



Air Quality Impacts of an Aviation Biofuel Industry: Preliminary Assessment for the Wood/Pulp/Paper Processing Industry and Prescribed Burns in the Pacific Northwest

Vikram Ravi, Farren H. Thorpe, Serena H. Chung, Joseph K. Vaughan, Michael P. Wolcott and Brian K. Lamb

Washington State University | Department of Civil and Environmental Engineering | Laboratory for Atmospheric Research



Introduction

The United States, through the Energy Independence and Security Act of 2007, has mandated an increase in the use of biofuels. Although biofuel is considered to be carbon neutral, the feedstock growth, harvesting, processing and transportation is expected to emit a wide range of air pollutants. Air pollution imposes both health and climate risks. Hence it is important to understand the fate of the emitted air pollutants. The NARA project relies on woody biomass from forest residue as feedstock. As a first step to assess the potential air quality impacts of such an industry, we look at the impact of existing wood/pulp/paper facility emissions on air quality in the Pacific Northwest. We also look at the emissions from prescribed burns in Washington, Montana and Idaho. Fires from prescribed burns are spatially very small and hence not usually captured by satellite (Tsao et. al., 2011). Since NARA project will use wooden biomass from forest resources and hence avoid emissions from slash burns, it will help in improving the air quality during those months. The regional air quality modeling system, called AIRPACT-4, is used for this analysis.

Objectives

- To modify the existing AIRPACT-4 emission inventory to omit wood/pulp/paper processing facilities (Figure 1)
- To assess the impact of wood/pulp/paper industry on summertime ozone, particulate matter ($PM_{2.5}$) and air toxics (formaldehyde) for a base case with all emissions and for a case without wood processing emissions.
- To investigate the spatio-temporal distributions of prescribed burn activities in the states of ID, MT and WA

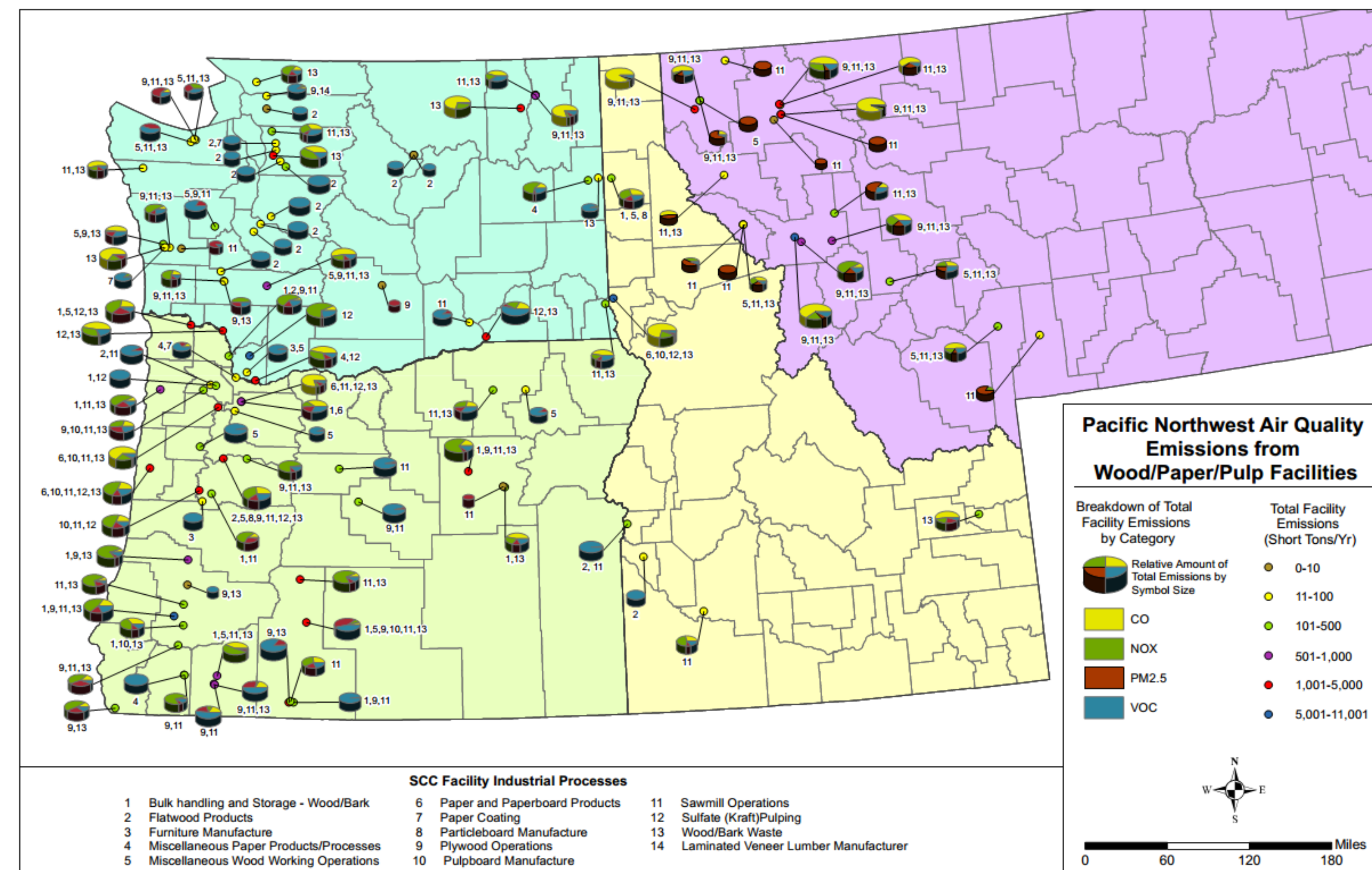


Figure 1: Wood/pulp/paper processing facilities in the Pacific Northwest

Methodology

- The WSU Laboratory for Atmospheric Research provides daily air quality forecasts for criteria pollutants for the Pacific Northwest using the AIRPACT-4 system (Figure 2)
- An ozone episode which occurred during June 26 – July 4, 2013 was simulated
- Model simulations were carried 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 Canada
- Data for slash and prescribed burns is provided by the Department of Ecology for Washington and Airshed Management Group for Idaho and Montana

Conclusions & Future Work

- Wood/pulp/paper facility emissions impacts on concentrations of $PM_{2.5}$ and formaldehyde are modest and contribute only near the point sources considered in this study.
- Concentration difference maps show that contributions to ozone could be 10-15 ppb for some hotspots, but in general the contribution is small (<5 ppb).
- Ozone concentration difference maps show that ozone contributions from the wood industry emissions cover a greater area compared to the areas affected by $PM_{2.5}$ and formaldehyde.
- Most of the prescribed and slash burn activities take place in the months of September – November. Particulate emissions from these burns are significantly higher than wood industry, and can severely impact the local air quality

Future Research will include:

- Modeling of supply chain emissions scenarios as well as various process related emissions developed through life cycle analysis and ASPEN process modeling in the NARA project.
- Impact of prescribed burns on the local air quality will be studied by including prescribed fires and slash burns in the AIRPACT-4 system

AIRPACT-4 Air Quality Modeling Framework

- A WRF-SMOKE-CMAQ based modeling system: WRF - Weather Research and Forecasting model, SMOKE - Sparse Matrix Operating Kernel for emissions, and CMAQ - Community Multi-scale Air Quality model for pollutant fate and transport (Figure 2)
- Boundary conditions from the MOZART-4 global chemistry model
- Biogenic emissions from the MEGAN model
- Wild fires were not present during the period of simulation
- Detailed regional emissions compiled by the Department of Ecology (WA), Divisions of Environment Quality in Idaho & Oregon
- AIRPACT website: www.lar.wsu.edu/airpact

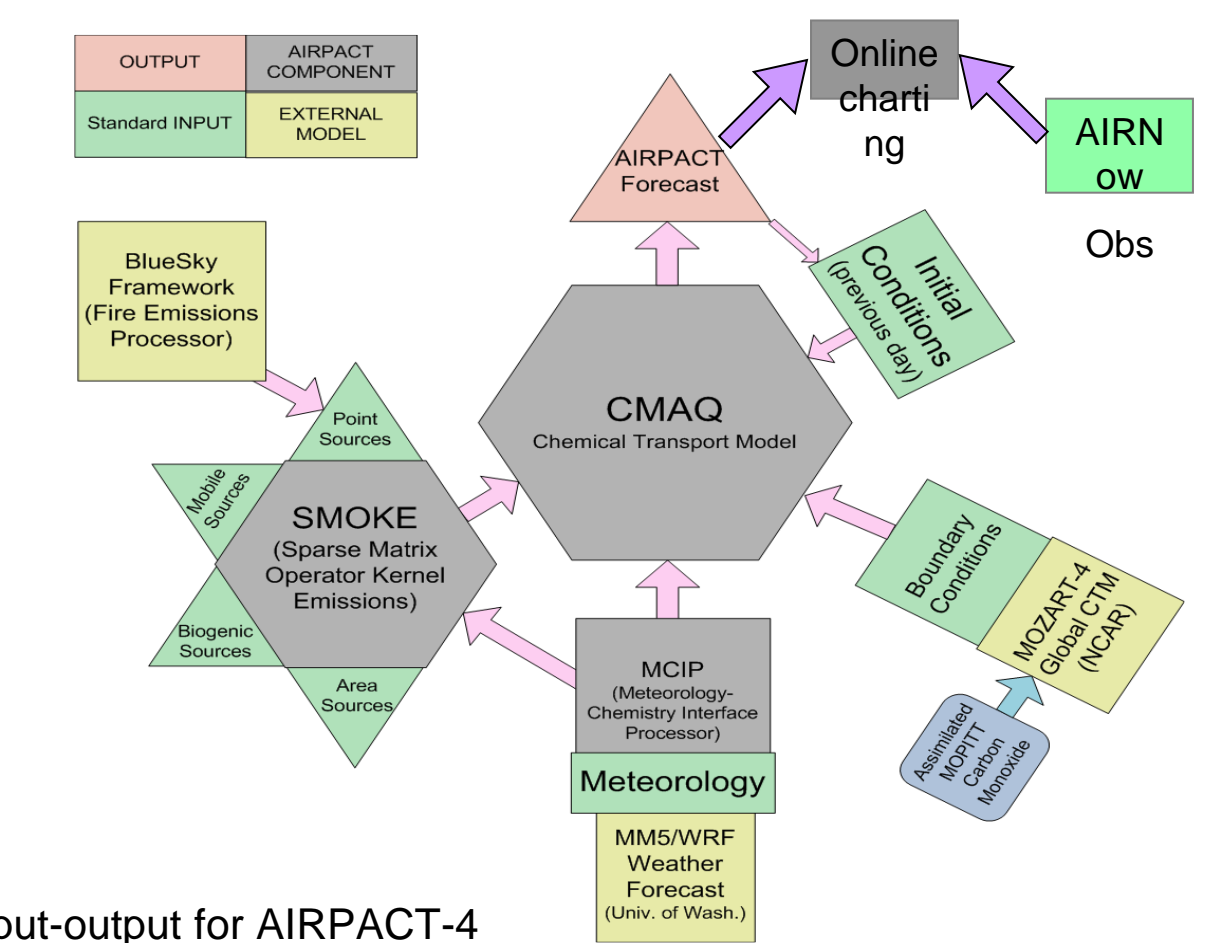
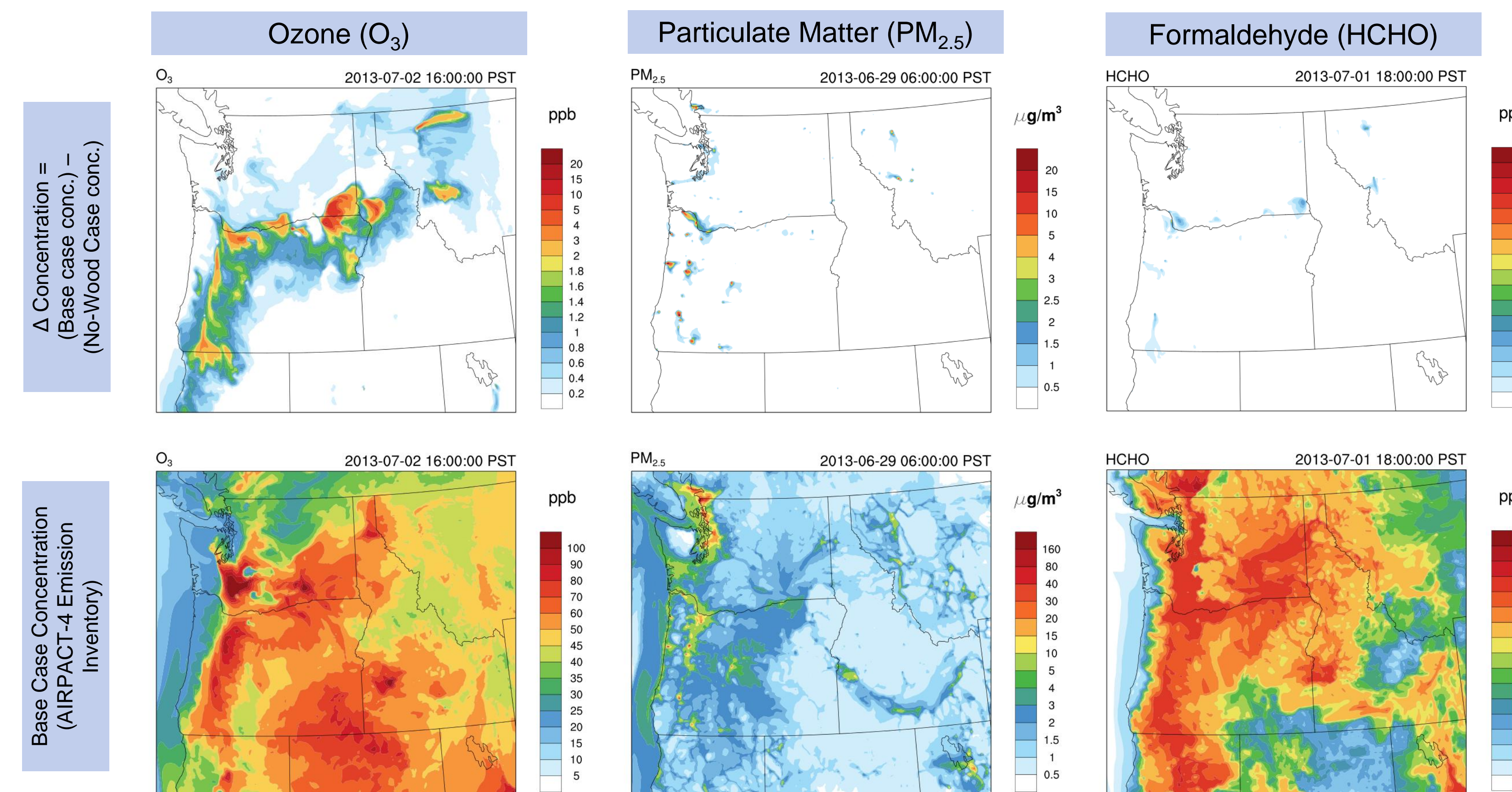
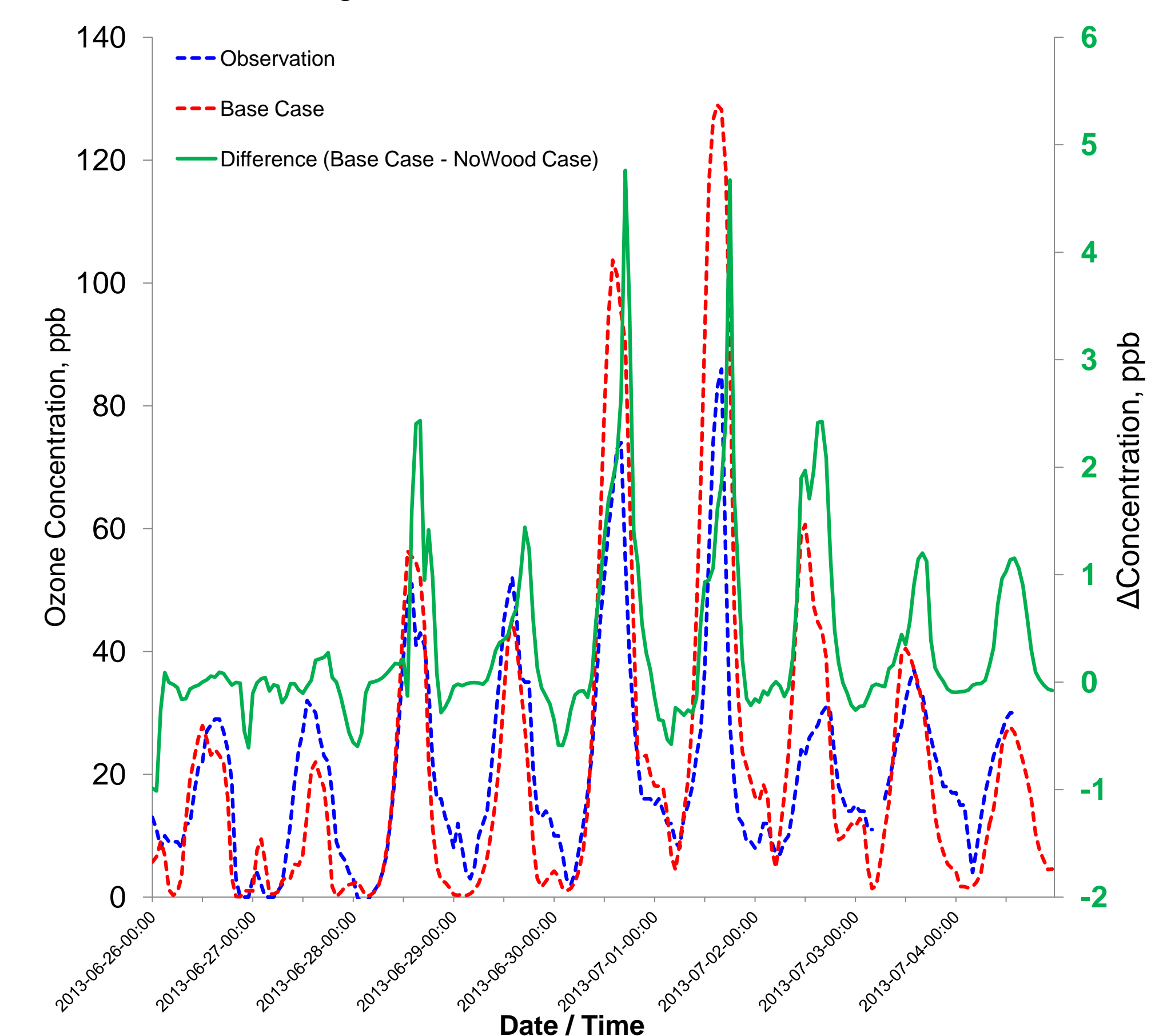


Figure 2: Various components and input-output for AIRPACT-4

Wood Industry Impact Analysis: Surface Concentration Snapshot



O₃: Trend for Lafayette, OR



Emission Comparison: wood industry vs. slash burn

Pollutant	Total Emission (Tons / year)		
	2011 (WA)*	2011 (ID&MT)**	Wood Industry
PM ₁₀	1768	16942	2126
PM _{2.5}	1524	14756	1826
NO _x	430	4372	9058
VOCs	547	4918	5670
CO	10092	87444	11535

* Slash only ** (prescribed + slash)

Prescribed forest fires and slash burns consume close to 2.5 millions tons (200,000 tons in Washington and 2.3 million tons in Idaho and Montana) of wooden biomass. Most of the burn activities take place in the months of September – October (figure 3). Prescribed and slash burns can significantly contribute (upto 30%) to $PM_{2.5}$ loadings in certain areas for some months of the year (Achtemeier et. al., 2011). Since particulate emissions from slash burn exceed current wood industry emissions by several times, it is important to understand possible impacts of slash burn on local air quality

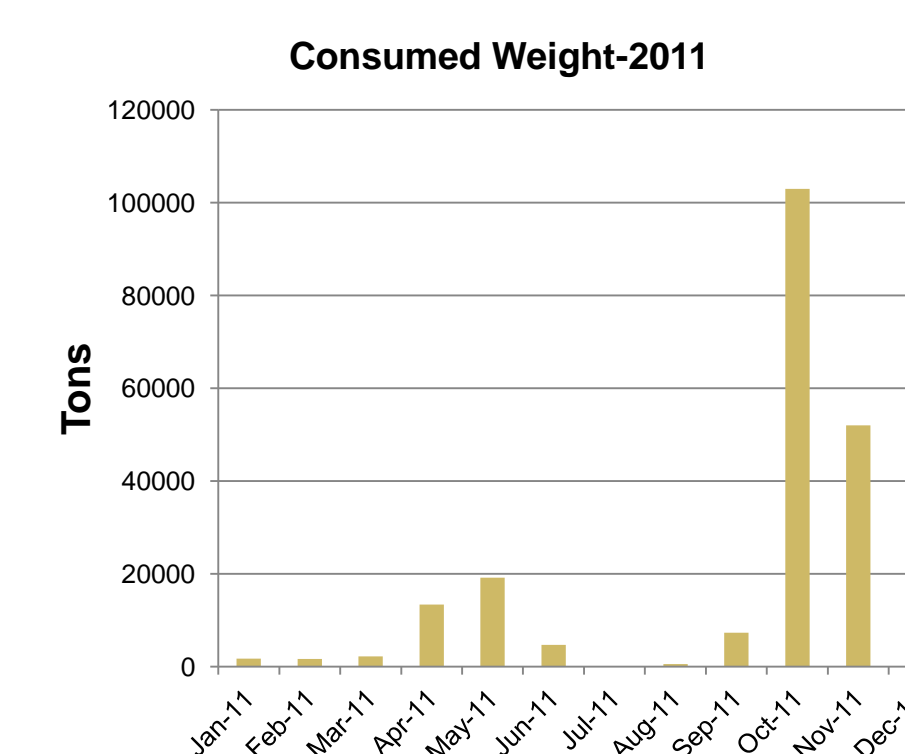
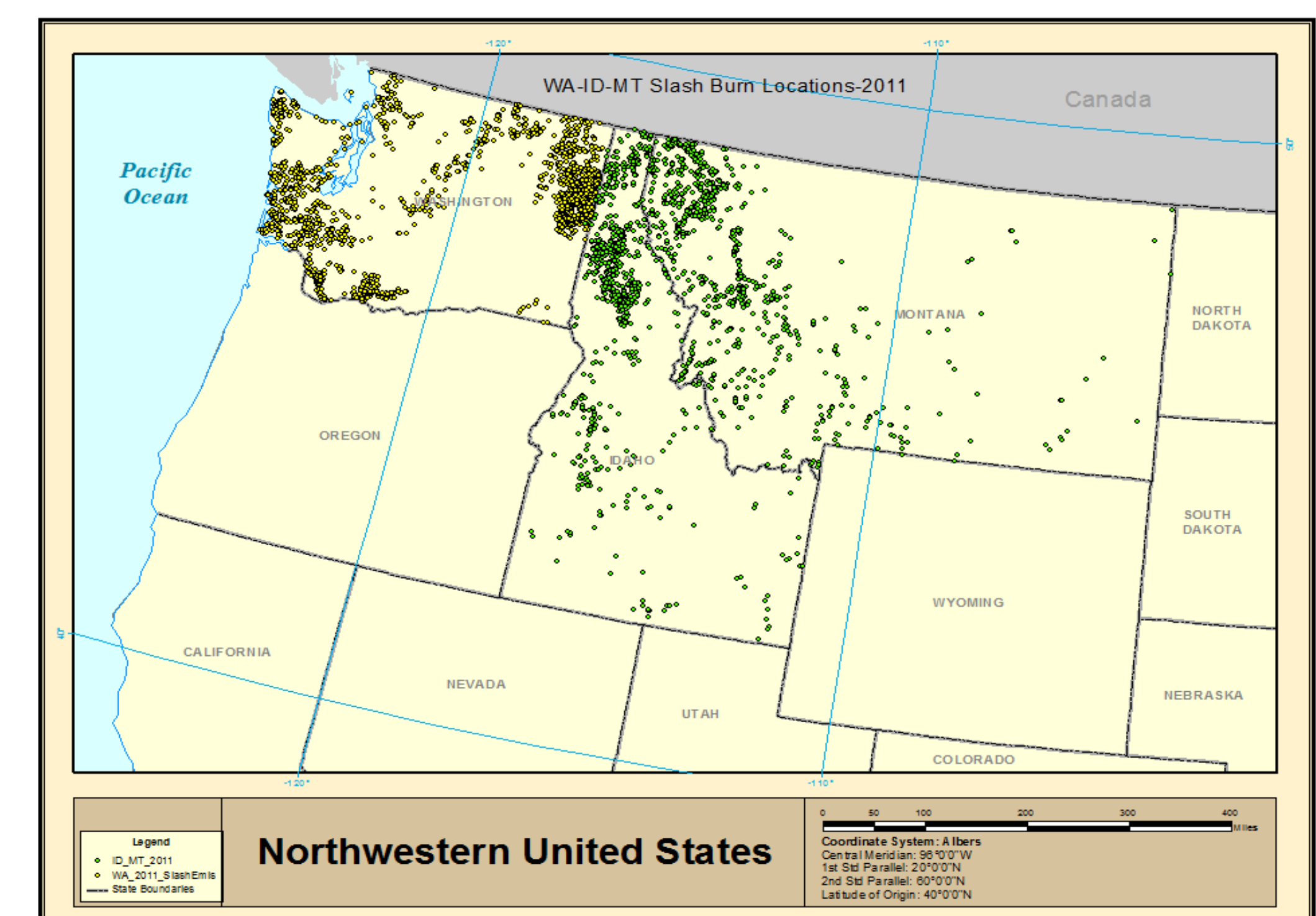


Figure 3: Left: Annual distribution of prescribed burns Right: Spatial distribution of burn events in WA, MT and ID



References

- Achtemeier et. al., Modeling smoke plume rise and dispersion from Southern United States, Atmosphere, 2011, 2, 358-388
- Tsao et al., Increased estimated of air pollution emissions from Brazilian sugarcane ethanol, 2011, Nature Climate Change, 2, 53-57

Acknowledgement

We would like to thank the Washington Department of Ecology and the Airshed Management Group for providing the annual emission data for the states of Washington, Idaho and Montana.

NARA

Northwest Advanced Renewables Alliance

NARA is led by Washington State University and supported by Agriculture and Food Research Initiative Competitive Grant from the USDA National Institute of Food and Agriculture