Appendix A. Background Ozone in the Idaho Region

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Background Ozone in the Idaho Region

The purpose of this report is to summarize the information available to characterize the background ozone in Idaho and the surrounding region. The background ozone is discussed in terms of the Maximum Daily Averaged 8-Hour (MDA8) ozone concentration "Design Value". The Design Value (DV) is defined as the 4th highest MDA8 for each year averaged over 3 years. For this analysis, the Design Value period is 2009 – 2011 because the background analysis used in the Pacific Northwest is based on modeling and data for that period. This DV metric is the focus of this discussion because it is the form of the EPA's National Ambient Air Quality Standard (NAAQS) for ozone and is used to determine compliance with the Clean Air Act. To put the background ozone into context, the current standard is a 3-year MDA8 DV of 75 parts per billion (ppb), and Idaho's Program Concentration Limit (PCL) for ceasing all crop residue burning activity is set at 75% of the NAAQS or 56 ppb for the MDA8 ozone. A new NAAQS is anticipated from EPA soon and is expected to be 70 ppb or lower, so the 75% PCL will then be 52 ppb or lower. To fully characterize the background ozone, this overview will summarize the current best estimates of the regional background ozone as measured at monitoring stations. Then the sources of the background ozone will be examined, based on recent national-level modeling studies. For this purpose, we will define three types of background:

- Natural Background (NB) – ozone formed from natural sources of ozone (O_3) and ozone precursor emissions nitrogen oxides (NOx) and volatile organic carbon compounds (VOCs) in the complete absence of global man-made emissions.
- North American Background (NAB)– ozone formed by precursors originating from human caused sources in all countries outside North America and from all the natural background sources. NAB excludes ozone precursors from all human activity in North America. It represents all the ozone that cannot be influenced by North American emission control regulations and therefore is often referred to as "Policy Relevant Background" (PRB).
- Regional Background (RB) - the actual background ozone level determined by monitoring in the Pacific Northwest, and by model-estimated values used to fill in the areas between the sparse monitoring network.

This overview focuses on the Regional Background (RB), but a brief look at the NB and NAB is included to aid in understanding how much of the RB is contributed by natural sources and by global human contributions in addition to "local" North American sources. It should be noted that the regional background is based on monitored values, and monitor-adjusted model results, while the NAB and NB can only be estimated using models.

Regional Background

The best picture presently available for the regional background ozone in the Pacific Northwest is provided in a map developed by the NW-AIRQUEST regional Air Quality science consortium using 2009-2011 monitored "design values" (DVs) and AIRPACT3 regional model outputs archived for the same period, as shown in Figure 1 (NW_AIRQUEST 2013). The model results fill in concentrations between the

monitors, and are adjusted so that the modeled values match the monitored values at those locations. As discussed above, the ozone DVs shown numerically in Figure 1 represent actual measured 3-year averages of the MDA8 recorded at the indicated fixed monitoring sites, while the color contours between the markers represent modeled values in unmonitored areas adjusted to fit the measurements at the monitor locations.

The regional background pattern reflected in Figure 1 shows that ozone is lower toward the north and northwest and higher toward the southeast corner of the region and around urban areas. The relative amount of sunshine and afternoon temperatures influence this overall pattern, as well as higher elevations and higher VOC and NOx precursor source emissions most likely originating from the oil and gas fields in southwest Wyoming and the Salt Lake City/Wasatch Front urban emissions. Precursor emissions from cities and power plants in California and northern Nevada may also contribute.

The agricultural (non-urban) areas in northern-most Idaho (Bonner and Boundary Counties) and northern Washington have background MDA8 design values around 55ppb, similar to those at Cheeka Peak, the "cleanest" low elevation site, located at the western tip of the Olympic Peninsula. In central Idaho, most of the rural areas from Sandpoint to Grangeville have a background MDA8 design value around 56 – 60 ppb. The agricultural areas in Southern Idaho, away from any cities, have design values mostly in the 61 – 65 ppb range, typified by the Craters of the Moon National Monument site (CMNM) which has an MDA8 design value of 61 ppb. The larger urban areas in the region cause elevated ozone downwind of their city centers in the 66 to 72 ppb range, however the "downtown" urban centers themselves typically show a depressed ozone level (45 ppb in Seattle, 57 pb in Portland, 56 ppb in Spokane, 63 ppb in Boise and 61 ppb in Logan Utah) resulting from the removal of ozone by reaction with the concentrated mobile source nitric oxide (NO) emissions in high traffic areas.

Ozone also increases with elevation due to the influence of stratospheric intrusion and free tropospheric transport from Asia, both of which increase in the spring. The ozone DV at rural sites in Idaho is highly correlated with elevation (R^2= 0.91), increasing 1.3 ppb for every 1000 ft increase in elevation.

The typical seasonal pattern in the MDA8 ozone values over the last 4 years (for CMNM) can be seen in Figure 2. During the spring and summer, many of the days are above the CRB Program Concentration Limit (PCL) of 56 ppb, while in the fall and winter, the MDA8 never exceeds 50 ppb.

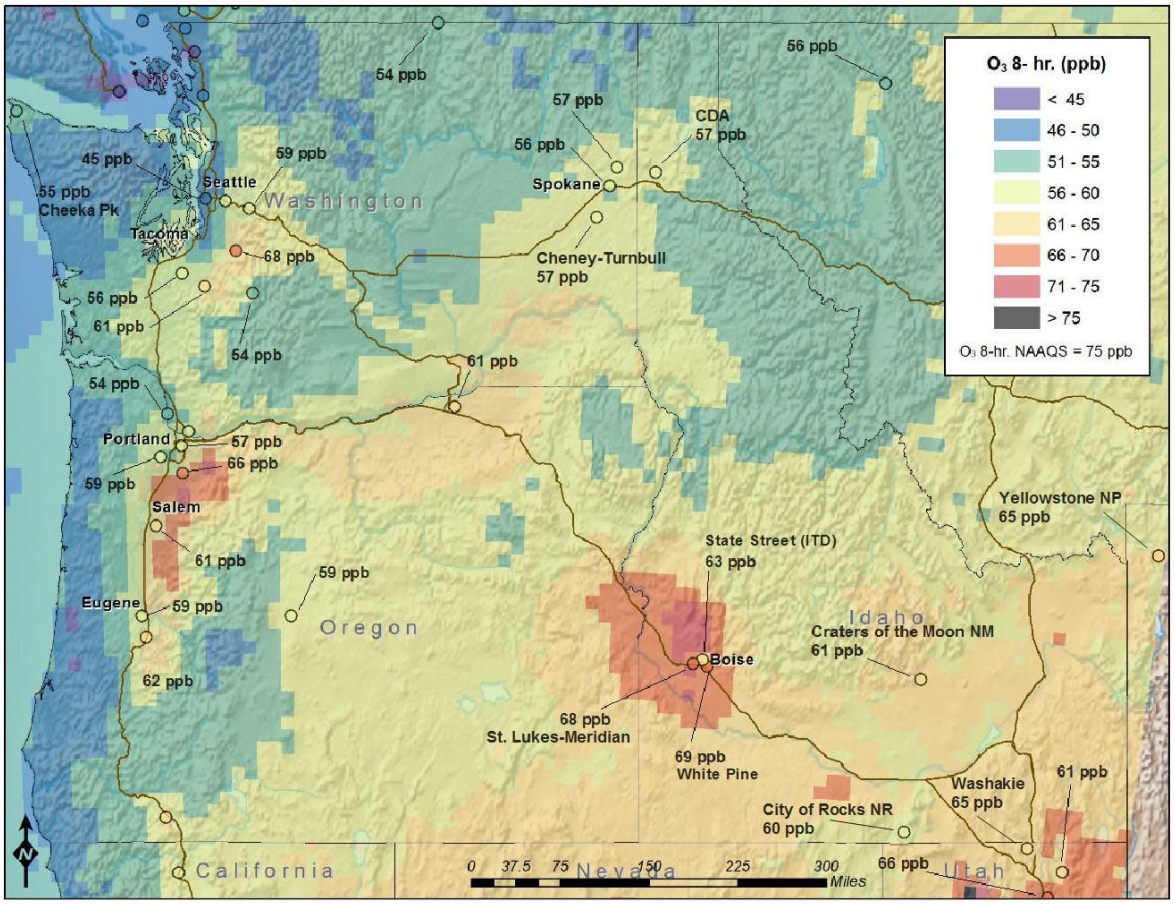

Figure 1 Regional Background Maximum Daily Average 8-hour Ozone Design Values at monitors and AIRPACT3 Model (colored grid cells), 2009 - 2011. NW-AIRQUEST (2013)

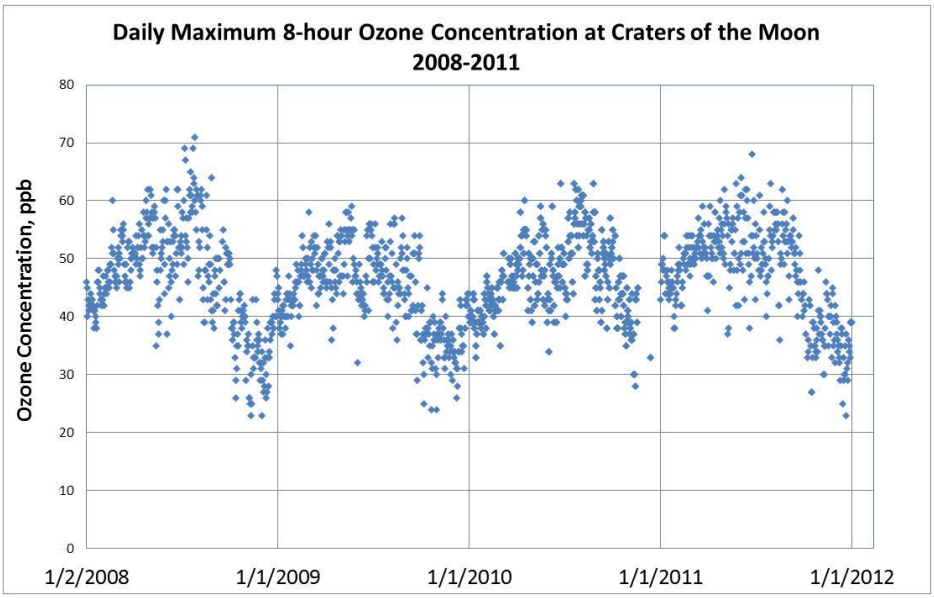

Figure 2 Daily maximum 8-hour ozone concentration at Craters of the Moon National Monument, 2008-2011. Data from USEPA (2014).

North American Background (NAB)

The North American Background is often referred to as the "Policy-Relevant Background" (PRB) because it represents the background ozone that USEPA regulations cannot influence. On the other hand, the difference between the NAB and the actual Regional Background (RB) concentrations represents the portion of the ozone that can potentially be influenced by USEPA regulations to limit human health risk. As a result, several major studies (Zhang 2011, McDonald-Buller 2011, and Emery et al 2012) have focused on the NAB (i.e. PRB) to inform EPA's deliberations on setting a new ozone standard. The latest of these studies, and perhaps the most accurate due to the higher resolution of the model used, is the study of Emery et. al. (2012). Emery found that excluding wildfires, the NAB is 40 – 50 ppb in northern Idaho and low-elevation portions of the Treasure Valley and Magic Valley while it is 50 – 60 ppb in the rest of southern Idaho.

Natural Background (NB)

The models used to show the NAB can also be used to show the case in which all man-made emissions are removed from the global inventory, and methane levels are returned to levels believed to be present prior to the industrial revolution, essentially the natural levels that existed "before man". This modeling scenario reflects totally natural conditions, only including sources such as biological sources, lightning (NOx emissions), naturally caused wildfires and stratospheric intrusion of ozone into the troposphere. The Natural Background (NB) was estimated (Zhang et. al. 2011) to average 9 ppb lower than the NAB at western low-altitude sites and 13 ppb lower at "high altitude" sites (>1500m). Thus, if the NAB at CMNM (a high altitude site) is approximately 55 ppb, the average contribution at this site from the natural background, would be 13 ppb less or approximately 42 ppb. Therefore at CMNM where the monitored design value is 61 ppb the Natural Background contributes approximately 69% of the regional background, the North American human activity (~6 ppb) contributes approximately 10%, and trans-oceanic emissions (with anthropogenic methane) contribute around 21%.

Source Origin Contributions to the Regional Background

Rough approximations of the NAB, NB and local North American source origins are represented in Figure 3 too show DEQ's best estimates of source origins. These contributions are very approximate because they are derived from different models reported in different studies and simulating different model years. The relative magnitude of the NB, NAB, and local human emissions can be found in Figure 3, however, due to the approximate nature of this chart, as discussed above, graph values should not be formally cited or quoted.

Future Trends

The "free tropospheric" ozone over western North America (i.e. generally free of North American urban/industrial emissions) increased 29% in the period 1984 – 2011 measured at relatively remote western locations (Cooper, 2013). In addition, Cooper (2013) reports that over the central portion of that period, (1990 – 2005) Asian NOx emissions increased 103%, while North American and European emissions declined. Since the trend in Asian emissions is projected to continue growing as the Chinese economy expands, we may expect the rural western ozone to increase also, particularly in the spring when transport from Asia is facilitated by the global weather patterns (Cooper, 2013). On the other

hand, DEQ expects the urban ozone contributions, such as those in the Treasure Valley to decline somewhat as a result of lower emission standards for new cars that are entering the fleet each year and local vehicle emissions testing programs in Ada and Canyon County.

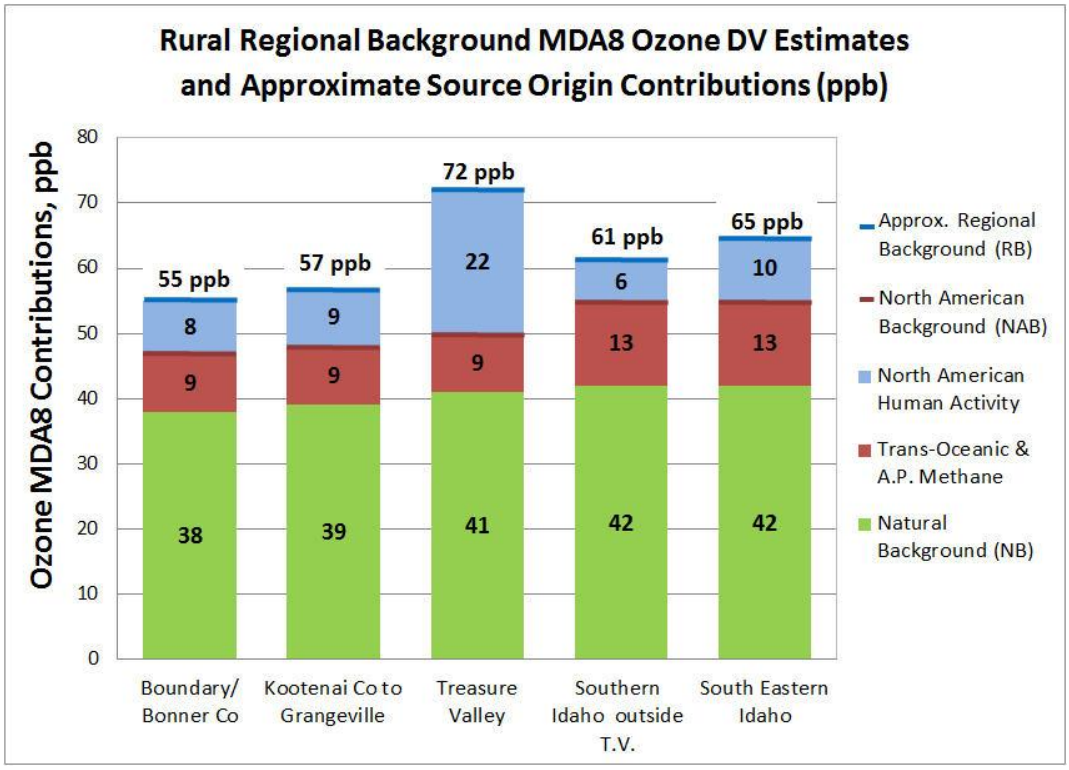

Figure 3 Regional Background Maximum Daily Average 8-Hour (MDA8) ozone Design Values and approximate origin contributions in agricultural areas of Idaho based on rough interpolation of Figure 1 (NW-AIRQUEST, 2013) and North American Background (Emery et. al., 2012) as well as Natural Background (NB) estimates (Zhang et. al., 2011). Note, "A.P. Methane" in legend is "Anthropogenic Methane" (man-caused), part of the global emissions in NAB that is not part of the Natural Background (NB). The NB contribution includes only natural NOx, VOC and methane sources (bottom green-shaded bar). North American Background (NAB) includes all emissions below the dark red line (= NB + Trans-Oceanic + A.P. Methane); Regional Background values include the entire bar (dark blue line), adding North American human-produced emissions to the NAB. Caution: Values shown are rough approximations from multiple studies for illustrative purposes only and should not be cited or quoted.

Summary

This overview summarizes the regional background ozone levels in and around Idaho. In addition, results from "Policy Relevant Background" studies carried out by EPA are provided to show approximately how much of the ozone in Idaho comes from local human-caused (North American) sources, from human activity on other continents, primarily Asia, and from strictly natural sources.

The source origins contributing to these regional background concentrations may be only roughly approximated since different models are used and rough interpolation from the referenced studies (Emery, 2012 and Zhang, 2011) is inexact, however for several locations throughout the Idaho region, we may generally estimate that:

- the natural background may contribute around 55 – 70%
- trans-oceanic transport (plus anthropogenic or human caused methane) contributes around 10 to 20%, and appears to be increasing in importance, primarily in the spring.
- North American human activity, including local urban emissions contributes around 10 – 31% and is expected to slowly decline in importance, at least near cities where traffic is the primary source of precursors.

To support current CRB operations, the rural ozone for Kootenai County is best represented by the Greenbluff site north of Spokane (DV=57 ppb), while rural areas of north-central Idaho from Benewah County to Grangeville appear to best represented by Washington's Cheney-Turnbull monitor in the rural Palouse area southwest of Spokane (DV = 57 ppb). The Treasure Valley rural areas are best represented by the St. Luke's, Meridian monitor (DV = 68 ppb) and most of the rest of southern Idaho is best typified by the ozone values at Craters of the Moon NM (DV = 61 ppb, although lower elevation areas may be slighly lower and more populated areas such as Twin Falls, or higher elevations may be slightly higher.) Finally, the southeast corner of rural Idaho near the Utah border is best reflected by the Washakie site in Utah where the DV is 65 ppb, and high elevation sites in the northeast corner may be best represented by the Yellowstone site where the DV is also 65 ppb. See Figure 1 for site locations. DVs discussed above reflect the period 2009 – 2011.

References

Cooper, Owen R, 2013. *Global surface ozone trends, a synthesis of recently published findings*, NOAA GMD Global Monitoring Annual Conference, May 21-22, 20132, Boulder, Colorado.

Emery, C., Jung, J., Downey, N., Johnson, J., Jimenez, M., Yarwood, G., and Morris, R., 2012. *Regional and global modeling estimates of policy relevant background ozone over the United States*, **Atmos. Environ**., 47, 206–217.

McDonald-Buller, E. C., Allen, D. T., Brown, N., Jacob, D. J., Jaffe, D., Kolb, C. E., Lefohn, A. S., Oltmans, S., Parrish, D. D., Yarwood, G., and Zhang, L., 2011. *Establishing Policy Relevant Background (PRB) ozone concentrations in the United States*, **Environ. Sci. Technol**., 45, 9484–9497.

NW-AIRQUEST 2013. *Lookup 2009-2011 design values of criteria pollutants. 2013.* Source: http://lar.wsu.edu/nw-airquest/docs/3state_bg_conc_maps_methodology.pdf

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Zhang, L., Jacob, D. J., Downey, N. V., Wood, D. A., Blewitt, D., Carouge, C. C., van Donkelaar, A., Jones, D. B. A., Murray, L. T., and Wang, Y., 2011. *Improved estimate of the policy-relevant background ozone in the United States using the GEOS-Chem global model with $1/2° times 2/3° horizontal resolution over North America*, **Atmos. Environ**., 45, 6769–6776.

Appendix B. Rathdrum Prairie Burn Memo and Burn Day Analysis

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Memo

To: **File**

From: R. Paul/ M. Boyle

Date: **08/07/13**

Re: **Burn Day Rathdrum Prairie**

1. Burn Decision Synopsis

After reviewing the forecasted meteorological conditions CRO suggested to make up to 370 acres available for possible burning today. Models were forecasting a southwest/west-southwest winds in the afternoon. Soil moisture was checked on 8/7 in the afternoon and appeared to be in the 35-40% range (soil feel & appearance method). Finally, school is not yet in session which will allow a slightly larger "smoke trajectory" path. Burn time was identified as 12-4pm based on forecasted temperatures. The proposed burns were discussed by phone with the North Idaho Burn Coordinator at between 8:30 – 9:00am. Actual on-site conditions will be determining factor prior to igniting the field.

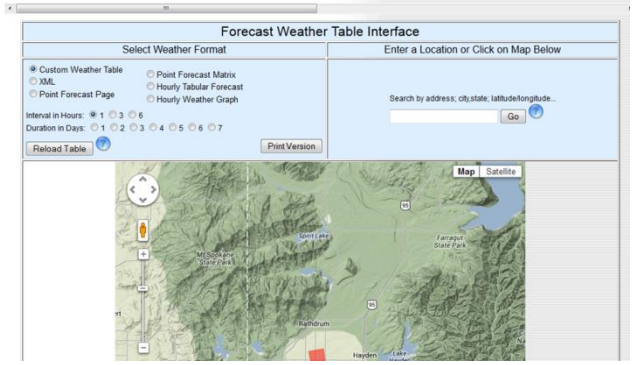
2. Met and AQ Data Review

a. Spot Forecast

Forecast Created at: 8am PDT Aug 7, 2013

Custom Weather Forecast Table

Wed Aug 07																								
Weather																								
Daily-Temp	High 90 Low 58																							
Chance of Precip	0%						0%						0%						0%					
Precip	0.00"						0.00"						0.00"						0.00"					
12-hr Snow Total	0"												0"											
FRET	0.20"																							
1-Hour	5am	6am	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	Mdnt	1am	2am	3am	4am	5am
Temp	58	59	62	65	69	73	76	78	81	82	85	89	90	89	88	83	76	70	66	63	60	59	58	58	57
Cloudiness	4%	4%	4%	4%	4%	4%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	23%	23%	23%	23%	23%	23%	30%
Dewpoint	51	53	54	55	56	56	57	55	55	52	50	48	44	44	47	49	51	50	50	49	49	48	49	49	48
Relative Humdity	78%	79%	75%	70%	63%	55%	51%	44%	40%	35%	30%	24%	20%	21%	24%	30%	41%	49%	56%	60%	65%	66%	71%	72%	71%
Wind	NE 5	NE 5	NE 5	SE 3	SE 3	SE 3	SW 5	SW 5	SW 5	W 10	W 10	W 10	W 7	W 7	W 7	SW 2	SW 2	SW 2	S 2	S 2	S 2	SE 2	SE 2	SE 2	E 3
Snow Level (ft)	12020	12020	12020	12020	12020	12020	12293	12293	12293	12293	12293	12293	12857	12857	12857	12857	12857	12857	12834	12834	12834	12834	12834	12834	12526



b. Pseudo Soundings

Morning Forecasting for Kootenai

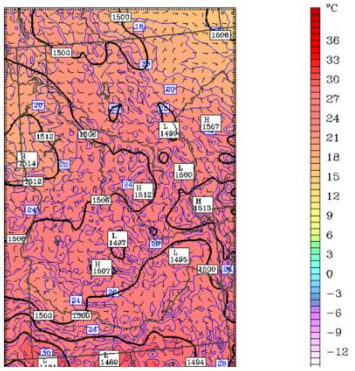
Model Resolution:	1.3km			Model Run:	2013080700				SiteID:	KCOE		Name:	COUER D'ALENE, ID
Date		Time in PDT											Comments
8/7/2013		10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	
Vent. Index		P	P	M	G	G	G	G	G	G	NP	NP	NP	G: >4700, M: (2350 - 4700]
G: good, M: marginal, P: poor, NP: very poor		1599	1810	3202	6741	8397	9758	>9999	>9999	9275	108	158	60	P: (235 - 2350], NP: <=235
Surface (20m) Winds	Direction	SSE	WSW	WSW	WSW	WSW	WSW	SW	SW	W	W	WSW	WSW	Orange text for surface wind speed: >=12 mph and <=15 mph
	Speed (mph)	5.8	4.4	6.4	10.2	11.2	10.6	11.6	10.8	9.6	4.0	4.3	5.2	
Surface (20m) Temperature (degree F)		76.0	78.9	80.9	82.7	83.6	84.5	85.2	85.2	85.0	82.5	79.6	75.1	Red text for surface wind speed: > 15 mph
Surface (20m) Relative Humidity (%)		34.7	31.6	29.2	24.1	24.2	22.4	21.3	21.2	20.7	28.6	30.8	35.6	
Planetary Boundary Layer (PBL)	Height (feet)	2041	3015	3648	4849	5512	6752	7940	7940	7077	197	269	85	Height is above model terrain surface
	Direction	SW	SW	SW	WSW	WSW	WSW	W	W	W	W	W	WSW	
	Speed (mph)	6.0	10.0	10.0	13.3	13.9	15.5	15.0	14.5	12.8	6.3	7.0	5.2	5 kts = 5.75 mph
700mb (~10,000 ft MSL)	Height (feet)	7432	7432	7432	7432	7432	7432	7432	7432	7432	7432	7432	7432	Height is above model terrain surface
	Direction	WSW	WSW	WSW	WSW	WSW	WSW	W	W	W	W	WNW	WNW	
	Speed (mph)	17.5	17.4	18.1	18.3	17.0	16.2	15.0	14.5	12.8	8.9	7.3	6.1	10 kts = 11.5 mph
850mb (~5,000 ft MSL)	Height (feet)	2544	2544	2544	2544	2544	2544	2544	2544	2544	2544	2544	2544	Height is above model terrain surface
	Direction	SW	SSW	SW	WSW	WSW	WSW	WSW	WSW	W	W	WNW	W	
	Speed (mph)	9.8	5.3	6.7	10.0	12.8	12.9	13.8	13.5	13.0	13.1	11.3	12.2	15 kts = 17.25 mph

Morning Forecasting for Kootenai

Model Resolution:	1.3km			Model Run:	2013080700				SiteID:	KOTX		Name:	SPOKANE, WA
Date		Time in PDT											Comments
8/7/2013		10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM	
Vent. Index		P	P	M	G	G	G	G	G	G	NP	P	P	G: >4700, M: (2350 - 4700]
G: good, M: marginal, P: poor, NP: very poor		1242	1882	3743	7908	>9999	>9999	>9999	>9999	5653	147	404	647	P: (235 - 2350], NP: <=235
Surface (20m) Winds	Direction	SSW	SW	SW	SW	WSW	W	WSW	WSW	WSW	WSW	SW	SW	Orange text for surface wind speed: >=12 mph and <=15 mph
	Speed (mph)	6.1	6.5	8.1	9.9	11.3	10.7	12.5	10.7	11.0	6.1	8.1	11.1	
Surface (20m) Temperature (degree F)		74.4	78.0	80.5	83.2	84.5	85.2	85.2	85.0	84.5	82.1	78.2	74.8	Red text for surface wind speed: > 15 mph
Surface (20m) Relative Humidity (%)		39.4	33.1	29.7	23.7	20.0	20.4	15.8	16.9	14.0	21.3	26.4	31.7	
Planetary Boundary Layer (PBL)	Height (feet)	1493	2129	3399	5869	7398	8173	7192	6916	3783	177	364	430	Height is above model terrain surface
	Direction	WSW	WSW	W	WSW	WSW	W	WSW	W	W	WSW	WSW	WSW	
	Speed (mph)	6.8	7.0	13.9	14.9	14.1	12.0	10.7	11.0	11.4	10.0	12.3	17.3	5 kts = 5.75 mph
700mb (~10,000 ft MSL)	Height (feet)	7431	7431	7431	7431	7431	7431	7431	7431	7431	7431	7431	7431	Height is above model terrain surface
	Direction	WSW	WSW	WSW	WSW	WSW	WSW	WSW	W	WNW	WNW	NNW	N	
	Speed (mph)	17.1	16.8	16.1	16.2	14.1	12.3	10.7	11.0	7.7	8.3	8.3	7.1	10 kts = 11.5 mph
850mb (~5,000 ft MSL)	Height (feet)	2543	2543	2543	2543	2543	2543	2543	2543	2543	2543	2543	2543	Height is above model terrain surface
	Direction	W	W	WSW	WSW	WSW	WSW	WSW	WSW	W	W	W	W	
	Speed (mph)	10.4	10.1	9.5	11.5	13.3	13.6	14.4	13.6	12.3	12.2	11.0	10.6	15 kts = 17.25 mph

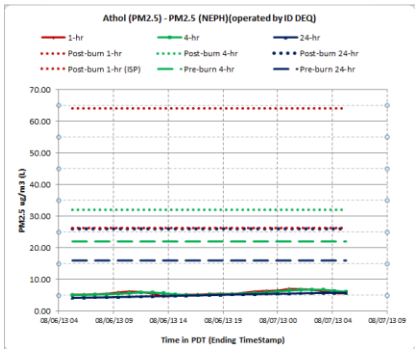
c. Weather Model

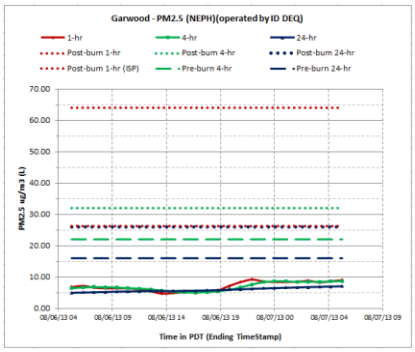
UW WRF-GFS 4km Domain Init: 12 UTC Wed 07 Aug 13
Fcst: 9 h Valid: 21 UTC Wed 07 Aug 13 (14 PDT Wed 07 Aug 13)
Temperature at 850mb (°C)
Geopotential Height and Wind at 850mb (m and full barb = 10kts)

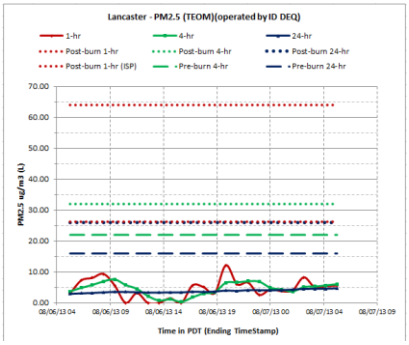


d. Air Quality Data

i. DEQ


Athol (PM2.5) - PM2.5 (NEPH)(operated by ID DEQ)
1-hr
4-hr
24-hr
Post-burn 1-hr
Post-burn 4-hr
Post-burn 24-hr
Post-burn 1-hr (ISP)
Pre-burn 4-hr
Pre-burn 24-hr
PM2.5 ug/m3 (L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
08/06/13 04
08/06/13 09
08/06/13 14
08/06/13 19
08/07/13 00
08/07/13 04
08/07/13 09
Time in PDT (Ending TimeStamp)


Garwood - PM2.5 (NEPH)(operated by ID DEQ)
1-hr
4-hr
24-hr
Post-burn 1-hr
Post-burn 4-hr
Post-burn 24-hr
Post-burn 1-hr (ISP)
Pre-burn 4-hr
Pre-burn 24-hr
PM2.5 ug/m3 (L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
08/06/13 04
08/06/13 09
08/06/13 14
08/06/13 19
08/07/13 00
08/07/13 04
08/07/13 09
Time in PDT (Ending TimeStamp)


Lancaster - PM2.5 (TEOM)(operated by ID DEQ)
1-hr
4-hr
24-hr
Post-burn 1-hr
Post-burn 4-hr
Post-burn 24-hr
Post-burn 1-hr (ISP)
Pre-burn 4-hr
Pre-burn 24-hr
PM2.5 ug/m3 (L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
08/06/13 04
08/06/13 09
08/06/13 14
08/06/13 19
08/07/13 00
08/07/13 04
08/07/13 09
Time in PDT (Ending TimeStamp)

ii. WDOE Ozone Data:

Site:Spokane-Greenbluff -		
Date	Time	O3
		ppm
8/6/2013	12:00 AM	0.028
8/6/2013	1:00 AM	0.028
8/6/2013	2:00 AM	
8/6/2013	3:00 AM	0.025
8/6/2013	4:00 AM	0.025
8/6/2013	5:00 AM	0.017
8/6/2013	6:00 AM	0.02
8/6/2013	7:00 AM	0.019
8/6/2013	8:00 AM	0.024
8/6/2013	9:00 AM	0.031
8/6/2013	10:00 AM	0.038
8/6/2013	11:00 AM	0.046
8/6/2013	12:00 PM	0.049
8/6/2013	1:00 PM	0.051
8/6/2013	2:00 PM	0.058
8/6/2013	3:00 PM	0.059
8/6/2013	4:00 PM	0.06
8/6/2013	5:00 PM	0.057
8/6/2013	6:00 PM	0.041
8/6/2013	7:00 PM	0.043
8/6/2013	8:00 PM	0.046
8/6/2013	9:00 PM	0.047
8/6/2013	10:00 PM	0.047
8/6/2013	11:00 PM	0.042
8/7/2013	12:00 AM	0.045
8/7/2013	1:00 AM	0.042
8/7/2013	2:00 AM	0.037
8/7/2013	3:00 AM	0.035
8/7/2013	4:00 AM	0.03
8/7/2013	5:00 AM	0.025
8/7/2013	6:00 AM	0.022
8/7/2013	7:00 AM	0.028
8/7/2013	8:00 AM	0.035
Minimum		0.017
MinDate		6-Aug

3. Expected Conditions

Wind direction and temp forecasted for today should aid in proper smoke management. Forecast for a westerly component with winds should help to limit ground smoke up the trench towards Garwood, etc. Will launch a pibal balloon to confirm transport winds.

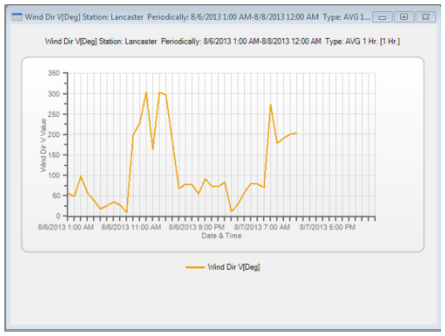
4. Burn window

a. Pre-Ignition Temperature/Weather Data

Weather Conditions for:
Coeur d'Alene, Coeur d'Alene Air Terminal, ID (KCOE)
Elev. 2350 ft, Latitude: 47.77667, Longitude: -116.8167

Most Recent Observation: Wed, 07 Aug 2013 21:53 PDT (0453 GMT)
Current Time: Wed, 07 Aug 2013 21:57 PDT (0457 GMT)

Time (PDT)	Temp (F)	Dew Point (F)	Wind Direction (mph)	Wind Speed (mph)	Wind Gust (mph)	Visibility (miles)	Clouds	Weather	Altimeter (inches)	Sea Level Pressure (inches)	Relative Humidity %	Heat Index (F)	Windchill (F)	Wind Chill (F)	Comments
07 Aug 01:17 PDT	85	54	16	WSW	0	10.00	CLR		30.00	1015.5					OK
07 Aug 01:55 PDT	85	54	16	W	3	10.00	CLR		30.00	1014.7					OK
07 Aug 02:55 PDT	85	54	16	S	3	2.00	CLR		30.00	1014.7					OK
07 Aug 03:55 PDT	84	54	15	S	3	10.00	CLR		30.01	1015.0					OK
07 Aug 04:55 PDT	84	54	15	S	3	10.00	CLR		30.01	1015.0					OK
07 Aug 05:55 PDT	84	54	16	E	3	2.00	CLR		30.01	1015.0					OK
07 Aug 06:55 PDT	84	54	15	SSE	0	10.00	CLR		30.00	1015.0					OK
07 Aug 07:55 PDT	84	54	15	CALM		10.00	CLR		30.00	1015.0	42	88			OK



Pibal Sounding 07 Aug 13

Layer Number	Azimuth	Elevation	Top of Layer	Layer Avg Wind	Avg Wind, Sfc. to Layer
1	032.0	36.0	700	212/11	212/11
2	031.0	34.0	1350	210/12	211/11
3	032.0	39.0	2000	216/05	212/09
4	029.0	41.0	2630	196/07	209/09
5	043.0	43.0	3250	276/10	223/08
6	056.0	42.0	3850	278/13	236/08
7	048.0	39.0	4430	202/16	228/09
8	061.0	35.0	5350	269/30	241/11
9	062.0	33.0	5600	250/11	242/11
10					
11					
12					
13					
14					
15					

b. Communications/Observations

12:13 Ralph contacted me and provided the pibal field info. I entered the data into the program and relayed the processed data information to Ralph over the phone.

12:21 I spoke to Melissa over the phone and requested approval for the fields. We also discussed wind direction requirements for the two fields and I verbally relayed the current pibal data.

12:23 I e-mailed pibal information to Gary, Melissa, and Brian. Melissa and I discussed current wind direction per pibal info

Aprox 12:25 Melissa contacted me and told me fields were “approved”.

12:30 Spoke to Brian over the phone gave him OK to proceed.

1:10 Brian contacted me and updated me on the progress and also sent a photo (below). The picture depicted good columnar lift occurring. Brian reported that the smoke was behaving as expected at this time. Brian reported that there was a delay in the initial lighting because the growers water truck broke down momentarily. Once they got it running they commenced ignition. Initial ignition was reported to begin at ~12:45.

1:46 Brian called to report fire was just about out. Reported some ground smoke odor north along highway 95 per last communication with Ralph. Transport smoke was going well to the east there was a good amount of smoke but it appeared it was

staying aloft well. Brian mentioned that there was some fire activity erupting and would get back to me. I reported to Brian that the last airport reading at 1:35 indicated a SE wind.

2:00 I looked at NWS CDA airport data again, wind had returned to SW

c. Weather Data

Weather Conditions for:

Coeur d'Alene, Coeur d'Alene Air Terminal, ID (KCOE)

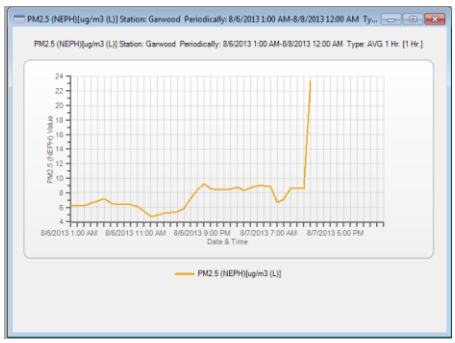
Elev: 2320 ft; Latitude: 47.76667; Longitude: -116.81667

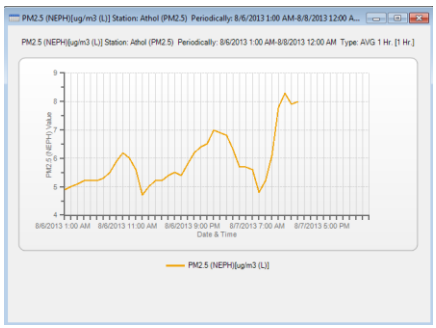
Current time: Wed, 07 Aug 1:58 pm (PDT)

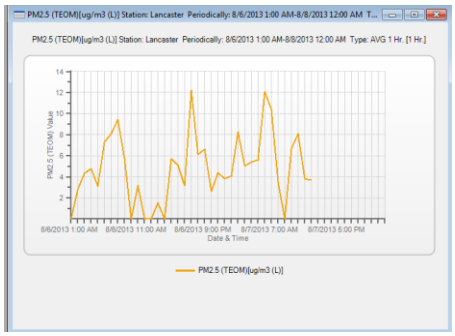
Most Recent Observation: Wed, 07 Aug 1:55 pm PDT (PDT)

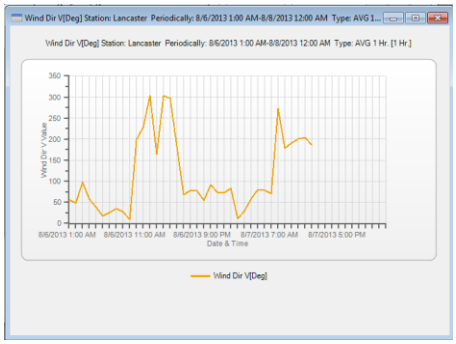
Time (PDT)	Temp. (f)	Dew Point (f)	Relative Humidity (%)	Wind Direction	Wind Speed (mph)	Visibility (miles)	WX	Clouds	Altimeter Setting (inches)	Station Pressure (inches)	6 Hr Max Temp	6 Hr Min Temp	24 Hr Max Temp	24 Hr Min Temp	Quality Control
07 Aug 1:55 pm PDT	84	52	33	SSW	6	10.00		CLR	29.94	27.522					OK
07 Aug 1:35 pm PDT	84	54	35	SE	5	9.00		CLR	29.95	27.532					OK
07 Aug 1:15 pm PDT	82	54	37	SW	6	10.00		CLR	29.95	27.532					OK
07 Aug 12:55 pm PDT	82	54	37	W	3	10.00		CLR	29.96	27.541					OK
07 Aug 12:35 pm PDT	82	54	37	S	3	5.00		CLR	29.96	27.541					OK
07 Aug 12:15 pm PDT	81	54	39	S	3	10.00		CLR	29.97	27.550					OK
07 Aug 11:55 am PDT	79	54	42	S	5	10.00		CLR	29.97	27.550					OK
07 Aug 11:35 am PDT	79	52	39	E	3	3.00		CLR	29.97	27.550					OK
07 Aug 11:15 am PDT	79	54	42	SSE	6	10.00		CLR	29.98	27.560					OK

2:04 Ralph and Brian called to ask about any complaints so far today. I reported non had come in. I also reported the last hour data from Athol (8ug) and Garwood (23ug). Garwood data indicates it received some surface smoke. Athol did not record impact yet. Ralph didn't expect it would because his observations indicated smoke was to the east of highway 95 but there was some areas of odor on 95.

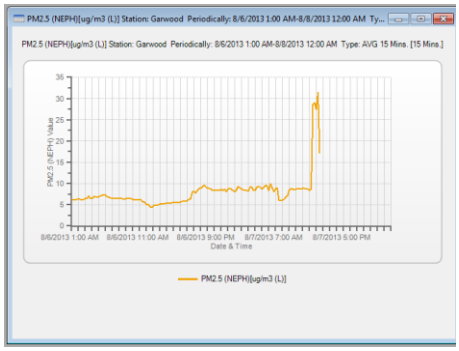








2:31 I polled Garwood Neph and noted AQ appeared to be clearing out. The last 15 min average was 17ug.



2:34 Ralph called to report ignition was commencing on the 220 acre field. Igniting NE corner now, really good flames and going well already. Ralph indicated the pre-approval winds as SW @ 6 mph.

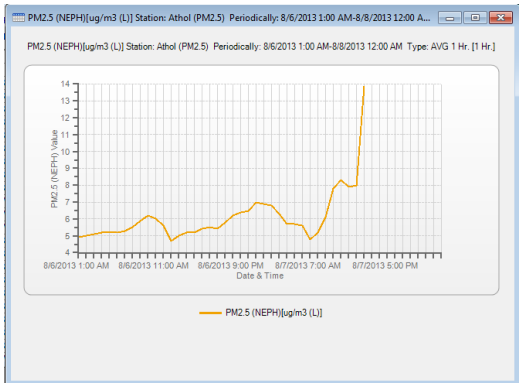
2:48 Brian called to report fire had jumped Huetter Rd and was burning wheat field near the SE corner of the KBG field.

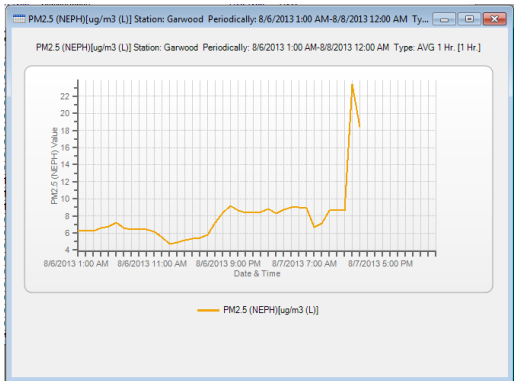
3:04 Brian called and reported wheat field was being attacked and would likely burn to the pivot area then burn itself out if it gets that far. Grass field is continuing to be ignited. It is burning fairly quickly and getting good lift and good column formation at this time. Brian commented that there were a lot of observers along the sides of the road and near Karleens field. Brian suggested to some of them that he was near that they get out of the way. I reported that ground smoke had reached the Athol area and the Garwood monitor had since cleared.

Weather Conditions for:
Coeur d'Alene, Coeur d'Alene Air Terminal, ID (KCOE)
Elev: 2320 ft; Latitude: 47.76667; Longitude: -116.81667

Current time: Wed, 07 Aug 3:09 pm (PDT)
Most Recent Observation: Wed, 07 Aug 2:55 pm PDT (PDT)

Time (PDT)	Temp. (f)	Dew Point (f)	Relative Humidity (%)	Wind Direction	Wind Speed (mph)	Visibility (miles)	WX	Clouds	Altimeter Setting (inches)	Station Pressure (inches)	6 Hr Max Temp	6 Hr Min Temp	24 Hr Max Temp	24 Hr Min Temp	Quality Control
07 Aug 2:55 pm PDT	88	50	27	S	5	10.00		CLR	29.93	27.513					OK
07 Aug 2:35 pm PDT	88	52	29	W	6	9.00		CLR	29.93	27.513					OK
07 Aug 2:15 pm PDT	86	52	31	CALM		10.00		CLR	29.94	27.522					OK
07 Aug 1:55 pm PDT	84	52	33	SSW	6	10.00		CLR	29.94	27.522					OK
07 Aug 1:35 pm PDT	84	54	35	SE	5	9.00		CLR	29.95	27.532					OK
07 Aug 1:15 pm PDT	82	54	37	SW	6	10.00		CLR	29.95	27.532					OK
07 Aug 12:55 pm PDT	82	54	37	W	3	10.00		CLR	29.96	27.541					OK
07 Aug 12:35 pm PDT	82	54	37	S	3	5.00		CLR	29.96	27.541					OK





3:22 Ralph called to update. Reported a nice column, maybe reaching up to 4000' max. there was very little ground smoke at this time smoke looking good, pretty sure everything was lit now. The wheat field was now out.

3:30 I reported to CRB group PM conference call about Rathdrum burns today.

Weather Conditions for:
Coeur d'Alene, Coeur d'Alene Air Terminal, ID (KCOE)
Elev: 2320 ft; Latitude: 47.76667; Longitude: -116.81667

Current time: Wed, 07 Aug 3:50 pm (PDT)
Most Recent Observation: Wed, 07 Aug 3:35 pm PDT (PDT)

Time (PDT)	Temp. (f)	Dew Point (f)	Relative Humidity (%)	Wind Direction	Wind Speed (mph)	Visibility (miles)	WX	Clouds	Altimeter Setting (inches)	Station Pressure (inches)	6 Hr Max Temp	6 Hr Min Temp	24 Hr Max Temp	24 Hr Min Temp	Quality Control
07 Aug 3:35 pm PDT	90	45	21	W	7	9.00		FEW060	29.91	27.494					OK
07 Aug 3:15 pm PDT	88	48	26	S	5	10.00		CLR	29.92	27.503					OK
07 Aug 2:55 pm PDT	88	50	27	S	5	10.00		CLR	29.93	27.513					OK
07 Aug 2:35 pm PDT	88	52	29	W	6	9.00		CLR	29.93	27.513					OK

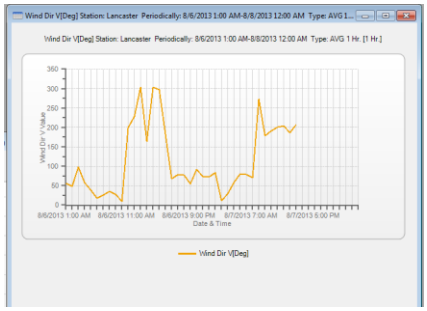
3:39 Brian reported the field was done. No ground smoke left. Looks clear aournd there.

5. Conclusions

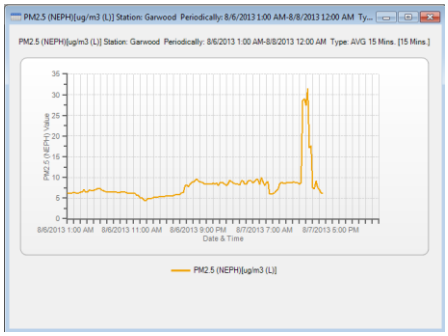
Completed 370 acres today. After the 150 acre field was completed approval was given to complete the 220. At the intitial ignition of the 220 acre field flames were significant. Flames jumped Huetter rd and ignited a wheat field. This delayed completeing the initial ignition of the 220 acres, however, once the crew got back onto the ignition process it went fairly quick. Even with factoring in the delay, the 220 acres went up in just over one hour. Wind direction at the Lancaster monitor indicated roughly a 200 degrees direction through the burn window. NWS airport wind direction reported more variability. Wind speeds were roughly 4 mph. The temperature was slightly higher than expected today. The 220 acre field produced very good lift with top of column reaching over 3000'. Some surface smoke was generated during the 150 acre burn especially near the completion. The 150 acre field appeared to have more residue and therefore more soil moisture which likely contributed to limiting vertical lift of the smoke. Overall, smoke dissipated very well today. No complaints of smoke impacts were received by DEQ however a citizen who lives in Coeur d'Alene near Kathleen Ave, was concerned about the practice of field burning and contacted DEQ.

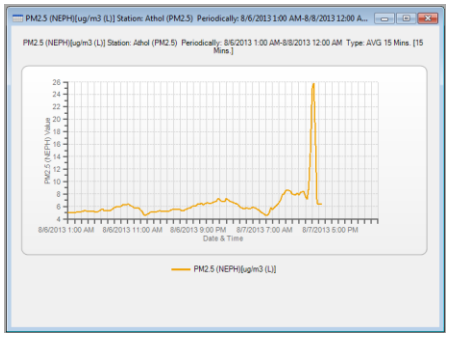
The ambient temperature wind speeds and wind direction aided in good smoke dispersion for this day. The dry fuel condition was also a significant factor.

Equipment problems and escaped fire delayed quicker ignition of the both fields. If these problems could have been avoided, plume rise and reduction of ground smoke (especially for the first field) may have been greatly reduced.



Transitory surface smoke was monitored at Garwood and Athol. The 15 minute averages are depicted below. Hourly concentration maximums were: Athol: 14.0ug/m3, Garwood: 23.4ug/m3.

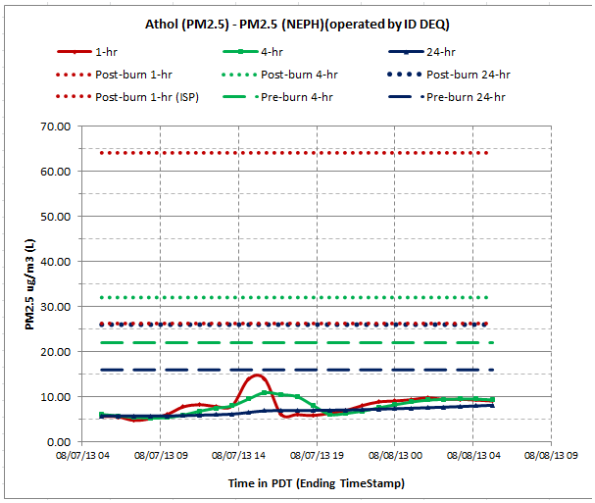


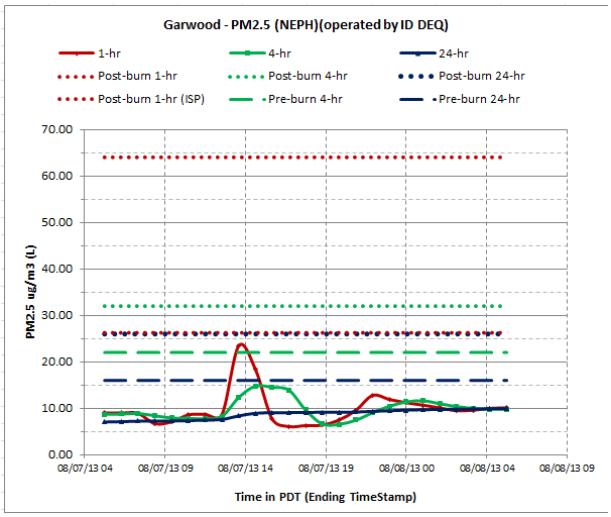


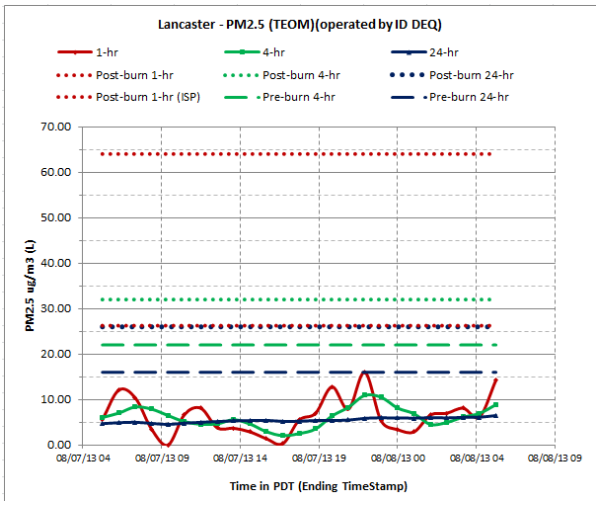
8/8 Data review: Ozone measured at the Greenbluff monitor in Spokane recorded a maximum 8-hour concentration of 0.063ppm for Wednesday 8/7. Based on temperature forecast and data from 8/6 ozone was not expected to exceed 0.056 for more than 6 hours for this burn day. Data on 8/8 revealed 0.057ppm was exceeded for a full 8 hours on this burn day. The AQI for Wednesday 8/7 was 61 which is a Moderate condition.

Site:Spokane-Greenbluff -		
Date	Time	O3
		ppm
8/7/2013	12:00 AM	0.045
8/7/2013	1:00 AM	0.042
8/7/2013	2:00 AM	0.037
8/7/2013	3:00 AM	0.035
8/7/2013	4:00 AM	0.03
8/7/2013	5:00 AM	0.025
8/7/2013	6:00 AM	0.022
8/7/2013	7:00 AM	0.028
8/7/2013	8:00 AM	0.035
8/7/2013	9:00 AM	0.047
8/7/2013	10:00 AM	0.055
8/7/2013	11:00 AM	0.06
8/7/2013	12:00 PM	0.066
8/7/2013	1:00 PM	0.066
8/7/2013	2:00 PM	0.067
8/7/2013	3:00 PM	0.063
8/7/2013	4:00 PM	0.063
8/7/2013	5:00 PM	0.06
8/7/2013	6:00 PM	0.057
8/7/2013	7:00 PM	0.055
8/7/2013	8:00 PM	0.056
8/7/2013	9:00 PM	0.057
8/7/2013	10:00 PM	0.056
8/7/2013	11:00 PM	0.054
8/8/2013	12:00 AM	0.051
8/8/2013	1:00 AM	0.049
8/8/2013	2:00 AM	
8/8/2013	3:00 AM	0.042
8/8/2013	4:00 AM	0.031
8/8/2013	5:00 AM	0.031
8/8/2013	6:00 AM	0.036
8/8/2013	7:00 AM	0.04
8/8/2013	8:00 AM	
Minimum		0.022

The PM2.5 monitors (depicted below) did not record exceedences of any post burn criteria for Wednesday.




Garwood - PM2.5 (NEPH)(operated by ID DEQ)
1-hr
4-hr
24-hr
Post-burn 1-hr
Post-burn 4-hr
Post-burn 24-hr
Post-burn 1-hr (ISP)
Pre-burn 4-hr
Pre-burn 24-hr
PM2.5 ug/m3 (L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
08/07/13 04
08/07/13 09
08/07/13 14
08/07/13 19
08/08/13 00
08/08/13 04
08/08/13 09
Time in PDT (Ending TimeStamp)


Lancaster - PM2.5 (TEOM)(operated by ID DEQ)
1-hr
4-hr
24-hr
Post-burn 1-hr
Post-burn 4-hr
Post-burn 24-hr
Post-burn 1-hr (ISP)
Pre-burn 4-hr
Pre-burn 24-hr
PM2.5 ug/m3 (L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
08/07/13 04
08/07/13 09
08/07/13 14
08/07/13 19
08/08/13 00
08/08/13 04
08/08/13 09
Time in PDT (Ending TimeStamp)

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BURN DAY ANALYSIS FOR THE RATHDRUM PRAIRIE AIR SHED FOR AUGUST 7, 2013.

OBJECTIVE:

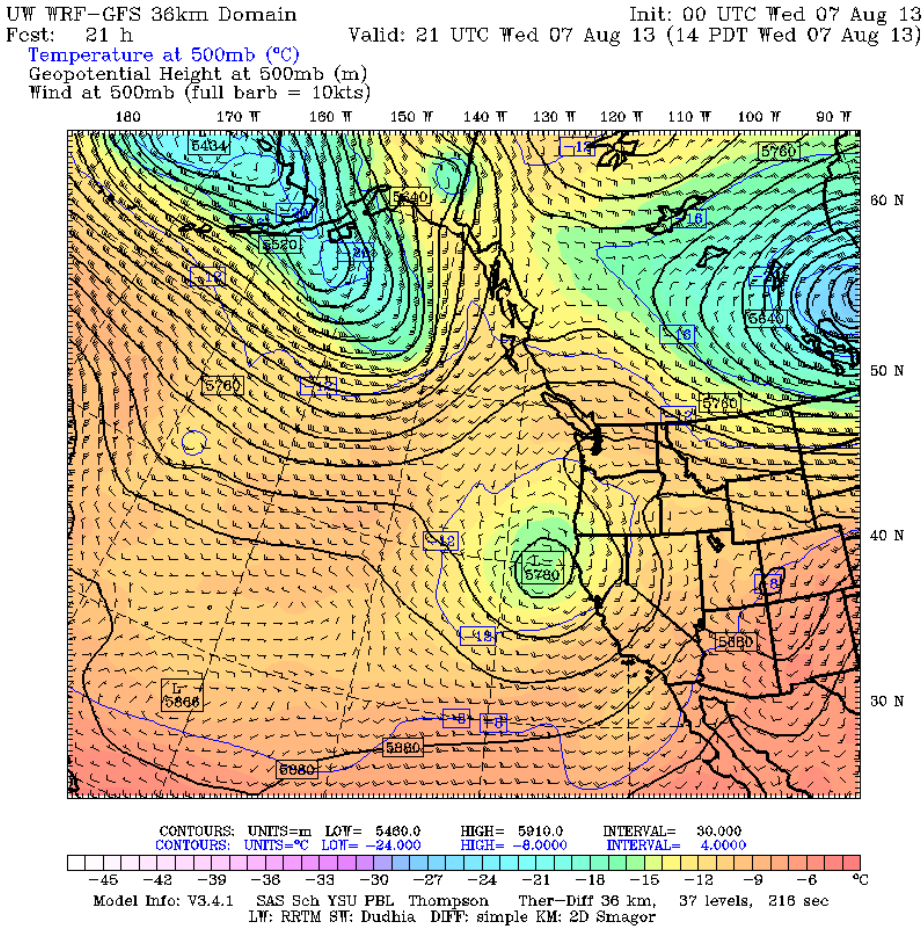
Field burning successfully on the Rathdrum Prairie can be a very eventful task even when the weather parameters that have been established for success are witnessed at the time of ignition. The shape of the Purcell Trench of northern Idaho nearly requires that smoke travel southwest to northeast. This is also the geographical shape of the Purcell Trench.

So the objective for successful Crop Residue Burning on the Rathdrum Prairie, which is in the Purcell Trench, would suggest that smoke should initially travel to the northeast, lift off the ground surface quickly (unstable air), and then disperse into the atmosphere leaving minimal or no smoke near the surface layer.

Analysis of the Rathdrum Prairie Burn of August 7th, 2013.

I order to prepare an analysis like this I will need to start at the upper levels of the atmosphere over northern Idaho. This is called the synoptic level or the steering level for Pacific storms.

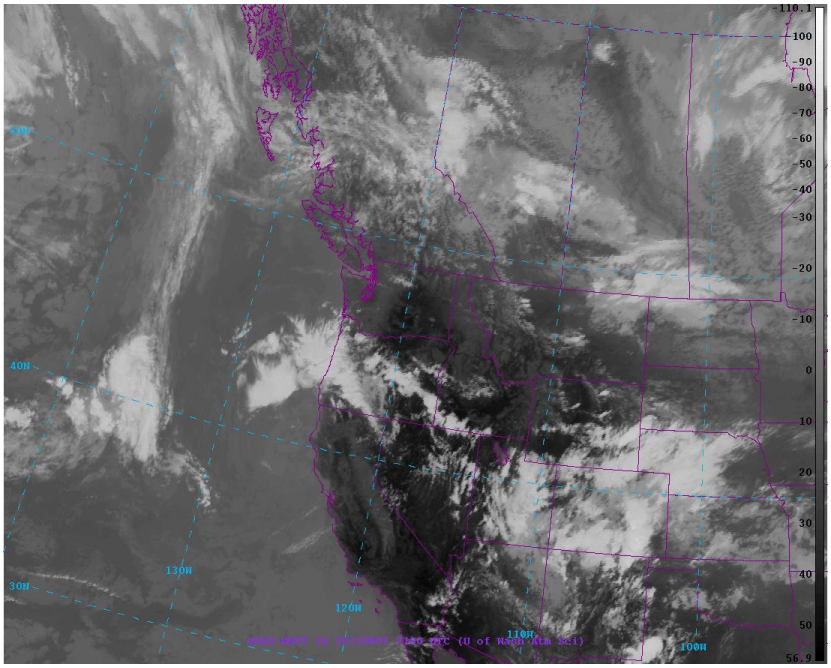
The first graphical chart I will look at is the 500 millibar MM5 forecast graphic. This graphic is on the next page. We have a warm 500 millibar high pressure ridge over the air shed with a northwest wind aloft signaling that the Rathdrum Prairie is on the leading edge of the ridge under a subsiding air mass. The upper level low off the California coast is of no or very little significance with the days burning on the Prairie. This low will become an issue for the region later in the week. The upper level low north of the Dakotas produced precipitation late in the previous week before this burn. It had been dry for 5-6 days prior to the burn.

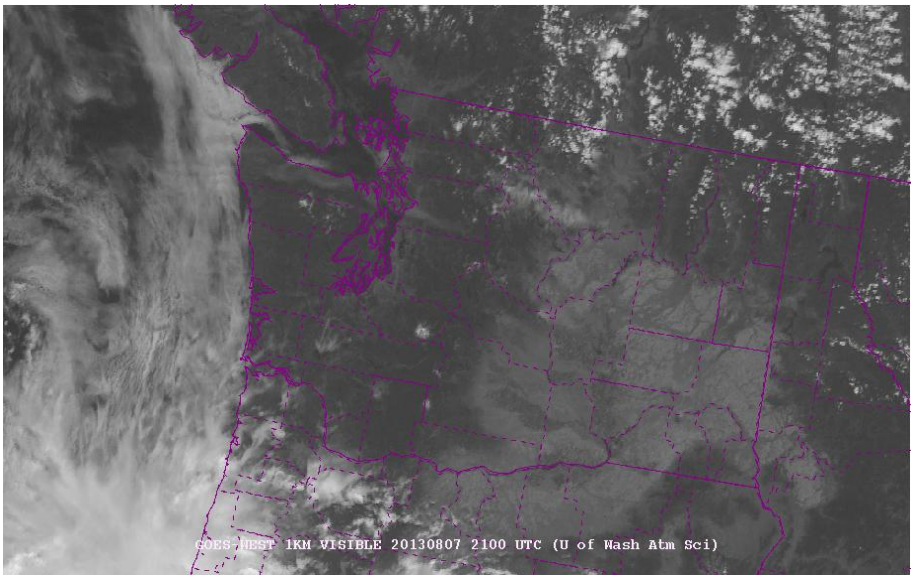


Next I will look at a couple of satellite photos the first will be and Infra-Red (IR) photo and the second will be a visual photo from approximately the same time frame.

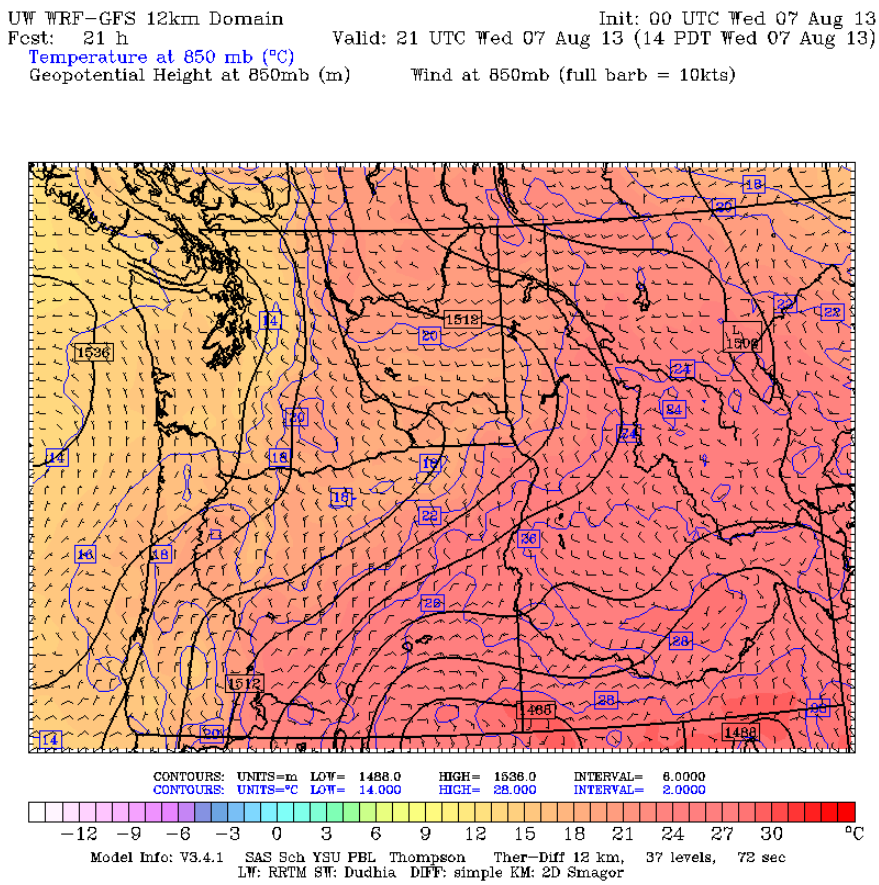
In the IR photo we can see skies over northern Idaho are void of mid and high clouds as they would show up as white clusters on IR which measures temperature, i.e. the whiter the cloud the colder the temperature. On the IR we see clouds near and around the low over Northern California and north of the Dakotas where the other low is located per the 500 millibar MM5 graphic above.

The visual photo below the IR photo shows the clear skies over northern Idaho and the Rathdrum Prairie. There are some cumulus clouds over the mountains to the east as daytime heating is lifting and condensing residual moisture from the past rain in the mountains.



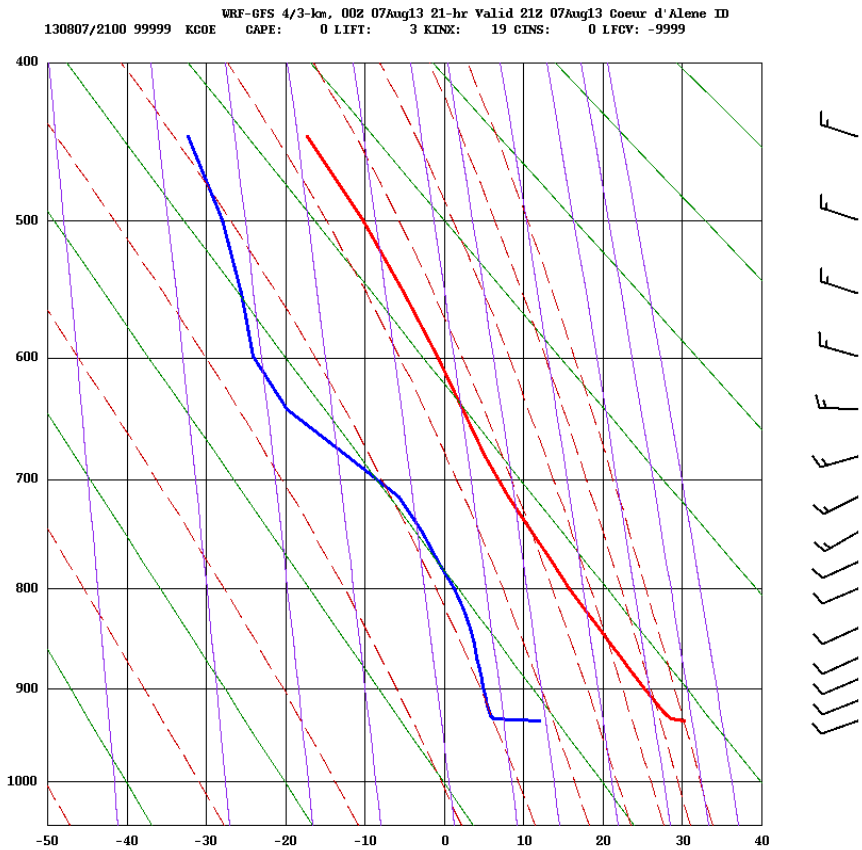


The next MM5 graphic we will look at is the 850 millibar constant pressure chart that gives us a good look at potential transport winds in the area.



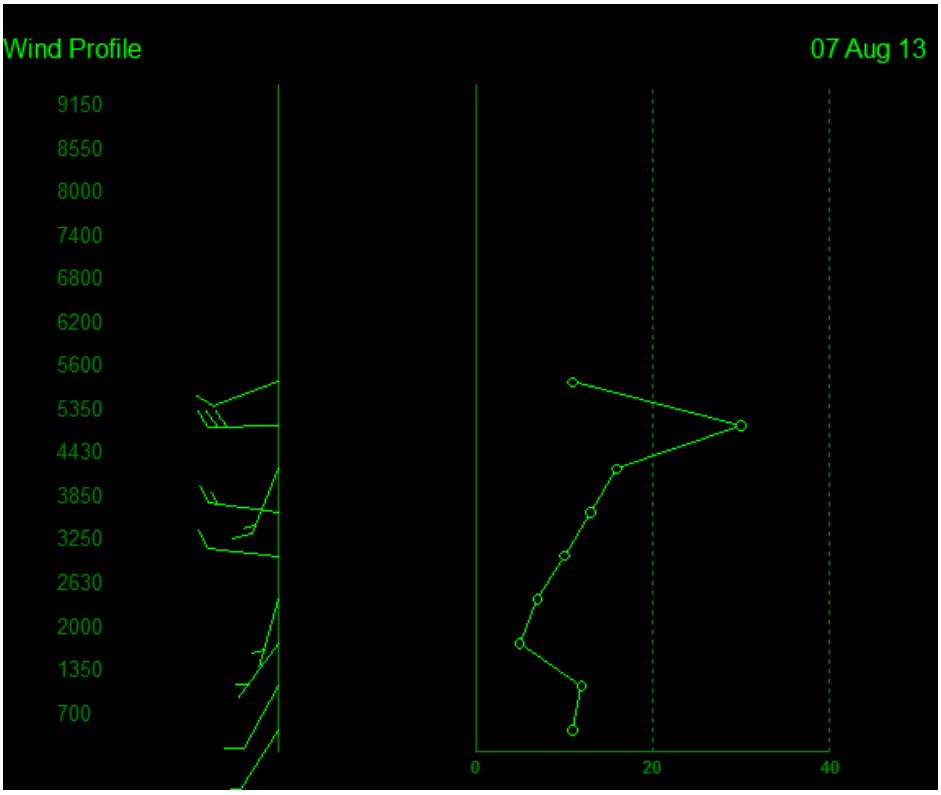
As we can see in the above graphic we have a southwest wind at 850 millibars. The direction is due to the high pressure ridging into eastern Washington and northern Idaho south of Kootenai County. A southwest wind has been determined to be a "good" wind direction for successful burning on the Rathdrum Prairie. The high pressure ridge is cooler therefore we can see the cooler air mass over eastern Washington (yellowish) while northern Idaho is a little warmer (reddish) in color. If we are advecting this cooler air into northern Idaho, which makes sense, due to the position of the high pressure that will enhance and help to further destabilize the lower atmosphere.

So now let us look at the sounding and Pilot Balloon (PIBAL) taken the day of the burn.

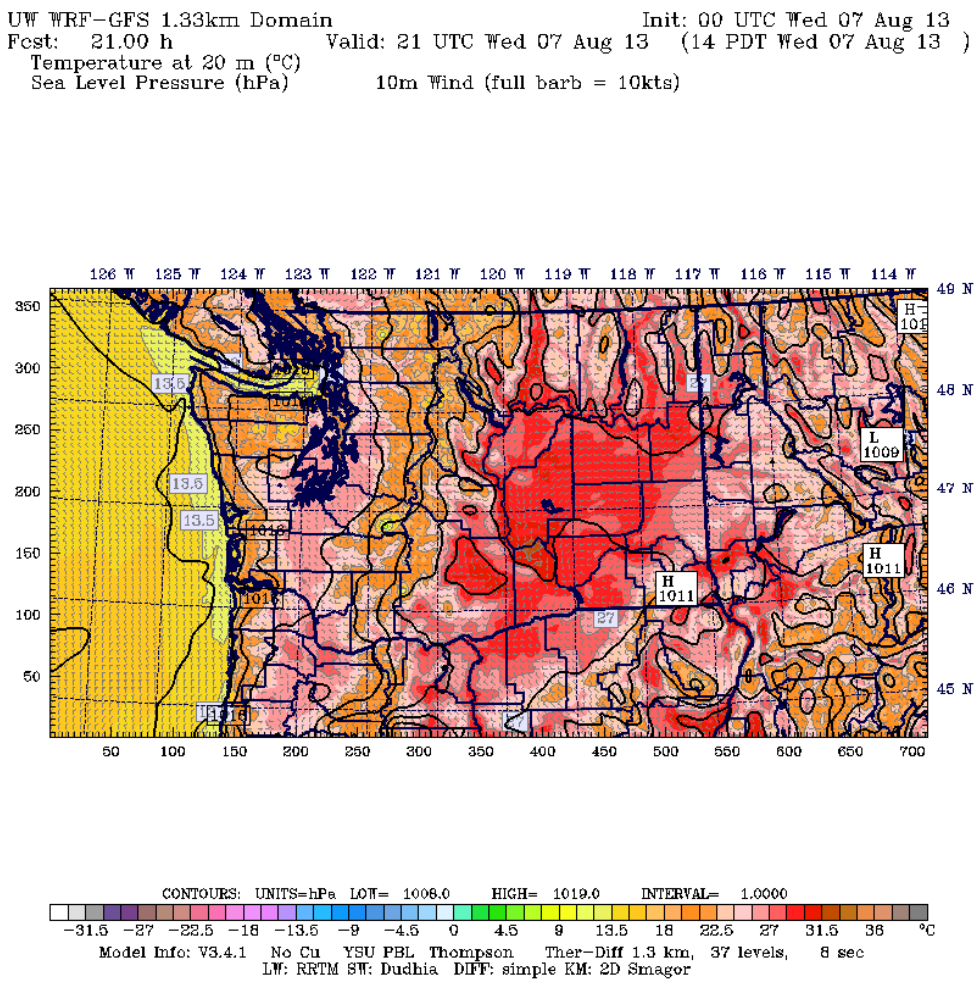


This is the 21Z (14P) sounding from the MM5 high resolution 1.33 km domain. This is the highest resolution graphic we have. On this sounding we are seeing a good wind direction and speed that we need for a successful burn on the Rathdrum Prairie. The heat induce surface layer is quite unstable and as mentioned earlier in the analysis the cool advection to the west at 850 millibars seems to be helping to destabilize the lower level of the atmosphere to near 7,000 feet AGL. "This is a very good looking sounding for burning." So lets' couple this sounding up with the PIBAL sounding taken at the burn site prior to ignition of the field.

The PIBAL which is actual measured wind direction and speed differs a little from the skew T sounding from the MM5. The wind direction is a little more southerly than we would like it to be, but it did shear to the west just above the surface at the 3250 gate. The wind speed is nearly perfect as the surface wind speed is around 10 mph and then diminishes a little as the smoke lifts, then the speed increases at each gate to the top of the sounding. The only element here I would like to see more of a southwest direction initially.



Now we will look at the surface data that we have. I mentioned earlier that we received some rain in the area 5-6 days prior to the burn. Since that rain daytime temperatures were warming into the upper 80s and lower 90s, while Relative Humidity (RH) was ranging from 20-25 percent at the approximate ignition time. This was also the case the day of the burn. At 2pm COE airport, which is adjacent to the field to be burned, reported 90 degrees and 20 percent RH. The graphic below is also from the MM5 and a high resolution surface 1.33km graphic. This surface graphic shows the heat buildup in the Columbia Basin with fingers of heat moving up into the valley areas of eastern Washington and northern Idaho. One of these areas where the temperature is warmer is in the Purcell Trench.



We are seeing a close trend to the optimum conditions preset earlier in this analysis. Ventilation with the higher mixing heights and 10 mph surface wind speeds produced very good ventilation as shown in the photo of the burn below.

CONCLUSIONS:

After reviewing all the data collected and received from IDEQ the ideal day for burning was very close to being represented. After many years of forecasting and looking at data from past and present for Rathdrum Prairie burns we can draw some concrete conclusions.

First and foremost dryness of soil and fuel must be met with little or no "greenup" present in the fuel. There is no variance for these basic fire weather parameters. The fuel must be ready to burn and soil moisture has to be at a minimum. Both of these parameters can reach this state very quickly this time of the year when we have maximum temperatures in the 90s and minimum RH near 20 percent. With five days of drying prior to the burn day on August 7th these fire weather requirements were met.

Also after years of preparing and training for burning on the Rathdrum Prairie we know where the smoke emanating from the burn "has to go". We know the transport wind direction has to be southwest to west southwest at a speed of 10 mph or greater. The surface wind direction also has to be southwest to west southwest with an optimum surface wind speed in the 7-10 mph range. Smoke has to move north of COE airport and Hayden Lake, while lifting high enough to effectively clear highway 95. Smoke also must be south of the southern arm of Lake Pend Oreille before dispersing and entering the mountains to the east. We also need ample lift, and the higher the mixing depth, the better chance we have to do a successful burn in the Rathdrum Prairie Air Shed. A relatively dry sounding (forecast) from COE airport is extremely important to lift the smoke to a pre-determined height in the lower atmosphere.

The Purcell Trench is a southwest to northeast oriented valley. So smoke has a natural tendency to travel "up" this valley towards Lake Pend Oreille. If any of the above weather parameters are not met the burn can follow the valley and impact cities near Athol and/or Bayview.

As stated in a previous burn day analysis lateness of the season is a documented hindrance to successful burning on the Rathdrum Prairie. If the above parameters are met we can have a successful burn. This area is not an easy forecast during the burn season. Terrain features produce variations in wind direction and wind and speed.

As in all field burns caution needs to be constantly monitored. I hope this brief analysis can serve as a training tool for all of us as we attempt to complete future successful burns on the Rathdrum Prairie.

Gary Bennett – Meteorologist

Appendix C. Burn Decision Summary

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Table C1. August burn decisions—northern Idaho.

		Burn Decision by Smoke Management Area - Northern Idaho						
Date		Boundary SMA (County)	Kootenai SMA (County)	Central SMA	Clearwater County	Idaho County	Latah County	Nez Perce County
August 1, 2013		No Requests	Wind	No Requests	No Requests	No Requests	No Requests	No Requests
August 2, 2013		No Requests	Fuel Moisture	No Requests	No Requests	No Requests	No Requests	No Requests
August 3, 2013	Weekend							
August 4, 2013	Weekend							
August 5, 2013		No Requests	Fuel Moisture	No Requests	No Requests	No Requests		No Requests
August 6, 2013		No Requests	Fuel Moisture	Burn	No Requests	No Requests	Burn	No Requests
August 7, 2013		No Requests	Burn	Burn	No Requests	No Requests	Burn	No Requests
August 8, 2013		Wind	No Requests	Ventilation	No Requests	Ventilation	Ventilation	No Requests
August 9, 2013		Burn	No Requests	Red Flag	No Requests	Red Flag		No Requests
August 10, 2013	Weekend							
August 11, 2013	Weekend							
August 12, 2013		No Requests	No Requests	No Requests	No Requests	No Requests	No Requests	No Requests
August 13, 2013		No Requests	No Requests	Burn	No Requests	Burn	No Requests	No Requests
August 14, 2013		No Requests	No Requests	Ventilation	No Requests	Ventilation	No Requests	No Requests
August 15, 2013		No Requests	No Requests	Grower not ready	No Requests	Grower not ready	No Requests	No Requests
August 16, 2013		Ventilation	No Requests	Grower not ready	No Requests	Grower not ready	No Requests	No Requests
August 17, 2013	Weekend							
August 18, 2013	Weekend							
August 19, 2013		Burn	No Requests	No Requests	No Requests	No Requests	No Requests	No Requests
August 20, 2013		Burn	No Requests	Burn	No Requests	Burn	No Requests	Burn
August 21, 2013		Ventilation	No Requests	Burn	No Requests	Burn	No Requests	Burn
August 22, 2013		Burn	No Requests	Red Flag	No Requests	Red Flag	Red Flag	Red Flag
August 23, 2013		Red Flag	No Requests	Red Flag	No Requests	Red Flag	Red Flag	Red Flag
August 24, 2013	Weekend							
August 25, 2013	Weekend							
August 26, 2013		Fuel Moisture	No Requests			Burn	Fuel Moisture	Burn
August 27, 2013		Burn	No Requests	Burn	Burn	Burn	Burn	Burn
August 28, 2013		Harvest	No Requests	Burn	Burn	Burn	Burn	Burn
August 29, 2013		Harvest	No Requests	Burn	Burn	Burn	Grower not ready	Burn
August 30, 2013		Poor Met. Cond.	No Requests	Burn	Grower not ready	Burn	Grower not ready	Grower not ready
August 31, 2013	Weekend							

Note: Red Flag = National Weather Service issued a red-flag warning for high fire risk
Air Quality = Burn approval was not acceptable based on current or forecasted air quality levels
Ventilation = The ability of the atmosphere to disperse smoke was unsuitable for good smoke management

Table C2. September burn decisions—northern Idaho.

		Burn Decision by Smoke Management Area - Northern Idaho						
Date		Boundary SMA (County)	Kootenai SMA (County)	Central SMA	Clearwater County	Idaho County	Latah County	Nez Perce County
September 1, 2013	Weekend							
September 2, 2013	Holiday							
September 3, 2013		Poor Met. Cond.	Ventilation	Ventilation	Ventilation	Ventilation	Ventilation	Ventilation
September 4, 2013		Burn	Burn	Burn	Burn	Burn	Burn	Burn
September 5, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
September 6, 2013		Fuel moisture	No requests	Burn	Burn	Fuel moisture	Fuel moisture	Fuel moisture
September 7, 2013	Weekend							
September 8, 2013	Weekend							
September 9, 2013		Burn	No requests	Burn	Burn	Burn	Burn	Burn
September 10, 2013		Burn	No requests	Burn	Burn	Burn	Burn	Wind
September 11, 2013		Burn	No requests	Burn	Burn	Burn	Ventilation	Ventilation
September 12, 2013		Burn	No requests	Burn	Burn	Burn	Burn	Ventilation
September 13, 2013		Ventilation	No requests	Burn	Burn	Burn	Burn	Burn
September 14, 2013	Weekend							
September 15, 2013	Weekend							
September 16, 2013		Fuel moisture	No requests	Burn	Burn	Burn	Burn	Burn
September 17, 2013		Fuel moisture	No requests	Burn	Burn	Burn	Burn	Grower not ready
September 18, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
September 19, 2013		Fuel moisture	No requests	Burn	Fuel moisture	Fuel moisture	Burn	Burn
September 20, 2013		Fuel moisture	No requests	Burn	Wind	Burn	Burn	Burn
September 21, 2013	Weekend							
September 22, 2013	Weekend							
September 23, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	No requests	Fuel moisture	Fuel moisture
September 24, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	No requests	Fuel moisture	Fuel moisture
September 25, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
September 26, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	No requests	Fuel moisture	Fuel moisture
September 27, 2013		Poor Met. Cond.	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Burn	Burn
September 28, 2013	Weekend							
September 29, 2013	Weekend							
September 30, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture

Note: Fuel Moisture = Fuel or soil moisture levels were not appropriate for burn approval
Wind = Current or forecasted wind velocities were not appropriate for burn approval
Ventilation = The ability of the atmosphere to disperse smoke was unsuitable for good smoke management

Table C3. October burn decisions—northern Idaho.

		Burn Decision by Smoke Management Area - Northern Idaho						
Date		Boundary SMA (County)	Kootenai SMA (County)	Central SMA	Clearwater County	Idaho County	Latah County	Nez Perce County
October 1, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
October 2, 2013		Fuel moisture	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
October 3, 2013		Fuel moisture	No requests	Burn	Fuel moisture	Fuel moisture	Burn	Fuel moisture
October 4, 2013		No requests	No requests	Burn	Burn	Fuel moisture	Burn	Fuel moisture
October 5, 2013	Weekend							
October 6, 2013	Weekend							
October 7, 2013		No requests	No requests	Burn	Wind	Burn	Burn	Burn
October 8, 2013		No requests	No requests	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture	Fuel moisture
October 9, 2013		No requests	No requests	Burn	Fuel moisture	Fuel moisture	Burn	Fuel moisture
October 10, 2013		No requests	No requests	Burn	Fuel moisture	Fuel moisture	Burn	Burn
October 11, 2013		No requests	No requests	Burn	Burn	Fuel moisture	Burn	Burn
October 12, 2013	Weekend							
October 13, 2013	Weekend							
October 14, 2013	Holiday							
October 15, 2013		No requests	No requests	Burn	No requests	Burn	Burn	Burn
October 16, 2013		No requests	No requests	Burn	Fuel moisture	Burn	Burn	No requests
October 17, 2013		No requests	No requests	Burn	No requests	No requests	Burn	Burn
October 18, 2013		Air Quality	Air Quality	Burn	Air Quality	Burn	Air Quality	Air Quality
October 19, 2013	Weekend							
October 20, 2013	Weekend							
October 21, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests
October 22, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests
October 23, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests
October 24, 2013		Poor Met. Cond.	No requests	Burn	No requests	Burn	Burn	No requests
October 25, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests
October 26, 2013	Weekend							
October 27, 2013	Weekend							
October 28, 2013		No requests	No requests	Burn	No requests	Burn	Wind	No requests
October 29, 2013		No requests	No requests	Burn	No requests	Fuel moisture	Burn	No requests
October 30, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests
October 31, 2013		No requests	No requests	Burn	No requests	Burn	Burn	No requests

Note: Fuel Moisture = Fuel or soil moisture levels were not appropriate for burn approval
Wind = Current or forecasted wind velocities were not appropriate for burn approval

Table C4. August burn decisions—southern Idaho.

		Burn Decision by Smoke Management Area - Southern Idaho						
Date		Southwest Idaho	Southern Magic	Northern Magic	Southeast Idaho	Eastern Idaho	Weiser and Payette	Blaine and Camas
August 1, 2013		Red Flag	Red Flag	Red Flag	No Requests	No Requests	Red Flag	No Requests
August 2, 2013		Burn	Burn	No Requests	No Requests	No Requests	Burn	No Requests
August 3, 2013	Weekend							
August 4, 2013	Weekend							
August 5, 2013		Burn	Burn	Red Flag	Burn	Red Flag	No Requests	No Requests
August 6, 2013		Burn	Burn	Burn	No Requests	No Requests	No Requests	No Requests
August 7, 2013		Red Flag	Burn	Burn	Burn	No Requests	No Requests	No Requests
August 8, 2013		Burn	Red Flag	Red Flag	No Requests	No Requests	No Requests	No Requests
August 9, 2013		Burn	Burn	Burn	No Requests	No Requests	No Requests	No Requests
August 10, 2013	Weekend							
August 11, 2013	Weekend							
August 12, 2013		Air Quality	Red Flag	Burn	Burn	No Requests	No Requests	No Requests
August 13, 2013		Burn	Burn	Burn	Red Flag	Red Flag	No Requests	No Requests
August 14, 2013		Air Quality	Air Quality	Air Quality	Burn	Burn	No Requests	No Requests
August 15, 2013		Air Quality	Air Quality	Air Quality	Air Quality	Air Quality	No Requests	No Requests
August 16, 2013		Air Quality	Air Quality	Air Quality	Air Quality	Air Quality	No Requests	No Requests
August 17, 2013	Weekend							
August 18, 2013	Weekend							
August 19, 2013		Burn	Burn	Burn	Burn	Burn	No Requests	No Requests
August 20, 2013		Red Flag	Red Flag	Red Flag	Burn	Burn	No Requests	No Requests
August 21, 2013		Red Flag	Red Flag	Red Flag	Red Flag	Red Flag	No Requests	No Requests
August 22, 2013		Red Flag	Red Flag	Red Flag	Red Flag	Red Flag	No Requests	No Requests
August 23, 2013		Burn	Burn	Burn	Red Flag	Red Flag	No Requests	No Requests
August 24, 2013	Weekend							
August 25, 2013	Weekend							
August 26, 2013		Burn	Burn	Burn	Burn	Burn	No Requests	No Requests
August 27, 2013		No Requests	Red Flag	Red Flag	Burn	Burn	No Requests	No Requests
August 28, 2013		No Requests	Red Flag	Red Flag	Burn	Burn	No Requests	No Requests
August 29, 2013		No Requests	Burn	Burn	Burn	Burn	No Requests	No Requests
August 30, 2013		No Requests	Burn	Burn	Burn	Burn	No Requests	No Requests
August 31, 2013	Weekend							

Note: Red Flag = National Weather Service issued a red-flag warning for high fire risk
Air Quality = Burn approval was not acceptable based on current or forecasted air quality levels

Table C5. September burn decisions—southern Idaho.

		Burn Decision by Smoke Management Area - Southern Idaho						
Date		Southwest Idaho	Southern Magic	Northern Magic	Southeast Idaho	Eastern Idaho	Weiser and Payette	Blaine and Camas
September 1, 2013	Weekend							
September 2, 2013	Holiday							
September 3, 2013		Fuel Moisture	Fuel Moisture	Fuel Moisture	Fuel Moisture	Fuel Moisture	No Requests	No Requests
September 4, 2013		Fuel Moisture	Fuel Moisture	Burn	Burn	Burn	No Requests	No Requests
September 5, 2013		Fuel Moisture	Fuel Moisture	Fuel Moisture	Burn	Fuel Moisture	No Requests	No Requests
September 6, 2013		Fuel Moisture	Fuel Moisture	Fuel Moisture	Burn	Burn	No Requests	No Requests
September 7, 2013	Weekend							
September 8, 2013	Weekend							
September 9, 2013		Burn	Burn	Burn	Burn	Fuel Moisture	No Requests	No Requests
September 10, 2013		No Requests	Burn	Burn	Burn	Burn	No Requests	No Requests
September 11, 2013		No Requests	No Requests	Burn	Burn	Burn	No Requests	No Requests
September 12, 2013		Fuel Moisture	Fuel Moisture	Fuel Moisture	Fuel Moisture	Fuel Moisture	No Requests	No Requests
September 13, 2013		Fuel Moisture	Fuel Moisture	Fuel Moisture	Burn	Fuel Moisture	No Requests	No Requests
September 14, 2013	Weekend							
September 15, 2013	Weekend							
September 16, 2013		Burn	No Requests	No Requests	Burn	Burn	No Requests	No Requests
September 17, 2013		Wind	Burn	No Requests	Wind	Fuel Moisture	No Requests	No Requests
September 18, 2013		Burn	Wind	No Requests	Wind	Fuel Moisture	No Requests	No Requests
September 19, 2013		Burn	No Requests	No Requests	Wind	Burn	No Requests	No Requests
September 20, 2013		Wind	Wind	No Requests	Burn	Burn	No Requests	No Requests
September 21, 2013	Weekend							
September 22, 2013	Weekend							
September 23, 2013		Burn	Wind	No Requests	Burn	Burn	No Requests	No Requests
September 24, 2013		Fuel Moisture	Burn	No Requests	Burn	Burn	No Requests	No Requests
September 25, 2013		Fuel Moisture	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
September 26, 2013		Fuel Moisture	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
September 27, 2013		Fuel Moisture	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
September 28, 2013	Weekend							
September 29, 2013	Weekend							
September 30, 2013		Fuel Moisture	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests

Note: Fuel Moisture = Fuel or soil moisture levels were not appropriate for burn approval
Wind = Current or forecasted wind velocities were not appropriate for burn approval

Table C6. October burn decisions—southern Idaho.

		Burn Decision by Smoke Management Area - Southern Idaho						
Date		Southwest Idaho	Southern Magic	Northern Magic	Southeast Idaho	Eastern Idaho	Weiser and Payette	Blaine and Camas
October 1, 2013		No Requests	Fuel Moisture	No Requests	Burn	Burn	No Requests	No Requests
October 2, 2013		No Requests	Burn	No Requests	Burn	Burn	No Requests	No Requests
October 3, 2013		No Requests	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
October 4, 2013		No Requests	Fuel Moisture	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
October 5, 2013	Weekend							
October 6, 2013	Weekend							
October 7, 2013		No Requests	Burn	No Requests	Burn	Burn	No Requests	No Requests
October 8, 2013		No Requests	Wind	No Requests	Burn	Wind	No Requests	No Requests
October 9, 2013		No Requests	No Requests	No Requests	Burn	Burn	No Requests	No Requests
October 10, 2013		No Requests	No Requests	No Requests	Fuel Moisture	Fuel Moisture	No Requests	No Requests
October 11, 2013		No Requests	No Requests	No Requests	Fuel Moisture	Burn	No Requests	No Requests
October 12, 2013	Weekend							
October 13, 2013	Weekend							
October 14, 2013	Holiday							
October 15, 2013		No Requests	Burn	No Requests	No Requests	Burn	No Requests	No Requests
October 16, 2013		No Requests	Burn	No Requests	No Requests	Burn	No Requests	No Requests
October 17, 2013		No Requests	No Requests	No Requests	No Requests		No Requests	No Requests
October 18, 2013		No Requests	No Requests	No Requests	Burn	Burn	No Requests	No Requests
October 19, 2013	Weekend							
October 20, 2013	Weekend							
October 21, 2013		No Requests	No Requests	No Requests	Burn	Burn	No Requests	No Requests
October 22, 2013		No Requests	No Requests	No Requests	No Requests	Burn	No Requests	No Requests
October 23, 2013		No Requests	Burn	No Requests	Burn	No Requests	No Requests	No Requests
October 24, 2013		No Requests	Burn	No Requests	No Requests	No Requests	No Requests	No Requests
October 25, 2013		No Requests	Burn	No Requests	Burn	Burn	No Requests	Burn
October 26, 2013	Weekend							
October 27, 2013	Weekend							
October 28, 2013		No Requests	Fuel Moisture	No Requests	Fuel Moisture	No Requests	No Requests	No Requests
October 29, 2013		No Requests	Fuel Moisture	No Requests	Fuel Moisture	No Requests	No Requests	No Requests
October 30, 2013		No Requests	Wind	No Requests	Fuel Moisture	No Requests	No Requests	No Requests
October 31, 2013		No Requests	Wind	No Requests	Fuel Moisture	No Requests	No Requests	No Requests

Note: Fuel Moisture = Fuel or soil moisture levels were not appropriate for burn approval
Wind = Current or forecasted wind velocities were not appropriate for burn approval

Appendix D. Meteorological Summary for the Fall Burn Season

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Meteorological Summary for the Fall Burn Season

Introduction

This meteorological summary was provided by DEQ's contract meteorologist, Gary Bennett of Bennett Fire Weather Services, and DEQ's staff meteorologist, who took over fire weather forecasting duties for southern Idaho for DEQ's use beginning September 30. Many of the images used to illustrate meteorological conditions represent conditions some distance above the surface. Height above the surface is expressed in millibars of atmospheric pressure, with a lower millibar number equating to higher altitude. The images were produced using a computer-based modeling system known as MM5 (Fifth-Generation NCAR/Penn State Mesoscale Model).

Gary Bennett conducted a pre-season fire weather training session for northern Idaho staff. This training was held in Spokane and covered burning techniques and fire weather meteorology.

Fire weather forecasting for the 2013 fall burn season began on July 25. Forecasts were sent to DEQ analysts and field personnel by 8:00 a.m. and 3:00 p.m. each day, followed by conference calls at 8:30 a.m. and 3:30 p.m. The morning conference calls were used to discuss the weather forecast for that day and the afternoon conference calls were used to discuss the preliminary forecast for the next business day as well as to discuss the events of the current day.

Leading up to the fall burn season, springtime weather across the state was generally mild and quite dry, with the exception being a somewhat wet June in northern Idaho.

Northern Idaho

July

July was a very warm month for all of northern Idaho. The warm temperatures and generally dry conditions across the Pacific Northwest lead to a series of lightning caused wildfires, especially over the mountains later in July. The lightning produced wildfires to the south, east over Montana, and west in eastern Oregon and eastern Washington. The smoke generated from the wildfires affected air quality at times over the northern Idaho airsheds. Smoke from the larger wildfires became a problem by the end of July.

Figure 1 shows the weather pattern over northern Idaho that was typical for much of the month of July. The first few days of July were the hottest days of the summer. Lewiston recorded a high temperature of 107°F on July 1 and also recorded high temperatures of 90°F or greater on 27 of the 31 days in July. All weather reporting stations recorded above average temperatures and below average precipitation during July.

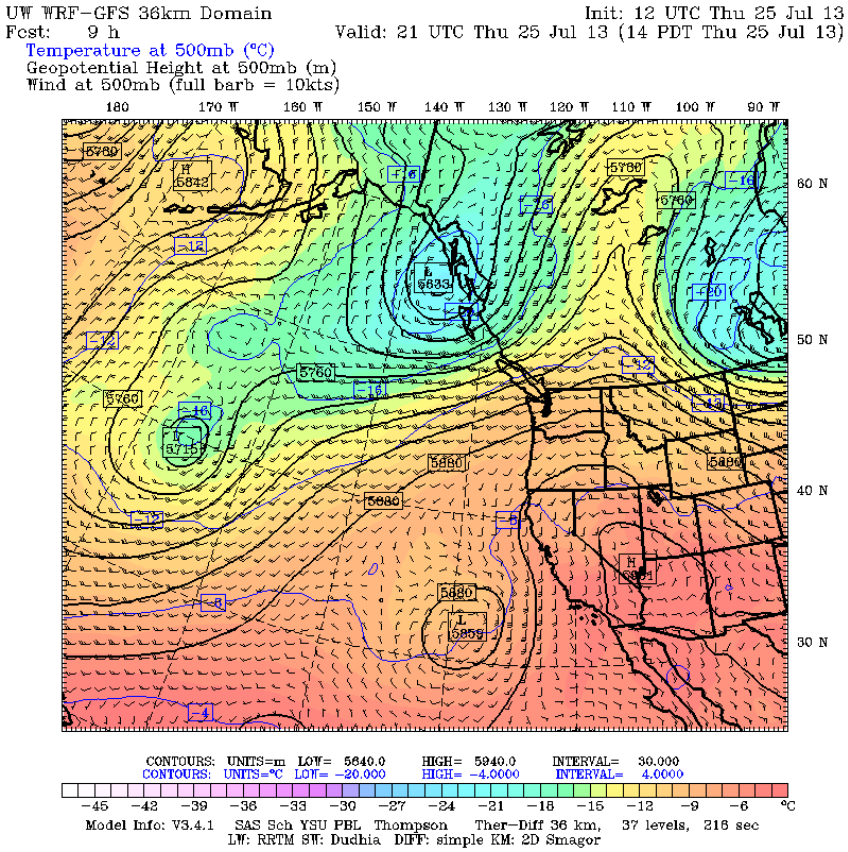

Figure 1. 500 millibar chart for July 25, 2013.

August

August started out with an active upper level weather pattern over northern Idaho. The weather pattern changed to a progressive pattern as the northern branch of the jet stream moved south over British Columbia. There was a series of weather disturbances that moved across southern and central British Columbia.

Figure 2 shows an upper low along the Washington/Oregon border. The beginning of August saw a progressive weather pattern over the Inland Northwest. The first 2–5 days of August saw between 0.3 and 0.5 inch of rain at most weather stations. Bonners Ferry recorded nearly 0.8 inch during this time frame. Most fields, especially in Boundary County, were dampened considerably and burning was hindered across much of northern Idaho.

The small storm noted above moved east and high pressure returned to northern Idaho with high temperatures in the mid-80s to mid-90s. Residual moisture left over from the early August storm finally dried out enough to make for acceptable burning.

By middle of August another large Pacific storm approached central British Columbia. The flow aloft backed to the south and southwest over northern Idaho, which provided a greater chance for thunderstorms over the region.

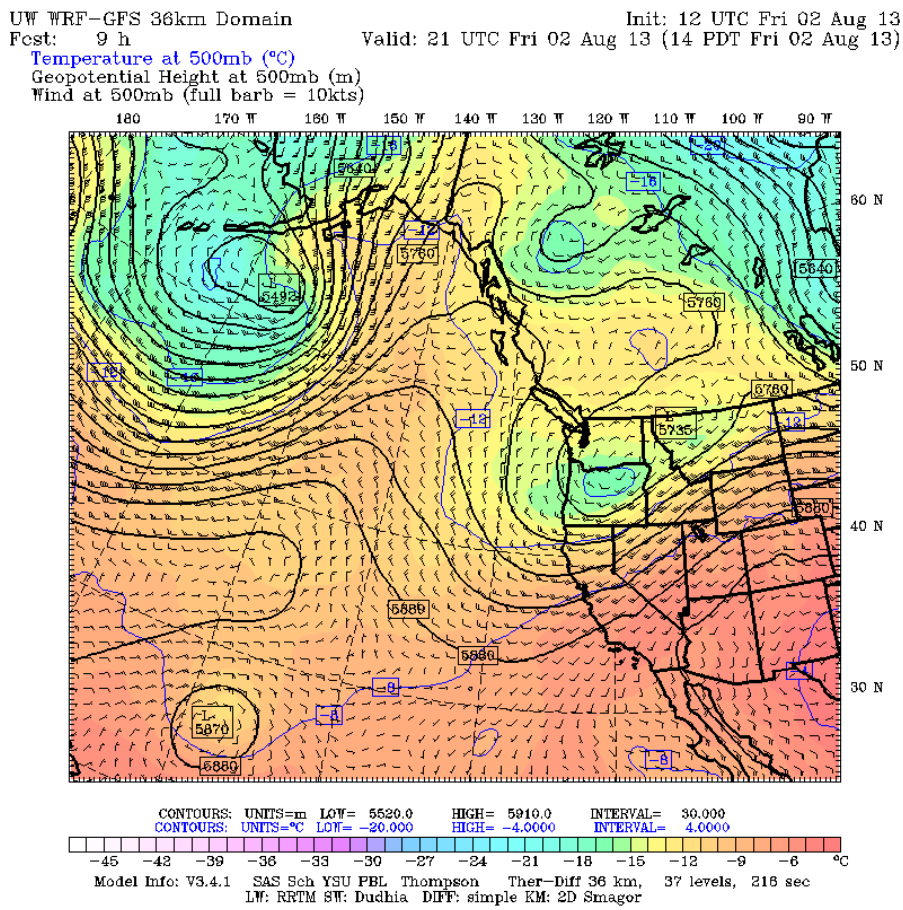

Figure 2. 500 millibar chart for August 2, 2013.

Figure 3 and Figure 4 depict the change in the upper level flow pattern over northern Idaho. Observed maximum temperatures over the southern Clearwater airshed during the second and third weeks of August were very warm, but cloud build ups and thunderstorms produced isolated showers.

Most weather reporting stations received a few hundredths of an inch of rain at various times during the middle two weeks of August.

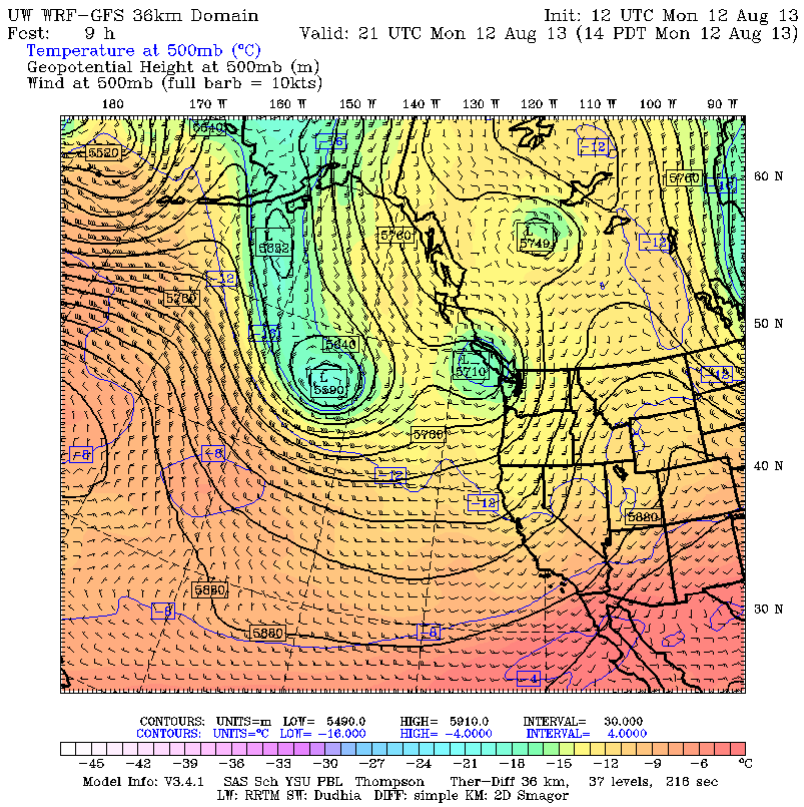

Figure 3. 500 millibar chart for August 12, 2013.

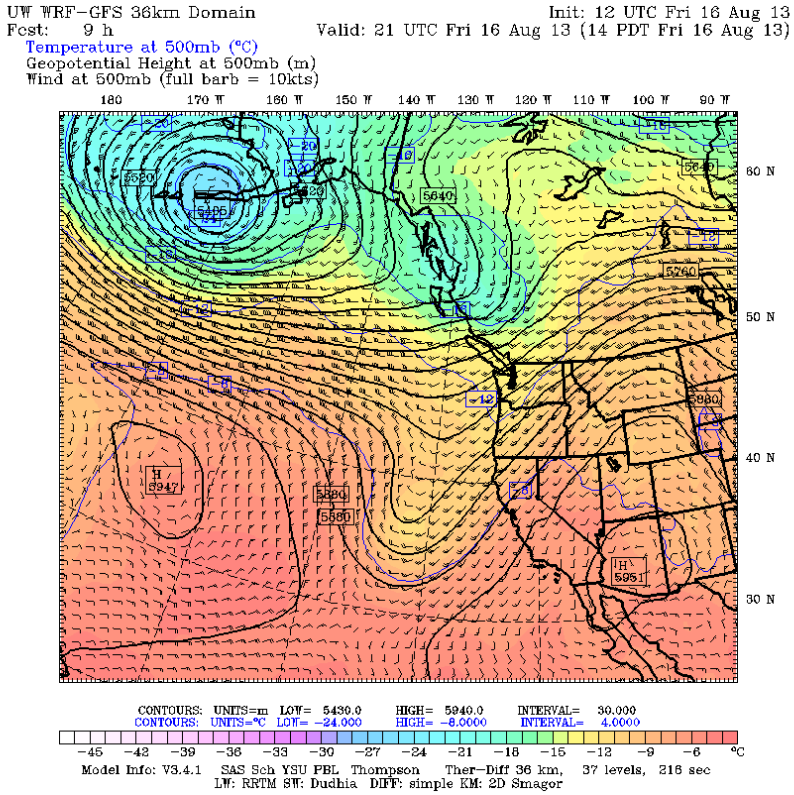

Figure 4. 500 millibar chart for August 16, 2013.

During the last week and a half of August, a series of showers and thunderstorms moved into northern Idaho and produced continued rain for the region. Figure 5 shows the upper level low positioned off the British Columbia coast and the southwest flow aloft over the Pacific Northwest.

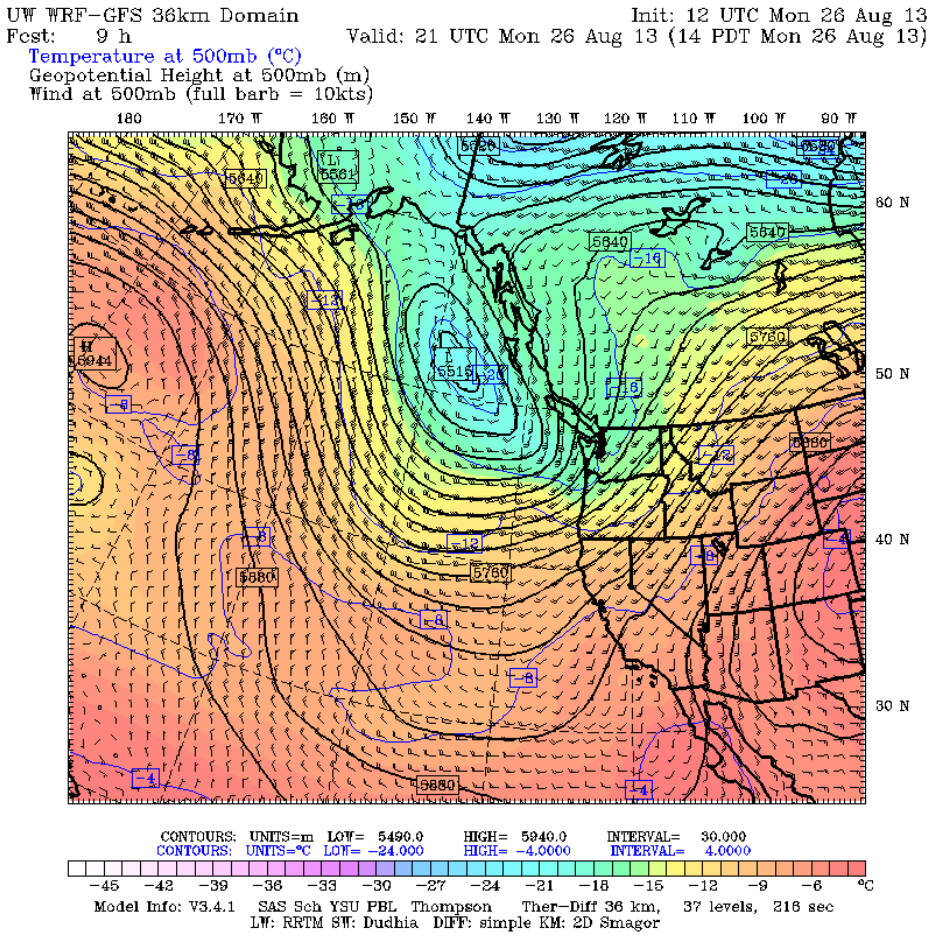

Figure 5. 500 millibar chart for August 26, 2013.

By the end of August, the upper low off the British Columbia coast had moved southeast towards Washington, which cooled temperatures and brought more light rain to the region. The progressive weather pattern and periodic rains made for unsuitable conditions for burning at times.

August ended with above average temperatures at all reporting stations, except for Bonners Ferry, which was near average. Precipitation ended up being slightly below average at Lewiston and Pullman but above average from Potlatch north to Bonners Ferry.

September

September is typically one of the drier months in the Northwest, but this year impressive rainfall throughout the region broke many records. The month began with widespread thunderstorms and locally heavy rainfall on the 4th and 5th. During the first week of September, a cold and unstable upper level trough approached the Washington Coast. Figure 6 depicts this Pacific storm. As the

low approached the west coast the high pressure ridge was forced east by the incoming low and trough. This ridge was previously over northern Idaho and produced warm and dry weather over the Inland Northwest.

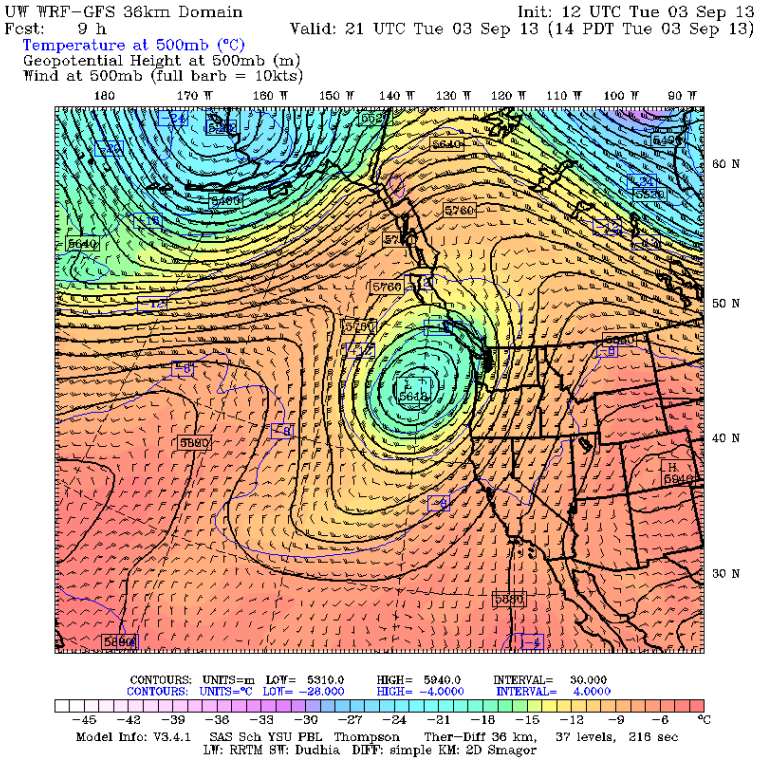

Figure 6. 500 millibar chart for September 3, 2013.

As the first week of September progressed, this upper level low moved into eastern Washington and northern Idaho. The cool and unstable nature of the upper low and trough produced showers and thunderstorms across northern Idaho. Daytime high temperatures dropped into the upper 60s and lower 70s as the low moved slowly through the region. This particular upper low and trough moved very slowly across eastern Washington and northern Idaho because it was moving under and through a strong upper level high pressure ridge over British Columbia. This pattern would persist through the week with scattered showers and thunderstorms. Figure 7 shows the slow movement of the trough, which on September 6 was still located over north central Washington. The upper low finally moved east into Montana over the weekend of September 7–8, as high pressure became the dominant weather feature over northern Idaho. The air mass over northern Idaho then dried out and warmed up.

Precipitation amounts over the first week of September were widespread and ranged from nearly a quarter of an inch to well over a half inch at nearly all weather reporting stations. The early September wet weather started the late summer “slow down” in burning that would last for the rest of the burn season.

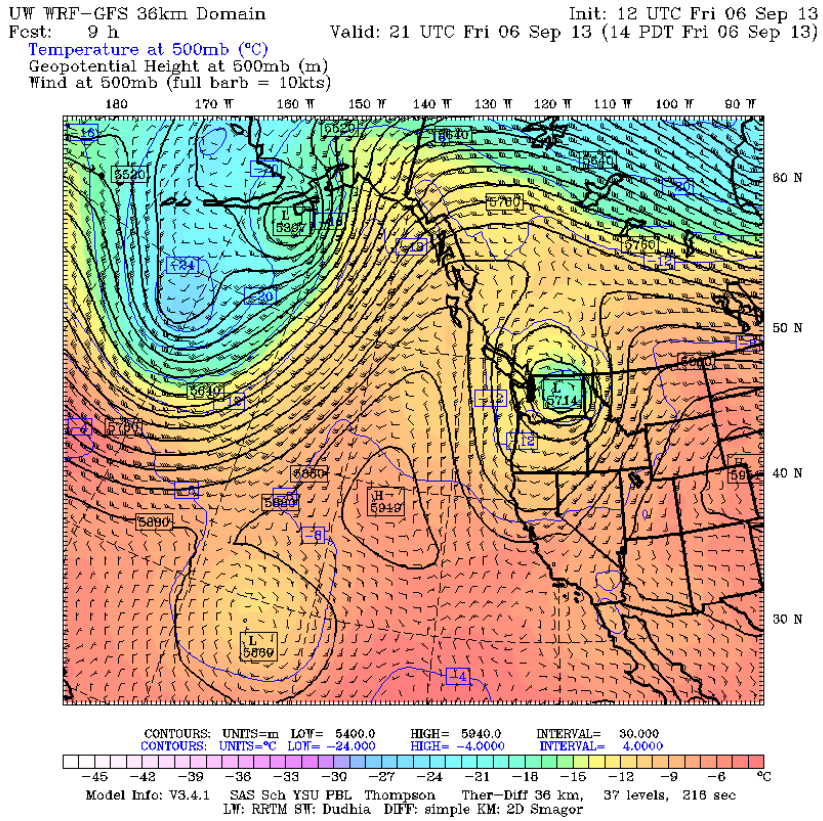

Figure 7. 500 millibar chart for September 6, 2013.

The dominant high pressure ridge remained over northern Idaho through mid-month. The warm and dry conditions under the ridge helped to dry out fields. Figure 8 shows the Pacific Northwest under a large area of high pressure on September 13.

By September 16 (Figure 9) a trough of low pressure had developed along the coast and was beginning to influence the weather over northern Idaho. The progressive nature of the upper level weather pattern would continue through the remainder of September. The upper level jet stream became centered over the Pacific Northwest and the northerly branch of the Pacific jet stream kept the unstable upper troughs and lows consistently moving into northern Idaho. Figure 10 and Figure 11 show winds at the 300 millibar level (approximately 30,000 feet above sea level), which is a good level for watching jet stream movement.

From the middle of September there were only three days when weather stations throughout northern Idaho did not report measurable rain. Monthly rainfall totals were well above average throughout northern Idaho. Bonners Ferry recorded 4.04 inches of rain in September effectively shutting down the burn season. This amount was also the greatest September rainfall for Bonners Ferry since record keeping began in 1907. Pullman recorded 2.66 inches, Potlatch: 2.20 inches, and Lewiston: 1.57 inches. These rainfall amounts were well above average for each individual weather station. Temperatures were well above average at all weather stations over northern Idaho.

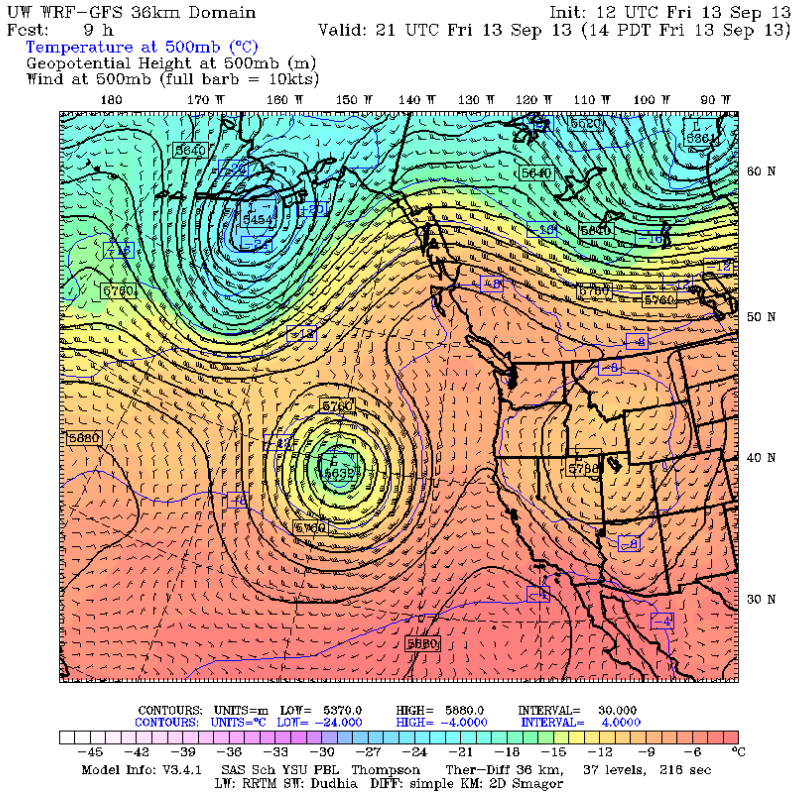

Figure 8. 500 millibar chart for September 13, 2013.

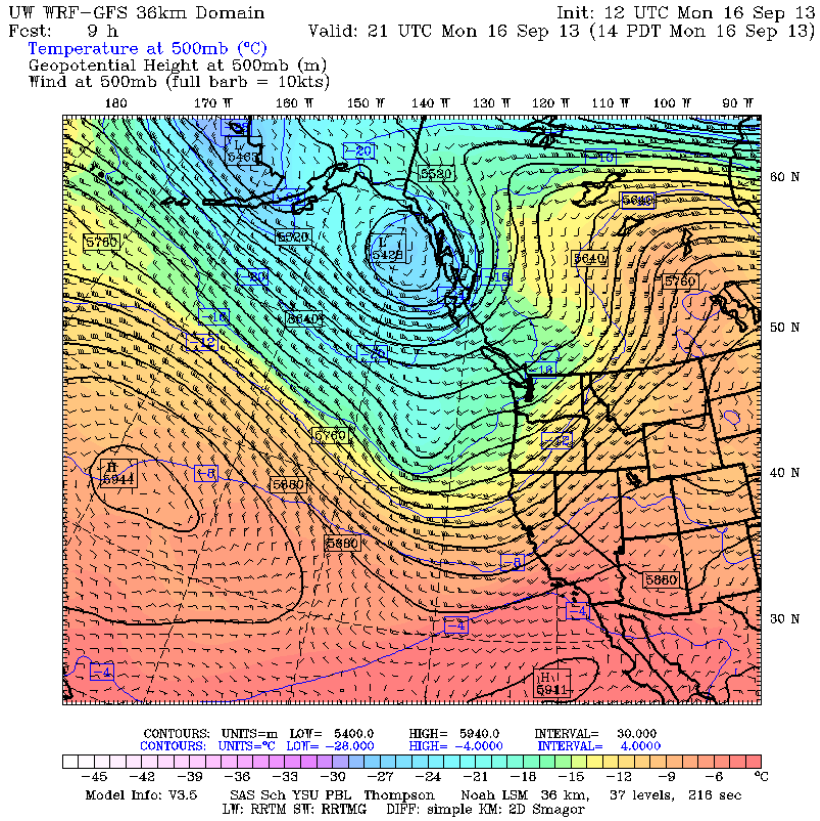

Figure 9. 500 millibar chart for September 16, 2013.

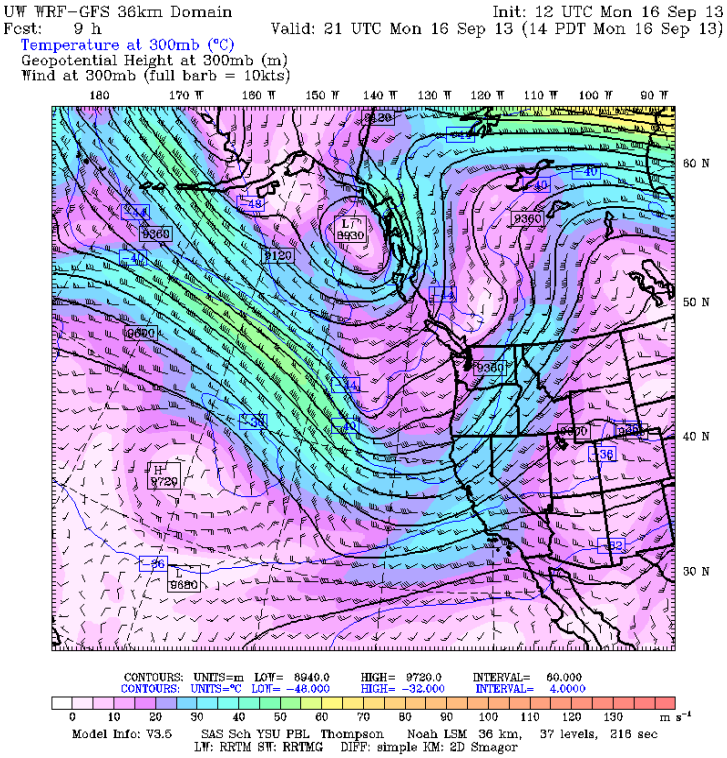

Figure 10. 300 millibar chart for September 16, 2013.

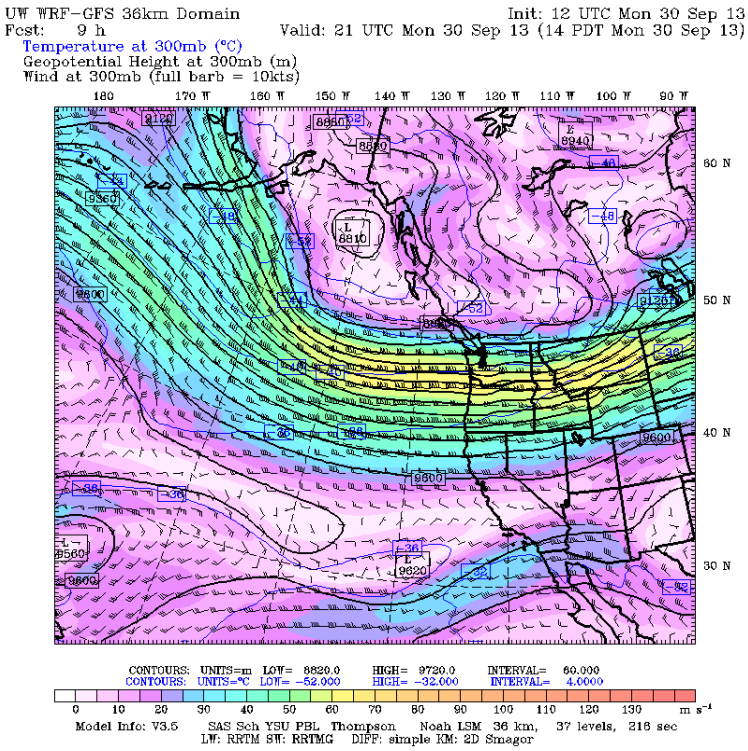

Figure 11. 300 millibar chart for September 30, 2013.

October

The month of October started out looking like a repeat of September as another Pacific storm approached the west coast. This storm began development west of Vancouver Island on September 30.

Figure 12 shows the strong westerly flow aloft into northern Idaho. The upper level storm that developed off the Washington coast moved east with the flow aloft into northern Idaho. Precipitation amounts were light with this storm. The upper low that developed during the first week of October moved southeast into eastern Wyoming by October 4. Figure 13 shows this movement and the building dry high pressure ridge over eastern Washington. This high provided a couple of dry days for northern Idaho.

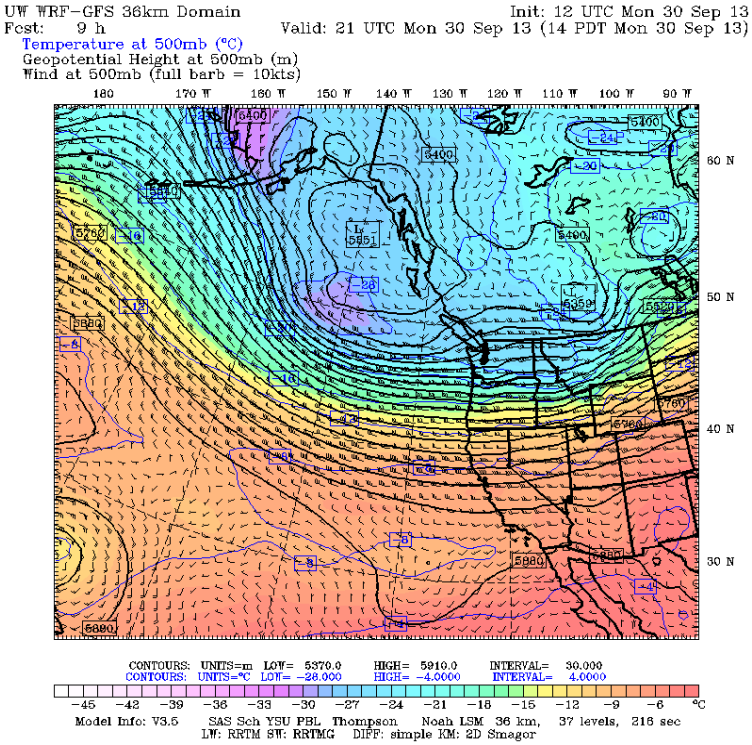

Figure 12. 500 millibar chart for September 30, 2013.

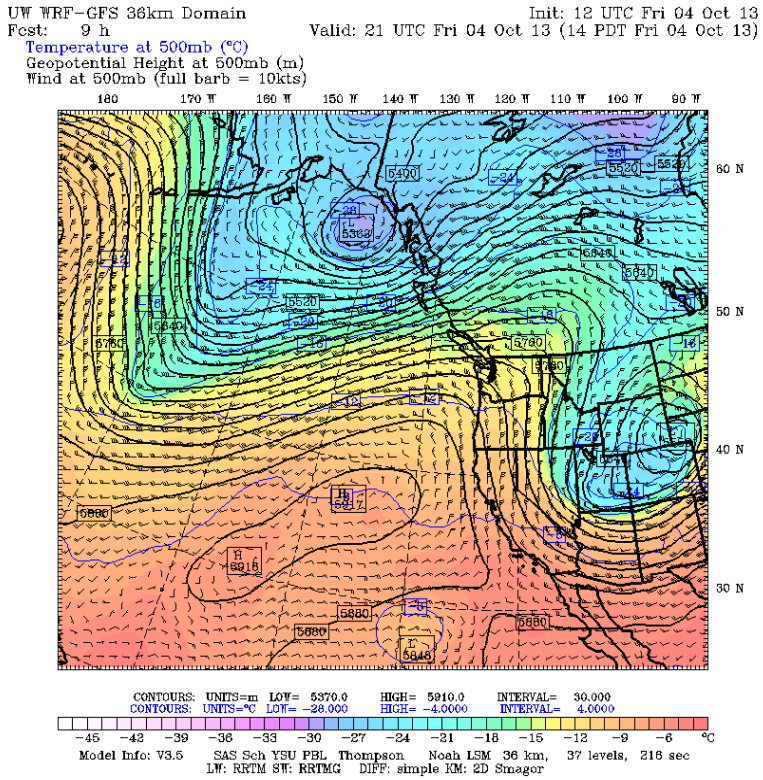

Figure 13. 500 millibar chart for October 4, 2013.

By October 7 another Pacific storm moved over northern Idaho, which brought a little more light rain to the area—generally around a tenth of an inch. Figure 14 shows this Pacific storm as it moved across eastern Washington and into northern Idaho. The wind in the mixed layer was strong enough to break up the low clouds and fog that had formed under the brief high pressure ridge over the region during first week of October.

Figure 15 shows a large high pressure ridge that developed well off the west coast. This high moved east and became the dominant weather feature for northern Idaho for the remainder of October. Ventilation issues brought on by very damp soil conditions, low mixed ceiling heights, and very light wind speeds in the mixed layer as well as at the surface hindered burning during this time.

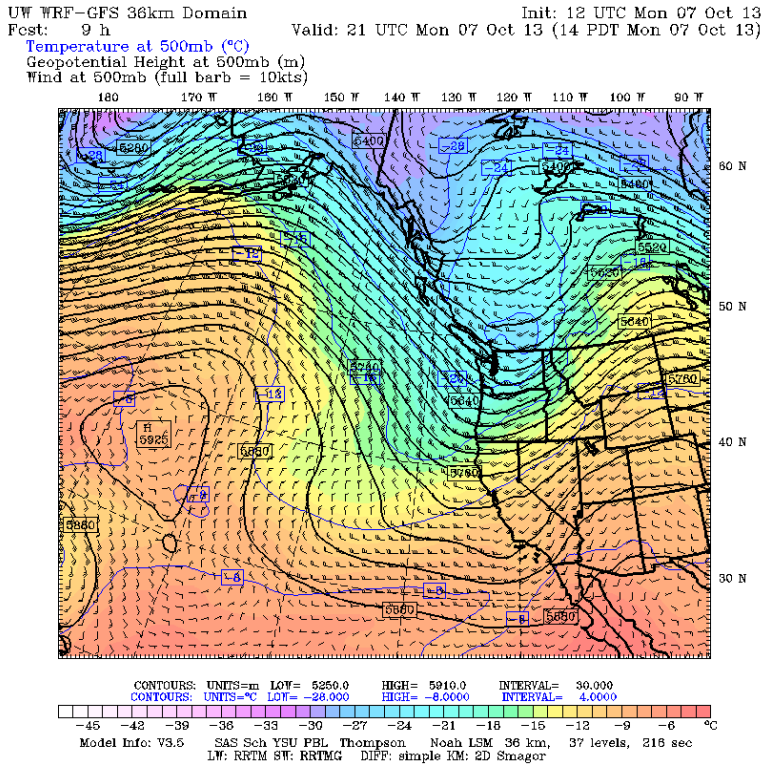

Figure 14. 500 millibar chart for October 7, 2013.

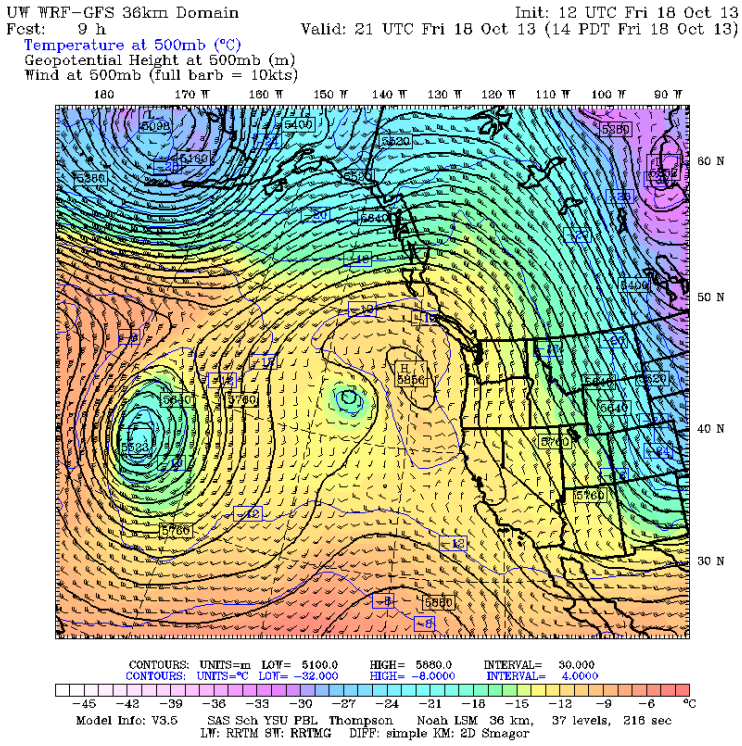

Figure 15. 500 millibar chart for October 18, 2013.

Figure 16 shows the ventilation index chart. The graphic shows the poor to marginal ventilation index values that were typical during the last week of burn season.

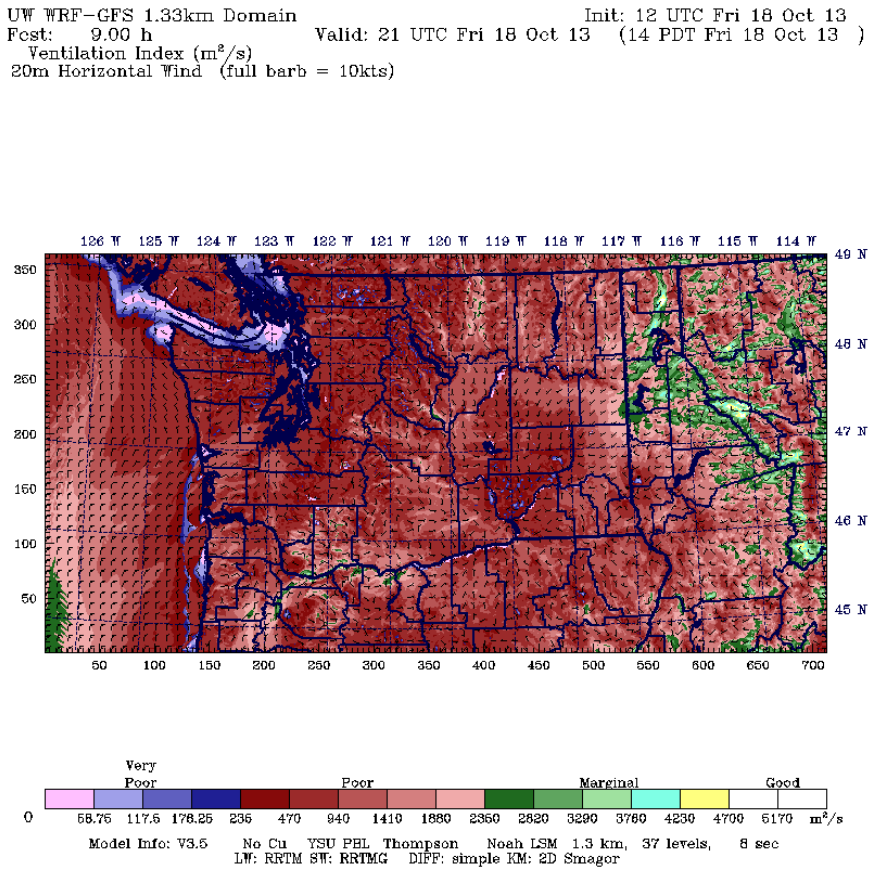

Figure 16. Ventilation Index for October 18, 2013.

Southern Idaho

July

July was a very warm month for all of southern Idaho. The generally dry conditions and warm temperatures led to a series of lightning-caused wildfires across the rangeland and mountains in July and August. The smoke generated from the wildfires began to affect air quality over the southern Idaho airsheds, with smoke from the larger wildfires becoming a problem by the end of July.

This July was the second-warmest July on record for the Boise area with 30 of the 31 days above 90°F and 10 days above 100°F. The temperature reached 110°F on July 1 and the monthly average maximum temperature was 98°F. Figure 17 shows the large high pressure system over the western states. This was typical of the weather pattern for much of the month of July.

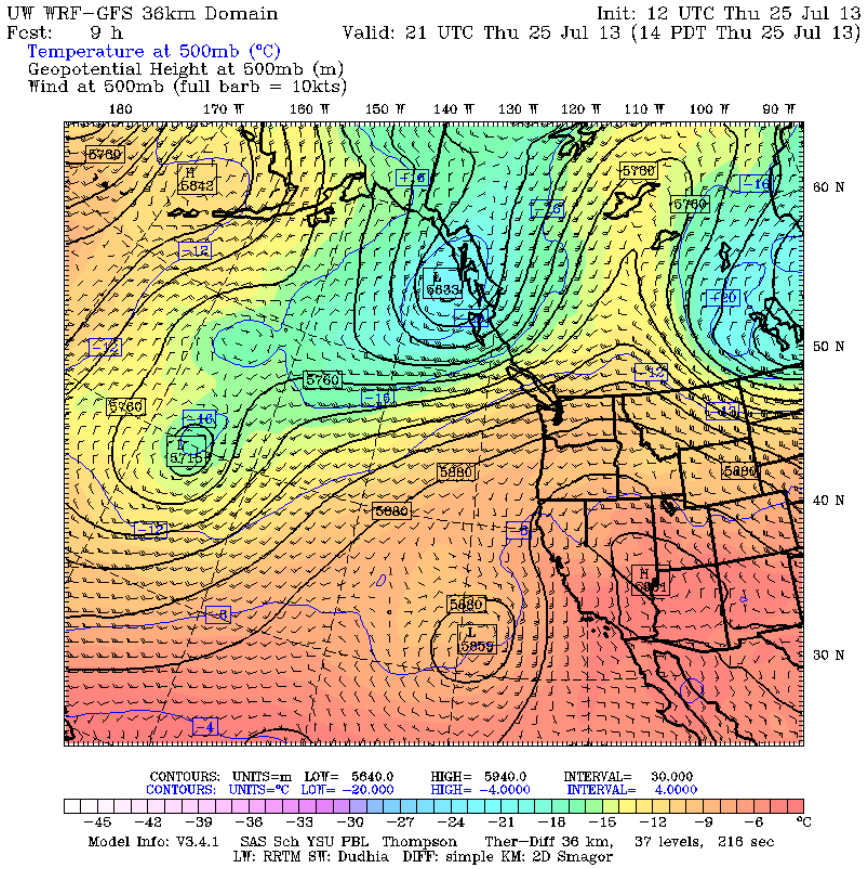

Figure 17. 500 millibar chart for July 25, 2013.

July monthly precipitation amounts were below average at all reporting weather stations with the region receiving roughly one-third of the July monthly average with July 16 being the only day with measurable precipitation. Some locations in the Eastern Highlands and Central Mountains received trace amounts of precipitation in late July.

August

During the first week of August, an upper level trough moved across the Pacific Northwest but remained just north of southern Idaho. Figure 18 shows the upper low forming over the Oregon/Washington border before retrograding and settling off the California coast.

August was also a very warm month and turned out to be one of the hottest Augusts on record. Precipitation was quite limited and showers were very widely scattered with gusty winds being the primary component of summer thunderstorms rather than rain. A pattern of southwesterly flow would be the persistent feature through this month as several lows would drop from the Gulf of Alaska and settle along the California/Oregon/Washington coast. Southeast and eastern Idaho recorded precipitation on August 1 and did not experience any further precipitation until the last week of August, except for a trace in Driggs during the second week of the month.

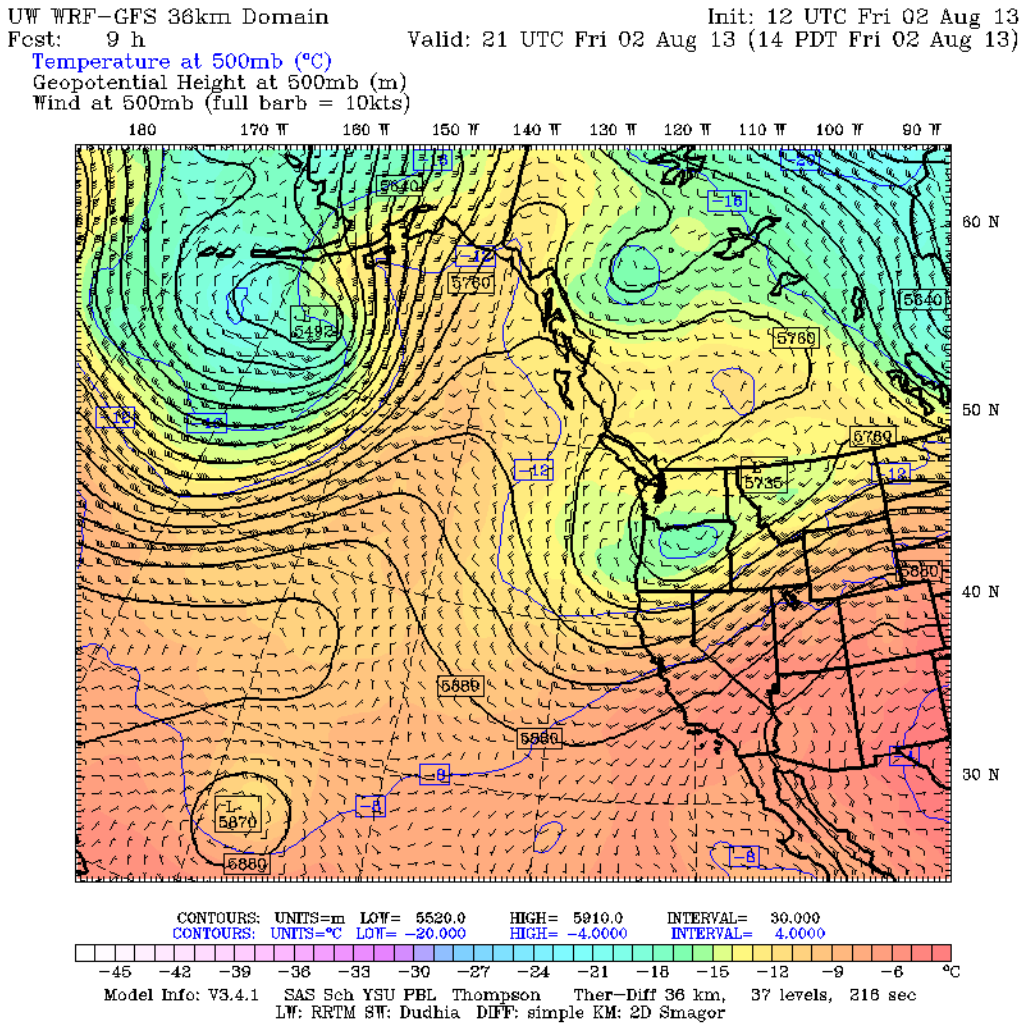

Figure 18. 500 millibar chart for August 2, 2013.

By the second week of August, higher pressure had built over the desert southwest as an upper trough developed off the west coast. This pattern brought an unstable air mass over southern Idaho but with limited precipitation. Temperatures across southern Idaho reached into the upper 90s and lower 100s, with Boise reaching 106°F on August 7.

The warm upper level ridge over southern Idaho during the first and second weeks of August kept temperatures in the 90–100°F range. Light winds in the mixed layer and at the surface hindered ventilation as wildfire smoke drifted occasionally over all airsheds inhibiting visibility and opportunities to approve crop residue burning. Analysis of satellite imagery showed that smoke from the large Rim Fire in California was being carried into southern Idaho on the southwesterly winds. Figure 19 shows the ridge over southern Idaho with the high centered over Arizona.

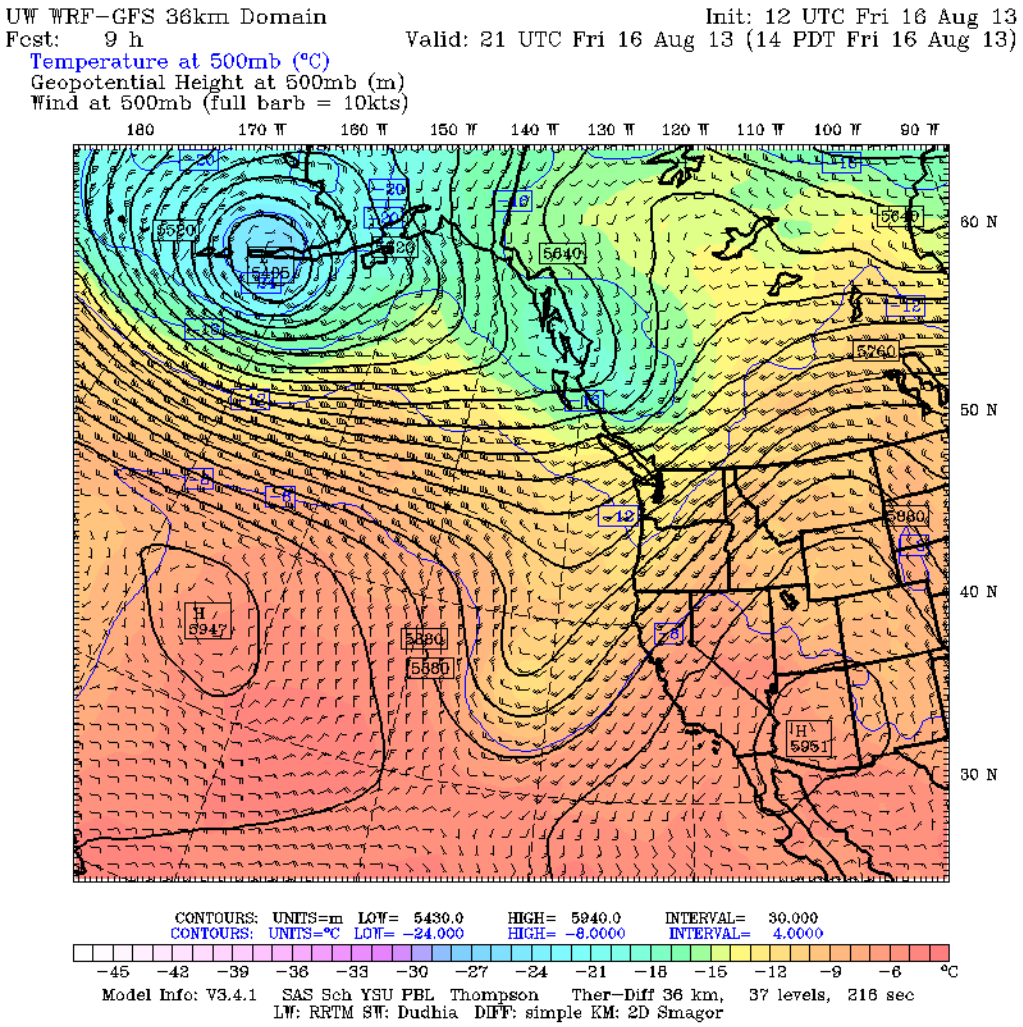

Figure 19. 500 millibar chart for August 16, 2013.

Boise was the only area in southern Idaho to record above average rainfall for the month of August at 0.21 inch above average due to an isolated thunderstorm on August 22. The monthly Boise Airport precipitation total of 0.45 inch is likely not representative of the total regional precipitation due to the extreme variability that is inherent with isolated thunderstorms. The rest of southern Idaho experienced spotty precipitation through the last 2 weeks of August as monsoon moisture was carried into southern Idaho via the southwest flow.

Figure 20 shows the warm southwesterly flow over southern Idaho in late August. The storm track was well north of Idaho across northern British Columbia. The trough off the coast did keep some mid- and high-level moisture moving inland at times, but rainfall was very limited. This southwesterly flow also kept nighttime temperatures relatively warm. Wildfire smoke was present for much of the month due to the persistent southwesterly flow.

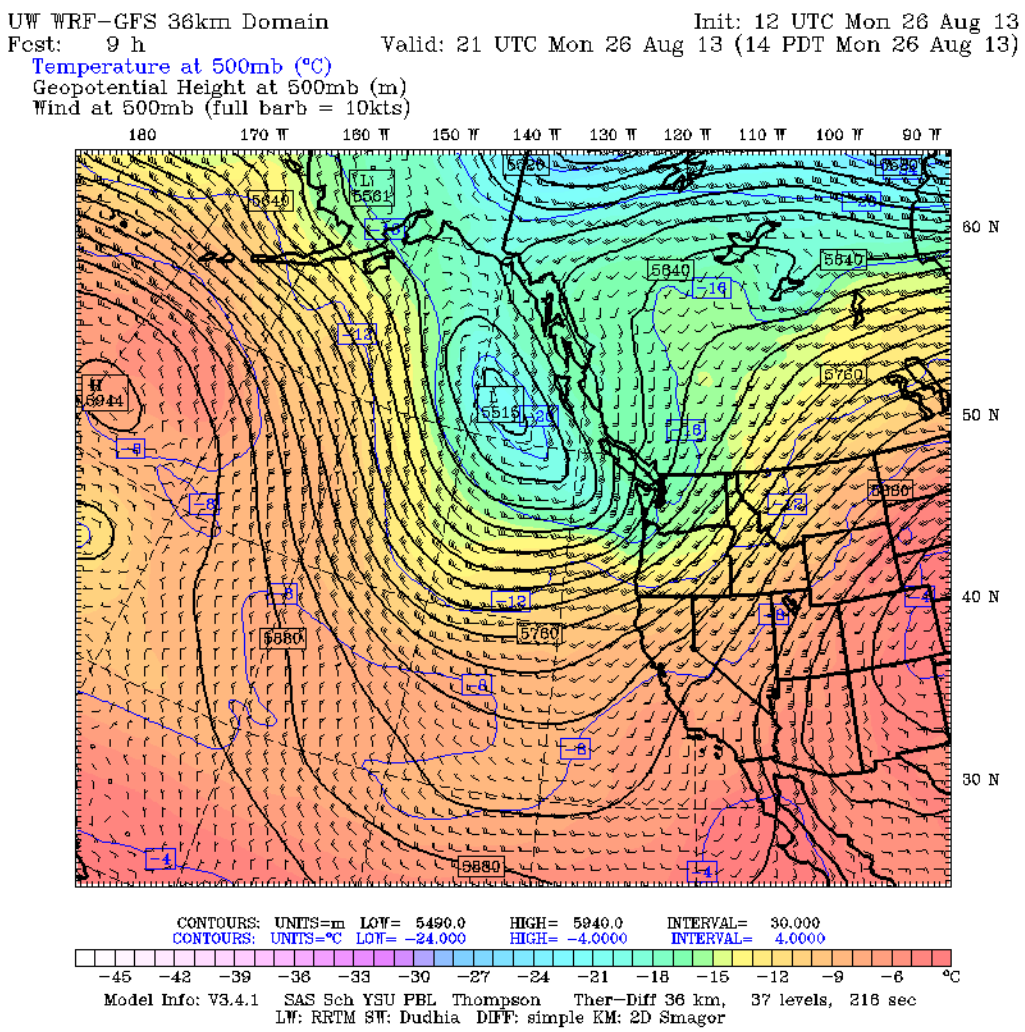

Figure 20. 500 millibar chart, August 26, 2013.

September

By the first week of September the upper level trough that was off the coast was pushed east into Idaho by a Pacific storm moving into the Gulf of Alaska. Coupled with strong monsoon moisture, the result was warmer temperatures, gusty surface winds, and the wettest September since 1998. The gusty winds produced increased wildfire activity and fanned the existing fires to grow even larger. Figure 21 shows the breakdown of the upper ridge as a low pressure system moved into the Pacific Northwest. The high pressure was now centered over Colorado.

Figure 22 shows that the upper ridge axis had moved farther east as the low had also moved further inland. This upper level trough and a moist southerly flow aloft produced spotty precipitation across southern Idaho. The first week of September saw 94 degree temperatures, 24 hour precipitation totals of 0.49 inch, and wind gusts of 51 miles per hour.

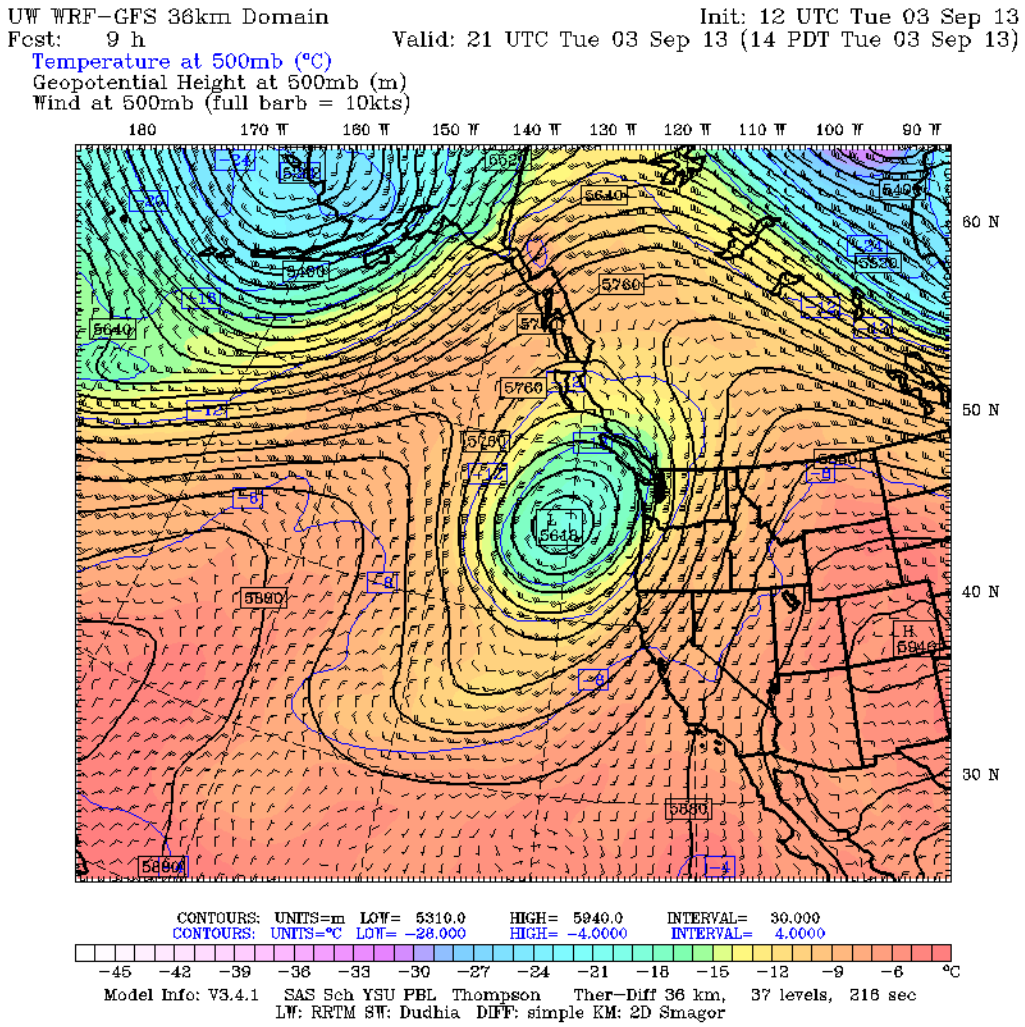

Figure 21. 500 millibar chart for September 3, 2013.

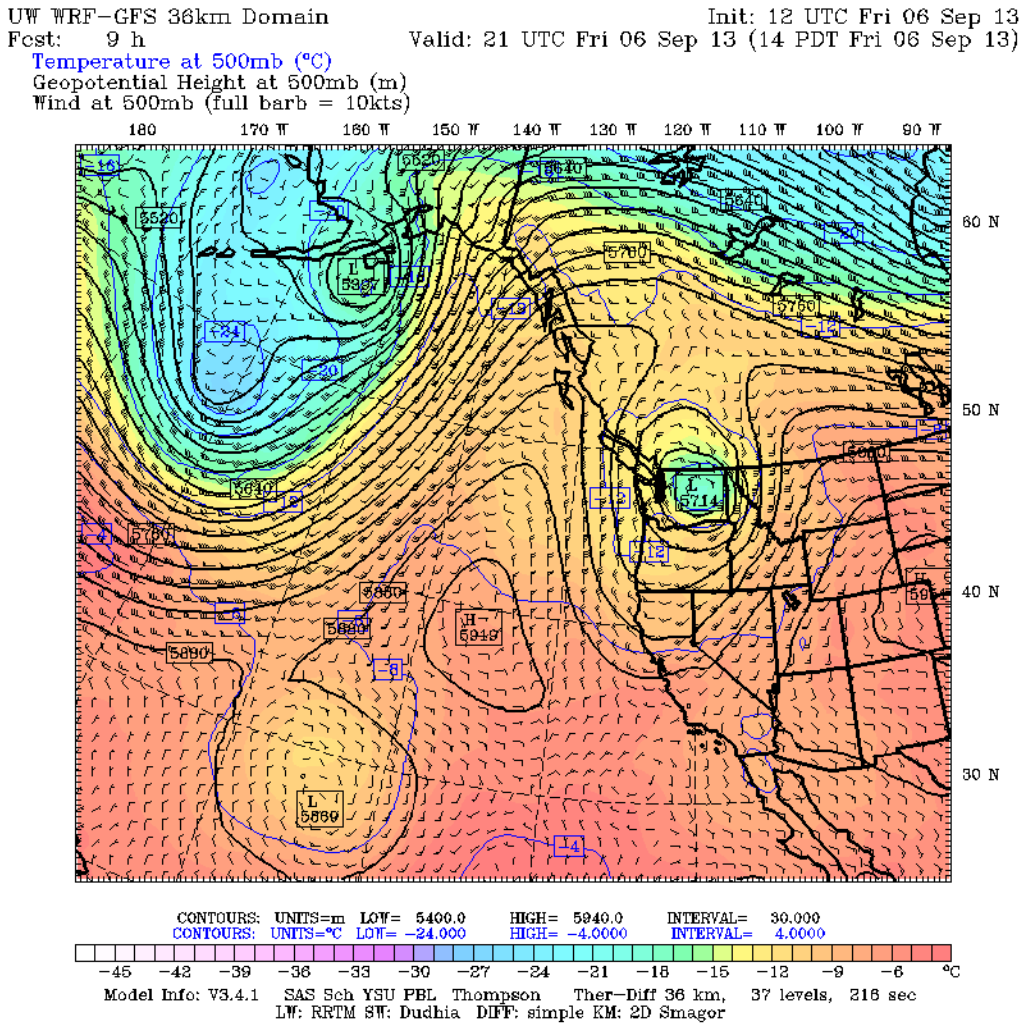

Figure 22. 500 millibar chart for September 6, 2013.

Summer returned to southern Idaho after the first week of September. The cool upper level trough moved east and dry and stable higher pressure began to rebuild off the west coast. Figure 23 and Figure 24 show the persistent high pressure that was typical of the next two weeks of September.

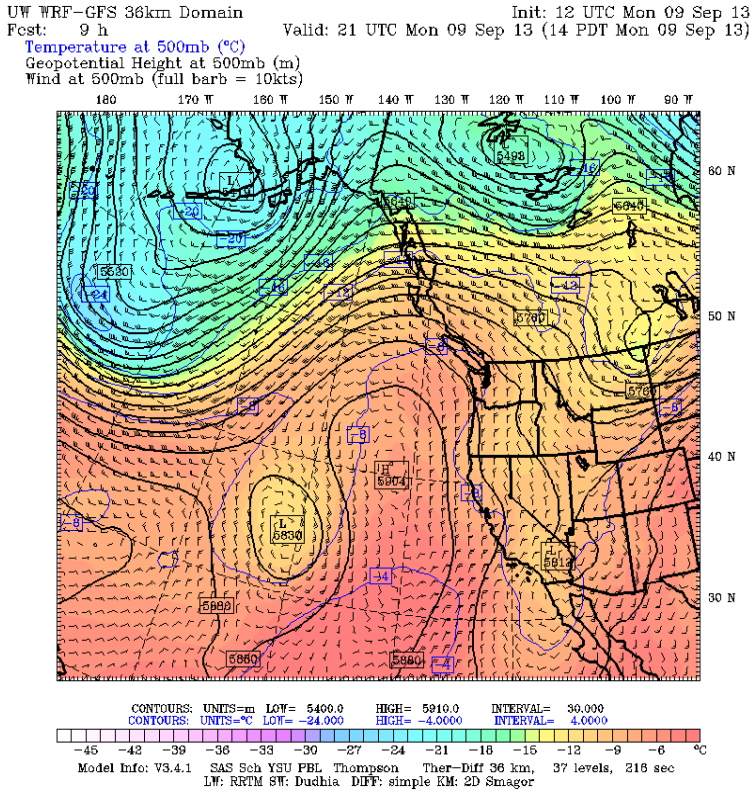

Figure 23. 500 millibar chart for September 9, 2013.

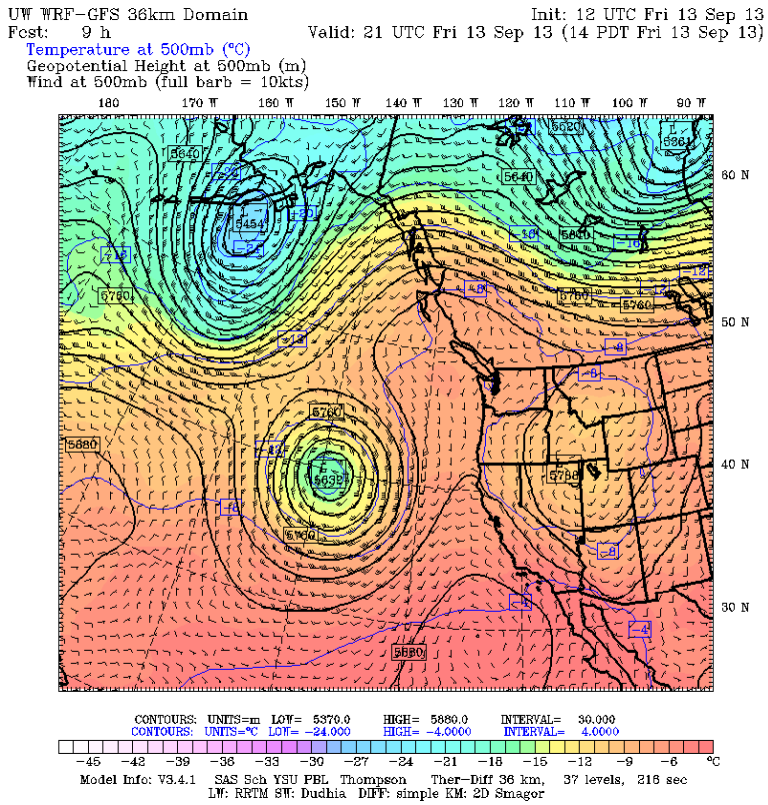

Figure 24. 500 millibar chart for September 13, 2013.

The upper trough positioned in the Gulf of Alaska would dig along the west coast pumping up the ridge over southern Idaho. The high pressure ridge would then remain blocked into position over southern Idaho for nearly the next week. Figure 25 shows the ridge beginning to breakdown with the approaching trough.

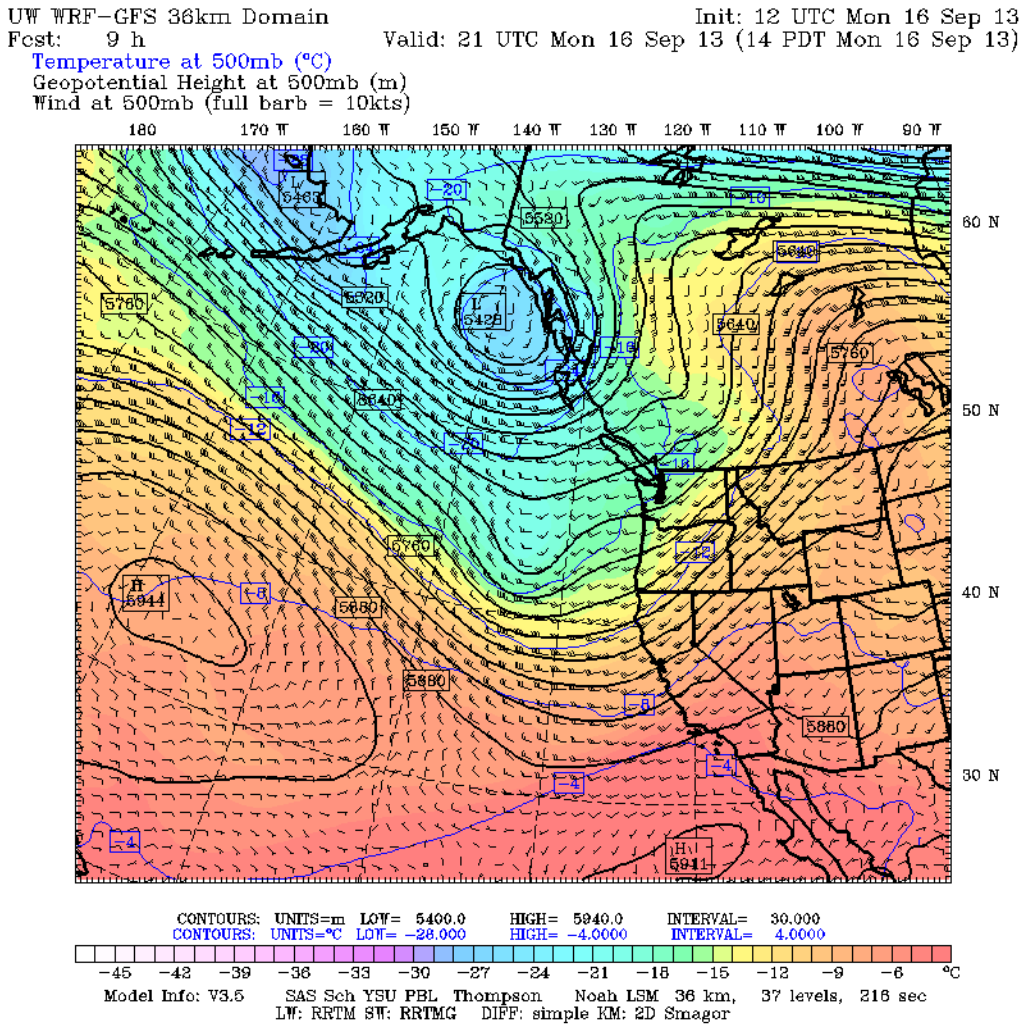

Figure 25. 500 millibar chart for September 16, 2013.

On September 17, a strong pacific cold front initiated a quick transition to early fall weather where temperatures averaged below normal most days as strengthening west winds over the north pacific carried a series of cold upper level troughs over the Pacific Northwest (Figure 26). Temperatures were more typical of late October than late September. Wind speeds were the limiting factor in burning during this time period with most days experiencing wind gusts over 20 miles per hour.

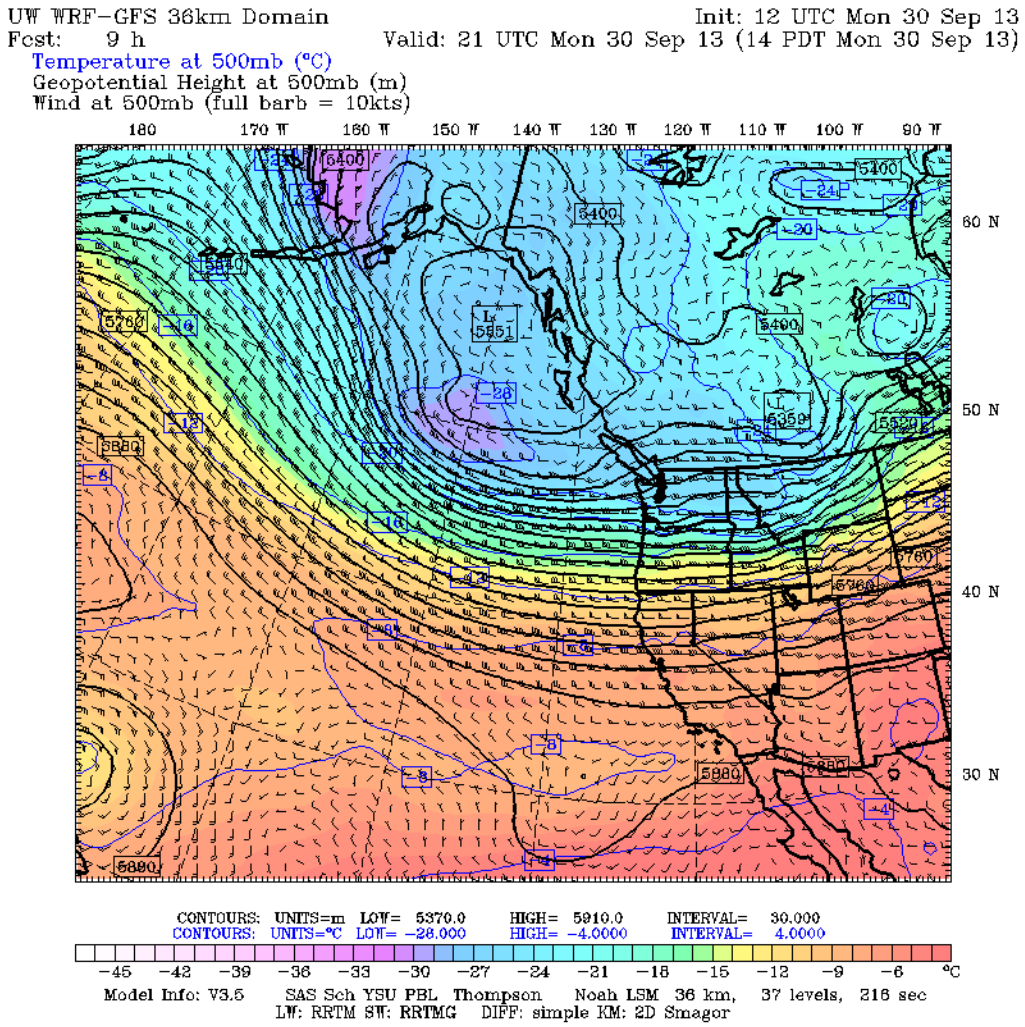

Figure 26. 500 millibar chart for September 30, 2013.

October

The month of October began with a strong high pressure ridge over the Pacific Northwest. Figure 27 shows the ridge just extending into southwestern Idaho with the storm track over northern Idaho and southern British Columbia.

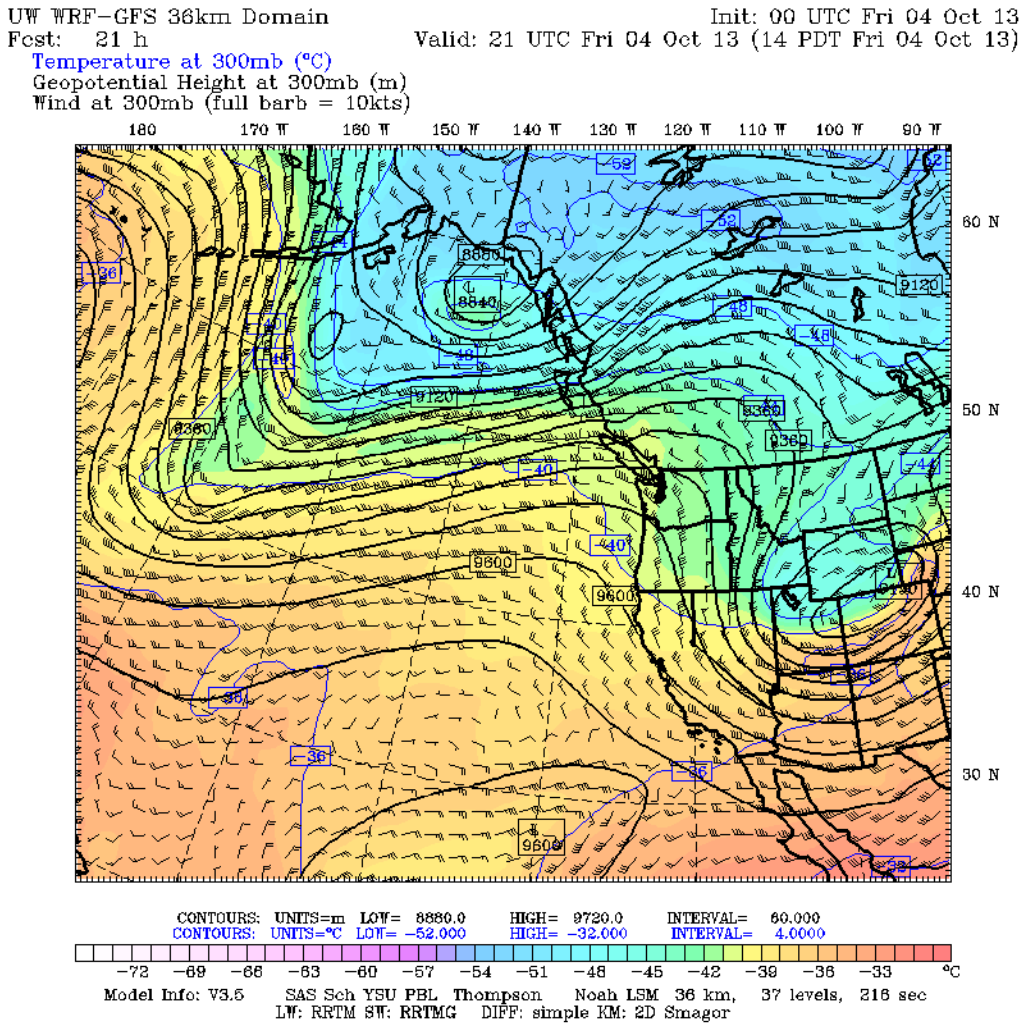

Figure 27. 500 millibar chart for October 4, 2013.

Figure 28 shows a major shift in the weather pattern over southern Idaho. The offshore low would move from the coast and bring temperatures nearly 20°F cooler by October 27. At this point, freezing rain and snow became a common occurrence in the forecast, particularly at elevated areas across southern Idaho.

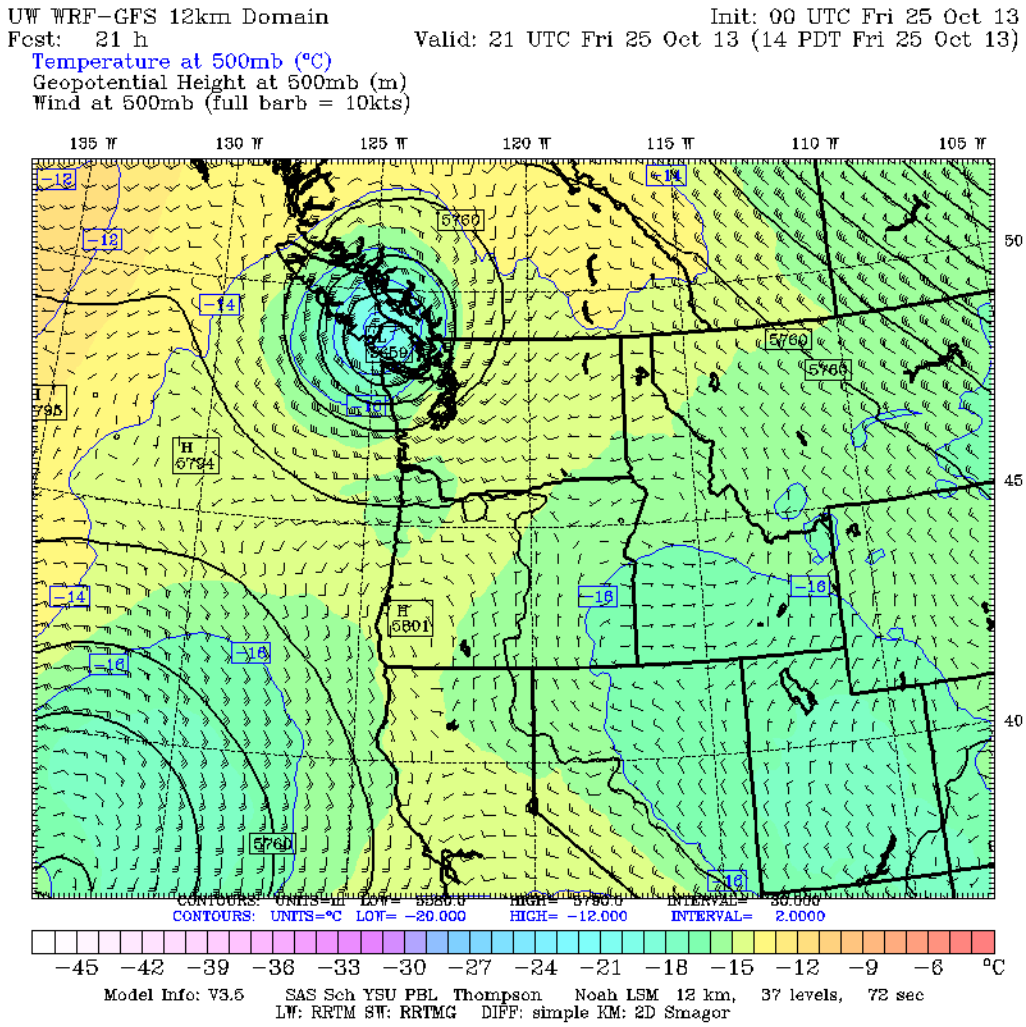

Figure 28. 500 millibar chart for October 25, 2013.

The progression of Pacific storms would become more complicated as the offshore low over the Puget Sound would gradually move southeast and intensify over northern Nevada as shown in Figure 29.

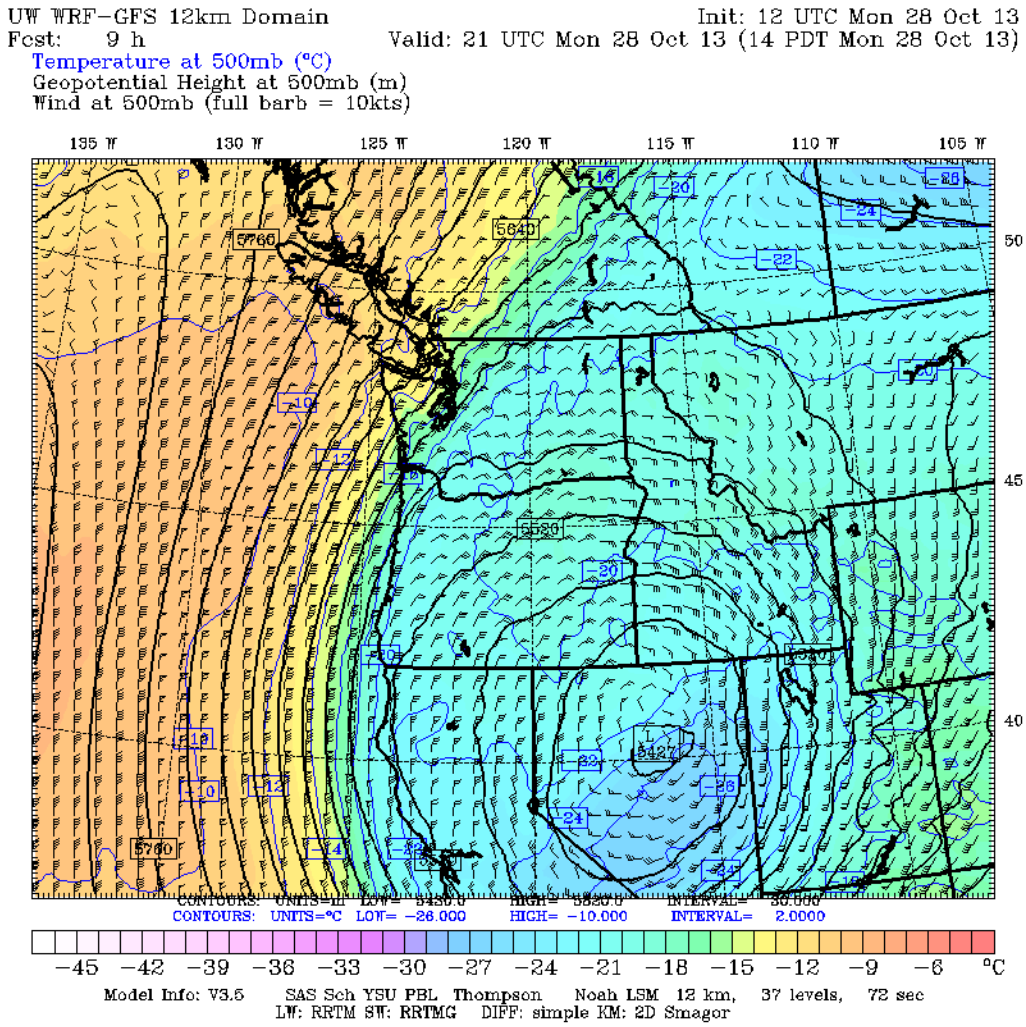

Figure 29. 500 millibar chart for October 28, 2013.

November

The southern Idaho burn season continued into the month of November with the beginning of the month experiencing a progressive upper air pattern with eastward moving weather systems from the north Pacific alternating with transient high pressure ridges. Figure 30 and Figure 31 show the westerly progression of Pacific storms. This weather pattern usually signals the beginning of the end for wildfire and crop residue burning across all of Idaho and the Pacific Northwest. Figure 30 shows the warm transient ridge over Idaho, while Figure 31 shows the shortwave trough that has now flattened the high pressure ridge with a moist westerly flow as the jet stream has lowered into Washington State.

On November 16, a moist system out of the Gulf of Alaska brought 2 inches of snow to the valley floors, bringing an end to the crop residue burn season.

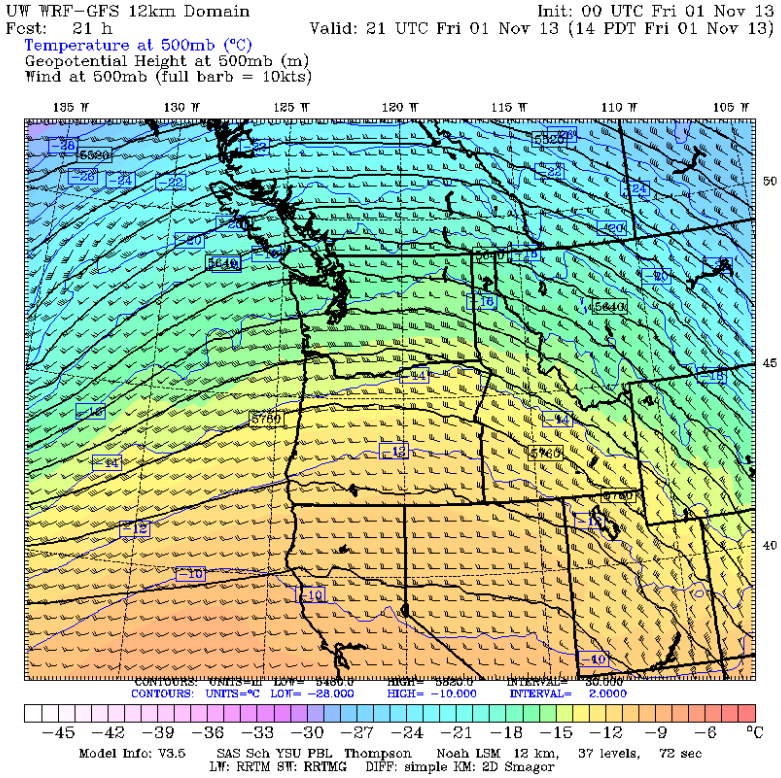

Figure 30. 500 millibar chart for November 1, 2013.

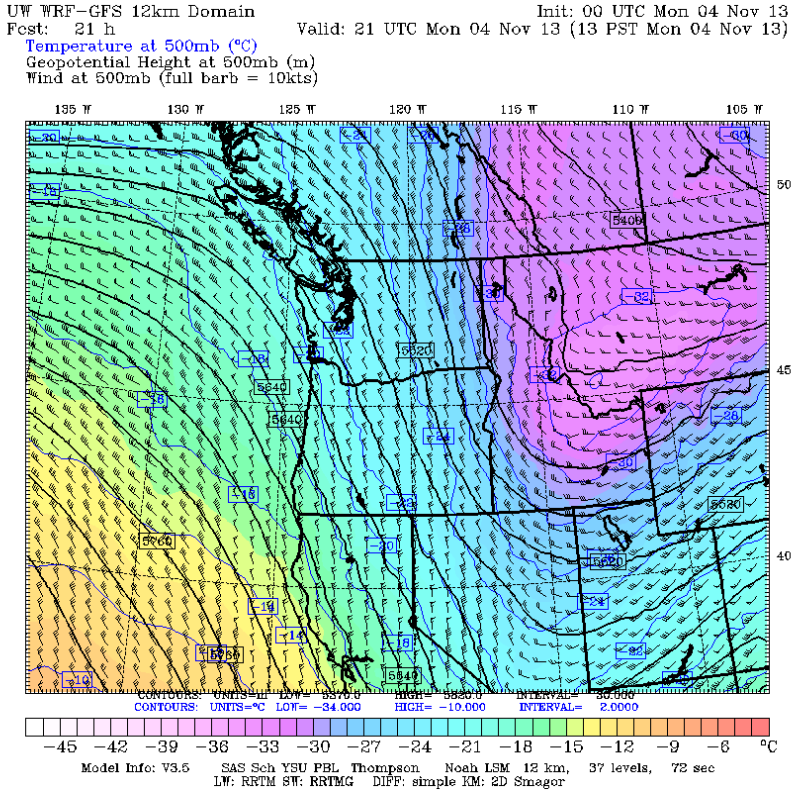

Figure 31. 500 millibar chart for November 4, 2013.