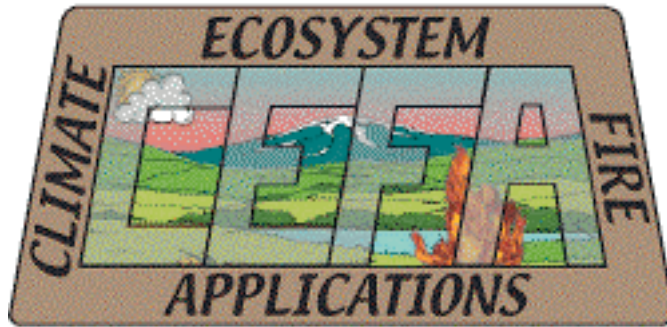

Program for Climate, Ecosystem and Fire Applications



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

Annual Report

Timothy J. Brown
Beth L. Hall



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vision of Atmospheric Sciences
November 2001

CEFA Report 01-04

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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 2000 - 30 September 2001. 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

November 2001

Introduction

This annual report is the first 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 2001. 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 and fuels specialists. Project concepts can originate at all levels including local, state and national offices as well as DRI.

This report describes activities and accomplishments under the AA for the period 1 October 2000 – 30 September 2001. Report sections include an overview of tasks during the year, other related activities, travel, presentations and meetings, and publications. Also, since this is the first year of the national AA, a brief history of the DRI Program for Climate, Ecosystem and Fire Applications (CEFA) is given.

History

CEFA was established in October 1998 under a BLM Nevada State Office Assistance Agreement. The primary mission of CEFA was defined under this AA and is also being applied under the new national agreement. Specific mission statements are as follows:

- Perform studies and applied research to improve the understanding of relationships between climate, fire and natural resources.
- Serve as a liaison between the decision-maker (user) and the scientific research community by providing product training, education, assisting in technology transfer and eliciting user feedback.
- Provide climate and weather information directly for fire and ecosystem decision-making and strategic planning.

- Improve operational fire weather forecasting using new knowledge of climate and meteorology.
- Develop and maintain a data warehouse for fire, ecosystem and related climate information.
- Develop decision-support tools for fire applications.
- Provide a societal interactions component.

In the fall of 1999, Mr. Paul Schlobohm, BLM Fire Management Specialist at the National Interagency Fire Center (NIFC), was stationed at Reno, Nevada to work specifically with CEFA, and to serve as the liaison between BLM and CEFA for a minimum of three years. DRI provides office space and some resources for Mr. Schlobohm, and BLM covers a few incidentals such as phone and copy charges. CEFA can unreservedly report that our relationship with Mr. Schlobohm has been productive, informative and of high value. We believe this form of collaboration a necessity in order to establish the partnership desired between the two organizations, and hope that it can continue throughout the lifetime of the AA and beyond.

Approximately one year after Mr. Schlobohm's arrival, the national AA was put into place formalizing the partnership between the two organizations. CEFA is currently the primary group working under this Agreement, though other groups (e.g., ecology, restoration, hydrology) within DRI may participate using CEFA as a conduit. CEFA's main focus thus far has been climate and weather topics.

Since its inception, CEFA has accomplished tasks for other land management agencies, such as the USDA Forest Service (USFS). CEFA has formed strong partnerships with the National Intelligence Coordination Center (NICC) and the California Wildfire Agencies (e.g., BLM, USFS, National Park Service, California Department of Fire and Forestry Protection and Los Angeles and Orange counties). Because of these partnerships and other research projects, BLM only provides partial annual support for CEFA. These links are valuable assets to BLM by further providing a knowledge base for CEFA's own enhanced education and training about the fire business. The work being done for these agencies also have high value and relevance to the projects being undertaken for BLM by CEFA.

CEFA also works closely with the Western Regional Climate Center (WRCC), one of six regional climate centers funded by NOAA and other project funds. WRCC maintains an archive of historical climate data (including Remote Automatic Weather Stations (RAWS)) and information for the western U.S. CEFA has collaborated on several wildfire related projects with WRCC using both their data and expertise resources.

CEFA personnel currently include the Director, a Research Scientist/Deputy Director, two graduate students, one hourly assistant, and the BLM staff individual. It is planned to hire a technical assistant early in 2002.

Tasks

Seven tasks were defined and approved by BLM management in the late fall of 2000. Task orders 1, 2 and 3 were begun in the first half of 2001, and task orders 4, 5 and 7 were begun in the early fall of 2001. It is planned to define specific tasks and deliverables for task order 6 in December 2001, and to have that project begin in 2002. These tasks have been spread out depending upon the scope of the task and other CEFA project commitments.

Task Order 1: CEFA Infrastructure and Administration

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

- Salary for CEFA administration and management by Director and Deputy Director (2 months and 1 month, respectively).
- Emergency 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.

The short-term projects during this reporting period included providing climate forecast information to several GACCs, providing climate data, information, and input for the Great Basin 2001 Assessment and providing climate information for a post-analysis of the Modoc-Blue Complex fire in northern California.

The primary computer hardware upgrades during this reporting period included the purchase of a high-density (80Gb) Digital Linear Tape (DLT) drive, and a 70Gb fixed storage drive for our Silicon Graphics, Inc. (SGI) Origin 200 workstation. This upgrade supports all CEFA tasks.

Web administration is an ongoing process, however, one notable enhancement was the development of a new home page and associated links. Many of the current and planned tasks will utilize the CEFA web site as one of the technology transfer components. 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 2: Climate Analysis of the 2000 Fire Season

This task was completed during August 2001. Its primary components included:

- Developing a data set of climate variables for the 2000 season including precipitation, lightning strike occurrence and surface and upper air temperature, relative humidity, wind speed and wind direction.
- Analyzing the climate data set on monthly and seasonal time scales.
- Examining National Fire Danger Rating System (NFDRS) indices.
- Investigating the possible role of La Niña in relation to the fire season.

The key findings are presented in a report available at:

http://cefa.dri.edu/Publications/publications_index.htm. In summary, several critical climate factors came together to substantially increase fire danger and fire severity from April through August 2000. These included a persistent pattern of below average precipitation, above average temperature, below average relative humidity and high levels of lightning occurrence.

Figure 1 shows an example of plots for RAWS maximum relative humidity (of interest for nighttime fuel moisture recovery) from the report. The especially unique characteristic of the season was the wide spread occurrence of all of these factors across nearly the entire West during the fire season. This combination of dry and warm conditions in addition to frequent ignition sources led to the well above average fire season. Other large-scale climate factors were examined in relation to the season. For example, the Southwest monsoon began early and strong, but it was weak during July and only moderate in August in terms of atmospheric moisture (lightning was still plentiful) thus allowing for a continued fire season in this region. There was the occurrence of a weak La Niña during the year, however, there was no obvious evidence that it played a significant role in the season's outcome overall.

The results of the climate analysis also highlighted the need for four national initiatives:

- The development and implementation of national scale operational climate monitoring for wildfire, prescribed fire and fire use planning.
- The development and implementation of a national consistent ground-based monitoring network for live fuel moisture.
- The implementation of operational year-round RAWS.
- The implementation of an improved and reliable national fire occurrence database.

It is recognized that these initiatives are large in scope, but are highly desirable in order to perform many necessary studies and product development for decision-making and strategic planning. A prototype system for the first item in the list above will be implemented in Task 4 described below.

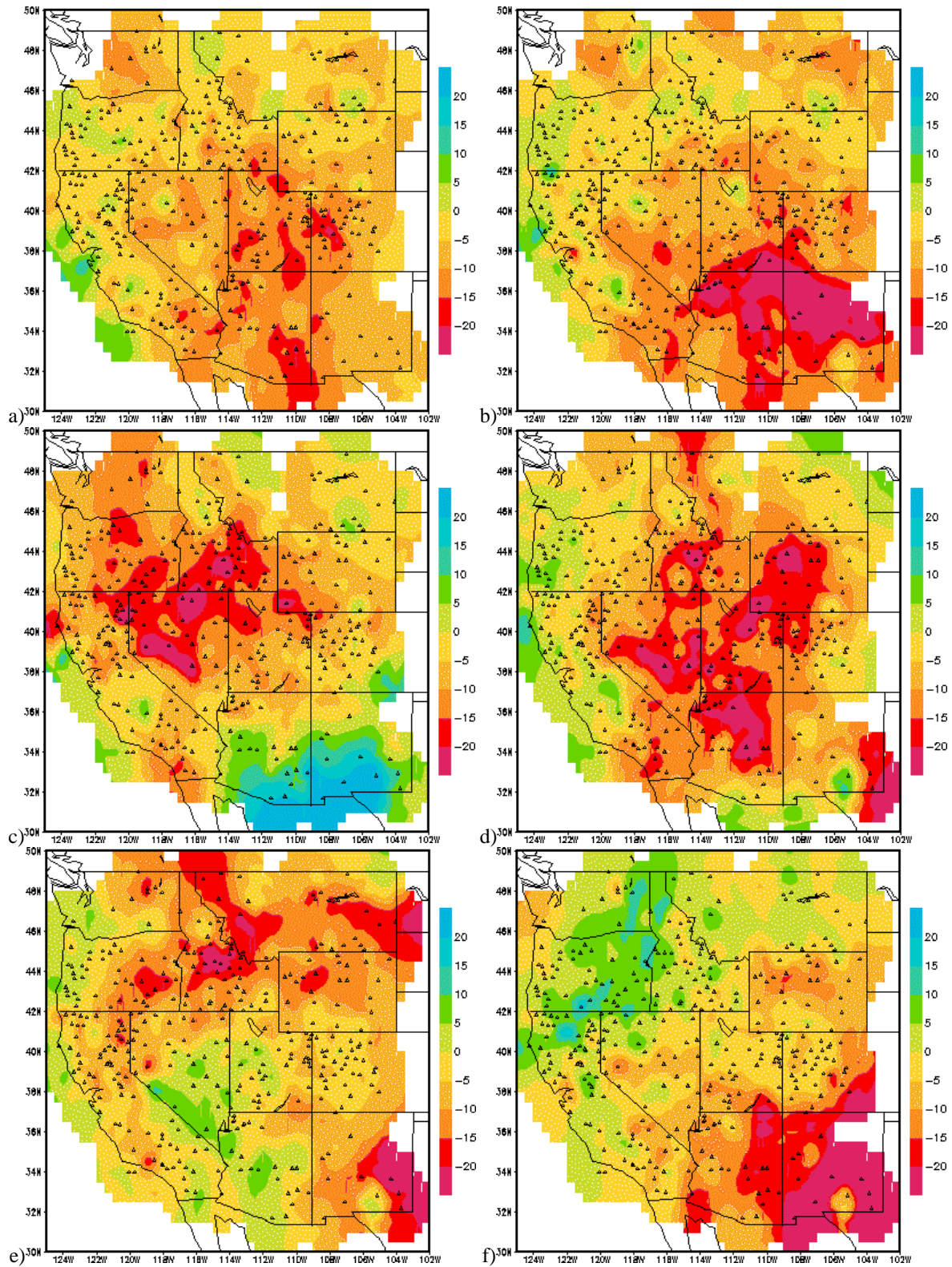


Figure 1. Example plots taken from the 2000 fire season climate analysis report. RAWs minimum relative humidity anomalies (%) based on hourly values for a) April, b) May, c) June, d) July, e) August and f) September 2000. Cool colors (e.g., green) represent above average anomalies and warm colors (e.g., red) represent below average anomalies (see color bar). RAWs station locations are indicated by triangle symbols. Data source: Western Regional Climate Center.

Task Order 3: Development of Lightning Climatology Information over the Western U.S.

The primary tasks for this project were to:

1. Acquire historical lightning data from the National Lightning Detection Network (NLDN), the Automated Lightning Detection System (ALDS), and Alaska lightning strike occurrence from the Alaska Fire Service (AFS).
2. Compare NLDN and ALDS to determine if the two data sets could be merged into one climatological period.
3. Develop monthly lightning climatologies for the western U.S.
4. Develop hourly by month lightning climatologies for the western U.S.
5. Create and provide lightning climatology information in the form of animations and still frame images via web-based access.

ALDS data (1985-1996) are currently archived at WRCC and were obtained in house for this study. NLDN data (1990-2000) were acquired from Global Atmospheric, Inc. (GAI). GAI records and archives the strike data thus making the information proprietary. Data for the period 1994-2000 were purchased by a collaborative arrangement between CEFA and the Scripps Institution of Oceanography, and BLM purchased data for the year 1990-1993. Though requests were made for data with AFS, the information has not yet been received and will not be included in the first set of products.

Final results of this project are anticipated during November 2001. Delays from the original time frame occurred due to two primary issues. First, GAI informed CEFA of the recent development of a correction grid that could be applied to the original data. Time was taken to examine the correction grid concept and apply it in the generation of the climatology information. Second, extra features were added to the CEFA web site for accessing the information that were not noted in the original task order, including a java animation player and a clock enhancement for choosing hourly displays.

Before final products can be released, approval is required by GAI regarding content and access. It is intended for interagency wildfire users (federal, state and county) to have access to the information via a check of the incoming IP address. This address must be approved by GAI. Disclaimers regarding the usage of the products are provided on the web site. Access to the information will be available at: http://cefa.dri.edu/Cefa_Products/cefaprod_index.htm.

During the course of the study, it was determined that because of significant differences in the observing networks, detection efficiency and location errors, ALDS and NLDN could not be combined into a single climatology. Thus, only NLDN climatologies were prepared for this project. Figure 2 is an example display from the lightning climatology showing the average number of strikes for August 00 UTC across the western U.S. Other monthly and hourly times are displayed in a similar manner. Results from this project will be presented at the American Meteorological Society Fourth Symposium on Fire and Forest Meteorology to be held in Reno, NV during November 2001.

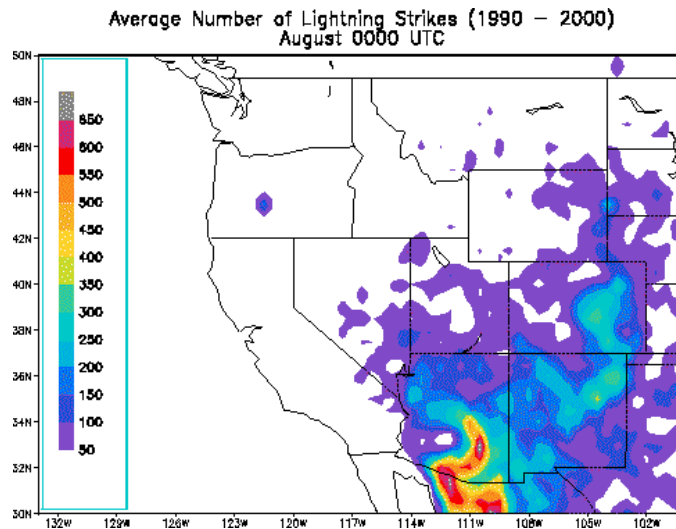


Figure 2. Example plot of a western U.S. lightning climatology for August 00 UTC available from the CEFA web site products page.

Task Order 4: Utilization and Evaluation of Climate Information and Forecasts for Fire Management

This task was officially begun in September 2001. The overall 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. It is anticipated that three years will be required to fulfill all of the project objectives. A Ph.D. graduate student is assigned to the project, though other CEFA personnel are also involved. 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) Forecasting Research Group. The following specific tasks are planned for the first year:

1. Develop a system for producing weekly and monthly climate anomaly maps of surface maximum/minimum temperature and relative humidity using RAWS and upper-level wind streamlines (in particular 500 mb) using National Centers for Environmental Prediction (NCEP) reanalysis model grids.
2. Perform analysis of critical fire weather patterns associated with BLM Nevada field offices. The methodology will be applied to the entire western U.S. in years 2 and 3.
3. Perform an evaluation of ECPC weekly, monthly and seasonal forecasts of fire climate variables (i.e., temperature, relative humidity, wind speed and precipitation) by comparing model output with observations from RAWS.
4. Develop displays of fire danger forecasts from the ECPC models.
5. Acquire IRI monthly climate forecasts, combine ensemble forecasts into a probabilistic forecast for temperature and precipitation, provide forecast anomalies and probabilities via the CEFA web site in the form of a model and forecast matrix.
6. Provide training to GACC meteorologists and intelligence personnel on the use of experimental climate forecasts.

Each task above has its own specific deliverable noted below:

1. Web based maps and animations to be placed in the assessments section of the CEFA web site.
2. A journal paper submitted to gain scientific acceptance of the results. The results will also be summarized in a report and distributed to relevant agency personnel within Nevada (e.g., GACC and National Weather Service meteorologists).
3. A journal paper submitted to gain scientific acceptance of the results. A report describing the results of the analysis and the benefits to the fire agencies.
4. Web based maps via the ECPC and CEFA web sites.
5. Web based maps via the CEFA web site.
6. Providing training and discussion at the national Intelligence Officers meeting addressing both GACC meteorologists and intelligence personnel. Other training opportunities as warranted by users.

Figure 3 is an example climate forecast plot for total precipitation from the CEFA web site. These monthly forecasts are provided by IRI and will be further developed for fire management strategic planning.

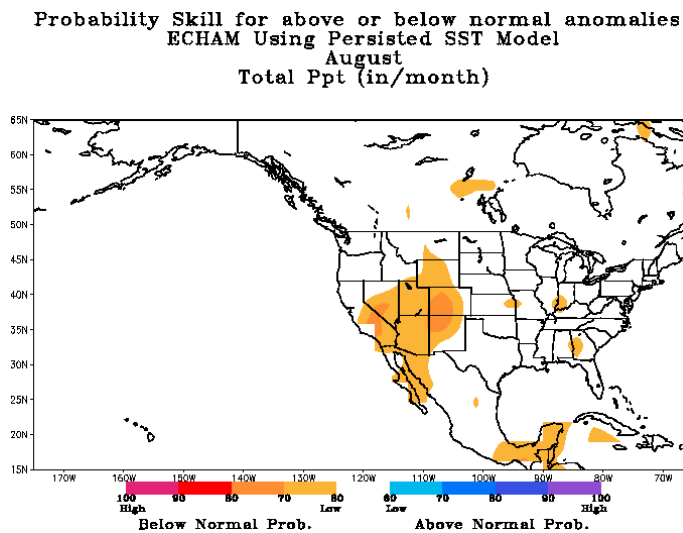


Figure 3. Example plot of a monthly climate model forecast for total precipitation based on prediction information provided by the International Research Institute.

Task Order 5: Analysis of the Southwest Monsoon in Relation to Fire Danger Characteristics.

This task was officially begun in September 2001. The primary objective is to identify quantitative relationships between climate and weather elements resulting from the Southwest monsoon and its subsequent impact on fire danger. The products derived from the project will provide information for decision-making related to resource allocations and prescribed fire and fire use activities. The project duration is anticipated to be three years. A Masters graduate student is assigned to the project, though other CEFA personnel are also involved. CEFA will be working closely with select agency representatives in the Southwest region (Arizona, Colorado, New Mexico, Nevada and Utah) to identify operational weather and climate thresholds and discuss results and their relevance. The tasks listed below are specific for the first year:

1. Develop a system for producing daily and weekly climate anomaly maps of surface relative humidity using Remote Automatic Weather Station (RAWS) combined with other station data such as National Weather Service (NWS) METAR specific to the monsoon region.
2. Collect and quality control fire occurrence data from the USFS and Department of Interior national databases, and state agencies.
3. Analyze fire occurrence quantitatively to produce relevant occurrence characteristics that can be related to climate and weather patterns.
4. Analyze regional precipitation and relative humidity patterns.
5. Contact prescribed fire managers across the monsoon region to determine fire prescription ranges for relevant weather variables.
6. Results of the analyses will be presented at meetings, workshops and conferences as warranted.

Each task above has its own specific deliverable noted below:

1. Web based maps and animations to be displayed at the CEFA web site.
2. Availability of a fire occurrence database for the monsoon region.
3. Web based maps showing relevant fire occurrence statistics, and an agency report summarizing the results of this analysis.
4. Web based maps showing relevant precipitation and relative humidity regional patterns, an agency report summarizing the results of this analysis, and a journal paper to gain scientific acceptance of the results.
5. An agency report describing the results of this analysis and providing tables of relevant prescription parameters.
6. Presentations as warranted.

Task Order 6: A Comparison of the Standardized Precipitation Index to Other Drought Indices for Application to NFDRS.

This task concept was approved during Fall 2000 by the state FMOs, but specific project tasks and deliverables will not be determined until late calendar 2001.

Task Order 7: Web Access to RAWS Data and Products.

This task is being accomplished within WRCC by separate BLM funds but using CEFA as a project and collaboration conduit. The primary project objective is to build upon recent efforts to revamp the internal storage and access system for RAWS data and initiate system-wide improvements. This work officially began in August 2001. Specific project tasks include:

1. Finish conversion of RAWS station data from ASCII text to internal binary indexed format.
2. Finish conversion of RAWS station metadata to internal format.
3. Development of metadata display graphs.
4. Development of a RAWS station selection interface.

5. Adaptation of Cerro Grande display format to all RAWS stations (<http://www.losalamos.dri.edu/index.html>).
6. Development of web accessible data listing capability.
7. Development of web accessible wind rose program.

It is anticipated that the work will be completed by June 2002.

Other Activities

Other activities that are not directly associated with a task order, but are of relevance to BLM are provided in this section.

Working with Mr. Paul Schlobohm

In addition to the regular interactions between CEFA and Mr. Schlobohm in conjunction with the AA and related task orders, personnel work with him on a frequent basis as part of his university training and graduate degree. For example, Dr. Tim Brown, Director of CEFA, provides Mr. Schlobohm with academic guidance and direction on his Masters thesis topic. Dr. Brown and Mr. Schlobohm also interact closely on other research projects and concepts. For example, the two individuals are collaborating on a project to examine the relationship between the standardized precipitation index and fire danger and fire occurrence. Preliminary results of this work will appear in the Proceedings of the American Meteorological Society Fourth Symposium in Fire and Forest Meteorology to be held in Reno, Nevada during November 2001. Beth Hall, Research Scientist and CEFA Deputy Director works with Mr. Schlobohm regarding data and computer programming training and issues.

GACC Training

In November 2000 Dr. Brown was invited to attend the national Intelligence Officers annual meeting in Santa Fe, New Mexico to discuss the utilization of climate forecast products and other climate information.

In February 2001 Dr. Brown and Rick Ochoa provided a two-day training class on fundamental elements of climate and meteorology relevant to the information that the intelligence officers routinely work with.

CAP and CLIMAS Interactions

CEFA collaborates with both the Scripps Institution of Oceanography California Applications Program (CAP) and the University of Arizona Climate Assessment for the Southwest (CLIMAS). The CAP interactions have involved developing products for the California Wildfire Agencies jointly with those agencies, and working with ECPC. Also, CEFA has been working with CAP in the development of a seasonal statistical fire severity forecast. Further information about CAP can be found at: <http://meteora.ucsd.edu/~meyer/caphome.html>.

The collaboration with CLIMAS has primarily involved co-organizing the 2001 Fire and Climate Workshops during February and March 2001. These workshops brought together national and regional climate scientists, fire managers and decision-makers to formally and informally discuss the utilization of climate information in fire management. Further information regarding these workshops can be found at: <http://www.ispe.arizona.edu/climas/fire>.

Great Basin RAWs Network Analysis

In February 2001 work was completed on the Great Basin RAWs network analysis jointly funded by USFS and BLM. The primary objectives of the project were:

- To develop guidelines for more optimal decisions regarding future acquisition and placement of stations.
- To develop parameters for the optimal placement and operation of weather stations within the Great Basin that have area-wide importance as well as interagency support and value.
- To identify user needs for both climatological (regional assessment) and operational weather (suppression and prescribed burning) information.

The findings of this study are available in the report posted at: http://www.dri.edu/CEFA/Publications/publications_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 2000 through 30 September 2001 (FY01). Invited refers to an invitation for CEFA to attend. In many cases, the travel costs were covered by the requesting agency or means other than Task Order 1.

October 30-November 2 (Maui, HI): Tim Brown presentation at the national Fire Danger Working Team meeting (invited).

November 13 (Lake Arrowhead, CA): Tim Brown presentation at the California Fire Weather Working Group meeting.

November 15 (Santa Fe, NM): Tim Brown presentation at the national Intelligence Officers annual meeting (invited).

February 14-16 (Tucson, AZ): Tim Brown involvement and presentation at the 2001 Fire and Climate Workshop.

February 27-28 (Reno, NV): Tim Brown and Rick Ochoa training presentation to the GACC intelligence officers (invited).

February 28 (Reno, NV): Dr. Larry Hamilton, Director of BLM National Office of Fire and Aviation, CEFA site visit.

March 21 (Boise, ID): Tim Brown presentation at the BLM national operations meeting.

March 23 (Boulder, CO): Tim Brown presentation at the University of Colorado (invited).

March 27-28 (Tucson, AZ): Tim Brown presentation at the Fire and Climate in the Southwest 2001 workshop.

April 2 (Riverside, CA): Tim Brown and Beth Hall presentation at the California Fire Weather Working Group meeting.

June 18-20 (Tucson, AZ): Tim Brown presentation at the NOAA Office of Global Programs North American Monsoon Experiment meeting (invited).

June 22-27 (Reno, NV): Tim Brown ordered up on the Martis fire to work with FBAN.

August 21 (Sacramento, CA): Tim Brown attend USFS meeting on developing interagency operational mesoscale meteorology forecasts for California and Nevada.

September 5 (Salt Lake City, UT): Tim Brown presentation and meeting at University of Utah to discuss mesoscale meteorology models.

Reports and Publications

Brown, T.J., and B.L. Hall, 2001: Assessing long-term fire danger variability and change from climate model output. To appear in *Proceedings American Meteorological Society Fourth Symposium on Fire and Forest Meteorology*, November 2001.

Cayan, D., M. Dettinger, R. Hanson, T. Brown and A. Westerling, 2001: *Investigation of Climate Change Impacts on Water Resources in the California Region*, Department of Energy Accelerated Climate Prediction Initiative (ACPI) Progress Report 1/19/01, Scripps Institution of Oceanography, U.S. Geological Survey, Desert Research Institute, 26 pp.

Hall, B.L., and T.J. Brown, 2001: Development of lightning climatology information over the western U.S. To appear in *Proceedings American Meteorological Society Fourth Symposium on Fire and Forest Meteorology*, November 2001.

Roads, J.O., F.M. Fujioka, and T.J. Brown, 2001: Development of a seasonal fire severity forecast for the contiguous U.S.: weather forecast and validation. To appear in *Proceedings American Meteorological Society Fourth Symposium on Fire and Forest Meteorology*, November 2001.

Schlobohm, P.M., and T.J. Brown, 2001: Fire danger and the standardized precipitation index. To appear in *Proceedings American Meteorological Society Fourth Symposium on Fire and Forest Meteorology*, November 2001.

Westerling, A.L., A. Gershunov, D.R. Cayan, and T.J. Brown, 2001: A western United States fire climatology. Submitted to the *Bulletin of the American Meteorological Society*.

Westerling, A.L., A. Gershunov, D.R. Cayan, and T.J. Brown, 2001: A western United States fire climatology. *Proceedings American Meteorological Society Symposium on Climate Variability, the Oceans, and Societal Impacts*, 157-159.

Westerling, A., D.R. Cayan, A. Gershunov, M.D. Dettinger, and T.J. Brown, 2001: *Statistical Forecast of the 2001 Western Wildfire Season Using Principal Components Regression*. Contribution to the Experimental Long-Lead Forecast Bulletin, Center for Ocean-Land-Atmosphere Studies, University of Maryland, 5 pp.