Dear topical editor,

Thank you for your helpful comments, shown in blue and italics below. Find our replies directly below each comment.

1. Section 3.1.2, steady-state vs. equilbrium:

I was hoping for a more thorough rewrite of this section - I find it very hard to digest and the overlap with section 2.2 is adding to my confusion. In the last paragraph of Section 3.1.2, you introduce (for the first time) the welfare theorems by Arrow and Debreu, which state that "a competitive market equilibrium can be determined as a Pareto optimum". You then proceed to claim that this is exactly what the Negishi approach does. But in my (maybe wrong?) understanding, a Nash solution (under certain assumptions, which seem to be met by your statement on internalizing an externality) is also the result of a competitive market equilibrium - which (per Section 2.2) differs from the Negishi approach.

It could be that trying to explain the solution method before having discussed the underlying economic principles puts the reader onto a very challenging path to follow your exposition. Please reconsider at which point in the manuscript to introduce these concepts, and how to properly introduce the difference beteen equilibrium, general equilibrium and steady state.

We moved information from section 3.1.2 to section 2.2 for providing economic background when describing the solution methods. Section 3.1.2 is revised and now includes the paragraph “Arrow and Debreu (1954) introduced two welfare theorems with the general equilibrium theory. The so-called Second Welfare Theorem, in particular, states that the market equilibrium can be determined from a Pareto optimum solution. This finding provides the conceptual basis for the Negishi approach, and the market equilibrium is determined from the social planner’s solution. Manne and Rutherford (1994) first applied the Negishi approach in an intertemporal setting using a joint maximization algorithm (which is similar to the present algorithm).”. Section 3.1.2. is changed to “In economics, the long-term economic growth is called “steady state”, meaning the stability of the evolution problem (note: in contrast to physical sciences, “steady state” in the context of macro-economic growth theory means that key characteristics of the system, such as the savings rate, income share of labor, etc., remain constant, while the overall economy still grows). If an economic system is stable, a deviation from the steady state growth path leads to transition processes that close the gap to the steady state (or balanced growth path) asymptotically. During this process the markets are in equilibrium (i.e. prices equal demand and supply) in each time step. This ensures that basic accounting requests are met (i.e. no loss of commodities at the global level). The REMIND model is supposed to analyse transitions to a balanced growth path in response to policies while market equilibrium is ensured at each time (step). The general equilibrium concept on which REMIND is based is mathematically and numerically tractable and the fundamental theoretical framework of a majority of economic models. It aggregates the independent decisions of various economic agents so that production and consumption are consistent, with a balance between supply and demand, which leads to an efficient allocation of goods and services in the economy. Yet, this concept also has some limitations. On the one hand, there are strong assumptions like the perfect information for all agents. On the other hand, uniqueness and robustness of the equilibrium cannot be demonstrated for a very general set

of assumptions (Balasko, 2009). The ability of REMIND to model long-term growth dynamics and ensuing energy demands is hardly contained by limitations of the equilibrium concept. Application of this concept is contained to international trade interactions, while the dynamics of long-term growth is mainly driven by preferences, productivities, technological change, capital accumulation, population growth and endowments (e.g. fossil resources).”.

2. The arbitrary choice of a 50% tax mark-up on net-negative emissions: I understand the rationale for disincentivizing net-negative emissions, but my question concerned the choice of that value. I do not think that "the 50% assumotion is the middle ground" is a very convincing argument.

The value of 50% is a policy assumption like many other assumptions which are necessary to run scenarios with such a long-horizon model. We changed the sentence to “REMIND assumes the value of 50% to balance the likelihoods that net-negative emissions might be treated equally to emission reductions or not incentivized at all, i.e. a tax of 100% which would preclude any revenues.”.

List of main changes made in the manuscript:

- reworked section 2.2
- reworked section 3.1.2