J12.4 THE CALIFORNIA AND NEVADA SMOKE AND AIR COMMITTEE (CANSAC) AN INTERAGENCY PARTNERSHIP TO MEET DECISION-MAKING NEEDS

Timothy J. Brown*[1], Francis M. Fujioka[2], Chris Fontana[3]

[1]Desert Research Institute, Reno, Nevada
[2]USDA Forest Service, Riverside, California
[3]USDA Forest Service, Redding, California

1. INTRODUCTION

The California and Nevada Smoke and Air Committee (CANSAC) is a consortium of fire weather and air quality decision-makers, managers, meteorologists and scientists in partnership to provide operational meteorological support for wildland fire and smoke management, and advance the scientific understanding of atmosphere and fire interactions. CANSAC is one of five regional Fire Consortia for Advanced Modeling of Meteorology and Smoke (FCAMMS) consortia established as part of the National Fire Plan, and is dedicated to fire and smoke management issues in the California and Nevada region. Currently, CANSAC related research is being undertaken via the USDA Forest Service Pacific Southwest Research Station, while the operational component is being developed and implemented at the Desert Research Institute (DRI) Program for Climate, Ecosystem and Fire Applications (CEFA) in collaboration with the CANSAC constituents. This paper provides an overview of CANSAC, including a brief history, a description of the planned operational facility, and current research activities.

2. BRIEF HISTORY

In the spring of 1999, the California FIRESCOPE Fire Weather / Fire Danger Group (hereafter referred to as the California Wildfire Agencies (CWA)), met for the first time to discuss the possibilities of forming a consortium of federal, state, county and local fire and air quality agencies that for decision-making purposes would utilize value-added products from an operational mesoscale meteorology model. These products would include standard meteorological elements (e.g., temperature, humidity, wind, precipitation), and value-added information of smoke dispersion and transport, fire danger and fire behavior.

**Corresponding author address:* Timothy Brown, DRI/DAS/CEFA, 2215 Raggio Parkway, Reno, NV 89512; email: tbrown@dri.edu

The interest in developing an operational facility to provide these products, and incorporating them in decision-making processes, had been growing over recent years with the realization that new tools and methods were becoming available that could improve forecasts and add substantial information value. A consortium of user groups at the University of Washington was looked upon as a desirable framework (see Mass et al. 2003 and the web site http://www.atmos.washington.edu/~cliff/consortium.html).

The catalyst came about a year later when the California Air Resources Board began public hearings on amendments to Title 17 of the California Code of Regulations regarding Agricultural Burning Guidelines (see http://www.arb.ca.gov/regact/agburn/45daynotice.doc for the proposed changes announcement, and http://www.arb.ca.gov/regs/title17/toc17.htm for legal text). Four of the five general new guidelines directly relate to prescribed burning, which is a subset of agricultural burning.

The first new guideline is the implementation within each air district of a smoke management program "that minimizes or avoids the health impacts of smoke from agricultural burning, including prescribed burning, on smoke sensitive areas". Each program will also contain "a daily system for regulating the amount, timing and location of burn events to minimize smoke impacts". The second guideline requires the submittal of a smoke management plan, with the amount of information required for each plan dependent on the size of the burn. The larger the burn, and hence the more likely a sensitive area impact, the more information required, such as detailed reporting, monitoring and contingency plans. The third guideline emphasizes smoke prevention and reduction, and doing so by determining "the appropriate amount, location and scheduling of burn projects, considering daily weather and air quality conditions". The fourth guideline calls for improving "meteorological data and tracking techniques to accommodate necessary increases in prescribed burning". This is designed to improve burn day declarations. Currently, only 500 mb height is specifically required to make this decision from the atmospheric perspective. Though not completely void of meteorological considerations, the fifth guideline addresses non-burn alternatives to meet management objectives.

Another factor that helped crystallize the operational concept is that the fire weather meteorologists at the California Interagency Fire and Forecast Warning Units of Redding and Riverside knew from everyday experience that improved information would be beneficial and was obtainable in principle. Fire management, and fire and fuels specialists around the state agreed, and consensus was reached that an operational facility was desired to meet the new demands for information and decision accountability. Over the next one and one-half years, several meetings in California were convened to reach this consensus and define partners that would comprise a consortium of interested parties from both fire and air quality agencies.

By mid-2001, a dozen federal, state, county and local agencies were identified as potential partnership members. In the fall of 2001, a draft charter was composed that effectively was a Memorandum of Understanding (MOU) among the agencies that would be directly involved in the project. During the following winter and spring, efforts continued on establishing charter members, and in July 2002, a consortium Board of Directors was formed and given the name California and Nevada Smoke and Air Committee (CANSAC). (It was recognized early on that though originally driven within California, Nevada as an immediate neighbor should also be a partner in the endeavor; Oregon was already part of the Pacific Northwest consortium.) The board members were representatives of their respective agencies, and linkages to the necessary start-up and continued support funding required for the project on an annual basis.

Reaching consensus on doing something is one thing and often easy, but finding the funding to support it is another matter. Over $600K was required during the first year to implement the project and maintain it for one year. Nearly half of this included funds for computer hardware needed to run the high-resolution meteorology model and produce all of the desired output. Earlier in 2001, the California Department of Forestry and Fire Protection (CDF) developed a grant proposal to the U.S. Fish and Wildlife Service (FWS) to fund the hardware portion of the project. The operational costs were to be combined from the other committee members. In early 2002, the grant was awarded, and CANSAC appeared well on its way to being operational. But for the next 18 months, a series of events happened, perhaps not unlike the eastern U.S. blackout of 2003 – starting with some triggering event, tripping switches along the way, and ending in a total widespread blackout. In our case, a series of bureaucratic obstacles, politics and legal rules changes, all interconnected in some manner, impeded the hardware grant process until it stopped completely. As one of this paper's co-authors astutely noted, "The Donner party got over the Sierra's faster than this grant".

However, in July 2003, a breakthrough occurred via a combination of previous funding commitments, year-end funds and a significant grant from FWS. Enough funding was secured to finally begin the implementation and operations of the facility starting in September 2003.

3. COFF - FOR SMOKE MANAGEMENT

After about a year since the beginning of the CANSAC concept, CEFA became unofficially involved in the project, being part of the conference calls and meetings throughout the various consortium organizational steps. The first proposal describing what an operational concept for CANSAC might entail was first drafted in early 2000. This was primarily intended as documentation and information in the process of building the consortium membership. In April 2000, CEFA was asked to submit a project concept to CWA. This document outlined in detail hardware and personnel requirements to run an operational facility meeting the defined needs of the consortium agencies. It was not until May 2002 that CEFA submitted a formal proposal, which was formally accepted for intended funding in October 2002 (when it appeared that all of the funding was being realized).

The requirements provided by CANSAC were operational forecasts of meteorology elements relevant to fire and smoke management, including surface and upper-air fields. A large number of value added products were to be produced and distributed, including smoke dispersion and transport, fire danger indices and specialized fire behavior maps, all in a variety of output forms, but with strong emphasis on geographic information system formats and interactive mapping and visualization. The Pennsylvania State University/National Center for Atmospheric Research MM5 mesoscale meteorology model (http://www.mmm.ucar.edu/mm5/mm5-home.html) was the preferred engine for producing the atmospheric output. Forecasts should extend out 24 to 72 hours depending on the domain. Three nested domains were defined at 36, 12 and 4 km resolutions, with the smallest one covering all of California and Nevada, and the largest covering the Great Basin, Southwest U.S. and a large part of the eastern Pacific Ocean. Calculations should be done on 37 sigma levels for each grid point. Forecasts should be produced within 4-5 hours real clock time from the initialization time.

These are not necessarily unique requirements, but it was soon recognized that the inner 4 km domain was going to be key in producing forecasts operationally in real-time for a large area, representing approximately 260x260 grid points. Since rectangular or square grids are preferred domains for the MM5, the geographic shape of California also made it conducive to include all of Nevada, though it had been decided earlier the state should be a partner.

Discussions with NCAR, University of Utah, University of Washington, USDA Forest Service in East Lansing, Michigan and Athens, Georgia endorsed the concept of a PC cluster to run the model. Financial considerations also encouraged this concept, as it was felt that the available hardware funds would be sufficient to purchase a high-end cluster, but not a necessarily equally functional or superior server system. The original specifications, designed in 2000, called for 128 AMD Athlon processors linked together via Myrinet communications. The original output requirements have not changed, but computing hardware clearly continues to advance and improve. In the fall of 2003, new hardware specifications will be drawn and the system constructed. Though all options will be considered, it is likely that a PC cluster will still be the preferred system.

Space within DRI in Reno, Nevada has been configured for a cluster, including special air handling units, 50 kVA UPS and diesel backup generator. Internally, CEFA refers to the proposed hardware facility as the CEFA Operational Forecast Facility, or COFF – for smoke management. It is intended to perform the basic daily operations, special operational runs such as for specific prescribed fires or wildfire incidents, and research support in between the operational activities.

4. FROM THE GROUND UP

What makes CANSAC unique from other large-scale federal and state top-down projects is that the concept has always been a grassroots effort, from the ground up, driven by agency needs and desires for information. Bringing together a dozen federal, state, county and local agencies is not a trivial task, especially when each one has to provide funding. Getting that funding to DRI can also be challenging, as each agency basically has their own set of forms, procedures, protocols and personnel for handling these situations. Fortunately, DRI has an existing cooperative Assistance Agreement with the Bureau of Land Management (BLM) National Office of Fire and Aviation in Boise, Idaho that provides a very efficient mechanism of funding transfer. There are several agency internal agreements that allow for smoother flow as well, such as other Interior agencies with BLM, the USDA Forest Service with Interior, and CDF with the USDA Forest Service.

To date there are twelve official members of CANSAC – USDA Forest Service Regions 4 and 5, USDA Forest Service Pacific Southwest Research Station, Bureau of Land Management California and Nevada, U.S. Fish and Wildlife Service, National Park Service, California Air Resources Board, California Department of Forestry and Fire Protection, California contract county fire departments (e.g., Los Angeles County Fire Department), San Joaquin Air District, and the Nevada Division of Forestry. However, other agencies in both states are anticipated to become members once operations begin in earnest. DRI, though the contractor, is contributing as a non-voting member with some cost-share support.

The Board of Directors (BOD) is comprised of representatives of those agencies that provide funding for CANSAC. Board members have voting rights on relevant CANSAC issues. The BOD primary responsibilities include developing necessary MOU's, approving annual operational plans, submitting to funding agencies annual program and progress reports, provide overall management of CANSAC, and reviewing recommendations of the Technical Advisory and Operational Applications Groups.

The Technical Advisory Group (TAG) is appointed by the BOD and is comprised of members with technical backgrounds in atmospheric modeling and research. For continuity, there is one member from the operational group. The primary tasks of TAG include monitoring MM5 output and making recommendations for improved model performance, coordinating with other modeling centers, reviewing research projects and assess for applicability of field use, working with the Pacific Northwest consortium to implement

"Bluesky" (discussed below), and submitting recommendations and reports to the BOD.

The Operational Applications Group (OAG) is appointed by the BOD and is comprised of users of the products generated by COFF. All facets of the community are represented, including meteorologists, prescribed fire managers, air quality officials, etc. One member of TAG is assigned to the group for continuity. The tasks of OAG are representing the potential end user, recommending new graphics and visualizations for field use, communicating to groups within their respective agencies to disseminate information and market products, and submitting recommendations and reports to the BOD.

All three groups will meet semi-annually. CEFA will have a representative within each group.

5. RESEARCH

The 2000 wildfire season, remarkable in many ways, provided the setting for establishing the National Fire Plan (http://www.fireplan.gov). Elements of the plan include firefighting, rehabilitation, hazardous fuels reduction, community assistance, accountability, and research. An outgrowth of these elements was recognition that research was needed for the development, improvement and validation of various models for fire weather, fire danger, fire behavior and smoke. Through an internal Forest Service process, a small number of agency researchers submitted proposals built around a concept of regional modeling consortia, and upon acceptance, lead to the development of five regional Fire Consortia for Advanced Modeling of Meteorology and Smoke (FCAMMS; see http://www.fs.fed.us/fcamms). Figure 1 shows the home locations of the five consortia, and their basic areas of responsibility. Note that CANSAC is comprised of two locations – Reno, where the operational facility is being implemented, and Riverside, where the FCAMMS research is currently taking place.

Given the nature of the fire and air quality management applications addressed by FCAMMS, the task of providing research and development support for CANSAC or any of the other consortia is no less daunting than that of providing the mesoscale model-based operational support. For example, the spatial scale of the applications under consideration varies from a meter for the fire behavior models to 10 km for regional fire danger and smoke transport models. However, the time constraints imposed by the operational requirements limit usage of mesoscale models to grid spacings of an order no less than 1 km.

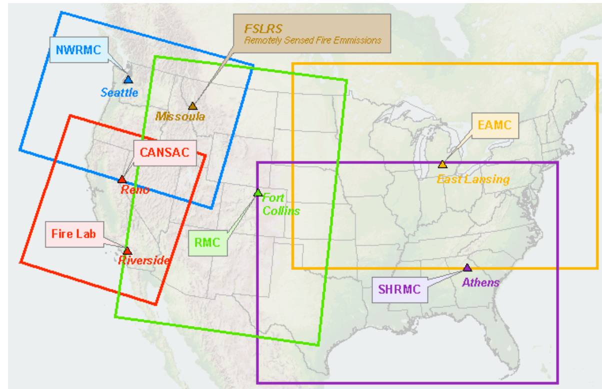

Figure 1. Locations of the FCAMMS consortia and areas of responsibility.

The FCAMMS members provide a significant advantage in fire research and development, arising from decades of experience at the corporate level. In California, Forest Service scientists have performed research dealing with fire weather and fire danger rating since the 1920s (Wilson and Davis 1988). The Riverside Fire Lab actively engaged in dispersion modeling research in the 1980s. The current research program at the Fire Lab includes integrated weather and fire behavior modeling (Fujioka 2002), high resolution fire danger rating (Fujioka et al. 2000), and weekly to seasonal prediction of fire severity (Roads et al. 2001). Another research project on air quality modeling will soon be under way.

5.1 *Weather/Fire Modeling*

Given the weather, fuels, and terrain data, fire planners now have a modeling system – FARSITE (Finney 1998) – to simulate fire spread from an initial fire location, also given. Unlike the mesoscale weather model, FARSITE will run adequately on a laptop computer, except perhaps for multiple fire simulations. We expect that CANSAC will provide mesoscale weather predictions for input to FARSITE, so that fire planners can generate fire spread predictions to plan either fire suppression or prescribed fire operations. Our research to date, however, indicates that the model-generated fire spread predictions are far from perfect.

Fujioka (2002) simulated the growth of the 1996 Bee Fire in the San Bernardino National Forest, California, using high resolution (2 km grid spacing) weather information from a mesoscale model, and FARSITE. The resultant simulation, only 15 minutes after ignition time, grew nearly twice as fast as the actual fire in the head fire spread direction. A similar modeling study of the 2002 Troy Fire in San Diego County, combining MM5 and FARSITE (Jones et al. 2003), also showed a tendency of the simulations to overestimate the actual spread rate (Figure 2). Information from these studies will be useful not only to CANSAC, but also to others employing similar modeling approaches.

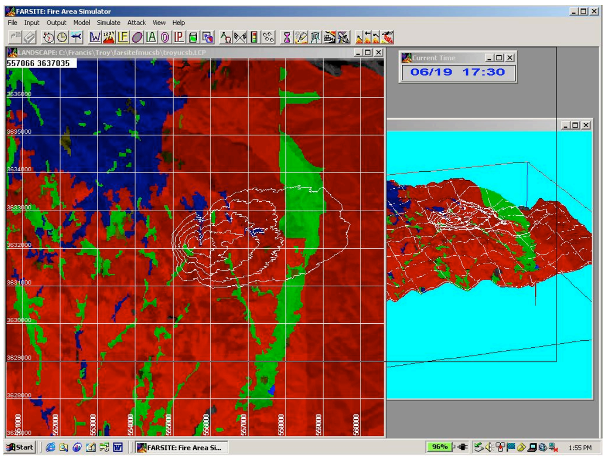

Figure 2. Screen shot of FARSITE simulation of the Troy Fire in San Diego County, 19 June 2002. The perimeters represent the simulated growth at hourly intervals, ending at 1730 PDT.

5.2 *Air Quality Modeling*

Air quality management, as well as fire management, is a primary interest of CANSAC. In California and elsewhere, one affects the other; wildland fire emissions may impact air quality, consequently air quality conditions may determine the conduct of prescribed fire operations. The Riverside Fire Lab will team with the University of California, Riverside, to investigate the effectiveness of combining MM5 with EPA's Community Multiscale Air Quality Model (CMAQ) in predicting fire impacts on air quality in California. The Western Regional Air Partnership (WRAP) established the Regional Modeling Center at UC Riverside to provide western states and tribes with modeling tools to perform regional haze analysis as required by the Clean Air Act. We aim to provide CANSAC with model-generated predictions such as Figure 3, which shows a map of ozone concentrations during an air quality episode affecting central California in July 2000.

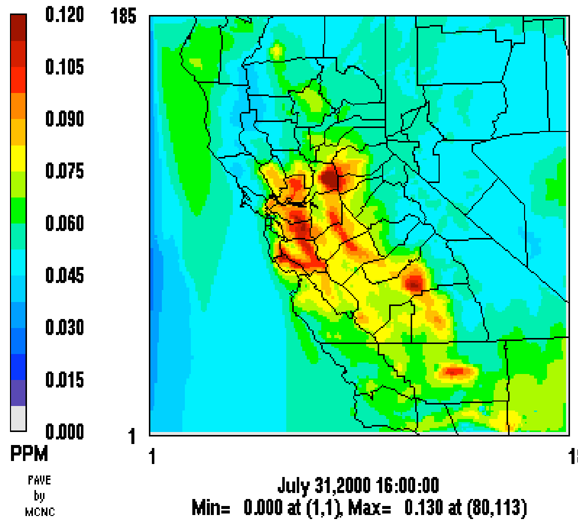

Figure 3. Model-generated map of ozone concentrations over central California on 31 July 2000. Figure provided by Gail Tonnesen, UC Riverside Regional Modeling Center.

6. SUMMARY AND FUTURE

The next step for operational CANSAC is the development and implementation of COFF. During the fall and early winter of 2003, the computing system configuration will undergo its final development, installation, and testing. An atmospheric modeler and a computer support individual will be hired by DRI. The MM5 will be installed and tested, and during the spring of 2004, will be implemented in an operational configuration. By late spring or early summer, it is hoped to start the flow of products to the decision-makers. After that will begin a long process of refinement, developing new value-added products, and applied research.

One component that is certain to be implemented is BlueSky, a Forest Service project that provides a modeling framework for the prediction of cumulative smoke impacts from agriculture, forest and range fires (see http://www.fs.fed.us/bluesky). The framework includes meteorology, fire characteristics, emissions and smoke dispersion. Combined with Environmental Protection Agency RAINS visualization tools, the system provides interactive web based graphics of the model output utilizing ArcIMS and Geographic Information System tools (see http://www.blueskyrains.org).

Other research efforts, particularly involving applications of fire danger and fire behavior, will be integrated into the system. This will include forecasts of fire danger based on the National Fire Danger Rating System (e.g., NWCG 2002), and forecasts of fire behavior and growth utilizing systems such as FARSITE (http://farsite.org).

There is no shortage of academic research ideas that can be converted into decision-making information. However, it will be the needs of the fire and smoke community that impels CANSAC. Through the process, applications will be encouraged and facilitated, and science linked to the ground. CANSAC is a customer-based concept. The customer may not always be right, but their decisions will now be more accountable.

7. ACKNOWLEDGEMENTS

The consortium is user-driven, and it was the ambitious drive of a number of individuals that brought CANSAC to reality. The authors would like to thank the individuals on the Board of Directors that worked with great encouragement and diligence to bring the project together. A few of these individuals started at the idea conception point over four years ago, and have persisted through the realization of an operational facility. CEFA is very appreciative of the individuals within the federal, state and county agencies that are making the funding opportunities happen. Without this support, the project would still only be a concept and desire.

8. REFERENCES

Finney, M.A., 1996: *FARSITE: Fire Area Simulator—Model Development and Evaluation*. USDA Forest Service Research Paper RMRS-RP-4, Ogden, UT, 47 p.

Fujioka, F.M., D.R. Weise, and R.E. Burgan, 2000: A high resolution fire danger rating system for Hawaii. Proc., *3rd Symposium on Fire and Forest Meteor.*, 9-14 January 2000, Long Beach, CA, Amer. Meteor. Soc., 103-106.

Fujioka, F.M., 2002: A new method for the analysis of fire spread modeling errors. *Intl. J. Wildland Fire*, **11**:193-203.

Mass, C.F., and others, 2003: Regional Environmental Prediction over the Pacific Northwest. *Bull. Amer. Meteor. Soc.* (submitted). Current draft copy available at: http://www.atmos.washington.edu/~cliff/consortium.html.

NWCG, 2002: *Gaining an Understanding of the National Fire Danger Rating System*. National Wildfire Coordinating Group Report NFES 2665, P. Schlobohm and J. Brain (Eds.), 71 pp. Available from National Interagency Fire Center or online at http://www.nwcg.org.

Roads, J.O., S.-C. Chen, and F. Fujioka, 2001: ECPC's weekly to seasonal global forecasts. *Bull. Amer. Meteor. Soc.*, **82**, 639-658.

Wilson, C.C. and J.B. Davis, 1988: *Forest Fire Laboratory at Riverside and fire research in California*, Gen. Tech. Rep. PSW-105, Pacific Southwest Forest and Range Experiment Station, USDA Forest Service, Berkeley, CA. 22 pp.