NCASI Fact Sheet

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Does Forest Bioenergy Affect Global Temperature?

DECEMBER 2018

Introduction

There is considerable concern about the rate at which global CO_2 emissions are increasing and the implications for global temperatures in both the near and long term. This has led to calls for steep near-term reductions in emissions. Unfortunately, there is widespread confusion about the relationship between the timing of CO_2 emissions and global temperature change. This confusion has been particularly evident in the debate about the potential benefits of forest bioenergy.

How Does Global Temperature Respond to CO_2 Emissions?

The global temperature response to CO_2 is related to the total amount of CO_2 in the atmosphere and this quantity is very large compared to the amounts added in a single year. In 2013, the atmosphere contained 828 petagrams (Pg) of carbon (IPCC 2013). Considering all sources and sinks, this level was increasing at a rate of 4 Pg C per year (IPCC 2013). This increase, therefore, is less than one-half of one percent per year. Over time, this can become very significant, but on a year-to-year, or even decade-to-decade, basis it is understandable that temperature is relatively unresponsive to near-term increases or decreases in CO_2 emissions.[1]

In the words of the US Global Change Research Program, "Large reductions in emissions of the long-lived GHGs [like CO2] are estimated to have modest temperature effects in the near term (e.g., over one to two decades) because total atmospheric concentration levels require long periods to adjust, but are necessary in the long term to achieve any objective of preventing warming…" (USGCRP 2017 Pg. 394)

What About "Tipping Points?"

As global temperature increases, there is considerable concern about encountering ecological "tipping points." These can occur when temperature, precipitation, or other climate change-related variables cross a threshold that challenges the viability of an ecosystem. As global temperature increases toward the eventual peak global temperature, ecosystems will suffer the impacts associated with any thresholds occurring below peak temperature. It is only by reducing peak global temperature, therefore, that these thresholds can be avoided. This will require reducing cumulative emissions of CO_2. (IPCC 2013)

Then Why is There so Much Urgency to Reduce Emissions Immediately?

The urgency to reduce near-term CO_2 emissions is not connected in science to concerns about near-term temperatures. Instead, the urgency to reduce CO_2 emissions in the near-term results from an understanding of the enormity of the challenge of converting the world's energy systems to low- or zero-carbon. Delays in making this conversion result in

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[1] Note that this discussion pertains only to CO_2. Some other greenhouse gases, methane for instance, have a more significant impact on near-term temperatures.

continued emissions of fossil fuel-derived CO_2, which add to long-term cumulative CO_2 emissions.

Knowing this, it becomes clear why not all increases in near-term CO_2 emissions should be judged equally. Near-term increases in CO_2 that allow later reductions in cumulative CO_2 emissions are very different from those that do not.

What Does This Have to do With Forest Bioenergy?

The timing question is particularly relevant to the topic of forest bioenergy because with increased harvesting and increased production of forest bioenergy, it is not uncommon to see more CO_2 in the atmosphere in the near term, compared to a scenario without increased forest bioenergy. Even if fossil fuels are displaced, increased use of forest bioenergy can result in increased CO_2 in the atmosphere in the near term because biomass generally burns less efficiently than fossil fuel. Over longer periods, however, CO_2 emissions from forest bioenergy systems are almost always lower than from comparable fossil-fuel based systems.

The time required for increased use of forest bioenergy to transition from net CO_2 emissions to net CO_2 reductions depends on several factors. In the case of wood grown specifically for harvesting, bioenergy merely returns CO_2 to the atmosphere that was previously removed from the atmosphere, resulting in net zero biogenic CO_2 emissions and immediate benefits when displacing fossil fuel. In the case of certain residual materials used for energy (e.g., spent pulping liquors), the transition is also essentially immediate (Gaudreault and Miner 2015). In other cases, this transition requires more time.

Considering the materials most likely to be used for energy, increased use of forest bioenergy to displace fossil fuels is likely to result in net benefits to atmospheric CO_2 within a decade or two, although longer times can be encountered in some circumstances. (Miner et al. 2014). After this transition is completed, the benefits of displacing fossil fuels with forest bioenergy continue to accrue.

Summary

Climate models indicate that near-term global temperatures are insensitive to near-term CO_2 emissions. On the other hand, these models indicate there is a "near linear relationship between cumulative CO_2 emissions and peak global mean temperature." (IPCC 2013) The significance of near-term emissions of CO_2, therefore, depends on whether they increase cumulative CO_2 emissions in the longer term. These timing considerations are directly related to questions about biogenic CO_2 resulting from increased use of forest bioenergy. Increased use of forest bioenergy can result in higher near-term CO_2 emissions compared to continued use of fossil fuel but, as long as land remains in forest, cumulative CO_2 emissions are reduced in the longer term when fossil fuels are displaced by forest bioenergy. In the case of certain residuals and biomass derived from wood grown specifically to be harvested, the benefits of displacing fossil fuels may be realized immediately. For other forest-derived materials likely to be used for energy, benefits will typically be observed within a decade or two, although longer times are sometimes encountered.

References

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