friedli, H., Lotscher, H., Oeschger, H., Siegenthaler, U., and Stauffer, B., 1986. “Ice core record of the 13C/12C ratio of atmospheric

- CO₂ in the past two centuries. *Nature*, Vol. 324, pp. 237-238.
- From, E. and Keeling, C.D., 1986. "Reassessment of late 19th century atmospheric carbon dioxide variations in the air of western Europe and the British Isles based on an unpublished analysis of contemporary air masses by G.S. Callendar." *Tellus*, Vol. 38B, pp. 87-105.
- Grudd, H., 2008. "Torotrask tree-ring width and density AD 500-2004: A test of climatic sensitivity and a new 1500-year reconstruction." *Climate Dynamics*, doi 10.1007/s00382-007-0358-2, 1-17.
- Hall, B.I., 2007. "The Little Ice Age and Medieval Warm period in the South Shetland Islands, Antarctica." *The Holocene*, Vol. 17, pp. 1253-1258.
- IPCC, 2001. *Climate Change 2001: The Scientific Basis* (Cambridge University Press).
- IPCC, 2007. "Climate Change: The Physical Science Basis. Summary for Policymakers," pp. 1-21.
- Jaworowski, Z., 1994. "Ancient atmosphere—validity of ice records." *Environmental Science & Pollution Research* Vol. 1, No. 3, pp. 161-171.
- Jaworowski, Z., Segalstad T.V., and Hisdal, V., 1990. "Atmospheric CO₂ and Global Warming: A critical review," pp. 1-75. Norsk Polarinstittutt, Oslo, Report No. 59.
- Jaworowski, Z., Segalstad, T.V., and Ono, N., 1992. "Do glaciers tell a true atmospheric CO₂ story?" *The Science of the Total Environment*, Vol. 114, pp. 227-284.
- Kreutz, K. J., Mayewski, P.A., Meeker, L.D., Twicker, M.S., Whitlow, S.I., and I.I. Pittalwala, 1997. "Bipolar changes in atmospheric circulation during the Little Ice Age." *Science*, Vol. 277, No. 5330, pp. 1294-1296.
- Kurschner, W. M., van der Burgh, J., Visscher, H., and Dilcher, D.L., 1996. "Oak leaves as biosensors of late Neogene and early Pleistocene paleoatmospheric CO₂ concentrations." *Marine Micropaleontology*, Vol. 27, pp. 299-312.
- Legates, D.R., 2003. Statement before U.S. Senate, July 29, 2003. In *Committee on Environment & Public Works*, http://www.senate.gov/hearing_statements.cfm?id=212845, pp. 1-5, U.S. Senate.
- Loehle, C., 2007. "A 2000-year global temperature reconstruction based on non-tree-ring proxies." *Energy & Environment*, Vol. 18, No. 7-8, pp. 1049-1058.
- Loehle, C. and McCulloch, J.H., 2008. "Correction to: A 200-year global temperature reconstruction based on non-tree-ring proxies." *Energy & Environment*, Vol. 19, pp. 93-100.
- Mangini, A., Spötl, C., and Verdes, P., 2005. "Reconstruction of temperature in the Central Alps during the past 2000 yr from a $\delta^{18}O$ stalagmite record." *Earth and Planetary Science Letters*, Vol. 235, pp. 741-751.
- Mann, M.E., Bradley, R.S., and Hughes M.K., 1999. "Northern Hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations." *Geophysical Research Letters*, Vol. 26, No. 6, pp. 759-762.
- McIntyre, S. and McKittrick, R., 2003. "Corrections to the Mann et al. (1998) proxy data base and Northern hemispheric average temperature series." *Energy & Environment*, Vol. 14, No. 6, pp. 751-771.
- Mosley-Thompson, E. and Thompson, L.G., 1992. "Spatial and temporal characteristics of the Little Ice Age: The Antarctic ice core record." <http://stinet.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADP007347>.
- Muller, R.A., 2003. "Medieval global warming: The perils of letting politics shape the scientific debate." *Technology Review*, Dec. 17, 2003.
- Nefel, A., Moor, E., Oeschger, H., and Stauffer, B., 1985. "Evidence from polar ice cores for the increase in atmospheric CO₂ in the past two centuries." *Nature*, Vol. 315, pp. 45-47.
- Royer, D. L., Wing, S.L., Beerling, D.J., Jolley, D.W., Koch, P.L., Hickey, L.J., and Berner R.A., 2001. "Paleobotanical evidence for near present-day levels of atmospheric CO₂ during part of the Tertiary." *Science*, Vol. 292, pp. 2310-2313.
- Schwander, J., Barnola, J.M., Andrie, C., Leuenberger, M., Ludin, A., Raynaud, D., and Stauffer, B., 1993. "The age of the air in the firn and the ice at Summit, Greenland." *J. Geophys. Res.*, Vol. 98(D2), pp. 2831-2838.
- Soon, W., 2003. Senator Jeffords's follow-up questions for Dr. Willie Soon. Attachment I for question #38., pp. 1-41. <http://cfa-www.harvard.edu/~wsoon/1000yrclimatehistory-d/Soon-replytoJefford.pdf>.
- Soon, W. and Baliunas, S., 2003. "Proxy climatic and environmental changes of the past 1000 years." *Climate Research*, Vol. 23, pp. 89-110.
- Soon, W., Baliunas, S.L., Idso, C., Idso, S., and Legates, D.R., 2003. "Reconstructing Climatic and Environmental Changes of the Past 1000 years: A Reappraisal." *Energy & Environment*, Vol. 14, pp. 233-296.
- Svensmark, H., 2007. "Cosmoclimatology: A new theory emerges." *Astronomy & Geophysics*, Vol. 48, No. 1, pp. 1-18.
- Svensmark, H. and Calder, N., 2008. *The Chilling Stars: A New Theory of Climate Change*. (Icon Books, Ltd.).
- Tyson, P.D., Karlen, W., Holmgren, K., and Heiss, G.A., 2000. "The Little Ice Age and Medieval Warming in South Africa." *South African Journal of Science*, Vol. 96, pp. 121-126.
- Usoskin, I.G. et al., 2004. "Latitudinal dependence of low cloud amount on cosmic ray induced ionization." *Geophysical Research Letters*, Vol. 31 (L16109), doi: 10.1029/2004GL01507.
- Usoskin, I.G., Solanki, S.K., Schussler, M., Mursula, K., and Alanko, K., 2003. "Millennium-scale sunspot number reconstruction: Evidence for a unusually active Sun since the 1940s." *Physical Review Letters*, Vol. 91, No. 21, pp. 211101-1 - 211101-4.
- Veizer, J., 2005. "Celestial climate driver: A perspective from four billion years of the carbon cycle." *Geoscience Canada*, Vol. 32, No. 1, pp. 13-28.
- Wagner, F., Bohncke, S.J.P., Dilcher, D.L., Kurschner, W.M., van Geel, B., and Visscher, H., 1999. "Century-scale shifts in early Holocene atmospheric CO₂ concentration." *Science*, Vol. 284 (June 18), pp. 1971-1973.
- Wagner, T., Aaby, B., and Visscher, H., 2002. "Rapid atmospheric CO₂ changes associated with the 8,200-years-B.P. cooling event." *Proceedings of the National Academy of Sciences*, Vol. 99, No. 19, pp. 12011-12014.
- Wolff, E., 2003. "Ice core records of Quaternary climate, and the link between climate and greenhouse gases." In *Geological Society—Abstracts*. www.geolsoc.org.uk/template.cfm?name=geoevents_abstracts&eventId=PG20&abstractId=cwcc_ab7&abstractType=ext.