The Role of Land-Cover Change in High Latitude Ecosystems: Implications for Carbon Budgets in Northern North America

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- **Questions:**

  (1) Are Lakes and Wetlands Drying Up in Alaska?

  (2) What are the Consequences of Land Cover Change in Alaska and Canada for Carbon Storage in the Region?

- **Goals:**

  (1) To evaluate the extent to which lakes and wetlands are drying up in the Alaska region.

  (2) To elucidate the mechanisms responsible for changes in carbon storage of the Alaska-Canada region during the 20th Centruy.

- **Approaches:**

  (1) Conduct change detection analyses for 10 focus areas in Alaska by calculating lake areas in aerial photos and Landsat imagery available from approximately 1950 to present.

  (2) Use spatially and temporally explicit data on land cover change in the Alaska-Canada region to drive the Terrestrial Ecosystem Model (TEM) framework and compare results in the context of inversions of carbon exchange between the atmosphere and the land surface in the region.

Results

Are Lakes and Wetlands Drying Up in Alaska?

- In general, the area of open water of closed drainage in Alaska seems to be declining over the last several decades, with losses up to 33% in some wetland complexes.
- Analyses are being conducted to evaluate the “thermal” vs. “water balance” hypotheses of water loss.
- How inter-annual variability influences our results is a major concern, and needs further evaluation.

What are the Consequences of Land Cover Change in Alaska and Canada for Carbon Storage in the Region?

- Both increases in CO_2 and fire appear to have large effects on carbon storage, but the magnitude of these effects appear to have approximately balance each other since about 1970 when the fire frequency in Canada doubled.
- Climate, N deposition and O_3 have had smaller effects on carbon storage, with climate and N deposition tending to increase carbon storage, while O_3 tends to decrease carbon storage.
- Simulations conducted to date required the addition of fire to simulate patterns of inter-annual variability that are similar to those estimated by atmospheric inversions.
- A major challenge in integrating multiple data sets of disturbance into the modeling framework include harmonizing the stand-age distributions in the data sets developed for driving the model framework with data from forest inventory analyses on stand-age distributions.

Major Conclusions and Publications

Major Conclusions:

- The area of open water bodies in Alaska has been declining over the last several decades, with losses up to 33% in some wetland complexes.
- Comparisons of simulations with atmospheric inversions suggests that fire drives the inter-annual pattern of carbon exchange with the atmosphere in the Alaska-Canada region.
- Fire disturbance in the Alaska-Canada region is sensitive to climate warming and has doubled in frequency since 1970. It appears that the increased fire frequency may be offsetting carbon sequestration from other factors (increases in atmospheric CO_2, climate warming, and N deposition).

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