

**2013 EPA
AgSmoke Project**

Robert Elleman, EPA Region 10 *2013 NW-AIRQUEST Meeting*

2013 EPA AgSmoke Project

- **Measure smoke from agricultural field burning to help Airpact-4 smoke tracer**
- **Modest study with modest expectations**
 - **Need to target effort to highest payoff for model**
- **Partner with Nez Perce Reservation, Washington-Ecology, Idaho DEQ, and WSU**
- **EPA Contacts**

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EPA-ORD Instrumented Balloon

- CO_2
 - CO
 - temperature
 - GPS
 - 3D wind velocity
 - black carbon
 - $\text{PM}_{2.5}$
- batch sampling of
 - VOCs
 - SVOCs
 - PM_{10} and $\text{PM}_{2.5}$
 - Cl species
 - PM-borne metals
 - organic matter



Build on Studies From Mid-2000s



AIR SCIENCES INC.

FINAL REPORT:

CEREAL-GRAIN RESIDUE
OPEN-FIELD BURNING
EMISSIONS STUDY

QUANTIFYING POST-HARVEST EMISSIONS FROM BLUEGRASS SEED PRODUCTION FIELD BURNING

MARCH 2004

GRASS SEED CROPPING SYSTEMS FOR A SUSTAINABLE AGRICULTURE

WASHINGTON STATE DEPARTMENT OF ECOLOGY

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

ENVIRONMENTAL PROTECTION AGENCY REGION 10

WASHINGTON TURFGRASS SEED COMMISSION

COEUR D'ALENE TRIBE

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In collaboration with:

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Missoula, MT



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Development of the ClearSky smoke dispersion forecast system
for agricultural field burning in the Pacific Northwest

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Particulate emissions from wheat and Kentucky bluegrass
stubble burning in eastern Washington and northern Idaho

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Build on Studies from mid-2000s

Table 2
ClearSky hybrid source plume rise parameters

	Parameter value
<i>Buoyant area source (smoldering fraction)</i>	
Effective height of emissions (m)	0.5
Source temperature (K)	324
Effective exit velocity (m s^{-1})	1.4
Initial vertical spread (m)	100
<i>Buoyant line source (flaming fraction)</i>	
Line height (m)	0.5
Source temperature (K)	361
Line width (along wind) (m)	5
Effective exit velocity (m s^{-1})	2.2

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emission factor for wheat stubble, for a heading fire, was taken as $3.6 \text{ g PM}_{2.5} \text{ kg}^{-1} \text{ fuel}$ (7.2 lb ton^{-1}) or 0.36% of the residue load; and the emission factor for KBG was taken to be $30 \text{ g PM}_{2.5} \text{ kg}^{-1} \text{ fuel}$ (66 lb ton^{-1}) or 3.3% (Air Sciences Inc., 2003 and Johnston and Golob, 2004). The ratio between the

Based upon the Air Sciences results, plume rise parameters were selected for the flame front (buoyant line source) and smoldering (buoyant area source) portions of the burn as given in Table 2. The initial line width and flame height were assumed from qualitative observations of burning fields.

Based on information provided by the burn coordinators, the rate of field burn was set to 100 acres per hour and applied uniformly to all regions.

The crop residue burned in Washington is primarily wheat stubble and the crop residue burned in northern Idaho is primarily KBG. The $\text{PM}_{2.5}$

flaming and smoldering emissions was assumed to be 80:20. An estimated residue load of 6919 kg ha^{-1} ($2.8 \text{ tons acre}^{-1}$) was used for calculating the emissions.

To evaluate the hybrid source approach used in ClearSky, a modest field campaign was completed during the summer/fall burn season in 2004. The focus of the campaign was to collect plume rise measurements from agricultural field burns and then compare those plume rise measurements to the plume rise predicted in ClearSky.

Plume heights were measured during nine field burns over four days of the 2004 agricultural burn season. The dates for the plume height measurement campaign included July 30, August 20, September 8, and September 29, 2004. Four wheat stubble field

ClearSky Burn Scenario Input Form

Enter information into the fields below for submission to ClearSky:

— STEP 1 —
Click map to get coordinates.
To remove a point, click it again.
Latitude: _____
Longitude: _____

— STEP 2 —
Field burn information.
Enter Acreage: 200
Field burn rate (acres/hr): 200 (integer)
Crop Type: Wheat Bluegrass
Fuel loading (tons/acre): 4 (integer)
Start burn: 10 am 12 Pacific Daylight Time
[Enter] [Clear Form] [Reset All]

Click "Enter" to see your selection in the table below. Additional burn sites may be added by completing Steps 1 and 2 again before continuing to Step 3.

— STEP 3 —
Specify runtime and output domain.
Select run date: 20100326 (yyyymmdd)
Select output domain: Washington (state wide)

— STEP 4 —
User information.
Your email: _____
Affiliation: IDEQ Couer d'Alene

[RUN CLEARSKY!]

Burn Area	Latitude	Longitude	Acreage	Burn Rate	Crop Type	Fuel Load	StartBurn
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Size and Location | Fuels | Moisture | Consumption | Timing | Emissions | Notes

Use Fuels From
 FCCS Fuelbed #60 From Map
 FCCS Fuelbeds
 LANDFIRE Fuel Loading Models
 Custom Fuel Loading

Fuel Loading Results
 1-hr: 0 tons/acre
 10-hr: 0 tons/acre
 100-hr: 0 tons/acre
 1,000-hr: 0 tons/acre
 10,000-hr: 0 tons/acre
 >10,000-hr: 0 tons/acre
 Total Sound Woody
 Duff Depth

Canopy: 0 tons/acre
 Shrubs: 0.34 tons/acre
 Grasses: 0.11 tons/acre

Welcome to BlueSky Playground!
 Use BlueSky Playground to model your fires, estimate pollutant emissions, and predict downwind smoke concentrations.
 • To get started, create one or more *emissions scenarios* to model your fires. You simply specify the size, type, and location of the fires; then you can choose to accept defaults or you can modify specific details about fuel loading, moisture, etc. After creating an emissions scenario, you can generate a map of the fire(s) to generate a map of the fire(s).

Consumption Model
 Consume 3
 Canopy Consumed: 0 %

Consumption Results
 Flaming: 0.62 tons/acre
 Smoldering: 0.00 tons/acre
 Residual: 0.00 tons/acre
 Total: 0.62 tons/acre

View Existing Dispersion Scenarios

View Totals Average Fuels & Emissions per Acre

Category	Value (tons/acre)
Fuel	~0.5
Consumed	~0.5
GHGs	~1.5
PM2.5	~0.5
PM10	~0.5

Edit Emissions Info
 Name: ag burn (shared)
 Notes:
 Last Modified: 03/12/2013, 11:32:31 AM

View Totals Average Fuels & Emissions per Acre

Category	Value (tons/acre)
Fuel	~0.5
Consumed	~0.5
GHGs	~1.5
PM2.5	~0.5
PM10	~0.5

Diurnal Profile of % Total Consumption Day 1

Hour (local time)	Flaming (%)	Smoldering and Residual (%)
0	0	0
8	0	0
10	~5	~1
12	~10	~1
14	~10	~1
16	~5	~1
18	0	0
20	0	0

CH₄: 1.39 tons
 NO_x: 0.76 tons
 VOCs: 6.40 tons
 NH₃: 0.44 tons
 SO₂: 0.32 tons
 Heat: 87.83 BTU/ft²

Discard Changes Apply

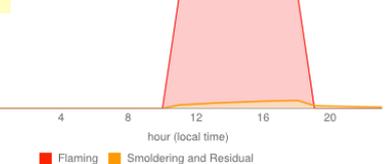
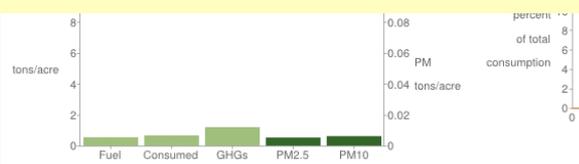
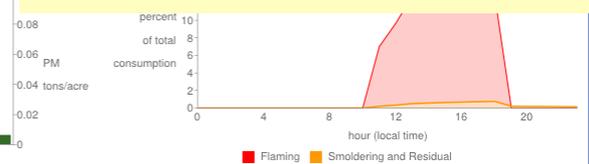
Discard Changes Apply

Inputs to BlueSky Emissions Tool

- Area Burned
- Location
- Fuel Type
- Fuel Loading
- Fuel Moisture
- Consumption

– Flaming, smoldering, and residual

➔ Emissions



Study Overview

- **Measure smoke emissions with instrumented balloon and with ground samplers**
- **Seven measurement days during 2013 fall burning season in 1-2 major locations**
- **Ability to sample multiple nearby burns in a day**
- **Try to capture variability in fuel loading, meteorology, crop type, and fuel moisture**
- **Results to be used in Airpact-4 smoke tracer**

Ag Burn Outlook Forecast Criteria

MM5 4-km output 11:00 AM – 4:00 PM	Units	Red no burn	Yellow marginal	Green burn OK
Average Surface Wind Speed	m/s	> 8	5 – 8	< 5
	MPH	> 18	11 - 18	< 11
Average Transport Wind Speed	m/s	< 2	2 – 4	> 4
	MPH	< 4.5	4.5 - 9	< 9
Maximum Mixing Height	m	< 1000	1000 – 1400	> 1400
	feet	< 3300	3300 - 4600	> 4600
Minimum Ventilation Index	m²/s	< 2350	2350 – 4700	> 4700