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COMMENT

A response to 'The Stern Review: A Dual Critique'

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The authors of 'The Stern Review: A Dual Critique'[1] in the preceding issue of this journal describe the Stern Review on the Economics of Climate Change as "neither accurate nor objective", casting doubt on the extent of global warming, melting of ice caps and the role of greenhouse gases (GHG). They question (1) the "maturity" of climate prediction; (2) "flaws in the alarmist paradigm"; (3) "mishandling of uncertainties"; (4) "scandal of non-disclosure and poor archiving", and (5) "inadequacies of peer reviews". As any consideration of the potential economic consequences of climate change depends critically on the physical evidence for this process, my comment is principally concerned with the scientific basis.

The climate history of Earth during the glacial–interglacial cycles of the last one million years provides an essential context for an understanding of current climate changes, including the relations between solar irradiance, greenhouse gas (GHG) forcing, albedo changes and global temperatures. According to Petit et al.[2] the same sequence of events in each glacial termination involved "orbital forcing (with a possible contribution of local insolation changes) followed by two strong amplifiers, greenhouse gases acting first, then deglaciation and ice–albedo feedback". During the last glacial termination (~19–10 kyr) sharp increase in solar insolation forcing, amplified by feedback by GHG (17–11.5) (Table 1), resulted in mean temperature increase of about 9°C.[2]

Table 1 summarizes mean variation rates of temperature, sea level and GHG concentrations during (A) the last termination (19–10 kyr), (B) the Holocene (10 kyr to mid-19th century), (C) mid-19th century to mid-1970s, and (D) mid-1970s to 2005, based on ice core studies,[2] IPCC–2001 and IPCC – 2007,[3] NASA–GISS,[4] CSIRO Marine and Atmospheric Research,[5] UK Meteorological Office[6] datasets and science journals. Major trends include:

A. Rates of temperature rise from the mid-19th century are higher than

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Table 1: Mean greenhouse gas levels, temperatures and sea level change rates
(A) the end-glacial; (B) the Holocene; (C) the industrial period (from about 1800), and (D) 2nd half of the 20th century and early 21st century

	CO_2 ppm/variations	CH_4 ppb/variations	Temperature anomaly/variations °C	Sea level (metres)/variations (cm/yr)[15–17]
(A)	17–11.5 kyr 180–260 ppm +0.014 ppm/yr	17–11.5 kyr 370–630 ppb + 0.047 ppb/yr	19–10 kyr: +0.0009°C/yr 19–11 kyr: +0.001°C/yr +9°C	17-11 kyr –120 to –60 metres +1.0 cm/yr
(B)	11.5 kyr–19th century 265–255 ppm stable/decline	11.5 kyr–19th century 715 ppb and decline	Mostly stable 0–1100AD: +0.00027°C/yr 1100–1600: –0.0012°C/yr (LIA) 1600–1900: +0.0013°C/yr	11–7 kyr –40 to –4 metres +1.2 cm/yr
(C)	1800–2000 280–360 ppm (1.5 W/m^2) +0.66 ppm/yr	1800–2000 750–1620 ppb (0.5 W/m^2) +7.25 ppb/yr	1880–1910: overall decline 1910–1945: +0.013°C/yr 1945–1980: fluctuations	1904–1953: +0.203 ± 0.035 cm/yr 1920–1980: +0.25cm/yr 1965–1978: +0.2 cm/yr 1954–2003: +0.145 ± 0.034 cm/yr IPCC–2007: 1961–2003: 0.18 cm/yr
(D)	1960-2005: 1.4 ppm/yr 1995-2005: 1.8 ppm/yr (20% rise in radiative forcing) 2006: 2.1 ppm/yr 2006: 381 ppm	?stable	1975–2004: +0.019°C/yr 1997–2004: +0.027°C/yr	NASA:1993–2004: 0.29–0.33cm/yr; 1993–2003: 0.31 cm/yr

Data sources: IPCC–2001 and 2007; NASA/GISS 2006; NASA/NOAA; CSIRO and indicated references

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those of the glacial termination (17–10 kyr) by more than a factor of 10, increasing to a factor of 20 and higher from the mid-1970s.

B. Rates of sea level (SL) rise from the early 20th century (~0.2 cm/yr) are about 20 percent the glacial termination rates (~1.0–1.2 cm/year), accelerating to +0.29–0.33 cm/year during 1993–2005.

C. Rates of CO_2 increase from the late 19th century (~0.6–0.7 ppm/yr) are almost a factor of 50 the glacial termination rates (~0.014 ppm/yr), accelerating during 2000–2005 from 1.8 to 2.1 ppm/year. Rates of CH_4 increase (~7 ppb/year) increased by a factor near 150 but appear to have stabilized late in the 20th century.

D. Increasing rates of sea level rises reflect thermal expansion and ice sheet melting with rising temperatures. The accelerated rise of temperature and GHG concentrations from the mid-1970s is followed by accelerated sea level rise from about 1993, likely reflecting lag effects.

The above is contrasted to statements by the 'Dual Critique' authors which question global warming, i.e. "Moreover, given that the estimated temperature change over the late twentieth century amounted to only a few tenths of a degree" (p. 171); "In the post-1979 interval, the most recently revised satellite data show little change, especially in the tropics and Southern Hemisphere" … "The trend, such as it is, is at least in part an artifact caused by irregularities such as volcanic eruptions and El Nino events" (p. 172) (referring to Gray, V., 2006, *Energy & Environment*, 17: 707–714). The 'Dual Critique' authors do not appear to be aware that temperature buffering effects due to high evaporative rates in the tropics and tropical islands, loss of ice albedo in the poles, and other factors, result in global temperature increases that rise rapidly with higher latitude.[4]

The 'Dual Critique' authors refer to a statement: "half the warming over the twentieth century might be explained by solar changes"[11] and to the potential effect of cosmic rays.[12] However, the role of solar irradiance was summed by Solanki (2002)[8]: "prior to roughly 1980 the solar irradiance on the whole ran parallel to and even slightly ahead of the Earth's temperature. This is consistent with a causal relationship. After 1980, however, the Earth's temperature exhibits a remarkably steep rise, while the Sun's irradiance displays at the most a weak secular trend. Hence the Sun cannot be the dominant source of this latest temperature increase, with man-made greenhouse gases being the likely dominant alternative."

From the mid-1970s, temperature and solar irradiance records are decoupled, including mean temperature increase by about 0.5°C (Figure 1). Further warming (IPCC–2007 Fig. SPM–3) took place since 2000 despite a decline in solar irradiance.[9] This trend is consistent with GHG forcing, which from the mid-19th century induces a total anthropogenic effect of about +1.6 W/m^2.[3] The role of cosmic rays in enhancing nucleation in clouds, with increased albedo, potentially counters increase in solar irradiance.[9,13]

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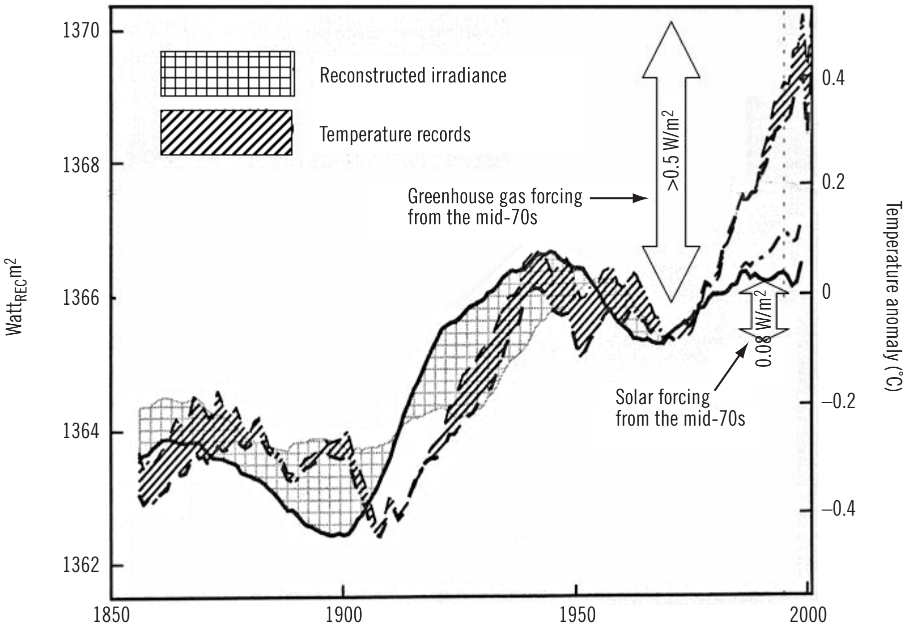
Figure 1: Variations in solar irradiance and temperature records during 1850–2000



Source: Solanki (2002)[8]
Note the decoupling of the temperature and irradiance fields from about the mid-1980s.

The 'Dual Critique' authors question the maturity of climate research and projections. This criticism is best answered with a quote from Hansen et al. (2006)[4] (p. 11): "The pattern of global warming has assumed expected characteristics …", confirming the maturity of climate research. One assumes the critics accept the physical reality of absorption and re-emission of thermal radiation by GHG. Since 1751, roughly 305 billion tonnes of carbon have been released to the atmosphere from fossil fuels and cement production,[10] with atmospheric CO_2 retention of about 60%, reaching 381 ppm in 2006, namely 36 percent higher than the maximum interglacial level of 280 ppm. With increasing CO_2 loss from land due to de-vegetation, drought and fire, and a decline in the capacity of warming oceans as CO_2 sinks (1980s –1.9 PgC/yr; 1990s –1.7 PgC/yr),[3] an increasingly larger proportion of CO_2 remains in the atmosphere. In particular, vulnerable carbon pools on the scale of many hundreds of GtC, represented by methane-rich high-latitude and tropical bogs and sea bottom methane hydrates threaten major carbon feedback effects.

The 'Dual Critique' authors discuss the GHG role of water vapor. However, by contrast to the long residence time of CO_2 in the atmosphere (5–200 years) H_2O levels vary markedly in time and place. Whereas stronger evaporation over oceans and the tropics with rising temperature increase rainfall in the tropics and subtopics, the opposite effects occur in the dry lower-mid latitudes.

When a consensus, true or false, emerges in a scientific discipline, it is not sufficient for critics to point out uncertainties and gaps in knowledge, such as always exist in science, for example Darwinian evolution or plate tectonics. The onus is on the critics to attempt to offer alternative explanations for the large database on which such consensus is based. This the 'Dual Critique' authors have not done.

By using the term "alarmist", repeated throughout their paper, the critics reflect adversely on the professional integrity of climate scientists. This and other types of derogatory language do nothing to advance the science or logic of their criticism. By contrast, it is the ethical duty of scientists to draw attention to observations of potential concern to society, be it ozone depletion, the cancer effects of asbestos and tobacco smoking, or dangerous climate change.

The authors of 'Dual Critique' are critical of the peer review system of scientific journals, but do not suggest alternative ways of stemming a flood of uncontrolled material into the scientific literature, opening it to disinformation and interference by vested interests.

Wallace Broecker, the famous marine scientist of Columbia University, wrote in 1986: "The inhabitants of planet Earth are quietly conducting a gigantic environmental experiment … we play Russian roulette with climate and no one knows what lies in the active chamber of the gun". The question is how far will the levels of CO_2 , CH_4, N-oxide, CFC and HFC, global land–sea temperatures, melting of ice sheets and glaciers, and sea levels need to rise before the critics realize that the delicate balance of the Earth's atmosphere—the thin lung-like membrane on which advanced life depends—must not be abused as an open sewer for industrial waste products.

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