Modeling Change of Forest Carbon Stores in the St. Petersburg Region, Russia

Project title: Driving Forces of Change in Regional Carbon Stocks: Comparison of the Western Oregon, USA and St. Petersburg Region, Russia

PIs: Olga N. Krankina[1], Mark E. Harmon[1], Ralph Alig[2], Warren B. Cohen[2], Joseph Donnegan[2]

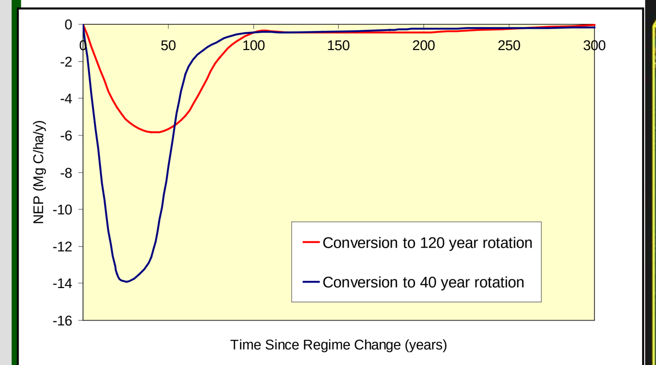
[1]Forest Science Department, Oregon State University, Corvallis, OR 97331, USA; [2]USDA Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331, USA

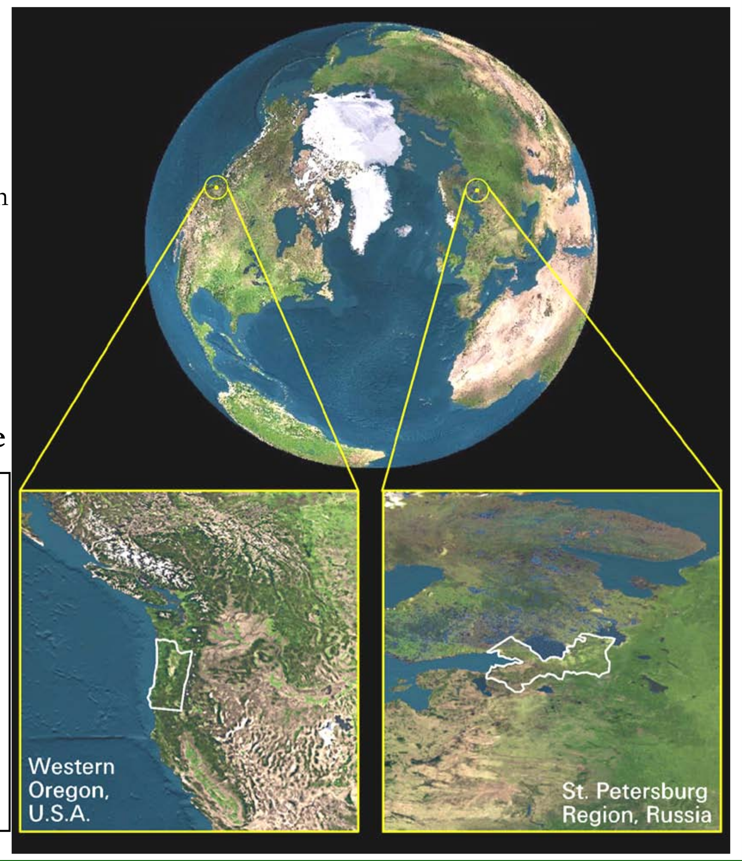
1. INTRODUCTION

In meeting the challenge of understanding driving forces of change in regional carbon stores we initially focus on:

1. Scaling up carbon models from stand to landscape level (PNW)
2. Developing spatial models of change in carbon stores
3. Reconciling model results with the primary source of data for socio-economic models, i.e. forest inventory data.

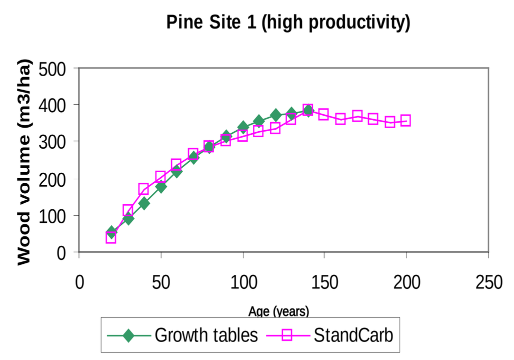
NEP at Landscape Scale Following Change in Disturbance Regime

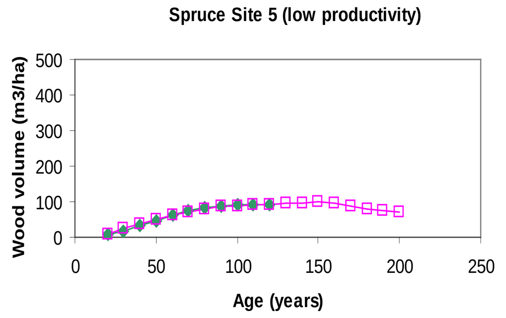


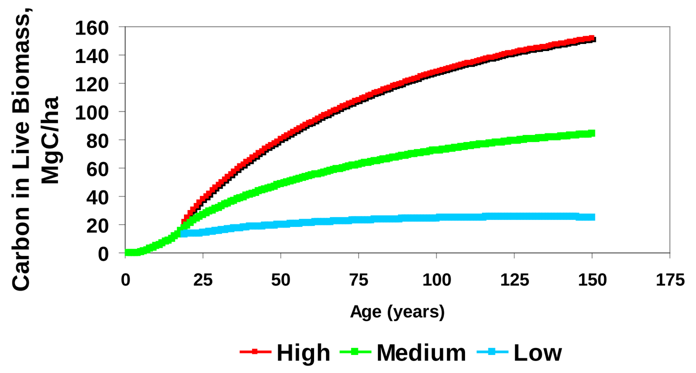


2. PARAMETERIZATION AND TESTING OF STANDCARB

StandCarb was developed for the PNW (Harmon and Domingo 2001). To use it in the St. Petersburg study region we compiled the necessary environmental data and then trained the model to match changes in wood volume with stand age in local growth tables adjusted for actual stand density. The parameterized model represents changes in C stores per ha following clearcut harvest for 5 productivity classes and 4 major tree species in the region: Pine, Spruce, Birch, and Aspen.





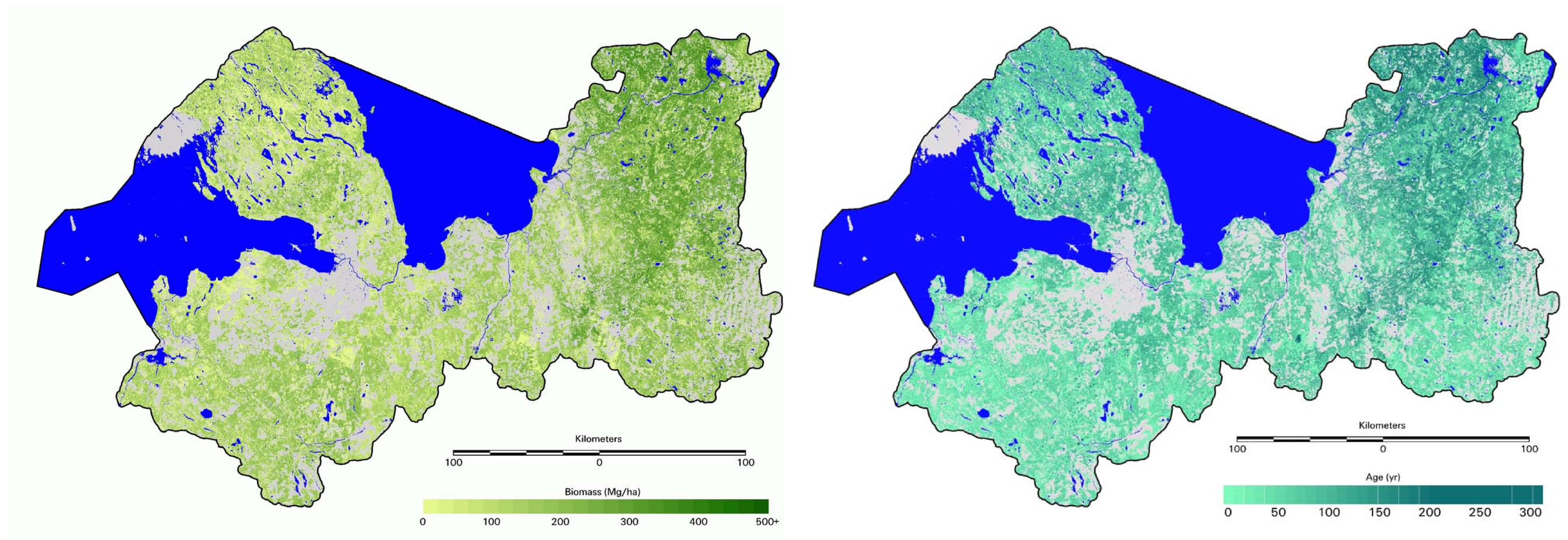


The effect of productivity class on biomass accumulation over time is stronger than the effect of species. We allowed the model to grow mixed forest for 3 productivity levels: high and medium was dominated by spruce and low was dominated by pine. Model outputs include carbon store in live forest biomass (left) and the total ecosystem carbon store including litter, CWD, and soil.

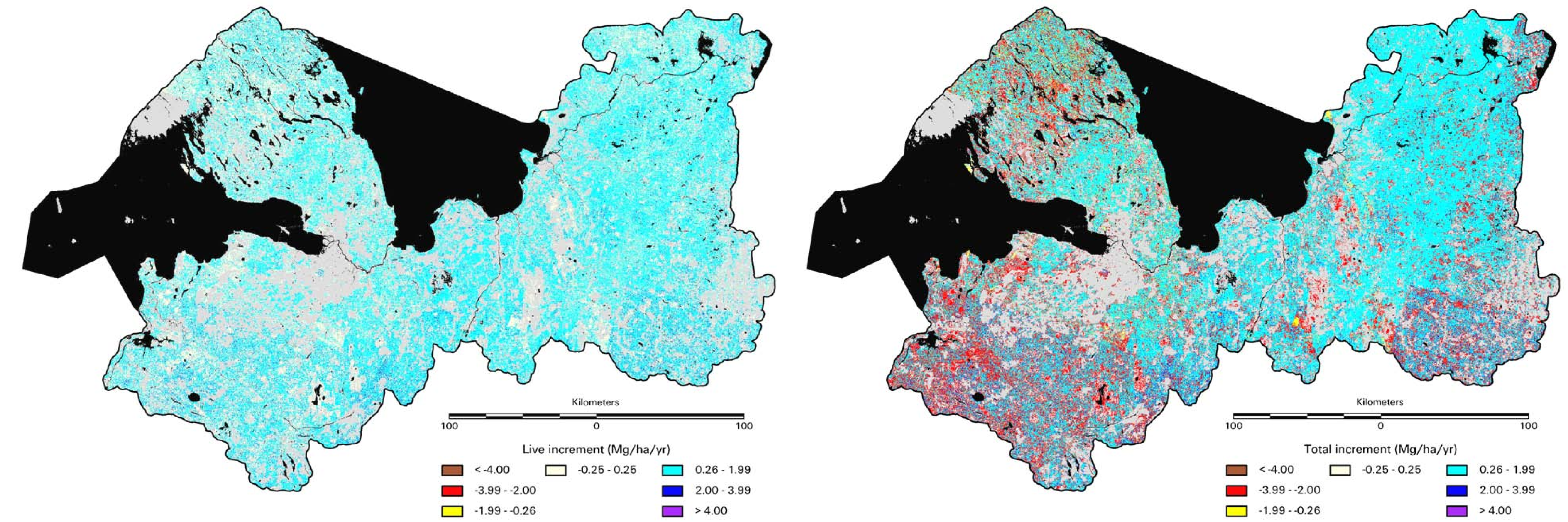
3. MAPPING OF FOREST BIOMASS, STAND AGE, AND NET CHANGE IN CARBON STORES

Continuous Mapping of Live Forest Biomass (left) and Stand Age (right)

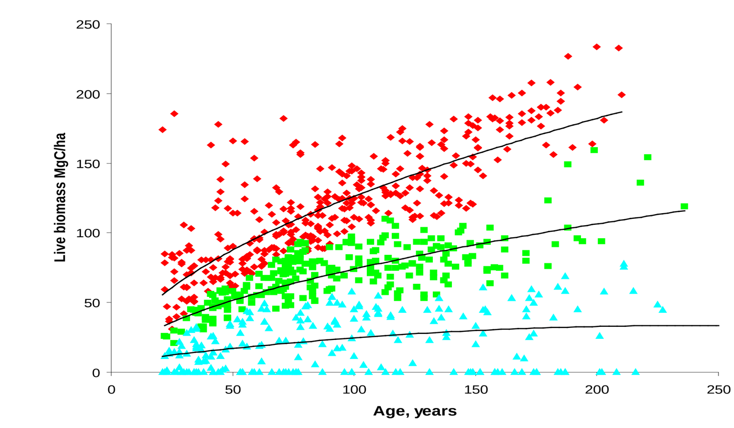
based on 13 Landsat TM and one MSS image from 1986-1995 (Oetter et al., In review)



Mapping Net Annual Change in Live Forest Biomass Carbon (left) and Total Ecosystem Carbon (right) based StandCarb output

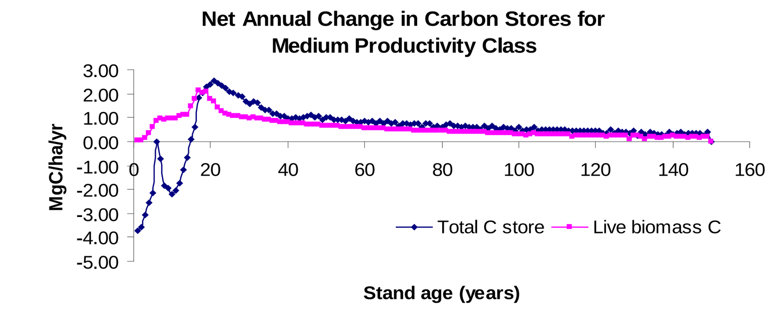


4. SPATIAL MODELING OF NET CHANGE WITH STANDCARB

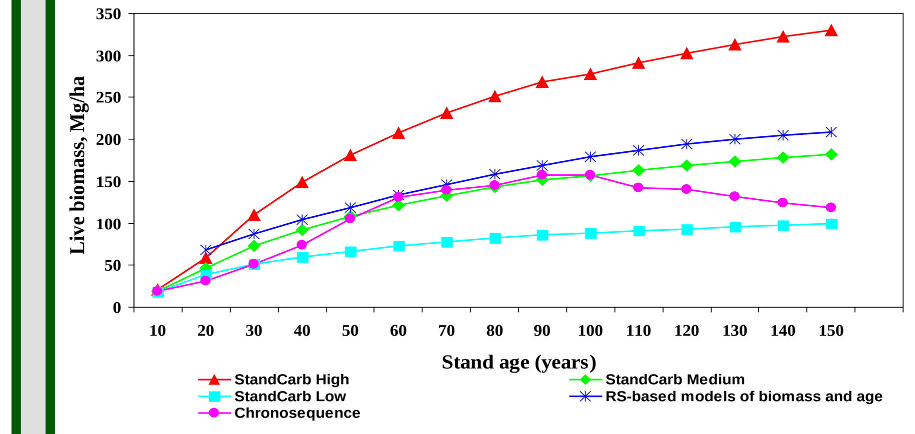


StandCarb predicts net annual change of carbon store in live forest biomass and in total ecosystem carbon for each forest pixel depending on its productivity class and age (see example below). Note that net change in live biomass remains positive for all ages: it reaches MAX of 2.12 MgC/ha at age 17 then gradually declines to 0. Net change in total ecosystem carbon is negative in forests younger than 15 years (they are net sources of C); it reached MAX of 2.53 MgC/ha at age 21, then declines. Projected net change for each pixel is used to produce regional maps of carbon sources and sinks (box 3 bottom)

Live biomass over stand age scatter for a random sample of Landsat pixels from maps on left. Each pixel is assigned one of 3 productivity classes based in its projected live biomass and age value (for ages >20 years). The boundaries between productivity classes are based on StandCarb model simulation.



5. INTERCOMPARISON OF RESULTS



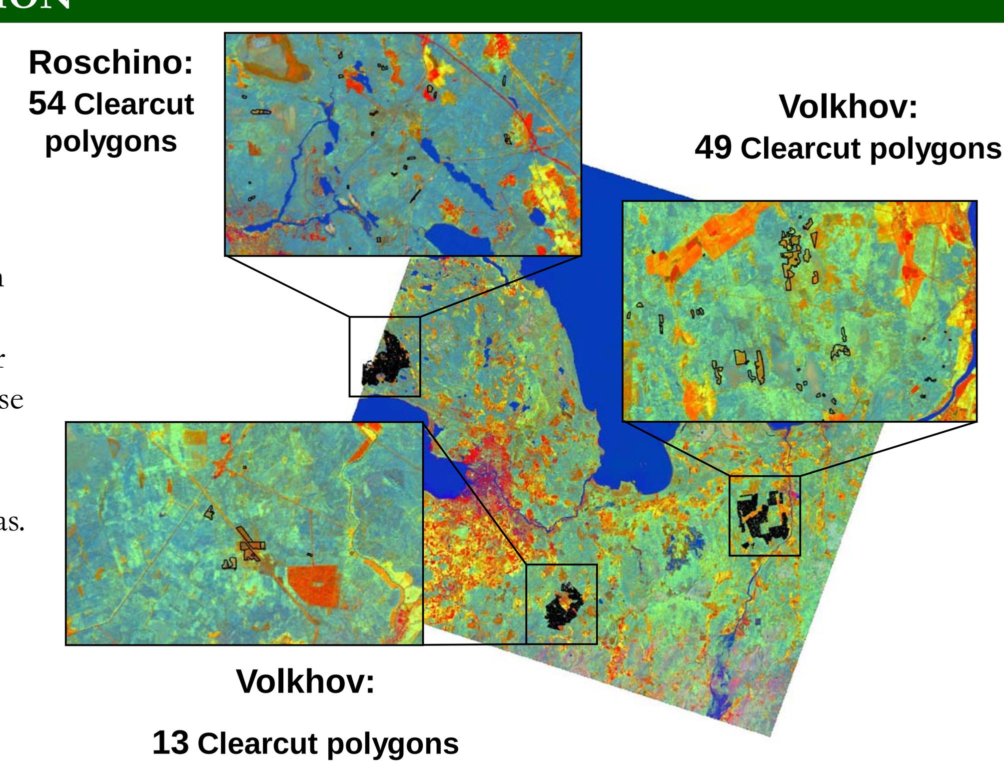
Three independent estimates of live biomass changes with age of forest stands are in good agreement (left):

1. StandCarb model predictions for medium productivity class (high and low are also shown)
2. Chronosequence of 216 thousand stand records from routine forest inventory of 1992 (averages). Decline after age 100 is the effect of timber harvest.
3. Landsat TM-based models of biomass and forest age (trendline from a scatter of 900 randomly selected pixels)

The regional estimate of net change in live forest biomass based on forest inventory (1.65 TgC/yr average for 1988-98) is lower than our model prediction (3.24 TgC/yr). However, if we adjust the inventory-based estimate for greater forest area covered by remote sensing (factor 1.13) and adjust our model prediction for timber removal (-1.25TgC/yr), estimates thus adjusted are very close (1.87 and 1.99 TgC/yr, respectively)

6. NEXT STEP: CHANGE DETECTION

The direction and magnitude of net change in forest carbon stores vary greatly during the first 20-25 years following disturbance (box 4, right). Thus, greater accuracy in tracking forest disturbance and mapping of young forests is critical for improved estimates of regional carbon dynamics. Clearcut harvest is the most common type of disturbance in the region and forest cover usually regenerates within 2-4 years. We plan to use change detection on a sequence of 3-4 Landsat scenes spaced over 20-25 years to map forest disturbance separating clearcuts from burned areas. This disturbance layer will be used to verify and adjust the mapping of young forests and associated carbon sources and sinks. A set of clearcut polygons surveyed in 1992 (126 total, right) will be used as a test set for clearcut detection.



7. REFERENCES

Harmon, Mark E.;Domingo, James B. (2001) A users guide to STANDCARB version 2.0: a model to simulate the carbon stores in forest stands .

Cohen, W. B., T. K. Maiersperger, T. A. Spies, and D. R. Oetter. 2001. Modelling forest cover attributes as continuous variables in a regional context with Thematic Mapper data. International Journal of Remote Sensing 22:2279-2310.

D.R. Oetter, W.B. Cohen, O.N. Krankina, and T.K. Maiersperger. (In preparation). Land Cover Mapping for Carbon Studies in the St. Petersburg Region of Northwest Russia and comparisons with Western Oregon

See additional information at: `http://www.cof.orst.edu/cof/fs/faculty/krankina.htm`