



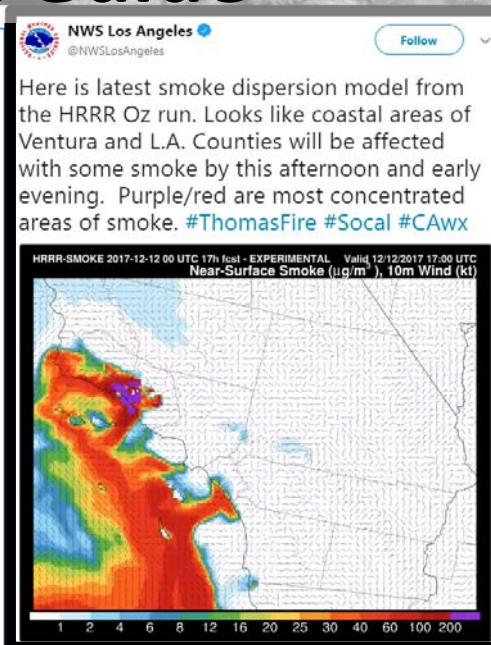
# HRRR-Smoke

## Experimental forecasting model

## Quick Guide

### Why is the HRRR-Smoke Model Important?

The High-Resolution Rapid Refresh Smoke (HRRR-Smoke) is a three-dimensional model that allows simulation of mesoscale flows and smoke dispersion over complex terrain, in the boundary layer and aloft at high spatial resolution over the CONUS domain. The smoke model comprises a suite of fire and environmental products for forecasters during the fire weather season. Products derived from the HRRR-Smoke model include the Fire Radiative Power (FRP), Near-Surface Smoke ( $PM_{2.5}$ ), and Vertically Integrated Smoke, to complement the 10-meter winds, 1-hour precipitation, 2-meter temperature and surface visibility experimental forecast products.



Social media post from NWS—Los Angeles, CA using the Near-Surface Smoke product from HRRR-Smoke Model, initialized at 0000 UTC, 12 December 2017.

### What are the HRRR-Smoke Model specifications and resolutions?

| Data used                                                                                                                                                                                  | Spatial Resolution                                                                                         | Temporal Resolution                                                                                                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>HRRRX meteorological input</li> <li>Rapid Refresh (RAP) with smoke experimental model</li> <li>Polar-orbiting (VIIRS and MODIS) FRP data</li> </ul> | <ul style="list-style-type: none"> <li>3-km horizontal grid spacing</li> <li>50 vertical levels</li> </ul> | <ul style="list-style-type: none"> <li>Updated every 6 hours</li> <li>Forecast lead time is 36 hours</li> <li>Model forecasts initialized at 00, 06, 12, and 18 UTC</li> </ul> |

### Impact on Operations

#### Primary Application

#### Fire intensity and forecasted fire smoke:

Identifies areas that exhibit intense fires and forecasts smoke dispersion over flat and complex terrain.



**Meteorology:** HRRR-Smoke utilizes meteorological input data prepared by the GSI data assimilation system for HRRRX and boundary conditions from RAP-smoke forecast model (covering North America).

**Parameterization:** Model incorporates biomass burning emissions and inline plume rise parameterization based on satellite FRP data.

### Limitations

#### Missed Detections:

Fire detections in the model could be missing due to cloud coverage, or infrequent overpass times by polar orbiting satellites.

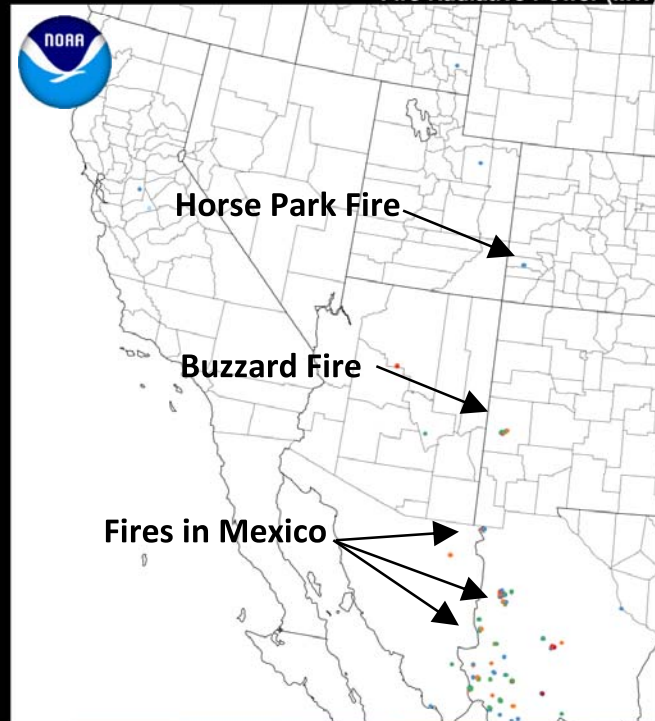


**Model input:** A simple diurnal cycle is applied for the biomass burning emissions. Fire behavior dependence on weather is not simulated by the model. HRRR-Smoke assumes persistence in forecasting the biomass burning emissions.

**Accuracy:** Uncertainties in the satellite FRP data and estimates of the biomass burning emissions impact the accuracy of the smoke concentration forecasts. Uncertainties in weather forecasting by HRRRX will also affect smoke forecasts (e.g. wind speed/direction, mixing layer height, etc.).

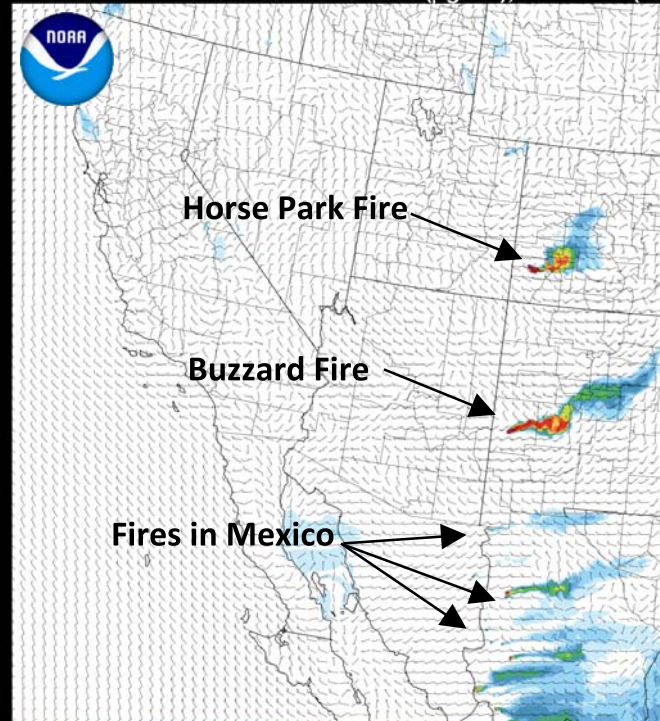
HRRR-SMOKE 2018-05-29 00 UTC - EXPERIMENTAL

Fire Radiative Power (MW)



0 10 25 50 100 250

HRRR-SMOKE 2018-05-29 00 UTC 0h fcast - EXPERIMENTAL 05/29/2018 00:00 UTC  
Near-Surface Smoke ( $\mu\text{g}/\text{m}^3$ ), 10m Wind (kt)



1 2 4 6 8 12 16 20 25 30 40 60 100 200

Fire Radiative Power (top-left, expressed in MegaWatts, MW) and Near-Surface Smoke (top-right, expressed in  $\mu\text{g}/\text{m}^3$ ) products, derived from the HRRR-Smoke Model. The Near-Surface Smoke overlays 10-meter wind data, expressed in knots. Products highlight the Horse Park Fire in southwestern Colorado, Buzzard Fire in western New Mexico, and fires in Mexico. Model run initialized at 00 UTC, 29 May 2018.

HRRR-SMOKE 2018-05-29 00 UTC 0h fcast - EXPERIMENTAL 05/29/2018 00:00 UTC  
Vertically Integrated Smoke ( $\text{mg}/\text{m}^2$ )



2 5 8 11 15 20 25 30 40 50 75 150 250 500

The Vertically Integrated Smoke (left, expressed in  $\text{mg}/\text{m}^2$ ) of the fires in the southwestern United States and Mexico. Model run initialized at 00 UTC, 29 May 2018.

HRRR-Smoke Website  
<https://rapidrefresh.noaa.gov/hrrr/HRRRsmoke/>

For model related questions, please contact Ravan Ahmadov ([ravan.ahmadov@noaa.gov](mailto:ravan.ahmadov@noaa.gov)) and Eric James ([eric.james@noaa.gov](mailto:eric.james@noaa.gov))

HRRR-Smoke is developed at NOAA/ESRL/GSD in collaboration with NOAA/NESDIS, NASA and other institutes. The project is funded by the JPSS PGGR program.

### Fire Product Definitions

**Fire Radiative Power (FRP)** – FRP data is processed during the HRRR-Smoke initialization, by processing FRP for the model domain detected during previous 24-hours by VIIRS and MODIS. Model simulates fire emissions and plume rise using static FRP fields for 36 hours of smoke forecast.

**Near-Surface Smoke** – Fire emitted fine particulate matter (PM<sub>2.5</sub>, or fire smoke) concentrations at ~8 meters above the ground.

**Vertically Integrated Smoke** – Simulated total PM<sub>2.5</sub> mass within vertical columns over each model grid cell. Columns are ~25 kilometers above the ground. Product displays the effect of fire smoke load that includes smoke in the boundary layer as well as aloft, illustrating the integral effect of fire smoke throughout the atmosphere.