State of the planetary life support system

"We're simply talking about the very life support system of this planet"
Joachim Hans Schellnhuber, Director of the Potsdam Climate Impacts Institute and Climate Advisor to the German Government http://www.reuters.com/article/2009/09/28/us-climate-science-idUSTRE58R3UI20090928

Since the inception of the IPCC in 1989, contributing climate scientists had to labour under restrictive conditions which, in some instances, resulted in compromised climate change projections, most particularly in terms of ice melt rates, sea level rise and projected extreme weather events. Extended periods of scientific consultations and debate, aimed at reaching consensus, have in some instances led to conservative estimates of the scale and pace of climate change, to be followed by further editing by government officials (including US, China, Russia, Saudi Arabia) with political agendas [1].

Following the release in February 2007 of the 4th IPCC Assessment Report [2], based on up to 2005 data (Figure 1), an international group of climate scientists reported atmospheric CO2 concentrations, temperature levels and sea level rise rates have increased at the maximum of, or above, IPCC projections (Figure 2) [3]. It follows, at least in this respect, IPCC projections can be regarded as reliable but **minimum** estimates of climate change trends.

Rahmstorf et al. 2007 [3] state: "*Overall, these observational data underscore the concerns about global climate change. Previous projections, as summarized by IPCC, have not exaggerated but may in some respects even have underestimated the change, in particular for sea level*."

David Wasdell, an accredited IPCC reviewer, pointed out the report has overlooked positive feedback loops which involve amplification dynamics of climate change within the atmosphere-ocean-cryosphere system, examples including [4]:

1. The albedo (reflection)-loss factor inherent in the melting of land ice, sea ice and snow, opening sea and lake water surfaces which absorb infrared radiation, warming the water and leading to further ice melt (the so-called albedo-flip effect).
2. Elevated atmospheric greenhouse gas levels result in higher temperatures which, in turn, result in further release of CO2 from water (which have lower solubility of CO2 with higher temperatures) and from drying and burning biosphere, notably tropical forests (Amazon, Congo).
3. Warming ocean water to a depth of 3000 meters, resulting in release of sea-bed methane-bearing clathrates as amplifying feedback of climate change.
4. Release of methane from melting permafrost, with consequent rise in greenhouse gas levels, further warming and melting of more permafrost.
5. Decreased salinity of the North Atlantic Ocean consequent on (1) increased precipitation; (2) supply of Greenland fresh ice melt water, and (3) lesser extent of sea ice, retarding the meridional overturning circulation which drives the North Atlantic Thermohaline Current (NATC), thus threatening its shutdown.
6. A slowing down or collapse of the NATC will result is lesser heat transfer from tropical oceans to high latitudes, increasing low-latitude temperatures which ensue in tropical hurricanes.

IPCC projections (Figure 1) give an impression of gradual climate changes, taking only limited account of the effects of continental ice melt dynamics, the opening of the Arctic ocean, potential collapse of the NATC, melting of the Himalaya

glaciers (the so-called "3rd Pole") and methane release from melting permafrost, warming Arctic water bodies and drying and burning tropical forests [5] (Figure 3).

In so far as the IPCC-2007 report has led to a definition by the EU of a 2 degrees C maximum permissible mean global temperature rise, according to Hans Joachim Schellnhuber: "*But the two degree guardrail is somewhere around or above the tipping point. So two degrees is not a good compromise! It is the dividing line between dangerous and catastrophic climate change*" [6].

Admitting the rate of ice sheet melt dynamics were yet unclear, IPCC-2007 sea level rise projections, estimated as 0.18-0.59 meters by 2010, are considered to be under-estimates. Rahmstorf et al [7] suggest 0.5-1.4 meters SL rise above 1990 by the end of the Century.

Hansen and Sato (2011) [8] state:

"*Deglaciation, disintegration of ice sheets, is nonlinear, spurred by amplifying feedbacks. If warming reaches a level that forces deglaciation, the rate of sea level rise will depend on the doubling time for ice sheet mass loss.*" …

And:

"*Business-as-usual scenarios result in global warming of the order of 3-6°C. It is this scenario for which we assert that multi-meter sea level rise on the century time scale are not only possible, but almost dead certain. Such a huge rapidly increasing climate forcing dwarfs anything in the palaeo-climate record. Antarctic ice shelves would disappear and the lower reaches of the Antarctic ice sheets would experience summer melt comparable to that on Greenland today*".

Following the 1998 El-Nino peak, the rise in mean global temperatures continued, the period 2000-2010 being the warmest in the instrumental record [9] (Figure 4). In contrast to the impression of gradual climate projections which may be obtained by IPCC projections (Figure 1), the spate of heat waves/fire, hurricanes and floods around the world, which doubled in frequency between 1980 and 2009 (Figure 5), manifests the response of the atmosphere-ocean system to increased radiative forcing by anthropogenic greenhouse gas, namely the over 320 billion tons carbon (GtC) emitted since the 18th century, more than 50 percent the original inventory of the atmosphere.

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Earth and paleo-climate science,
7 March, 2011

[1] http://www.monbiot.com/2007/04/10/the-real-climate-censorship/
[2] http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml ; http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html ; http://www.ipcc.ch/publications_and_data/ar4/syr/en/spm.html ; http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms3.html
[3] Rahmstorf et al., 2009. Recent climate observations compared to projections. http://www.pik-potsdam.de/~stefan/Publications/Nature/rahmstorf_etal_science_2007.pdf
[4] David Wasdell, February 2007. Political Corruption of the IPCC Report? http://www.meridian.org.uk/Resources/Global%20Dynamics/IPCC/contents.htm
[5] Lenton et al., 2008. Tipping points in the Earth system. http://researchpages.net/esmg/people/tim-lenton/tipping-points/ ; http://sciencewatch.com/dr/nhp/2009/09julnhp/09julnhpLentET/
[6] http://universitypost.dk/article/two-degrees-warmer-may-be-past-tipping-point
[7] http://www.sciencemag.org/content/315/5810/368.short
[8]
[9] http://www.ncdc.noaa.gov/sotc/?report=global ; http://www.extremeweatherheroes.org/science-of-extreme-weather/globalevidence.Aspx ; http://novakeo.com/?p=8766# ; http://www.bom.gov.au/climate/enso/feature/ENSO-feature.shtml

Figure 1

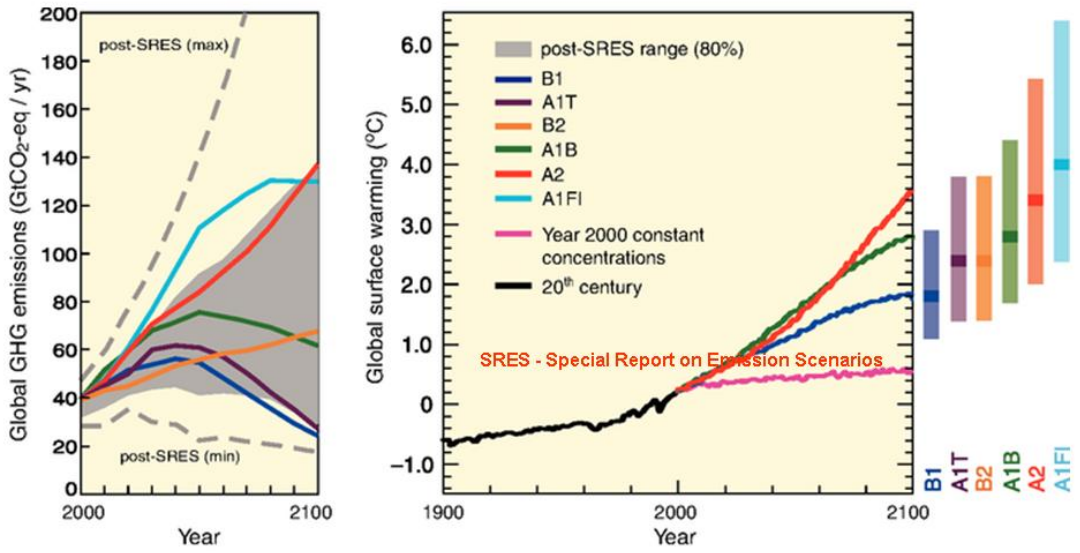

Figure 1. Left Panel: Global GHG emissions (in GtCO2-eq) in the absence of climate policies: six illustrative SRES marker scenarios (coloured lines) and the 80th percentile* range of recent scenarios published since SRES (post-SRES) (grey shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions include CO2, CH4, N2O and F-gases. Right Panel: Solid lines are multi-model global averages of surface warming for scenarios A2, A1B and B1, shown as continuations of the 20th-century simulations. These projections also take into account emissions of short-lived GHGs and aerosols. The pink line is not a scenario, but is for Atmosphere-Ocean General Circulation Model (AOGCM) simulations where atmospheric concentrations are held constant at year 2000 values. The bars at the right of the figure indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios at 2090-2099. All temperatures are relative to the period 1980-1999. http://www.ipcc.ch/publications_and_data/ar4/syr/en/figure-spm-5.html
*percentile is the value of a variable below which a certain percent of observations fall

Fig. 2

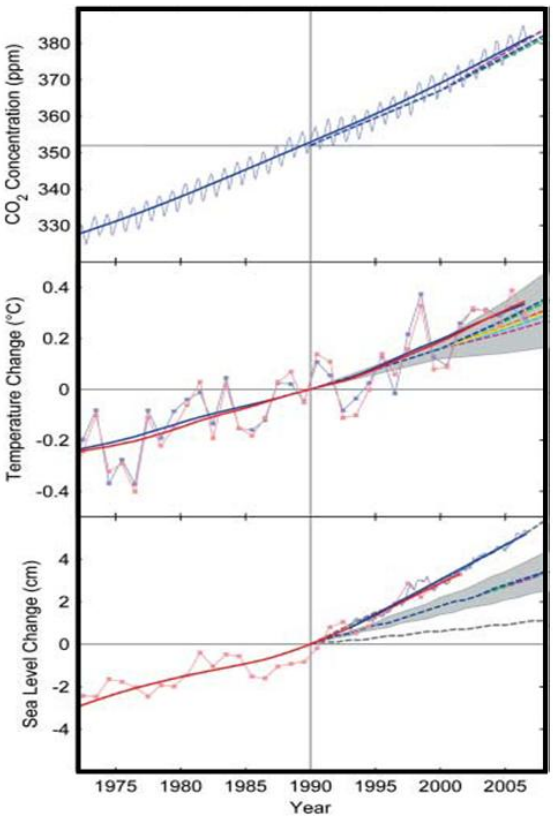

Figure 2. Changes in key global climate parameters since 1973, compared to the scenarios of the IPCC [shown as dashed lines (A1FI, light blue; A1B, purple; A1T, blue; A2, red; B1, yellow; and B2, green) and grey ranges in all panels]. **(a)** Monthly carbon dioxide concentration and its trend line at Mauna Loa, Hawaii (blue) up to January 2007, from Scripps in collaboration with NOAA. **(b)** Annual global-mean land and ocean combined surface temperature from GISS (red) and the Hadley Centre / Climatic Research Unit (blue) up to 2006, with their trends. **(c)** Sea-level data based primarily on tide gauges (annual, red) and from satellite altimeter (3-month data spacing, blue, up to mid-2006) and their trends. All trends are non-linear trend lines and are computed with an embedding period of 11 years and a minimum roughness criterion at the end, except for the satellite altimeter where a linear trend was used because of the shortness of the series. For temperature and sea level, data are shown as deviations from the trend-line value in 1990, the base year of the IPCC scenarios.
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Fig. 3

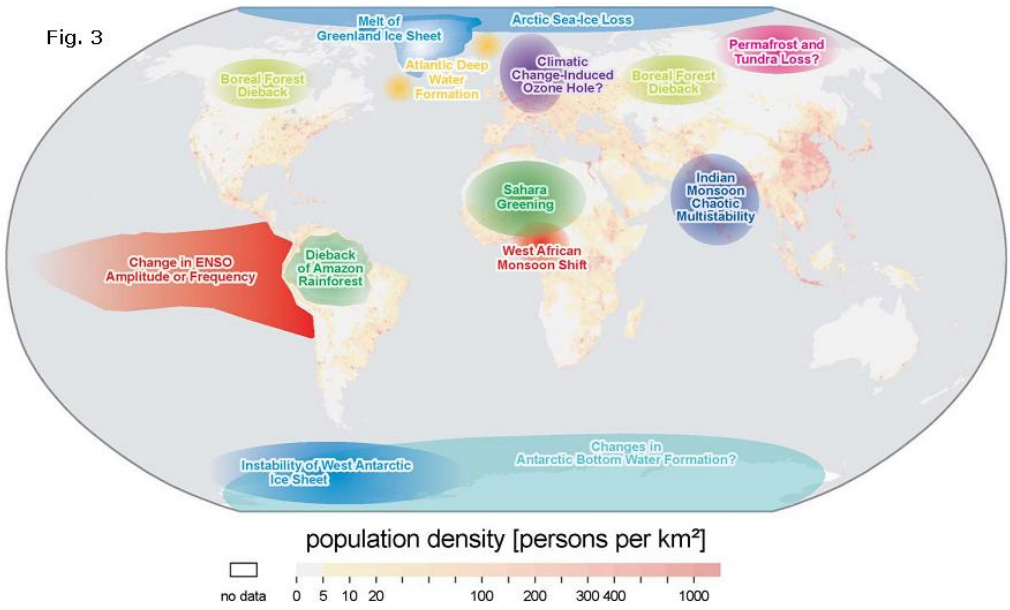

Figure 3.

Map of potential policy-relevant tipping elements in the climate system overlain on global population density. Subsystems indicated could exhibit threshold-type behavior in response to anthropogenic climate forcing, where a small perturbation at a critical point qualitatively alters the future fate of the system. They could be triggered this century and would undergo a qualitative change within this millennium. We exclude from the map systems in which any threshold appears inaccessible this century (e.g., East Antarctic Ice Sheet) or the qualitative change would appear beyond this millennium (e.g., marine methane hydrates). Question marks indicate systems whose status as tipping elements is particularly uncertain. Lenton et al., 2008.
http://www.pnas.org/content/105/6/1786.figures-only

Fig. 4

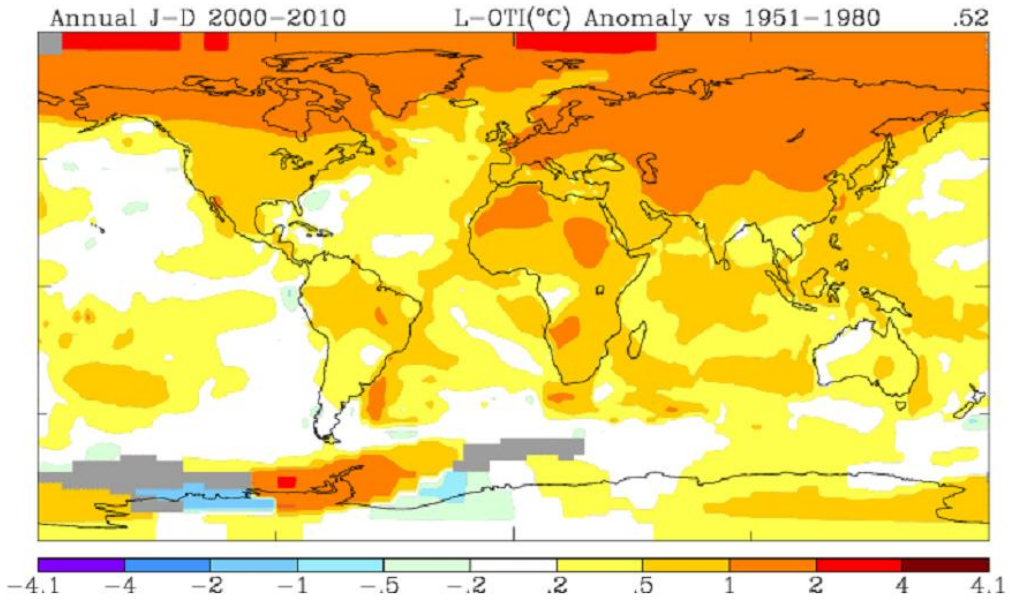

Figure 4. Mean annual (Jan-Dec) global temperatures for 2000-2010 relative to 1951-1980. http://data.giss.nasa.gov/gistemp/maps/

Fig. 5

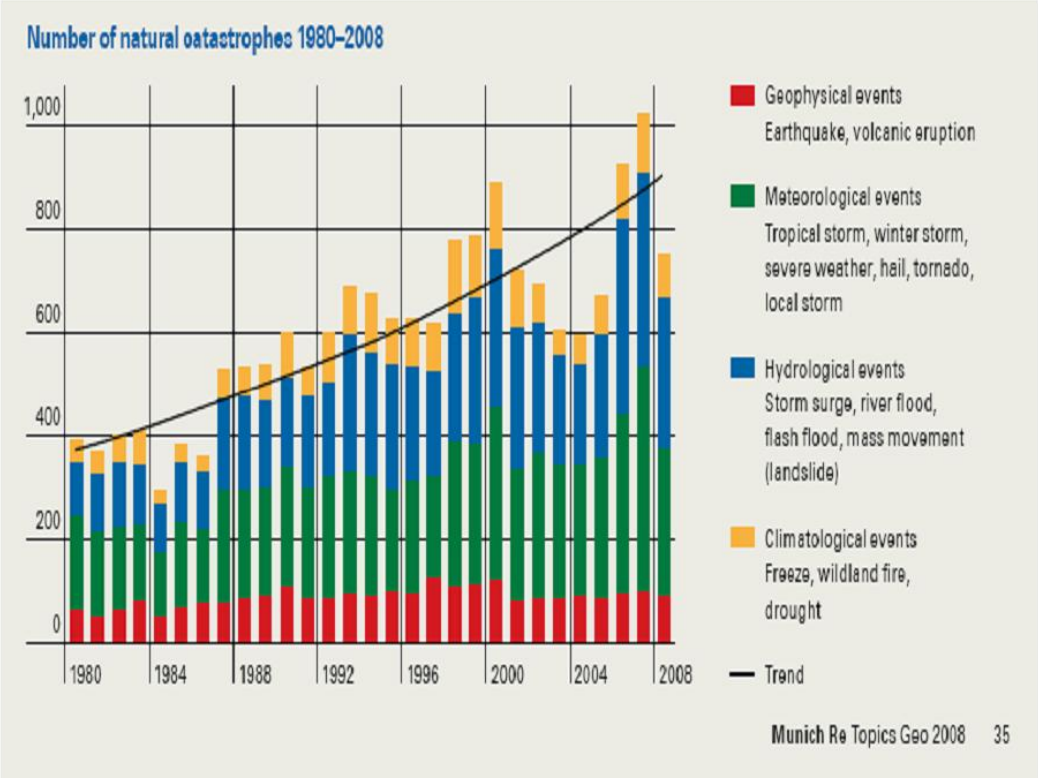

Figure 5.

Frequency of global geophysical events and natural catastrophes, 1998 - 2008. From Topics Geo: Natural catastrophes 2008 analyses, assessments, positions. https://www.munichre.com/touch/login/en/service/login.aspx?ReturnUrl=/touch/publications/en/list/default.aspx?id=1060