Application of a regional air quality modeling system to wind erosion of dust and ash from a large post-fire burn scar.

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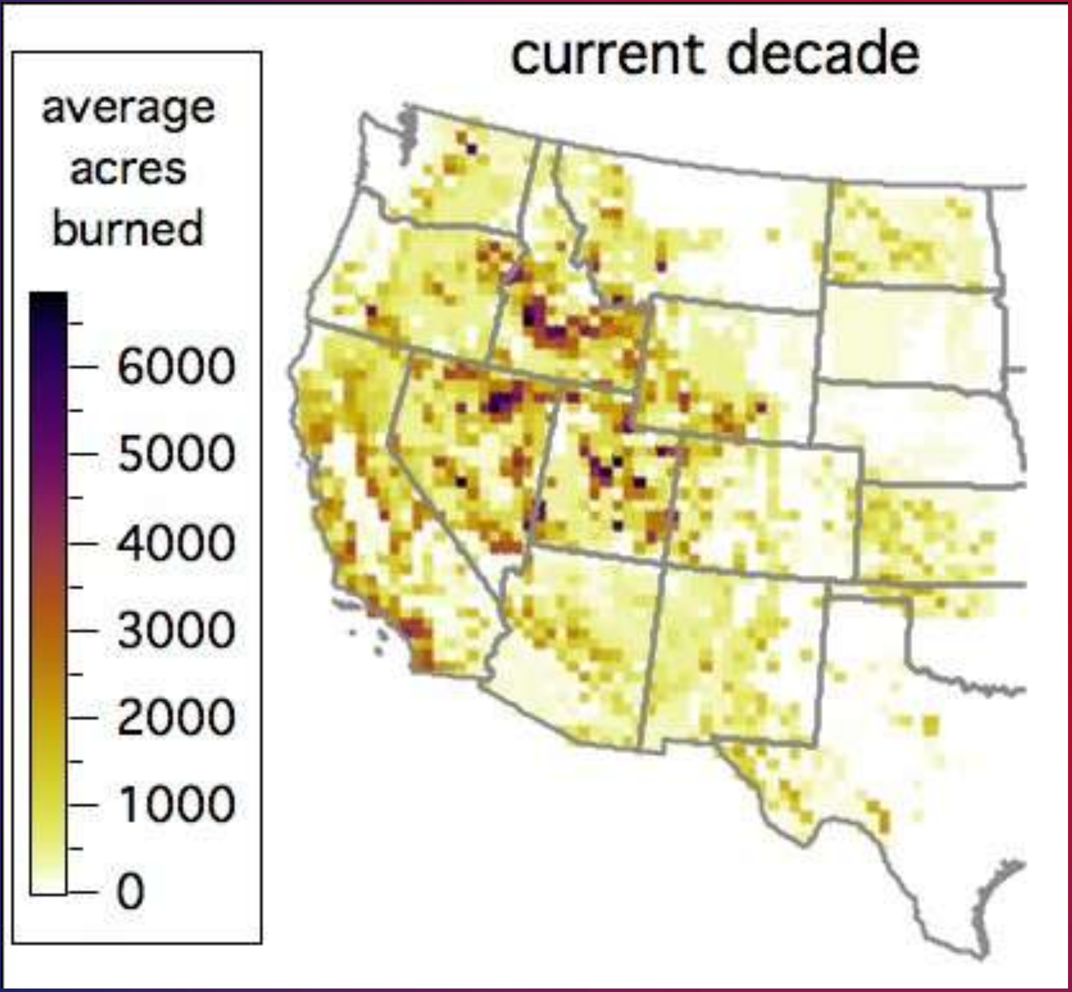
Presented at DUST2014
June 5, 2014
Castellana Marina, Italy

Area Burned



Historical Fires in the US

(NCDC)

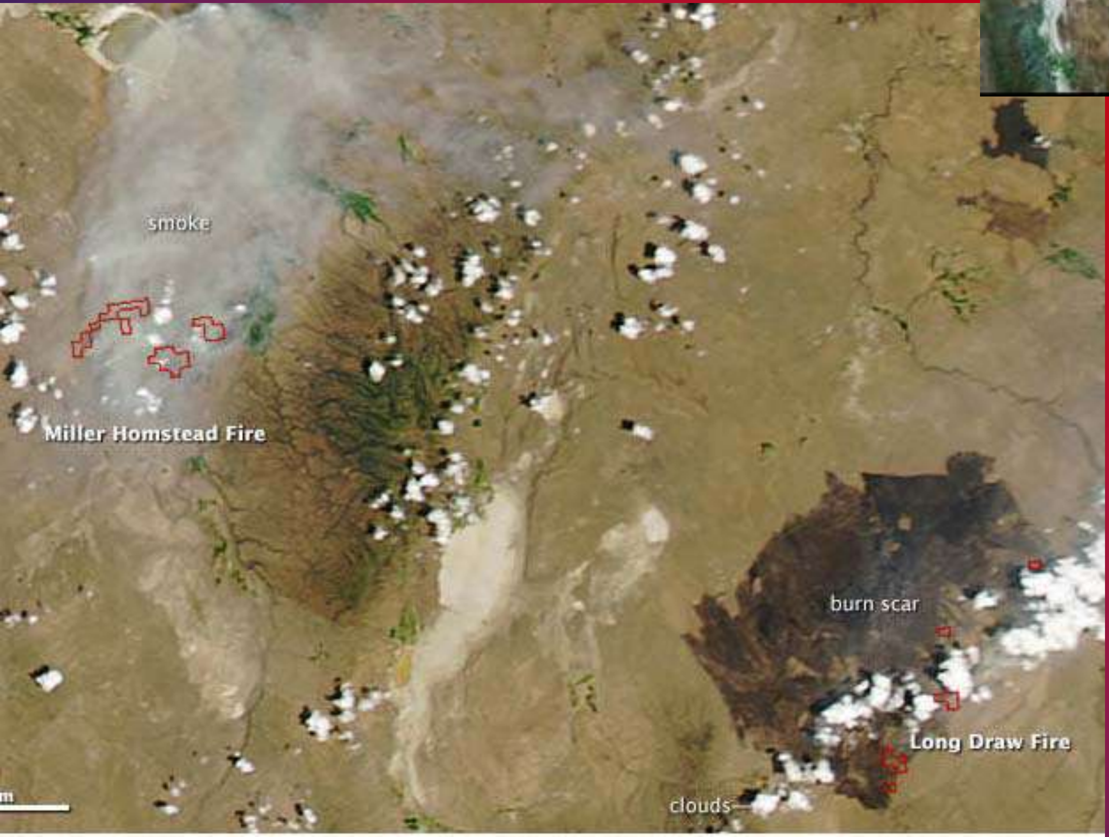
Year	*Area (acres)*
1995	1,159,544
1996	3,821,579
1997	1,799,884
1998	837,714
2000	4,657,901
2002	4,526,369
2004	5,101,664
Average	3,129,236
Total	21,904,654

Ave. ~ 3 million acres per year

Impact of post-fire wind erosion

- Millions of hectares each year can burn in the western US
- Burn scars are highly erodible surfaces with high loadings of ash and soil
- Erosion from burn scars can have large impacts on air quality and visibility
- Climate change projections indicate more fires and, hence, more potential for wind erosion from burn-scars
- These sources are not yet treated in regional air quality models

Long Draw Fire, July 8-16, 2012 225,672 ha

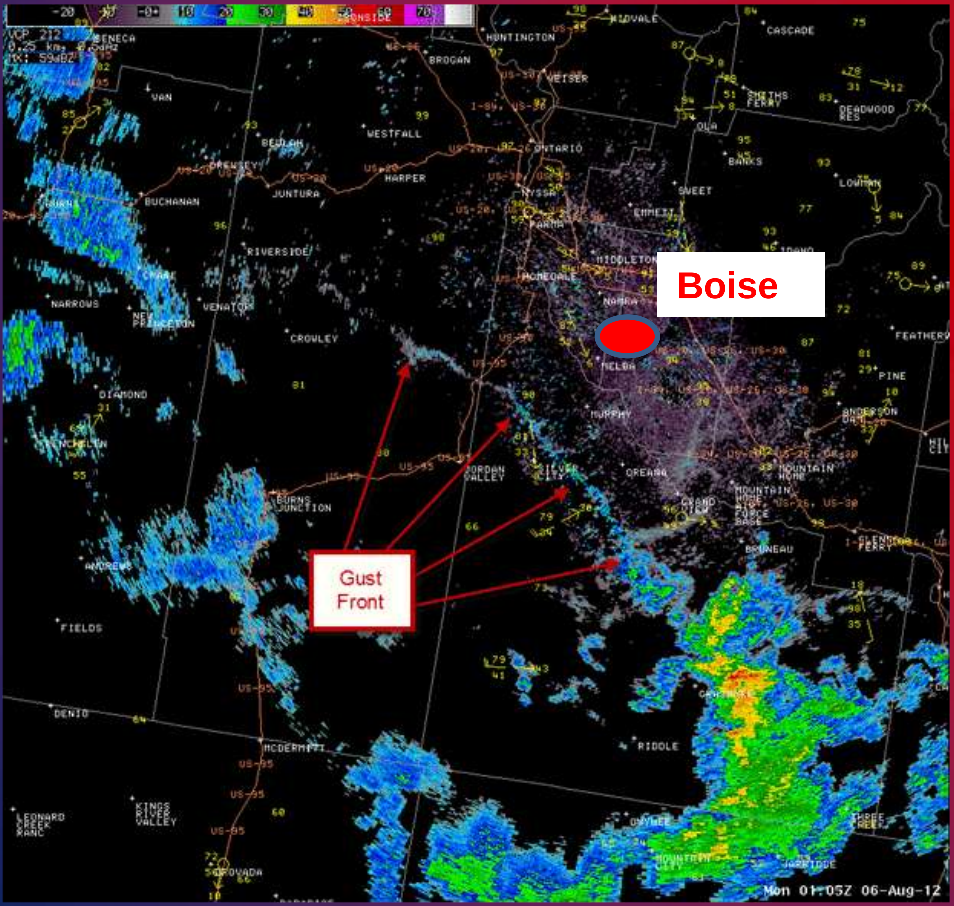


5 Aug 2012
- Fast moving gust front

- Produced haboob dust event
  - Peak winds at 1700 MST

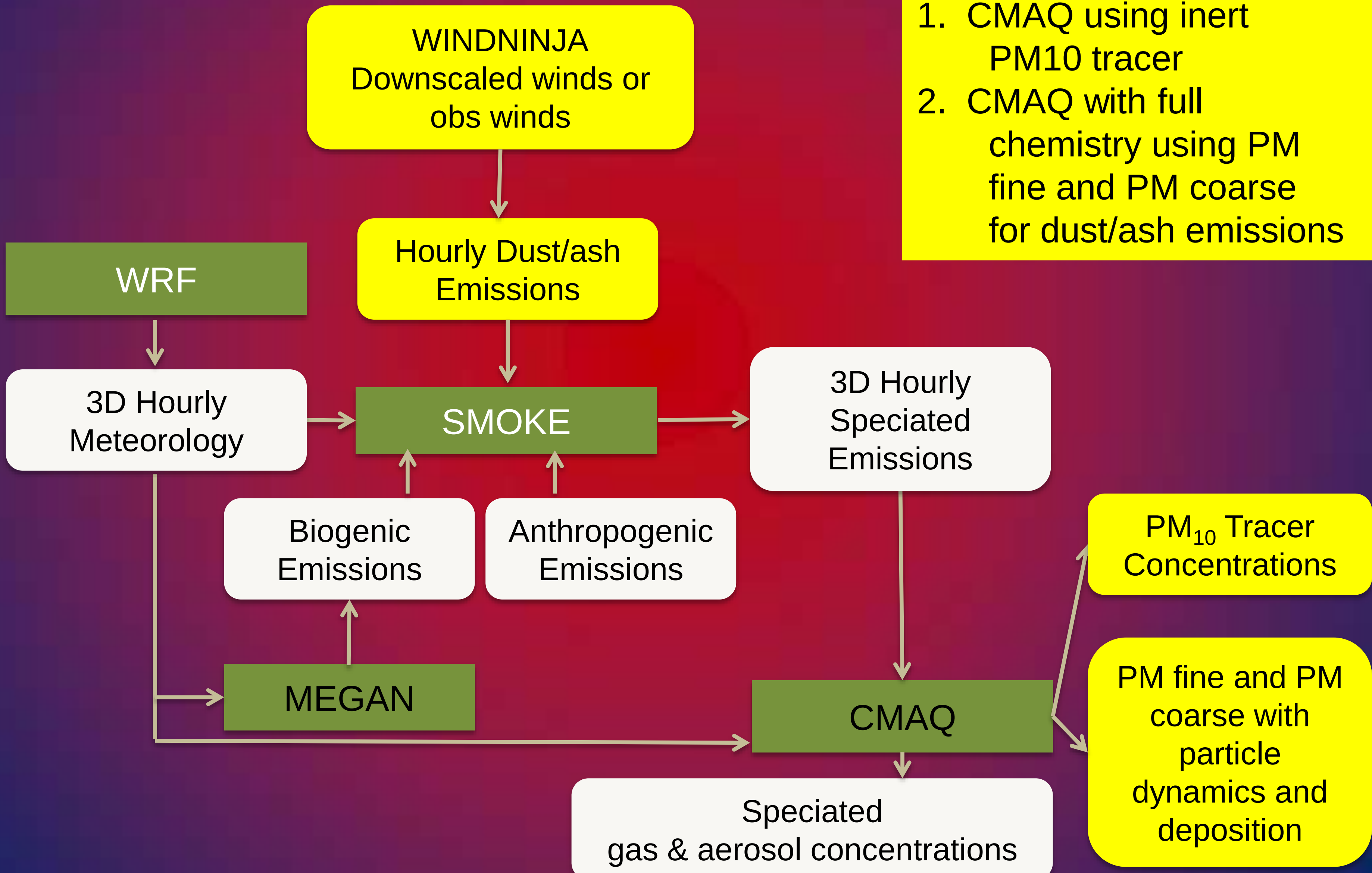
- Impacted Boise urban area
  - Peak PM10 at 2100 MST

Gust Front & Haboob near Boise, Idaho 2000 MST, 5 August 2012

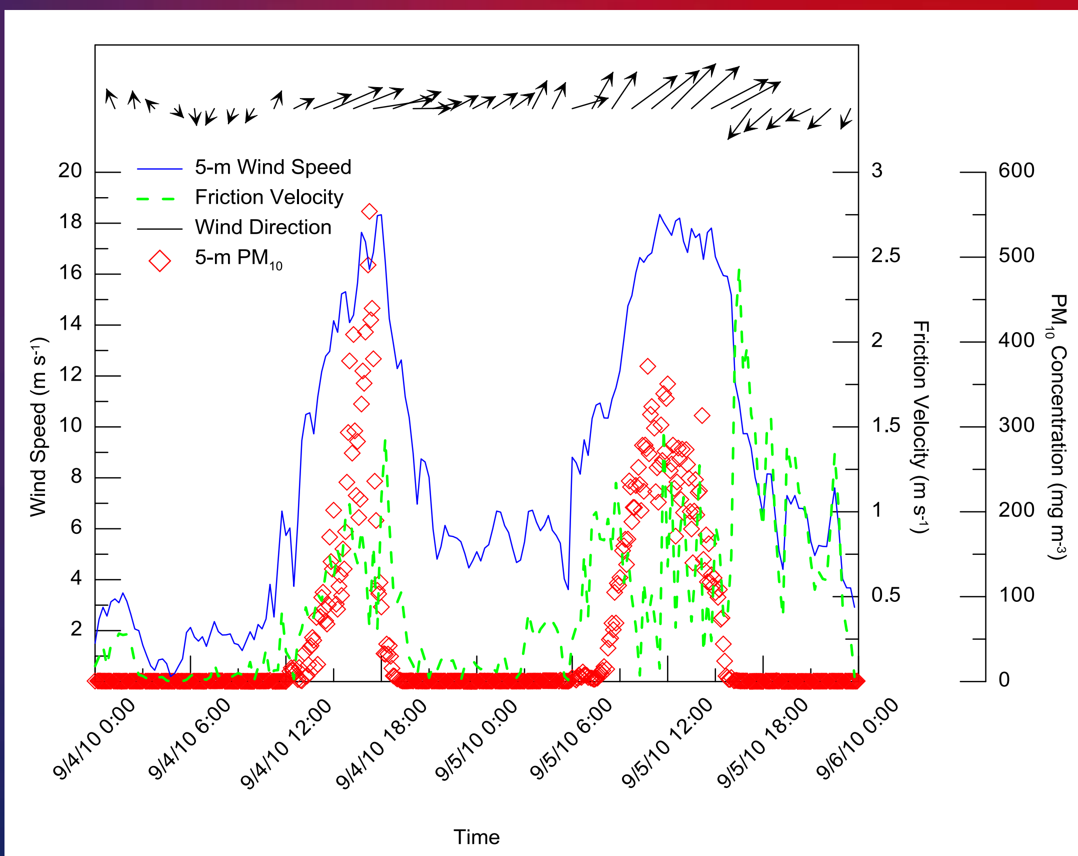


AIRPACT Modeling Framework for Post-fire Wind Erosion

1. CMAQ using inert PM10 tracer
2. CMAQ with full chemistry using PM fine and PM coarse for dust/ash emissions



Emission algorithm for post-fire erosion

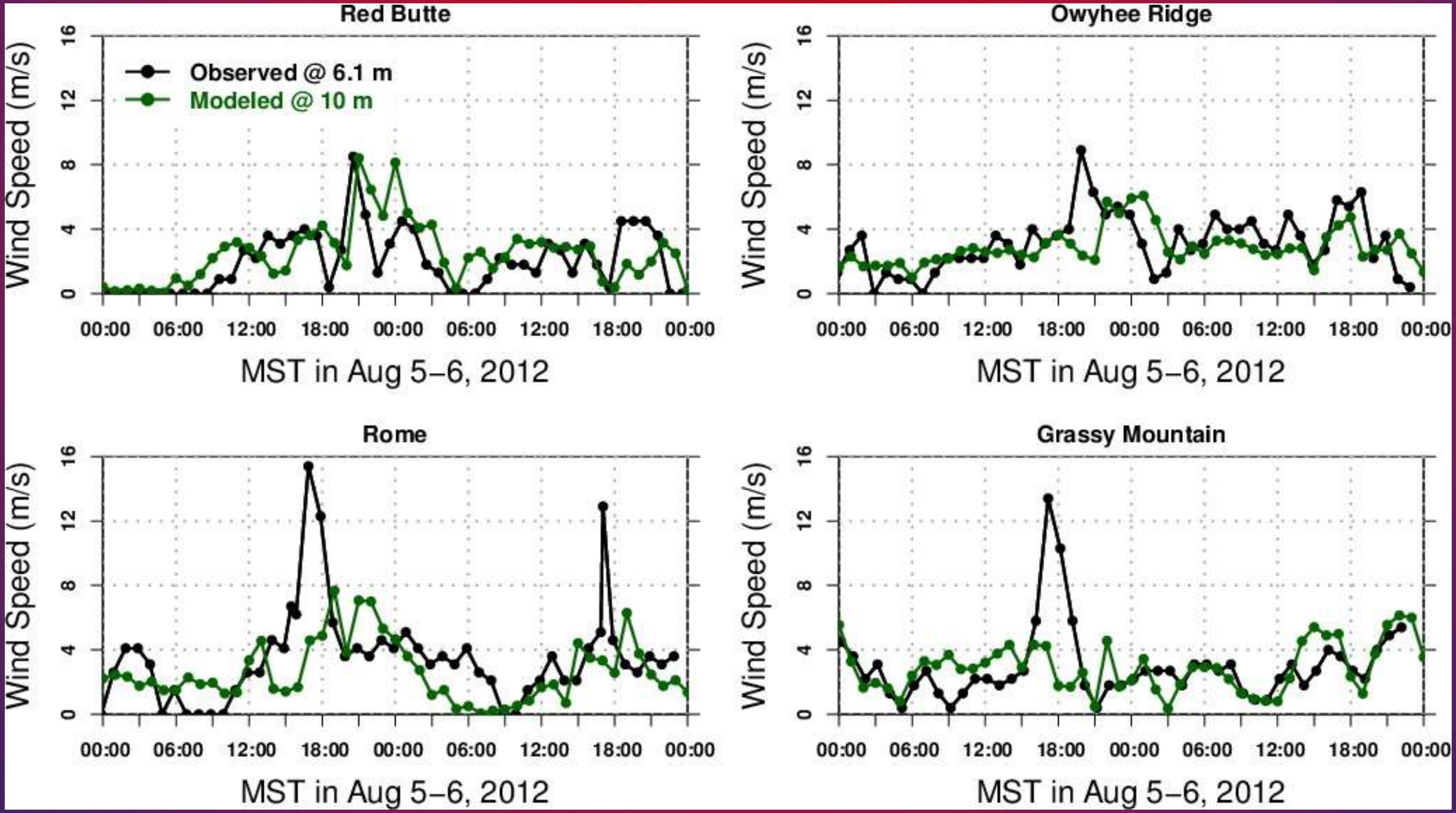


- Empirical formulation using Jefferson fire PM flux measurements and wind tunnel erosion data (Wagenbrenner et al., 2012)

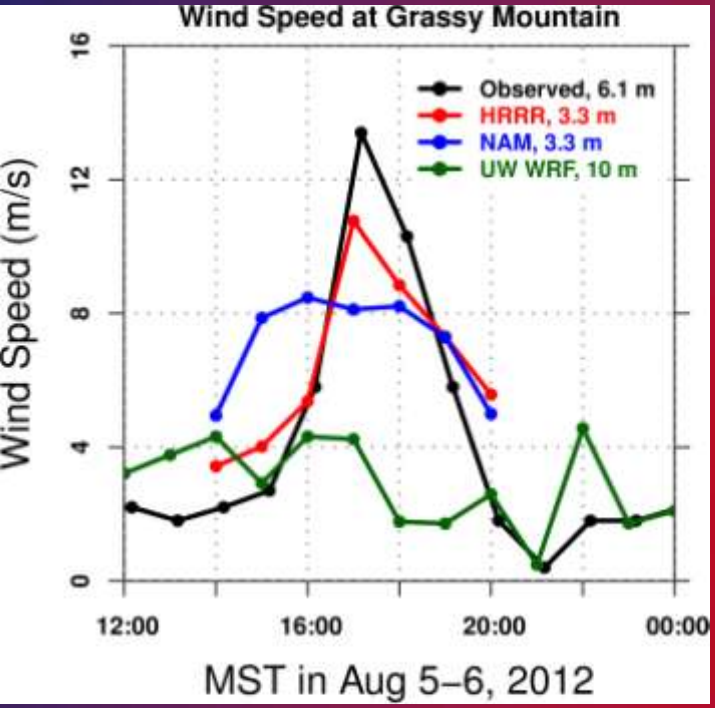
$$Flux = \frac{K\rho}{g} u_*[u_*^2 - u_{*t}^2]$$

- Threshold friction velocity of 0.22 m s^{-1}
- K = 0.0007 m^{-1}
- $PM_{2.5}$ = 60% of PM_{10}

Forecast WRF vs Observed
Surface Wind Speeds: Missed the Gust Front



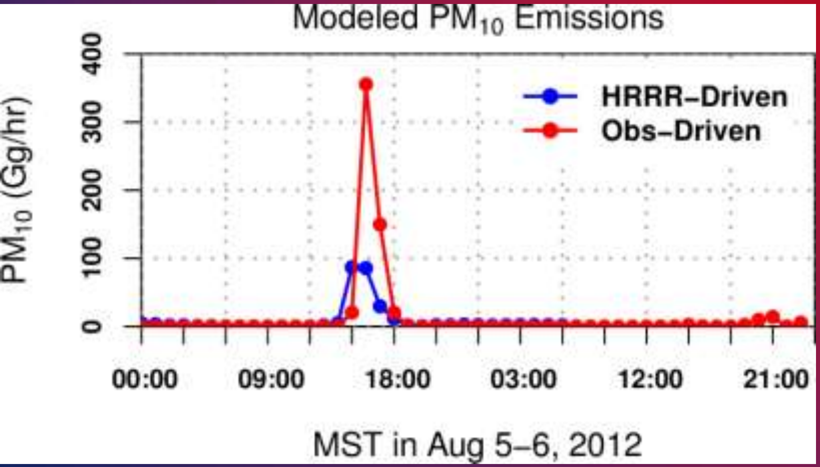
Use Local Winds for Emission Estimates

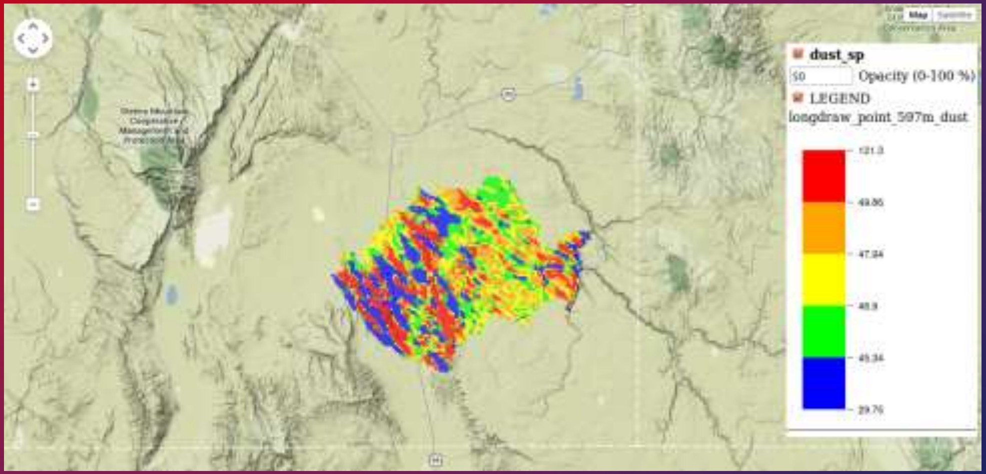


Observed winds
- Peak speeds of 16 m/s
- Time 1700 MST

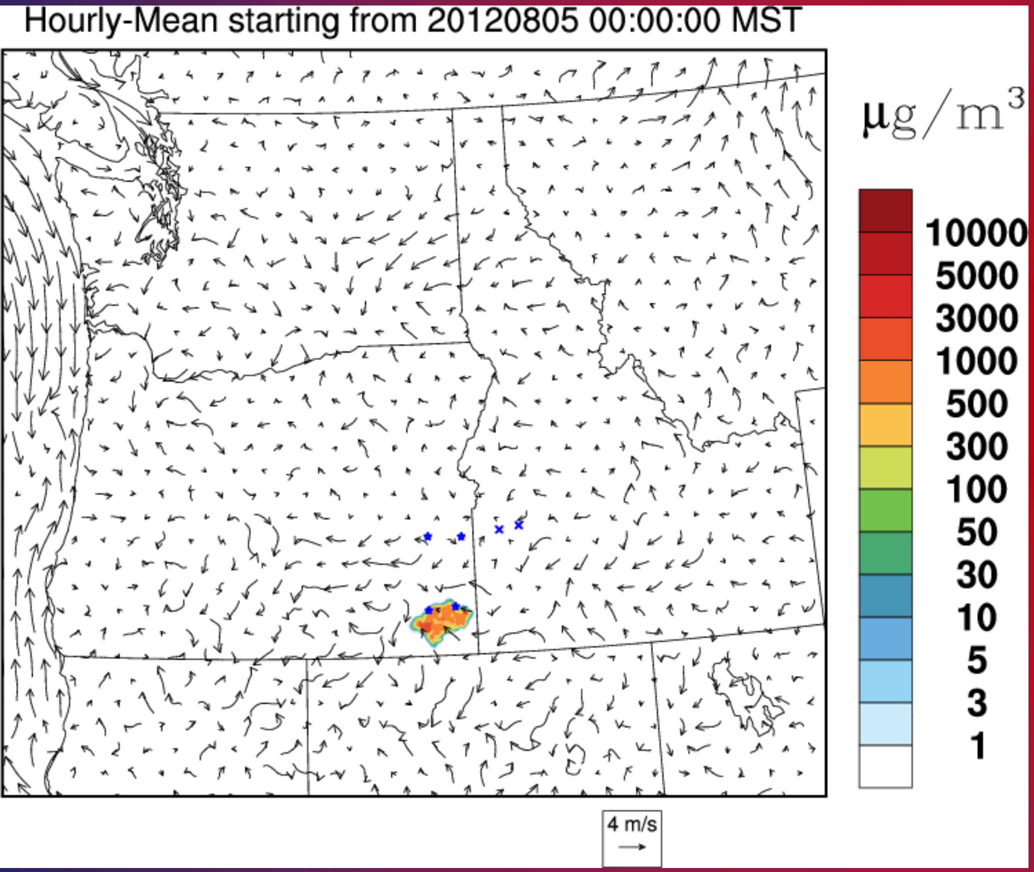
Model simulations
- HRRR (3 km)
- WRF (4 & 12 km)

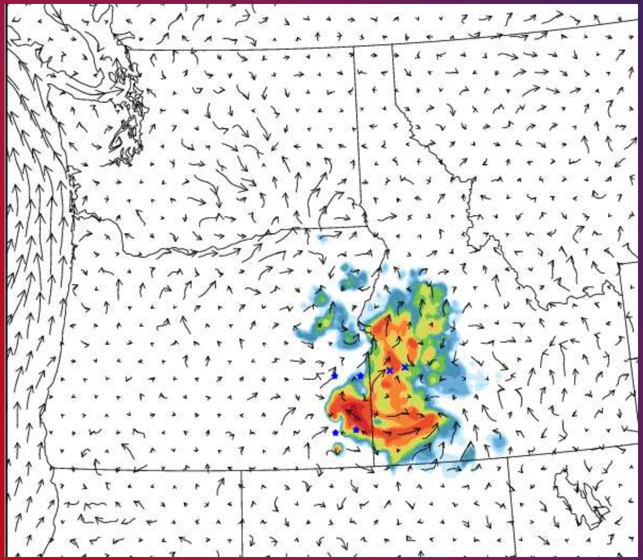
Downscaled with WindNinja
- mass conservation interpolation

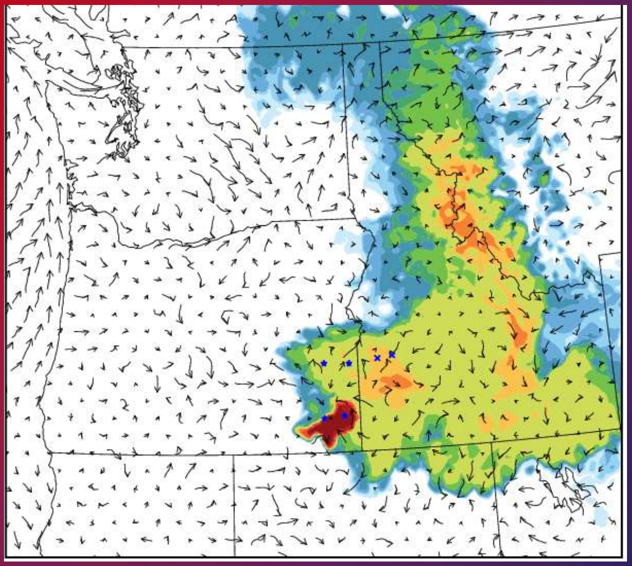




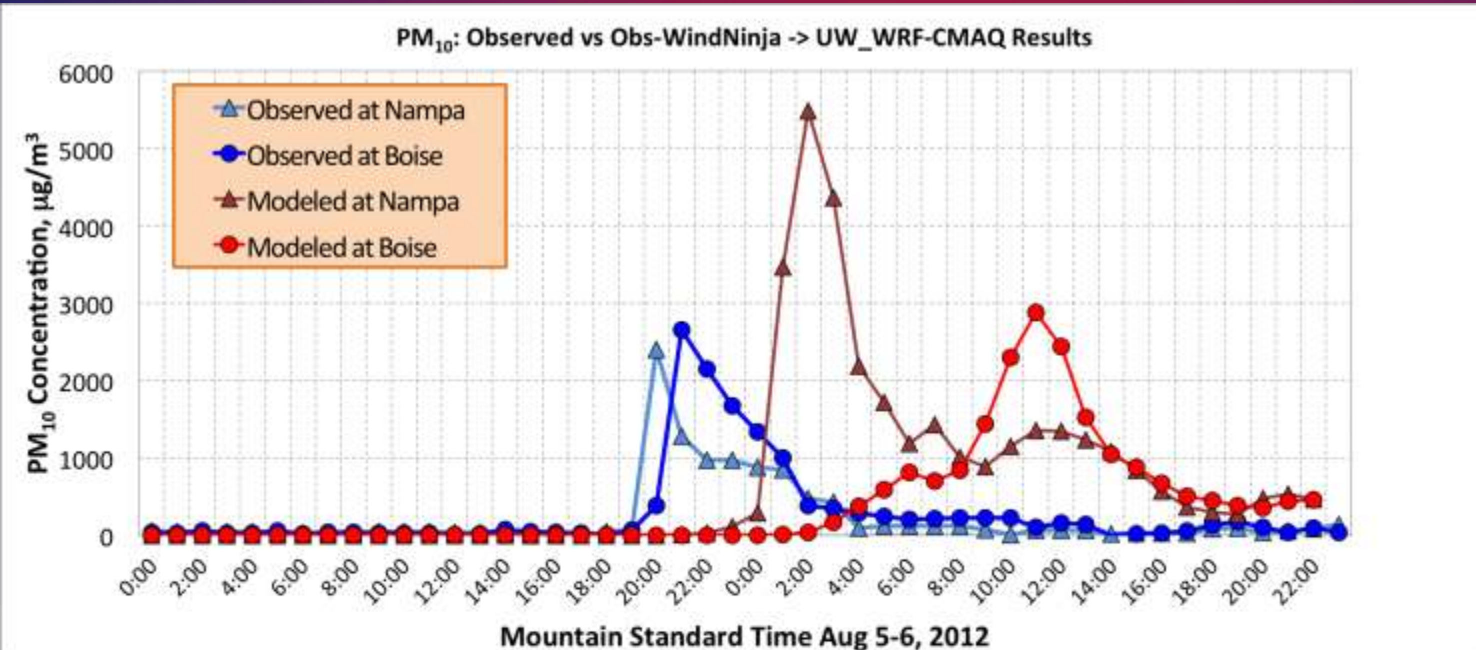
PM_{10} Concentrations Modeled with Obs-driven Emissions



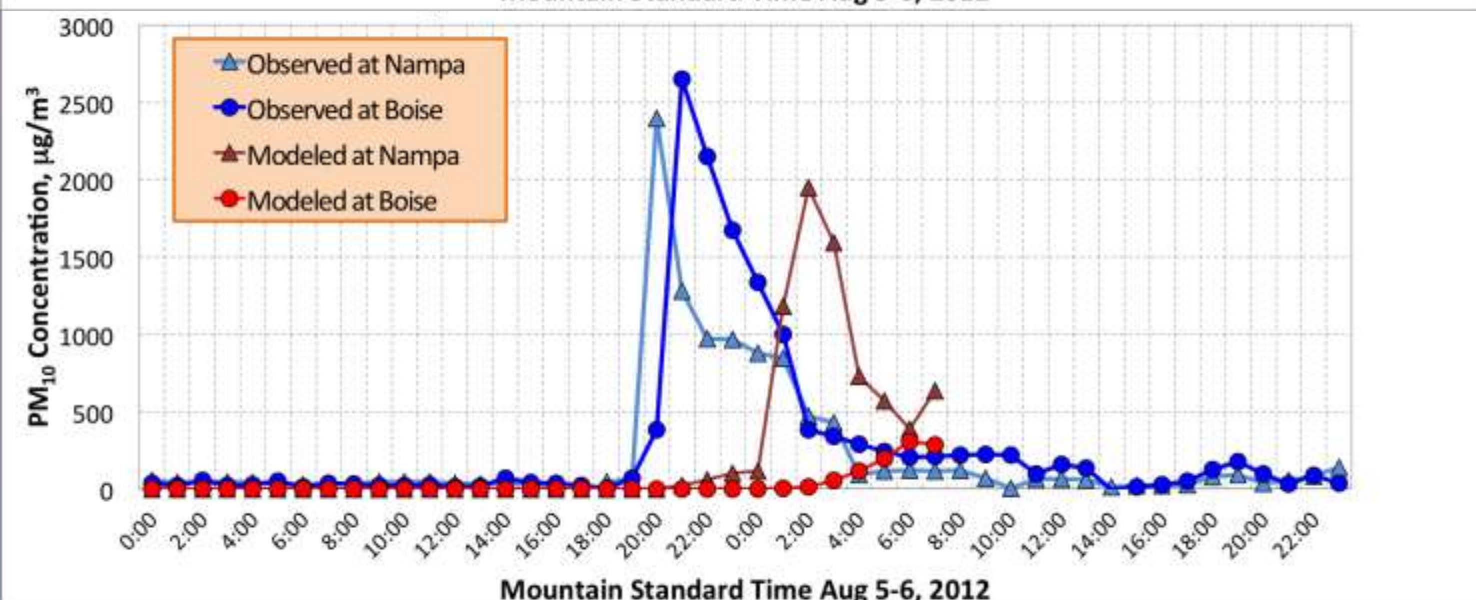




CMAQ PM10 Tracer vs Observed PM_{10} Concentrations

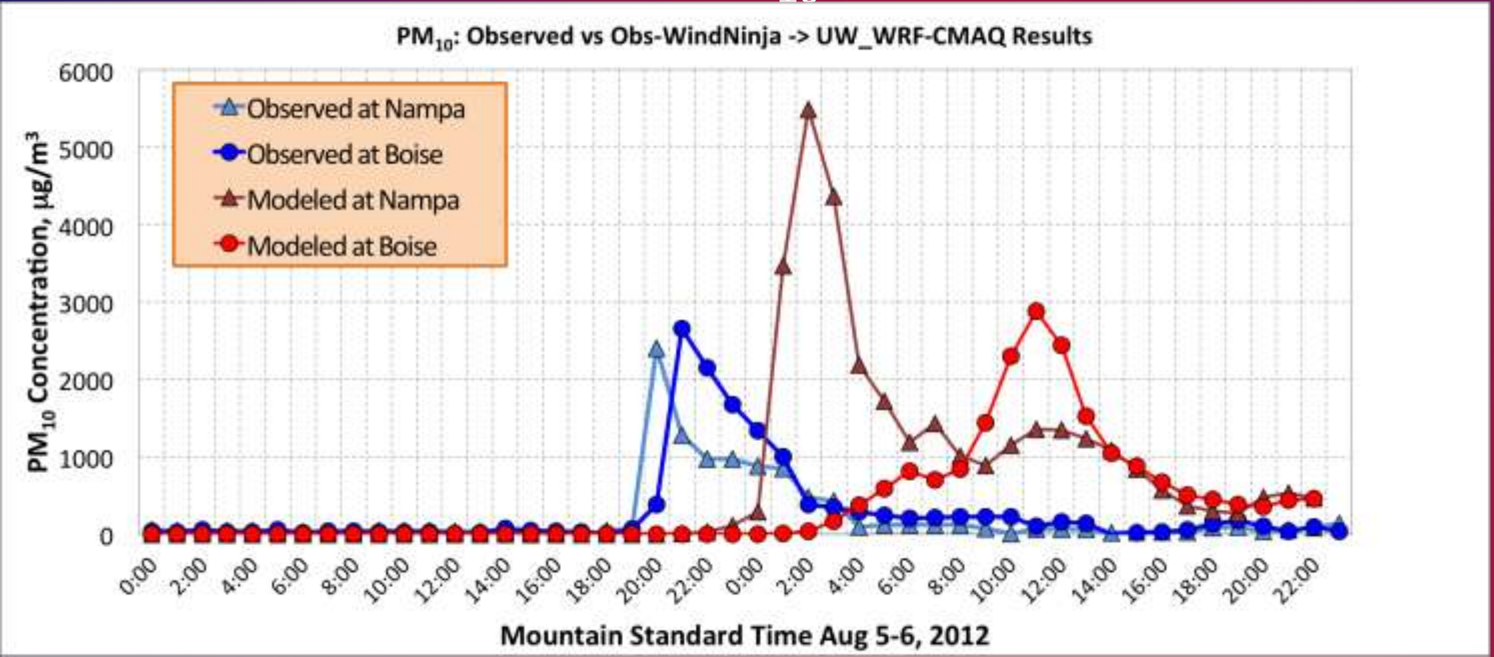


Emissions driven with Observed winds



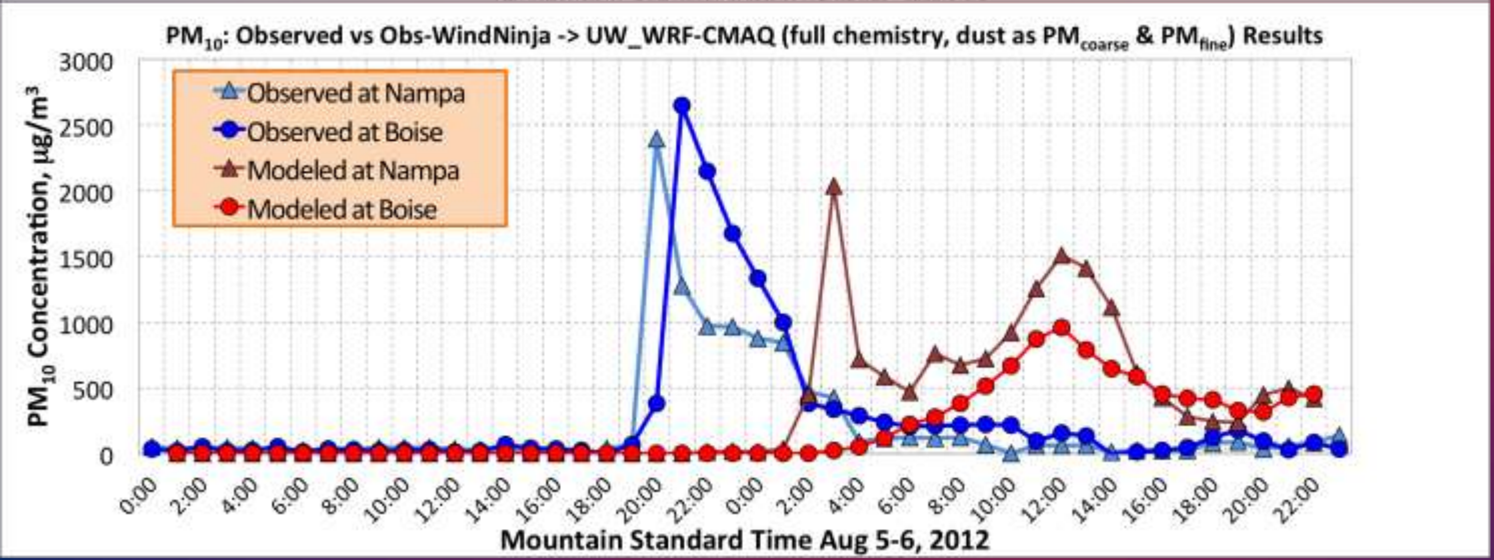
Emissions driven with HRRR (3 km) winds

Modeled with Obs-driven Emissions vs Observed PM_{10} Concentrations



CMAQ with PM10 tracer run

Peak Obs at 2000-2100 MST
Peak Model at 0200 and 1000 MST

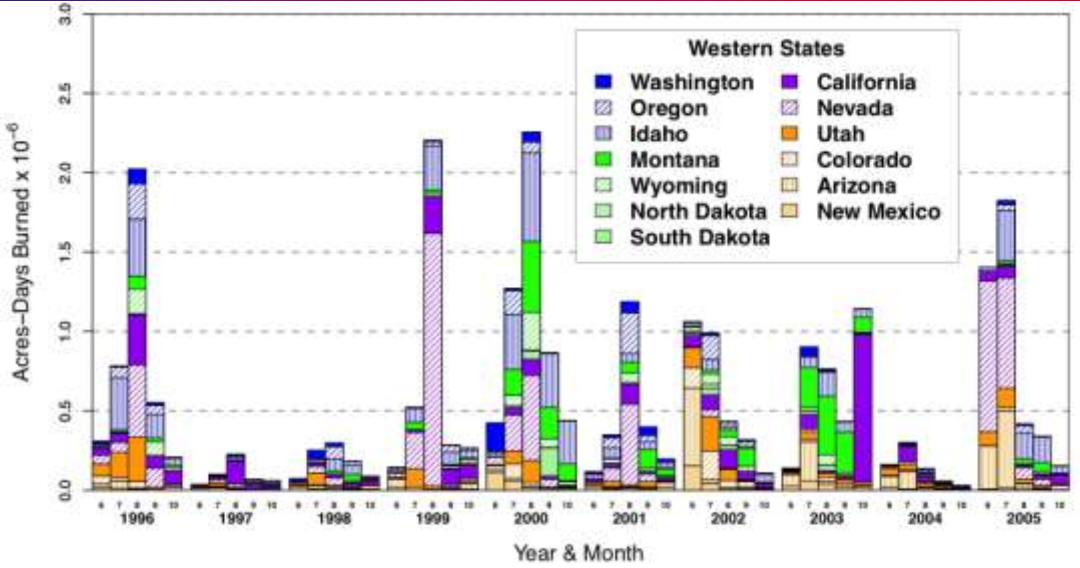


CMAQ with 2 particle modes and dynamics

Summary

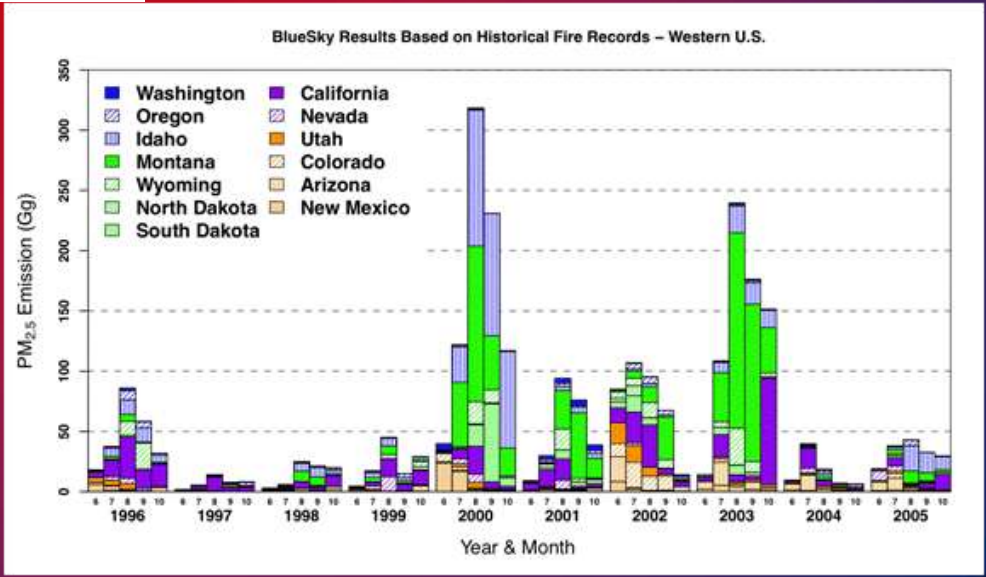
- Long Draw post-fire case study
  - Excellent example of the high impact that can be associated with post-fire wind erosion
- Emission modeling requires accurate local winds
  - Need for accurate down-scaled winds
  - Use of local observations
- Dust transport modeling shows the wide-spread impact of these erosion events
  - Relatively good performance for PM concentrations
  - Poor timing due to issues with forecast meteorology
- Case study provides the basis for routine treatment of erosion from burn-scars within the AIRPACT forecast system

Western US Fire Activity
Jun-Oct, 1996-2005

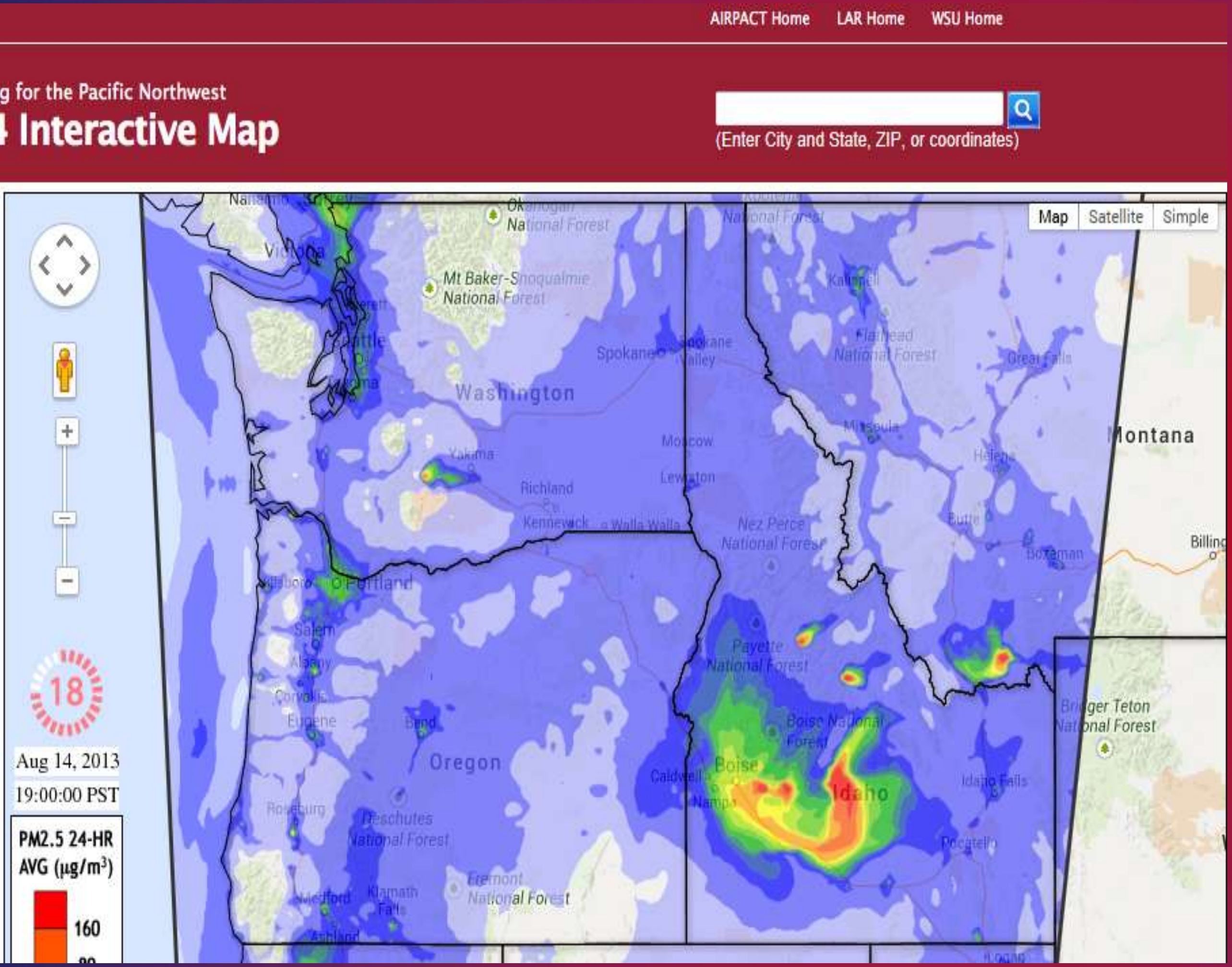


Area-days burned

PM2.5 Emissions



AIRPACT Air Quality Forecast System



- Daily automated operations
- WRF meteorology
- Dynamic emissions
  - Anthropogenic
  - Biogenic
  - Wildfires
- CMAQ chemical transport model
- 4 km horizontal grid cells

http://lar.wsu.edu/airpact