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ROMAN- Realtime Observation Monitoring and Analysis Network

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1. INTRODUCTION

The Real-time Observation Monitor and Analysis Network (ROMAN) has been developed to provide real-time weather data to meteorologists and land managers who deal with wildland fire. ROMAN is a web-based system designed to provide access to weather observations from a large number of networks across the United States. The system displays data in fast-loading formats tailored to the wildland fire community. The interface is intuitive, interactive, and dynamic. The software is designed to be accessible to the wide range of fire professionals requiring observational data, from the top levels managers using high speed networks to the fire behavior analyst in the field using a slow dial-up connection.

ROMAN has been under development since April 2002 and tested during the 2002 and 2003 fire seasons. In the relatively short time that ROMAN has been operational, its use has grown quickly. Fire behavior analysts, long-term fire analysts, fire management officers, and geographic area coordination center meteorologists use ROMAN to monitor weather conditions for strategic and tactical decision making as well as to determine the impacts of weather on fire behavior and fire fighting resources. National Weather Service (NWS) meteorologists use ROMAN at forecast offices to monitor conditions within their County Warning Areas (CWAs), issue spot fire forecasts as well as general forecasts, and for verifiying forecasts and outlooks. NWS incident meteorologists, who are assigned to support fire suppression operations, use ROMAN in the field to monitor weather conditions in the vicinity of major wildland fires.

ROMAN is an expansion of the capabilities of MesoWest, which has been developed at the University of Utah over the past decade to provide access to surface weather information (Horel et al. 2002a, 2002b). Many of the display capabilities found in ROMAN were implemented initially at the Missoula NWS Weather Forecast Office by Tim Barker to general and fire weather operations in that region.

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2. ROMAN DATA SOURCES

Surface data from weather observing stations across the United States have been linked together into a common MySQL database. The Automated Surface Observing System network maintained by the NWS, Federal Aviation Administration, and the Department of Defense is supplemented by networks supported by over 120 government agencies and commercial firms. Data from over 5000 stations are currently available in ROMAN. The Remote Automated Weather System (RAWS) network, operated by United States land management agencies, provides the largest single combined source of surface weather observations in the western United States (Fig. 1) as well as many stations in the eastern United States and Alaska (not shown). Weather conditions at most stations are available at least once per hour; some stations report observations every five minutes.

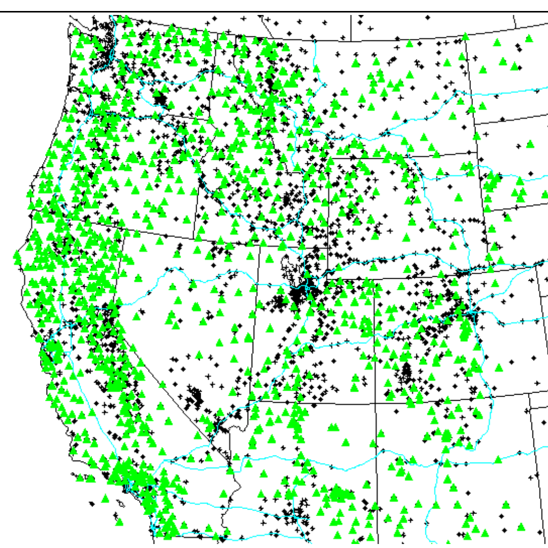

Figure 1. Stations available in ROMAN in the western United States. RAWS stations- triangles; other stations- plus symbols.

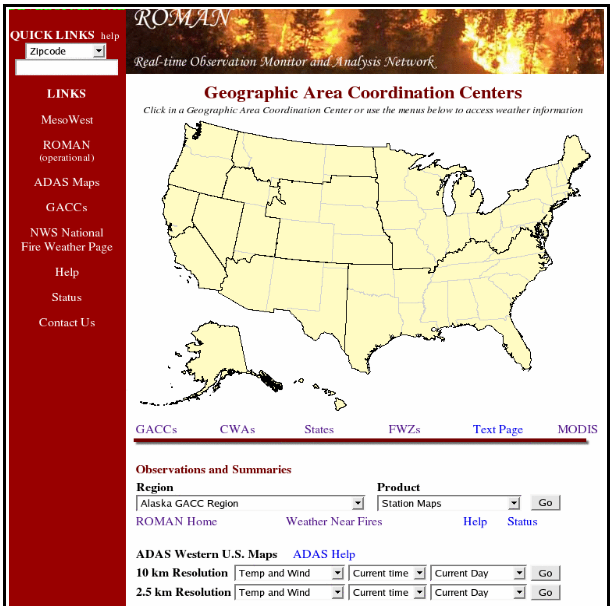

Figure 2. ROMAN web portal (www.met.utah.edu/roman).

3. ROMAN USER INTERFACE

The top-level ROMAN web page is shown in Fig. 2. The user may select a variety of ways to access weather information from this page. Because of the wide spectrum of users, geographic areas of interest are defined by state, Geographic Area Coordination Center (GACC), or CWA and Fire Weather Zone (FWZ) as defined by the NWS. The CWA interface for Salt Lake City is shown in Fig. 3. In order to display data collected from portable Fire RAWS stations (as well as permanent RAWS stations that occasionally are moved to support local

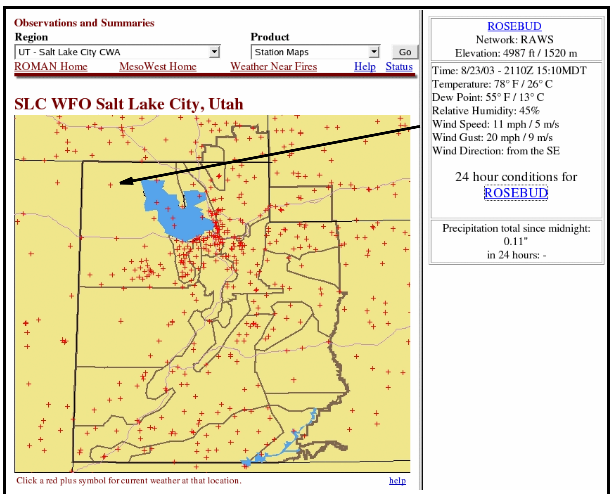

Figure 3. CWA interface for the Salt Lake City WFO. The plus symbols provide access to weather information (in this instance Rosebud, UT was chosen). CWA tabular summaries are subdivided into the forecast zones delineated by gray lines.

data needs), the station metadata required to georeference the observations by state, GACC, WFO, and FWZ and the maps that are used to display the stations are updated daily.

Once a station is selected from one of the user interfaces, weather information is summarized in tabular and graphical forms (Fig. 4). The user can toggle between metric and English units, local time vs. UTC, or select a number of other display options. Depending upon when data began to be archived for each network, observations can be retrieved from January 1997 to the present. An estimate of the quality of the observations based upon simple checks and comparison to other observations available at that time is also made. Data may be output to a spreadsheet for off-line analysis as well.

Tabular summaries of weather observations are available by pull down menus and are organized by state,

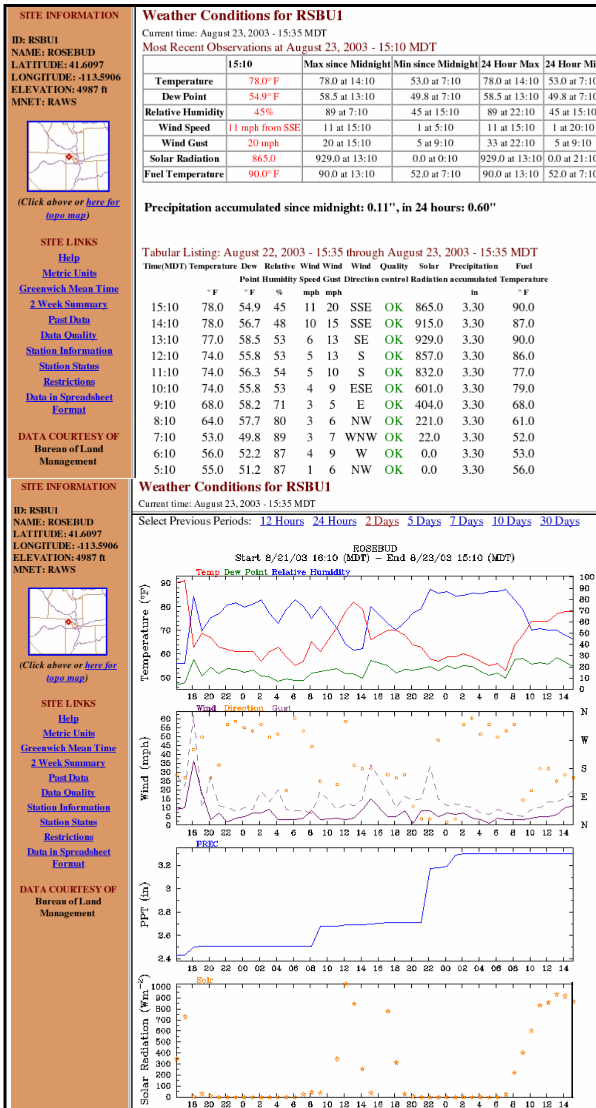

Figure 4. Tabular and time series station displays.

Table 1. Current Weather Summary of RAWS stations for a predictive service area within the Eastern Great Basin Coordination Center.

Current Weather Summary for Eastern Great Basin GACC Region

Settings: RAWS | Eastern Great Basin GACC Region | Reports within last 12 hrs | Change Settings

Last updated 22:36 UTC 8/23/2003 Sort by elevation Help QC Flag: Ok, Caution, Suspect

CIC: Central Idaho Interagency Dispatch Center

		Time		Current					24 Hour					Precipitation			
Station	Elev	LOCAL	UTC	TEMP	RH	WIND	DRCT	PKWND	MAX T	MIN T	MAX RH	MIN RH	MAX G	1 HR	3 HR	6 HR	24 HR
BONANZA	6411 ft	1605MDT	2205	75	19	6	W	19	75	45	100	19	41	0	0	0	0.38
CHALLIS	5249 ft	1600MDT	2200	83	19	6	SE	13	83	47	95	19	42	0	0	0	0.23
COPPER BASIN	7822 ft	1605MDT	2205	70	20	6	SW	18	70	32	100	20	39	0	0	0	0
EZRA CREEK	6660 ft	1610MDT	2210	76	24	5	E	19	76	49	92	24	38	0	0	0	-
INDIANOLA	3501 ft	1605MDT	2205	87	16	3	SE	11	87	55	63	16	12	0	0	0	-
KRILEY CREEK	5200 ft	1525MDT	2125	77	31	6	NNW	12	77	52	83	31	31	0	0	0	0.33
LEADORE CREEK	6001 ft	1525MDT	2125	77	21	9	WNW	14	77	43	100	21	40	0	0	0	0.11
LITTLE CREEK	4619 ft	1605MDT	2205	85	23	4	WSW	15	85	53	100	23	54	0	0	0	0.27
ROAD CREEK	8199 ft	1540MDT	2140	65	28	9	WSW	26	65	42	98	28	57	0	0	0	0.21
SALMON	4961 ft	1550MDT	2150	74	29	10	NNE	19	76	53	73	29	55	0	0	0	0.34
SKULL GULCH	5098 ft	1605MDT	2205	73	31	6	WNW	19	73	51	100	31	42	0	0.01	0.01	-

GACC, CWA, or FWZ. These summaries are subdivided by county, predictive service area, forecast zone, and fire weather forecast zone, respectively. The stations can be sorted within each subdivision either alphabetically or by elevation. Users may also select the observational networks to display (RAWS only, NWS and RAWS, or All Networks) and the amount of data to be displayed for each station (1-12 h). All tabular summaries auto-update every 5 minutes to provide continuous monitoring.

Tabular summaries are designed for specific applications and include:

- •Current Weather Summary
- •24-Hour Trend Monitor
- •Fire Weather Monitor
- •Temperature, Relative Humidity, and Wind Speed Maximum and Minimum Summaries
- •Precipitation Monitor
- •Precipitation Summary

Each of these summary products are described briefly below.

The *Current Weather Summary* is intended to provide a quick overview of the current weather situation in the selected geographic area. It provides access to current, 24 h maximum/mininum, and precipitation summary information for all available weather stations within the selected region (see Table 1). The page posts the most recent observations of temperature, relative humidity, wind speed and direction, and peak wind, as well as maximum/minimum values of temperature, relative humidity and wind speed over the past 24 hours. 1, 3, 6, and 24 h precipitation totals are also provided.

The *24-Hour Trend Monitor* displays current and 24 h trend information for all available weather stations within a geographic region (state, GACC, CWA, or FWZ). The trend in temperature, dewpoint temperature, relative humidity, wind speed and direction, and wind gusts are available. The same software is used to monitor trends within a user-defined radius of an object (placename, zipcode, latitude/longitude coordinate pair, or fire). Users can query the MySQL database for matches to over 400,000 place names (summits, population centers, etc.) sorted by state.

The *Fire Weather Monitor* is designed to assess extreme weather conditions within a geographic area (Table 2). Fire specialists can quickly assess where weather wind speed, wind gust, relative humidity, or precipitation exceed values set by the user. The user can choose either the logical "And" or "Or" operator. The "And" operator lists stations for which all of the selected thresholds have been exceeded at the same time during the selected time period. For example, stations where red flag conditions (combination of high wind and low relative humidity) are occurring can be determined. If all the conditions are satisfied at a station more than one time, then the most recent observation will be displayed. The "or" operator lists all the stations that have exceeded the threshold value for each variable during the selected time period. The stations are listed in descending order for each variable. For each station, only the most extreme value that occurred in the time period is listed. Any station reporting weather or obstructions to visibility (rain, thunder, blowing dust, etc.) is also shown.

The *5 Day Maximum/Minimum Summaries* provide access to 24-hour maxima and minima of either temperature, relative humidity, or wind speed during the past 4 days for all available weather stations within the selected region, as well as the maximum and minimum values since local midnight at each station. Short-term trends that affect fuels and fire growth can be assessed with these tools.

The extent and duration of precipitation events can

Table 2. Fire Weather Monitor display for the 2200 UTC 24 August, 2003. RAWS stations in the Eastern Great Basin GACC region that had sustained winds in excess of 15 mph and relative humidity below 25 % during the past 2 h are shown.

Fire Weather Monitor for Eastern Great Basin GACC Region

Settings: 2 -h Summary RAWS | Eastern Great Basin GACC Region

Thresholds: Wind >= 15 mph; Gust >= mph; Gust >= mph; RH <= 25 %; RH>= %; Precip/2 hrs>= inches; AND / OR; Change Values

22:39 UTC 08/24/2003 Help QC Flag: Ok, Caution, Suspect

Station	Info	Time	Wind mph	Relh %	Weather
ACRI1 **ARCO**	RAWS 5381 ft	2130Z 15:30MDT	19	13	
CBFI1 **COPPER BASIN**	RAWS 7822 ft	2205Z 16:05MDT	17	15	
FLEI1 **FLECK SUMMIT**	RAWS 6499 ft	2205Z 16:05MDT	18	15	
LDOI1 **LEADORE CREEK**	RAWS 6001 ft	2125Z 15:25MDT	15	14	
MKBI1 **MULKEY BAR**	RAWS 6319 ft	2130Z 15:30MDT	15	11	
OHOI1 **OHIO GULCH**	RAWS 6220 ft	2135Z 15:35MDT	18	15	
RDKI1 **ROAD CREEK**	RAWS 8199 ft	2140Z 15:40MDT	19	17	
VENU1 **VERNON**	RAWS 5499 ft	2125Z 15:25MDT	15	24	

be determined from the *Precipitation Monitor* and *Precipitation Summary*. The former lists precipitation totals in fixed time intervals (1, 3, 6, 12 24 h as well as since midnight and 1300 LT) for all available weather stations within the selected region. The totals are calculated by looking at the most recent observation and observations during the past 24 hours. The latter provides access to precipitation totals over a range of time intervals (i.e., past 2, 5, 7, or 30 days) for all available weather stations within the selected region. The Precipitation Summary also displays the days since predefined threshold values (.01, .10, .25, .50, and 1.0 in) of precipitation were recorded during a calendar day.

4. WEATHER NEAR FIRES

Once a wildland fire breaks out, fire professionals need to be able to identify the available weather resources in the vicinity of the fire. Even individuals familiar with the locations of the permanent weather stations in a particular area may be unaware of portable FIRE RAWS stations that are often deployed to support fire suppresion operations. In order to assess quickly the locations of stations in the vicinity of major fires, a number of tools have been created to expedite this task (in addition to simply searching by latitude/longitude or place name).

The locations of all active and recently contained major fires are retrieved daily from the National Interagency Fire Center as well as the map generated by the Center to display the locations of many of those fires (Fig. 5). Pull down menus organized by Geographic Area Coordination Center (GACC) list all the fires while links to each GACC provide access to maps that display the locations of the fires (Fig. 6). Once the user selects a specific fire from either the map interface or the pull down menus, the current weather and 24-h trend in the vicinity of the fire are available in a tabular format (Table 3).

Another way to determine the weather conditions in the vicinity of major fires is illustrated in Fig. 7. The MODIS interface relies upon georeferencing of the actively burning and previously burned areas derived from satellite (see http://activefiremaps.fs.fed.us for details). The locations of weather stations are superimposed upon the topographic maps generated by the Remote Sensing Applications Center and weather condi-

Table 3. Weather near the Trapper Creek, MT fire complex.

Trapper_Creek_Complex Fire: Latitude 48.791 Longitude -113.914   25590 acres
(*Fire location* provided by: *TopoZone*)

24-Hour Trend Monitor

Settings: 2 -h Summary RAWS 50 mi Radius Change Settings

24-Hour Changes 22:48 UTC 08/23/2003   Sort by: name or elevation   Help   QC Flag: Ok, Caution, Suspect

Station	Info	Dist/Dir	Time	Temp	DewT	RH	Dir	Spd	Gust
TR513 **FRWS-20**	RAWS 6781 ft	6 mi W	2225Z 16:25MDT 2125Z 15:25MDT	53/- 6 56/- 5	36/- 4 39/+ 1	53/+ 4 52/+ 11	WSW / WNW WSW / W	5/+ 3 6/+ 2	16/+ 7 17/+ 5
NS039 **POLEBRIDGE**	RAWS 3550 ft	19 mi WSW	N/A 2145Z 15:45MDT	73/+ 0	40/- 5	30/- 6	SW / N	15/+ 9	23/+ 6
WGRM8 **WEST GLACIER**	RAWS 3199 ft	20 mi S	2210Z 16:10MDT 2110Z 15:10MDT	70/ 69/- 9	41/ 40/+ 4	35/ 35/+ 13	WSW/ WSW / W	5/ 9/+ 2	17/ 16/+ 4
CYFM8 **CYCLONE**	RAWS 5299 ft	20 mi WSW	2150Z 15:50MDT 2050Z 14:50MDT	66/- 1 66/- 6	38/- 2 40/+ 1	36/- 2 39/+ 8	SW / E SSW / SSW	5/+ 4 9/+ 6	27/+ 16 22/+ 10
SRYM8 **ST. MARY**	RAWS 4560 ft	22 mi E	2225Z 16:25MDT 2125Z 15:25MDT	71/- 4 73/- 6	35/+ 5 39/+ 11	27/+ 8 29/+ 14	NNE / SSW S / W	8/+ 3 7/+ 3	25/+ 12 22/+ 12
TR545 **FRWS-22 (ROBER**	RAWS 6489 ft	27 mi SW	2220Z 16:20MDT 2120Z 15:20MDT	60/- 1 59/+ 0	38/- 3 41/+ 4	44/- 4 51/+ 7	SSW / NW S / NW	7/+ 6 8/+ 6	20/+ 14 18/+ 8
TR512 **FRWS-19**	RAWS 6781 ft	28 mi WNW	2225Z 16:25MDT 2125Z 15:25MDT	55/- 2 56/+ 1	35/- 8 36/- 6	46/- 12 47/- 14	SSW / SSW S / WSW	16/+ 4 15/+ 3	32/+ 14 31/+ 10
HNYM8 **HUNGRY HORSE**	RAWS 3225 ft	29 mi SSW	2210Z 16:10MDT 2110Z 15:10MDT	76/ 76/+ 0	39/ 41/+ 0	26/ 28/+ 0	W/ SW / SW	8/ 6/- 3	23/ 24/+ 8
TR543 **STILLWATER**	RAWS 3117 ft	34 mi WSW	2230Z 16:30MDT 2130Z 15:30MDT	77/+ 8 75/+ 5	33/- 15 35/- 12	20/- 26 23/- 20	SW / NE SW/	7/+ 4 7/+ 3	16/+ 9 22/+ 7

Figure 5. ROMAN Weather Near Fires summary page.

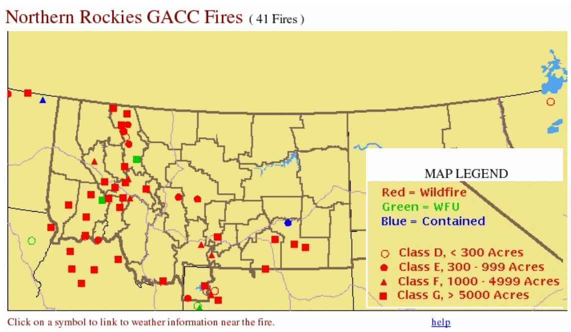

Figure 6. Location of major fires on 24 August, 2003 in the Northern Rockies GACC.

tions at those stations can be determined.

5. ADAS SURFACE ANALYSES

The distortion of weather systems as they interact with the mountainous terrain of the western United States presents many challenges for the weather forecaster. In order to enhance the use of MesoWest/ ROMAN observations in NWS and fire weather operations, data assimilation using the Advanced Regional

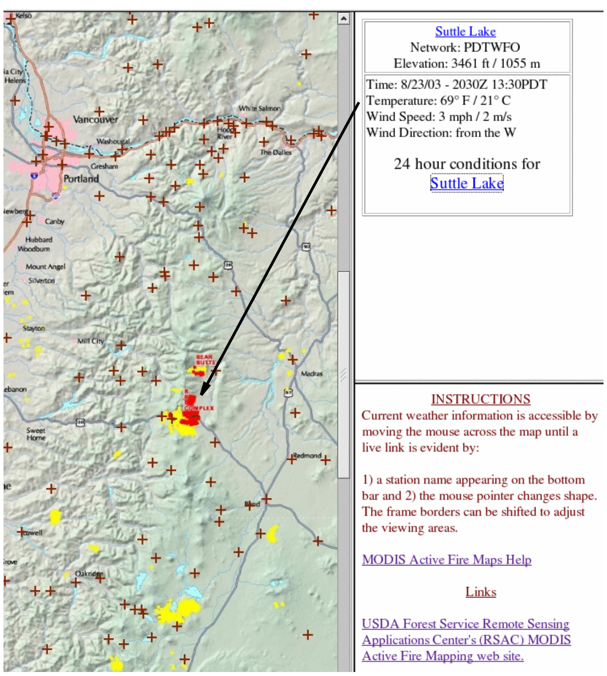

Figure 7. ROMAN MODIS interface. Superposition of ROMAN station locations (plus symbols) in central Oregon upon MODIS active fire map on 23 August, 2003. Yellow denotes previously burned areas while red denotes areas burning within the past 24 hours. The ROMAN MODIS interface allows access to station information and current weather information by selecting one of the plus symbols (in this case the Suttle Lake station near the Bear Butte fire complex).

Prediction System Data Assimilation System (ADAS) is used to synthesize the irregularly spaced observations onto a regular grid over the western United States (Lazarus et al. 2003). ADAS surface analyses are generated every 15 minutes (hourly) at 10 km (2.5 km) horizontal resolution. Maximum/minimum temperature, relative humidity, and wind speed summary graphics for 00-00 UTC and 12-12 UTC periods are also created (e.g., Fig. 8). A user interface is coupled to the contoured graphical maps to allow a user to access station weather observations

6. OPERATIONAL DEPLOYMENT

The ROMAN software developed and tested during the 2002 and 2003 fire seasons is intended to become operational for the 2004 fire season. To reduce RAWS data latencies (i.e., the time span between when the observation is taken and when it is available to the end user) and to improve overall reliability of the ROMAN system, the software will be installed on Linux computers to be housed at the Boise WFO, which is located within the National Interagency Fire Center (NIFC) facility. RAWS data received at NIFC will be processed quickly, stored in the MySQL database, and made available to end users. Other MesoWest data streams will travel over a dedicated communication link from the University of Utah to the Boise WFO. Databases at the University of Utah and Boise WFO will contain identical content, which will help to provide redundancies in case of hardware failure.

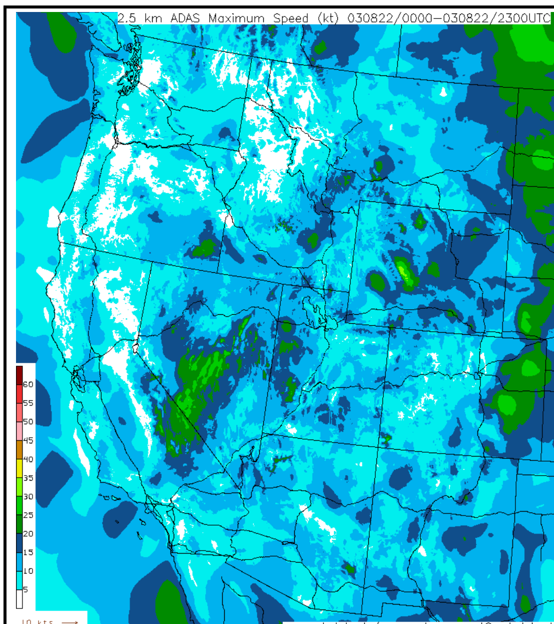

Figure 8. Maximum wind speed (kt) between 00-23 UTC 23 August, 2003 based on hourly ADAS 2.5 km analyses.

7. FUTURE IMPROVEMENTS

RAWS stations report estimates of fuel state (moisture and temperature) as well as weather information. Because of concerns regarding the reliability of some of the fuels data, the decision was made to limit user access to that data, which is stored in ROMAN. Nonetheless, weather and fuels are the two components of the NWS's Red Flag Warning program. The watch and warning products are used to alert firefighters and fire management personnel of combinations of critical fuels and weather that can contribute to extreme fire behavior. Weather forecasters not only must monitor trends to identify critical weather patterns but also must obtain information regarding the condition of fuels. NWS forecasters have requested that land management agencies develop a streamlined method to provide fuels information for the red flag program. Current methods are time consuming, labor intensive, and disruptive to operational flow of forecast offices and dispatch centers. From the perspective of the users of the red flag program, people who are not knowledgeable of fuels, let alone experts in the field, are making interpretive decisions. Since weather changes more rapidly than fuel condition, the decision to issue a red flag warning is often heavily weighted toward meteorological conditions. However, insufficient knowledge or inadequate assessments of fuels leads to warning based solely on meteorological conditions and often lead to overwarning in an attempt to err on the side of caution. Thus, the development and implementation of a Red Flag Fuels Decision Support System has been proposed. That system would provide a single source of fuels data and the condition of those fuels in an easy to use format. Automated specification of fuel states and manual updates of the output would provide a snapshot of fuels condition appropriate for use in the Red Flag program as well as for other operational programs. The system would be coupled with ROMAN to provide integrated access to weather and fuels information.

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8. REFERENCES

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