Analysis of Crop Burning Rules in Florida Using Surface and Satellite Measurements

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Abstract

- Sugarcane farming and burning in the Everglades Agricultural Area contributes to fine particulate matter (PM2.5) concentrations in South Florida
- We analyze recent satellite and surface data to identify any measurable change in PM2.5 concentrations
- Satellite data is not without error
  - To complete an accurate analysis, we must first identify discrepancies between satellite and ground measurements
- We select surface observation sites throughout Florida and calculate monthly average PM2.5 concentrations for those sites
- We compare surface and satellite data over time to reach conclusions about how PM2.5 concentrations have changed
- We find the difference between satellite measurements and surface averages and use radial basis function interpolation to approximate values across the state
- Applying these corrections to satellite data, we create a more accurate dataset of PM2.5 concentrations statewide

Introduction

- Sugar farming and production
  - One of Florida's largest commercial industries
  - Sugar cane is burned before harvesting to remove leaves, eases the cutting of shoots
  - Creates significant air pollution in Palm Beach County
- Fine particulate matter (PM2.5)
  - Particles with diameter less than 2.5 microns, or 0.0025 millimeters
  - High PM2.5 concentrations can cause severe health problems, and even death
  - Prior study by Nowell et al. (2022) of 2004-2018 data found sugarcane burning increased winter PM2.5 by as much as 1.4 $\mu g/m^3$, causing 1 to 6 deaths per year
- We want to examine whether new burning rules in 2019 changed average PM2.5 concentrations

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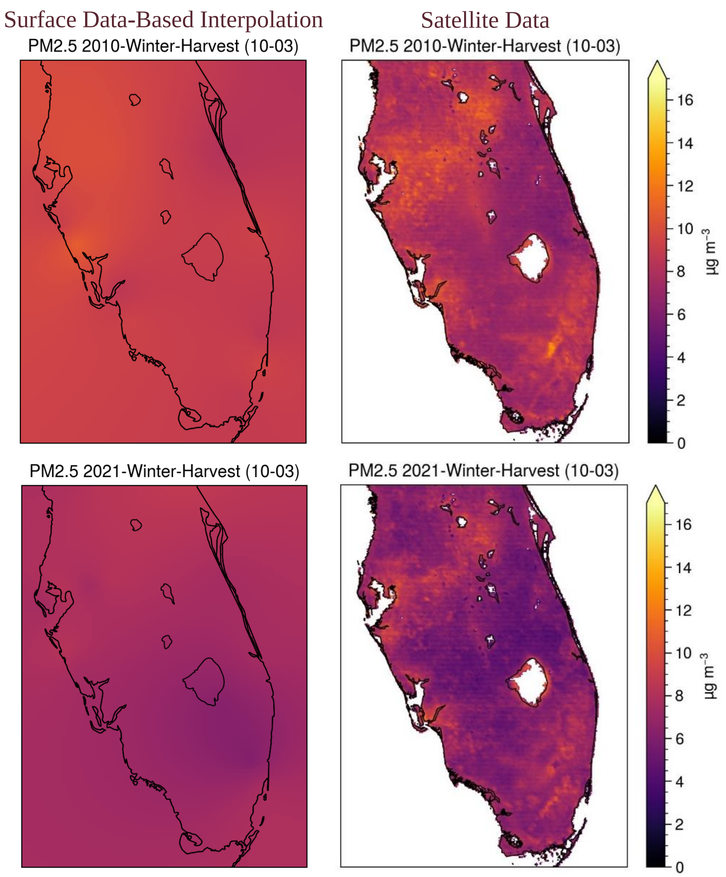
Methods

- Surface data analysis from 2010-2022 using outdoor air quality data from the EPA
  - Screened Florida sites to identify stations with high data completeness (>80%) over the whole period
  - 27 out of 59 sites satisfied this requirement
- Satellite data analysis from 2000-2022 using monthly satellite data from van Donkelaar (2023)
  - Found and plotted seasonal averages (harvest vs. summer seasons) and found the difference between each summer and the adjacent harvest seasons to identify large-scale seasonal differences
  - Found average PM2.5 concentration for each month
- Comparison
  - Found the difference between average surface and satellite values, then used the radial basis function to interpolate the satellite correction across Florida

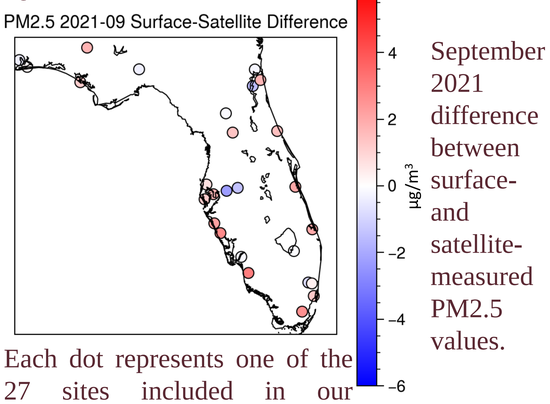
Results

Fig. 1



Winter harvest season (October-March) average PM2.5 concentrations for 2010-11 and 2021-22 winters, derived from surface interpolation (left) and satellite data (right).

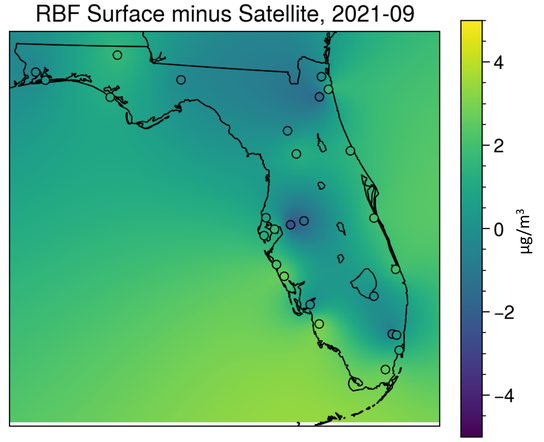
Fig. 2



Each dot represents one of the 27 sites included in our analysis.

September 2021 difference between surface- and satellite-measured PM2.5 values.

Fig. 3



Interpolation of data from Figure 2 across the state of Florida. By adding these values to monthly satellite data, we will obtain a corrected dataset for surface PM2.5 concentrations.

Conclusions

The analysis of satellite and surface air quality measurements has yielded some significant results:

- PM2.5 pollution levels have seen a statewide decline since 2010.
  - Figure 1 shows the significant difference from the winter of 2010-11 to winter 2021-22.
  - Both the surface and satellite data indicate this trend, a positive sign for continued improvements in air quality throughout Florida, including in the metropolitan areas and Everglades in South Florida.
  - While the decrease is most obvious over the longer period, it appears to have continued over recent years, though slight year-to-year oscillations make it difficult to definitively state this without more data.
- Surface data exhibited many of the same large-scale characteristics as the satellite data on a seasonal level, as seen in Figure 1.
  - This demonstrates the viability of our method of interpolating the surface data.
  - It also indicates the accuracy of the satellite dataset, further shown by the fact that surface measurements were usually within only 2-3 µg/m^3 of satellite values, despite some random month-to-month deviation.
- Once interpolated differences like those shown in Figure 3 are added to the satellite dataset, we will continue with a statistical analysis to identify any significant change in the Everglades Agricultural Area during harvest season before and after 2019.

References

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