The September 22-23, 2006 Offshore Flow Event Over Northwestern California

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On 20 September 2006, strong high pressure at the surface and aloft settled over the Northeast Pacific and the Pacific Northwest, as a thermal low pressure surface trough was situated along the California coast line. The two systems were favorably positioned to produce a robust offshore flow regime across much of southern Oregon and northern California on 22 and 23 September 2006. Critical fire weather conditions produced by the strong offshore winds combined with a very dry air mass over the region resulted in widespread red flag warnings across the Eureka CWA interior fire weather district. During this offshore flow event, warm weather prevailed not only inland, but at the coast where 70 degree Fahrenheit or higher temperatures were recorded along the Redwood and Mendocino coasts. Eureka also set a new daily record of 82 degrees on September 23 which broke the record of 76 last set in 1946. Model guidance had a good handle of the situation for day time maximum temperatures and minimum relative humidity on 23 September 2006, especially along the coast. This will be shown through "Smart Initialized" data from the Graphical Forecast Editor (GFE).

Synoptic Situation

High pressure dominated the Northeast Pacific with a ridge axis extending into British Columbia. A "Rex-like" blocking pattern was set up along 130W longitude with upper level high pressure over the Northeast Pacific and an upper low pressure system in the Eastern Pacific southwest of Southern California as seen in water vapor imagery shown in Figure 1.

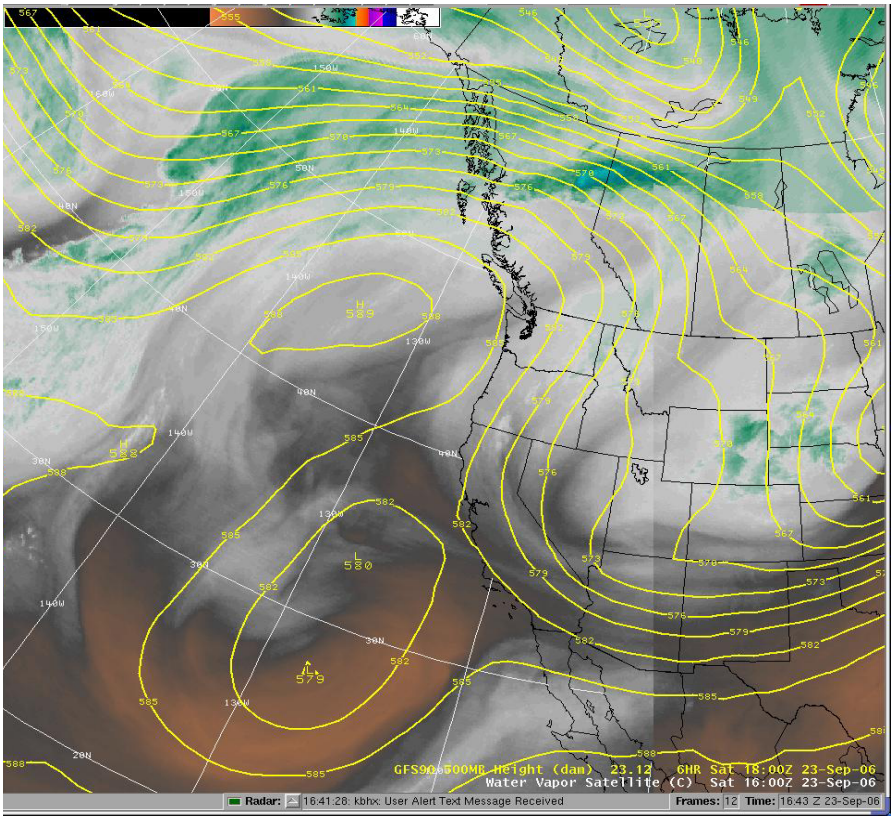


Figure 1. Water vapor imagery for 23 Sept 2006 with 12Z 23 Sept 2006 GFS90 500 hPa heights (yellow contour) overlaid.

Strong offshore flow prevailed on Saturday 23 September 2006 and was clearly noticeable in visible satellite imagery as shown in Figure 2. The smoke emanating from the Bar Complex wild fire near Weaverville, California was swept out toward the ocean producing a smoke layer visible by coastal residents between Eureka and Crescent City. The smoke layer was aloft with bases approximately 6000 to 7000 feet above mean sea level.

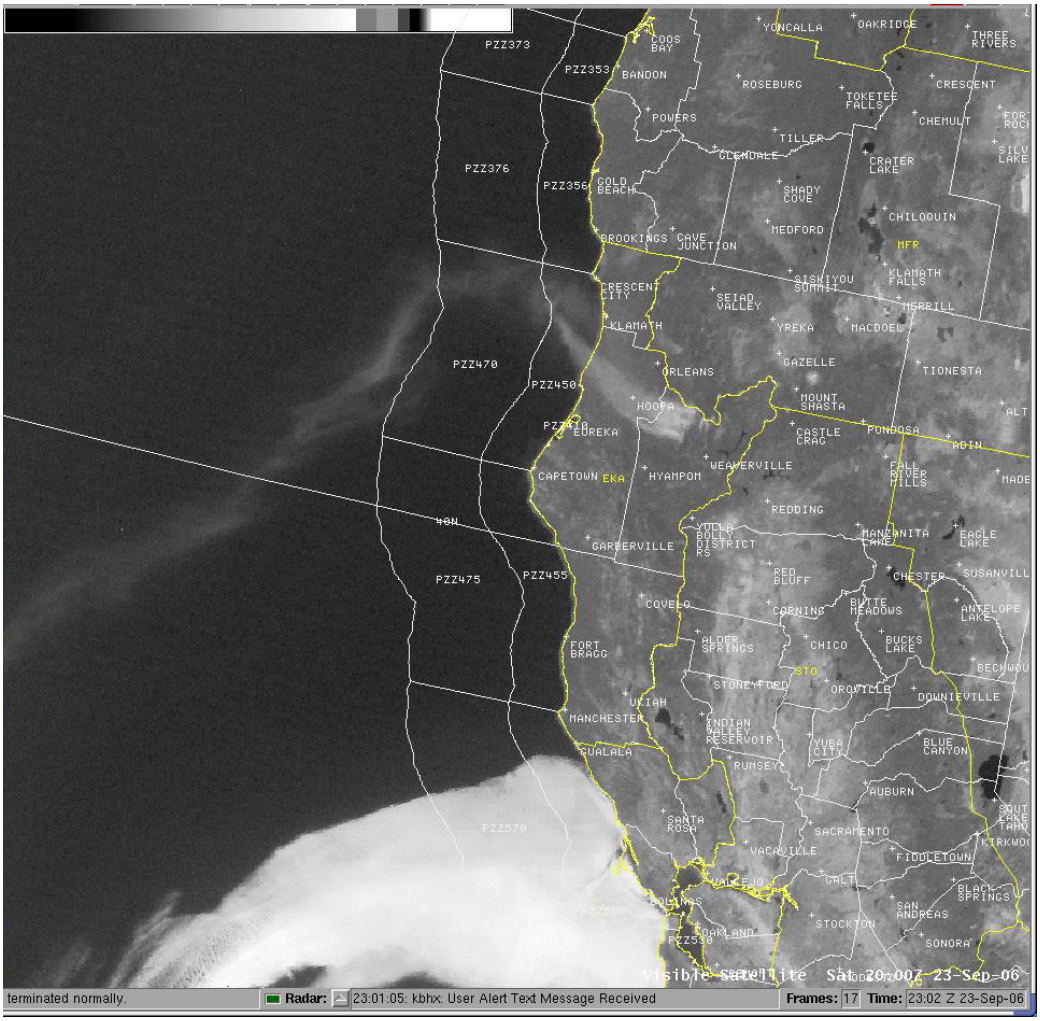


Figure 2. Visible imagery from 23 September 2006 at 20Z (1300 LST).

At the surface, strong high pressure dominated the Northeast Pacific and over the Great Basin. A thermally induced surface low over the coast of California created a tight pressure gradient across Southwestern Oregon and Northern California which produced the offshore flow regime. Shown in Figure 3 are mean sea level pressure contours and wind speeds at 850 hPa initialized by the 23 September 2006 12Z run of the GFS. Northeast to east winds over the interior northwest California were initialized at 20 to 25 mph. Numerous RAWS stations located between 2500 to 7000 feet had observed sustained northeast winds at 15 to 25 mph and gusts ranging between 20 and 30 mph.

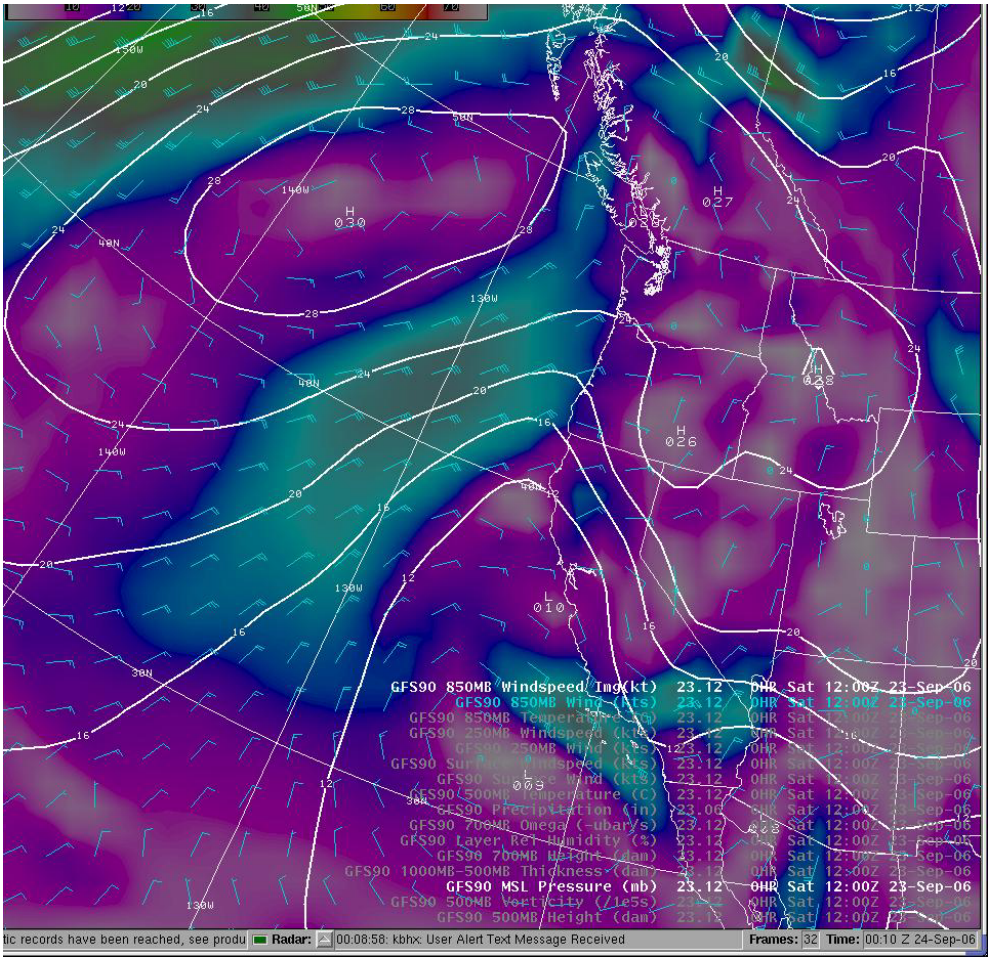


Figure 3. 12Z 23 Sept 2006 GFS90 MSLP (white contours) and 850 hPa wind and wind speeds (image).

Critical Fire Weather Conditions Inland

A very warm and dry air mass over the region combined with gusty offshore winds over the ridge tops resulted in widespread Red Flag conditions across interior Northwest California. A Fire Weather Watch (FWW) was first issued on the morning of 20 September 2006 as very dry conditions along with gusty northeast and east winds were expected over the upper slopes and ridge tops. The initial watch was issued for the time period beginning on Friday 22 Sept 2006 at 13Z (0600 LST) through Sunday 24 Sept 2006 at 13Z (0600 LST). The FWW was upgraded to a Red Flag Warning (RFW) Thursday 21 September 2006 (Table 1). The RFW was in effect from midnight Friday through Saturday afternoon. Many RAWS stations in the Eureka CWA verified the RFW. These stations include Rodeo Valley, Trinity Camp, Cooskie Mountain, Schoolhouse, Mendocino Pass, Hopland UC, Ship Mountain and Limestone.

Table 1.

Watch/Warning	Issued	Valid
Fire Weather Watch	Wednesday 20 Sept 2006	13z Friday 22 Sept – 13z Sunday 24 Sept
Red Flag Warning	Thursday 21 Sept 2006	07z Friday 22 Sept – 00Z Sunday 24 Sept

Wild fires, known as the 'Uncles' and the 'Bar' complexes in the Eureka CWA had been burning since mid summer. The gusty northeast winds and very dry weather pattern lead to fire growth and faster runs making fire abatement difficult. The RFW were issued with enough lead time to allow the required resources to assist the fire inhibition teams.

Warmer Than Normal Temperatures along the Coast

The warm conditions were not only felt across the interior. Coastal locations had their fair share of temperatures soaring into the 70s and 80s. WFO Eureka recorded a high temperature of 82 on Saturday 23 September 2006. This temperature broke the record high of 76 which was last set in 1976. Eureka's low temperature for that morning was 42 which tied the record last set in 1996. This was the first ever occurrence in which a double record occurred for Eureka.

As offshore flow dominates the wind pattern, coastal locales are subject to warmer than normal temperatures. Relatively warm and dry air is brought toward the coast from the interior. The already warm air is modified by downsloping off the coastal mountain ranges which further warms the air due to adiabatic compression. Although these temperatures were higher than the norm, it is not unusual to have abnormally high temperatures under these offshore flow regimes.

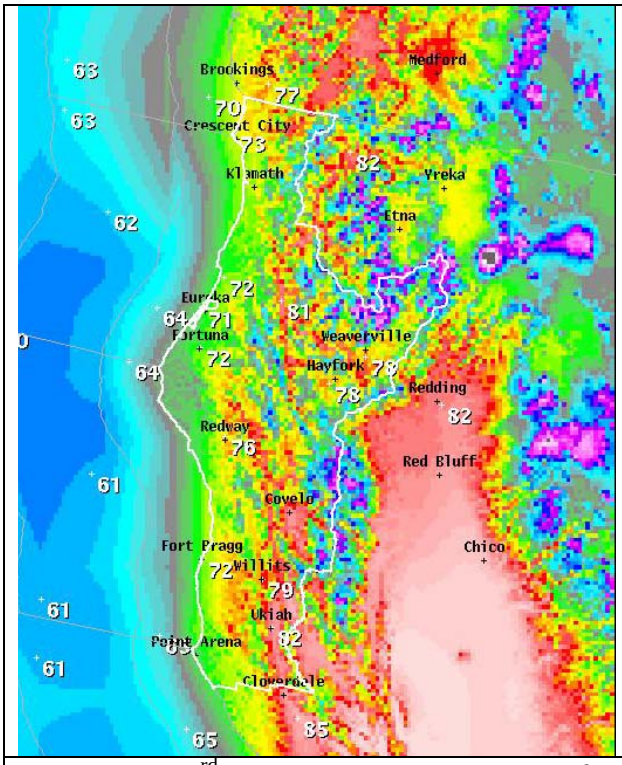
Listed below are max temperatures recorded on Saturday 23 September 2006 for select coastal locations.

OBSERVATION SITE……...HIGH TEMP (ºF)……30 YEAR AVERAGE (ºF)
Crescent City Airport ….……...79……...66
Crescent City 3NNW Co-op site……82……...66
McKinleyville (Arcata Airport)…….82……...M
Eureka…….82…….. 62
Orick……...78…….. 71
Shelter Cove…….....81…….. 67
Fortuna……... 87……...M
Ft Bragg Co-op…….. 69……...66

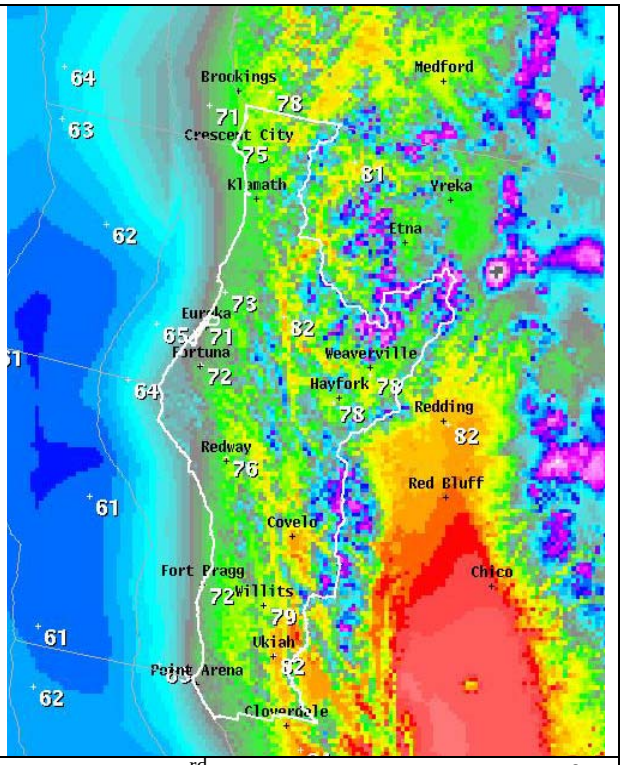
Model Guidance

Model solutions from the Global Forecast System (GFS), North American Model (NAM), and Eureka's locally run high resolution Weather Research and Forecasting (WRF) were available for forecast guidance (Table 2 and 3). The Graphical Forecast Editor uses the raw model output and calculates various forecast elements. This paper will focus on the maximum temperatures and minimum relative humidity values forecasted for the record setting day of 23 September 2006. The forecast images were captured from the GFE after running through their particular calculations also known as SmartInit. The following model forecasts were available at 00Z and 06Z 23 September 2006.

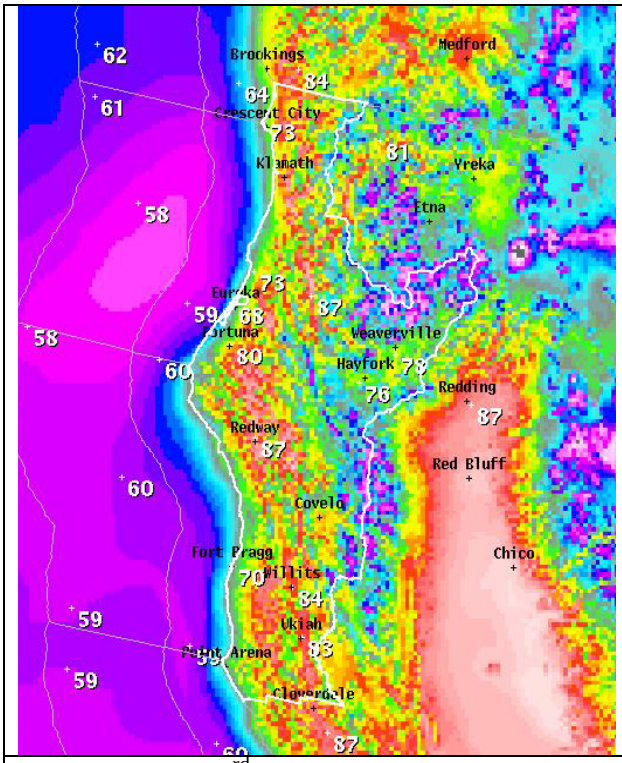
MaxT



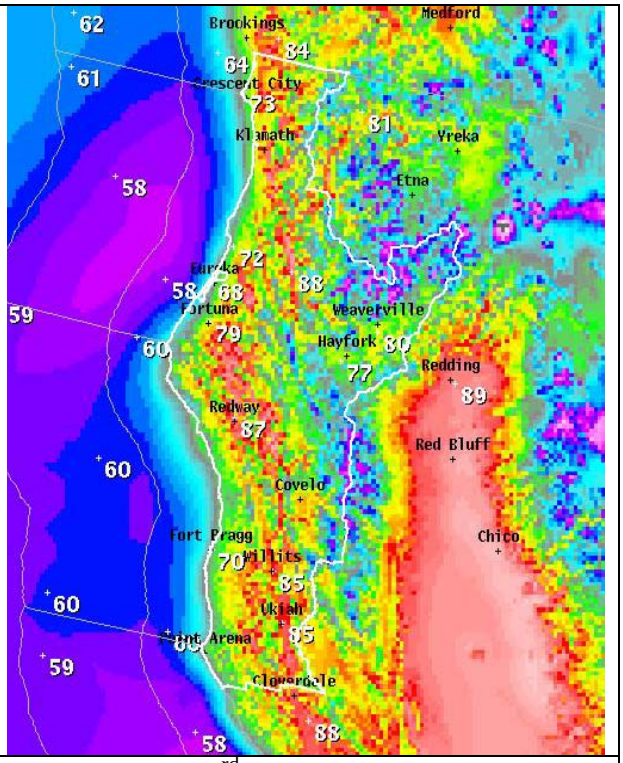
GFS 00Z 23rd September valid MaxT for 23rd.



GFS 06Z 23rd September valid MaxT for 23rd.



NAM12 00Z 23rd September valid MaxT for 23rd.



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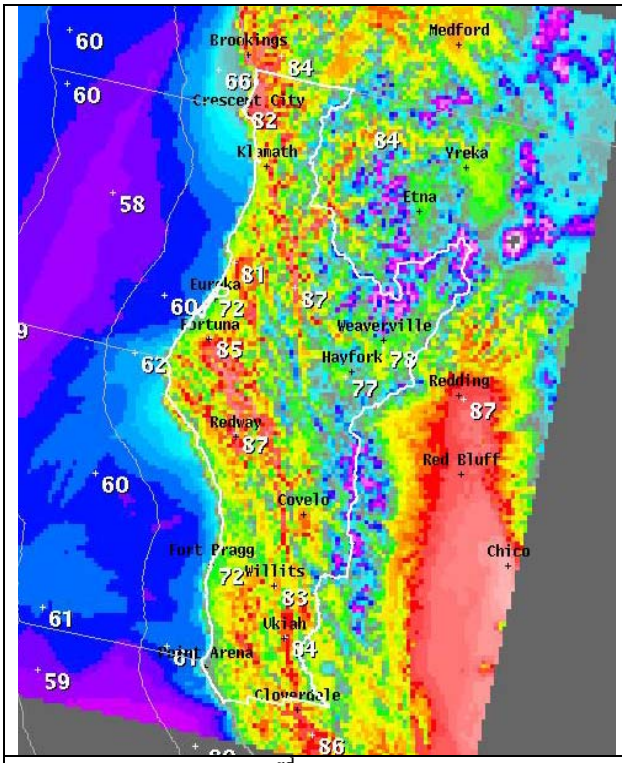
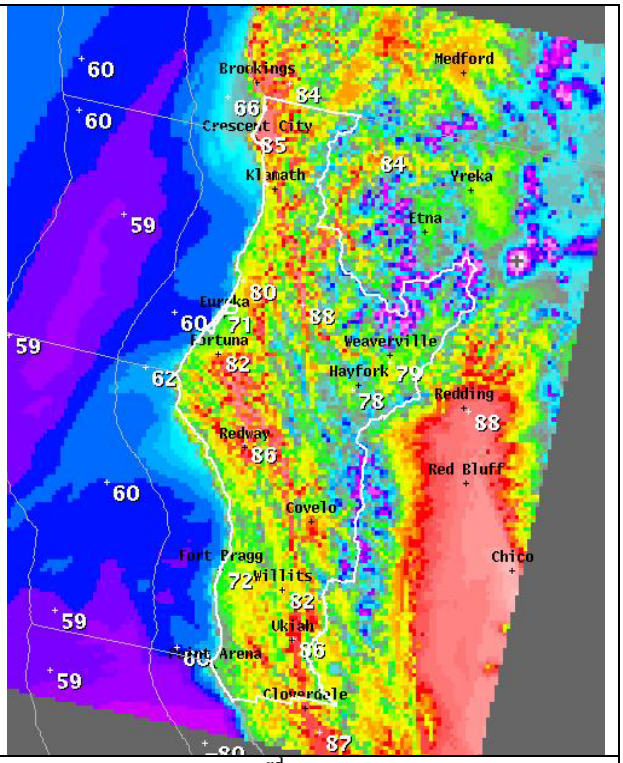


EKA WRF 00Z 23rd September valid MaxT for 23rd.

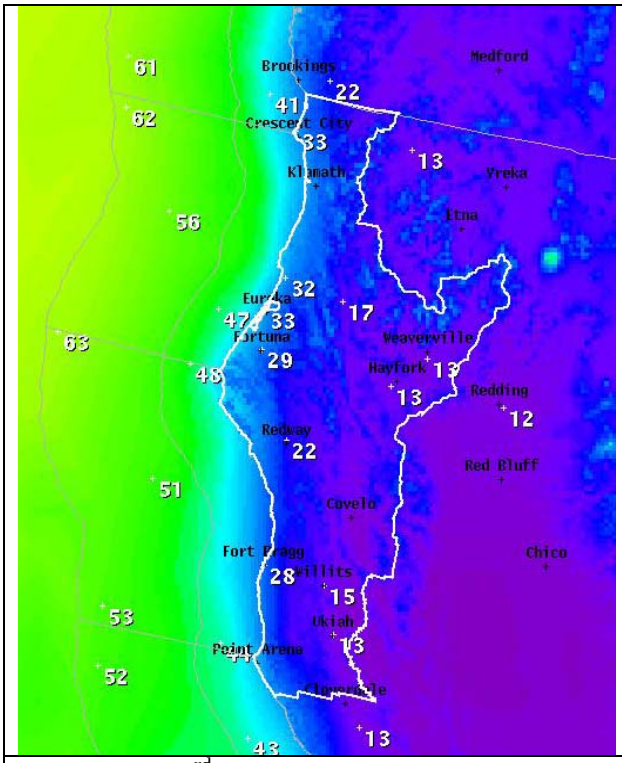


EKA WRF 06Z 23rd September valid MaxT for 23rd.

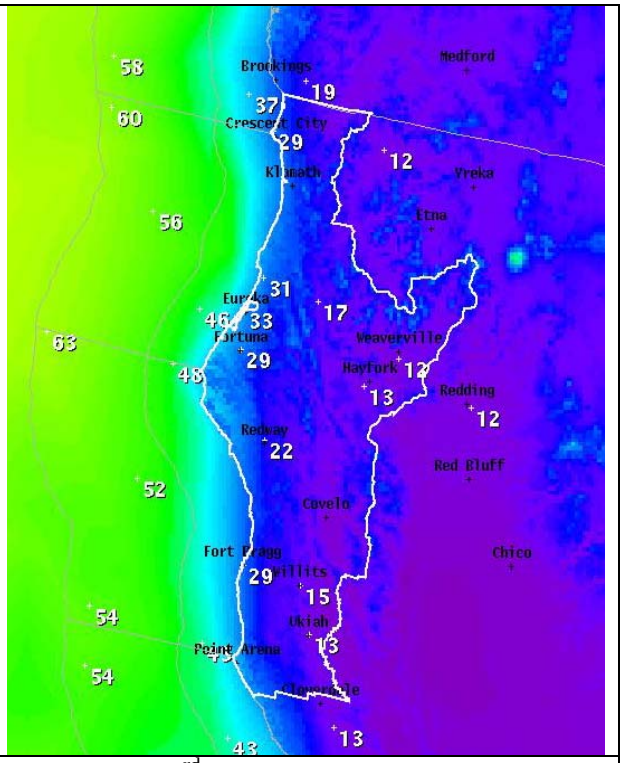
Table 2.

Temperature in ºF	GFS Forecast Max Temp valid 23rd		Eta12 Forecast Max Temp valid 23rd		Eka_WRF Forecast Max Temp valid 23rd		OBSERVED MAX TEMP on 23rd Sept.
Site	00Z	06Z	00Z	06Z	00Z	06Z	
Crescent City	73	75	73	73	82	85	79
Arcata Airport	72	73	73	72	81	80	82
Eureka	71	71	68	68	72	71	82
Fortuna	72	72	80	79	85	82	87
Weaverville (5 ¢ Raws)	78	78	78	80	78	79	84
Hayfork	78	78	76	77	77	78	83
Ukiah	82	82	83	85	84	86	88

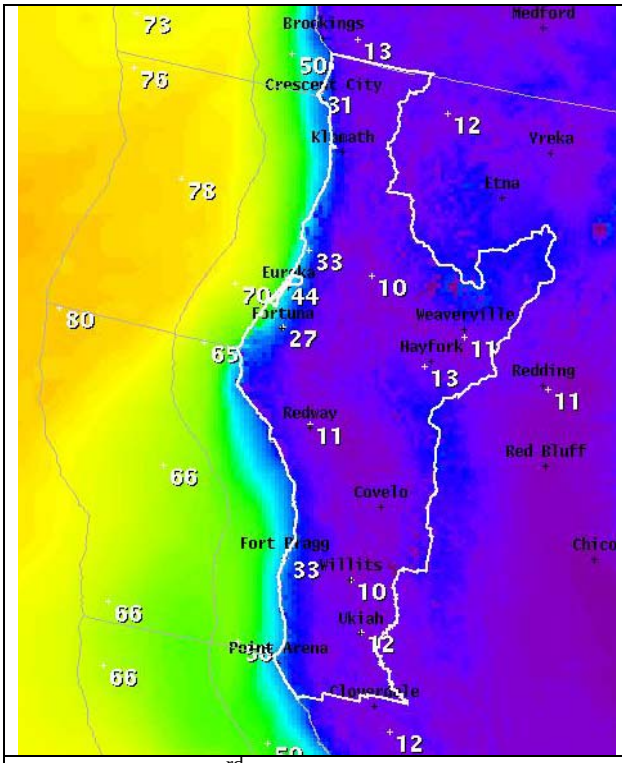
MinRH



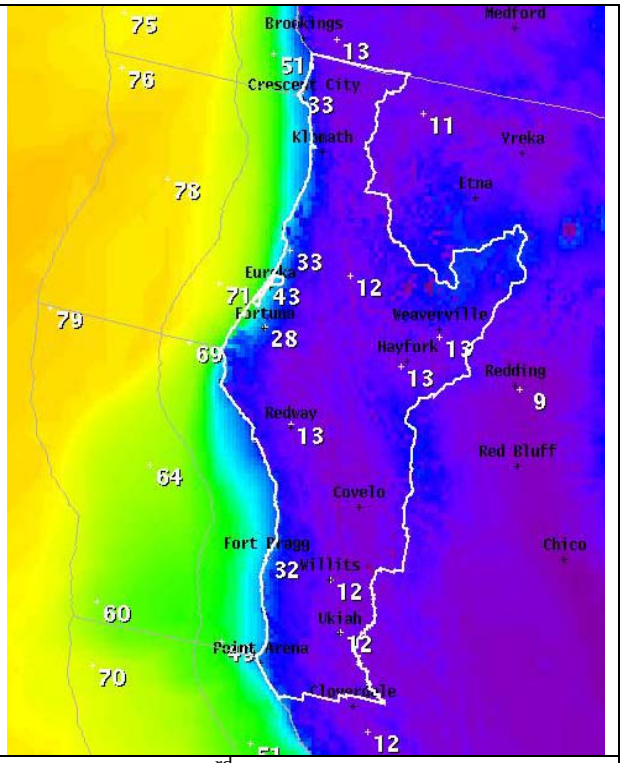
GFS 00Z 23rd September valid MinRH for 23rd.



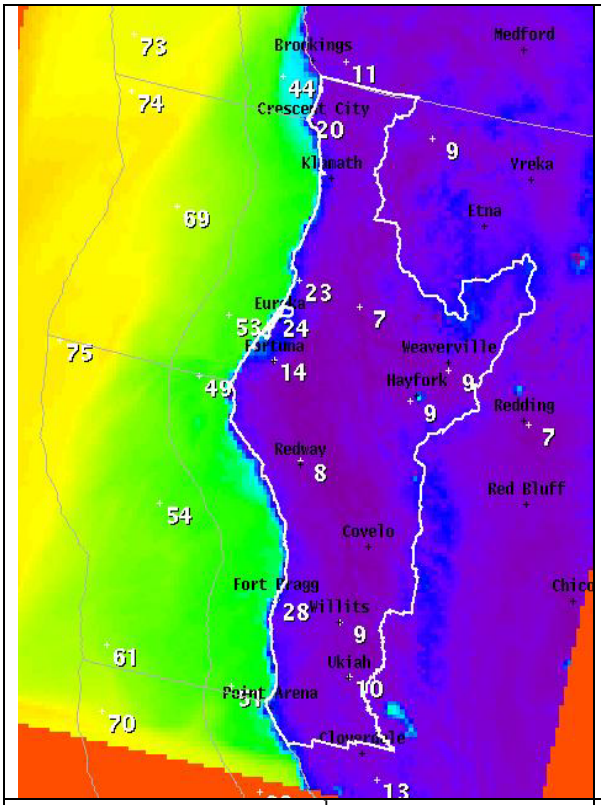
GFS 06Z 23rd September valid MinRH for 23rd.



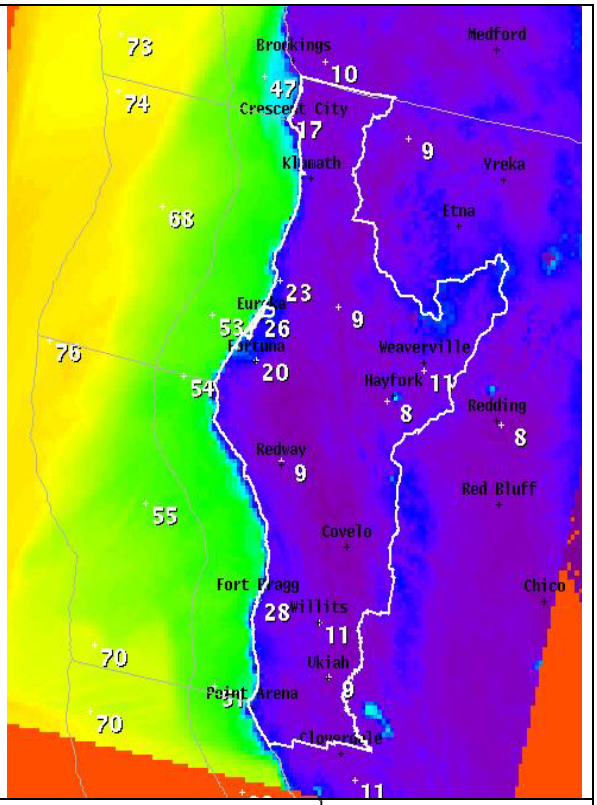
NAM12 00Z 23rd September valid MinRH for 23rd.



NAM12 06Z 23rd September valid MinRH for 23rd.



EKA WRF 00Z 23rd September valid MinRH for 23rd.



EKA WRF 06Z 23rd September valid MinRH for 23rd.

Table 3.

Relative Humidities in %	GFS Forecast Min RH valid 23rd		Eta12 Forecast Min RH valid 23rd		Eka_WRF Forecast Min RH valid 23rd		OBSERVED Min RH on 23rd Sept.
SITE	00Z	06Z	00Z	06Z	00Z	06Z	
Crescent City	33	29	31	33	20	17	24
Arcata Airport	32	31	33	33	23	23	18
Eureka	33	33	44	43	24	26	M
Fortuna	29	29	27	28	14	20	18
Weaverville (5 ¢ Raws)	13	12	11	13	9	11	9
Hayfork	13	13	13	13	9	8	6
Ukiah	13	13	12	12	10	9	11

Conclusion

A strong northeast pressure gradient produced a robust offshore flow event over northwest California from 22-23 September 2006. The gusty northeast winds combined with very dry air produced critical fire weather conditions over the interior fire weather zones of the Eureka CWA which prompted the issuance of a Red Flag Warning for these zones. Additionally, warm and dry conditions were also felt along the coast which is not unusual under these offshore flow regimes. Daytime high temperatures recorded along the coast were above normal and on September 23rd resulted in a record daily max temperature following a record morning minimum temperature at Eureka. Model guidance from "smart initialized" model data in the GFE for the GFS, NAM, and EKA_WRF captured higher than normal temperatures at the coast. Comparing forecasted values from the models available, the locally run and recently available EKA_WRF max temperature and minimum relative humidity values were more in line to what was observed. However, further analysis on each model's guidance and more cases will be required in order to gain an understanding of model biases and why the EKA_WRF prevailed.

A Note on EKA WRF

The EKA_WRF is the Science Operations Officer and Training Center's (SOO/STRC) Weather Research and Forecasting (WRF) Environmental Modeling System (EMS). The system consists of Penguin Altus 1300 Dual Core AMD Opteron Processor with 4 CPU running at 2.01 GHz and 1 GB RAM.

The EKA_WRF was set up using the Advanced Research WRF (ARW) core. The domain covers the EKA CWA and coastal waters, covering 11270 grid points at 4.0 km resolution. The model runs occur 4 times a day at the synoptic times using NAM 12 km tiles and the high resolution sea surface temperature data as its initial and boundary conditions. Currently, the simulation length of each run is 24 hours with hourly output. Each run takes about 4.5 hours to complete, which includes acquiring the model initialization and preparation, running the model, post processing and transferring the files into the AWIPS system available for D2D and GFE.