Environ Geol (2007) 52:1007–1009
DOI 10.1007/s00254-006-0519-3

REBUTTAL

Rebuttal of "On global forces of nature driving the Earth's climate. Are humans involved?" by L. F. Khilyuk and G. V. Chilingar

W. Aeschbach-Hertig

Received: 23 August 2006 / Accepted: 12 September 2006 / Published online: 5 October 2006

In a recent paper, Khilyuk and Chilingar (2006) promote their view that the human influence on climate is negligible compared to natural forces driving the Earth's climate. They conclude from this opinion that measures to reduce carbon dioxide emissions, such as defined by the Kyoto Protocol, are merely a waste of money. The scope of the paper is very broad, covering topics such as the Earth's radiation balance, the influence of changing orbital parameters on insolation, the entire history of the Earth's degassing and the composition of the atmosphere, the internal heat sources of the Earth, the role of the ocean and microbial activities in the climate system, and the temperature history of the last millennia. The hypotheses put forward by Khilyuk and Chilingar (2006) on these topics are not only unusual, but unfortunately in many points misleading, inconsistent, or even plainly wrong, as will be shown in the following. At the very least, the authors fail to adequately represent the large body of "conventional" literature in the different fields.

Khilyuk and Chilingar (2006) state that based on their "adiabatic model of heat transfer in the atmosphere" the entire energy generated by humans could heat the atmosphere by no more than 0.01°C. This may be true but is irrelevant, since no serious scientist ever claimed that global warming is due to direct heating of the atmosphere, but to an enhancement of the greenhouse effect, which the paper does not discuss.

W. Aeschbach-Hertig (✉)
Institute of Environmental Physics,
University of Heidelberg, Im Neuenheimer Feld 229,
69120 Heidelberg, Germany
e-mail: aeschbach@iup.uni-heidelberg.de

Khilyuk and Chilingar (2006) claim that "changes in the global atmospheric temperature are closely correlated with the changes in solar activity", illustrated by curves of temperature and solar magnetic cycle length in their Fig. 1. This figure is identical to Fig. 6 in a former paper by the same authors in this journal (Khilyuk and Chilingar 2004) and unfortunately is not further explained (which temperature record is used, how is the cycle length related to solar activity?). Worse, however, only a document from two strangely cited websites (Robinson et al. 1998) is given as source of this figure, although there are well-known original publications on the hypothesis that the solar magnetic cycle length is linked to climate (Friis-Christensen and Lassen 1991; Lassen and Friis-Christensen 1995). As the original sources are not cited, it is no surprise that a later rebuttal of this hypothesis (Laut 2003) is not mentioned.

In their discussion of the influence of the orbital parameters on insolation, Khilyuk and Chilingar (2006) state correctly that Earth's insolation differs by about 6% between aphelion and perihelion. However, these variations of insolation during the course of the year are practically irrelevant for the annual mean insolation. On interannual time scales, it is not correct to say that "the variations in the global average Earth's insolation attributed to the planet's orbital deviations can reach up to 10% of the long-term average radiation level". Of the orbital parameters, only the eccentricity variations change the net annual irradiance of the Earth, but merely by about 0.2% over a 100 kyr period (Saltzman 2002). Khilyuk and Chilingar (2006) apparently confound the ~10% variations of the northern summer insolation over the past 500 kyr shown in their Fig. 2 with variations of

the global mean insolation. Such variations of the global mean insolation would of course immediately explain the ice age cycles by a simple radiation balance, similar to the calculations in the paper. Yet, the point of the orbital theory of the ice ages is that variations in the latitudinal distribution of the insolation can cause large climate changes even as the annual global mean insolation remains constant (Saltzman 2002). Thus, the calculations of Khilyuk and Chilingar (2006) on the temperature response to changes of the orbital parameters and the conclusion that the recent global warming is insignificant in comparison are misleading.

Khilyuk and Chilingar (2006) present a theory that links the Earth's outgassing rate to the rate of sea floor spreading. This theory is used to explain the recent increase of methane in the atmosphere by "a high level of current tectonic activity". Unfortunately, the only evidence cited for this high activity is a paper in Russian (Yasamanov 2003) that is virtually inaccessible to most readers of Environmental Geology. Khilyuk and Chilingar (2006) completely ignore the large body of literature on the sources and sinks of methane. A short review of the current knowledge about the methane balance has recently been given by Lowe (2006) in the context of the surprising finding of a methane source from plants (Keppler et al. 2006). Interestingly, the tectonic methane source that Khilyuk and Chilingar (2006) refer to is about ten times larger than the total of the identified sources listed by Lowe (2006).

A highlight of the outgassing theory of Khilyuk and Chilingar (2006) is their comparison of the total anthropogenic carbon dioxide emission of 1.003×10^{18} g with the hypothesized total mass of CO_2 degassed from the mantle throughout geologic history of 4.63×10^{23} g. This is used to declare that the total anthropogenic CO_2 emission "constitutes less than 0.00022% of the total CO_2 amount naturally degassed from the mantle during geologic history" and conclude that "the anthropogenic carbon dioxide emission is negligible (indistinguishable) in any energy-matter transformation processes changing the Earth's climate". It seems that the authors forgot to take the time factor into account. The anthropogenic emission happened during 200 years, whereas the natural degassing during geologic history spanned 4.5 billion years. Thus, the above numbers yield a yearly anthropogenic flux that is about 50 times larger than the mantle degassing flux, which hardly is negligible. It appears that the authors assume that the 4.63×10^{23} g of CO_2 degassed from the mantle all remained in the atmosphere. Yet, the present day atmosphere contains less than 3×10^{18} g of CO_2, and compared to this number the total anthropogenic CO_2 emission of 1×10^{18} g certainly is significant.

Another interesting explanation by Khilyuk and Chilingar (2006) is the following: "When the global temperature rises, the solubility of the carbon dioxide in the ocean water decreases, and part of the carbon dioxide content of the ocean water is transferred into the atmosphere, creating an illusion that the increased concentration of the carbon dioxide heating the atmosphere is a result of anthropogenic activity." While it is true that the solubility of CO_2 decreases as the surface ocean warms, Khilyuk and Chilingar (2006) ignore once again the state-of-the-art literature, which shows that the ocean actually acts as a sink for CO_2 and warming of the ocean only decreases the oceanic CO_2 uptake, rather than leading to CO_2 release to the atmosphere (e.g., Sabine et al. 2004; Sarmiento et al. 1998).

The paper of Khilyuk and Chilingar (2006) contains several more unconventional theories, e.g., the twice repeated hypothesis that in 0.6 Gyr "endogenic oxygen" will degas from the Earth's core, increase the atmospheric pressure to 40 atm and the global temperature to over 80°C, or the hypothesis that the main internal heat source of the Earth is not radioactivity but "gravitational matter differentiation". All these hypotheses are not well substantiated either by original arguments or by credible references. One of the weaknesses of the paper is that much of the cited literature is in Russian, thus not easily accessible, or refers to websites, some of them as dubious as http://www.junkscience.com. If the authors think that theories of anthropogenic global warming are junk science, they should themselves adhere to higher scientific standards, e.g., by citing the relevant literature in the fields they cover, but they fail to do so. Some of their major conclusions are simply unsupported allegations, e.g., when they claim that "the major causes of currently observed global warming are: rising solar irradiation and increasing tectonic activity".

Another example for the failure of Khilyuk and Chilingar (2006) to substantiate their claims and to refer to the state-of-the-art literature is their Fig. 11, showing a simplified picture of the global temperature curve of the past 1,000 years. Based on an article in the Bulletin of the American Association of Petroleum Geology, this figure shows the medieval warm period at +2°C and the little ice age at –1°C relative to the present. It certainly is not a fair representation of the intense recent debate about the global (or rather: northern hemisphere) temperature evolution over the past millennium. One might expect that the authors would refer to the famous "hockey stick" curve of

Mann et al. (1998), which has been a major target of the criticism of climate change skeptics in recent years. Or to the latest attempt to reconstruct such a curve presented by Moberg et al. (2005), or other studies as summarized by Briffa and Osborn (2002). None of all these important papers are cited by Khilyuk and Chilingar (2006), instead it is claimed that ''the global average temperature dropped about 2°C over the last millennium'', which is squarely at odds with the findings of all these studies.

It is astonishing that the paper of Khilyuk and Chilingar (2006) (as well as Khilyuk and Chilingar 2004, for that matter) could pass the review process of a seemingly serious journal such as Environmental Geology. Such failures of this process, which is supposed to guarantee the quality of published literature, are likely to damage the reputation of this journal.

References

Briffa KR, Osborn TJ (2002) Blowing hot and cold. Science 295:2227–2228

Friis-Christensen E, Lassen K (1991) Length of the solar cycle: an indicator of solar activity closely associated with climate. Science 254:698–700

Keppler F, Hamilton JTG, Braß M, Röckmann T (2006) Methane emissions from terrestrial plants under aerobic conditions. Nature 439:187–191

Khilyuk LF, Chilingar GV (2004) Global warming and long-term climatic changes: a progress report. Environ Geol 46:970–979

Khilyuk LF, Chilingar GV (2006) On global forces of nature driving the Earth's climate. Are humans involved? Environ Geol 50:899–910

Lassen K, Friis-Christensen E (1995) Variability of the solar cycle length during the past five centuries and the apparent association with terrestrial climate. J Atmos Terr Phys 57:835–845

Laut P (2003) Solar activity and terrestrial climate: an analysis of some purported correlations. J Atmos Sol-Terr Phys 65:801–812

Lowe DC (2006) A green source of surprise. Nature 439:148–149

Mann ME, Bradley RS, Hughes MK (1998) Global-scale temperature patterns and climate forcing over the past six centuries. Nature 392:779–787

Moberg A, Sonechkin DM, Holmgren K, Datsenko NM, Karlén W (2005) Highly variable Northern Hemisphere temperatures reconstructed from low- and high-resolution proxy data. Nature 433:613–617

Robinson AB, Baliunas SL, Soon W, Robinson ZW (1998) Environmental effects of increased atmospheric carbon dioxide. pp 8 (http://www.info@oism.org; http://www.info@marshall.org)

Sabine CL, Feely RA, Gruber N, Key RM, Lee K, Bullister JL, Wanninkhof R, Wong CS, Wallace DWR, Tilbrook B, Millero FJ, Peng T-H, Kozyr A, Ono T, Rios AF (2004) The oceanic sink for anthropogenic CO_2. Science 305:367–371

Saltzman B (2002) Dynamical paleoclimatology. Academic, San Diego, pp 354

Sarmiento JL, Hughes TMC, Stouffer RJ, Manabe S (1998) Simulated response of the ocean carbon cycle to anthropogenic climate warming. Nature 393:245–249

Yasamanov NA (2003) Modern global warming: causes and ecological consequences (in Russian). Bull Dubna Int Univ Nat Soc Man 1(8):12–21