

# CENSE: Cardiopulmonary Events from Smoke Estimator

Proposal to Amazon Catalyst Program at WSU Submitted  
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Joseph K Vaughan, PhD [jvaughan@wsu.edu](mailto:jvaughan@wsu.edu) †

Julie R Fox, PhD, MHS, [julie.fox@doh.wa.gov](mailto:julie.fox@doh.wa.gov) †

Matthew Kadlec, PhD, DABT, [mkad461@ecy.wa.gov](mailto:mkad461@ecy.wa.gov)

Dwight Barry, PhD, [dwight.barry@seattlechildrens.org](mailto:dwight.barry@seattlechildrens.org)

# CENSE grows out of the AIRPACT-Fire project.

- ▶ Funded through the Joint Fire Sciences Program for 2015-2018.
- ▶ AIRPACT-Fire is a 3-year project innovating improvements in:
  - ▶ 1) wildfire and smoke modeling in the AIRPACT-5 air-quality forecasting system, particularly forecasting of PM2.5, particulate matter causing human health effects, and
  - ▶ 2) **Communication of human health risks associated with wildfire smoke.**
- ▶ AIRPACT-5 provides daily air-quality forecasts at: <http://www.airpact.wsu.edu/>
- ▶ Builds on an extensive review of the epidemiological literature on Wildfire PM2.5 and Human Health Effects, conducted by Matt Kadlec, PhD & DABT, WA Dept. of Ecology.
- ▶ CENSE App prototype is being designed & coded by WSU/EECS Senior Design Class.
- ▶ Functionality of CENSE App will also be served through website.
- ▶ (Perhaps CENSE should be licensed to a commercial or non-profit organization?)

# Signing up for the CENSE App

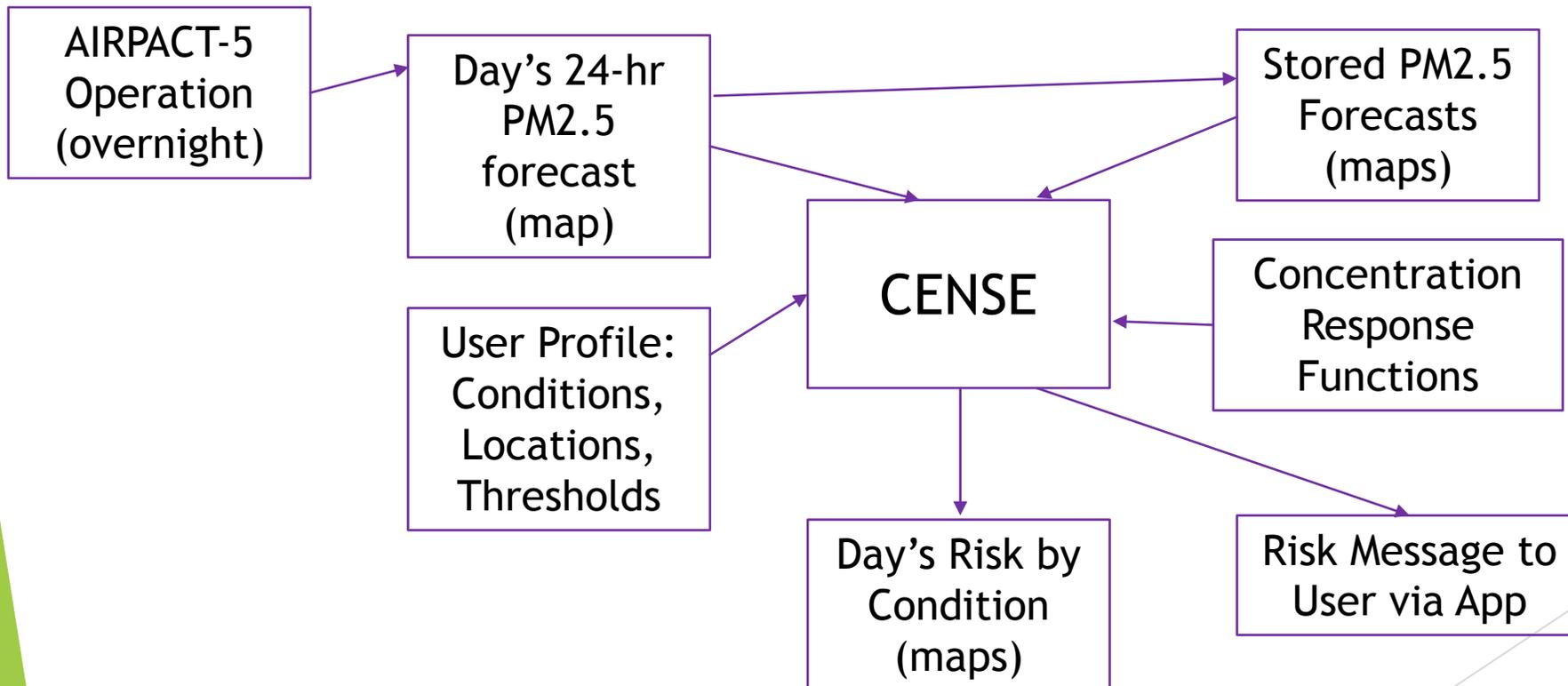
- ▶ Potential users learn about CENSE from health care providers or public health orgs.
- ▶ App will be available for both Apple iPhones and Android phones.
- ▶ User downloads the app from Apple Store or other provider, or from project website.
- ▶ User signs up through the app or on the project website.
- ▶ User must acknowledge and accept:
  - ▶ Liability Waiver and Disclaimer stating that AIRPACT and CENSE are research projects; that the user has no guarantee that information provided will be useful, reliable, correct, or even available, and that the user remains responsible for any and all consequences of using the app.
  - ▶ Privacy Notification stating what information will be collected and how it will be stored and used.
- ▶ User builds a profile (see next slide).
- ▶ Concentration Response Functions (Matt Kadlec) and daily PM2.5 forecast are used to compute a risk map for each medical condition. (See slide 8)
- ▶ CENSE app users get notification if estimated risk meets their own risk threshold.
- ▶ CENSE will occasionally solicit users for feedback for app evaluation and improvement.

# Setting up a profile (Signing up, cont.)

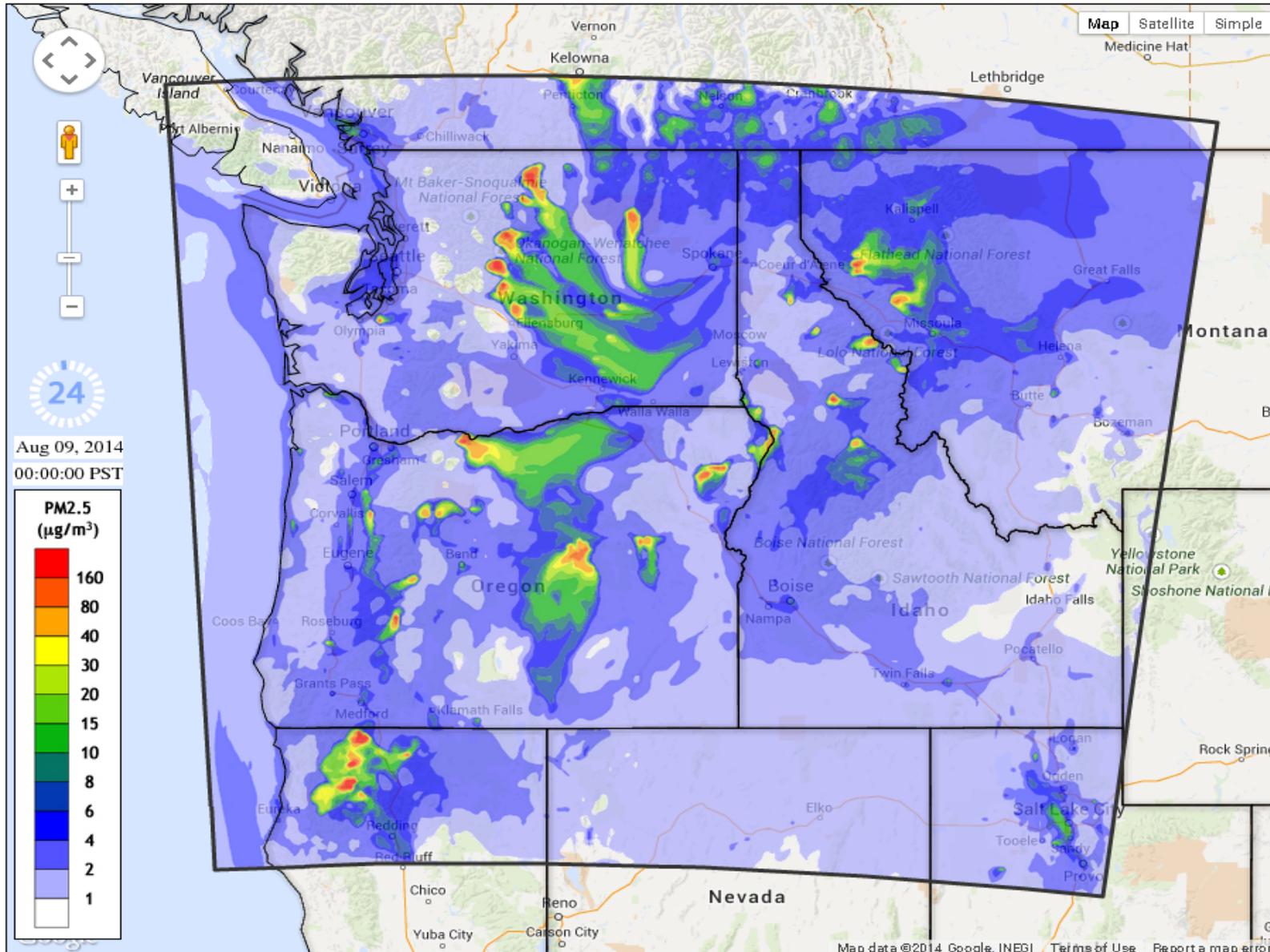
- ▶ Establish Identity: Identity can be MAC or cell phone # or email, any unique string supporting effective contact.
- ▶ Choose one or more medical conditions (diagnoses) of interest to the user.
  - ▶ These can cover the user, one or more children and/or other adults in household.
- ▶ Set Risk Threshold for each of the medical conditions (optionally):
  - ▶ User can set unique thresholds for excess risk for notification for each condition.
  - ▶ User can accept default threshold of 20% excess risk.
- ▶ Provide location information:
  - ▶ User can provide address, zip code, or locate using Google Map feature.

# CENSE Daily Operation and Data Flow

- ▶ Get map of daily 24-hr PM2.5 forecast for PNW from AIRPACT-5
- ▶ Use Concentration Response Functions (CRFs) to convert maps of PM2.5 to maps of risk.
- ▶ Notify user of condition & location specific risk if it exceeds threshold.



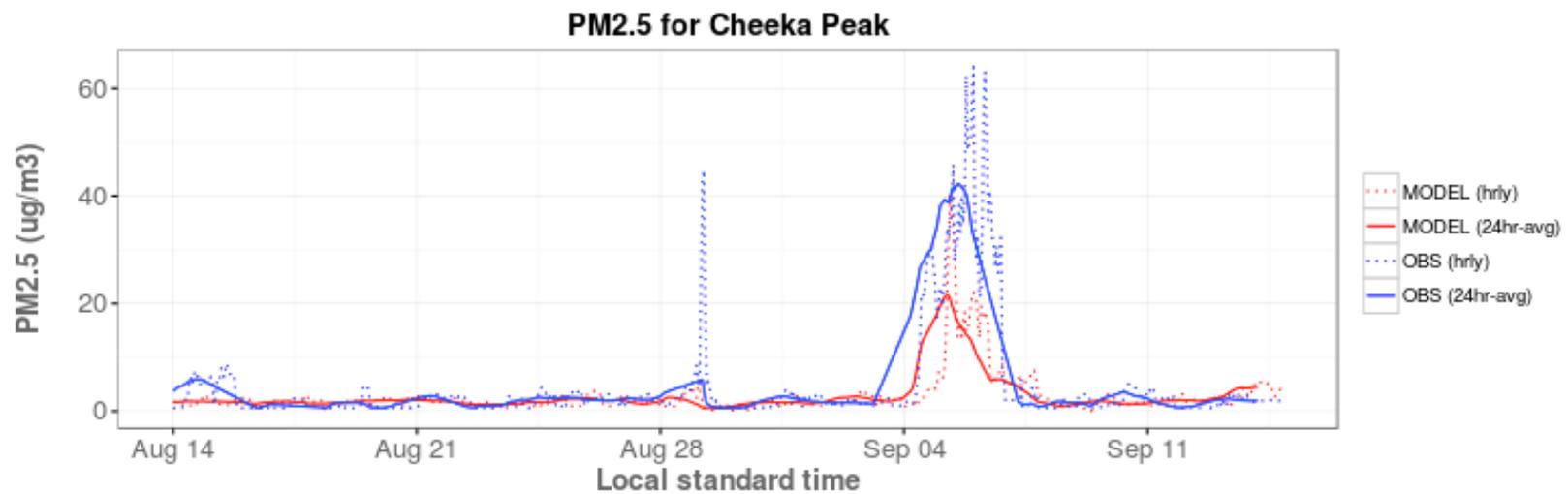
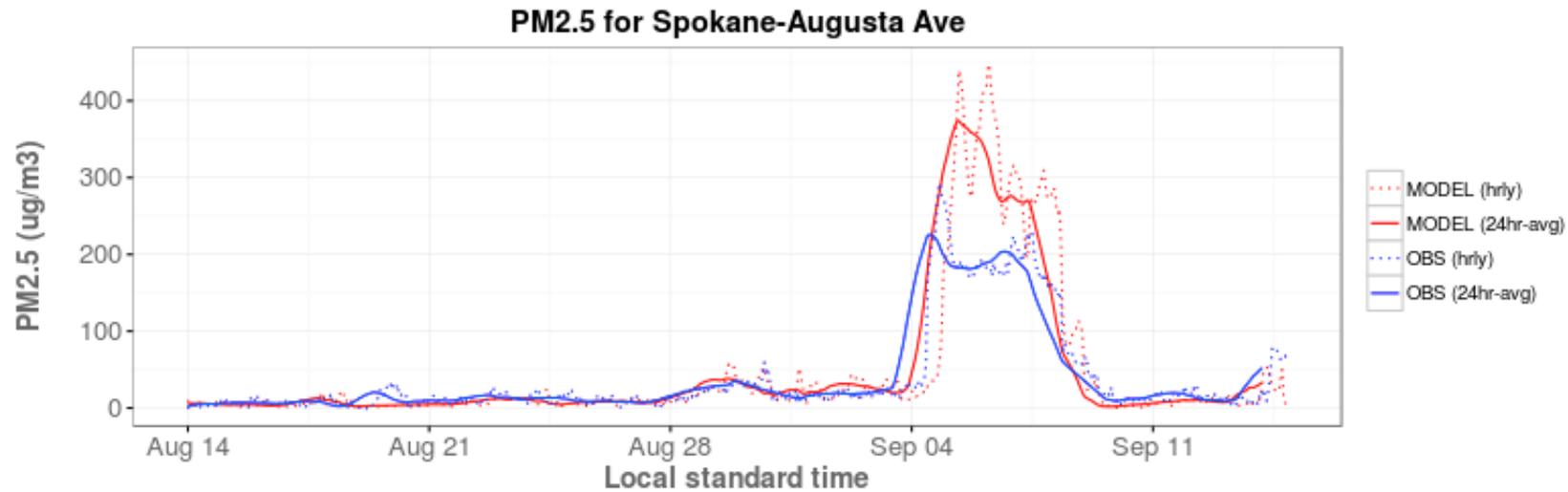
# Forecasting and communicating wildfire smoke health risks



**AIRPACT is an evolving system of models that forecast air pollution concentrations including wildfire smoke. WSU has operated AIRPACT since 2001 and is now on AIRPACT-5.**

Slide from talk by Matt Kadlec at  
Smoke Management in the Northwest Meeting  
Boise Idaho, March 19, 2018

# Forecasting and communicating wildfire smoke health risks



**AIRPACT5 gets monitoring results from agency-operated instruments and compares these to model forecast results.**

# Concentration-Response Function = $\frac{\Delta \text{ effect rate}}{\Delta 1 \mu\text{g}/\text{m}^3 \text{ day}}$

- ▶ Expresses risk as relative risk w/ units of percentage increase over background.
- ▶ Estimates sensitivity of illness incidence rate in exposed populations to PM<sub>2.5</sub> increment.
- ▶ Given size of exposed population and its ordinary rates of illnesses, CRFs allow estimation of numbers of attributable cases.

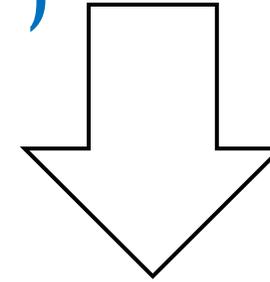
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# Literature searches



National Library of Medicine PubMed:

((wildfire\* OR brushfire\*) OR ((vegetati\* OR wild OR forest OR brush) W/2 (fire\* OR burn\* OR smoke OR particulate\* OR particle\*))



**Daily average wildfire  
PM2.5 effects on  
incidence rates of  
illnesses and deaths**

Slide from talk by Matt Kadlec at  
Smoke Management in the Northwest Meeting  
Boise Idaho, March 19, 2018

Alman et al 2016  
Carmo et al 2010  
Crabbe 2012  
Delfino et al 2009  
Dennekamp et al 2015  
Elliott et al 2013  
Gan et al 2017  
Haikerwal et al 2015  
Haikerwal et al 2016  
Hänninen et al 2009  
Johnston et al 2006  
Johnston et al 2014  
Kollanus et al 2016  
Moeltner et al 2013  
Silva et al 2013  
Yao et al 2014

# WE have examined other apps... Compared to CENSE:

- ▶ EPA AIRNow app addresses general health risk:
    - ▶ <https://www.data.gov/energy/applications/airnow/>
    - ▶ Current and forecast values of AQI (Air Quality Index) based on monitoring and National Air Quality Forecasting Capability
  - ▶ Propeller serves asthma and COPD patients, collecting medication use data:
    - ▶ <https://www.propellerhealth.com/>
    - ▶ Sensor connects to inhaler and captures use data.
    - ▶ Uses patient symptom history and weather, but not AQ model results.
  - ▶ SMOKE SENSE app is a citizen science study:
    - ▶ <https://www.epa.gov/air-research/smoke-sense-study-citizen-science-project-using-mobile-app>
    - ▶ Current and forecast values of AQI (Air Quality Index) based on monitoring and National Air Quality Forecasting Capability
    - ▶ Collects user input on response to wildfire smoke, to research smoke effects.
    - ▶ For the study of communication strategies.
  - ▶ Vadyanathan, Yip & Garbe, 2018: NCEH & CDC study using census tracks.
- EPA AIRNow and Smoke Sense both report EPA/NOAA model results for AQI.
  - Only Propeller addresses any specific subset of conditions, those of inhaler users.
  - Only Smoke Sense is specific to wildfire.
  - None *push* risk warnings to users.
  - Little customization.
  - Not sure yet....

# Timeline: Committed *and proposed*

- ▶ April 12: Conference call with WA Dept. Of Health on requesting data from the RHINO database for evaluating CENSE computation for previous wildfire period/s.
- ▶ April 27, 20 minute presentation before Amazon Catalyst evaluation team.
- ▶ April 27, EECS Senior Design Class turns in prototype CENSE app. (LATE!)
- ▶ *June 2018, Compute Risk Maps for 2017 wildfire season.*
- ▶ *July 2018, Submit IRB application to Evaluate CENSE computations using WA DOH's Rapid Health Information NetwOrk (RHINO) data. This likely involves a Data Use Agreement with DOH and Ecology.*
- ▶ *Wildfire Season 2018, Volunteers testing use of CENSE app and providing feedback from user perspective.*
- ▶ *September 2018, EECS Senior Design Class resumes work on CENSE app.*
- ▶ *Spring 2019, negotiate a host institution to operate CENSE?*
- ▶ *Wildfire season 2019, deploy updated CENSE app.*

## Status

- ▶ Funded by Amazon Catalyst as per letter of May 31.
- ▶ Accepted as WSU I-Corps project for summer 2018 for development of a commercialization strategy.
- ▶ CENSE App & back-end development continuing...

# Questions?

- ▶ Follow up with Joseph K Vaughan, PhD
  - ▶ [jvaughan@wsu.edu](mailto:jvaughan@wsu.edu)
  - ▶ 509-335-2832