



# Preliminary work on smoke taint of grapes in the Columbia Basin.

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NW-AIRQUEST and NRMCM meeting.

Thursday, Feb. 3, 2022

## Background:

- An economic analysis of the 2020 wildfires conducted by the Wine Institute estimated losses up to \$3.7 billion.
- When vineyards and grapes are exposed to smoke this can result in wines with undesirable sensory characters, such as smoky, burnt, ashy or medicinal, usually described as “**smoke tainted**”.
- **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.

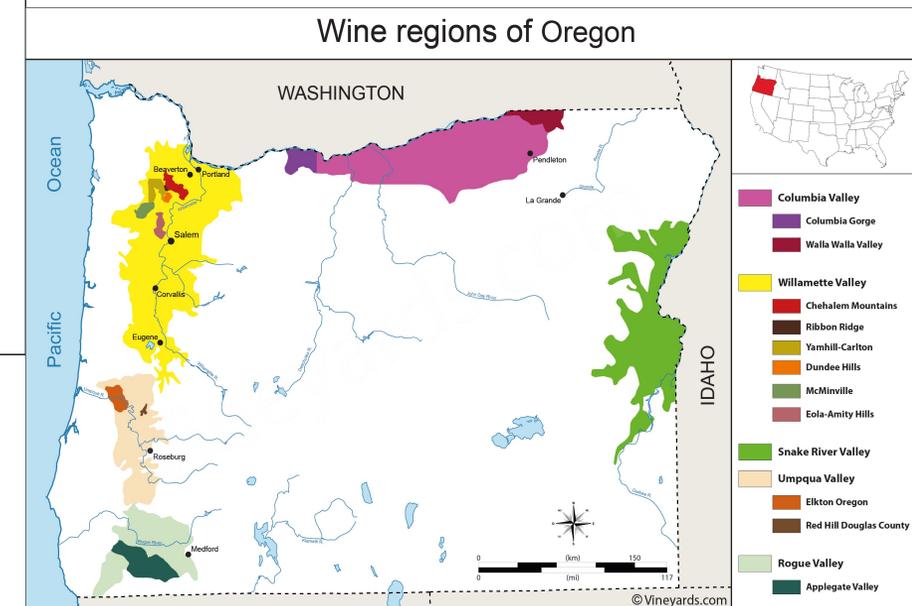
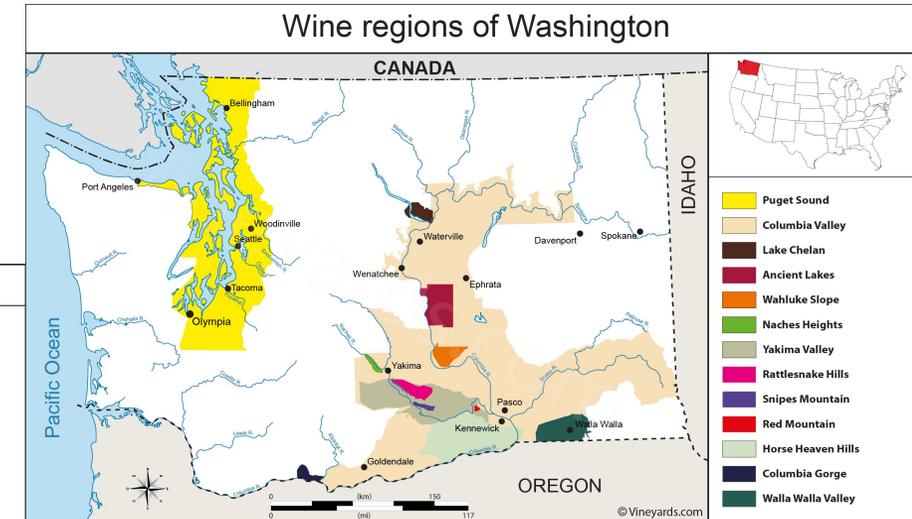
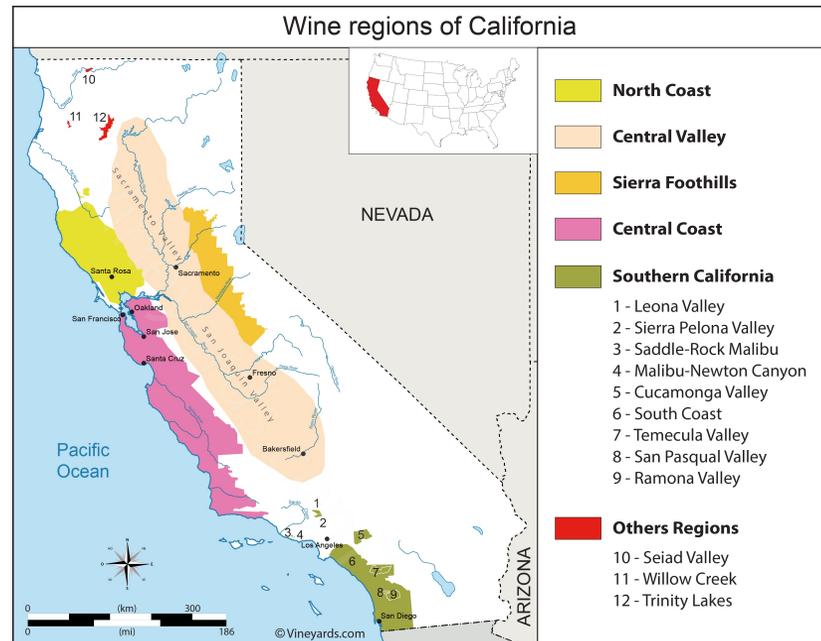
## Current limitations include:

- Lack of nexus between the current atmospheric measurements and grape smoke exposure risk.
- Expensive analytical laboratory techniques to determine smoke exposure marker compound composition in the grapes.



# Assessment and management of risk associated with wildfire smoke exposure of grapes in the vineyard.

- \$7.65 million awarded USDA-NIFA-SCRI grant
- Performing Institution: Oregon State University
- Collaborators: Washington State University and UC Davis.
- Advisory board: stakeholders from state wine groups and representatives of individual wineries in California, Oregon and Washington.



# Objective 1

Develop air quality and vine health smoke exposure risk assessment techniques. -- Thomas Collins, WSU.

[tom.collins@wsu.edu](mailto:tom.collins@wsu.edu)

- 1) Develop low-cost air quality monitoring network using existing particulate matter (PM) data and gas sensors to predict risk during vineyard smoke exposure events.
  - *Hypothesis: low-cost and existing climate and irrigation sensors and stations can predict risk during a wildfire event.*
  
- 2) Apply gas chromatography ion mobility spectrometry in the field to provide real-time assessment of grape and wildfire smoke composition.
  - *Hypothesis: Gas chromatography ion mobility spectrometry can provide real-time assessment of grape and wildfire smoke composition.*

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- 3) Follow changes in volatile phenols/VOC concentrations with age and distance from smoke source.
  - *Hypothesis: Measurement of changes in volatile phenol/VOC concentration with age and distance from smoke source using PTR-MS and GC-MS will provide improved assessment of risks to grape and wine quality compared to measurement of smoke density alone. -- Tom Jobson, LAR*
- 4) Linkage of economic data to air quality modeling results
  - *Hypothesis: A digital spreadsheet-based decision support tool that incorporates and applies research results from this project can provide information about the financial consequences of alternative managerial actions that vineyard managers must choose from, as they act in response to smoke events.*

# Objective 1

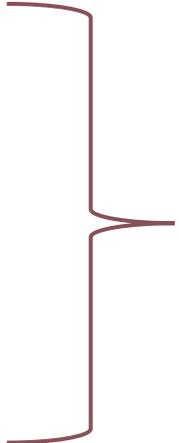
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5) Develop air quality models by associating age, density and composition of smoke plumes with changes in fruit and wine composition and assessments of wine quality. -- LAR, WSU

- *Hypothesis: Air quality modeling can provide information by associating age, density and composition of smoke plumes with damage to grape and wine quality.*

- HYSPLIT back trajectory's locations ← AIRPACT
- Machine Learning Model



Increase understanding of the meteorology, chemistry and particulate matter that occur in air parcels during smoke taint events to create a forecasting system for smoke exposure risk relying on air-quality modeling.

# Objective 2

Determine wildfire smoke impacts to grapevine physiology and fruit quality and develop decision-support and mitigation strategies. -- Alexander Levin, OSU, [alexander.levin@oregonstate.edu](mailto:alexander.levin@oregonstate.edu).

- 1) Integrate spatiotemporal data from field sampling, in-situ sensors and remote sensing to model drivers of smoke impact on berry and vine physiology.
  - *Hypothesis: Data from new and existing low-cost environmental sensors coupled with in-field measurements can be leveraged to predict how smoke event timing, duration, and composition impact vine health and fruit composition.*
- 2) Determine dose-response relationship between smoke exposure level and smoke volatile phenol concentration in grape berries at distinct berry developmental stages.
  - *Hypothesis: Smoke volatile phenol concentration in grape berries increases linearly with increasing smoke exposure level, with no difference in response across berry developmental stages.*

# Objective 2

Determine wildfire smoke impacts to grapevine physiology and fruit quality and develop decision-support and mitigation strategies. -- Alexander Levin, OSU, [alexander.levin@oregonstate.edu](mailto:alexander.levin@oregonstate.edu).

- 3) Field-scale evaluation of grapevine response to simulated wildfire smoke exposure across developmental time using different fuel sources.
  - *Hypothesis: Fuel source and timing of smoke exposures as a function of berry development will affect fruit and wine smoke volatile phenol concentration.*
- 4) Develop and test food-grade grape functional coatings to prevent adsorption of smoke compounds.
  - *Hypothesis: Functional coatings carrying smoke -trapping and -binding compounds applied to grapes prior to smoke events will prevent or reduce adsorption of smoke compounds into wine grapes.*

## Objective 3

Develop smoke exposure risk assessment for the winery. -- Elizabeth Tomasino, OSU, [elizabeth.tomasino@oregonstate.edu](mailto:elizabeth.tomasino@oregonstate.edu).

- 1) Quantitation of free and bound smoke compounds from grapes and wine.
  - *Hypothesis: Differences in the chemical footprint of baseline and smoke exposed grapes and wines will indicate chemical markers of smoke impact risk.*
- 2) Evaluate ability of small-scale fermentations to predict risk in large scale fermentations.
  - *Hypothesis: Small-scale fermentations can predict risk in large scale wine fermentations.*
- 3) Establish perception and rejection thresholds for smoke taint in Pinot noir, Cabernet sauvignon, Syrah and Riesling wines.
  - *Hypothesis: Sensory evaluation of wines for smoke compounds will show thresholds for smoke exposure.*

## Objective 4

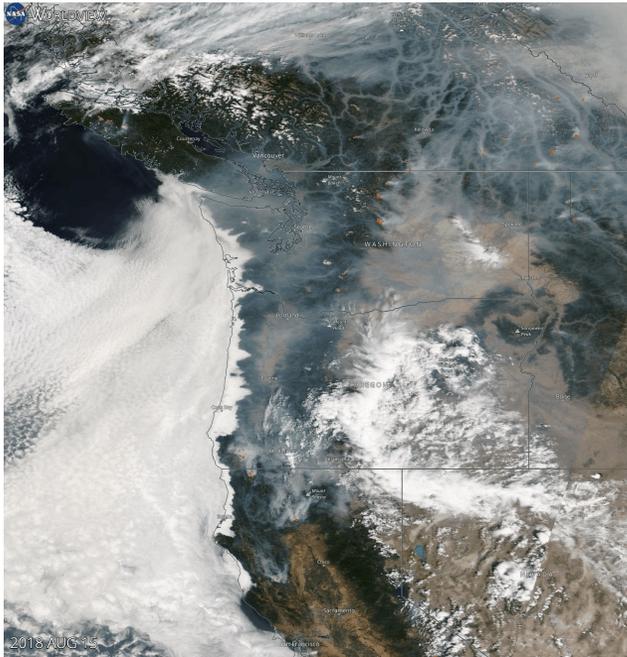
Develop grape smoke exposure risk management plan. -- Anita Oberholster, UCD, [aoberholster@ucdavis.edu](mailto:aoberholster@ucdavis.edu).

- *Hypothesis: Research outcomes will enable effective actions to facilitate adoption of management practices.*

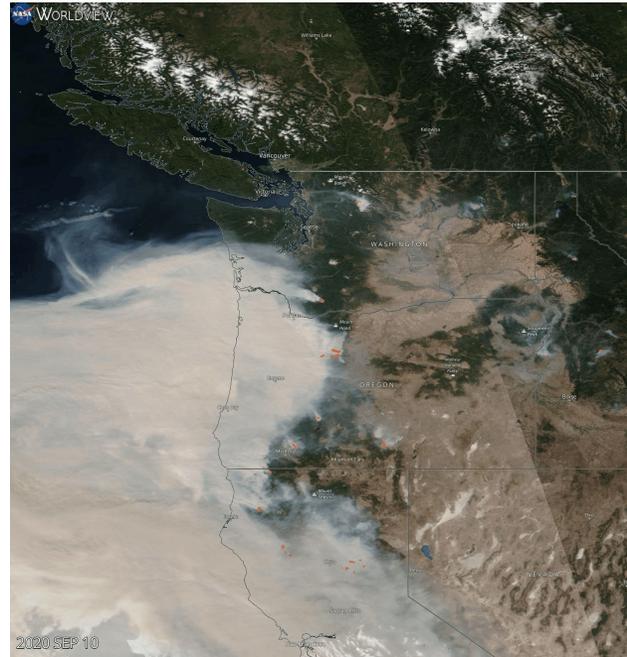
# Preliminary back trajectory analysis on Columbia Basin.

- Past case studies:
  - Wenatchee picked as a representative site.

Aug 2018: **No Smoke taint was detected.**



Sep 2020: **Smoke taint was detected.**

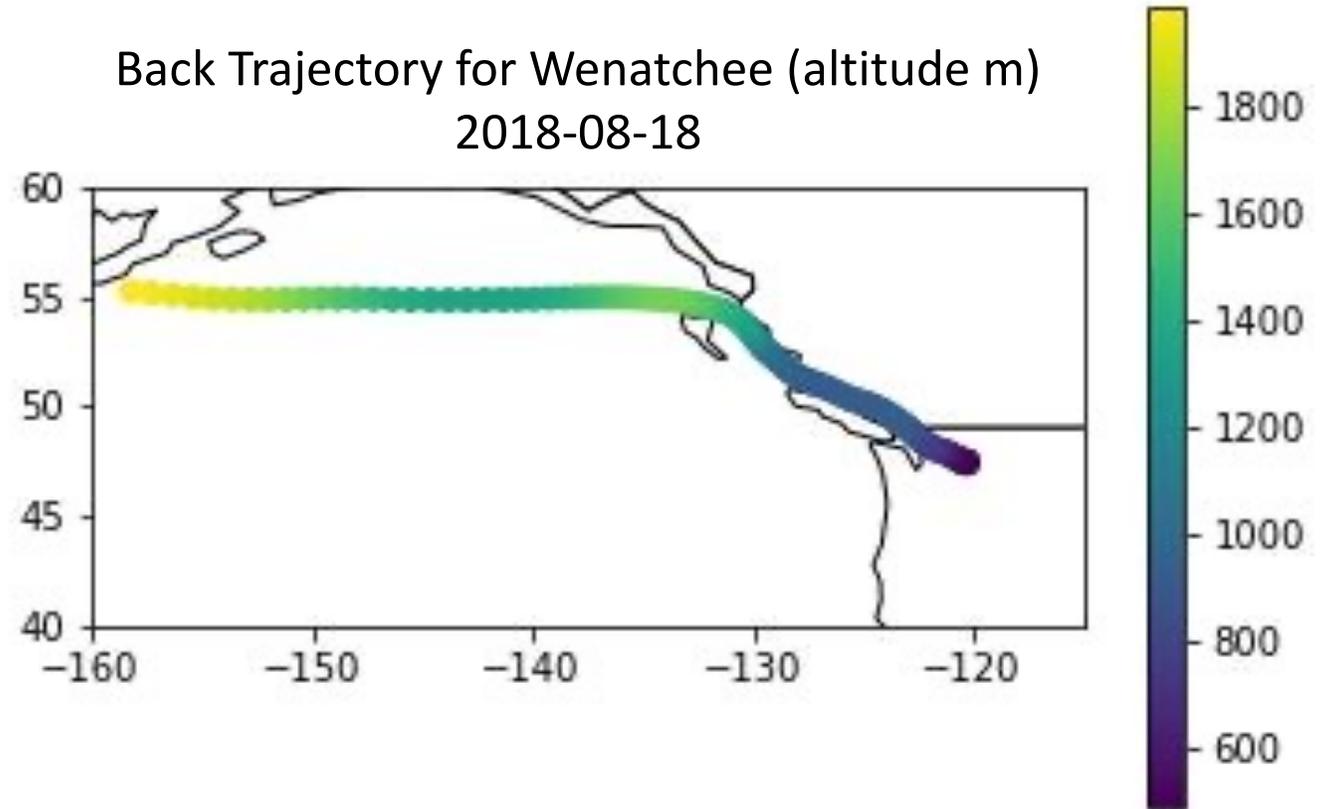


- Immediate task to do:
  - Current AIRPACT's chemistry results will be used to determine potential chemical changes along the back trajectories.
  - Identification of meteorological and chemical changes that occur in air parcels that contribute to smoke taint.

# Wenatchee Aug 2018: No Smoke taint was detected.

Air parcel coming from NW of  
Wenatchee:

- Presence of descendent air parcel trajectory indicates stable conditions (High pressure system).

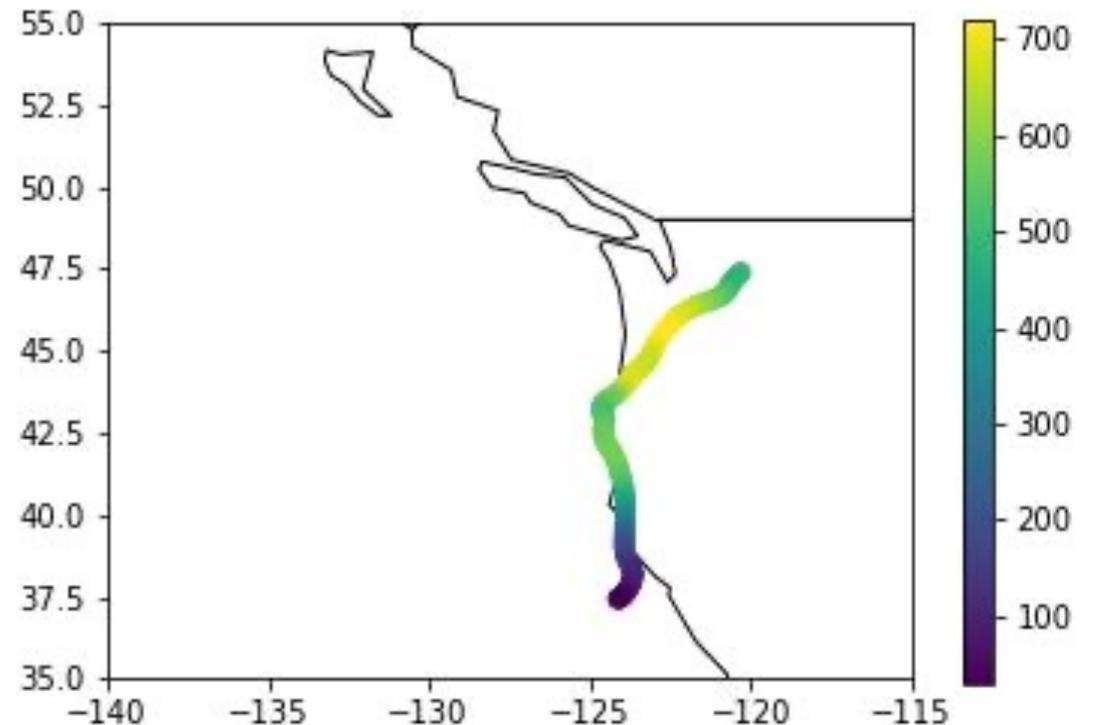


# Wenatchee Sep 2020: Smoke taint was detected.

Air parcel coming from SW of  
Wenatchee:

- Presence of ascendent (mixed) air parcel trajectory indicates unstable conditions.

Back Trajectory for Wenatchee (altitude m)  
2020-09-14



➤ Re-run AIRPACT for those events with a larger domain and possible new chemistry mechanism.

# Future forecasting system

- Develop a machine learning model specific for the winery's locations.
- Current model does not catch extreme events (high PM!!)
  - Explore different ML models that focus on change detection and anomaly detection. TBD !!

# Problems to resolve.

- Deposition mechanism of semi-volatile phenolic compounds onto grapes.
- Accuracy of AIRPACT when process volatile phenols.
  - Explore chemical mechanism in CMAQ.
  - Explore the process of free volatile phenols by MEGAN and BlueSky.
- Increase AIRPACT's domain and spatial resolution.
  - Vineyards from California
  - Airflow from the Pacific ocean.
- Representation of atmospheric ageing and its relationship with smoke taint.
  - Correlation between the type of vegetation that is burned and smoke taint.
- Relationship between smoke taint and “criteria pollutants”.

and more ...



Thank you