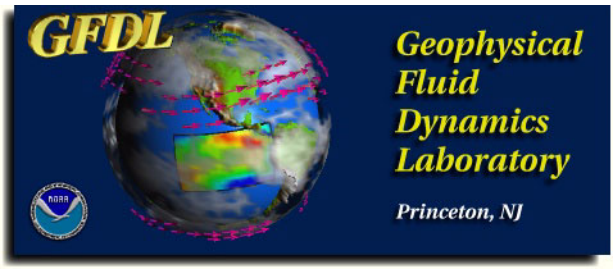
Global Warming Commitment: Temperatures Would Rise Even With No Additional Greenhouse Gas Increases



The climate could warm by 1.8°F without any further increase in atmospheric greenhouse gas levels, say scientists from NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) who have estimated the amount of future warming expected from present day greenhouse gas concentrations. Their computer model simulations indicate that much of the warming associated with past human activity has not yet been realized.

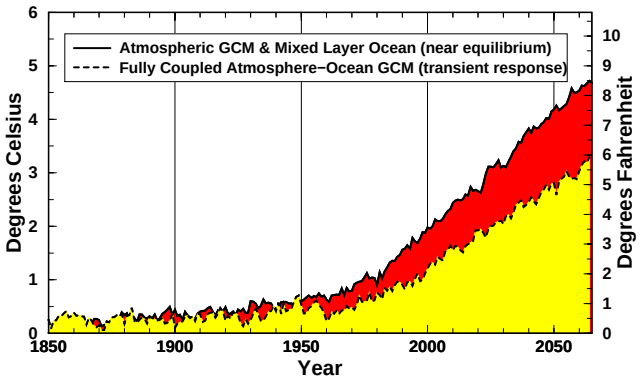
TAKE HOME POINTS

- ☛ Even if atmospheric greenhouse gas (GHG) levels were to be stabilized at present levels, surface air temperatures would continue to rise well into the future as the global ocean slowly warms & comes into balance with the rest of the climate system.
- ☛ Stabilization of GHG levels implies near zero future emissions - an unrealistic assumption.
- ☛ The simulated present day global warming commitment of 1°C (1.8°F) is relatively large compared to the warming observed in the past 140 years, which is about 0.6°C (1°F).

In a paper published in the April 15, 2001 issue of *Geophysical Research Letters*, NOAA/GFDL scientists Richard Wetherald, Ronald Stouffer and Keith Dixon report that the warming would continue well into the future even if atmospheric greenhouse gases (GHGs) remain at current levels. The continued warming occurs as more energy comes into the Earth's atmosphere from the Sun than is returned to space. This global heat imbalance, or disequilibrium, persists as the world's oceans slowly warm in response to increasing levels of atmospheric GHGs. The researchers refer to the future warming associated with present GHG levels as a "warming commitment", since the warming is required by the heating imbalance, but has not yet occurred.

The GFDL computer model results indicate that the globally averaged surface air temperature would warm by 1°C (1.8°F) from the present if the global climate system, which includes the oceans, was given time to fully equilibrate (come into complete balance) with present day GHG levels. Note that the stabilization of GHGs at current levels requires the unrealistic assumption of little or no future GHG emissions. When realistic estimates of future emissions are used in the climate change experiments, the magnitude of the warming commitment increases throughout the 21st century (see figure). The faster the rate of GHG increases, the larger the warming commitment (and warming). The time required to complete the equilibration process is very long, perhaps more than 1,000 years, because of the ocean's large thermal inertia.

The present day global warming commitment of 1°C (1.8°F) is relatively large when compared with warming observed in the past 140 years which is about 0.6°C (1°F). These results suggest that much of the warming ultimately associated with past human activity is not yet apparent in the observed surface temperature record.



The dashed line (top of yellow area) shows model-projected global mean surface air temperature changes for the fully coupled climate system as GHG levels continually increase (°C left axis, °F right axis). The upper solid line (atmosphere/mixed layer ocean model results) approximates the temperature changes that ultimately would be realized if the coupled system had sufficient time to equilibrate with contemporaneous GHG levels. Thus, the vertical extent of the red area (*i.e.*, the vertical distance between the dashed and solid lines) represents the extent that the climate system is in disequilibrium with the transient greenhouse gas forcing … the "warming commitment".

The scientists note that many factors need to be better understood to further refine these estimates. One source of uncertainty is that the extent to which the ocean transports heat both vertically and horizontally is not well known. Additional uncertainty stems from an incomplete understanding of the ways that clouds respond to changes in radiative forcing, such as those associated with changing GHG levels. How levels of GHGs and other climatically important atmospheric constituents will vary in the future is also not known with precision, thereby limiting the accuracy of computer model projections of future climate change.

REFERENCE: Wetherald, R.T., R.J. Stouffer, and K.W. Dixon, 2001: Committed warming and its implications for climate change. *Geophysical Research Letters*, vol. 28 (no. 8), p. 1535-1538.

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Geophysical Fluid Dynamics Laboratory
Princeton, New Jersey 08542
http://www.gfdl.noaa.gov

Phone: 609-452-6500 Fax: 609-987-5063 E-mail: Keith.Dixon@noaa.gov