Wildfire smoke forecasting in Washington

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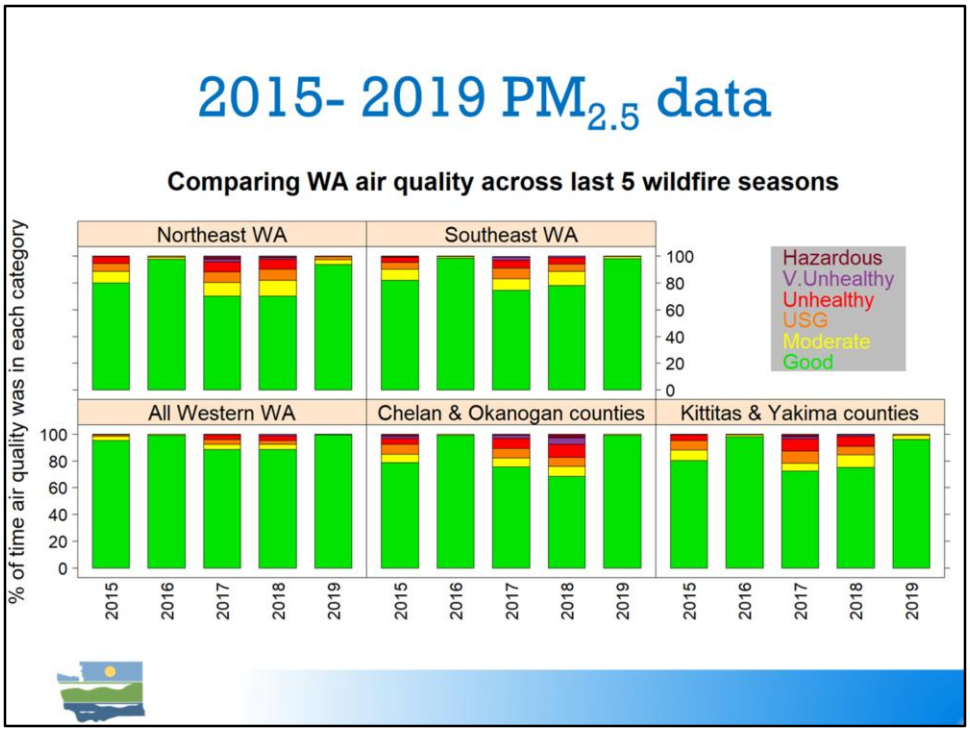
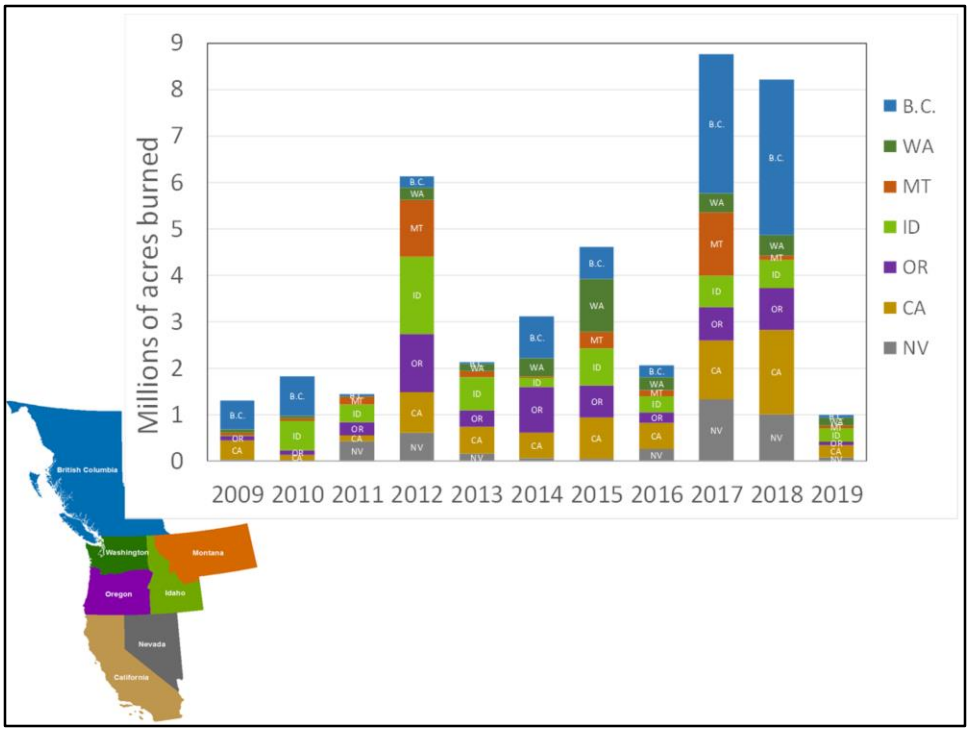
Comparing recent wildfire seasons

Summer	Acres burned in WA	# of exceedences of $PM_{2.5}$ NAAQS (FEM/ FRMs)
2012	259,526	123 (5)
2013	152,603	3 (0)
2014	386,972	32 (0)
2015	1,137,664	198 (15)
2016	293,717	1 (0)
2017	409,989	488 (137)
2018	438,834	539 (140)
2019	169,742	3 (0)

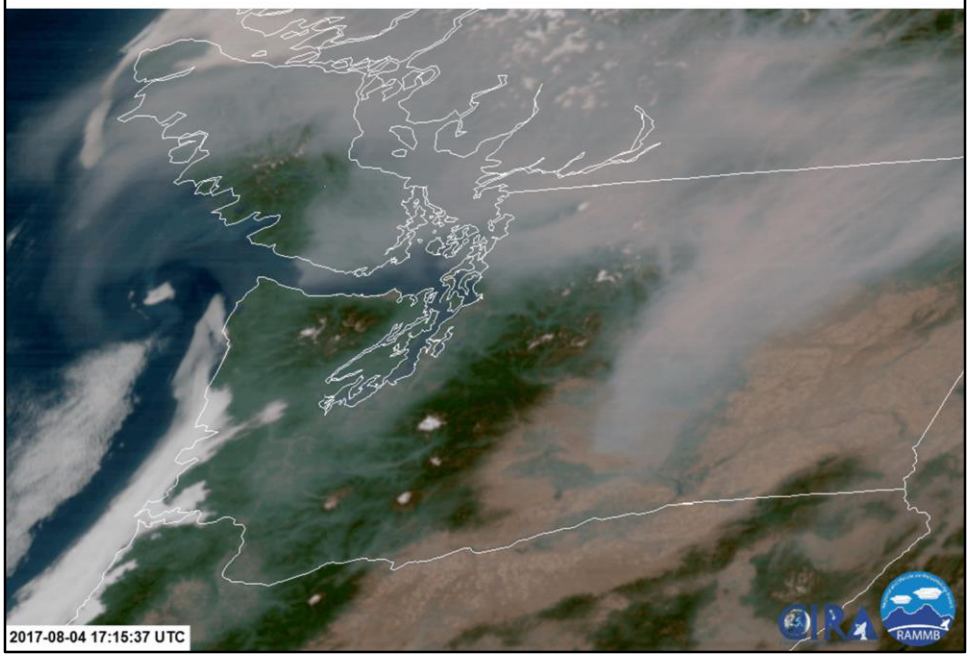
Most PM2.5 impacts not in the year with most acres burned. Depends on fire locations, fuel types and meteorological patterns

2015- 2019 $PM_{2.5}$ data

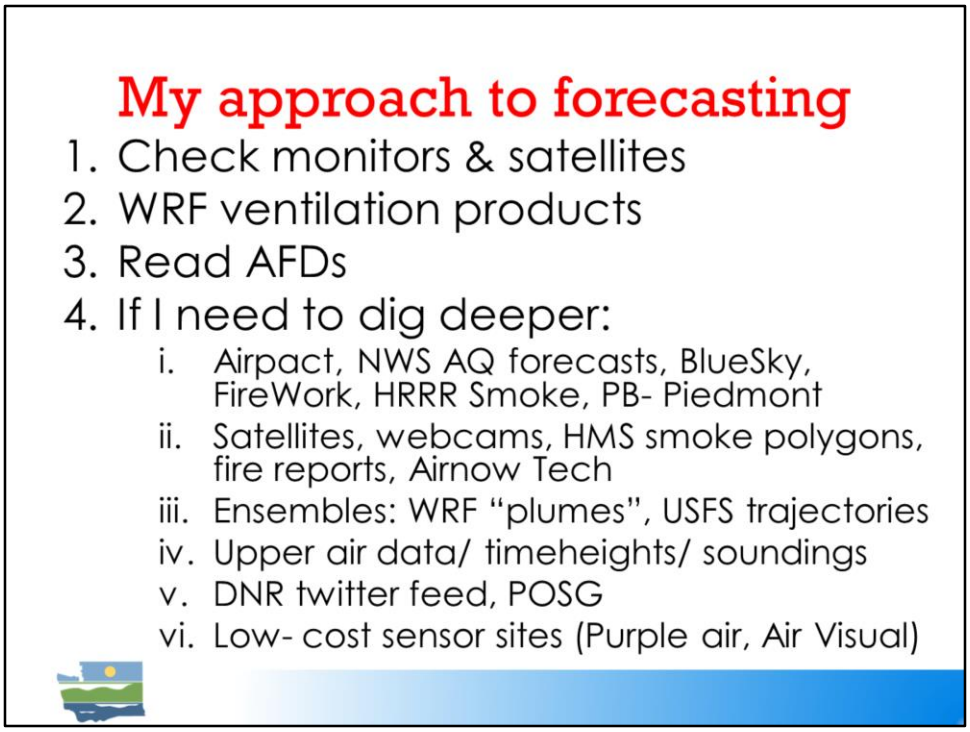



Millions of acres burned
9
8
7
6
5
4
3
2
1
0
2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
B.C.
WA
MT
ID
OR
CA
NV
British Columbia
Washington
Montana
Oregon
Idaho
Nevada
California

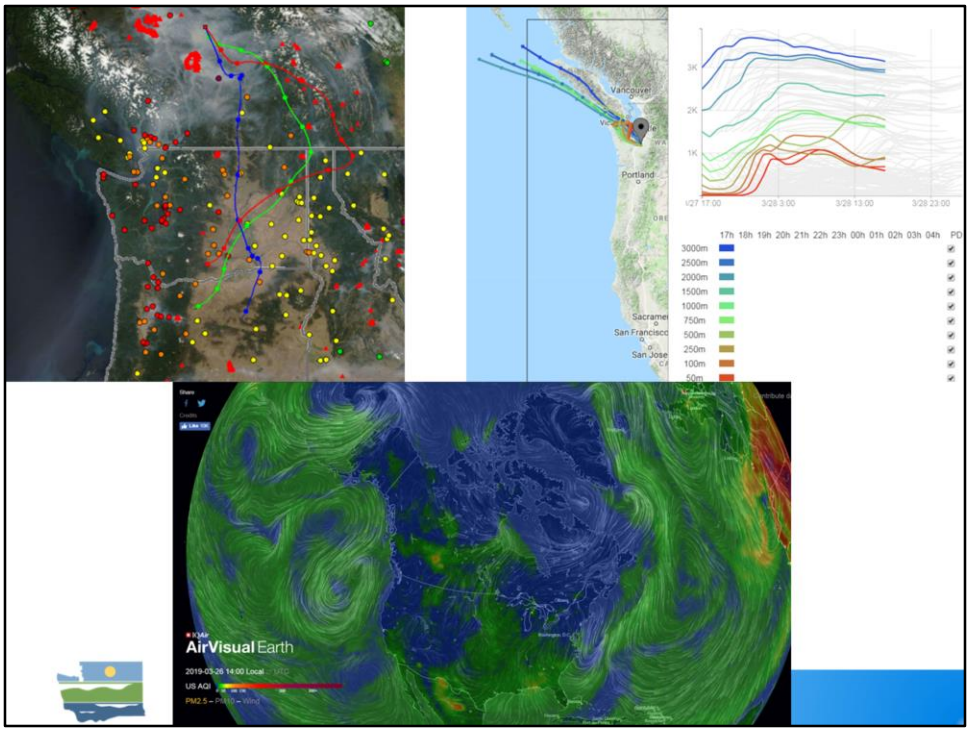
Conditions bringing wildfire smoke to western WA



High pressure over the PNW, thermal trough offshore → smoke from BC/ Cascade fires dragged over Seattle



Which monitors to check? Depends on wind patterns and where fires are.
If there is nothing of importance, stop after Step 3.



Topleft: Airnow Tech Navigator with yesterday's monitors (24hr PM2.5 means), MODIS satellite picture and HYSPLIT forward trajectories
Topright: USFS ensemble trajectories and plume heights
Bottom: Air Visual earth map of all low cost sensors + official (FEM, Neph etc) monitors interpolated. Current snapshot only, not a forecast.

Compilation of wildfire smoke resources: http://wildfire.x10host.com/

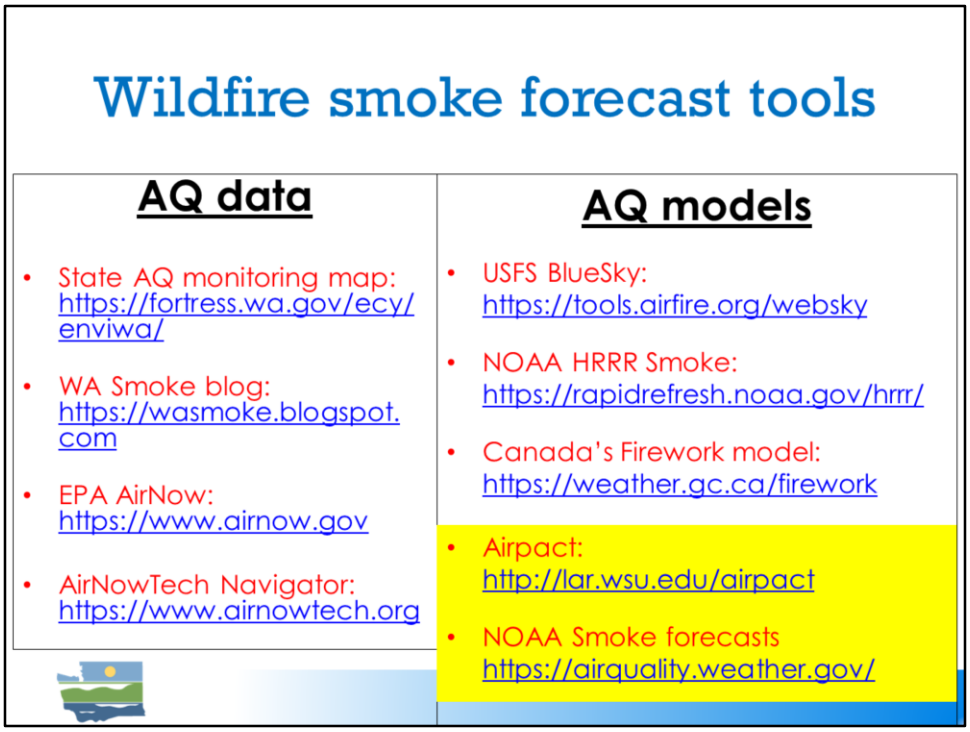
USFS products at http://tools.airfire.org
See Ensemble forward trajectories (12km, only 48 hrs out)

NAM (5km, 72 hrs), ECMWF (9km, 168 hours) & GFS (22km, 168 hrs) graphics: http://windy.com

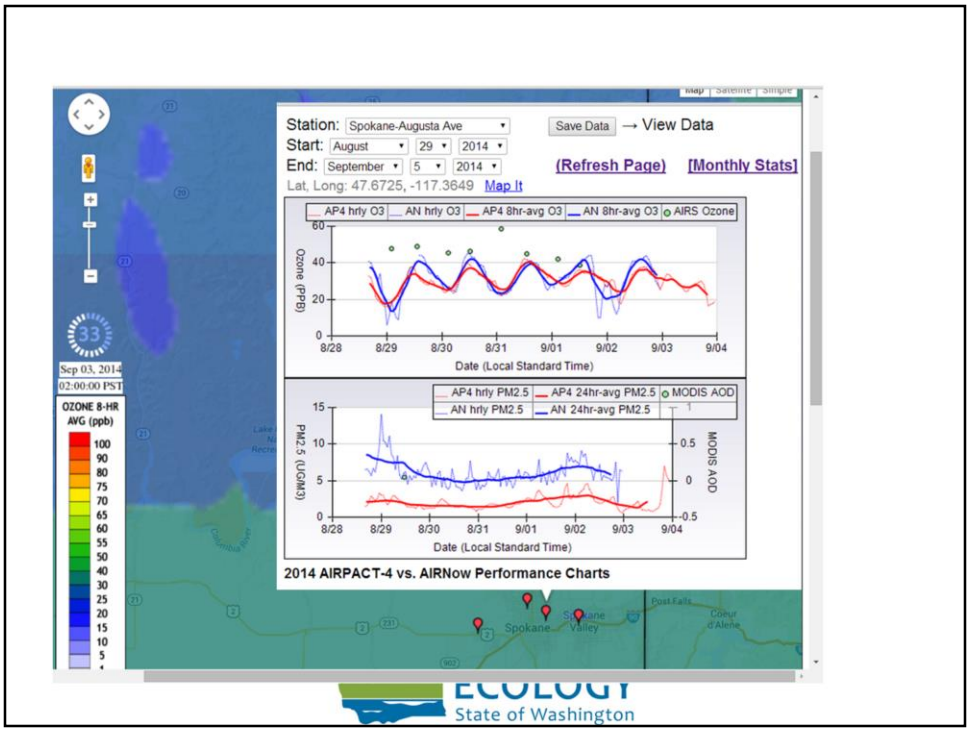
UW 4km Ensembles: https://atmos.washington.edu/mm5rt/ensembles/

WRF verification plots:
https://atmos.washington.edu/~qcreport/verification_index.psp

Scroll down to section on upper air data:
https://atmos.washington.edu/marka/pnw.html

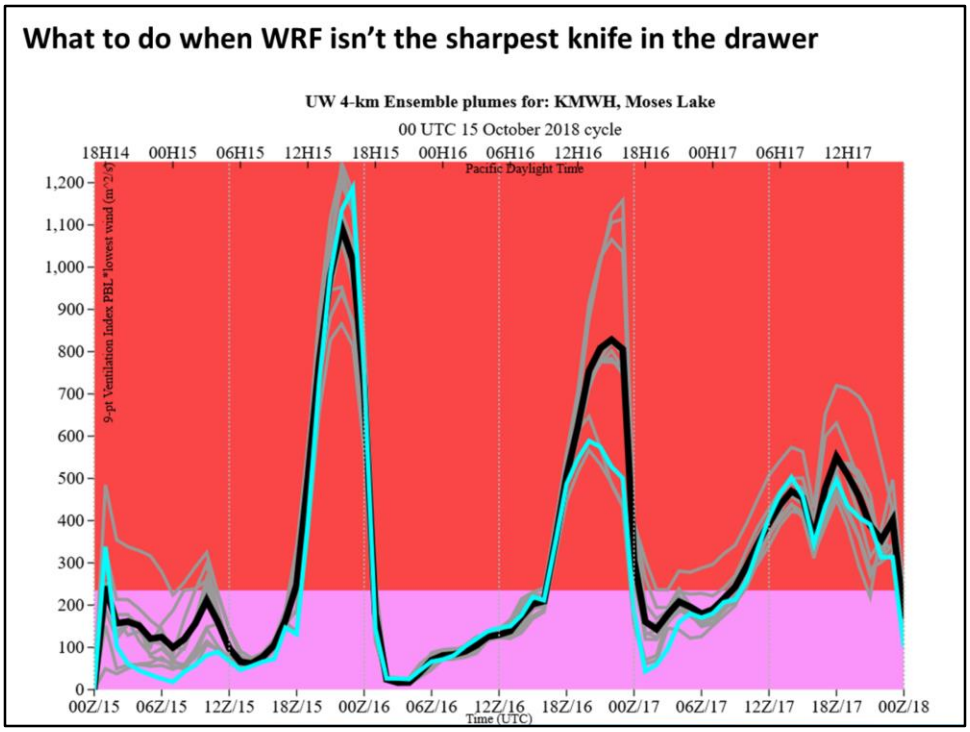


Yellow highlighted models are the only ones that do O3 forecasts



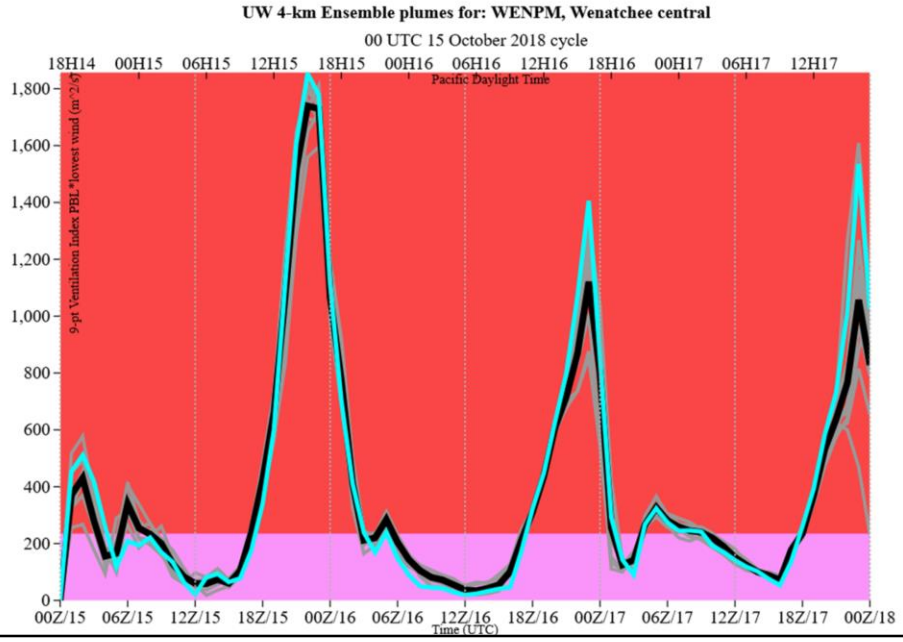
Airpact model vs monitor performance in the recent past. Adjust model forecast by how much bias over the last few days

What to do when WRF isn't the sharpest knife in the drawer



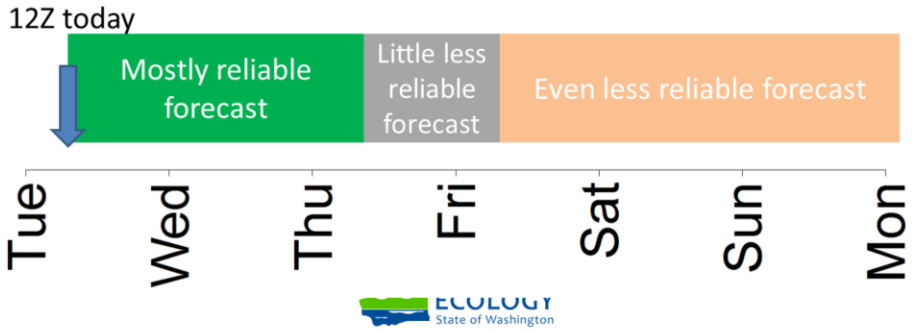
An example where WRF was different to the ensemble mean. If it is a borderline decision, base it on the ensemble mean, not just the operational WRF alone.

What to do when WRF isn't the sharpest knife in the drawer



Forecasting realities

- WRF d[model]/dt shows how stable the forecast is
- Ensemble spread shows forecast confidence
- The prediction for beyond the 3rd day is less certain.
- The earlier the forecast is required, the earlier the 3-day period ends



New forecast tool: WSU Machine learning model

- Developed site-specific O_3 | $PM_{2.5}$ vs met relationships
- Use WRF ensembles to predict out 2 days
- Point forecasts of ensemble means only

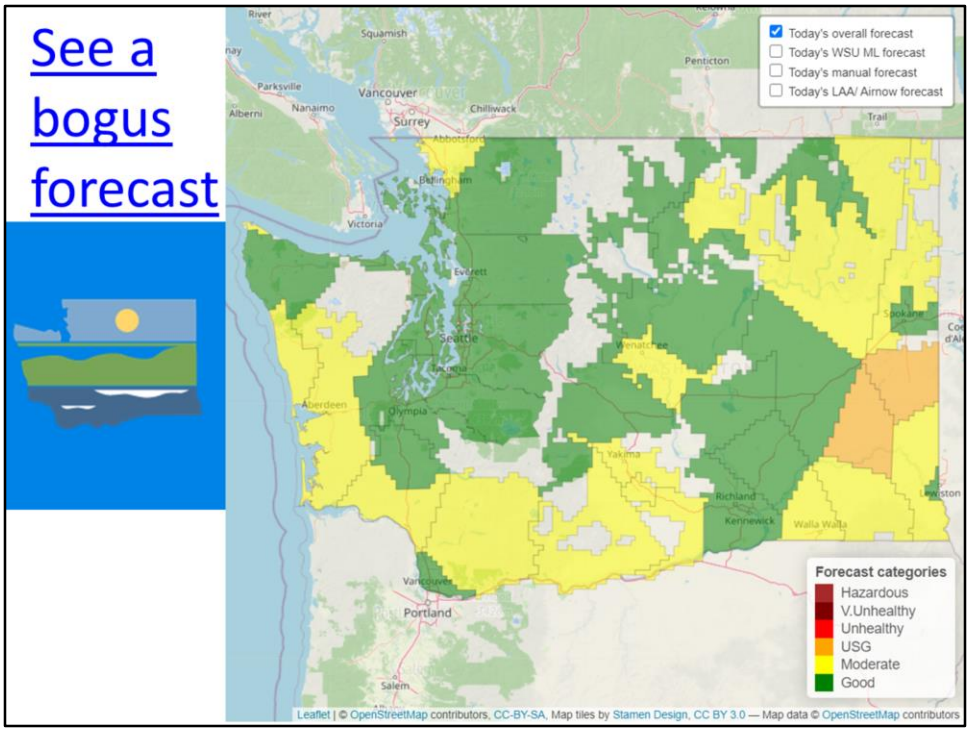
For wildfire season

- Leveraged previous work: area represented by WA monitors

Forecast hierarchy

1. Any manual overriding
2. LAA forecasts submitted to AirNow passed thru unchanged.
3. WSU ML model forecast

- *Should* appear on smoke blog by July



Public will only see the overall forecast, mouseover will show the name of the area and the forecast category. One map per forecast day, but it will scan for updates several times a day.

Getting the word out

- WA Smoke blog
  - Updated as needed
  - USFS ARA reports + overview
  - Public queries & responses
- Media queries and interviews
- Understand the audience and their needs. Schools, health districts, tourists, hikers etc.


A
Less lightning.
No early start to fire season.
THREE-MONTH OUTLOOK
TEMPERATURE PROBABILITY
2.5 MONTH LEAD
VALID JAS 2020
MADE 16 APR 2020
EC MEANS EQUAL CHANCES FOR A, N, B
A MEANS ABOVE
N MEANS NORMAL
B MEANS BELOW
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Below
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Near-Normal
33% 40% 50% 60% 70% 80% 90% 100%
Probability of Above

Questions?

2 slides from NWS Seattle

2020 Fire Season Outlook

webinar of 5/16/2020

So Let's Talk About 2019…

- Pre-season:
  - Persistent warm and dry conditions would set up over the Pacific NW (especially March, May and June)
  - Long Range Forecast Outlooks expected these conditions to persist.

- During the season:
  - A return to near normal temperatures
  - Increased rainfall in July and August but most noticeably in September when fall-like conditions set up early.

The "New Normal"

- If we look at the past 10 years (2009-2019), 5 of them are in the top 10 for acres burned (WA + OR):
  - **2018 – 1,336,096 (4th)**
  - **2017 – 1,142,442 (5th)**
  - **2015 – 1,823,473 (1st)**
  - **2014 – 1,383,514 (3rd)**
  - **2012 – 1,520,374 (2nd)**
- These years ran the entire range of the El Nino/La Nina cycle.
- Instead of relying on analog years, it might be a good practice to head into the season thinking that it will be an active one unless there are strong indicators otherwise!