USING AIRPACT FOR AIR QUALITY FORECASTING SUPPORT

NW-AIRQUEST ANNUAL MEETING, JUNE 9-11, 2020

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WASHINGTON STATE UNIVERSITY

TOPICS (SLIDE #):

- What is AIRPACT? (3)
- Domain and Grid (4)
- The AIRPACT Framework (5)
- AIRPACT website Introduction (6-8)
- Training Objective and Resources (9)

SWITCH TO LIVE DEMO →

or

- Additional Slides for Tour of Website (10-25)

LIVE DEMO:

- Homepage Tour
- Animated Maps
- Layers, submenus and options
- Winds
- Ventilation Index
- Boundary Conditions
- Curtain Plots
- Performance Plots (2 ways) and Stats
- Kalman Filter Bias-corrected PM2.5
- (ML Forecast for Tri-Cities Ozone?)

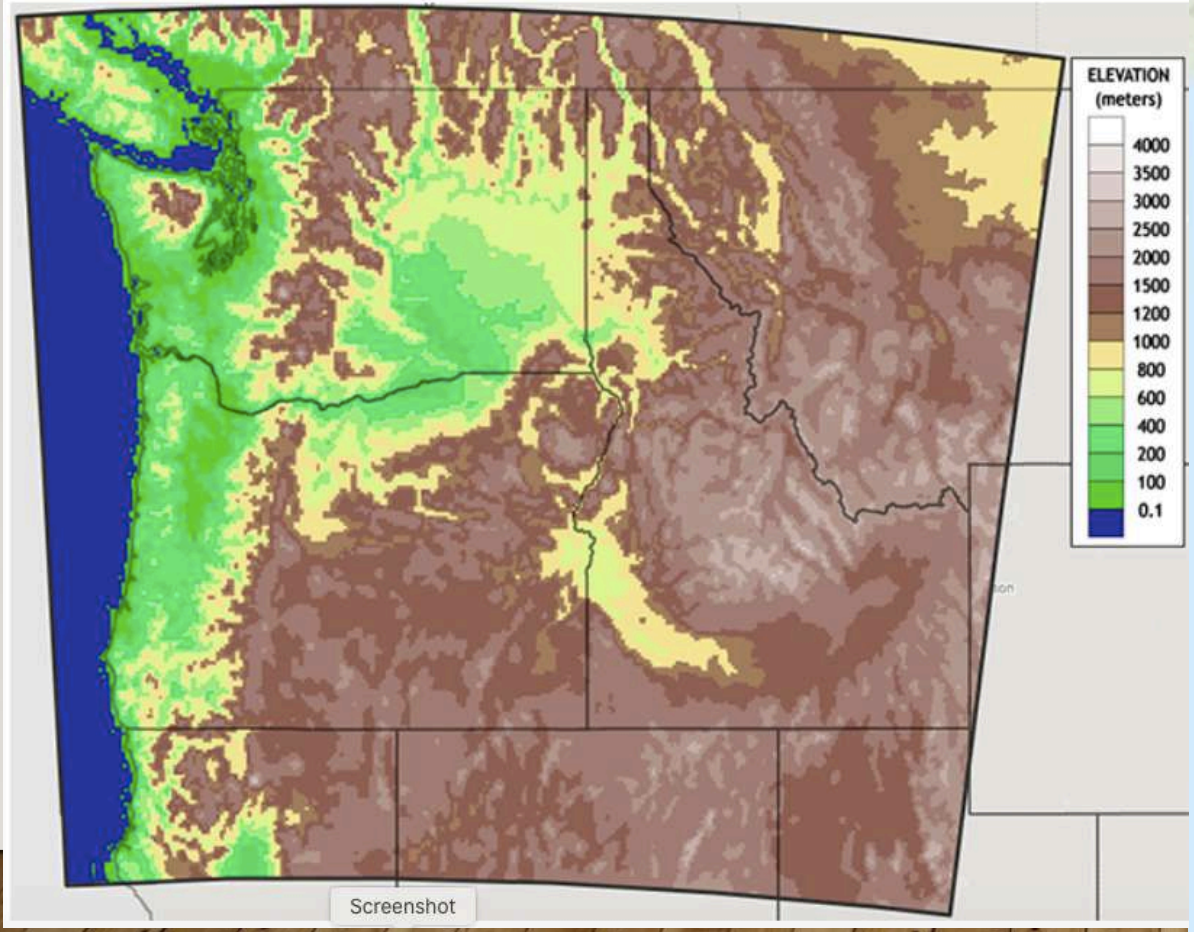
WHAT IS AIRPACT v5 (AIRPACT5)?

- Automated (computerized) system for predicting air quality (AQ) for 2 days for the Pacific and Inland NW, running overnight, daily.
- AIRPACT calculates the chemistry and physics of AQ as determined by multiple processes, including:
  - Emission,
  - Dilution,
  - Chemical Reactions,
  - Aerosol Physics,
  - Removal Processes:
    - Dry deposition and
    - Rainout.
- Pollutant emissions are (along with meteorology) major inputs affecting AQ.
- Emissions are calculated referring to detailed spatial databases:
  - land use,
  - traffic volumes,
  - industrial emissions,
  - and natural emissions, including…
  - dynamic near-real time WILDFIRE emission!
- AIRPACT also has built in performance tracking.

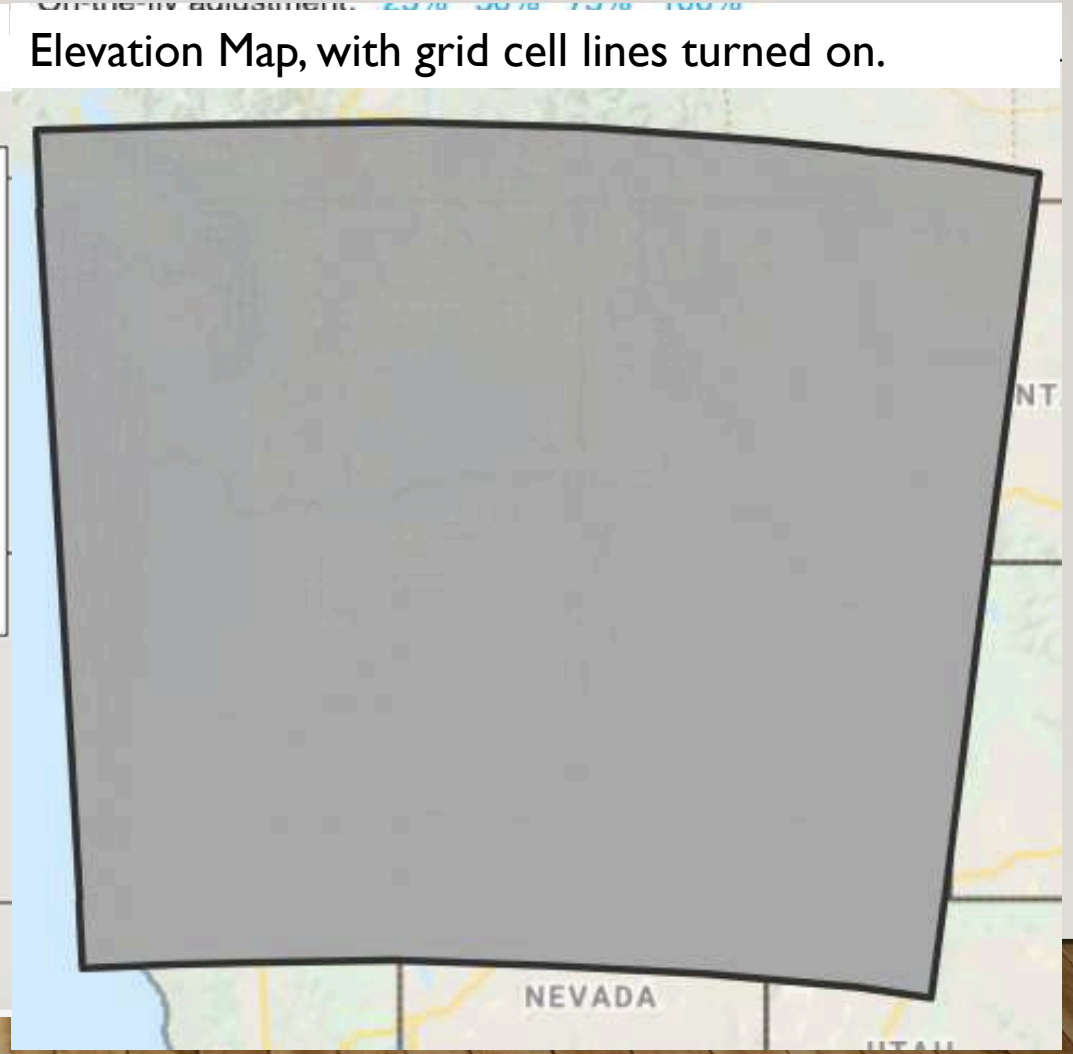
DOMAIN:

- … a "4-km domain," meaning a grid of 4 km by 4 km cells, numbering 258 columns (West to East) by 258 rows (South to North), for ~73,530 cells in the 2-D surface layer,. With 37 vertical layers, ~ 2.72 million cell volumes, each requiring the solution of governing AQ equations.

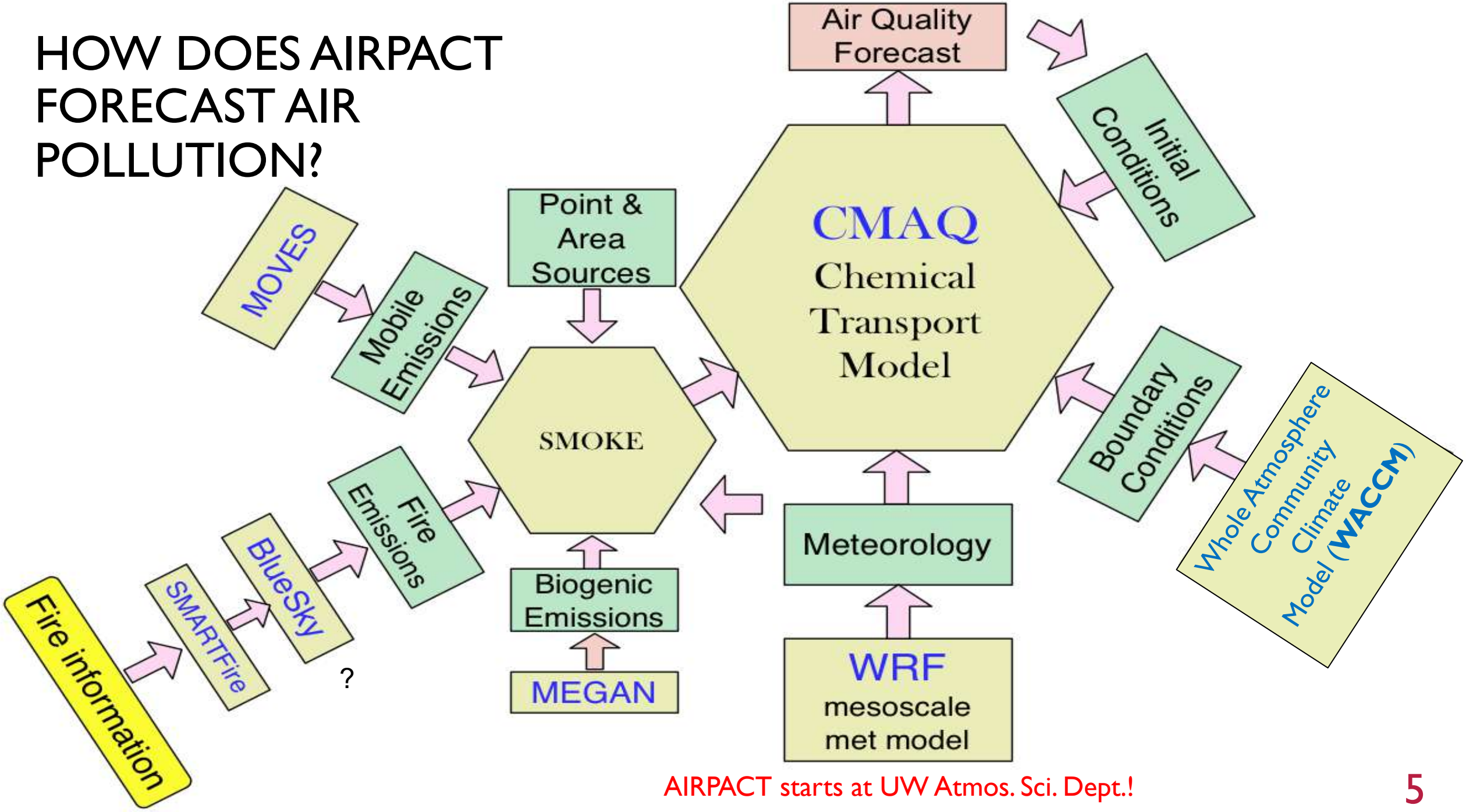
Elevation Map of AIRPACT Domain



Elevation Map, with grid cell lines turned on.



HOW DOES AIRPACT FORECAST AIR POLLUTION?



AIRPACT starts at UW Atmos. Sci. Dept.!

WEBSITE FOR AIRPACT AQ FORECASTING PRODUCTS: HTTP://LAR.WSU.EDU/AIRPACT

- Map view animations of hourly meteorology, emissions and pollutants
- Curtain plots showing boundary conditions and S-N and W-E transects
- Performance Plots showing forecast performance by date for monitoring sites
- Tri-Cities Machine Learning Ozone Forecast (solution independent of AIRPACT)
- Coming Soon: Bias Corrected 24-hr Daily Average PM2.5 AIRPACT forecast
- And More…

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Air-quality forecasting for the Pacific Northwest

AIRPACT

1) See new content under Intro to AIRPACT.
2) Try new Lat/Long read-out for cursor position located below animated maps on the right.

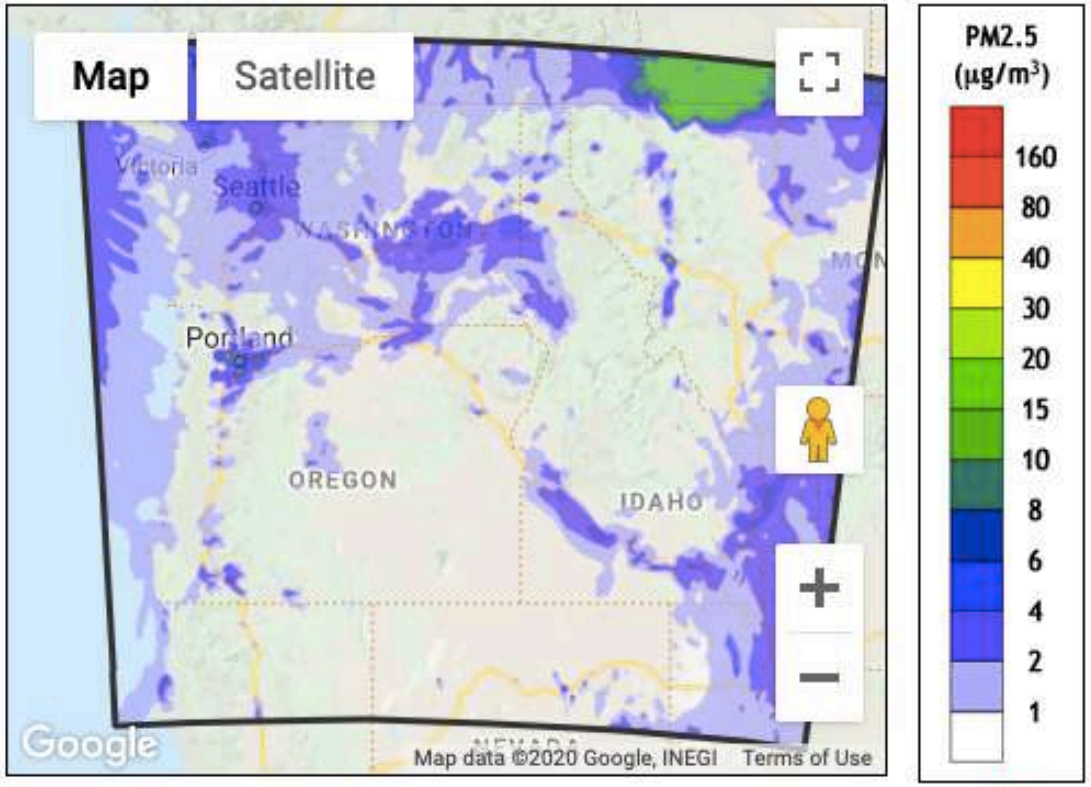
AIRPACT Home
Graphics Products
LAR Home

Intro to AIRPACT
Domain
Collaborators
Background
Change Log
News
Disclaimer
Contact

Activities/Related Programs:

NW-AIRQUEST
AIRNow
BioEarth
BlueSky
CEREO
FireBC
WRF Forecasting
NSPIRE
WSU Laboratory for Atmospheric Research

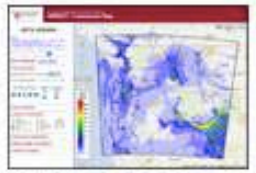
Today's PM2.5 Modeling Prediction



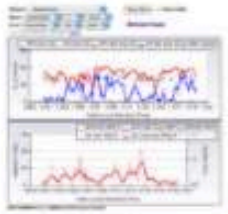
AIRPACT-5

May 19, 2020
07:00:00 PST

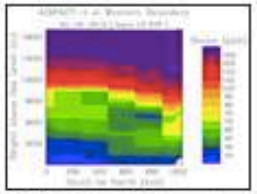
Today's SMOKE Forecast



AIRPACT-5 imagery



AIRPACT Performance



AIRPACT-5 Boundary Conditions

Tri-Cities Ozone Forecast

WASHINGTON STATE UNIVERSITY

Air-quality forecasting for the Pacific Northwest

AIRPACT

1) See new content under Int
AIRPACT.
2) Try new Lat/Long read-out
position located below anima
the right.

Recent Announcements

- AIRPACT Home
- Graphics Products
- LAR Home

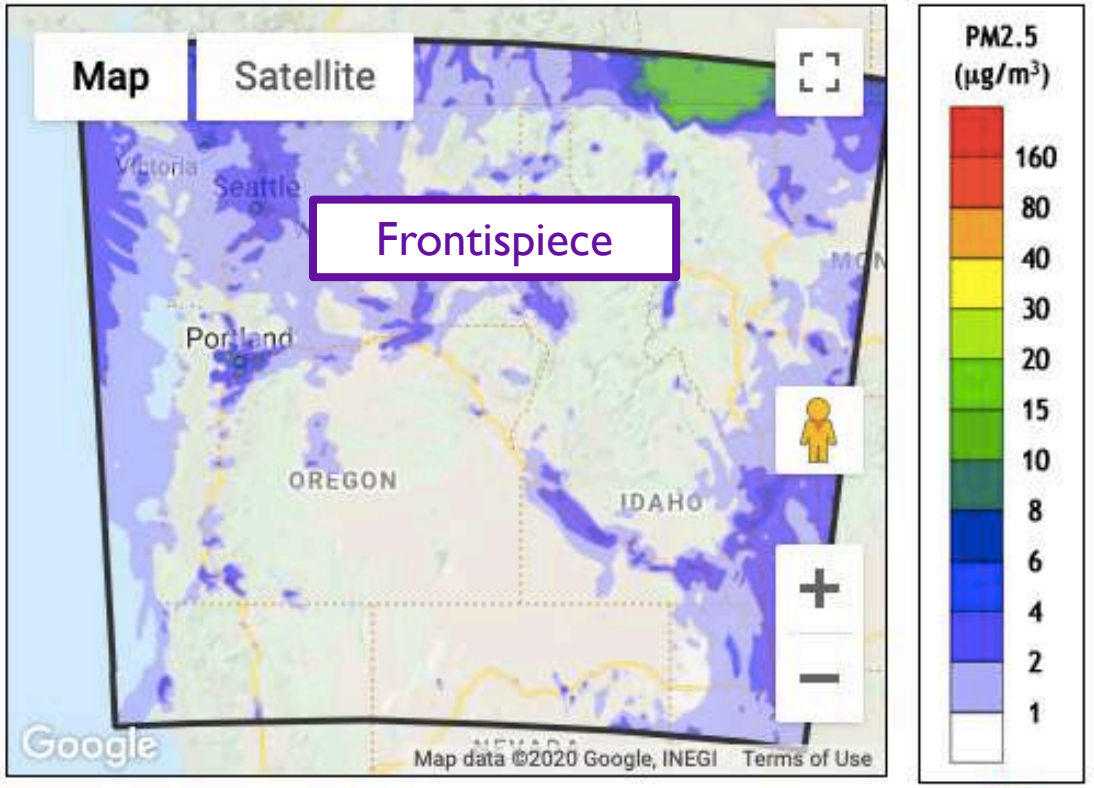
- Intro to AIRPACT
- Domain
- ators
- und
- Log
- Disclaimer
- Contact

Left-hand Side Links

Activities/Related Programs:

- NW-AIRQUEST
- AIRNow
- BioEarth
- BlueSky
- CEREO
- FireBC
- WRF Forecasting
- NSPIRE
- WSU Laboratory for Atmospheric Research

Today's PM2.5 Modeling Prediction



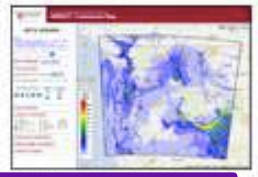
Frontispiece

AIRPACT-5 May 19, 2020
7:00:00 PST

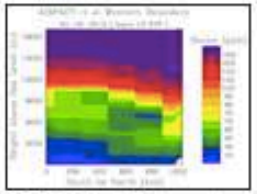
Central Lower Links

Tri-Cities Ozone Forecast

Today's SMOKE Forecast



AIRPACT Performance



AIRPACT-5 Boundary Conditions

Right-hand Side: AIRPACT Forecast Imagery

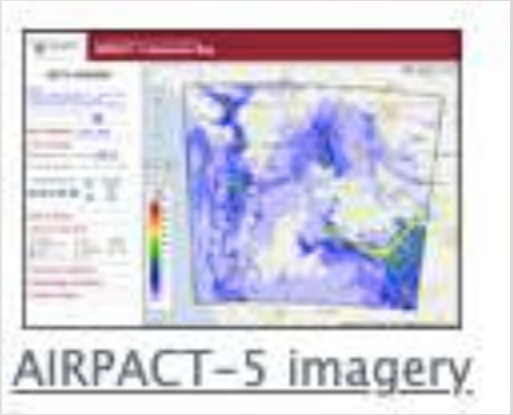
TRAINING OBJECTIVE:
FAMILIARIZE NW-AIRQUEST WITH AIRPACT PRODUCTS FOR FORECASTING

RESOURCES:

- AIRPACT5 Website at http://lar.wsu.edu/airpact
- PDF discussing navigating AIRPACT5 products is found in
  - Homepage LHS Link, Intro to AIRPACT: What Should I Look At
- New PDF!
  - Cheat Sheet with Links for AIRPACT5 Forecast Guidance
- Live Demonstration ⟶

DEMONSTRATION OF ANIMATIONS: (1 OF 2)

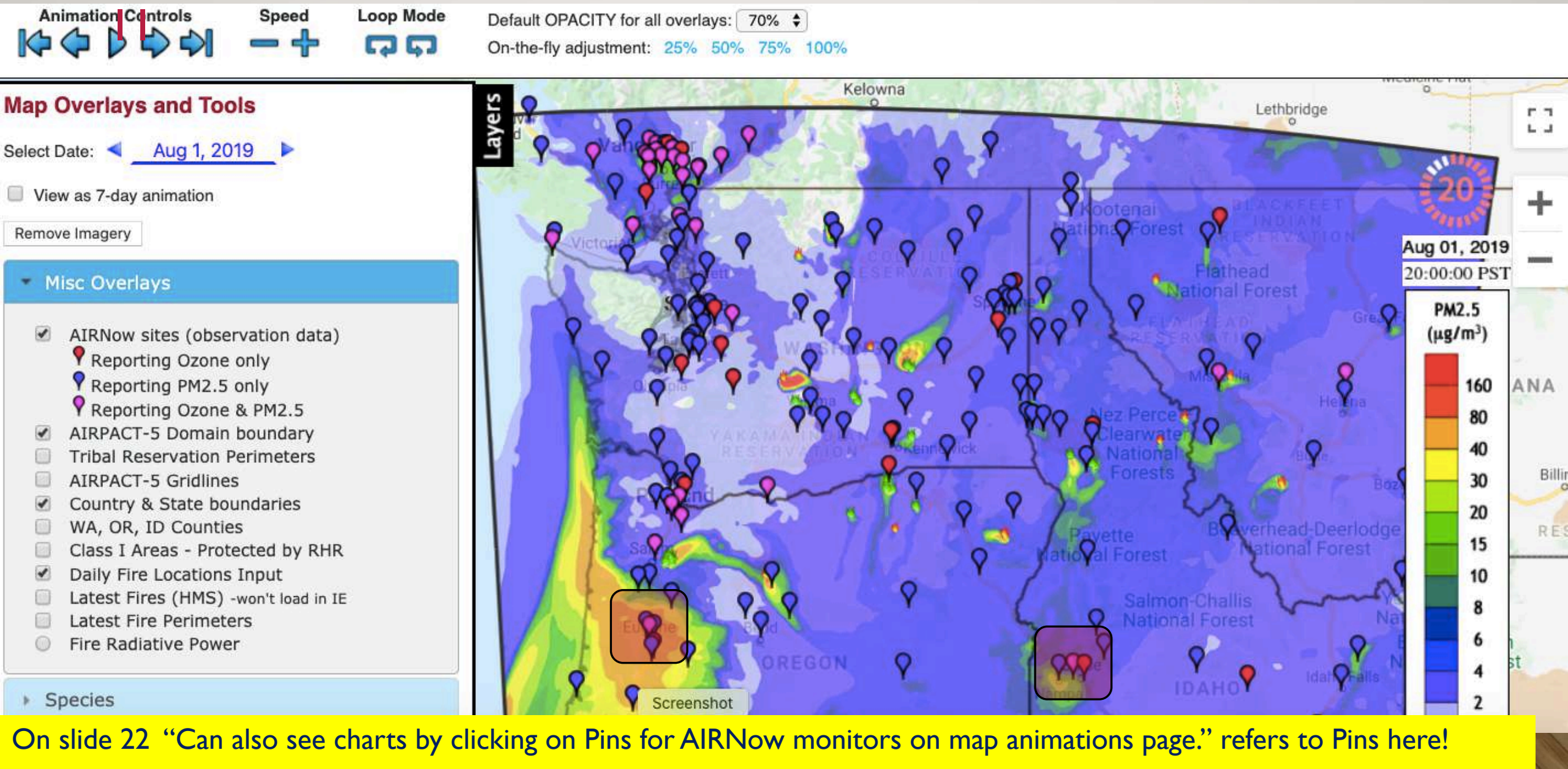
- Frontispiece: Quick Look on home page is set for either PM2.5 or Ozone, of current 48-hr run.
- RHS Links to forecast animated forecast maps:
  - General viewer for forecast animations: and under BLACK TAB:
    - Miscellaneous overlays:
    - (Pollutant) Species,
    - Emissions,
    - Meteorology,



- Today's SMOKE Forecast for PM2.5 with fire location layer set to display:

Bookmark as http://lar.wsu.edu/airpact/gmap/ap5/ap5smoke.html (HINT: These both lead to the same viewer!)

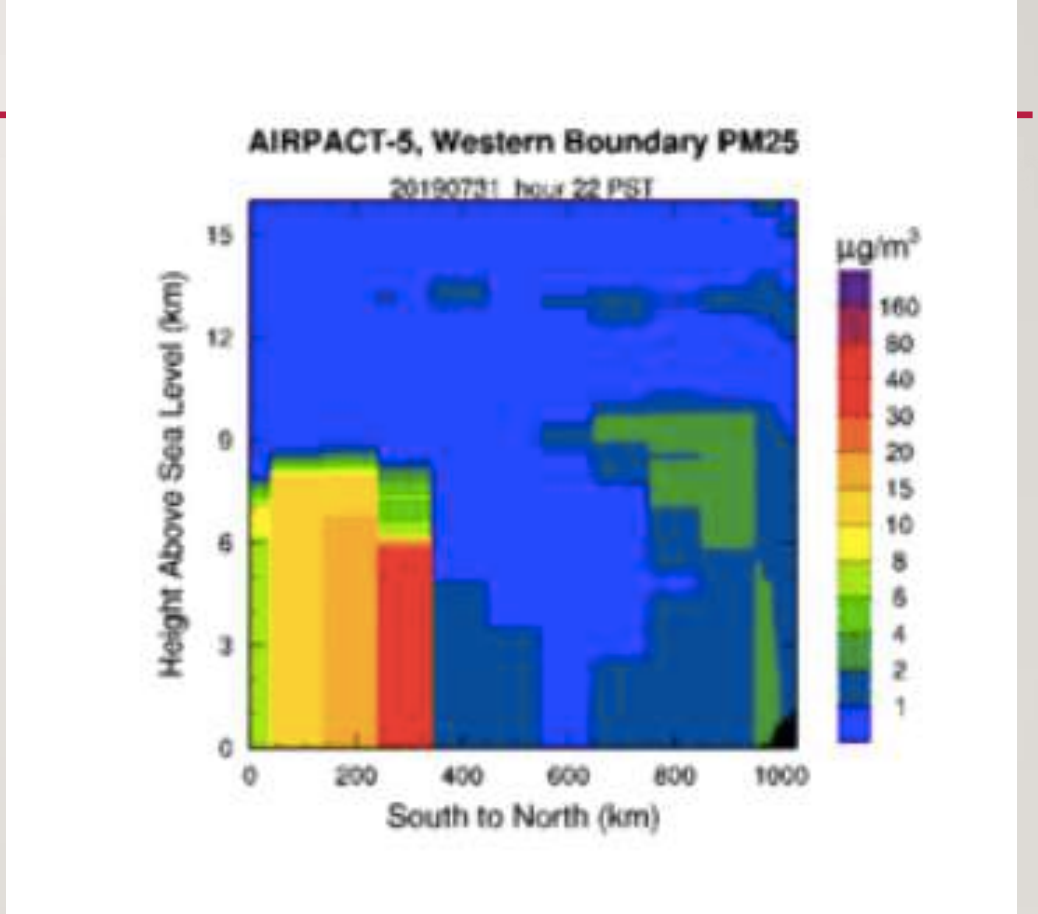
Today's SMOKE Forecast



On slide 22 "Can also see charts by clicking on Pins for AIRNow monitors on map animations page." refers to Pins here!

WESTERN BOUNDARY CONDITIONS FROM WACCM:

- AUGUST 1, 2019
- High PM2.5 concentrations are present to a depth of ~ 8 km on the southern third of the western BCON, from the global WACCM forecast.
- Probably smoke origination or advected from offshore.



2019 AIRPACT-5 vs AIRNow Performance

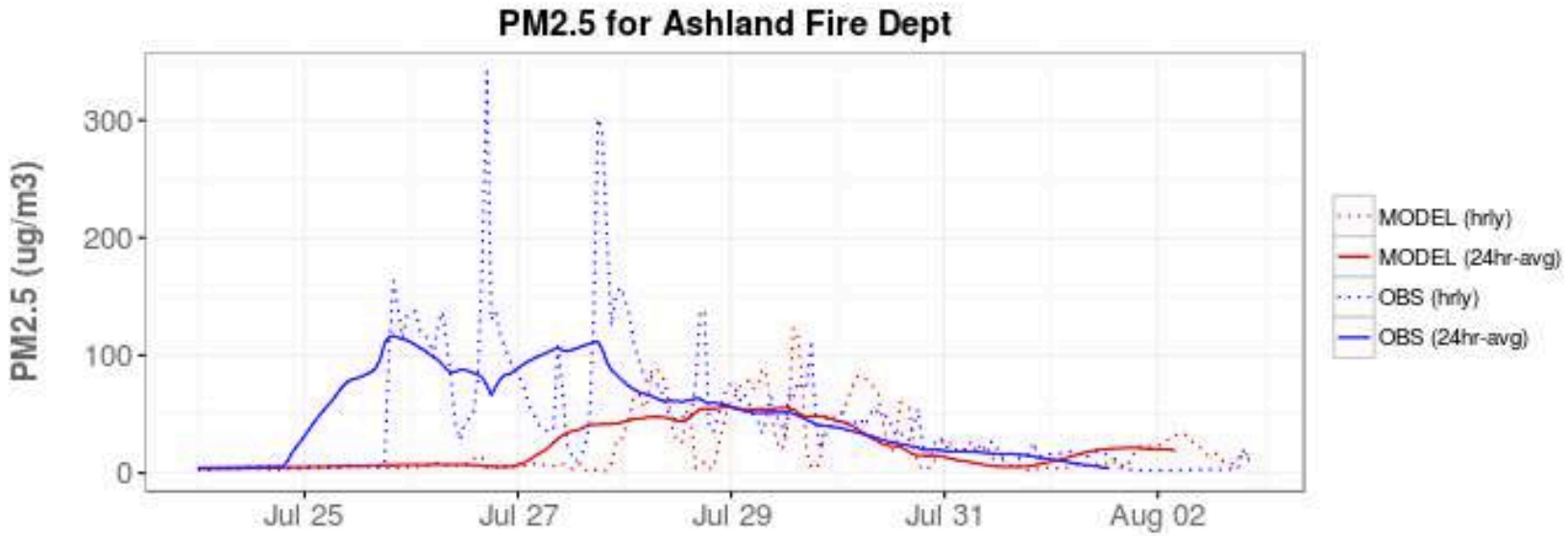
Station

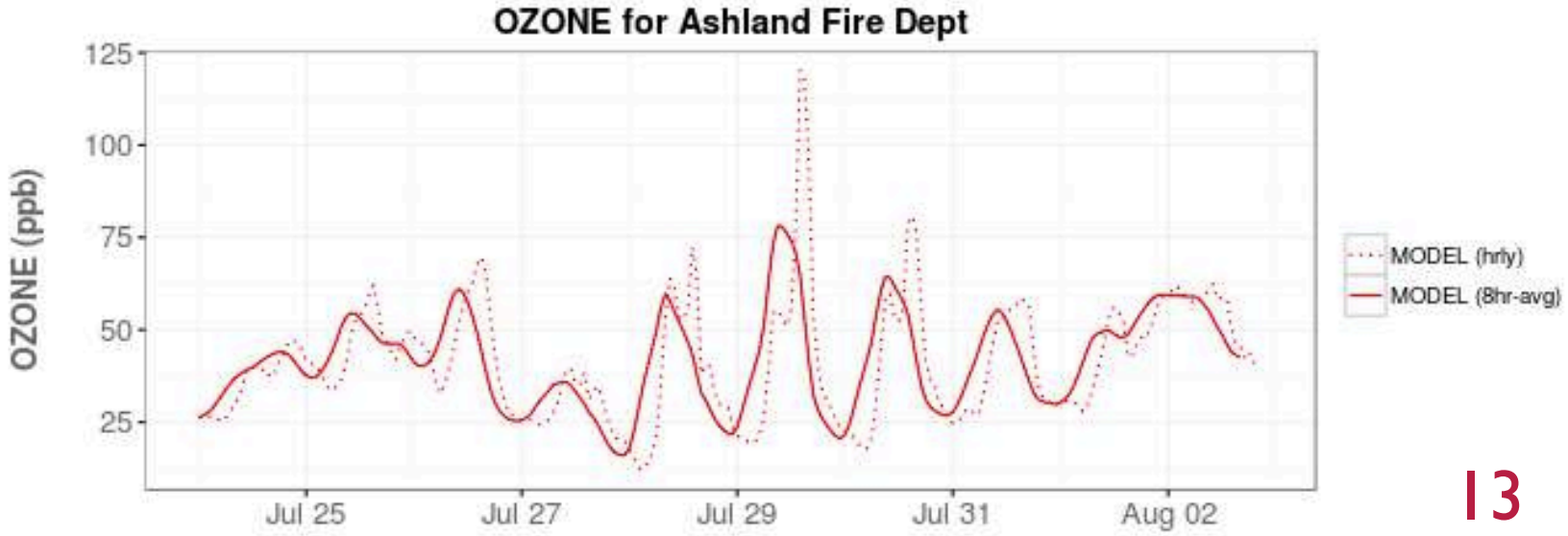
Ashland Fire Dept

Date range

2019-07-24 to 2019-08-02

Download Data





Summary: Ashland, OR monitor shows 2 days earlier arrival of plume from offshore and south. Max 24-hr rolling average of ~100 µg/m3 from monitor vs ~65 µg/m3 from forecast. AIRPACT was late and low.

Today's SMOKE Forecast

Animation Controls | Speed | Loop Mode

Default OPACITY for all overlays: 70%

On-the-fly adjustment: 25% 50% 75% 100%

Map Overlays and Tools

Select Date: Aug 1, 2019

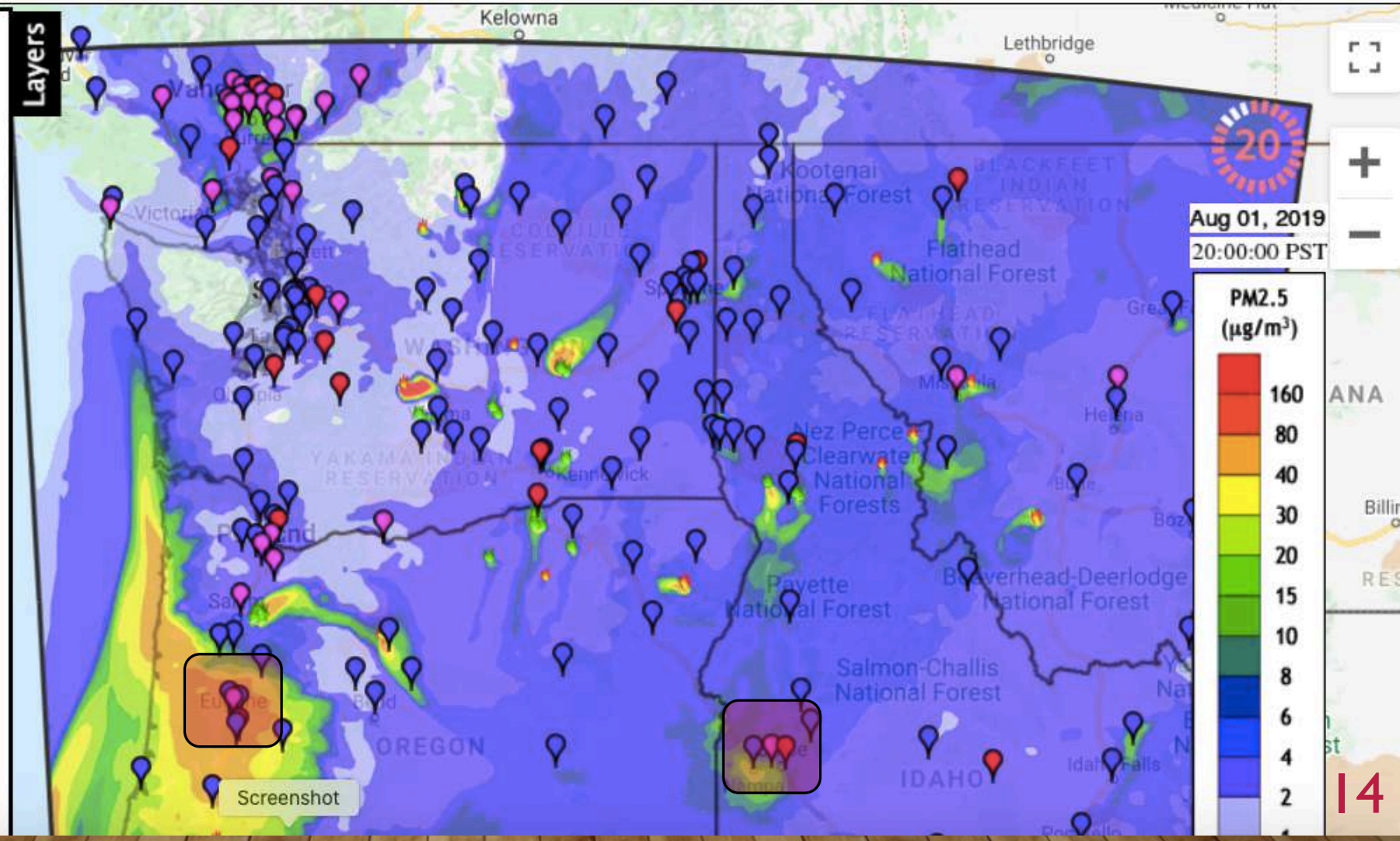
View as 7-day animation

Remove Imagery

Misc Overlays

- [x] AIRNow sites (observation data)
  - Reporting Ozone only
  - Reporting PM2.5 only
  - Reporting Ozone & PM2.5
- [x] AIRPACT-5 Domain boundary
- [ ] Tribal Reservation Perimeters
- [ ] AIRPACT-5 Gridlines
- [x] Country & State boundaries
- [ ] WA, OR, ID Counties
- [ ] Class I Areas - Protected by RHR
- [x] Daily Fire Locations Input
- [ ] Latest Fires (HMS) -won't load in IE
- [ ] Latest Fire Perimeters
- ( ) Fire Radiative Power

Species



2019 AIRPACT-5 vs AIRNow Performance

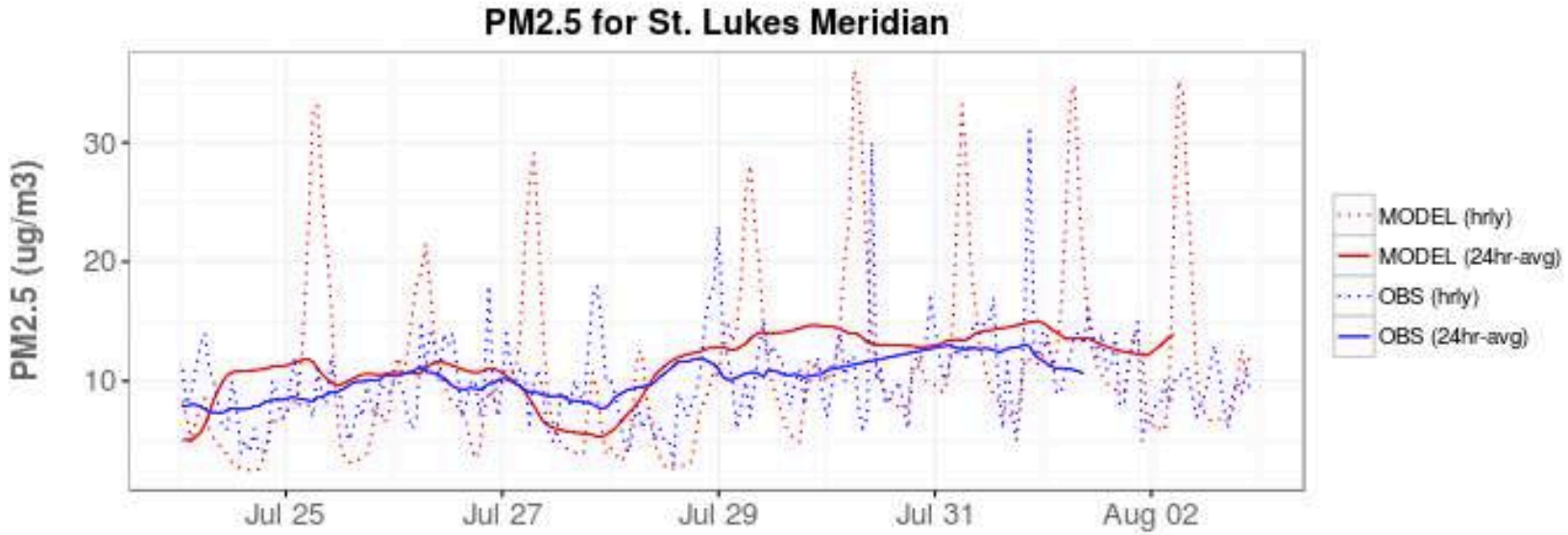
Station

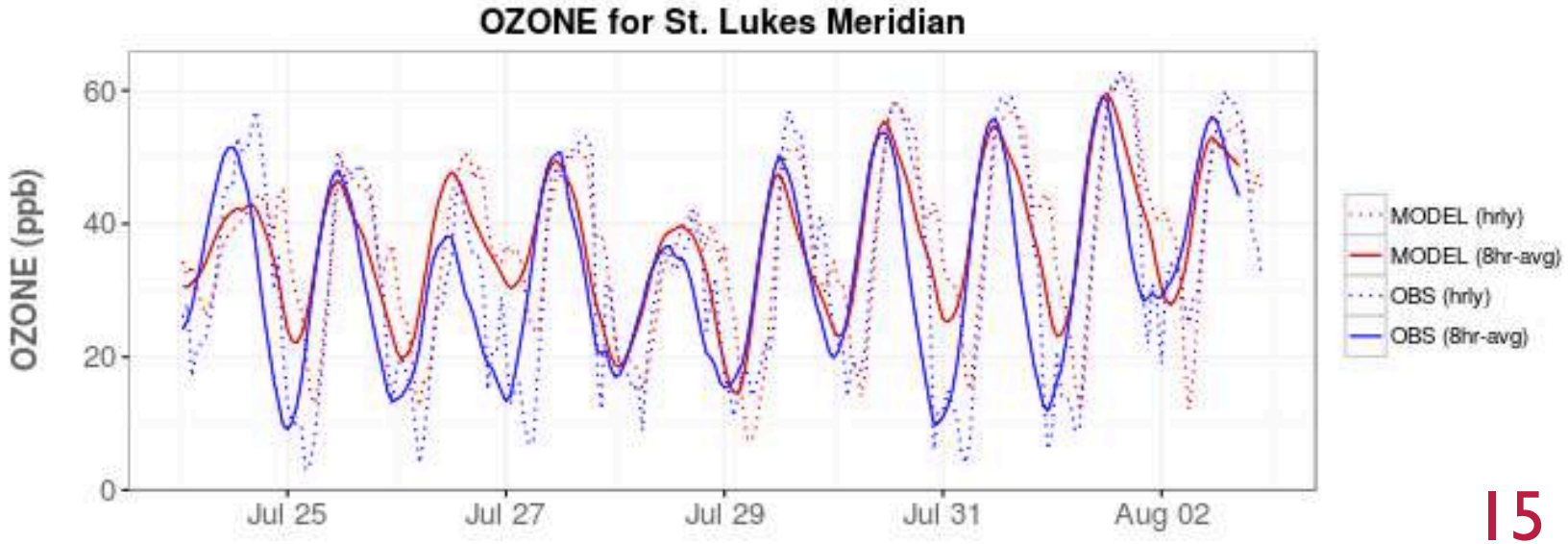
St. Lukes Meridian

Date range

2019-07-24 to 2019-08-02

Download Data





Summary: Meridian, ID shows monitor and AIRPACT agreeing within ~ 4 µg/m3 PM2.5 over period of gradual increase of ~ 9 days. Ozone agreement is pretty good with 7 of 10 of the daily zone peaks very accurate in timing and magnitude, both. No nearby fire modeled.

HOW DOES AIRPACT GET WILDFIRES TO MODEL, AND HOW DOES IT MODEL THEM? SUMMARY:

- Satellite instruments locate fires and estimate size
- Fires are treated as point sources
- Emissions are estimated by size and fuel type (w/ loading)
- Plume rise is estimated by heat release estimate
- Wildfire emissions are blended with all other emissions and provided to CMAQ.

AIRPACT-5 Fire Emissions (Modified BlueSky)

- SMARTFIRE-2 is queried at 10 pm PDT for USA fire locations and sizes
  - NOAA HMS fire-detects and Infrared fire perimeters from GEOMAC
  - "Spin-up" (24-hrs) and "persistence" used
    - Fire locations detected 1-2 days prior to the forecast date.
  - All fire sizes divided by 3 (corrects HMS double counting)
  - Rx fire assumed if October – June (treated as pile burn)
    - Rx Fires not fuel specific (assumes 4 tons per acre)
    - Avoids very large over-estimates in cold months

Courtesy of Farren Herron-Thorpe, ECY, 2020

- FCCS fuels map from BlueSky 3.5.1 queried
  - Fire emissions and heat flux looked up from BlueSky sensitivity analysis
    - Emissions scale linearly
    - Heat flux scales non-linearly
    - Allows fire emissions to be processed in less than 5 minutes, even when there are 1000s of fire locations

- Canadian fire emissions come directly from BlueSky Canada
  - BlueSky Canada does not assume large acres per HMS detect, so no Rx fire replacement or size adjustment is needed.

AIRPACT-5 Fire Plume Rise

- Original BlueSky approach specified Plume Top, Plume Bottom, and Smoldering Fraction based on Briggs (no PBL considered)
  - Used until 2014
- Improved SMOKE approach used WRF PBL to constrain plume rise
  - Used until 2018
- Note: SMARTFIRE aggregates HMS hot-spots locations, which directly impacts BlueSky heat and plume rise calculation.
  - Plume rise is modeled individually for each aggregated location.
  - Total heat release is used rather than heat/area.

Courtesy of Farren Herron-Thorpe, ECY, 2020

AIRPACT-5 Fire Plume Rise Update

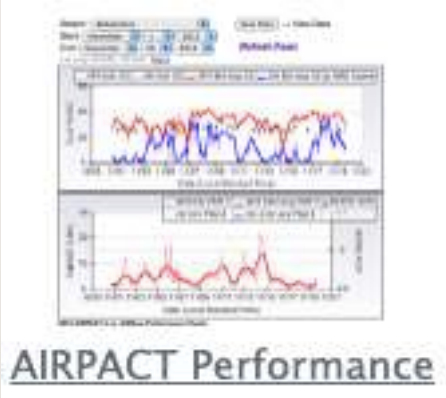
New Modified Plume Rise Approach developed by Wei Zhang (IDEQ) addresses plume rise problems in the SMOKE approach:

1. Smoldering fraction is too low:
   Change implements new smoldering fraction by plume class based on the literature (WRAP/ DEASCO3)
   - SMOKE calculates smoldering fraction using area burned.
     - New “virtual area” provided to SMOKE
2. Plume rise is too high for large fires:
   Change assumes multiple fronts for big fires and reduces the heat flux which is used for plume rise
   - SMOKE calculates plume rise as a function of heat
     - New “virtual heat” provided to SMOKE

Courtesy of Farren Herron-Thorpe, ECY, 2020

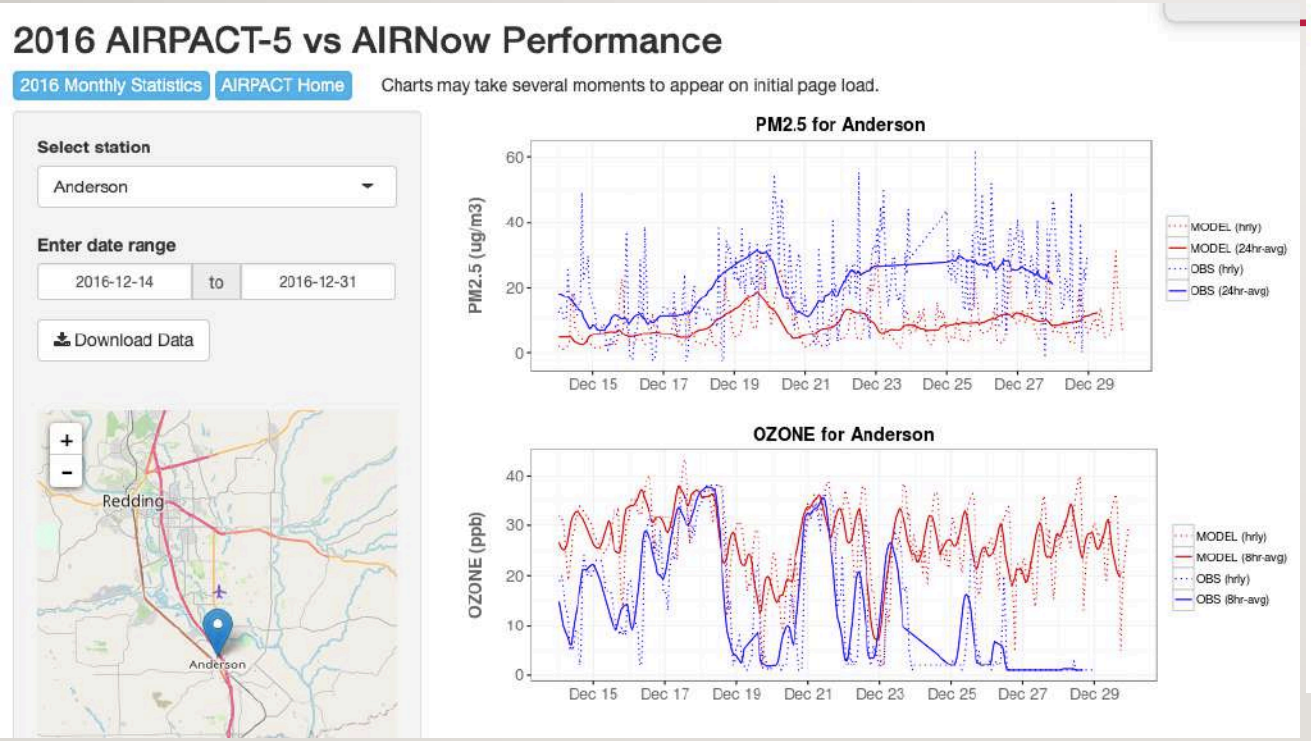
HOW DOES AIRPACT PERFORM?

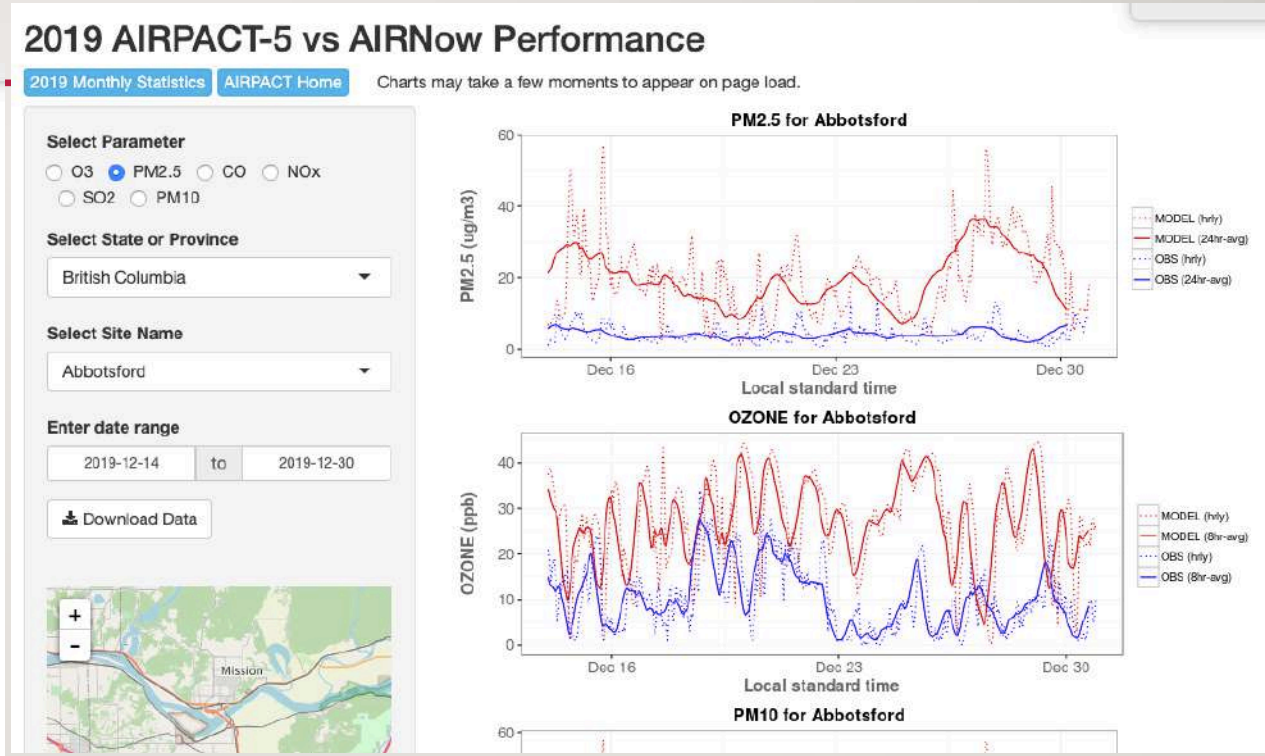
- RHS Link to Performance **charting** and statistics:


AIRPACT Performance

- Current selection of plot option dynamically filters (limits) further choices, except for older results of 2016.
- Can also see charts by clicking on Pins for AIRNow monitors on map animations page. (as was mentioned on slide 11.)

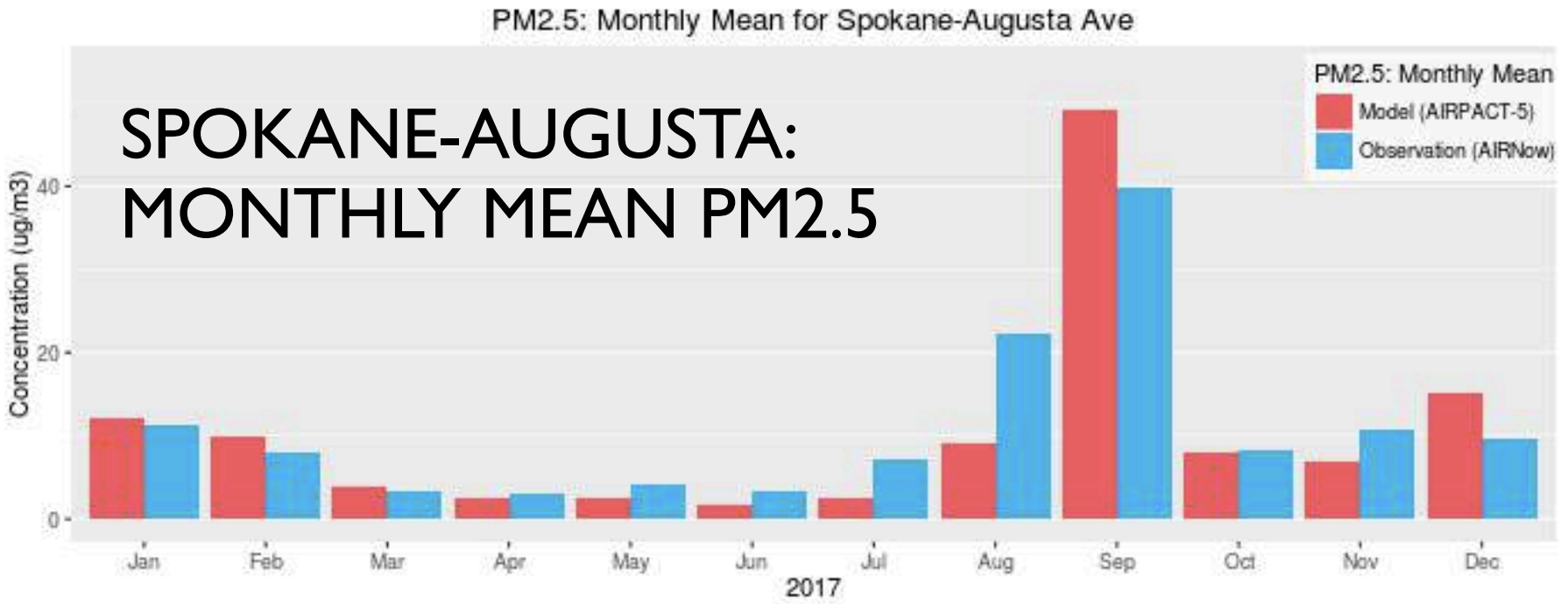
PERFORMANCE CHARTING:
2016 .VS. CURRENT

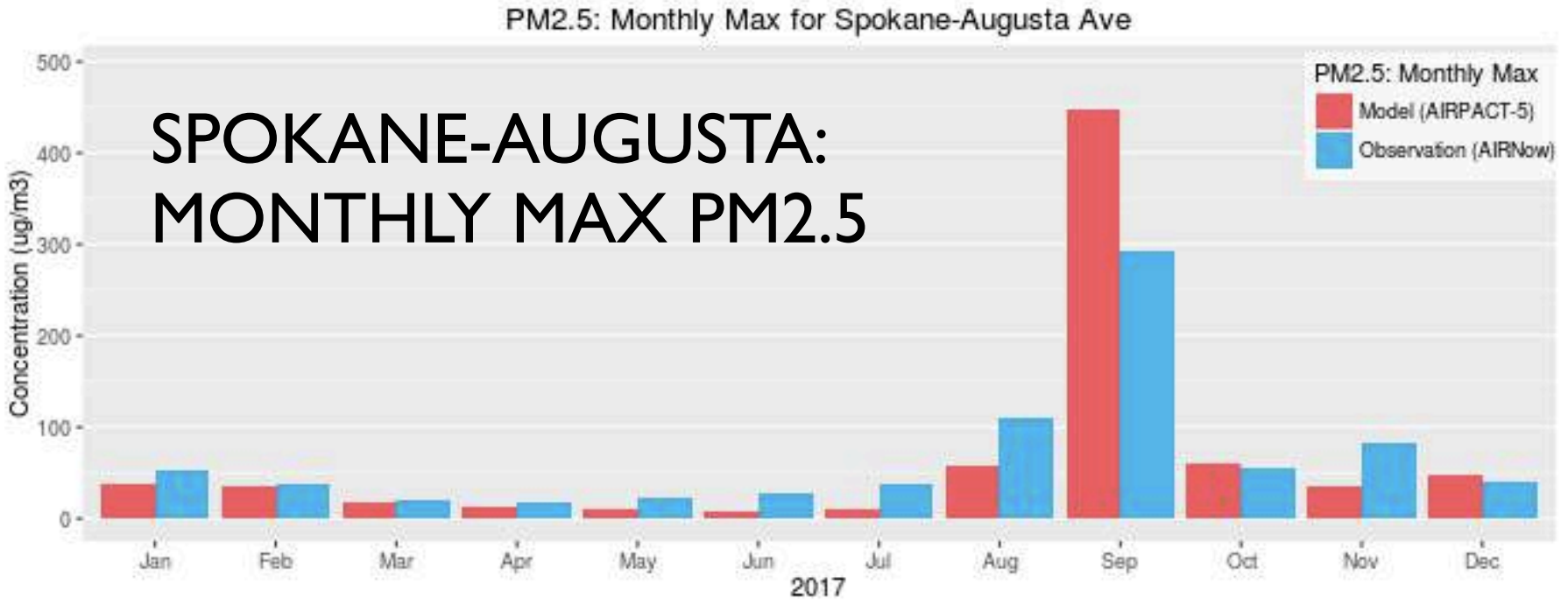




HOW WELL DOES AIRPACT MODEL WILDFIRES?

NOT SO WELL!



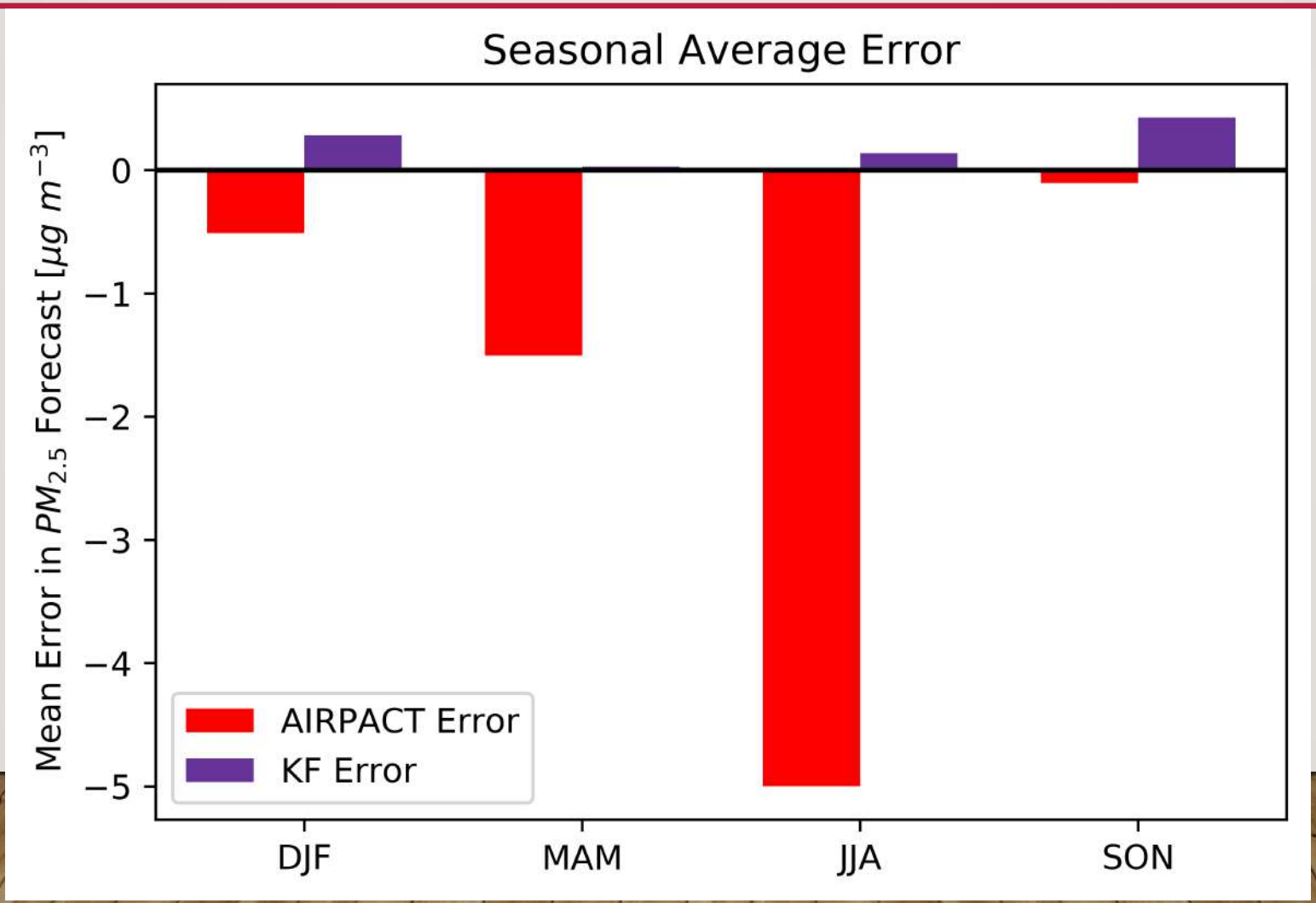


TWO PAPERS IN PREPARATION

Operational Bias Correction for PM2.5 using the AIRPACT Air Quality Forecast System in the Pacific Northwest, Nicole June (PSU) , Joseph Vaughan (WSU), and Brian Lamb (WSU), draft manuscript in preparation, 2020.

Decadal evaluation of the AIRPACT regional air quality forecast system in the Pacific Northwest from 2009-2018, draft manuscript in preparation, Jordan Munson (WSU), Joe Vaughan (WSU), Brian Lamb (WSU), and Yunha Lee (WSU), draft manuscript in preparation, 2020.

DRAFT, UNPUBLISHED RESULTS: KALMAN FILTER FOR PM2.5 BIAS CORRECTION, WITH KRIGING



END OF SHOW