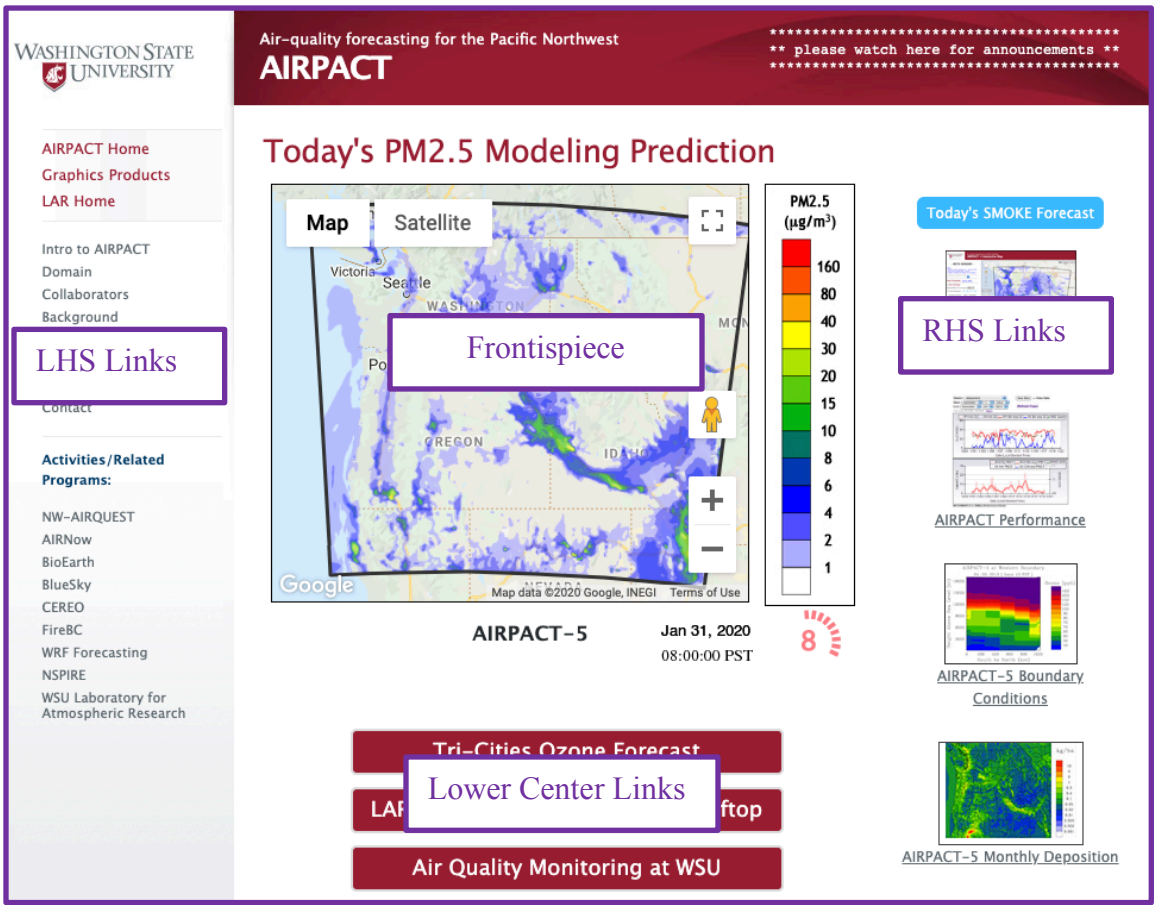
# What should I look at?
# A tour of AIRPACT5 as a downloadable PDF.

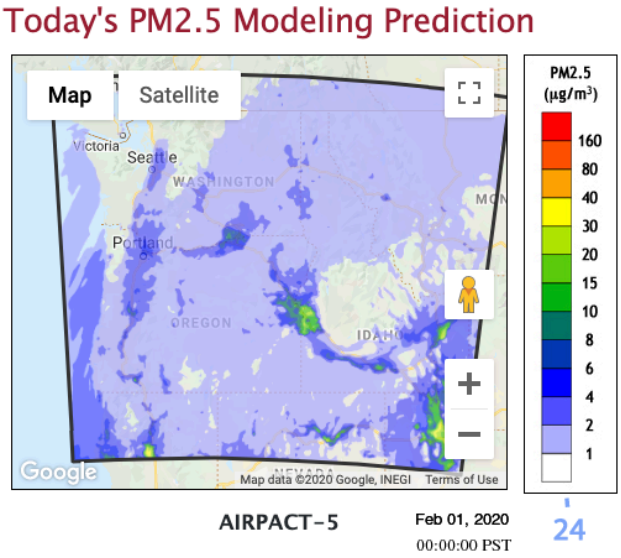
THE AIRPACT HOMEPAGE at [http://lar.wsu.edu/airpact/](http://lar.wsu.edu/airpact/) shows by default today's forecast, displayed as seen here, which will be discussed in terms of the labels that have been added below, e.g. LHS Links



## Frontispiece

In the center is an animation providing the user immediate access to today's forecast, showing hourly average values of a pollutant, either ozone mixing ratios for the warm season or PM2.5 mass concentration otherwise.

Values shown are 48 hourly averages with a clock sweeping out hours 0 through 23 in red ticks for the first day and then hours 24 through 47 as blue ticks for the second day. In the example shown here the clock below the legend shows the first hour of the second day. Note that the graphics for the DAY2 results are deleted after 5 days, after which time the animation will only show the first day.




Hourly averages denote the average over the hour beginning at the designated hour, so the example shows the map of hourly averaged PM2.5 for hour 24 of the run, which is hour 00 to hour 01 PST of February 1st, 2020.

## LHS Links

### Left-Hand Side Links

On the left-hand side is a list of links as noted here. Some of the Graphics Products will be discussed in the next section.

- AIRPACT Home
- Graphics Products (contains links to all such products)
- LAR Home

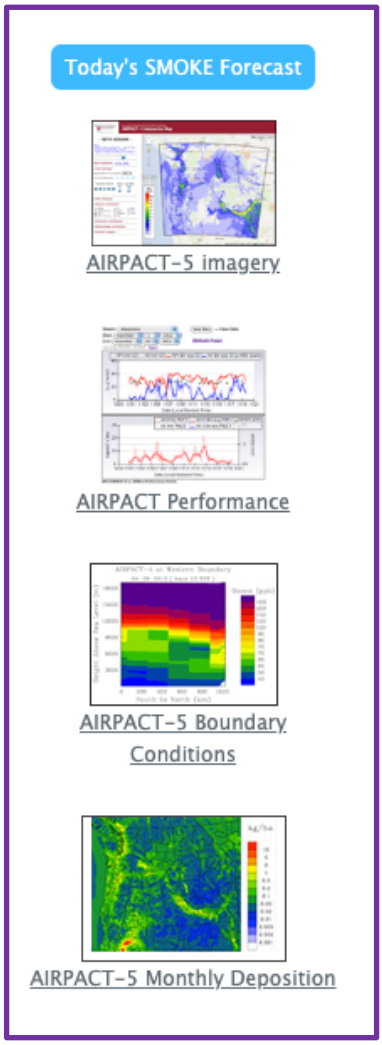
- Intro to AIRPACT ***This is a good place to learn about AIRPACT!***
- Domain
- Collaborators
- Background
- Change Log
- News
- Disclaimer

- Contact
- Activities/Related Programs: (These are additional links to other programs or websites),

RHS Links

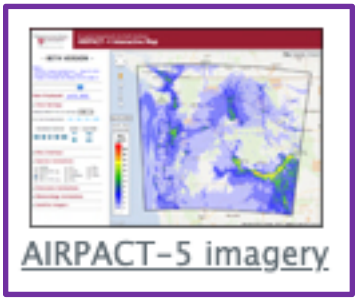
## Right-Hand Side Links

On the right-hand side are five icons, shown to the right and discussed briefly in order next, that link to AIRPACT Model results and products. There are more complete discussions for AIRPACT-5 Imagery and AIRPACT Performance further on.

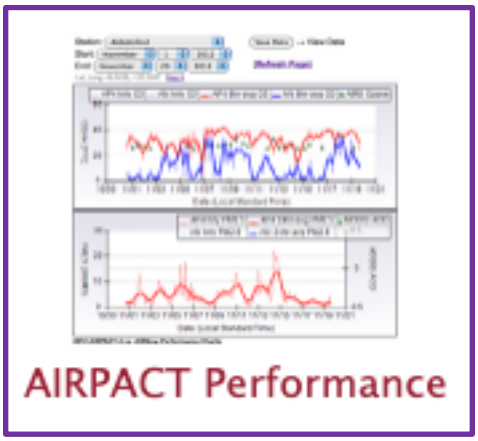



**Today's SMOKE Forecast**

Today's SMOKE Forecast is a link to animations of smoke as represented by PM2.5 forecast results. The same results can be found as well through the next link. Details of display options will be discussed under AIRPACT-5 Imagery.

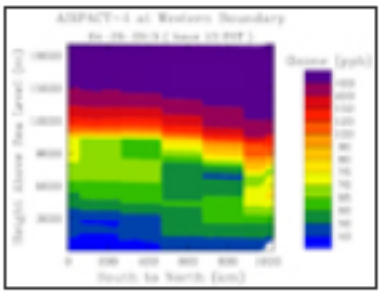



**AIRPACT-5 imagery is the primary link through which the CMAQ model results for today's forecast should be explored! Use of the options behind this AIRPACT-5 imagery link is expanded upon in the next section, after the rest of these RHS links have been discussed in summary form.**




**Use of the options behind this AIRPACT performance link is expanded upon in a following section, after the last two of the RHS links have been discussed in summary form.**

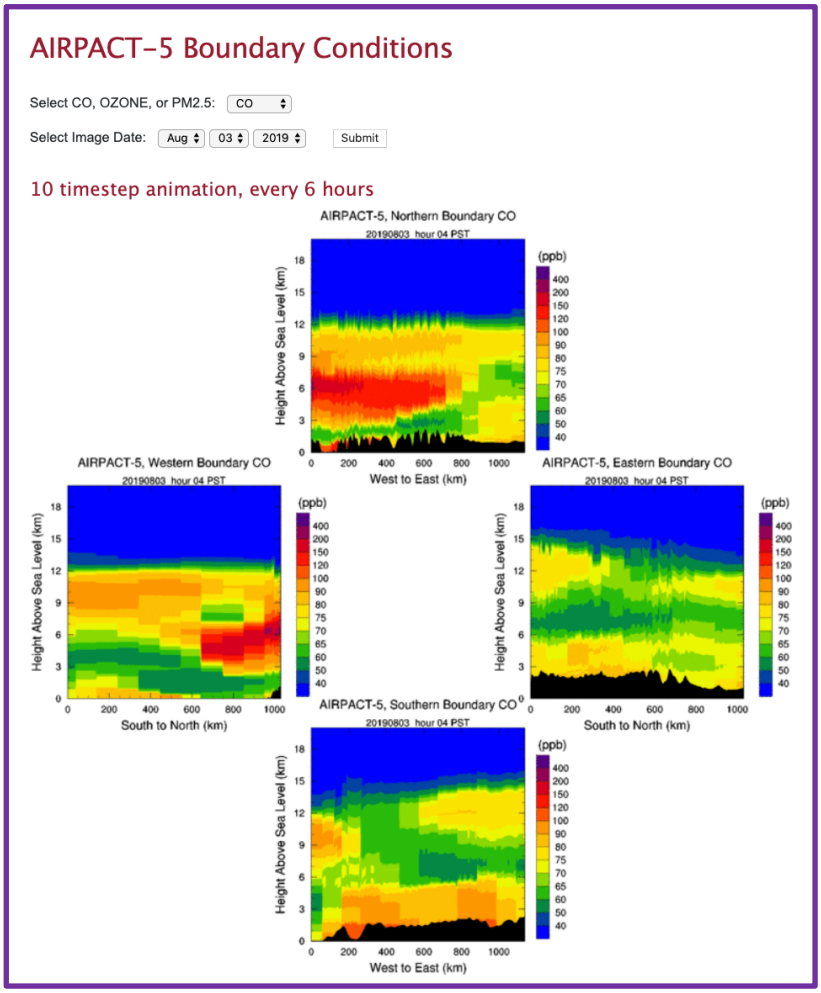
RHS Links Continued.



AIRPACT-5 Boundary Conditions

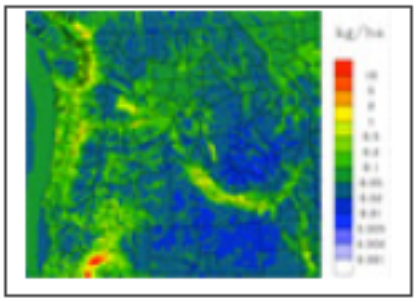
**AIRPACT-5** ***Boundary Conditions:*** This is a link to view the CMAQ boundary conditions animations for CO, ozone and PM2.5, only three of the 59 BCON species. CMAQ boundary conditions are derived from the (comparatively low-resolution) Whole Atmosphere Community Climate Model (https://www.acom.ucar.edu/waccm/forecast/). AIRPACT-5 accesses the WACCM datasets, extracts values found along the AIRPACT-5 boundaries, maps the WACCM locations to the AIRPACT locations, converts the WACCM species to the CB05 and aero6 species and writes results for ten 6-hour timesteps to cover the necessary 48-hour period for the two-day run. The animations show the terrain along each boundary in black at the bottom of each panel.

During wildfire season, elevated CO and PM2.5 are potentially advected across the domain boundaries. In the spring, ozone may be mixed down from the stratosphere. The plots show the WACCM-derived values on the boundaries *but don't indicate whether inflow conditions exist or not.*



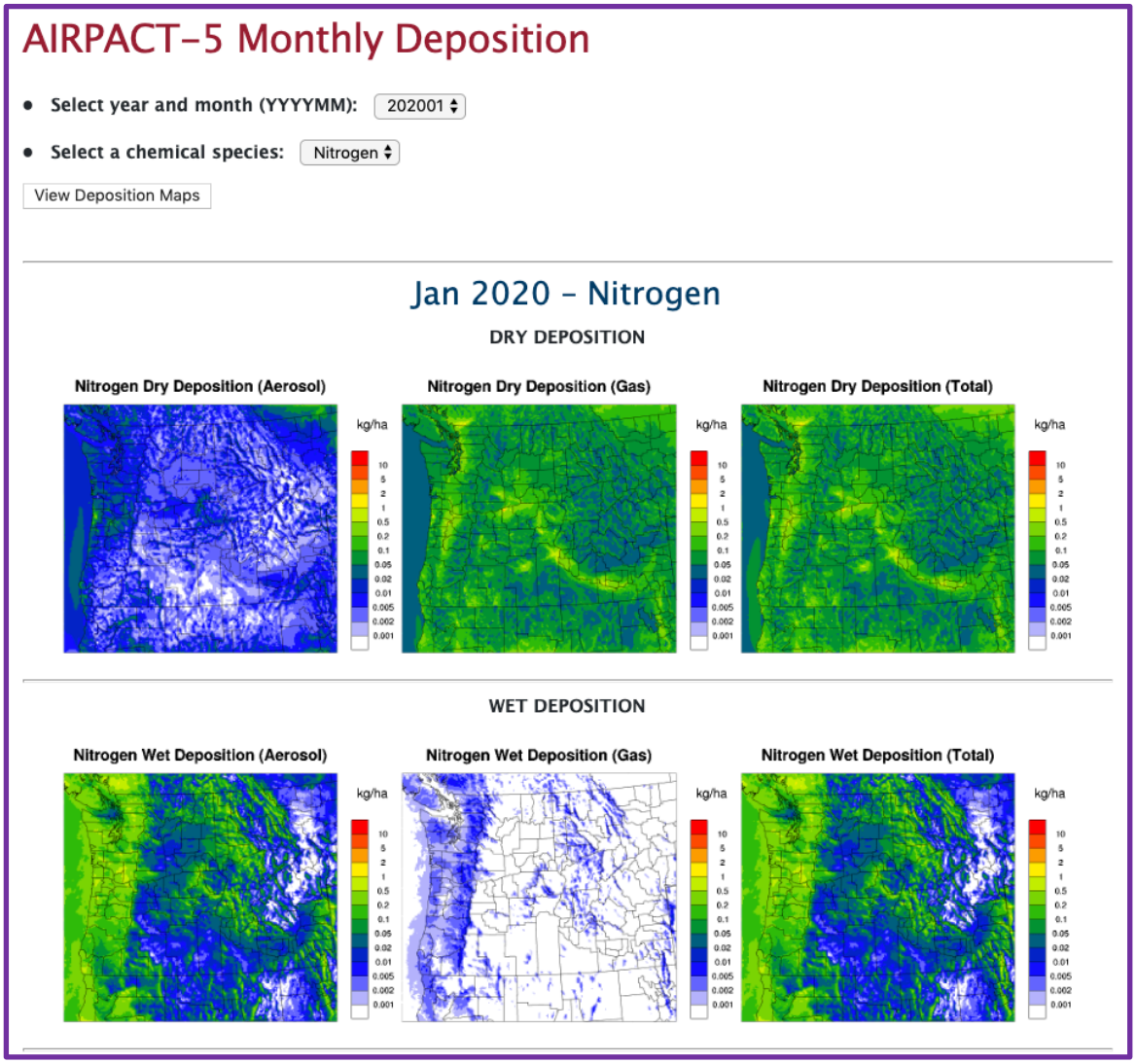
RHS Links

Continued.



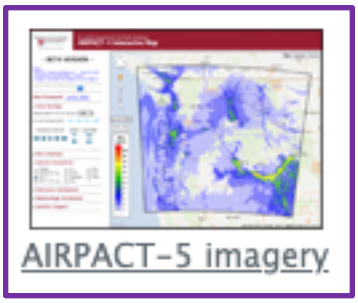
AIRPACT-5 Monthly Deposition

Deposition of nitrogen and sulfur species have implications for ecosystem function, due to acidification of soils and waters, and also due to the potential of excess nutrients affecting the relative success of native and non-native, i.e. “weedy” species.

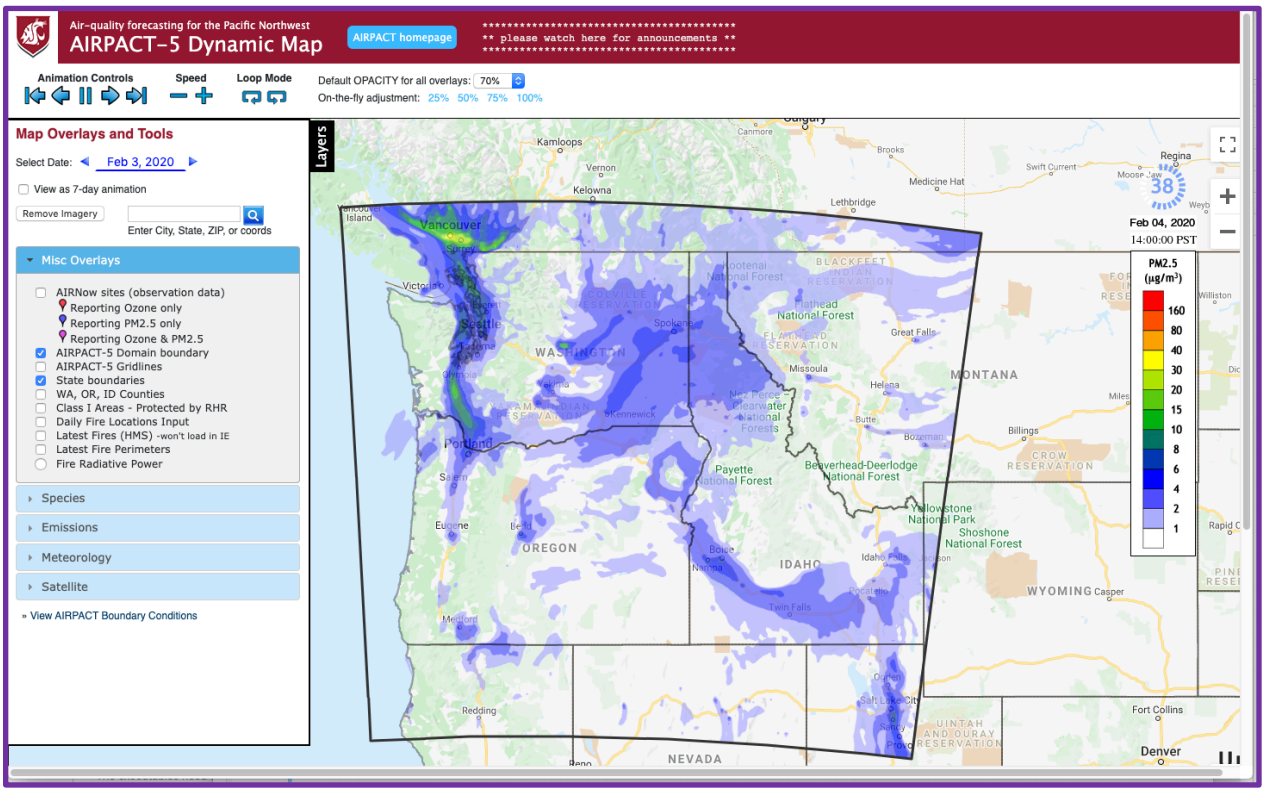


RHS Links Continued.

Discussion of details of “AIRPACT-5 Imagery” products.




Daily AIRPACT forecast results are presented under this link. Here is what one sees behind that link.

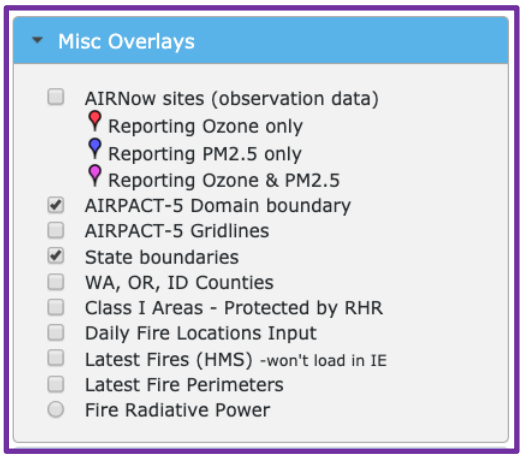



The banner contains controls for how the animation should run: forward, backward, fast, slow, or freeze; and layer opacity controls. The animation in the center defaults to hourly average ozone in warmer months and hourly average PM2.5 otherwise. Values shown are 48 hourly averages, with a clock sweeping out hours 0 through 23 in red ticks for the first day and then sweeping out hours 24 through 47 as blue ticks for the second day; by default DAY1 and DAY2 results are shown in continuous, repeating animations. AIRPACT results are shown in Pacific Standard Time (year ‘round) s the 0 hour result is the average from midnight to 1 AM PST, etc.

Layers toggles between expanding and minimizing the *navigation box* on the LHS.

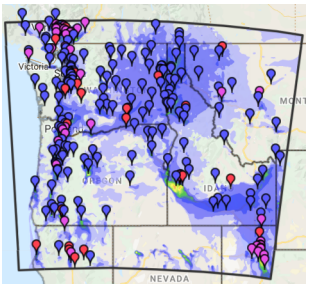
At the top of that *navigation panel* are controls for selecting the date, and an option to see a 7-day animation ending with the current DAY1 results.

Next come a series of dropdown *menus* which are expanded/hidden when selected/not-selected: Misc Overlays, Species, Emissions, Meteorology, Satellite. These *menus* are each discussed next. There is at the bottom another link for Boundary Conditions, leading to the same results discussed above.




Misc (miscellaneous) Overlays: Users have a bunch of options, two of which are turned on by default: domain boundary and state outlines. Two specific layers to explore by checking boxes (□) in the Misc Overlays include 'AIRNow sites (observation data)' and 'Daily Fire Locations Input'.

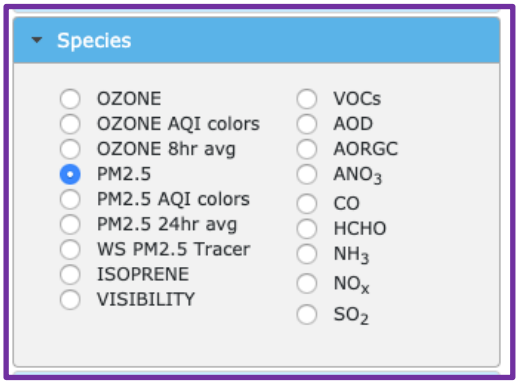
Regarding AIRNow Sites: click into these sites (see on right) to see performance plots of ozone and PM2.5.

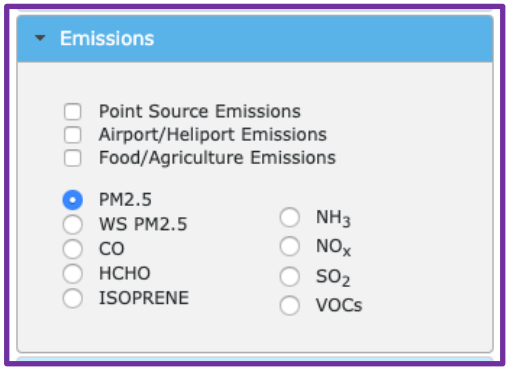


Species: These options control what species will be animated.

Species options are of three types:

- Chemical pollutants, molecular gases or precursors or lumped precursors, expressed as mass mixing ratios (ppm or ppb): ozone, isoprene, VOCs, CO, HCHO (formaldehyde), NH3 (ammonia), NOx (nitrogen oxides) and SO2.
- Particulate (or aerosol) compounds, as mass concentrations: PM2.5, AOD, AORGC, ANO3
- Aerosol Optical Depth (AOD in range of 0.0 to > 2.0) and Visibility in Deciviews.




Emissions:

There are three selection boxes to see locations of point emissions.

Chemical and particulate emissions are available for:

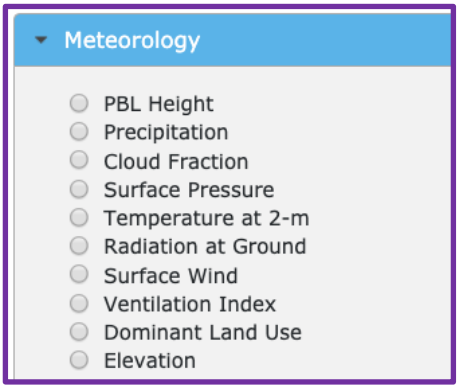
Ozone precursor emissions: HCHO, Isoprene, NOx and VOCs, are all shown in moles/second. Particulate emissions: PM2.5 and Wood Stove PM2.5, are shown in grams per second.

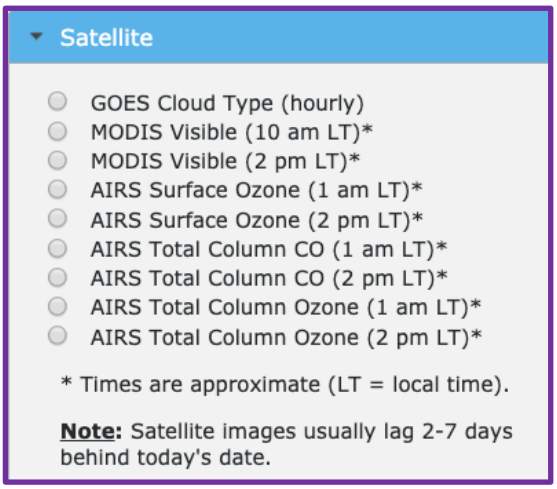
Meteorology:

Data offered for display, from the WRF forecast as passed through (or augmented by) MCIP processing, include those shown to the right. Also, two options require further clarification:

Planetary Boundary Layer (PBL) Height is the estimated depth of the mixed layer near the ground.

Ventilation Index [m2/s] is computed as the PBL [meters] multiplied by the average wind speed [m/s] in the first ~40 m layers, calculated per cell.
http://vista.cira.colostate.edu/Improve/haze-metrics-converter/




Satellite:

These products are not available in near-real time.

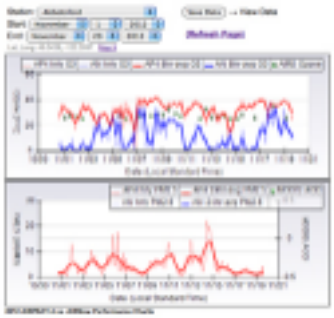
They can be found after a delay of some days.

View AIRPACT Boundary Conditions: This is a link (discussed above in RHS section) to view the CMAQ boundary conditions animations for CO, ozone and PM2.5., derived from the (comparatively low-resolution) Whole Atmosphere Community Climate Model (https://www.acom.ucar.edu/waccm/forecast/).

(end of discussion on "AIRPACT-5 Imagery" products)

RHS Links Continued.

## Discussion of “AIRPACT Performance” products.

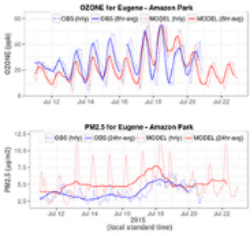


AIRPACT Performance

This discussion will summarize the features for the Chart Performance Tools, as shown here, from the top of the AIRPACT Performance page; further down that page there are other options (not discussed further here) to explore addressing speciated performance and older AIRPACT3 results. This discussion focuses on recent capabilities, some of which aren’t well supported for older data.

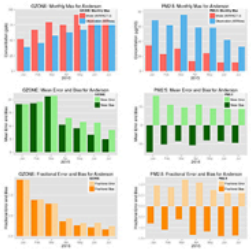
### Chart Performance Tools

The following links display AIRPACT forecast results versus AIRNow observations at all domain-included AIRNow-reporting sites. AIRPACT and AIRNow results are updated daily; simulation data predict today's forecast, while observation data run one day behind the simulation data. AIRPACT comparators are surface layer cell concentrations as forecast on the hour.




**AIRPACT Hourly Comparisons**
(OZONE, PM2.5) AIRPACT vs. AIRNow Observations
(includes moving averages)

AIRPACT-5: 2020 | 2019 | 2018 | 2017 | 2016
AIRPACT-4: 2016 | 2015 | 2014 | 2013 | 2012



**AIRPACT Monthly Statistics**
(monthly summary charts for
AIRPACT vs. AIRNow Observations)

AIRPACT-5: 2020 | 2019 | 2018 | 2017 | 2016
AIRPACT-4: 2016 | 2015 | 2014 | 2013 | 2012

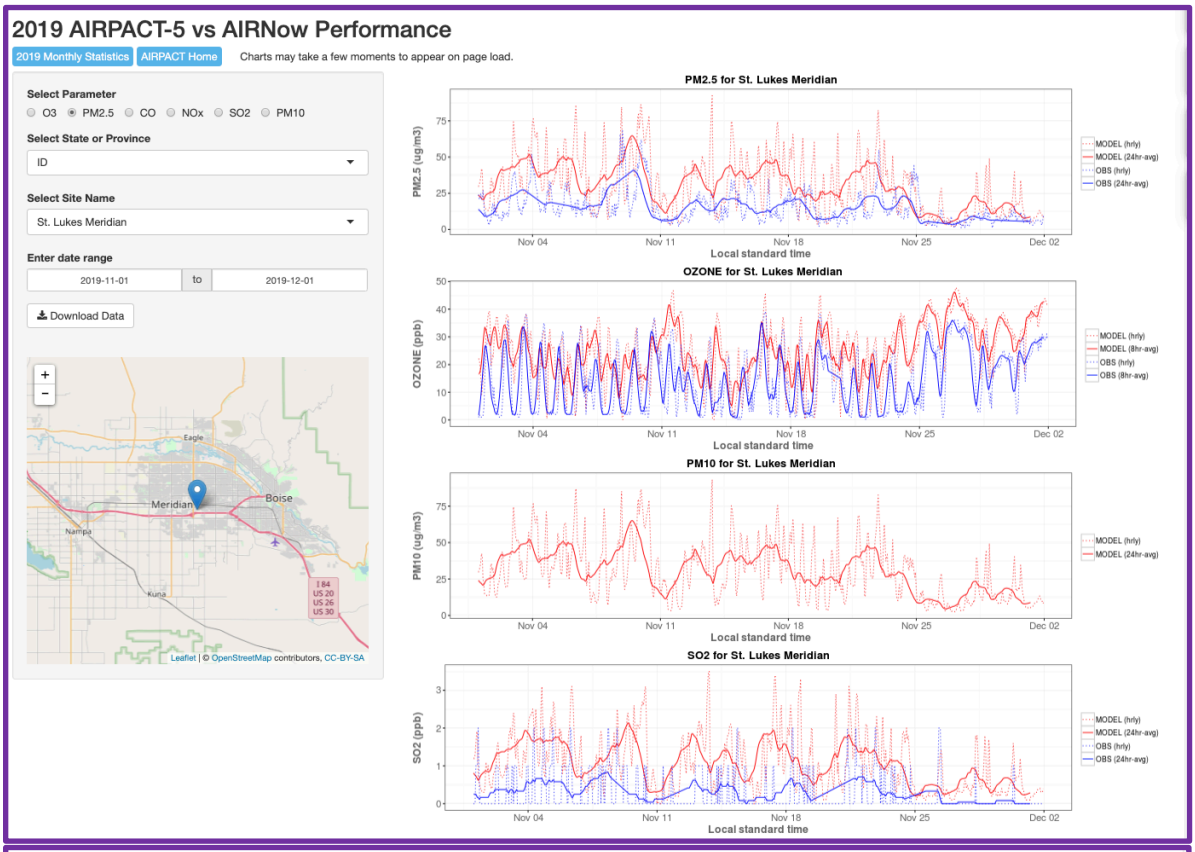
Options on the left-hand-side provide performance plots for comparison of AIRPACT-4 or -5 forecast results at monitoring sites vs the AIRNow observations at those sites. The right-hand-side options provide statistical results. There are buttons provided under within both options to switch back to the other, from charts to stats and from stats to charts.

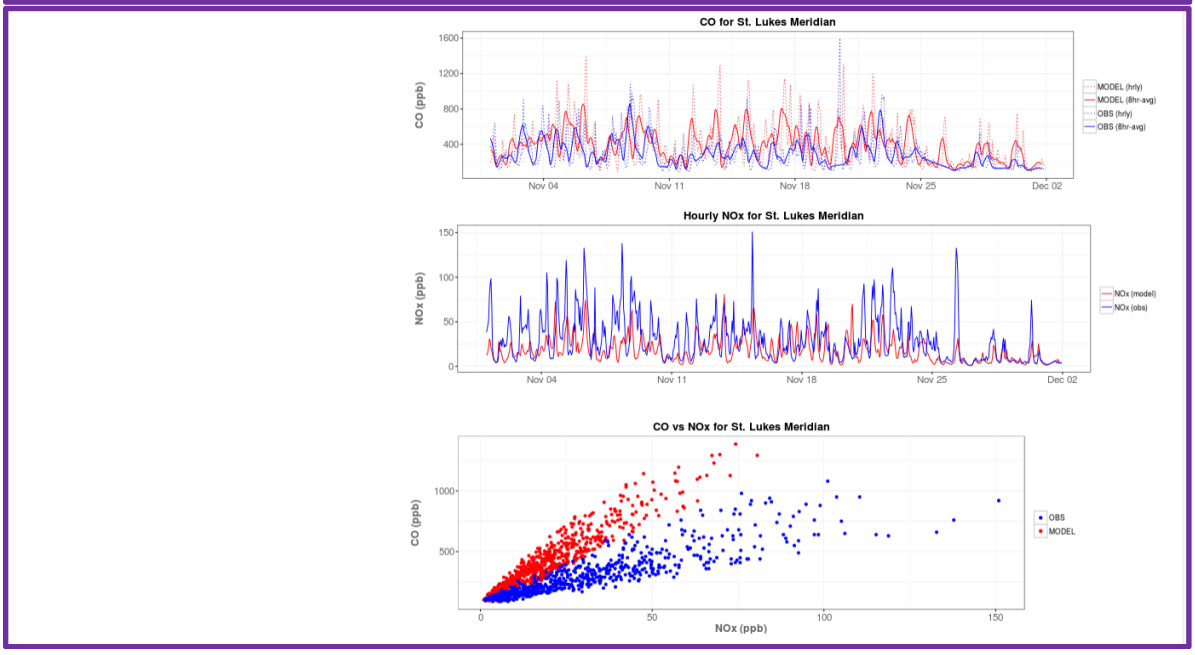
Performance plots for air-quality monitoring sites are available on the Left-hand side of this page. These charting tools offer a series of filters to find and display performance for an AQ site. Note that these options and charts can be slow to load – *so be very patient!* A lime green banner indicates when the requested action is processing/loading. To see the full capability, click into 2019 or 2020, then:

- Select the parameter, meaning pollutant species, of interest; this filters (conditions) subsequent option choices.
- Select State or Province; this also filters subsequent options.
- Select Site Name: *(You may find it helpful to poke around in another window showing* "AIRPACT-5 Imagery" *with the Misc Overlays: AIRNow sites button selected)*
- Adjust the date range to display, within the requested year.
- Charts will show, for that site & date range:
    - **Time series plots in red for AIRPACT/CMAQ model results for the grid cell within which the selected site is located,** with solid lines for rolling averages, and with dotted for hourly values; and
    - **Time series plots in blue for data captured by monitors and reported via AIRNow. in, plots in blue**, with solid lines for rolling averages, and with dotted for hourly values, and
    - Scatter plot(s) of CO [ppb] over NOx [ppb], **blue for AIRNow observations** and **red for AIRPACT**.
    - Rolling averages are computed over 8 hours for ozone and over 24 hours for PM2.5, reflecting NAAQS standards.
- To download the data you've displayed, click the Download Data button to display a comma-separated variable format list of the data, suitable for saving as a CSV file.

**An example of performance plotting output is shown on the next page.**

**Example:** This page shows performance results plotting for November 2019, for the St Lukes Meridian site, with observations for PM2.5, ozone, SO2, CO, and NOx, and a scatter-plot for CO over NOx. Since there are no AIRNow observations for PM10, only AIRPACT-5 PM10 is shown in the third line plot.

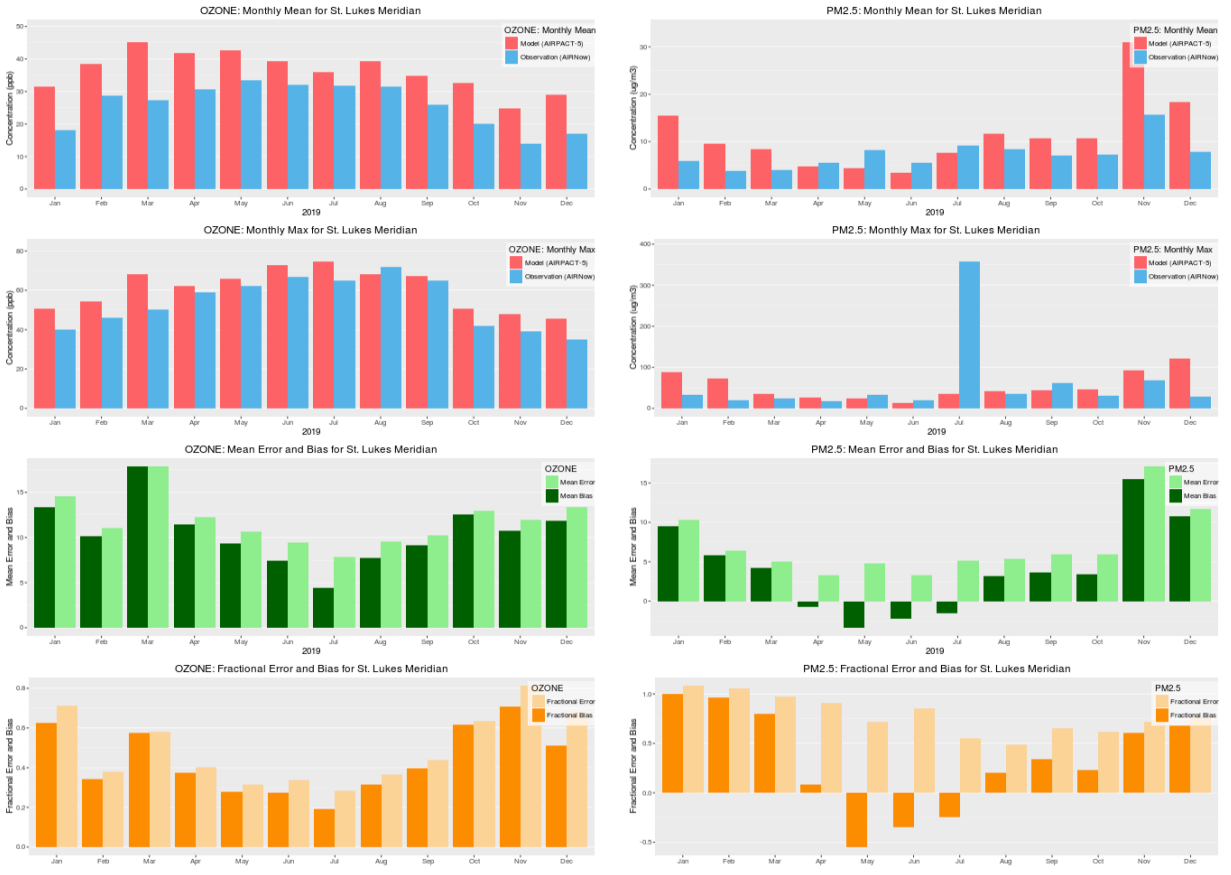


Options on the right-hand-side provide performance statistics as bar charts plots for AIRPACT-4 or -5 forecast results at monitoring sites vs the AIRNow observations at those sites.

**An example of performance statistics bar charts is shown on the next page.**

**Example:** This shows the 2019 performance statistics for the St Lukes Meridian site for ozone and PM2.5.




AIRPACT-5 Monthly Summary Statistics for ( AQSID: 160010010 )

| | YrMo | avg_o3_ap | avg_pm_ap | avg_o3_an | avg_pm_an | max_o3_ap | max_pm_ap | max_o3_an | max_pm_an | mb_o3 | me_o3 | mb_pm | me_pm | fb_o3 | fe_o3 | fb_pm | fe_pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2019-01 | 31.52758 | 15.459375 | 18.21637 | 5.995868 | 50.8 | 88.1 | 40 | 32 | 13.382108 | 14.526075 | 9.5139118 | 10.356336 | 0.6272519 | 0.7106742 | 0.99903259 | 1.0865301 |
| 2 | 2019-02 | 38.44449 | 9.534673 | 28.59938 | 3.736132 | 54.5 | 73.2 | 46 | 20 | 10.188975 | 11.014752 | 5.8164918 | 6.405397 | 0.3406775 | 0.3797841 | 0.96490990 | 1.0561297 |
| 3 | 2019-03 | 45.20685 | 8.334543 | 27.42797 | 4.023843 | 68.2 | 35.6 | 50 | 24 | 17.887832 | 17.916643 | 4.1639551 | 5.066900 | 0.5770956 | 0.5782035 | 0.79560382 | 0.9704586 |
| 4 | 2019-04 | 41.85736 | 4.794306 | 30.55385 | 5.514327 | 62.2 | 25.5 | 59 | 17 | 11.428531 | 12.265175 | -0.7181948 | 3.285244 | 0.3749992 | 0.4016853 | 0.08166351 | 0.9060735 |
| 5 | 2019-05 | 42.58522 | 4.332124 | 33.33518 | 8.185897 | 65.9 | 23.2 | 62 | 33 | 9.357064 | 10.665374 | -3.3771368 | 4.811325 | 0.2807292 | 0.3173012 | -0.54908024 | 0.7208697 |
| 6 | 2019-06 | 39.44569 | 3.360000 | 32.04749 | 5.577684 | 73.0 | 14.0 | 67 | 19 | 7.480447 | 9.474302 | -2.2244350 | 3.312853 | 0.2743417 | 0.3382529 | -0.34892952 | 0.8581475 |
| 7 | 2019-07 | 36.05611 | 7.710556 | 31.69638 | 9.208914 | 74.7 | 36.0 | 65 | 358 | 4.395265 | 7.823955 | -1.4949861 | 5.116992 | 0.1905019 | 0.2843965 | -0.24894573 | 0.5487923 |
| 8 | 2019-08 | 39.19919 | 11.636022 | 31.41538 | 8.457259 | 68.0 | 40.9 | 72 | 36 | 7.763776 | 9.564336 | 3.1796472 | 5.332972 | 0.3162822 | 0.3675444 | 0.20692188 | 0.4871436 |
| 9 | 2019-09 | 34.98259 | 10.668899 | 25.89894 | 7.030075 | 67.1 | 44.5 | 65 | 62 | 9.135897 | 10.240875 | 3.6446617 | 5.930376 | 0.3964450 | 0.4366354 | 0.34000579 | 0.6555773 |
| 10 | 2019-10 | 32.55874 | 10.673387 | 19.94110 | 7.325581 | 50.9 | 46.2 | 42 | 30 | 12.581781 | 12.946712 | 3.4261286 | 5.967305 | 0.6185146 | 0.6371616 | 0.23196627 | 0.6186732 |
| 11 | 2019-11 | 24.73264 | 31.008472 | 14.03949 | 15.602241 | 47.8 | 92.4 | 39 | 69 | 10.736389 | 11.945416 | 15.4574230 | 17.158543 | 0.7078427 | 0.8147631 | 0.60959597 | 0.7127359 |
| 12 | 2019-12 | 28.88266 | 18.384140 | 16.95972 | 7.813019 | 45.6 | 120.6 | 35 | 28 | 11.891250 | 13.336806 | 10.7628809 | 11.736288 | 0.5099872 | 0.6793328 | 0.67538202 | 0.7623103 |

**EXPLANATION:**
**AQSID:** Air-quality monitoring site identifier (from AIRNow)
**avg_o3_ap:** monthly mean ozone value from AIRPACT-5
**avg_o3_an:** monthly mean ozone value from AIRNow
**max_o3_ap:** monthly maximum ozone value from AIRPACT-5
**max_o3_an:** monthly maximum ozone value from AIRNow
**avg_pm_ap:** monthly mean pm2.5 value from AIRPACT-5
**avg_pm_an:** monthly mean pm2.5 value from AIRNow
**max_pm_ap:** monthly maximum pm2.5 value from AIRPACT-5
**max_pm_an:** monthly maximum pm2.5 value from AIRNow
**mb_o3:** monthly mean bias for ozone
**me_o3:** monthly mean error for ozone
**fb_o3:** monthly fractional bias for ozone
**fe_o3:** monthly fractional error for ozone
**mb_pm:** monthly mean bias for pm2.5
**me_pm:** monthly mean error for pm2.5
**fb_pm:** monthly fractional bias for pm2.5
**fe_pm:** monthly fractional error for pm2.5

(end of discussion on “AIRPACT Performance”)

Lower Center Links

There are three items here:

Tri-Cities Ozone Forecast

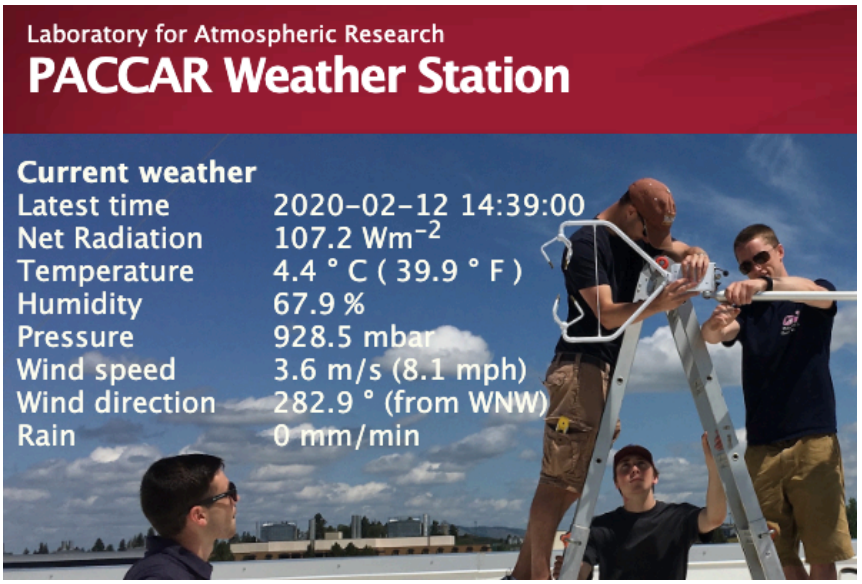
LAR Weather Station: PACCAR rooftop

Air Quality Monitoring at WSU

**The Tri-Cities Ozone Forecast** is for ozone in the Kennewick and nearby areas. Developed by researchers at Washington State University in collaboration with the Washington Department of Ecology, the forecast tool is based on a novel machine learning approach that uses recent measured ozone levels together with forecast weather conditions to estimate ozone levels for a 72-hour forecast period. The machine learning method trains a model using observed ozone levels from the past several years and then estimates next day ozone levels based on the patterns observed in recent years.

This Tri-Cities O3 forecast can be bookmarked, here: http://lar.wsu.edu/tricitiesozone.html.

**LAR Weather Station: PACCAR Rooftop** shows near-real time and past data, and also provides for data download. The instruments are maintained by Dr. Heping Liu and his students. The available met variables are as seen here:




**Air Quality Monitoring at WSU** links to a site maintained by WSU Environmental Health and Safety, not by LAR. This EH&S site reports PM2.5: https://airquality.wsu.edu/

END OF "What Should I Look At?" DOCUMENT