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Discussions

Interactive comment on "Coupled Climate–Economy–Biosphere (CoCEB) model – Part 1: Abatement efficacy of low-carbon technologies" *by* Keroboto B. Z. Ogutu et al.

Anonymous Referee #1

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General assessment: The paper presents an IAM with the intent to better explain the role of investments in low-carbon technologies in mitigating climate change. The model is a simplified version of DICE 2013. However, some of the changes made to the economy-components are very counter-intuitive, if not incorrect, and others lack motivation. It is not apparent how the paper improves on previous models and some of the conclusions presented are not supported by the analysis. I recommend to reject the paper.

Major comments: The economic part of the model is misspecified. Equation (4) contains the economy-wide budget constraint. It reads

Y- X = I + ME + GE

where X = tau Y is the tax revenue collected by the government and GE is the share of spent on abatement

GE = tauB X = tauB tau Y.

Rearranging yields:

Y = I + ME + GE + X = I + ME + tauB X + X = I + ME + (1 + tauB) X

Total tax revenues are hence not X but (1 + tauB) X.

Furthermore, the statement on p. 5 that "government spending, expect for abatement, does not affect the size of per capita GDP" is incorrect. Total output (after damages have been deduced) is allocated over different uses: investment (I), consumption (ME), abatement (GE) and other government spending (X). This directly follows from the budget equation (4). However, it is not at all clear what other government spending is used for – or why it is there at all. It seems that the government is burning the money (but at least without creating additional GHG emissions). Any form of optimization (which is absent from the model) would immediately result in tauB = 1 and a reduction of X to the preferred level of abatement. Currently there is a substantial inefficiency (X) in the model that is not motivated in any form and maybe more worryingly, the abatement effort is directly tied to the size of this inefficiency (GE = tauB X).

The growth model itself is highly unusual as well. It uses two stocks of capital, physical and human capital, that are both driven by the same type of investment (I) as in Mankiw et al. (1992). However, although human capital is specified in per capita terms (line 9 on p. 4), its growth rate is linearly increasing in the population growth rate. This would make sense for the total stock of human capital but less so for a per capita measure. Currently it implies that everyone becomes smarter if a child is born in some distant place. Both complications deviate from the DICE model and are not motivated.

The authors see a key contribution of their paper in modelling investments in low-carbon technologies. Equations (4), (14) and (16) specify the cost and the technology improvement aspects. However, it is not clear how this is an improvement on DICE 2013. The functions are specified somewhat differently, but the underlying logic is the same. The emission reduction rate in DICE is exogenously controlled and differs between scenarios (as does tauB in the present manuscript). Both variables determine both the costs and the trajectory of emission intensity of the economy while actual emissions also depend on output.

Rather un-intuitively, the authors label D as “damage” (p. 4). However, net per capita output Y is strictly increasing in D. Specifying damages as 1/D would rectify this and would also be in line with DICE. The deviations from the DICE model – at least in the economics part – are either deeply worrying or unmotivated.

I am also concerned about how the authors interpret their results. “As will be shown in Table 3 below, the losses from mitigation in the near future are outweighed by the later gains in averted damage” (p. 10). This statement is not supported by the data presented in Table 3 which contains information on abatement and damage cost for 2100. While for 2100 the reduction in damages exceeds abatement expenditures, the statement contains a comparison between near-term abatement costs and reductions in long-term damages. While not given explicitly, near-term abatement costs are substantial as indicated by the reduction in GDP growth rates (Figure 1e) and the fact that by 2100 total GDP is still highest in BAU (see below). Moreover, such a statement requires to compare costs and benefits across time. Typically IAMs do this by specifying a social discount rate (see the discussion between Nordhaus, Stern and others). The model does not contain a social welfare function or any other indicator as to how costs and benefits should be compared if occurring at different points in time.

“The CoCEB model shows that taking no abatement measures to reduce GHGs leads eventually to a slowdown in economic growth [. . .]. This slowdown implies that future generations will be less able to invest in emissions control or adapt to the detrimental impacts of climate change. . .” (p. 13) While this might eventually be correct, it is not within the range of data presented in this paper. While the growth rate in BAU is below

the other scenarios by 2100, the level of GDP in BAU is still higher than in any other scenario. While these numbers are not reported in the paper, they can be deduced from the numbers on the average annual growth rates given on p. 10 and from Figure 1e. Hence, future generations will be richer under BAU (at least up to 2100) and their ability to invest in mitigation or adaptation is higher not lower than in the other scenarios.

References: Mankiw, N. Gregory; Romer, David; Weil, David N. (May 1992). "A Contribution to the Empirics of Economic Growth". Quarterly Journal of Economics. 107 (2): 407–437. doi:10.2307/2118477

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