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

FIRE AND CLIMATE CHANGE IN ALASKA
Paul Duffy and T.Scott Rupp, University of Alaska

Tuesday, August 21; 1:00-2:00PM (ADT)

SUMMARY

The Alaska Center for Climate Assessment and Policy (ACCAP) held its third of a series of monthly Climate Teleconferences on Tuesday, August 21, 2007. The focus was FIRE AND CLIMATE CHANGE IN ALASKA. We had over 45 participants including representatives from the Aircraft Owners and Pilots Association, Alaska Conservation Solutions, Alaska Department of Environmental Conservation, Alaska Department of Natural Resources, Alaska Fire Service, Alaska Municipal League, Alaska Public Radio, Alaska State Climate Impact Assessment Commission, Alaska Native Science Commission, Daily News Miner, Northern Alaska Environmental Center, NOAA/ National Weather Service, Office of Senator Murkowski, Office of Senator Thomas, State of Alaska Fire Marshal, National Park Service, The Nature Conservancy, The Wilderness Society, U.S. Fish & Wildlife Service, University of Alaska, ACCAP Steering committee and scientific specialists.

PRESENTATION
The teleconference presentation by Paul Duffy is available as a .pdf file on the ACCAP Climate Teleconference Website under “Archive of Past Conferences”:
http://www.uaf.edu/accap/teleconference.htm

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As a major source of ecological disturbance in the boreal forest, fire initiates succession and modifies vegetation. Because most human-caused fires occur near roads and population centers where suppression priority is highest, research has shown that human-caused fires account for over 60% of all fires in Alaska, yet only 10% of area burned.

In general fire in Alaska is concentrated in the interior boreal forest (the Kenai Peninsula not withstanding), however, monthly weather/teleconnection indices drive annual variability in statewide area burned. Climatic patterns such as the Pacific Decadal Oscillation influence the location of annual fire activity. In past years, fire activity has been regionally concentrated throughout the interior, however in 2005 fire perimeters span the entire interior.

A gradient boosting model has been created to deconstruct the influence of weather on annual area burned. This model does a good job of replicating historical records of area burned. Results show that mean June temperature (56˚F) and total August precipitation (1.8 in.) are threshold indicators for large fire years in Alaska.

Fire severity impacts vegetation and patterns of post-fire re-growth. Fires that consume a larger depth of organic matter on the forest floor result in higher soil temperature and lower soil moisture. Recent research shows that with less severe fires, when only a shallow layer of organic matter is burned, the forest tends to return to spruce composition. However, aspen and spruce forest return will dominate with more severe fires that burn deeply through the organic layer to mineral soil. Early season fires tend to consume more organic layer than late season fires. Larger fires, which typically burn later in the season, have higher average burn severity. Therefore, fire size can be used as a proxy for weather conditions and seasonality. With climate change, longer growing season promotes larger fires and more severe burning. This accelerates a change in dominant forest vegetation from conifer to deciduous.

Recorded fire data in Alaska exist only back until about 1950. However, with this understanding of feedbacks between climate and fire, we can create models that link to historical climate data sets and estimate annual area burned back to 1860. ALFRESCO is a spatially explicit model of fire, climate, and vegetation that links climate data with fire activity and is used to understand both past and projected future fire regimes. Model tests show that ALFRESCO does a good job of predicting a historical spatial distribution of fire on the landscape and replicating observed stand age. Model outputs indicate an overall increasing stand age through out interior Alaska, which corresponds to increasing flammability.

Climate scenarios from the Intergovernmental Panel on Climate Change (IPCC) were used as inputs to ALFRESCO. One scenario represents the most potential warming (Hadley) and one the least potential warming (PCM). These were used in conjunction with two scenarios for global population and energy use; A2 representing high and B2 representing medium values. While inter-annual variability can be expected, model outputs for both scenarios show overall increasing temperature and precipitation.

Four sets of climate maps were used to drive ALFRESCO model runs for a time period out to the year 2100. Area burned for each scenario was evaluated across 100 replicates. Results show an accelerated rate of burning with non-linear increase in cumulative area burned under all climate change scenarios. We can therefore expect an increase in average annual area burned as well as an increase in deciduous dominated forest stands.

Changes in fire regime and vegetation types can also be expected to result in overall decreasing area of winter caribou habitat (spruce stands >80 years old). Scenarios for the year 2100 range from just over half of 1900 area to approaching total loss of winter caribou habitat. In contrast, vegetation changes from a climate induced increased fire regime are expected to double 2000 area of moose habitat (deciduous stands 10-31 years old) These vegetation changes from dark, heat absorbing spruce to light, heat reflecting deciduous can be expected to decrease the overall amount of absorbed surface energy, creating one of the few regional scale negative feedbacks to climate warming.

In summary, the annual area burned in Alaska is strongly driven by climatic factors. Forecast changes in climate will alter forest vegetation by increasing the severity and extent of the fire

regime. We can expect impacts on property and ecosystem services such as moose and caribou.

Continued work in this area will use the latest 2007 IPCC maps to update and refine these forecasts based on future climate estimates as part of the Scenarios Network for Alaska Planning (SNAP) project, funded by the University of Alaska.

DISCUSSION COMMENTS AND QUESTIONS

- Has there been any research to investigate economic impacts of the expected changes in fire and vegetation, especially as related to forest products industry?
  - Response (Terry Chapin): We are not aware of specific studies in that area, however Glen Juday's research at UAF has shown that spruce forests have been deteriorating as a result of the combined impacts of spruce budworm and drought. So there are reasons for concern for spruce forests as a timber resource, regardless of what happens to fire.

- You showed the correlations between area burned and average June temperature and total August precipitation. Are these state-wide averages or for specific region? Are there significant differences on those variables around the state?
  - Response: To do this work we needed climate stations that were reliable back to 1950. There aren't too many of those that also provide reasonable geographic coverage. For each month and each year, we took the average monthly temperature for Fairbanks, Bettles, Delta, McGrath, Nome and two others. We averaged those 7 stations for each month for each year. Using those climate data we have a well predicting model. This is a very simple method, but among a number of possible metrics, it performed the best. If we know what the summer climate will be we can predict fire activity, the trick is to predict weather.

- Wouldn't the trajectory of fire activity change as the forest stands change from coniferous to deciduous?
  - Response: Yes. At some point eventually we will convert to such an extreme relative proportion of deciduous forest type on the landscape that it will change the fire dynamics. However, I do not think that will happen within the next 100 years. The link is a function of the relative distribution and spatial configuration of deciduous forest on the landscape. This is something that we are working on, but will take time to reconfigure the model.

- Last month's ACCAP teleconference highlighted work at the NOAA Climate Prediction Center to provide a Storminess Index for the Alaska region. This would potentially provide temperature and precipitation predictions three months in advance (i.e. prediction in March/April for June/August temperature and precipitation). It could also provide an ensemble of different possible outputs with a confidence factor. Feeding this input into ALFRESCO might provide a range of confidence factors for area burned and fire season predictions. ACCAP is doing a good job bringing together scientists and various groups whose work could benefit each other.
  - Response: We could certainly take ensemble inputs and produce forecasts for area burned. However, using standard teleconnection modes (like East Pacific Decadal Oscillation and El Niño), is a bit like trying to screw in a screw with a vice grip. The June temperature variable has the least correlation with indices that the climate prediction center currently has data for. We are currently working with John Walsh at the International Arctic Research Center to use historical data to key an Alaska teleconnection. We are looking for ways to better forecast the upcoming fire season.

- Continued discussion: This kind of information would be useful to rural residents whose travel is very closely tied to weather conditions, especially storms and ice conditions. It would also be helpful for rural residents to have more information to predict snow and ice conditions in the winter.

- Can the model include habitat for other subsistence species, like buffalo?
  - Response: It would be possible to run the model with specific vegetation parameters for buffalo habitat or other terrestrial subsistence species.

- In rural areas, we used to observe small conifers coming in after a fire. Now, we see just deciduous coming back. At what point will the deciduous start burning?
  - Response: We have also observed very few sites where there are young conifers on the landscape. In terms of when the deciduous will burn, I don't know the answer to that. That would be an entirely new ecological state on the landscape. It would be difficult to get information about that unless we can conduct experimental burns. But, at some point it will definitely happen.

- It seems that more frequent fires will increase the threat to rural Native villages.
  - Response: Yes, as we see more fires burning on the landscape, we can expect to need more suppression resources to protect life and property in rural areas.

- Are there ways to protect Native villages from fire?
  - Response: Yes, the Tanana Chiefs Conference, Bureau of Indian Affairs, Fish and Wildlife Service and other organizations have been working with villages throughout the interior to employ local workers, remove hazardous fuel, and create fire breaks around communities. Some villages are beginning to explore the possibility of using this as biofuel for heat. Terry Chapin and Orville Huntington on the call could provide more information.

- I have some traditional knowledge on fire sites in Ventie and Arctic Village. We are seeing more rabbits than usual. My grandfather says that is probably due to the animal shift after the 2004-2005 fire. Can we expect these animals to stay around or go back? The martin has started to come up to this area, which is very unusual.
  - Response (Terry Chapin): Those are really interesting observations. I can think of several explanations. One is the possibility that you gave. Another one is that hare populations are increasing all over the state right now, so your observations may be part of the overall hare cycle.

- One Native Elder told me that now that trees have been burned by fire, permafrost thaw will increase.
  - Response: (Terry Chapin): Yes, I think that is a very good observation.

- In the ALFRESCO model, when looking at lighting caused fire, did you use random generator or did you use an algorithm?
  - Response: We used a random generator. It goes through each year and tests each cell. Flammability is a function of climate (from spatially explicit climate maps) and the vegetation type (spruce cell is 3x-4x more likely to ignite than deciduous). There is a spatial pattern of lighting that varies from year to year consistent with topography, but we don't account for that. In general the randomness associated with ignitions is probably one of the greatest uncertainly in the model. That is why we run a number of replications and analyze results across model results.

- When you incorporated the IPCC data, was that also specific to Alaska?
  - Response: Yes, we looked at the emissions scenarios report from 2005, the A2 and B2 emissions scenarios and used the Hadley and PCM models that have spatially explicit climate maps for Alaska out to 2100. We are currently working on doing the same thing through work with the Scenario Network for Alaska Planning.

- In looking at 25 years of data, we seem to be seeing an increasing trend of lightning strikes frequency in the interior. Is the climate change modeling able to project changes in convective frequency in precipitation. For example, if increase in precipitation forecast by climate models is mostly convective, we can expect to have higher lightening strike densities in the interior, which would increase fire starts.
  - Response: That's a great question and something that we currently are not familiar with. We primarily use temperature and precipitation at monthly resolution. I don't know if climatologists have the resolution to predict convective versus other precipitation. It seems reasonable to expect that warming would be associated with convective precipitation and therefore more lightning strikes
  - Continued discussion: Generally warming is driving by high pressure ridging episodes.
  - These high pressure rides could be driven by teleconnections.
  - (Sharon Alden, AICC) We know the specific patterns that lead to more lightning. What we don't know is if climate models identify 500 millibar patterns in the upper level ridges. A storminess index might also give us a shorter term clue about convective precipitation.
  - Response: In general we have found that we are not necessarily ignition limited. If we see warm and dry conditions across the state, there will be an ignition. The spatial scale of analysis is important in our model outputs. It works well on the larger regional scale of interior Alaska. However, it starts to break down if we try to look more locally (say 50 mile radius around Fairbanks).

- Has this model been linked to particulate matter models and human health impacts?
  - Response: I'm not aware of work in that area. But it would be a good application.

- Given the indicated changes in forest composition from conifer to deciduous, it would be useful to have more research that explores the economic impact of these projected forest changes to the state.
  - Response (Peter Larsen, ISER): ISER is currently engaged in a project with both ACCAP and SNAP (Scenario Network for Alaska Planning), that projects climate change impacts on public infrastructure state-wide. This model could be adapted to take into account the work that Paul and Scott are doing on fire regimes to look at where infrastructure may be impacted by fire.
  - Response (Sarah Trainor): There are also indirect economic impacts on communities from increased fire activity, both positive and negative. In particular, increased fire activity and associated costs of fire suppression and hazard fuel reduction can be considered in planning and zoning decisions.
  - Continued discussion: (Luke Hopkins): In addition, if there is a lot of deciduous growth, that can be considered for biofuels for alternative energy generation.

- Is there a way to bring this information into the local and regional scale fire management response plans?

- Response (Dean Brown, Deputy Director State Forestry & Chair of the Alaska Wildland Fire Coordinating Group): There is an interagency wildland fire plan that is updated annually by the Alaska Fire Service, State of Alaska and U.S. Forest Service through both the zone and area offices who work with land managers. Last year we had a presentation at our annual meeting by Glen Juday and Scott Rupp and we are looking to have similar information exchange at this year's meeting. We are clearly facing changing situations. Both suppression and management agencies have to respond to these changes. The more scientific information that we can include in our planning processes, the better off we will all be and we would certainly appreciate that contact.

- Having ALFRESCO results and area burned maps available as a forecast rather than a hindcast would certainly be useful. This could help tie together puzzle pieces that are now separate. It would be neat to be able to go to a website and see forecast graphics.
  - Response: Paul and Scott plan to meet with fire managers and decision makers in February to help specifically identify how their research can meet information needs. The slides in this presentation are just a cross-section of thousands of graphic outputs from the research. To put these together in a meaningful way is not a trivial task. We are working on ways to provide meaningful and useful information. Everyone is encouraged to contact Sarah Trainor (contact information below), with feedback and suggestions for improving technology transfer.

To provide feedback on this summary, the teleconference, or to suggest topics for future teleconferences please contact: Sarah Trainor, fnsft@uaf.edu, 907-474-7878.