

VISITOR RESEARCH REPORT

Visitor Name: Dr. Elena Kukavskaya,
VN Sukachev Institute of Forest, Siberian Branch of
Russian Academy of Sciences

Area of Research: Siberian biomass burning emissions estimates

Period of Visit: September 1, 2010 – May 31, 2011

Introduction:

This report describes the scientific research accomplished under the auspices of a Fulbright scholarship, working with Dr. Amber Soja. This report defines research goals and provides a list of detailed accomplishments. However, the accomplishments overlook the foundation of these accomplishments, thus the true achievements. While serving at the National Institute of Aerospace, numerous computer skills and programs were introduced that will serve overarching research in the future, both at the Institute of Forest and with continuing international collaborations [i.e. Geographic Information System (GIS), possibility of programming in GIS]. Additionally, I have had access to numerous satellite products and data sets; I have had the opportunity to work with Moderate Resolution Imaging Spectroradiometer (MODIS) thermal anomaly and area burned products, as well as having had a brief introduction to satellite-based lidar [Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO)]. Moreover, I am currently enrolled in several fire-related groups, and I have met colleagues with whom I will continue to collaborate.

On the Fulbright website, it states the Fulbright is designed to “increase mutual understanding between the people of the United States and the people of other countries.” My last 9 months has been full of both personal and professional gatherings and travel, where numerous relationships that will continue beyond my 9 months have been established. Given the definition of the Fulbright program, this project and time has been a genuine success.

Research Goal:

The main aim of this visit is to develop methods for improved estimates of large-scale carbon emissions due to forest fires in Siberia by using GIS technologies to integrate data from detailed field campaigns and large-scale satellite data, ecosystem and carbon maps.

Strategy:

Fire emission estimates are calculated using the amount of area burned, the amount of fuel an ecosystem contains, the amount of fuel consumed and emissions factors. Errors in any variable can lead to questionable estimates of actual emissions. Based on a literature search, Russian biomass burning emissions estimates vary by an order of magnitude, depending on the data used and methodology. So, improvements in estimates of organic matter combustion patterns, carbon released and total annual emissions in boreal Russia are desperately needed.

Development of rigorous methods for combining forest inventory data on fuel storage and experimental carbon release data with satellite data on fire parameters makes it possible to improve the estimates of fire-related carbon emissions from the boreal forests. To estimate regional- or continental-scale emissions, it is necessary to use remotely sensed fire data. Combining these data with experimental field data will result in improved accuracy in carbon emissions from a variety of fire intensities.

Accomplishments:

A GIS-based carbon database for Russia was generated on the basis of forest inventory data from VA Alexeyev and RA Birdsey (1998).

The existing GIS map of the ecoregions of the Former Soviet Union was corrected (the empty polygons were attributed to the correspondent features with the use of original paper map) and spatially adjusted.

Using an ecosystem map and forest inventory data, the new maps of carbon storage for the Former Soviet Union were made.

The combination of the carbon storage map and organic matter combustion obtained by Russian and North American scientists for the last several decades, as well as our experimental data on carbon emissions from various fire intensities, resulted in the generation of GIS carbon consumption database.

Area burned in Russia (and Siberia separately) from 2002 to 2010 was estimated based on different data sources (MODIS area burned, MODIS active fire detections products and AVHRR data).

Active fire detection data were overlaid on different ecosystem maps (GLC-2000, Globcover-2009, Ecosystem map of the Former Soviet Union) to reveal the fact that ecosystem type burned (that is one of the parameter to estimate fire emissions) varies substantially for the same year from map to map.

Together with GIS analyst, a GIS baseline model that ingests fire and carbon consumption data was created to obtain fire emissions at three levels of severity (low, medium and high).

A global wildfire-based, carbon consumption database was created to verify carbon emissions using published data.

A database was generated from June 2006 through July 2007 for North America that provides the coincidence in the Hazard Mapping Systems (HMS) smoke product and CALIPSO track overpass times and locations for an ongoing fire plume injection height project.

Future Work:

The work on GIS carbon consumption map will be continued to include more detailed fuel layers to the map that would result in obtaining more accurate fire emissions that are of global significance both for Russia and the global community.

To further disseminate scientific results, publication of the project accomplishments and results is planned in both English and Russian journals to acquaint the world scientific society with data, models, and emission estimates obtained during the carrying out the project.

The relationships established with scientists from NASA, University of Louisville, US Forest Service and others organizations engaged in the same field of work will lead to the potential future

collaborations. Currently the work on two joint international projects that include emissions estimates is being conducted.

Pending Publications:

Fire emissions estimates in Siberia. E.A. Kukavskaya, A.J. Soja, A.I. Sukhinin, D. Westberg, G.A. Ivanova, D.J. MacRae, S.G. Conard. International Boreal forest research association: 15th annual scientific conference. Krasnoyarsk, Russia, 2011.

Evidence of Climate-induced Change in the Republic of Tyva. A.J. Soja, E.A. Kukavskaya, L.V. Buryak, O.M. Kalenskaya, N.M. Tchebakova, E.I. Parfenova, V. Kanzai, G.A. Ivanova, A.I. Sukhinin, P. Stockhouse, D. Westberg Ecology 2011.

Post-fire ground fuel biomass changes in light conifer forests of the Lower Angara region, Siberia. G.A. Ivanova, S.G. Conard, E.A. Kukavskaya, D.J. McRae, S.V. Zhila. Environmental Research Letters. 2011.

Seminars Presented:

Two seminars on “Fire Emissions and the Influence of Fire Severity on the Carbon Balance in the Boreal Forest of Siberia” were presented during my visit. The first one was at NASA Langley Research Center, March 2011 (Hampton, VA). The other one was at the University of Louisville, March 2011 (Louisville, KY).

Also, the presentation on the current and past work was given at NASA Langley Research Center in the course of Land-Cover/Land-Use Change program manager visit, April 2011 (Hampton, VA). The reason of my participation in the seminar organized for LCLUC manager, Garik Gutman, is that I have been taken part in three big international projects supported by this program that relate to my current research.

Moreover, the results of the research were presented at two poster presentations during American Geophysical Conference, December 2010 (San-Francisco, CA):

- Climate-induced change in fire regimes in Tyva;
- Carbon Emission from forest fires on Scots pine logging sites in the Angara region of central Siberia.

In addition, my newly gained knowledge was shared during the workshop with a research team that was funded by NASA on “Integrating Historic Patterns of Wildfire, Emissions, and Climate for Siberia as a Basis for Estimating the Impacts of Fire on Carbon Cycling, Quantifying Past Fire/Climate Interactions, and Projecting Future Fire/Climate Change Impacts” project (Belfast, ME).

Pending Presentations:

The results of my research are planned to be presented at the 15th International Boreal Forest Research Association (IBFRA) science conference, August 2011 (Krasnoyarsk, Russia) and at the International conference on fire behavior and risk, October 2011 (Sardinia, Italy).