Summary of WWRP Fire Weather Workshop

Hosted by Bureau of Meteorology and Bushfire Cooperative Research Centre
Melbourne, Australia
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Workshop Structure and Aims

Aim: Through international collaboration consider mechanisms to demonstrate the processes by which weather information is maximized in wild fire management and decision making and to enhance these processes.

Approach: It is proposed that a workshop be convened to explore possibilities for the development of a proposal for international collaboration under the auspices WWRP project.

Overall Summary and Outcomes

1. Provision of Fire Weather and Fire Risk Indices

Fire danger indices have been developed in many countries to assess the risk or potential for dangerous fire and its behaviour. Systems and indices developed include the Canadian Forest Fire Weather Index (FWI) System (Canada), *Orieux* Index (France), *Carrega* Index (France), Numerical Index (France), IREPI Index (Italy), Portuguese Index, Icona Index (Spain), National Fire Danger Rating System (NFDRS, USA), *Drought Mac-Arthur* Index (Australia), *Angstrom* Index (Sweden), *Lourenço* Index (Portugal, the *M-68*Forest Fire Danger Index and the Experimental Grassland Fire Danger Index (Germany) and the Montalegre Index (Brazil).

The primary user community for these indices are fire management and emergency response agencies. These indices are employed on time scales from hours (emergency response) to monthly and seasonal time scales.

A requirement for improved intermediate range i.e. the medium to extended period products was also highlighted by the Australian user community. This is being investigated in the US with the development of the Significant Fire Potential product which forecasts daily fire risk, weather and resource projections out to 7 days. A joint research project involving the USDA Forest Service and the Scripps Institution of Oceanography Experimental Climate Prediction Center ECPC) is currently testing seasonal forecasts of the US NFDRS indices, derived from 16-week numerical weather predictions produced at ECPC.

Clarification of uncertainty in predictions was clearly identified by the users as an important requirement. In addition increased temporal resolution and specificity in the products e.g. to effectively discern the diurnal cycle was required.

No one fire danger rating system has been accepted for use internationally. Each country has their own technique for a variety of reasons. Limited comparisons of the various approaches have been undertaken e.g. a study conducted in Portugal reported by D. Viegas concluded that the Canadian Fire Weather Index (based on noon observations of meteorological observations of temperature, humidity, wind and rainfall) provides an acceptable description of fire danger. This index is based on the use of observational data and has been implemented by the Canadians within South East Asia, Eurasia, South America, New Zealand, Eurasia and Mexico.

The fire danger indices can be produced from numerical weather prediction models. This is already happening with regional and global models e.g. the NCEP Fire Weather Index. In addition, seasonal outlooks (Scripps seasonal model forecasts) are developed in this way.

An extended range of globally based NWP products, with high temporal and spatial resolution, and providing ensemble-based modes would have significant potential and application. Real time production and availability of such fire danger indices would enhance their overall use. Specific applications include:

a) Provision of real time global fire risk assessment from medium range forecast models for all WMO member nations
b) Potential for the development of a global data bank providing a climatological record of fire danger and associated behaviour-through the use of global reanalysis data.
c) Global characterisation of uncertainty and likely extreme behaviour through ensemble techniques
d) Provision of a global fire risk benchmark and validation necessary for improved fire risk assessment
e) Global seasonal fire risk metrics
f) Provision of a systematic link between fire risk assessment from NWP and requirements for climate model based fire risk assessment.

A forecast of these indices only requires a forecast of standard meteorological variables such as wind, temperature and humidity coupled with a forecast of fuel state, which corresponds to meteorological factors, and knowledge of topography.

The meeting agreed that WWRP promotion of a global approach to the provision of fire danger indices incorporating the above capabilities would provide significant advances over current schemes. The involvement of major operational numerical weather prediction centers should be encouraged to provide such valued added products in real time. Provision of such information in GIS compatible structures through web-based approaches would be an additional benefit. Operational centers

providing deterministic models, ensemble and seasonal forecast models should be approached for this project. Intercomparison, validation and benchmarking would follow. These products and datasets would provide a powerful base for planning and disaster mitigation activities.

Several members of the group are already interested in pursuing this activity. Within the US NCEP already has developed products in this way based on the Weather Forecast Index. However, the Australians (using local regional and global models) and the Canadians (providing expert support for the implementation of their Fire Weather Index) have an interest in direct involvement to meet current program requirements. The following summarises potential contributors to such an activity.

Potential contributors: Bureau of Meteorology NCEP, ECMWF, MSC, MeteoFrance, TIGGE.

2. Links to On Going International activities

Within the UN International Strategy for Disaster Reduction (ISDR) framework fire mapping and monitoring using remote sensing techniques is a significant activity. Satellite based sensing techniques are employed for global monitoring and early detection of fire, assessing fuel state and associated impacts e.g. aerosols, smoke etc. Links with the meteorological and in particular the NWP community would be mutually beneficial. The satellite community can provide improved specification of fuel state, information on ignition factors such as lightning that is important for fire potential and validation of fire indices. One important focus for these activities is Global Observation of Forest Cover/Global Observation of Land Cover Dynamics - Fire Mapping and Monitoring Implementation Team" (GOFC/GOLD Fire IT) which cooperates closely with the Global Wildland Fire Network. One of the priority activities of the GOFC/GOLD Fire IT is to promote the development of satellite-sensor based wildland fire early warning systems. Initiatives combining weather-based and remote sensing based fire systems have significant potential to enhance early warning and detection of fire.

As a consequence of the Tsunami Disaster and the UN World Conference on Disaster Reduction (WCDR, Kobe, Japan, January 2005) the government of Germany has announced it will host the Third International Early Warning Conference (EWC III) in Bonn Germany,27-29 March 2006. An initiative developed by the WWRP and its partners with the GOFC/GOLD Fire IT could have potential input to EWC III. This framework provides an opportunity to raise awareness of the science community, the users and the potential sponsors.

A planning meeting with WWRP/GOFC/GOLD Fire IT and the Wildland Fire Collaboratory should be undertaken to develop such a collaboration. The GFMC at

Freiburg University has been offered by Dr J. Goldammer as a potential location. Importantly however the role of the WWRP needs to clarify what capacity it can bring to such a collaboration. Production of global fire danger indices as discussed above could provide that link. As stated the use of ensemble techniques for probability information would extend the current capability. WWRP needs a potential program with requirements known for participation before such a meeting. Involvement of one or several major operational forecast centers could provide this link.

From the NWP point of view linking with the satellite community can provide important information on land surface processes.

It should be noted that joining with the international Early Warning Programme under the auspices of the United Nations International Strategy for Disaster Reduction (Un-ISDR) has potential for further development and financing of research and technology

The workshop showed from experience in the US within CANSAC that the development of effective partnerships with fire managers is most important in optimizing the use of fire weather information.

3. Fire Behaviour Modelling

Fire behaviour modeling is employed to describe among other things the intensity, flame characteristics and rate of spread of a particular fire. Fuel type, state, topography, and weather interact to determine the fire behavior.

A range of various models are currently employed to model these characteristics. They range from experience, empirically based statistical models (eg, Canadian Forest Fire Behavior Prediction (FBP) System), semi-empirical models (e.g., BEHAVE, FARSITE based on energy conservation), hybrid approaches (CAWFE), and the extremely complex physically based models (e.g., FIRETEC, FDS that solve the physical equations governing combustion and heat transfer). Integrating fire behaviour models and weather prediction systems into a fire behaviour system is a key issue and an important lead into decision support systems for fire management. It should be noted that FARSITE has been employed in real time by the USDA Forest Service and that NCAR has demonstrated its model CAWFE during the COlorado Real-Time modeling Test-CORT. The FBP System also runs operationally at a national scale as a daily extension of the FWI System product in Canada.

The meeting established a number of directions that have significant potential and noted:

a) Development, testing and intercomparison of fire behaviour models of various degrees of sophistication should be encouraged and facilitated. Complex fire

behaviour models are beyond the capabilities of current technology to implement in real time but use of a hierarchy of models can provide significant advances in this area.

b) Validation of fire behaviour models is essential. Certain models are successful in reproducing fire behaviour under specific fuel type and environmental conditions. However once models are applied with different fuel types, fuel moisture and weather, the modelling capability is found to have limitations. Comparison of fire behaviour models under prescribed burn conditions with direct and indirect measurements of fuel state and weather condition is essential.

Prescribed large scale burns incorporating meteorological regimes of interest are planned for NSW within 12-18 months as part of the Bushfire CRC activities. These burns could provide a basis for an international experimental modelling and intercomparison activity.

c) Provision of high spatial and temporal resolution NWP to capture the diurnal cycle in the boundary layer and evolution of land surface processes in complex topography. Extreme events are of particular concern, extreme dryness and strong wind events

d) Providing uncertainty measures with fire behaviour modeling. Required for risk assessment and management. Current techniques e.g. USDA Forest Service employ comparisons with observations to characterize the uncertainty. Use of mesoscale ensemble predictions could provide a an important link to develop uncertainty associated with weather.

e) The characterization of fire behaviour at the rural urban interface was highlighted as an important area. This would involve intercomparison of sophisticated fire behaviour models in non real time.

Possible Action: Collaboration with the Bushfire CRC on its prescribed burn program. Would involve intercomparison and validation of fire behaviour models, validation of remote sensing of fuels state, use and validation of high resolution ensemble mesoscale models. Potential Partners: Bushfire CRC, Bureau of Meteorology, USDA, NCAR, U. Coimbra, the EU-funded FIRE PARADOX program (2006-2009), GFMC, GOFC/GOLD, Canadian Forest Service.

4. **Community and Decision Support Systems(DSS)**

Key issues in fire management pertain to level of risk associated with the spread of fire and smoke in both uncontrolled and prescribed burns. For the very short range forecasts (few hours), the possibility of extreme fire behaviour is of main concern, for periods out

to one week likely scenarios for overall fire behaviour are considered i.e. which fires can be controlled and will larger fire fronts result. Scenario assessment is a key issue.

At the fire fighting level, decision support providing point based weather forecast information was highlighted e.g., the NCAR Dynamic Integrated Forecast System (DICast). The use of consensus techniques and mesoscale ensemble forecasts have considerable potential here. Use of simpler fire behaviour models e.g. FARSITE linked to NWP also has considerable potential as a DSS for fire spread.

In the US DSS is being underpinned on high resolution NWP e.g. fire behaviour with CORT but it also impacts smoke dispersion aids e.g. CALPUFF,HYSPLIT and the more general approaches to air quality systems e.g. the CANSAC Bluesky modeling framework (provides fire characteristics, meteorology, emissions and smoke dispersion with web output) and WRF-Chem_fire at NCAR. As stated previously ensemble information has considerable potential in all these applications. Coupling ensemble NWP to the smoke and ash plumes dispersion problem has considerable potential for scenario evaluation.

The development and use of DSS systems would benefit considerably from improved mesoscale ensemble work. Strategic support from WWRP for advancement of these activities and entrainment of the appropriate modeling groups into fire weather applications would be of benefit.

Application and use of DSS would in a WWRP role be best handled within an FDP framework.

5. FDP Activities

The FDP mode of activity is on going in many countries but essentially on national basis e.g. CANSAC within the USA , the Bushfire CRC within Australia are providing on-going links between the meteorological and fire user communities. Nationally-based agency cooperation is the key to these activities. Formalised programs of international collaboration, focusing research groups and user groups on common real time problems has not developed.

At this meeting, Australian Fire Agencies, the Bushfire CRC and the Bureau of Meteorology saw potential and expressed in principle willingness to host an FDP activity. It was clear from the international contributions that existing techniques in operations and under development could provide significant advances over current processes employed in Australia.

The international groups also perceived value and a willingness to become involved.

Possible activities for focus within an FDP include:

a) Assessment of fire danger risk in particular with high temporal and spatial resolution indices encompassing the medium range (0-10 days) and including the potential for extreme fire risk.
b) Demonstration of the utility of fire behaviour modeling techniques in fire management e.g., FARSITE for guidance in short term fire decision making
c) Provision of uncertainty information in risk assessment
d) Optimisation of systems and techniques for information sharing and decision making within wild fire management

The Bushfire CRC is well placed within the Australian community for such an activity. It has direct links with all aspects of the fire community and a well established links with the user communities. The Bushfire CRC has expertise in place to enhance interactions between the research groups and the user communities. The value of FDP activities in terms of economic impact, public good could therefore be readily assessed and quantified.

Bilateral and cooperative agreements did develop at the workshop in areas of common interest. e.g., CRC and AFAC emissions modeling working within Australia. Building on these activities is an obvious way to develop a truly multi national approach within the FDP framework. Potential partners for an FDP activity include: Australia(Bushfire CRC), US (USDA, DRI, NCAR, BLM), Canada (CFS)and Portugal(UC).

Establishing a WWRP footprint in this area would aid this whole process. Support for international collaboration is an issue. Building links with the ISDR could provide an avenue for this to happen. Developing a WWRP role in the following areas is recommended:

1. Development of a WWRP program supporting a suite of global fire danger indices based on ensemble techniques and produced routinely by key operational centers. Would include development of a fire index database, with links to GOFC/GOLD and ISDR. Key issue is the development of uncertainty measures for decision making.
2. Supporting a multinational validation and intercomparison of fire behaviour modeling and remote sensing of fuel e.g. within the prescribed burn programs planned in Australia and New Zealand and the EU-funded FIRE PARADOX program.

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