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Improving nitrogen cycling in a land surface model (CLM5) to quantify soil N_2O, NO, and NH_3 emissions from enhanced rock weathering with croplands

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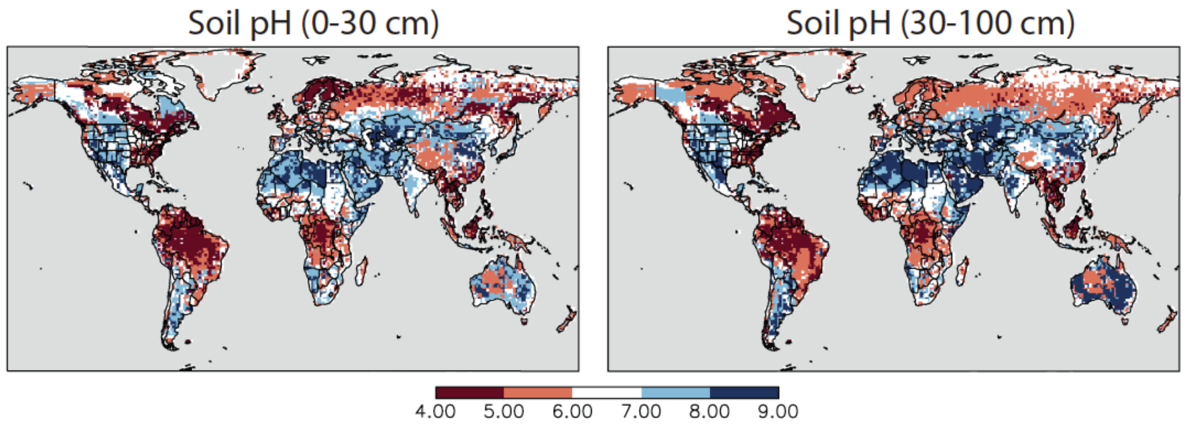

Figure S1: Global map of topsoil (0-30 m) and subsoil (30-100 cm) pH from Harmonized World Soil Database v1.2, regridded to the Community Land Model (CLM) grid cell resolution (0.9 degree x 1.25 degree) for the nominal year of 2000.

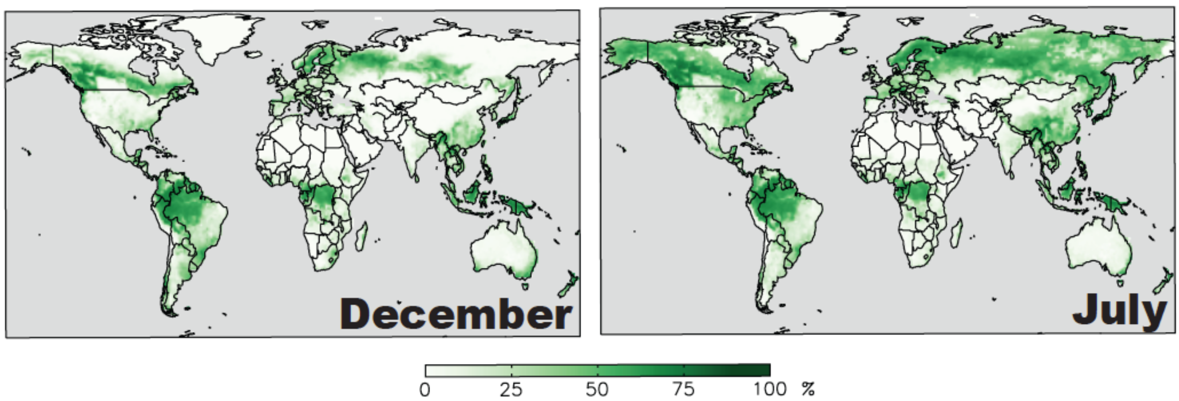

Figure S2: Monthly average of the canopy reduction factor for December and July implemented in CLM5, calculated using Yan et al., (2005) approach.

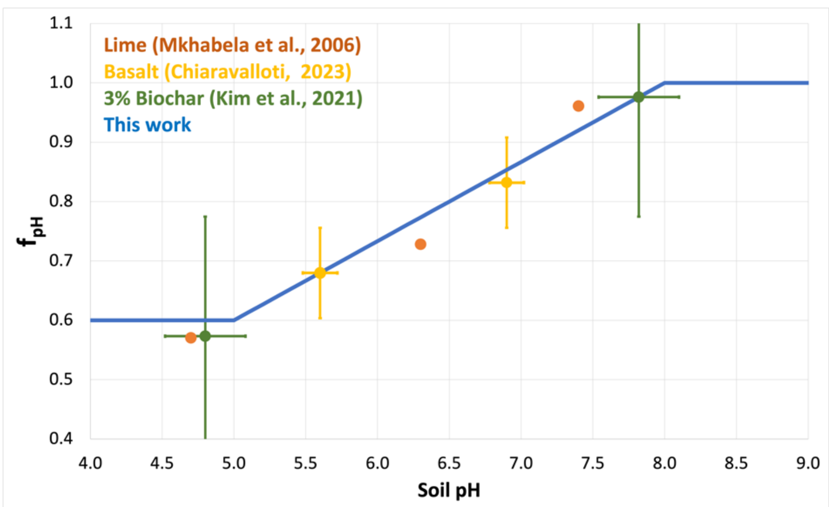

Figure S3: New model parameterization of the NH_3 emission in CLM5 as a function of soil pH (f_{pH}) derived from direct observations from basalt (12 t rock/ha), biochar (3%) and lime applications (See section 2.3.4 for further information).

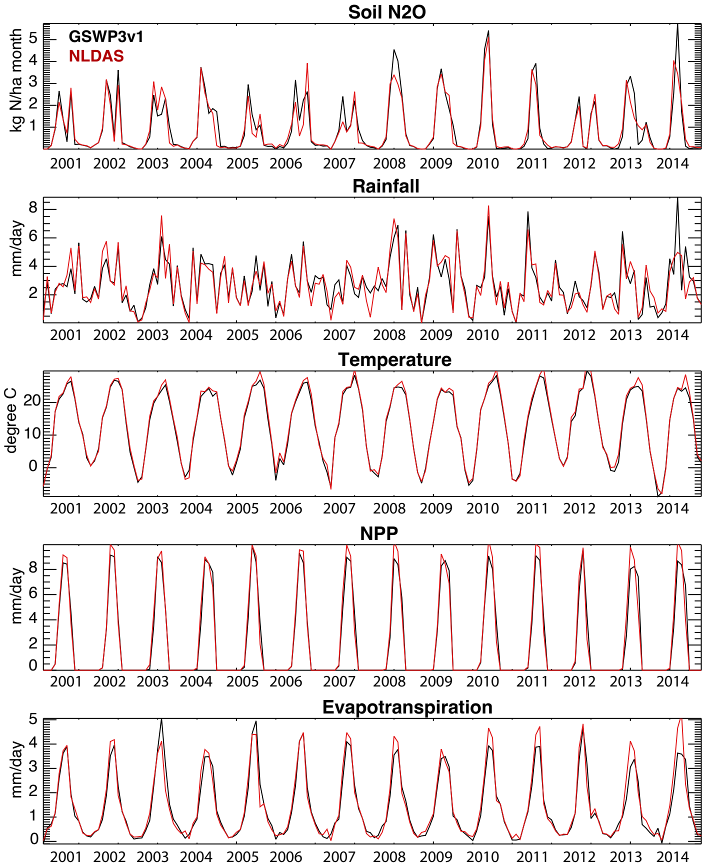

Figure S4: Monthly timeseries of soil N_2O (kg N ha^{-1} month^{-1}), rainfall (mm day^{-1}), temperature (^{o}C), net primary productivity (NPP; mm day^{-1}) and evapotranspiration (mm day^{-1}) for a single-point simulation for maize at the Energy Farm with NLDAS (red) and GSWP3v1 (black) atmospheric forcings, from 2001 to 2014.

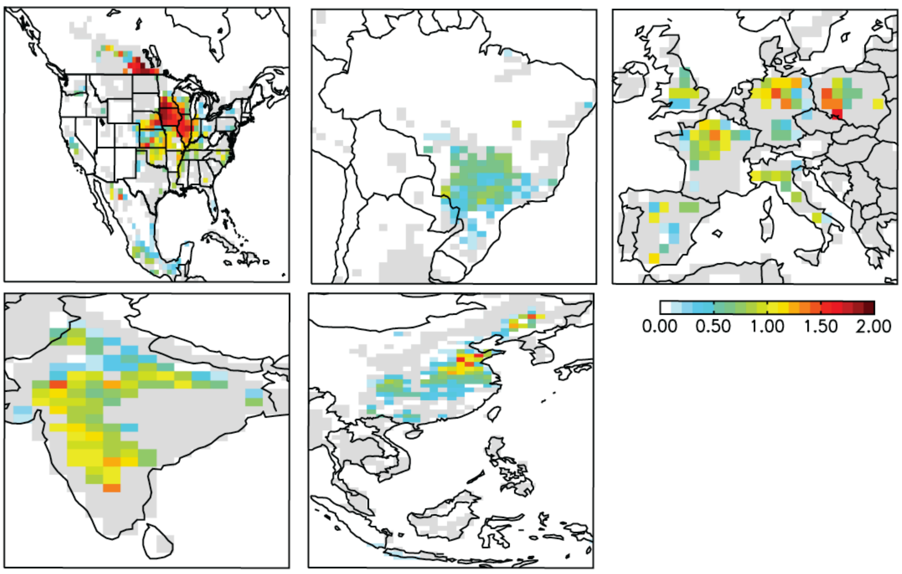

Figure S5: Close-up view for the changes in soil pH after annual basalt applications in a 25-year timeframe to remove 2 Gt CO_2 (Beerling et al., 2020). Grey are grid cells with > 10% crops, in which basalt was not applied.

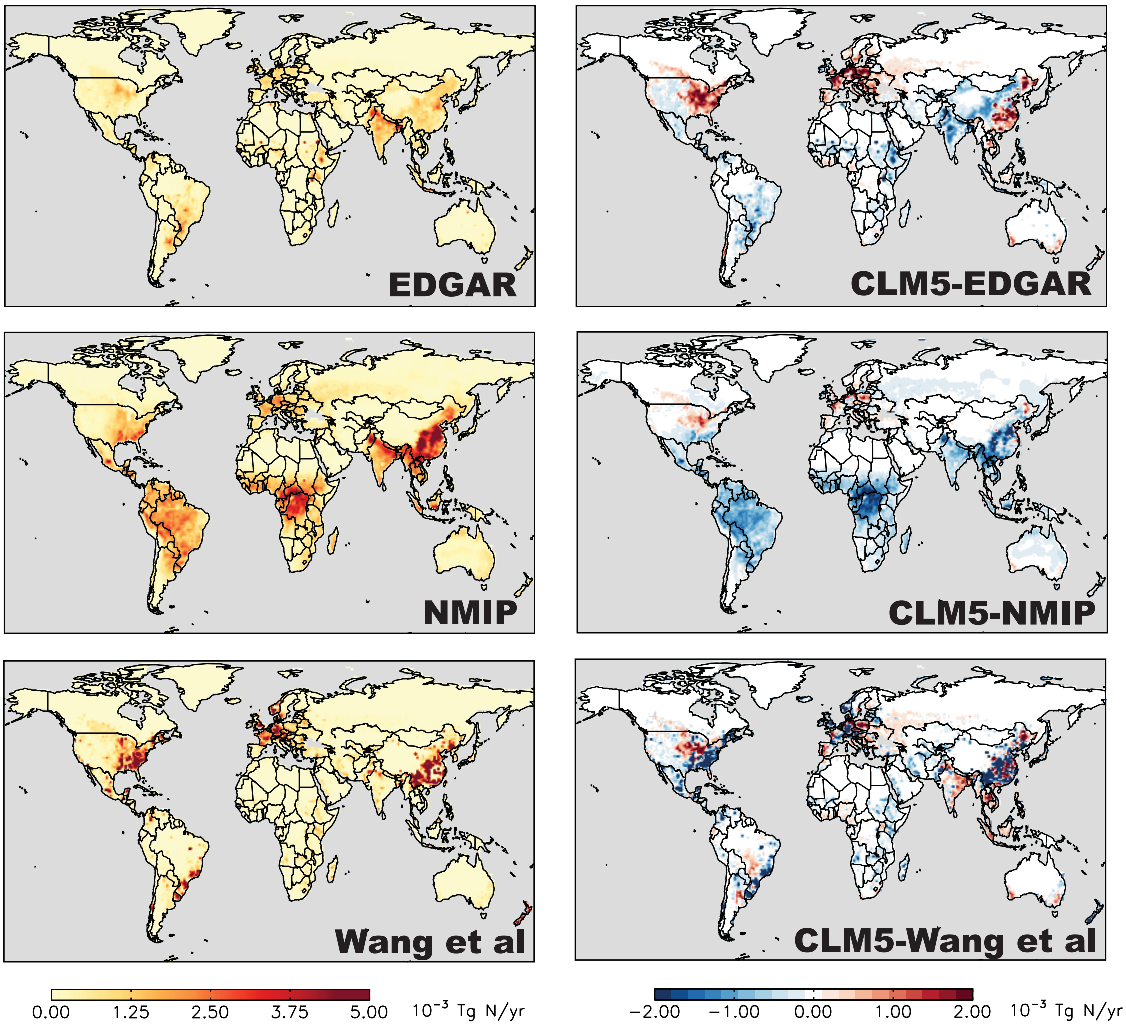

Figure S6: Comparison of soil N_2O emission estimated by CLM5 and other emission inventories. Spatial distribution of annual-total N_2O emission estimated by EDGAR, NMIP and Wang et al. (2020) (left column) and differences in annual total N_2O between CLM5 and previously recorded estimates (right column) are shown, correspondingly. Colour scales are saturated at respective values.

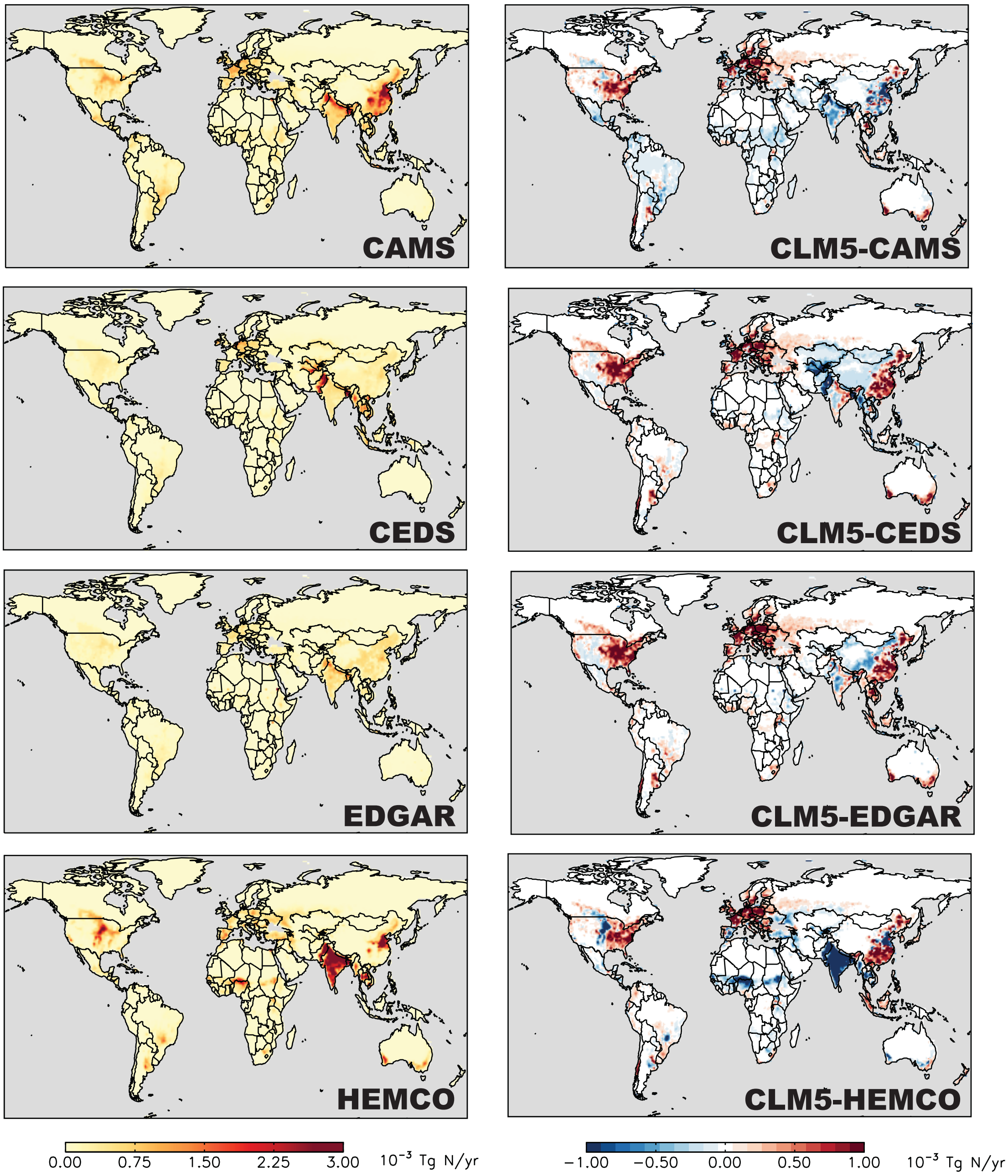

Figure S7: Comparison of soil NO emission estimated by CLM5 and emission inventories (Table 1). Spatial distribution of annual-total N_2O emission estimated by CAMS, CEDS, EDGAR and HEMCO (left column) and differences in annual total NO between CLM5 and the emission inventories (right column) are shown, correspondingly. Soil NO emissions in HEMCO were weighted by cropland fraction Colour scales are saturated at respective values.

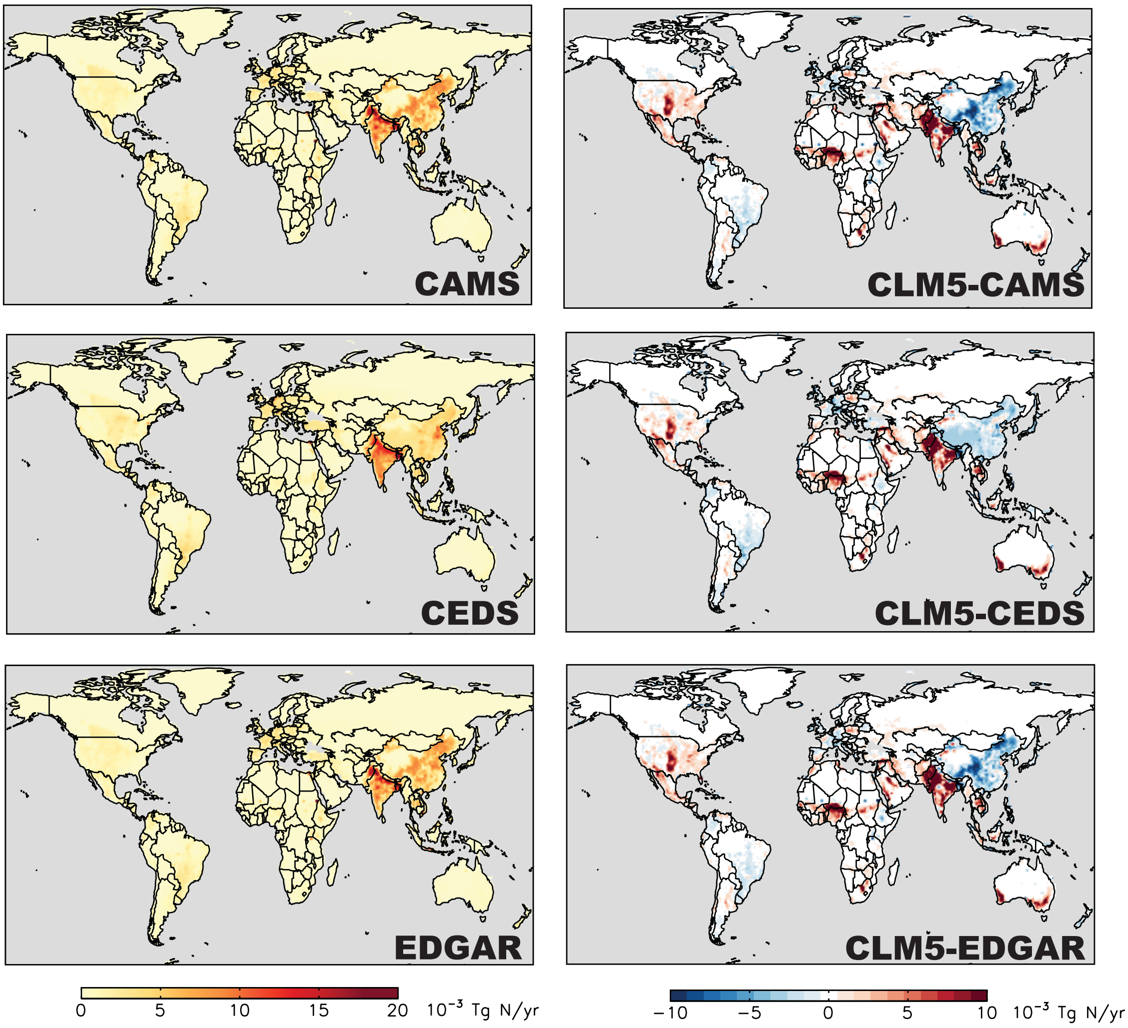

Figure S8: Comparison of soil NH_3 emission estimated by CLM5 and other emission inventories (Table 1). Spatial distribution of annual-total NH_3 emission estimated by CAMS, CEDS and EDGAR (left column) and differences in annual total NO between CLM5 and the emission inventories (right column) are shown, correspondingly. Colour scales are saturated at respective values.

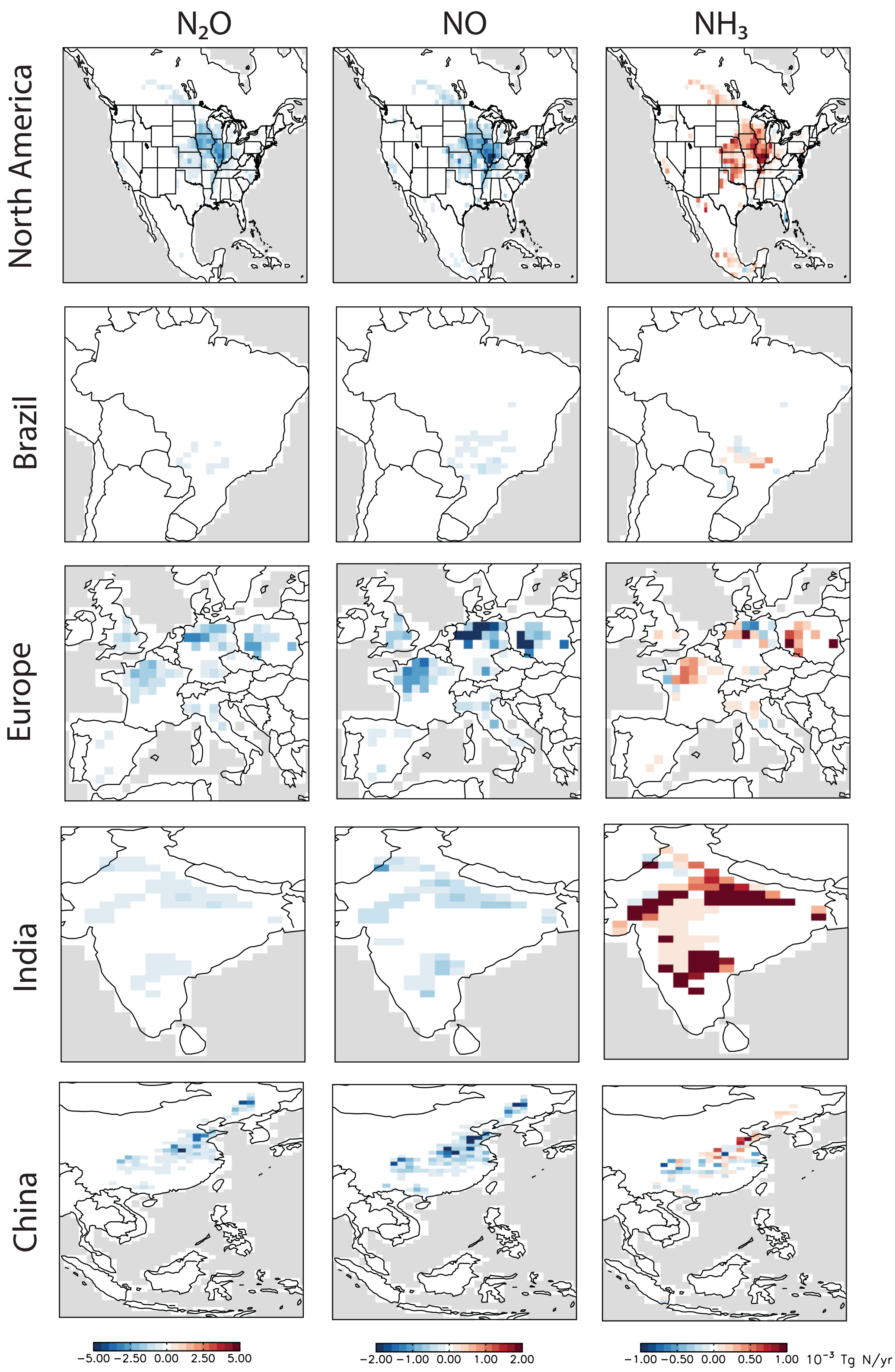

Figure S9: Close-up view of the changes in annual soil N_2O, NO and NH_3 fluxes across the main five agriculture regions (North America, Brazil, Europe, India, and China) based on reductions in soil pH projected by the ERW model to sequester 2 Gt CO2/yr (Beerling et al., 2020).

References:

Beerling, D.J., Kantzas, E.P., Lomas, M.R. et al. (2020), Potential for large-scale CO_2 removal via enhanced rock weathering with croplands. Nature **583**, 242–248. https://doi.org/10.1038/s41586-020-2448-9

Wang, Q., Feng Zhou, Ziyin Shang, Philippe Ciais, Wilfried Winiwarter, Robert B Jackson, Francesco N Tubiello, Greet Janssens-Maenhout, Hanqin Tian, Xiaoqing Cui, Josep G Canadell, Shilong Piao, Shu Tao (2020), Data-driven estimates of global nitrous oxide emissions from croplands, *National Science Review*, Volume 7, Issue 2, 441–452, https://doi.org/10.1093/nsr/nwz087

Wieder, W.R., J. Boehnert, G.B. Bonan, and M. Langseth. 2014. Regridded Harmonized World Soil Database v1.2. Data set. Available on-line [http://daac.ornl.gov] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1247.