

“Northern Eurasia Land Surface Properties and Change and its Role in the Global Earth System” NEESPI Workshop Report (Aspen Global Change Institute, Aspen, Colorado, 12-17 August 2007)

The past NEESPI activities include presentations at the international conferences, successful proposals to National and International Agencies and the International Polar Year, publication of the special NEESPI issue of “Global and Planetary Change” journal (April 2007), establishment of the network of the NEESPI Focus Research and Science Support Centers in the United States, Russia, China, and Germany, organization of 1st NEESPI Science Team Meeting and several regional NEESPI Workshops. During the past two years, the NEESPI scientists published more than 200 refereed publications. A list of NEESPI meetings, workshops, and conference sessions consist of 19 titles and the present Aspen Workshop was the 20th. **The Workshop Results** composed from reports and recommendations of its several working groups are below.

The current status of changes across the NEESPI domain is characterized by an overwhelming evidence of a significant air and soil temperature rise over the last 40 years, recession of mountain glaciers, thawing/warming of permafrost (that may promote an increase in methane and CO₂ emission from permafrost) as well as reports of shifts in seasonality (earlier spring onset), wetter conditions in the regions west of the Ural Mountains and drier conditions across the entire Northern Asia, significant runoff increases to the Arctic Ocean and the Caspian Sea and decreases in northern China, Central Asia, and Mongolia enhanced by land use and water withdrawals. In some cases, precipitation increased, but because of a strong temperature increase, the indices (of drought, fire weather, etc) indicate drier conditions. These climatic changes were supported by reports of vegetation changes and of an increase in frequency in uncontrolled fires in the boreal forest across Northern Asia. These changes overlapped with environmental changes related to socio-economic changes due to collapse of the Soviet Union (a) in Russia and Ukraine: a decrease in forest logging and large agriculture farming (a general decrease in cultivated land use and harvest); reduction of fire, insect, and pest control; an increase of carbon uptake due to fires; and growing concerns about the aging infrastructure built on permafrost that is thawing (b) in Central Asia: a decrease in cattle number, and partial recovery of land from pre-1990 overgrazing. In Northern China and Mongolia, since 1970, an increase in desertification and in Eastern Europe, since 1990, alterations in cropping system were observed.

Major deficiencies in data needs for the NEESPI region include data on (a) evapotranspiration and soil moisture, (b) forest biomass structure, (c) methane and CO₂ emissions, and aerobic or anaerobic decomposition rates, (d) wetland dynamics, (e) vegetation changes, (f) climatology in complex topographic areas, and (g) a lack of data to support current and the near future remote sensing products. Major deficiencies in process knowledge include effects of bog dynamics and their interaction with permafrost thawing and vegetation changes; of the ability to estimate regional-scale changes using local indications of deforestation, desertification, forest type changes, bogging, gas emissions, fires, etc; of a general biophysical properties of vegetation in response to an atmospheric CO₂ increase; and of transient biomes sensitivity to environmental changes.

Known modeling efforts on a regional scale relevant to NEESPI (~30 items) were defined as modeling either with a domain that spanned most or all of the NEESPI region, or smaller scale modeling efforts applied to enough sites so as to represent the region. Models were classified into off-line terrestrial ecosystem models, off-line land surface schemes, offline chemical transport models, and coupled regional and global climate models. Global coupled models were limited to those where there were known specific recent efforts to improve processes relevant to the NEESPI region (e.g., evaluation of the effects of vegetation change in the region on global climate or improvements of permafrost representation). Among the missing links and/or poorly represented processes in contemporary models the Workshop listed (a) in land surface models: key features of the land surface which the current generation of land surface models fails to capture include wetlands, permafrost regions, semi-arid regions, dynamics of freeze-thaw, and water management; furthermore, the following important processes, critical to NEESPI water and energy cycles, are poorly captured in current land surface models: snow redistribution, groundwater-surface water interactions, dust generation, and energy exchange among different surfaces; (b) in fully coupled models, global or regional: the lack of detail in aerosol feedbacks; and (c) in terrestrial ecosystem models poorly described near-coastal processes, lateral fluxes to surface water/river system, as well as many things related to aerosols including deposition.

NEESPI-Globe interactions. Among the regional changes in the NEESPI domain that are affecting the globe the major factors were carbon storage change, changes in temperature gradients affecting global atmospheric circulation, surface cover change that affect regional (and thus global) radiation budget; changes in fresh water budget of the

Arctic Ocean and in atmospheric aerosol emissions. On the other hand, the NEESPI domain is highly sensitive to small changes in global circulation as demonstrated by temperature, humidity, cryospheric, and vegetation changes. In particular, the domain being generally a dry region, is very sensitive to changes in westerly circulation and associated moisture transport.

Strategic directions of NEESPI research:

- Cold region studies aiming at a better understanding (a) of permafrost processes and permafrost change effect on regional and global carbon cycle and (b) of interaction of hydrological and biological systems responsible for emission and composition of greenhouse gases
- Hydrological and land cover change studies in semiarid areas with a large social impact
- Establishing a baseline model (for example, create a regional reanalysis model) and different scenarios of environmental change coupled with higher resolution regional models accounting for critical regional feedbacks
- Studies of vulnerability and resilience of coupled human-environmental system with changing climatic and environmental conditions and impact of these changes on human health.

The priority topics for local to regional scale biogeochemistry modeling for the NEESPI region are the improving of (a) assessments of changes in forest composition: dynamics, dispersal and migration, (b) representation of radiative balance in plant communities/biomes, and (c) capabilities to simulate biogeochemistry: in particular, nutrient cycling (N, P) and emissions of non-CO₂ trace gases, and aerosols; while for similar **hydrometeorological modeling the priority topics** are (a) the offline LSM intercomparison using a suite of high quality validation data sets within the region, (b) a thorough assessment of LSM performance in the orographically dominated regions, (c) a consistent addressing of known deficiencies of existing LSMs in permafrost, semi-arid, and wetland areas, and (d) securing seamless coupling of the hydrometeorological and biogeochemistry modeling for the NEESPI region.

Among the short term and easily achievable objectives the workshop listed: wetlands mapping and monitoring; linking surface radiation budget and land cover characteristics; integration of the NEESPI pilot projects deliverables; improvement of data access and visualization; and compiling an inventory of untapped datasets over Northern Eurasia from old national archives.

Action items:

- To organize an intense field campaign along the permafrost zone boundary and in areas of changing forest type
- To encourage more data mining, exchange, the production of value-added and synthesis of related datasets;
- To form a working group to evaluate alternative land cover-land use data for NEESPI region and to develop recommended land surface model parameters associated with current land cover classes
- To conduct simple experiments using existing global or regional climate models to explore a few biophysical feedback scenarios which are needed to leverage and “hook” the ongoing modeling activities with more built-in physics and biogeochemistry
- To organize within NEESPI a “scenarios activity” on land use, industrial, and energy policies to meet a need for plausible socio-economic forcing/impact factors development due to their strong feedbacks to environmental change
- To link NEESPI closer to interests of Space Agencies by organizing specific field work linked to new sensors that are currently under development and verification of existing remote sensing products.

To foster global collaboration between ESM and NEESPI Communities, the workshop recommended performing multiple model intercomparisons over northern high latitudes (north of 45°N) but focused on the NEESPI domain. This will allow quantifying uncertainties and sensitivity of biogeochemical feedbacks and interactions in northern high latitudes: crossing model scales and complexity. This should be done using impact and ecological knowledge that is infused appropriately into models with an initial focus on carbon cycle, land use dynamics, emissions, land cover change, and hydrology. To make this recommendation happen, a protocol and roadmap were developed.

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Finally, an extensive program for **NEESPI outreach activities** was developed that include publications, workshops, training schools for early career scientists, and further involvement of the NEESPI researchers in the IGBP, WCRP, and IHDP activities.

List of the Workshop participants: http://neespi.org/meetings/Aspen2007_Workshop_Participants.pdf

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References:

- Groisman, P.Ya., S.A. Bartalev, and the NEESPI Science Plan Team, 2007: Northern Eurasia Earth Science Partnership Initiative (NEESPI): Science plan overview. *Global and Planetary Change*, **56**, issue 3-4, 215-234.
- Northern Eurasia Earth Science Partnership Initiative (NEESPI), 2004: *NEESPI Science Plan* (Eds., P.Y. Groisman and S.A. Bartalev), 217 pp. [Plan is available for download at <http://NEESPI.org/>]