Modeling the interinfluence of fertilizer-induced NH$_3$ emission, nitrogen deposition, and aerosol radiative effects using modified CESM2

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15 Supplementary Figures

Figure S1. Contrasting annual-total fertilizer-induced NH$_3$ estimated by fully coupled CAM4-chem with online CLM5 NH$_3$ emission and NH$_4$ deposition ([CAM4_CLM5]), and CAM4-chem with online CLM5 NH$_3$ and prescribed NH$_4$ deposition ([CAM4_CLM5_CLIM]) at 2000-level fertilization. The prescribed NH$_4$ map in [CAM4_CLM5_CLIM] is from the monthly average of [CAM4_CLM5] over 5 years. Panel (a) summarizes the regional differences of annual-total NH$_3$ emission between the two cases ([CAM4_CLM5]–[CAM4_CLM5_CLIM]). Panel (b) shows the spatial distribution of their differences.
Figure S2. Annual-mean atmospheric NH$_3$ estimated by fully coupled CAM4-chem with online CLM5 NH$_3$ emission and NH$_4$ deposition ([CAM4_CLM5]), CAM4-chem with fertilizer-induced NH$_3$ emission from CMIP6 emission inventory and online NH$_4$ deposition ([CAM4_CMIP6]), and CAM4-chem with online CLM5 NH$_3$ and
prescribed NH$_3$ deposition ([CAM4_CLM5_CLIM]) at 2000-level fertilization. The prescribed NH$_3$ map in [CAM4_CLM5_CLIM] is from the monthly average of [CAM4_CLM5] over 5 years. Panel (a) summarizes correlation analysis between the three cases and the IASI satellite retrievals. Panels (b), (c), (e), and (g) show the column NH$_3$ concentration of IASI and the three simulation cases correspondingly. Panels (d), (f) and (h) show concentration differences between each case and the IASI observations. Color scales are saturated at respective values, and ranges of values are shown in the legend titles.

**Figure S3.** Contrasting the changes in NH$_3$ emission (Tg-N yr$^{-1}$) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.
**Figure S4.** Contrasting the changes in plant nitrogen uptake (Tg-N yr\(^{-1}\)) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.

**Figure S5.** Contrasting the changes in grain production (Tg yr\(^{-1}\)) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.
Figure S6. Contrasting the changes in annual-mean surface temperature (°C) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.

Figure S7. Contrasting the changes in annual-mean Latent Heat Flex (W m⁻²) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.
Figure S8. Contrasting the changes in annual-mean Sensible Heat Flux (W m$^{-2}$) of [CAM4_CLM5_CLIM] and [CAM4_CLM5_NDEP] with respect to the fully coupled [CAM4_CLM5], when fertilizer application is increased by 30%.