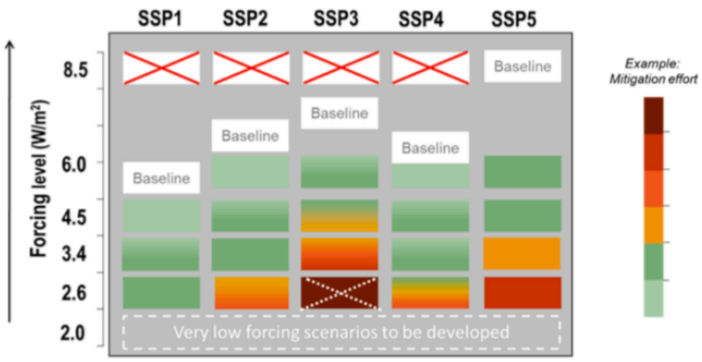
Anonymous Referee #2

Received and published: 1 March 2020

Due to its substantial energy demand and huge population, China's future air pollutants and greenhouse gas emissions are of great importance both locally and internationally. This work developed a dynamic projection model to predict future emissions under various SSP-RCP scenarios, with a particular focus to integrate local policies. This is an important contribution, and will help to fill the missing gap from those global-scale studies. I suggest minor revisions for acceptance.

Response: We appreciate the Referee's accurate summary and the positive tone. We have one-by-one addressed the Referee's comments.

1. SSP and RCP scenarios can interact in different combinations. I understand it is impractical to simulate all scenario combinations, but maybe the author could consider adding some justifications of why choosing SSP1-26, SSP2-45, SSP3-70, SSP4-60, and SSP5-85 scenarios? Also, it would be could to add a few sentences about the implications due to such choices?



Response: We thank the Referee for the constructive comments.

First, socio-economic scenarios (i.e. SSPs) constitute an important tool for exploring the long-term consequences of anthropogenic climate change and available response options (Kriegler et al., 2012). As part of the scenario development process, consistent and harmonized quantitative elaborations of population, urbanization and economic development have been developed for all the SSPs. The quantitative elaborations of the SSP narratives are then referred to as 'baseline' scenarios, and the SSP narratives themselves do not include explicit climate policies (Rao et al., 2017). The mitigation effort (i.e. climate mitigation scenarios) of the SSP scenarios is then a function of both the stringency of the target and the underlying energy and carbon intensities in the baselines. This could result in some cases in infeasibilities in terms of meeting mitigation targets for a complete overview of the SSP baseline and climate mitigation scenarios (Rao et al., 2017; Riahi et al., 2017). As shown in Figure R1, not all cells of the matrix have to contain a consistent scenario. For example, a shared socio-economic pathway with rapid development of competitive renewable energies, low population growth and environmental orientation would be hard to reconcile with a 6 degree warming, even without climate policy (Kriegler et al., 2012). The full set of multiple SSPs and forcing outcomes forms a matrix of possible integrated scenarios are shown in Figure R2 (white cells; O'Neill et al., 2016).

Further, in this study, five SSP-RCPs scenarios (i.e. SSP1-26, SSP2-45, SSP3-70, SSP4-60, and SSP5-85 scenarios) are chosen according to the Scenario Model Intercomparison Project (ScenarioMIP) for CMIP6 (Figure R2; O'Neill et al., 2016). O'Neill et al (2016) describe ScenarioMIP's objectives, experimental design, and its relation to other activities within CMIP6 in detail. In summary, O'Neill et al (2016) choose an SSP for each global average forcing pathway by taking into consideration the possibility that the sensitivity of climate outcomes to SSP choice may be larger than anticipated. To account for that possibility, choices were based on one or, when compatible, more of the following goals: facilitate climate research; minimize differences in climate; and ensure consistency with scenarios that are most relevant to the IAM/IAV communities. Therefore, an experimental design has been identified consisting of eight alternative 21st century scenarios (i.e. SSP5-8.5, SSP3-7.0, SSP2-4.5, SSP1-2.6, SSP4-6.0, SSP4-3.4, SSP5-3.4-OS, SSPa-b) plus one large initial condition ensemble (SSP3-7.0) and a set of long-term extensions (SSP5-8.5-Ext, SSP5-3.4-OS-Ext, and SSP1-2.6-Ext), divided into two tiers defined by relative priority.

Therefore, to cover all the SSPs scenarios (one scenario from each SSP), we further choose five abovementioned scenarios from the experimental design in the ScenarioMIP. And we have added the related clarification and implications due to such choices in the revised manuscript.

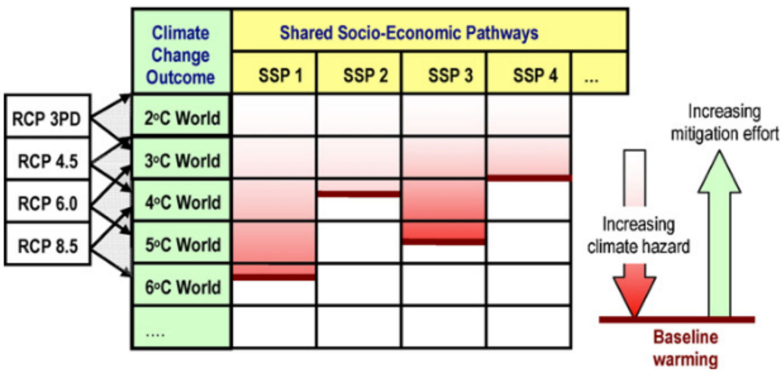


Figure R1. Matrix of socio-economic "reference" developments (characterized by shared socio-economic pathways, SSPs) and climate change outcomes (determined by representative concentration pathways, RCPs). White cells indicate that not all combinations of shared socio-economic pathways and climate change outcomes may provide a consistent scenario (Kriegler et al., 2012).

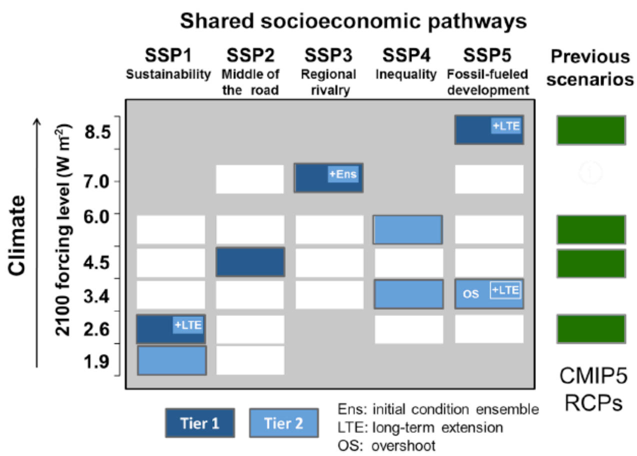


Figure R2. SSP-RCP scenario matrix illustrating ScenarioMIP simulations (O'Neill et al., 2016).

References:

Kriegler, E., O'Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H. and Wilbanks, T.: The need for and use of socio-economic scenarios for climate change analysis: A new approach based on shared socio-economic pathways, Global Environmental Change, 22(4), 807–822, doi:10.1016/j.gloenvcha.2012.05.005, 2012.

O'Neill, B. C., Tebaldi, C., van Vuuren, D. P., Eyring, V., Friedlingstein, P., Hurtt, G., Knutti, R., Kriegler, E., Lamarque, J.-F., Lowe, J., Meehl, G. A., Moss, R., Riahi, K. and Sanderson, B. M.: The Scenario Model Intercomparison Project (ScenarioMIP) for CMIP6, Geosci. Model Dev., 9(9), 3461–3482, doi:10.5194/gmd-9-3461-2016, 2016.

Riahi, K., van Vuuren, D. P., Kriegler, E., Edmonds, J., O'Neill, B. C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J. C., Kc, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., Ebi, K., Hasegawa, T., Havlik, P., Humpenöder, F., Da Silva, L. A., Smith, S., Stehfest, E., Bosetti, V., Eom, J., Gernaat, D., Masui, T., Rogelj, J., Strefler, J., Drouet, L., Krey, V., Luderer, G., Harmsen, M., Takahashi, K., Baumstark, L., Doelman, J. C., Kainuma, M., Klimont, Z., Marangoni, G., Lotze-Campen, H., Obersteiner, M., Tabeau, A. and Tavoni, M.: The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, Global Environmental Change, 42, 153–168, doi:10.1016/j.gloenvcha.2016.05.009, 2017.

Rao, S., Klimont, Z., Smith, S. J., Van Dingenen, R., Dentener, F., Bouwman, L., Riahi, K., Amann, M., Bodirsky, B. L., van Vuuren, D. P., Aleluia Reis, L., Calvin, K., Drouet, L., Fricko, O., Fujimori, S., Gernaat, D., Havlik, P., Harmsen, M., Hasegawa, T., Heyes, C., Hilaire, J., Luderer, G., Masui, T., Stehfest, E., Strefler, J., van der Sluis, S. and Tavoni, M.: Future air pollution in the Shared Socio-economic Pathways, Global Environmental Change, 42, 346–358, doi:10.1016/j.gloenvcha.2016.05.012, 2017.

2. The author compared their predicted emissions with CMIP6 results, which reveal notable differences. Could the author provide some relevant guidance/instructions for CMIP6 and future DPEC users? For instance, which model is more reliable/useful under which circumstances? How to interpret the results from these different methods, respectively, in China's context?

Response: We thank the Referee for the constructive suggestion.

As we described in the manuscript, our DPEC model aims to provide a set of emission projection datasets, which integrate region-specific and sector-based local policies within the global IPCC scenarios. DPEC is more reliable/suitable for the researchers who focus on the China's near- and mid-term air pollution and climate change issues or look into the global/regional impacts due to China's air pollution and CO_2 emissions as their notable differences in recent years. While for other global issues not focusing on China, regional emissions of the CMIP6 results are created under the same frameworks, which can better capture the variations and differences among regions under the same assumptions and circumstances.

In China's context, first, the results from these different methods reveal the differences of historical emission inventory, our MEIC emission inventory can provide more reliable and detailed technology distributions and emissions of the base year, which also lays the foundation of future projections. Second, the differences of future emission trends are because our developed dynamic projection model could better reflect the local policies, which is less considered in the global model.