Building an Updated Estimate of Greenhouse Gas Emissions from Agricultural Fires

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Abstract

The U.S Environmental Protection Agency (EPA) maintains a database of greenhouse gas sources, and a table of greenhouse gas estimates stemming from agricultural fires are included in their report. While the EPA's estimates for greenhouse gas emissions stemming from agricultural fires are a helpful resource, we hope to improve upon their information by analyzing a wider range of crops and land types in order to calculate greenhouse gas estimates. In addition, since the EPA does not provide spatial data with its agricultural fire estimates, we plan to organize our data in maps so it is apparent where these emissions are stemming from. It is important to get an accurate estimate of agricultural fires' impact on greenhouse gas emissions, especially because this data can be used to better shape agricultural practices. We used an already existing database of fires in the Eastern United States, and hope to compare the estimates produced by this new database for agricultural fire emissions to the values the EPA has published.

Introduction

GEUFE (GOES Eastern US Fire Emissions) is a database of fires in the Eastern United States which uses satellite imagery and an extensive array of different land types present in the Eastern United States, which can be used in order to produce accurate and detailed estimates of greenhouse gas emissions. These estimates tend to be higher than other existing databases (including the one used by the EPA) due to the larger amount of fires detected using a satellite-based method and the more accurate land classifications.

The database used by the EPA to calculate agricultural fire emissions includes certain land types and crop types, but with less detail than can be achieved using the GEUFE database. For example, while the EPA includes total emissions estimates for CO and NOx, the EPA does not further break down this data by crop or by region.

Agricultural burning is an area of ongoing research, and getting an accurate estimate of agricultural burning's impact is key. During this research, we primarily focus on agricultural burning's impact on greenhouse gas emissions, but other aspects are being studied as well - for example, particulate matter created in crop burning has been found to impact health in surrounding communities.

Methods

We used a 1-year time period of GEUFE data, which aligns with the time period the EPA uses in its annual greenhouse gas report.

We limited the scope of the database to only include fires in the Eastern contiguous united states. The EPA only accounts for domestic emissions, so this was necessary in order to compare our results. Furthermore, we did not look at the Western United States, since we only wanted to examine the effect of intentional crop burning. Wildfires are much more common in the Western United States and this unintentional burning would have skewed our data.

We used emission factor (EF) values found in literature to estimate the greenhouse gas values (including CO and NOx) stemming from each type of cropland.

To sift through the GEUFE database and calculate the emissions from each fire in the dataset, Python and Excel were used. We also used Cartopy, Matplotlib, and GeoPandas in Python in order to produce maps showcasing the values calculated from the GEUFE database. We were also able to filter this data for only certain crops and get estimates of the emissions produced by a single crop (for example, by only looking at rice-growing areas or sugarcane fields).

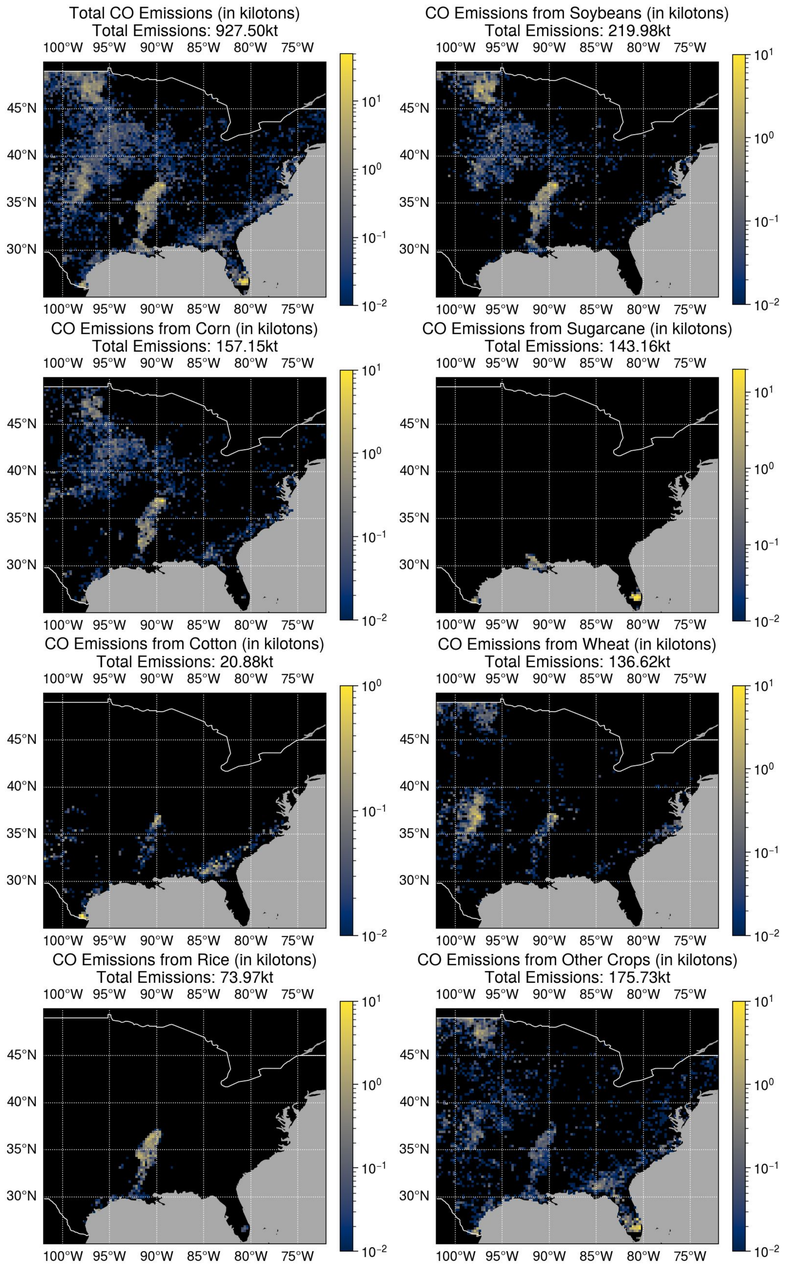
Results

After plotting estimated emissions from the GEUFE database, we found that the estimated value of CO emissions in our analysis was 927kt, while the EPA lists a value of 501kt, nearly half of our value. Similarly, we estimated the value of NOx emissions to be 27kt, above the EPA estimate of 19kt. This was expected, since the GEUFE database includes a much more extensive list of fires than the EPA's database.

While the EPA does not break down CO and NOx emissions from agricultural burning further, our analysis shows that these emissions come from a wide variety of crops (shown in the visualizations to the right and in the table below).

	CO estimate	NOx estimate
GEUFE | Corn	157kt	2.7kt
GEUFE | Cotton	21kt	0.9kt
GEUFE | Rice	74kt	2.3kt
GEUFE | Soybeans	220kt	3.3kt
GEUFE | Sugarcane	143kt	7.1kt
GEUFE | Wheat	137kt	5.5kt
GEUFE | Other Crops	176kt	5.5kt
GEUFE | Total	**927kt**	**27kt**
EPA | Total	**501kt**	**19kt**

Finally, we were able to show the location of these agricultural burning emissions. Areas near Lake Okeechobee in Southern Florida were found to have the highest emissions as a result of concentrated sugarcane burning. Other hotspots were concentrated around other agricultural regions such as the Mississippi Delta and the Great Plains, which was an expectation we had going into mapping.



Conclusion

By using the updated GEUFE database in this analysis, we estimated greenhouse gas emissions caused by agricultural burning to be higher than suggested in the EPA's published data. This was an expected conclusion, since the GEUFE database has a higher estimate for fires than most databases currently in use.

However, our analysis using the GEUFE database suggests that the EPA may be significantly underreporting greenhouse gas emissions stemming from agricultural burning.

This research can continue to be expanded on with emissions other than CO and NOx, such as CH4, NO2, or CO2 using further literary values.

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