



Air quality impacts of an aviation biofuel industry- preliminary assessments

Vikram Ravi and Brian Lamb

Department of Civil & Environmental Engineering
Washington State University

Northwest Advanced Renewables Alliance





- Key air quality (AQ) issues in the Northwest
 - Ozone (NO_x, VOC precursor emissions)
 - PM_{2.5} (particulate matter, both primary and secondary)
 - Air toxics (formaldehyde, benzene, etc)

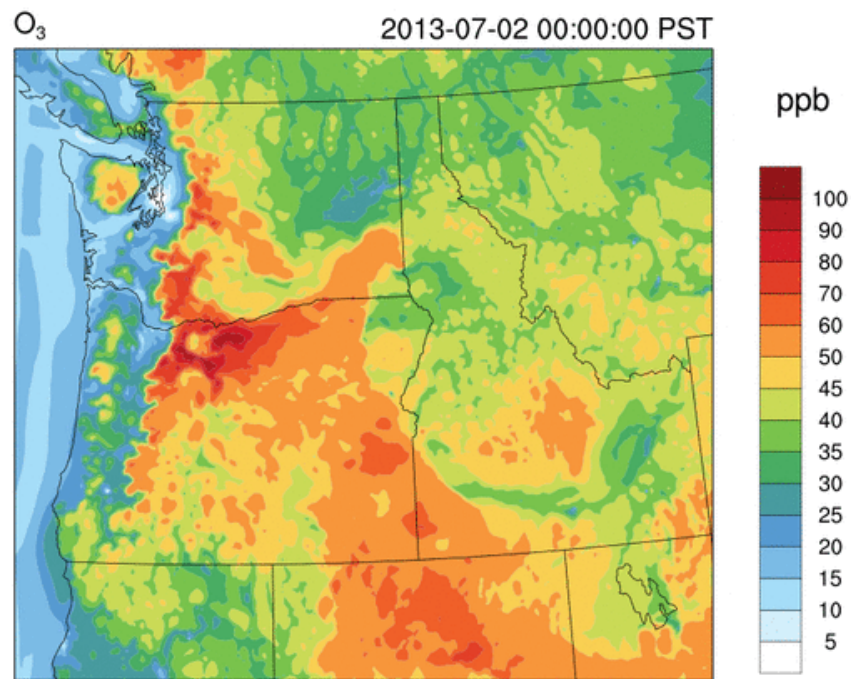
- NARA air quality modeling approach
 - Apply the AIRPACT-4 modeling framework
 - Assess the benefits of reduced prescribed fires—harvesting of biomass will reduce the need for prescribed fires
 - Assess impacts of biojet supply chain scenarios—supply depots and biorefinery emissions



AIRPACT-4: an advanced air quality modeling system

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- AIRPACT-4: a numerical air quality forecast system
- Explicit simulation of the chemistry and physics of air pollutants
- Dynamic emissions treatment
 - Urban, industrial, and mobile emissions
 - Biogenic emissions
 - Wildfire and prescribed fire emissions
- Output hourly concentration of various gaseous and aerosol pollutants



AIRPACT-4 : model domain and simulated ozone concentration for the Pacific Northwest

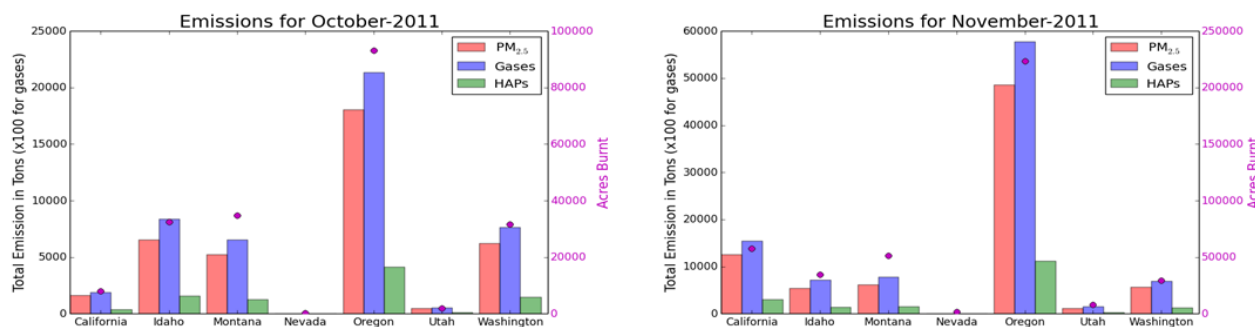
<http://www.lar.wsu.edu/airpact/>



Air Quality: Models and Methodology

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- Prescribed fire emissions for the model domain were extracted from the National Fire Emission Inventory (NFEI) 2011 available from the US EPA. Fire emission data shows that emissions peak during the months of October and November.
- Model simulations were completed for the period 10 October – 15 November, 2011 for three different emission scenarios:
 - **100% Fire (with fire) Case:** includes all the fire emissions as per NFEI 2011
 - **30% Fire Case:** includes all the fire sources as per NFEI 2011, but all fire emissions (& heat flux) uniformly reduced by 70%
 - **No Fire Case:** none of the fires from NFEI 2011 were included



Prescribed fire emissions (bars) and acres burned (dots) for the AIRPACT-4 domain as per NFEI 2011.



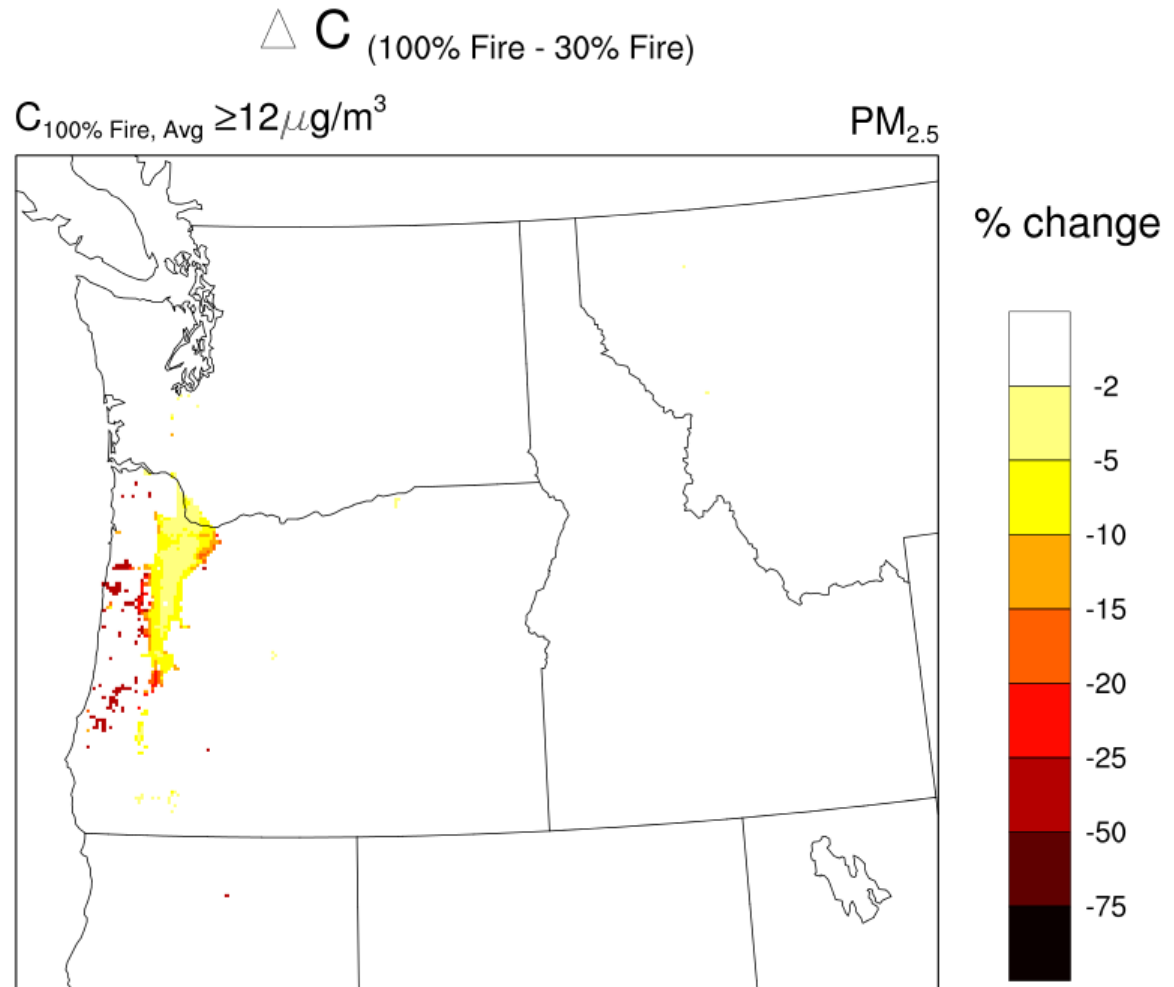
NARA



• Impact of emission reduction by 70%

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- 70 % emission reduction scenario reduces $PM_{2.5}$ concentration by 50% -75% for some areas
- Emission reduction impact is maximum for Oregon (where most fires occur)
- Cells where 37 day average concentration for 100% fire case is $> 12\mu g/m^3$ only are considered.



NAAQS for $PM_{2.5}$ annual average concentration is $12 \mu g/m^3$

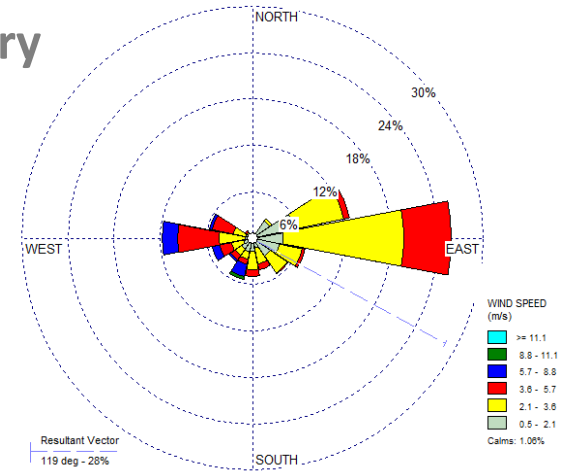


• Impact of biorefinery emissions – Initial assessment

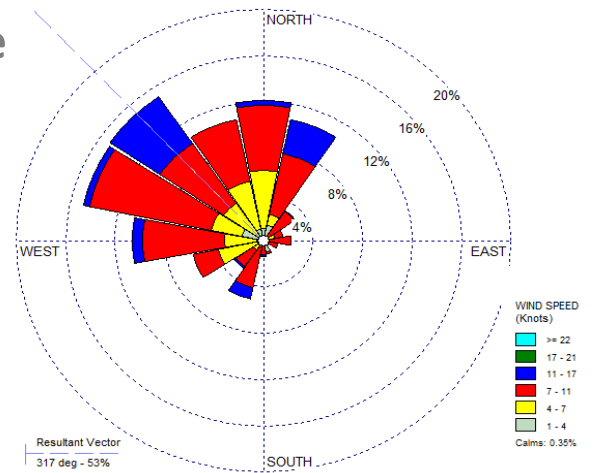
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- Meteorological input data covering January- 2013 and July- 2014 were obtained from the Weather Research & Forecasting (WRF) system processed using Mesoscale Model Interface Program (MMIF).
- Model simulations using the EPA's AERMOD model were used to predict concentrations for both months.
- AERMOD doesn't take into account any chemical transformations.

January



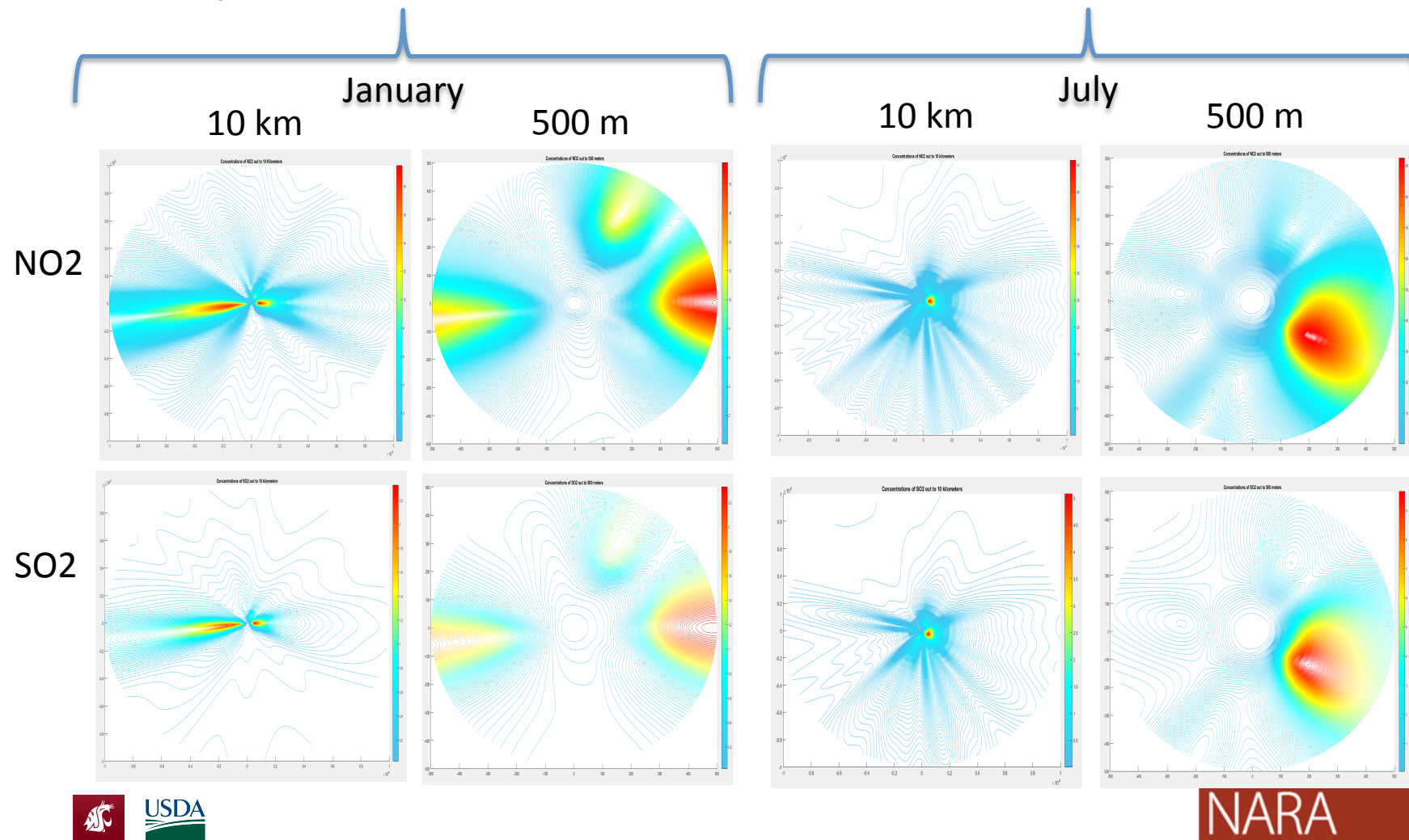
June





Impact of biorefinery emissions – Initial assessment 2015 Annual Meeting Spokane, WA

- As expected, maximum concentration occurs in the direction of the wind
- Modelled maximum concentrations for both SO₂ and NO₂ were both below NAAQS for the criteria pollutants





• Next Steps

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- Emissions from the biorefinery:
 - Either provided by ASPEN modeling group or
 - Estimated based on EPA's AP-42 emission factor database
- Various point source of emissions considered at biorefinery are:
 - Feedstock preparation
 - MBS pretreatment
 - Enzymatic Hydrolysis
 - GEVO process
 - Hog Fuel Boiler
 - Co-products
 - Fuel storage
- Point emissions from biorefinery will be combined with the reduced fire scenarios and net impact will be quantified for O₃, PM and air toxics considering two scenarios:
 - Scenario I – AIRPACT emissions for point, mobile and area sources + fire emissions
 - Scenario II - AIRPACT emissions for point, mobile and area sources + reduced fire emissions + biorefinery emissions



Thank you !!

Questions/ Comments?



- NARA: air quality impact assessment

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Wood product industry impacts

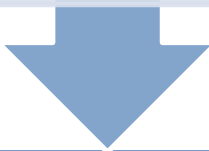
Impact on $PM_{2.5}$ levels are small and localized
Hourly maximum O_3 contributions can be 10-15 ppb, and effects are also visible far away from the sources

Results presented at
NARA annual
meeting 2013



Prescribed fire impacts

Prescribed fires contribute significantly to poor air quality for some locations in PNW
Environmental benefits from avoided fire emissions could be significant for these locations



Biojet supply chain impacts (next steps)

Based on different supply chain emission scenarios from Life Cycle Analysis and ASPEN modeling groups: including emissions from mobile sources and facility emissions

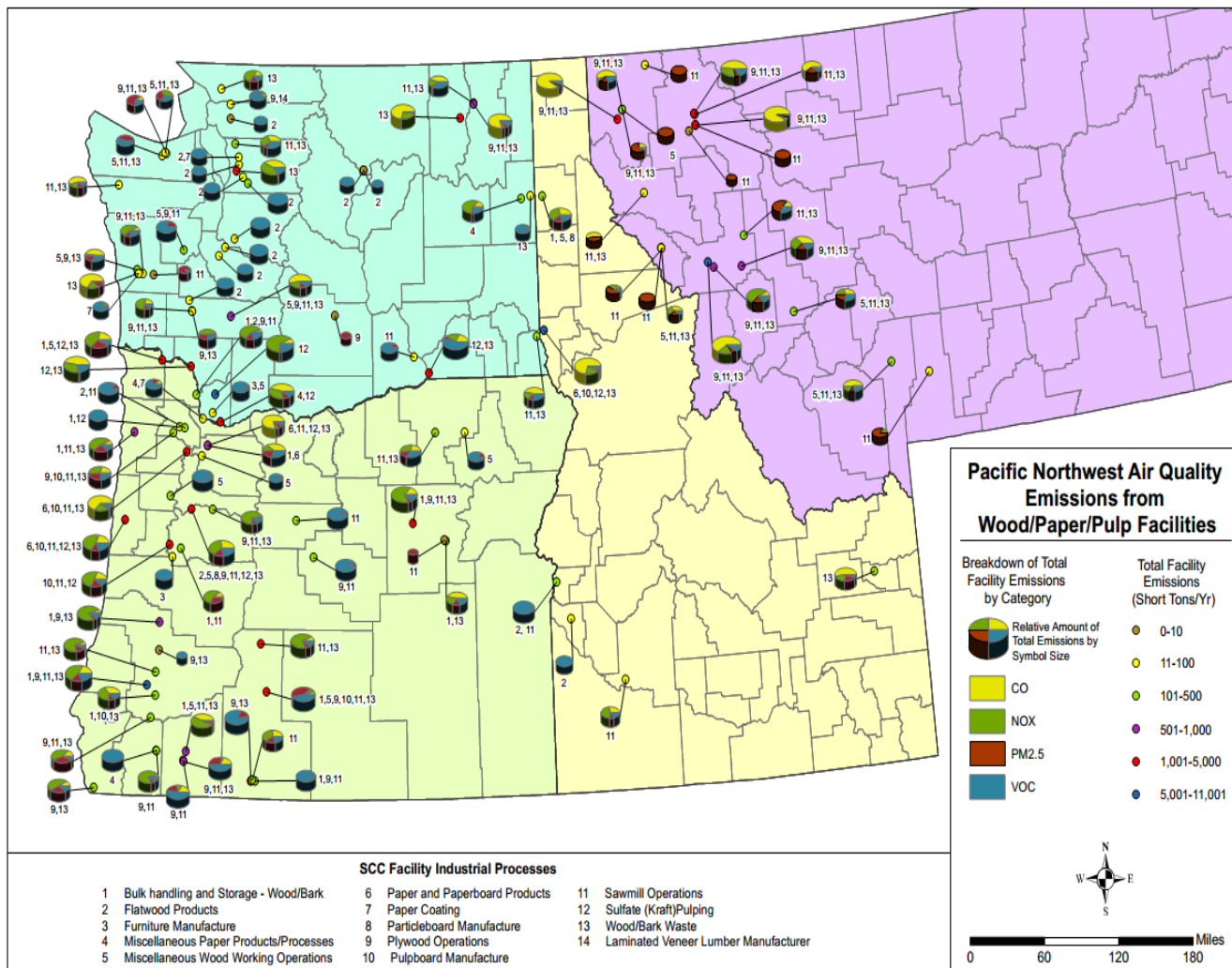


• Assessment of the impact of the current wood products industry

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- Simulations for an ozone episode during June 26 – July 4, 2013
- Model simulations for the episode for two different scenarios:

- **Base Case:** uses the current AIRPACT-4 emission inventory
- **No-Wood Case:** all wood / pulp / paper point sources from AIRPACT-4 domain zeroed out, including those in Washington, Oregon, Idaho, Montana, California, Utah and part of Southern Canada





Analysis: surface concentration snapshots

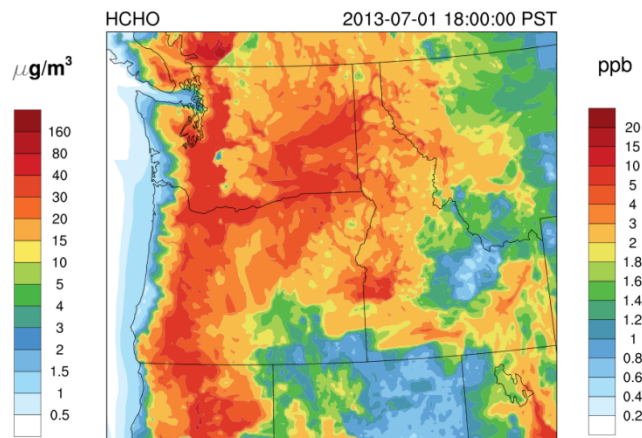
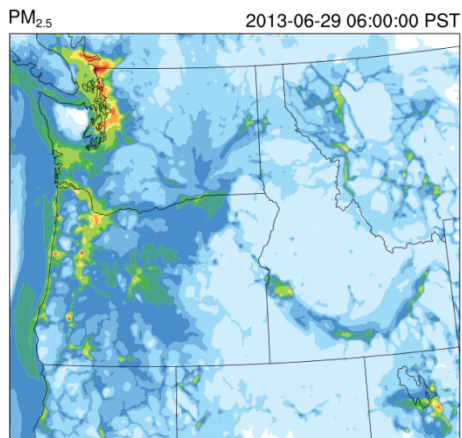
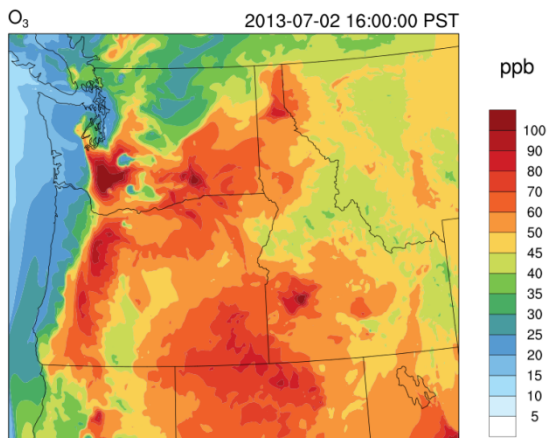
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Ozone
(O₃)

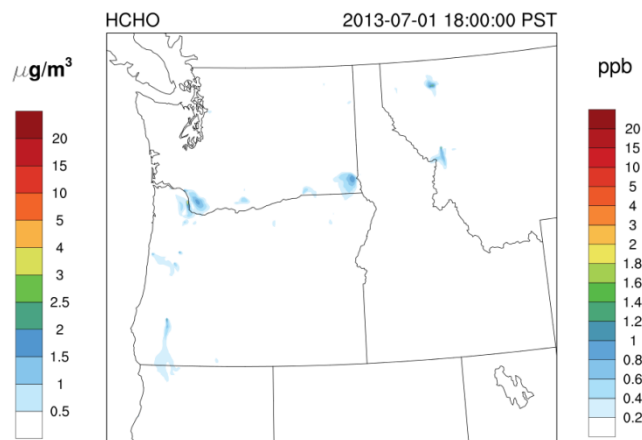
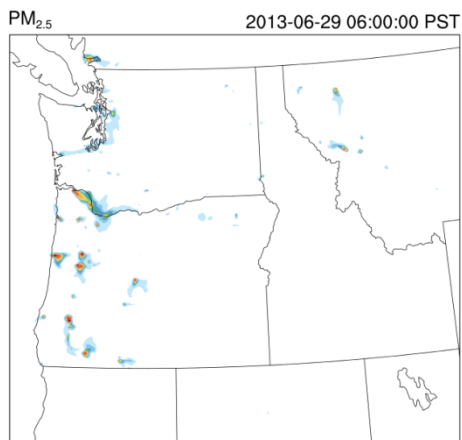
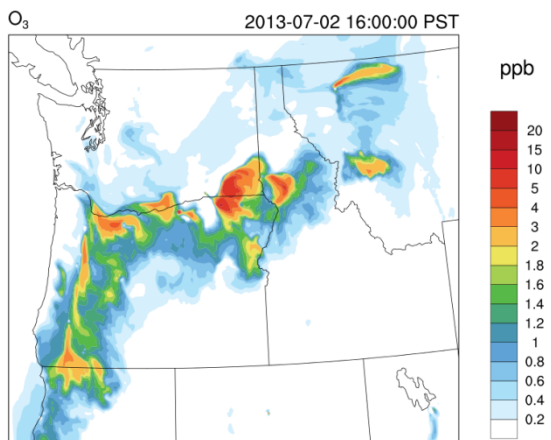
Particulate Matter
(PM_{2.5})

Formaldehyde
(HCHO)

Base Case
Concentration
(AIRPACT-4
Emission Inventory)



Δ Concentration =
(Base case conc.) -
(No-Wood Case
conc.)

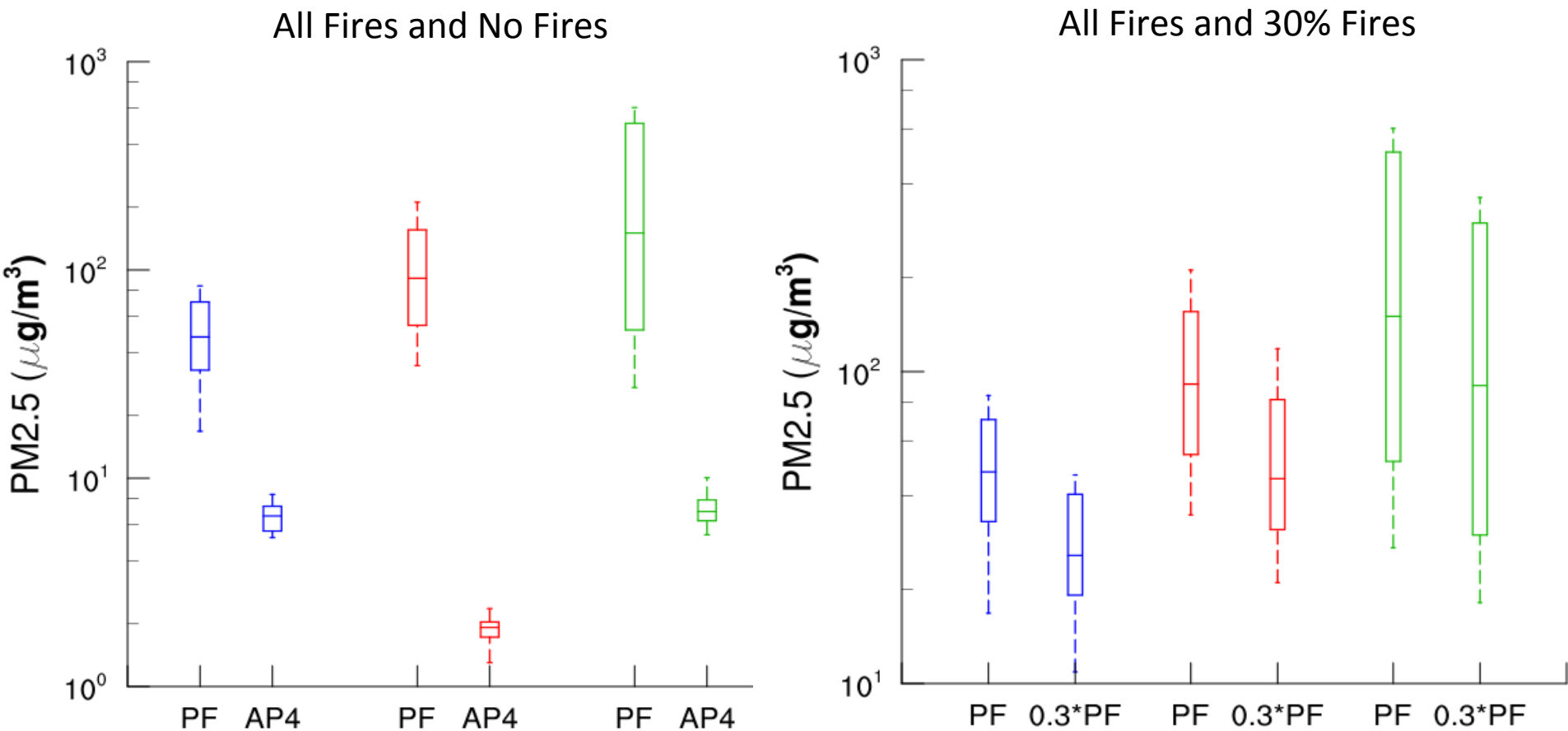


NARA



• Fire Impacts on $[PM_{2.5}]$: Sensitivity Analysis

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AP4 – AIRPACT4 emissions only

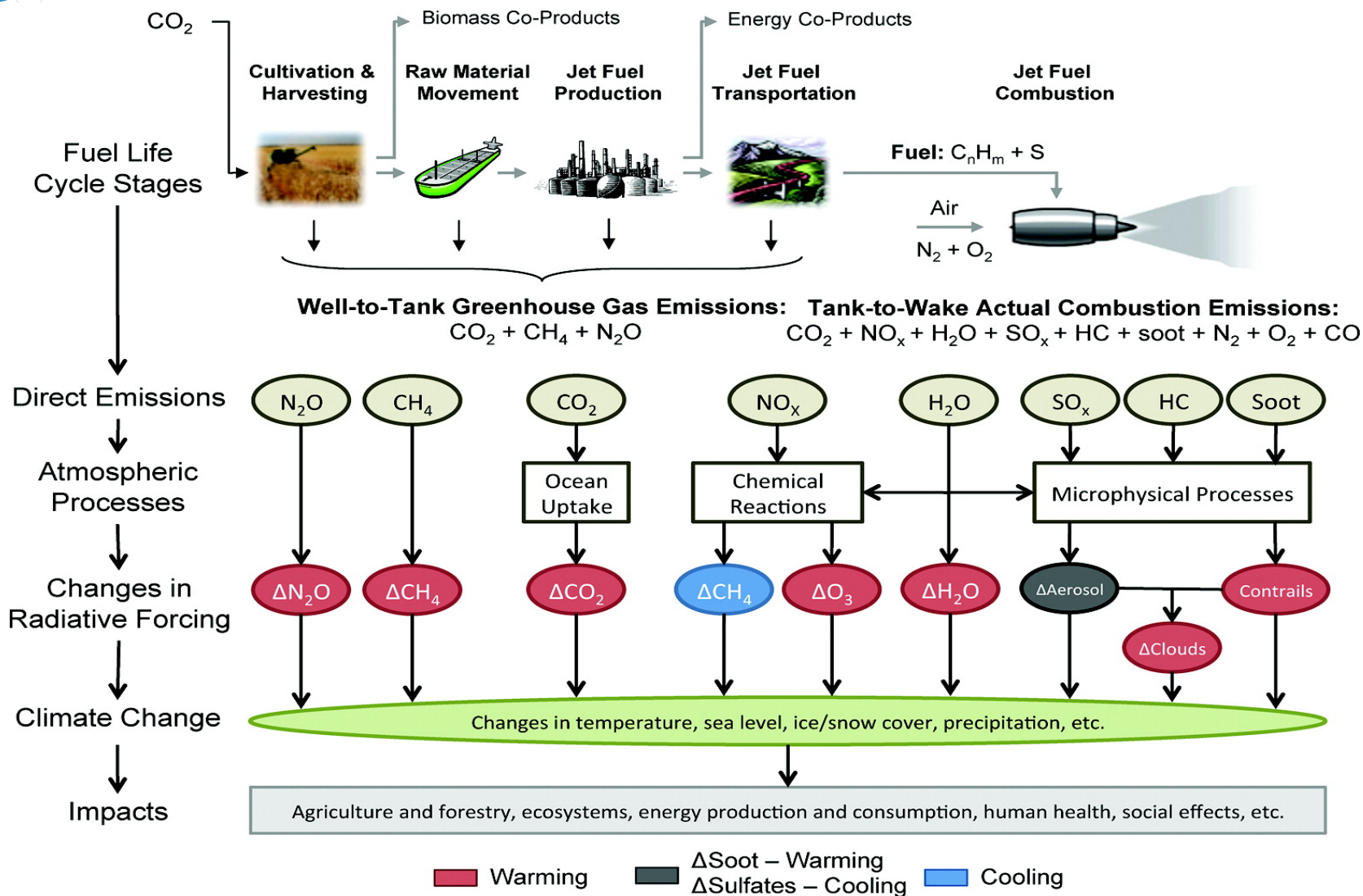
PF – All prescribed fires;

0.3*PF- all fire emissions decreased by 70%



Biofuel: climate impacts

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Stratton et. al 2011

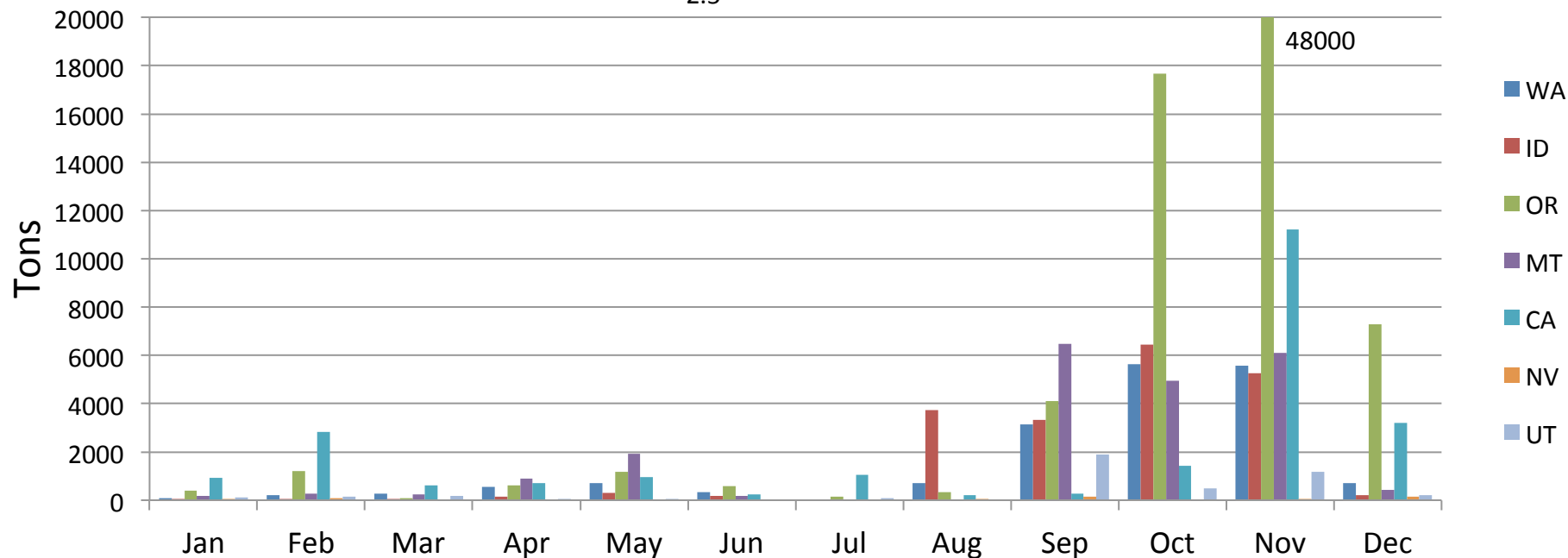


• Assessment of the benefits of reduced prescribed fires

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- Model simulations for month of October & November 2011
 - Oct-Nov are the peak prescribed fire months
- Prescribed fire emissions from the EPA National Emission Inventory NEI for fires
- Specific cases modeled:
 - No fires
 - With all fire emissions from the NEI
 - With 30% of the fire emissions from the NEI (70% reduction due to biomass harvesting)

NEI 2011 based PM_{2.5} emissions from Prescribed Fires



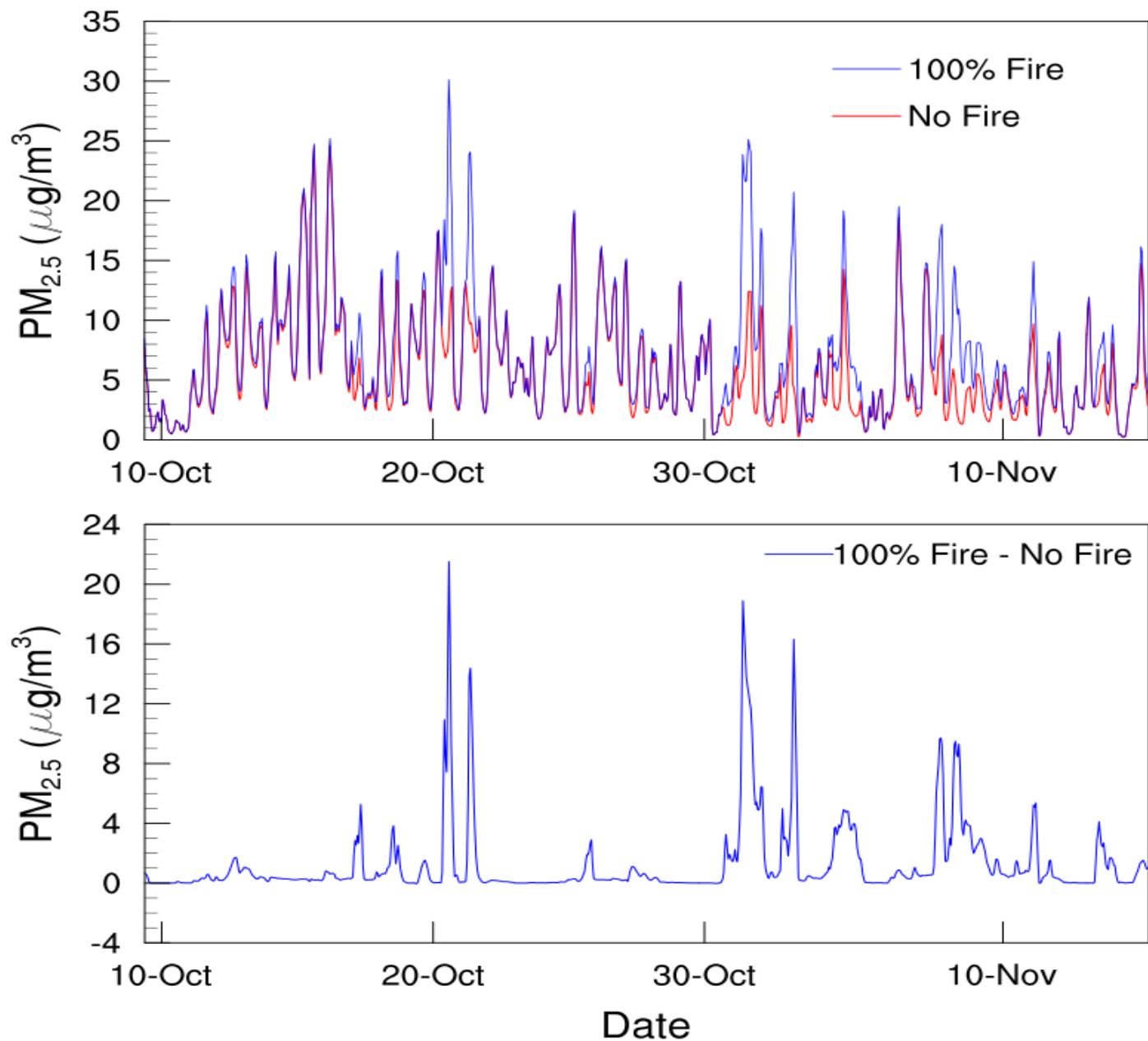


- Fire emission contribution to $PM_{2.5}$ at Oakridge, OR

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Air Quality Standard for
24-hr average $PM_{2.5}$
concentration is $35 \mu\text{g}/\text{m}^3$

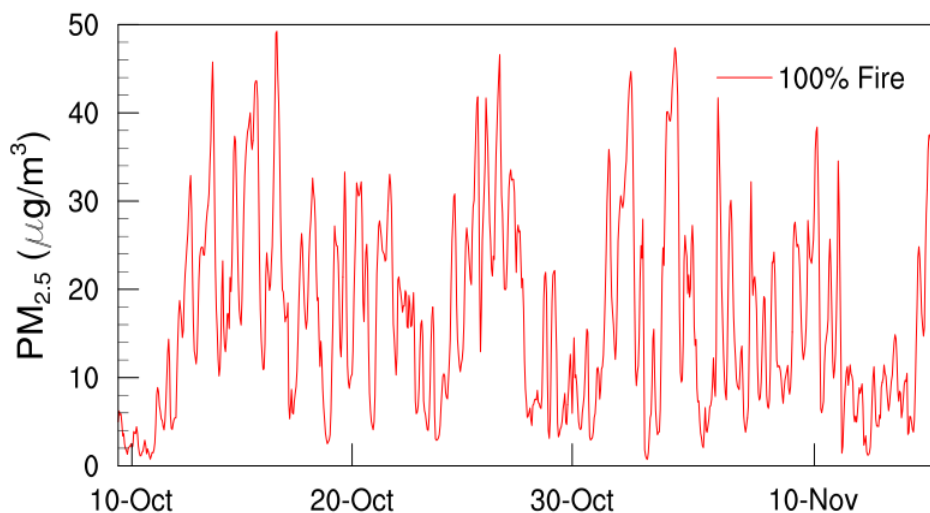
contribution
from fires can
be as large as
 $15\text{--}20 \mu\text{g}/\text{m}^3$.



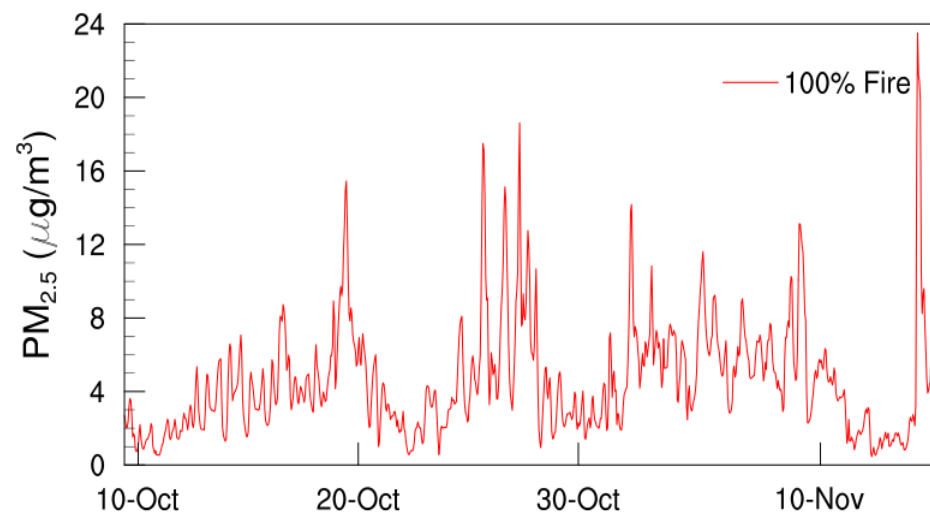


- Fire emission reduction: benefits from a biofuel industry 2015 Annual Meeting
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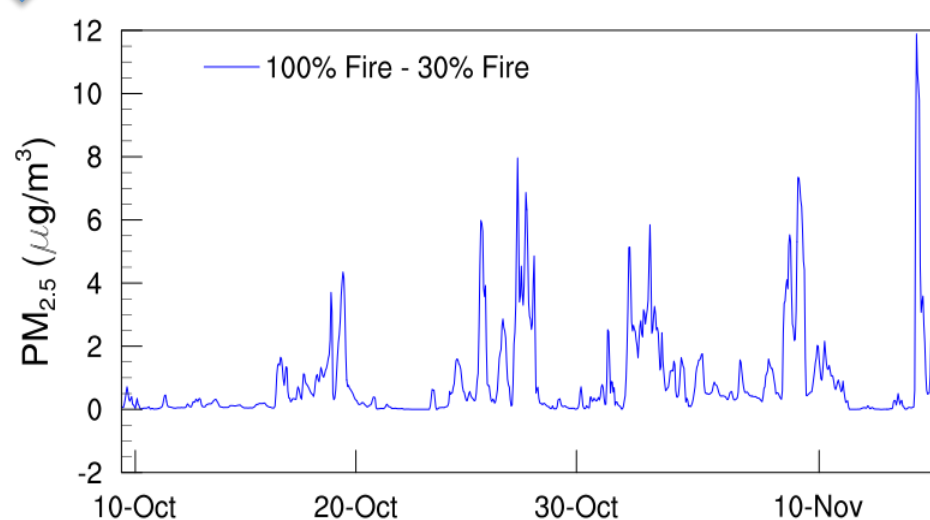
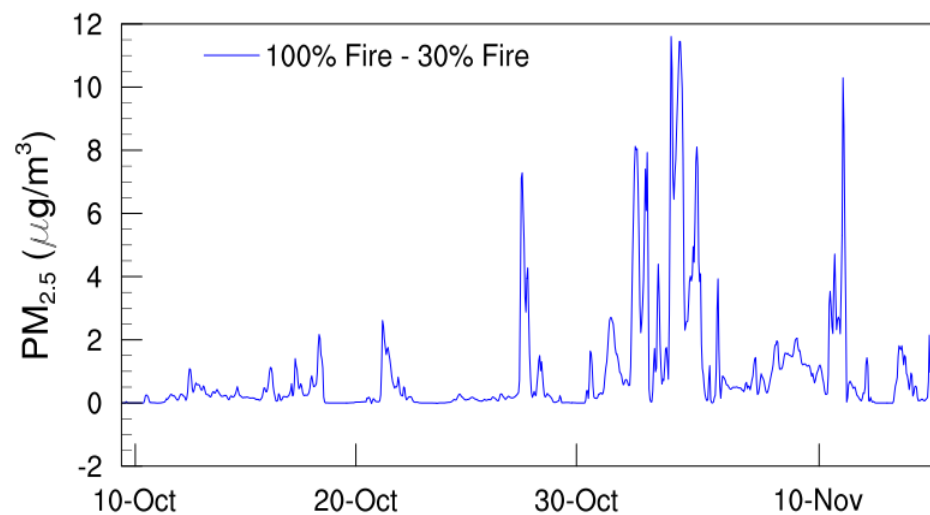
Springfield



Pinehurst



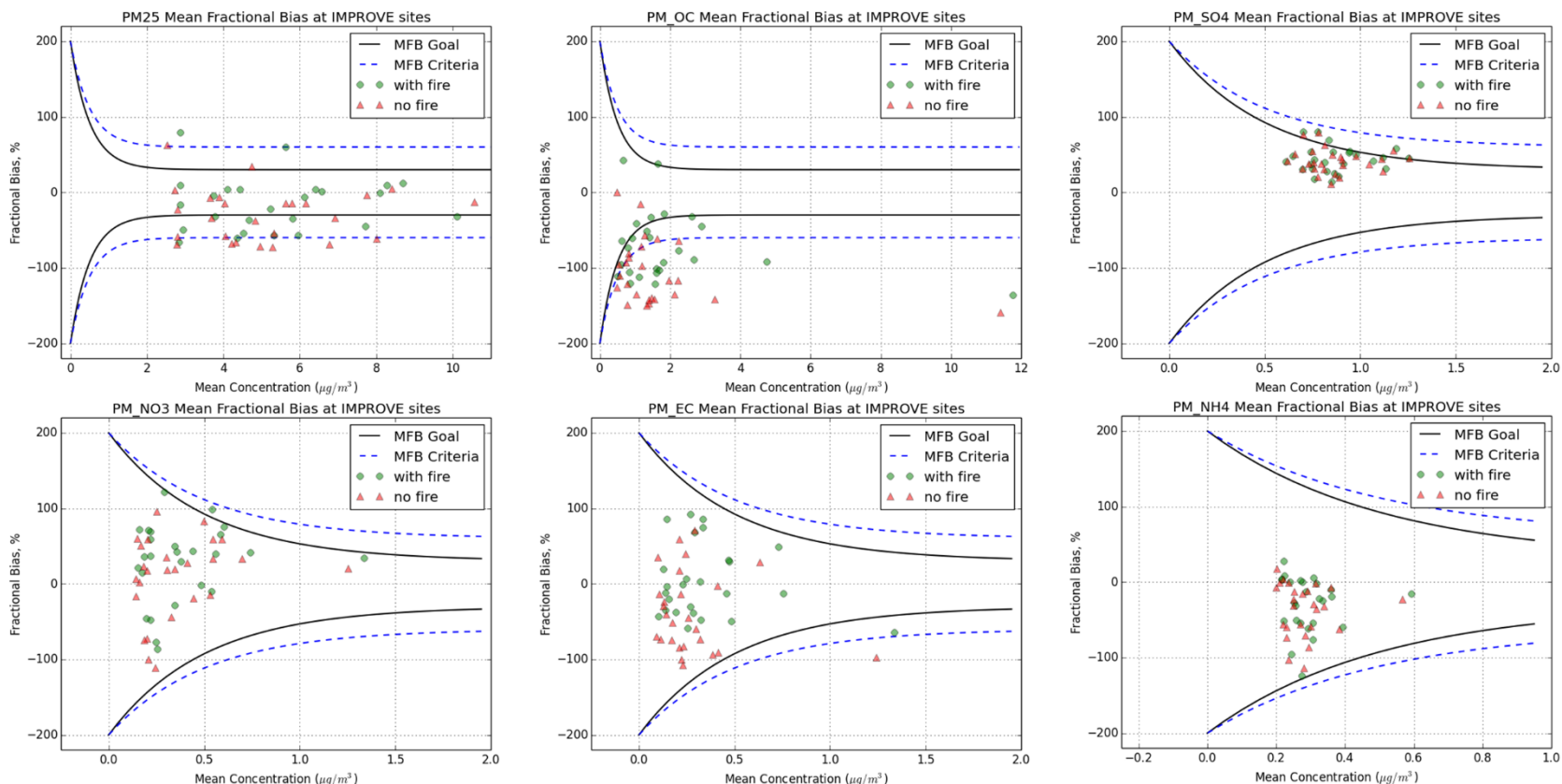
Benefits of biomass harvesting for biofuel





Model performance evaluation

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Clockwise from top left: Model performance evaluation for total PM_{2.5} mass, Organic Carbon (OC), Sulfate ion, Ammonium ion, Elemental Carbon (EC) and Nitrate ion. Speciated observations are from 26 IMPROVE network sites in WA, OR, ID, MT, & CA. MFB for each species is compared against “goals” (best accuracy a model can achieve) and “criteria” (acceptable level of accuracy). Inclusion of prescribed fire emissions results in significant improvement of model performance for organic carbon and total PM_{2.5}.