Extending AIRPACT-5 Forecasts to Three Days

NW-AIRQUEST Meeting
26 October 2023

Presented by:
Amin Vahidi
Joe Vaughan
Von Walden

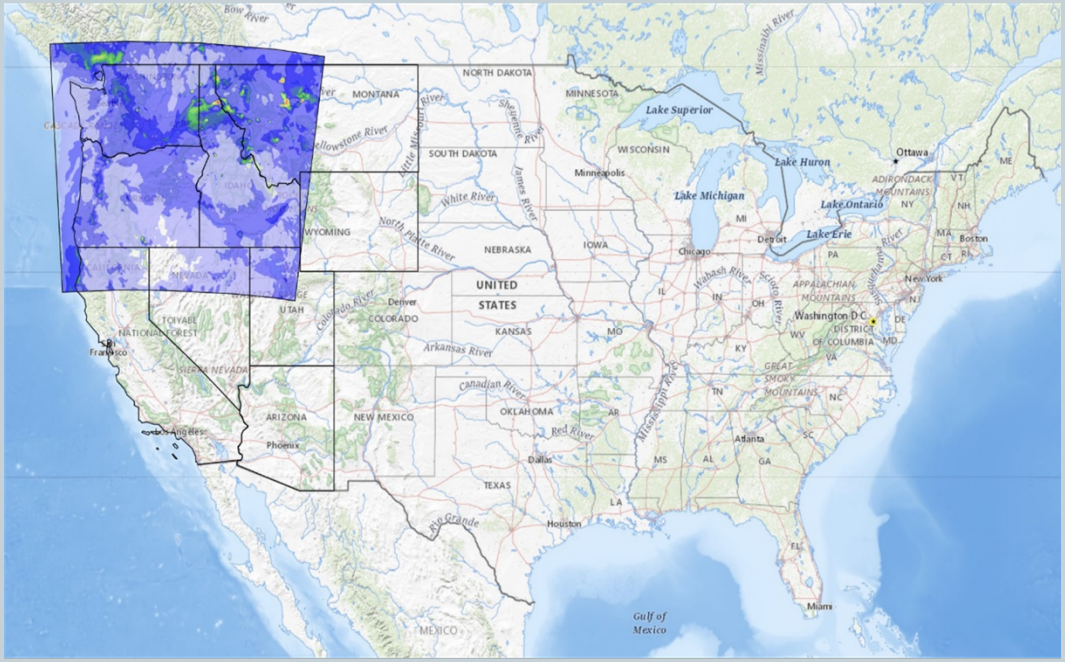
from LAR/CEE/WSU

Review

- AIRPACT (Air Indicator Report for Public Awareness and Community Tracking)
- a complex air quality forecasting system that predicts air pollutants concentrations and depositions
- developed at Washington State University in 2001 and has been operating for over 20 years
- currently provides a 48-hour (2-day) forecast

Introduction

- Model Domain : WA, OR, and ID; W MT; NW WY; N CA, NV, and UT; S Canada
- Grid Resolution : horizontal 4 km x 4 km; vertical 37 layers



Model Configuration

- 3 emission categories: anthropogenic, natural, and wildfire
  - Anthropogenic - National Emissions Inventory
  - Biogenic – MEGAN (Model of Emissions of Gases and Aerosols from Nature)
  - Wildfires – USFS BlueSky Pipeline
- UW WRF v4.1.3 used with MCIP v5.1
- SMOKE v3.5.1 assigns the emissions
- CMAQ (Community Multiscale Air Quality) model, v5.0.2

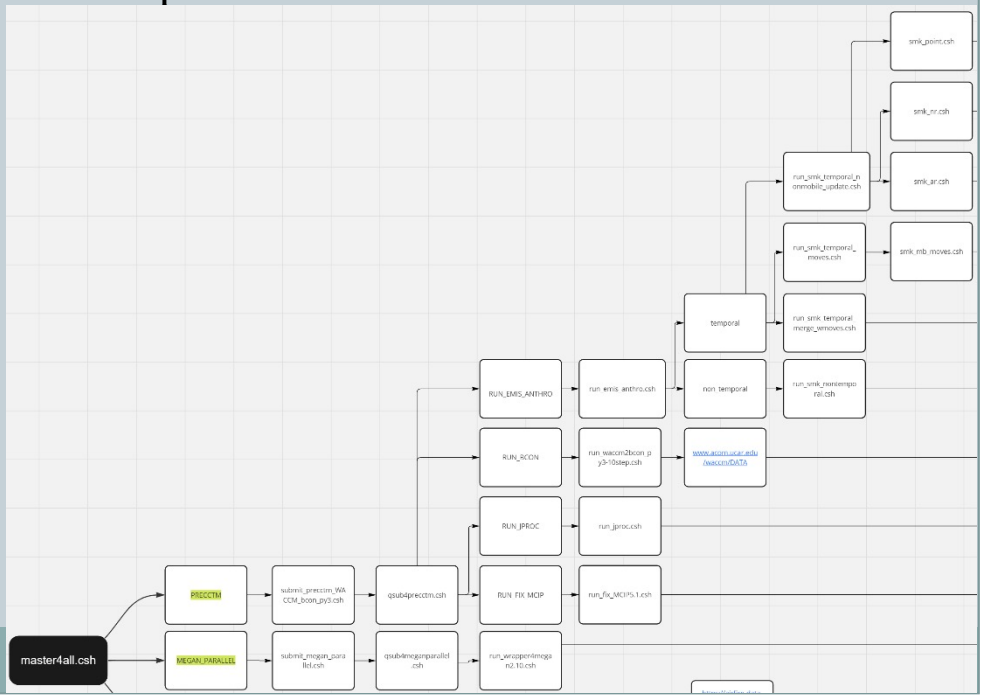
Goals

- Extend the forecast period to 72 hours (3 days)
- Provide initial evaluation of forecast performance

Materials and Methods

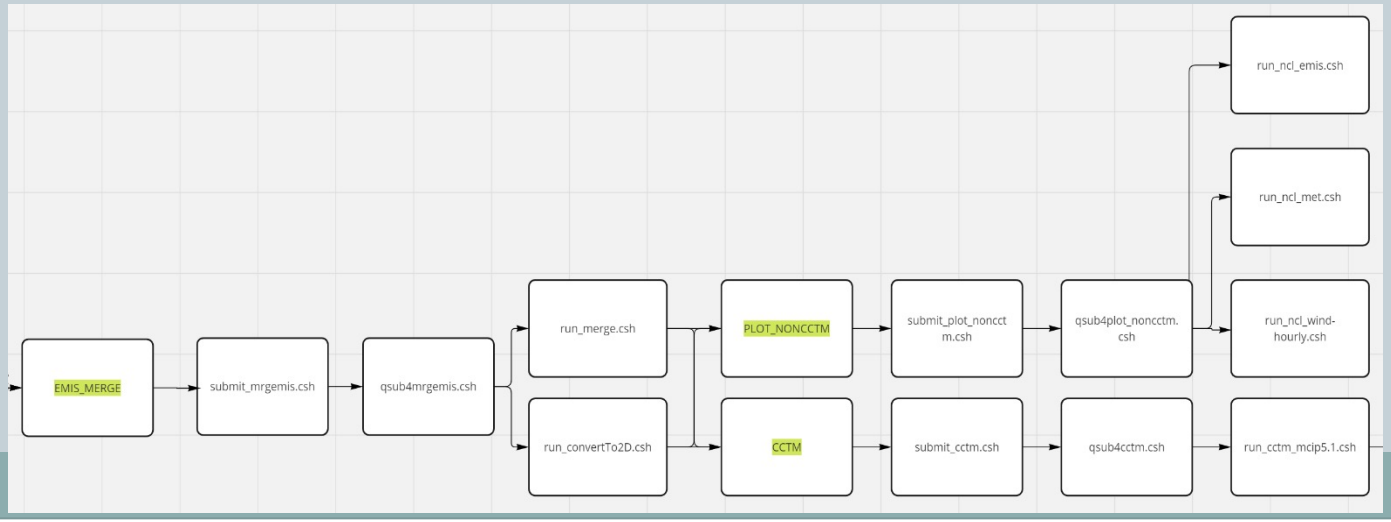
Creating and Testing 9 main scripts for DAY3:

- 1. megan
- 2. precctm
  - Fix_MCIP
  - WACCM_BCON :
    - The Whole Atmosphere Community Climate Model
    - Template bcon file and Python code were updated.
    - Increasing the time-step to 14
    - 1 additional file were downloaded.
  - JPROC
  - Emis_Anthro
    - Nonmobile
      - Point
      - Nroad
      - Area
    - Moves
    - Merge



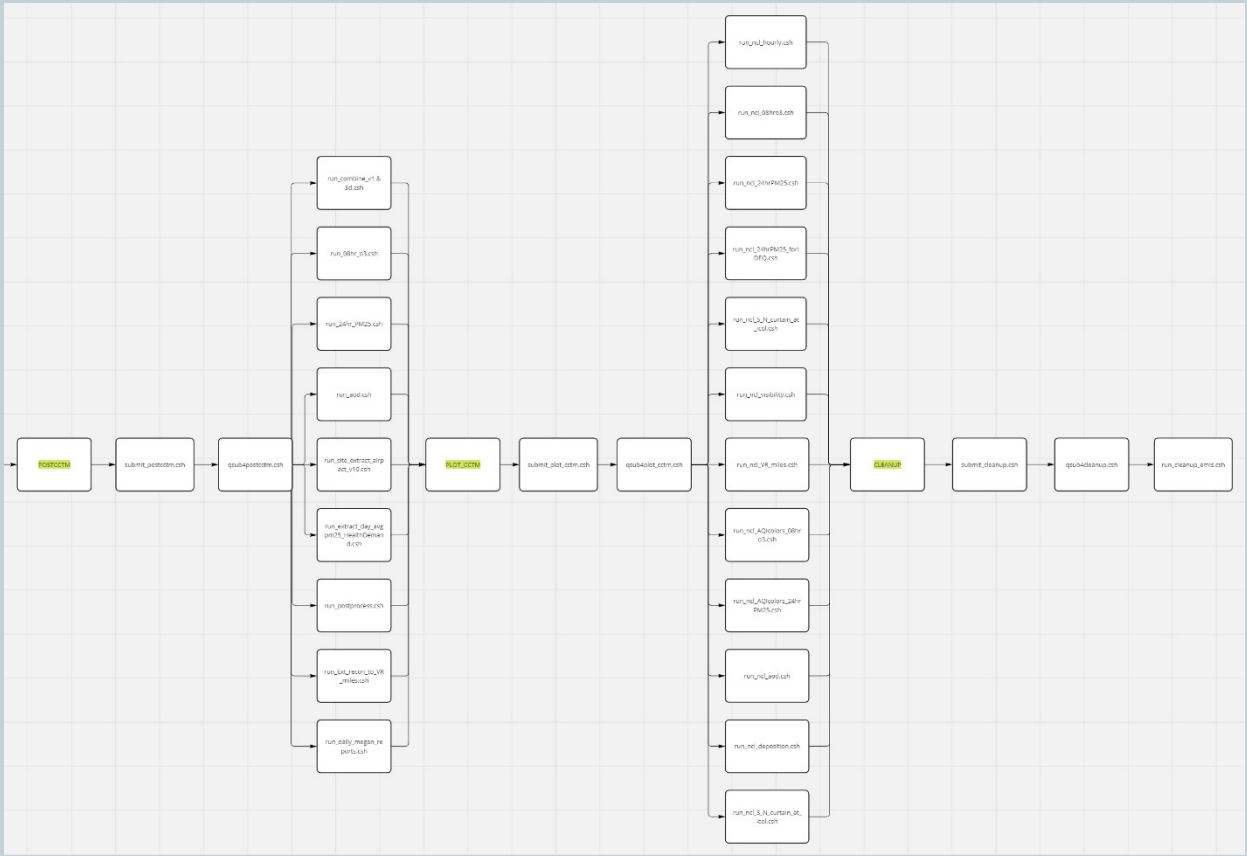
Materials and Methods

- 3. fireemis
- 4. mrgemis
- 5. plot_noncctm
  - Met
  - Emis
- 6. cctm (CMAQ Chemistry-Transport Model)



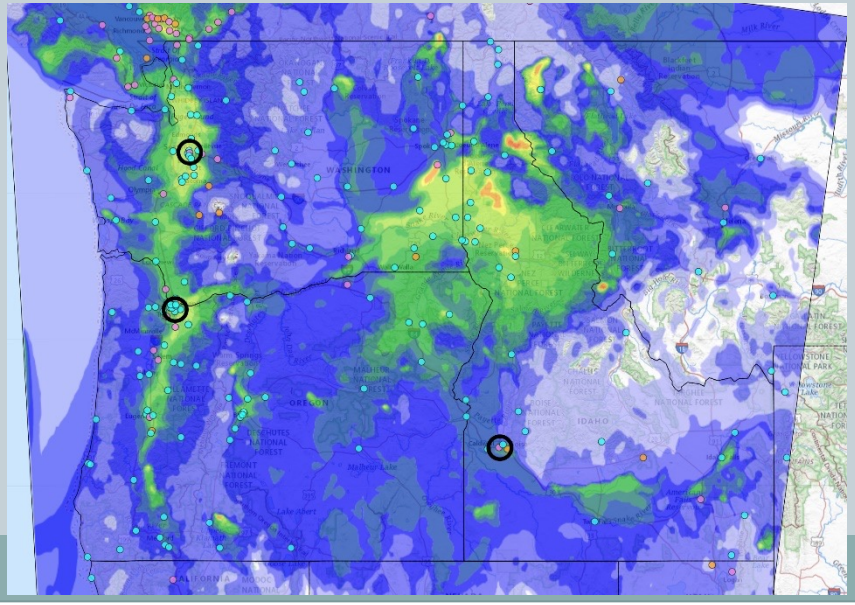
Materials and Methods

- 7. postcctm
  - Combine
  - 8 hr O3
  - 24 hr PM2.5
  - Site_extract, …
- 8. plot_cctm
  - Hourly
  - 8 hr O3
  - 24 hr PM2.5
  - AQI, …
- 9. Cleanup
- Master4all_day3



Materials and Methods

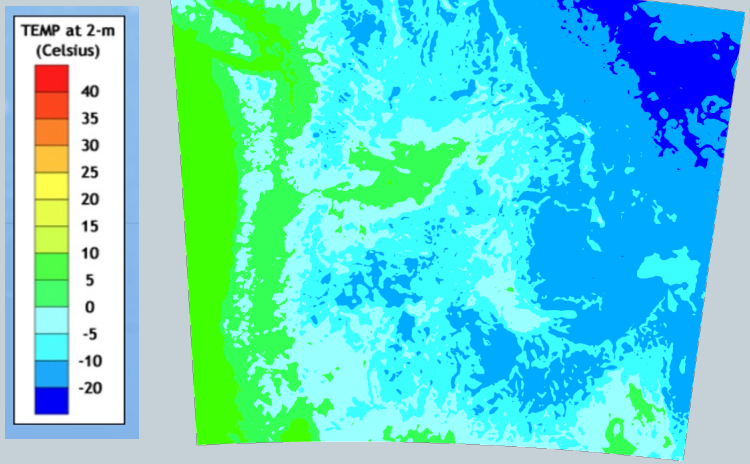
- 3-day AIRPACT forecasts were run for 11 March 2023 and 15 May 2023
- Forecasts results for Day 1, Day 2 and Day 3 were compared against observations
- Observations were obtained from 3 urban monitoring stations (Seattle-Beacon Hill, Portland-SE Lafayette and Boise-St. Lukas Meridian)

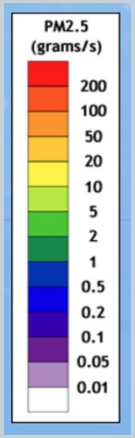


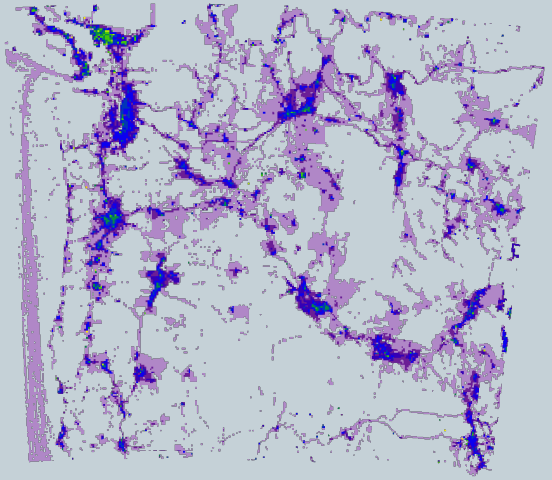
Materials and Methods

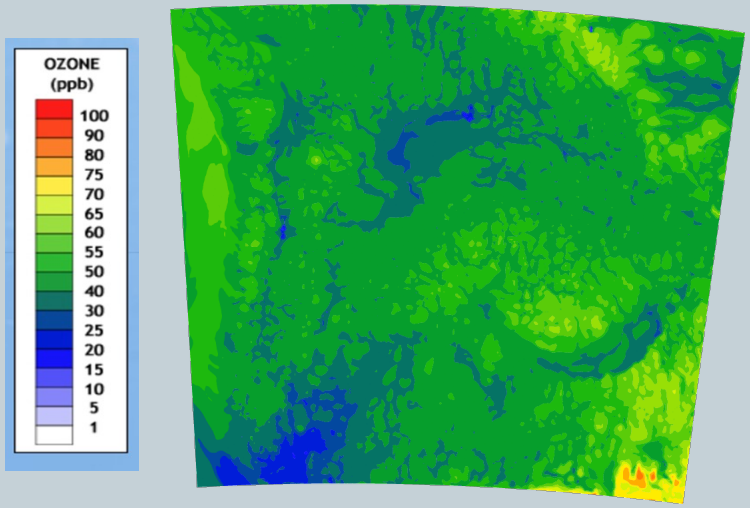
- Mcip for Day3: UW Rainier Cluster
- 7 scripts:
- AQSIM_AIRPACT5_wMCIP5.1.pl
  - AQSIM_MCIP5.1_AIRPACT5_DAY3.pl
    - AIRPACT_to_Aeolus_MCIP5.1_DAY3.pl
      - AP5_DAY3_ssh_Aeolus.csh
      - AP5_mcip5.1_37_DAY3.csh
        - Mcip5.1_AP5_37_DAY3.csh
        - Rsync_MCIP5.1_37_DAY3.csh

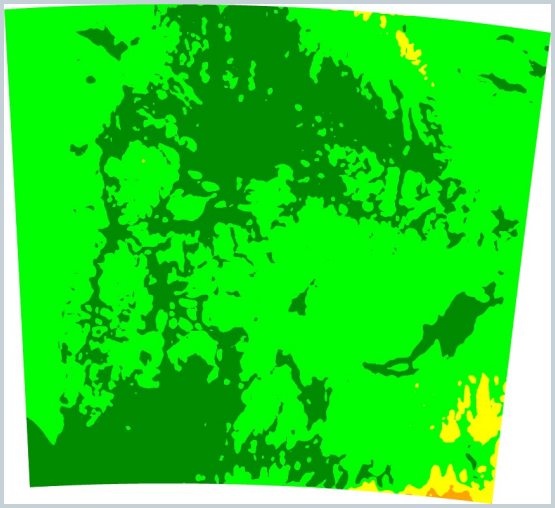
Results (Plots)



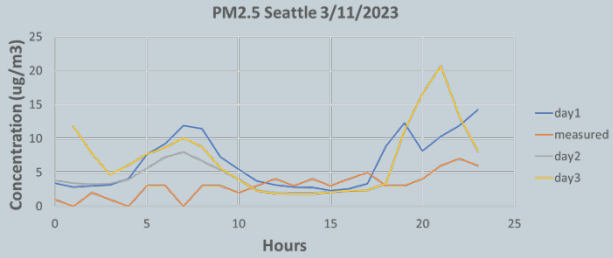


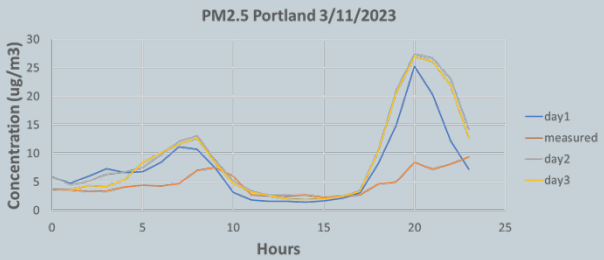


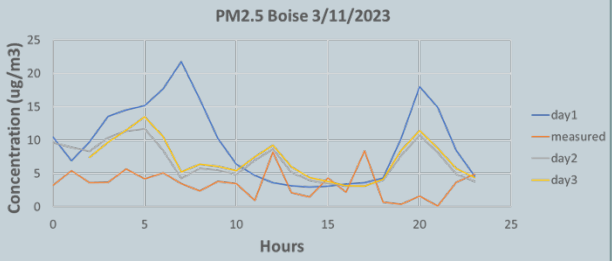


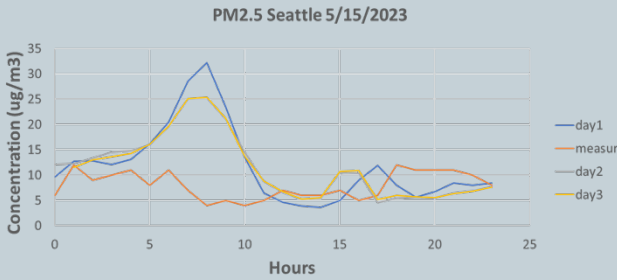


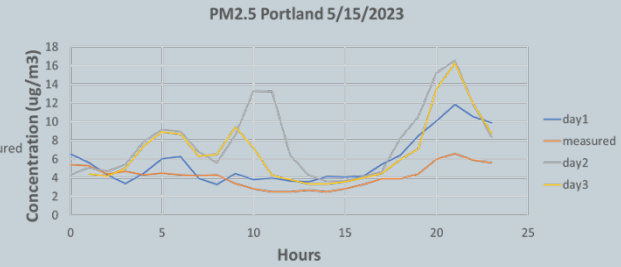
Results (PM2.5)

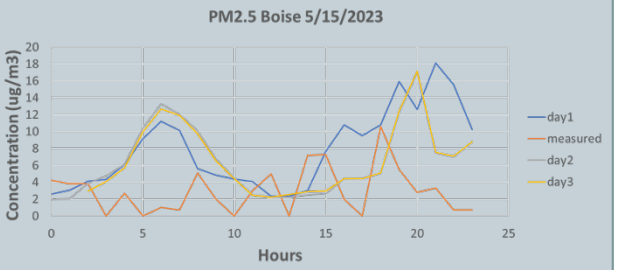




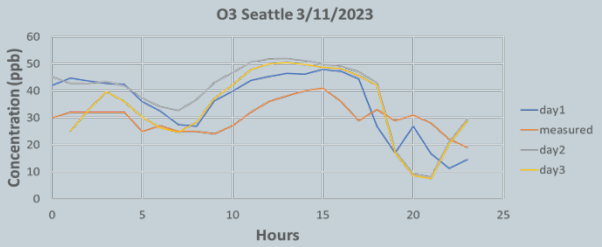


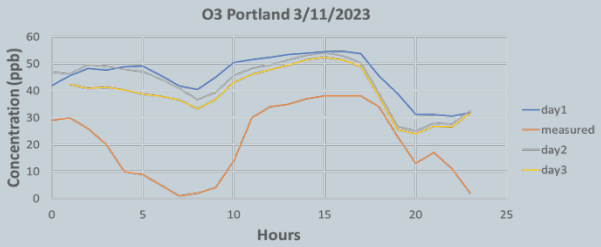


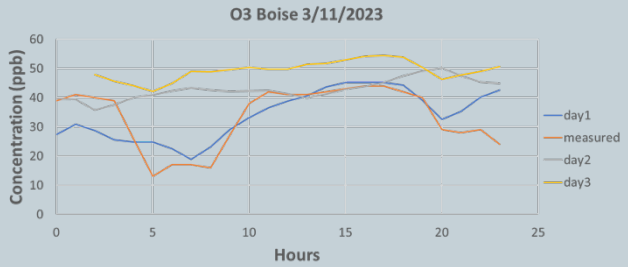


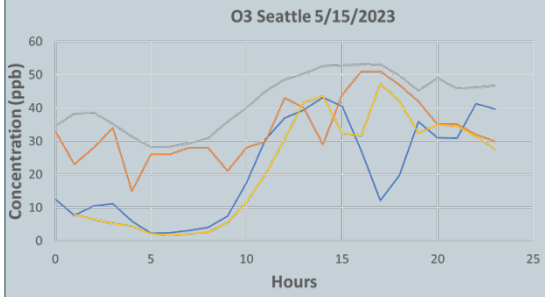


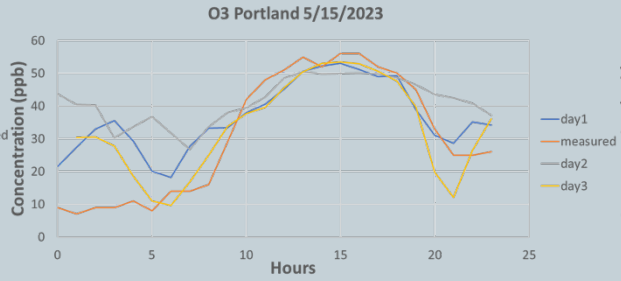
Results (O3)

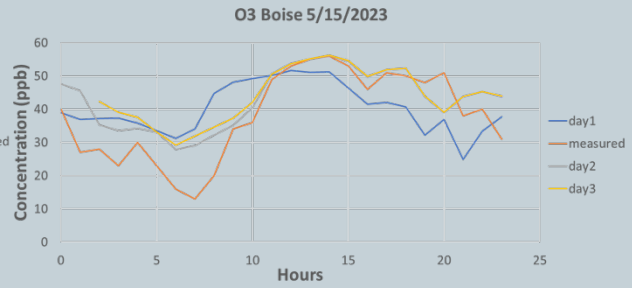

O3 Seattle 3/11/2023
Concentration (ppb)
Hours
day1
measured
day2
day3


O3 Portland 3/11/2023
Concentration (ppb)
Hours
day1
measured
day2
day3


O3 Boise 3/11/2023
Concentration (ppb)
Hours
day1
measured
day2
day3


O3 Seattle 5/15/2023
Concentration (ppb)
Hours
day1
measured
day2
day3


O3 Portland 5/15/2023
Concentration (ppb)
Hours
day1
measured
day2
day3


O3 Boise 5/15/2023
Concentration (ppb)
Hours
day1
measured
day2
day3

Results

- Root Mean Square Error
- Method as a technique

RMSE (µg/m³)								
PM2.5								
Day1			Day2			Day3		
S	P	B	S	P	B	S	P	B
3.65	2.27	5.48	2.51	4.25	3.39	6.63	5.08	3.87

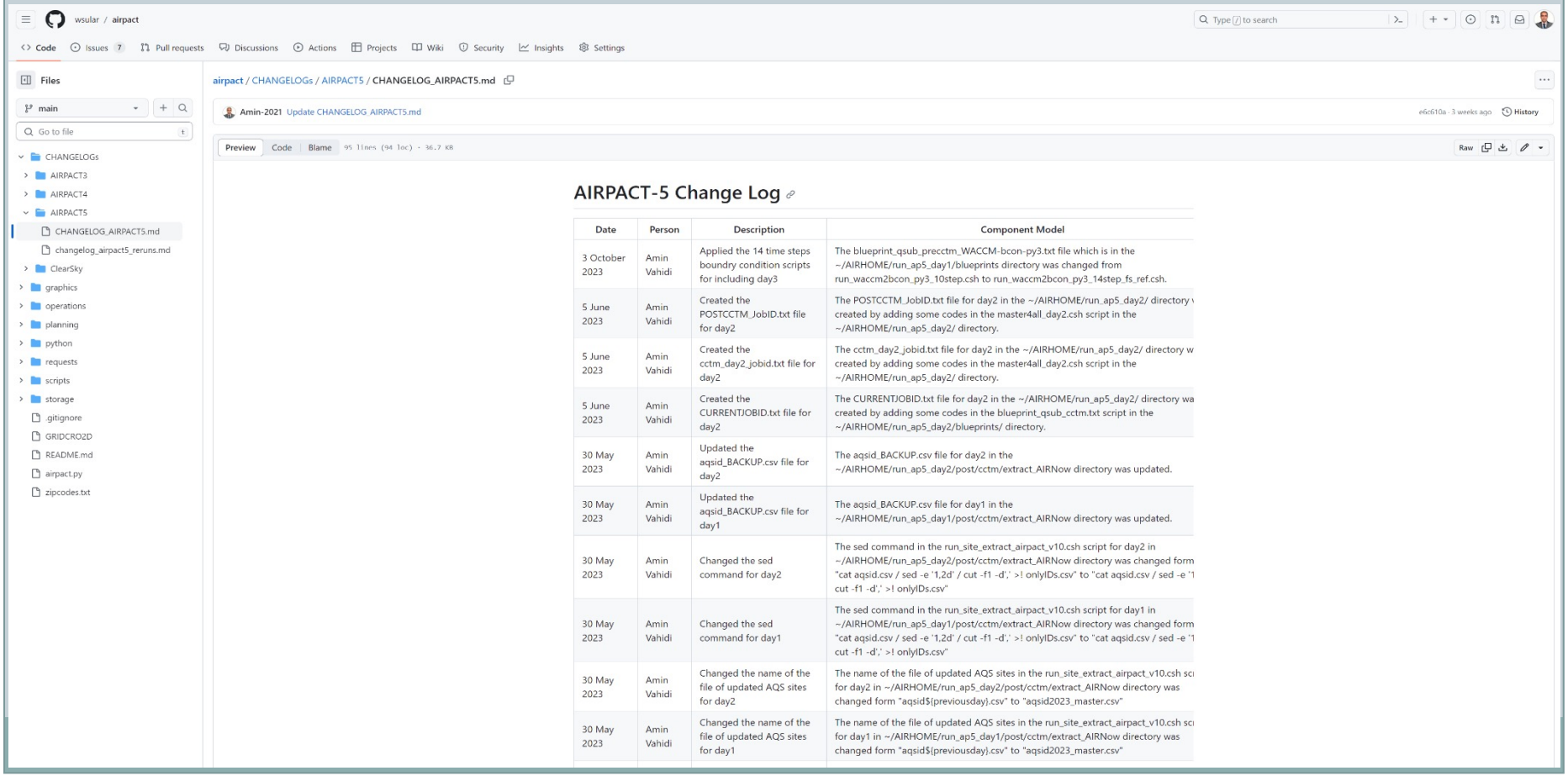
RMSE (ppb)								
O3								
Day1			Day2			Day3		
S	P	B	S	P	B	S	P	B
9.19	17.78	1.71	6.99	4.25	7.54	6.63	7.04	16.65

Conclusion

- AIRPACT has the ability to provide a 3-day (72-hour) forecast (using a similar method for the Day 2 forecast)
- The PM2.5 forecasts for Day 2 and Day 3 are similar, especially near the end of the day
- Mostly of both PM2.5 and Ozone are overpredicted for Day 1, Day 2 and Day 3
- These conclusions are preliminary because only 2 days were forecasted.
- Plan: Compare the monthly and seasonal results of Day1, Day2 and Day3
- Remaining Issue: Timing

CHANGELOGs

- https://github.com/wsular/airpact/blob/main/CHANGELOGs/AIRPACT5/CHANGELOG_AIRPACT5.md



wsular / airpact

Code | Issues 7 | Pull requests | Discussions | Actions | Projects | Wiki | Security | Insights | Settings

Files

main

Go to file

- CHANGELOGs
  - AIRPACT3
  - AIRPACT4
  - AIRPACT5
    - CHANGELOG_AIRPACT5.md
    - changelog_airpact5_reruns.md
  - ClearSky
  - graphics
  - operations
  - planning
  - python
  - requests
  - scripts
  - storage
  - .gitignore
  - GRIDCRO2D
  - README.md
  - airpact.py
  - zipcodes.txt

airpact / CHANGELOGs / AIRPACT5 / CHANGELOG_AIRPACT5.md

Amin-2021 Update CHANGELOG AIRPACT5.md — e6c610a · 3 weeks ago — History

Preview | Code | Blame — 95 lines (94 loc) · 36.7 KB — Raw

AIRPACT-5 Change Log

Date	Person	Description	Component Model
3 October 2023	Amin Vahidi	Applied the 14 time steps boundry condition scripts for including day3	The blueprint_qsub_precctm_WACCM-bcon-py3.txt file which is in the ~/AIRHOME/run_ap5_day1/blueprints directory was changed from run_waccm2bcon_py3_10step.csh to run_waccm2bcon_py3_14step_fs_ref.csh.
5 June 2023	Amin Vahidi	Created the POSTCCTM_JobID.txt file for day2	The POSTCCTM_JobID.txt file for day2 in the ~/AIRHOME/run_ap5_day2/ directory v created by adding some codes in the master4all_day2.csh script in the ~/AIRHOME/run_ap5_day2/ directory.
5 June 2023	Amin Vahidi	Created the cctm_day2_jobid.txt file for day2	The cctm_day2_jobid.txt file for day2 in the ~/AIRHOME/run_ap5_day2/ directory w created by adding some codes in the master4all_day2.csh script in the ~/AIRHOME/run_ap5_day2/ directory.
5 June 2023	Amin Vahidi	Created the CURRENTJOBID.txt file for day2	The CURRENTJOBID.txt file for day2 in the ~/AIRHOME/run_ap5_day2/ directory wa created by adding some codes in the blueprint_qsub_cctm.txt script in the ~/AIRHOME/run_ap5_day2/blueprints/ directory.
30 May 2023	Amin Vahidi	Updated the aqsid_BACKUP.csv file for day2	The aqsid_BACKUP.csv file for day2 in the ~/AIRHOME/run_ap5_day2/post/cctm/extract_AIRNow directory was updated.
30 May 2023	Amin Vahidi	Updated the aqsid_BACKUP.csv file for day1	The aqsid_BACKUP.csv file for day1 in the ~/AIRHOME/run_ap5_day1/post/cctm/extract_AIRNow directory was updated.
30 May 2023	Amin Vahidi	Changed the sed command for day2	The sed command in the run_site_extract_airpact_v10.csh script for day2 in ~/AIRHOME/run_ap5_day2/post/cctm/extract_AIRNow directory was changed form "cat aqsid.csv / sed -e '1,2d' / cut -f1 -d',' >! onlyIDs.csv" to "cat aqsid.csv / sed -e '1 cut -f1 -d',' >! onlyIDs.csv"
30 May 2023	Amin Vahidi	Changed the sed command for day1	The sed command in the run_site_extract_airpact_v10.csh script for day1 in ~/AIRHOME/run_ap5_day1/post/cctm/extract_AIRNow directory was changed form "cat aqsid.csv / sed -e '1,2d' / cut -f1 -d',' >! onlyIDs.csv" to "cat aqsid.csv / sed -e '1 cut -f1 -d',' >! onlyIDs.csv"
30 May 2023	Amin Vahidi	Changed the name of the file of updated AQS sites for day2	The name of the file of updated AQS sites in the run_site_extract_airpact_v10.csh sc for day2 in ~/AIRHOME/run_ap5_day2/post/cctm/extract_AIRNow directory was changed form "aqsid${previousday}.csv" to "aqsid2023_master.csv"
30 May 2023	Amin Vahidi	Changed the name of the file of updated AQS sites for day1	The name of the file of updated AQS sites in the run_site_extract_airpact_v10.csh sc for day1 in ~/AIRHOME/run_ap5_day1/post/cctm/extract_AIRNow directory was changed form "aqsid${previousday}.csv" to "aqsid2023_master.csv"

MAC-MAQ Conference (September 2023-Davis,CA)

Extending AIRPACT-5 Forecasts to Three Days

Mohammadamin Vahidi Ghazvini, Joseph K. Vaughan, and Von P. Walden

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Website: https://airpact.wsu.edu/

1. Introduction

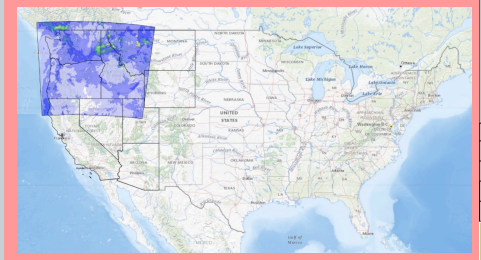
The AIRPACT (Air Indicator Report for Public Awareness and Community Tracking) model, version 5, is a complex air quality forecasting system that predicts air pollutants concentrations and depositions. It was developed at Washington State University in 2001 and has been operating for over 20 years. The model currently provides a 48-hour (2-day) forecast.

Our goals are to:

- **Extend the forecast period to 72 hours (3 days)**
- **Provide initial evaluation of forecast performance**

2. Model Configuration

- UW WRF 4.1.3 coupled to CMAQ
- Model Domain – WA, OR, and ID; W MT; NW WY; N CA, NV, and UT; S Canada
- Grid Resolution - horizontal: 4 km x 4 km; vertical: 37 layers
- 3 emission categories: anthropogenic, natural, and wildfire
  - Anthropogenic - National Emissions Inventory
  - Biogenic – MEGAN
  - Wildfires – USFS BlueSky Pipeline
- SMOKE 3.5.1 combines the emissions
- UW WRF and SMOKE output are used as input to the CMAQ (Community Multiscale Air Quality) model, v5.0.2
- CMAQ simulates atmospheric transport, dispersion, and deposition of air pollutants.



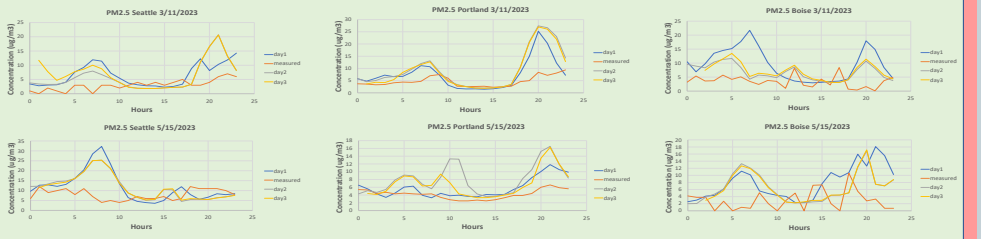
Acknowledgments

This research was supported by NW-AIRQUEST Consortium.

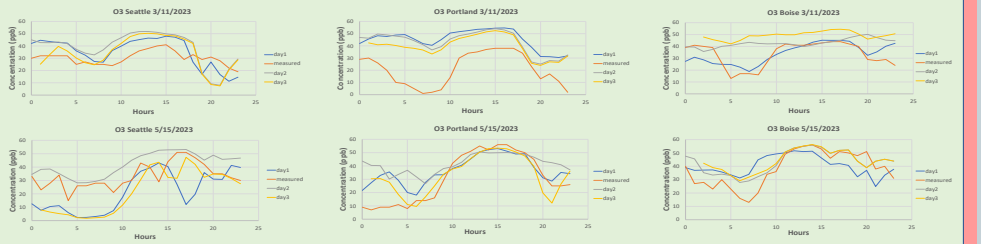
3. Results

- 3-day AIRPACT forecasts were run for **11 March 2023** and **15 May 2023**
- Forecasts results for Day 1, Day 2 and Day 3 were compared against observations
- Observations were obtained from 3 urban monitoring stations (**Seattle-Beacon Hill, Portland-SE Lafayette and Boise-St. Lukas Meridian**)

PM2.5



Ozone



RMSE (µg/m3)									RMSE (ppb)								
PM2.5 at S: Seattle, P: Portland, and B: Boise									O3 at S: Seattle, P: Portland, and B: Boise								
Day1			Day2			Day3			Day1			Day2			Day3		
S	P	B	S	P	B	S	P	B	S	P	B	S	P	B	S	P	B
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4. Conclusion

- AIRPACT has the ability to provide a 3-day (72-hour) forecast (using a similar method for the Day 2 forecast)
- The PM2.5 forecasts for Day 2 and Day 3 are similar, especially near the end of the day
- Both PM2.5 and Ozone are overpredicted for Day 1, Day 2 and Day 3
- These conclusions are preliminary because only 2 days were forecasted. The Day 3 forecast will be added operationally in October 2023.

Thank you!