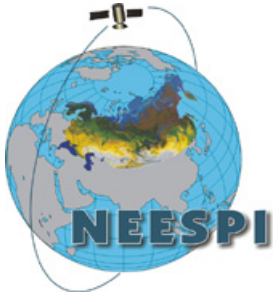
Northern Eurasia Earth Science Partnership



(NEESPI): An update

Pavel Groisman

UCAR Project Scientist at NOAA National Climatic Data Center, Asheville, North Carolina, USA

Richard Lawford

International GEWEX Project Office, Washington, DC, USA

Vladimir Kattsov

Voeikov Main Geophysical Observatory, St. Petersburg, Russia

Recognition

NEESPI is 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 Study Area includes: Former Soviet Union, Northern China, Mongolia, Fennoscandia, & Eastern Europe

NEESPI duration ~ 10 years

Current NEESPI Statistics (August 2009):

More than 560 scientists from more than 200 institutions of 30 countries are working on more than 130 individual funded projects under the Initiative umbrella (with annual budget ~$15M), several more projects are in the process of joining NEESPI.

Additionally, NEESPI receives in kind assistance from EU, US, Russian, Chinese, Japanese, Ukrainian and International Agencies and Institutions.

NEESPI Outreach, http://neespi.org

During the past 3 years, 23 dedicated NEESPI Workshops and 6 NEESPI Open Science Sessions at the International Meetings were convened and more than 350 papers and books were published (the total number of publications exceeds 500).

In April 2007: 1st Special NEESPI issue (13 papers) in *Global and Planetary Change*

In December 2007: 2nd NEESPI Special issue in *Environmental Research Letters* (15 papers)

In April 2009: Book **"***Regional Aspects of Climate-Terrestrial-Hydrologic Interactions in Non-boreal Eastern Europe"* Groisman and Ivanov (Eds.) published by Springer Verlag.

In May 2009: An overview NEESPI paper in *Bull. Amer. Meteorol. Soc.*

Current situation:

- Two more books are *in press*.
- Submissions of papers to the 3rd NEESPI Special issue in *Environmental Research Letters* is open (we anticipate that ~35 papers will be submitted)
- Book "*Regional Environmental Changes in Siberia and Their Global Consequences"* is in preparation (scheduled for autumn 2010)

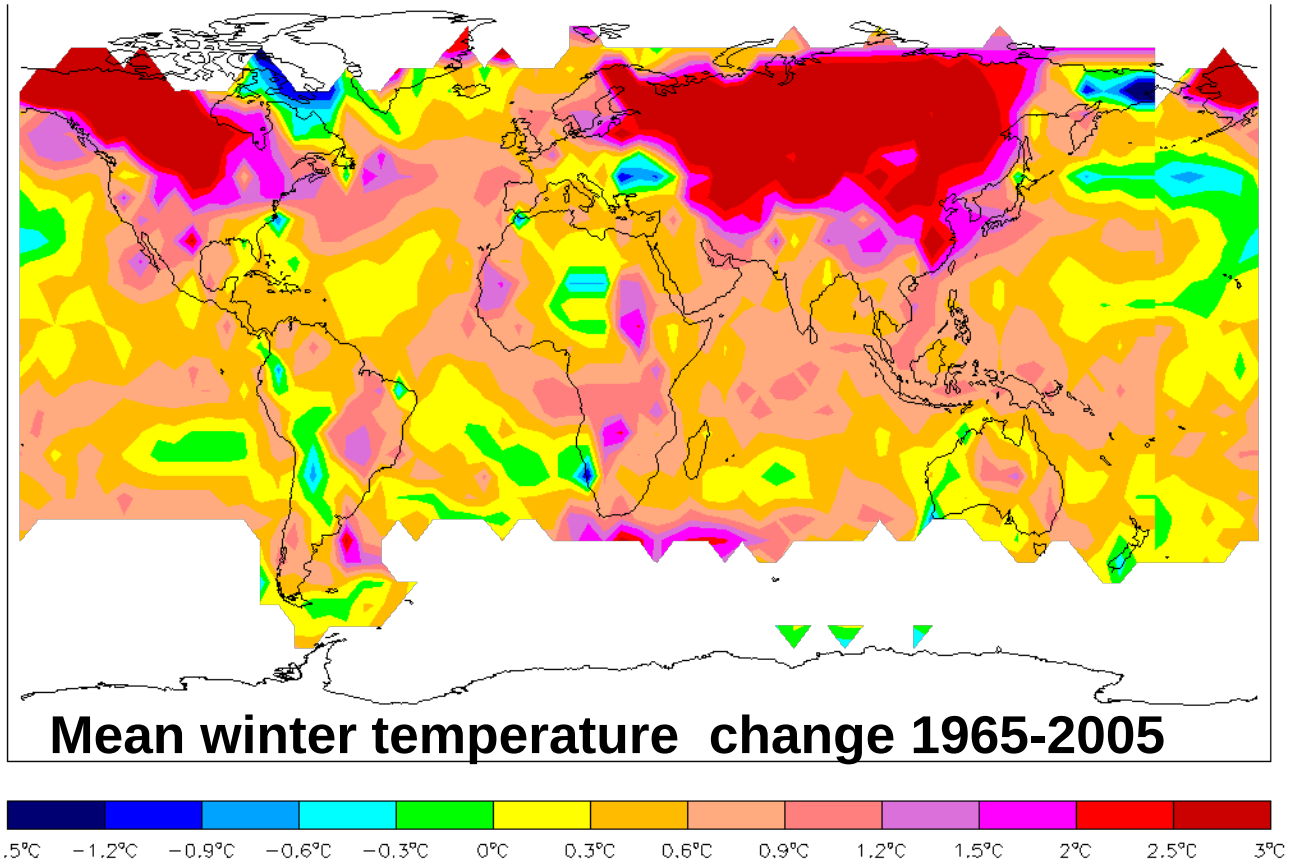
Latest large NEESPI gatherings:

- **June 2-6, 2008, Helsinki, Finland. Regional NEESPI Science Team Workshop "Environmental and Climate Change in High Latitudes of Northern Eurasia**
- **August 23-28, 2008, Odessa, Ukraine. Regional NEESPI Science Team Workshop "Regional aspects of climate-terrestrial-hydrologic interactions in non-boreal Eastern Europe"**
- **15-19 December 2008, San-Francisco, USA. NEESPI Session at the Annual Fall AGU Meeting**
- **4-6 March 2009, St. Petersburg, Russia. NEESPI programmatic Workshop "Hydrological application of changes in land cover/use, water management and climate across Northern Eurasia"**
- **April 20-23, 2009, Vienna, Austria. NEESPI Session at the EGU General Assembly 2008.**
- **April 24, 2009, Sopron, Hungary. First Consultative Workshop of the Regional NEESPI Research Center for Non-boreal Southeast Europe**
- **July 14-15, 2009, Krasnoyarsk, Russia. Regional Workshop devoted to Siberia**

Nearest future

- **Sept. 9-15, 2009, Bishkek, Kyrgyzstan. Regional Event devoted to High Elevation Studies (summer school, and two workshops)**
- **NEESPI Sessions at the Annual Fall AGU Meeting (Dec. 2009, San Francisco, California, USA) and at the Annual EGU Assembly (May 2010, Vienna, Austria)**

NORTHERN EURASIA IS IMPORTANT BECAUSE:



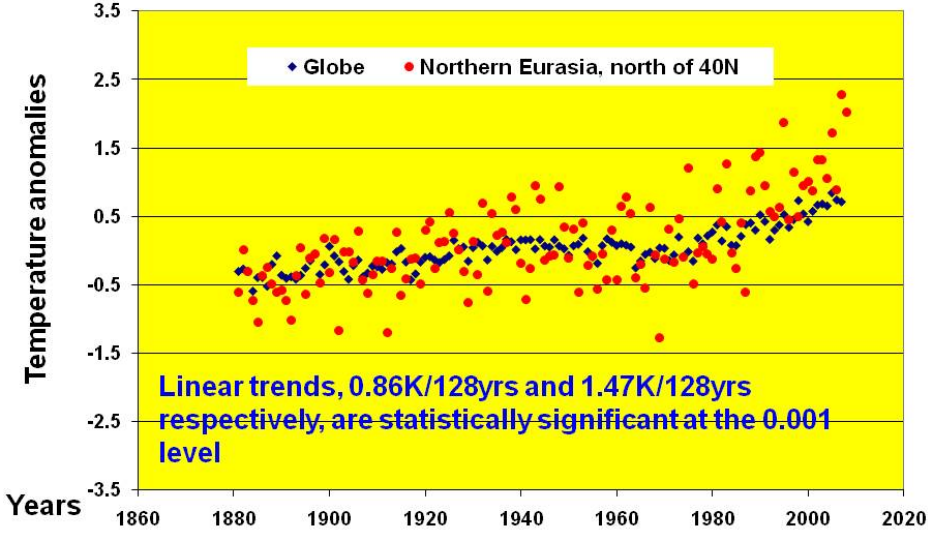
Large climatic & environmental trends have been occurring in the region and these changes will have global impacts and feedbacks.

The region contains at least two major growing geopolitical powers.

Why contemporary climatic changes in Northern Eurasia force us to be expedient in our research?

Firstly, changes are accelerating, particularly, in Siberia => eight new NEESPI projects with their foci on Siberia (with total budget of ~ 4M $US) were launched in 2009.

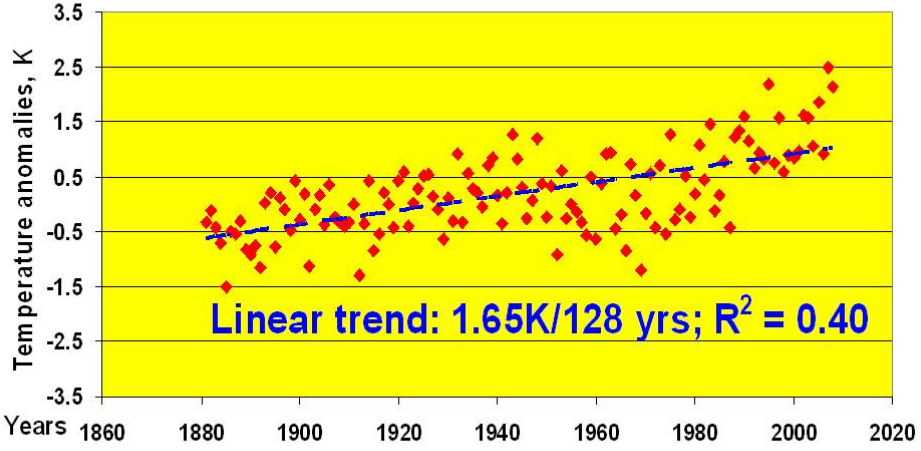
Global (latitudinal zone from 60°S to 90°N) and Northern Eurasia (north of 40° N) surface air temperature anomalies, 1881-2008



(Archive of Lugina et al. 2007 updated).

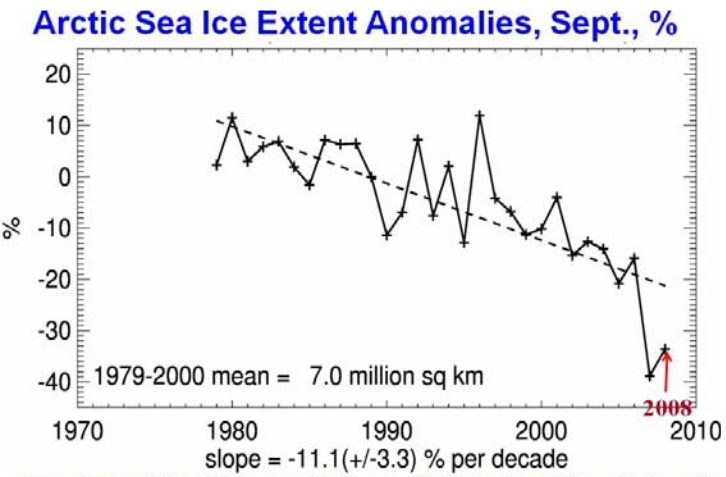
Northern Asia, north of 40°N. 1881-2008.

Surface air temperature anomalies from the 1951-1975 reference period



During the past twenty years, all anomalies were above 0.5K and eight of them were above 1.5K. Year 2007 showed a record anomaly of 2.5K.

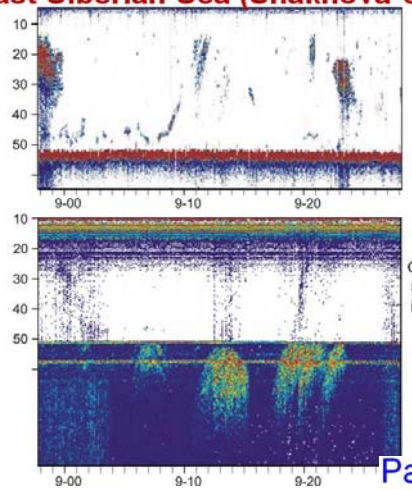
Secondly,



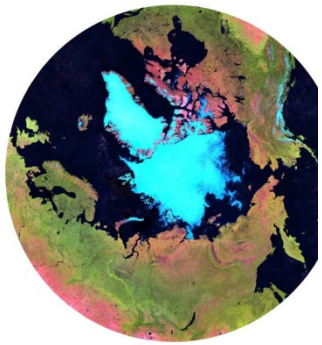
Courtesy of Dr. Florence Fetterer, NSIDC, Boulder, Colorado

- We are facing a non-linearity in environmental and climatic changes in Northern Eurasia right now due to
  - Dramatic retreat of the Arctic sea Ice that is causing rampaged coastal erosion (up to 10 m yr^{-1}), release of carbon (both, methane and CO_2) stored in the frozen shelf and coast, and additional source of heat and moisture in early winter
  - Impact on the World Ocean thermohaline circulation due to changes in the fresh water inflow into the Arctic Ocean
  - Feedbacks to the global carbon budget and climate due to permafrost thaw, wetlands transformation , land cover changes, and ecosystems shift

Methane bubble release from the seabed in the East Siberian Sea (Shakhova et al. 2009).



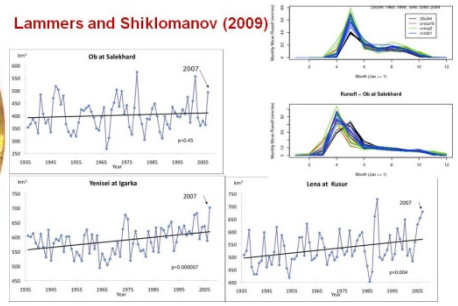
Pan-Arctic Ocean Drainage



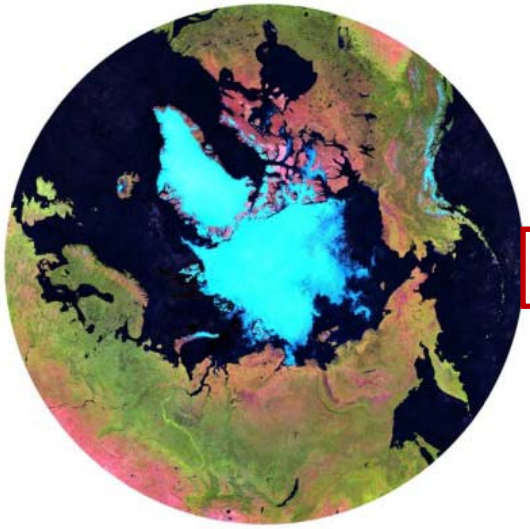
Terra-MODIS RGB, July-Sept 2008, 250 m resolution. Courtesy of Dr. Alexander Trishchenko, Chief, Canada Centre for Remote Sensing

Runoff changes in the deltas of three major Siberian rivers. Observations and future projections

Lammers and Shiklomanov (2009)

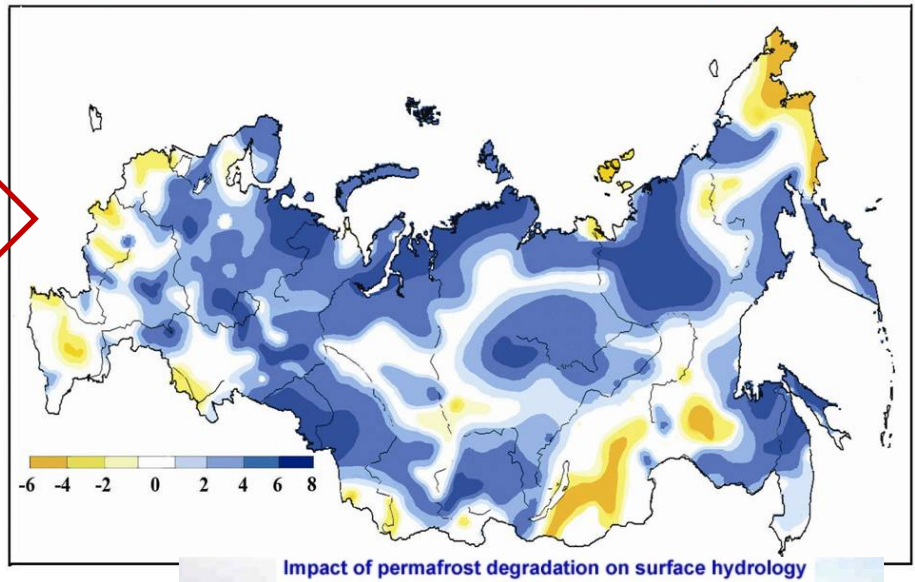


Each picture on the previous slide can be expanded into a story using recent NEESPI results. Two examples:



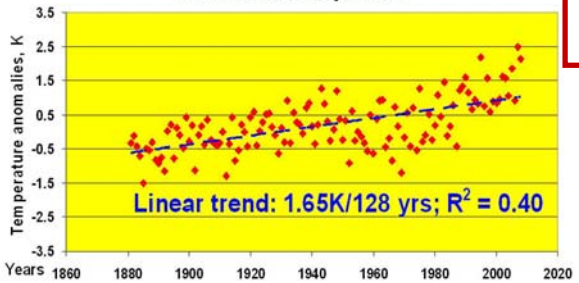
Observed sea ice retreat => more atmospheric moisture in early winter over usually dry continent => deeper snow cover over Eurasia (Bulygina et al. 2009)

Number of days with deep snow cover on the ground (> 20 cm). Linear trends for the 1951-2006 period; [days/10yr]



Northern Asia, north of 40°N. 1881-2008.

Surface air temperature anomalies from the 1951-1975 reference period



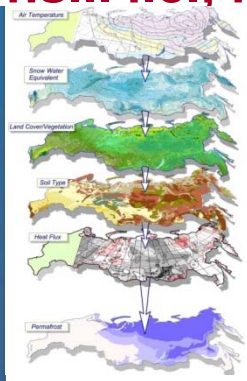
During the past twenty years, all anomalies were above 0.5K and eight of them were above 1.5K. Year 2007 showed a record anomaly of 2.5K.

Dramatic warming in Siberia => projected land cover change (cf., Vygodskaya et al. 2007) begins earlier => after forest fire and permafrost thaw the forest is being replaced by steppe

Impact of permafrost degradation on surface hydrology and vegetation

Thawing of ice-rich permafrost, triggered by the forest fire in Central Yakutia, transforms boreal forest into steppe-like habitats (photo by V. Romanovsky)

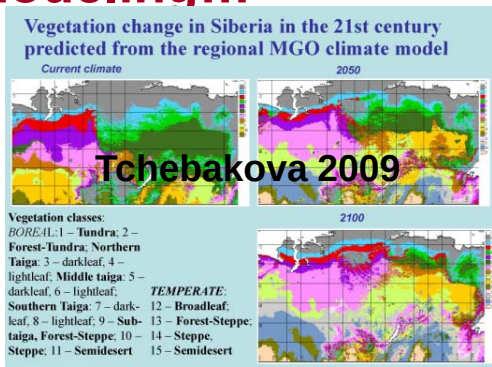
First phase foci of NEESPI were monitoring and analyses. **After the NEESPI Workshop in August 2007 at the Aspen Global Change Institute, a new course was accepted towards strengthening of the NEESPI research focus on projections... i.e., focus on modeling…**

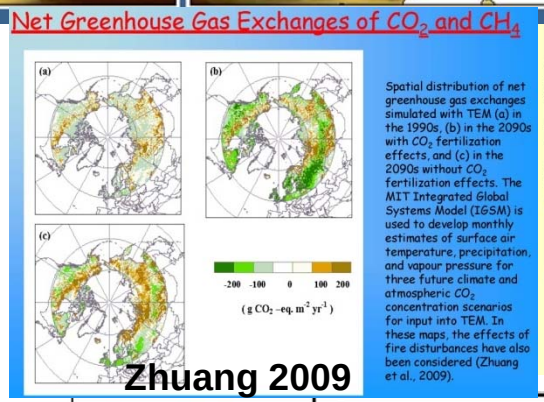


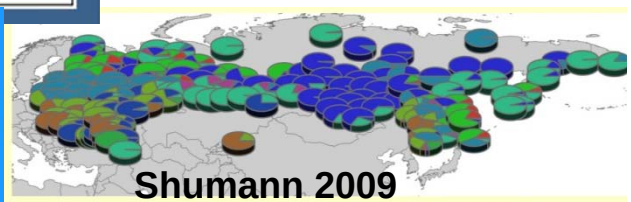
GIPL-2 Model

The GIS multi-layered Data Base interactive model for Spatially Distributed Permafrost and Active Layer Dynamics modeling in the Northern Eurasia.

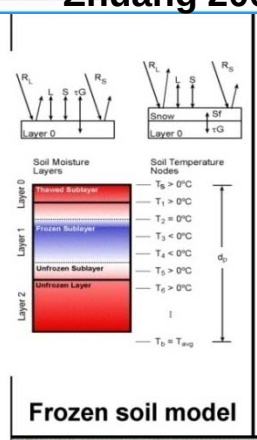
(Marchenko et al., 2008)

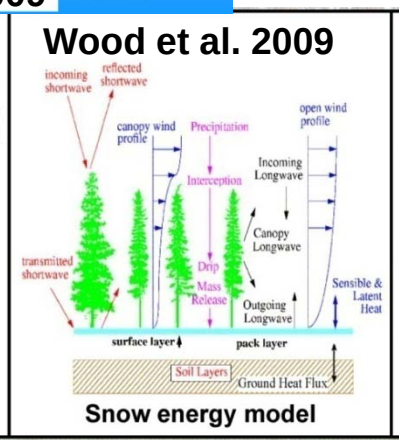


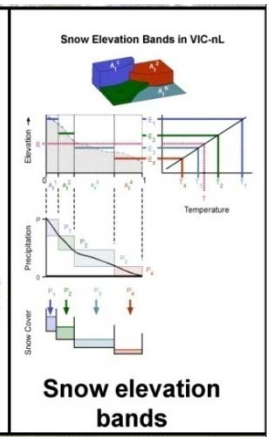


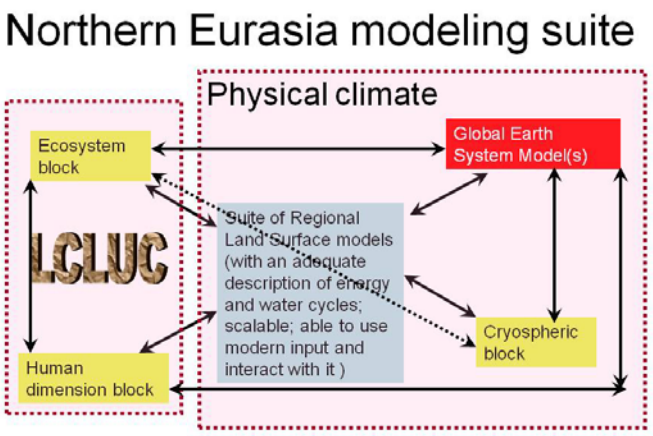


Efforts are made to blend modern RCMs with vegetation, carbon flux, permafrost, hydrological, and dust production models within a North Eurasia modeling suite and link it to the MIT Earth System model.





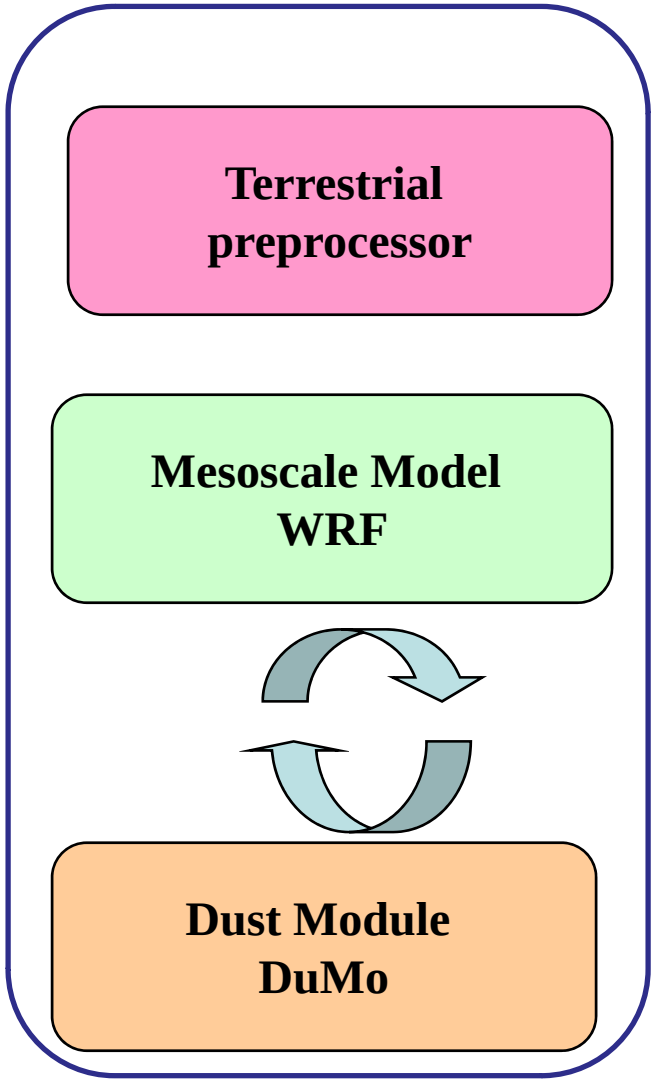




Each picture in the previous slide represents a specialty model (or a configuration of models) and/or recent results of their application within the NEESPI domain

- VMGO Regional Climate Model (Shkolnik et al. 2008)
- Results of coupling of VMGO RCM with Siberian biospheric model (Thebakova et al. 2009)
- Permafrost dynamic model (Marchenko et al. 2008)
- Terrestrial Ecosystem Model (Zhuang et al. 2009)
- Application of GAP model driven by in situ data (Shuman et al. 2009)
- Specialty modifications to VIC hydrological model to handle the cold regions changes (Wood, Troy, et al. 2009)
- MIT Earth System Model (Sokolov et al. 2009)
- A coupled regional modeling system WRF-DuMO (Darmenova et al. 2009**; illustrated in detail in the next two slides)**

Example: A coupled regional modeling system WRF-DuMO



- Adjustable water/land cover mask to reproduce different historical LULC scenarios in Central and East Asia;
- Data base of land properties for dust emission

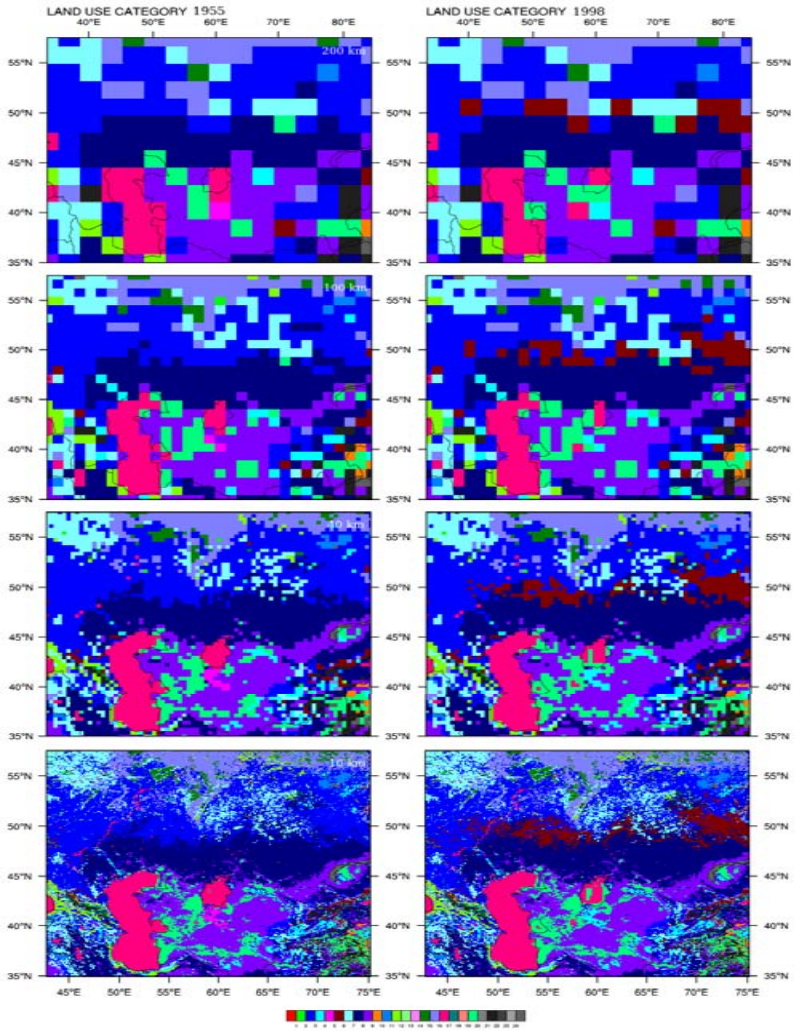
- Flexible nesting capability (down to 1 km)
- Driven by re-analysis data (NCEP or ECMWF)

- Physically based-dust production schemes (coupled with the land model)
- Physically based-treatments of size-resolved dust composition

Darmenova, K., I.N. Sokolik , Y. Shao, B. Marticorena, and G. Bergametti, 2009: Development of a physically-based dust emission module within the Weather Research and Forecasting (WRF) model: Assessment of dust emission parameterizations and input parameters for source regions in Central and East Asia . *J. Geophys. Res.*, 114, D14201, doi:10.1029/2008JD011236.

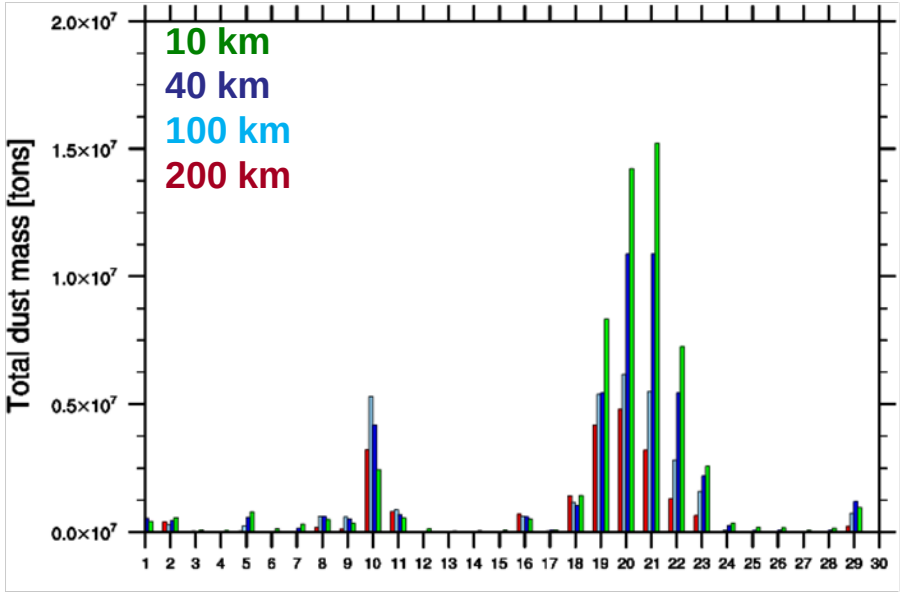
Dust emission modeling with WRF-DuMo

Land-use/land-cover changes in Central Asia
1950s vs. 1990s
Model's grid size: 200, 100, 40 and 10 km



WRF-DuMo simulations performed for representative grid sizes reveal that GCM-like models significantly underpredict dust emission and hence dust burden in the atmosphere and associated impacts.

IPCC assessments (performed with GCMs) of radiative forcing of dust aerosol impacts on climate have significant biases, especially in regions affected by land-cover/land-use changes.



Time series of daily dust loadings simulated with WRF-DuMo at four model grid sizes (April 1955)

Five NEESPI Science and Data Support Centers provide information for the NEESPI domain according to their functions:

- **Within the United States**
- ***For hydrometeorological information:***
- ***National Climatic Data Center, Asheville, NC***
- ***For remote sensing information:***
- ***Goddard Space Flight Center, Greenbelt, MD***

Within the Russian Federation

- ***For hydrometeorological information:***
- ***Research Institute For Hydrometeorological Information, Obninsk, Kaluga Area***
- ***For remote sensing information:***
- ***SCANEX Corp., Moscow***

Within China

- ***Beijing Climate Center***

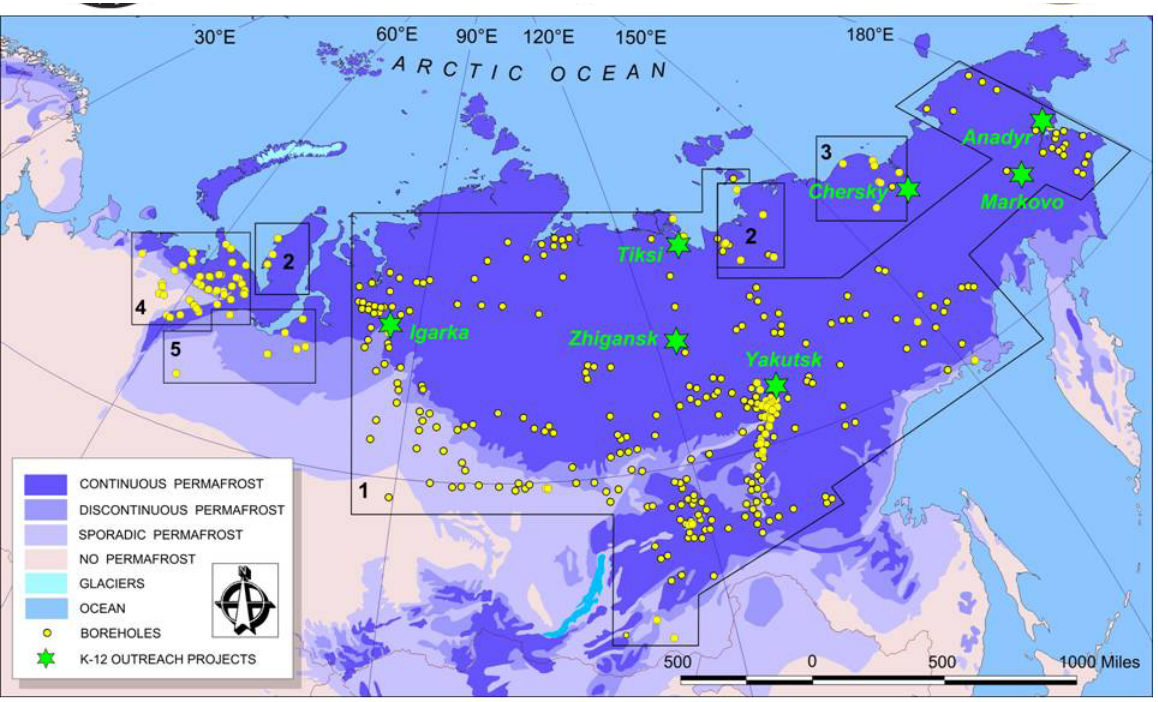
Additionally:

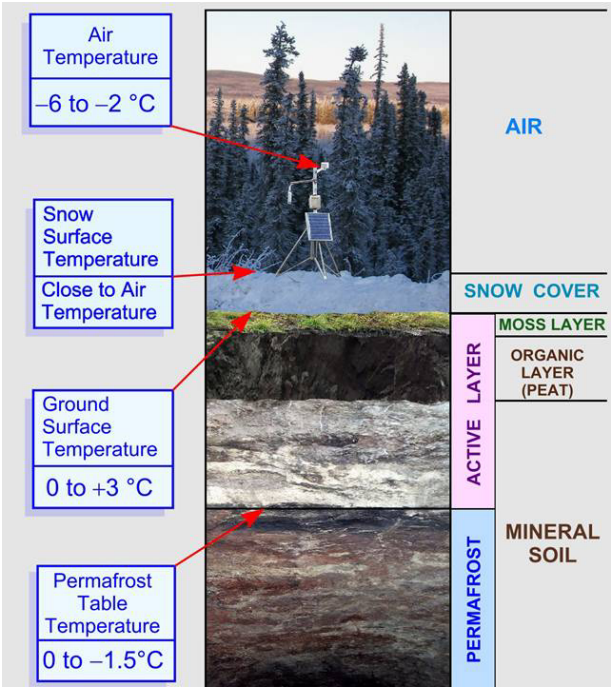
Metadata of all environmental data sets that are available for the NEESPI scientists are conveniently located at http://wwwdata.forestry.oregonstate.edu/MDEDIT/index.aspx

NEESPI Data Policy was accepted several years ago and is available at: http://neespi.org/web-content/meetings/IIASA/NEESPI_Data-Publications-policies_final.pdf

Data sets collected within the NEESPI domain that are of particular interest for CEOP. Part 1.

Soil temperature profiles across the permafrost areas of Northern Eurasia collected within several international projects. Borehole locations coincide with CEOP MOLTS and the data are archived in JOSS





Data sets collected within the NEESPI domain that are of particular interest for CEOP. Part 2.

Data of two **currently active** Siberian Observatories maintained by Max Planck institute for Biogeochemistry, Jena, Germany:

Zotino, 60.75N 89.38E

- 1998-2001 (Project Eurosiberian Carbonflux), 2002-2005 (Project TCOS-Siberia)

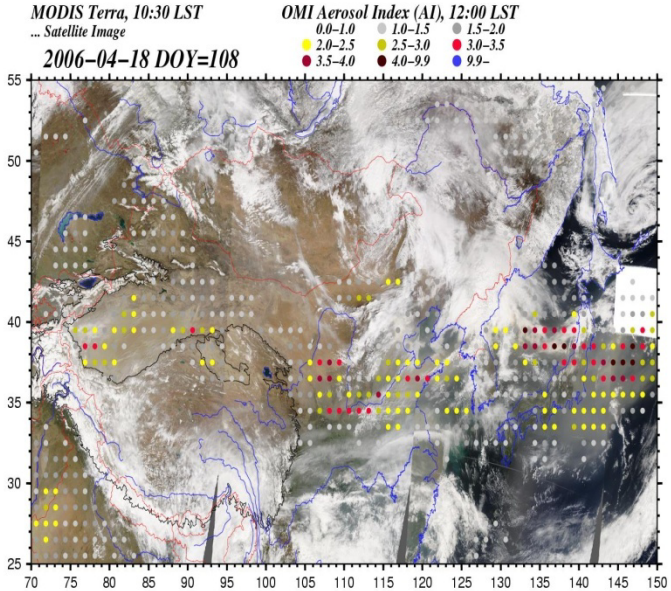
Cherskii, 68.50N 161.20E

- 2003-2005 (Project TCOS-Siberia)

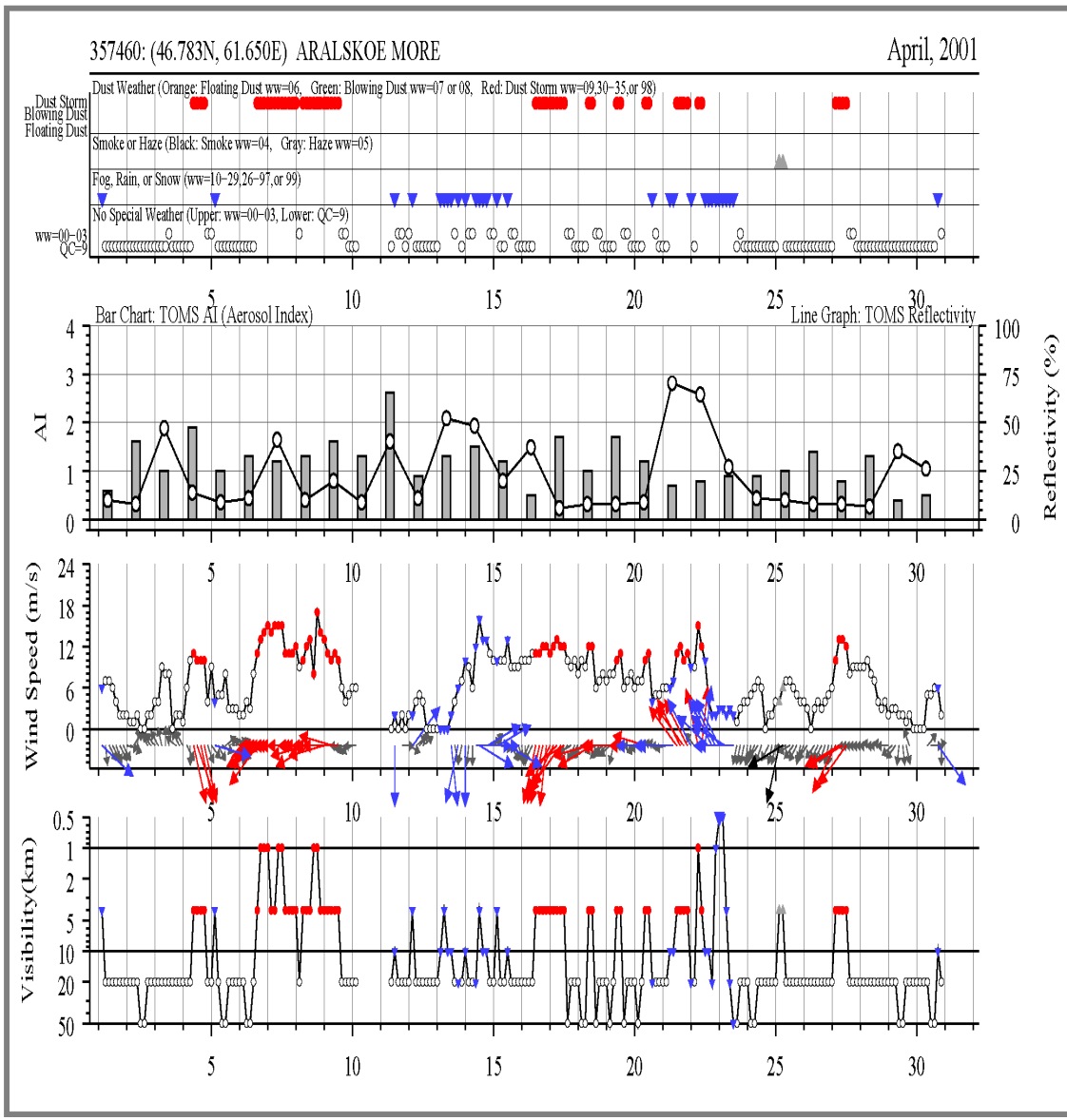
Both sites have SFC, TWR, STM, FLX observations processed according to the CarboEurope standard flux data base protocol. Time frame of transfer to the CEOP Archive: September 2009. The sites are included in CEOP MOLTS.

POC - Prof. Martin Heimann, Director MPI-Jena.

Part 3. Asian Dust Databank (an observation-based climatology of dust events for the past 50 years)



Examples of integrated analysis of satellite and ground-based observations. The upper panel shows satellite data of MODIS/Terra and OMI AI on April 18, 2006. The right panels show time series of visibility, wind speed & direction, TOMS AI & reflectivity, and WMO present weather during April 2001 for Aralskoe More meteorological station (Kurosaki and Sokolik, *J. Climate*, 2009).



Russian Global NWP model SL-AV: Current state, planned developments, and future CEOP contributions.

Prof. Mikhail Tolstykh, RAS Inst. of Numerical Math. and Hydrometcentre of Russia. Personal Communication

Description. Dynamical core of own development (vorticity-divergence semi-Lagrangian semi-implicit formulation on the unstaggered grid; 4th order finite differences); Model was validated in Held-Suarez test (3yr integration)

Medium-range weather forecast version: 0.9° x 0.72° , 28 (operat.) & 50 levels;

New version: 0.45° x 0.37 ° , 50 levels, microphysics: ALARO-0 –under testing.

Seasonal forecast version: 1.40625° x 1.125° degrees, 28 levels

Subgrid-scale parameterizations from French model ARPEGE/ALADIN (ALARO branch), incl. ISBA scheme and its assimilation.

Current activities: Development of locally mass-conserving semi-Lagrangian advection on a reduced lat-lon grid; Parameterization of peatland (important for T2m forecast in Siberia); Development of LETKF data assimilation

Planned activities: 1) Multilayer soil; 2) Permafrost in seasonal forecast version; 3) Ozone cycle; 4) Bonan's vegetation scheme

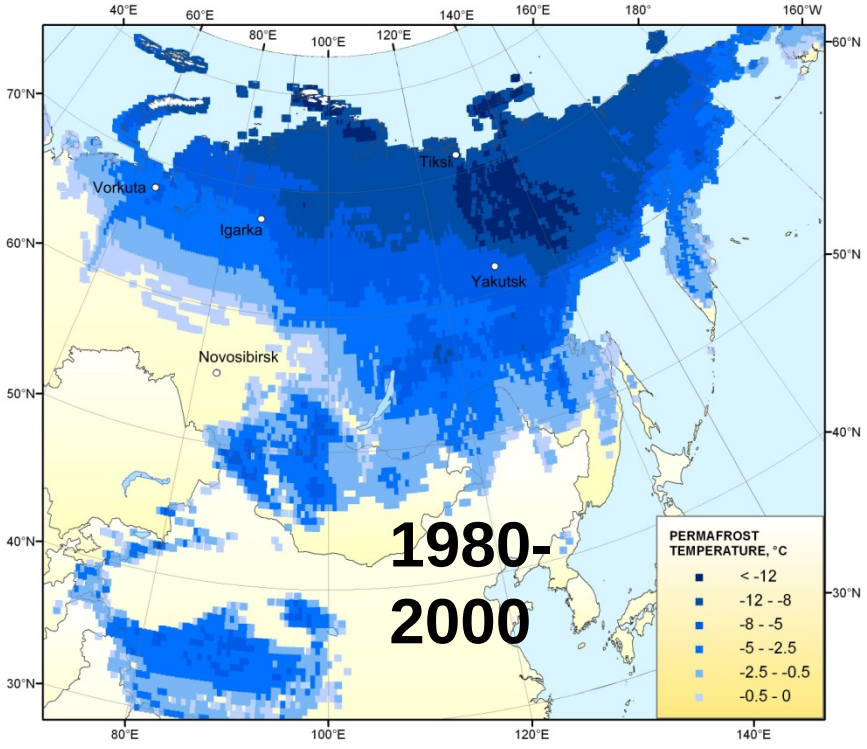
The modelers' team could do MOLTS and is preparing to meet the CEOP requirements for this action

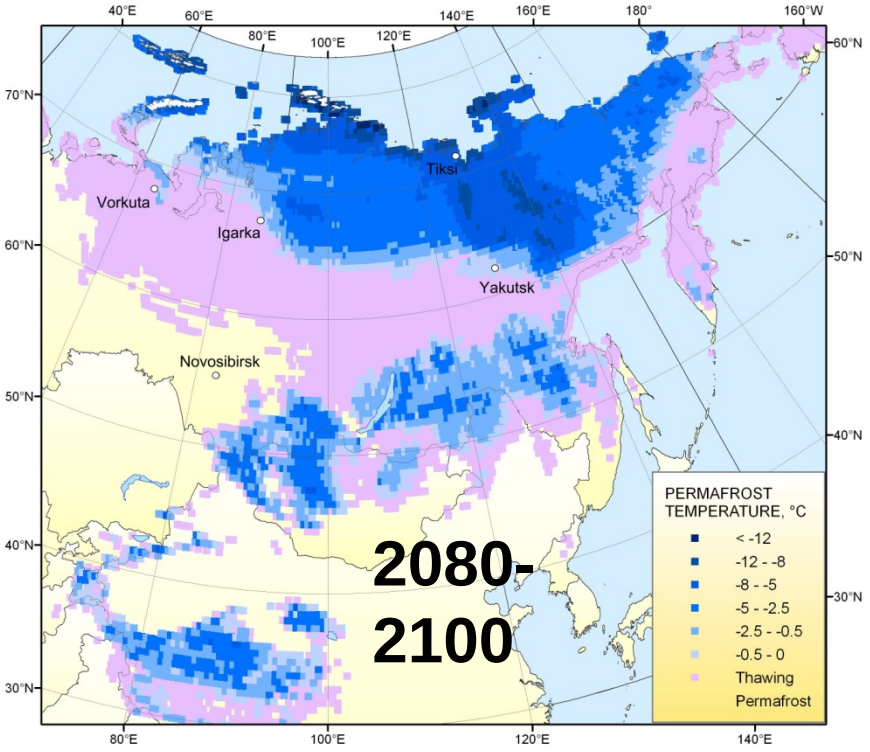
NEESPI Plans

- **Successfully complete the current set of funded projects**
- **Continue monitoring and process studies with a priority attention to the "hot" spots revealed in the NEESPI domain:**
  - **Cold land areas (particularly, in the permafrost zone)**
  - **Dry land belt of Northern Eurasia**
- **Maintain a set of Land observatories (e.g., Fedorovskoe, Zotino, Valdai, Cherskii, Tiksi, and others) to secure a representation of unique NEESPI domain features for the process studies**
- **Continue strategic efforts to blend within a modern Northern Eurasia Suite of Models regional climatic, vegetation, carbon, cryospheric, hydrological, land use, and dust production models and link the Suite to the Global Earth System models. This Suite, when it become fully operational, will complete the main NEESPI science objective.**

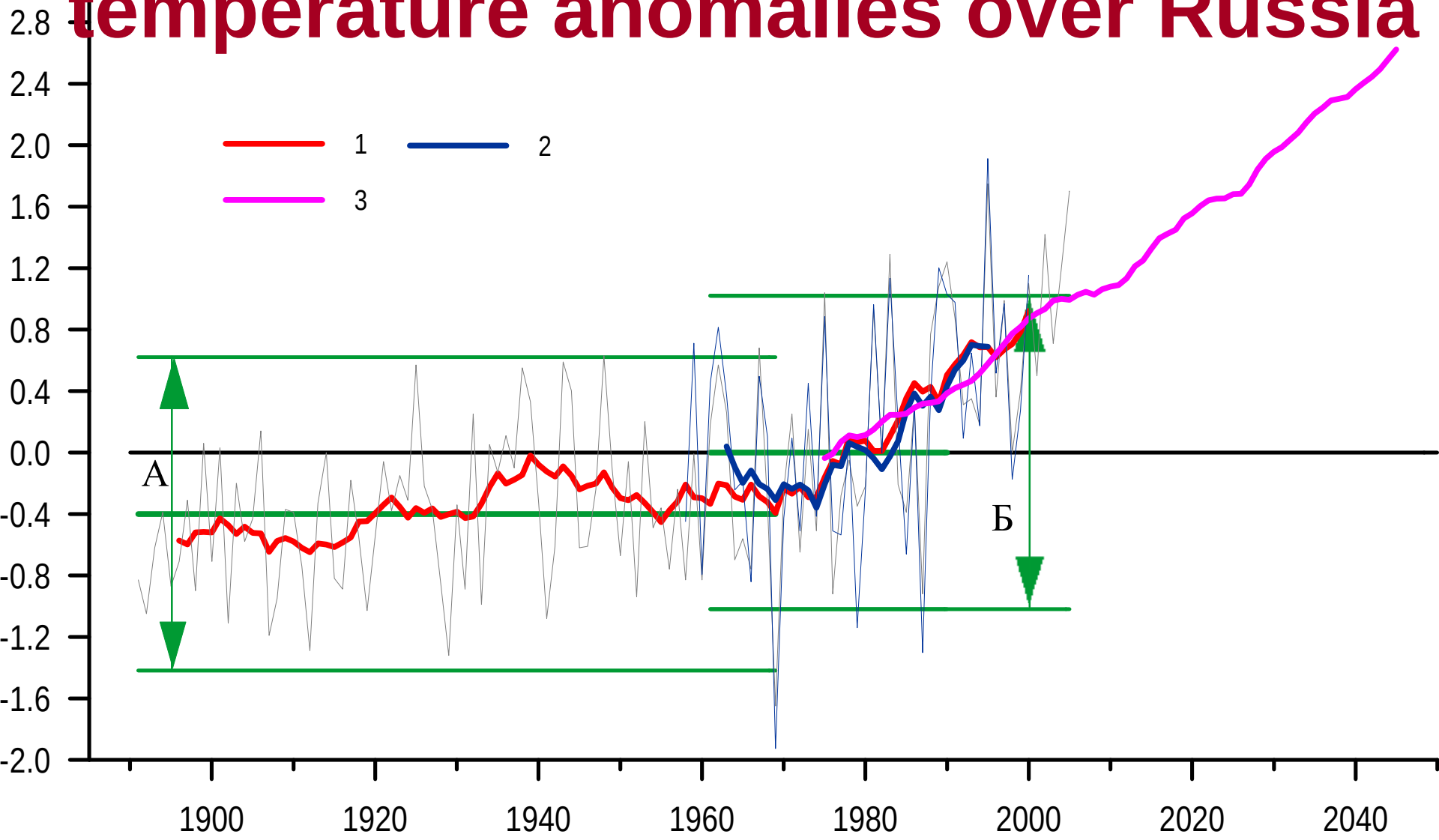
Reserve

Modeled permafrost temperatures in Northern Eurasia (mean annual temperature at the permafrost surface).





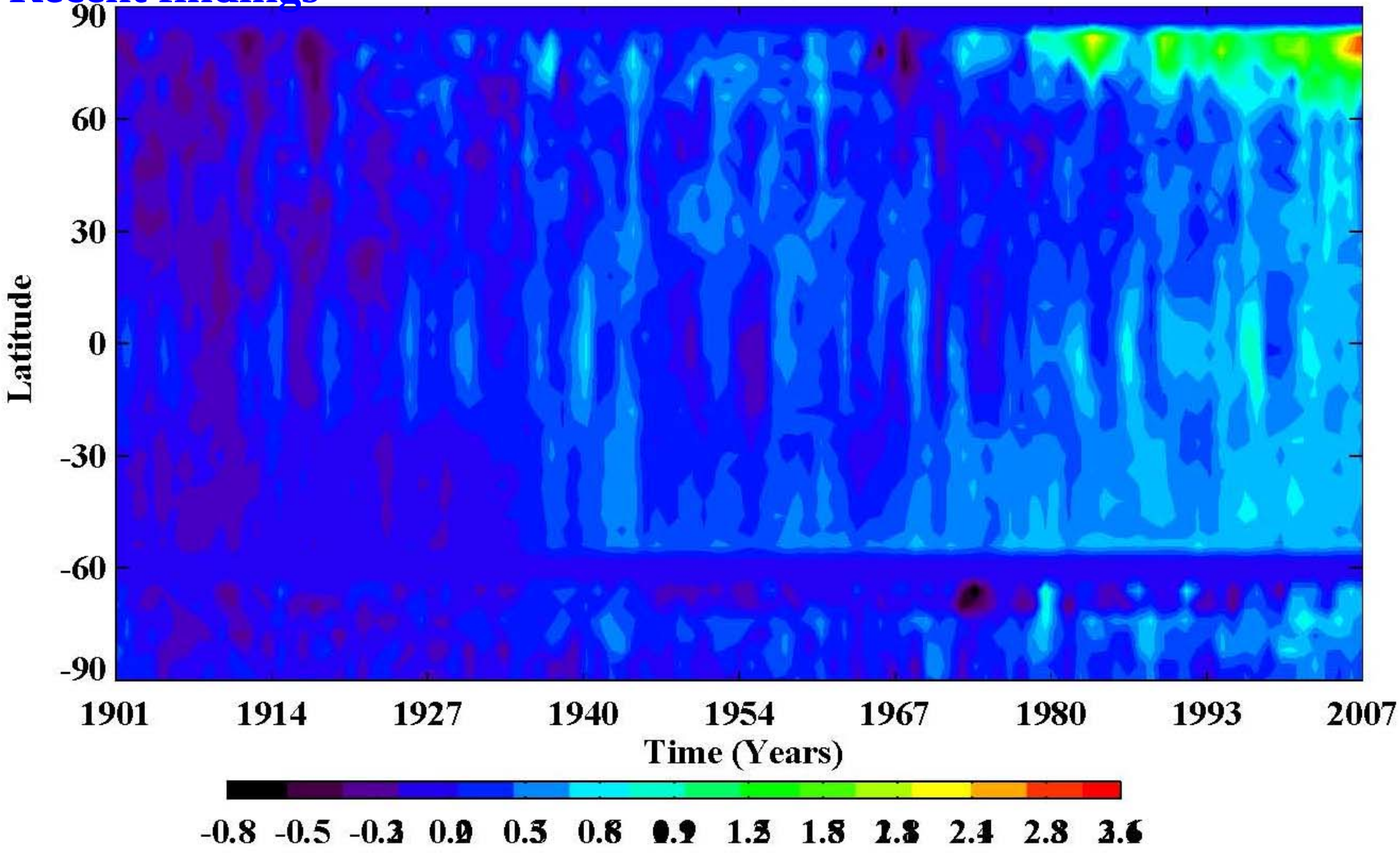
Observed and projected surface air temperature anomalies over Russia



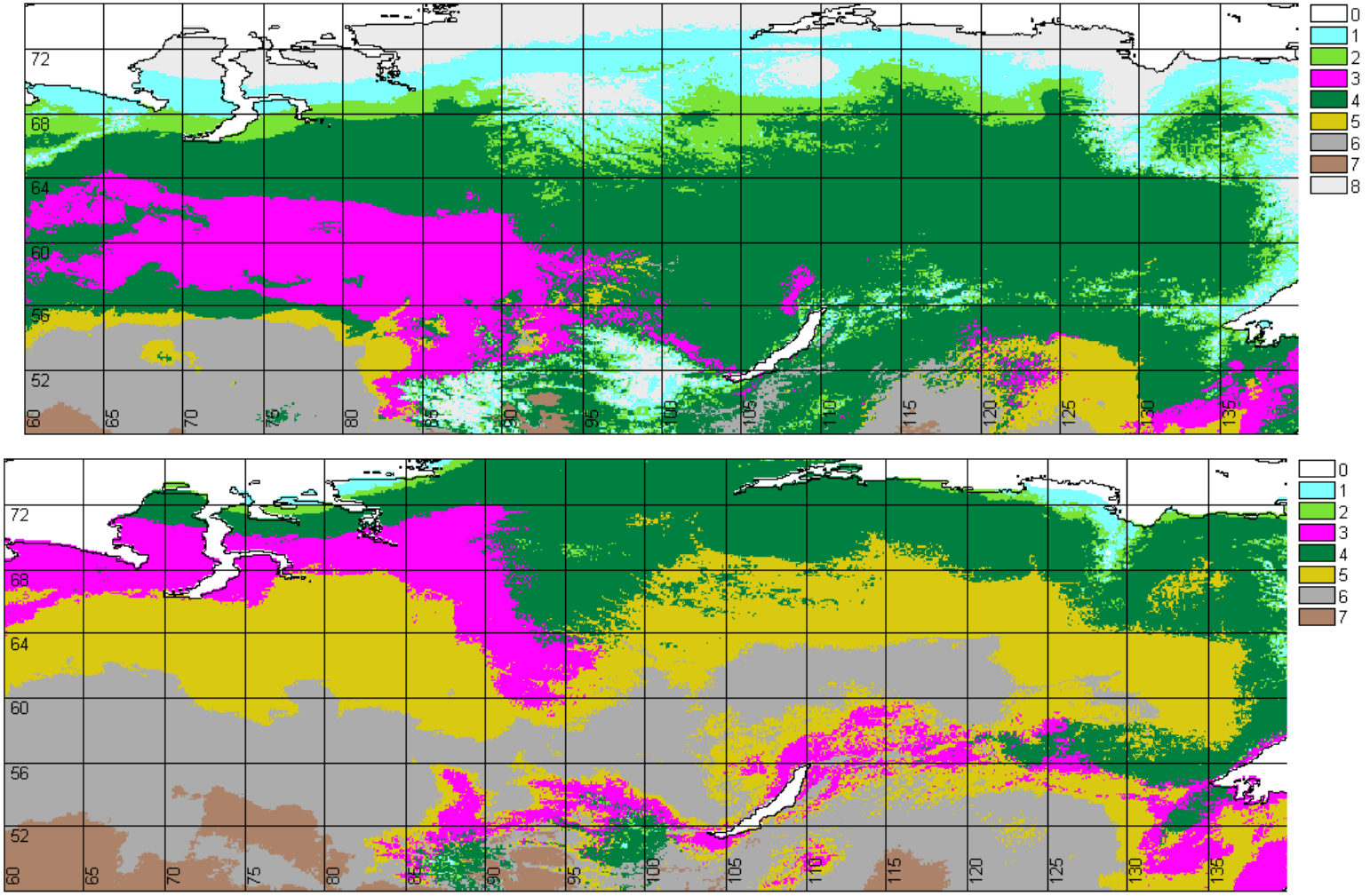
(1) station data, (2) reanalyzed (ERA-40) data, and (3) simulated /projected by 17-member ensemble of the latest IPCC Global Climate Models in a “business as usual” scenario (Meleshko et al. 2007) .

Annual land surface air temperature changes due to "forcing" by SST and sea ice changes (Sokolov 2008)

Recent findings



Biome distribution over Siberia in current (a) and 2090 (b) climates (Vygodskaya et al. 2007)



Water (0),Tundra (1), forest-tundra (2), darkleaf taiga (3) and lightleaf taiga (4), forest-steppe (5), steppe (6), semidesert (7), and polar desert (8).