Smoke at Each Ventilation Adjective

The adjectives listed are unverified forecasts. When the atmosphere was forecasted to be in transition near the time of the photo, details are provided.

Unless noted, each photo is of a different day and burn.

Photos by Colorado Air Pollution Control Division staff.

Background

Viewed very close to a fire, smoke plumes often appear to have good loft, clear the ground completely and remain elevated. Viewing from farther away often shows a different picture. Although sometimes smoke returns to earth so far away that by then it has diluted to invisibility, the bottom of all smoke plumes eventually mixes back to the ground surface. To monitor smoke fully one must be able to see the plume for as far as smoke is heavy enough to be visible against the sky.

Ventilation adjective, sometimes labeled 'smoke dispersal' on a forecast, measures for a specific time and place the atmosphere's [forecasted] capacity to dilute a pollutant. It is the single best predictor of how the weather is likely to enable or prevent smoke impacts. Each ventilation adjective corresponds to a certain numeric range of the index.

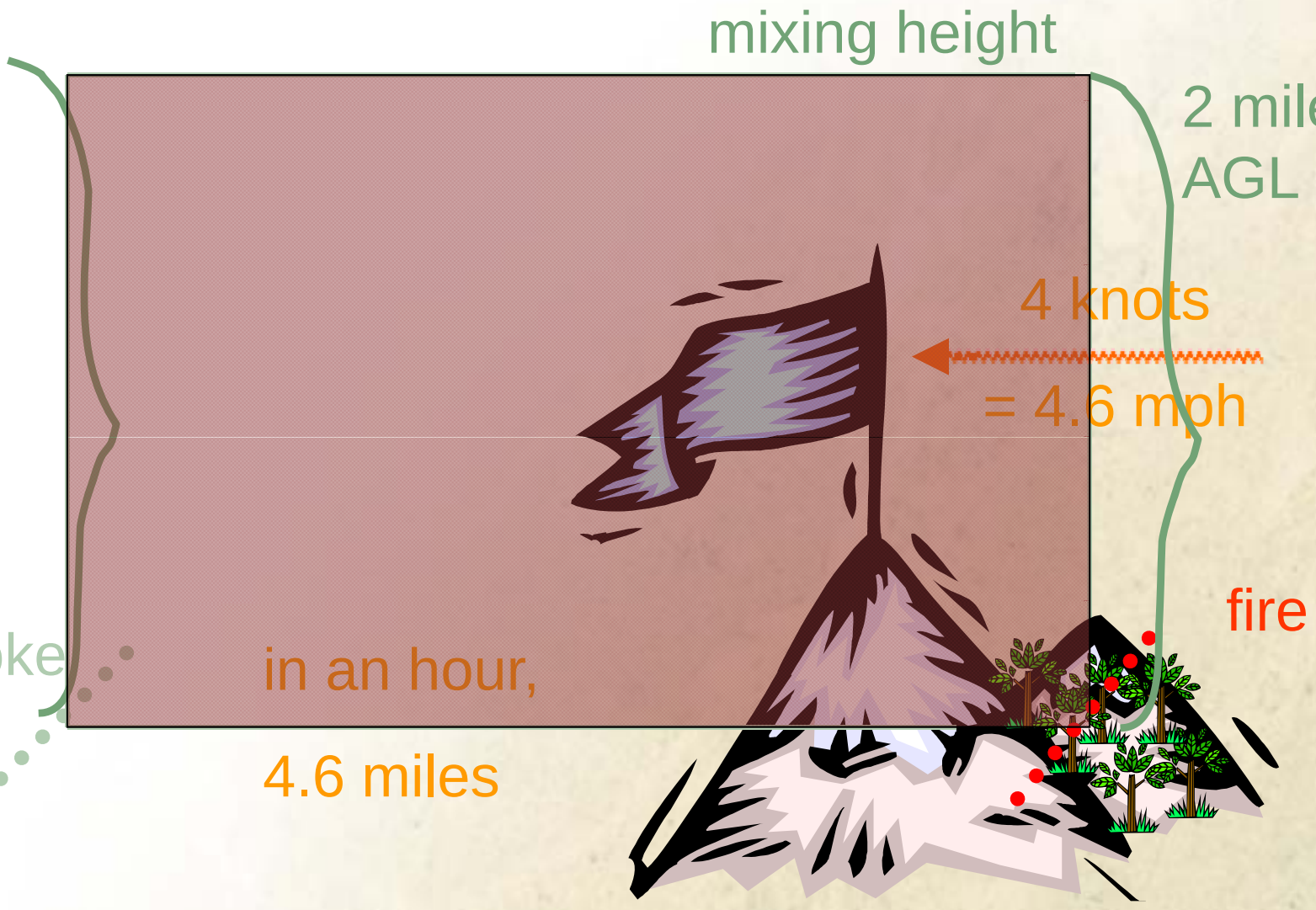
(Background, con't)

Think of ventilation index as the size of a curtain of air passing over a point on a line of spreading fire. A diagram is in the next slide. The curtain is the amount of air within which the smoke will dilute as it travels downwind. The bigger the curtain, the more diluted a given amount of smoke will become.

More technically, ventilation index is mixing height times the average wind speed through the mixed layer. Mixing height measured in feet times wind speed measured in knots yields a metric with little intuitive appeal, knot-feet. But think of it as examples. A ventilation forecast of 40,000 knot-feet, the breakpoint between fair and poor, can be obtained from a ceiling of 4,000' and average wind of 10 knots (11.5 mph). The same 40,000 knot-feet can come from a mixing height of 10,000' and 4 knots.

Even more roughly, equate knot-feet with mph and generalize that average height through the mixed layer in midday is usually similar to transport wind speed. Using those approximations, one can coarsely estimate ventilation index from a forecast of mixing height and wind speed.

Ventilation Index, Curtain of Air



Poor

Both the more distant light-colored plume and the dark plume to which the arrows point are smoke. The lighter colored band appears to be lower because of the camera angle but is not. It appears light because (1) it contains steam as well as particulates, and (2) mostly because it is scattering sunlight. Burning of this unit was started and finished before the morning inversion broke.

Poor

1/21/09, industrial stack in Gypsum, CO

Poor

3/28/08 12:39,
Comanche Grassland


Poor
4/28/08 06:29
Hermosa

Poor

Fair

Same burn as previous photo. Smoke is lifting straight up from the fire, implying light wind and strong instability through the mixed layer. The mixing height is fairly low, causing the plume to shear sharply. One cropped color distortion of the same photo shows the plume's shape more clearly, while the other highlights the hazy and capped boundary layer. Both were more evident visually than in the photo.

Fair

11/1/07 11:27

Shamrock E of Bayfield

Fair

11/2/07 15:36

Banded Peak near Chromo


Fair
2/12/08 14:53
Arkansas Mtn N of Cotopaxi

Fair

Fair

Same burn and vantage point as previous photo, and about 40 minutes later

4/22/08 13:47

Rocky Mtn Arsenal

This and the next photo are of the same burn. The forecast was for fair until 11;00, good until 12:00 then very good. From about half a mile away from and looking toward the burn, the smoke there is lofting well.

Fair or Good

(See previous photo.) Looking in the opposite direction shows that has dispersed to ground level before reaching the background ridge whose view is hazy.

9/30/08 11:28

Good

Good

Mixing height was forecasted to reach 7,000’ by noon. The plume is dispersing out of sight within about (3.5 * 7000/5280 =) 4-5 miles from the burn. It appears to mix to ground level for at least half that distance.

9/23/08 12:21

N of Dolores

Good

The picture covers almost 180º, and shows both initial loft then the smoke resurfacing.

9/24/08 14:04

N of Dolores

Good

10/02/08 12:31

Ken Caryl, Denver

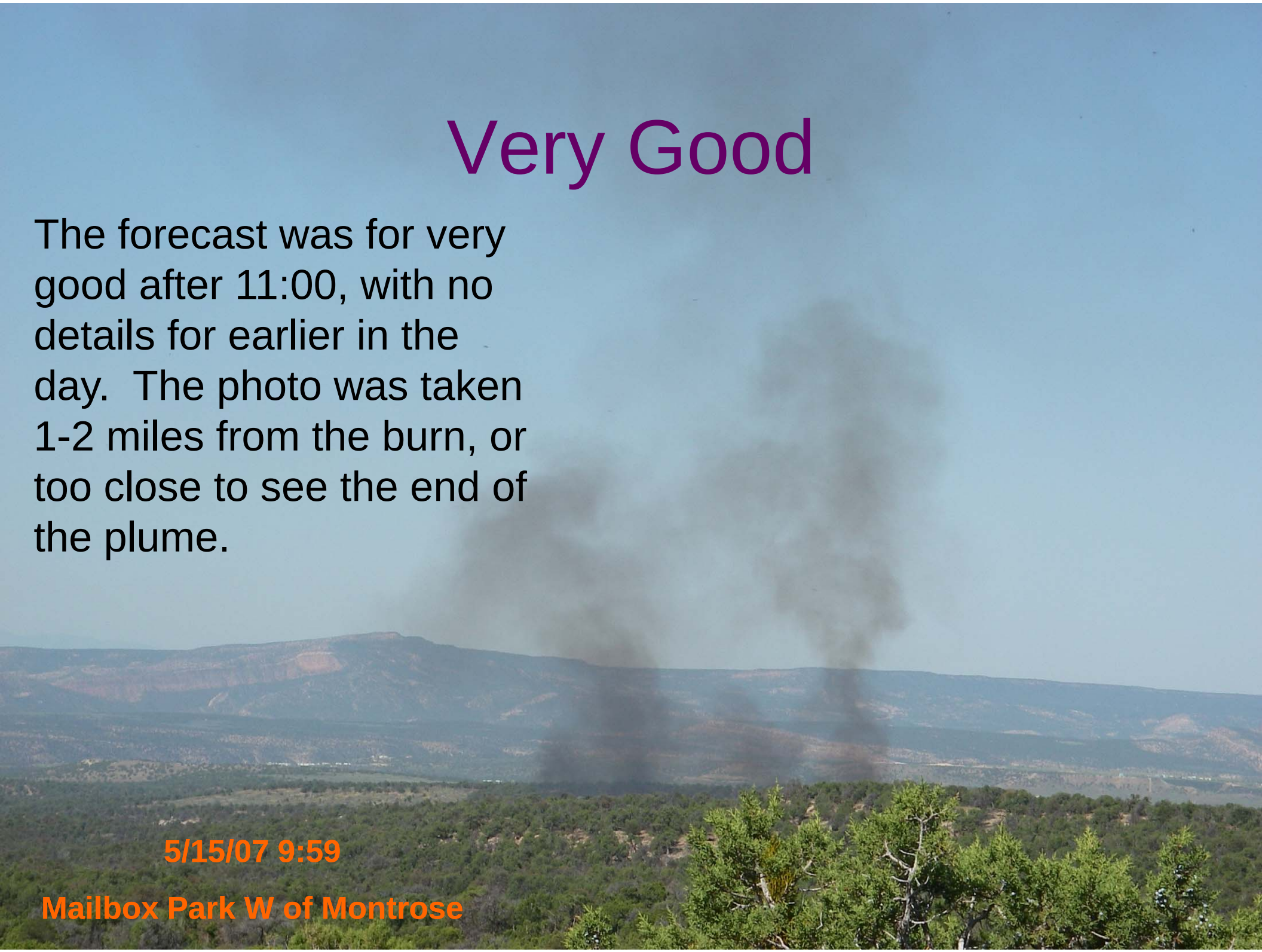
Very Good

Very Good

The forecast was for very good by 13:00, with no details. The atmosphere may have begun to stabilize when this photo was taken.

Very Good

The forecast was for very good after 11:00, with no details for earlier in the day. The photo was taken 1-2 miles from the burn, or too close to see the end of the plume.



Very Good

10/8/08 14:00

Sledgehammer S of Lake George

Very Good

Cold surface temperature is discouraging some of the smoke from rising.

4/8/08 14:44

Ten Mile Piles S of Granby


Initial rise is less than 30°,
but the plume turns upward
as it approached the bowl.
Very Good
10/24/08 12:50
Heil Ranch, Boulder

Very Good

Forecasted mixing height is 9500’ and transport windspeed around 15 mph. While a more favorable ventilation index usually implies less smoke impact, at the upper end of the scale an additional dynamic needs to be considered. The strong wind that brings top-notch ventilation can lay over a plume, bringing and holding smoke to ground level far downwind.

10/29/08 12:45

Bassam Park, view S from Fairplay

Excellent

Excellent

Excellent

20’ wind averaged 7 mph. Plume level was probably slightly faster. The fire is 10 miles away. The dashed line is the limit of visible smoke, 20 miles from the fire.

6/10/07 14:31

Trimble Point N of Dolores

Excellent

Same fire a few hours later. The limit of apparent smoke is about 40 miles from the fire.

6/10/07 17:15

Trimble Point N Of Dolores

Excellent.

Fire is 18 mi. away

Other Aspects of Ventilation

Atmospheric decoupling underway as the evening inversion forms. Some smoke is held at ground level. Elsewhere the fire's heat counters the moment's subtle temperature changes with height and allows the smoke to continue to rise.

Bent's Old Fort N.P.

Blown Forecast for Excellent?

no. This photo faces WNW. A rotor immediately east of the fire and coming off the Continental Divide in the background has caught up the smoke and rolled it into the valley.

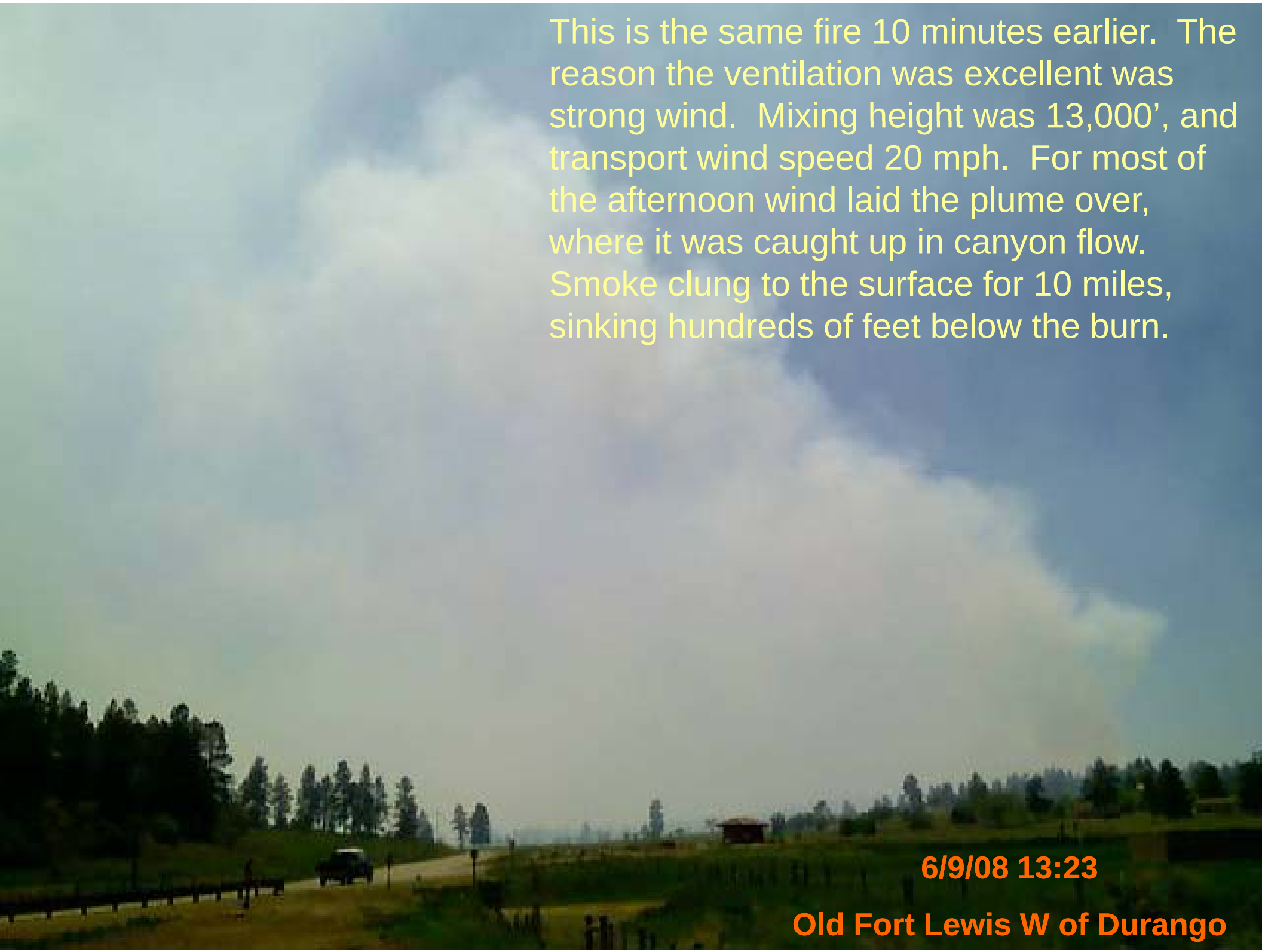
Eddy Creek W of Nathrop

The atmospheric structure warrants excellent dispersion, but cold down drafts from virga are pushing smoke back to the surface.

5/28/08 14:26

James Mark Jones SWA SE of Fairplay


Excellent, but
see next photo.
6/9/08 13:33
Old Fort Lewis W of Durango


This is the same fire 10 minutes earlier. The reason the ventilation was excellent was strong wind. Mixing height was 13,000', and transport wind speed 20 mph. For most of the afternoon wind laid the plume over, where it was caught up in canyon flow. Smoke clung to the surface for 10 miles, sinking hundreds of feet below the burn.
6/9/08 13:23
Old Fort Lewis W of Durango

Fair ventilation, after ring firing of moderate load grass lofted the plume higher than at any other time of the day. Some of the smoke drifted left (NW), as it had all day. But the heat pulse lofted some smoke higher, into a wind shear layer that transported it E. The plume continued to spread apart in both directions.