Climate and Predictability of Alaska Wildfires

Peter Bieniek

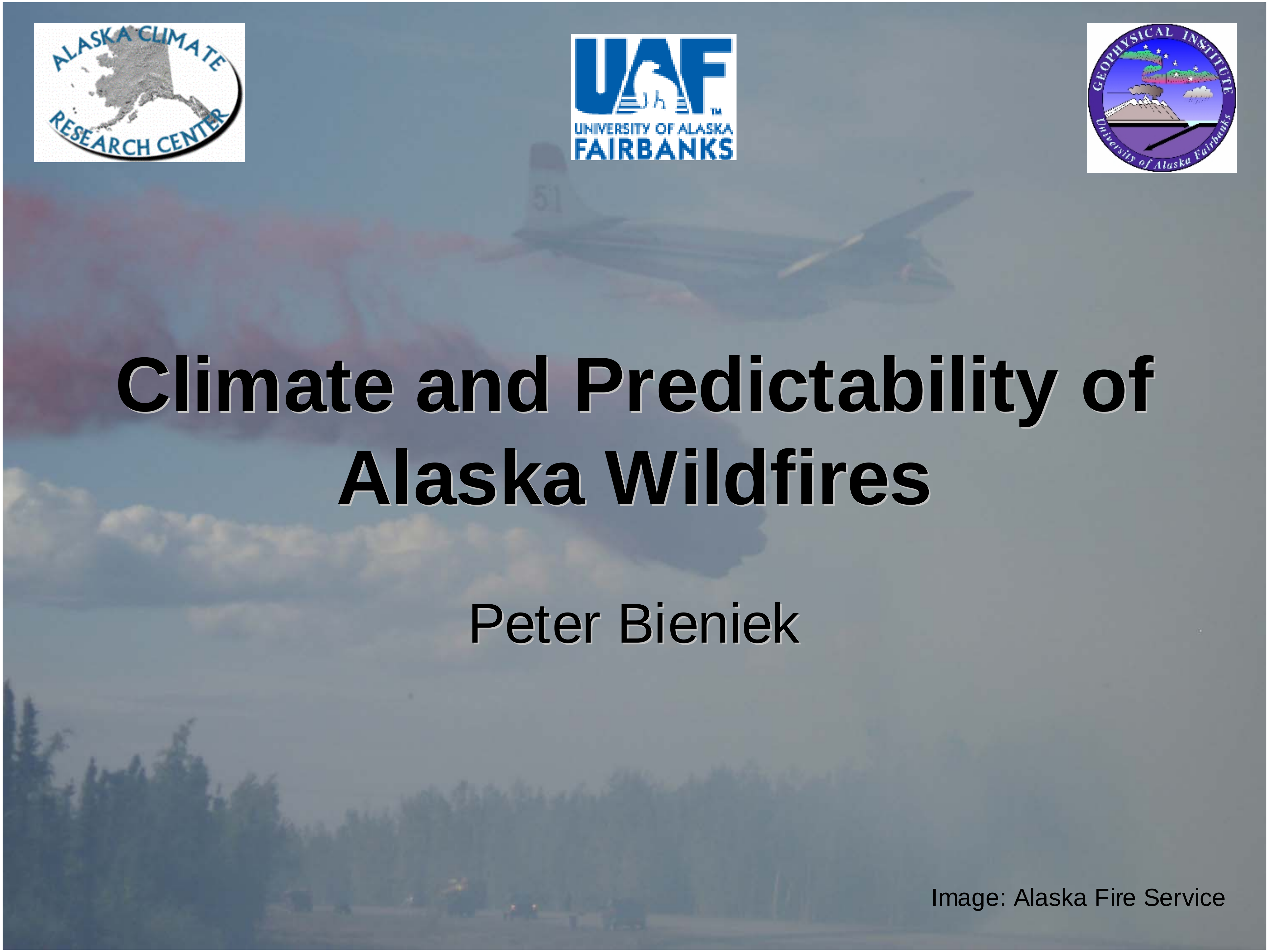
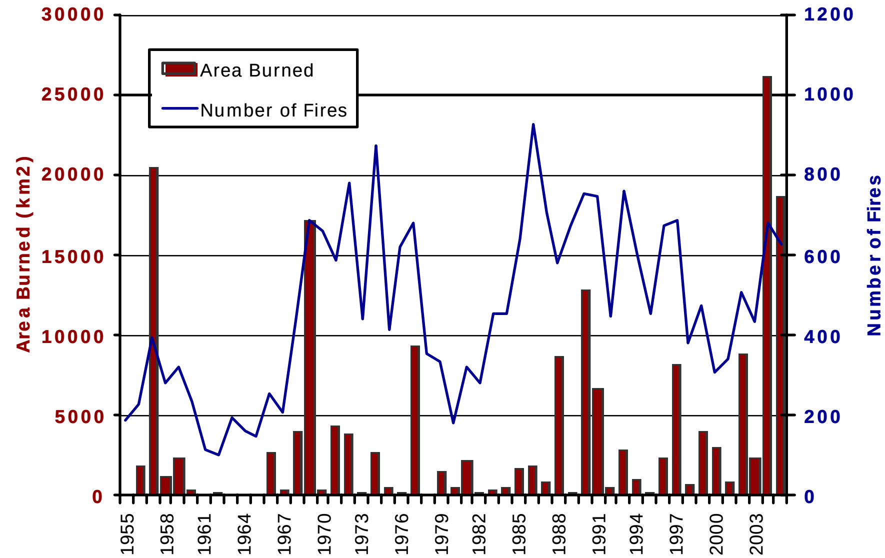


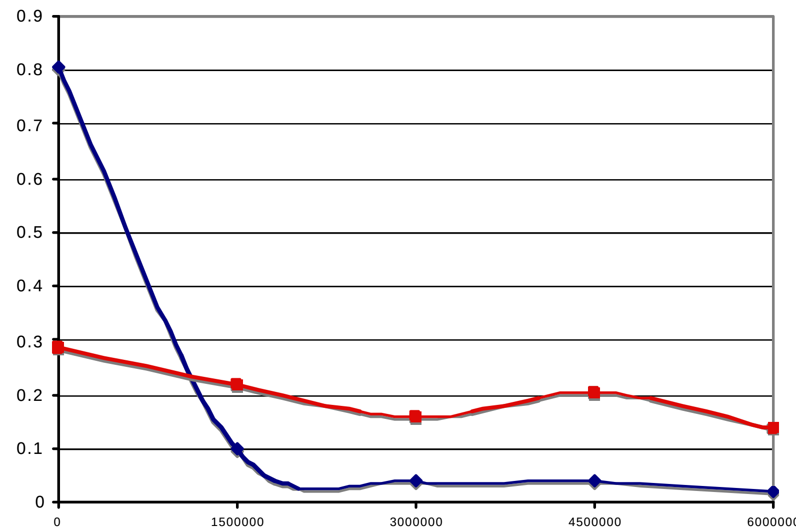
Image: Alaska Fire Service

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Wildfire in Alaska

- A few seasons contain most of the area burned
- Extreme seasons generally are occur discretely
- Area burned has poor correlation with number of fires





Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Research Objectives:

- Determine seasonal average synoptic climate conditions associated with years of extreme high and low area burned
- Assess the predictability of wildfire using monthly or seasonally average climate data

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Data used:

- Alaska Fire Service total seasonal area burned 1955-2005
- NCEP/NCAR Reanalysis for the Northern Hemisphere 1955-2005, and Climatology 1968-1996
  - 500hPa geopotential height
  - 700hPa geopotential height
  - 700hPa specific humidity
  - Total column precipitable water
  - Surface air temperature
  - 1000-500hPa layer thickness

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Seasonal Climatology of Extreme years

- Ranked all years in order of area burned
- Identified years at the top and bottom 10% of the ranking
- Seasonal composite anomalies for spring and summer for each extreme
- Spring
  - March April May
- Summer
  - June July August

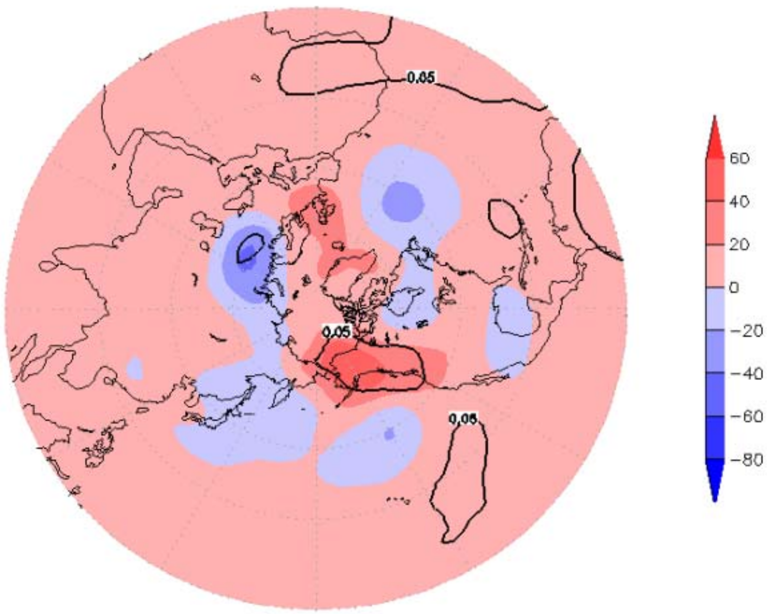
Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Extreme years rankings

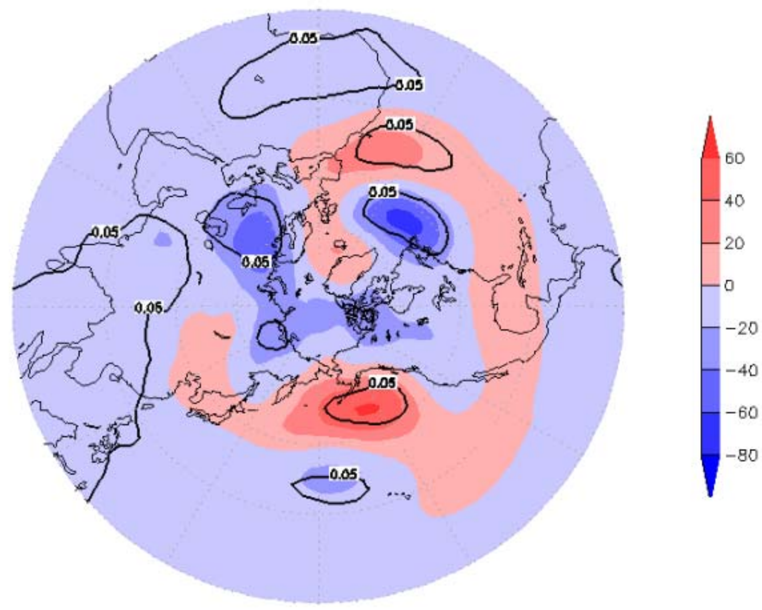
High Years		Low Years	
Year	Area Burned (km^2)	Year	Area Burned (km^2)
1957	20435.3	1961	20.6
1969	17125.6	1964	13.9
1990	12905.7	1965	28.7
2004	26165.8	1978	31.4
2005	18615.5		

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Spring: 500hPa height



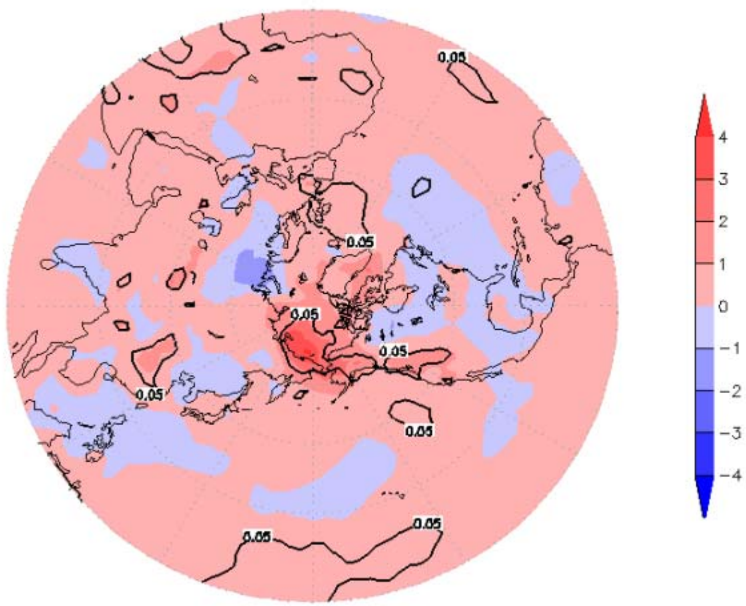
High



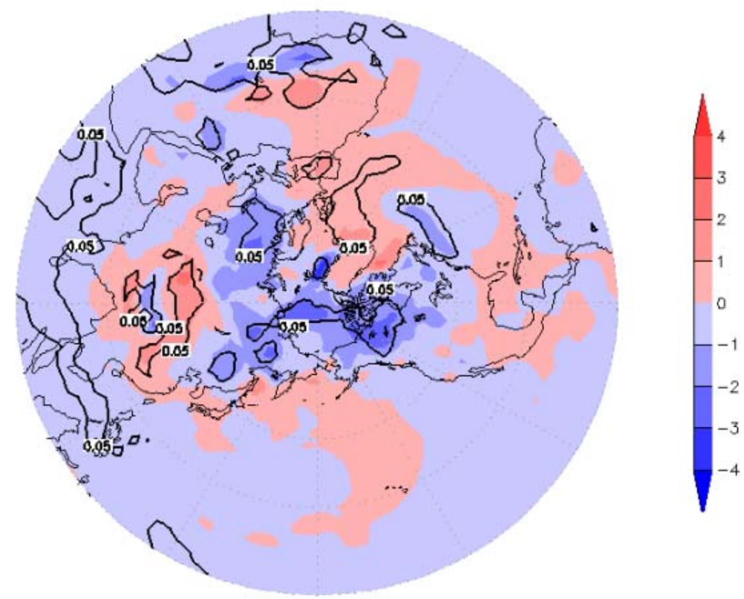
Low

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Spring: surface air temperature



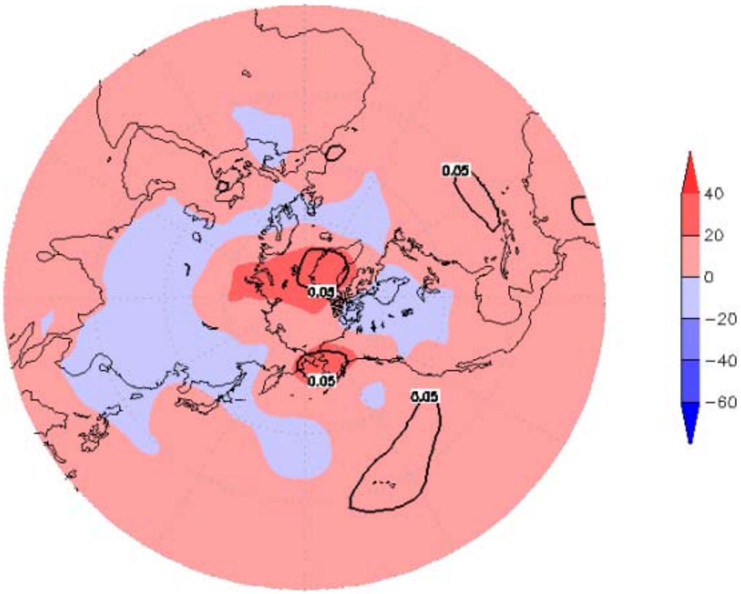
High



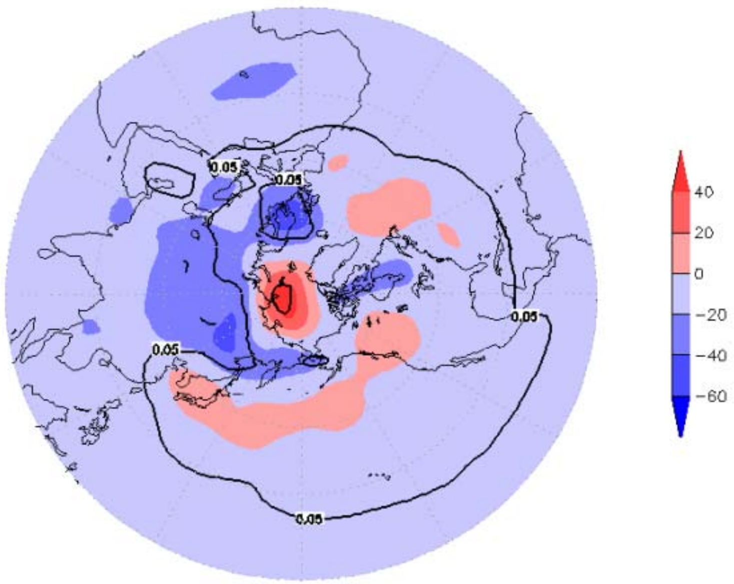
Low

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Summer: 500hPa height



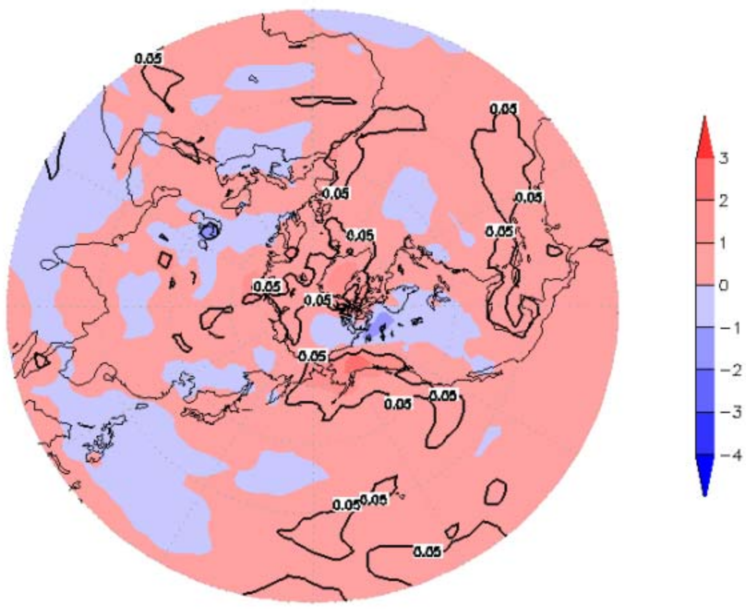
High



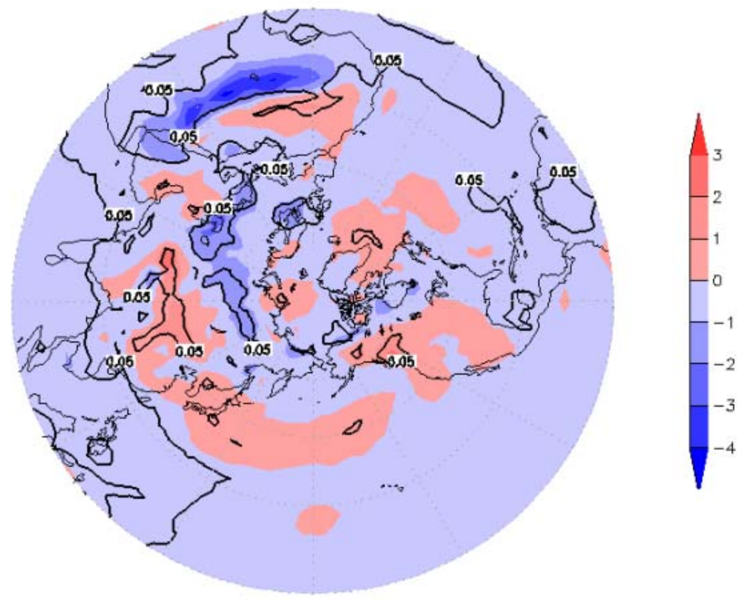
Low

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Summer: surface air temperature



High



Low

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

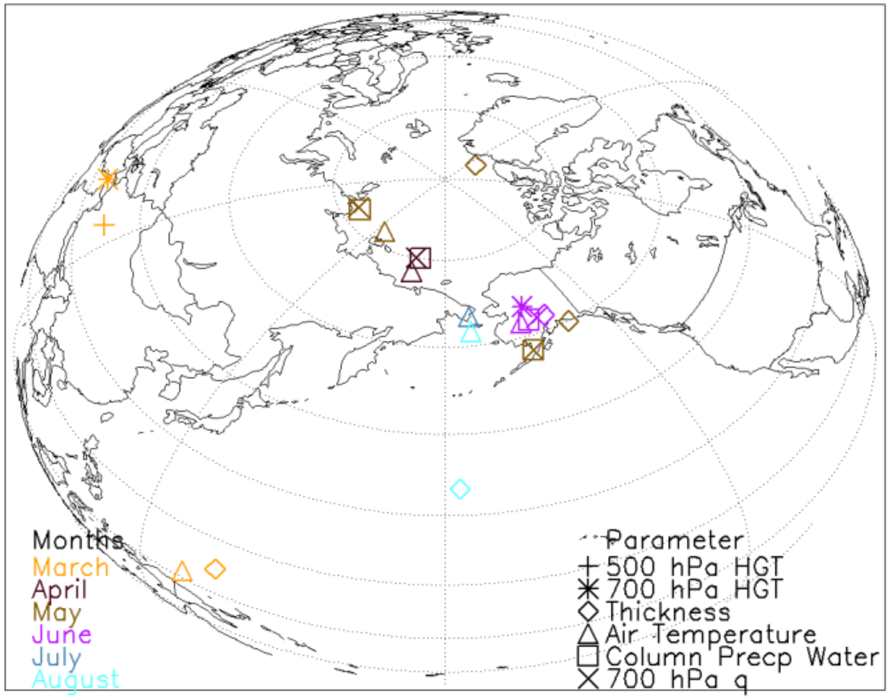
Procedure:

- Point correlations of each of the climate variables with area burned for each month March through August
- Determine areas of high correlation and extract data for a representative point
- Multiple Regression
  - $Y = a_1*x_1 + a_2*x_2 + \ldots + a_n*x_n + b$
  - Backward elimination scheme

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

23 Potential Predictors

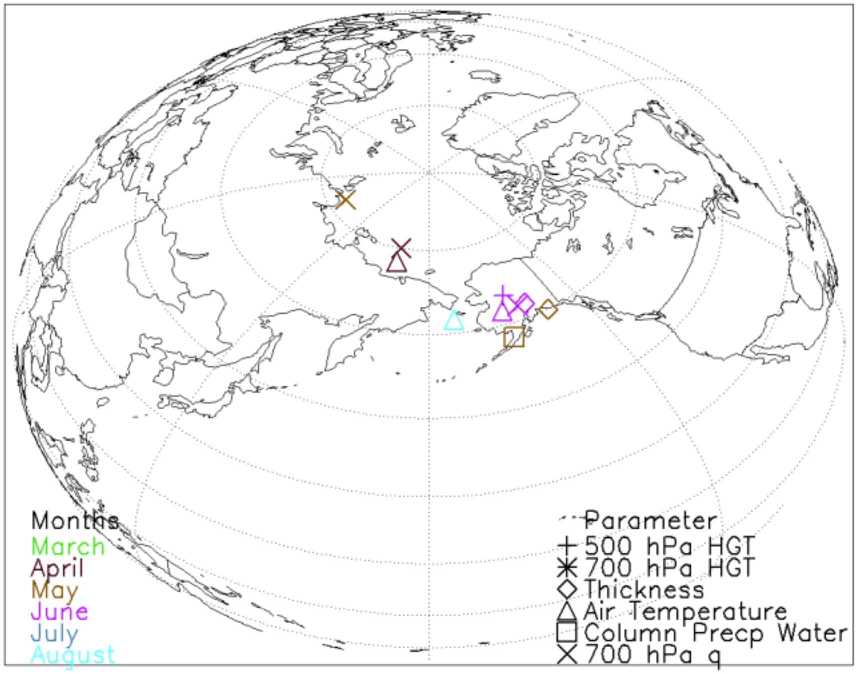
Variable #	Month	Lat	Lon	Variable Type
1	3	37.5	85	500 hPa HGT
2	3	35	72.5	700 hPa HGT
3	3	7.5	147.5	Thickness
4	3	2.5	142.5	Air Temperature
5	4	75	165	700 hPa Q
6	4	72.5	165	Air Temperature
7	4	75	167.5	Total Precp Water
8	5	57.5	202.5	700 hPa Q
9	5	77.5	112.5	700 hPa Q
10	5	77.5	140	Air Temperature
11	5	77.5	115	Total Precp Water
12	5	57.5	202.5	Total Precp Water
13	5	60	215	Thickness
14	5	85	305	Thickness
15	6	65	205	500 hPa HGT
16	6	65	205	700 hPa HGT
17	6	62.5	207.5	700 hPa Q
18	6	62.5	202.5	Air Temperature
19	6	62.5	205	Total Precp Water
20	6	62.5	210	Thickness
21	7	65	187.5	Air Temperature
22	8	62.5	187.5	Air Temperature
23	8	35	182.5	Thickness



Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Spring and Summer multiple regression

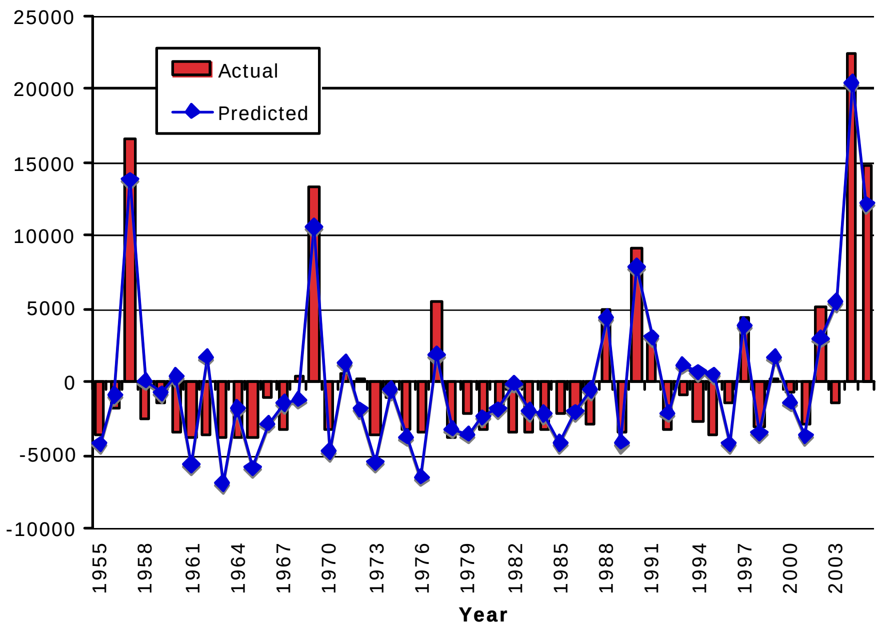
Varnum	Coefficient	Std. Error	t value	p value
intercept	3.17E+07	6.20E+07	0.511	6.12E-01
5	5.98E+06	1.63E+06	3.658	7.34E-04
6	-1.48E+05	6.92E+04	-2.145	3.81E-02
9	2.18E+06	1.02E+06	2.148	3.79E-02
12	5.39E+05	1.43E+05	3.754	5.53E-04
13	-2.40E+04	6.76E+03	-3.549	1.01E-03
16	-1.89E+04	6.97E+03	-2.718	9.66E-03
18	2.76E+05	9.88E+04	2.796	7.92E-03
19	4.91E+05	1.18E+05	4.148	1.70E-04
22	5.23E+05	1.30E+05	4.030	2.43E-04
23	2.21E+04	1.03E+04	2.136	3.89E-02
F stat: 21.02, p value: 6.53E-13				
R: 0.92, R^2: 0.84				



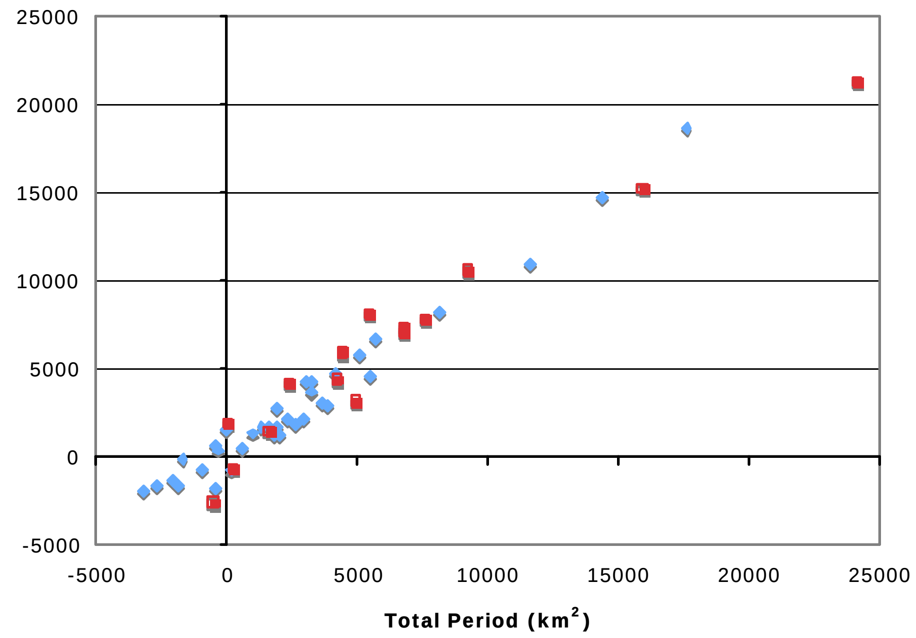
$$Y = 5.98E{+}06 \cdot X_5 - 1.48E{+}05 \cdot X_6 + 2.18E{+}06 \cdot X_9 + 5.39E{+}05 \cdot X_{12} - 2.4E{+}04 \cdot X_{13} - 1.89E{+}04 \cdot X_{16} + 2.76E{+}05 \cdot X_{18} + 4.91E{+}05 \cdot X_{19} + 5.23E{+}05 \cdot X_{22} + 2.21E{+}04 \cdot X_{23} + 3.17E{+}07$$

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Spring and Summer multiple regression



Regression fitting



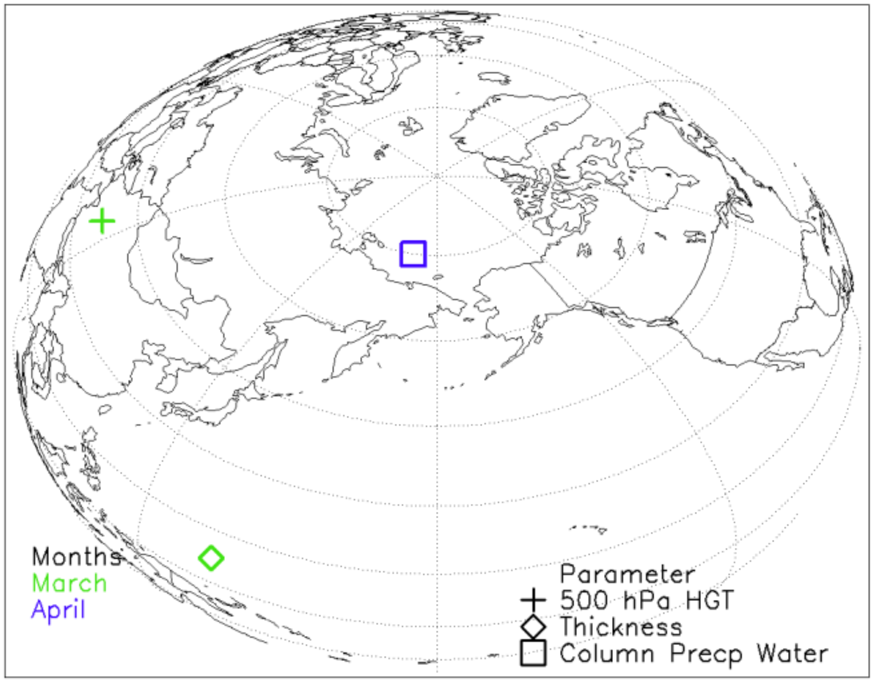
Cross validation

$$Y = 5.98E{+}06 * X_5 - 1.48E{+}05 * X_6 + 2.18E{+}06 * X_9 + 5.39E{+}05 * X_{12} - 2.4E{+}04 * X_{13} - 1.89E{+}04 * X_{16} + 2.76E{+}05 * X_{18} + 4.91E{+}05 * X_{19} + 5.23E{+}05 * X_{22} + 2.21E{+}04 * X_{23} + 3.17E{+}07$$

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

March-April multiple regression

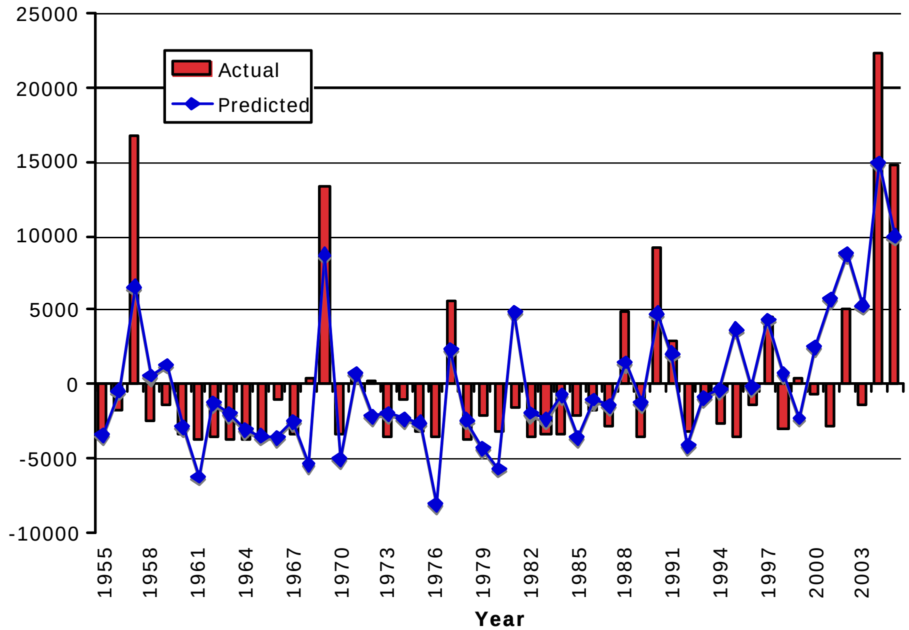
Varnum	Coefficient	Std. Error	t value	p value
Intercept	-4.43E+08	1.03E+08	-4.289	8.87E-05
1	2.04E+04	6.41E+03	3.179	2.61E-03
3	5.65E+04	1.90E+04	2.970	4.67E-03
7	7.99E+05	1.79E+05	4.464	5.01E-05
F stat: 24.76, p value: 9.31E-10				
R: 0.78, R^2: 0.61				



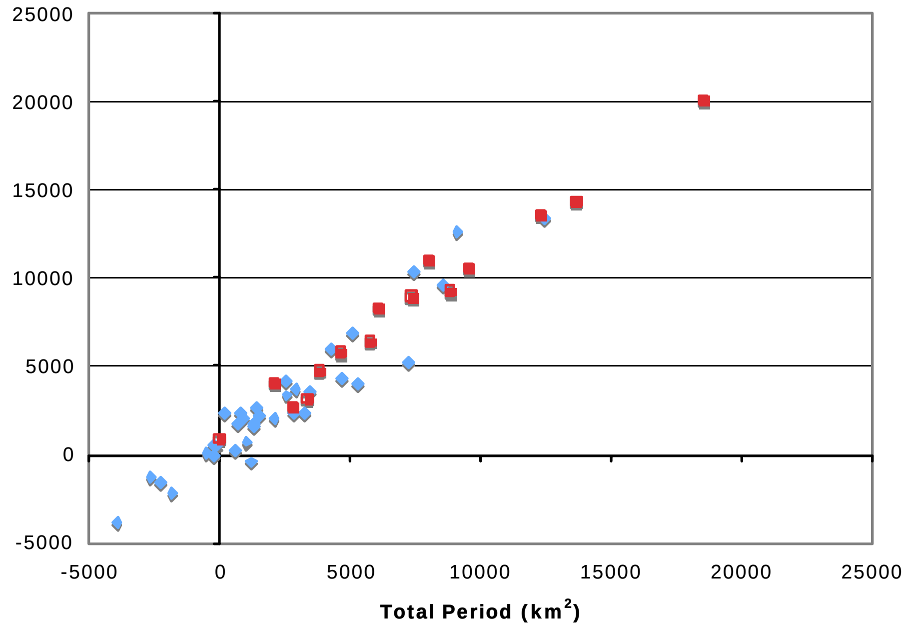
$$Y = 2.04E+04*X_1 + 5.65E+04*X_3 + 7.99E+05*X_7 - 4.43E+08$$

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

March-April multiple regression



Regression fitting



Cross validation

$$Y = 2.04E+04*X_1 + 5.65E+04*X_3 + 7.99E+05*X_7 - 4.43E+08$$

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Conclusions

- Separate anomalies for extreme high and low cases.
- Monthly average climate variables can be used to predict and diagnose area burned
- Climate variables in the preseason can be used alone to predict the upcoming fire season
- Season area burned in Alaska has a strong relationship with the monthly and seasonal climate of both the spring and summer

Copyright 2007, Nancy Sohler, nl9s@columbia.edu

Thank you!

Questions?

- Funding:
  - State of Alaska, Alaska Climate Research Center

Image: Alaska Fire Service

Copyright 2007, Nancy Sohler, nl9s@columbia.edu