Union of Concerned Scientists

November 14, 2008

Dean Simeroth
Chief, Criteria Pollutants Branch

John Courtis
Manager, Alternative Fuels Section

California Air Resources Board (CARB)
1001 I Street
Sacramento, CA 95812

Subject: Treatment of Time in Life Cycle Accounting in the Low Carbon Fuel Standard Regulatory Draft

Dear Mssrs. Simeroth and Courtis,

We appreciate the opportunity to comment on the latest draft regulation of the Low Carbon Fuel Standard (LCFS). We commend you and your staff for your groundbreaking work in the important area of lifecycle analysis, and particularly for grappling with the urgent and complex task of quantifying emissions associated with indirect changes in land use induced by increased production of biofuels feedstocks. Our comments in this letter address the question of how to account for CO_2-equivalent emissions (CO_2e) over time. We plan to submit another letter in the next several weeks with more detailed comments on the regulatory draft.

CARB is proposing various approaches to account for carbon impacts, including dividing total emissions by some reference period like 30 years and using economic discounting. This approach is consistent with how regulatory agencies have traditionally weighted the economic costs and benefits of reducing criteria pollutant emissions. Since criteria pollutants have a short residence time in the atmosphere, it is appropriate to account for their emissions in tons per day or per year. But CO_2e can have a long residence time of decades, even centuries, and the radiative forcing of a ton of carbon emitted today has more impact than a ton released thirty years into the future. We recommend that CARB use the physical science impact of greenhouse gases over time to calculate emissions impacts.

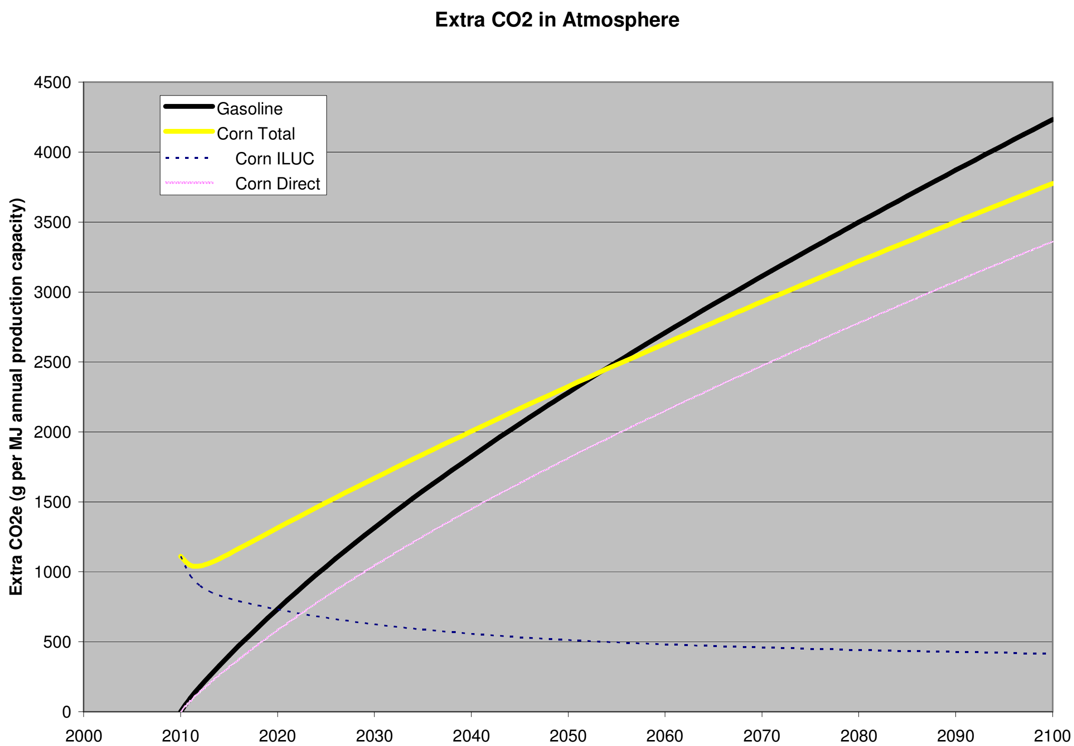
Two quantities are of special importance: the actual amount of climate-forcing gasses in the atmosphere at future dates and the relative global warming impact over time. As a general rule, any policy designed to reduce emissions should reduce both the concentration of climate forcing gasses and the cumulative radiative forcing that the planet experiences by a certain date.

We elaborate our point in the following two examples, using data and formulas from the most recent IPCC report[1] and Scenario A in Appendix A from CARB's supporting documentation for the draft regulation.[2] For simplicity, we assume CO_2 is the only global warming gas, but a more complete analysis would need to track the residence time of each gas individually. In our first example, we evaluate each year's emissions, and track their reduction as they are absorbed by the carbon cycle as described by the equation from the IPCC report:

$$a_0 + \sum_{i=1}^{3} a_i \cdot e^{-t/\tau_i}$$

$$\text{where } a_0 = 0.217,\ a_1 = 0.259,\ a_2 = 0.338,\ a_3 = 0.186,\ \tau_1 = 172.9,\ \tau_2 = 18.51,\ \tau_3 = 1.186$$

In Figure 1 we compare the emissions from the corn ethanol case to the gasoline (or reference) case, also showing the separate contributions for corn from direct and indirect land use change emissions. For land cleared in 2010 and producing fuel in 2011, it is not until 2054 that the corn ethanol case leads to lower atmospheric carbon levels than the gasoline case.



However, the CO_2 in the atmosphere understates the impact because the global warming potential is a function of the cumulative radiative forcing, which reflects the fact that the early

[1] Forster, P. V. et al. 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[2] Appendix A: Preliminary Evaluation of the Land Use Change Effects for Corn Ethanol Production. We utilize Scenario A, with ILUC emissions of 1110 g CO_2EE per mega joule (MJ) of annual ethanol production capacity (37 g/MJ for 30 years), direct annual emissions (not including land use changes) from ethanol production of 75.6 g/MJ and lifecycle gasoline emissions of 95.2 g/MJ.

emissions are warming the earth for longer than the later emissions, contributing to irreversible damage such as the melting of the ice sheets. In our second example, we estimate the relative global warming potential as simply the cumulative radiative forcing, defined on page 210 of the IPCC report.

The GWP of component i is defined by:

$$GWP_i = \frac{\int_0^{TH} a_i \cdot [C_i(t)]dt}{\int_0^{TH} a_r \cdot [C_r(t)]dt}$$

where TH is the time horizon, a_i is the radiative forcing per unit mass increase in atmospheric abundance of component i [both the modeled case and the reference case model only CO2 so $a_i = a_r = 1$], [Ci(t)] is the time-dependent abundance of i, and the corresponding quantities for the reference case (r) in the denominator.

By this metric, shown in the Figure 2 below, the cumulative radiative forcing of the corn ethanol case is more than 87% worse than gasoline in 2030, remains 32% worse in 2050, and it takes 100 years of biofuels production until the cumulative radiative forcing of ethanol and gasoline are equal.

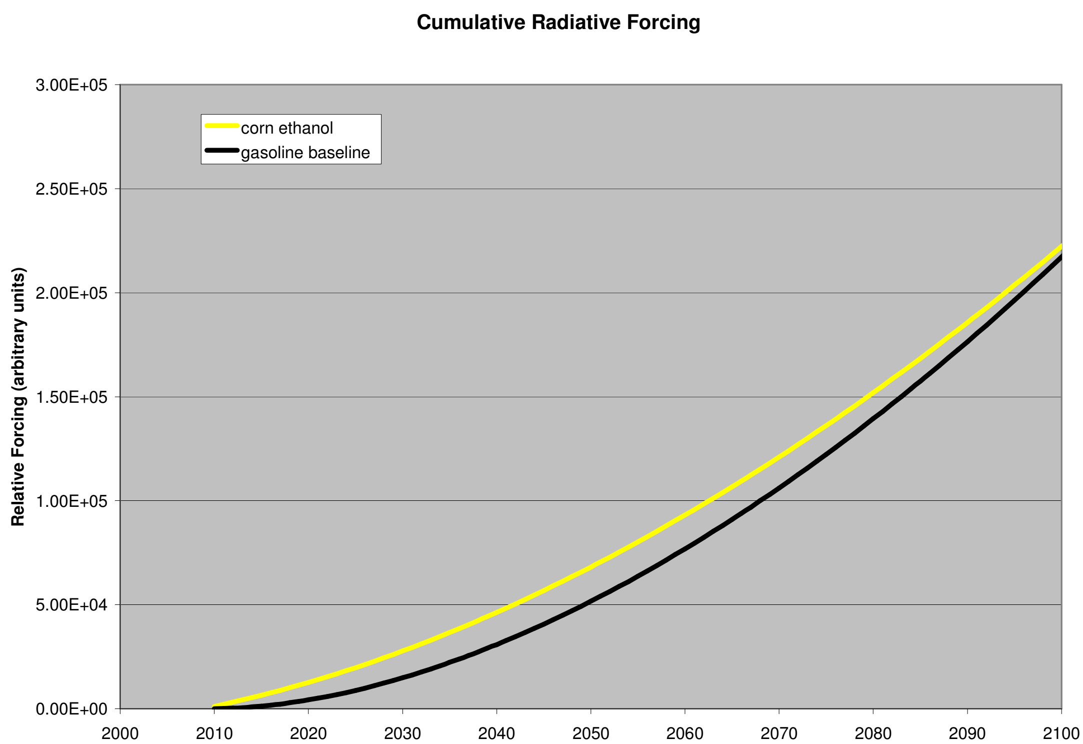


Figure 1: Cumulative Radiative Forcing

Table 1 on the following page shows how the breakeven times for the abundance and cumulative radiative forcing change depending on the relative magnitude of the input parameters.

Scenario	A	B	C
30 year amort LUC	37	88	20
One time ILUC	1110	2640	600
Gasoline g/MJ	95.2	95.2	95.2
Corn g/MJ	75.6	75.6	75.6
Abund breakeven	2054	> 100 yrs	2035
Abund 10% threshold	2094	> 100 yrs	2056
Abund 20% threshold	> 100 yrs	> 100 yrs	> 100 yrs
CRF breakeven	2111	> 100 yrs	2065
CRF 10% threshold	> 100 yrs	> 100 yrs	> 100 yrs
CRF 20% threshold	> 100 yrs	> 100 yrs	> 100 yrs
2030 CO2 reduct.	-27%	-92%	-5%
2050 CO2 reduct.	-2%	-33%	8%
2061 CO2 reduct.	3%	-21%	11%
2111 CO2 reduct.	12%	0%	16%
2030 CRF reduct.	-87%	-234%	-37%
2050 CRF reduct.	-32%	-104%	-8%
2061 CRF reduct.	-20%	-77%	-2%
2111 CRF reduct.	0%	-28%	10%

Table 1: Scenario Comparison from CARB draft LCFS, Appendix A

In all cases LUC emissions occur in 2010, and production of fuel starts the next year. All cases increase the cumulative radiative forcing measured in any time period up to 50 years, and in all but the most lowest case (Scenario C) there is no net reduction in warming even with a 100 year time horizon.

All of these calculations assume no change in the value of emissions over time. For many reasons, including the uncertainty of future fuel production patterns, the future intensity of transportation emissions, and the value of preventing near term catastrophic damage from climate change, it may indeed be sensible to derate the importance of future emission changes relative to near term emissions, as discussed in a draft paper by O'Hare and Plevin.[3] At a minimum, the greenhouse gas impact of biofuels should be measured in a way that reflects the best physical science basis for understanding the impact, and these results should be consistent with the incentives and estimates provided by other tools for analyzing risks.

We will be contacting you in the next several days to set up a meeting to discuss our recommendations for accounting for carbon over time. We look forward to continued collaboration on the development of a robust regulation grounded in sound science.

Sincerely,

Jeremy Martin
Senior Scientist, Clean Vehicles

Eli Hopson
Washington Representative, Clean Vehicles

Patrician Monahan
Deputy Director for Clean Vehicles

[3] O'Hare, M., Plevin, R. 2008. DRAFT:Proper accounting for time in LCA further increases crop-competitive biofuels' GHG deficit relative to petroleum.