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Interactive comment on “The integrated Earth System Model (iESM): formulation and functionality” by W. D. Collins et al.

Anonymous Referee #1

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This fascinating paper describes the coupling of an integrated assessment model (IAM, GCAM) to the IPCC-class CESM global Earth system model. The idea is not new, other institutions continue to discuss the development of a human dimension in global climate models (MIT, Yale, U Edinburgh). The MIT IGSM is a lower resolution precursor to iESM. GCAM has 5-year temporal resolution and 14 socioeconomic regions, much lower spatiotemporal resolution than the CESM. In the iESM framework, GCAM is run in serial mode attached to the massively parallel-running CESM, which the authors claim is appropriate. The paper introduces potential future applications of the coupled iESM framework concerning climate change impact on energy demand, supply and production, but the paper primarily focuses on land use land cover change and implementation of the Global Land-Use Model into the CLM component of CESM. Previously, the community approach has involved applying gridded fixed off-line emis-

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sions scenarios (pre-calculated by IAMs) into the global climate models. In this way, uncertainty in human decision-making is accounted for by running a range of IAM trajectories in the global climate models without any feedbacks from the future climate change onto the IAM trajectory. This approach must be methodologically wrong for the future land use land cover change trajectories that will be sensitive to local, regional and global climate change. However, this standalone paper does not offer any convincing evidence that the massive coding work and computational expense is justified by new “better” information that could not be obtained by running many IAM scenarios and cases in a global climate model? A further concern is that the short-lived radiatively-active species in CAM are not yet fully coupled to the CLM in the default version of the CESM. Worse still, effects of local and regional radiative forcing mechanisms such as short-lived species (aerosols) on local and remote climate response are very poorly understood to date.

I have a few questions regarding the major science goal of the iESM development: “Will climate change itself affect global human decision making and biogeochemical and biogeophysical processes?”

1. Is future global human economic-energy decision making sufficiently logical that it can be predicted to the extent and accuracy that it can be made into a computer program?
2. Different human cultures make decisions in different ways and with different priorities and value systems. How can all of these possibly be accounted for? Are they even known? Is there any evidence that “global human decision making” exists?
3. The coupled human-climate approach in iESM needs to be validated based on historical events. For example, if iESM is run for the 20th century, is it able to simulate the Great Acceleration that started in the 1950s? This simulation represents an important test of the framework.
4. If iESM is run for the past millennium, is it able to simulate the human land use land

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cover change that occurred across this period (e.g. such as in Pongratz et al., 2008)? If iESM is run on longer Pleistocene timescales, it is able to simulate the flourishing of human civilization in the Holocene versus the previous InterGlacials?

5. There exists controversy in the social science literature over the human response to water availability and the possibility of subsequent regional conflict. Some studies suggest that water availability may be a driver of violent conflict while other research does not support this phenomenon. How will iESM address such uncertainties in human-climate linkages?

6. Do users need to hard-wire the system for their own particular research application? For example, if a user wanted to study the economic-energy system response to lower Manhattan and Florida being submerged in seawater, there are of course multiple possible human and society outcomes and responses, but how does GCAM decide the single global human response? And how do we know if it is 'right' and/or realistic?

Interactive comment on Geosci. Model Dev. Discuss., 8, 381, 2015.

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