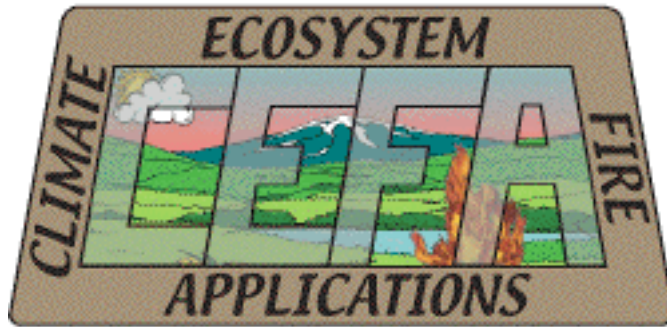*Program for Climate, Ecosystem and Fire Applications*

Climate and Ecosystem Studies and Product Development for Wildland Fire and Resource Management

Annual Report

Timothy J. Brown
Beth L. Hall

Forward

In November 2000 an Assistance Agreement 1422RAA000002 was established between the Bureau of Land Management National Office of Fire and Aviation and the Desert Research Institute. This report describes the activities at the DRI Program for Climate, Ecosystem and Fire Applications (CEFA) under this Agreement during the period 1 October 2002 - 30 September 2003. For further information regarding this report or the projects described, please contact either:

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**Climate and Ecosystem Studies and Product Development
for Wildland Fire and Resource Management**

Annual Report to the Bureau of Land Management

by
Timothy J. Brown and Beth L. Hall

Program for Climate, Ecosystem and Fire Applications
Desert Research Institute

December 2003

A.   INTRODUCTION

This annual report is the third under the Bureau of Land Management (BLM) national Office of Fire and Aviation and the Desert Research Institute (DRI) cooperative Assistance Agreement (AA) 1422RAA000002, and covers the federal fiscal year 2003. The 5-year AA was signed by BLM and DRI during November 2000. The overall scope of the AA is climate and ecosystem studies and product development for wildland fire and resource management. Its objective is to establish and maintain a partnership between BLM and DRI that allows for product development, applied research, training, education and consultation using DRI scientific expertise in climatology, meteorology and terrestrial ecology. The deliverables under this AA are intended to have high interagency value in addition to specific BLM agency needs. The target audience varies depending upon the product or information, but includes among others fire management, Geographic Area Coordination Center (GACC) meteorologists, GACC intelligence officers, fire behavior analysts, fuels specialists and fire specialists. Project concepts can originate at all levels including local, state and national offices as well as at DRI.

This report describes activities and accomplishments under the AA for the period 1 October 2002 – 30 September 2003. Report sections include an overview of tasks during the year, other related activities, travel, presentations and meetings, and publications. For a brief history of the DRI Program for Climate, Ecosystem and Fire Applications (CEFA), see the annual report for federal FY2001 (CEFA Report 01-04).

B.   TASK ORDERS

This section describes AA tasks specific to BLM that were in progress during federal FY2003. Administrative Task Order 1 began in the first half of calendar year 2001 and is ongoing; project Task Orders 4, 5 and 7 began in the early fall of 2001, and are in their second year; Task Order 8 was combined with Task Order 10; Task order 9 began in summer 2002 and is in its second year; Task Order 6 began in August 2002; new Task Orders 11, 12, 13 and 14 will begin in September 2003.

Task Order 1: CEFA Infrastructure and Administration (Sponsor: BLM)

This task order provides for some basic infrastructure required for CEFA general operations. The primary components include:

- Salary for CEFA administration and management by Director and Deputy Director (partially used to allow CEFA personnel to be available on short notice as if they were agency staff).
- Readily available funds for short-term projects requested by field identified during and as a result of the fire season.
- Travel including field visit for training and discussion, working team meetings, workshops and scientific conferences.
- Materials and supplies including computer software upgrades and license fees, computer hardware related supplies (e.g., tapes, diskettes, printer toner, etc.), and books and reference materials.
- Reasonable computer hardware upgrades (e.g., disk storage drives).
- Publication charges related to conference proceedings, report printing, and scientific journal publications.
- CEFA web administration.
- Salary for GIS, specialized computer programming and hourly student support.

Accomplishments for the reporting period are as follows:

Two significant "short-term" projects were undertaken by agency request during this reporting period. CEFA was co-organizer of the Predictive Services National Seasonal Assessment Workshop held in Mesa, Arizona in February 2003. This workshop brought together climatologists, Predictive Service units, and fire managers from across the country to produce Geographic Area Coordination Center (GACC) seasonal fire outlook reports. The workshop was structured to foster communication between climate forecasters and GACC specialists, and to enhance communication and cooperation between the GACC's. Products from the workshop included a national seasonal fire potential outlook, a two-page flyer providing outlook information for national fire directors and Washington, D.C. interests, and a final report. The success of this workshop has lead to the planning of two similar workshops to be held in 2004.

The 10-day and monthly fire potential outlooks now produced by each GACC lead to the development of a plan initiated by CEFA in collaboration with Tom Wordell of Predictive Services to implement scientific verification, validation and evaluation. An internal briefing document for Predictive Services on this issue was developed by Tim Brown and Tom Wordell. The utilization of initially defined verification criteria was attempted by the Southwest GACC. A report from this GACC indicated that further criteria refinement was needed. One of the key issues facing Predictive Services is the quantitative definition of certain products, in particular, fire potential. A revised verification implementation plan is under development, and will be presented and discussed at the Predictive Services December 2003 annual meeting in Whitefish, MT.

CEFA continues to respond to agency questions regarding climate and meteorological data. For example, CEFA provided the Western Great Basin GACC with a Nevada wind analysis as part of a project to examine Nevada red flag warnings. CEFA responded to approximately a dozen media requests for fire climate related information. CEFA appeared in four regional and national newspaper articles of which we are readily aware. CEFA was highlighted as an integrated science program on the NOAA Office of Global Programs web site.

Two desktop computers were purchased for graduate students during this reporting period. A high-end Sun server system (Sun Fire V480 dual processor) and several Sun Ray thin clients were also purchased within the CEFA program, but this was done using California and Nevada Smoke and Air Committee (CANSAC) funds. Several software license renewals and updates were administered.

Web administration is an ongoing process. Some new and updated CEFA products were added to the site (see tasks below). The current CEFA web site address is http://cefa.dri.edu.

Travel and publications under Task 1 are listed in separate sections below.

Task Order 4: Utilization and Evaluation of Climate Information and Forecasts for Fire Management (Sponsor: BLM)

This task officially began in September 2001, and this reporting period represents the second year of the project. The overall project goal is to develop climate forecast products and information that can be utilized for wildfire, prescribed fire and fire use strategic planning and decision-making. Most of the project emphasis was applied to task 2 (see below). A Masters level graduate student is assigned to the project, along with involvement from other CEFA personnel. This project is collaborative with the Scripps Institution of Oceanography Experimental Climate Prediction Center (ECPC), Scripps California Applications Program (CAP) and the International Research Institute (IRI) for Climate Prediction. The following specific task elements were planned for the second year:

1) Continue development of climate monitoring tools for assessments and planning. During the first year of the project, several near-real time climate monitoring tools of interest to fire meteorologists and management were developed. Under this task, refinement of the initially developed products will be done, and some new products will be developed as requested by the field.
2) Continue evaluation of ECPC weekly to seasonal forecasts of fire climate variables (i.e., temperature, relative humidity, wind speed and precipitation) and fire danger indices by comparing model output with Remote Automatic Weather Station (RAWS) observations. This analysis will assess the performance of the model, and provide indications on how model improvements can be made. The analysis will provide forecast skill information for GACC and NWS fire weather meteorologists.
3) Provide training as required to GACC meteorologists and intelligence personnel on the use of experimental climate forecasts. Through this process, continue the utilization of climate forecasts in strategic planning.
4) Prepare a paper/report on climate factors affecting the U.S. wildland fire seasons during the past four years (1999-2002). These past four years have had some very interesting characteristics regarding the extent of fire activity and the spatial variability of fire occurrence. If this period represents the beginning of a trend, as some fire management individuals speculate, then an improved understanding of links between climate and fire would provide important information for strategic planning. This report will assess the role of climate during this period, and provide guidance as to what climate factors may be of particular relevance in near-term future years.

The funding for this project ends 31 December 2003. This task element is also a Master's thesis project for a DRI/CEFA graduate student, with expected completion in October 2003. Accomplishments for each task are discussed below. Because any journal papers or agency reports are dependent upon the final thesis manuscript, these deliverables are anticipated to be completed during the first half of 2004 to fulfill the Task Order deliverables. As expected, most of the emphasis was placed on task element 2. Accomplishments for the reporting period are as follows:

1. Climate monitoring tools for assessments and planning

Existing monitoring products developed during the previous year were maintained on the CEFA web site. There were no requests for new products this year from the field, and none were developed. During the year, the International Research Institute for Climate Prediction (IRI) substantially changed their accessibility to monthly climate forecasts, and the various models that produce those forecasts. CEFA began a process of reassessing the models that could be used for monthly forecasts, and began developing new computer scripting code that would provide for routine access of the forecast grids. It is anticipated that CEFA will begin receiving these experimental forecasts again in January 2004, including the incorporation of the model changes. These forecasts will be used in part for the planned seasonal assessment workshops. GACC meteorologists (and others) will have access to the forecasts should they desire to utilize the forecast information in the development of their monthly outlooks.

2. Verification of ECPC climate forecasts

Much of the emphasis of Task Order 4 was placed on the verification of Scripps Institution of Oceanography Experimental Climate Prediction Center (ECPC) weekly to seasonal forecasts of fire climate variables. These forecasts, produced by the ECPC Regional Spectral Model (RSM) include temperature, precipitation, relative humidity and wind. ECPC also produces corresponding forecasts of NFDRS fire danger indices including energy release component, burning index, spread component and ignition component. The value of this project is that it represents the first effort ever of comparing climate model forecasts to actual RAWS observations. The results will provide an indication of forecast confidence to users of this information (e.g., Predictive Services meteorologists), and provide quantitative forecast skill information that researchers can utilize in model development and improvements.

Figure 1 shows the western U.S. study area of the project. The vertical and horizontal lines represent the RSM model grid, approximately 60 km for each grid cell. The red triangles indicate 262 Remote Automated Weather Station (RAWS) sites used in the study. The study period is from 27 September 1997 through 28 December 2002. Thus, RAWS sites were selected that met quality data requirements for this period. Verification was done by comparing RAWS to the forecasts, the RSM model input data to the forecasts, and the RAWS observations to the RSM model input data. Analyses included seasonal (3-month) forecasts, monthly forecasts (3 individual months during the forecast period), and weekly forecasts (12 individual weeks during the forecast period). Verification statistical analyses included standard deviations, bias, root mean square error and anomaly correlations (both spatial and temporal). In order to compute anomaly correlations, anomalies are found for both RAWS and RSM by subtracting their respective climatologies for the relevant temporal period. A statistical correlation formula is then applied to compute the linear association between anomalies of RAWS observations and RSM forecasts. Higher correlations indicate better forecasts (+1 would indicate a perfect agreement with observations, and 0 no correlation).

For space considerations here, it would be difficult to show all of the detailed results and graphics that are in the final thesis copy. However, a few examples are offered here. Figure 2 shows the time series of bias results for the nine atmospheric elements examined in the study. The elements are maximum, minimum and average temperature; maximum, minimum and average relative humidity; precipitation (duration and amount); and wind speed. International scientific metric units were used in the study (Kelvin for temperature, mm for precipitation amount and meters per second for wind speed). Note that in the planned agency report, these values will be converted to English units. The red line corresponds to the first week in the 12-week forecast period, and the blue line to the seasonal forecasts. All of the series show variability, and for a few elements (e.g., minimum RH, wind speed), a strong seasonal cycle is

apparent. All elements show a bias to some extent. For example, temperature is typically under-forecast by the RSM, and relative humidity is typically over-forecast. This type of information aids meteorologists in how to interpret the model output, and researchers can perform studies to better understand the nature of the bias.
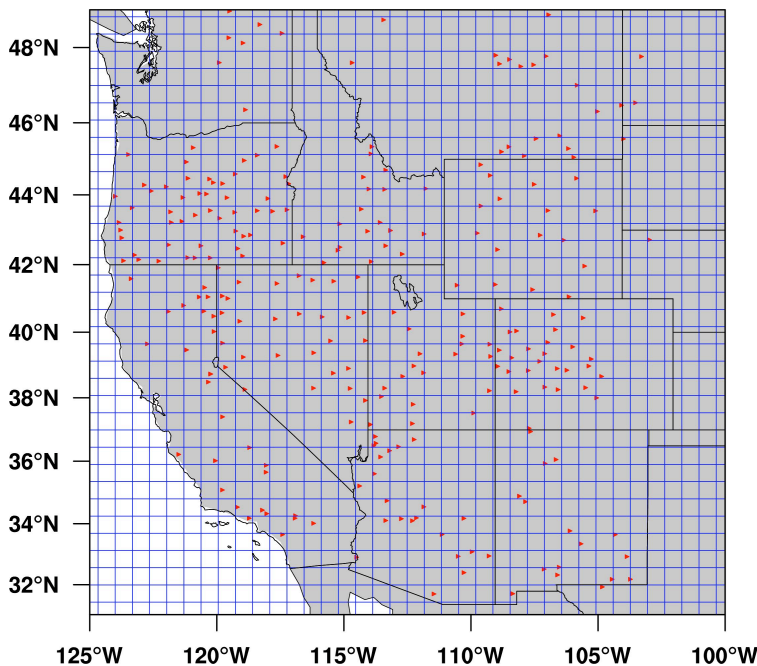

Figure 1. Map showing region of climate model forecast evaluation for the Scripps ECPC regional spectral model. Red symbols indicate locations of RAWS used in the study, and the grid lines represent the model grid resolution (~60 km).

Figure 3 shows results for the temporal bias analysis of BI, ERC, IC and SC. All of the fire danger indices show a model bias of under-predicting. This is not surprising given the negative bias for the atmospheric elements that comprise fire danger. A seasonal cycle is depicted for each index. The ERC shows the least bias on average in comparison to the other indices.

Anomaly correlations were also analyzed for each forecast time series (e.g., week 1, week 2, etc. and seasonally). Maximum and average temperature turned out to have the highest correlation overall (around 0.7), with relative humidity, precipitation and minimum temperature next at around 0.5, followed by wind speed at 0.4. This suggests that the RSM has at least some forecast skill for all of the atmospheric elements, but especially temperature. The correlations for all of the fire danger indices were lowest at around 0.2, suggesting that much further work is needed to improve these forecasts.

Some forecasts seem to be better in certain spatial regions than in others. Figure 4 shows the June through August season RAWS and RSM forecast anomaly correlations for each of the atmospheric elements analyzed in the study. It should be cautioned that some extraneous contouring has occurred due to gaps in the RAWS spatial distribution (e.g., Pacific Northwest in Figure 1), but overall, the contours provide a good indication as to how well the forecasts perform spatially. Higher correlations are denoted by warmer (i.e., orange and red) colors. The high correlations (i.e., > .60) over much of the interior West for relative humidity suggests that the RSM does a reasonably good job of forecasting RH anomalies at least in this region.

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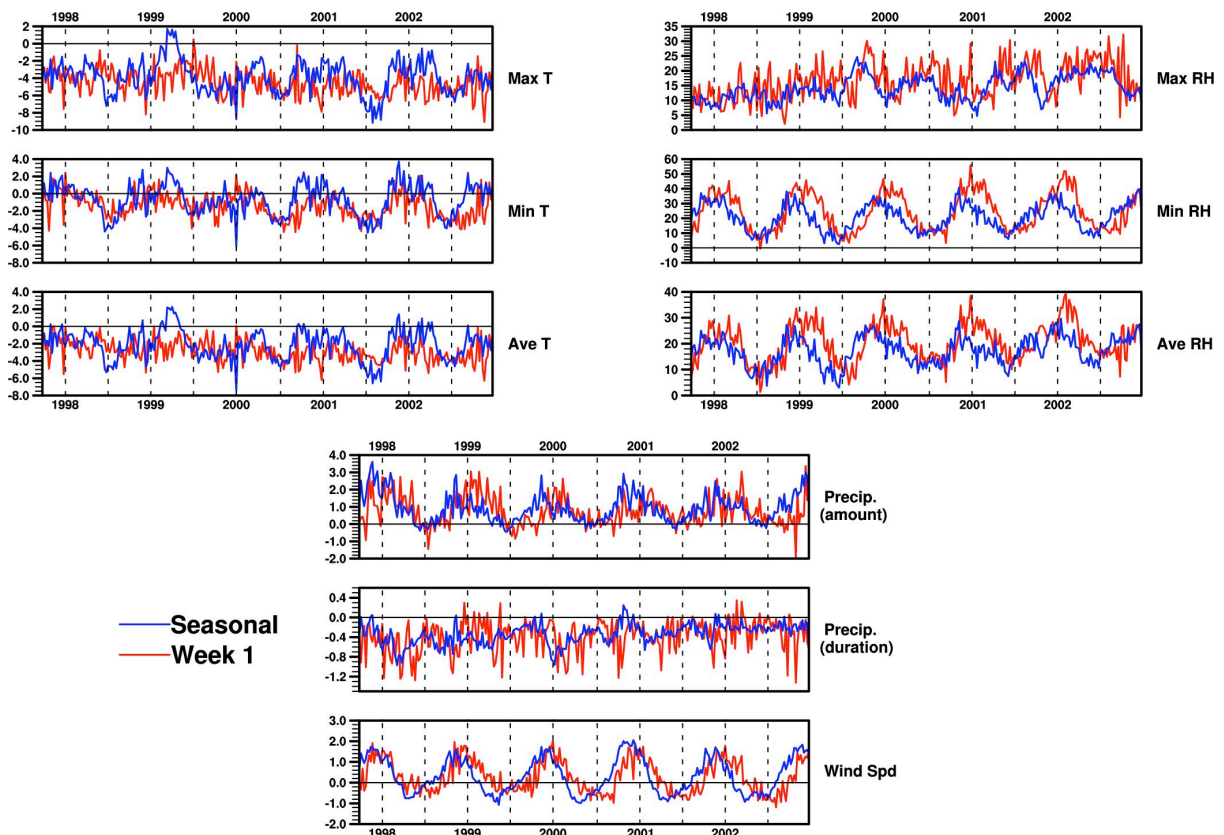
Figure 2. Week 1 (red line) and seasonal (blue line) RSM forecast bias for maximum, minimum and average temperature (degrees Kelvin); maximum, minimum and average relative humidity (%); precipitation amount (mm); precipitation duration (days); and wind speed (meters/second) for all western RAWS combined.
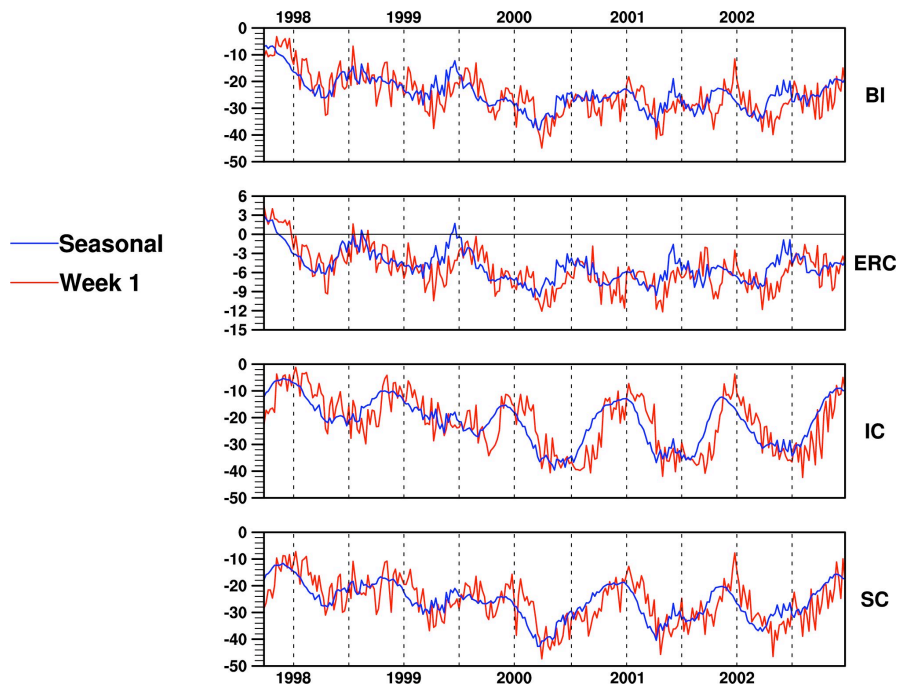

Figure 3. Week 1 (red line) and seasonal (blue line) RSM forecast bias for the Burning Index (BI), Energy Release Component (ERC), Ignition Component (IC) and Spread Component (SC).
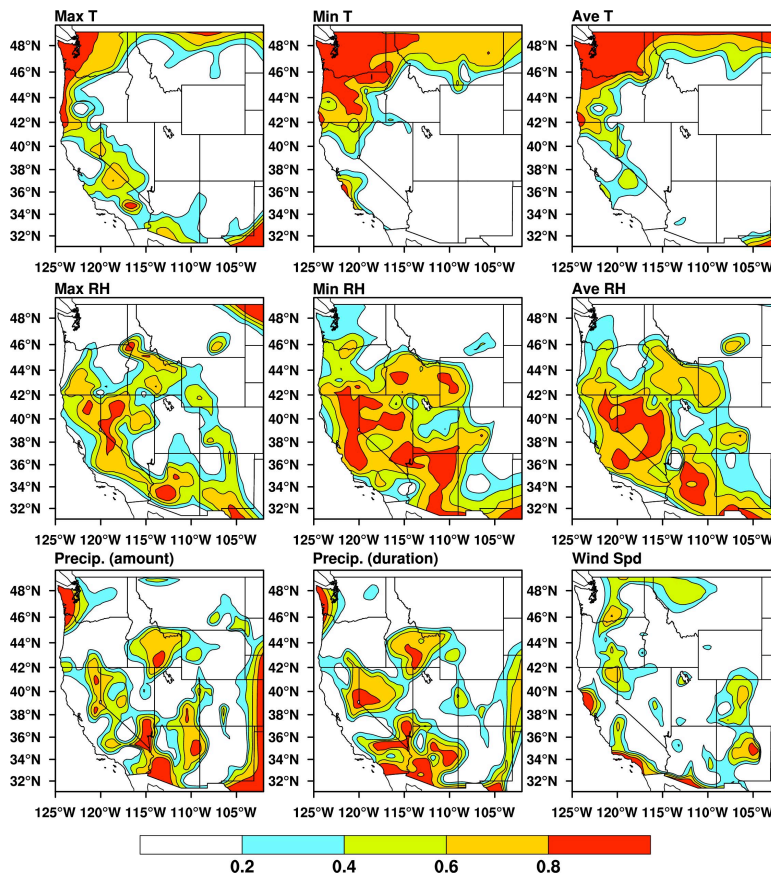
Figure 4. Shaded contours of RAWS and RSM forecast anomaly correlations for the atmospheric elements maximum, minimum, average temperature (Max T, Min T, Ave T); maximum, minimum, average relative humidity (Max RH, Min RH, Ave RH); precipitation (amount and duration); wind speed.

Figure 5 shows the June through August season RAWS and RSM forecast anomaly correlations for each of the fire danger indices. Portions of the interior West are highlighted with larger correlations (i.e., > .60) especially for BI and ERC. This is likely related to the large relative humidity correlations shown in Figure 4.

In summary, the skill of the week 1 forecasts of atmospheric elements (especially temperature) is high. Not surprisingly, the skill decreases substantially for the remaining forecast weeks. Thus, for Predictive Services meteorologists, the RSM forecasts could yield useful information in the preparation of the GACC 10-day outlooks. The seasonal forecast skill is much lower, especially for fire danger indices. However, the spatial distribution of skill suggests some areas may have higher forecast utility than others. This seems to be especially true for BI and ERC in the interior West.

A journal article and a summary report of the project results for the GACC Predictive Services meteorologists will be prepared based upon the thesis manuscript. It is anticipated that these will be completed during the first half of 2004. A proceedings paper was prepared for presentation at the American Meteorological Society 5th Symposium on Fire and Forest Meteorology, Orlando, Florida, November 2003. The thesis will be available from the CEFA web site in the publications section.

Should a phase II of this project be developed, it would be desirable to perform an analysis comparing the RSM forecasts directly to each RAWS used in the study to assess site-specific

forecast skill. It would also be beneficial to develop RSM model output statistics equations for RAWS to complement the work being undertaken in Task Order 11.
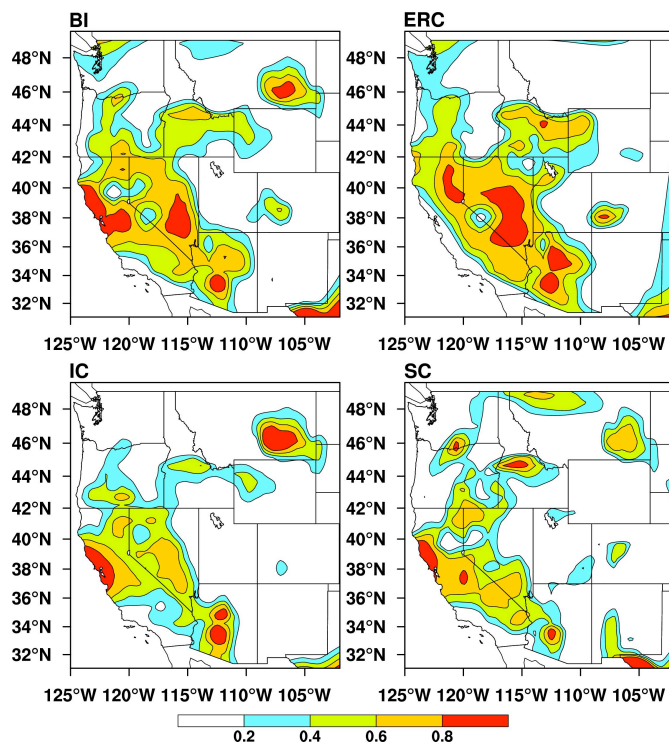

Figure 5. Shaded contours of RAWS and RSM forecast anomaly correlations for NFDRS indices burning index (BI), energy release component (ERC), ignition component (IC) and spread component (SC).

3. GACC meteorologist training

No new training was specifically requested during this reporting period. However, see new projects below for a description of a medium-range forecast workshop planned for 2004. Some training on experimental model long-lead forecasts was undertaken during the national seasonal assessment workshop described under Task Order 1. This primarily consisted of descriptions of the model output and the elements that go into the model in order to produce a forecast.

4. Climate factors and recent wildfire seasons

The U.S. wildfire seasons since 1999 have been interesting in that all of them have been notable particularly in terms of the total area burned, multiple events and large fire occurrence. To some extent, unique situations may be attributable to the annual outcome, but there may be some common factors as well (e.g., fuel conditions, drought). For example, much of the West is experiencing its sixth year of drought. This task element provides for the examination of atmospheric factors in an attempt to identify key links between climate and fire during the period 1999-2002. As the 2003 fire season matured, it became clear that another high profile year was occurring given the extent of activity in Arizona and the northern Rockies. At the end of October southern California capped the season with some of the largest fires in the state's history. Initial work for a new BLM/CEFA drought project (see new projects below), suggested that some more examination was going to be needed to successfully complete this task objective. Therefore, this task element will be completed by June 2004. It is intended to prepare a report/paper describing the role of climate in fire during the period 1999-2003. The long-term drought will most likely be identified as a strong contributing factor; some detail will be provided. Additional

emphasis will be placed on climate extremes in relation to fire extremes, with both in the context of global change.

Task Order 5: Analysis of the Southwest Monsoon in Relation to Fire Danger Characteristics (Sponsor: BLM)

This task officially began in September 2001. The primary objective is to identify quantitative relationships between Southwest Monsoon climate and weather elements and subsequent effects on fire danger and fire occurrence. A Masters level graduate student is assigned to the project, along with involvement from other CEFA personnel. The following specific task elements were planned for the second year:

1) Continue analysis of regional meteorological patterns. This component will help identify characteristics of the monsoon itself. The analysis will include quantifying climate characteristics to establish onset dates, duration and strength of the monsoon.
2) Determine the relationships between climate factors and wildland fire activity, especially as related to large fire occurrence. This analysis will be accomplished by the utilization of statistical and visualization methods, along with the incorporation of scientific expertise.
3) Prepare a paper/report describing the results of the study. A journal paper will be prepared to gain scientific acceptance of the results. A project report will be prepared for fire agency use.
4) Results of the analyses will be presented at meetings, workshops and conferences as warranted.

The funding for this project ends 31 December 2003. This task element is also a Master's thesis project for a DRI/CEFA graduate student, with expected completion in December 2003. Accomplishments for each task are discussed below. Because any journal papers or agency reports are dependent upon the final thesis manuscript, these deliverables are anticipated to be completed during the first half of 2004 to fulfill the Task Order deliverables. Accomplishments for the reporting period are as follows:

1. Analysis of regional meteorological patterns

Monsoon onset dates were examined using two primary definitions (Phoenix official dew point definition – three consecutive days of average 55°F or higher dew point; Southwest Predictive Services (SPS) minimum relative humidity (RH) – five out of seven days minimum RH ≥ 20%). The two different definitions show substantial interannual variability in onset date. For some years, onset dates might be similar, but for others there could be as much as a two-week difference. The Phoenix definition was developed only for the specific city location, though it is often used in broader regional scales. For comparison, the Tucson definition is three consecutive days of average 54°F or higher dew point. The SPS definition applies to individual RAWS sites in Arizona and New Mexico.

The strength and duration of the monsoon are much more problematic than the onset. Again, different meteorological elements could be used to define strength, however, there is no single accepted definition of strength. A large U.S.-Mexico agency atmospheric science field research experiment is planned for the monsoon region during the next few years, and perhaps through this work some insight into strength may be revealed. In the present study because of the complexities of the onset analysis and time constraint, it was decided not to pursue a strength analysis. This would be worthwhile to address further in a future study. There is also no formal definition of monsoon duration, and none was determined in this project. For this

study, generally the end of August was used to denote duration, though depending upon the specific analysis, duration may have continued into September.
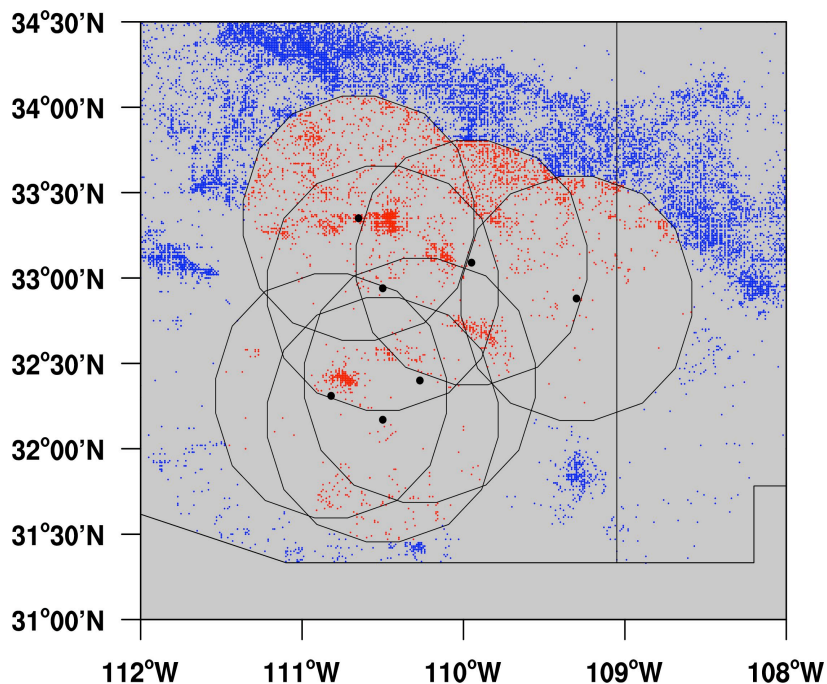

Figure 6. Locations of RAWS (black dots) in southeastern Arizona study region. Circles represent 50-mile radius around each station. Red dots indicate fire locations within each RAWS radii, and blue dots indicate fire locations across the region. The cluster of fires near the top of the map highlights the Mogollon Rim region.

In order to establish onset dates to relate to fire, historical data from seven RAWS were used to acquire 1300 local time daily relative humidity values and compute a dew point for the period 1980-2002. Figure 6 shows the RAWS locations within the southeastern Arizona study region. Fires (red points) within a 50-mile radius of each RAWS were used in the occurrence analysis. The fires were comprised primarily of federal occurrence (USFS 5100-29 and DOI 1202 reports) though some state fires were included from the Coarse-Scale Spatial Data for Wildland Fire and Fuel Management project (http://www.fs.fed.us/fire/fuelman/index.htm).

Figure 7 shows the climatological time series of daily dew point (green line), minimum relative humidity (blue line) and number of fires (red line) in southeastern Arizona. A five-day running mean is applied to each series. Starting in early June, the dew point exhibits a steady increase until around late July, and remains fairly level until the latter half of August when it slowly declines. Relative humidity begins a rapid increase in value near the end of June, and in early July slowly increases until early August where it shows little trend until a gradual decline in early September. Fires exhibit a substantial increase in the latter half of June, with a very abrupt decline beginning at the end of the first week in July. This date corresponds to the climatological onset of the monsoon. Given that both dew point and relative humidity increase in correspondence with the monsoon arrival, and that fires decrease, it is easy to formulate an assumption that there must be a relationship between monsoon and fire.

The complexities of the project limited the research in scope compared to that originally planned. Thus, two objectives became the focus of the study: 1) Determine the applicability of two monsoon onset definitions (dew point and minimum RH) to fire occurrence; and 2)

quantitatively assess fire/atmospheric elements occurring within the monsoon season. Because of the analysis complexities that became apparent during the project and the available time frame to complete the work, it was decided to focus the study region just to southeastern Arizona. This area typically receives the largest and most direct monsoon influence, and thus may exhibit the strongest statistical signals.
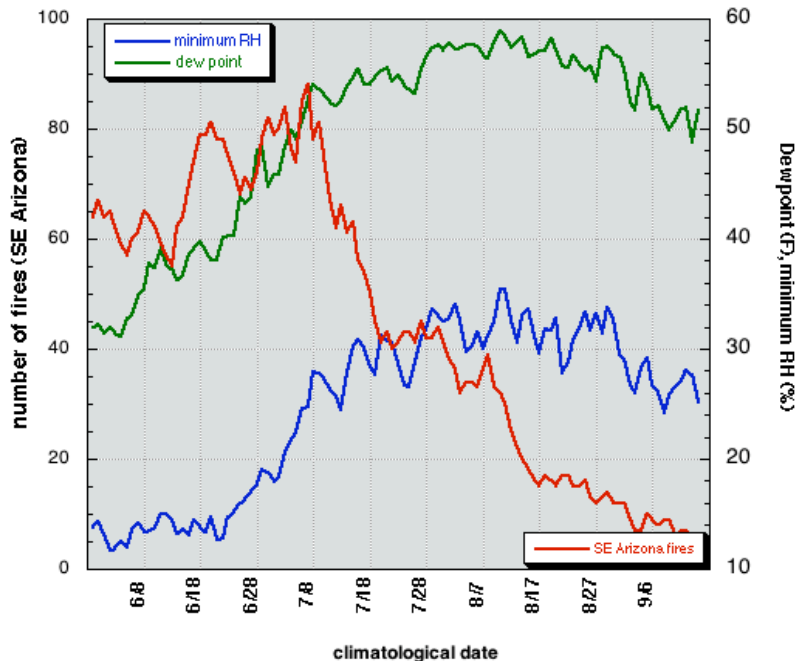

Figure 7. Climatological time series of southeastern Arizona dew point (°F; green line), minimum relative humidity (%; blue line) and fire starts (red line).

2. Climate and fire relationships

Determining relationships between the monsoon and fire is difficult because of inherent complexities of these two physical phenomena. Both exhibit substantial interannual and intra-seasonal variability for reasons not fully identified and understood. Atmospheric changes stemming from the monsoon results in both fire producing and fire mitigating effects. Lightning accounts for 50% of the fires in the study region, which means that the remaining 50% are human caused. Given this, fire starts were separated by human and natural cause for detailed analysis. Figure 8 shows that the decline in fire starts in Figure 7 was primarily due to a rapid decline in human caused fires (red line). Natural fires (blue line) continue until mid-August when a decline begins. Lightning occurrence also rapidly increases around the beginning of the monsoon, and continues at elevated levels until early September. Analysis of dew point and lightning suggests that a dew point value of 60 or higher (single day or more event) is required to reduce fire occurrence. It is speculated that dew points in the low 60s and above produces "wet" thunderstorms, while values less than 60 tend to be more "dry". The correspondence between natural fires and lightning makes intuitive sense.

The lack of a similar pattern for human fires suggests different reasoning may be required. Human fires do decrease with larger dew points, but if lightning fires continue with upper 50s values while human fires decrease, then the latter suggests perhaps non-physically based factors are playing a role. We can only speculate that it may be a function of less outdoor activities, due to more extreme climate conditions for human comfort (a combination of

increased monsoon humidity and increased summer temperatures, and perhaps increased thunderstorm occurrence). This speculation can be tested given records of outdoor human activities such as park and campground passes, but this information has proven difficult to acquire in database form.
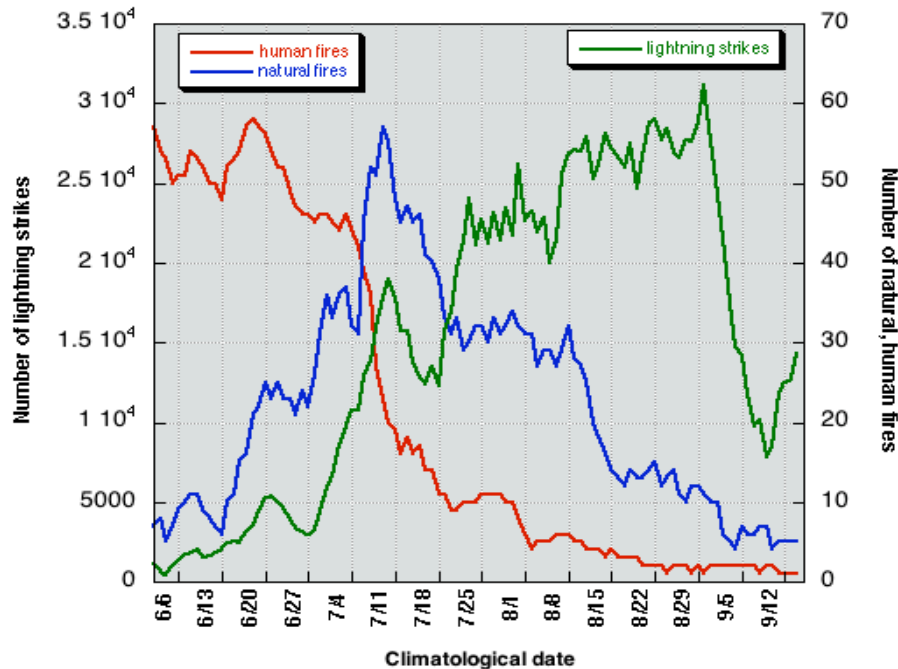

Figure 8. Climatological time series of southeastern Arizona human caused fires (red line), natural caused fires (blue line) and lightning occurrence (green line). Lightning data source is the Vaisala-GAI National Lightning Detection Network.

Fire occurrence (counts and large (≥ 100 acres)) after onset for both dew point and minimum relative humidity definitions were analyzed to determine if either definition is a satisfactory indicator of fire activity. The analysis further refined the counts by timber and shrub vegetation types. Other dew point and minimum relative humidity thresholds were also examined. Figure 9 shows a histogram of the daily dew point frequency (red bars) and human fire counts (blue bars). Human fire counts appear to begin decreasing around a dew point of 60, which also seems to be the case for natural fires (Figure 10). Larger decreases in fire count are seen with higher dew point values in both figures, but the number of times that these dew point values occur is also decreasing substantially. This same pattern of decreasing fire occurrence with decreasing dew point days was also seen for multi-day dew point thresholds, such as three consecutive days of a particular dew point value.

Large fires were not found to decrease with increasing dew point or minimum RH, however, the small number of large fire occurrences (70 during the 23 years) hampered efforts to statistically identify any succinct pattern. Large fires are an important management concern, and deserve further research in other monsoon-affected areas with higher occurrence counts.
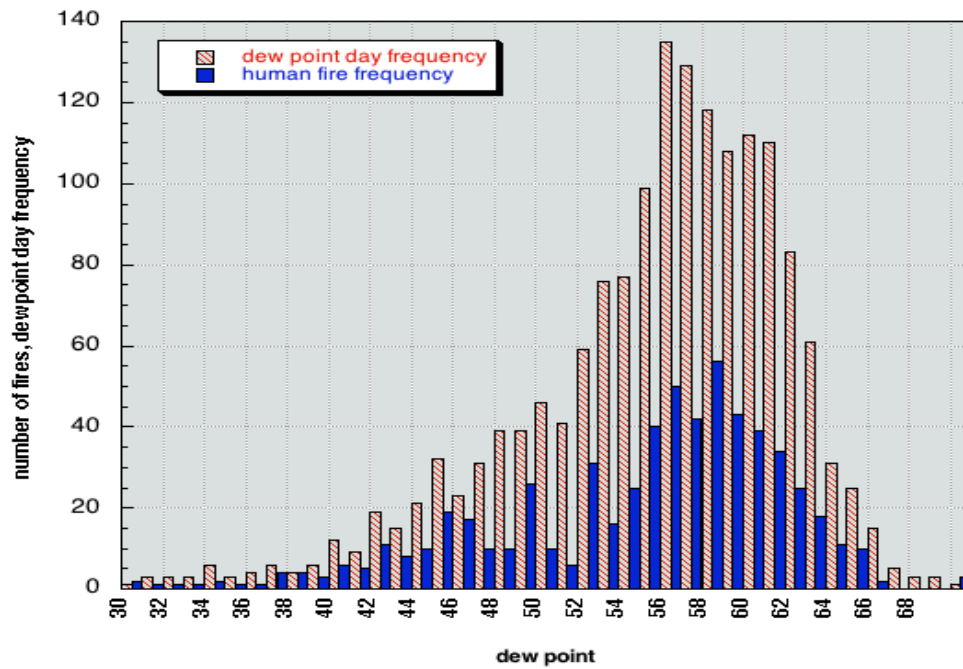
Figure 9. Bar chart of dew point value (°F; red bars) and human fire counts (blue bars) associated with that dew point value.
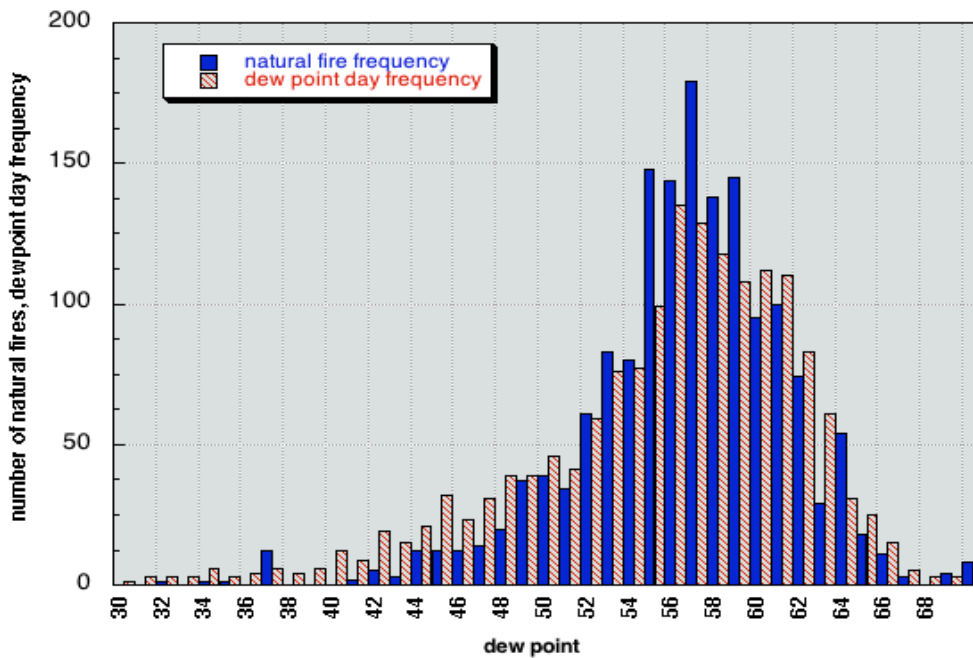
Figure 10. Bar chart of dew point value (°F; red bars) and lightning fire counts (blue bars) associated with that dew point value.

The primary conclusions of this study are:

- The Phoenix dew point and GACC minimum relative humidity definitions of monsoon onset applies to human fires, but not to natural fires. This suggests that separate factors are occurring such as decreased human activity during the monsoon season and increased "dry" thunderstorms.

- A dew point value of 60 or larger for a single day is a potential moisture threshold for decreasing natural fire occurrence, perhaps due to increased "wet" thunderstorms.
- The current Phoenix and GACC definitions by themselves are not sufficient as an indicator of reduced fire occurrence regardless of size.
- No dew point or relative humidity definition was found to be sufficient in determining a reduction in fire occurrence regardless of size.

It is evident from this project that fire and monsoon interactions are complex and deserve further work. It is hoped that a phase II of the project can be developed in collaboration with Southwest Predictive Services. In this joint effort, the Southwest GACC meteorologists would play a significant role in identifying data and information needs, as well as working directly with CEFA on the analysis.

3. Prepare report/paper

A journal article and a summary report of the project results for the GACC Predictive Services meteorologists will be prepared based upon the thesis manuscript. It is anticipated that these will be completed during the first half of 2004. A proceedings paper was prepared for presentation at the American Meteorological Society 5th Symposium on Fire and Forest Meteorology, Orlando, Florida, November 2003.

4. Project presentation

A proceedings paper was prepared for presentation at the American Meteorological Society 5th Symposium on Fire and Forest Meteorology, Orlando, Florida, November 2003.

Task Order 6: A Comparison of Precipitation/Drought Indices Used in Fire Management (Sponsor: BLM)

This Task Order was funded in August 2002. The project was scaled back considerably from its original inception due to budgetary constraints, and thus a very limited amount of research could be undertaken. The primary focus was to assess the strengths and weaknesses of the standardized precipitation index (SPI), the Palmer drought severity index (PDSI and its derivatives), and Keetch-Byram Drought Index (KBDI) in relation to fire danger and fire activity. The following specific task elements were planned:

1) Acquire programming code and/or software for calculating various drought/precipitation indices including SPI, PDSI, and KBDI.
2) Acquire historical precipitation data and develop precipitation climatology.
3) Assess the strengths and weaknesses of the three indices by performing spatial and temporal scale statistical analyses.
4) Prepare a paper/report summarizing the analysis results and provide recommendations on the potential use and application of these drought indices in the context of wildland fire management planning.

The funding for this project ends 31 December 2003. Because the project effectively became an exploratory pilot study, it was decided to place emphasis on the SPI and PDSI for two reasons. First, both SPI and PDSI are traditionally computed for monthly and longer scales, whereas KBDI is typically computed as a daily index. Therefore, it would be difficult to compare the indices directly for the different time scales. Both SPI and PDSI could be computed on a daily basis. However, daily values are not readily available to the field in an operational setting. Thus, the second reason for only working with SPI and PDSI is to examine how longer-term

indices that are directly available to the field are correlated to fire activity. Accomplishments for the reporting period are as follows:

1. Acquire index software code

KBDI code was obtained when CEFA received complete NFDRS code from Larry Bradshaw at the Missoula Fire Sciences Laboratory. Fortran language code for both SPI and PDSI was acquired by CEFA from the National Climatic Data Center (NCDC). In fact, this same code was applied in a project completed by Mr. Paul Schlobohm during his work at DRI. The original reason for the code acquisition was to be able to compute SPI and PDSI at various time scales. However, after deciding to only analyze field accessible data, the code was not used in the project. It is valuable to have the code readily in house though, as it will likely be utilized in future projects.

2. Acquire precipitation data and climatology

With the change in project strategy, the acquisition of a precipitation database also changed. It was decided to utilize divisional climate data as established by NCDC. The Western Regional Climate Center (WRCC) computes monthly PDSI and SPI for several different integrated month periods up to 72 months. Thus, PDSI and SPI values were acquired from WRCC and used in the project. A derivation of PDSI, PDSI-Z, was also acquired for the analysis. These indices provide for both representation of precipitation and climatology.

3. Temporal and spatial scale analyses

The primary analysis consisted of calculating Spearman-Rank correlation values for the drought indices with number of fires, area burned, and energy release component (ERC) at a monthly time scale for the areas shown in Figure 11. The two primary project questions were to assess if a particular index is better correlated to a fire characteristic than another, and if there are regional distinctions for a particular index with the strongest correlation. Eleven indices were examined including the PDSI, PDSI-Z, and SPI for 9 integrated periods including 1, 3, 6, 12, 24, 36, 48, 60 and 72 months. The data period consisted of 22 years from 1980-2001. A number of RAWS within each climate division were used to compute a divisional monthly ERC value.

Figure 12 provides an example of Spearman-rank monthly correlations for the various drought indices and the number of fire starts for the southern Utah region in Figure 11. The correlations are 1-month lags, that is, the drought indices precede the fire starts by one month (e.g., July indices correlated with August fire starts). The most notable feature is that no single index dominated all of the months. This was the case for all of the study regions. Figure 13 shows a similar style plot for the area burned. Most all indices showed a negative correlation to area burned. Negative correlations can be interpreted as a general association of increasingly drier months followed by increasingly area burned, and vice versa for positive correlations. Figure 14 shows the monthly correlations for ERC, and again no single index dominated all of the months, though all indices showed a negative correlation to ERC.
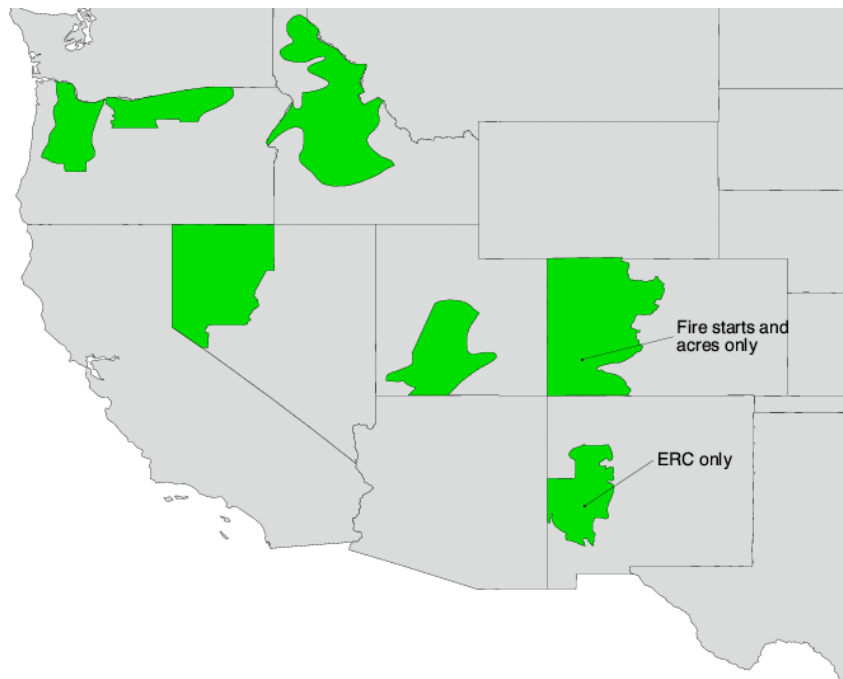
Figure 11. Climate division areas used in the study are denoted in green. Unless indicated otherwise, fire starts, area burned and energy release component (ERC) were analyzed in each region.
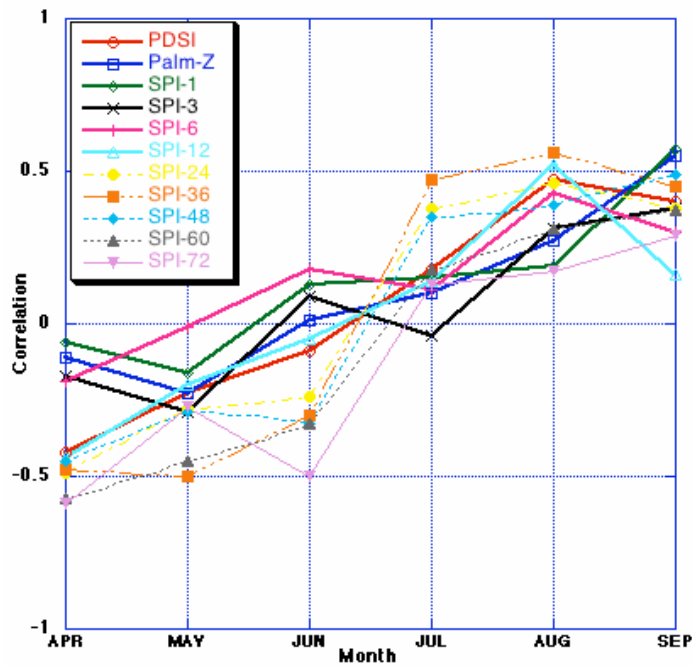
Figure 12. Spearman-rank correlations for southern Utah area monthly drought indices (color coded in the legend) and fire starts. Indices precede fire starts by one month (e.g., July indices correlated with August fires).
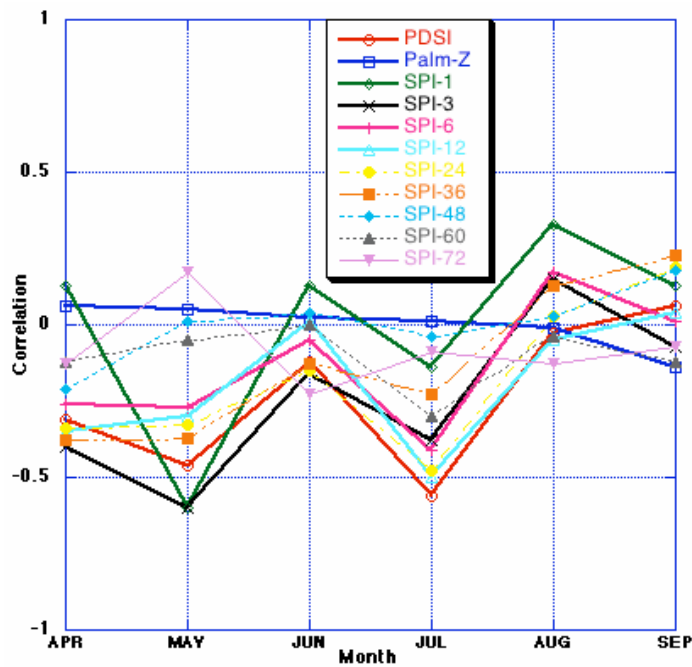
Figure 13. Spearman-rank correlations for southern Utah area monthly drought indices (color coded in the legend) and area burned (acres). Indices precede fire starts by one month (e.g., July indices correlated with August area).
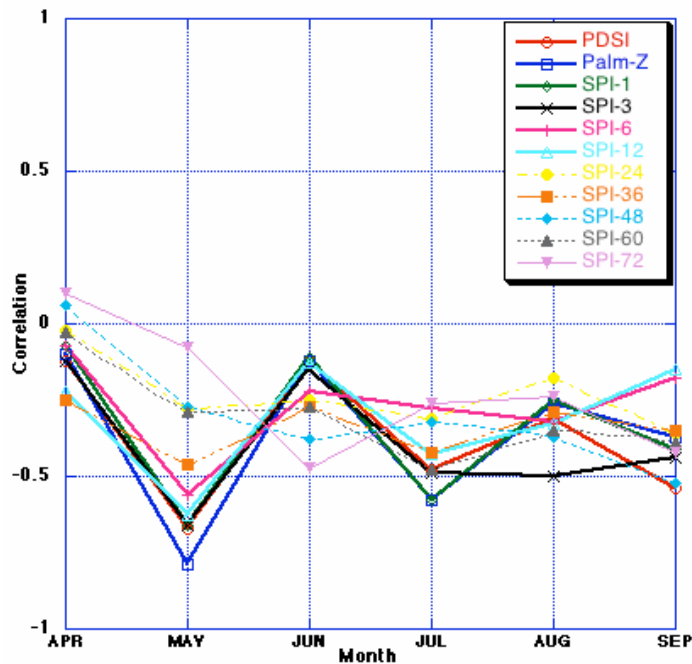
Figure 14. Spearman-rank correlations for southern Utah area monthly drought indices (color coded in the legend) and ERC. Indices precede fire starts by one month (e.g., July indices correlated with August ERC).

Indices from the six different regions were compared in correlation tables. To compute correlations, each SPI integrated time period is treated as a separate index (e.g., 1-month, 6 month, 48 months, etc.). However, the computation of SPI for any time period is the same; it is only the integration of months that is different to be termed a separate index. Likewise, Palmer-

Z is a derivative of PDSI, and thus is very closely related. Thus, the indices can be examined in terms of separate identities, but also as two types based on their computations: SPI-type and Palmer-type.

Table 1 shows for each region the drought index with the highest magnitude correlation (regardless of sign) to the number of fire starts in the following month (e.g., July index preceding August fires). No single index dominates a month for all regions, nor is one consistent for all months for any specific region. However, for some regions there is a preferred index type. The SPI-type dominates all months in central Idaho, western Oregon, northwestern Nevada and western New Mexico. In central Oregon-Washington SPI-type occurs in four of the six months, but in southern Utah Palmer-type dominates four of the six months.

Table 1. Drought index with the highest magnitude correlation to the following month fire starts for each study region.

Month	Central Idaho	Western Oregon	Central OR-WA	Northwest Nevada	Southern Utah	Western New Mexico
APR	-0.50 (SPI-72)	-0.45 (SPI-3)	0.31 (SPI-1)	0.26 (SPI-3)	-0.46 (PDSI)	-0.59 (SPI-72)
MAY	-0.69 (SPI-24)	-0.55 (SPI-3)	-0.36 (SPI-72)	0.31 (SPI-1)	-0.59 (PDSI)	-0.50 (SPI-36)
JUN	-0.21 (SPI-3)	0.35 (SPI-1)	-0.34 (SPI-60)	-0.36 (SPI-36)	-0.46 (PDSI)	-0.50 (SPI-72)
JUL	-0.56 (SPI-36)	-0.64 (SPI-60)	-0.39 (SPI-1)	-0.56 (SPI-48)	-0.36 (SPI-12)	0.47 (SPI-36)
AUG	0.23 (SPI-6)	0.41 (SPI-12)	0.28 (Palm-Z)	-0.57 (SPI-1)	-0.39 (Palm-Z)	0.56 (SPI-36)
SEP	-0.38 (SPI-72)	0.46 (SPI-12)	0.39 (Palm-Z)	-0.37 (SPI-72)	-0.53 (SPI-60)	0.57 (SPI-1)

A negative sign here refers to a tendency towards a "dry" month followed by "increased" fires and vice versa for the positive value. Larger values indicate a stronger trend association. There is a slight preference for negative correlations, but it cannot be stated uniformly that "dry" months are followed by "increased" fire occurrence. Clearly, there are cases of "wet" months being followed by "increased" fire occurrence. Depending upon the month and/or region, this correlation may be indicative of a physical cause and effect relationship, but for other cases, the correlation sign may simply be an indicator of intra-seasonal variability. This discussion holds as well for area burned and ERC relationships shown below, of which the correlations can be interpreted in a similar manner.

Table 2 gives the drought index with the highest magnitude correlation to the following month area burned for each study region. The regions showing consistent monthly SPI-type correlations are central Idaho, central Oregon-Washington, and northwestern Nevada. Western Colorado and Southern Utah had five of six months with a SPI-type index, and western Oregon had four of six months with a SPI-type index. As with fire occurrence, there is a slight preference for negative correlations, the variability in months and region makes it difficult to claim a uniform relationship between specific index and area burned. However, the SPI-type index does dominate the area burned correlations.

Table 3 gives the drought index with the highest magnitude correlation to the following month ERC for each study region. Unlike fire occurrence or area burned, no index is uniform for the months at any location. However, it is interesting to note that except for two instances (central Oregon-Washington in June and western New Mexico in September), negative

correlations dominated the months and regions. Despite the variability in the correlation magnitudes, this uniformity in trend supports claims that ERC is a drought-like index.

Table 2. Drought index with the highest magnitude correlation to the following month area burned for each study region.

Month	Central Idaho	Western Oregon	Central OR-WA	Northwest Nevada	Southern Utah	Western New Mexico
APR	-0.27 (SPI-72)	0.24 (SPI-1)	-0.41 (SPI-48)	-0.35 (SPI-72)	-0.36 (SPI-3)	-0.40 (SPI-3)
MAY	-0.61 (SPI-24)	-0.38 (PDSI)	-0.48 (SPI-48)	-0.57 (SPI-6)	-0.24 (SPI-6)	-0.60 (SPI-3)
JUN	-0.39 (SPI-6)	0.60 (SPI-1)	-0.42 (SPI-60)	-0.25 (SPI-1)	-0.43 (PDSI)	-0.23 (SPI-72)
JUL	-0.41 (SPI-1)	0.58 (PDSI)	-0.46 (SPI-48)	-0.31 (SPI-60)	-0.44 (SPI-12)	-0.56 (PDSI)
AUG	0.37 (SPI-6)	0.79 (SPI-3)	-0.19 (SPI-1)	-0.22 (SPI-3)	-0.31 (SPI-72)	0.33 (SPI-1)
SEP	0.31 (SPI-12)	0.43 (SPI-60)	0.34 (SPI-6)	0.32 (SPI-24)	-0.20 (SPI-72)	0.23 (SPI-36)

Table 3. Drought index with the highest magnitude correlation to the following month ERC for each study region.

Month	Central Idaho	Western Oregon	Central OR-WA	Northwest Nevada	Southern Utah	Western New Mexico
APR	-0.20 (PDSI)	-0.68 (SPI-36)	-0.21 (Palmer-Z)	-0.21 (SPI-3)	-0.25 (SPI-36)	-0.58 (Palmer-Z)
MAY	-0.61 (SPI-3)	-0.43 (PDSI)	-0.25 (SPI-3)	-0.59 (PDSI)	-0.79 (Palmer-Z)	-0.61 (Palmer-Z)
JUN	-0.23 (SPI-6)	-0.50 (SPI-12)	0.27 (SPI-48)	-0.25 (SPI-72)	-0.47 (SPI-72)	-0.48 (SPI-1)
JUL	-0.60 (SPI-1)	-0.48 (PDSI)	-0.17 (PDSI)	-0.51 (Palmer-Z)	-0.58 (Palmer-Z)	-0.69 (SPI-24)
AUG	-0.57 (SPI-36)	-0.48 (SPI-36)	-0.37 (SPI-36)	-0.59 (SPI-48)	-0.50 (SPI-3)	-0.58 (SPI-1)
SEP	-0.74 (Palmer-Z)	-0.67 (SPI-1)	-0.85 (SPI-1)	-0.38 (Palmer-Z)	-0.54 (PDSI)	0.28 (SPI-60)

Figure 15 shows the frequency of the highest magnitude correlations by index for each fire variable in the study for all of the months combined. The red, blue and green bars represent fire starts, area burned and ERC, respectively. Each index was correlated with one or more fire variables at least once. From this graph, it is difficult to determine a dominant specific index. Clearly, SPI-type occurs more often than Palmer-type. Though some bars appear higher than others, the actual difference is often only two or three. However, combining occurrence, area and ERC counts for each index suggests some preferred indices, such as PDSI, Palmer-Z, SPI-1, SPI-3, SPI-36 and SPI-72. In other words, this group of indices is in a higher count distribution compared to the group of remaining indices.

In summary, no single index was consistent in high magnitude correlations for any month or for any region. The SPI-type index dominated the correlations for fire occurrence and area burned. The correlations for ERC were closer to an equal mix of index type. The results of this project are of value, but the limited amount of Task resources has restricted the project to achieving the desired goal of generating a statement for fire management containing recommendations on the usage of these drought indices. Some further work is required before this ultimate objective can be obtained. Some proposed future work would be the examination

of seasonal fire variables. While monthly correlations are of interest, seasonal correlations cover a longer-term aspect of climate and can provide relevant information for seasonal fire planning. Focusing strictly on the index with the highest correlations may overlook indices with lower, but more consistent correlations for either in time or by region. Thus, a more detailed correlation analysis would be beneficial. The utilization of logistic regression would allow for a predictive assessment of the drought indices and the fire variables. It is hoped that a phase II of this project can be developed to address these issues.
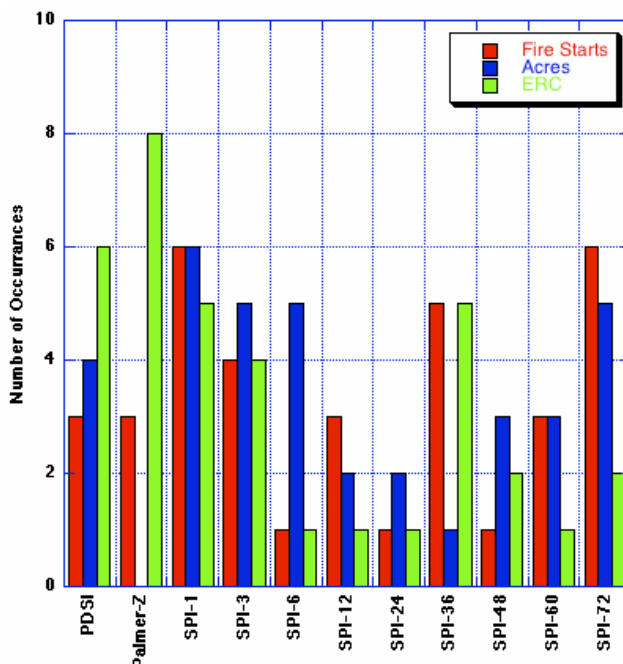
Figure 15. Bar chart showing frequency of the highest magnitude correlations by index for each fire variable for all months combined. The red, blue and green bars represent fire starts, area burned and ERC, respectively.

4. Report

A proceedings paper was prepared for presentation at the American Meteorological Society 5th Symposium on Fire and Forest Meteorology, Orlando, Florida, November 2003. This paper will serve as the project report unless a phase II allows for more complete analysis to meet the original project objectives.

Task Order 7: Web Access to RAWS Data and Products (Sponsor: BLM)

This task is being accomplished within WRCC by separate BLM funds, but using CEFA as a project conduit. The primary project objective is to build upon recent efforts to reconstruct the internal storage and access system for RAWS data and initiate system-wide improvements. This work officially began in August 2001, and this reporting period represents the second year of the project through the period 30 June 2003. In June 2003, a year three Task Order was funded by BLM for the period 1 July 2003 – 30 June 2004. Accomplishments for this period will be described in the FY04 CEFA annual report. Statement of Work specific task elements during the project second year included:

1) Continue conversion of RAWS station data from ASCII text to internal binary indexed format. This permits much faster I/O for applications programs. To date all stations more than two years old have been converted. The fact that new stations are always coming on line makes this a low-impact but on-going task.
2) Product Development. Product development will occur with user-community technical feedback [see task element 3 below]. Modification of some products to meet user needs is possible and will be approved by the Administrative Representative. Products will be developed in text and graphic formats.
3) RAWS Advisory Group. An interagency RAWS advisory group will be set up to provide timely, focused feedback to product development. The group will consist of 10-15 individuals involved in a cross section of fire-related disciplines.
4) New web page design. A new organizational structure will be made to the website including a new home page directing the visitor to products (including existing products), information, and related links.
5) ASCADS Re-engineering. Developments in the re-engineering of ASCADS are critical to the success of the infrastructure and products of this Task Order. This task element places a priority on close coordination between WRCC and BLM ASCADS redesign efforts.
6) Technology transfer/Training. Products will be presented in several formats to appropriate groups. Presentations may include the National BLM Fire and Aviation Meeting, December 2002; Geographic Area Meteorologists meeting, March 2003.

Accomplishments for the reporting period are as follows:

1. RAWS data conversion

Conversion of new RAWS station data from ASCII text to internal binary indexed format is an ongoing process and takes place on a near-real time basis (approximately 15 minutes upon receipt of data). New stations are brought online typically within a week of receipt of first data. The one-week delay allows for verification and entry of all metadata parameters for the new station.

2. Product development

Several product categories were identified in the Task Order Statement of Work:

a) Station metadata – Historical information has been developed for all stations. The information currently is not publicly accessible, but can be made available to a station owner upon request.

b) Climate summaries – Available online summary products include daily weather summaries, monthly weather summaries, daily summaries (with wind chill and heat index by special NIFC request in regards to the shuttle recovery effort February 2003), and monthly summaries with potential (Penman) evapotranspiration.

c) Quality control – Preliminary programs have been developed. These programs are planned for implementation in 2004.

d) Missing data estimates – Preliminary regression algorithms have been coded, but testing needs to be undertaken. Testing is planned for 2004.

e) Frequency distributions – This product is available on the web.

f) Thresholds – This product is under development. It is anticipated to be available on the web in 2004. An example of thresholds would be precipitation daily amount probabilities that could be utilized in determining season ending events.

3. RAWS advisory group

The RAWS advisory group was established in Spring 2003. Its function is to provide feedback as products become available, and to recommend potential new products and existing product modifications. The group consists of ten interagency members that actively use RAWS information. Individuals are responsible for providing feedback to WRCC. Some individual feedback was provided and acted on during this reporting period.

4. New web page design

A RAWS web page was implemented in Spring 2003 (see link address in 6. below). The purpose of the new interface is to provide access to all historical RAWS data. It also allows for interactive data retrieval and product generation, such as wind roses and time series plots.

5. ASCADS re-engineering

Software reprogramming was undertaken for proper communication in response to the ASCADS computer system changeover in March 2003.

6. Technology transfer/training

Web accessible products were presented at the GACC meteorologist/NWCG Fire Danger Working Team meeting in Fairbanks, Alaska, March 2003, and the NWCG Fire Weather Working Team meeting in Salt Lake City, April 2003. The web products are available from http://www.raws.dri.edu/index.html.

In March 2003, two Sun Fire 280 servers were purchased with add-on funding from BLM. These machines provide the web server processing. In April 2003, a PC notebook was purchased for data process program development and field presentations. In June 2003, a PC desktop was purchased to improve existing data acquisition and processing functions.

Task Order 8: Development and Implementation of the CEFA Operational Forecast Facility (Sponsor: CANSAC/Interagency)

This Task Order was scheduled to end on 31 December 2002. However, the development and implementation of the CEFA Operational Forecast Facility (COFF) was delayed until 1 October 2003 due to the primary hardware funding support not being available until September 2003. As a result of this delay, it was decided in conjunction with BLM to let Task Order 8 terminate per its scheduled date, and have Task Order 10 be the primary Statement of Work for COFF. Task Order 10 was originally established in regards to the operation of the facility. See Task Order 10 below for the COFF project.

Task Order 9: Development of U.S. Operational Fire Danger 15-Day Forecasts (Sponsor: USDA Forest Service)

One of the primary objectives of Predictive Services at the National Interagency Coordination Center (NICC) is to provide relevant information about weather, climate and fuels

for decision-making and planning for resource allocations and the determination of national preparedness levels. Prediction needs of weather, climate and fuels include short-term (1-2 days), medium-term (3-10 days), and long-term (30-90 days) forecasts. Operational daily forecasts from NWS provide much of the needed weather and climate forecast information for these periods, and there are also a number of experimental climate forecasts available that offer monthly and seasonal climate predictions. Forecasts of vegetation and fuel conditions at these various time scales are much more difficult to generate. Indices from NFDRS are often projected forward (e.g., via Fire Family Plus) as an indicator of future fire danger and then related to fire business, especially in terms of severity potential and resource demands. In order to predict preparedness levels and assess resource demands on daily and longer time scales at the national level, information needs include forecasts of weather, climate, fire danger, fire severity and fire potential along with how these factors relate to the various aspects of fire business. This project addresses two components of these needs, forecasts of weather and fire danger as an aid in assessing national preparedness levels and resource allocations.

The overall goal of the project is to develop a prototype system for producing operational forecasts of fire danger on a daily basis out to fifteen days. It incorporates national needs at NICC with operational forecast products produced by NWS. Techniques developed at the Missoula Fire Sciences Laboratory (MFSL) were used for producing national gridded predictions of ERC using fuel model G (ERC-G) by inputting NCEP/NWS Global Forecast System (GFS) model forecasts of temperature, relative humidity, wind, cloud cover and precipitation into NFDRS algorithms. To facilitate the standardized ERC concept, an ERC-G gridded national climatology was produced by MFSL. Then a national map of standardized ERC was produced by CEFA on an experimental and operational basis for use at NICC and the GACCs. Fifteen-day forecasts have been chosen for the prototype in part based upon information requests for preparedness level planning requirements at NICC and by GACC Predictive Services. The GFS model has been chosen for the prototype as an NCEP/NWS operational product meeting the 15-day requirement. This project is a collaborative effort with MFSL and NICC.

Task elements required for this project include developing a gridded ERC-G climatology, developing computer code that ingests gridded GFS forecasts into NFDRS algorithms, developing a system for producing daily operational forecasts, and developing desired output maps. Specific task elements are:

1) Develop gridded ERC-G climatology. A U.S. 8 km gridded climatology of temperature, relative humidity and precipitation currently being developed at the University of Montana will be used to produce a 16-year (1982-1997) climatology of ERC-G. Fuel model G will be applied to all climatology grid points. A mean and standard deviation value will be computed for each grid point that will be used to standardize the forecast values. The 8 km grid will be integrated to produce a climatology grid that matches the operational weather forecast grid.

2) Develop computer code linking NFDRS algorithms and GFS weather forecasts. The prototype gridded NFDRS code will be modified to interface with the GFS grids and run on a 15 day cycle instead of next-day.

3) Develop operational system for producing daily forecasts. This primarily involves putting in place computer code to access the operational daily forecasts, setting up the process to compute the daily ERC-G forecasts (including initializing the grid with real-time heavy and live fuel moistures), and producing the relevant output (e.g., map graphics).

4) Develop forecast output product. Web accessible forecast maps are the primary product output for the prototype forecast system. Initially these will consist of national maps of shaded contour ERC-G standardized values and percentiles for

each forecast day. However, NICC will be strongly relied upon for suggestions in developing the output product, especially in regard to content and appearance.

5) Evaluation of forecast products. This will consist of evaluating the utilization of the prototype system, and not a quantitative verification of the forecast products. During this period, NICC will assess the product for its utility and value in determining national preparedness levels and resource needs. Some minor relevant changes to the prototype system and its output can occur during this phase.

Accomplishments for the reporting period are as follows:

1. Gridded ERC climatology

A daily 8km ERC-G grid was produced at the University of Montana, Numerical Terradynamic Simulation Group (NTSG) under direction of MFSL. The DAYMET model provided the underlying high-resolution climatology of daily surface temperature, precipitation, humidity and radiation over complex terrain using both a digital elevation model, and daily observations of minimum and maximum temperatures and precipitation from ground-based meteorological stations. The calculation of ERC requires fuel moisture, state of the weather and precipitation duration. These values had to be estimated for input into the model. Woody and herbaceous fuel moisture was estimated from NDVI data. NFDRS state of the weather was estimated utilizing a cloud cover condition based on solar radiation provided by DAYMET. Precipitation duration was estimated using a combination of climate class and season. Details of the methods are provided in Hall et al (2003; see publication list). The ERC-G climatology was calculated on a daily 8 km grid for the period 1982-1997. These 8km grids were then averaged to match the available GFS forecast grids of 1 and 2.5 degrees. Daily mean and standard deviation values were calculated for generation of the final standardized product.

2. Develop computer code

NFDRS computer code provided by Larry Bradshaw at MFSL is being used to produce the ERC-G forecasts. The code was modified as necessary to allow for the direct input of GFS forecast weather fields of temperature, humidity, cloud cover and precipitation. Specialized code was also written to generate the ERC-G daily mean and standard deviation values.

3. Develop operational system

A combination of Unix scripts and computer code was developed that would allow for the daily operational production of standardized ERC-G forecast maps. The GFS forecasts are currently acquired from NCEP via an ftp process. Once the forecast grids are received, a computer script runs the code for calculating the standardized values at each mode grid point and forecast time. Following the calculations, graphical code produces the forecast maps that are then made available on the CEFA web site.

4. Develop output products

The output products were developed in conjunction with Tom Wordell at NICC. The primary products are the forecast maps of ERC-G, ERC-G anomalies, and standardized ERC-G. Map scale values and color shading preferences were provided by NICC. Figure 17 shows an example map of an ERC-G forecast for 18 UTC 14 Friday November 2003 based on the model run time of 00 UTC Wednesday 12 November 2003. Figure 18 shows an example map of ERC-G anomalies. The anomalies are found by subtracting the ERC-G mean climatology from the forecast values. An attribute of the anomaly map is that one can readily determine how far a forecast value is from its typical daily climatology value. Figure 19 shows an example

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forecast map of standardized ERC-G values that corresponds to Figure 17. Portions of the southern states show a greater than 2 standard deviation, which would be considered substantially above average for the day and thus indicating increased fire potential at least as based on ERC. This is not well depicted in Figure 17 that only shows the actual ERC-G values. Below average ERC-G values in the northern states highlight areas where fire potential is probably not a significant concern. The web address for the forecast maps is http://www.cefa.dri.edu/data/NatlERC/natlErc.html.
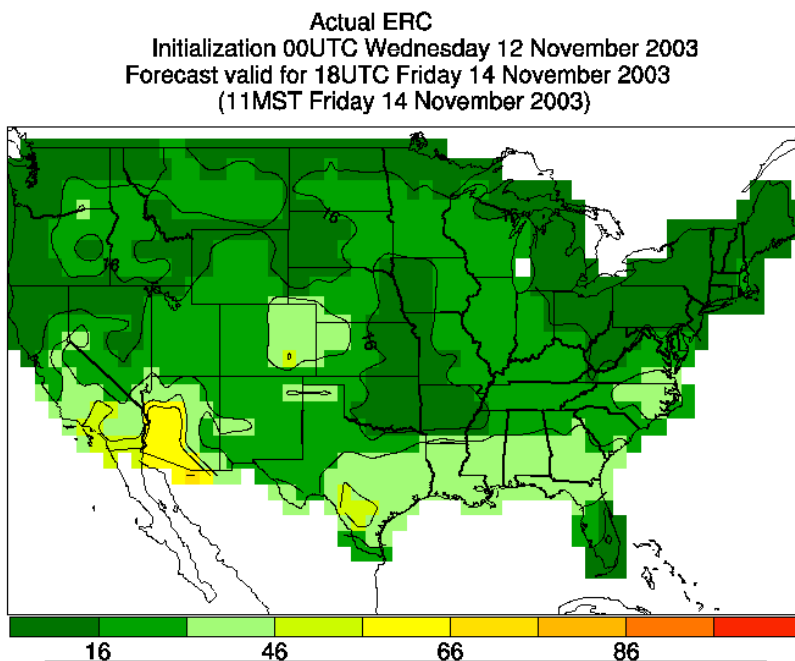

Figure 17. Example map of forecast ERC-G based on NCEP GFS model output. Color scale depicts range of ERC-G values.
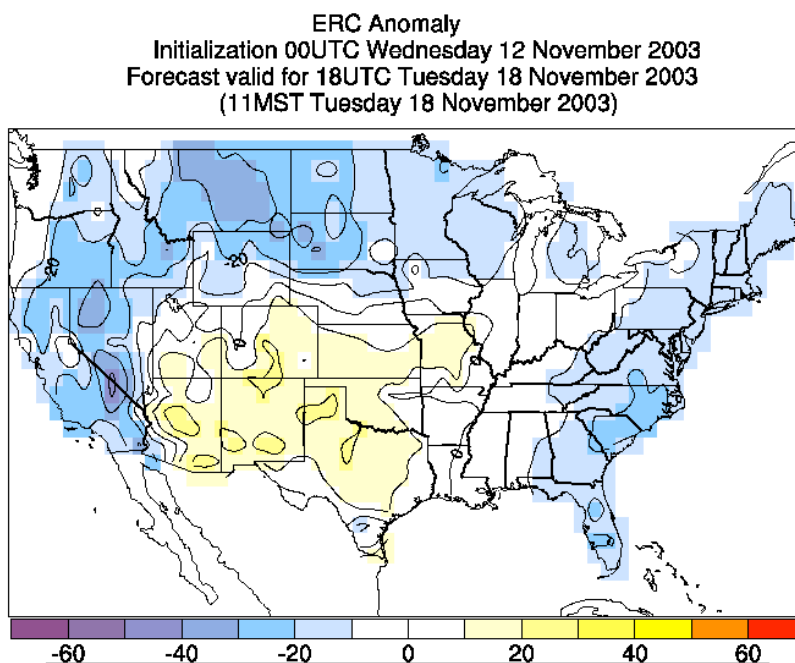

Figure 18. Example map of forecast ERC-G anomalies based on NCEP GFS model output. Color scale depicts range of ERC-G anomaly values.

National Standardized ERC Forecasts

Print image

Actual Time 1100 MST	Stand. ERC	Actual ERC	ERC Anom.	ERC Std. Dev.
Wednesday 12 November	1-day	1-day	1-day	1-day
Thursday 13 November	2-day	2-day	2-day	2-day
Friday 14 November	3-day	3-day	3-day	3-day
Saturday 15 November	4-day	4-day	4-day	4-day
Sunday 16 November	5-day	5-day	5-day	5-day
Monday 17 November	6-day	6-day	6-day	6-day
Tuesday 18 November	7-day	7-day	7-day	7-day
Wednesday 19 November	8-day	8-day	8-day	8-day
Thursday 20 November	9-day	9-day	9-day	9-day
Friday 21 November	10-day	*-day	10-day	10-day
Saturday 22 November	11-day	11-day	11-day	11-day
Sunday 23 November	12-day	12-day	12-day	12-day
Monday 24 November	13-day	13-day	13-day	13-day
Tuesday 25 November	14-day	14-day	14-day	14-day
Wednesday 26 November	15-day	15-day	15-day	15-day

Mouseover Effect Off

Standardized ERC
Initialization 00UTC Wednesday 12 November 2003
Forecast valid for 18UTC Friday 14 November 2003
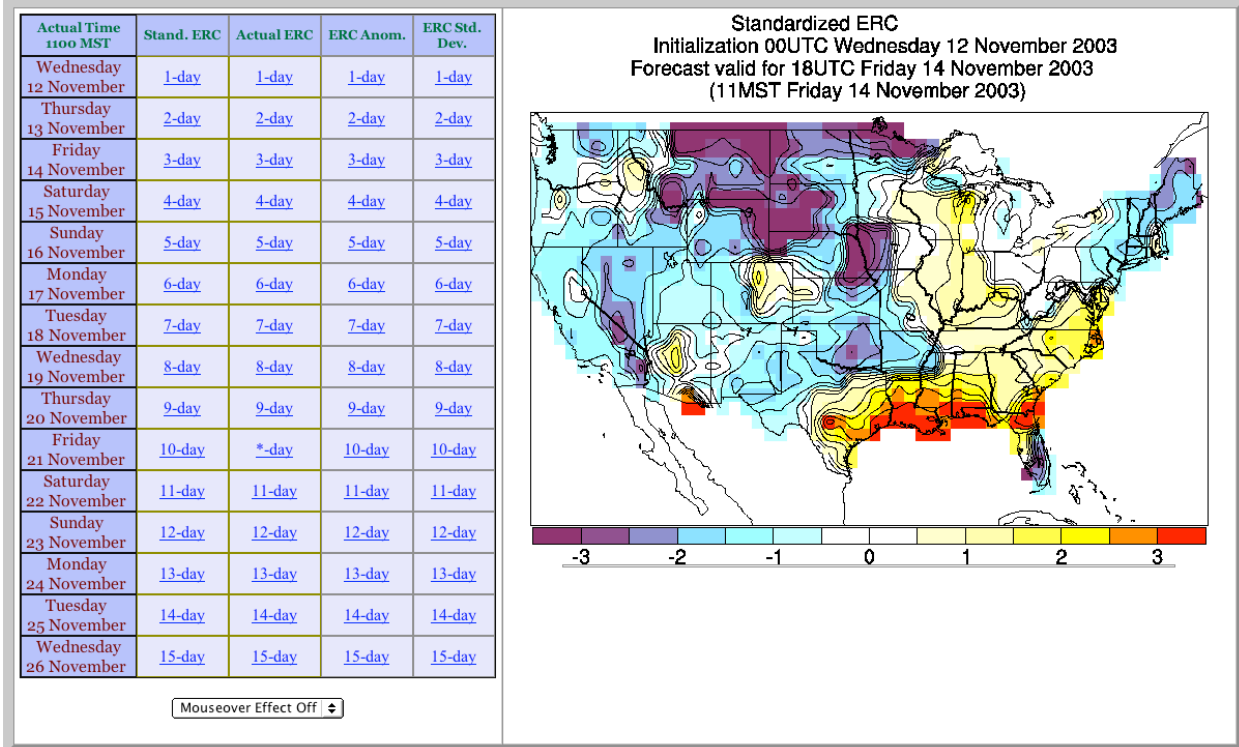(11MST Friday 14 November 2003)

-3 -2 -1 0 1 2 3

Figure 19. Example web page from the CEFA/NICC national standardized ERC forecast products. Shown is map of forecast standardized ERC-G based on NCEP GFS model output. Color scale depicts range of ERC-G standardized values.

5. Product evaluation

During the 2003 summer fire season, the forecast maps were evaluated by NICC. It was found that the product was quite useful for planning purposes. By July 2003 it was decided to develop task elements for a second year of this project that would focus on forecast uncertainty, particularly by utilizing GFS ensemble forecasts. However, by late in the season it was realized that in some regions the standardized values appeared reasonable, but for other geographic areas they seemed to not be representative of RAWS observed. Thus, by the end of the season, it was proposed that some verification and validation work be undertaken to assess the product and baseline climatology. The task elements below identify work that will be undertaken in FY04 to address some validation components of the current system:

1) Define missing data criteria and acquire daily RAWS from WIMS for a set of stations meeting the criteria. These data will be used to generate station climatologies of ERC-G.
2) Acquire daily historical RAWS from WIMS for stations that meet the defined criteria.
3) Acquire daily DAYMET climatology for grid points that match the selected RAWS.
4) Acquire daily NCEP GFS initialization grids for the period 1 May – 30 Sep 2003.
5) Generate RAWS climatology.
6) Perform statistical analysis that compares the RAWS and DAYMET climatologies.
7) Perform statistical analysis that compares GFS and RAWS observed values for the study period.
8) Perform statistical analysis that compares RAWS historical ERC-G to the provided ERC-G data used for the forecast standardized values.

Task Order 10: Operations of the CEFA Operational Forecast Facility (Sponsor: CANSAC/Interagency)

In October 2001, a concept proposal was submitted to the California and Nevada Wildfire Agencies to develop and implement an operational, mesoscale meteorology forecast facility for smoke and fire management to be referred to as the CEFA Operational Forecast Facility (COFF). The purpose of the facility is to provide high-spatial resolution weather forecasts and value-added products for federal, state and local fire and smoke management agencies in California and Nevada. Forecasts at 6-hour intervals out to 72 hours will be made available on a grid covering all of California and Nevada at 36, 12 and 4 km spatial resolution. Products from COFF will enhance and improve forecasts of smoke dispersion and transport, fire danger and fire behavior in addition to providing general meteorological forecast information over the two state area. Meteorologists from Predictive Services, air regulatory agencies, and the National Weather Service are the primary intended recipient of the products and information. However, any decision-maker (e.g., FBANs, fuel specialists, fire specialists and fire management) with knowledge of gridded meteorological output will find value in the products.

The California Firescope Weather Working Group approved the concept proposal in 2001, and subsequently formed the California and Nevada Smoke and Air Committee (CANSAC) currently comprising thirteen federal, state, county and local agencies. Figure 20 provides a flow chart of current committee membership. The committee is comprised of a governing board, a technical advisory committee, and a user advisory group.

The USFS Pacific Southwest Research Station (PSW) is a member of the CANSAC consortium as depicted in the Figure 20 organizational chart, and is also an important research partner with COFF. PSW represents one of five USFS regional modeling consortia to support the National Fire Plan, thus linking COFF to the Fire Consortia for Advanced Modeling of Meteorology and Smoke (FCAMMS). See http://www.fs.fed.us/fcamms for more information.

In order to operate COFF, each committee member will provide the necessary funding. Annual funding is estimated to be on the order of $30-50K per member per year, with total operating costs expected to be approximately $375K per year (applied research costs are not included in this amount). The U.S. Fish and Wildlife Service provided a $200K grant in August 2003 that, combined with other interagency funds, will allow for the purchase of the computer hardware infrastructure. Each participating agency will need to establish an arrangement to allow funding transfers to DRI. BLM, other DOI agencies, and agencies that can utilize a DOI funding transfer mechanism can utilize the existing BLM/DRI cooperative Assistance Agreement 1422RAA000002.

Several task elements are planned for the first year, of which the first part will be devoted to designing and building the computing infrastructure, putting in place required personnel, establishing product requirements and specifications, testing the MM5 model, and begin developing a real-time verification system. The primary task elements include:

1) Hire necessary personnel to operate the facility.
2) Determine final computer hardware specifications and purchase system components.
3) Develop an annual operating plan in conjunction with CANSAC.
4) Establish first year product requirements and specifications.
5) Build and test the high-performance computing cluster.
6) Implement and test the MM5 model.
7) Begin development of the real-time verification system.
8) Begin producing operational forecasts.
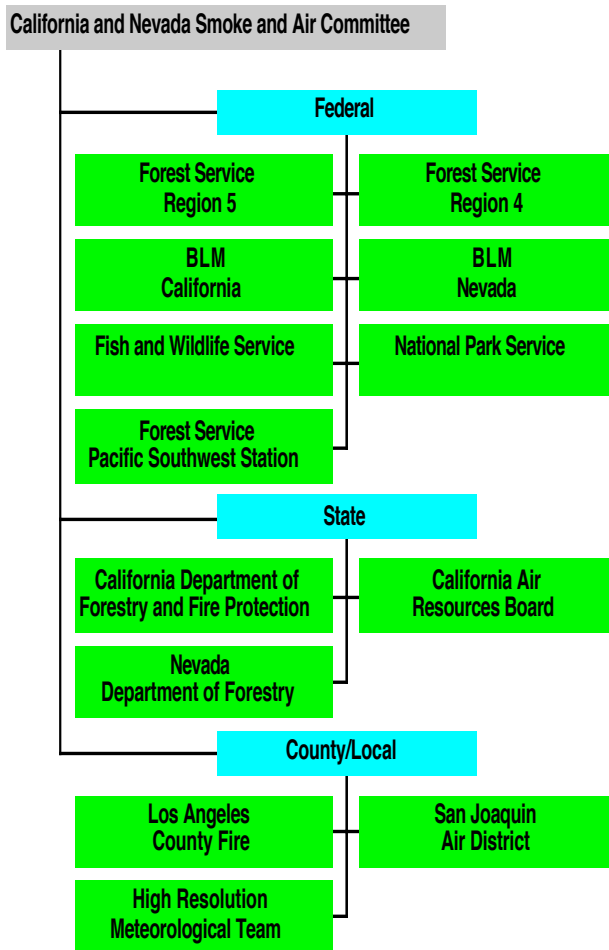9) Assessment of 2004 fire season products.

Figure 20. Membership organizational chart of the California and Nevada Smoke and Air Committee (CANSAC) as of September 2003.

Results of these activities will be discussed in the CEFA FY04 annual report. General deliverables from the COFF project will include:

1) Meteorological model forecast output as defined by the committees.
2) Web based application products.
3) Reports and/or presentations describing the functions and operations of COFF.

Task Order 11: Development of Model Output Statistic Products for California Predictive Services (Sponsor: Rocky Mountain/California Predictive Services)

Task Order 11 is a new project conceived in July 2003 and scheduled to begin 1 September 2003. Results of the project will be given in the CEFA FY04 annual report. Provided below is the introduction and task elements from the Statement of Work.

Both northern and southern California Predictive Services groups (CAPS), and the Rocky Mountain Predictive Services group (RMPS) produce meteorological forecasts and information in support of fire management activities. Reliable meteorological information and products are critical for many fire management needs involving decision-making and strategic planning. Associated with evolving information requirements is the need to produce new and improved meteorological products that supports these demands. To meet these needs, CAPS and RMPS

have developed some product priorities to aid in the 2003 fire season and beyond. This Statement of Work (SOW) describes a proposed set of products that will be beneficial as decision-support tools for the Predictive Services meteorologists and others. The overall goal of the project is to extract and add value to relevant information from the National Weather Service numerical models for use by fire weather meteorologists and fire management. Primary objectives include 1) developing computing software that will extract relevant meteorological elements from numerical weather models; 2) performing a regression analysis and developing model output statistic (MOS) type equations that relates model output to a specific set of Remote Automatic Weather Stations (RAWS); and 3) developing and providing value-added products and information from the MOS equations. This project will be a collaborative effort between the Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA) CAPS, and RMPS, but other Geographic Area Coordination Centers (GACCs) may contribute to the effort and utilization of these products. This SOW is written under the assumption that CAPS and RMPS will equally contribute to the project, as combining the two efforts will reduce each area's total cost.

Specific task elements include:

1) Development of weather model grid point output. CEFA will make available, on a daily basis, customized text files of weather model grid point data. CAPS and RMPS will provide a list of desired latitude/longitude model grid points. CAPS and RMPS will provide a list of desired meteorological elements to be extracted from the model(s), such as 500 mb relative humidity, 700 mb temperature, etc. Model projections that will be utilized include 6-hourly forecasts or the highest resolution available from the desired model. Initialization times of 00 and 12 UTC will be used for the products. The AVN/MRF (GFS) model will be utilized as appropriate. CEFA, CAPS and RMPS will work together in the development of a suitable format for the resultant text file (e.g., heading nomenclature).

2) Development of MOS type equations based on weather model output in relation to specific RAWS. Statistical regression techniques will be utilized in developing the equations. These methods incorporate both historical model output and RAWS in the equation development. Based upon an initial exploration of the data, the most appropriate regression method will be utilized (e.g., linear, robust), along with relevant regression diagnostics (e.g., graphical summaries, outlier influence, bias checks). The MOS type output based on regression equations for the specified RAWS within California will include:
   o 3-hourly forecasts of temperature, relative humidity, dewpoint, wind speed and wind direction from initialization to 48 hours.
   o 6-hourly Max/Min Temperature and Max/Min RH from initialization to 48 hours.
   o 3-10 day forecasts of 00 and 12 UTC temperature, relative humidity, dewpoint, wind speed and wind direction.
   o 1-10 day forecasts of BI, IC, SC, ERC, 100-hour and 1000-hour fuel moisture.

3) Development of RAWS climatologies. Climatologies will be developed for the specified RAWS for temperature, relative humidity, dew point and wind speed. These will be used for task 4 below.

4) Development of value-added products from the MOS type output. Once the MOS type output is developed, some value-added products such as graphics and summaries can be provided. These will be summarized in a format agreed upon by CEFA, CAPS and RMPS. Specific text and graphical outputs will include:
   o Forecast climatological anomalies (departures from average) for each forecast period for temperature, relative humidity, dewpoint, and wind speed.
   o Forecast climatological percentiles (90th or 97th percentile) for each forecast period for temperature, relative humidity, dewpoint, and wind speed.

- o Graphical displays in meteogram type format.
- o 10-day forecast of Haines Indices (high level) for each RAWS grid point.
5) Prepare report. A report will be prepared documenting the project, and describing the activities and results of each task.

Task Order 12: Long-lead forecasting workshop (Sponsor: NICC Predictive Services)

Task Order 12 is a new project conceived in July 2003 and scheduled to begin 1 January 2004. However, project timing will solely depend upon the specific workshop date chosen by the GACC meteorologists. Results of the project will be given in the CEFA FY04 annual report. Provided below is the introduction and task elements from the Statement of Work.

Much of the emphasis in Predictive Services has centered on the strategic movement of resources based on a short-term predictions of weather for the next three days. Longer range forecasting beyond five days requires a somewhat different set of skills for meteorologists. These include the use of ensemble forecasting, confidence levels, and knowledge of using numerical weather prediction models for extended predictions. Many Predictive Services meteorologists come from backgrounds that focused on forecasting for the next five days and specialized training is needed to improve their skills in long-range forecasting. A three-day long-range forecasting workshop would meet these needs.

The objectives of this project is to improve longer range forecasting (days 5-14) through training on numerical models, ensemble forecasting, confidence levels, Southwest monsoons, etc. The proposed workshop should result in improved forecasts and in turn, better pre-positioning of firefighting resources. The accuracy of the weekly outlooks would serve as the metric for project success.

This project will survey current research and training materials on long- and medium-range forecasting and ensemble forecasts. Existing material will be utilized as much as possible with modification as needed to focus on the required skills for Predictive Services. The project will be a collaborative effort between the Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA) and the National Interagency Coordination Center (NICC) Predictive Services.

Specific task elements include:

1) Review of existing long-range forecast workshops and material such as those of COMET (Cooperative Program for Operational Meteorology, Education and Training), National Weather Service and universities.
2) Coordinate with the NWS Hydrometeorological Prediction Center and Climate Prediction Center, and universities on potential training material and instructors.
3) Develop an agenda and select instructors.
4) Procure meeting room, training materials, etc. including travel expenses of instructors.
5) Host a workshop (20-25 participants) in Reno in early 2004.

Task Order 13: Understanding Drought for BLM Business (Sponsor: BLM)

Task Order 13 is a new project conceived in July 2003 and scheduled to begin 1 September 2003. Results of the project will be given in the CEFA FY04 annual report. A

graduate student is assigned to the project. Provided below is the introduction and task elements from the Statement of Work.

There is little question that drought can have extreme impacts on the environment and subsequently human activities. Broad scale ecosystem impacts from drought include forest and rangeland stress and increased fire risk. Drought impacts management objectives by forcing the implementation of new actions and plans that take into account the current and projected conditions. For many ecosystem management objectives, drought should be considered in policy and planning development and implementation.

A recent BLM internal memo surveyed individuals regarding available information and impacts of drought on BLM activities. This raised interest and recognition that there are potentially many aspects of BLM business that are either related to or impacted by drought. This project, slated as a two-year initiative, addresses the understanding of drought in the context of BLM business. Both fire and resource implications will be addressed. The study will begin with a comprehensive literature review of what is currently known about drought that either directly affects or can potentially impact agency decisions and policy. This will be synthesized into a report. It is expected that this review will identify some key areas requiring additional analyses that will be undertaken in a second year of the project. Also during the first year, but likely extending into the second, an examination of what tools currently exist, or could be developed, that would provide drought prediction information to the agency for management planning purposes. Results from Task Order 6, "A Comparison of Precipitation/Drought Indices Used in Fire Management", will be utilized as part of this study, and likely expanded on in this project.

This project will be a collaborative effort between the Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA) and BLM. It is intended that this project be a two-year research study for a Master's level graduate student working with CEFA. However, this SOW only specifically describes the first year activities.

Specific task elements include:

1) Review existing scientific literature. Numerous scientific studies have been done over the years that discuss drought and its impacts. Some of these may be specific to an agency or project, while others could be linked to agency business. Under this task, an extensive literature review on drought will be undertaken. Specifically utilizing library and electronic resources, all scientific studies on drought that may have potential benefit to BLM and other land management agencies will be sought and collected.
2) Synthesize literature review. Once the reports and papers are collected, they will be synthesized into a comprehensive report describing various aspects of what is, and what is not known, about drought in the context of BLM planning and policy. Agency current and future potential needs will be considered in the synthesis process. This task is effectively a literature analysis.
3) Prepare report. A report describing the literature review and synthesis will be prepared upon completion of the project. It is also intended that this will be a portion of a Master's thesis from this project.
4) Examine and assess drought prediction tools. This task will address a BLM agency request to examine and assess current drought prediction tools that the agency may utilize for planning purposes. These tools may include specific model forecasts, or concepts realized from the literature review process that could lead to providing prediction information.

Task Order 14: Role of Climate in Prescribed Fire (Sponsor: BLM)

Task Order 14 is a new project conceived in July 2003 and scheduled to begin 1 September 2003. A graduate student is assigned to the project. Results of the project will be given in the CEFA FY04 annual report. Provided below is the introduction and task elements from the Statement of Work.

Many opportunities to meet management objectives utilizing prescribed fire are missed because of seasonal climate anomalies. A missed target goal in one year means more to deal with the following year, not only in simple terms of acres burned, but perhaps also in terms of affectively achieving the larger-scale management objectives. It is rare that more can be burned in a year than originally planned, at least in a controlled manner. Thus, prescribed fire use should be more opportunistic based on current and predicted climate conditions that provides the best opportunity to meet objectives and indicates potential underlying increased risk.

A recent informal analysis presented at the CEFA national program review in May 2003 indicated that climate information is highly underutilized for prescribed fire. The simple study results also indicated that the use of climate information varies regionally, with emphasis ranging among elements such as drought, smoke, fuel moisture, snow and wind. This study indicated that there would be high value in better understanding aspects of the use of climate information in prescribed fire planning and utilization.

The primary objective of this project is to perform and analyze a national survey of climate information utilization for prescribed fire. Federal and state agency personnel will be contacted for inquiry into their uses and needs of climate information for their prescribed fire activities. Summarization of this information will yield the key factors of climate information that are currently used or desired, as examined in regional agency contexts. The ultimate goal will be to have an improved understanding of the role of climate in prescribed fire, and to use this knowledge to help agencies establish effective burn policy and meet management objectives.

This project will be a collaborative effort between the Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA) and BLM/NIFC. It is intended that this project be a one-year research study for a Master's level graduate student working with CEFA.

Specific task elements include:

1) Develop a climate information use survey. As a first step, it will be necessary to develop a survey that has the necessary and relevant questions to achieve the primary objective. The survey will be designed using scientific methodology, and will utilize other related findings and questionnaires where available and relevant.
2) Implement survey. Following completion of the survey development, the survey will be undertaken. A list of primary contacts will be developed, with the help of fire agency personnel. The survey will be conducted via phone interviews.
3) Survey analysis. Once the survey is completed, a formal quantitative analysis will be performed. This will identify key aspects of the information collected. The synthesis of the information will also include aspects of climate not being utilized effectively.
4) Prepare report. A report describing the completed tasks and deliverables will be prepared upon completion of the project. It is also intended to produce a Master's thesis from components of this project.

OTHER ACTIVITIES

This section describes CEFA projects and activities that are not outlined in a specific Task Order, but are of relevance to BLM and interagency fire management.

Working with BLM AA Representative and Agency Liaison

Mr. Paul Schlobohm, BLM/NIFC Fire Management Specialist, was duty-stationed at DRI/CEFA for approximately three years ending in July 2003 at which time he returned to NIFC. Mr. Schlobohm serves as the national AA representative and agency-CEFA liaison. During his term at DRI, Mr. Schlobohm pursued university training and a graduate degree of which CEFA personnel worked with him on a regular basis. For example, Dr. Tim Brown and Beth Hall provided academic guidance and direction on his Masters thesis topic. Dr. Brown and Mr. Schlobohm also interact closely on the development of research projects and program implementation.

Mr. Schlobohm's graduate work was also considered a CEFA project. He successfully completed his thesis entitled "NDVI-derived Green-up Date for the National Fire Danger Rating System" in July 2003. The following is the abstract from the thesis:

A new method has been developed to objectively determine green-up dates for the National Fire Danger Rating System (NFDRS). This method has applications for the current point-data NFDRS and for possible future calculations of fire danger at higher spatial resolutions. The objectives of this thesis are to propose two features of a live fuel moisture model for NFDRS in the 21st century. The first feature is a method to determine in "real time" the green-up date at 1-km spatial and 1-week temporal resolutions using Normalized Difference Vegetation Index (NDVI) from NOAA Advanced Very High Resolution Radar (AVHRR). The second feature is a process to determine historical green-up dates for historical analysis purposes. The proposed method is the integration of area under a smoothed curve of NDVI from the curve minimum until the climatological green-up threshold is achieved. Application was made to historical data as if the method was being used operationally, that is, without knowledge of NDVI values outside each set of analyzed values. Pixels were classified by the magnitude of their climatological NDVI signature. Three 3x3 pixel study areas were chosen to represent relatively flat (Nevada), moderate (Florida), and steep (California) NDVI signals. The proposed method was applied to 1-week maximum composite NDVI observations (1989-2002) from the three locations. Median green-up dates were late May-to-early June, late-mid April, and late September-to-early November, and variation around the median was 2-3 weeks, 2-5 weeks, and 3 weeks for the California, Nevada, and Florida sites, respectively.

Figure 21 shows a simple example of the integral method for determining the green-up date. A smoother is applied to weekly period NDVI observations as shown by the blue line in the graph. The minimum of the curve is found (NDVI-Min), and the area under the curve is calculated for each period until 50% of the NDVI climatological area between minimum and maximum for the pixel is achieved. The period at which a 50% area occurs is considered the green-up date.
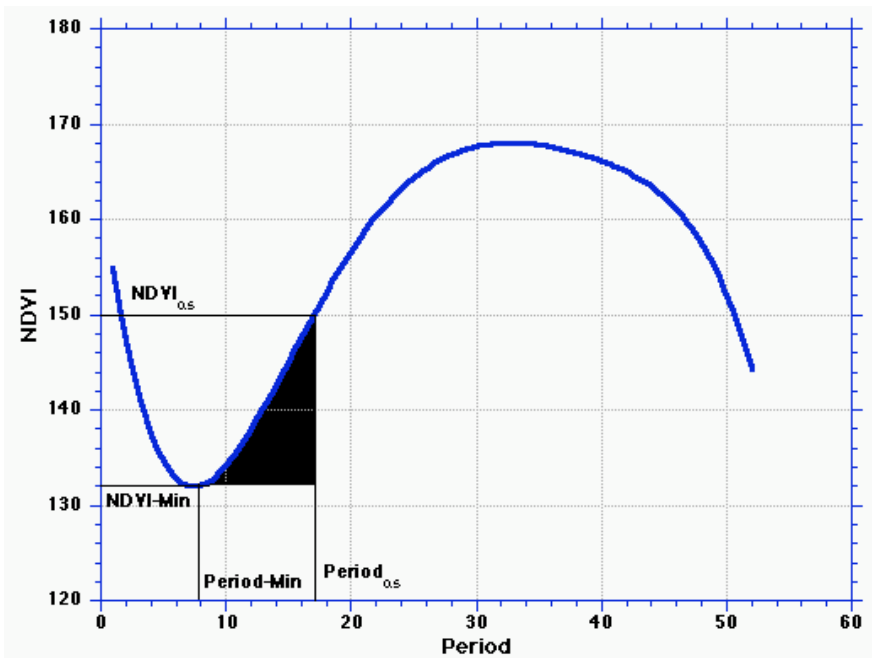
Figure 21. Example graph showing smoothed NDVI curve (blue line), and climatological NDVI 50% area under the curve between minimum and maximum values (black shading).

The primary study conclusion is that the method is useful for determining operational and historical green-up dates. The demonstrated strengths of the method include:

1) Applying the integral method to pixels of similar NDVI signature captures variation in vegetation condition at the 1-km spatial and 1-week temporal scales sufficient to discern similarities and differences in NFDRS green-up between neighboring pixels.
2) The method's independence on the interannual variability is shown by the identification of green-up dates during the time of greatest increase in NDVI for each of 11 or 12 years in three locations representing three distinct NDVI climatologies.
3) The method performs as it would in an operational setting, without knowledge of the annual NDVI maximum.
4) A new process should be able to reproduce the results of the current process of ocular estimation. The integral method can reproduce green-up dates determined by the current system, thereby producing the same fire danger ratings.
5) The integral method can identify historical green-up dates as supported by the computation of fire danger ratings from archived weather records.
6) The method can identify green-up dates at various times of the year.
7) The method can identify multiple green-up events in the same year.

These results were presented at the American Meteorological Society 5th Symposium and Fire and Forest Meteorology/2nd International Wildland Fire Ecology and Fire Management Congress in Orlando, Florida, November 2003. See the publication list below for the presentation and thesis references.

CEFA National Review

In May 2003, an interagency program review of CEFA was conducted for BLM. The purpose of the review was "to clarify the program's relevance, quality, and performance". The

review panel consisted of individuals experienced in fire management field operations, research program management, and interdisciplinary university/academic climate and social science research. Reviewers also had experience in the Joint Fire Science Program and the National Fire Plan. Panel members represented USDA Forest Service Research and Development, California Department of Forestry and Fire Protection, NOAA Office of Global Programs, BLM, Institute for the Study of Planet Earth (University of Arizona), Predictive Services at the National Interagency Fire Center, and the National Park Service. A report was prepared describing the CEFA program, and discussion of the panel's review comments and recommendations. Conclusions of the review were summarized in the report as follows:

> The CEFA program fulfills a unique niche by focusing on climate and wildland fire rather than weather and wildland fire. It also adds to the BLM's capabilities in applied fire science and supplements activities of the Joint Fire Science Program. Recent establishment of projects like the California and Nevada Smoke and Air Committee (CANSAC) have high potential to aid BLM in meeting performance goals under the National Fire Plan.

The primary recommendations from the review are as follows:

1. BLM should continue to support the CEFA program, but must determine how CEFA will be effectively linked to the agency.
2. BLM should develop a Stakeholder Oversight Advisory Panel to ensure the continuing relevance and performance of CEFA work.
3. BLM should develop a Science Quality Utility and Implementation Board to provide formal review of CEFA work for scientific merit to the agency.
4. BLM should assign an agency project monitor/scientist who will work onsite at DRI to facilitate the proper management of CEFA projects, and work directly with CEFA personnel in projects and career and educational opportunities.
5. BLM as lead agency for CEFA should ensure that a minimum "base" funding is supplied to the program to maintain a credible foundation for projects.
6. BLM should assess how to develop stronger ties between field operations and CEFA personnel.
7. BLM may wish to integrate activities and coordinate CEFA activities explicitly with the Geographic Area Coordination Centers (GACCs).
8. CEFA program reviews must be more frequent and formalized.
9. The CEFA program focus must evolve, but BLM should strive to maintain a unique focus to avoid redundancies with other agency programs.

In response to the review, a CEFA strategic initiative proposal for longer-term program management and sustainability will be considered by the NIFC Interagency Fuels Committee.

CAP and CLIMAS Interactions (Sponsor: NOAA Office of Global Programs)

CEFA has an established partnership with California Applications Project (CAP) and the University of Arizona, Institute for Studies of Planet Earth, Climate Assessment for the Southwest (CLIMAS) project. Both CAP and CLIMAS are NOAA Regional Integrated Science and Assessment (RISA) programs. One objective of the RISAs is to improve integration between science and users of scientific information. The CAP interactions, along with ECPC collaboration, have involved developing products jointly with California wildfire agencies. Examples include climate forecasts, the formation of CANSAC/COFF, and the California hourly fire danger project. Further CAP information can be found at: http://meteora.ucsd.edu/~meyer/caphome.html. As a result of this partnership, CEFA prepared

a special report on the potential impact of drought on condition class areas across the U.S (see publication list). This report highlighted areas where long-term drought in the West and winter season precipitation deficits in the Midwest were intersecting locations of condition class 2/3. The significance of these combined areas is that because of the dry conditions, wildfire may be especially severe and damaging.

The primary collaboration with CLIMAS during this year involved co-organizing the 2003 National Seasonal Assessment Workshop during February. This workshop brought together national and regional climate scientists, fire managers, and fuel and fire specialists to formally produce a national seasonal fire potential outlook. This information was utilized for both national and GACC planning. A special one-page outlook report was distributed to fire directors and fire management. A detailed report was published describing specific aspects of the workshop. Further information regarding CLIMAS is available at: http://www.ispe.arizona.edu/climas/index.html.

Hourly Fire Danger (Sponsor: California Interagency)

Over the past couple of years and in conjunction with several California wildfire agencies, CEFA has been developing a prototype and experimental system for calculating and displaying hourly fire danger in California. Using hourly RAWS from WRCC and NFDRS algorithms provided by Larry Bradshaw at MFSL, fire danger indices are computed for each fire danger rating area across the state, and a fire adjective class is calculated on an hourly basis. California wildfire agency personnel continue to evaluate the product as it is now being widely viewed within the state. A phase II of the project is being planned that will quantitatively examine the hourly fire danger values and produce a climatology based on historical hourly fire danger. In the meantime, the current product has been generally accepted by the California wildfire agencies. Individuals continue to evaluate the system for its operational utility. The web-based maps are available at http://cefa.dri.edu/HourlyFD.

Operational Mixing Height Forecasts (Sponsor: California Interagency)

CEFA continues to produce operational mixing height forecasts from the NCEP/NWS Eta model for the entire U.S. Regional maps are available for California. CEFA continues to provide California Predictive Services with a specific text product that is used as operational guidance for daily mixing height and transport wind forecasts. The forecast maps are available at http://www.cefa.dri.edu/Operational_Products/NCEP_Exp/exp_index.htm.

TRAVEL, PRESENTATIONS AND MEETING ACTIVITIES

This section provides brief information regarding travel, presentations and meeting activities relevant to CEFA and BLM during 1 October 2002 through 30 September 2003 (FY03).

September 18 (Sacramento, CA): Tim Brown participation at California and Nevada Smoke and Air Committee Board of Directors meeting.

October 4 (Albany, CA): Tim Brown participation in USFS Pacific Southwest Station meeting on research related to CANSAC.

October 16-18 (Tucson, AZ): Tim Brown presentation at the International Lightning Detection Conference.

October 22 (Reno, NV): Tim Brown participation in California Firescope meeting.

October 23 (Reno, NV): Tim Brown presentation at the Predictive Services Steering Committee meeting.

November 5-6 (Redding, CA): Beth Hall presentation at annual Predictive Services meeting.

November 19-20 (Scottsdale, AZ): Tim Brown presentation and participation as academic technical advisor in the NWCG Fire Danger Working Team meeting.

January 7 (Reno, NV): Meeting with Dr. John Roads, Scripps, to discuss climate forecast verfication project.

January 8-10 (Seattle, WA): Beth Hall Pacific Northwest Modeling Facility Tech meeting.

February 10-12 (Boulder, CO): Beth Hall and Hauss Reinbold attend NCL Training workshop.

February 11-12 (Long Beach, CA): Tim Brown organization of special evening fire session at the American Meteorological Society annual meeting.

February 25-27 (Tucson, AZ): Tim Brown participation in Predictive Services national seasonal assessment workshop.

March 11-13 (Phoenix, AZ): Tim Brown presentation and participation at NOAA/OGP Regional Integrated Sciences and Assessments workshop.

March 25-27 (Tucson, AZ): Tim Brown participation in CLIMAS Southwest regional climate and fire workshop.

May 8 (Reno, NV): CEFA national program review.

May 15 (Reno, NV): Tim Brown participation in Predictive Services group meeting.

September 11 (Reno, NV): Tim Brown presentation at National Weather Service Western Region Climate Services Workshop.

REPORTS AND PUBLICATIONS

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