

Keystone XL Pipeline to Contribute 0.00002 °C Warming in 50 Years

July 6, 2013

By Ken Gregory

U.S. President Obama is holding up approval of the Keystone XL pipeline project primarily due to his concern that the approval would contribute to global warming. We calculate that the approval of the Keystone project could contribute to 0.00002 °C warming in 50 years, based on incremental greenhouse gas emissions estimated by the U.S. State Department.

The Keystone XL project is a proposed 36 inch oil pipeline that would carry product from Canada's oil sands to Gulf Coast refineries. The U.S. State Department has conducted an extensive review of the environmental and economic impact of the project. The Environmental Impacts Statement shows that oil produced from the Canadian oil sands causes 17% more carbon dioxide (CO₂) emissions on a life-cycle basis than the average oil processed in the U.S. market in 2005.

According to the State Department analysis, the project approval would have little impact on the development of the Canadian oil sands because oil can be transported economically to the US refineries by rail, and the oil could be delivered to other markets. If the Keystone project were denied but other proposed new and expanded pipelines go forward, the incremental decrease in oil sands production could be approximately 20,000 to 30,000 barrels per day (bpd). If the Keystone project and other pipeline expansions projects (Northern Gateway, Trans Mountain, TransCanada East, etc.) were not built, the incremental decrease in oil sands production would be 90,000 to 210,000 bpd. The report says, "such production decreases would be associated with

a decrease in greenhouse gas emissions in the range of 0.35 to 5.3 MMTCO₂e annually if all pipeline projects were denied, and in the range of 0.07 to 0.83 million metric tons carbon dioxide equivalent (MMTCO₂e) annually if the proposed Project were not built."

We consider the mid-range of these estimates (0.07 to 5.3 MMTCO₂) of 2.7 MMTCO₂ to be the best estimate of the incremental emissions resulting from the Keystone project approval.

The incremental emissions have to be converted into degrees Celsius of warming using an estimate of climate sensitivity to increasing CO₂. The Intergovernmental Panel on Climate Change gave an estimate of climate sensitivity of 3 °C per double CO₂ based

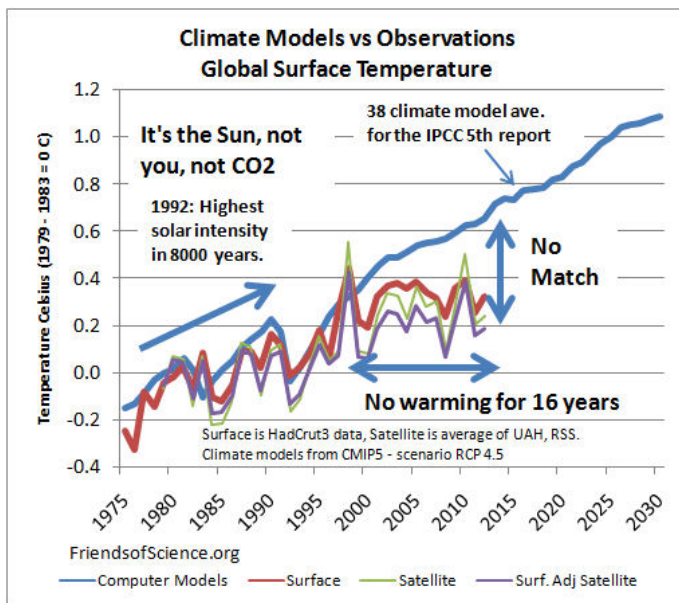


Figure 1. Climate models versus observations of global surface temperatures.

on climate models. These models assume that natural causes of climate change are insignificant and that about 95% of the 20th century warming was caused by greenhouse gas emissions. The global temperature index HadCRUT produced by the UK Hadley Centre and the Climate Research Unit shows that there has been no global warming over the last 16 years. All the climate models had forecast strong warming trends during this period, which strongly indicates that the climate models are much too sensitive to CO₂ emissions.

Technical papers published since 2010 show the climate sensitivity is much less than previously estimated by the IPCC. The chart below compiled by Paul C. Knappenberger shows the best estimates of climate sensitivity from recent studies, see [here](#).

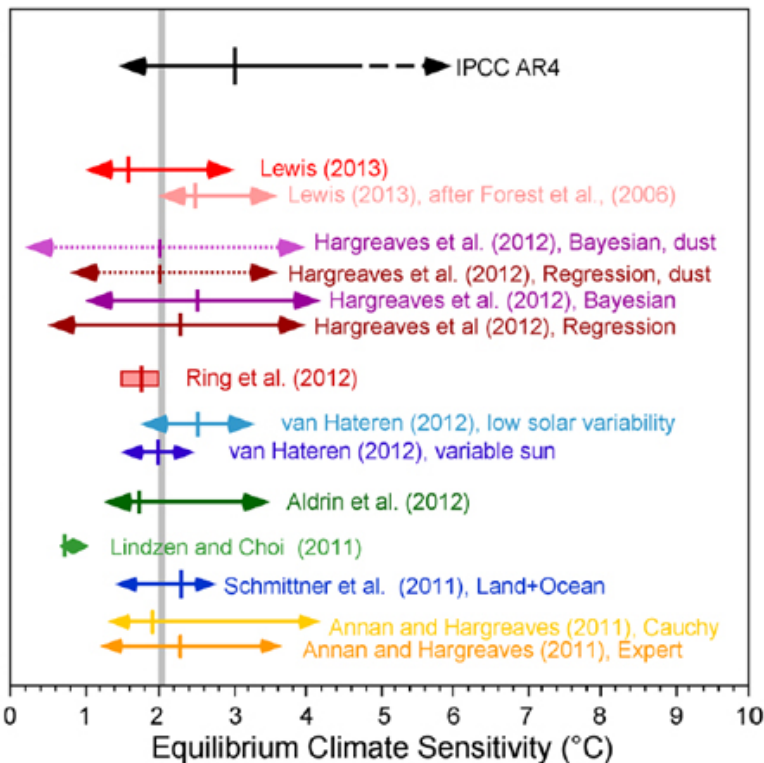


Figure 2. Recent estimates of climate sensitivity.

The top black line represents the range of the IPCC estimate of climate sensitivity given in the fourth assessment report, with the vertical black line indicating the best estimate of 3 °C/double CO₂.

The colored lines represent the range of estimates from 14 recent studies, with the vertical lines indicating the best estimates, and the arrows indicate the 5% to 95% confidence bounds. The gray vertical line is average of the 14 best estimates.

All of these estimate except the lowest one by Lindzen and Choi use the IPCC forcings, and implicitly assume no natural climate change other than from direct solar heat, or total solar irradiance (TSI). Numerous studies show that the solar effects on

climate are much greater than what can be explained by just the changes in TSI. The IPCC second order draft of the fifth assessment report admits as much by stating, "The forcing from changes in total solar irradiance alone does not seem to account for these observations, implying the existence of an amplifying mechanism." A paper by Nir Shaviv shows that the solar forcing associated with the eleven year solar cycle is about seven times larger than that caused by the TSI variations, see a summary [here](#).

The study by Lindzen and Choi (2011), see [here](#), in contrast, makes no assumption of the forcings that cause climate change, but instead directly measures the changes in the greenhouse effect. Their study compares changes in the outgoing longwave radiation (OLR) as measured by the ERBE and CERES satellites to changes in sea surface temperatures. The greenhouse effect is

the difference in effective top-of-atmosphere temperature and the surface temperature. Changes in the OLR is related directly to the top-of-atmosphere temperature. Changes in the greenhouse effect can be directly related to greenhouse gas concentrations to determine climate sensitivity.

The Lindzen and Choi estimate of 0.7 °C/double CO₂ is the only one that does not make an assumption of the solar forcing, but instead directly measures the change in the greenhouse effect. This is the only estimate that has scientific merit. The other 13 estimates ignore the overwhelming evidence that the total solar effects are much greater than the changes in TSI so these estimate should be rejected.

The US Environmental Protection Agency (EPA) estimates that the incremental CO₂ emissions resulting from the Keystone approval would be 18.7 MMTCO₂ by assuming that most of the oil would not be produced from the oil sands if the pipeline is not built. Considering the fact that oil can be transported by rail and other pipelines, this appears to be a very unrealistic assumption.

Paul C. Knappenberger used the climate model emulator MAGICC to calculate the climate impact of the incremental emissions from Keystone approval. He showed that the EPA's estimate of incremental emissions of 18.7 MMTCO₂ would cause a temperature rise of 0.000007 °C/yr using the average of recent climate sensitivity estimate of 2 °C/double CO₂, see [here](#).

Rejecting climate sensitivity estimates that assume no natural climate change other than from TSI and using the realistic 0.7 °C climate sensitivity estimate from the Lindzen and Choi study, the pipeline could cause 0.000003 °C/yr temperature rise in response to incremental emissions of 18.7 MMTCO₂.

Considering the fact that there are other pipeline options under consideration and the oil sands oil is flowing to the US in greater volumes by rail, the mid-range of the State Department estimates of incremental emissions of 2.7 MMTCO₂/year is much more reasonable. Using the realistic 0.7 °C climate sensitivity to doubling CO₂ and the State Department mid-range estimate of incremental emissions, the temperature impact of the Keystone pipeline would be (0.000003 X 2.7/18.7) 0.00000043 °C/year, or 0.00002 °C in 50 years.

The climate impact of approving and building the Keystone XL pipeline of 0.00002 °C in 50 years is insignificant and unmeasurable, so the pipeline should be approved.

Ken Gregory, P.Eng.

Director, Friends of Science