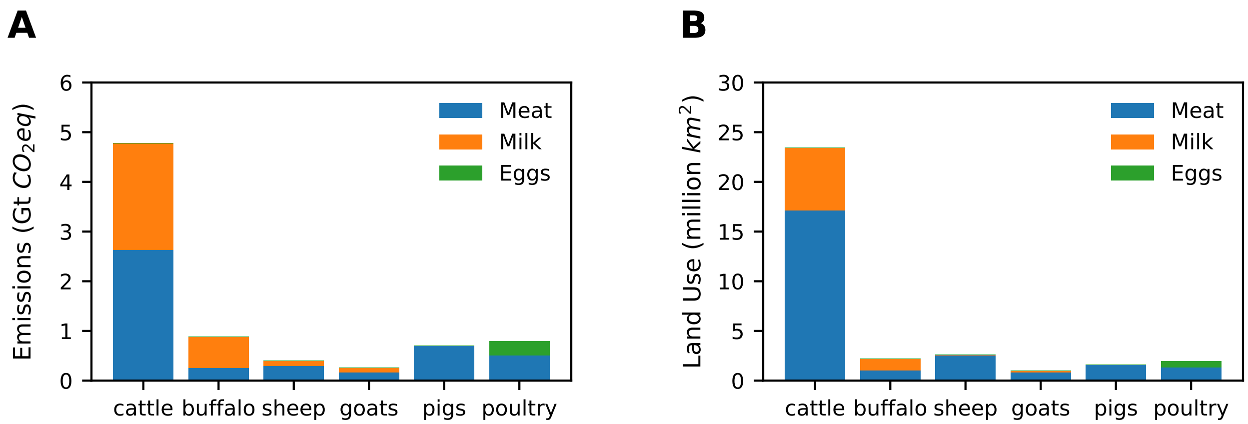

Figure 1. Global emissions and land use footprints of animal agriculture.

Total CO_2 equivalent emissions (A) assembled from species, product and country-specific production data from FAOSTAT for 2019 and species, product, region and greenhouse-gas specific emissions data from GLEAM (MacLeod et al., 2018), using CO_2 equivalents of 34 for CH_4 and 298 for N_2O. Land use (B) assembled from species, product and country-specific production data from FAOSTAT for 2019 and species and product specific land use data from (Poore and Nemecek, 2018).

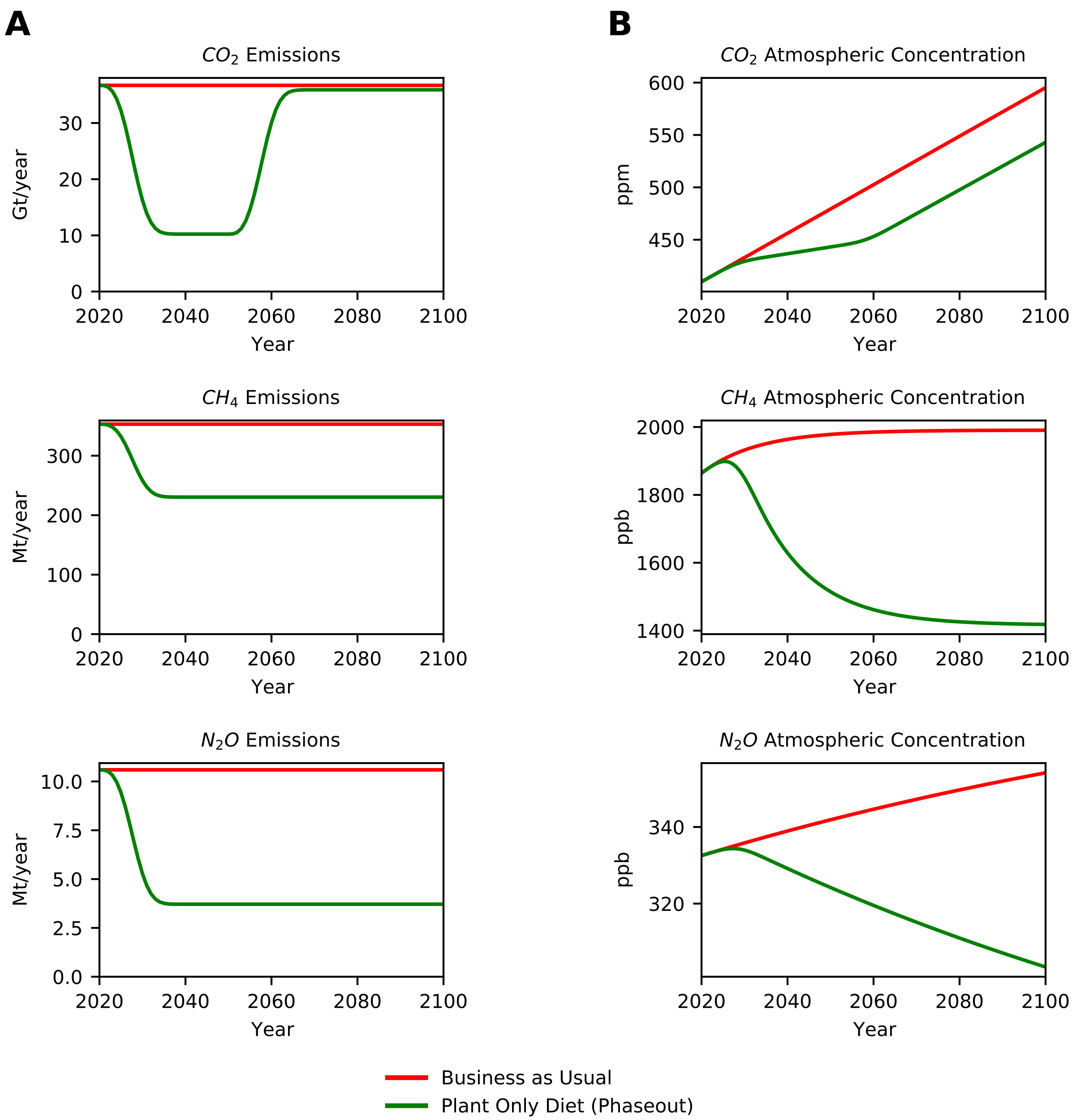

Figure 2. Impact of 15 year phaseout of animal agriculture on atmospheric greenhouse gas levels.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for Business as Usual (red) and Plant Only Diet (green) assuming a 15 year transition to new diet. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario.

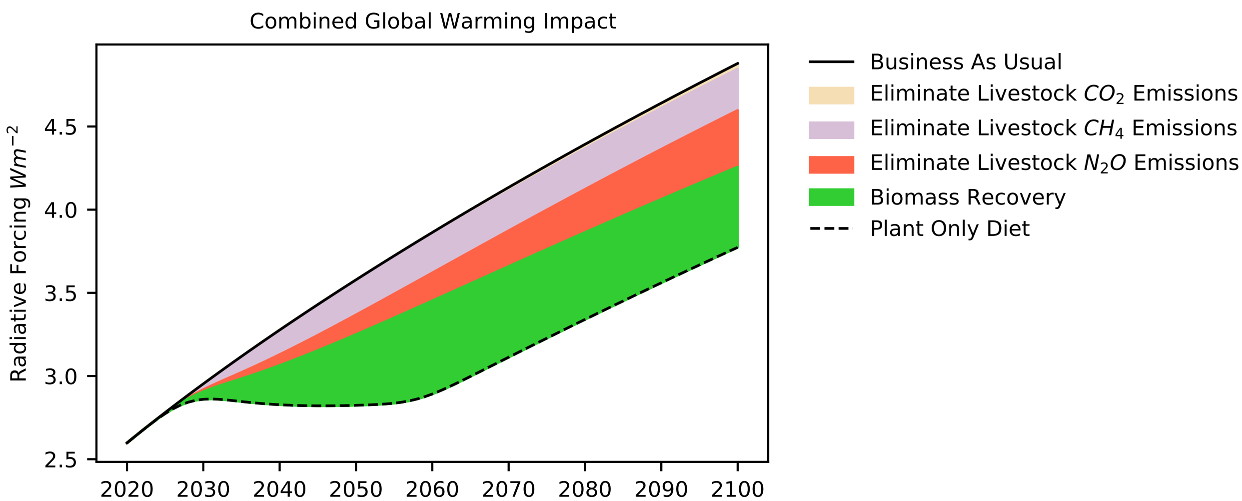

Figure 3. Phaseout of animal agriculture reduces global warming impact of atmosphere.

Effect of eliminating emissions linked to animal agriculture and of biomass recovery on land currently used in animal agriculture on Radiative Forcing (RF), a measure of the instantaneous warming potential of the atmosphere. RF values computed from atmospheric concentrations in by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011) with adjustment for gasses other than CO_2, CH_4 and N_2O as described in text.

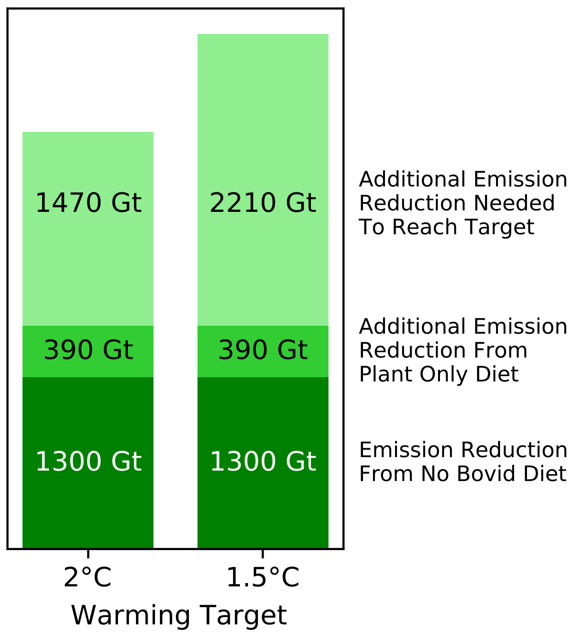

Figure 4. Impact of dietary transitions in curtailing global warming.

Using projected CH_4 and N_2O levels in 2100 under business as usual diet as a baseline for RF calculation, we computed the CO_2 reductions necessary to reduce RF from the business as usual diet level of RF=4.88 to the bovid-free diet level of RF=4.05 (1300 Gt CO_2), the plant-only diet level of RF=3.77 (1690 Gt CO_2), the 2.0˚C global warming target of RF=2.6 (3160 Gt CO_2) and the 1.5˚C global warming target of RF=1.9 (3900 Gt CO_2). For this analysis we used a corrected RF that accounts for the absence of other gases in our calculation by training a linear regression model on published MAGICC6 output to estimate from CO_2, CH_4 and N_2O levels the residual RF impact of other gases.

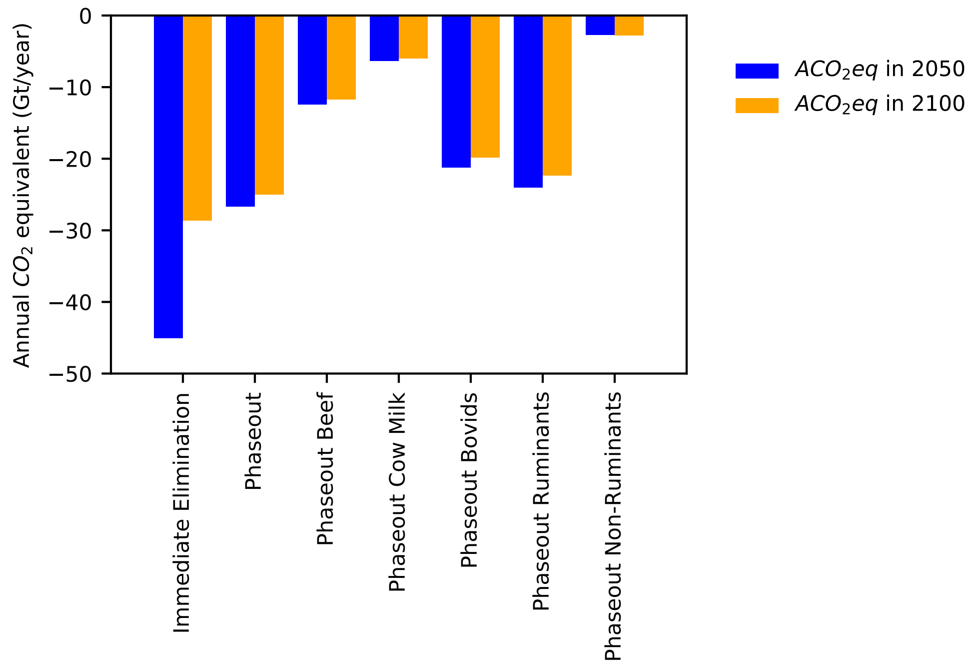

Figure 5. Annual CO_2 equivalents (ACO_2eq) of dietary scenarios

For each scenario we calculated the constant annual reduction in CO_2 emissions starting in 2021 that would produce the same cumulative radiative forcing as the scenario in the period from from 2021 to 2050 (blue bars), or from 2021 to 2100 (orange bars).

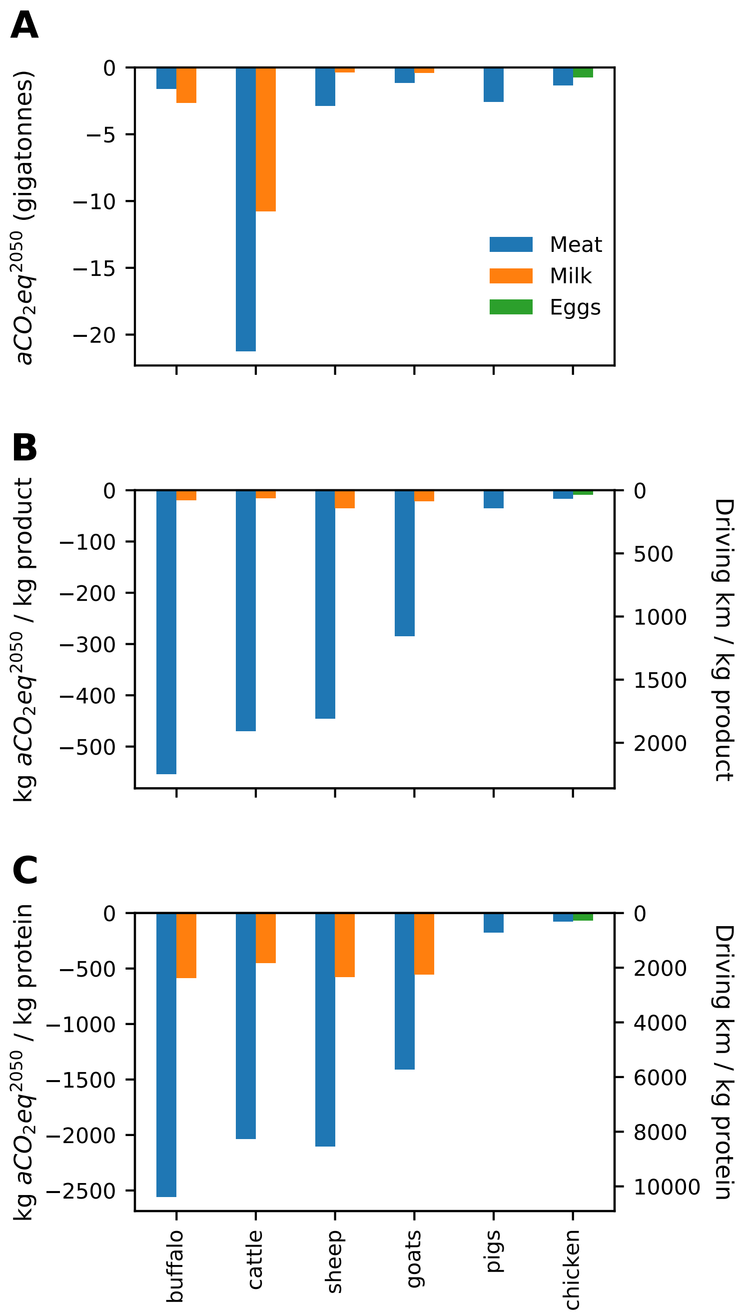

Figure 6. Emission equivalents of livestock species through 2050.

We calculated the (A) total annualized CO_2 equivalents through 2050, aCO_2eq^{2050}, for all tracked animal products, and the aCO_2eq^{2050} per unit production (B) or per unit protein (C). For (B) and (C) we also convert the values to driving equivalents, assuming cars that get 10.6 km per liter of gas (the average of new cars in the United States).

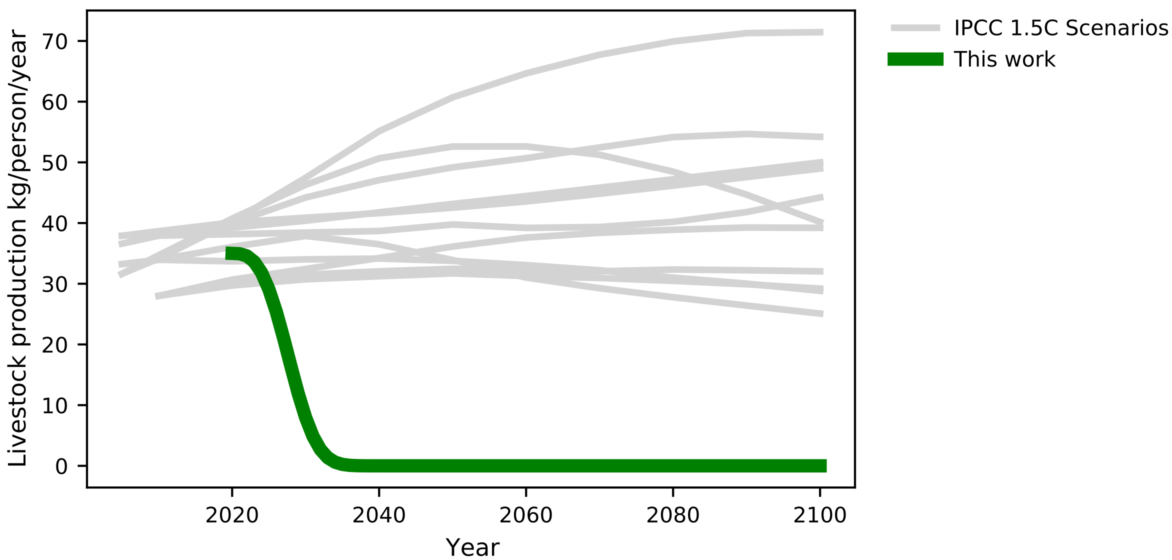

Figure 7. Projected per capita livestock production in SSP/IAM RF 1.9 scenarios.

We downloaded data for the Shared Socioeconomic Pathways (SSPs) (Riahi et al., 2017) from the SSP database (Version 2.0; last updated December 2018), and plot here the inferred per capita livestock production for scenarios meant to reach an RF target of 1.9 in 2100. While there is widespread acknowledgement of the impact that ongoing animal agriculture has on the climate, it is notable that most of these scenarios, which represent the most aggressive proposed mitigation strategies in this modeling framework, anticipate an increase in per capita livestock consumption, and none anticipate any significant reduction below current levels, in contrast to the complete elimination we propose here.

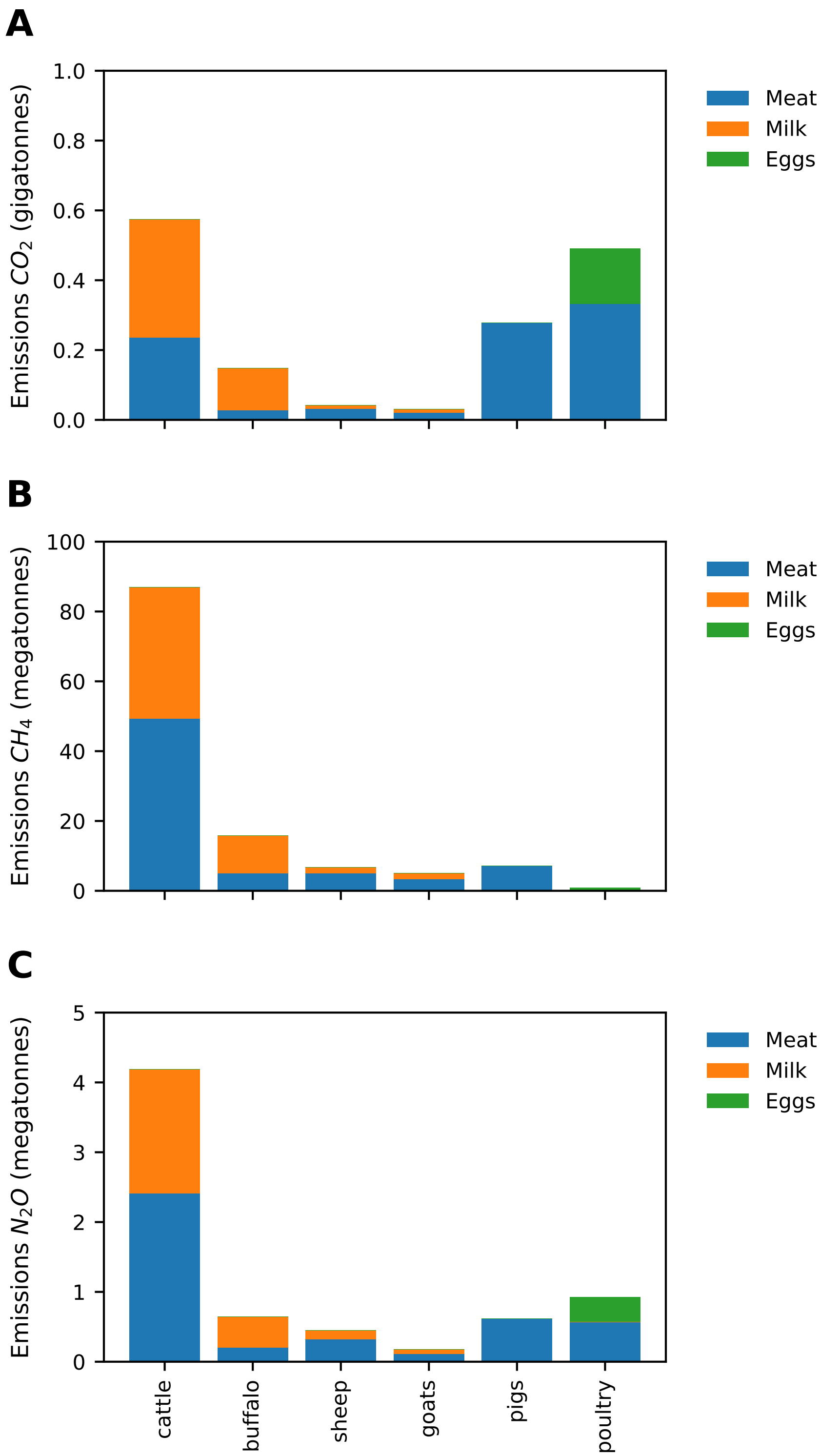

Figure 1-S1. Gas-specific emission footprints of animal agriculture.

Assembled from species, product and country-specific production data from FAOSTAT for 2018 and species, product, region and greenhouse gas-specific emissions data from GLEAM (MacLeod et al., 2018).

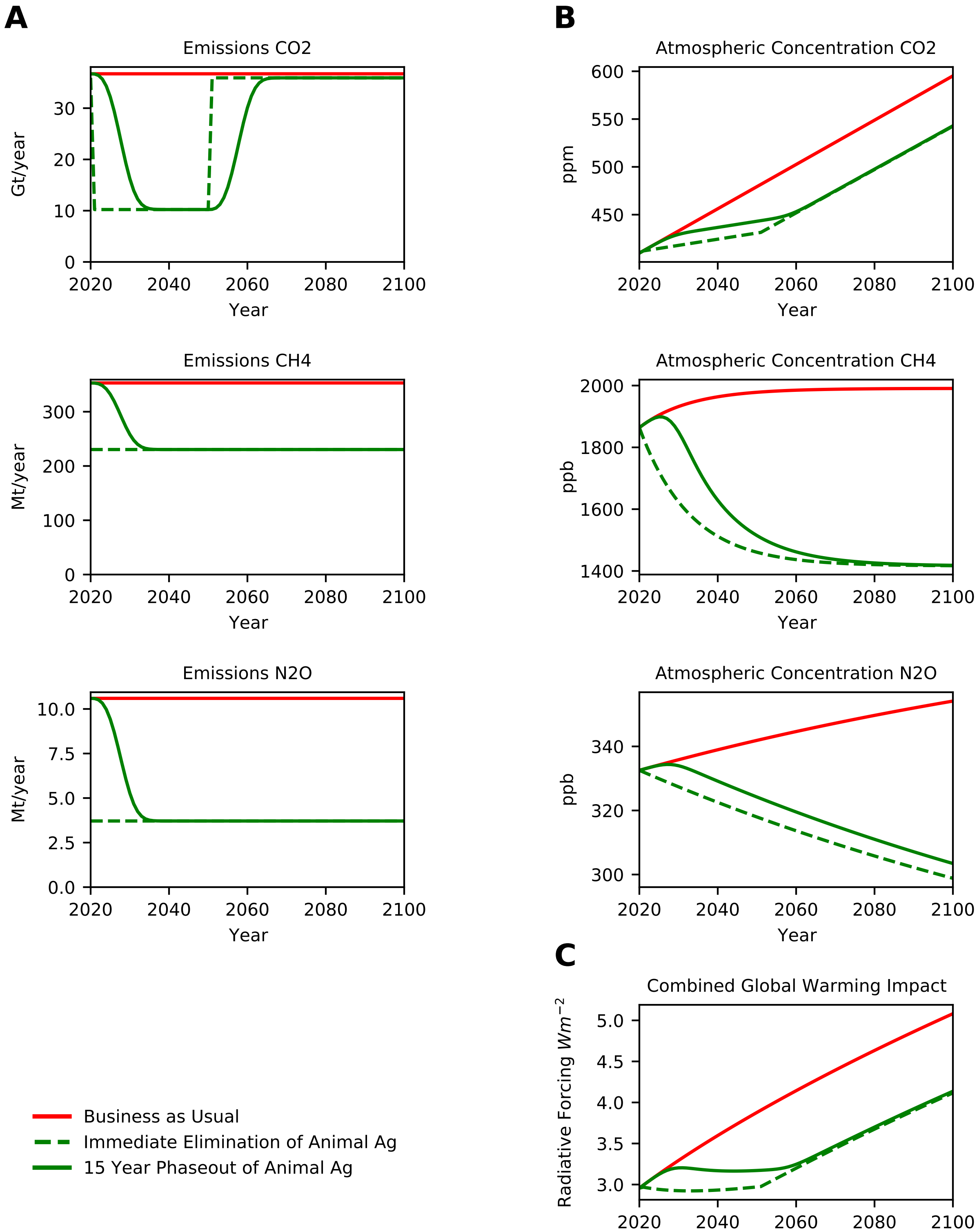

Figure 2-S1. Phaseout compared to Elimination.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

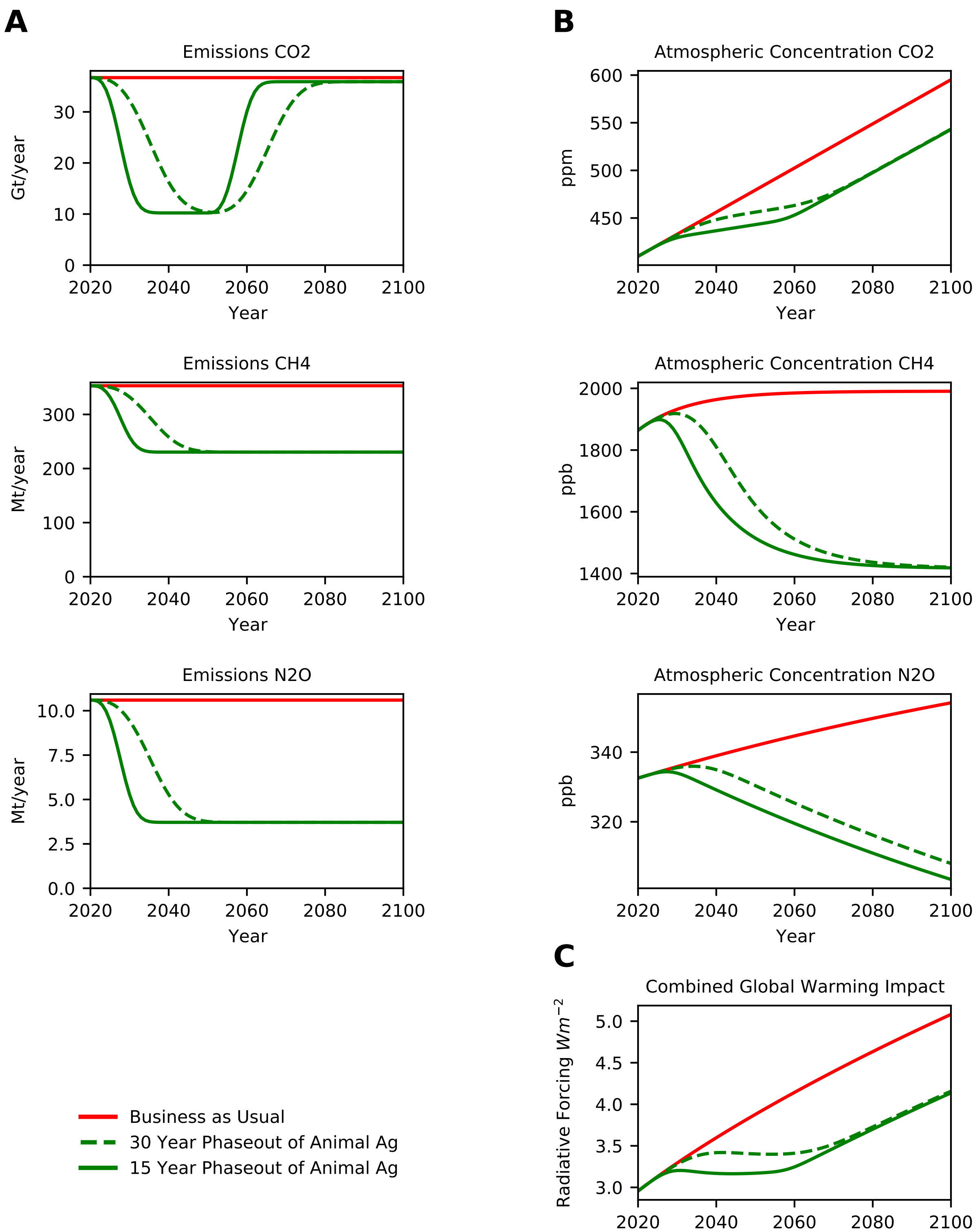

Figure 2-S2. Effects of Slower Phaseout.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

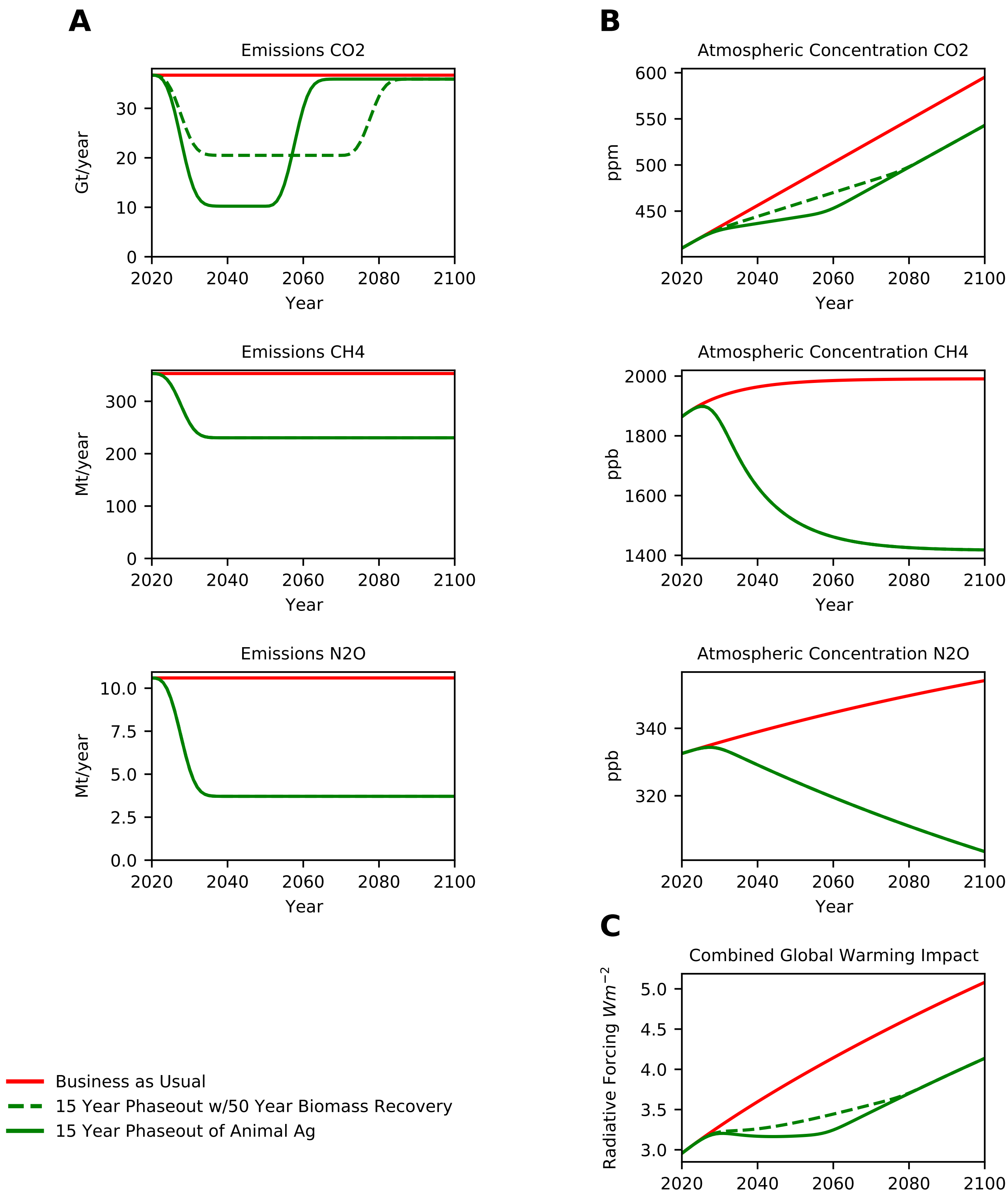

Figure 2-S3. Effects of Slower Biomass Recovery.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

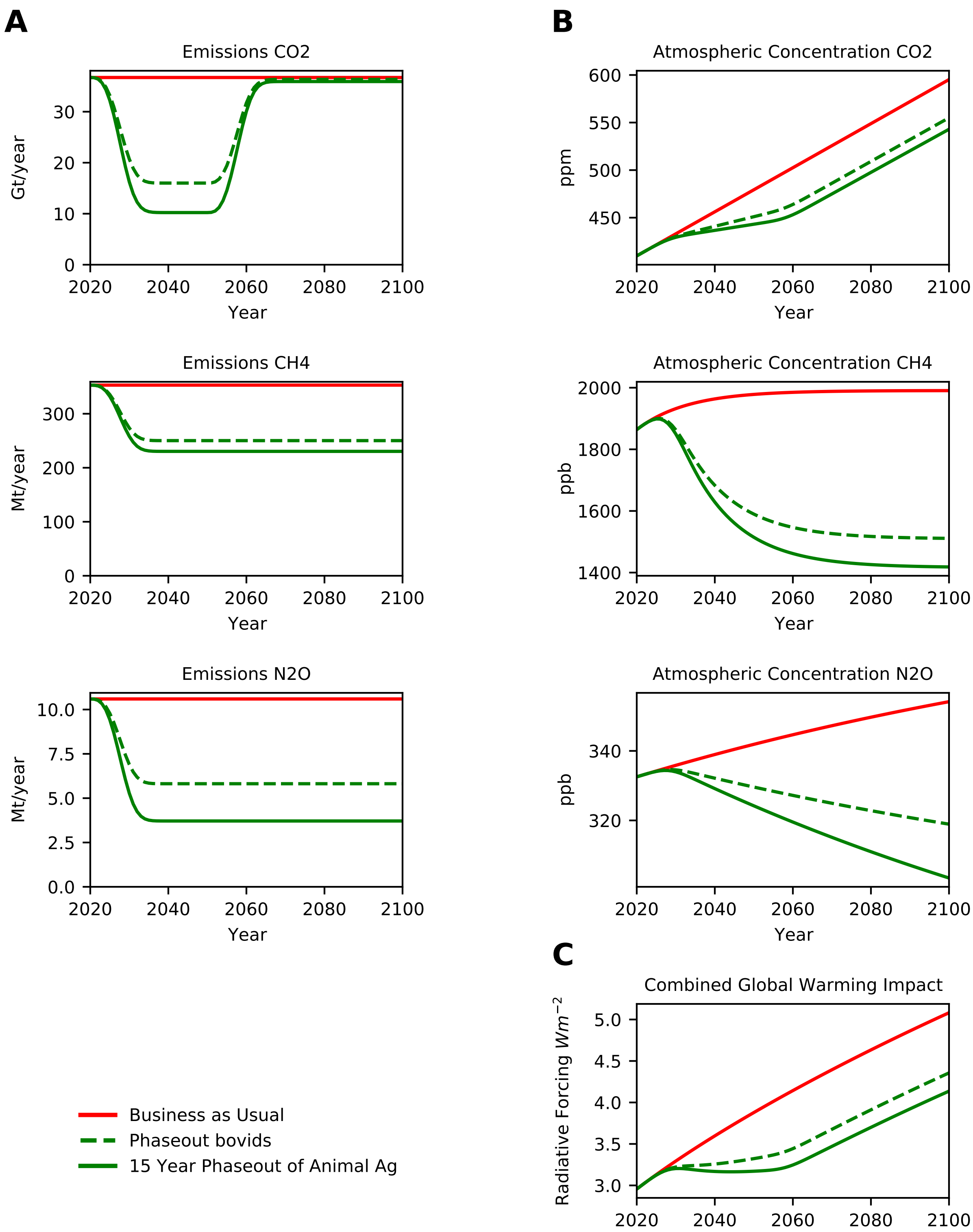

Figure 2-S4. Effects of Eliminating Bovids.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

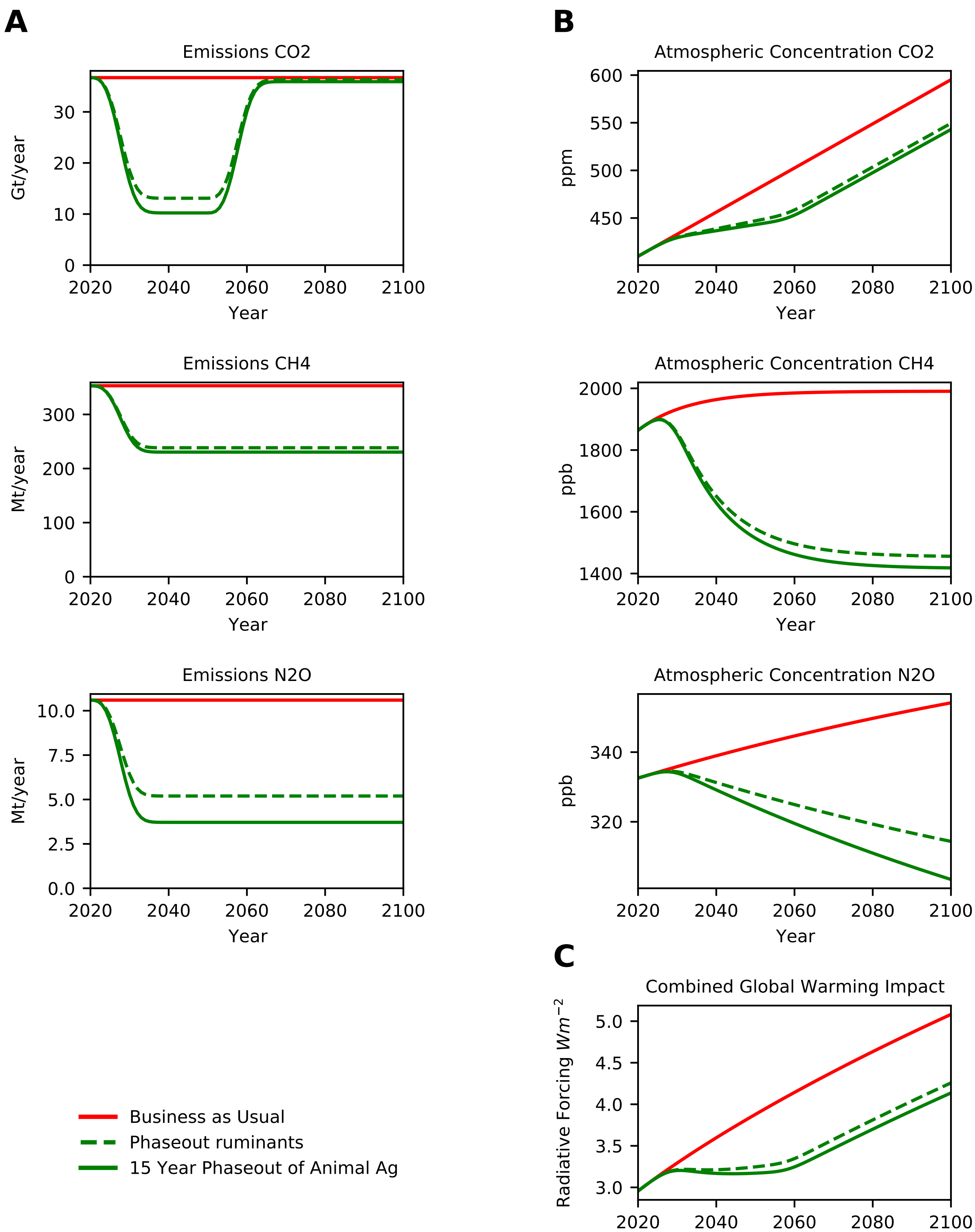

Figure 2-S5. Effects of Eliminating Ruminants.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

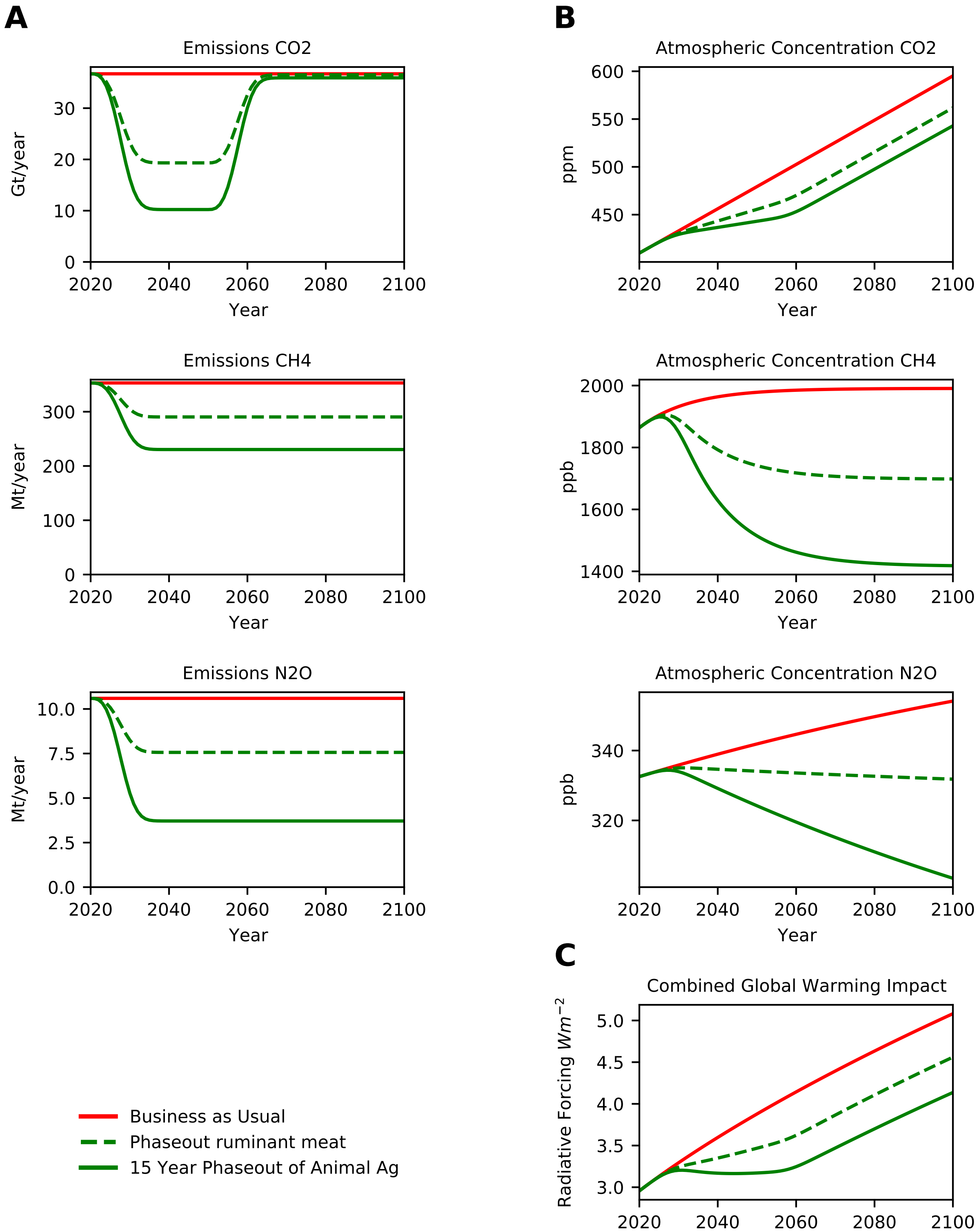

Figure 2-S6. Effects of Eliminating Ruminant Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

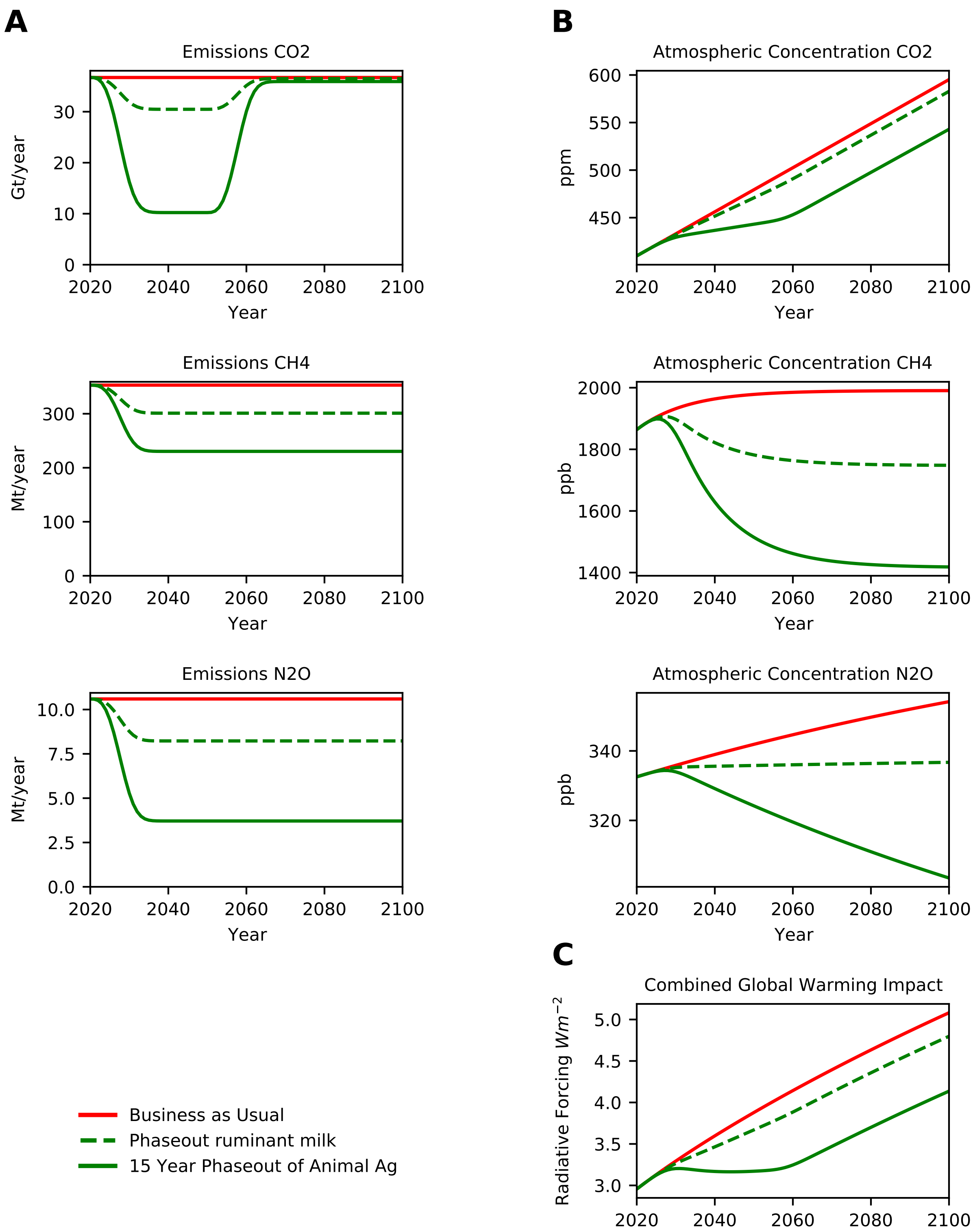

Figure 2-S7. Effects of Eliminating Ruminant Milk.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

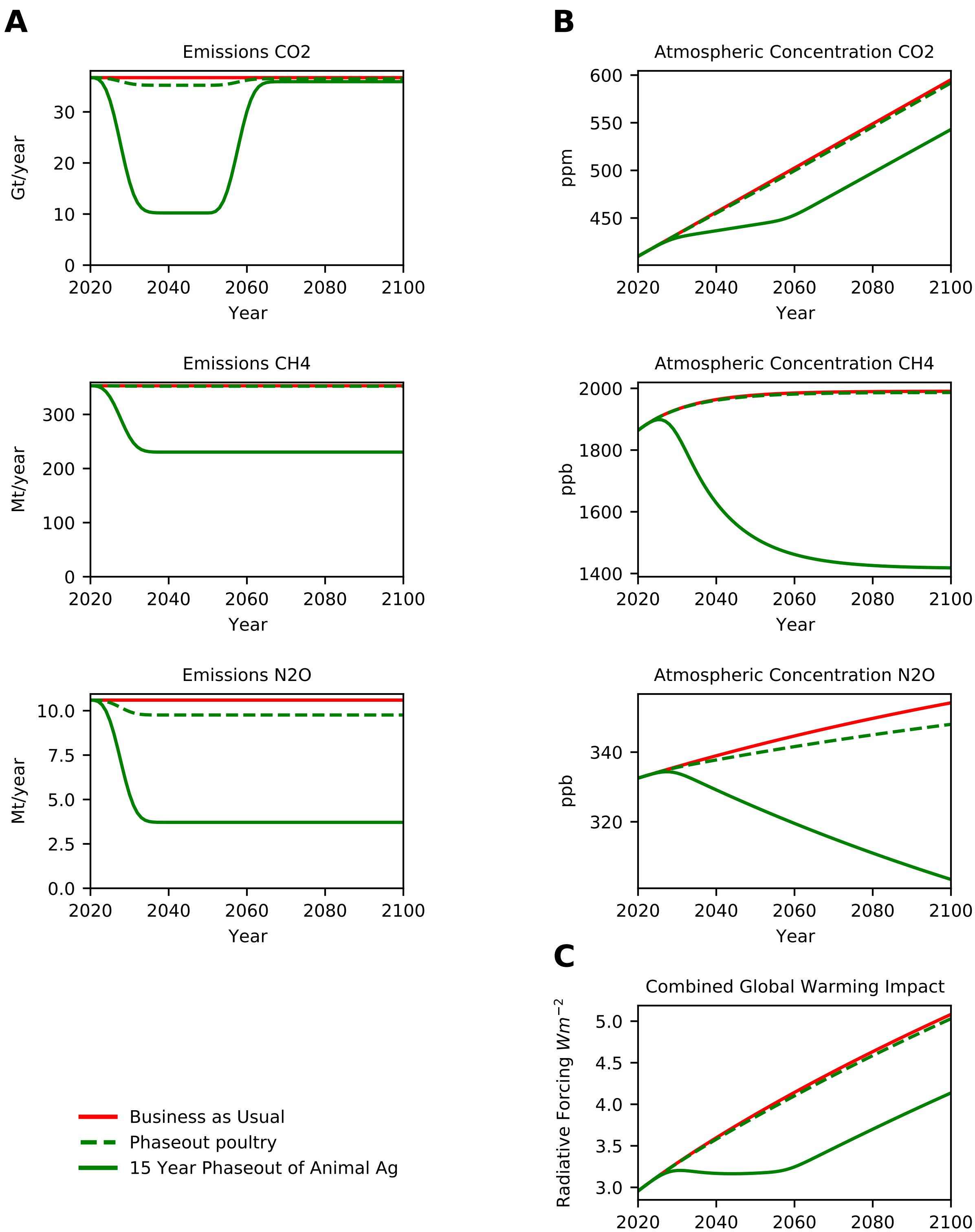

Figure 2-S8. Effects of Eliminating Poultry.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

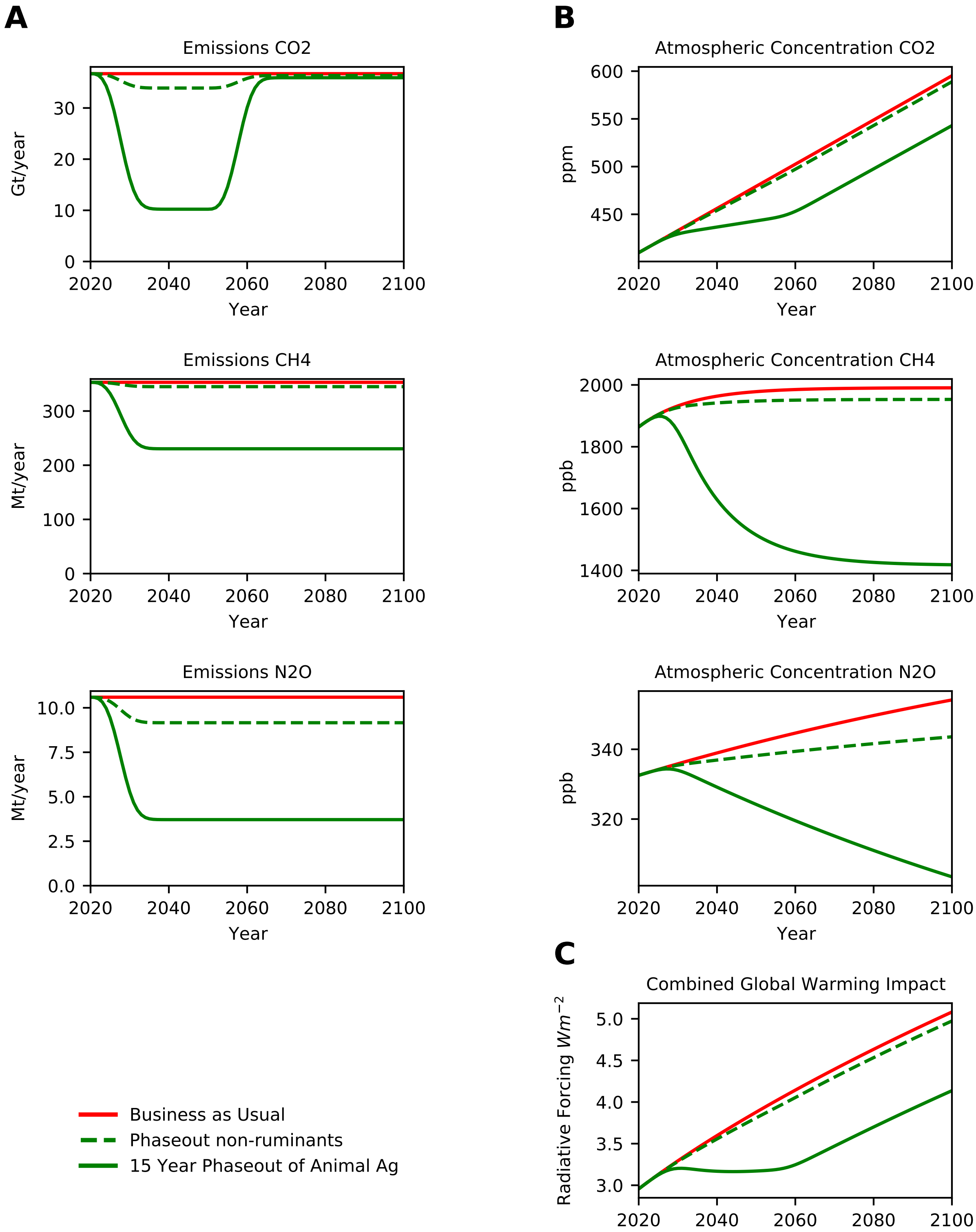

Figure 2-S9. Effects of Eliminating Non-Ruminants.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

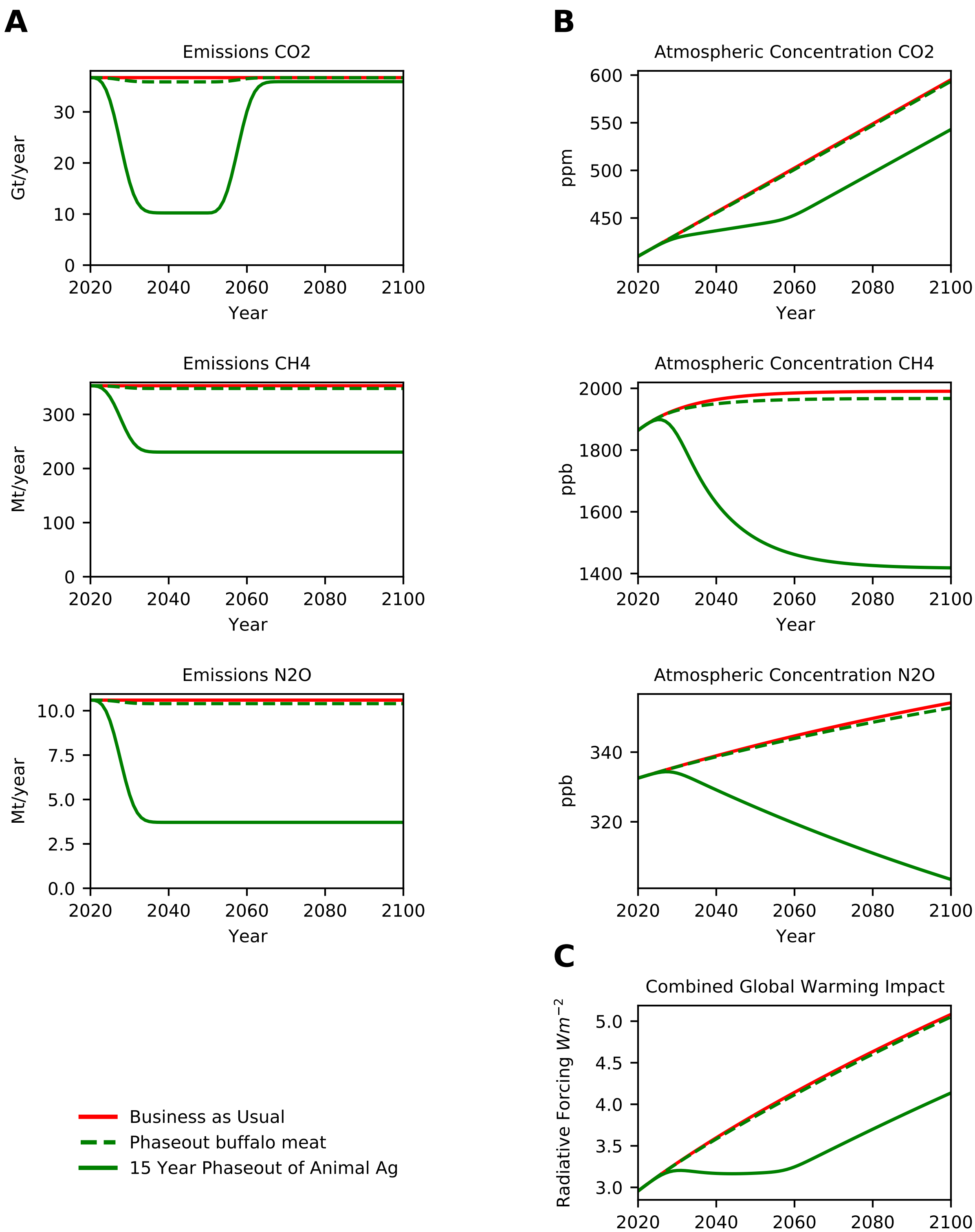

Figure 2-S10. Effects of Eliminating Buffalo Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

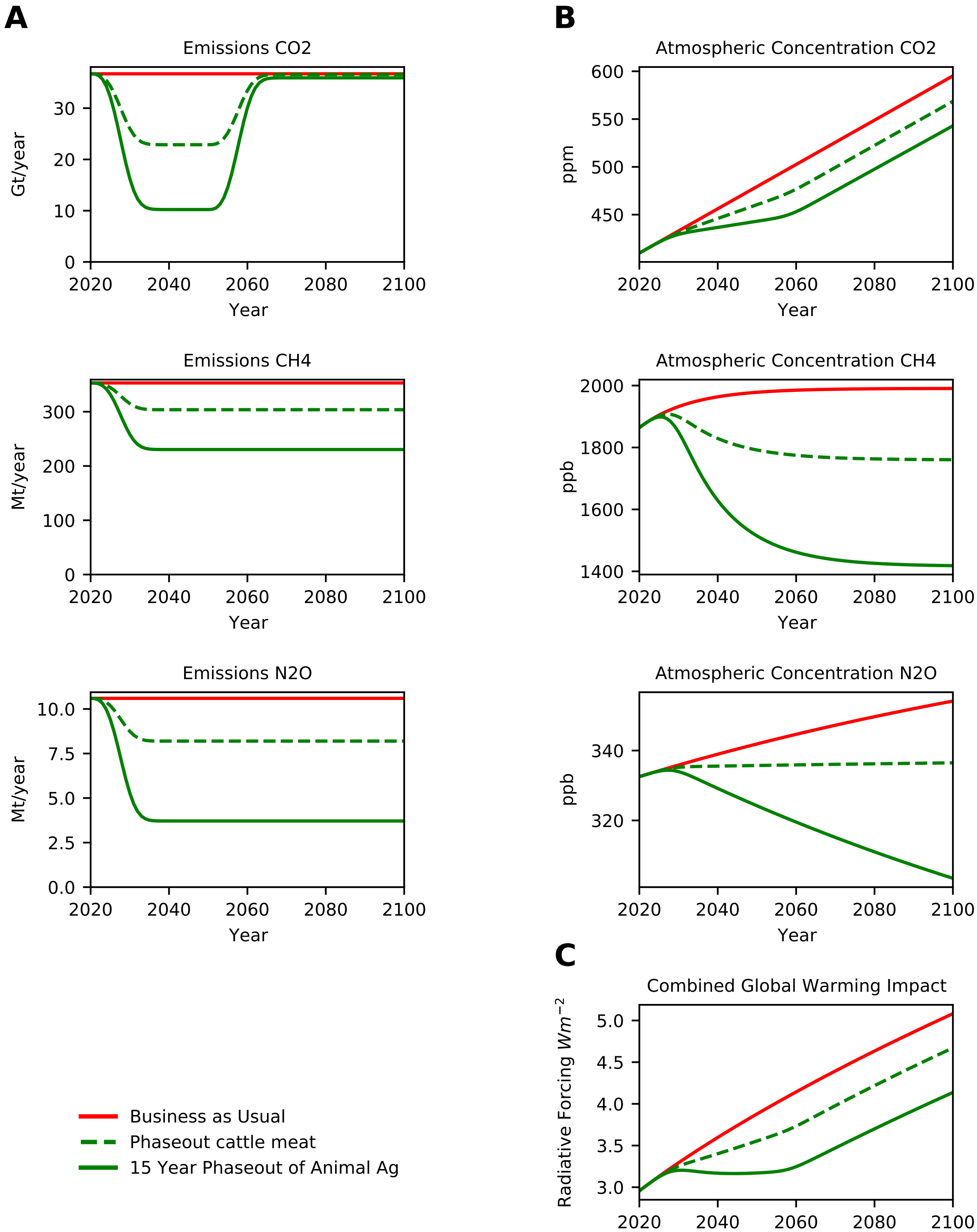

Figure 2-S11. Effects of Eliminating Cattle Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

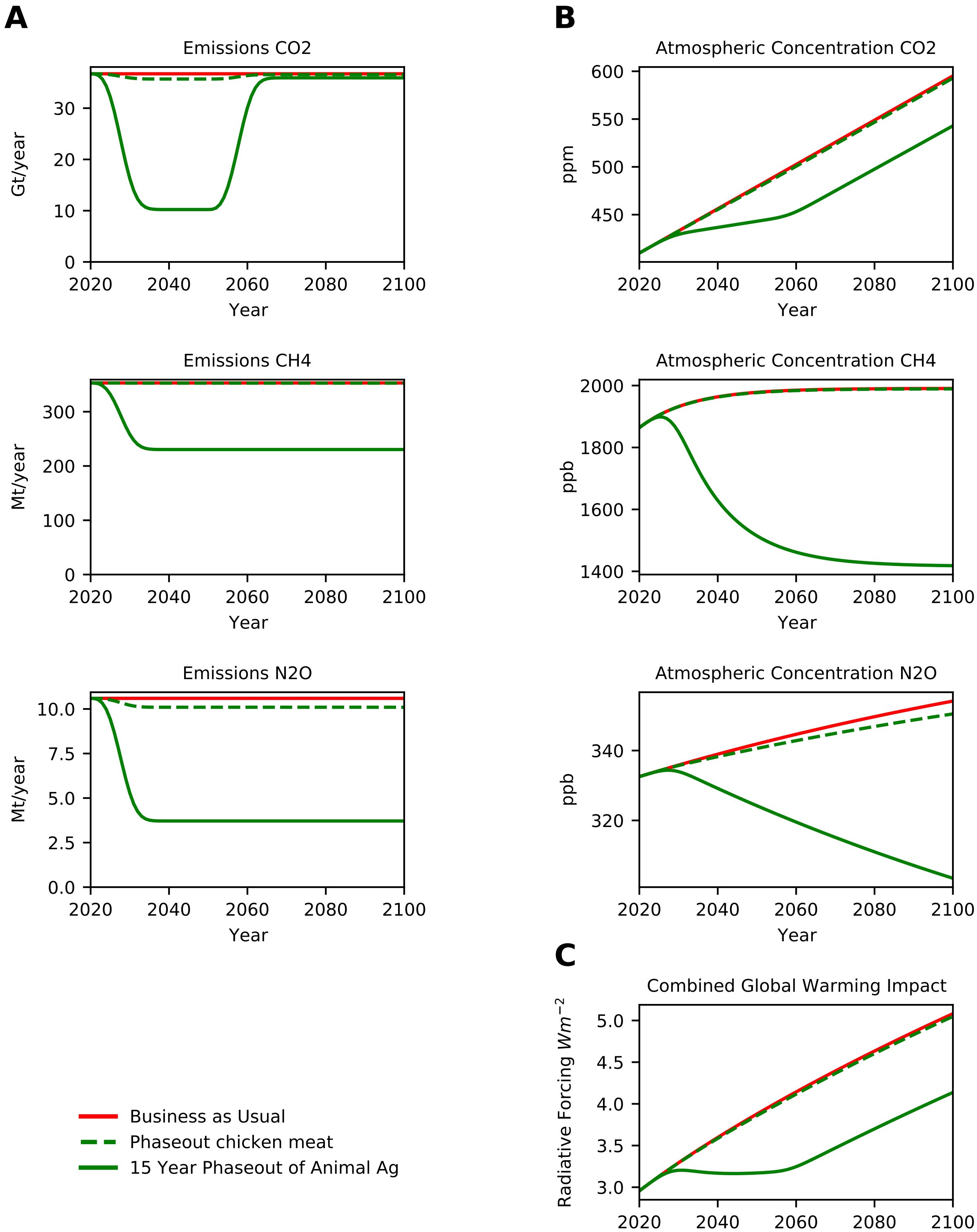

Figure 2-S12. Effects of Eliminating Chicken Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

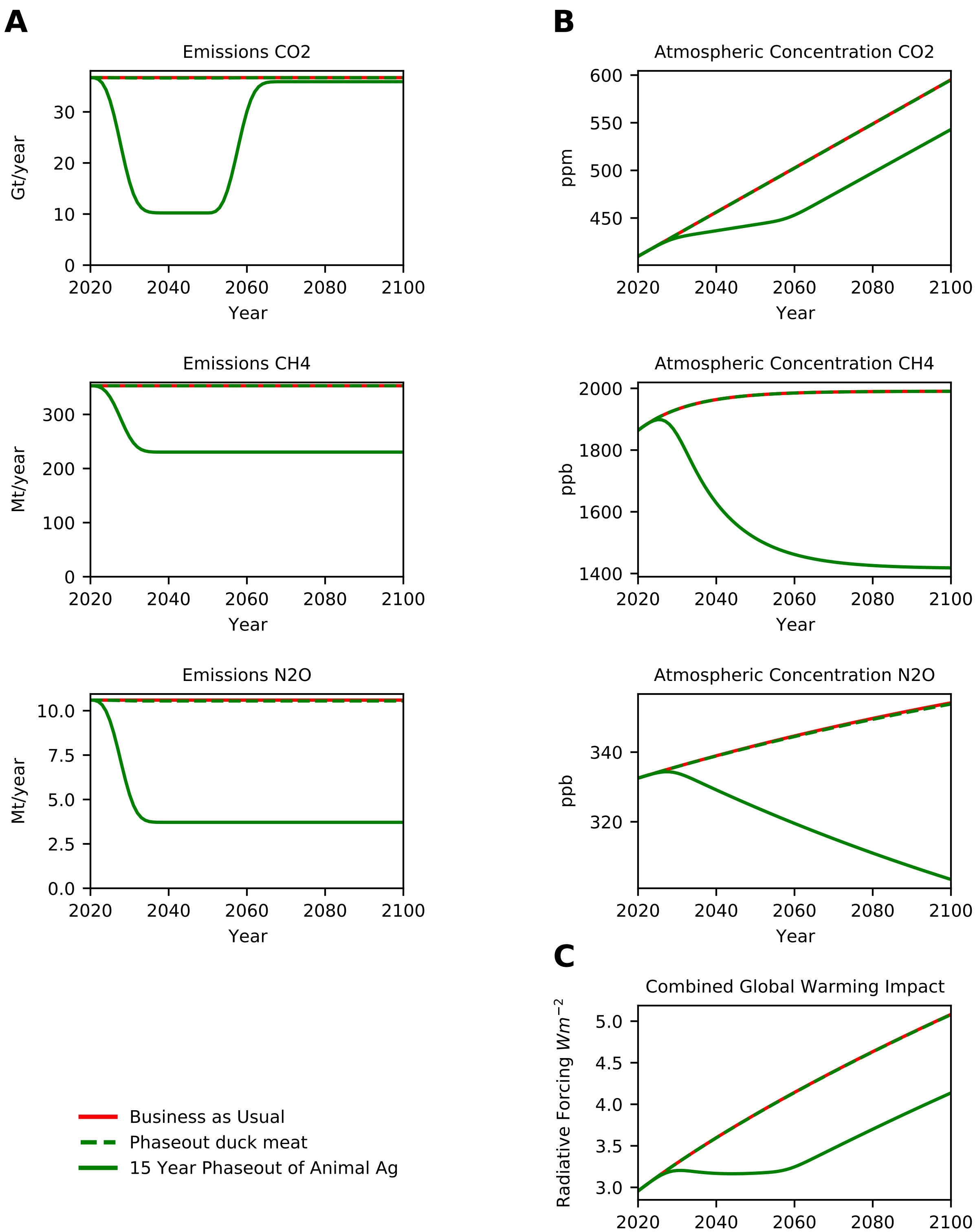

Figure 2-S13. Effects of Eliminating Duck Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

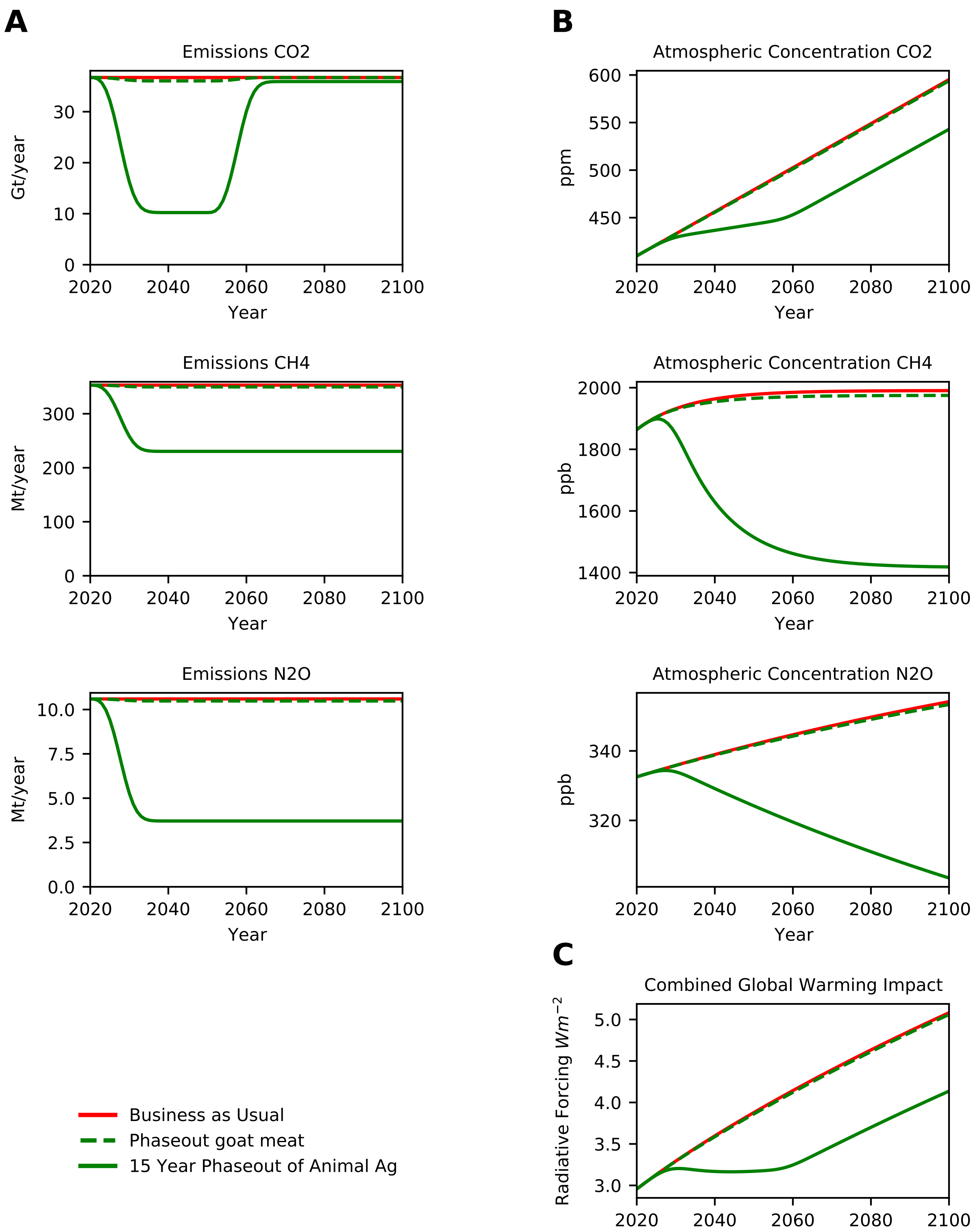

Figure 2-S14. Effects of Eliminating Goat Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

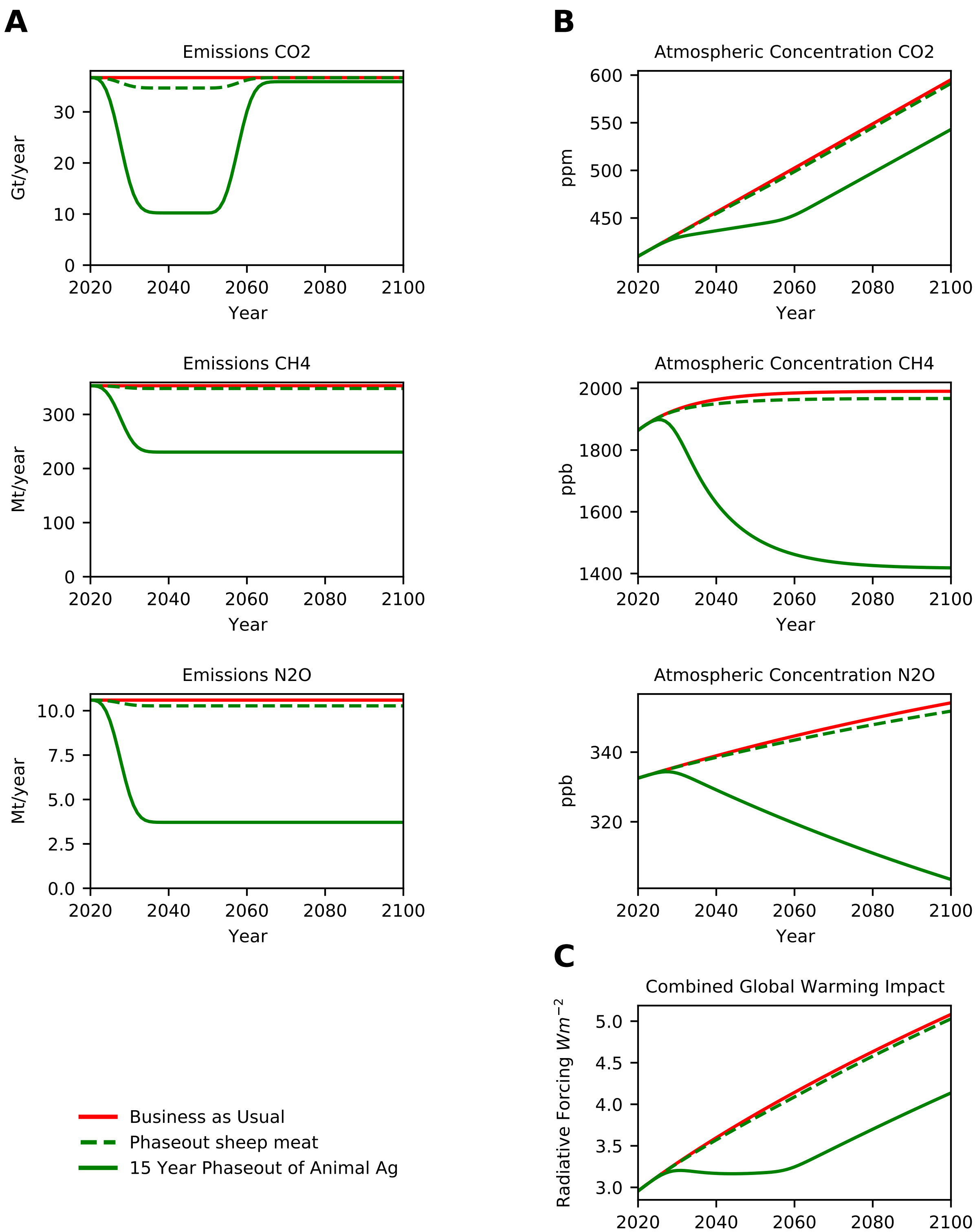

Figure 2-S15. Effects of Eliminating Sheep Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

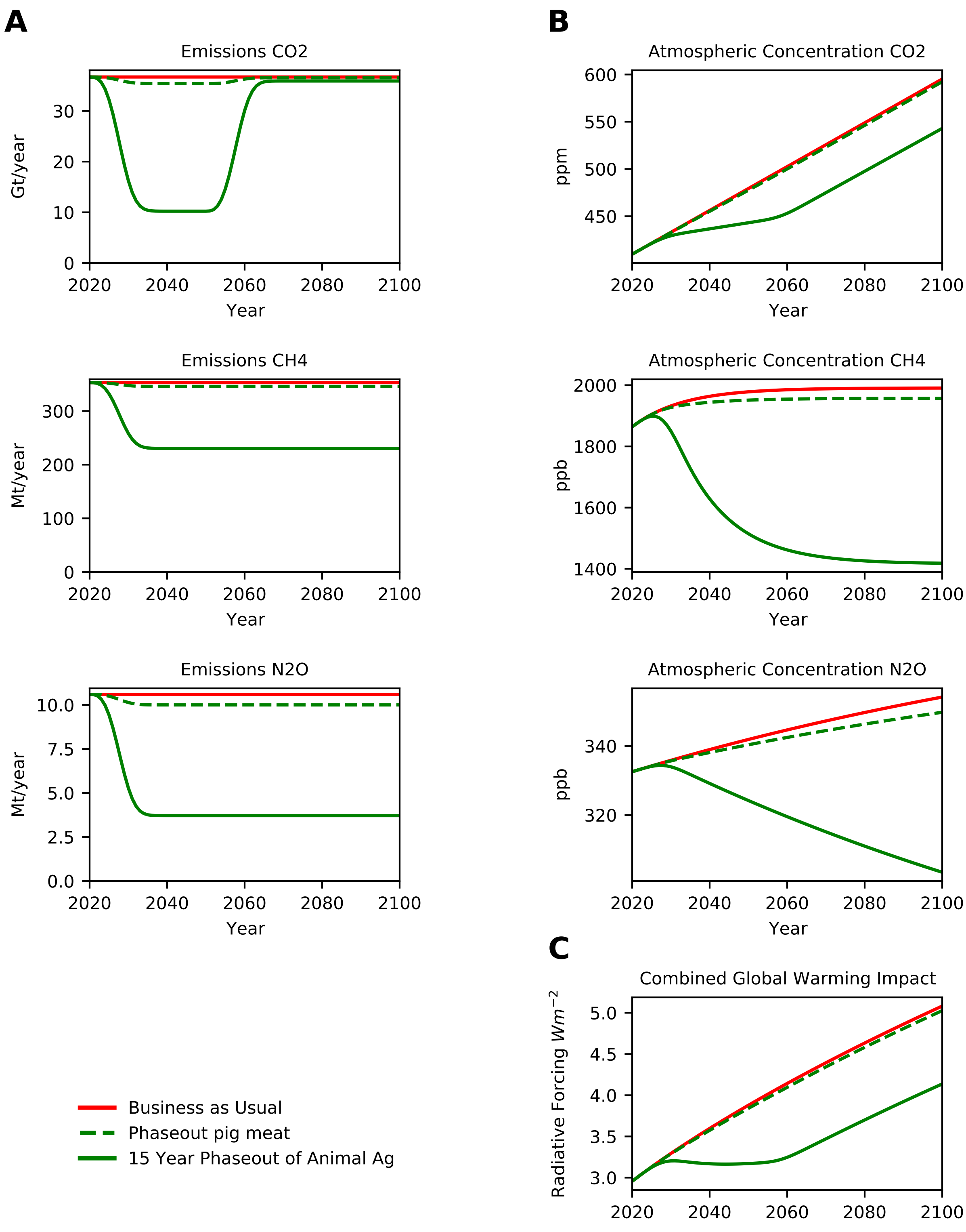

Figure 2-S16. Effects of Eliminating Pig Meat.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

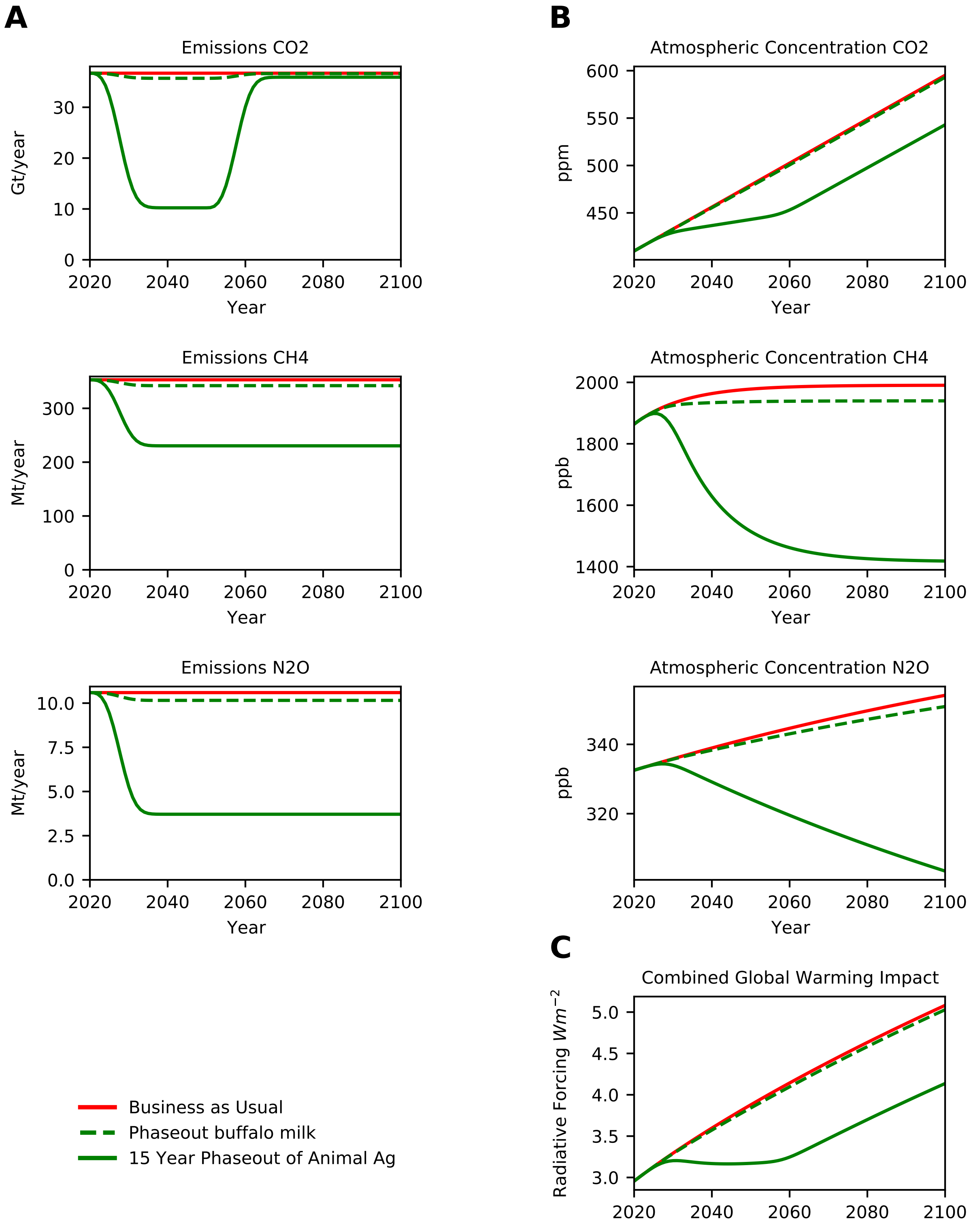

Figure 2-S17. Effects of Eliminating Buffalo Milk.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

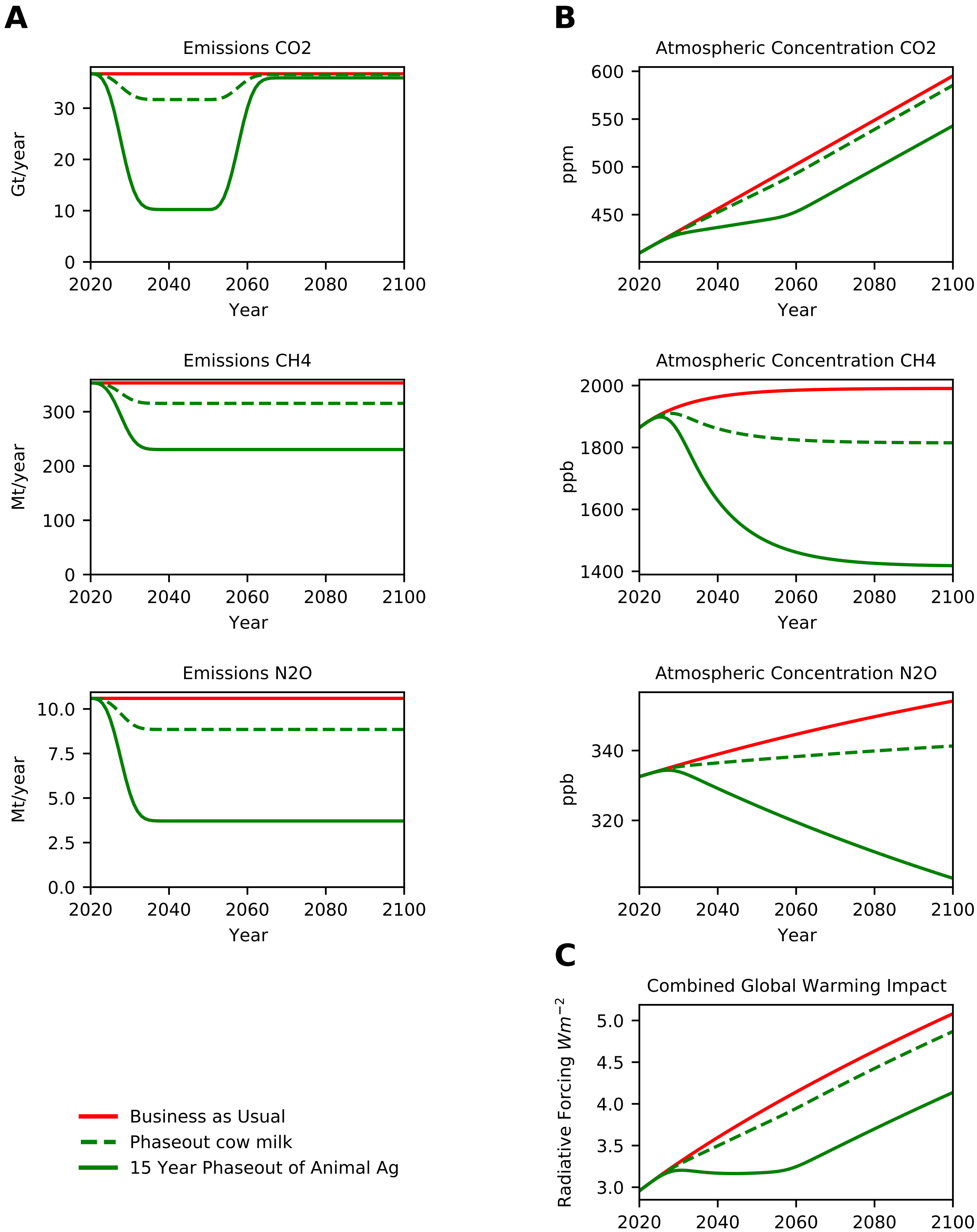

Figure 2-S18. Effects of Eliminating Cow Milk.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

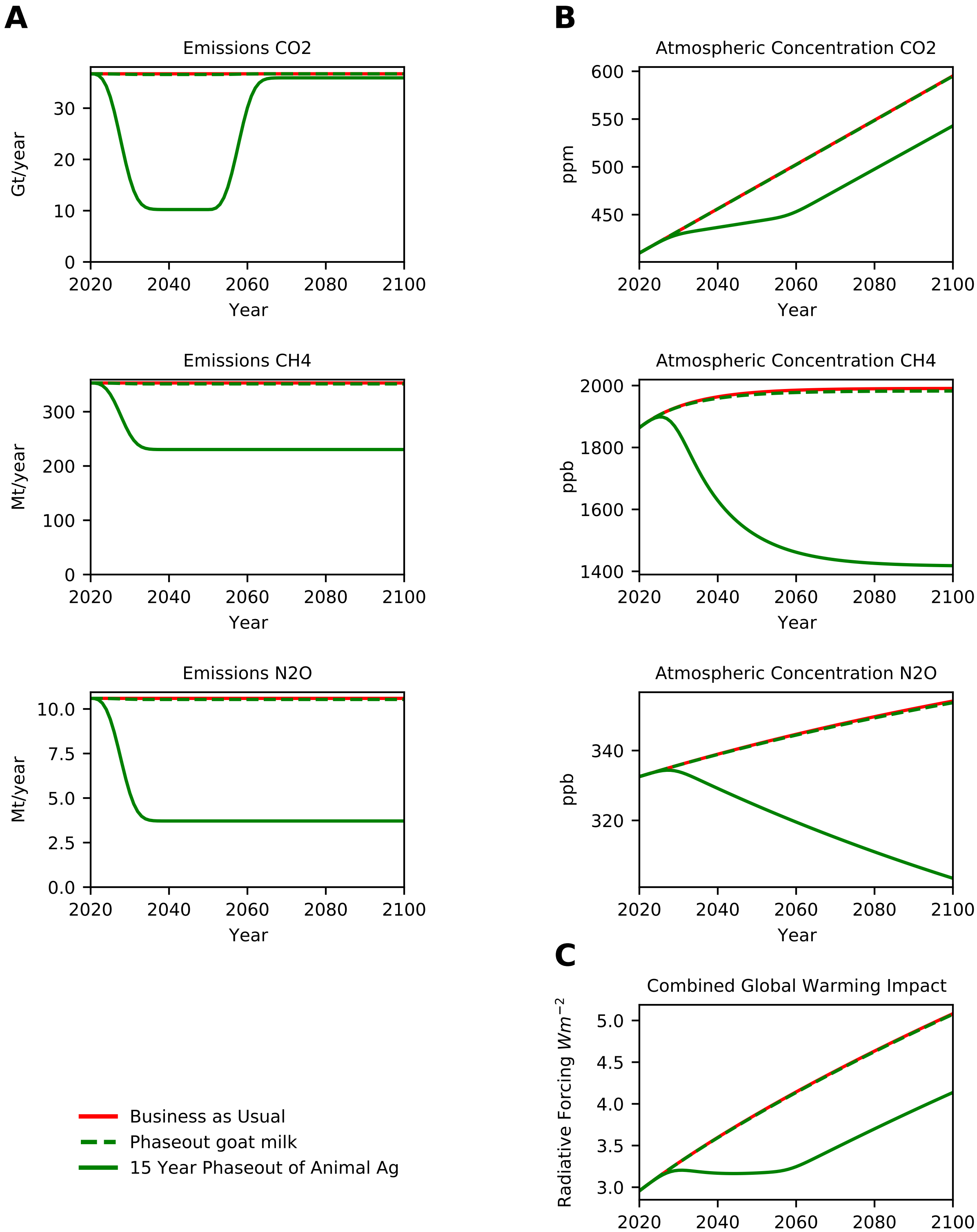

Figure 2-S19. Effects of Eliminating Goat Milk.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

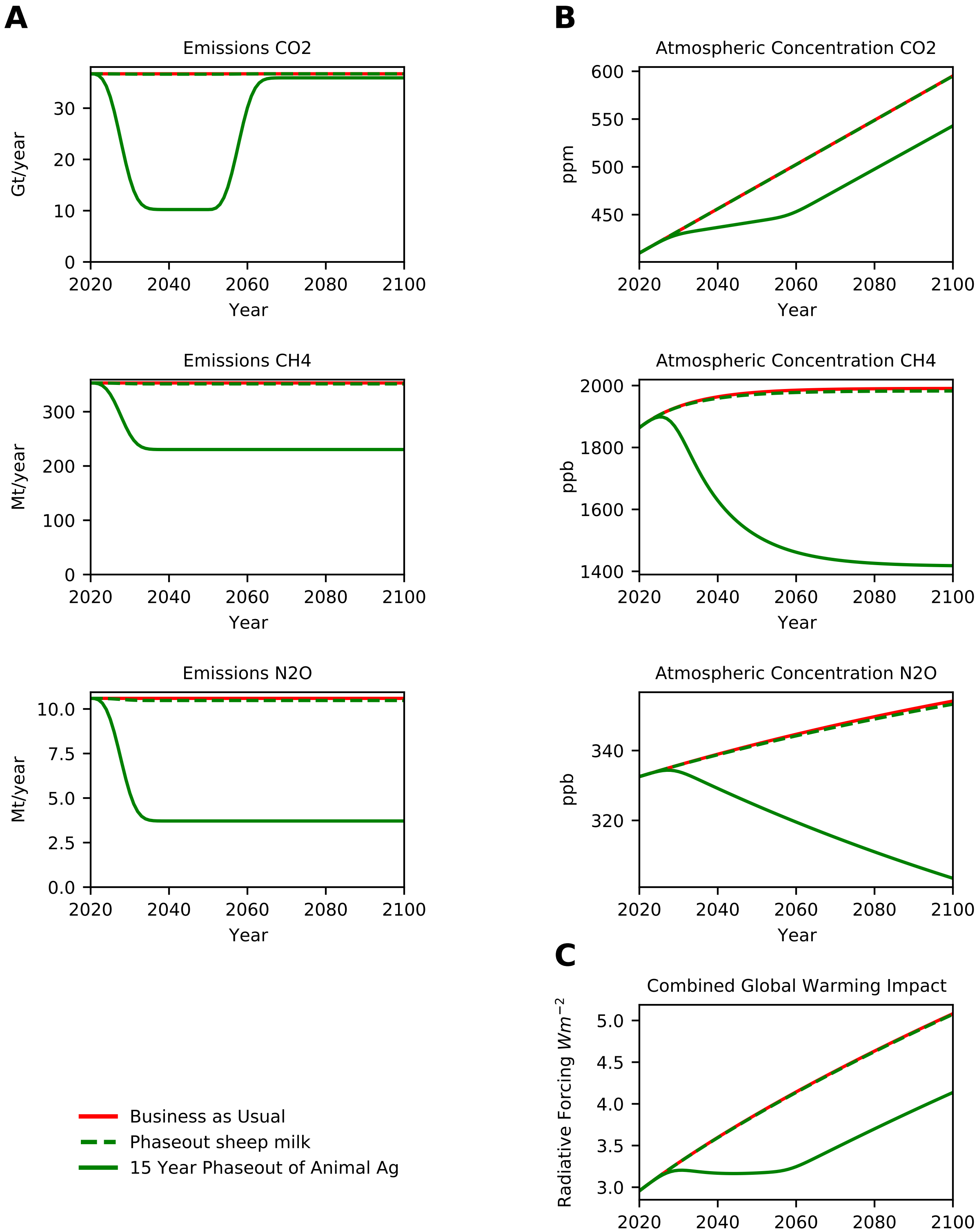

Figure 2-S20. Effects of Eliminating Sheep Milk.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

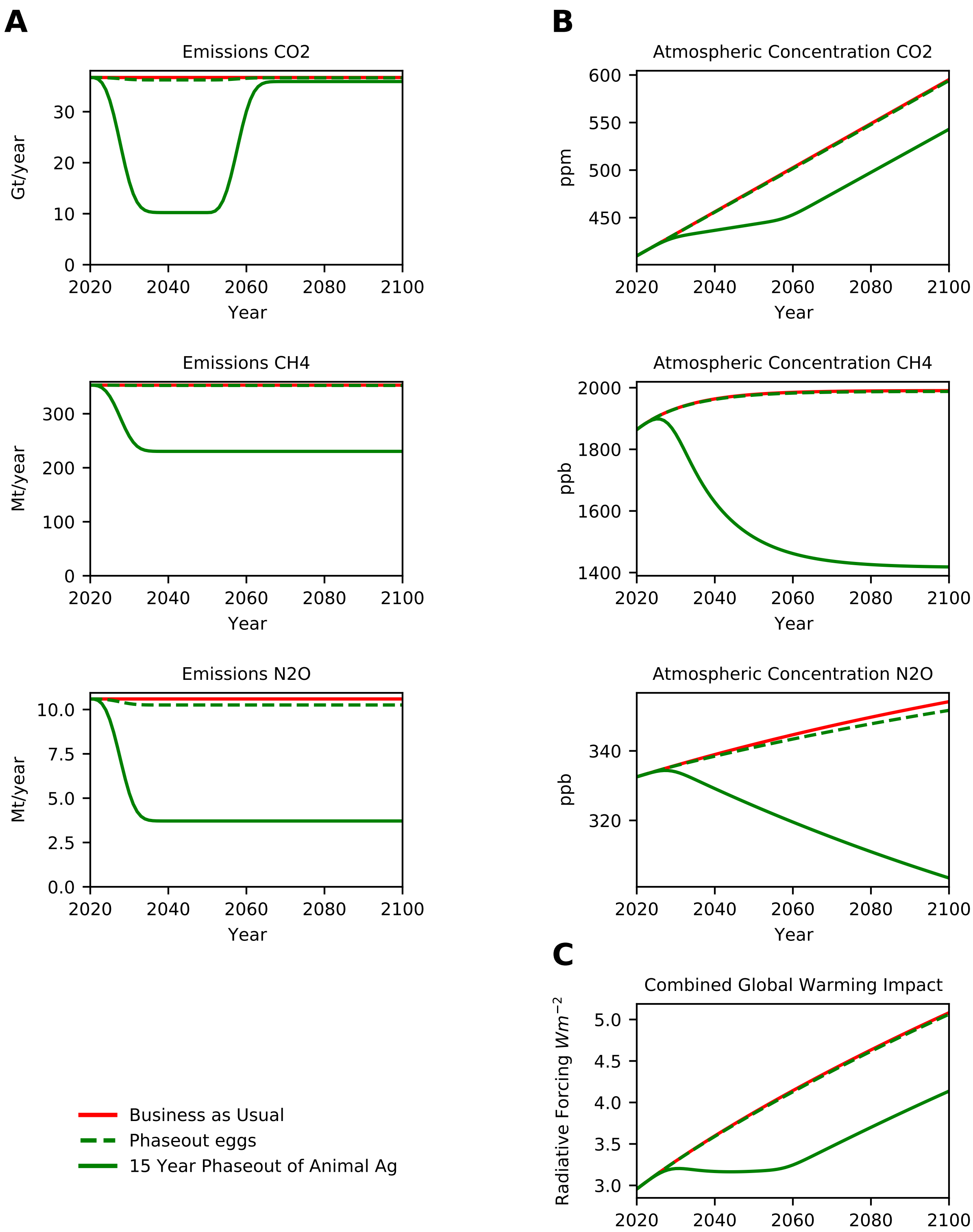

Figure 2-S21. Effects of Eliminating Eggs.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiative Forcing (RF) inferred from atmospheric concentrations in (B) by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011).

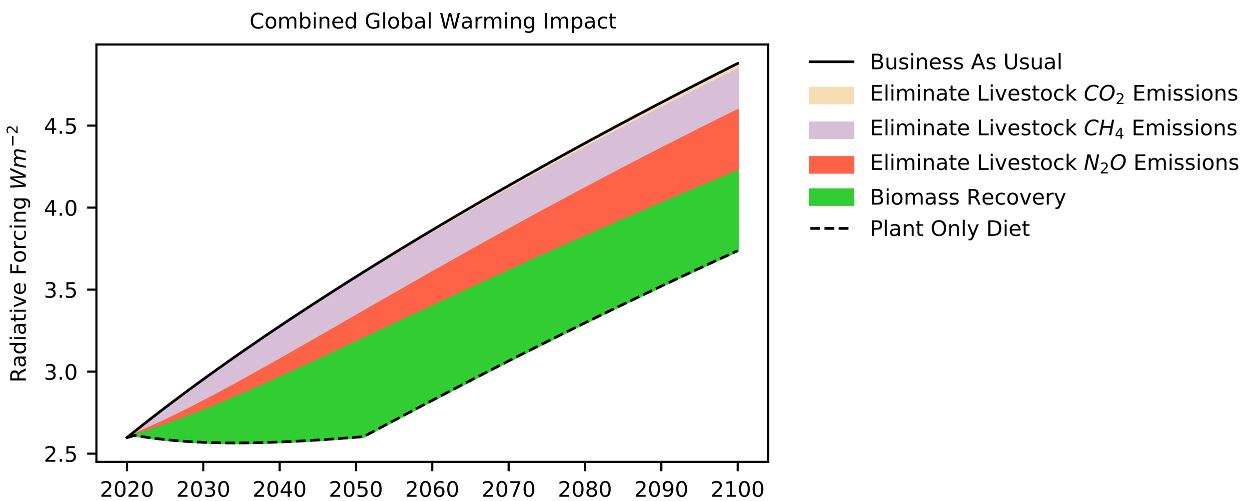

Figure 3-S1. Immediate elimination of animal agriculture reduces global warming impact of atmosphere.

Effect of eliminating emissions linked to animal agriculture and of biomass recovery on land currently used in animal agriculture on Radiative Forcing (RF), a measure of the instantaneous warming potential of the atmosphere. RF values computed from atmospheric concentrations in by formula of (Myhre et al., 1998; Ramaswamy et al., 2001) as modified in MAGICC6 (Meinshausen et al., 2011) with adjustment for gasses other than CO_2, CH_4 and N_2O as described in text.

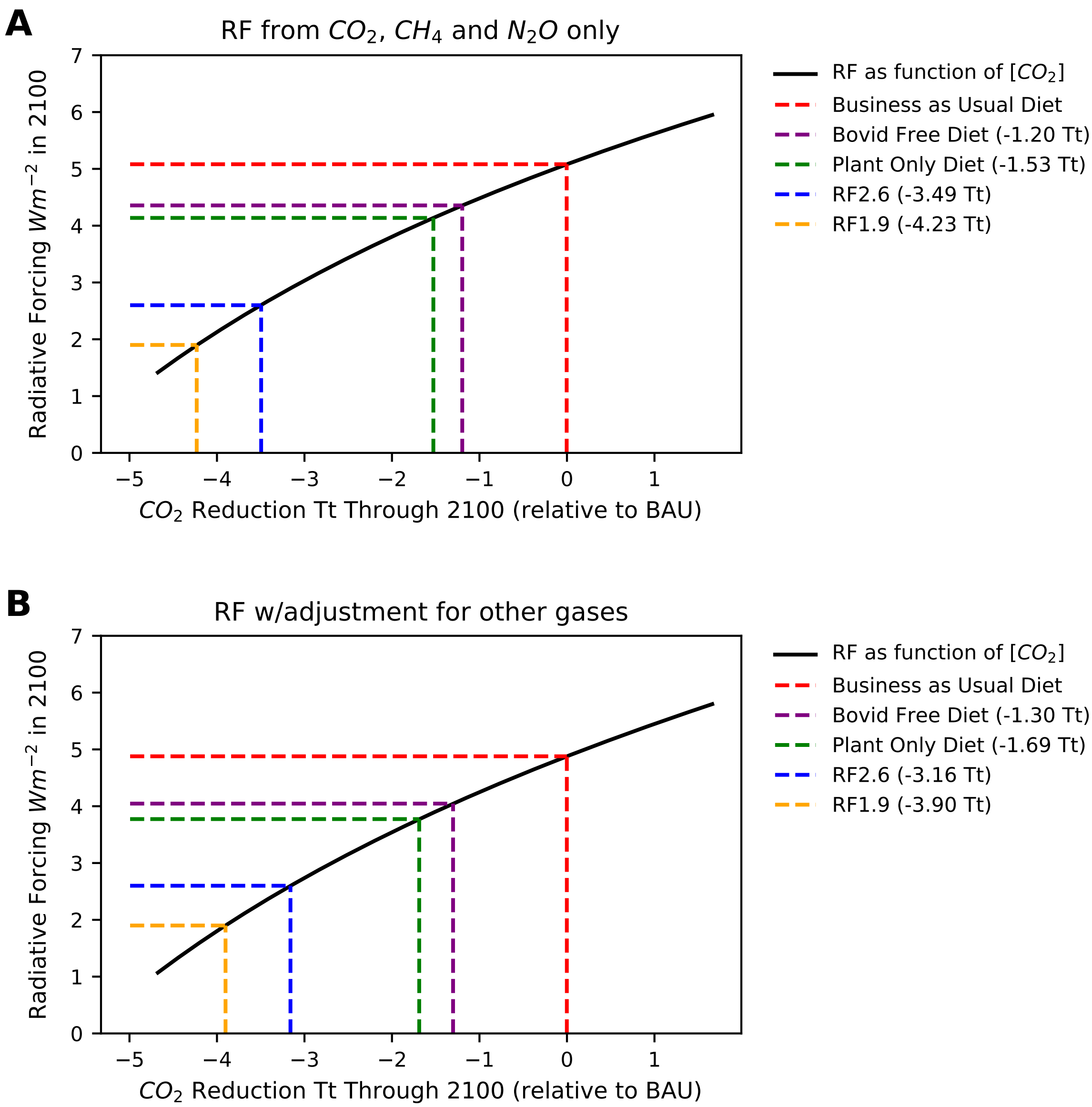

Figure 4-S1. Full carbon opportunity cost of animal agriculture.

We define the Emission and Land Carbon Opportunity Cost of animal agriculture as the total CO_2 reduction necessary to lower the RF in 2100 from the level estimated for a business as usual (BAU) diet to the level estimated for a plant only diet (POD). For these calculations we fix the CH_4 and N_2O levels in the RF calculation at those estimated for the BAU diet in 2100 and adjust CO_2 levels to reach the target RF. We also calculate ELCOC for just bovid sourced foods and determine the emission reductions necessary to reach RF's of 2.6 and 1.9, often cited as targets for limiting warming to 2.0˚C and 1.5˚C respectively. (A) Shows the results for RF directly calculated from CO_2, CH_4 and N_2O, while (B) shows an RF adjusted for other gases using multivariate linear regression on MAGICC6 output downloaded from the SSP database.

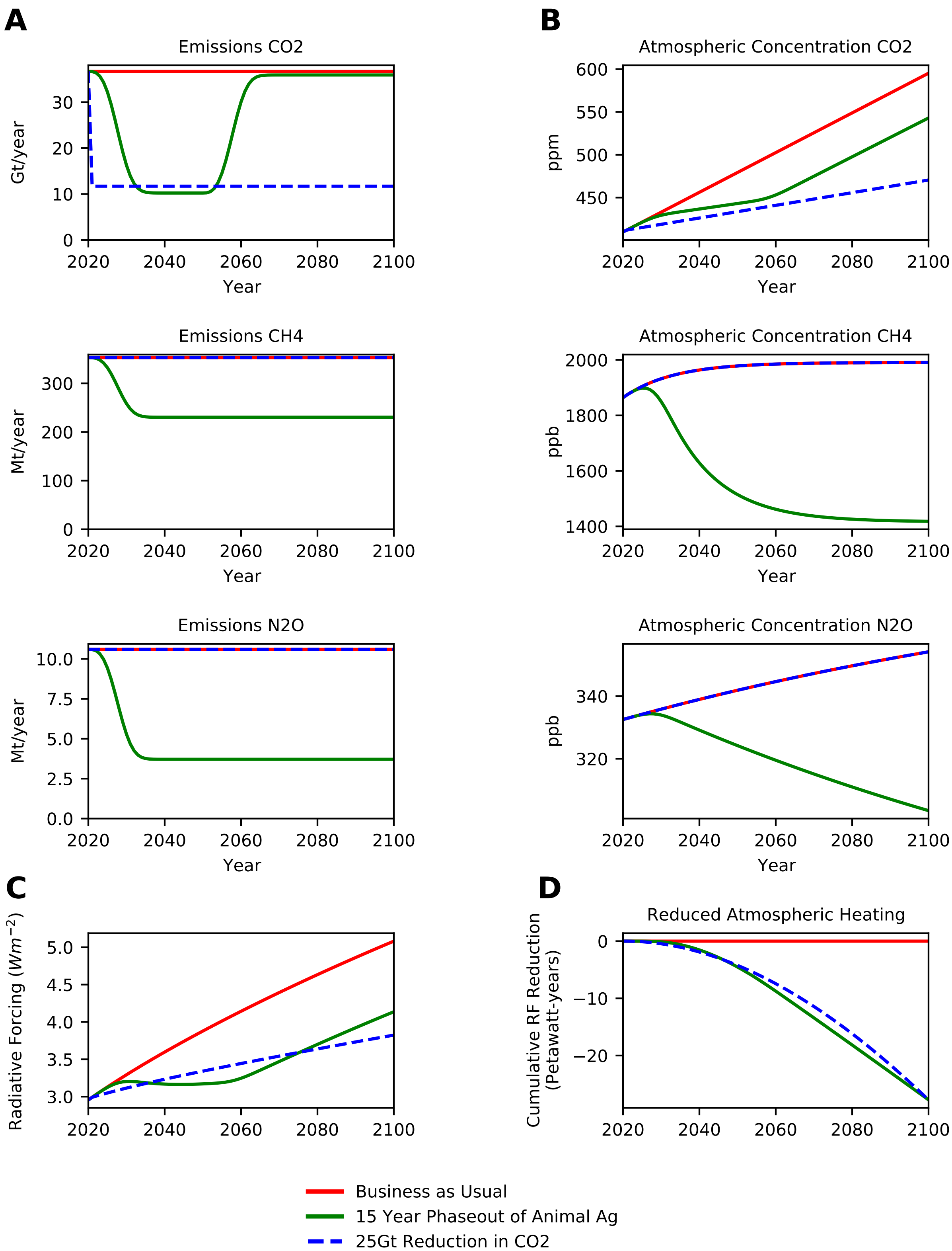

Figure 5-S1. ACO_2eq Calibration for PHASE-POD in 2100.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiation Forcing. (D) Cumulative difference between scenario and BAU of Radiative Forcing.

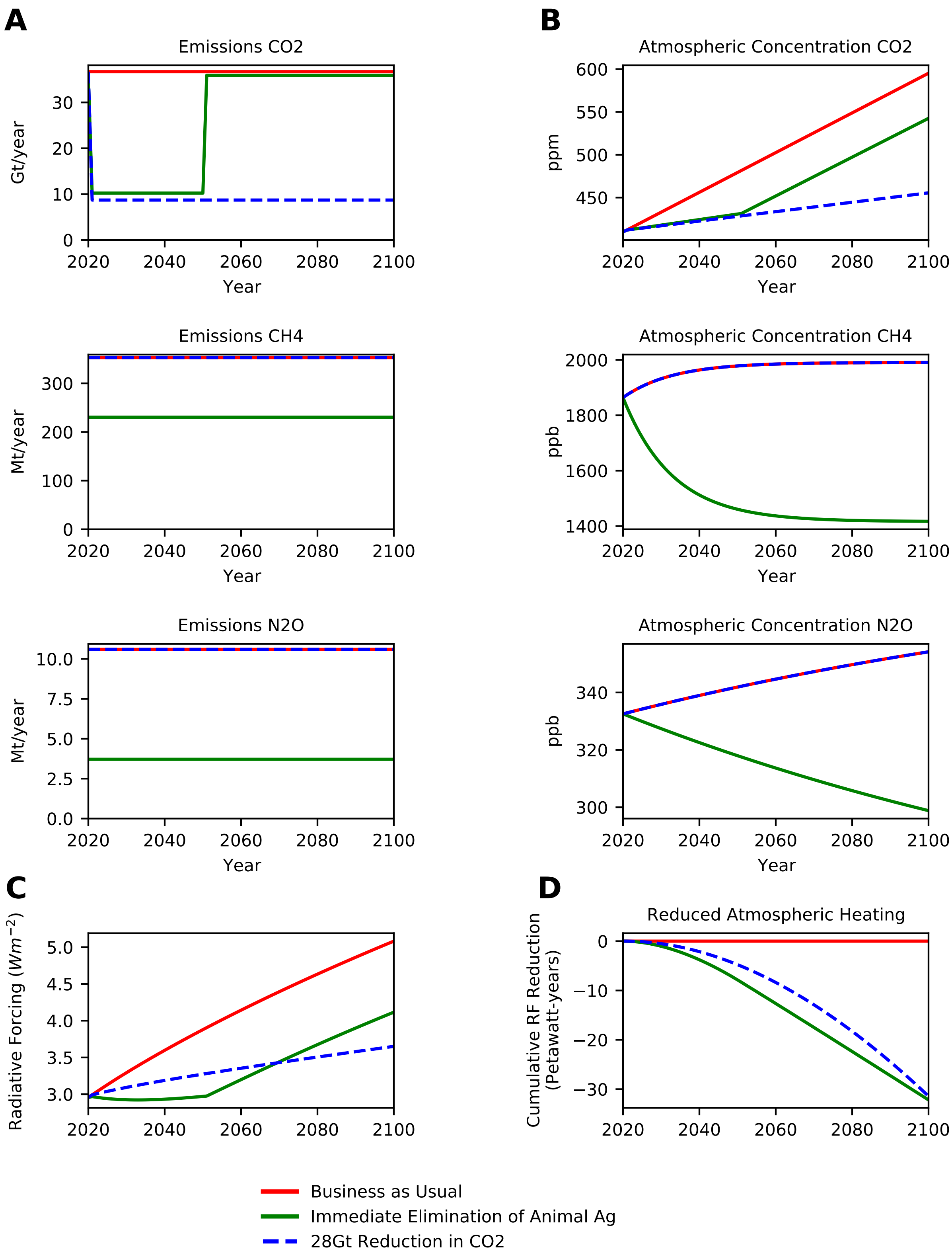

Figure 5-S2. ACO_2eq Calibration for IMM-POD in 2100..

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Cumulative difference between scenario and BAU of Radiative Forcing.

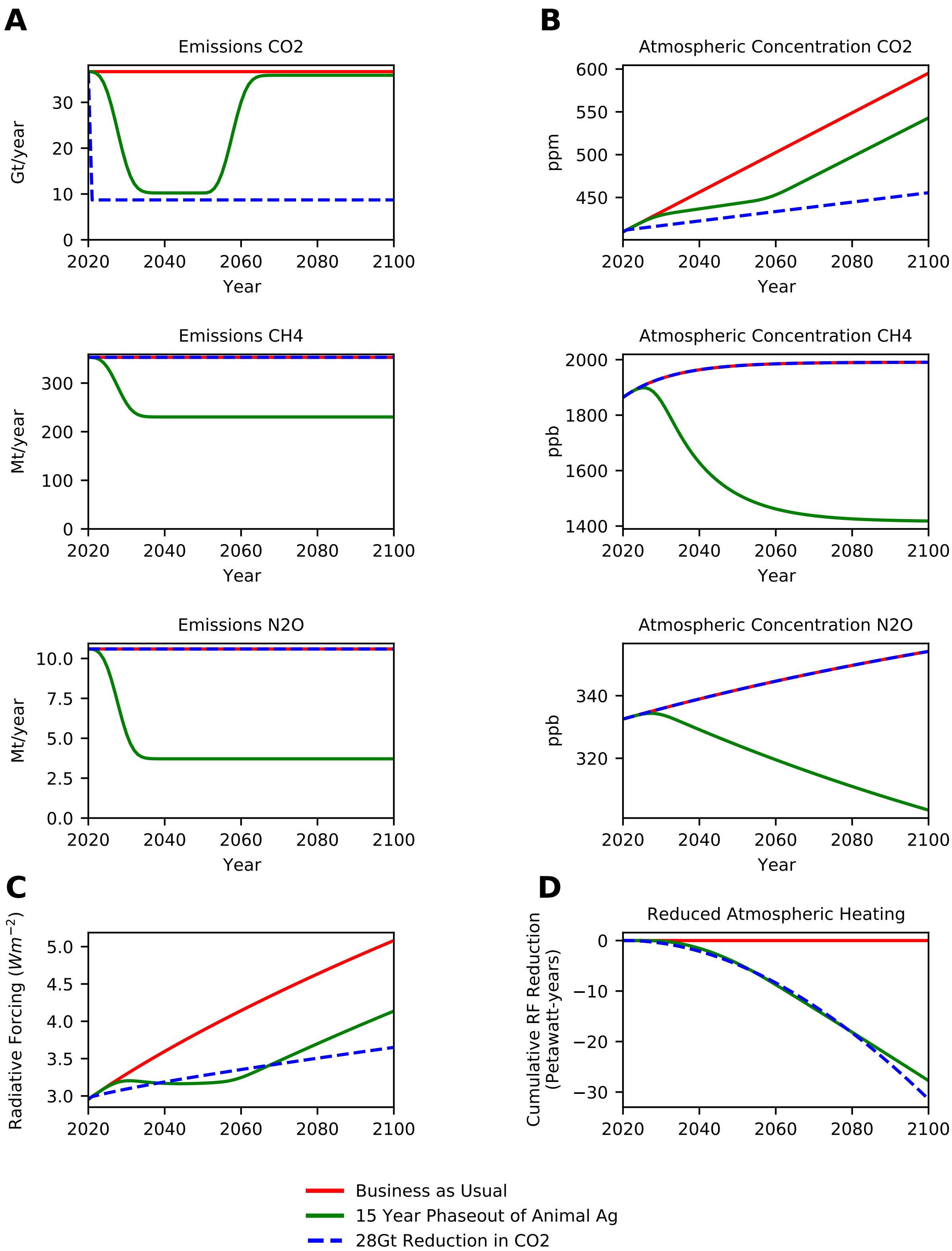

Figure 5-S3. ACO_2eq Calibration for PHASE-POD in 2050.

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Radiation Forcing. (D) Cumulative difference between scenario and BAU of Radiative Forcing.

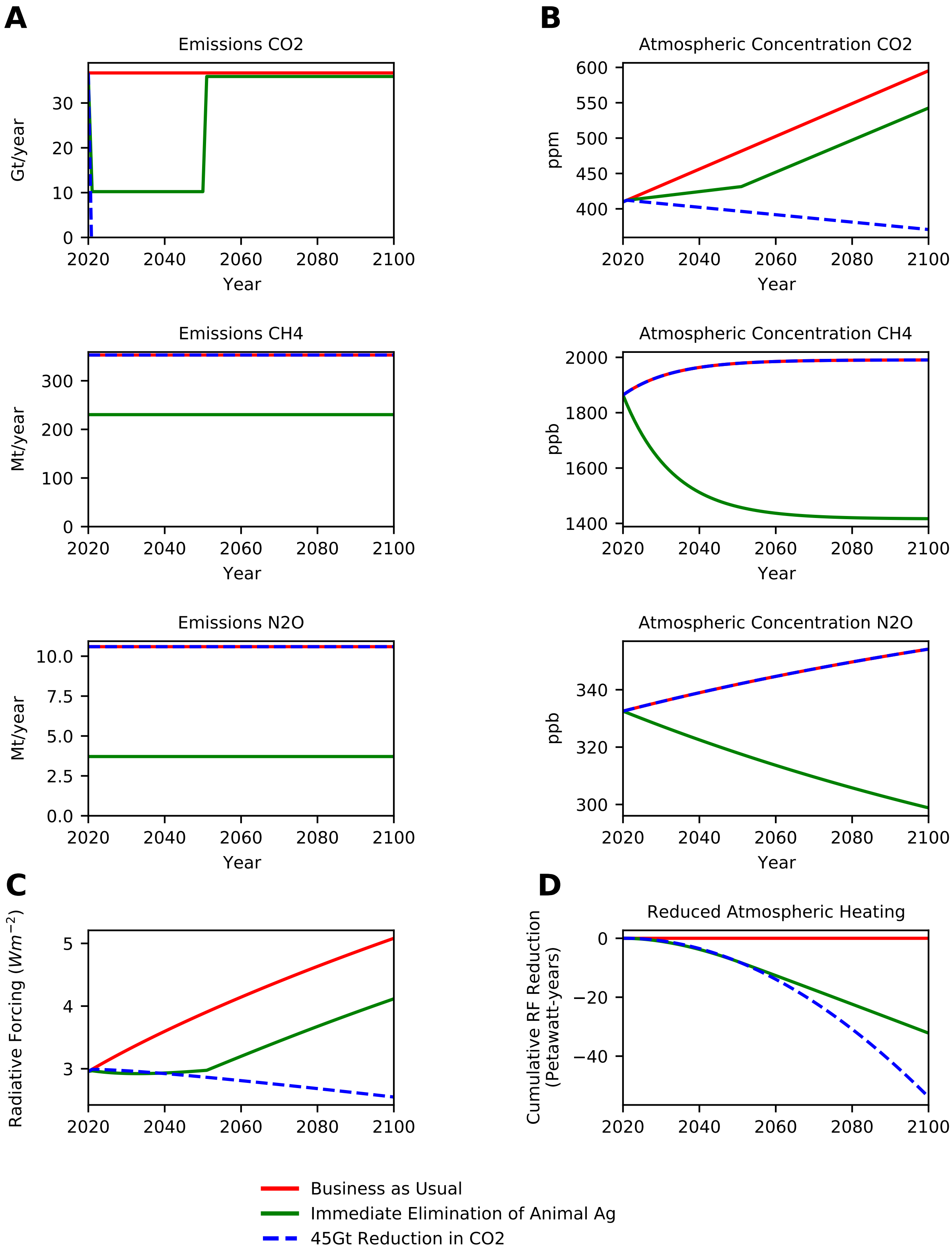

Figure 5-S4. ACO_2eq Calibration for IMM-POD in 2050..

(A) Projected annual emissions of CO_2, CH_4 and N_2O for shown scenarios. (B) Projected atmospheric concentrations of CO_2, CH_4 and N_2O under each emission scenario. (C) Cumulative difference between scenario and BAU of Radiative Forcing.

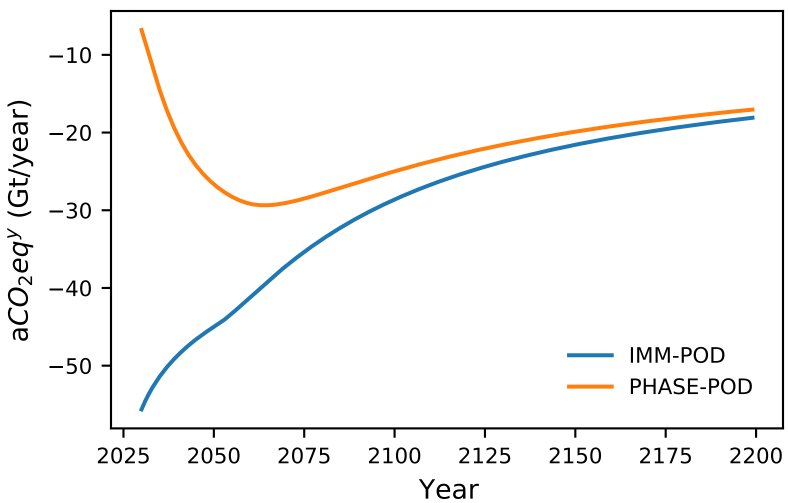

Figure 5-S5. Emissions reduction equivalents of ending animal agriculture

The equivalent CO_2 emission reductions associated with different interventions in animal agriculture, aCO_2eq, vary with the time window over which cumulative warming impact is evaluated. These plots show, for immediate elimination of animal agriculture (IMM-POD) and a 15-year phaseout (PHASE-POD) how aCO_2eq^y which is the aCO_2eq from 2021 to year y, varies with y. Because all of the changes in IMM-POD are implemented immediately, its effect is biggest as it is implemented and declines over longer time horizons (the decline int he first 30 years, when biomass recovery is occurring at a constant high right, is due to the slowing of annual decreasess in atmospheric CH_4 and N_2O levels as they asymptotically approach new equilibria). In contrast, PHASE-POD builds slowly, reaching a maximum around 2060 when biomass recovery peaks.

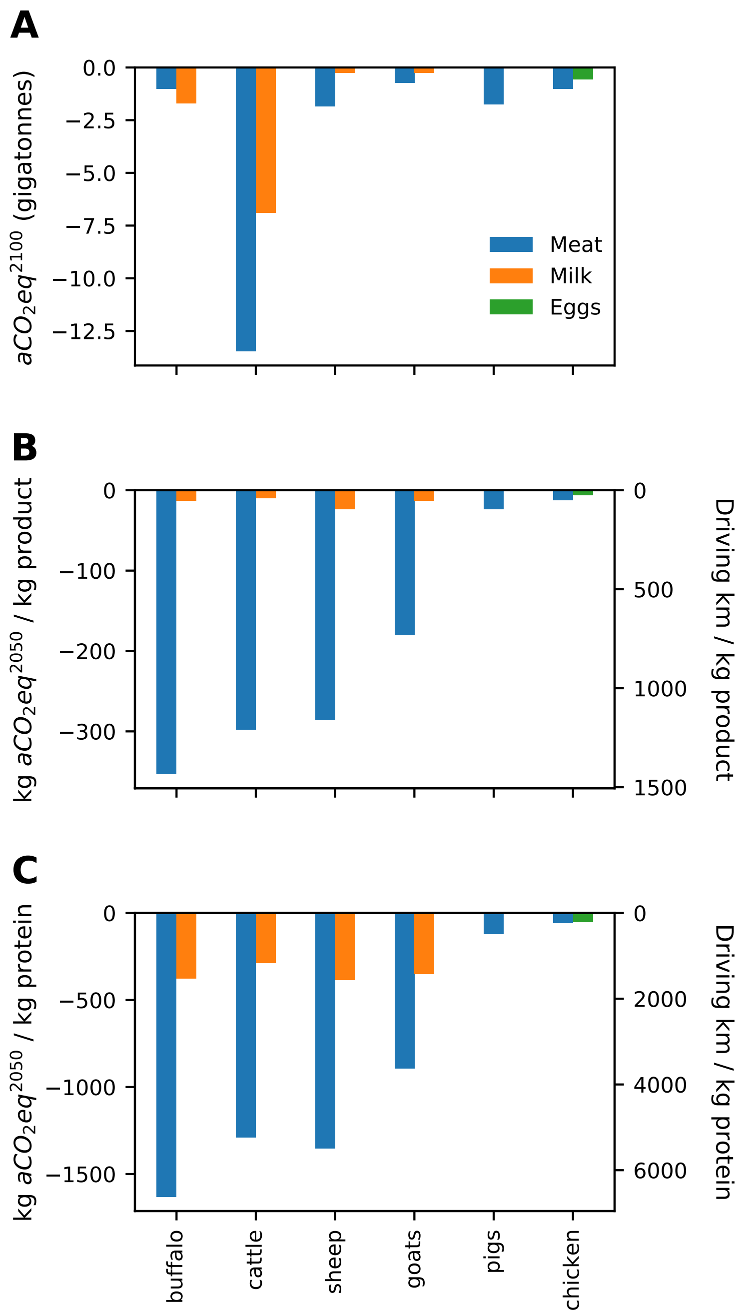

Figure 6-S1. Emission equivalents of livestock species through 2100.

We calculated the (A) total annualized CO_2 equivalents through 2100, aCO_2eq^{2100}, for all tracked animal products, and the aCO_2eq^{2100} per unit production (B) or per unit protein (C). For (B) and (C) we also convert the values to driving equivalents, assuming cars that get 10.6 km per liter of gas (the average of new cars in the United States).