Alaska Integrated Ecosystem Model

Project Description

Alaska land managers are increasingly asked to consider the effects of climate change as an element in the planning process, and in environmental impact analyses. Yet, there are few tools available with which to visualize future landscapes. The Alaska Integrated Ecosystem Modeling (AIEM) Project is a multi-institutional and multi-disciplinary enterprise designed to meet Alaska land managers' needs to understand the nature and rate of landscape change. We know that the physical and biotic components of the arctic and boreal ecosystems—permafrost, hydrology, disturbance (e.g., fire) and vegetation—are tightly linked and sensitive to climate change. The goal of the AIEM is to develop a dynamically linked model framework that incorporates climate-driven changes to vegetation, disturbance, hydrology, and permafrost, and their interactions and feedbacks.

The Big Picture

The physical and biotic components of arctic and boreal ecosystems – permafrost, hydrology, disturbance and vegetation are linked and sensitive to climate change. Managers need tools to visualize future landscapes that may result from the interaction of ecosystem components and physical processes. The AIEM will provide a decision support tool for forecasting ecosystem change and informing natural resource management.

Pilot Phase

The project's pilot phase (2010-2011) produced a conceptual framework for linking three models of ecosystem processes in Alaska – ALFRESCO, TEM, GIPL – and the primary processes of succession, fire, hydrology, and permafrost that they simulate (Fig. 1). A proof-of-concept model run was completed, in which the ALFRESCO model provided information about fire occurrence and severity to TEM, and TEM provided information on surface vegetation and organic layer properties to the GIPL, which was incorporated into a projection of permafrost and soil conditions. The Alaska Yukon River Basin (AYRB) was used as the test study area. Preliminary results of the pilot study suggest that the distribution of permafrost may decline from over two-thirds of the AYRB to 20%-30% (Fig. 2). In addition, fire activity in the study area is projected to remain high until mid-century, after which it will decline because of a shift toward less flammable deciduous forest.

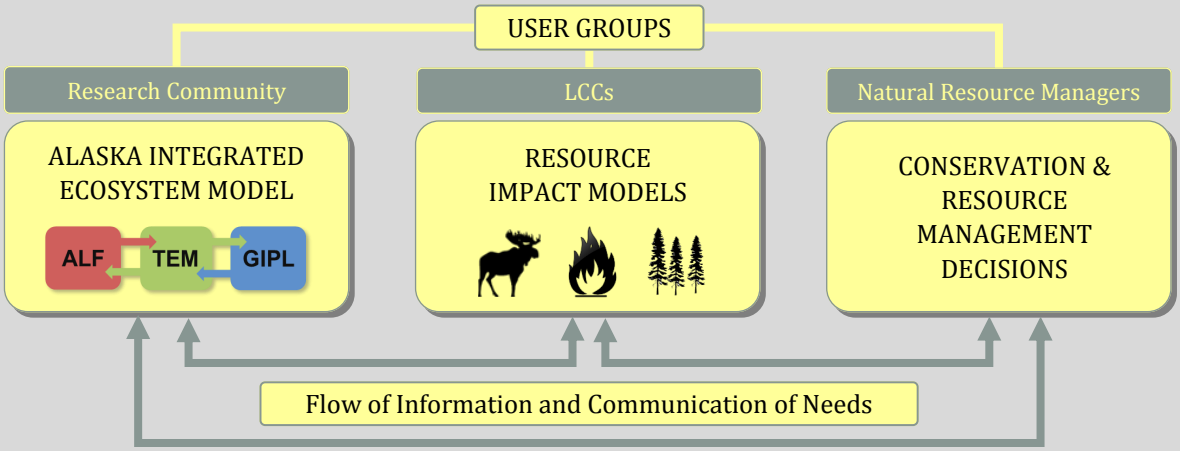

Figure 1. The Alaska Integrated Ecosystem Model (AIEM) will directly serve the research community, provide required data streams for resource impact models, and serve as a tool for natural resource managers.

Alaska Climate Science Center

The Alaska Climate Science Center provides scientific information, tools and techniques that managers and other parties interested in land, water, wildlife and cultural resources can use to anticipate, monitor and adapt to climate change.

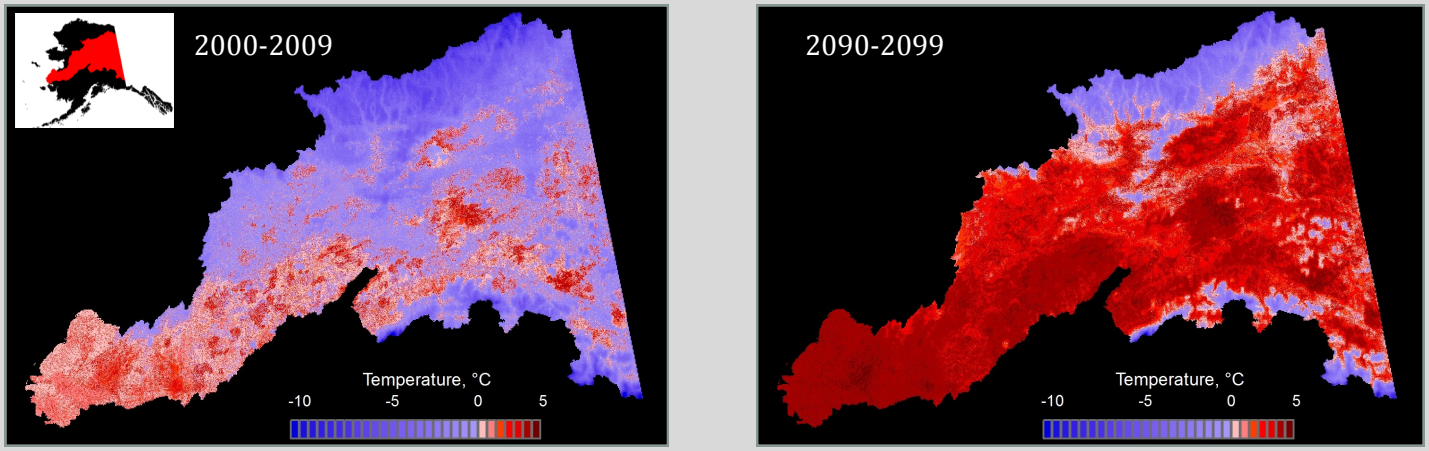

Figure 2. Mean annual ground temperatures at 1 m depth in the Alaska Yukon River Basin for an asynchronous coupled run simulated by the permafrost regime model GIPL. Simulated ground temperatures are driven by historical (2000-2009) and projected climate change scenarios (2090-2099). Blues depict temperatures <0°C and reds depict temperatures >0°C, indicating areas most likely to experience permafrost degradation over the next century.

Project Phase II

In the next phase of this multi-year project (2011-2015), our objectives are to synchronously couple the models, develop datasets for Alaska and adjacent areas of Canada, and phase in additional capabilities necessary to address the effects of climate change (Fig. 3). Working with our Landscape Conservation Cooperative partners, we identified three priority issues that need to be incorporated into the synchronous model: (1) tundra fire and treeline dynamics, (2) landscape-level thermokarst dynamics and (3) wetland dynamics. Ultimately, this tool will provide an integrated framework for natural resource managers and decision makers and produce specific scenarios of changes in landscape structure and function that could be used by resource-specific impact models.

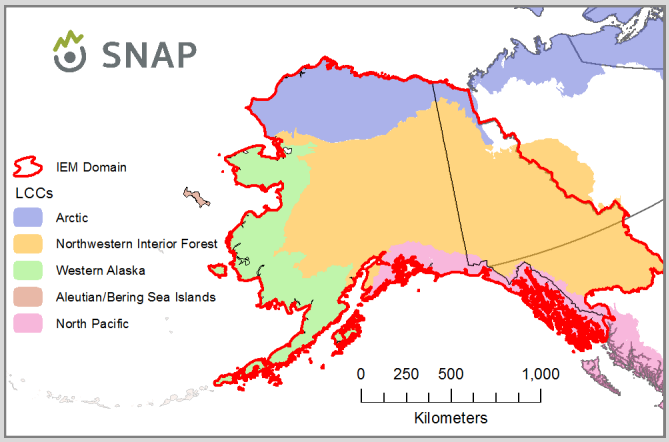

Figure 3. Geographic domain for the AIEM and location of Landscape Conservation Cooperatives (LCCs).

Project Timeline

Pilot Phase — 2010-2011: Develop Conceptual Model, Implement Static Model Coupling

Y1 — 2011: Implement Synchronous Model Coupling

Y2 — 2012: Assess Changes in Landscape Structure & Function

Y3 — 2013: Assess Tundra Fire & Succession Dynamics

Y4 — 2014: Assess Thermokarst Dynamics

Y5 — 2015: Assess Wetland Dynamics

To learn more about the AIEM:

Visit: http://www.snap.uaf.edu/projects.php –or– contact:
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