Planned Burn (PB)-Piedmont online version user guide

Climate, Ecosystem and Fire Applications (CEFA) Desert Research Institute (DRI)

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The Planned Burn (PB)-Piedmont model (Achtemeier 2005) is a numerical tool developed to evaluate the low-level transport of smoke associated with prescribed fire and wildfire. The underlying premise behind the model computations is to determine the state and activity of the surface drainage flow—a downslope flow regime as part of the broader mountain-valley circulation that occurs over moderate and steep terrain. Under relatively weak large-scale meteorological forcing, a drainage flow pattern becomes established when a sloped surface begins to cool faster than it warms (typically around sunset) when outgoing long-wave radiation begins to exceed incoming short-wave solar radiation. This scenario often leads to localized pressure forcing and negative buoyancy that traps cool (more dense) air near and along the sloped surface where either cool-air pooling or a downslope flow regime becomes established. In addition, when moist conditions are present, hygroscopic particles within the low-level smoke (produced from smoldering combustion within the burned area) may initiate or augment fog formation. Smoke or the combination of smoke and fog can create visibility hazards, particularly when transported across roadways (Achtemeier 2005).

In preparation for an upcoming prescribed burn or wildfire suppression activities, the PB-Piedmont model may be used to determine the likelihood of nighttime fog formation in conjunction with transport of smoke particulates that either disperse or settle in and around nearby drainage pockets that are within close proximity to the primary fire area. This web page hosts an experimental and slightly modified version of the original PB-Piedmont model for this purpose. Preliminary testing demonstrates consistent results as compared to original PC-version of the model (personal communication, Achtemeier 2017).

In summary, the PB-Piedmont model serves as predictive tool for prescribed fire and wildfire and may be used to identify spatial patterns of:

- Hygroscopic particles embedded within low-level smoke trajectories,
- Surface drainage flows that serve as a steering mechanism for aforementioned particulates,
- Post sunset (and early morning) fog formation in association with smoldering combustion in accordance with weak surface wind speeds (< 5mph), sufficient radiational cooling, and overnight moisture recovery.

Performing a model run: Along with the parameter choices below, the PB-Piedmont model operates on the premise of localized meteorological conditions (e.g., cooling, humidification, small pressure changes, and local drainage flows) that typically develop under reduced large-scale forcing and are contingent upon an afternoon/evening cool down period (or incubation period) that begins slightly before and continues after local sunset. For example, a model start time of 15:00 local time with a duration (or run time) of 12-18 hours would be required to capture potential fog formation that may setup overnight from say midnight into local sunrise. A run time beyond 24 hours has not been evaluated at this time.

Input parameters:
Ignition location: Point source location of fire ignition, (latitude/longitude, decimal degrees)—click and zoom or direct input capability (6 digits after the decimal point may be entered)
Time Zone: Local time zone (automatically determined from ignition location)
Start Date: Menu selection (model start date)
Start Time: Menu selection (model start time in local time)
Duration: Menu selection (model run time, from start to finish, in hours)

Terrain parameters:
Area burned: Value given (acres)
Grid Spacing: Menu selection (30 meter increments), <120 m considerably delays model run time
Sample radius: Value given (miles, represents the linear ground distance from the ignition (source) location to the surrounding burn perimeter

Fuel parameters:
Fuel type: Menu selection, 2 options: grass—a grassland or savanna type ground cover, trees (default)— forested land ground cover

Click Run Model

Other model sensitivity considerations:

- Results have been found to be highly sensitive to chosen fire area size—currently a square shape[1] determined based upon the fire ignition point and the surrounding radial distance—and its proximity, orientation, and inclusion of known drainage flow zones. Therefore, the user should consider an appropriate layout when inputting radial distance values.

Input Data:
At this time, analysis and forecast grids from the 5 km North American Model (NAM) are used to drive the meteorological conditions for the PB-Piedmont model (NOAA-NCEP 2014). These data are updated every 6 hours, and each dataset extends for 36 hours. The date/time options presented on this site's main page represent data available on the CEFA Web server, which generally includes the latest 4 datasets available. When the model is run, the closest forecast initialization time for the selected model start date/time is used. The variables used from the model include 2-meter temperature, 2-meter dew point temperature, 10-meter horizontal winds, mean seal level pressure, terrain height, and column-averaged cloud water. Note Local topography for the model is derived from USGS 30-meter national elevation database (NED 2014).

Output Data [two options]:
1. Display a kml file on a map by hour (independent radio button clicks). Displayed yellows correspond to smoke particulate transport locations and reds indicate where condensation and fog formation has taken place.

2. Download kml.zip for display in Google Earth, includes the following output files by simulation hour:
_hour.kml, geolocations of tracked smoke particulates (yellow push-pin identifiers)
_hour.kmz, a compressed version of _hour.kml
_hour_points.kml, same as displayed kml file mentioned above
_hour_points.kmz, a compressed version of _hour_points.kml

[1] The feasibility of replacing the square fire area with a more flexible non-square polygon fire area, a user-defined selection, is being evaluated.

Interpretation of Output Data:

Arizona example
The images below illustrate maps depicting smoke and fog particles (yellow and red dots, respectively) from a Plan-Burned Piedmont simulation. The simulation was based upon smoldering combustion from a prescribed burn conducted north of I-40 in Arizona and just west of Flagstaff, AZ. The input model data source was ECMWF-Interim gridded analysis (a coarser horizontal resolution at 12 km, but similar to the NAM data provided on the web). Input parameters were a 12.5 mile radius; 2500 acres burned; 120 m grid spacing; for a 14-hour simulation period from 1600 to 0600 MST, October 18-19, 2016. Grass land-cover was the chosen fuel type.

Image 1: Illustrates a smoke only particle pattern in yellow for the first output hour at 1630 MST. From the spatial distribution of particles, a weak but prominent west-southwesterly synoptic flow is discernable as shown by the east-northeastward drift of smoke particles.

Image 2: One hour later at 1730 MST illustrates a smoke pattern that reflects a change in the surface thermal pattern. Surface cooling and boundary layer decoupling are now underway with a localized pressure gradient prompting a new local wind pattern with eastward smoke particle drift.

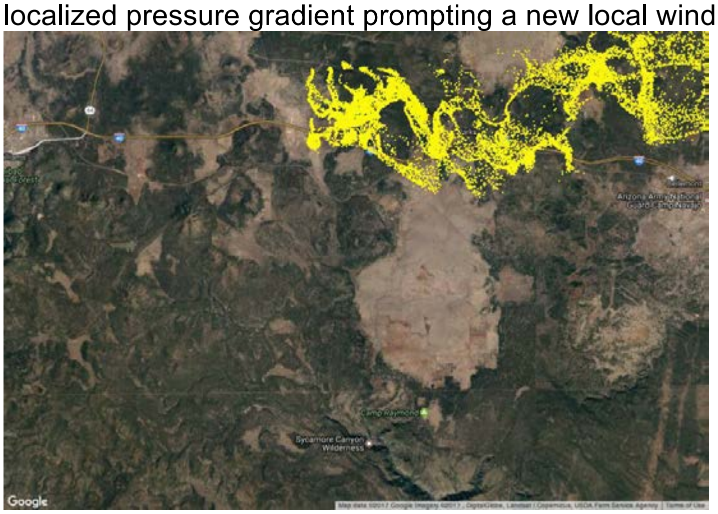
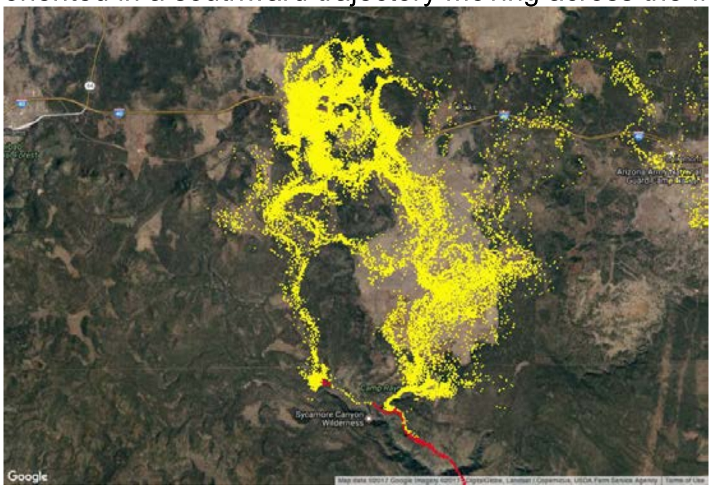


Image 3: A couple hours later at 1930 MST illustrates a similar pattern as in Image 2, but natural fog (possibly augmented from smoke particle drift acting as condensation nuclei) has now formed

well south of I-40 (red dots). The main smoke plume drift from the fire area to the north is now oriented in a southward trajectory moving across the freeway. This pattern continued overnight.



Kentucky example

The images below illustrate a maps depicting smoke and fog particles (yellow and red dots, respectively) from a Plan-Burned Piedmont simulation. The simulation was based smoldering combustion from a prescribed burn area just east of Slade, Kentucky north of the Bert T Combs Mountain Parkway. The input model data source was ECMWF-Interim gridded analysis (a coarser horizontal resolution at 12 km, but similar to the NAM data provided on the web). Input parameters were a 4 mile radius; 20 acres burned; 60 m grid spacing; for a 17-hour simulation period from 1600 to 0900 EST, November 15-16, 2016. Tree land-cover was the chosen fuel type.

Image 1: Illustrates a smoke only particle pattern in yellow for the first output hour at 1630 EST. From the spatial distribution of particles, a weak but prominent southwesterly synoptic flow is discernable as shown by the northeastward drift of smoke particles.

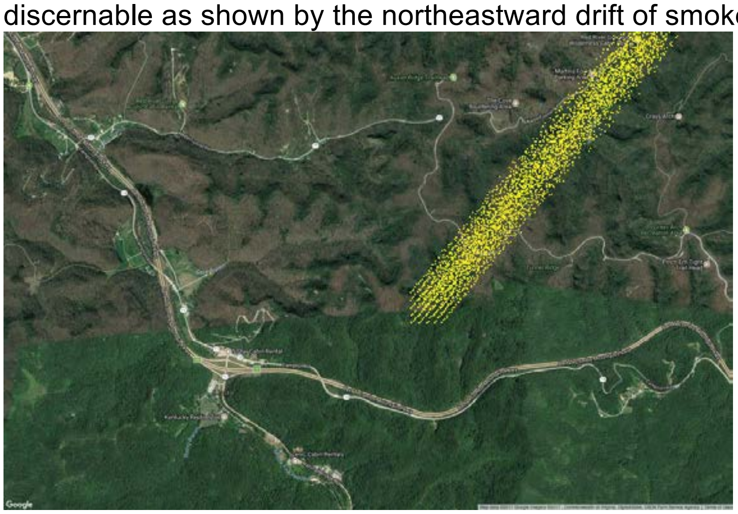


Image 2: Illustrates smoke only particles in yellow for the third output hour at 1830 EST. From the spatial distribution of particles, the southwesterly synoptic flow is still discernable. However, the pattern also reveals an operative southerly drainage flow—a response to surface cooling and a change in the localized pressure gradient.

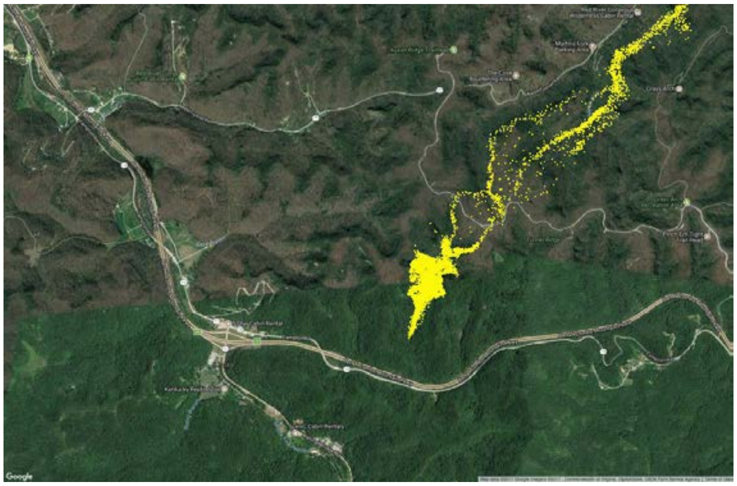


Image 3: As in image 2 at 2230 EST.

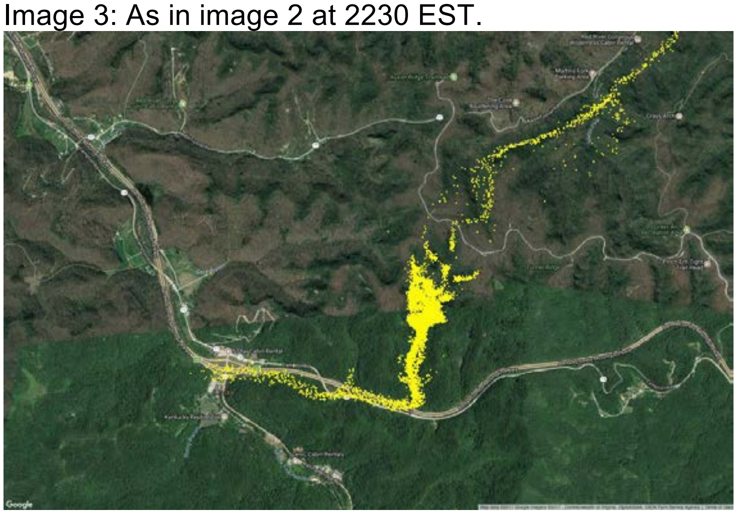
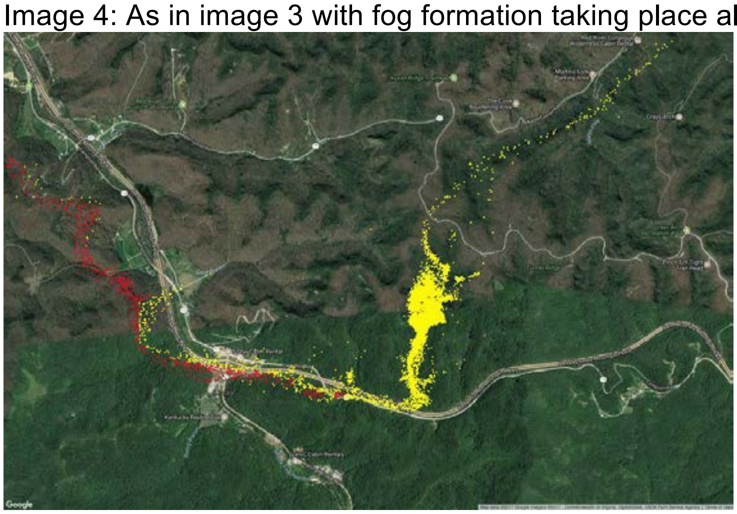


Image 4: As in image 3 with fog formation taking place along the roadway (red dots) at 0330 EST.



Feedback:
Please use the online form for product feedback.

References:
Achtemeier, G.L. 2005: Planned Burn-Piedmont. A local operational numerical meteorological model for tracking smoke on the ground at night: Model development and sensitivity tests. International Journal of Wildland Fire, 2005, 14, 85-98.

National Oceanic and Atmospheric Administration – National Centers for Environmental Prediction (NOAA-NCEP), 2014: North American Model. [http://www.nco.ncep.noaa.gov/pmb/products/nam/].

United States Geological Survey (USGS), 2014: National Elevation Dataset (NED). [https://lta.cr.usgs.gov/NED].

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