

Overview of smoke forecast map

Last updated: 7/18/2023

The smoke forecast map provides a prediction of fine particulate matter, shown as a PM_{2.5} Air Quality Index (AQI) category. Health warnings linked to each air quality category are available in the [What Is AQI PDF](#). Forecasts can be used to plan outdoor activities and reduce exposure to air pollution.

A five-day forecast is issued from June through October, when wildfire smoke is of concern, while a two-day forecast is issued for the rest of the year. The forecast map is broken into many zones, based on Ecology's network of air quality monitors and some local Clean Air Agency (CAA) management regions. The size of the zones are smaller in the cold months, because smoke impacts are localized.

The smoke forecast is based on:

- Forecasts issued by local clean air agencies and Ecology staff, based on professional judgment.
- Forecasts produced by the Idaho Department of Environmental Quality (IDEQ) Machine Learning (ML) model (an update to the WSU version formally used).
- Forecasts produced by the Ecology HYSPLIT model (wildfire season only)

Forecasts issued by local CAAs are retrieved from AirNow and assigned to the appropriate zones on the map. All forecasts issued by a local CAA or Ecology staff are shown unaltered on the map.

The IDEQ ML model uses previously monitored PM_{2.5} and the University of Washington (UW) Weather Research and Forecasting (WRF) model, to produce a two-day forecast. The average of Ecology's eight HYSPLIT forecast simulations is used to produce a five-day forecast. The automated forecast shown on the map uses the IDEQ ML model for days 1-2 and Ecology's HYSPLIT ensemble average for days 3-5 or when the ML forecast is unavailable.

Two-day forecasts from IDEQ Machine Learning (ML) model

WSU developed site-specific PM_{2.5} versus meteorology relationships using 4-kilometer UW WRF forecasts archived since 2017. These relationships show how PM_{2.5} has changed in recent years during different meteorological conditions. The relationships are used in combination with the UW WRF ensemble forecast average to construct a two-day forecast. More information is provided in [Fan et al., 2023](#). IDEQ updated the ML model to include bias correction and site characteristic inputs to capture regional effects. IDEQ also retrains the model with recent monitoring data every year.

Five-day forecasts from Ecology HYSPLIT ensemble model

Eight simulations of wildfire smoke are performed using the NOAA [HYSPLIT](#) model as implemented by Ecology. Each scenario has a unique method for calculating emissions, as listed in the Table on the following page. Meteorology is obtained from the UW WRF 12km extended forecast. Anthropogenic sources, boundary conditions, initial conditions, chemical reactions, and deposition are not included. Fire locations are from NOAA's Hazard Mapping System (HMS). Daily processes include:

1. Download NOAA HMS file for recent fire locations and remove duplicate locations
2. Assign 194 acres to each location and merge clusters (sum acres; max FRP)
3. Apply FRP modification formula (scenario-specific) for emissions; keep original FRP for heat
4. Assign daily emissions basis (66.1 Kg PM_{2.5} / MW)
5. Apply fire potential (USA) and fire danger (Canada) and vegetation factors
6. Apply hourly diurnal profile for heat and emissions (scenario-specific)
7. Create HYSPLIT input files (hourly emissions with heat and area for plume rise) sounds
8. Run all 8 HYSPLIT scenarios and report the average PM_{2.5} within each zone on the forecast map

HYSPLIT Emissions Scenarios

	S1	S2	S3	S4	S5	S6	S7	S8
First Hour Kept from HMS	Noon (-1 Day)	Noon (-1 Day)	2 a.m. (-1 Day)	2 a.m. (-1 Day)	Noon (-1 Day)	Noon (-1 Day)	Midnight (-3 Days)	Midnight (-3 Days)
Duplicate Dist.	10m	10m	10m	10m	10m	10m	50m	50m
FRP Modification Formula	FRP max = 100 min = 0.3	1.25 FRP max = 100 min = 0.3	2 sqrt FRP max = N/A min = 0.3	2 sqrt FRP max = N/A min = 0.3	4 sqrt FRP max = N/A min = 0.3	4 sqrt FRP max = N/A min = 0.3	FRP max = 100 min = 0.3	3 sqrt FRP max = N/A min = 0.3
Area per Detect	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)	194 Acres (r = 500m)
Merge Aggregation	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum	FRP = Max Area = Sum
Merge Distance	1000m	1000m	1000m	1000m	1000m	1000m	1000m	1000m
USA Fire Potential Factors	None	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50	Moist = 0.25 Dry = 1.00 Lightning = 1.00 Very Dry = 1.25 Hot = 1.25 Burn Env. = 1.25 Windy = 1.25 Hot & Dry = 1.50
CAN Fire Danger Rating Factors	None	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25	Low = 0.25 Moderate = 0.50 High = 0.75 Very High = 1.00 Extreme = 1.25
Vegetation Factors	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20	Barren = 0.01 Scrub = 0.40 Forest = 1.00 Crops = 0.20
Diurnal Profile	Legacy	Legacy	Legacy	WRF-CHEM	BlueSky	WRF-CHEM	BlueSky	Legacy

Diurnal Profile Hourly Factors

Hour (PST)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Emis. (Legacy)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.6	1	1.5	1.9	2.3	2.4	1.7	1	0.6	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Heat (Legacy)	0	0	0	0	0	0	0	0.5	1	1	10	20	20	20	10	1	0.5	0	0	0	0	0	0	0
Emis. (BlueSky)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.28	0.55	0.97	1.39	1.80	2.22	2.36	1.66	0.97	0.55	0.14	0.14	0.14	0.14
Heat (BlueSky)	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.65	2.04	5.52	8.95	12.21	15.43	16.47	11.13	5.52	2.04	0.29	0.29	0.29	0.29
Emis. (WRF-CHEM)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.8	1	1.2	1.5	1.7	1.5	1.2	1	0.8	0.5	0.2	0.2	0.2	0.2
Heat (WRF-CHEM)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.75	0.83	1.41	2.91	5.65	8.81	12.3	13.46	12.13	8.81	5.65	2.74	1.25	0.66	0.66	0.66	0.66