Space Science Observatory for Carbon in Russian Forests : COUL-Project

Sergey Bartalev

Russia-UK Round Table
«Interactions between Climate and Boreal Ecosystems in Northern Eurasia: potential cross-fertility between research projects»

Space Research Institute (IKI), Moscow, November 11, 2019

Carbon Budget in Russian Forests

- The existing estimates of carbon budget in Russian Forests are highly uncertain (3-4 times difference). The source of uncertainty is, first of all, the lack of reliable information on forests status and dynamics. With the adoption of the Paris agreement the importance of information on forests is increased
- Information for carbon budget estimation includes data on land cover (burnt areas, dead trees, felling sites, natural sparse forest, swamps, etc.), forest characteristics (growing stock, species, age, productivity) and ecological parameters (NPP). Data on natural (fires, diseases and pests, windthrow, draughts) and anthropogenic (felling, pollution) disturbances, as well as reforestation, are also vital
- Remote sensing can provide significant part of missing information on forest for a country-wide carbon budget estimation. However, the most expedient approach should integrate remote sensing, field measurements and mathematical models of forest dynamics

The COUL-Project Objectives

The COUL-Project is focused at the following objectives:

- development of a new systematic methodology for forest carbon budget assessment using a multi-sensor EO approach;
- integration of ground based and remote sensing data to improve existing and create new models;
- using the developed methodology to produce new dynamically updated GIS databases of Russian forests' characteristics;
- development of an informational system and technology for the continuous monitoring of Russian forests' carbon budget.

Main component of R&D at IKI

(I) Multi-annual of automatic near-real-time update EO data archive

(II) Automated EO data processing chains, including:

a. EO data pre-processing (cloud/shadow screening, image compositing, vegetation indexes generation, data time-series reconstruction and etc)

b. Thematic products generation (land cover/land use, active fires, burnt area and severity, and etc)

(III) Web-based Users' Interface with data analysis tools

(IV) Terrestrial ecosystems change analysis

Near-real-time update EO data archive at IKI

- MODIS Surface Reflectance MOD09 from NASA (2000 - ongoing)
- Landsat data download from USGS and ESA (1984-ongoing)
- Proba-V data download from VITO (2014-ongoing)
- Sentinel-2 data download from ESA (2016-ongoing)
- KMSS Meteor-M data from Russian Hydrometeo Service (2015-ongoing)
- Many other satellite instruments

RS data derived essential forest variables for Carbon Budget Assessment

- Forest and non-forest land cover types
- Dominant tree species and their composition
- Forest growing stock
- Forest density (relative growing stock, cover fraction)
- Forest Age
- Forest Site Index
- Forest biophysical characteristics (LAI, FAPAR)
- Forest disturbances, including:
  - burnt area and severity
  - other natural and human-induced disturbances
  - logging

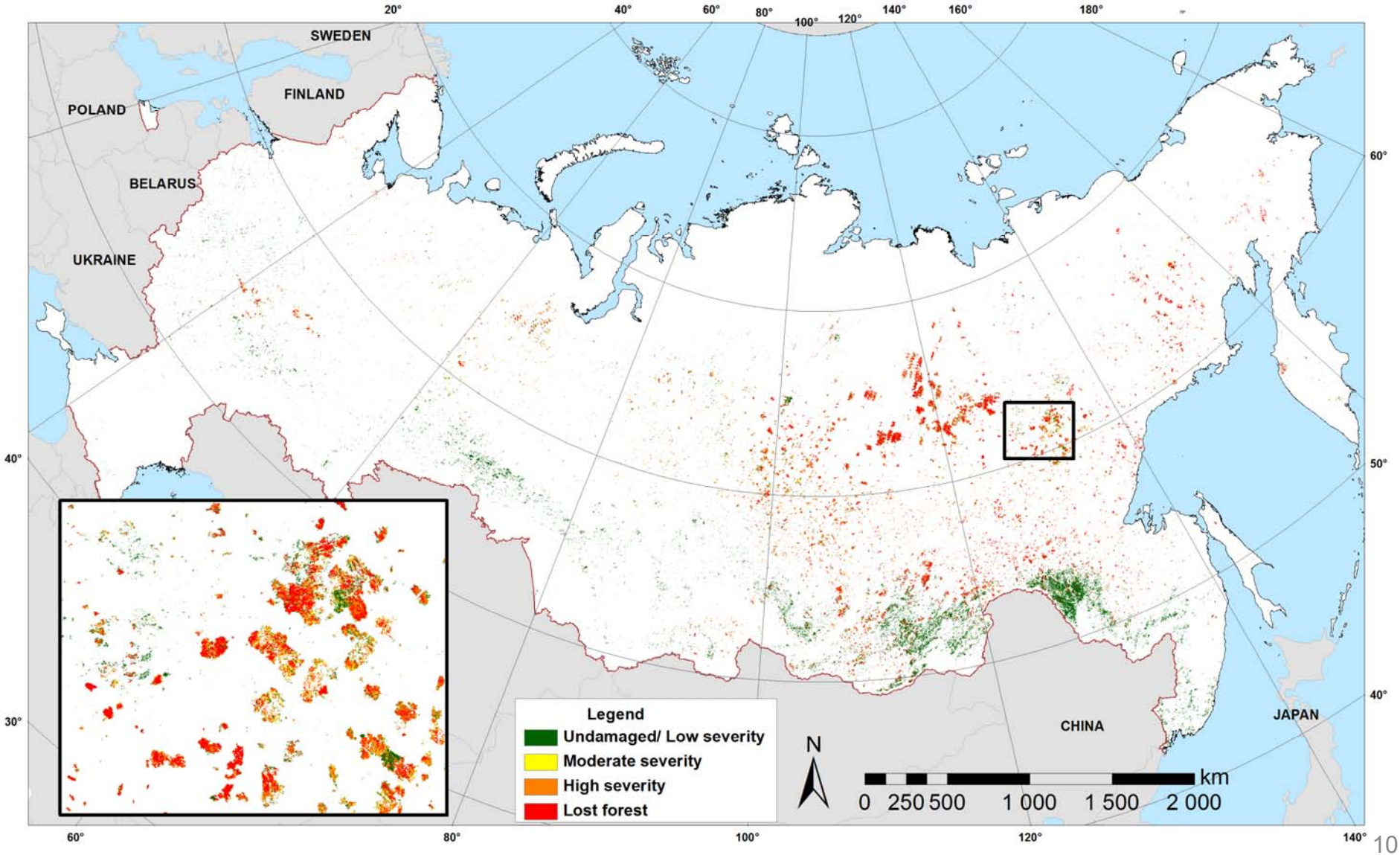
Land Cover Map

The land cover map for Russia based on MODIS 250 m

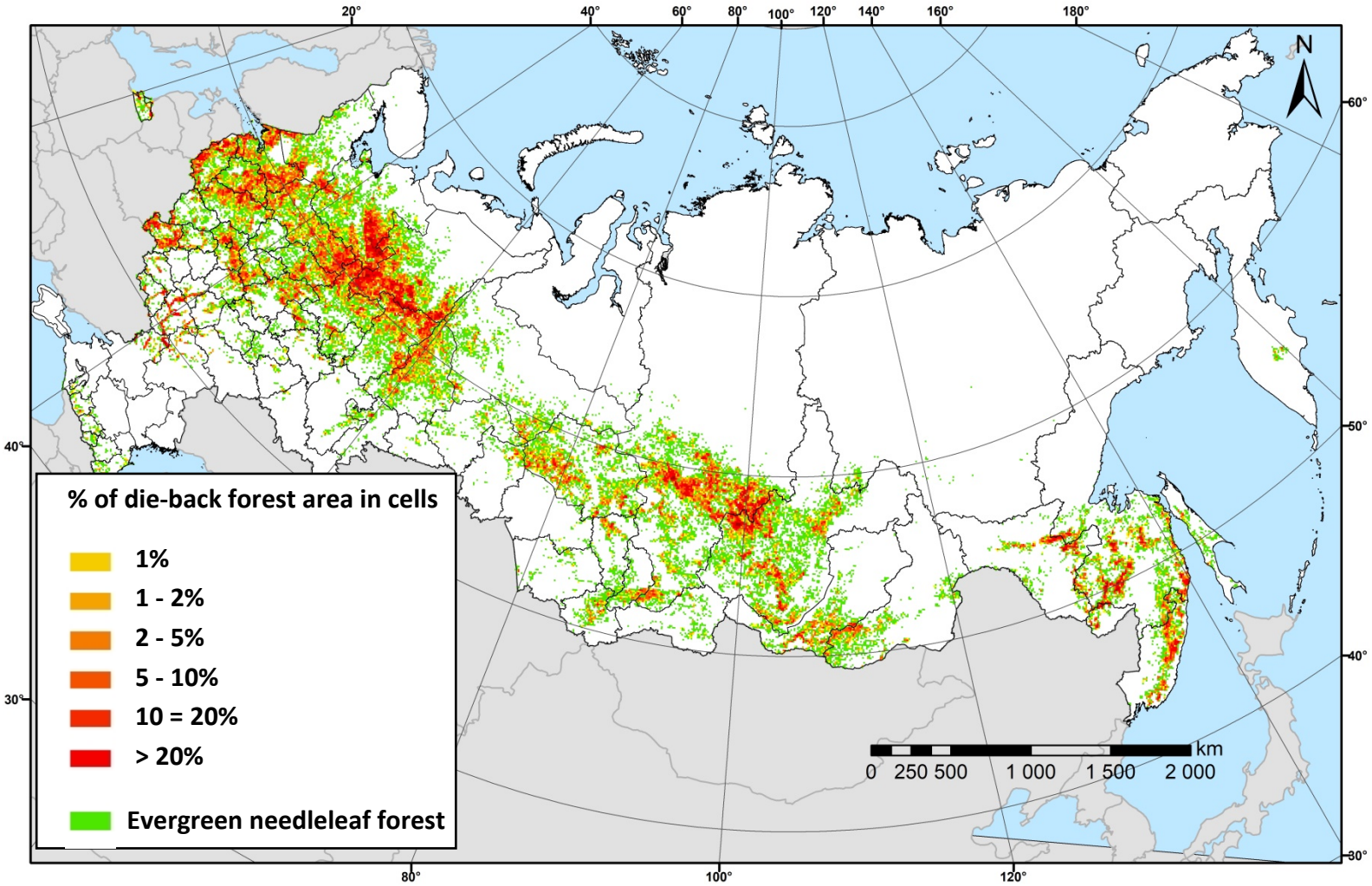
The forest cover is classified considering dominant tree species using seasonal time-series of MODIS data

Annual forest GSV retrieval based on MODIS data

Forest burn severity for years 2006-2018

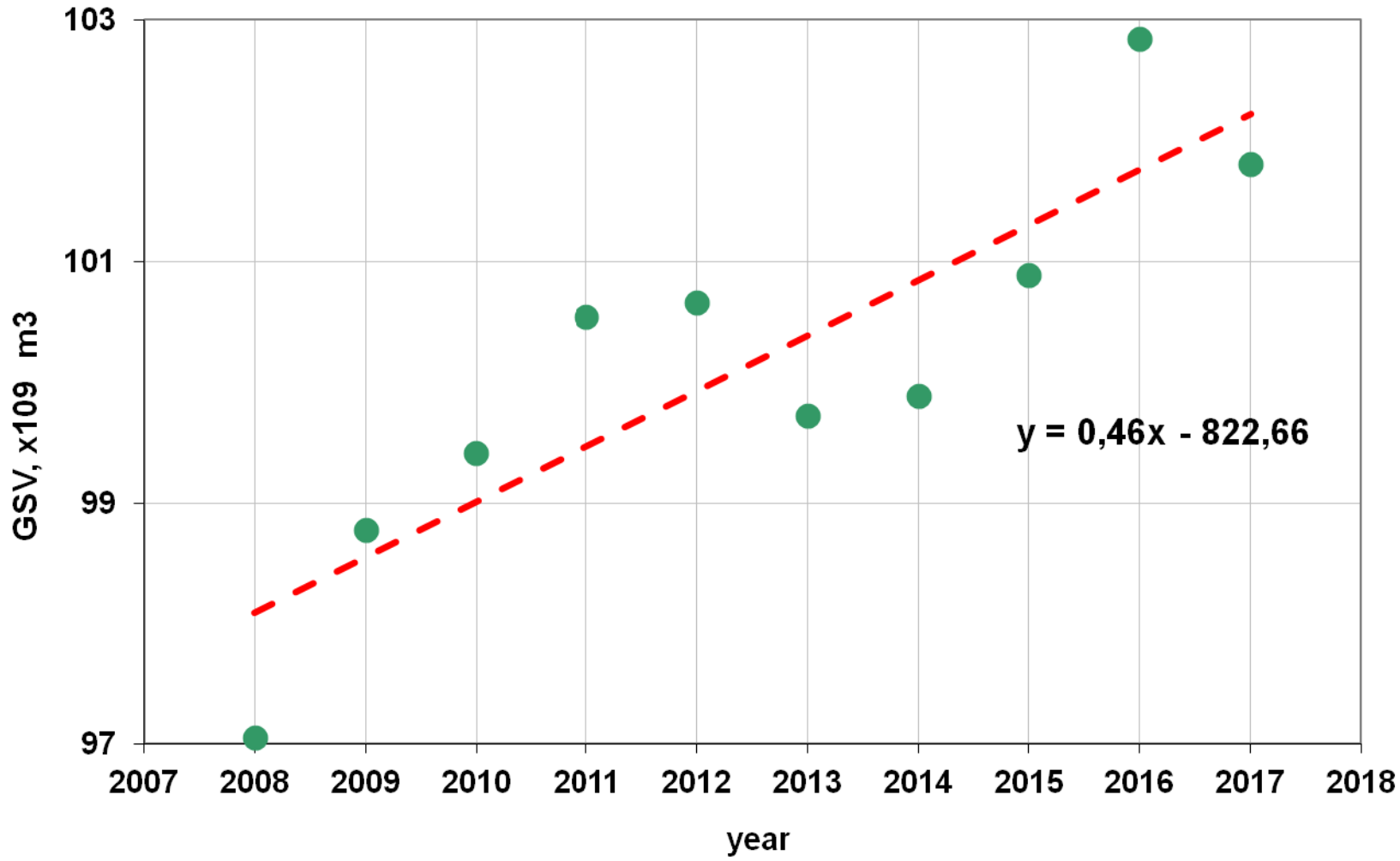


Non-fire caused die-back of evergreen needle-leaf forests

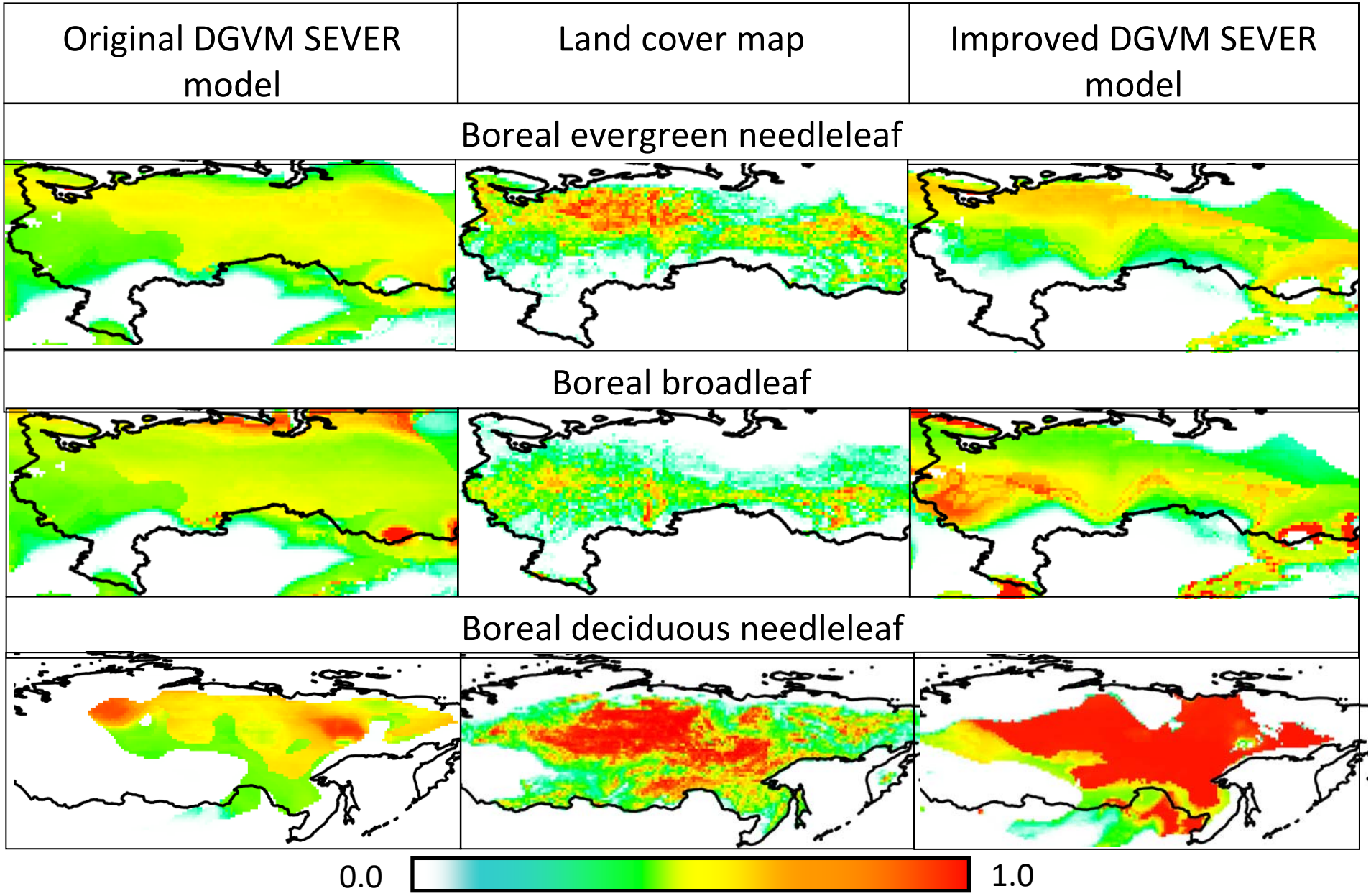


The dark-coniferous forest area of non-fire induced die-back during years 2003-2017 is estimated at $5{,}54 \times 10^6$ ha

Growing Stock Volume Dynamics in Russian Forest based on Remote Sensing Data

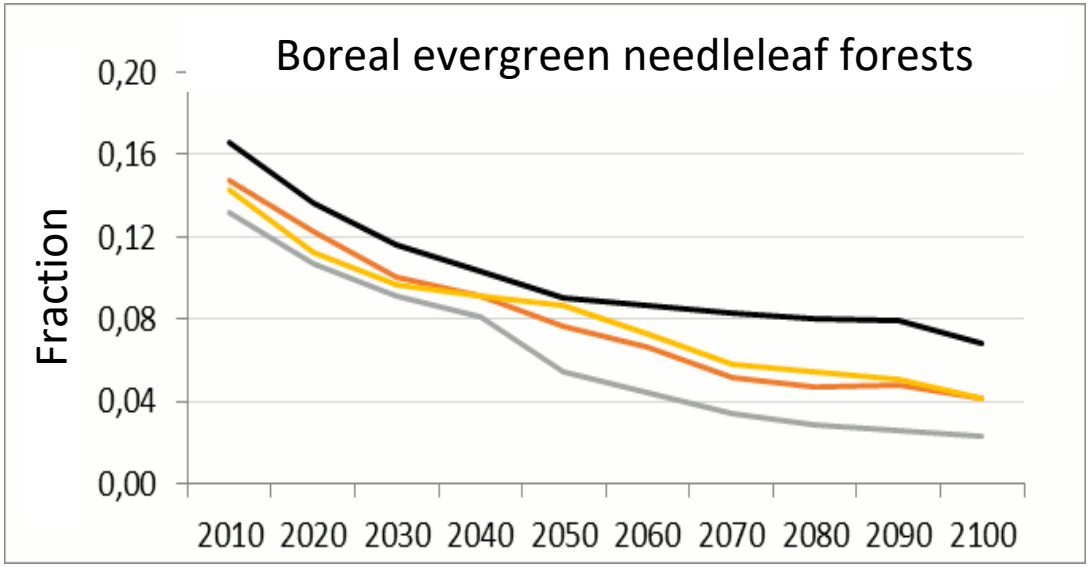


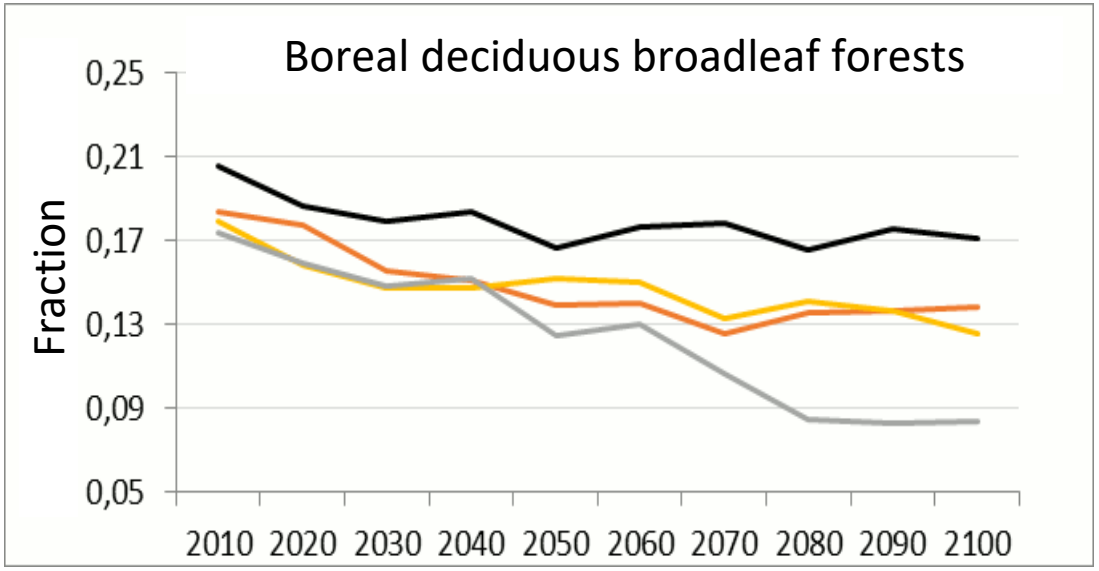
Modeling of forest types spatial distribution



Forest Dynamics & Climate Change Scenarios

Forecasts show decline in area of boreal broadleaf and needleleaf evergreen forests of Russia



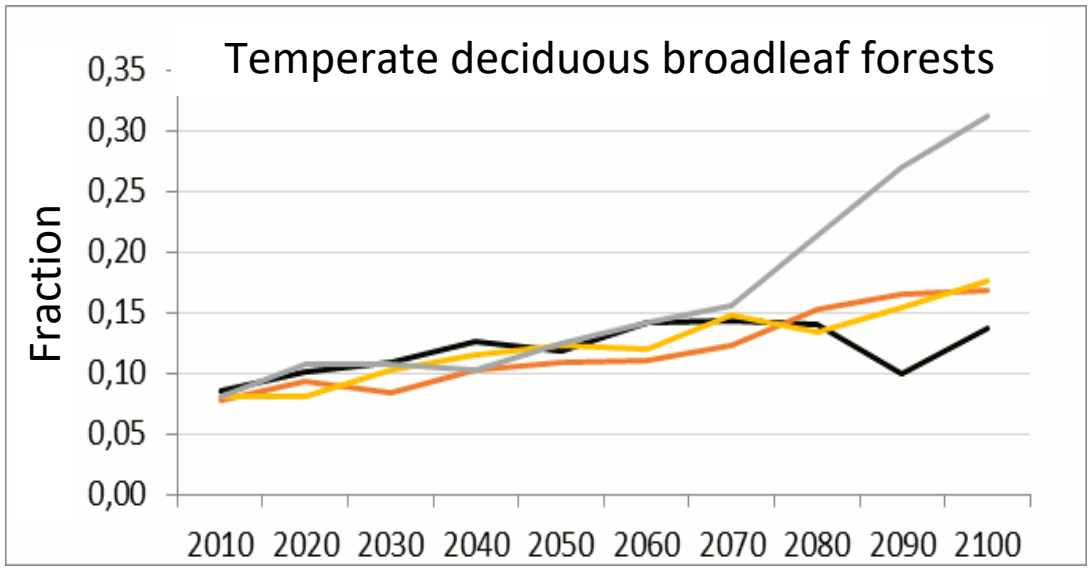


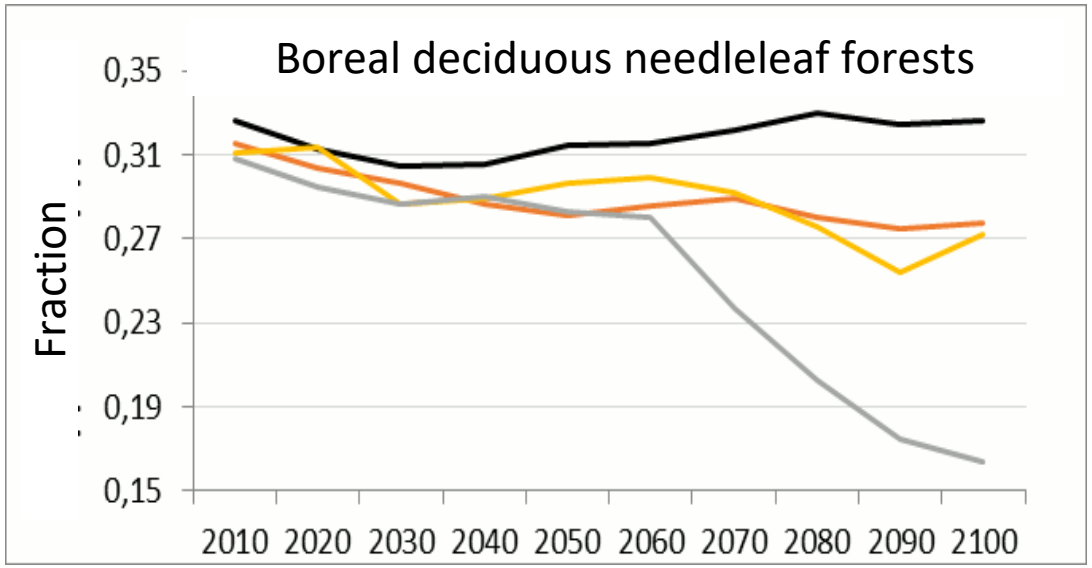
RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5

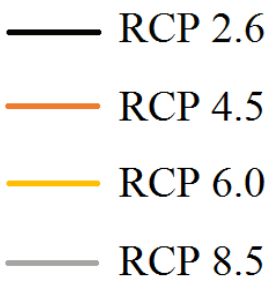
Forest Dynamics & Climate Change Scenarios

Boreal forests will be replaced by temperate broadleaf forests.

Also forecasts show steep decline in deciduous needleleaf forest for RCP 8.5 scenario.







Thank you for your attention !

This research study was supported by the Russian Science Foundation [grant number 19-77-30015].