

Incorporation of Woodstove Emission Forecasts Based on Heating Degrees into the AIRPACT-3 Modeling System

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1. Introduction

In the Pacific Northwest, woodstove usage is very common in the winter and can lead to wood-burning emissions such as PM_{2.5} and CO. Thus, the ability to predict woodstove emissions is essential for predicting PM_{2.5} concentrations correctly in the AIRPACT-3 (Air Indicator Report for Public Awareness and Community Tracking) air quality forecast system. In AIRPACT-3, the SMOKE (Sparse Matrix Operator Kernel for Emissions) tool reads emissions inventory files and generates files that are used by CMAQ (Community Multi-scale Air Quality) model to predict pollutant concentrations. SMOKE uses temporal profiles to predict emissions at different times of the year, week, and day. This project develops the capability to use model-forecast temperatures interpreted as heating degrees (base 50 F) to model woodstove usage and hence emissions. This involves modifying AIRPACT-3 and SMOKE scripting to separate woodstove emissions and then applying a temperature (heating degree) adjustment to generate hourly woodstove emissions. These heating-degree method results will then be compared against previous method results, both as emissions patterns in space and time and also as final AIRPACT-3 CMAQ PM_{2.5} results.

2. Separation of woodstove emissions

- There has been some over estimation of PM_{2.5} in large cities and some under estimation of PM_{2.5} in small towns.
- Woodstove emissions were turned off to be able to separate it from other emissions and focus on implementing a new calculation for woodstove emissions. This was also done to isolate woodstove emissions to implement the new method.
- Created a zero temporal profile and used the reference file to call the zero temporal profiles for woodstoves which turned off woodstove emissions.
- Below there is a major difference in the woodstove PM_{2.5} after the temporal adjustment was made. The figures demonstrate the amount of PM_{2.5} that is predicted by woodstoves alone.

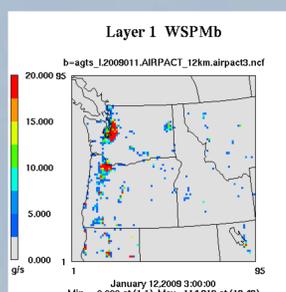


Figure 1 PM_{2.5} emissions from woodstoves within the Pacific northwest region.

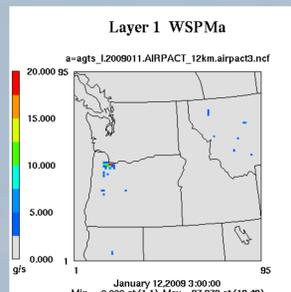
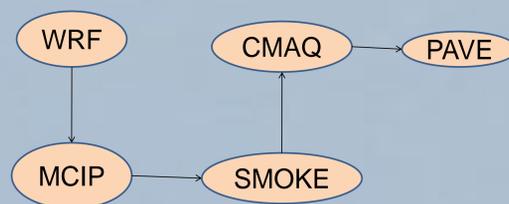


Figure 2 PM_{2.5} emissions from woodstoves temporal profiles turned off.

1. WRF (Weather Research and Forecasting model) - First the weather forecast is produced by the WRF model.
2. MCIP (Meteorology-Chemistry interface Processor) - The second step is MCIP. MCIP receives WRF output files and produces meteorological files that can be used by SMOKE. It outputs the files in input/output applications programming interface (I/O API) format which is then used by SMOKE.
3. SMOKE uses the MCIP output files and uses them in the script to create a speciated matrix of every pollutant and its value using temporal profiles.
4. CMAQ - then takes the output of SMOKE and produces a multi-layer effect of the emissions that came from SMOKE. It also shows the advection of emissions at different layers of the atmosphere.
5. PAVE - uses CMAQ files and develops a spatial projection of the concentration of pollutants.

Overview of AIRPACT-3



3. Producing only Woodstove emissions

- To produce only woodstove emissions the area reference file for SMOKE was adjusted to turn off all other emissions using the same zero temporal profiles previously created and applying them to all other emissions. Figures three and four demonstrate the differences which occurred to Nitrogen Monoxide after the zero profiles were applied.

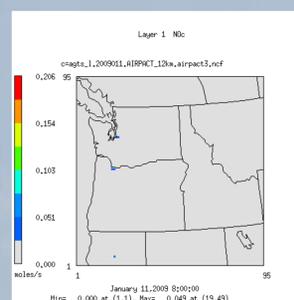


Figure 3 Nitrogen Monoxide emissions for the Pacific Northwest region after zeroing temporal profiles.

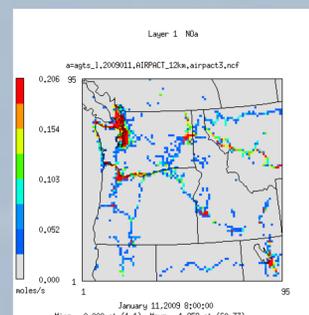


Figure 4 Nitrogen Monoxide emissions from woodstove in the Pacific Northwest

4. Incorporation of heating degrees

- Changed area inventory file so that it has tons per heating degree day (base 50) day (T/(hdd-50)-day).
- Adjusted the SMKINVEN file to treat the data as weekends so that it could go day by day instead of having a weekly cycle.
- Adjusted the Temporal file to read the daily emissions instead of yearly emissions.
- Then a temperature adjustment will be multiplied to the output of SMKMERGE. SMKMERGE combines Temporal, grdmat, and spcmat together.
 - Temporal sets up an hourly emissions distribution.
 - Grdmat outputs a grid with all of the allocations.
 - Spcmat speciates the emissions into different types of emissions.

5. Conclusion

- This work is still in progress. The anticipated results will be as follows:
 - The woodstove emissions will be calculated according to the temperature and not the date.
 - Woodstove emissions will be closer to emulating the usage of woodstoves since temperature effects will be treated explicitly.
 - The model predictions of woodstove emissions would be more accurate.

6. Future Work

- If the results prove that the changes made are beneficial then there will be a script produced to calculate woodstoves separately from the rest of the emissions and then merge the two.

Acknowledgements

I want to thank S. Pressley for the opportunity. I would also like to thank R. Gonzalez-Abraham, K. Christian, A. Arroyo for assistance with my project. This work was supported by the National Science Foundation's REU program under grant number