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Applications of MesoWest to Fire Weather

Carol M. Ciliberti*, John D. Horel, and Michael Splitt

NOAA Cooperative Institute for Regional Prediction
Department of Meteorology, University of Utah, Salt Lake City, Utah

1. INTRODUCTION

Surface data from weather observing stations across the western United States have been linked together as part of a project called MesoWest (Horel et al., 2001). The objectives of MesoWest are: (1) improve timely access to real-time observations for protection of life and property, (2) improve integration of observations for use in nowcasting, forecast verification,and as input to data assimilation systems, and (3) provide access to available data resources for research and education on weather processes in the western United States.

MesoWest augments the Automated Surface Observing System (ASOS) network of about 450 stations, maintained by the National Weather Service (NWS), Federal Aviation Administration, and the Department of Defense. MesoWest currently accesses weather data from over 3000 additional stations, providing a significant increase over the temporal and spatial density of the ASOS network. A local data assimilation scheme is used to synthesize the irregularly spaced observations onto a regular grid, for enhanced interpretation of the data in near-real time.

MesoWest currently includes data from over 40 public agencies and 20 commercial sources. The Remote Automated Weather System (RAWS) network, operated by the Bureau of Land Management and the Forest Service for fire management applications, provides the largest single combined source of surface weather observations in the western United States. The RAWS stations are primarily located in remote mountain regions. In contrast, nearly all ASOS stations are located at airports in valley locations and the average station separation for ASOS stations is 44 km in the western United States. Within the MesoWest data base, the average station separation is 15 km (Fig. 1)although there are regions of higher spatial density (e.g., northern Utah) and lower spatial density (northeast Arizona) across the western United States.

Corresponding author address: Carol Ciliberti, Dept. of Meteorology, Salt Lake City, UT 84112; e-mail cmciliberti@met.utah.edu.

2. MESOWEST OPERATIONS

MesoWest helps to integrate weather observations from a variety of sources to improve the spatial and temporal coverage of surface weather observations in the western United States. While ASOS stations report hourly (with more frequent updates available when specific weather criteria are met), the reporting frequency of stations included in MesoWest varies from 5 minute intervals to hourly. The latency between the actual observation time and the time data is available for use on the Internet via the MesoWest database varies from within 8-10 minutes of the valid time for ASOS stations while over 400 RAWS stations report with a latency of about 29 minutes. The weather observations are processed both synchronously and asynchronously. The synchronous portion of the processing is done at 15-minute intervals, but we are moving toward asynchronous processing in which each

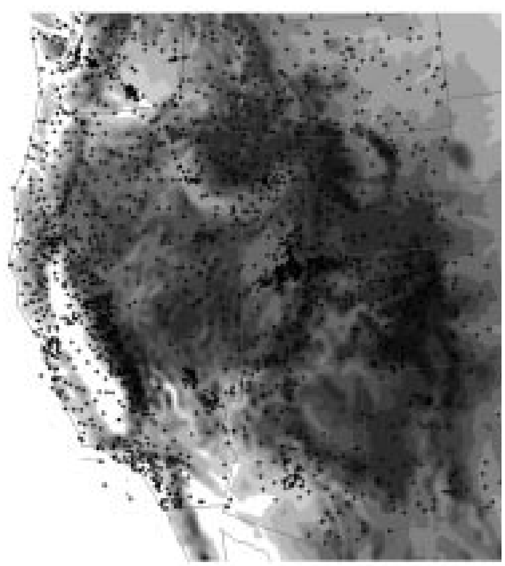

Figure 1. Locations of MesoWest stations superimposed upon the terrain of the western United States. Higher terrain is denoted by successively lighter shading

data stream is processed as soon as it is received, and immediately inserted into the MySQL data base. The RAWS stations are among those processed asynchronously, in order to minimize delay in availability of surface data for fire weather applications.

Quality control procedures are applied to the MesoWest data set in order to assign quality flags to the stations reporting at each processing interval. The first level of quality control applied to the data involves minumum and maximum flagging criteria. The value of each variable is checked against a range of expected values, and is flagged as “bad” if it lies outside the expected range (Splitt et al. 1998). In addition, a statistical linear regression is used to evaluate the quality of the surface temperature, dew point and pressure at each station. Data quality flags are assigned according to the agreement between the current observations and the regression values. These flags are not used to remove data from the database, but may be accessed by MesoWest users in order to evaluate the quality of data from individual stations.

Because the data are collected from a variety of networks, inconsistencies exist in siting, standards, and maintenance procedures. Data assimilation methods are applied to the MesoWest data set with a two-fold purpose: (1) to synthesize the irregularly spaced observations onto a regular grid, in order to aid in visual interpretation of a large data set and (2) provide an additional means of quality control of the data through quality check procedures included as part of the analysis. The temporal and spatial continuity of the analyses helps to distinguish MesoWest observations that reflect hazardous conditions underway from those due to poor siting or sensor errors.

Local data assimilation is performed at the Cooperative Institute for Regional Prediction (CIRP) using the University of Oklahoma Advanced Regional Prediction System (ARPS) Data Assimilation System (ADAS). The Utah ADAS uses the National Center for Environmental Prediction Rapid Update Cycle Version 2 (RUC2) 40-km resolution analysis at hourly intervals for an initial background field (Lazarus et al. 2001). Local data are interpolated onto the grid using the Bratseth method of successive corrections. ADAS utilizes a consistency check of the local surface data against the background field so that data that diverges too widely from the background will be discarded. This check is done by interpolating the gridded background data to the observation locations; if differences between the two exceed a specified threshold, the observations are discarded. A temporal quality control check is also performed, in which hourly changes at a single station are compared to average differences computed for surrounding stations. Again, the data are discarded if the difference exceeds a specified threshold.

Modifications have been made to the original ADAS in order to enhance performance over complex topography. The MesoWest data quality flags are used in place of a two-dimensional Barnes scheme originally configured as part of the ADAS spatial quality control. Data which have a “bad” flag are discarded and not used in the analyses. In addition, the spatial correlations in the Bratseth analysis have been modified to compensate for the large terrain gradients within the domain. The weights used in the observation-to-grid point analysis are reduced for grid points that are far above the surface. This approach allows for observations at high elevations to influence data-void locations in nearby mountain ranges while limiting their effect on the free atmosphere adjacent to the mountains.

3. MONITORING FIRE WEATHER

The MesoWest Internet site allows access to current or past weather conditions at over 3500 surface observing stations throughout the western United States. Weather observations are available from 1997 to the present. Users may select specific weather stations by station identifier or name, or by searching for stations by geographic location, zipzode, or state. The data at individual stations can be viewed in tabular format, or as graphical time series. Integrated views of weather conditions around the west include weather maps of MesoWest station data over a number of sub-domains, and a variety of analyzed graphical products from ADAS.

Starting during July 2001, users may also monitor weather conditions in the vicinity of all major fires in the western United States. Fires are listed and organized by Geographic Area Coordination Center. MesoWest data from the surrounding area may then be viewed within a search radius defined by the user. Links to maps are also provided in order to show the location of the fire in question.

4. SURFACE ANALYSES OVER THE WESTERN UNITED STATES

The spatial and temporal continuity of weather systems as they interact with the mountainous ter-

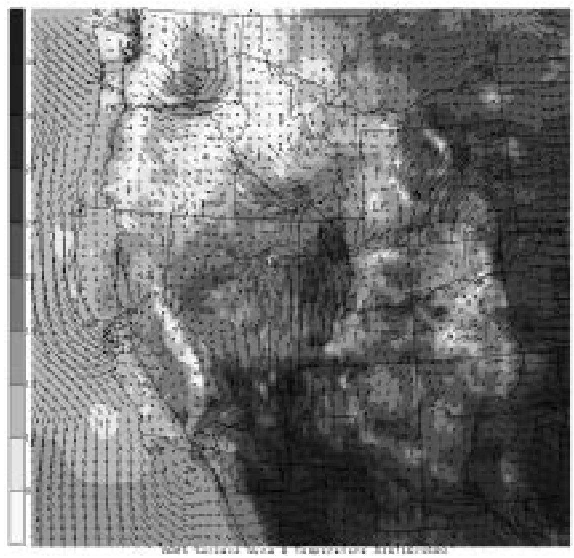

Figure 2. ADAS analysis of surface temperature (in °C according to the scale at the side) and surface wind streamlines at 1600 UTC 16 July 2001.

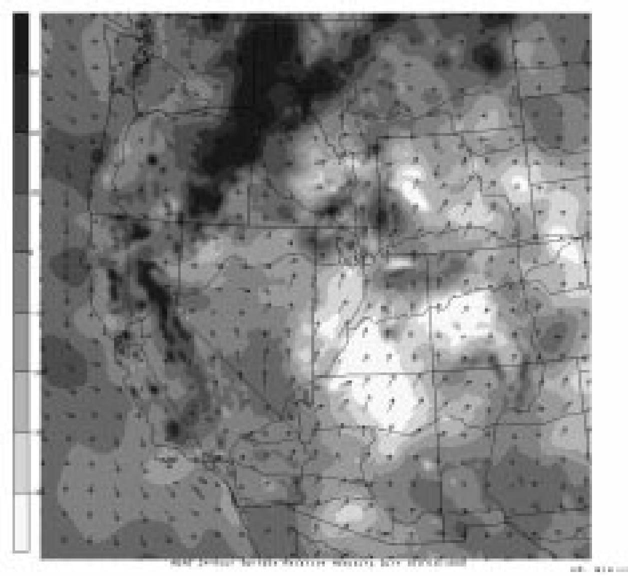

Figure 3. ADAS analysis of 24-hour surface relative humidity difference with 24-hour vector wind difference in m/s valid at 1600 UTC 16 July 2001.

rain of the western United States presents many challenges for the forecaster. In order to enhance the use of MesoWest observations in NWS and fire weather operations, ADAS surface analyses have been configured to run over the western United States at 10 km horizontal resolution and at 15 minute intervals. These analyses are currently run at the University of Utah in near-real time, and are distributed to NWS forecast offices throughout the NWS Western Region. In addition, graphical products are created on operational time scales and displayed on the Internet at www.met.utah.edu/mesowest. Research at CIRP has focused on the development of MesoWest/ADAS products that aid in assessment of current conditions and short term forecasting, including fire weather applications.

Fig. 2 shows an ADAS analysis of surface temperature and winds across the western United States domain. A diffuse frontal boundary extends diagonally across the domain, from northern California across southeast Idaho. A relatively cold air mass in northwest flow is depicted over the northwest corner of the domain. Significantly warmer temperatures and southerly flow predominate in the states south and east of Idaho, with temperatures over 30 deg C in southern Arizona and New Mexico. Western Utah shows a region of relatively strong south winds with temperatures in the 24 - 27 deg C range, indicating rapid warming over the area. At the same hour, a plot depicting the 24-hour change in relative humidity across the domain (Fig. 3) shows significant drying taking place over south and western Utah, western Colorado and most of Arizona. This figure also shows 24-hour vector wind differences, with increased southerly winds evident throughout the dry slot, and especially in western Utah.

Figs. 2 and 3 depict a warm, dry air mass combined with increasing winds at the surface, indicating potentially severe fire weather conditions for Utah and Arizona. The daily fire report released from the National Interagency Fire Center the morning of 17 July, 2001 noted 12 large fires burning in the eastern Great Basin region. The Beef Hollow fire in the southern Salt Lake valley of northern Utah initiated during the afternoon of July 16 and grew to 5,000 acres by 0500 MDT on July 17, making significant runs toward residences in the area. A fire weather watch was posted for western and central Utah in response to increasing west to southwest winds, a Haines Index of 6, and relative humidity dropping to the single digits.

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5. REFERENCES

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