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Regional Aspects of Climate-Terrestrial-Hydrologic Interactions in Non-boreal Eastern Europe

Edited by
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Sergiy Ivanov

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Regional Aspects of Climate-Terrestrial-Hydrologic Interactions in Non-boreal Eastern Europe

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Regional Aspects of Climate-Terrestrial-Hydrologic Interactions in Non-boreal Eastern Europe

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Preface

Regional Science Team Meeting "Regional aspects of climate–terrestrial–hydrologic interactions in non-boreal Eastern Europe" devoted to the southwestern areas of the NEESPI domain was held at Odessa, Ukraine, 23–28 August 2008. The Workshop earning the status of the ***NATO Advanced Research Workshop***. It was organized under the auspices of the Northern Eurasia Earth Science Partnership Initiative (NEESPI) with sponsorship from NATO Partnership for Peace Programme and International START Secretariat, and several Ukrainian, Russian, and U.S. Universities and Agencies. Odessa Environmental and Polytechnic Universities served as a host of the Meeting. The goal of the Meeting was to promote and coordinate research related to temperate Eastern Europe by bringing together an international group of researchers from diverse backgrounds, ranging from physical climate to ecosystem and human dimension fields. The Meeting brought together 47 participants from Ukraine, European Union, U.S., Russia, and Georgia.

In their presentations at the Workshop, the Participants summarized the current status of changes across the non-boreal Eastern Europe, set up major research priorities in this part of the NEESPI domain, identified the ongoing regional modeling efforts, outlined missing links and deficiencies in data and process knowledge, and developed a set of recommendations that will further advance the Initiative toward its objectives. Taking into account coherence of projections of warmer and drier climatic conditions for the region associated with "global warming", special attention was paid to regional scale hydrometeorological modeling and its linkage with optimal land use and early mitigation measures to prepare for future changes. In these regards, a rigorous fulfillment of national reforestation plans was suggested. These plans exist in each nation of the region but their priority should be raised. Among recommendations, the workshop stresses the need for much better environmental data exchange and integration among the countries within the region and investments in regional-scale hydrometeorological modeling to better understand ongoing environmental processes in the region.

Several publications based on the Meeting discussions are currently in preparation and/or submitted to refereed journals. However, a broader impact of this NATO Advanced Research Workshop will be seen for years to come. A significant number of graduate students and early career scientists from Odessa institutions attended the Workshop as listeners to acquire top notch experience. The Workshop presentations and Statement have been made publicly available through the NEESPI web site (http://neespi.org/meetings/Odessa_2008_presentations.html). To further extent the outreach of the Workshop, a work was started to prepare monograph "Earth Systems Change over Temperate Eastern Europe" and this ***NATO Advanced Research Workshop Proceedings*** has been compiled. It includes extended abstracts of 28 selected presentations at the Workshop.

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Sergiy V. Ivanov

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The Northern Eurasia Earth Science Partnership Initiative: An Introduction

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Abstract. Northern Eurasia, the largest landmass in the northern extratropics, accounts for ~20% of the global land area. Yet little is known about how the biogeochemical cycles, energy and water cycles, and human activities specific to this carbon-rich, cold region interact with global climate. A major concern is that changes in the distribution of land-based life, as well as its interactions with the environment, may lead to a self-reinforcing cycle of accelerated regional and global warming. With this as its motivation, the Northern Eurasian Earth Science Partnership Initiative (NEESPI) was formed in 2004 to better understand and quantify feedbacks between Northern Eurasian and global climates.

Keywords: northern Eurasian studies, NEESPI, climate and environmental changes

The Northern Eurasian Earth Science Partnership Initiative (NEESPI), whose domain of approximately 28.6 x 10^6 km^2 (Fig. 1) accounts for roughly 60% of the terrestrial land area north of 40° N, was formed to better understand the nature of global climate feedbacks to land processes and anthropogenic activities in the region. The ecosystems within this vast region vary substantially, from tundra in the North to semi-arid grassland and deserts in the South. Northern Eurasia has land cover unique to cold regions, including around 70% of the Earth's boreal forest and greater than two thirds of the Earth's permafrost.

The region is undergoing rapid changes resulting both from a warming climate and socio-economic changes. Lugina et al. (2007) reported that surface air temperature averaged over northern Eurasia increased by 1.4 K across Northern Eurasia – almost double the average for the global land areas – over the past 127

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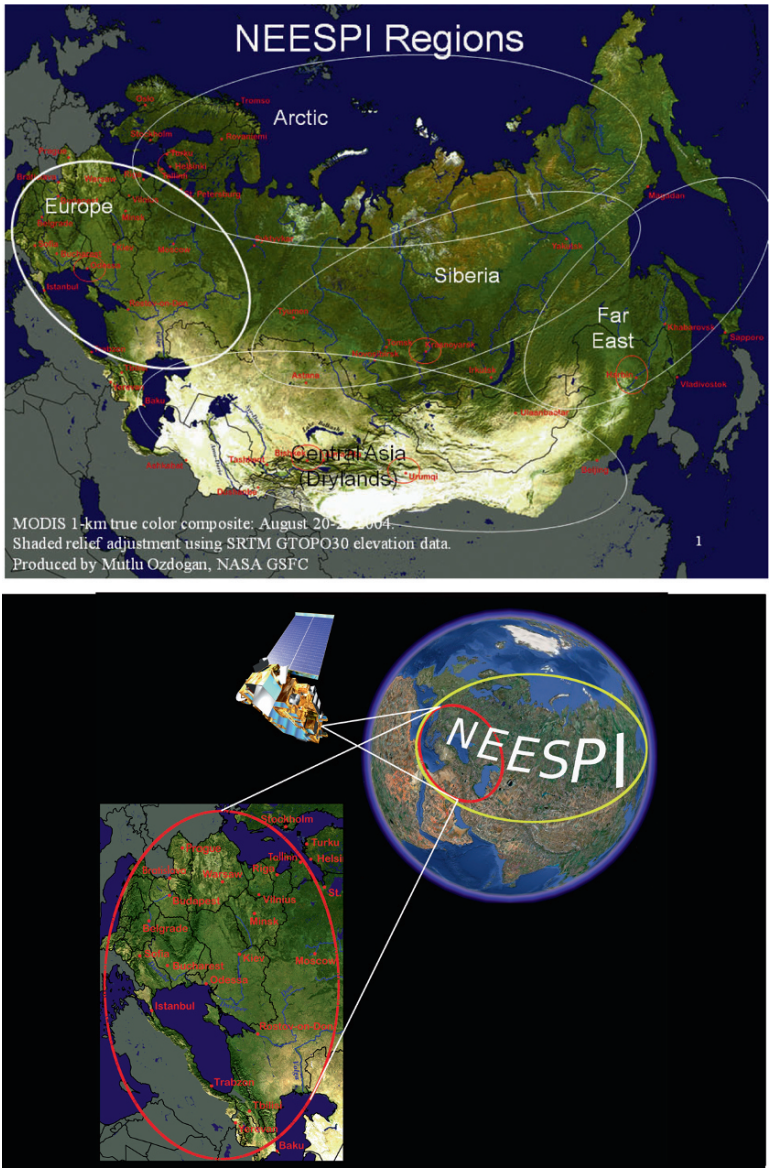

Fig. 1. (*Top*) NEESPI Study Area is loosely defined as the region lying between 15° E Longitude in the west, the Pacific Coast in the east, 40° N Latitude in the south, and the Arctic Ocean coastal zone in the north. Locations of past (Harbin, Urumqi, Helsinki, and Odessa) and projected (Krasnoyarsk and Bishkek) regional NEESPI focus research meetings are marked by red circles. (*Bottom*) Region (non-boreal Eastern Europe) that was a focus of this NATO Advanced Research Workshop.

years (Fig. 2). Given the large area of the region, these changes can have global influence as a result of associated changes in atmospheric circulation and through biogeophysical and biogeochemical feedbacks. In particular, interactions of the climate of Northern Eurasia with the global system have tremendous implications for global carbon management because more than half of all terrestrial carbon is stored in the boreal forest and tundra zones (mostly in soil), and two thirds of these zones fall within Northern Eurasia. Unfortunately, little is known about how this cold, carbon-rich region functions and the specifics of its interactions with the global system. In response to this deficiency of knowledge, NEESPI was formed in 2004 to better understand and quantify climate feedbacks within and beyond Northern Eurasia. NEESPI views the global Earth system as functioning through the interaction of biogeochemical, energy, and water cycles, and human activity (Groisman and Bartalev 2007). Biogeochemical cycles impact atmospheric and oceanic composition, soil formation, and biome evolution. Energy and water cycle processes define the Earth climate system as we know it. Human activity, beginning with the establishment of agriculture, forest harvest and mineral extraction, and continuing through industrial development, originally impacted regional environments and now alters the global climate system. NEESPI prioritizes scientific research that addresses processes with direct feedback to the global system and those of greatest importance to society in three main areas: terrestrial biogeochemical cycles, energy and water cycles, and societal–environment interactions.

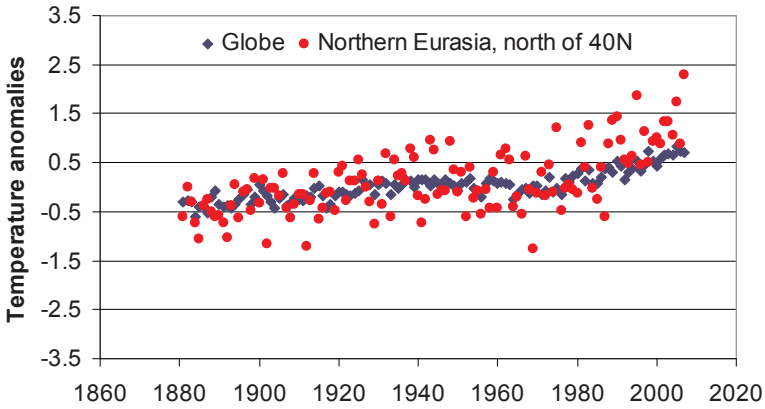

Fig. 2. Mean annual surface air temperature anomalies during the past 127 years over Northern Eurasia (linear trend 1.4 K per 127 years) compared to near-global changes within zone 60° S–90° N (linear trend 0.84 K per 127 years) (Archive of Lugina et al. 2007).

To date, the NEESPI has brought together more than 125 individually funded projects in the United States, Russia, China, European Union countries, Japan, and Canada. More than 25 of them include and/or are dedicated to studies in non-boreal Eastern Europe. On an intergovernmental level, the NEESPI research foci on regional modeling and studies of climate impacts and adaptation capacity were

included in a Memorandum of Understanding for Collaboration in the Fields of Meteorology, Hydrology, and Oceanography between the U.S. NOAA and the Russian Federal Service for Hydrometeorology and Environmental Monitoring. NEESPI has been also recognized by major International Earth Science Programs and Projects: the Earth System Science Partnership Program (ESSP), through its Global Water System Project, Global Land Project, and Global Carbon Project, by the ESSP-parent International Geosphere–Biosphere Programme and the World Climate Research Programme's Global Energy and Water Cycle Experiment and Climate and Cryosphere Projects.

The first group of NEESPI projects has mostly focused on assembling regional data bases (e.g., Leptoukh et al. 2007; NCDC 2008), on organizing improved environmental monitoring of the region (e.g., Loboda et al. 2007; Romanovsky et al. 2007, 2008), and studies of individual environmental processes (e.g., Khan et al. 2007; Smith et al. 2007). This has been a necessary step to address challenges that emerged in the region with rapidly and simultaneously changing climate, environment, and societal systems. Some of these efforts have not yet been completed we already see a general picture of changes taking place within the NEESPI domain (Groisman et al. 2009; de Beurs and Henebry 2008; Bulygina et al. 2007; Lammers et al. 2007). A clear understanding of the gaps in our knowledge of environmental changes in the NEESPI domain and consequent systematic addressing/resolving them were one of the intangible major achievements of the first stage of NEESPI. The NEESPI projects have since begun to consolidate spatially extensive projections of the consequences of regional-scale processes such as wildfires (Soja et al. 2007; McRae et al. 2006), soil carbon storage (Ojima and Chuluun 2008), forest dynamics (Shugart et al. 2006), permafrost change (Romanovsky et al. 2007, 2008) and methane generation (Bohn et al. 2007) into a regional ecosystem understanding. At the same time, intense field campaigns using fine-scale measurements of material and energy fluxes (e.g., Elansky et al. 2007; Georgiadi and Zolotokrylin 2007; Houghton et al. 2007; Kurbatova et al. 2008; Peregon et al. 2008; Shakhova et al. 2007; Walter et al. 2006) have begun providing locations and tools for testing these regional projections.

Early NEESPI findings have been used by IPCC Working Groups 1 and 2 in preparation of the Fourth Assessment IPCC Report (2007) and by the Russian Federal Service for Hydrometeorology and Environmental Monitoring in preparation of the First Assessment Report on Climate Changes and their Impacts over the Territory of Russian Federation. More recently, the NEESPI research focus has begun to shift towards modeling and its ability to project the future state of climate, environment, and societies in the NEESPI domain (e.g., Aizen et al. 2007; Bohn et al. 2007; Goetz et al. 2007; Romanovsky et al. 2008; Shkolnik et al. 2008; Stendel et al. 2007; Vygodskaya et al. 2007). This new focus requires a higher level of integration than in previous NEESPI studies. In a modeling context, it is not sufficient to describe a given environmental or societal process. This process should be linked to other processes in order to assess its actual role in the Earth system. Thus, modeling becomes an engine of integration of diverse regional studies

critical for understanding not only the functioning of the region's biogeochemical, energy, and water cycles, but also the role of humans in a rapidly changing, and vitally important, region.

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