



# The WRF-Chem-HYSPLIT framework to Simulate Smoke Taint.

Case study: Two wildfire smoke  
events at a central Washington  
State winery.

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# Smoke Taint

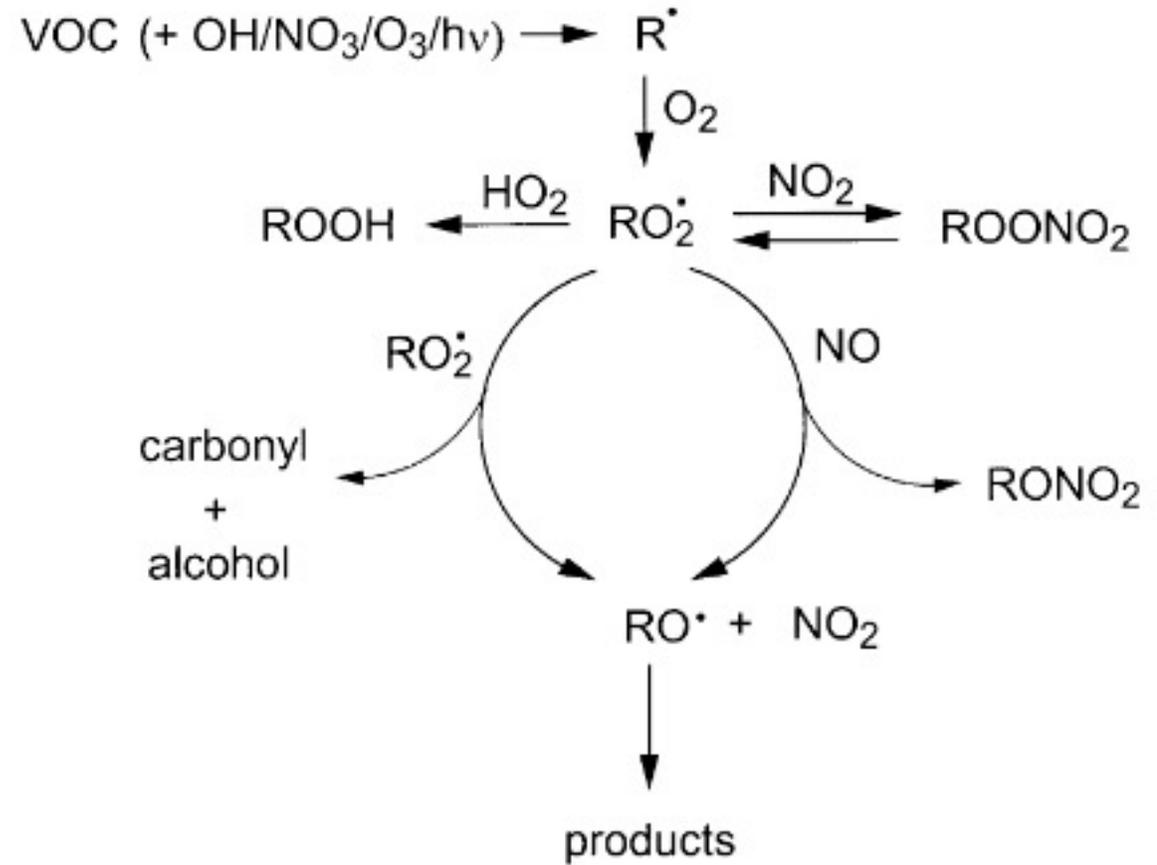
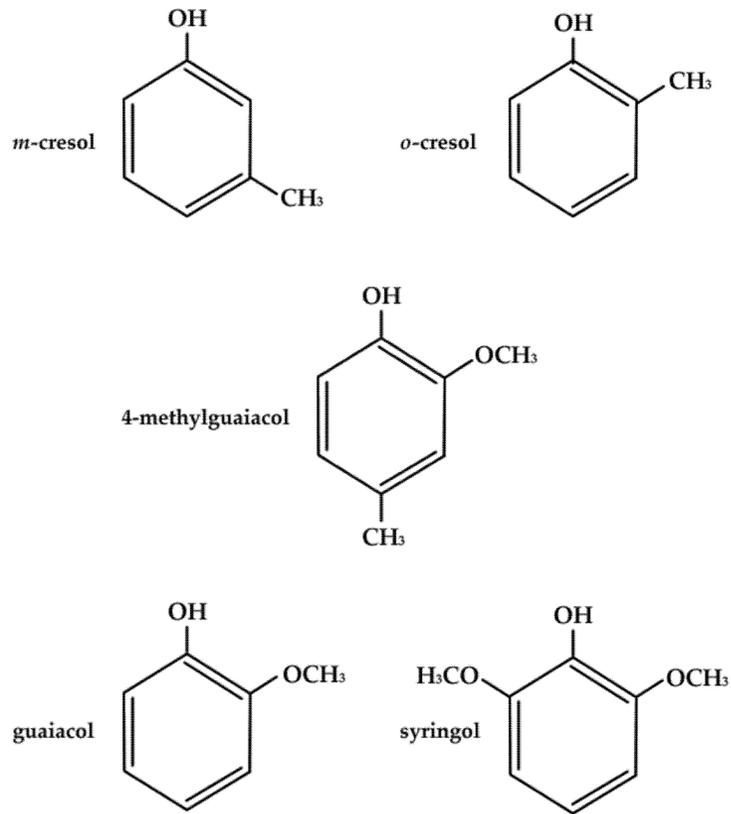
- When vineyards and grapes are exposed to smoke, this can result in wines with undesirable sensory characteristics, such as smoky, burnt, ashy, or medicinal.
- Volatile phenols, released into the air from wood burning through the pyrolysis of lignin, are the main known smoke exposure marker compounds causing smoke taint in wine.

Ph.D.  
objective

To investigate the influence of wildfire smoke plumes on grapes from an atmospheric-chemistry perspective.

# Smoke Taint

Volatile phenols in smoke



# Methodology

Characterize the presence of volatile phenols and other associated compounds (hereafter referred to as “**smoke taint conditions**”) from the analysis of the multiple atmospheric transformation pathways (either chemical or physical) of VOCs.



Research Tasks

1. Exploratory analysis of Smoke-Taint conditions using a CTM. (Paper 1)
2. Aging of smoke along Lagrangian Trajectories. (Paper 2)
3. The effect of dry deposition. (Paper 3)

# Simulation Scenarios

## Smoke-Taint-Free (STF) scenario

- **August 2018**, the VPs concentrations found in the exposed grapes weren't significant, resulting in not tainting the wine they produced.

08/10/2018	163	Unhealthy
08/11/2018	222	Very Unhealthy
08/12/2018	172	Unhealthy
08/13/2018	196	Unhealthy
08/14/2018	215	Very Unhealthy
08/15/2018	223	Very Unhealthy
08/16/2018	178	Unhealthy
08/17/2018	165	Unhealthy
08/18/2018	193	Unhealthy

08/19/2018	426	Hazardous
08/20/2018	287	Very Unhealthy
08/21/2018	154	Unhealthy
08/22/2018	159	Unhealthy
08/23/2018	186	Unhealthy
08/24/2018	145	Unhealthy for Sensitive Groups
08/25/2018	160	Unhealthy
08/26/2018	74	Moderate

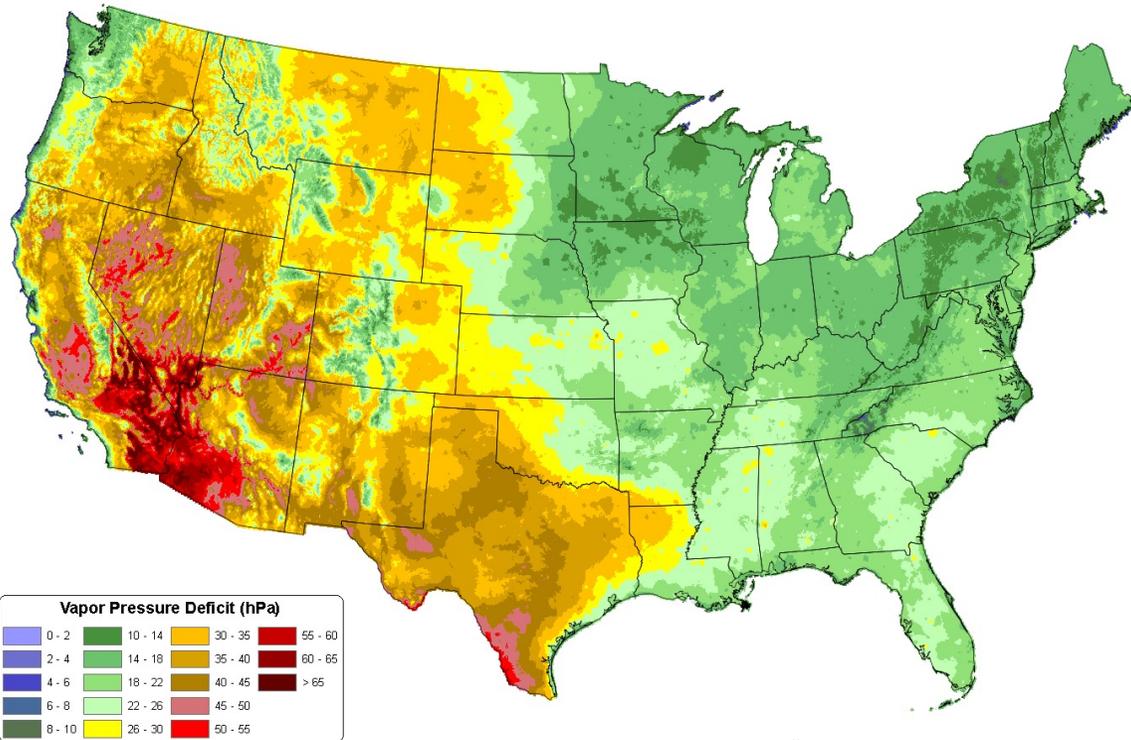
## Smoke-Taint (ST) scenario

- **September 2020**, where the VPs concentrations measured from the exposed grapes were high enough to taint the wine.

09/08/2020	170	Unhealthy
09/09/2020	186	Unhealthy
09/10/2020	156	Unhealthy
09/11/2020	190	Unhealthy
09/12/2020	285	Very Unhealthy
09/13/2020	468	Hazardous
09/14/2020	489	Hazardous
09/15/2020	295	Very Unhealthy
09/16/2020	179	Unhealthy
09/17/2020	181	Unhealthy
09/18/2020	167	Unhealthy

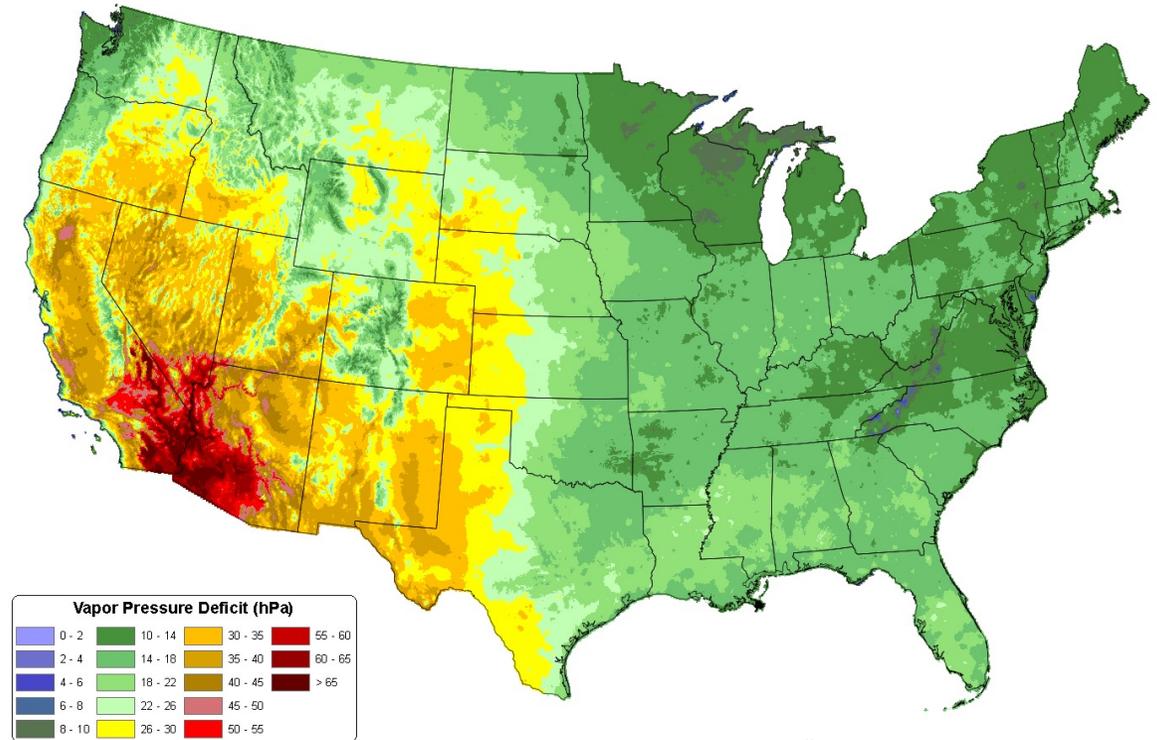
# 2018 and 2020 Western U.S. wildfires

Average Daily Maximum Vapor Pressure Deficit: Aug 2018  
Period ending 7 AM EST 31 Aug 2018  
(Map created 17 Mar 2021)



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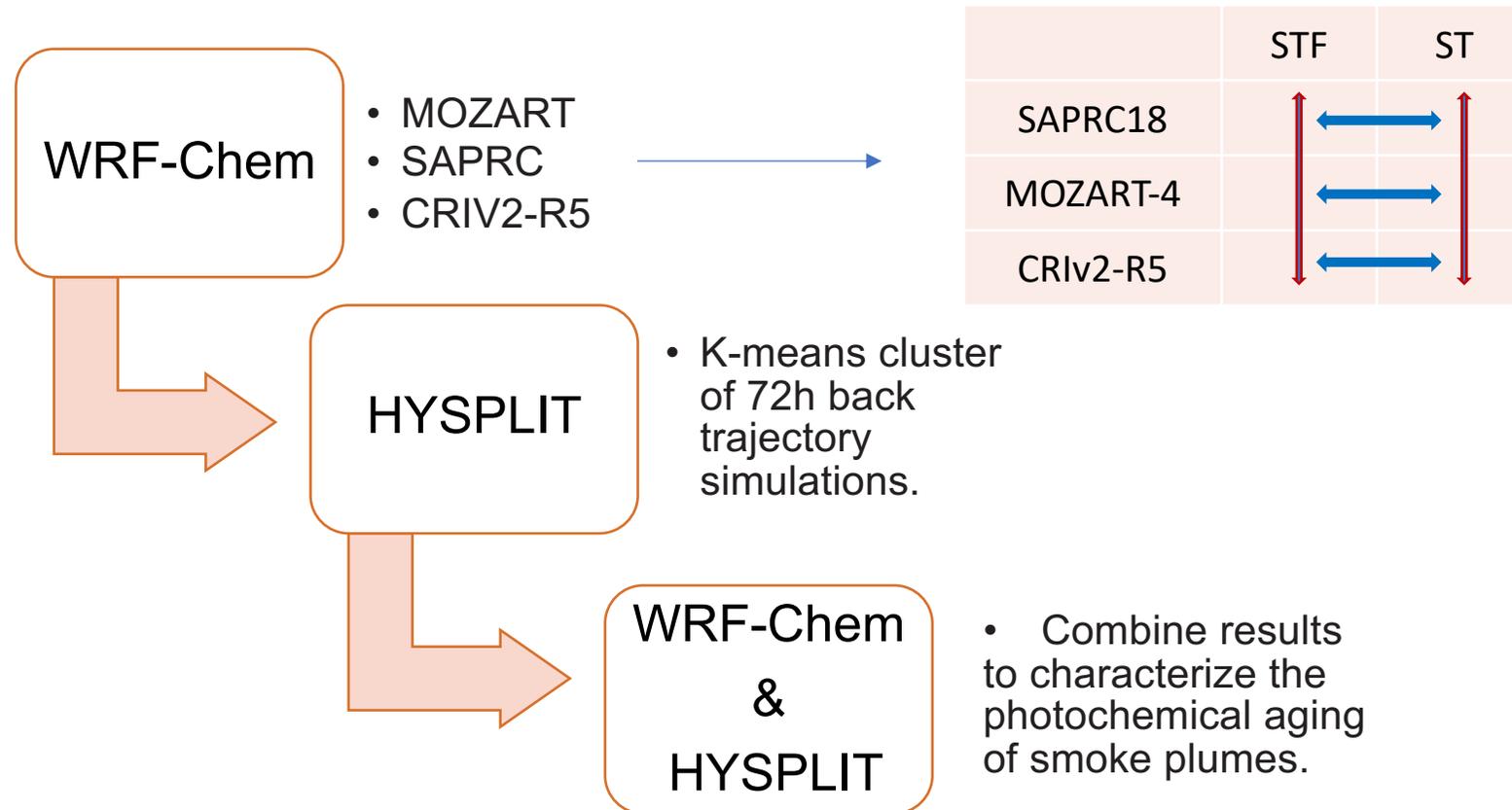
Average Daily Maximum Vapor Pressure Deficit: Sep 2020  
Period ending 7 AM EST 30 Sep 2020  
(Map created 26 Mar 2021)



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# Modeling framework

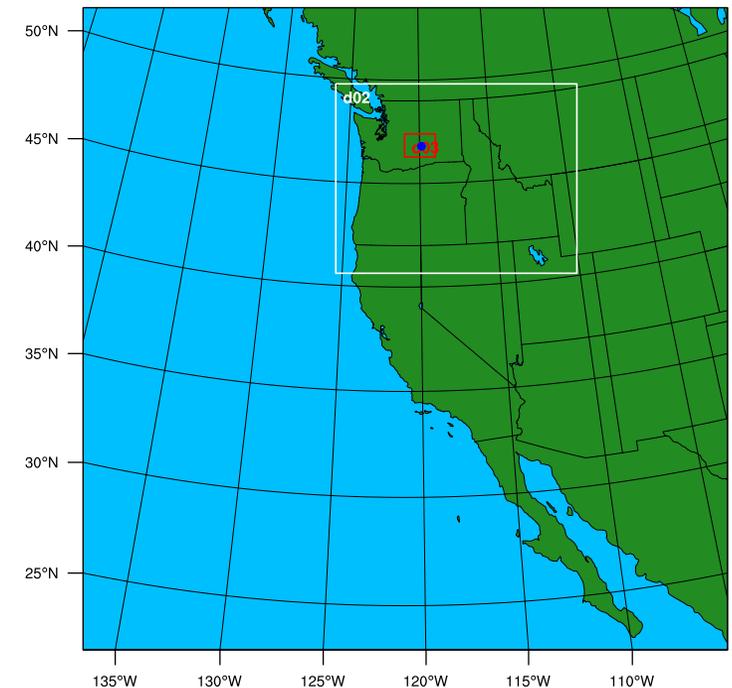
- To investigate the influence of wildfire smoke plumes on grapes from an atmospheric-chemistry perspective.



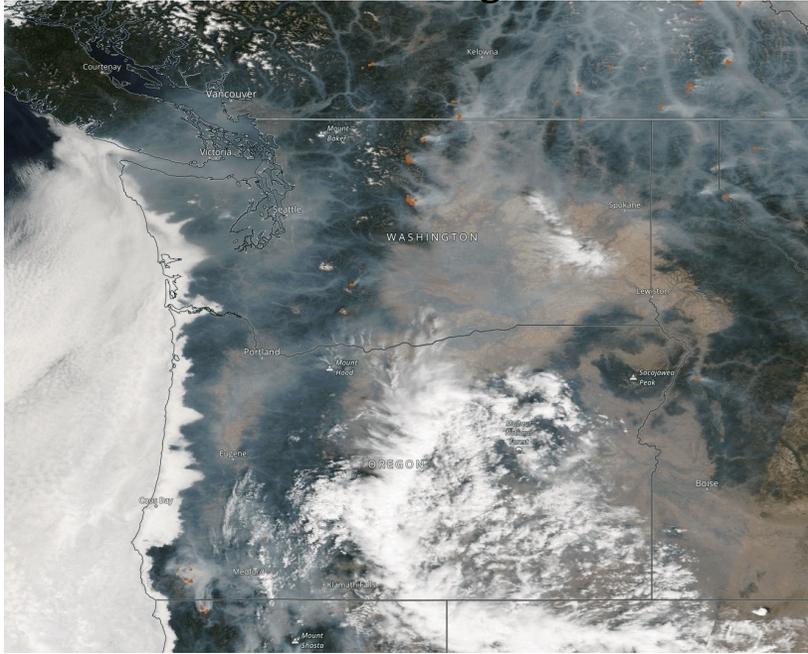
## WRF-Chem Configuration:

- 3 nested domains: 12 x 4 x 0.8 km grid cell resolution.
- Boundary and initial conditions: 6-hourly GFS-NCEP-FNL (meteorological) on 1x1 degree grids cells and 0.9x1.25-degree CAM-CHEM (chemical) models.
- Chemical mechanism: MOZART & MOSAIC.
- Anthropogenic emissions: NEI 2017 inventory.
- Fire emissions: FINNv2.5.
- Biogenic emissions: MEGAN

WPS Domain Configuration



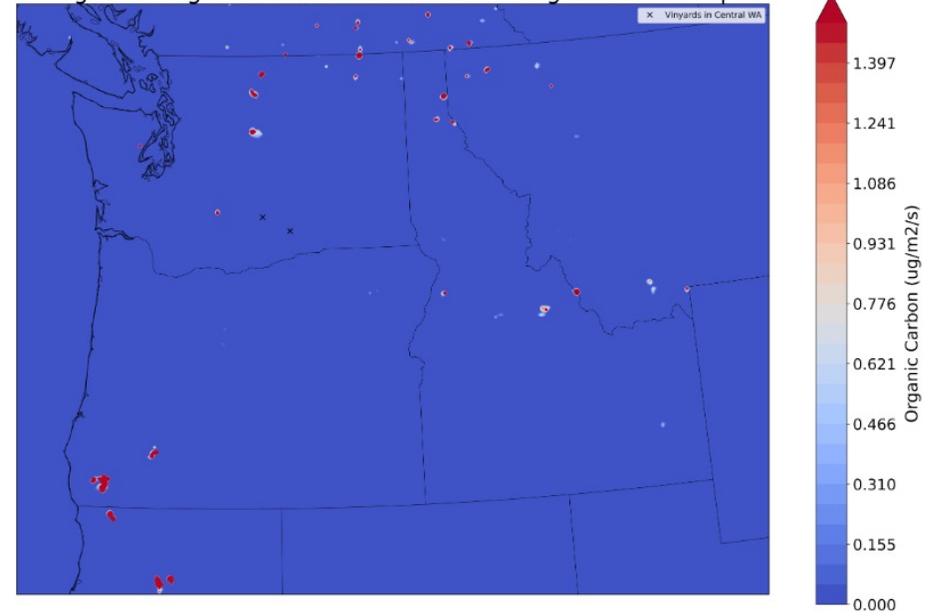
MODIS image



Aug 15<sup>th</sup>  
2018 at 1pm  
local time

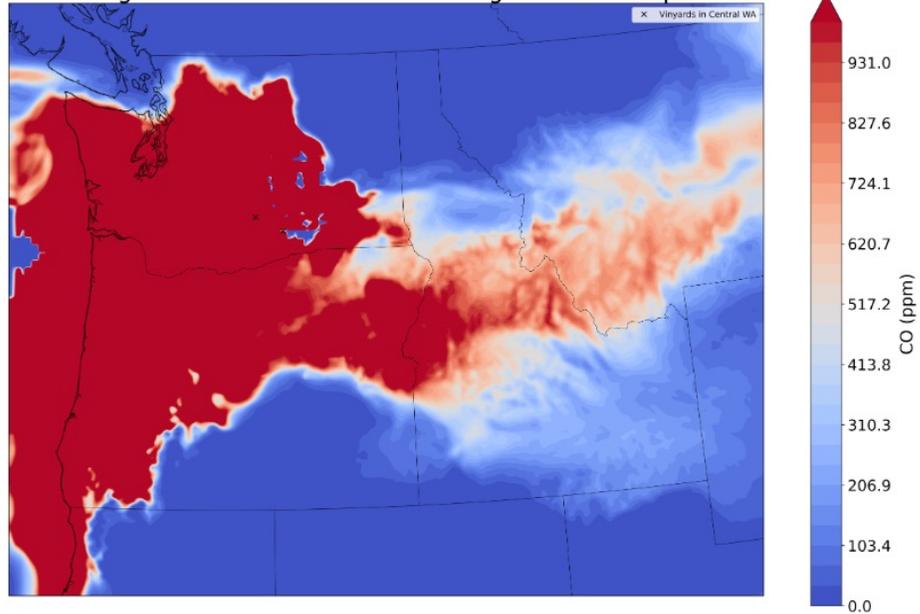
Integrated Organic Carbon emissions for Aug 15 2018 at 1pm

Organic Carbon emissions



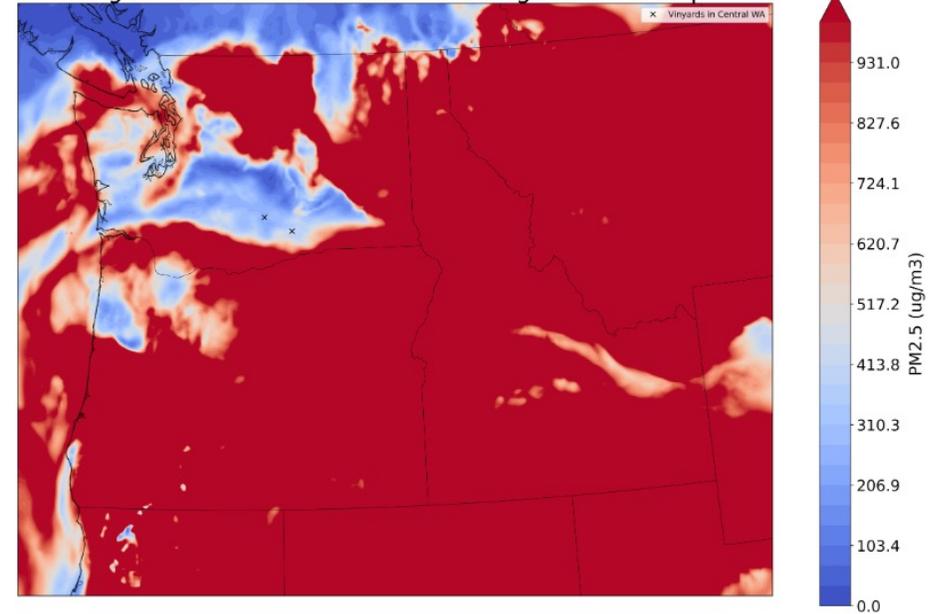
Integrated CO concentration for Aug 15 2018 at 1pm

CO

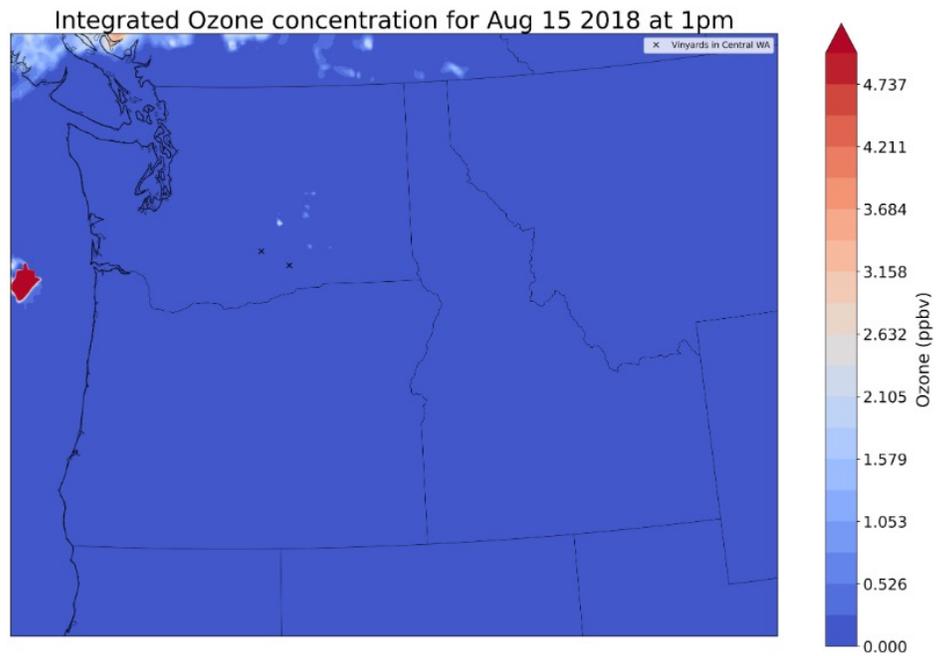


Integrated PM2.5 concentration for Aug 15 2018 at 1pm

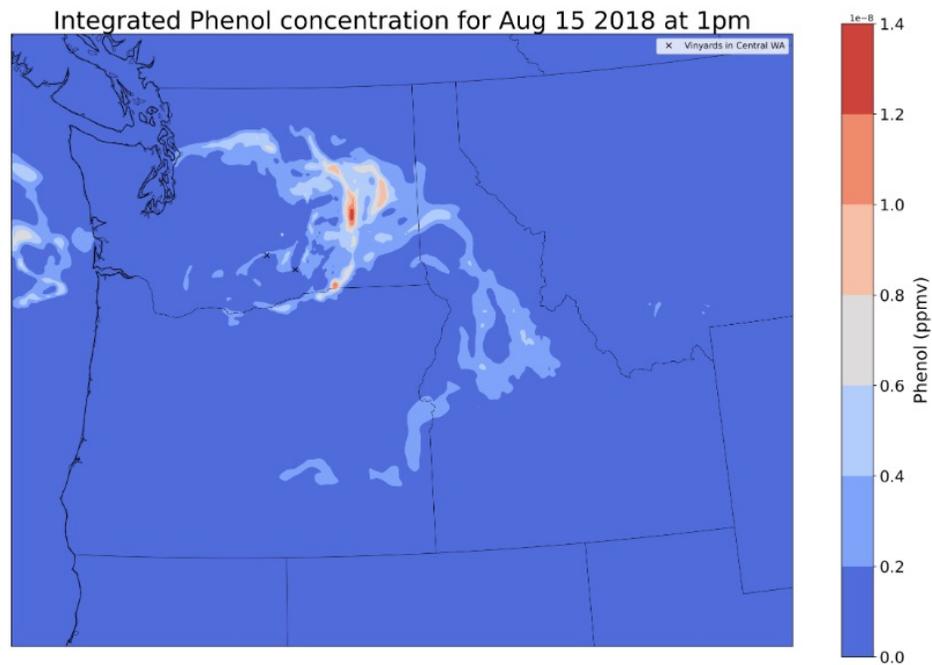
PM<sub>2.5</sub>



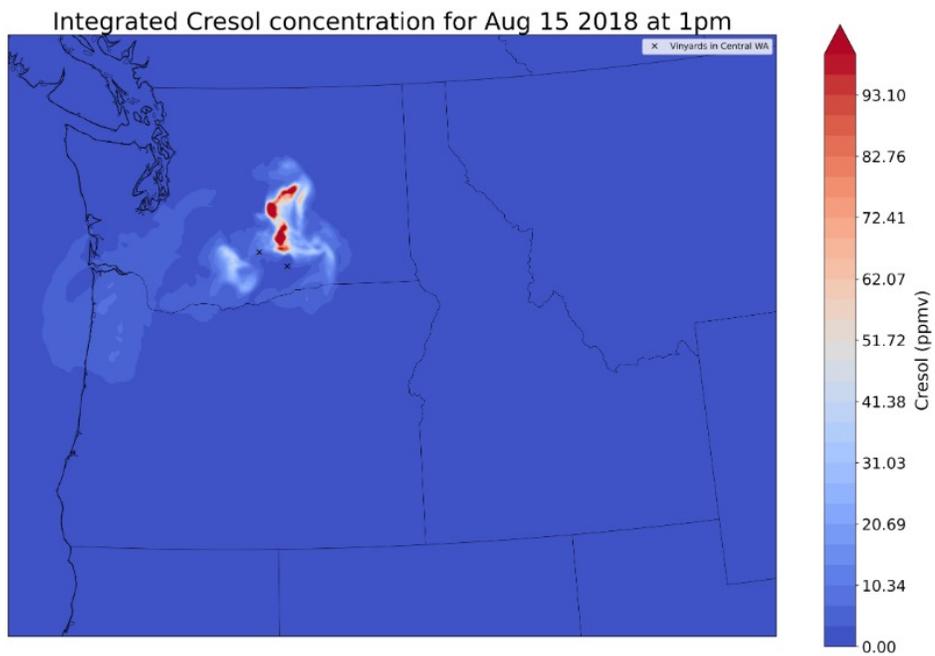
Ozone



Phenol



Cresol



# Future Work

- Investigate the reason for extremely high CO and PM<sub>2.5</sub> values.
  - Oxidation of multiple biogenic and anthropogenic precursors forms compounds of varying volatility, partitioning between the gas- and aerosol-phase depending on the total organic aerosol load.
  - Washout of gases and aerosols by convective precipitation schemes implemented in MOSAIC.
  - Dry deposition scheme.
- Investigate low Ozone values, their relation to NO<sub>3</sub> formation, and how that could impact the phenol and cresol sink process.

Thanks