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USGS Alaska LandCarbon Assessment

Baseline and Projected Future Carbon Storage and Greenhouse-Gas Fluxes in Ecosystems of Alaska
USGS Professional Paper 1826
Released May 26, 2016

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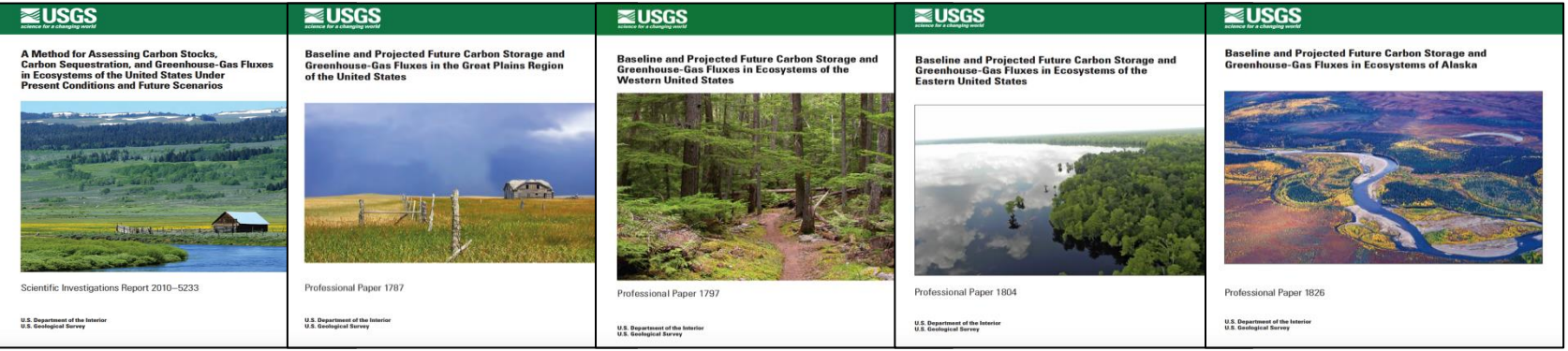
U.S. Department of the Interior
U.S. Geological Survey

National LandCarbon Assessment

- **Mandated by Congress (2007 Energy Independence and Security Act)**
- **In a series: the methodology, Great Plains, Western, Eastern, Alaska, and Hawaii**
- **Most of Alaska is not covered by national inventory, this is the first of its kind to fill a number of knowledge gaps about carbon and GHG emissions**
- **Most of Alaska is managed by DOI – This assessment has been completed by DOI**
- **More carbon stored in AK than the entire lower 48 states combined**

Methodology, 2011 Great Plains 2011 Western U.S. 2012 Eastern U.S. 2014 Alaska 2016



Hawaii, in progress

Science Team

USGS
U.S. Forest Service
University of Alaska Fairbanks
Purdue University

Report topics

Wildfire, climate change, vegetation shifting
Distribution of permafrost carbon
Upland carbon: historic and future
Lowland (wetland) carbon and methane: historical and future
Inland water carbon fluxes
Southeast Alaska carbon fluxes
Southeast Alaska forest management

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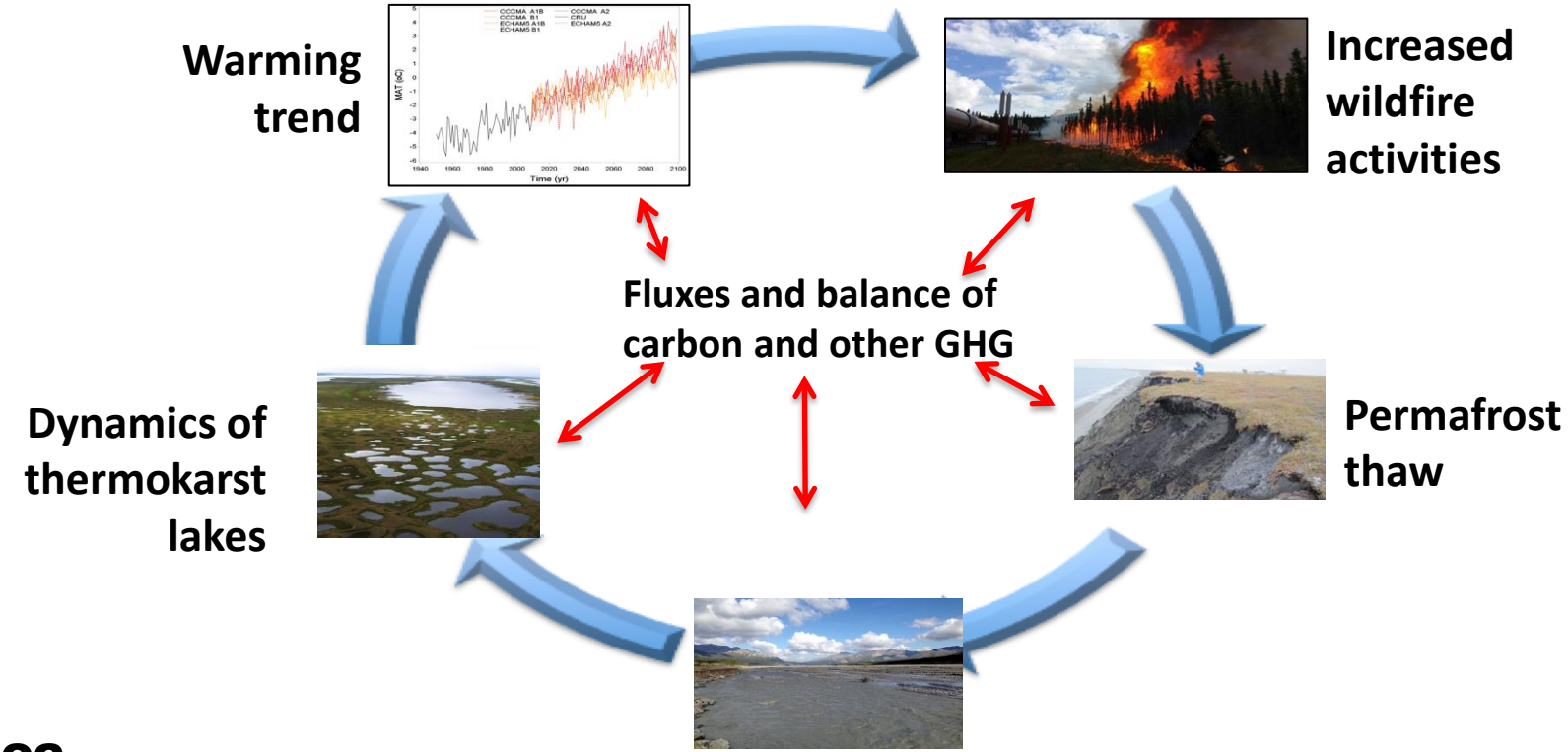
What factors drive Alaska carbon exchanges?



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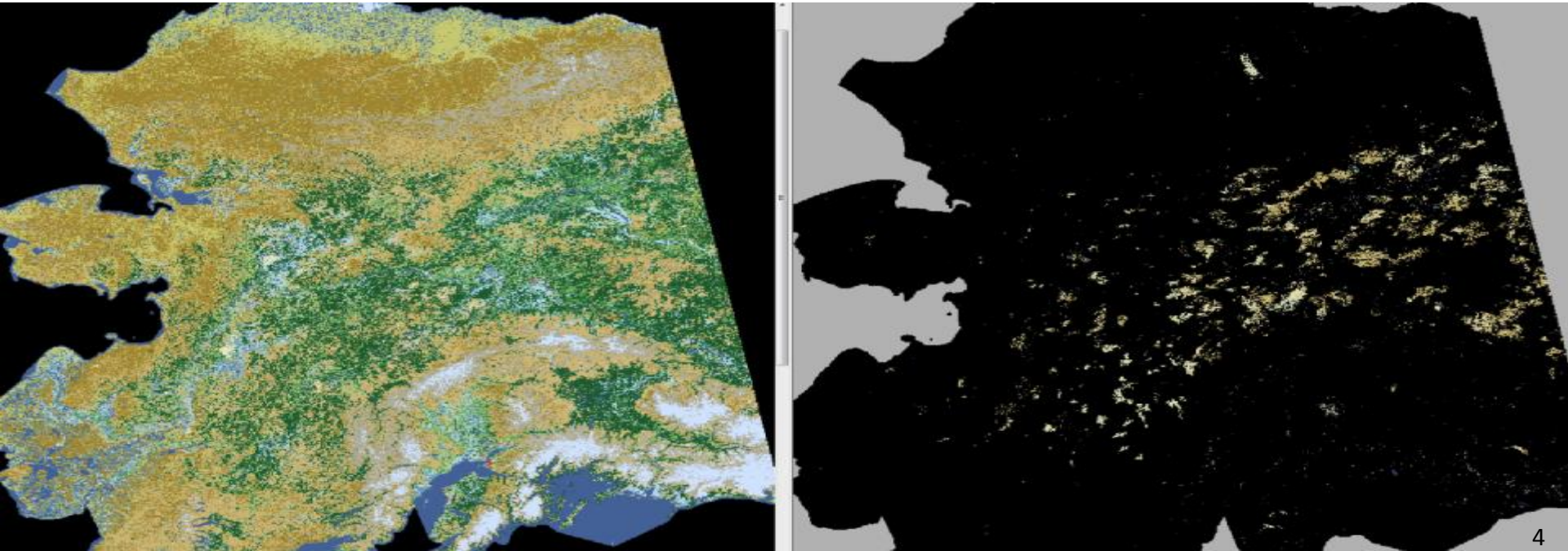
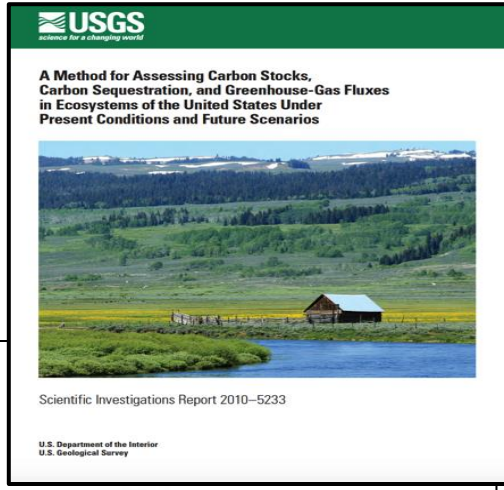
Wildfire activities in the boreal region are responsible for vegetation distribution and carbon balance.

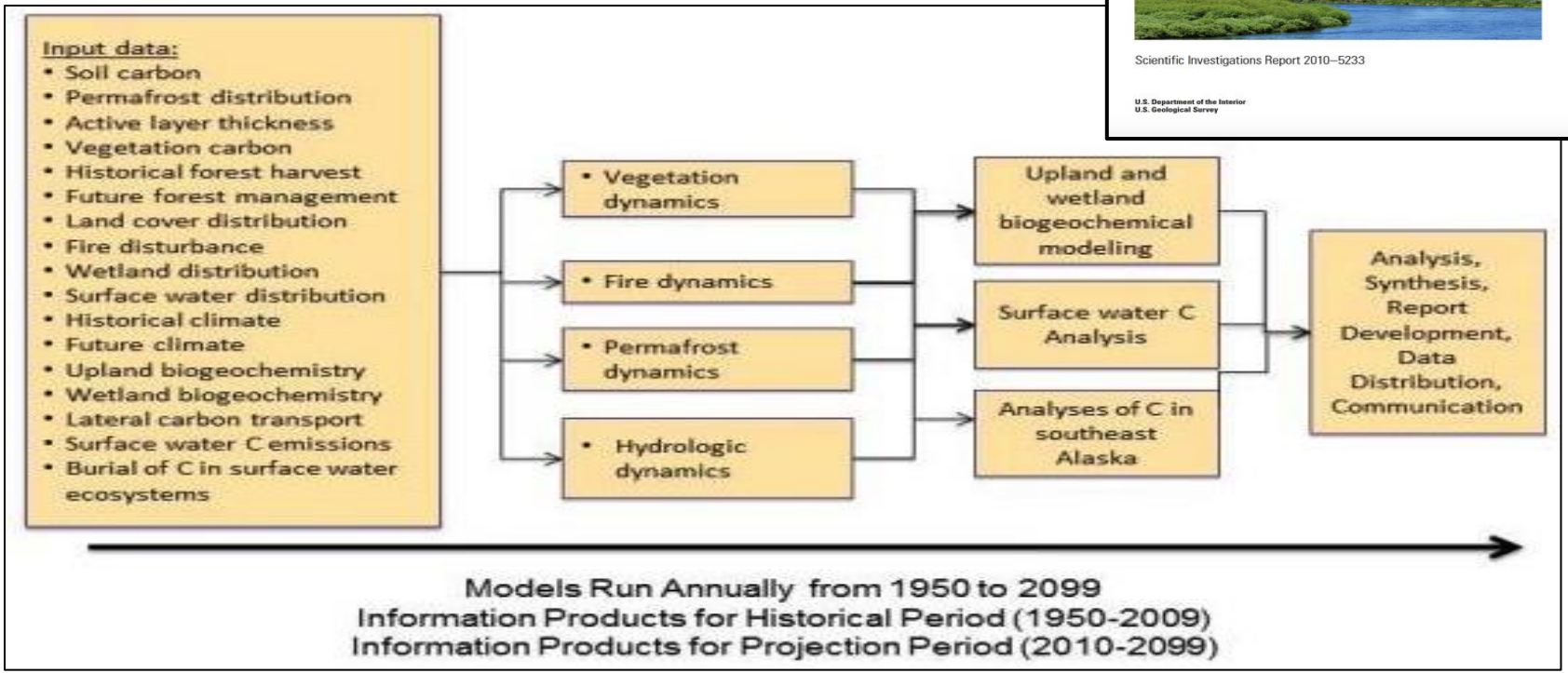
2011 National Land Cover Database (NLCD) land cover (left) and wildfire, 2001-2011 (right)



Methodology used for the assessment

(Modified from CONUS methodology)





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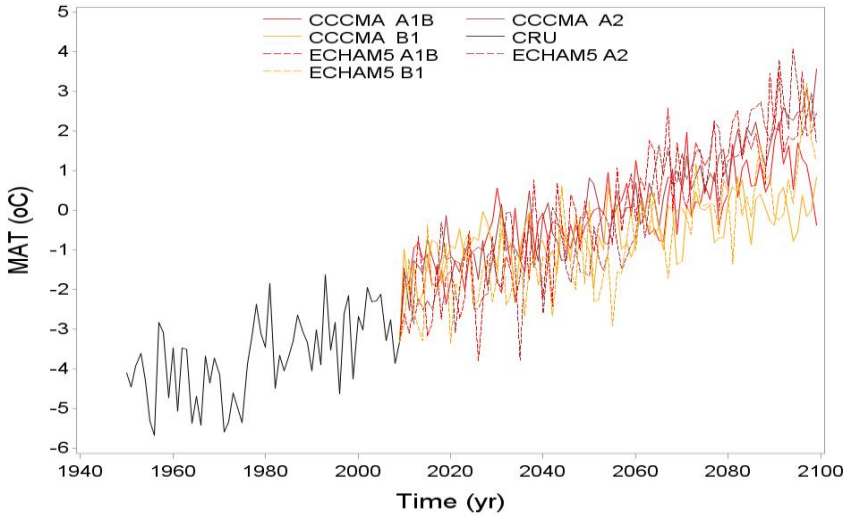
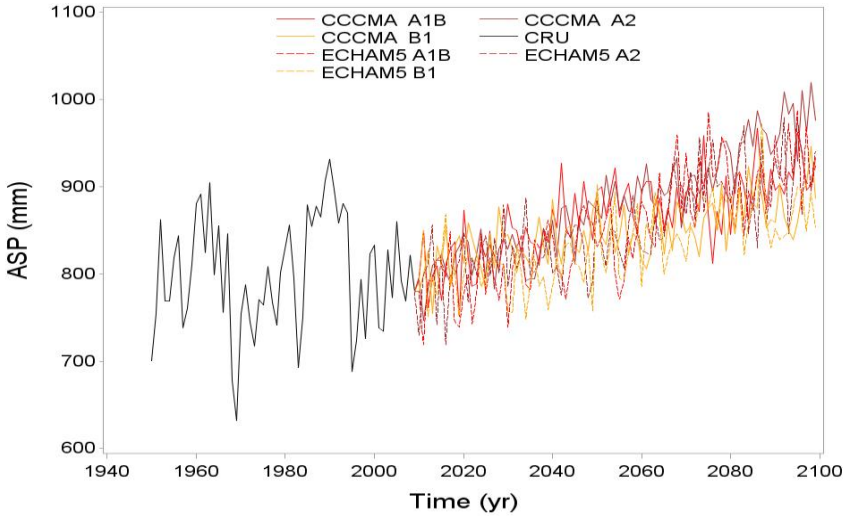
Climate data used in the assessment





Mean Annual Temperature (MAT) and Annual Sum of Precipitation (ASP) from 1950 to 2100 summarized for the simulation extent.
Black line represents the CRU data for the historical period. Colored lines represent the CCCMA (solid) and ECHAM5 (dotted) projections for the 3 emission scenarios.

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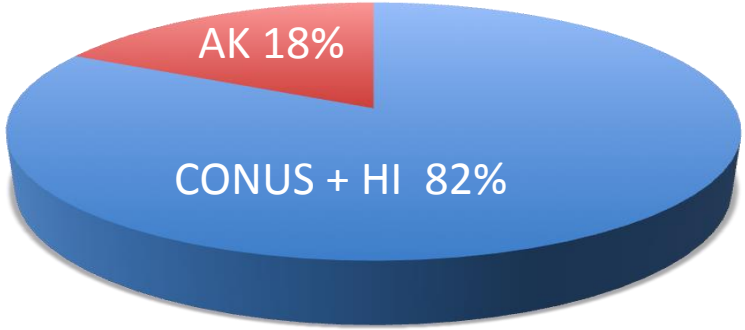
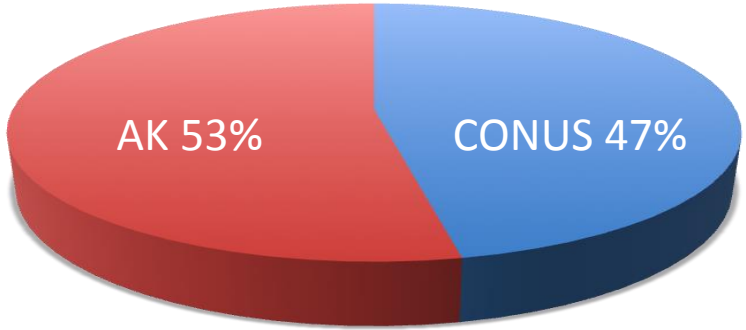
How much carbon is stored in Alaska?

U.S. total area



Total U.S. carbon stock[1]

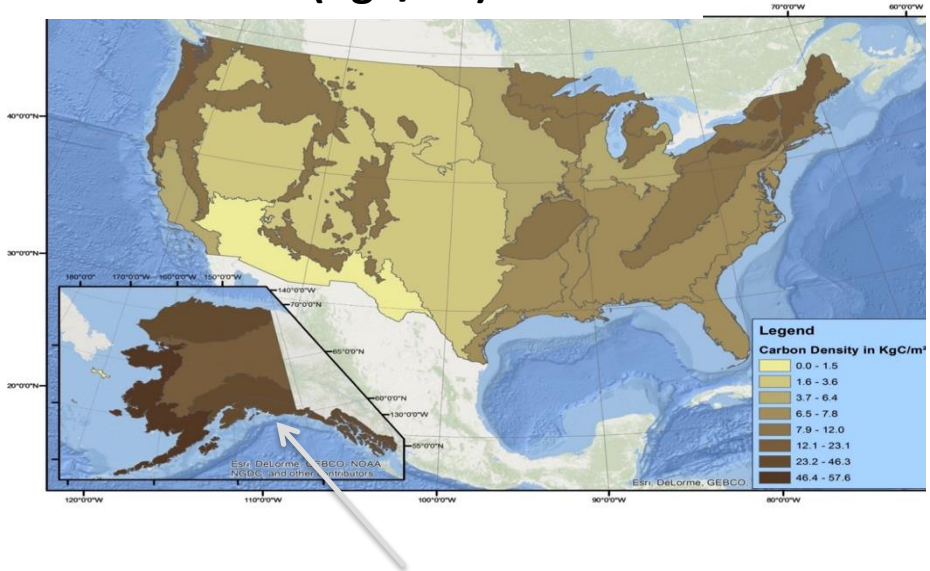


[1]USGS LandCarbon assessment

Is Alaska a carbon sink or source?

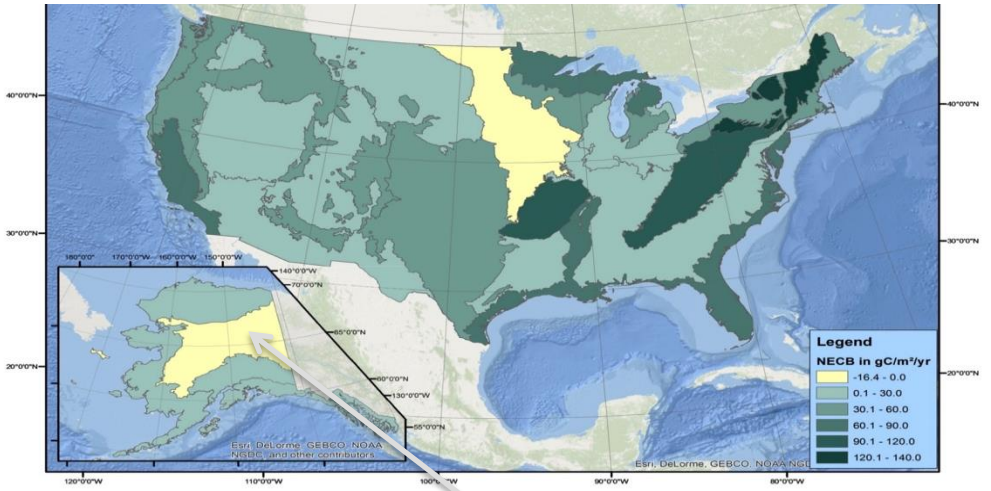
A. a weak carbon sink

Carbon stock (KgC/m^2)



AK has more carbon stored per unit-area than CONUS

Net ecosystem carbon balance (gC/m^2/yr)



But the state as a whole is a weak carbon sink (~ 3.7 TgC/yr). The boreal region is a carbon source by 7.9 TgC/yr (inset).

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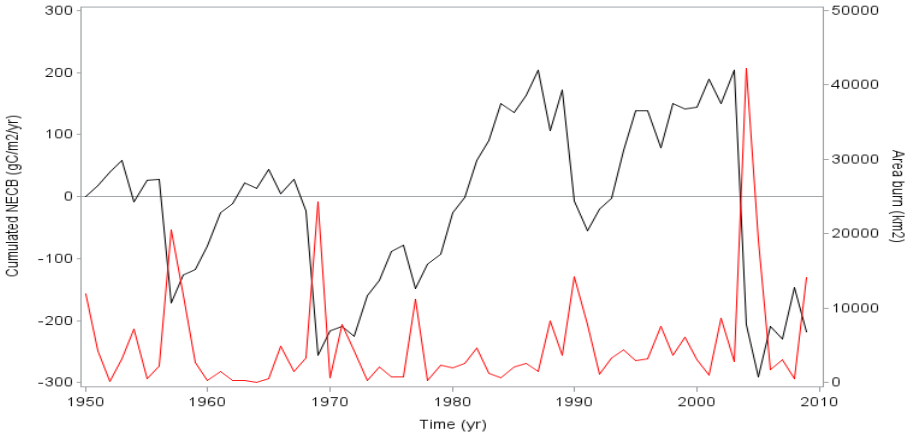
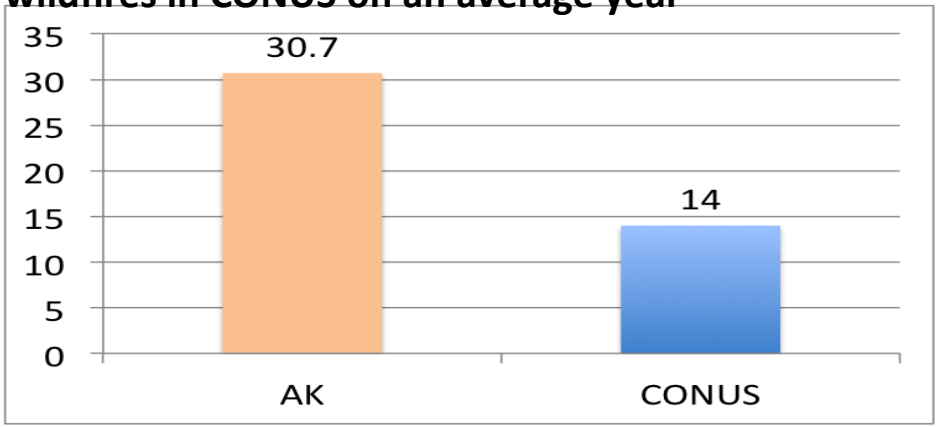
What is the role of fire in carbon flux and greenhouse gas (GHG) emissions in Alaska?

Relationship between cumulative NECB[1] (black line) and area of fire annually(red line)



Alaska wildfires emitted more GHG than wildfires in CONUS on an average year



[1]NECB = net ecosystem carbon balance
CONUS = continental US, lower 48 states

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The fate of permafrost in AK was part of the study.

Main findings:

38% of the state is underlain by permafrost

16-24% of AK permafrost could disappear by 2100

Pastick, et al, 2015, Distribution of near-surface permafrost in Alaska: Estimates of present and future conditions: Remote Sensing of Environment, v. 168, p. 301-315

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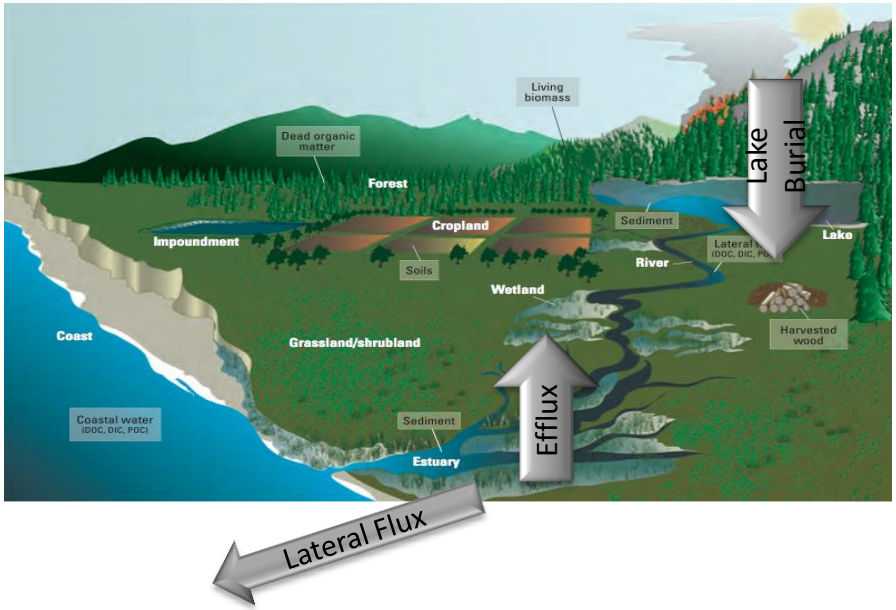
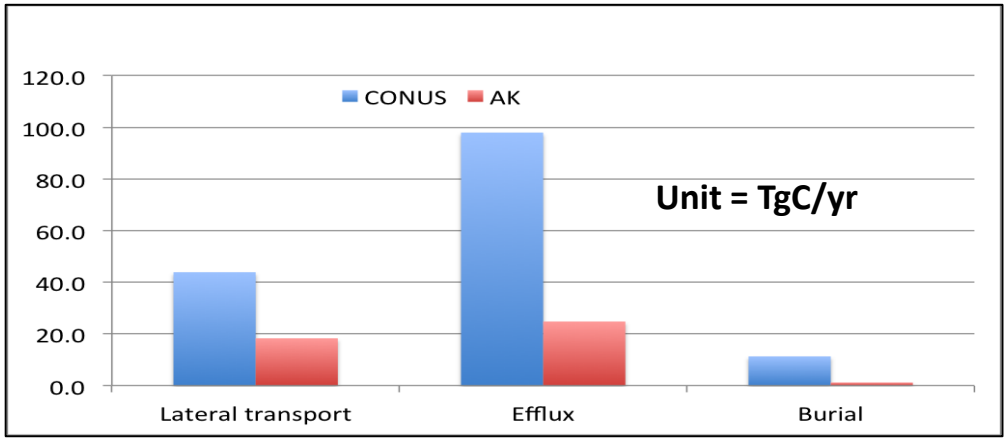
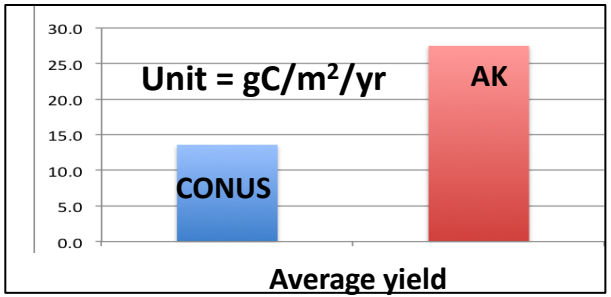
The aquatic environment of AK is very active in transitioning carbon.





Per unit area, AK waters transition more carbon than CONUS.



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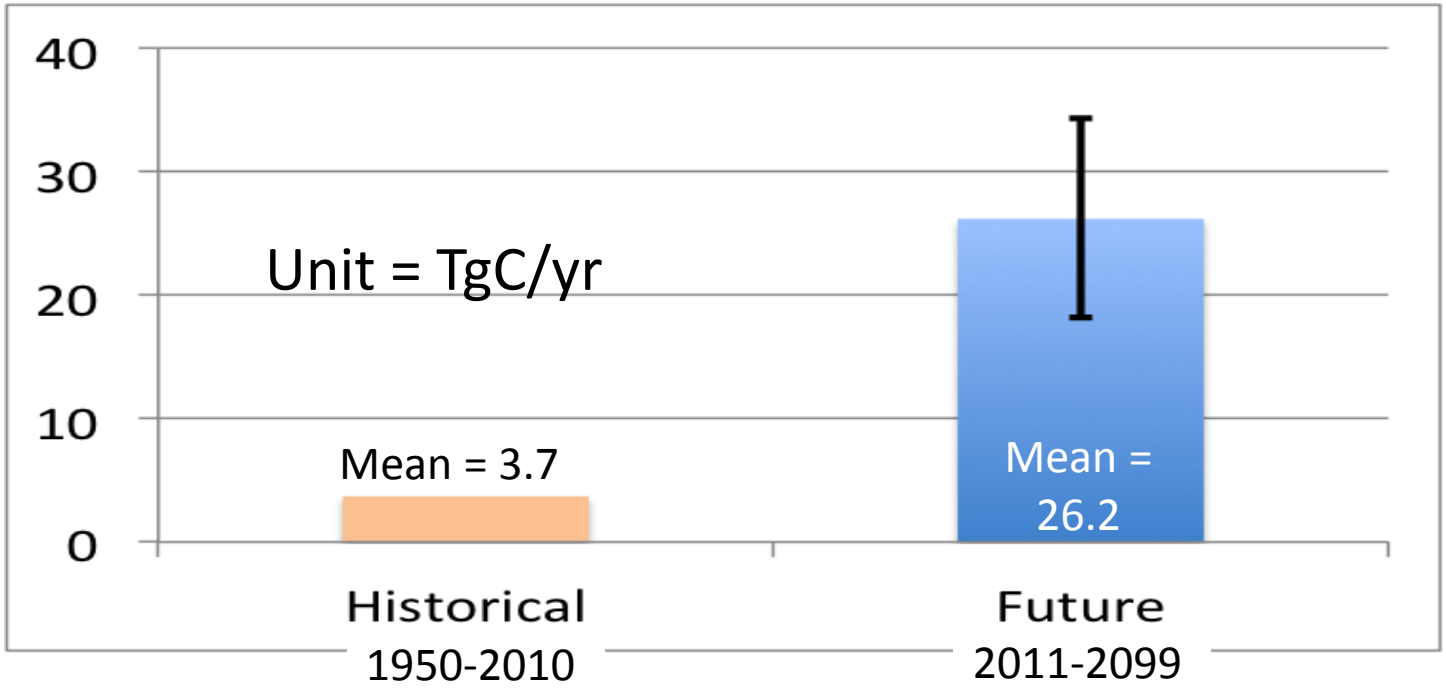
What may be the fate of carbon in future?

Alaska ecosystems may be a stronger carbon sink in future years despite possible increased wildfire. This is due to enhanced plant growth from longer growing season and CO^2 fertilization.



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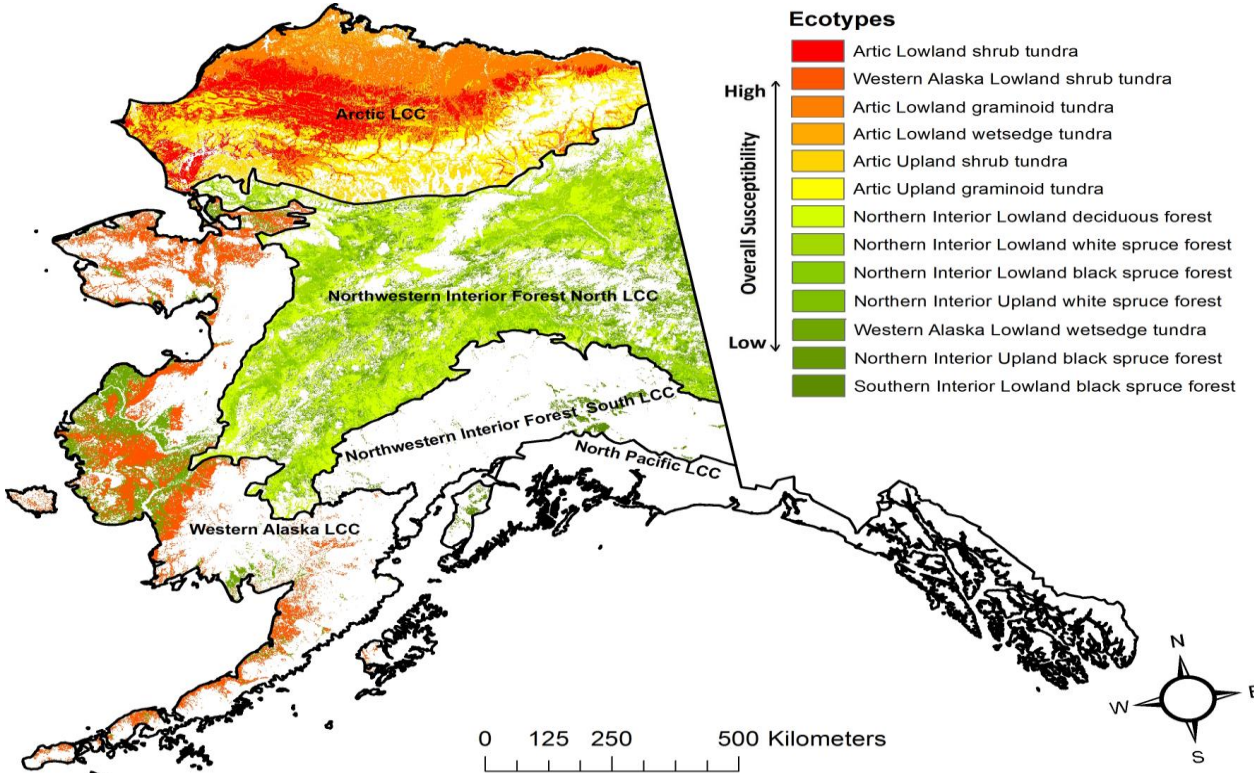
The assessment produced many publically-available GIS map products; this soil vulnerability map is an example.

Soil vulnerability –
a function of soil and permafrost properties that are susceptible to climate change

Overall soil susceptibility (respiration to the atmosphere, burning, and near-surface permafrost thaw) of major ecotypes in Alaska. White areas indicate ecotypes with marginal or no susceptibility.



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What are some sources of uncertainty in the results?

The major sources of uncertainty in this assessment are carefully detailed in the report. See Executive Summary for further information.

<u>Chief sources of uncertainty</u>

- **A study of carbon balance in Alaska may have higher uncertainty due to the fact that the input data are much more limited than the rest of the U. S.**
- **Similar to weather forecasting, projecting a set of biological conditions (such as carbon balance) into the future is based on hypothetical scenarios that are necessarily uncertain.**
- **Similar to our assessment across the 48 states, we were able to assess carbon fluxes in terrestrial systems (e.g. forests, wetlands, grasslands) as well as in aquatic systems (e.g. rivers and lakes) in separate analyses. However, the linkage of carbon exchange between terrestrial and aquatic systems has not been well established.**

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What is the significance of this assessment?

- **This assessment is the first of its kind for the state of Alaska as a whole. It fills a number of knowledge gaps concerning carbon exchanges (such as the effects of wildfire and permafrost thaw, the historical and future carbon balance).**

- **The results of the assessment are substantive inputs into the U.S. Global Change Research Program (USGCRP) 2nd State of Carbon Cycle Report (in progress).**

- **The new knowledge from this assessment provides important insight into carbon management strategies that might be implemented as part of national policies aimed at controlling the rate and overall magnitude of climate change.**

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What's next in AK by USGS LandCarbon?

- **Two major studies in collaboration with NASA:**

    1. **The fate of permafrost carbon in terrestrial and aquatic environments (led by Rob Striegl of USGS)**

    2. **The dynamics of thermokarst lakes in shaping carbon and methane emissions, as well as implications to subsistence of Alaskan natives (Helene Genet of University of Alaska Fairbanks)**

- **Sustained support for permafrost studies using combination of remote sensing and in-situ measurements**

- **Potential collaboration with EPA to improve AK boreal and arctic ecosystems in national GHG inventory reporting**

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