Wildfire Smoke Forecasting

- How Does Weather Affect Smoke Movement
- Smoke Model We Use
- Limits of Predictability

Chris Smallcomb, NWS Reno
chris.smallcomb@noaa.gov
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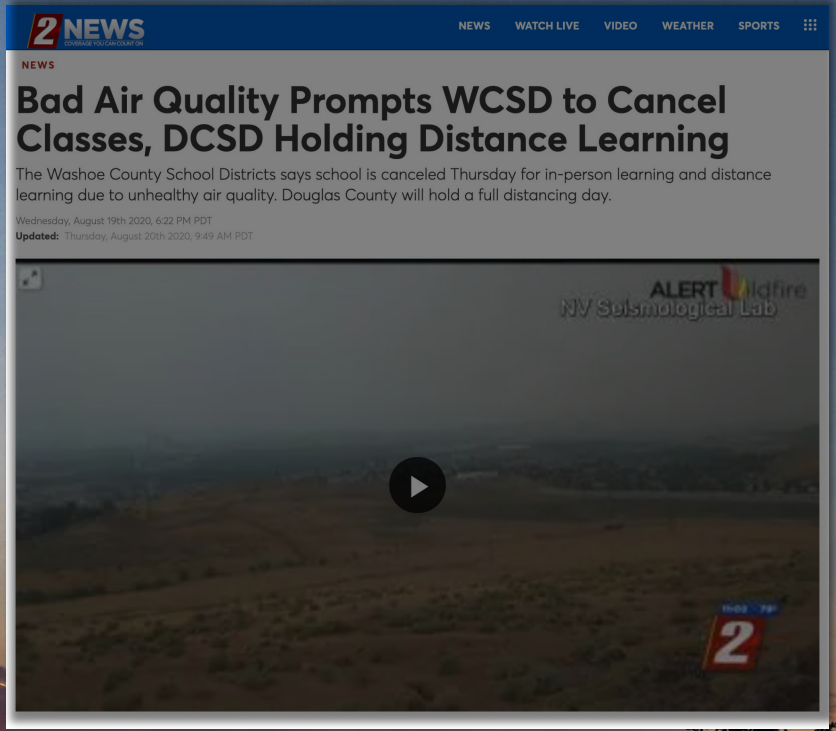
Our Experiences

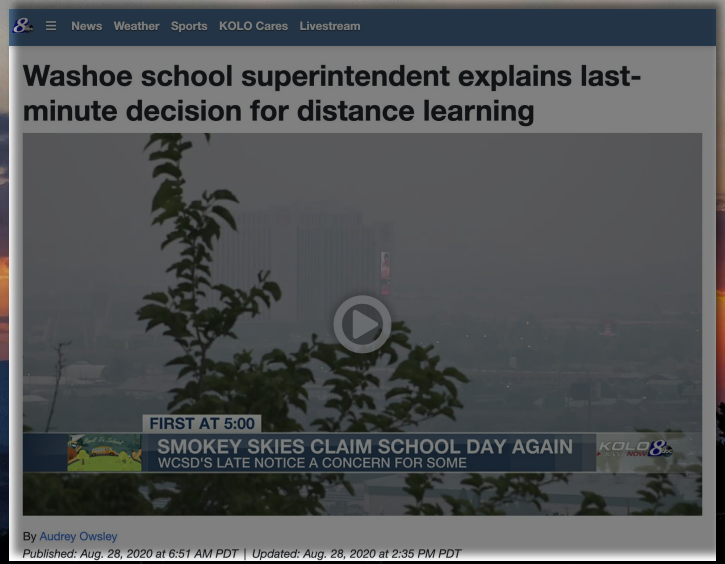
Smoke forecasting is NOT something you learn in weather school!

But we had past experience with HAZMAT weather support to draw upon.

Our Experiences

2020 turned in a huge year for us in smoke decision support!





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East Fork Fire between Markleeville and Minden, 7/2/21

Weather Influences on Smoke

Surprise, wind is important! But so is atmospheric stability.

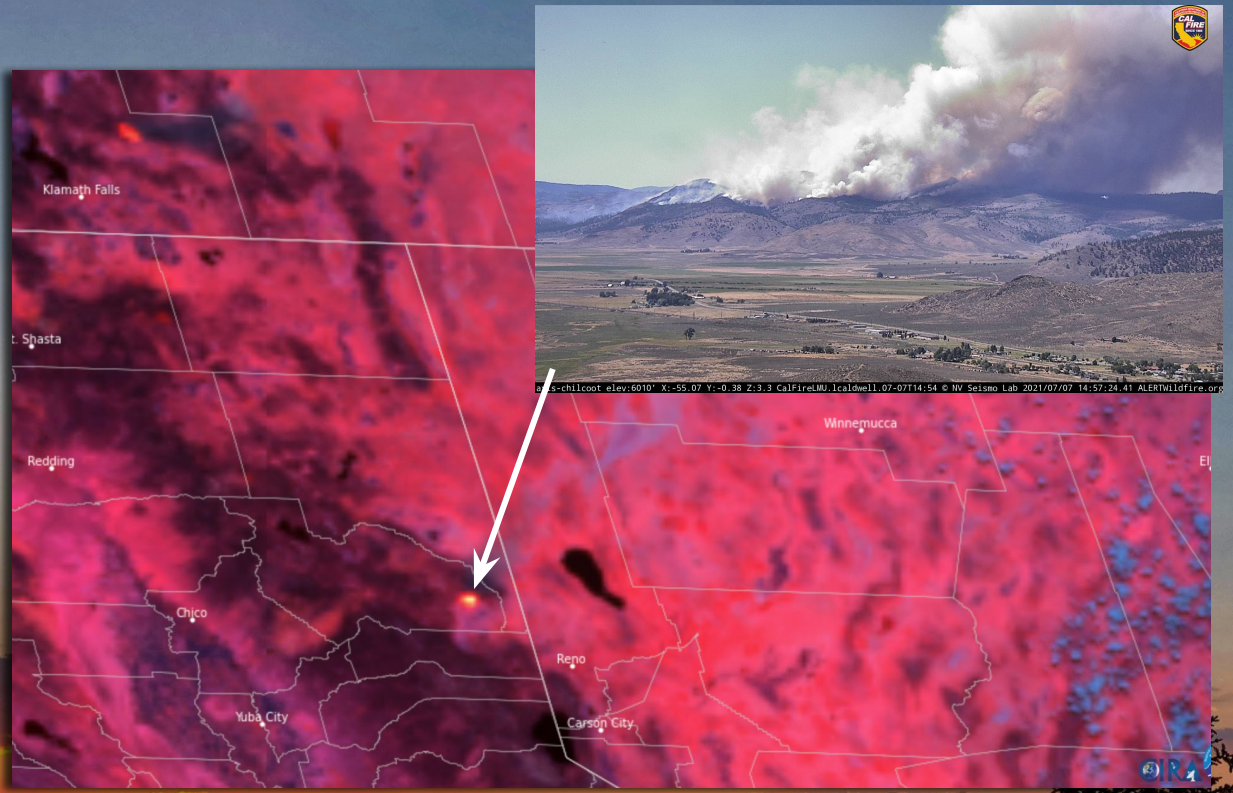
American Fire - August 2013

Weather Influences on Smoke

Thunderstorms can REALLY mess with a "perfect forecast"!

Smoke Models

NOAA's HRRR Smoke factors in satellite detected fire activity and predicted weather.



GOES Satellite visible and fire detection imagery, 7/7/21 @ 1430 PDT

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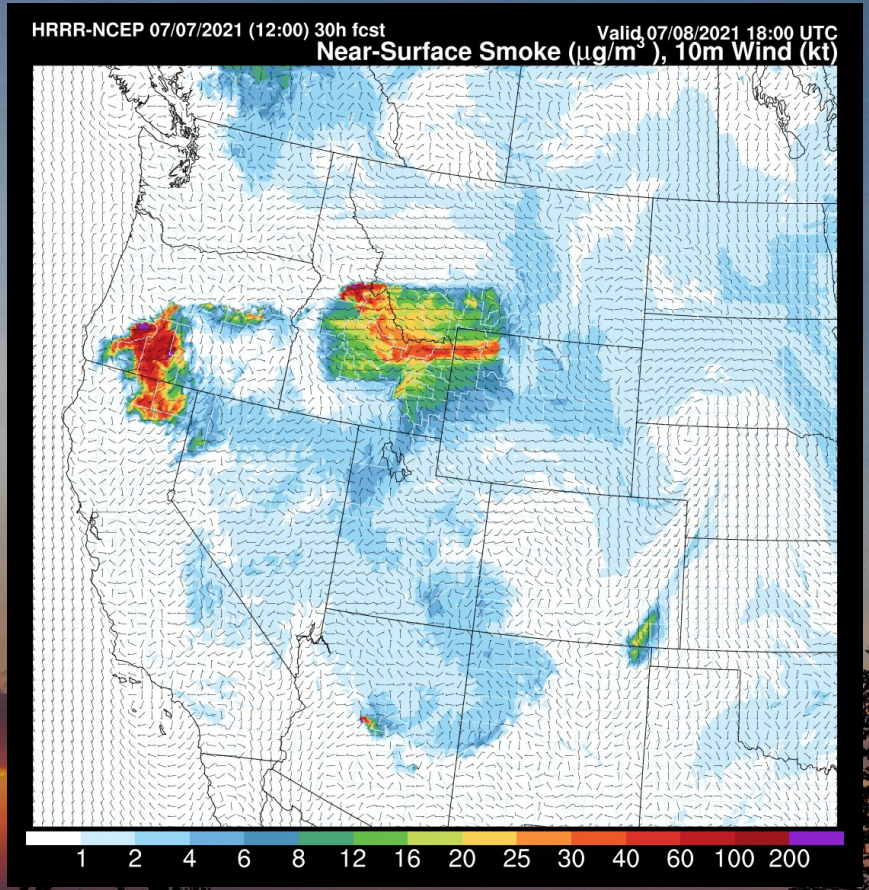
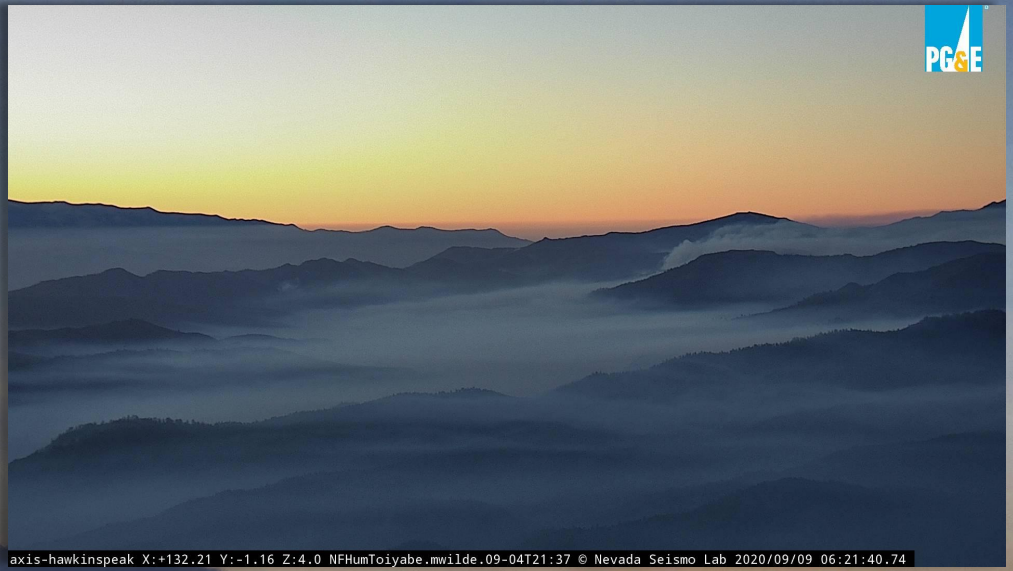
Smoke Models

1) near surface smoke versus “vertically integrated smoke”.
2) Smoke concentration vs AQI you see online



HRRR Smoke model data



They're All Great, But...

Limitations:

1) existing smoke, esp trapped in valleys
2) fine-scale wind patterns, esp 36+hrs out
3) thunderstorms…
4) brand new fires!

With All That In Mind…

Let's take a look at the forecasts leading up to the worst of the worst smoke in Reno, September 12-13 2020

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Situational Awareness - When Should I Freak Out?

NWS Reno 7-14 Day Scan for Upcoming Weather across the Eastern Sierra and Western Nevada

	Thurs 9/10	Fri 9/11	Sat 9/12	Sun 9/13	Mon 9/14	Tues 9/15	Wed 9/16	W2 9/17-23
Wind	Pretty light winds. Variable AM, light westerly PM.			Return of PM zephyr.	Breezy W/SW winds each afternoon/evening. Lake recreation impact possible.			Dry air mass with minimal precip chances. Typical winds. Rapid decline in daylight hours maximized around the autumn equinox.
Fire Weather	Dry air persists.	No critical areas but dry air persists. Night recoveries a little better.		Localized critical wind/rh.	Watch for possible critical wind/rh over more areas. Trending toward low-end critical winds each day but given the ongoing fire situation anything could be problematic.			
Thunderstorms	No moisture. No storms.					Possible buildups over Sierra.		
Flooding	No issues here that we can foresee.							
Unusual Temps	Cool start, but then comfy warm.	Warming back up to above normal but nothing too impactful. Pleasantly cool nights continue.			Cooling back off again, near or maybe even a touch below normal.			Near normal favored.
Smoke	Smoke moving back in by afternoon near and east of Sierra. Lasting through Friday at least. Will be very dense near and just east of Sierra.		Smoke impacts likely, but mixed confidence right now.	Increased potential for significant smoke impacts in more areas with stronger S/SW transport winds. Depends of course on status of Sierra fires.			TBD.	TBD

What Does This Mean? Integrates impacts and confidence

No worries	Low freakoutness	Moderate freakoutness	High freakoutness	Really bad

THURSDAY 9/10: Even 2-3 days out, limited confidence in weather and smoke forecasts kept us from freaking out too bad, just yet.

Situational Awareness - When Should I Freak Out?

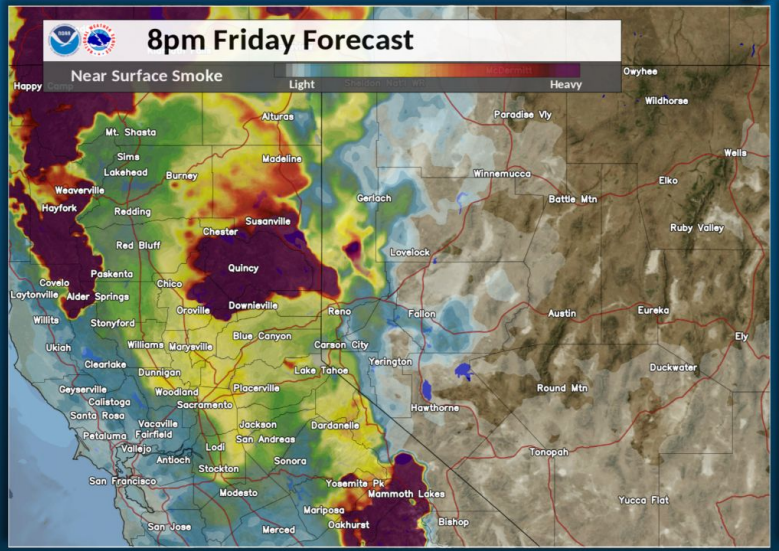
NWS Reno 7-14 Day Scan for Upcoming Weather across the Eastern Sierra and Western Nevada

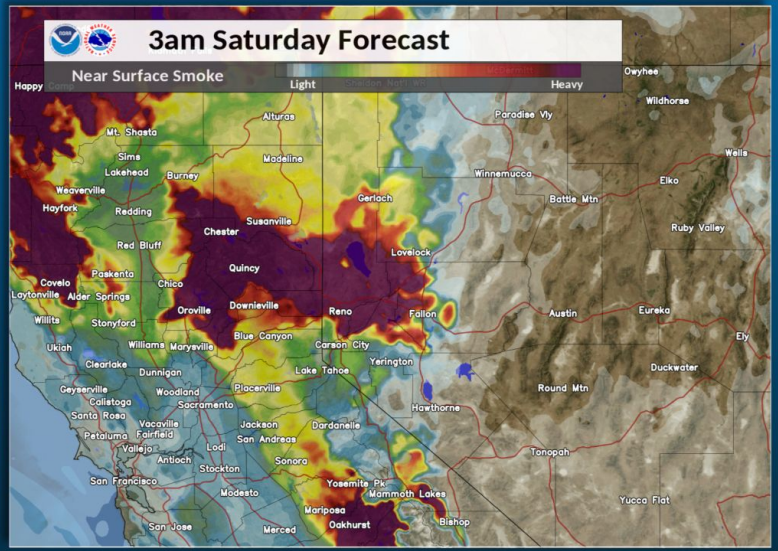
	Fri 9/11	Sat 9/12	Sun 9/13	Mon 9/14	Tues 9/15	Wed 9/16	Thur 9/17	W2 9/18-24
Wind	Pretty light winds. Variable AM, light westerly PM.		Gusty W/SW zephyr winds each afternoon. No big impacts but could see some choppy water on lakes.			Nothing overly remarkable.		Unfortunately not seeing any signs for rain, but also no big wind scenarios either.
Fire Weather	No critical areas but dry air persists. Poor humidity recovery W Nev, E Sierra.		Areas of critical wind, low humidity each afternoon. Best chances Tahoe & Sierra Front northward into NE California and far NW Nevada. Gusty winds persist on ridges, mid-slopes at night. Confidence still mixed but Monday might have most concern.			Continued dry...		
Thunderstorms	No moisture. No storms.							
Flooding	No issues here that we can foresee.							
Unusual Temps	Warming back up to above normal but nothing too impactful. Pleasantly cool nights continue.				Cooling off again. Possibly below normal by end of the week.			Near normal favored.
Smoke	Smoke continuing to impact the area with light westerly transport winds. Dense evening, overnight, early morning with some improvement each afternoon. Not all areas will be affected the same.		Smoke impacts likely, but mixed confidence right now.	Smoke issues likely to continue with increased S/SW transport winds but predicting impacts this far out is iffy.		TBD.		TBD

What Does This Mean? Integrates impacts and confidence	No worries	Low freakoutness	Moderate freakoutness	High freakoutness	Really bad

FRIDAY 9/11: Now within 1-2 days, our smoke models showed that it was going to be smoky. But no idea it would be "record setting"...

Smoke Simulation - Tonight





Light westerly transport winds kick in this evening resulting in smoke pouring back into the area. Drainage flows will allow smoke to settle into valleys by Saturday morning. There may be some spots where smoke is not as bad - such as Tahoe, and along/east of Hwy 95 as implied by the HRRR smoke model above.

The colors on these maps do not necessarily correspond to AQI colors. So focus on trends, relative values.

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9/11 HRRR Smoke: showing thick smoke pouring back into Reno and W Nevada with the afternoon zephyr breeze on 11th.

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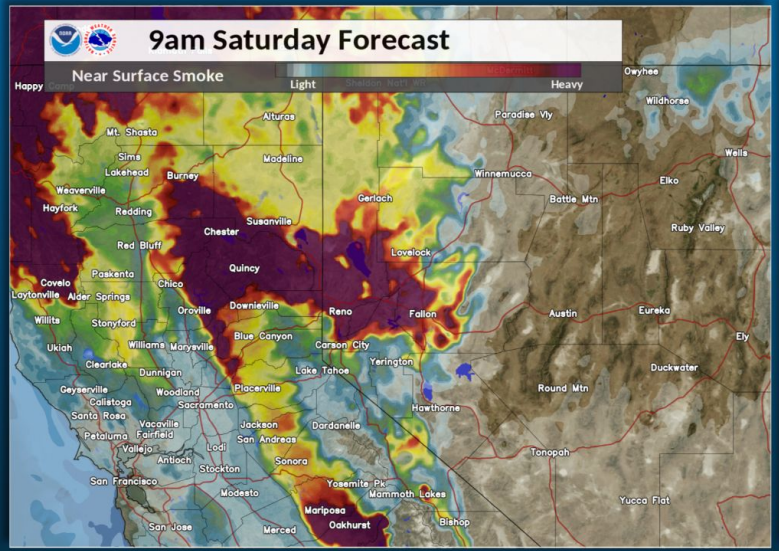
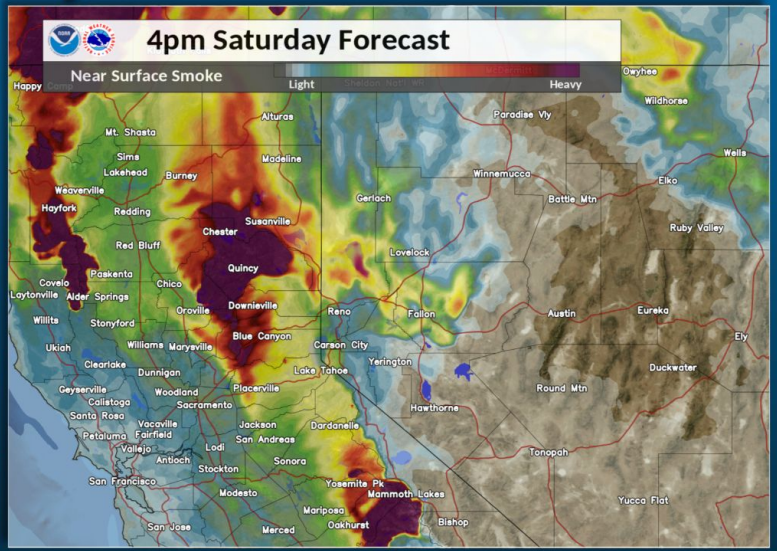
Smoke Simulation - Saturday Outlook





Saturday will start off smoky especially in valleys with near-zero winds. Mixing should allow for some improvement in the afternoon but it will be gradual. Light westerly transport winds will likely push smoke back into areas along and east of Hwy 395 Saturday late afternoon and evening. Not shown on the map since the model doesn't go out that far!

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9/11 HRRR Smoke: Showed thick AM smoke on 12th but then "mixing out" and becoming less awful in the afternoon…

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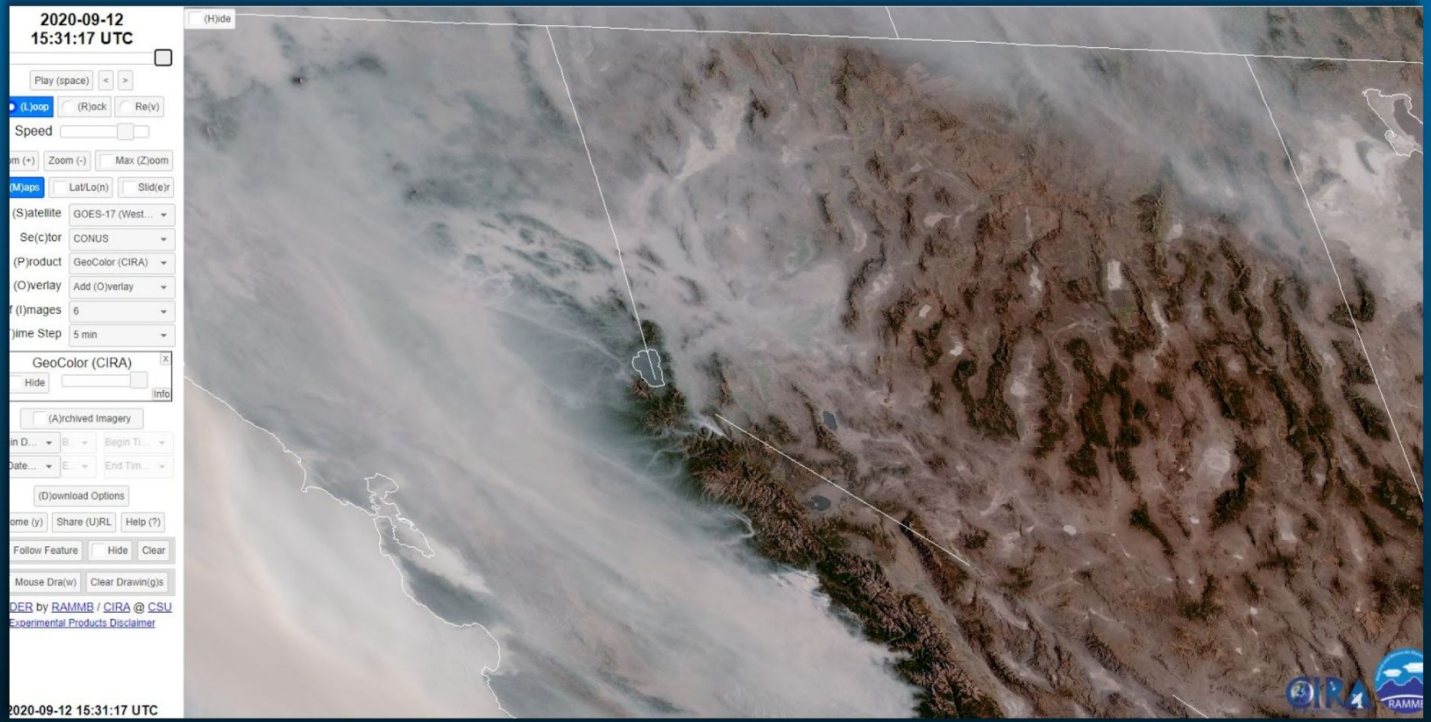
Sunrise Satellite View - Visible



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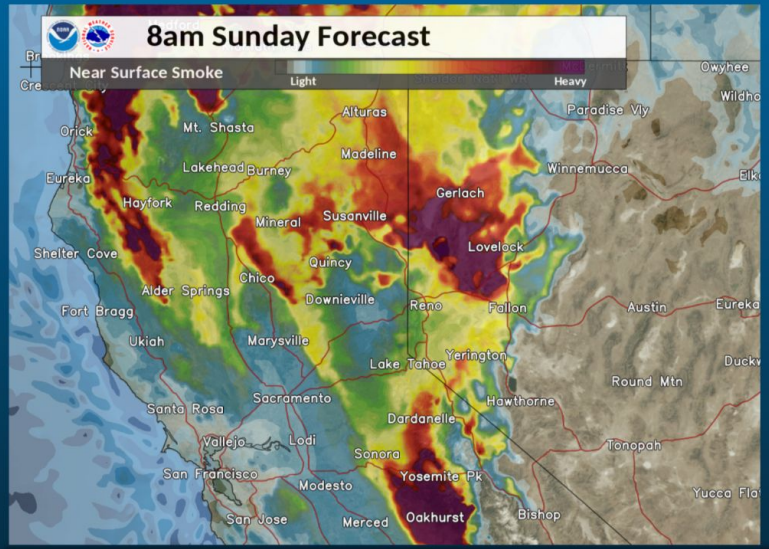
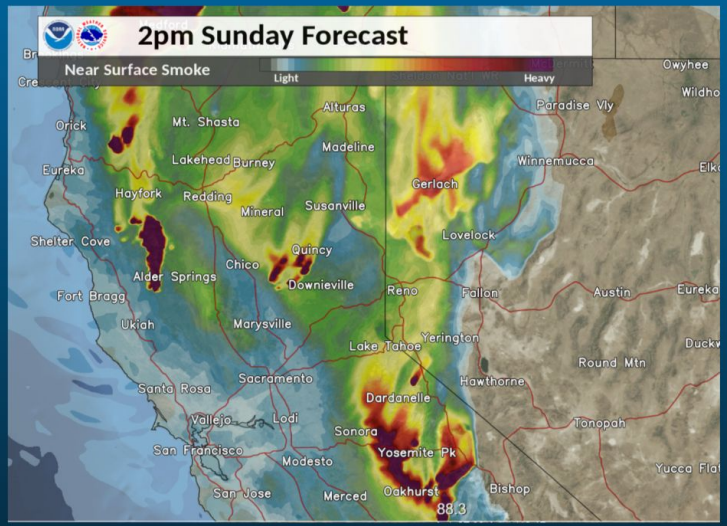
9/12 Satellite: woke up to thick smoke in the valleys, more or less in line with the model forecast. But the smoke didn't "mix out"!

Smoke Simulation - Sunday Outlook





More smoke to start the day Sunday, but increased flow will help to spread out smoke particulate matter. Of course, the breezy and dry conditions are likely to cause fires to burn more actively with additional smoke output.

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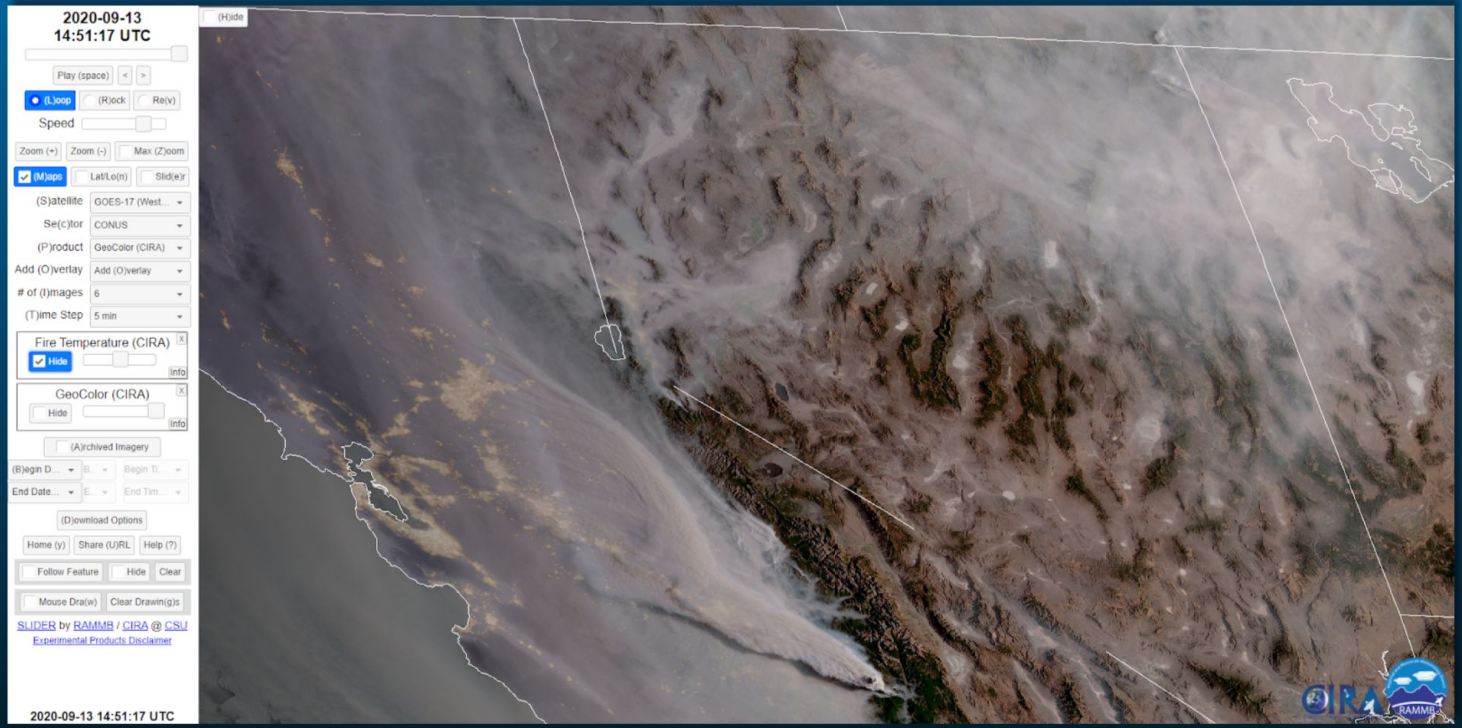
9/12 HRRR Smoke: Showing smoke in the area but not too bad for the 13th...

Sunrise Satellite View - Visible



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9/13 Satellite: Kind of looks the same as yesterday, doesn't it!?

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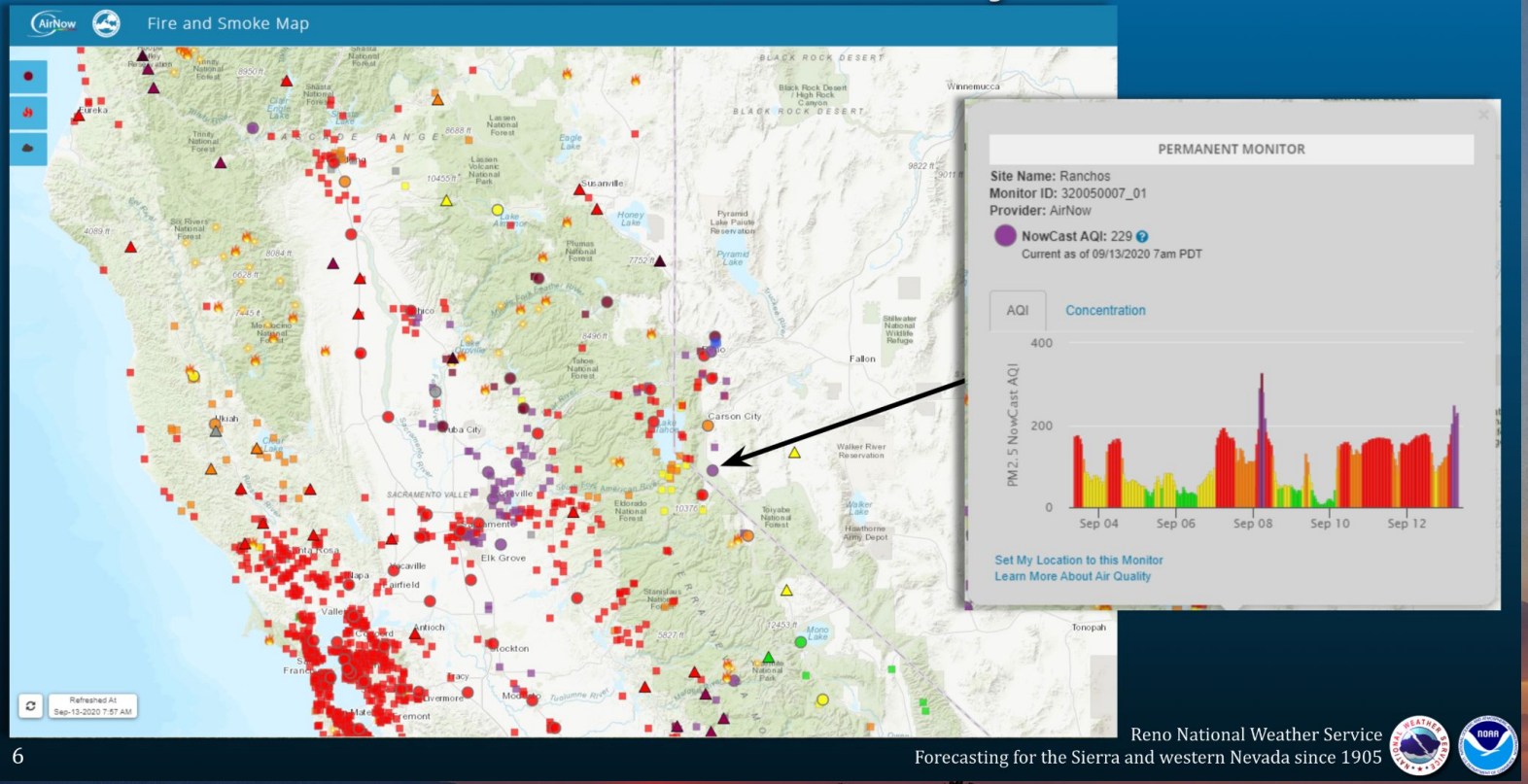
PM2.5 Smoke Status - 8 AM Sunday



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PM2.5 (Smoke) Observations 9/13: Pretty terrible air with many spots in unhealthy to very unhealthy status.

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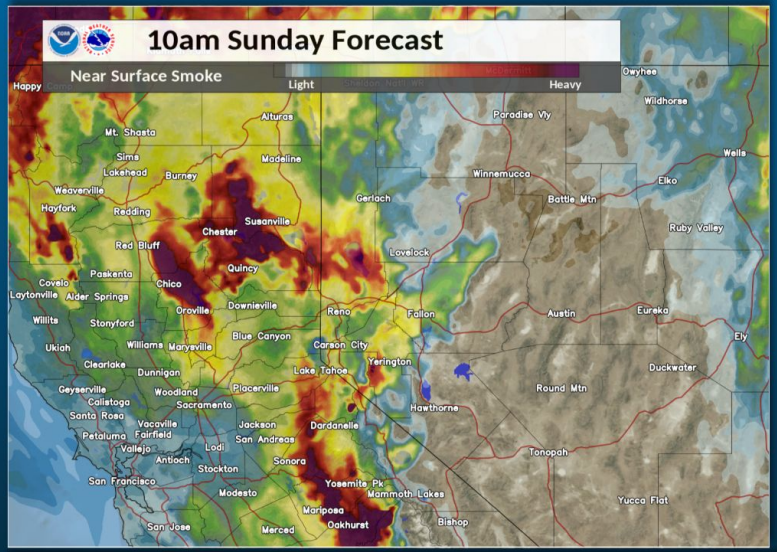
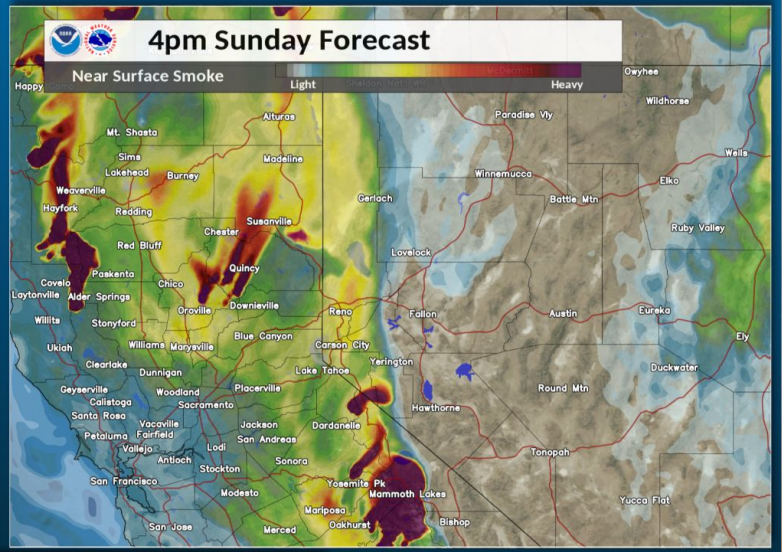
Smoke Simulation - Today





Light winds will yield very slow improvement in the smoke situation today especially for lower elevation valleys. Mixing may be enough for better conditions by mid to late afternoon similar to yesterday. However W/SW transport winds by late afternoon will bring large amounts of smoke back into areas such as Mammoth, Topaz, and Susanville from nearby fires.

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9/13 HRRR Smoke: It has smoke here but not nearly to the degree of what's being observed. Missing that "entrenched bad smoke"

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"Ash Devil" on Peavine, June 2020

Key Takeaways!

1) Smoke forecasting is decent in first 24-36 hours, looking at general trends.

2) Thunderstorm outflows, new fires, and smoke trapped in valleys can mess those forecasts up real quick.

3) Model smoke levels do not necessarily correlate directly with AQI.