Analysis of Modeled Wildfire Smoke Forecasts Using Ground Observed Aerosols

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Introduction

Wildfire smoke composition consists of particulate matter created by the burning of organic or manmade materials. Aerosols in the atmosphere come in different sizes; particulate matter of 2.5 micrometers and smaller arise concern for the general public because it is small enough to enter the bloodstream when inhaled. This makes it important to monitor where wildfire smoke will travel and in what capacity. The High Resolution Rapid Refresh (HRRR; http://rapidrefresh.noaa.gov/) model uses observations from polar-orbiting satellites to model smoke emissions and then traces the smoke aerosol. This is used to create a model and produce a smoke concentration forecast. In this research, control and experimental models are compared to the particulate matter observations taken from air quality stations.

Methods

- **PM 2.5 data comes from 4 western states and 58 air quality monitoring stations collected by AirNow (http://airnow.gov/). 31 of the stations recorded air temperature.**
- **Collected on July 28th and 29th, 2018.**
- **Forecasts ran over 12 hour intervals, one over the night and one during the day. Assessed at 12 and 0 UTC.**
- **Three categories of recorded data: observed, experimental, and control models.**
- **There are day and night measurements of PM 2.5 and temperature for each category.**
- **Difference, absolute error, and squared error between control-observed and experimental-observed were calculated for PM 2.5 and air temperature.**
- **Mean Error and Root Mean Squared Error were calculated for day, night, and overall time.**
- **Error values were plotted onto scatter graphs to evaluate the model and observed errors.**

Results

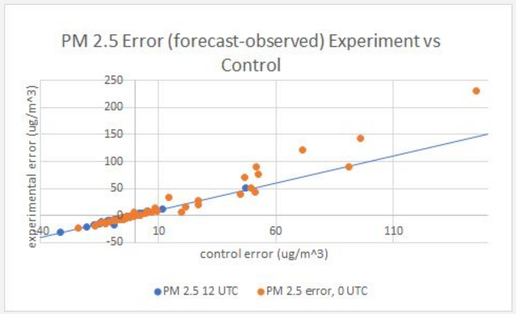

Fig. 1

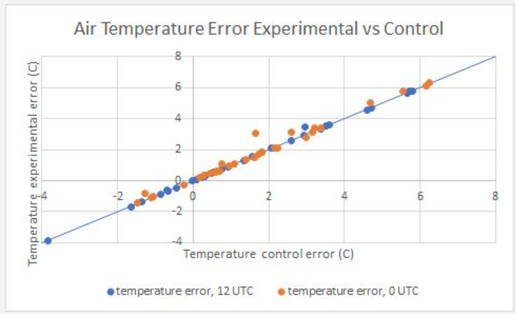

Fig. 2

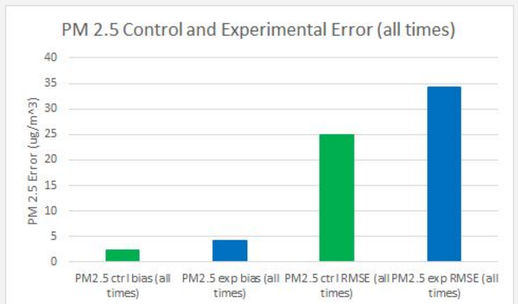

Fig. 3

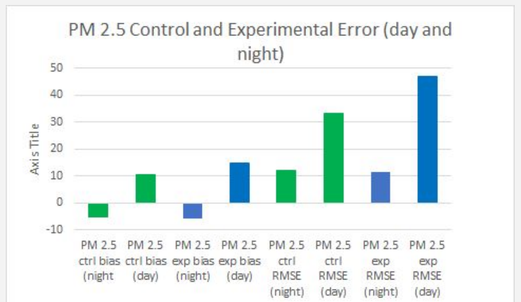

Fig. 4

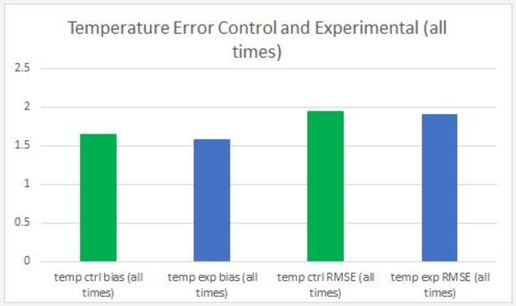

Fig. 5

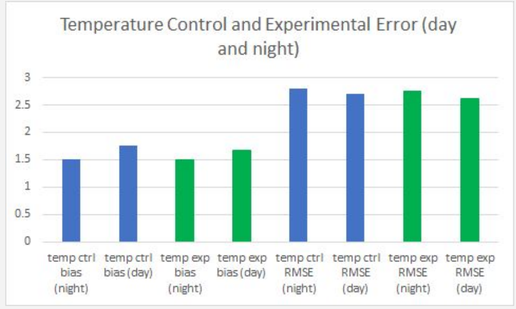

Fig. 6

Discussion

- **Results show that with the experimental smoke clearing model, air temperature forecast was improved slightly. This does follow with the original assessment's findings.**
- **PM 2.5 error values do not show an improving forecast and are degraded, providing mixed results between the two assessments.**
- **Either the experimental model needs a closer evaluation, or more aerosols were detected than just smoke. However, the high daytime bias of PM 2.5 in both the experiment and control models indicate that other aerosols were not the main source of error.**
- **Fig. 1 and fig. 2 portray the line y=x, not a trendline.**

Future Work

- **Analyzing a larger set of PM 2.5 data and averaging the aerosols that are not smoke could allow us to subtract the aerosols out, leaving only smoke PM 2.5 aerosols, giving a more accurate representation of smoke concentrations.**
- **A larger set of data, over a few weeks or months, as well as evenly spaced ground stations through more states in the U.S. would give us overall more accurate results and would tell us if HRRR placed too much of the smoke aerosol into the model (figure 1).**
- **Analyzing data from multiple wildfires would give a more inclusive data set and more beneficial results.**

References

Lahm, P. The United States Environmental Protection Agency. (2019). *Wildfire Smoke: A Guide for Public Health Officials: Ch. 2: Air Quality Impacts.* (Publication No. EPA-452/R-19-901).

Back, A., et al., 2020: Use of VIIRS Aerosol Optical Depth Information at NOAA GSL to Improve Smoke, Visibility, and Weather Forecasts in the Experimental High Resolution Rapid Refresh. *JCSDA Quart. Newsl. , No. 67*, Spring 2020, 1-7.

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