The Role of Land-Cover Change in High Latitude Ecosystems: Implications for the Global Carbon Cycle

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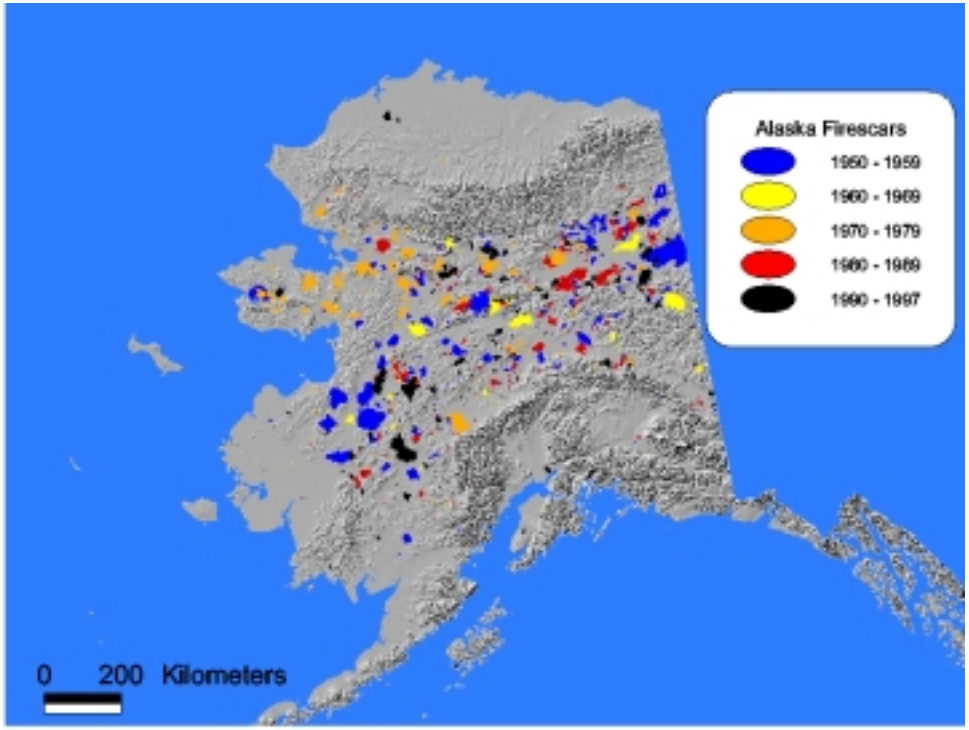
Introduction

Question - ***How will changes in atmospheric carbon dioxide, climate, and land-cover change in Alaska influence state-wide carbon storage?***

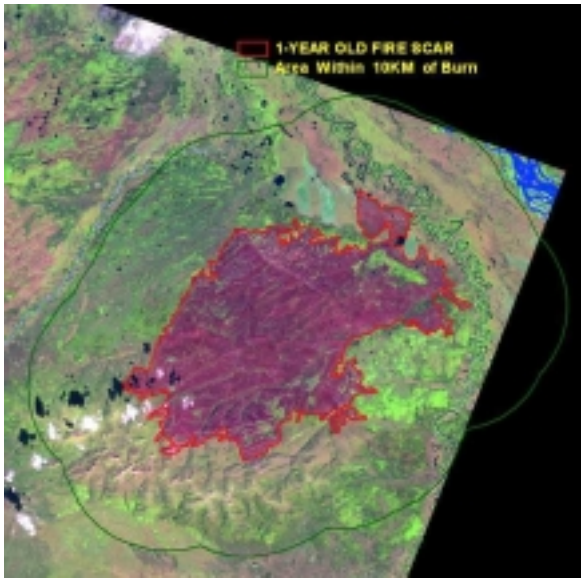
Goal - ***Develop a prototype spatially explicit modeling framework to elucidate how land-cover change in high latitude ecosystems influences carbon storage***

Strategy -

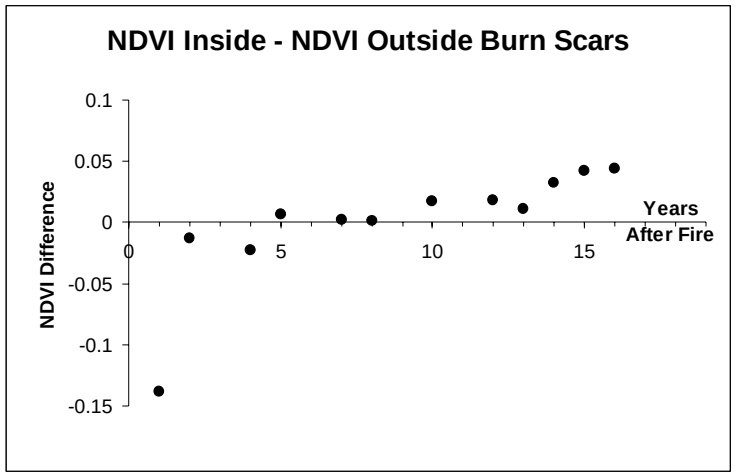
- ***Analysis of historical transient land cover***
- ***Develop components of modeling framework***
- ***Apply modeling framework***



Results - Analysis of Historical Transient Land Cover



- ***Boreal vegetation influences fire***
  (meso-scale climate, ignition probability, fire spread)
- ***Fire influences boreal vegetation***

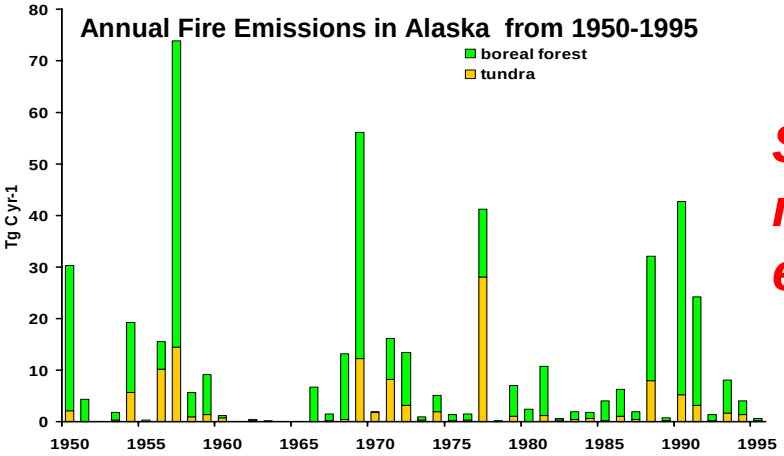


- ***Fast NDVI recovery following fire (5-10 years)***
- ***Post-fire NDVI even higher (>10 years)***

Future Steps:

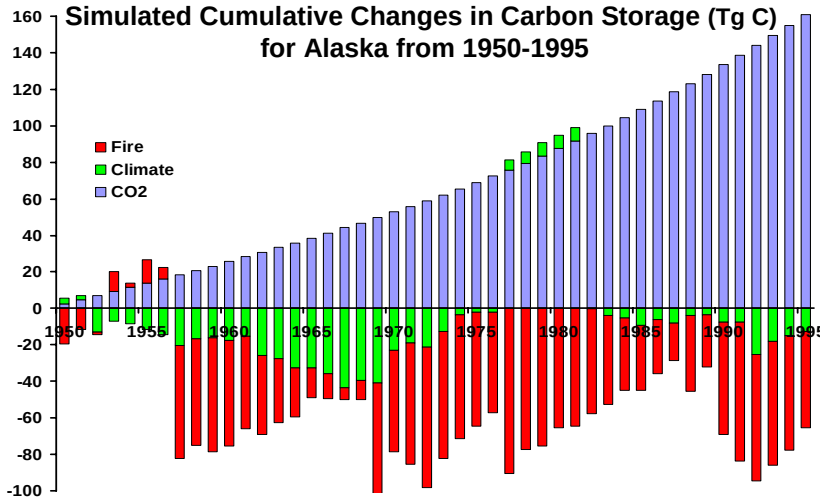
1) Determine the influence of vegetation on fire spread
2) Determine the influence of recent burns on meso-scale climate parameters

Results - Modeling for the Alaskan Domain



Simulations indicate that tundra fires may be responsible for substantial emissions in some years.

The results suggest that increasing atmospheric CO_2, climatic variation, and fire disturbance play substantial roles in the historical C dynamics of Alaska.



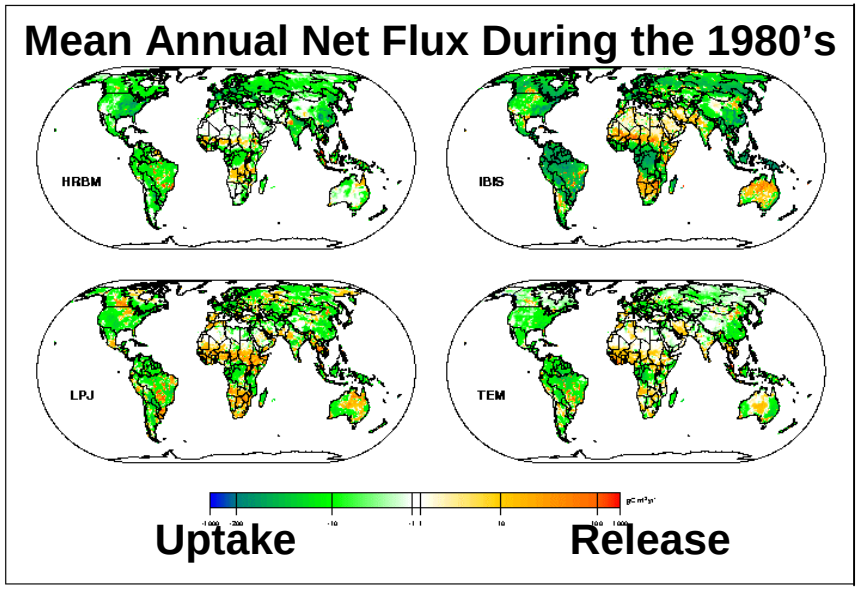
Future Steps

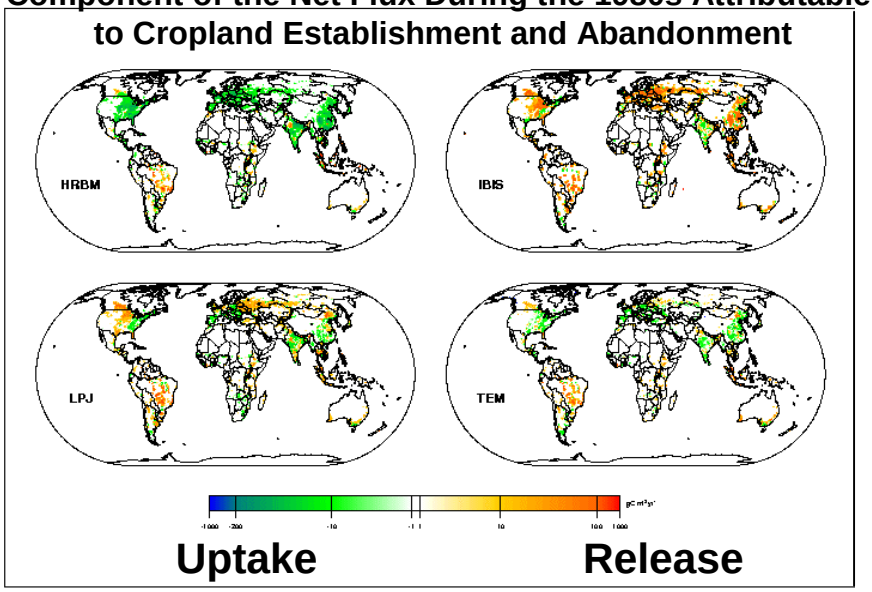
Evaluate Uncertainties:

(1) Sensitivity of C dynamics to assumptions about fire severity and historical fire frequency.

(2) Expand spatial scope of simulation to include Canada and compare with estimates of C dynamics from a time-dependent synthesis inversion.

Results - Modeling at the Global Scale





Results support the idea that the effects of tropical deforestation in the 1980s have been slightly more than counter-balanced by uptake, in part because of effects of rapidly rising CO_2, and in part because of uptake in the northern extra-tropics associated with the legacy of cropland abandonment during the last century.

Future steps

Development and improvements in the data sets on land-cover change to drive the modeling framework. These data sets need to incorporate the timing, extent, and types of major disturbances.

Conclusions

We have demonstrated that we can use the modeling framework to produce geographically and temporally explicit estimates of carbon exchange with the atmosphere given geographically and temporally explicit data sets on land-cover change. A key to reducing uncertainties in these estimates is the improvement of existing data sets and the development of new data sets on land cover-change that include the timing, extent, and types of major disturbances.

Publications

McGuire et al. (Submitted) Carbon balance of the terrestrial biosphere in the twentieth century: Analyses of CO_2, climate, and land-use effects with four process-based ecosystem models. Journal of Biogeochemical Cycling.

McGuire et al. (In preparation) The role of fire disturbance, climate, and atmospheric carbon dioxide in the response of historical carbon dynamics in Alaska from 1950 to 1997: A process-based analysis with the Terrestrial Ecosystem Model.

Boles, S. H. and D. L. Verbyla. 2000. Comparison of three AVHRR-based fire detection algorithms for interior Alaska. Remote Sensing of Environment. 72:1-16.

Verbyla, D. L. and S. H. Boles. (Submitted) Bias in land cover change estimates due to misregistration. International Journal of Remote Sensing.