Title: Nitrous oxide emissions from 2008 to 2012 for agricultural lands in the conterminous United States

Abstract: Nitrous oxide (N2O) is an important greenhouse gas (GHG) that also contributes to depletion of ozone in the stratosphere. Agricultural soils account for about 60% of anthropogenic N2O emissions. Most national GHG reporting to the UN Framework Convention on Climate Change assumes nitrogen (N) additions drive emissions during the growing season, but soil freezing and thawing during spring is also an important driver in cold climates. We show that both atmospheric inversions and newly implemented bottom-up modeling approaches exhibit large N2O pulses in the northcentral region of the United States during early spring and this increases annual N2O emissions from croplands and grasslands reported in the national GHG inventory by 11%. Considering this, emission accounting in cold climate regions is very likely under-estimated in most national reporting frameworks. Current commitments related to the Paris Agreement and COP 26 emphasize reductions of carbon compounds. Assuming these targets are met, the importance of accurately accounting and mitigating N2O increases once CO2 and CH4 are phased out. Hence, the N2O emission under-estimate introduces additional risks into meeting long term climate goals.

Contact: Stephen Ogle, stephen.ogle@colostate.edu

Recommended data citation – Ogle, S.M., Del Grosso, S.J., & Nevison, C. (2022). Nitrous oxide emissions from 2008 to 2012 for agricultural lands in the conterminous United States. Colorado State University. Libraries. http://dx.doi.org/10.25675/10217/235393

Format of data files – NetCDF

File Information

The two datasets are archived in compressed zip file, NitrousOxideEmissionsData_2008-2012.zip, and include emissions data that were compared in Del Grosso et al. (In press).

The 'DayCentSoilN2Oemissions_2008_2012.nc' file is in a netcdf v4 format that contains direct soil N_2O-N (kgN) emissions from the DayCent model as 10-day cumulative values. The data were created as a stack of rasters in R, with days 1-10 for 2008 as the first layer (netcdf layer name 1.1 for period 1 in year 1) and days 361-366 for 2012 as the last layer (layer name 37.5). Note that the last period for each year is the cumulative emissions value for 5 or 6 days (depending on the number of days in February associated with a leap year), rather than a 10-day sum. The data can be read directly as a raster stack in R with the terra or raster package, or opened and read in with the ncdf4 package in R.

The atmospheric inversion N_2O flux data are in a separate netcdf file for each year, AtmosphericInversionResults_2008.nc, AtmosphericInversionResults_2009, AtmosphericInversionResults_2010, AtmosphericInversionResults_2011, and AtmosphericInversionResults_2012. The units are micromol m-2 s-1. Additional meta-data information is found in the netcdf files.

Method(s)

The soil N_2O emissions data for the conterminous United States were generated by the DayCent ecosystem model using the crop and land-use histories for survey locations in the USDA-NRCS National Resources Inventory (NRI). The model also requires weather and soils data. Daily maximum/minimum temperature and precipitation data are based on gridded weather data from the PRISM Climate Data product. Soils data are obtained from Soil Survey Geographic Database (SSURGO). See Del Grosso et al. (2022) and US-EPA (2020) for more details about the simulations.

Atmospheric inversions were conducted using the CarbonTracker Langrage framework (Nevison et al. 2018). These results provide total N_2O fluxes for the domain using atmospheric observations and an inverse modeling, and are compared to the DayCent emissions to confirm seasonal patterns, particularly the role of freeze-thaw events in driving pulses of N_2O emissions from agricultural lands.

Associated publications

Del Grosso, S., S.M. Ogle, C. Nevison, R. Gurung, WJ. Parton, C. Wagner-Riddle, W. Smith, W. Winiwarter, B. Grante, M. Tenuta, E. Marx, S. Spencer, and S. Williams. 2022. A Gap in Nitrous Oxide Emissions Reporting Complicates Long Term Climate Mitigation. Proceedings of the National Academy of Sciences, 119(31), e2200354119. https://doi.org/10.1073/pnas.2200354119

Nevison, C., Andrews, A., Thoning, K., Dlugokencky, E., Sweeney, C., Miller, S., Saikawa, E., Benmergui, J., Fischer, M., Mountain, M. and Nehrkorn, T. 2018. Nitrous Oxide Emissions Estimated with the CarbonTracker-Lagrange North American Regional Inversion Framework. Global Biogeochemical Cycles, 32(3), pp.463-485.

US-EPA (2020) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018. EPA 430-R-20-002, United States Environmental Protection Agency.