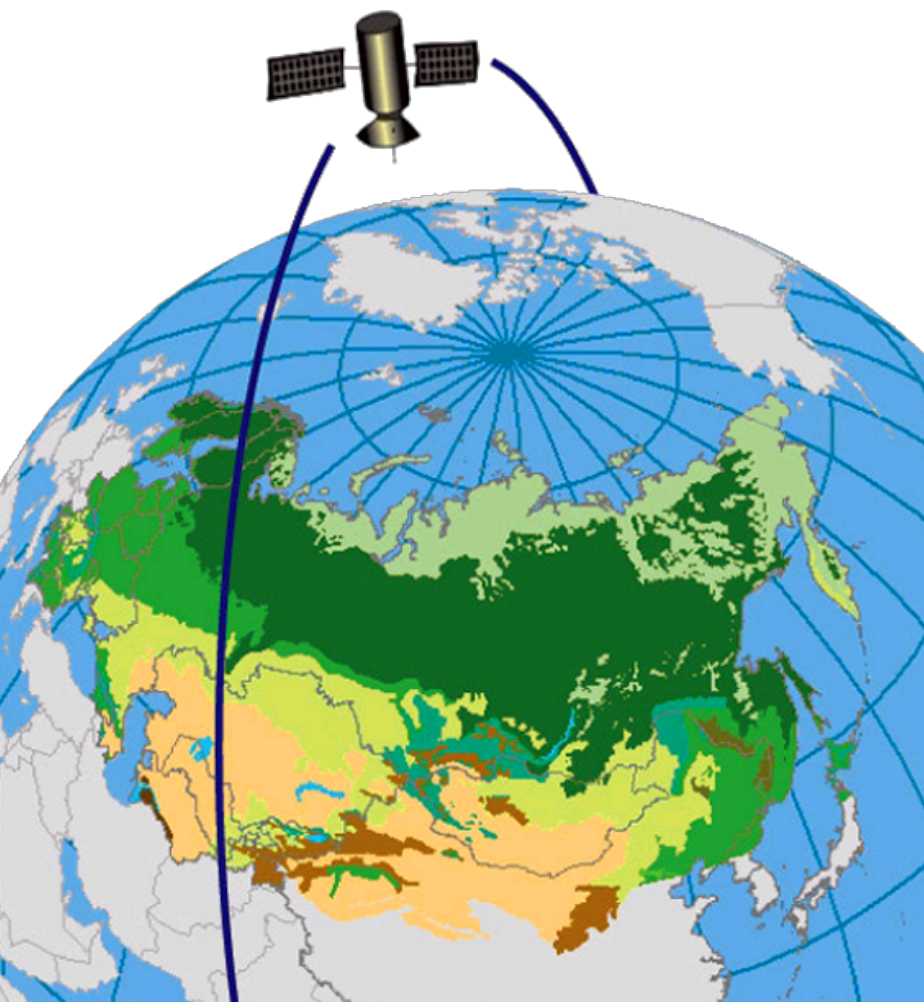


Current status of the Northern Eurasia Future Initiative (NEFI)

**Pavel Groisman (1,2,3),
Garik Gutman (4),
Sergey Gulev (2),
Shamil Maksyutov (5), and
Jiaguo Qi (6)**

1. UCAR at NOAA National Climatic Data Center, JOSS, Asheville, NC, USA
2. P. P. Shirshov Institute of Oceanology, RAS, Moscow, Russia
3. Hydrology Science and Services Corporation, Asheville, NC, USA
4. NASA Headquarters, Washington, District Columbia, USA
5. National Institute for Environmental Studies, Tsukuba, Japan
6. Michigan State University, East Lansing, Michigan, USA.



The NEESPI Study Area

<http://neespi.org>

**During the past 10 years,
NEESPI has been an interdisciplinary program of
internationally-supported Earth systems and science
research that addresses large-scale and long-term
manifestations of climate and environmental change**

NEESPI CONCEPT

We are living in the epoch of large changes in **Climate, Environment, and Human Activities**. All these changes now have become intertwined and affect each other => they have to be studied in a synergetic manner.

Considering the triad "climate - environmental impacts – socio-economic impacts", NEESPI is currently sufficiently covering diagnostics of regional climate, environmental, and ecosystem characteristics. However, the socio-economic impacts of variability and/or systematic changes in climate and environment are still poorly covered making it difficult to effectively plan future (and to accurately interpret already performed) model experiments.

=> NEFI ADD-ON TO THE NEESPI CONCEPT

The Northern Eurasia Future Initiative (NEFI) objective is to bridge climate and environmental studies with the economic consequences of the observed changes;

NEFI will provide the synergy between them and spurring the advances of physical sciences in quantifying observed and projected climate and environmental changes and the advances of the economic analyses and the impacts.

NEESPI Projects partition by topics and zones and general statistics

- **Biogeochemical cycles** **50%**
- **Energy and Water cycles** **30%**
- **Cryosphere changes** **15%**
- **Atmospheric Aerosol changes/impact** **5%**

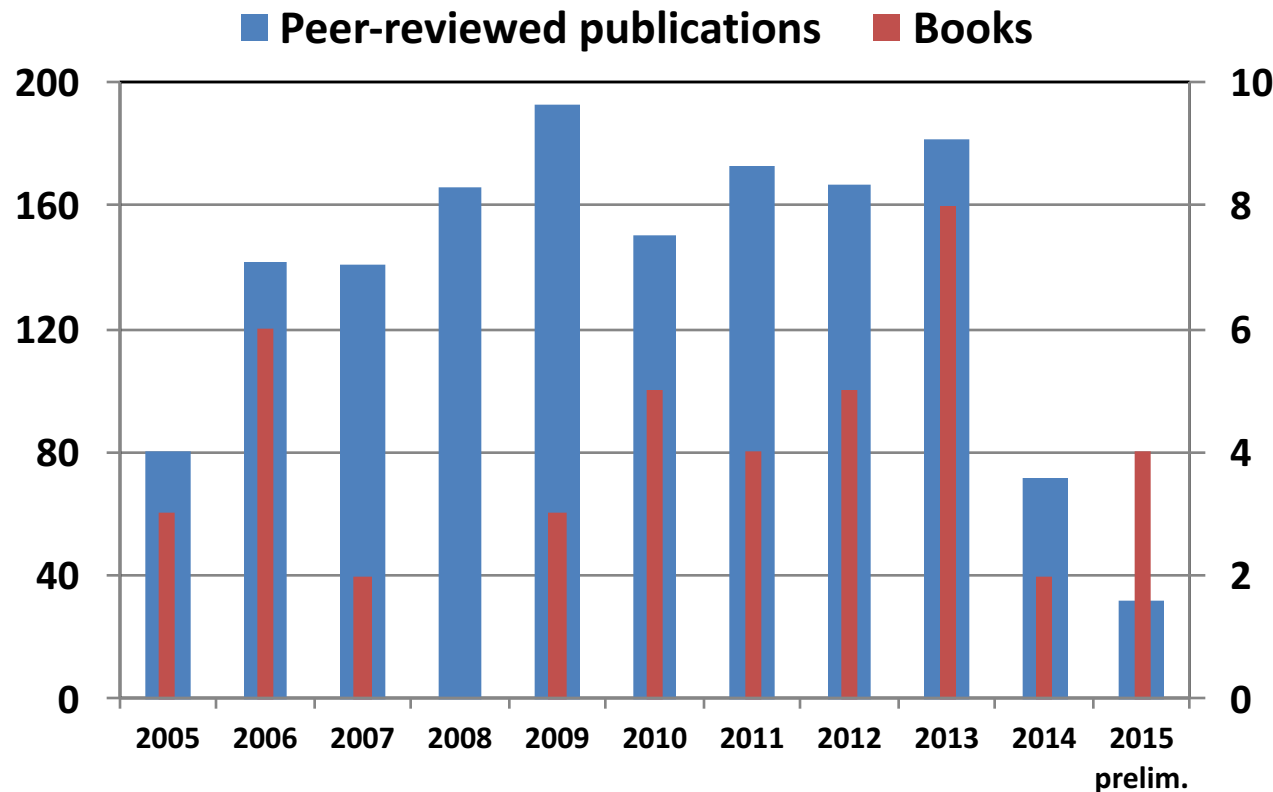
- **Boreal Zone and the Arctic** **75%**
- **Mid-latitude Dry Land Zone** **25%**

- **172 projects (27 of them are ongoing)**
- **~ 750 scientists from more than 200 institutions of 30 countries; more than 80 PhD theses defended.**

NEESPI Science Community

- At each AGU, EGU and (recently) JpGU Annual Meetings NEESPI sessions were organized
- Since 2006, more than 30 dedicated NEESPI Workshops and 23 NEESPI Open Science Sessions at the International Meetings were convened
- **Two or more** Early Career Scientists Summer Schools per year were organized in the past 7 years (since 2009).

NEESPI publications by year



- More than **1500** papers and **40** books were published or are in press

http://neespi.org/science/NEESPI_publications.pdf

The latest (present phase 3) NEESPI research foci consist from integrated assessments and projections and include a synergy of the knowledge gained from the analyses of the regional observational databases and from the development of and experimentation with regional Earth system modeling tools. **In particular, in the last 3 years, four review books summarized knowledge of the regional Earth System status and dynamics.**



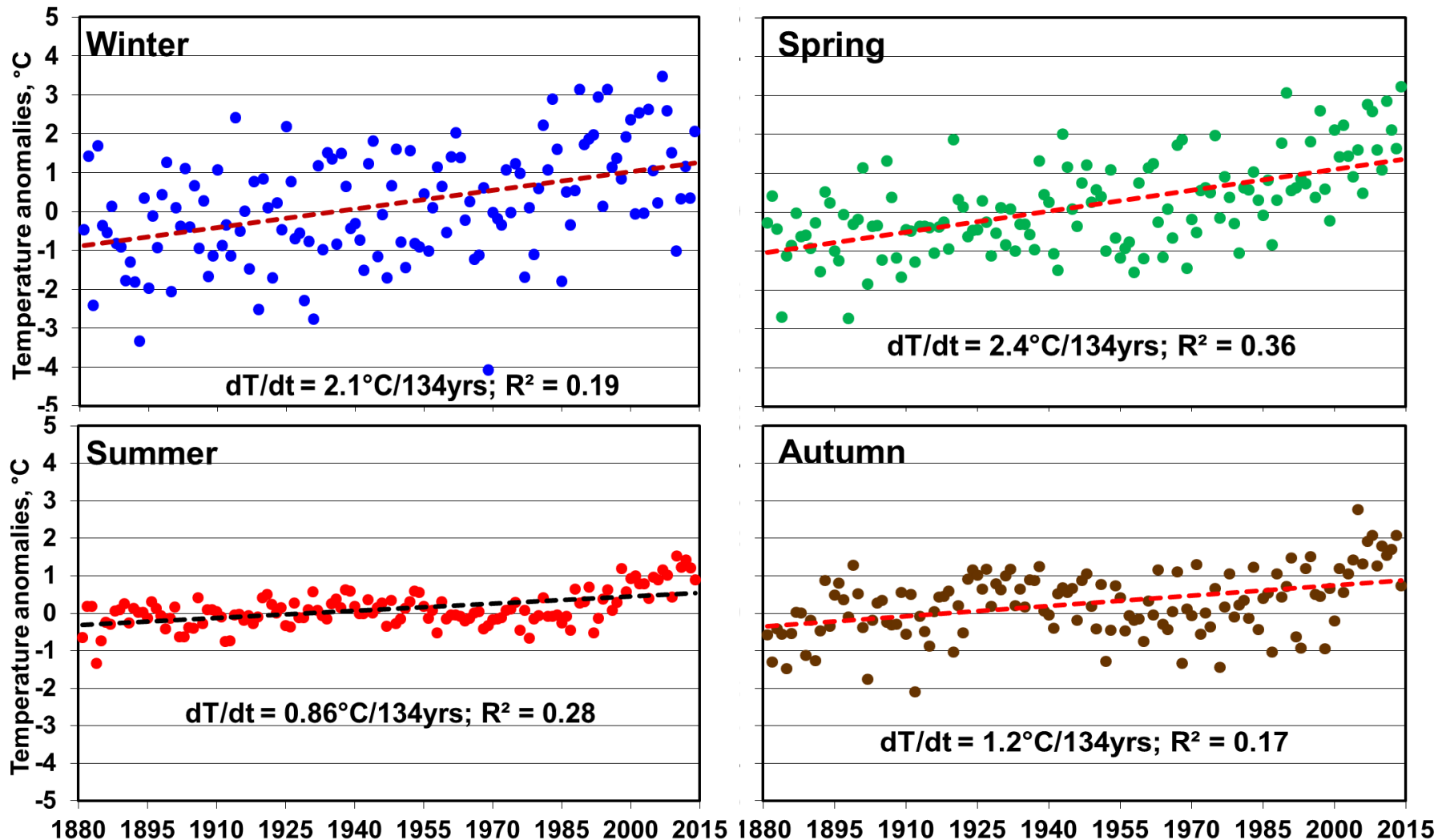
Land Use and Land Cover Change in Eastern Europe after the Collapse of the Soviet Union in 1991 (in 2016)

Two more overview books are in preparation and one more is planned.

Northern Eurasia Future Initiative (NEFI) as a successor of the Northern Eurasia Earth Science Partnership Initiative (NEESPI)

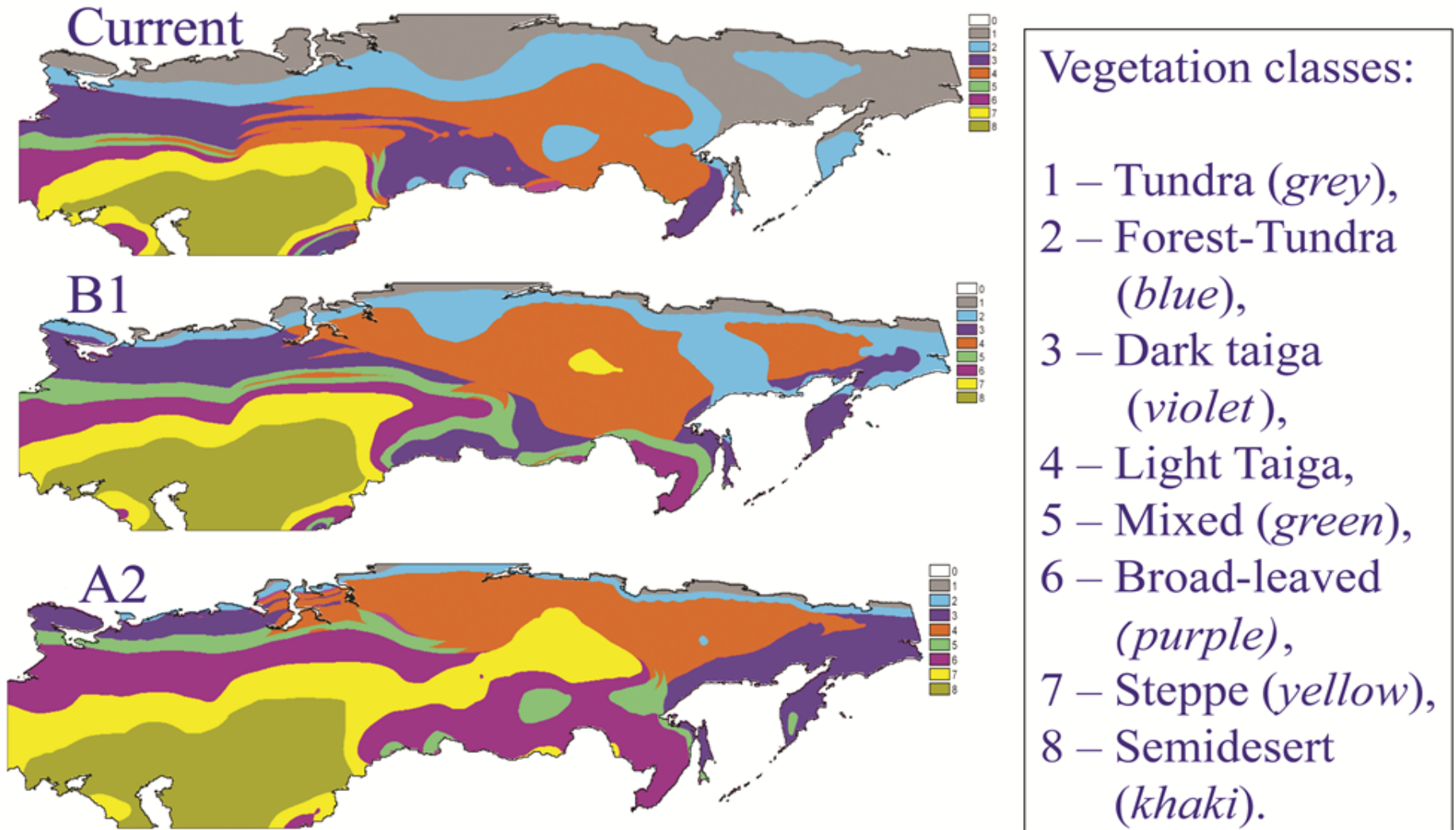
- **The Current Poster will provide summation of the past NEESPI achievements and justifications for a new focus study, NEFI**
- **Tomorrow. my Presentation will outline the NEFI Science Plan; its draft is at <http://neespi.org/NEFI-WhitePaperDraft.pdf>.**

Surface Air Temperatures in Northern Eurasia since 1881



Regional warming here is well above the Globe

Recent Projections of Ecosystems' Shifts



Vegetation distribution under present conditions and equilibrium vegetation distribution under future climate conditions (scenarios) over Northern Eurasia in current climate and by year 2090 (Archive of Tchebakova et al. 2016)

New/Old Science Questions

- How can we quantify and project the ecosystems dynamics in Northern Eurasia that:
 - i. are internally unstable (e.g., operate in narrow temperature ranges);*
 - ii. are interrelated with highly variable components of the cryosphere and/or are vitally controlled by components that have been systematically changing; and,*
 - iii. have a potential to impact the Global Earth system with unprecedented rates of change over few decades, e.g., due to, for example, catastrophic forest fires, dust storms, and hotly debated future methane release from the frozen ground in high latitudinal land and shelf areas.*
- What are the major drivers of the ongoing and future changes of the water cycle in Northern Eurasia and how will their changes affect the regional ecosystems, society and feedback to the Global Earth system and economy
- How to secure the sustainable development of societies of Northern Eurasia in the near future overcoming the “transitional” nature of their economics, environmental and climatic change challenges, and untying institutional legacies?

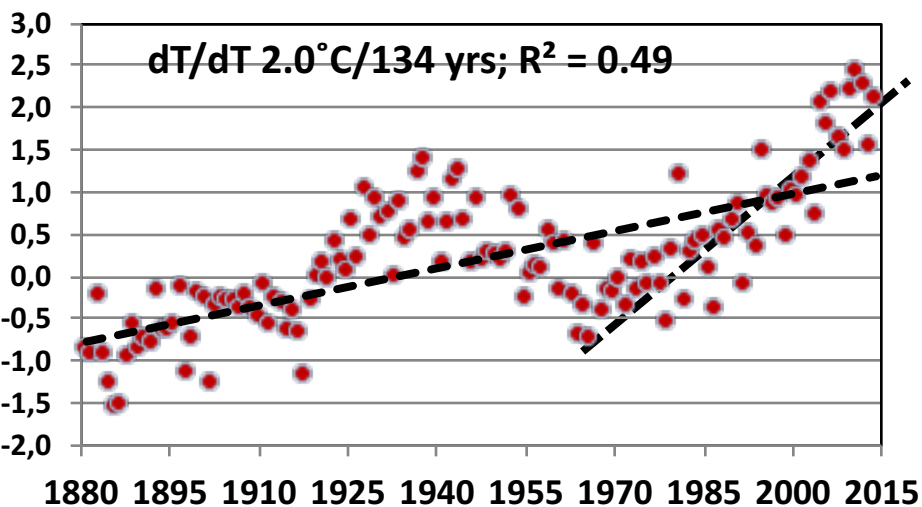
Foci of new research

- 1. Global change, particularly the warming of the Arctic**
- 2. Increasing frequency and intensity of extremes and changes in the spatial and temporal distributions of inclement weather conditions**
- 3. Retreat of all components of the cryosphere**
- 4. Changes in the terrestrial water cycle**
- 5. Changes in the biosphere**
- 6. Pressure on agriculture and pastoral production**
- 7. Changes in infrastructure**
- 8. Societal actions to mitigate negative consequences of the environmental change and to benefit from positive consequences**
- 9. Quantification of the role of Northern Eurasia in the global Earth and socioeconomic systems to advance research tools with an emphasis on observations and models.**

Research Focus: Global Impact of the Arctic Warming

- Direct regional warming/cooling
- Changes in atmospheric circulation
- Social and economic consequences

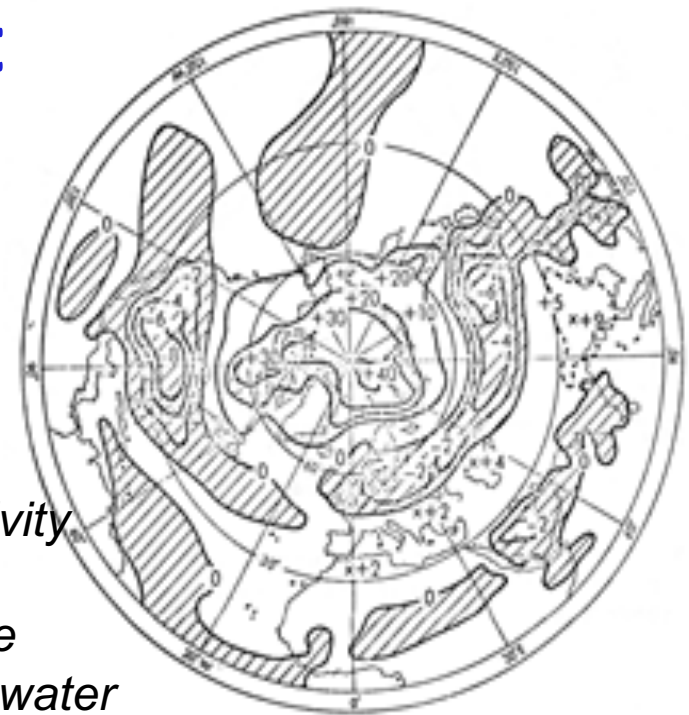
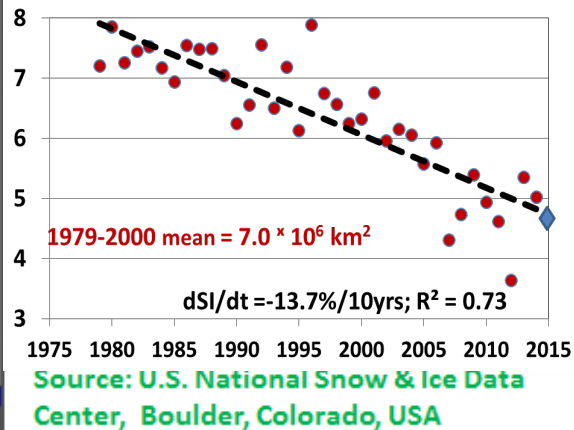
Annual surface air temperature anomalies area-averaged over the 60°N - 90°N latitudinal zone



Northern Hemisphere sea ice extent as of mid-September 2012 and September sea ice extent anomalies, %



September 1979-2015 anomalies, %



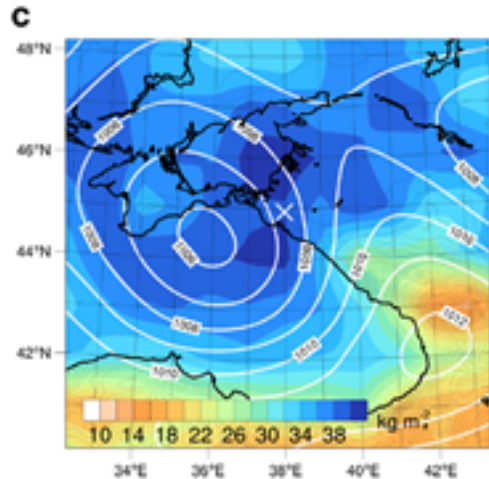
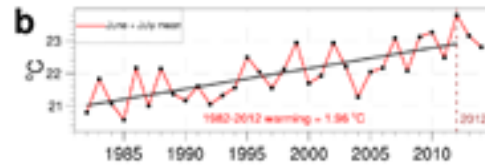
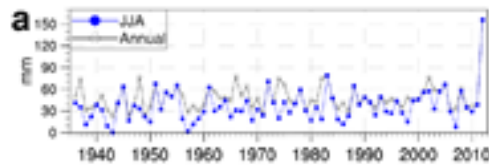
One of the first UCMO GCM sensitivity experiments with polar ice replaced by water at 0°C. Changes in January surface air temperature, °C (Newson 1973).

Source: U.S. National Snow & Ice Data Center, Boulder, Colorado, USA

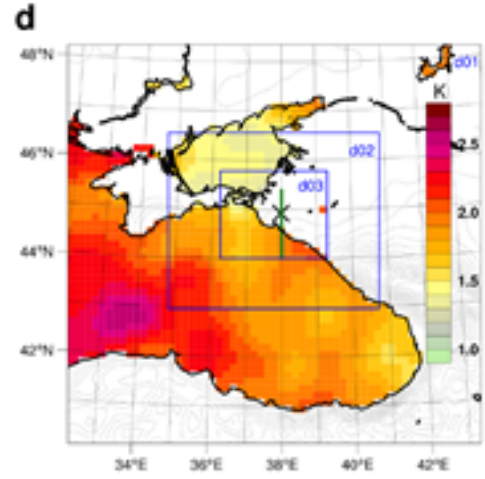
Summer and annual maximum daily precip at Krymsk station, mm/day

Black Sea June-July SST, °C

Research Focus: Extremes frequency and intensity in changing climate.



Precipitable water (kg/m^2) and SLP (hPa) on 6th July at 18Z (day of the event)

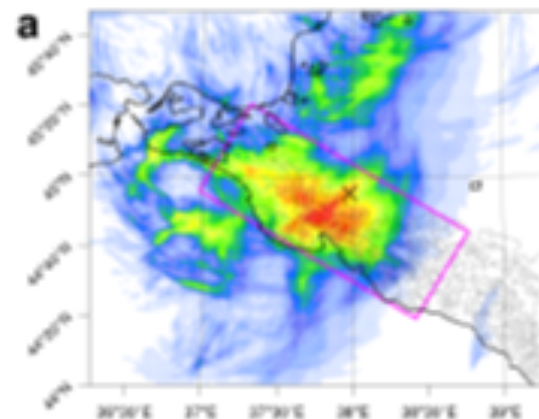


Three nested WRF domains used for simulation of the event (inner 600m resolution) and SST trend ($^{\circ}\text{C}$) for 1982-2012

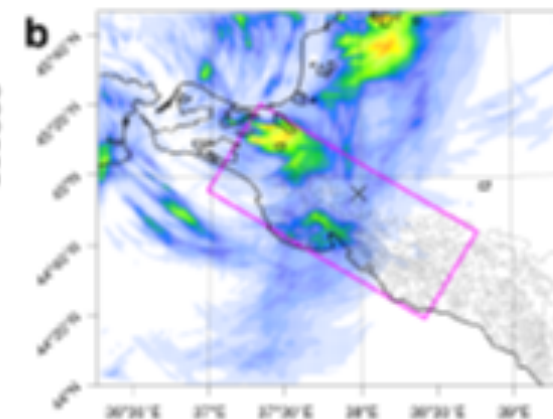
Total simulated precipitation from 6th July at 03Z to 7th July 2012 at 12Z

Realistic SST at the course of the event

Reduced SST with subtracted clim trend



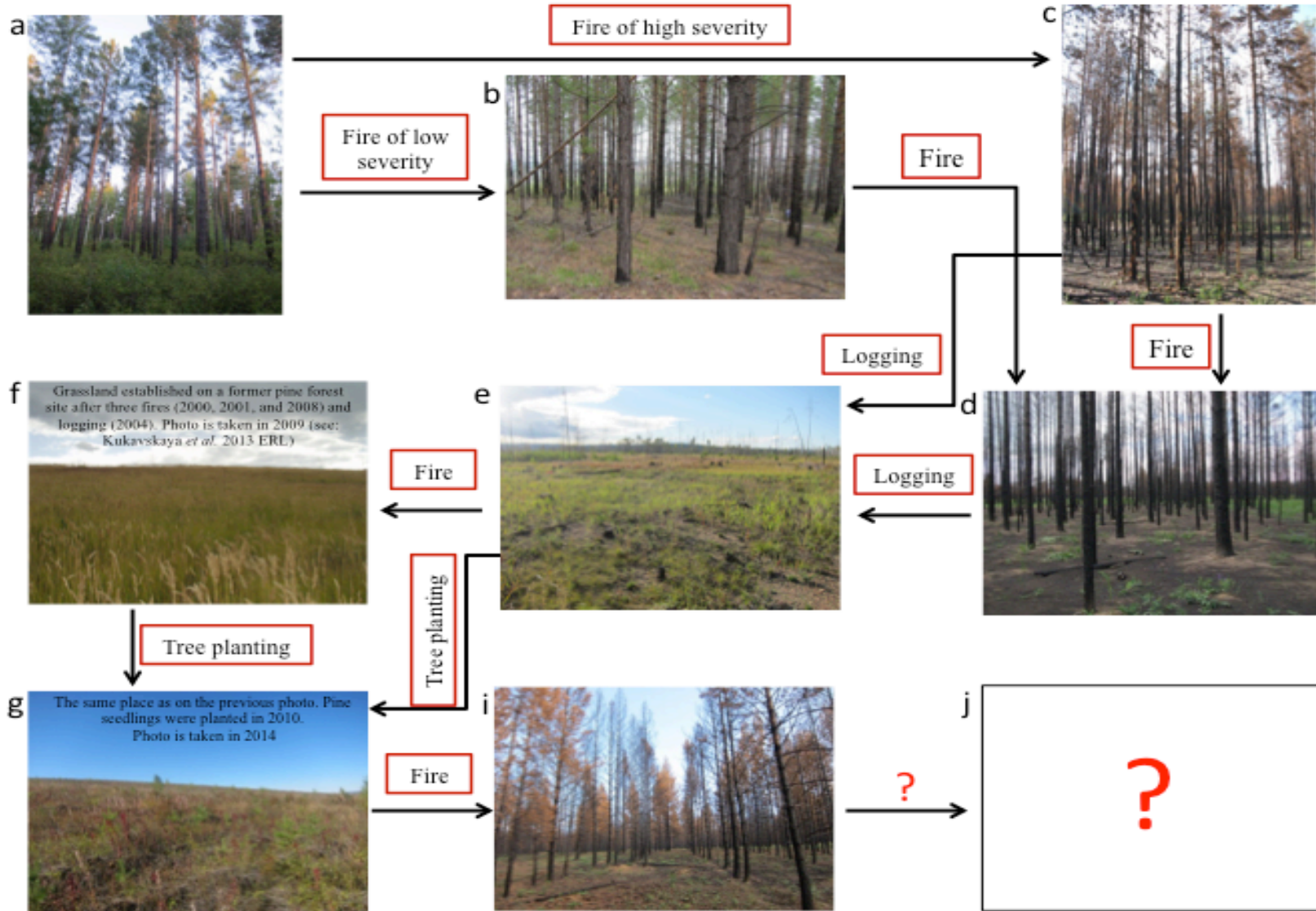
186 mm (171 mm observed)



23 mm

**Krymsk Flood
Russia,
July 7, 2012**

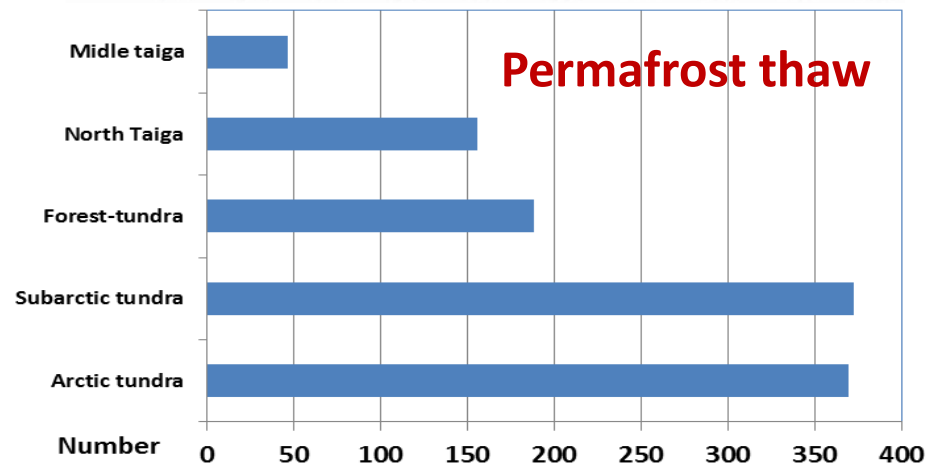
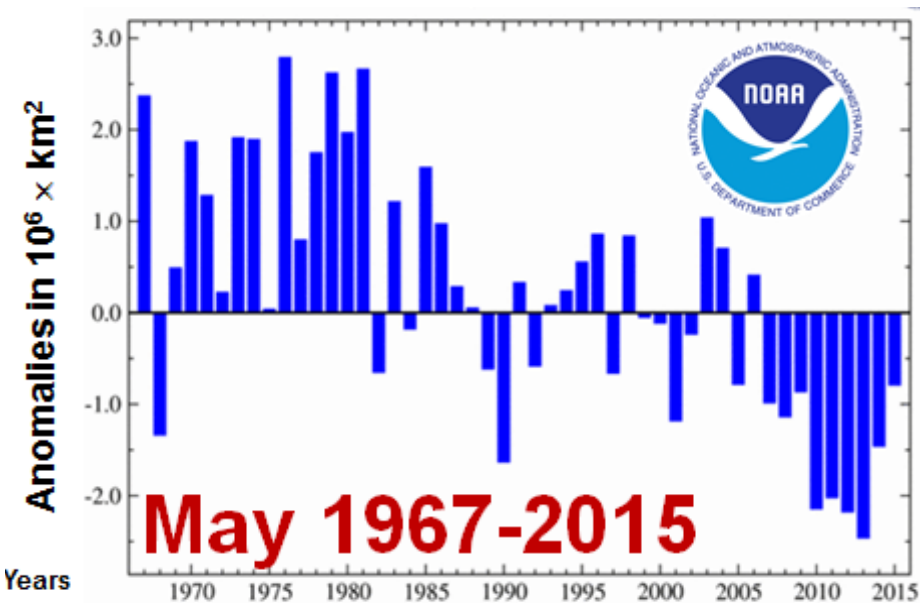
Research Focus: Extremes frequency and intensity in changing environment



Extreme events that affect the biosphere (Dr.Elena Kukavskaya)

Research Focus: Cryosphere retreat

May snow cover over Eurasia



Number of newly emerging thermokarst lakes in W. Siberia, 1973-2013 period, Polishchuk et al. 2015

We define “days with thaw” as the days when the mean daily temperature is above -2°C while snow on the ground is above 5 cm.

Annual number of days with thaw in West Siberia

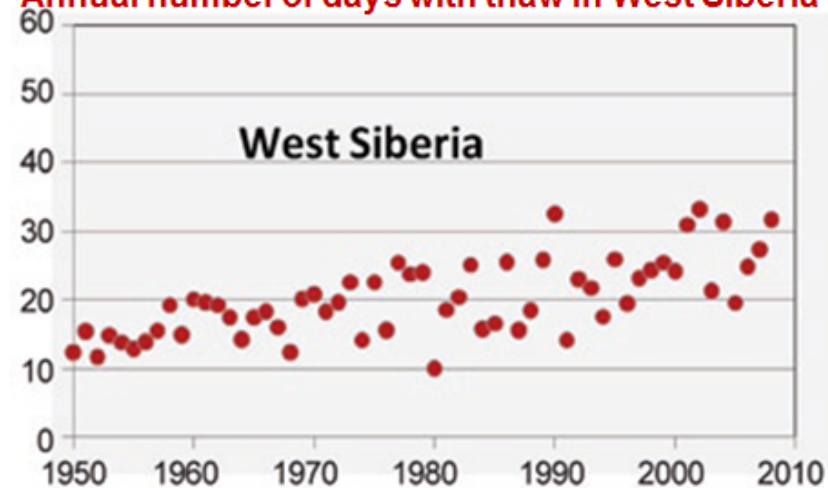
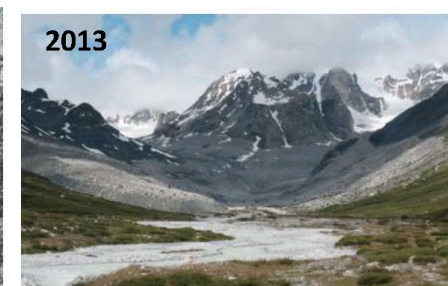
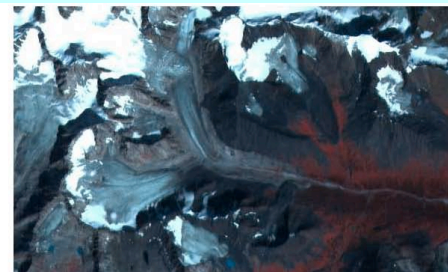


Photo by V.V. Sapozhnikov

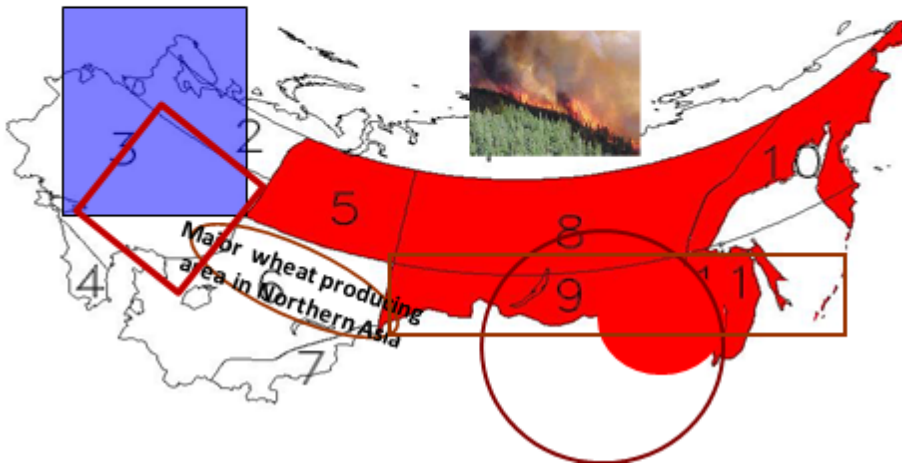
Upper Khovd River Basin



Research Focus: Water supply deficit

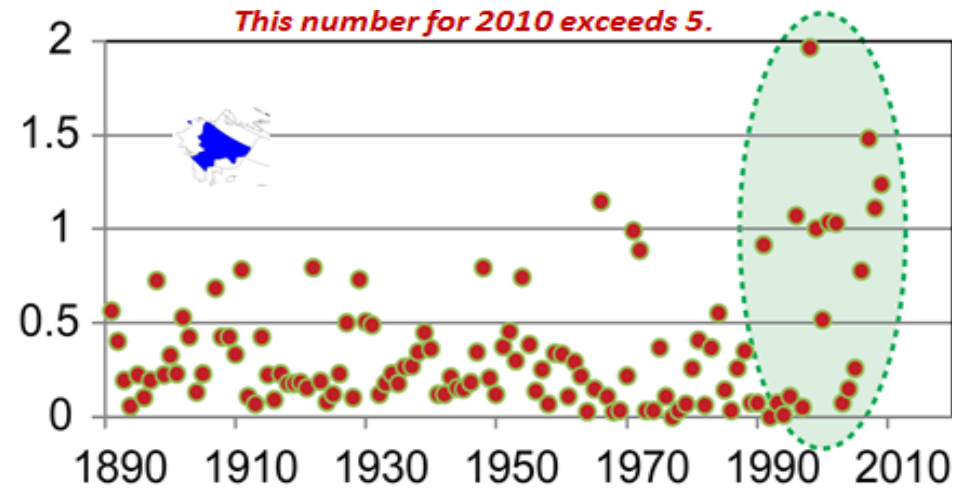
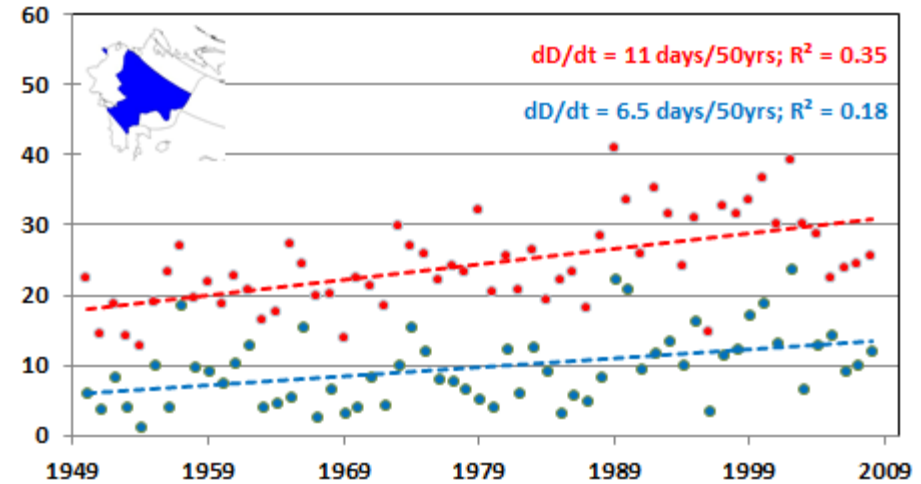
1. Mild winters with frequent thaws
2. Earlier spring onset
3. Longer vegetation season
4. Warmer summers and
5. No significant change in precipitation

All the above lead to summer dryness and promote extremely dry episodes



Changes in the surface water cycle over Northern Eurasia in the 20th century; areas with more humid conditions (**blue**), with more dry conditions (**red**), with more agricultural droughts (**circled**), and with more prolonged dry episodes (**rectangles**).

Annual and **winter** number of days with thaw over European Russia south of 60°N

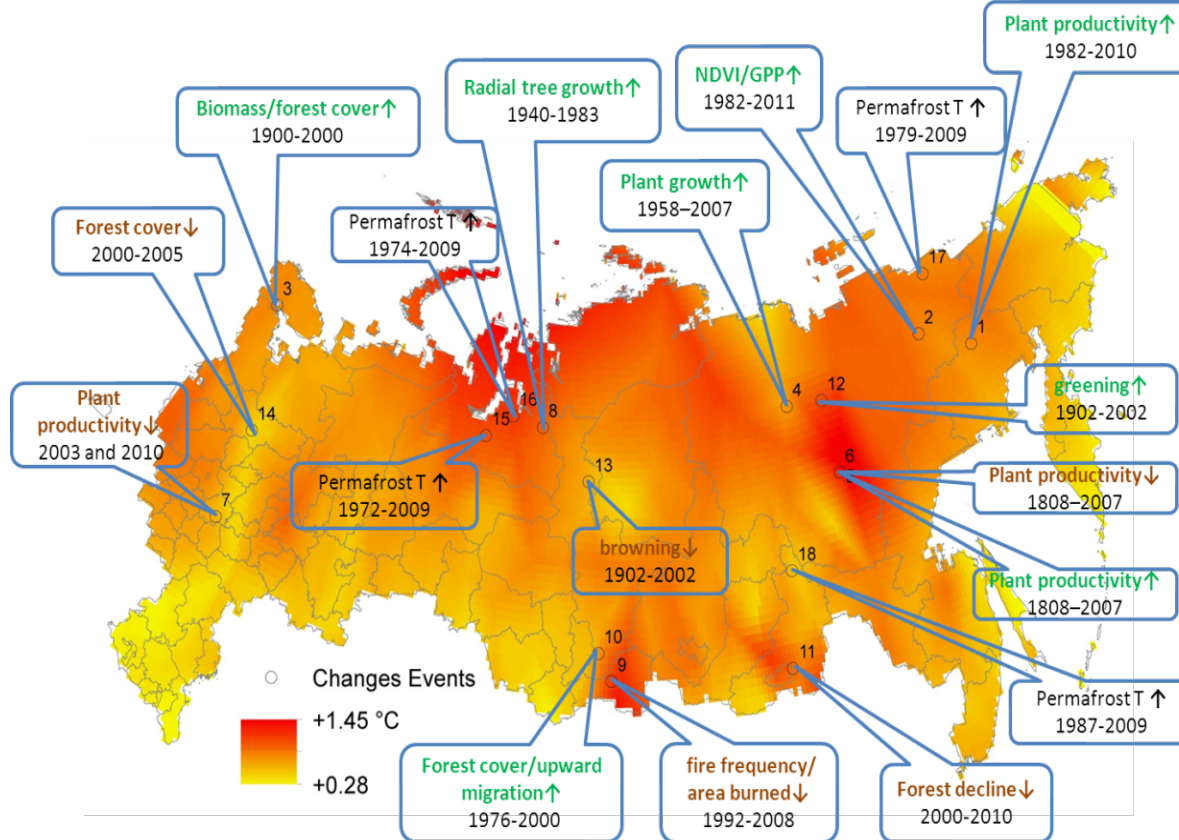


Number of "hot" nights, $T_{\min} > 23.9^{\circ}\text{C}$ over European Russia south of 60°N

Research Focus:

Biospheric changes

Synthesis of observed climate change impacts on Russian forests. The **green** (brown) font indicates positive (negative) impacts on vegetation while black font indicates the trend of changes (Schaphoff 2015).

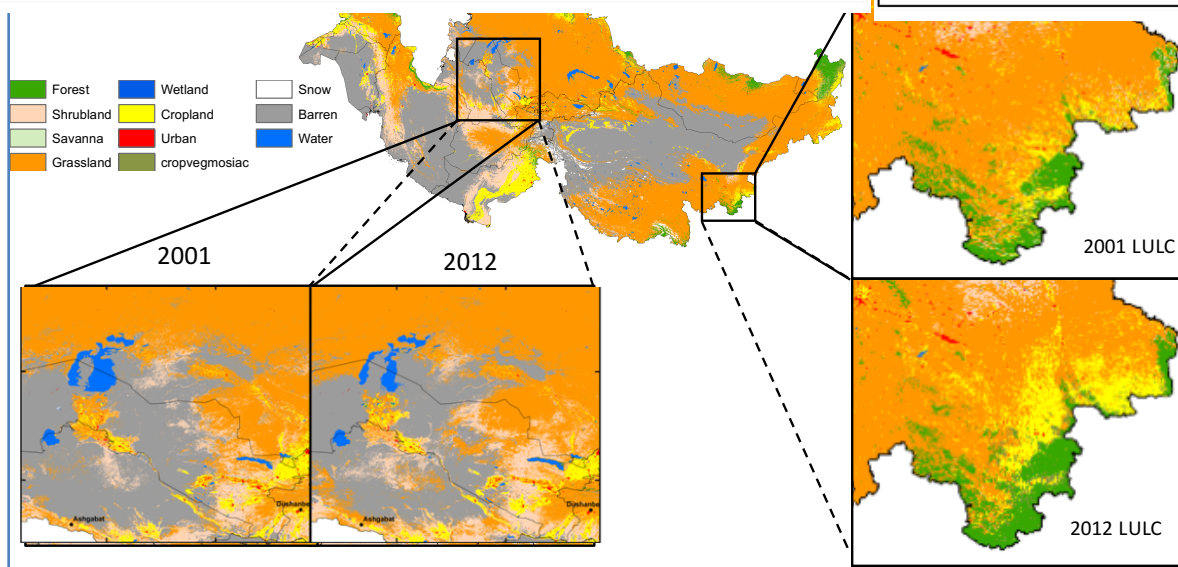
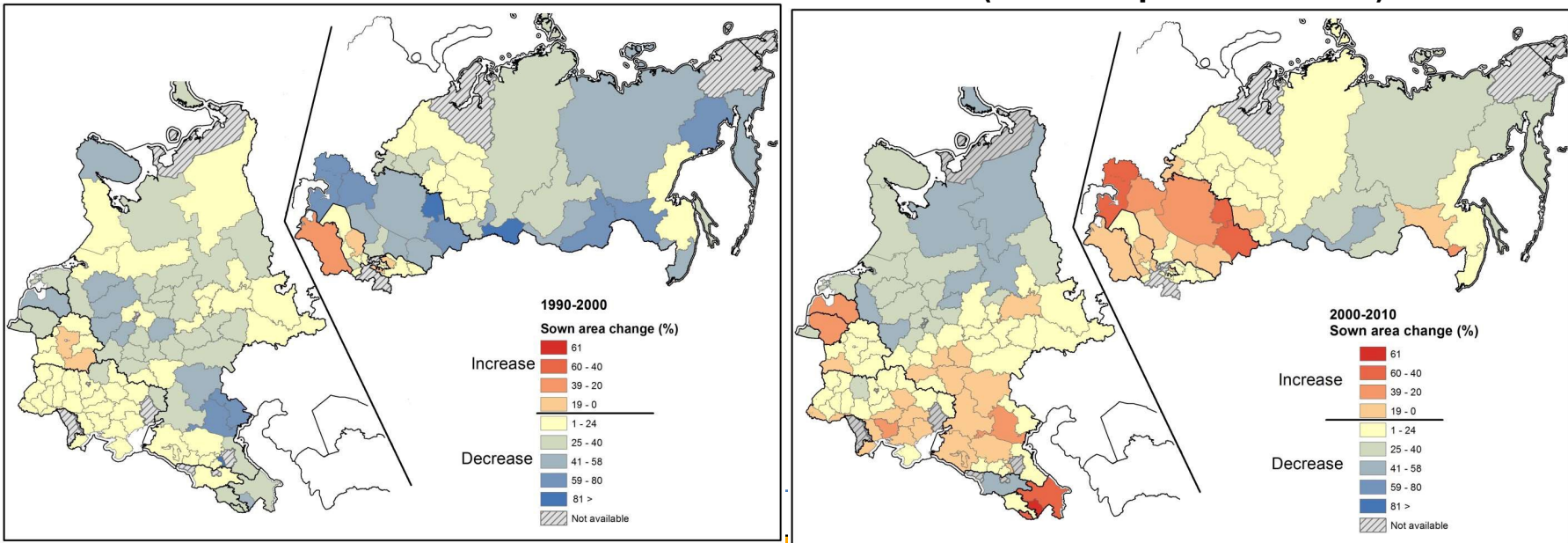


Future studies focus should be concentrated on

- Development of an integrated observing system on environment, land, landscapes and ecosystems;*
- Development of new classes of ecosystem process-based models on structure, growth, productivity and resilience of vegetation ecosystems as part of both integrated observing systems and scientific background of sustainable ecosystem management;*
- Developing integrated modelling clusters that would include ecological, social and economic components as the input to Earth system models*
- Developing strategies and policy recommendations for sustainable ecosystem management, adaptation to, and mitigation of, expected climate change.*

Research Focus: Pressure on agriculture and pastoral production

Land abandonment: Changes in sown areas across the former Soviet Union (left) from 1990 to 2000 and (right) from 2000 to 2010; areas of abandoned sown areas from 1990 to 2010 are: 40 Mha in Russia; 5.4 Mha in Ukraine; and 13 Mha in Kazakhstan (Prishchepov et al. 2016).



Agro-land losses:
LC/LU change in the Asian dryland belt from 2001 to 2012 (Qi et al. 2012, 2016).

Research Focus: Changes in infrastructure

Future studies within this focus should be concentrated on:

In High latitudes:

- Integrative analysis of the cumulative effects of infrastructure on social and natural systems and implications of climate and socio-economic changes on ecosystem services, residents, and industry;
- Developing adequate, economically-viable adaptation and mitigation strategies for northern communities and areas of intensive industrial development.

In the temperate zone of East Europe:

- *In-depth research of underlying and proximate land-use change drivers and socio-ecological interactions that cause land-cover change;*
- *Assessment of trade-offs between land-use and regional ecosystem services revealing optimal strategies for resource and climate-smart agriculture and land-use; and*
- *Studies of carbon management, CO₂ emissions, and short-lived climate pollutants.*

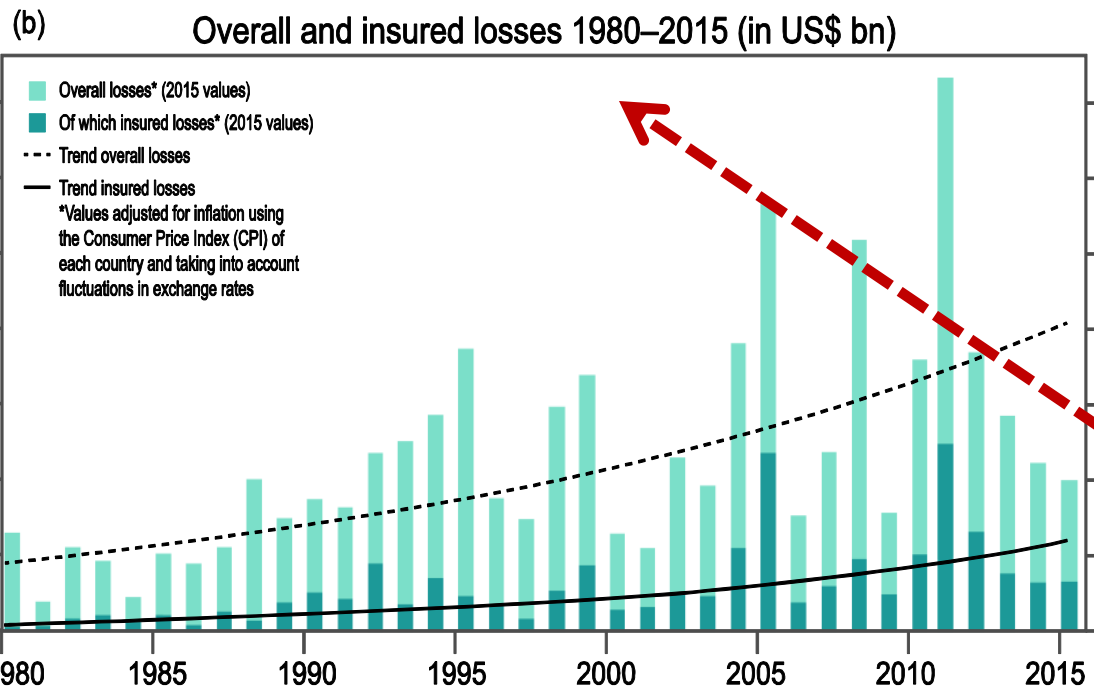
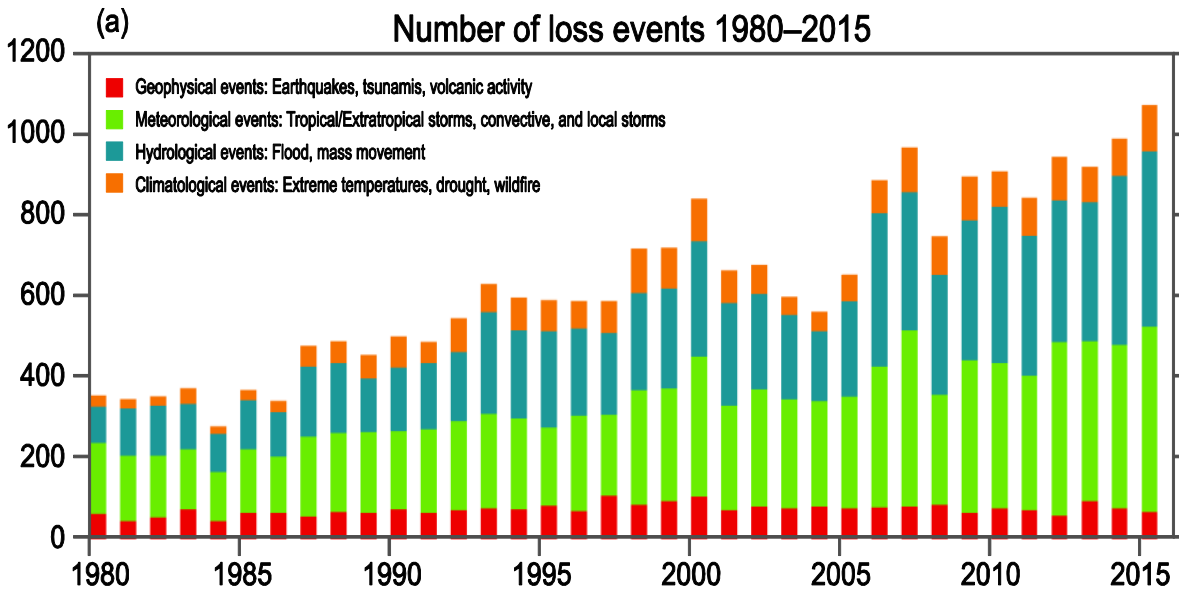
In the Taiga and Far East zones

- *integrated modeling of forest growth, fire, logging, infrastructure and other human land-use decisions, along with climate, providing the ability to build different scenarios of the future;*
- *Planning for sustainable future of regional communities involving legitimate economic uses of bio- and geologic resources which also preserve carbon sinks and biodiversity.*

In Central Asia, Mongolia and Northern China on answering the following questions:

- *How the infrastructure changes have facilitated regional food security from both production and consumption perspectives,*
- *If and how the major infrastructure changes reduced or escalated socioeconomic disparity at different spatiotemporal scales within and across the states in the region, and*
- *What are the critical infrastructures that would enable regional rural communities to improve their livelihoods.*

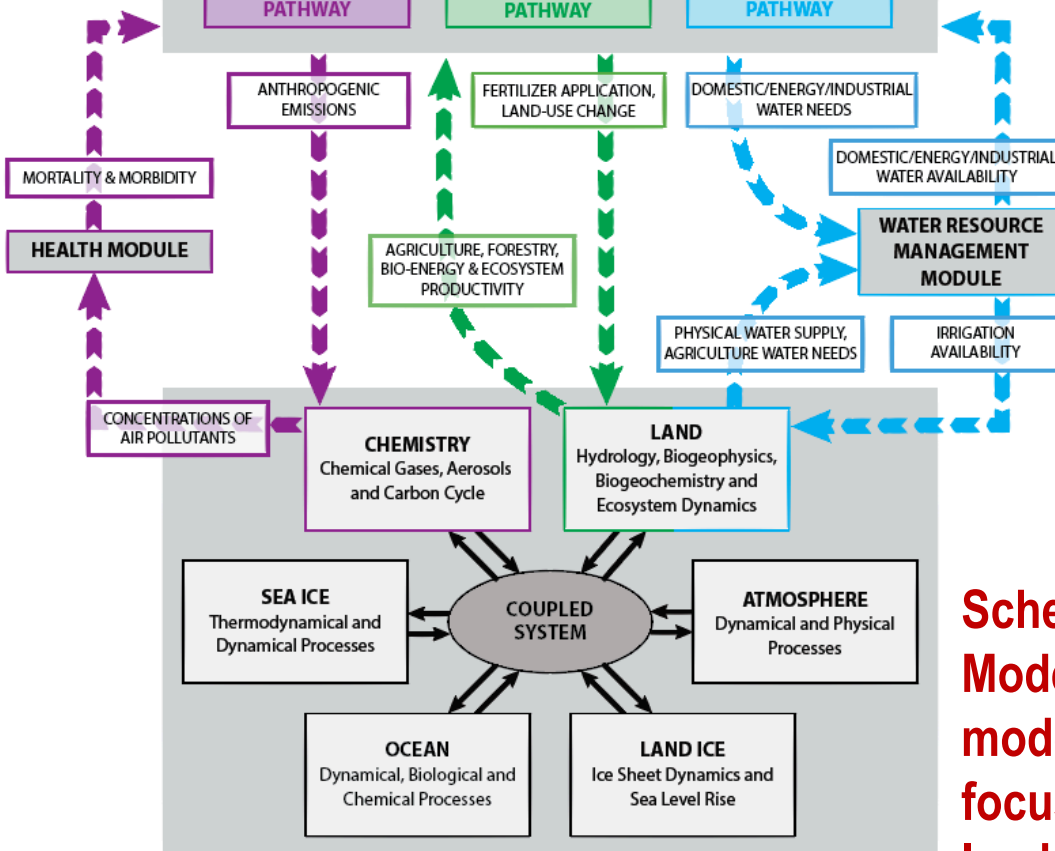
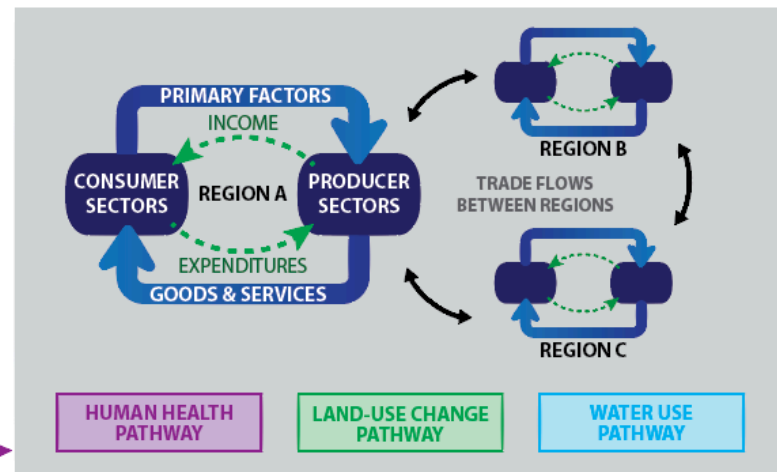
Research Focus: Societal feedbacks in response to environmental changes



Planning in order to be prepared for risks related to the **increasing possibility of changes and to reduce the adverse impact of disasters and increase resilience of the communities at risk is needed.** This planning should be based upon numerical experiments with models that realistically describe processes of environmental changes in all their complexity and interactions. *Future studies within this focus should be concentrated on development of such models with direct social feedbacks.*

The frequency and damage of the major natural and environmental disasters.
Source: Munich Re-insurance

HUMAN SYSTEM



EARTH SYSTEM

Research Focus: Role of Northern Eurasia in the global Earth and socioeconomic systems

Future studies within this focus should be concentrated on exploitation of a suite of regional process-oriented models, the Earth System models, and Integrated Assessment Models under different environmental and socioeconomic change scenarios with tracking the changes beyond the Northern Eurasia domain, i.e., teleconnections

Schematic of an Integrated Assessment Model (IAM) that couples a human activity model and an Earth system model with a focus on three feedback pathways: health, land-use change, and water resources.

**Transition from NEESPI to
“Northern Eurasia’s Future”
Initiative (NEFI)**

Future Earth:

New global platform for sustainability research launched in June 2014

- ***Future Earth*** – research for global sustainability, will provide a cutting-edge platform to coordinate scientific research which is designed and produced in partnership with governments, business and, more broadly, society.

Goal: **Interdisciplinary solution-oriented approach that will allow effective policy-making in environment management and control**

**MAIRS => Future Asia; BALTEX => Baltic Future;
NEESPI => “Northern Eurasia’s Future” Initiative (NEFI)**

Major NEESPI Science question remains intact:

- **How do Northern Eurasia's terrestrial ecosystems dynamics interact with and alter the biosphere, atmosphere, and hydrosphere of the Earth?**

But it is the time to expand this academic curiosity question “**how?**” to another, more practical:

- **What will the changes in this ecosystems dynamics and interactions mean for the societal well-being, activities, health, and strategic planning?**

NEFI Challenge

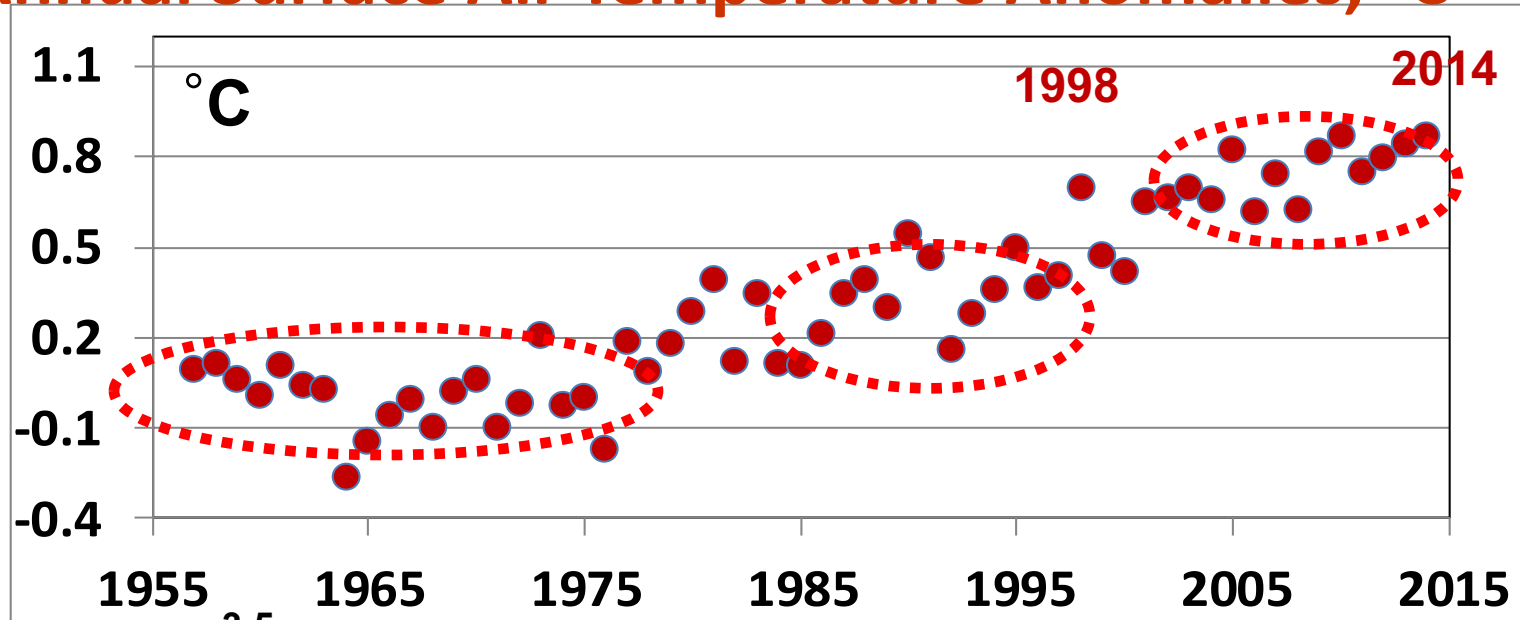
How to provide in Northern Eurasia a sustainable societal development (economy well-being, activities, health, and strategic planning) in changing climate, ecosystems, and... societies?

The latest events:

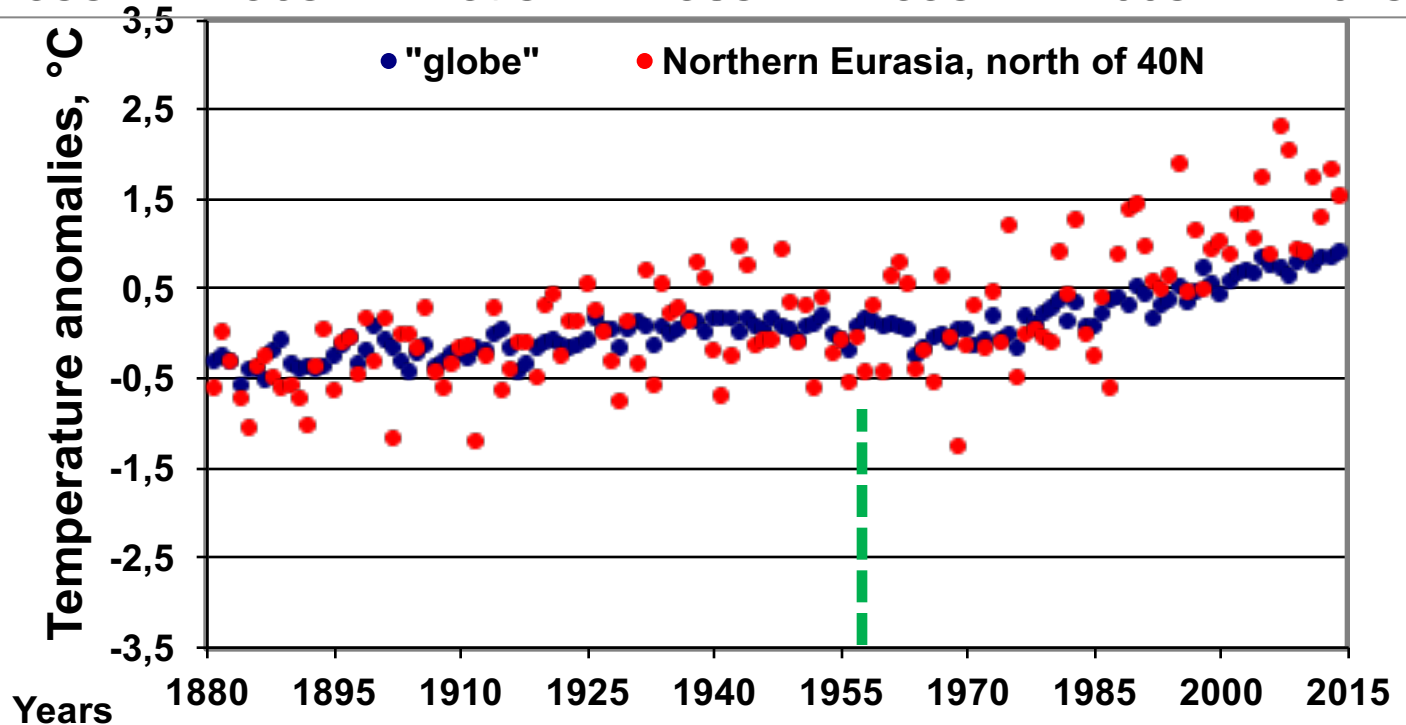
- **May 2016:** The NEFI White Paper (Science plan) has been completed and exposed for public comments at the NEESPI web site
- **June 2016:** We applied to the *Future Earth Program* leadership to consider NEFI as a regional component of the Program
- **July 14, 2016:** Invitation from the Journal of the Japanese Geophysical Union “*Progress in Earth and Planetary Science*” (**PEPS**) to submit the NEFI White Paper as a peer-reviewed manuscript.

Global Annual Surface Air Temperature Anomalies, °C

Global
temperature
anomalies



Rates of increase of
annual temperature
for the “globe” (60°S
to 90°N) and
Northern Eurasia are
0.96 °C/130 yr and
1.6°C/130yr
respectively (Lugina
et al. 2007, updated).



BARROW AK, USA
Population 4,212
71°17'44"N 156°45'59"W



New foci:
f. Transformation of
environment by man
and our need to survive
in this environment

NORILSK, RF
Population 175,365
69°51'N 88°13'E



TWO FACES OF THE ARCTIC

Courtesy of Prof. Nikolay
Shiklomanov, George
Washington University, DC, USA

