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**Geoscientific
Model Development
Discussions**

Interactive comment on "Modeling framework for exploring emission impacts of alternative future scenarios" *by* D. H. Loughlin et al.

Anonymous Referee #2

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This work uses a detailed bottom-up technology-based GHG and air pollutants emissions projection model and projects air quality changes in 2050. It is groundbreaking in many ways, as there is currently no such kind of study exists yet. In both developed and developing countries, air pollution is the most direct and immediate issue concerning future growth and development. Thus a study like this can help improve the projections and understanding of future air pollution impacts given technological and population growth and given ranges of scenarios, and help to calculate the co-benefits of air pollution under climate policies. There are a few areas that this paper can be further improved.

General comments: - Literature review on air pollution projections can be strengthened to provide readers a sense about the state-of-the-art air pollution projections, what they

achieved, what are the gaps, and how this research intends to fill an important gap. In the conclusion, compares the new findings with other projections, and provide discussion on whether this new approach, which is a large undertaking, provides additional insights? Such as improving the accuracy of projections?

- Is there any calibration of matching the SCC emissions with MARKAL emissions based on the crosswalk provided in Table 1? How do we know, and how kind of criteria can be used to evaluate, the validity and degree of confidence for the 5-step process described in pages 2026-2027.

Detailed comments: - Page 2026. Lines 9-20. "Point sources are represented by 8-digit SCCs. . . . regardless of industry." This subparagraph can be deleted. Interested readers can refer to the SCC codes by themselves.

- Page 2027. Due to the lack of data, growth factors for CO2, PM10 and NOx are used as surrogates for other species, including CO, VOC, and NH2 (CO2), PM2.5 (PM10), and CO, VOC, and NH3 (NOx). This seems to be a grossly over simplistic assumption. Can the author provide a Supporting Information to justify the rationale for this assumption even within an order of magnitude accuracy? This assumption may be ok if there is no significant technological change within the modeling period. However, with significant technological change (scenarios 1 vs 2), there can be significant changes in technology and fuel types within each matching SCC codes, such as within industrial sector (except refineries), within refineries, residential and commercial (combustion), and even within light-duty vehicles. Should sensitivity analysis be conducted to test the robustness of the outcomes to this assumption?

- Table 2. Electric sector emission factors for Scenarios 1 and 2 show a drastic different emission growth rate for CO2 (4 percent vs 96) percent. Yet, the emission factors for NOx and PM2.5 remain almost the same between scenarios 1 and 2? It order to achieve almost no emission growth in the electric sector between 2000-2050, significant technological change will be needed. However, for example, vast amount of

renewables, nuclear, and even coal/natural gas with CCS can significantly reduce CO2 and NOx and PM2.5 emissions.

- Future work. There is definite a lot of future work worth exploring. Many of which are not mentioned perhaps due to the length limitation. Examples such as improved spatial allocation methods, more scenario analysis, sensitivity analysis, or even methods to optimize (minimize) future air pollution impacts given growing demand. But this is definitely an exciting area for future work.

Interactive comment on Geosci. Model Dev. Discuss., 3, 2021, 2010.