Assessing the climate, health, and agricultural impacts of global NOx emission reductions

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Summary

Emissions of nitrogen oxides (NOx) contribute to ozone formation, which has various environmental and social effects. NOx emissions can also reduce methane levels by increasing the oxidation potential of the atmosphere. However, comprehensive studies on the environmental and societal impacts of NOx are lacking. While reducing NOx emissions is effective for addressing air pollution issues, it can also lead to higher methane concentrations in the atmosphere and a slight acceleration in global warming. Thus, further reductions of greenhouse gas emissions are necessary to simultaneously address air pollution and climate change.

INTRODUCTION

NOx emissions are projected in many studies to decrease significantly in the near future. And NOx emissions have the following effects on the chemical composition of the atmosphere.

- NOx emissions increase ozone (O_3) concentrations in the troposphere by participating in some reactions with VOC, methane, etc.
- NOx emissions decrease methane concentrations by increasing OH concentrations.

This study will evaluate the following assuming that significant NOx reductions have occurred.

- Climate Impacts of Increased Methane Concentration and Decreased Ozone Concentration
- Health Effects of Decreased Ozone Concentration
- Agricultural Impacts of Lower Ozone Concentrations

METHODOLOGY

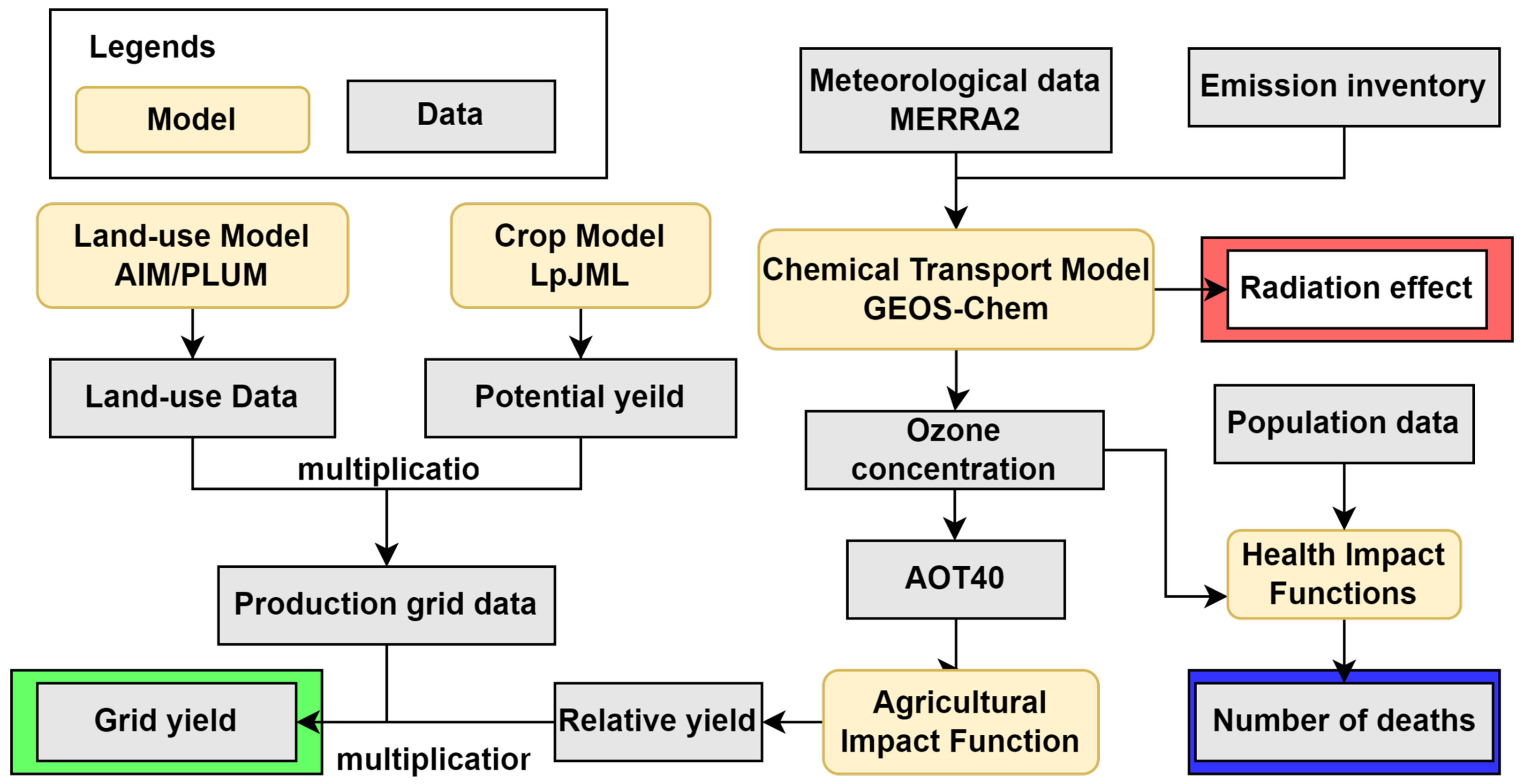

Figure 1 Research methodology frameworks of impact analysis

- GEOS-Chem version 13.2.0, a chemical transport model, was used to estimate concentrations and radiative effects for each substance.
- The Community Emissions Data System (CEDS) was used for the emissions inventory.
- Exposure indices and response functions, respectively, to assess health and agricultural impacts.

The following three scenarios were prepared to analyze the impact of NOx emission reductions

baseline:	Scenario where emission inventories are input with no specific reductions
NOx_rec50:	Scenario with 50% reduction in anthropogenic NOx emissions from all sectors
NOx_rec100:	Scenario with 100% reduction of anthropogenic NOx emissions from all sectors

RESULT

Fig.2 a) shows that the increase in radiative effects due to higher methane concentrations outweighed the reduction in ozone-derived radiative effects.

Fig.2 b) reflect the decrease in ozone concentrations in each region and the population exposed to the reduced concentrations.

Fig.3 c) reflects the changes in AOT40 for each scenario in the vicinity of land used for cultivation and cropland in each region, as well as the percentage of target crops in each region.

DISCUSSION AND CONCLUSION

- Our model showed that reducing all anthropogenic NOx emissions would reduce ozone-related deaths by 83.6% and ozone-related yield loss by 99.5%, while increasing the radiative effect by 8.3%.
- This indicates that measures to reduce NOx emissions are effective for solving air pollution problems but must also be used in conjunction with other greenhouse gas reduction measures.

a) Difference in radiative effect for each scenario

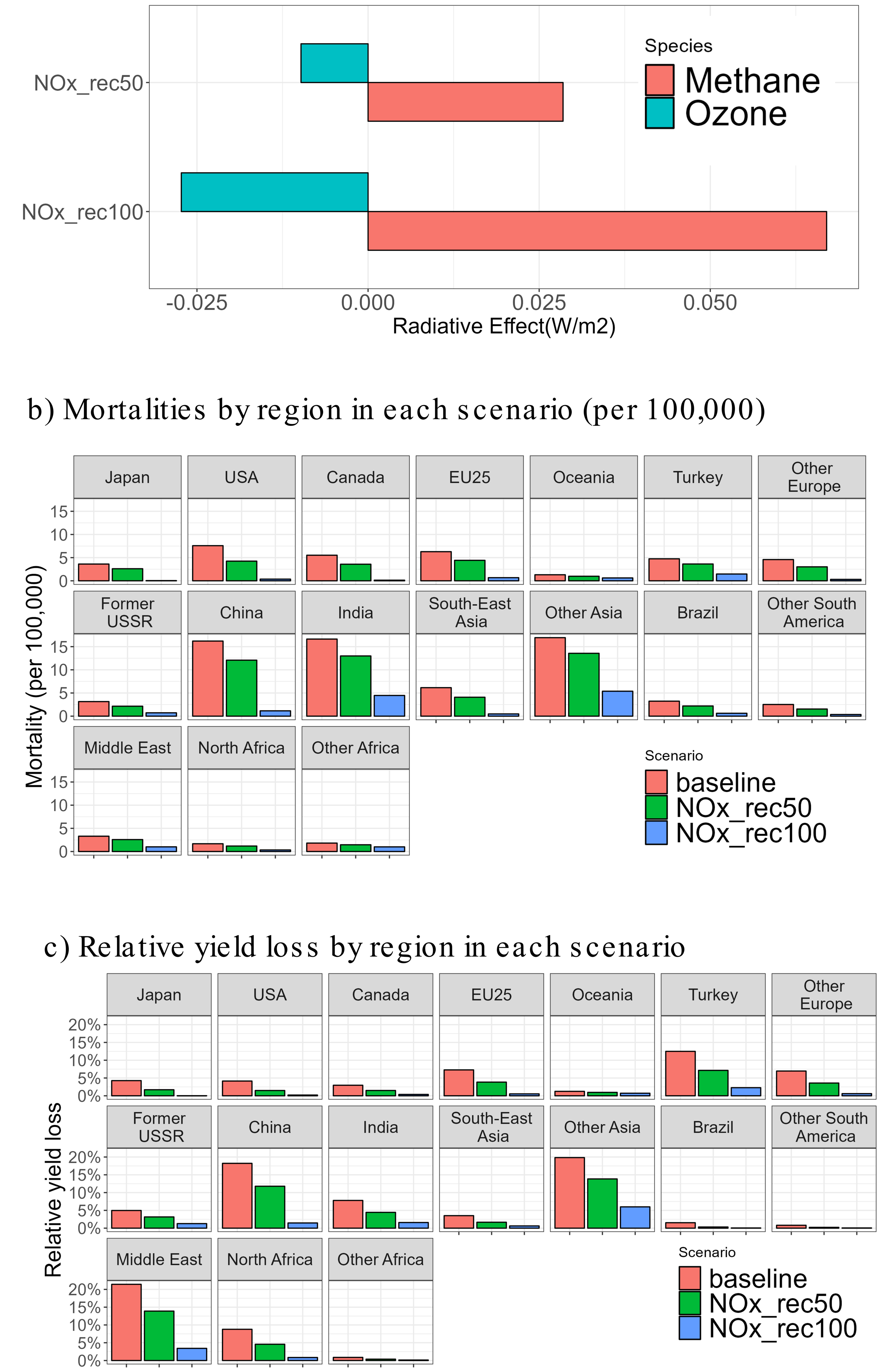

Figure 2 a) Difference from the baseline of radiative effect calculated in GEOS-Chem. b) Mortalities per 100,000 people per region. c) Relative yield loss per region for the scenarios assessed in this study.