Alaska Climate Teleconferences
Hosted by the Alaska Center for Climate Assessment and Policy

EXPERIMENTAL FORECAST OF AREA BURNED FOR INTERIOR ALASKA
Paul Duffy, Neptune Inc.
Tuesday, May 19, 2009**;** 10:00-11:00am Alaska Local Time

SUMMARY
Written by Brook Gamble

We had over thirty participants, including representatives from ABR Inc., Alaska State Division of Forestry, Alaska Native Tribal Health Consortium Center for Climate and Health, BLM Alaska Fire Service, EPA, Kawerak, Inc., KTUU Channel 2 TV Anchorage, National Weather Service Anchorage and Fairbanks Forecast Facilities, Neptune Inc, NOAA Fire Weather Program, Native Village of Buckland, Parker Associates Inc., Senator Paskvan's office, Senator Thomas's office, University Alaska Fairbanks, University of Maryland, US Fish and Wildlife Service, Yukon Flats National Wildlife Refuge.

PRESENTATION
The teleconference presentation is available as a .pdf on the ACCAP Wildfire website: http://www.uaf.edu/accap/wild_fires.html and also in our Climate Teleconference archives: http://www.uaf.edu/accap/telecon_archive.htm. Links to media coverage of the teleconference are also available on the ACCAP Wildfire website (url above).

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Wildfire is the dominant disturbance regime in Interior Alaskan forests and it accounts for the majority of stand disturbance. After a fire, succession modifies the forest structure. What once was a black spruce stand may initially be re-populated with birch. However, fires do not burn uniformly across the landscape, but leave unburned areas, resulting in a heterogeneous stand structure.

Interior Alaska contains 150 million burnable acres, which is approximately equal to the area of Montana and Idaho combined. The average annual area burned in the state is 840,000 acres (median 334,000 acres), however, the largest wildfire year recorded burned 6.4 million acres demonstrating large variability in acres burned per year. The majority of wildfires in Alaska occur in the Interior, bounded to the north by the Brook's Range and to the south by the Alaska Range.

The concept of this project is framed by the interactions among fire, climate, and vegetation. It is important to characterize the relevant spatial and temporal scales at which these interactions are most pronounced. While the impact of climate on fire seems obvious, these scales are less so.

We initially built a statistical model for annual acreage burned. In this model we use the log of area burned to normalize the data and meet the model assumptions. Seven stations throughout the interior were averaged. The explanatory variables of monthly temperature (April, May, June, July), monthly precipitation (June), and teleconnection indices from the NOAA Climate Prediction Center explain much of the interannual variability in this model.

To improve the accuracy of the predictive function, we applied gradient boosting models (GBM). This approach is conceptually similar to the linear regression approach in that it attempts to quantify area burned as a function of the explanatory variables. The gradient boosting model proved to be a better fit, however in years with the most area actually burned by wildfire, the predicted values tended to underestimate area burned compared to the observed values and conversely, in low wildfire years, the predicted area burned tended to overestimate area burned compared to the observed.

The next step applied the GBM to pre-wildfire season variables to give the model predictive capability. The explanatory variables used were April precipitation and the following teleconnections: Polar (January and February averages), East Pacific/North Pacific (April and February difference), and Pacific North American (January). Cross validation was performed by re-fitting the model 5000 times. All statistical analyses were performed in the open-source software program "R", http://www.r-project.org/.

Partial dependence plots show the relationship between area burned and the explanatory variables: average June temperature and total August precipitation. Distributions of June temperature and August precipitation over 1950 to 2007 are shown in the shaded green area on graph. The partial dependence plots also indicate thresholds of 14˚C June temp and 45mm August precipitation for large area burned.

We next applied the gradient boosting model approach to pre-season variables in order to generate a fire season prediction. In this process we use a range of teleconnection indices provided by the NOAA Climate Prediction

Center. In creating this model, a stepwise cross-validation procedure randomly eliminates 20 years from past forecast data to predict the years eliminated. This process is repeated in order to ensure predictions for any given year are not generated by actual observations for that year. Currently this process is performed monthly for March through June. Data are available at the end of each month. The forecasts are not a single value, but rather a distribution of predictions with associated probability.

The wildfire forecasts use subjectively determined thresholds of acres burned in which low= <500,000 acres, moderate= >500,000 and <1.5 million acres, high= >1.5 million acres. Based on data available in April 2009, the May 2009 forecast for Interior Alaska wildfires falls into the moderate threshold, with a median projection of 595,674 acres burned. Since we don't really have a crystal ball, the forecast will be wrong some percentage of the time. In working with fire managers in Alaska, we determined that the worst error would be to predict a low year, and then to actually have a high fire year. As shown in the error tables, predicted high values are correct 80% of the time, predicted moderate values are correct over 60% of the time and predicted low values result in either low or moderate area burned nearly 80% of the time.

The variability of the median forecast is less than the variability of observed annual area burned by wildfire. As a result, the median forecast still tends to overestimate low fire years and underestimate high fire years. One way to compensate for this error is to rank both the annual area burned data and the median forecast and then map the median forecast to the annual area burned with the corresponding rank. We can then identify how the predicted range of area burned compares to area burned in past years and where it falls in a ranking of annual area burned (ie. from the historical year with the least area burned, to that with the most area burned). When we do this for the 2009 predictions we find that predicted values fall somewhere between the 33rd and 32nd most severe fire years (out of 58 years from 1950-2008), which occurred in 1994 and 1958 respectively.

The accuracy of the model has also been tested by choosing a year in the past, say April 2000, and calculating output results for the 2000 fire season. These are then compared with actual area burned in 2000. This method shows a reasonable accuracy with still a slight under prediction of high fire years and over prediction of low fire years.

In conclusion, annual area burned in Alaska is strongly driven by climatic factors. This link is used to generate forecasts for annual area burned throughout interior Alaska.

The forecast is available on-line at:
http://zeus.neptuneinc.org/xRISA/index.html and is accessible through ACCAP's Wildfire page: **http://www.uaf.edu/accap/wild_fires.html** which

also provides in-depth information about ACCAP's projects, wildfire-related links and resources, and related ACCAP webinars such as podcast, summary, and slides. The forecast tool allows the user to choose the Google map interface and add monthly fire forecasts and other layers that are currently in development, including fire history and management options.

This information can be used by land/fire managers to make decisions about initial planning strategy for the wildfire season and to make informed resource allocations both within Alaska and in the lower 48 states. Future work includes regionalizing the forecast within Alaska and continuing to work with fire managers to better understand how this information can be most useful to them.

Discussion

Q: Do you use information from the RAWS stations in your predictions (http://fire.ak.blm.gov/predsvcs/fuelfire/fwist.php)? For all RAWS generating fire danger indices there are graphs illustrating current conditions w/ average and worst case conditions

A: This is a good point. There is a distribution of flammable vegetation across the landscape that is not incorporated into the model. In addition, as time passes and fire burns across the landscape, the distribution of vegetation will change. The model is based on current vegetation. However, there are currently projects underway with the Scenario Network for Alaska Planning that describe the potential shifts in vegetation as a function of fire in combination with climate change.

Q: Which is the most limiting input factor in the model? What information or data could improve the model the most?

A: That is a good question, but one that we have not analyzed yet. It is a challenge to identify what information might be *missing*, but developing regional and sub-regional forecasts is the next step. It may be hard to determine to what scales the model is legitimate. Regionalization will have to focus on the issue of ignition and the distribution of vegetation across the landscape.

Q: What is the source of the precipitation data? Do you take an average of station data?

A: Seven stations were identified that all had at least 95% of their weather data reported, dating back to 1950. These stations include Bettles, Delta Junction, Fairbanks, McGrath, Nome, Northway, and Tanana. The precipitation data was averaged for the state into a single data point. This was the most parsimonious *and* effective estimate of precipitation in terms of yielding the greatest explained variance in the annual area burned.

Q: 2002 was an anomalous year. Rainfall in April was an order of magnitude greater that year in April than usual. Do you think that this could explain why your forecast for area burned in 2002 was so much lower than actual?

A: Quite possibly. When the model does not perform accurately, it is usually because we have unprecedented climate or weather conditions. I expect that we will run into this situation more in the future with climate change.