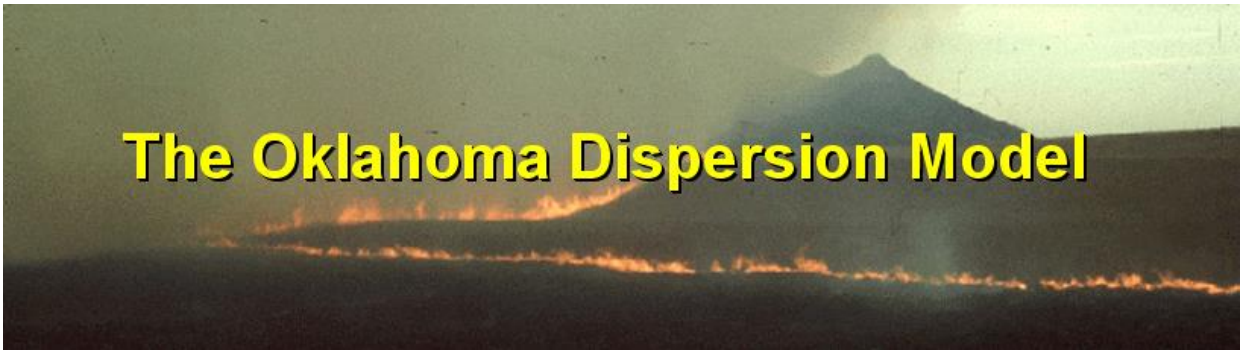

The Oklahoma Dispersion Model is a useful tool that can be used to estimate current and future conditions for the downwind dispersion of gases and small particulates released near the surface. Its applications include smoke dispersal from wildfires or prescribed burns, pesticide drift from ground or aerial applications, and animal odors associated with animal agriculture. The focus of the model is on concentrations at the surface (e.g., where people live and drive and where vegetation and animals are located) at downwind distances up to several miles. Thus, the Oklahoma Dispersion Model can serve as an operational management tool for scheduling activities so as to minimize downwind concentrations to sensitive non-target areas.

Output from the Oklahoma Dispersion Model can be accessed via the OK-FIRE website, located at:

https://www.mesonet.org/index.php/okfire

Products are available in map, chart, and table formats for current conditions as well as for past and forecast time periods.

The Oklahoma Dispersion Model

The Oklahoma Dispersion Model is a tool that was originally developed in the late 1990s and later implemented operationally using the Oklahoma Mesonet to assess surface dispersion conditions up to several miles downwind. It was originally developed for dispersion of farmstead odors but also is used to assess dispersion of wildland fire smoke as well as pesticides. The model breaks the atmosphere into six dispersion categories:

1 = Very Poor (VP)
2 = Poor (P)
3 = Moderately Poor (MP)
4 = Moderately Good (MG)
5 = Good (G)
6 = Excellent (EX)

The lower end of this scale (VP and P) typically occurs with surface temperature inversions, which inhibit mixing and cause poor dispersion. During such conditions a smoke plume will hang together as it drifts downwind and anyone near the narrow plume centerline will experience strong smoke concentrations. The upper end of this scale (EX and G) typically occurs with unstable atmospheric conditions, when the dispersion is good, both in the vertical and horizontal directions.

The Oklahoma Dispersion Model can be interpreted as follows - for a given distance downwind, smoke concentrations near the plume centerline will be the lowest under the excellent (EX) category and highest under the very poor (VP) category.

Operational Products of the Oklahoma Dispersion Model

A large number of dispersion products from the Oklahoma Dispersion Model can be found on the OK-FIRE website. They are available in map format for viewing conditions over the entire state, as well as in chart and table formats for individual Mesonet site locations.

There are two sources of data for the Oklahoma Dispersion Model: (1) the Oklahoma Mesonet for assessment of past and current dispersion conditions, and (2) an 84-hour forecast model (the "North American Mesoscale" (NAM) model) to provide hourly dispersion forecasts out to 3+ days in the future. For past and current dispersion conditions, the model uses various Mesonet-measured variables related to solar radiation, wind speed and direction, and temperature; all dispersion products based on Mesonet data are updated every 5 minutes providing real-time assessment of dispersion conditions. For future dispersion conditions the model uses forecasted solar radiation, wind speed, cloud cover amount, and cloud ceiling height. The NAM dispersion forecasts are updated every 6 hours. For both Mesonet and forecast modes, different calculation procedures are used at nighttime than during the daytime.

Maps

In the map products, dispersion categories are color coded with categories 4 through 6 (MG, G, EX) in increasing shades of green, while category 3 (MP) is colored in beige, category 2 (P) in orange, and category 1 (VP) in red. Figure 1 shows an example of a dispersion condition map with wind vectors (arrows) showing the wind directions. Dispersion category numbers are also shown at the Mesonet sites. This example is a rare case where all six categories are occurring across the state at the same time; smoke plumes would experience increasingly poor dispersion in the beige (3), orange (2), and red (1) areas. These areas were experiencing heavy cloud cover with light winds at the time.

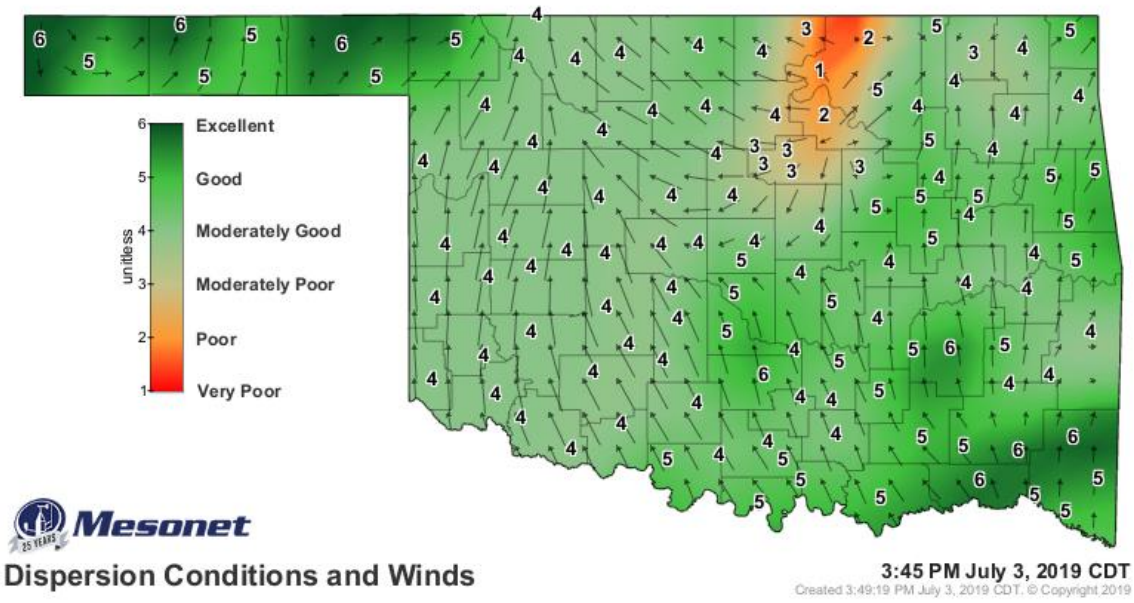

Figure 1. Example of a "current" map of dispersion conditions from the Oklahoma Dispersion Model using Oklahoma Mesonet data

Current, past, and forecast dispersion maps are available in the "Past & Forecast Animated Maps" section (left menu item) of the OK-FIRE website (Figure 2). To view current dispersion conditions, select "Dispersion Conditions & Winds" in the pull-down "Variable(s)" menu and then select "Current" as the time mode. Animations are possible over past time periods as well as through the 84-hour forecast. For either, select "Past" or "Forecast" as the time mode. Note that one can also select "Duration" and "Interval" for the animation. Then use the animation buttons at the bottom to advance through the time period that appears in the "Duration" field at the top. The middle button at the bottom is a play/pause toggle; the first button and last buttons take one to the first and last frames, respectfully, of the animation; and the second and fourth buttons allow one to manually advance backward or forward in time. Figure 2 shows this dynamic map interface section of the website. The animation has been stopped at 2 am July 4, 2019, showing very poor to poor dispersion conditions across eastern Oklahoma and the extreme western panhandle, with moderately good conditions across the rest of the state. Wind direction arrows show the direction a smoke plume would move, with the exception that under light wind conditions in the inversion areas (oranges and reds), the smoke plume would flow downhill to lower terrain due to cold air drainage.

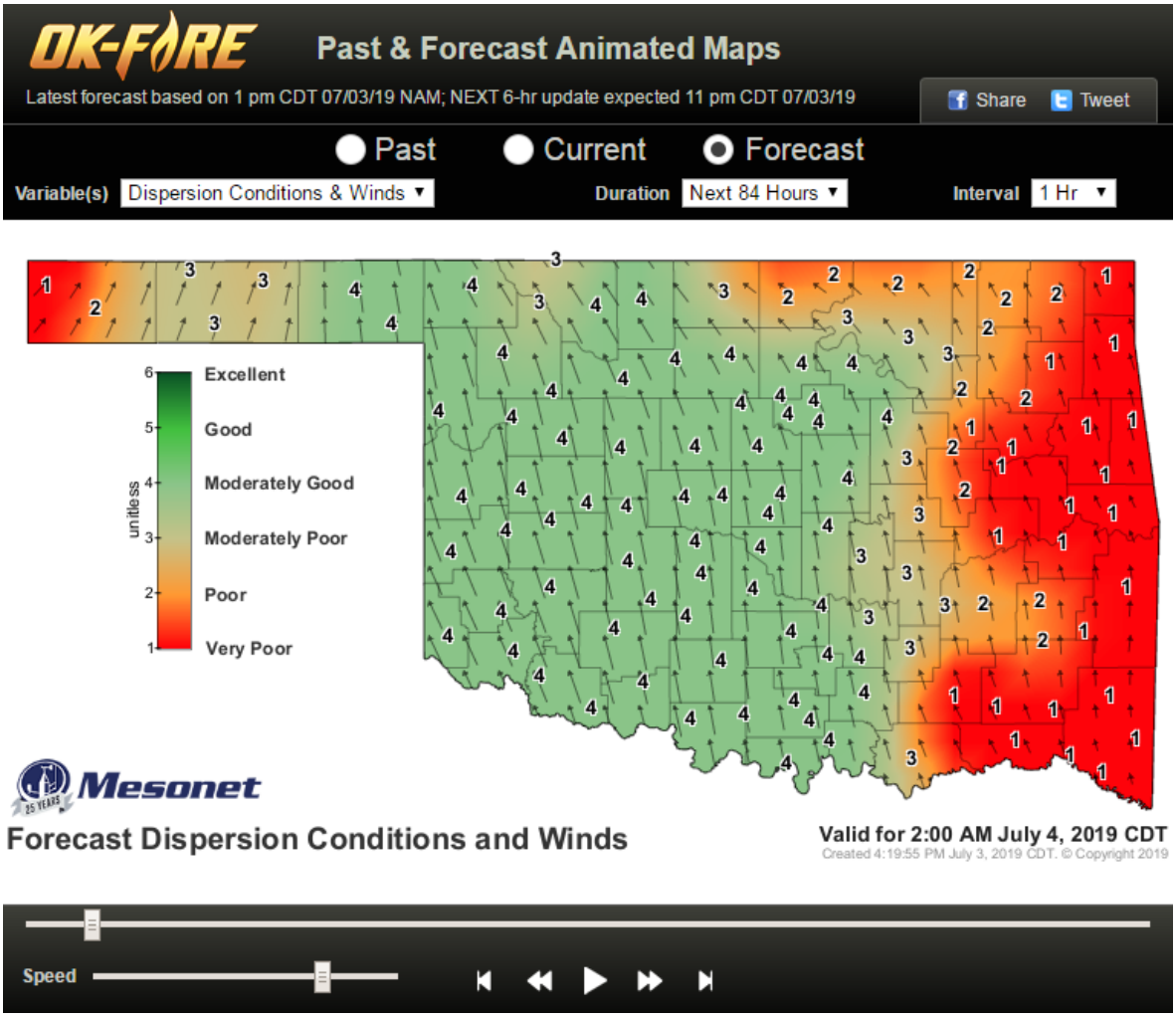

Figure 2. The dynamic map interface in the OK-FIRE website where past, current, and forecast dispersion maps can be viewed.

Charts and Tables

In addition to maps, one can get past and forecast charts and tables at any Mesonet site location. For site-specific smoke dispersion applications, these product formats are likely to be more beneficial than maps as they provide a time series at one location of either past or forecast dispersion conditions, the latter being useful for planning purposes.

To access dispersion charts and tables, go to the "Past & Forecast Charts/Tables" section (left menu item) of the OK-FIRE website (Figure 3). Select the Mesonet site of interest, then "Dispersion and Wind Conditions" in the "Variable(s)" pull-down menu. Then select either "Charts" or "Tables", and for the time mode, either "Past" or "Forecast". Note that one can also select "Duration" and "Interval" for either charts or tables. Finally, click "Get Data".

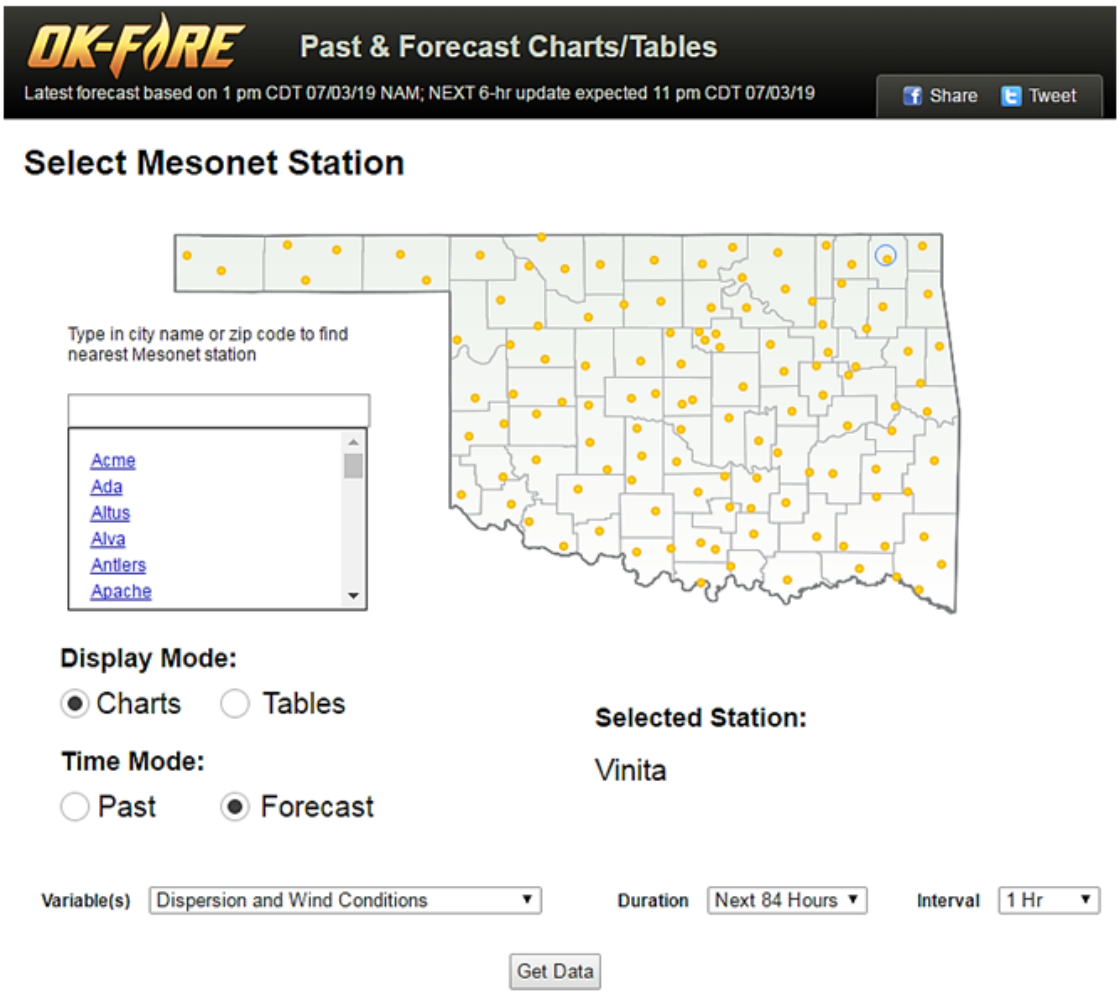

Figure 3. The interface for charts and tables in the OK-FIRE website where past and forecast charts or tables can be viewed.

Let's look at charts first. Figure 4 is an example of a forecast dispersion and wind chart for Vinita through the 84-h forecast period. The top graph shows the predicted dispersion conditions (vertical axis) from 1 (VP) to 6 (EX) over time (horizontal axis), while the bottom graph shows the corresponding forecast wind speed and wind direction (staff/barb symbols) over time. Winds blow in a direction parallel to the staff beginning at the barbed end. During the daytime on Thursday, Friday, and Saturday, the dispersion conditions are forecast to be 4 (MG) or better. During the overnight hours on Thursday, Saturday, and Sunday mornings, dispersion drops to 2 (P) or 1 (VP) due to very light wind speeds and (likely) temperature inversions. Smoke plumes during these conditions will drain gravitationally to lower elevations. However, during the overnight hours on Friday morning, dispersion is better with values of 3 (MP) or 4 (MG), due to slightly stronger wind speeds. Smoke plumes will likely move downwind to the north.

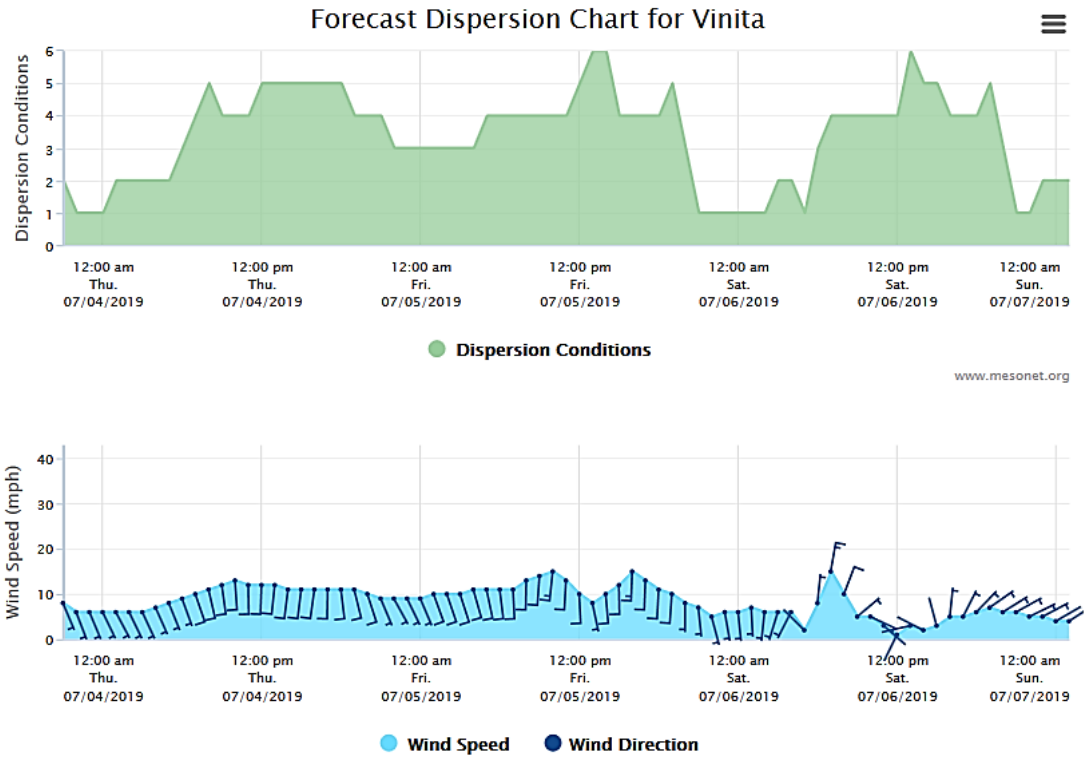

Figure 4. Example of a forecast dispersion and wind chart for Vinita. Predicted dispersion conditions (green) are shown in the top graph, and wind speeds (blue) and directions (staff/barb symbols) in the bottom graph.

Next let's look at tables. Figure 5 shows a portion of the forecast dispersion table for Vinita from 5 am through 7 pm on July 4. Note that the dispersion conditions are listed in the second column, the wind direction in the third column, and the wind speed in the fourth. Good (G) dispersion is predicted from noon through 6 pm, which would be a very suitable period for any activity that would emit smoke. The smoke plume would move toward the north with the predicted south winds. If no sensitive areas were located to the north of the smoke source, the time period for smoke emission could be extended to 7 am through 7 pm since MG or better dispersion conditions are predicted through this period.

Forecast Dispersion and Wind Conditions Table for Vinita

DATE / TIME	DISPERSION	WDIR	WSPD (mph)
Thu Jul 04, 2019 5:00 am CDT	P	SSE	8
Thu Jul 04, 2019 6:00 am CDT	MP	SSE	9
Thu Jul 04, 2019 7:00 am CDT	MG	SSE	10
Thu Jul 04, 2019 8:00 am CDT	G	SSE	11
Thu Jul 04, 2019 9:00 am CDT	MG	S	12
Thu Jul 04, 2019 10:00 am CDT	MG	S	13
Thu Jul 04, 2019 11:00 am CDT	MG	S	12
Thu Jul 04, 2019 12:00 pm CDT	G	S	12
Thu Jul 04, 2019 1:00 pm CDT	G	S	12
Thu Jul 04, 2019 2:00 pm CDT	G	S	11
Thu Jul 04, 2019 3:00 pm CDT	G	S	11
Thu Jul 04, 2019 4:00 pm CDT	G	S	11
Thu Jul 04, 2019 5:00 pm CDT	G	S	11
Thu Jul 04, 2019 6:00 pm CDT	G	S	11
Thu Jul 04, 2019 7:00 pm CDT	MG	SSE	11

Figure 5. Example of a forecast dispersion table for Vinita. Dispersion conditions, wind speed, and wind direction are shown for each hour of the 84-hour forecast.

In summary, the operational dispersion products from the Oklahoma Dispersion Model in OK-FIRE can be of great utility in monitoring smoke dispersion and planning prescribed burns. With respect to prescribed fire, the burner, by avoiding burning during poor dispersion conditions (MP through VP), will minimize negative smoke impacts to his or her neighbors.