Northern Eurasia Earth Science Partnership

Pavel Groisman

LCLUC, climate, environment and carbon in the NEESPI Program: An update

Recognition

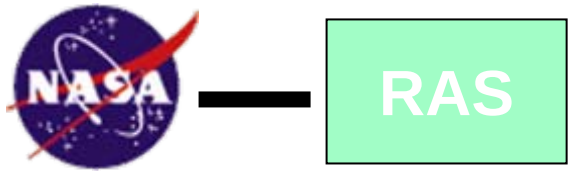
NEESPI is an interdisciplinary program of internationally-supported Earth systems and science research that addresses large-scale and long-term manifestations of climate and environmental change.

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

NEESPI duration ~ 10 years

NEESPI AND ITS PAST

NEESPI and the actions to develop its Science Plan were initially promoted by NASA and Russian Academy of Sciences (2003-2004).



Since early 2005, the NEESPI community has worked to make NEESPI inter-agency (in the U.S.) and international.

A central Science question:
"How do terrestrial ecosystems dynamics in Northern Eurasia interact with and alter the biosphere, atmosphere, cryosphere, and hydrosphere of the Earth?"

The NEESPI Science Plan (available on http://neespi.org) has elements that address concerns of WCRP, IGBP, IHDP, and DIVERSITAS Programs

Expansion

Two modes of NEESPI expansion

- Dedicated Calls (recent NASA and RAS and perspective in the NIS, EU, and China)
- Freely joined projects
- Benefits of the NEESPI membership
  - Improved links to collaborators in Northern Eurasia and to US and EU scientists working on similar problems
  - Exchange of ideas, datasets, and knowledge with other team members working on similar problems
  - Synergistic approach in working on complex problems
  - Priority access to remote sensing and in situ data collected over Northern Eurasia
  - Education: student exchange, doctoral and post-doc positions sharing among the Team Institutions

Dynamics of the NEESPI statistics

In July 2006, 364 scientists of 195 institutions from 31 countries participated in the first 54 funded projects.

In January 2007, 70 individual research projects (always with the international participation) were funded and approximately 30 funded projects were in process of recognition/joining NEESPI.

Current numbers: More than 400 scientists from more than 200 institutions are working on 104 individual funded projects under the Initiative umbrella and approximately 20 projects are in the process of joining NEESPI (+ in kind assistance from EU, US, Russian, Chinese, Japanese, and International Agencies and Institutions)

Example of in-kind assistance

To support a Summer Workshop-School in Fedorovskoe (Russia, July 2007) on Boreal Forest Environmental Studies, sponsors from

- Japan (National Institute of Environmental Sciences),
- China (Beijing Normal University),
- Russia (Russian Foundation for Basic Research and private companies),
- European Union (European Environmental Agency), and
- USA (NASA, Maryland University, and The International Arctic Research Center, Fairbanks, Alaska)

swiftly came together with a 6-digit sum of money.

Distribution of projects by major research themes in January 31, 2007. One project could be included in several groups

- Biogeochemical Cycles 19
- Hydrology 25
- Cryosphere 22
- Land Use 27
- Land cover 12
- Atmospheric Aerosols/Pollution 13
- Human dimension 18
- Biodiversity 9
- Large scale, integrative 39
- **Total 73**

Since that time, two RAS Mega-Projects, on Biodiversity and IPY (15 & 16 individual projects respectively), joined NEESPI

The State and Resource-Ecological Potential of Terrestrial Ecosystems of Northern Eurasia in the Conditions of Global Changes (PI, A.S. Isaev)

- Methodology for monitoring of biodiversity in Russian forests
- Relationships between soil variety and biodiversity in forest ecosystems
- Integrated databases on biodiversity of forests ecosystems in European part of Russia
- Dynamics of forest cover in central part of Russian Plain and tendencies for changes in biodiversity of natural and artificial forest ecosystems for the last century
- Succession dynamics and typology of boreal ecosystems in European part of Russia
- Dynamics of organic matters and biogenic elements in the southern taiga under global changes
- Biogeochemical cycles in the northern taiga forests: natural and pollution-induced changes
- **Mapping of forest ecosystems in Russia on remote sensing data**
- Satellite products sets for databases on Northern Eurasia's terrestrial ecosystems

Above is a subset of 16 individual projects of the 1st Russian Mega-project (program of the RAS Presidium on NEESPI)

RAS Mega-Project in support of IPY activities; subset of NEESPI-related projects (**Program P-16 of the Presidium of Russian Academy of Sciences; PI, Acad. V.M. Kotlyakov**)

- Climate Modeling and diagnostic in polar and sub-polar latitudes
- Temperature, small atmospheric constituents, and atmospheric chemistry in high latitudes
- Snow cover changes in Northern Eurasia and the atmospheric processes
- State of the Arctic cryosphere (glaciers and icebergs)
- Soil dynamics with environmental changes in high latitudes
- Analytical data base creation for the International Polar Year
- Arctic air pollution and its redistribution through the trophic chains
- Flora and fauna changes in the Arctic with climatic change and anthropogenic impact
- **Environmental conditions when humans first came to Northern Eurasia**
- Sustainability of social infrastructure of indigenous population in the Arctic
- In search for sustainability of ecosystems and society in the Arctic

Above is a subset of 15 individual projects

Siberian Integrated Regional Study (SIRS)

- ***Integrated study of natural and climatic changes and accompanying land-use risks***
- ***Functioning, biodiversity, ecological and resource potential of Siberian forests (PI, Evgeny Vaganov)***
- ***Study of hydrological and ecological processes in Siberian water bodies …***
- ***Comparative analysis of patterns of man-caused radionuclides migration in large water ecosystems …***
- ***State, structure and changes of cryosphere: Cryogenesis and its influence on natural and man-caused geosystems***
- ***Development of distributed informational analytical media for ecological systems study***
- ***Evolution of natural processes, man and his culture in late Cenozoic in Siberia and their influence on eco- and geosystems stability***
- ***Development of tools for satellite ecological monitoring of Siberia and Far East on the basis of new informational and telecommunicational methods and technologies***
- ***Enviro-RISKS: Man-induced Environmental Risks: Monitoring, Management and Remediation of Man-made Changes in Siberia***
- ***ENVIROMIS-2: Environmental Observations, Modeling and Information Systems - 2.***

Coping with Growing Pains

While the NEESPI Science Plan is balanced, a quick growth and non-proportionate funding caused different paces of development of different NEESPI components. To mitigate this disproportionality in implementation, we:

- **structure the Initiative by Topical and Regional Focus Research Centers**
- **move the NEESPI data support to Permanent Science Data and Services Centers, and**
- **promote clustering (integration) among the NEESPI Projects into virtual Mega-Projects and/or inception of interdisciplinary internally-integrated projects**

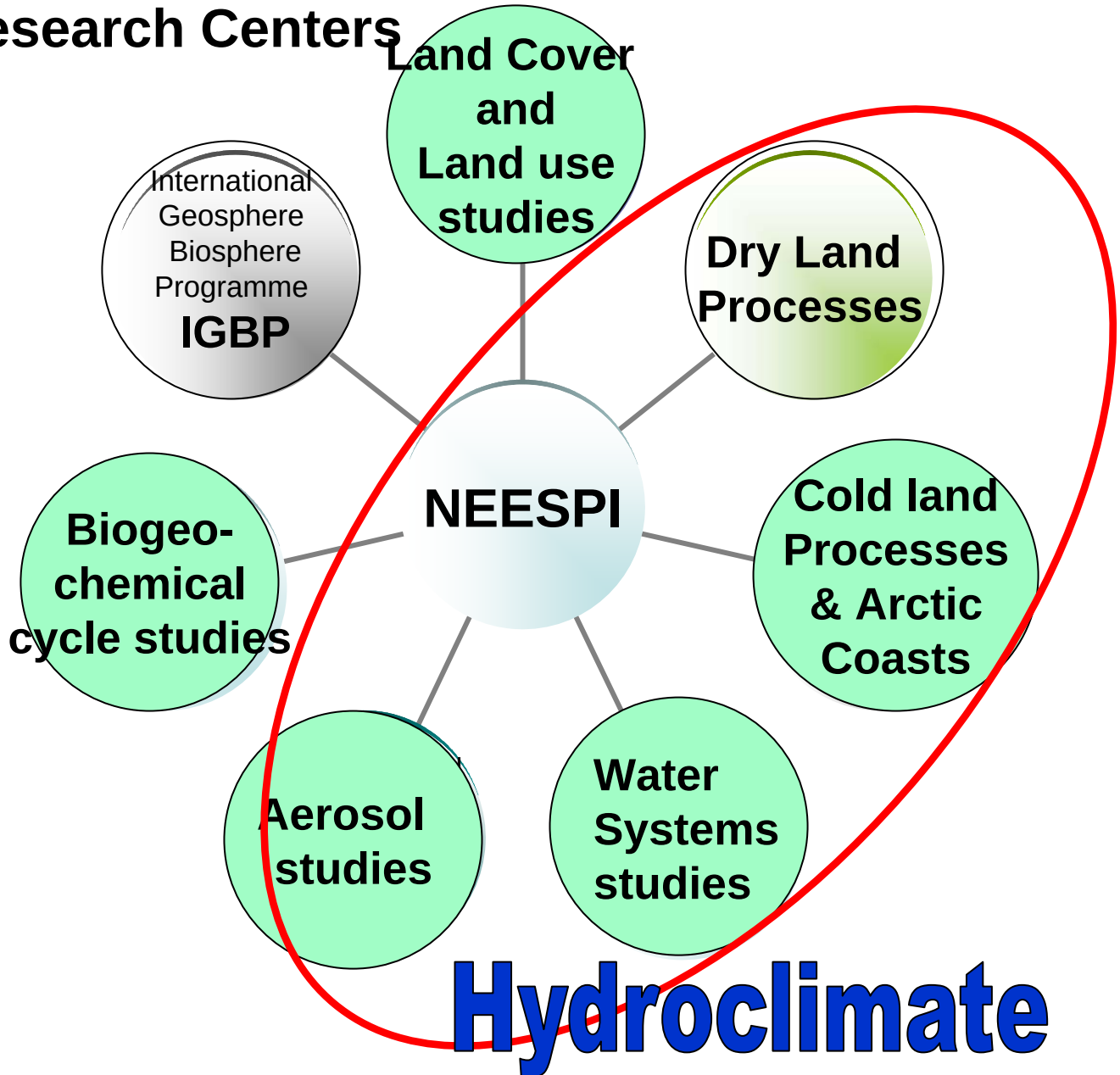
These steps will: (a) secure the continuity of the research within the cluster (or FRC) when individual projects (usually 3 year-long) expire; (b) allow the data preservation; and (c) will gradually balance advances in different research directions

Currently, there are the following NEESPI Focus Research Centers

- ***Center for Cold Land Processes and Arctic Coastal Studies***
- ***Center for Water System Studies***
- ***Center on Aerosol Studies***
- ***Center for Land Use Studies***
- ***Center for Biogeochemical Cycle Studies***
- ***Center for Land Cover Studies***
- ***Regional Center for Dry Land Processes Studies***
- ***Regional Center for NEESPI Studies in Eastern Europe***
- ***Regional Center for NEESPI Studies in Siberia***

Additionally, we envision (project): *Center for Integration of the NEESPI Results and Modeling Studies, and two more Regional FRCs (in Moscow and Vladivostok)*

Relationships used for Coordination with NEESPI Focus Research Centers



Towards the integration

Example of the NASA-NSF funded cluster of 10 NEESPI projects

- ***PI***: Dennis Lettenmaier. ***Diagnosis and Prognosis of Changes in Lake and Wetland Extent on the Regional Carbon Balance of Northern Eurasia***
- ***PI***: Eric Wood. ***An integrated understanding of the terrestrial water and energy cycles across the NEESPI domain through observations and modeling***
- ***PI:*** Charles Vörösmarty. ***Role of land cover and land use change in hydrology of Eurasian Pan-Arctic***
- ***PI:*** Vladimir Romanovsky. ***Permafrost dynamics within the Northern Eurasia region and related impacts on surface and sub-surface hydrology***
- ***PI***: Eric Wood. ***Collaborative Research: Understanding Change in the Climate and Hydrology of the Arctic Land Region: Synthesizing the Results of the ARCSS Fresh Water Initiative Projects***
- ***PI:*** Larry Hinzman. ***Current climate changes over Eastern Siberia and their impact on permafrost landscapes, ecosystem dynamics, and hydrological regime***
- ***PI:*** Vladimir Romanovsky. ***Thermal State of Permafrost (TSP): The U.S. contribution to the International Permafrost Observatory Network***
- ***PI***: Dennis Lettenmaier. ***Use of International Polar Year data to improve attribution of long-term hydrologic changes in Arctic Eurasian land areas***
- ***PI***: Alexander Shiklomanov. ***Study of Dam/Reservoir-Induced Hydrologic Changes in Large Siberian Watersheds: Regional Analysis to Pan-Arctic Synthesis***
- ***PI***: Vladimir Romanovsky. ***Development of a Network of Permafrost Observatories in North America and Russia: The US Contribution to the IPY***

“Arctic Land Surface Hydrology: Moving Towards a Synthesis” (Workshop, Princeton, NJ, Dec. 6-8, 2006)

- Workshop brought together an international team of scientists from 9 institutions in the United States, Russia, and Germany involved in several ongoing NEESPI projects to coordinate their efforts in field campaigns, remote and in situ data gathering efforts, regional modeling in the Arctic Ocean Basin of the NEESPI domain, and linkages of their projects to the Earth System Model that is being developed in The Max-Planck-Institute of Meteorology.

NEESPI Science plan major focuses

- **Focus on transient zones that are most vulnerable in the future changes**
  - **Coastal zone**
  - **Tundra-forest**
  - **Forest-steppe**
  - **Steppe-desert**
  - **Mountains**

Cold Lands

Dry lands

- **Focus on feedbacks that make the projection of the future changes uncertain**
  - **Biogeochemical feedbacks**
  - **Biogeophysical feedbacks**
  - **Human activity**
- *NEESPI Research Priorities:*

(a) the processes that directly feed back to the global Earth system and

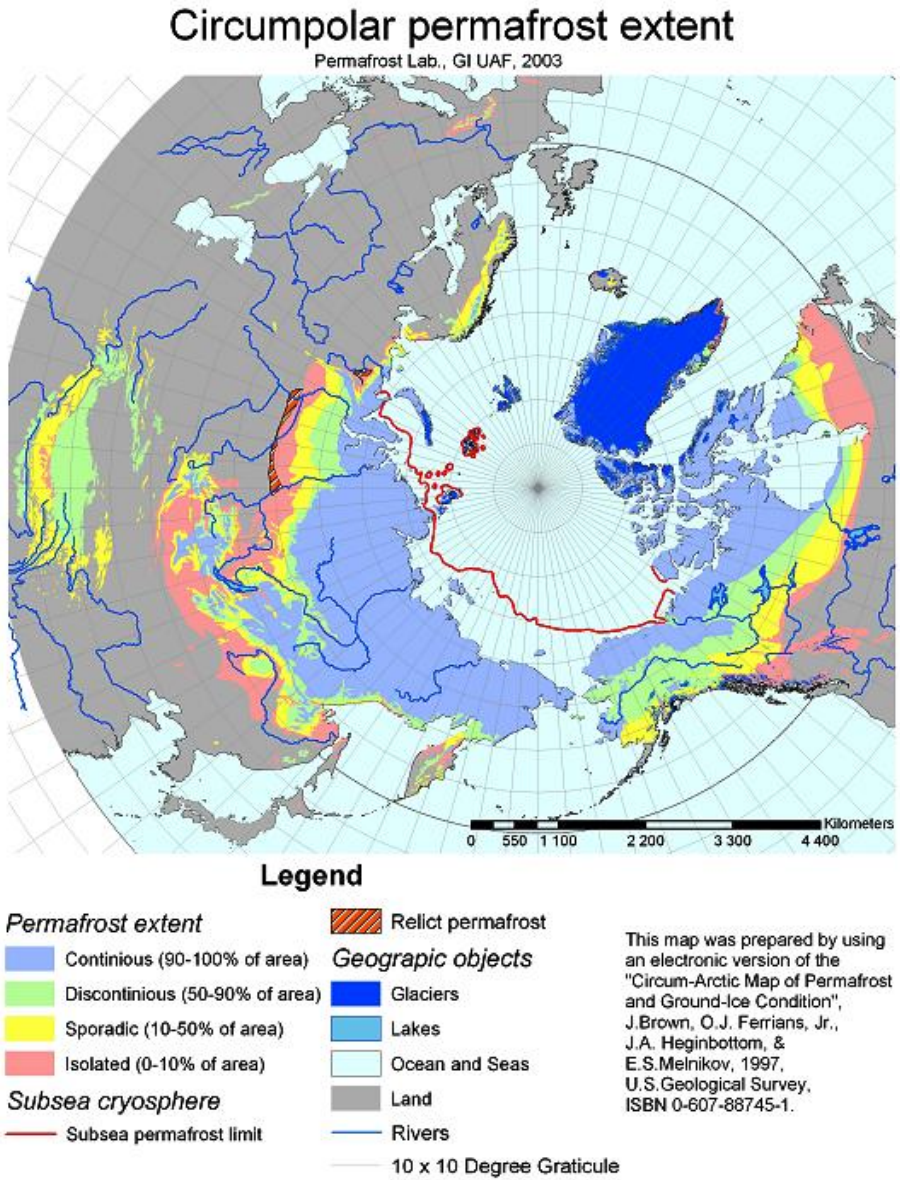
(b) the processes of major societal importance

Example of the NEESPI Focus Research Center

NEESPI Focus Research Center for Cold Land Processes and Arctic Coastal Studies (CLAC FRC)

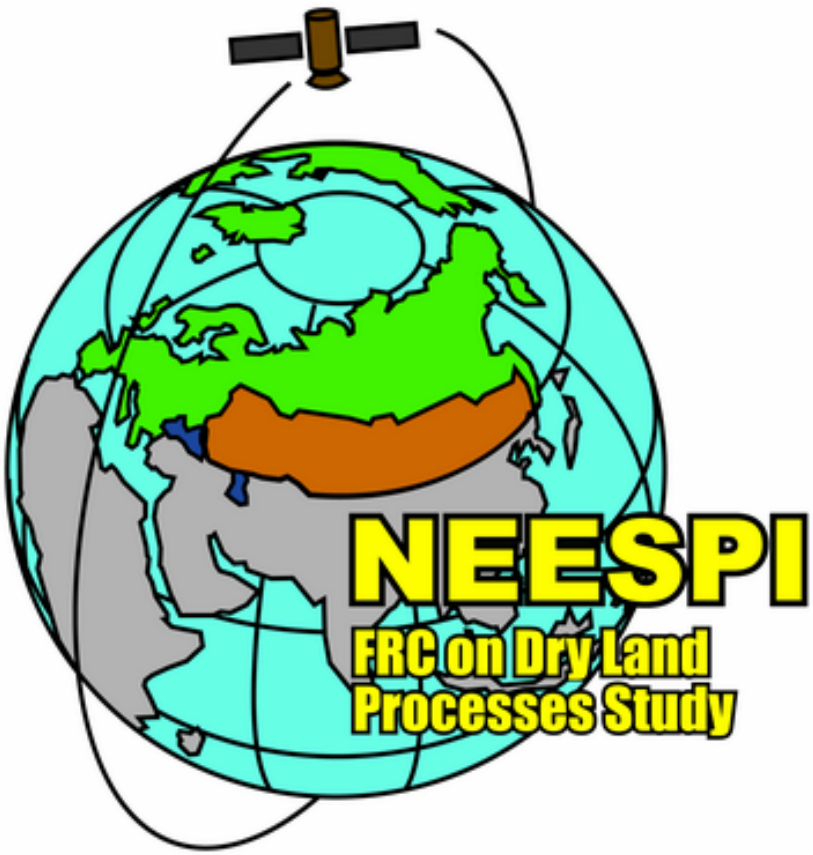
- **Venue:** International Arctic Research Center, University of Alaska Fairbanks, Alaska
- **Objectives:** conduct, promote, and facilitate research aimed at improved understanding and modeling of the cold land processes in the Earth System focusing on Northern Eurasia and its coastal zone
- **Links to International Projects:** CliC
- **Leaders:** Romanovsky, Hinzman, Walsh, Walker, Sergienko, Zheleznyak, Makshtas, Fukuda, Atkinson, Kofinas, Semiletov, Forbes
- **Current Science foci:**
  - Permafrost
  - Cold land hydrology and global biogeochemical cycles
  - Cryosphere interactions with climate, biota, and environment
  - Humans in the Arctic
- Funded and pending proposals to NSF, NOAA, NASA, JAMSTEC, JAXA, Far Eastern Branch of Russian Academy of Sciences, DOE, and ONR; 4 recognized IPY activities
- **Other relevant activities:**
  - ✓ The Focus Research Center is going to serve as one of the base institutions for CliC studies in Northern Eurasia and Alaska

NEESPI Cold Land & Arctic Coast Focus Research Center (First Workshop, Fairbanks, Alaska, April 6 - 8, 2006)

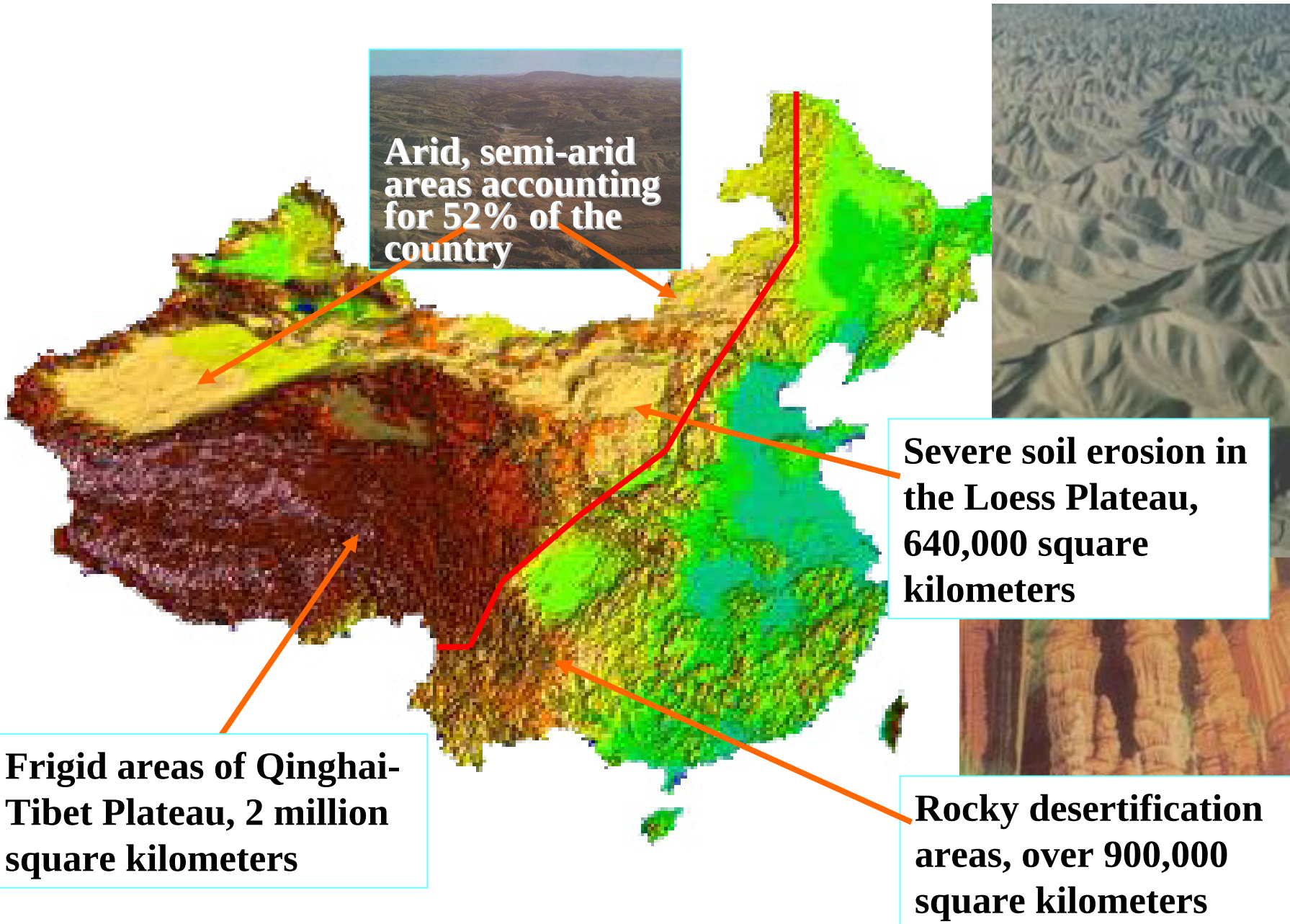


- Space-based technologies and models to address LCLUC problems
- Cold land hydrology
- Exploration of the coastal zone in the Arctic (e.g., methane flux)
- Permafrost monitoring and modeling
- Social Vulnerability to Climate and Environmental change
- Regional environmental modeling

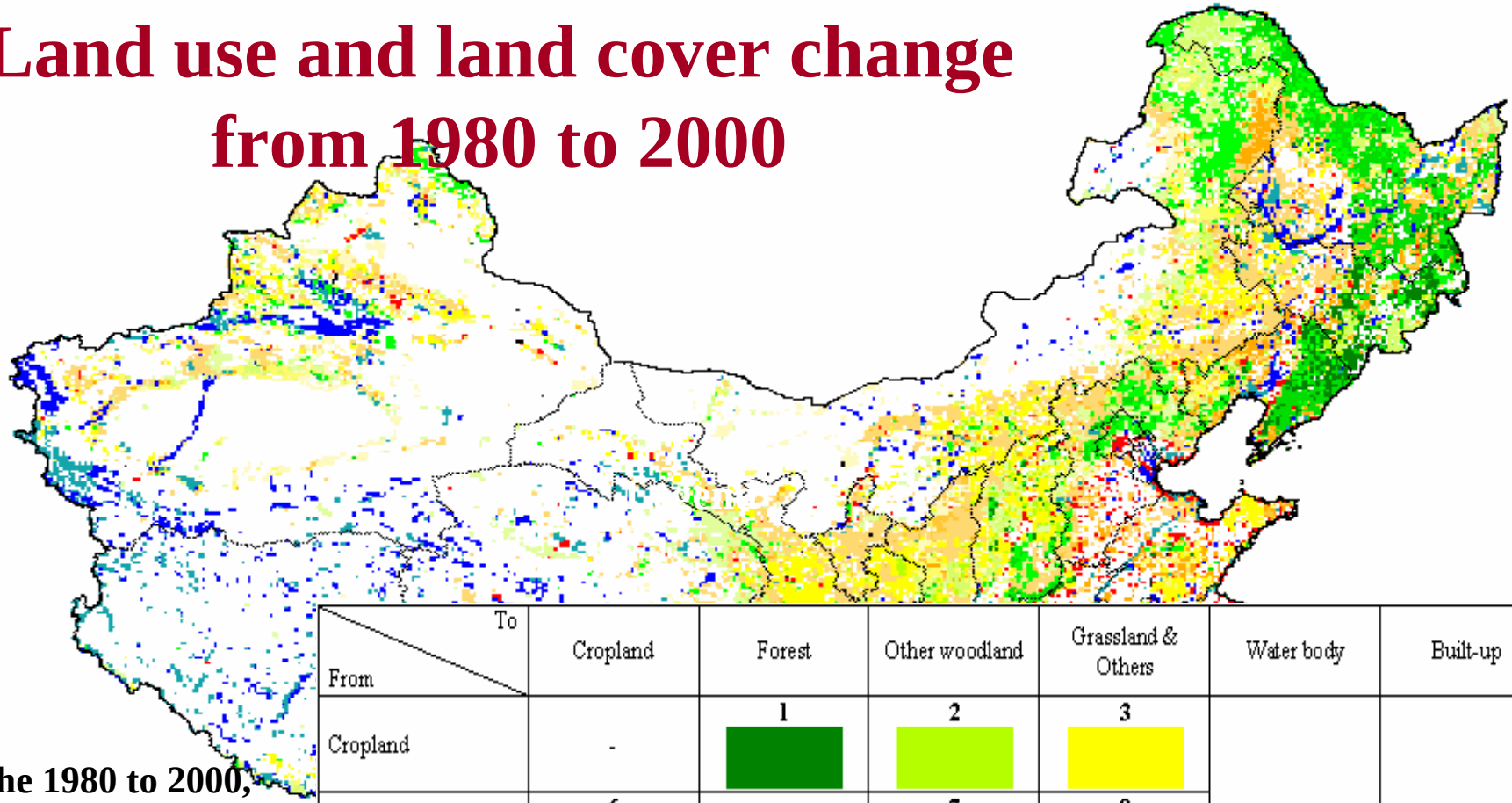
Regional NEESPI Focus Research Center on Dry Land Processes Studies (First Workshop, Beijing, China, 7-8 November 2006)



- Ecosystem Monitoring and Assessment
- Water issues in arid regions
- LCLUC ecological impact
- Aeolian Desertification
- Socio-economic responses to climatic and environmental changes
- Regional environmental modeling


Arid, semi-arid areas accounting for 52% of the country
Severe soil erosion in the Loess Plateau, 640,000 square kilometers
Frigid areas of Qinghai-Tibet Plateau, 2 million square kilometers
Rocky desertification areas, over 900,000 square kilometers

Land use and land cover change from 1980 to 2000



From \ To	Cropland	Forest	Other woodland	Grassland & Others	Water body	Built-up
Cropland	-	1	2	3		
Forest	6	-	7	8	4	
Other woodland	9	10	-	11		5
Grassland & Others	12	13	14	-		
Water body	15				-	
Built-up	16				4	-

From the 1980 to 2000, the outstanding change trend of land use in western China was that a lot of grassland and woodland was converted into cultivated land. During the past 10 years, the built-up area in Western China has increased by about 10%.

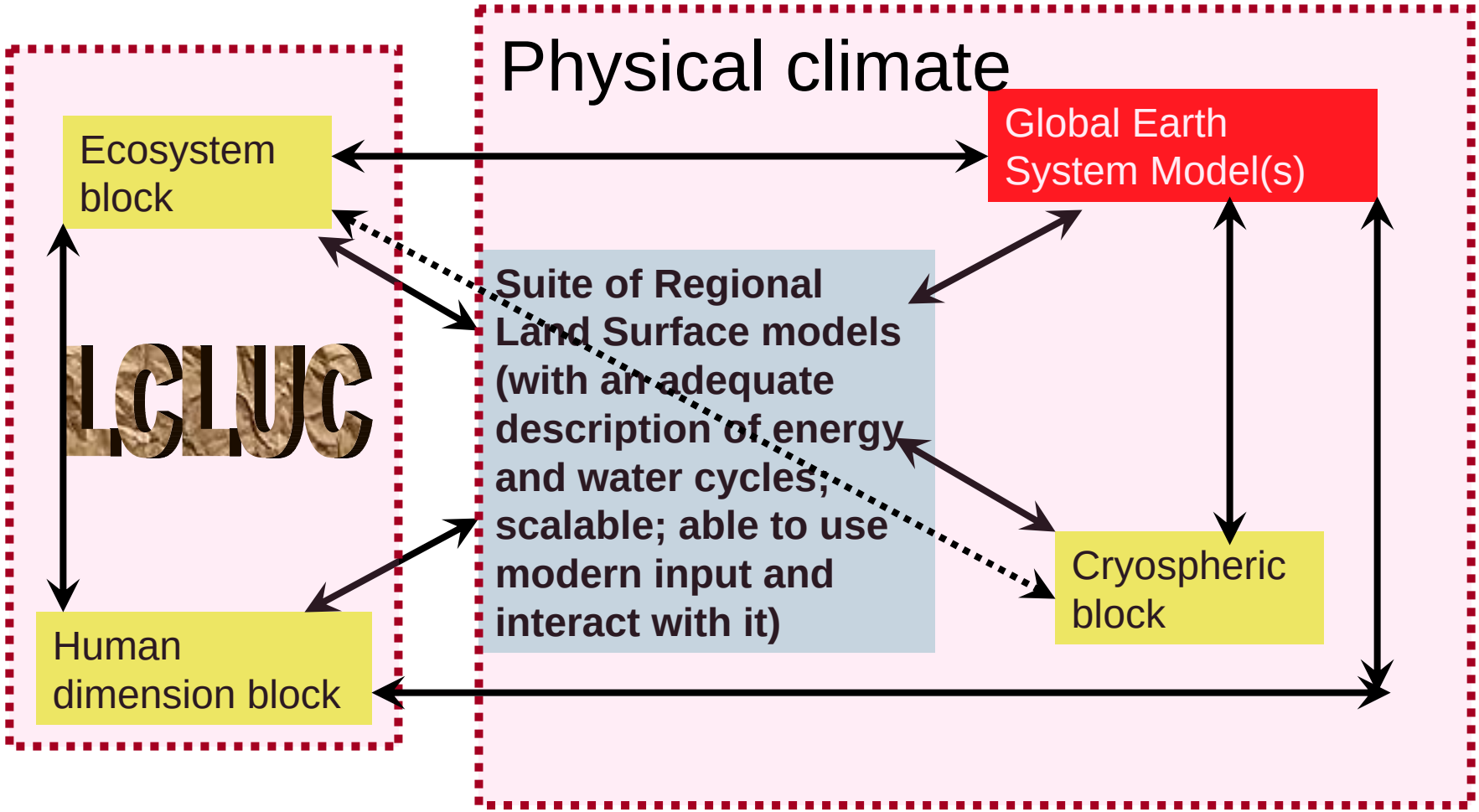
Peculiarity of the regional studies

- Opposite to North America, Europe, and several other parts of the Globe, we are still lacking many essential tools (e.g., well developed RCMs, hydrological models, and regional reanalyses) that are a prerequisit for answering the major NEESPI science questions =>

  (a) An urgent need for modern models' development and

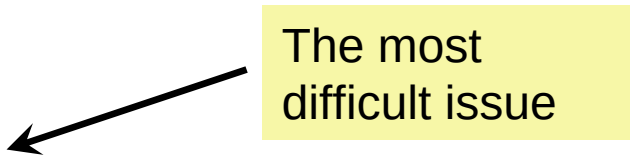
  (b) Investments in Education

Northern Eurasia modeling suite



Climate, Hydrology

- Regional climate models came to the domain
  - WRF, MM5 (Sokolik, Henebry, Lettenmaier)
- A two-tier hydrological modeling
  - UNH Water Balance Model (Vörösmarty)
  - Several modern land surface schemes
    - VIC (Lettemaier, Wood)
    - RAS IG LCM (Shmakin)
    - CCM LCM3 (Dickinson)
    - **New cold land hydrological schemes** (Hinzman, Wood)



- Data bases construction
  - (e.g., R-ArcticNET, permafrost, Giovanni System)
- First links with GCMs (MPI, NCAR)

LCLUC

- **Capacity building**
  - In the boreal zone (Krankina, Li, Schmullius, Vörösmarty)
  - in the southern part of the NEESPI domain (Geerken, Henebry, Liu, Ojima, Qi, Vörösmarty)
- **Calibration of modern RS products** (Gitelson, Henebry, Krankina, Schmullius, Sun, Woodcock)
- **Extremes: fires, land degradation** (Bartalev, Conard, Henebry, Korovin, Liu, Shugart, Soja, Sokolik, Vaganov)
- **Human impacts/feedbacks** (Imhoff, Liu, Ojima, Vörösmarty, Walker)

Major problems:

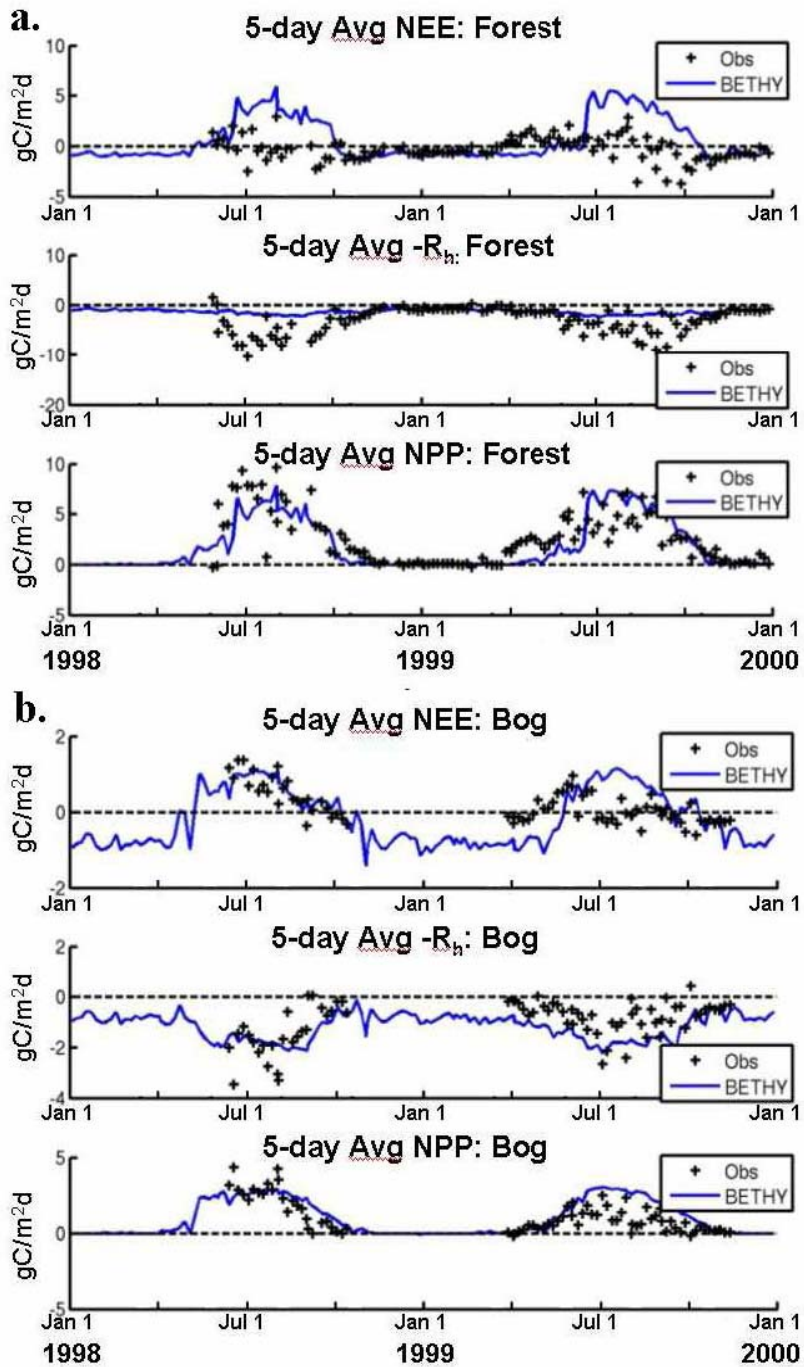
- **Coordination**
- **Small scale of some studies**
- **Unified input to other blocks of the Earth System modeling**

Biosphere

- Biospheric blocks are being developed/tuned
  - in the boreal zone (Chebakova, Houghton, Heimann, Inoue, Krankina, Li, Liu, Lettenmaier, Shugart, Xiao) and
  - in the southern half of the domain (Henebry, Xiao, Li, Liu, Zeng)
- Some of these blocks are reasonably well connected with LCLUC and LCMs and all of them consume modern RS products

Major problem:

Development of the biospheric block for permafrost areas



Results of the joint implementation of hydrological (VIC) and biospheric (BETHY) models to reproduce carbon flux components in the boreal forest zone

Simulated and observed CO_2 flux components (5 day average) at the (a) forest and (b) bog flux towers, Fedorovskoe site (taiga west of Moscow, Russia; 56.5°N, 32.9°E)

NEESPI Milestones for Year 2010

- To have in place:
  - a suite of tested land surface and regional climatic models that account for peculiarities of the energy and water cycles in Northern Eurasia
  - major components of the data support system (including near-real time dataflow) for these models
  - first version of the biospheric blocks for these models
- To complete all funded IPY activities in the region
- To organize during the next three-year-long period up to 20 summer schools and/or special courses for training of the Earth Science K-12 teachers and a new generation of the NEESPI domain Earth Science researchers.

Out-reach

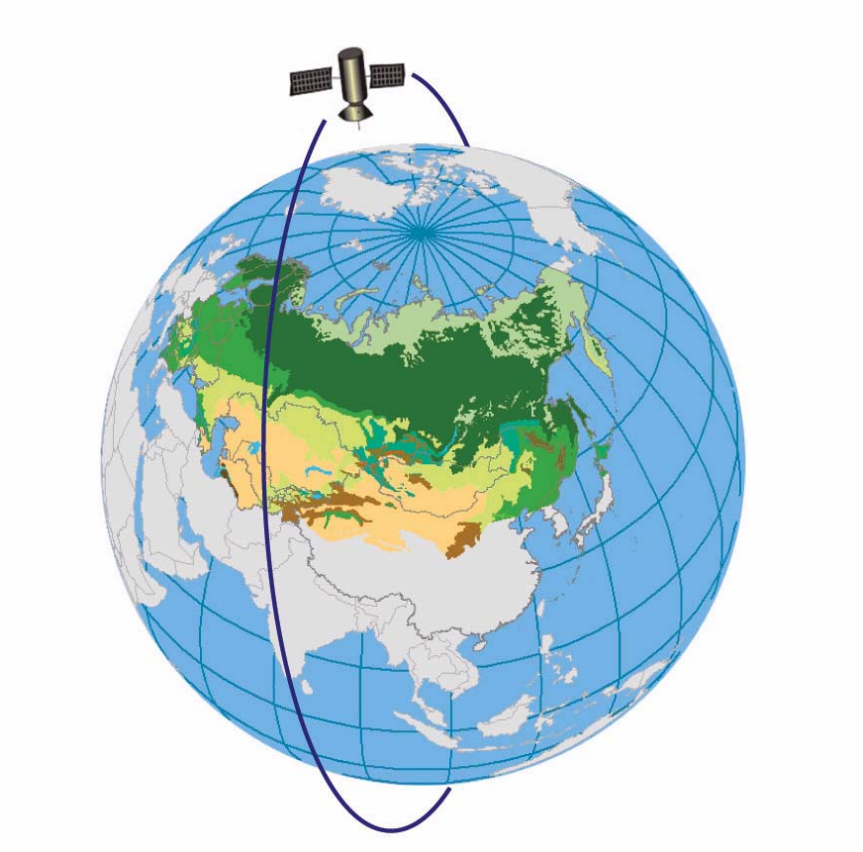
In 2005-2006: Approximately 200 papers and books published

In April 2007: 1st Special NEESPI issue (13 papers) in *GaPC*

In 2007-2008: 2 more NEESPI Special issues (~50 papers) in *ERL* and *J. Climate*

FOR MORE INFORMATION SEE THE NEESPI WEB SITE:

http://neespi.org



Side Note:

"NEESPI" is pronounced approximately like the Russian phrase for

"Don't sleep "

Northern Eurasia Earth Science Partnership Initiative