Early Season Forecasting of Fire Activity in Alaska

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Why is Forecasting Important?

• Goal of forecasting is to provide managers with one more piece of information that they can use to make decisions

• Early season forecasts can be used to ensure necessary resources are made available to the extent possible
What are the relevant spatial and temporal scales?
Obvious link between climate/weather and fire during the summer

Can the early season atmospheric circulation help develop a forecast?
Estimation Model Development

• The response of interest is annual area burned for the entire state

• Why this?

• Large enough region that we can more easily ignore the ignition component
Statewide Fire Scars for 1940-2011
Statistical Model Development

• Response: $\log(\text{Annual Area Burned})$

• 7 Explanatory Variables:
  – Monthly temperatures (April, May, June, July) and precipitation (June) from Western Region Climate Center
  – Teleconnection indices from PDO (JISAO) and East Pacific NOAA-Climate Prediction Center

• R-squared for the model is 0.79
Observed and Estimated Area Burned for 1950-2003

* Duffy et al (2005)
Building Predictive Models

- Next step is to apply GBM approach using “pre-season” variables
- Construct a statistical model with information from several different teleconnection indices
Atmospheric Teleconnections

• ENSO is probably the most familiar

• Recurring and persistent shift in atmospheric circulation and/or sea surface temperatures
Pacific Decadal Oscillation

* Figure courtesy of Hare IPHC
Building Predictive Models

• Currently, this process is performed monthly for March through August

• Data are available at the end of each month
Building Predictive Models

- Use a stepwise procedure to select the teleconnections to be used for explanatory variables
  - Polar (Jan, Feb avg)
  - East Pacific/North Pacific (Jan to May average)
  - Pacific North American (May)
  - May Temperature

* End of May Model
Current Model

• Advantages
  – Works reasonably well
  – Relatively simple to interpret

• Disadvantage
  – No information about where fires are most likely
Gradient Boosting Models

• Stochastic regression tree algorithm used in machine-learning

• Cross-validated model building

• Distribution of forecasts allows for the quantification of uncertainty

* Used the ‘gbm’ library in R stat software
Histogram of Forecasts Based on May Data

Actual Acreage Burned ~300,000
Partial Dependence Plots for GBM model

* Vertical axis shows expected acres as a function of the explanatory variable
Experimental Forecast of Area Burned for Interior Alaska

The purpose of this experimental forecast is to provide managers with a forecast of the area burned in Interior Alaska for the upcoming fire season. The forecast falls into one of the three categories:

- **Low** (less than 500,000 acres)
- **Moderate** (between 500,000 and 1,500,000 acres)
- **High** (greater than 1,500,000 acres)

**Median Forecast for the 2011 season is 450,000 acres (Low) as of the end of July.**

292,440 acres have burned as of August 16th.

http://fire.ak.blm.gov/content/sitepoint/current.pdf

- There is a 61% chance that less than 500,000 acres will burn.
- There is a 39% chance that between 500,000 and 1,500,000 acres will burn.
- There is a 0% chance that more than 1,500,000 acres will burn.
Error Table for Predictions Based on May Data

Predicted Low

Predicted Mod

Predicted High

< 500,000 ac

> 1,500,000 ac

< 500,000 ac

> 1,500,000 ac
Historical Performance

• Imagine it is May 2000….

• What type of forecast would this product obtain using only the data from 1950-1999?

• Now use this same approach for 2000-2011
Historical Application of Predictions from May Model
Experimental Spatial Forecast

• We can also extrapolate these point models across space using spatially explicit data sets

• We have spatially explicit monthly temperature and precipitation for roughly 1920 - present
August Precipitation 1977
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