Reviewer Comments on Manuscript:

"The Contribution of Transport Emissions to Ozone Mixing Ratios and Methane Lifetime in 2015 and 2050 in the Shared Socioeconomic Pathways (SSPs)"

General comments:

The manuscript offers a comprehensive assessment of transport emissions' impacts on ozone and the hydroxyl radical (OH) across different transport sectors using the EMAC Chemistry-Climate model's simulations. The study uses an innovative approach to quantify contributions to OH for the years 2015 and projections for 2050, under various SSPs. The analysis extends to ozone radiative forcing and methane lifetime reductions, highlighting the manuscript's value to environmental policy and planning stakeholders.
The manuscript is well written and provides an extensive analysis of the impacts arising from various emission scenarios. However, there are several areas where further development could enhance the study's robustness. After addressing the suggestions outlined below, the manuscript should be considered for publication due to its valuable contribution to the field.

Model Evaluation:

The manuscript would greatly benefit from a dedicated validation section. Such a section should detail the model's proficiency in simulating the chemical environment and meteorology for the base year of 2015. This could include comparisons of model outputs with observed data or results from prior studies to establish the model's skills.

Model Description:

The description of the EMAC model setup, including its chemical mechanisms, is thorough. Nonetheless, the manuscript would benefit from additional details on the model's parameterizations, particularly those influencing ozone and other chemical species. This should encompass radiation, deposition, and boundary layer schemes, as well as the land surface model used. A clarification on whether the simulations incorporate direct radiation feedback would be pertinent.

Introduction and Methods:

Structural Suggestions:

Consider relocating parts of the limitations and uncertainties discussion, currently in line 610, to the introduction or methodology sections. This would help set the reader's expectations early in the manuscript.

Analysis and Discussion:

Climate Change Impact:

Incorporating a discussion on the potential changes and impacts of climate change on atmospheric chemistry and transport patterns is recommended. This includes a thorough consideration of radiation feedbacks and their prospective effects on future climate change scenarios. For example, changes in surface and atmospheric temperatures can profoundly influence ozone chemistry; as temperatures increase, so do evaporation rates, which lead to a higher concentration of water vapor in the atmosphere, potentially affecting OH and ozone levels. Additionally, changes in cloud cover can alter photolysis rates, thereby impacting ozone formation and destruction.

Land Surface Model Considerations:

It is important to discuss the implications of land surface model choices within the simulations. Soil moisture variability, alterations in land use, and vegetation cover driven by climate scenarios play an important role in the soil's chemical processes and the land's overall energy budget. For instance, soil moisture dependent on the chosen climate scenario affects soil chemistry, influencing how land surface models simulate these processes. Similarly, changes in land use and vegetation cover have the potential to modify the absorption, reflection, and emission of radiant energy at the land surface. Moreover, the type of vegetation and temperature changes can affect the deposition of chemical species and their uptake by plants.

Sensitivity Analysis:

Could a sensitivity analysis be performed to evaluate how various model assumptions, such as chemical reaction rates and deposition processes in a changing climate, might affect the outcomes? This would contribute to understanding the study's conclusions' robustness.