Irina Sokolik
Georgia Institute of Technology

Project Abstract

Understanding the Role of Changes in Land-Use/Land-Cover and Atmospheric Dust Loading and their Coupling on Climate Change in the NEESPI Study Domain Drylands

Climate of Northern Eurasia has been undergoing major changes over the past century. Growing evidence suggests that land-use/land cover changes and increasing amounts of anthropogenic aerosols might be among the key drivers of observed climate change. Among main aerosol types, wind-blown mineral dust would be most affected by human-induced land-cover and land-use changes (LCLUC). Desiccation of the Aral Sea, conversion of the steppe in Kazakhstan to the agricultures fields in 1950s, severe desertification of northeast China resulting in the formation of new deserts are just a few examples of land-use changes that led to increased dust loadings over and downwind of the NEESPI study domain. Furthermore, by altering local mesoscale circulation and precipitation, land use processes could change the dust emission from natural arid and semi-arid regions. In turn, dust lifted in the atmosphere can affect the land processes by altering the surface radiation budget and photosynthetically active radiation, providing additional radiative heating of the boundary layer and by causing direct and indirect (via clouds) radiative forcing at the top-of-the-atmosphere. The degradation of visibility and health problems caused by dust make it an important air quality issue. The recent IPCC (2001) report pointed out that both LCLUC (via surface albedo) and atmospheric dust are important forcing drivers, yet they were considered as two independent factors. Given the intimate coupling between the land processes and wind-blown atmospheric dust and their importance in the climate system, an improved understanding of how land-use/land-cover changes affect Asian dust and associated feedbacks is urgently needed to make assessments of climate change more realistic. This proposal is a collaborative effort of the researchers having the multi-year experience in the atmospheric dust, LCLUC, and climate fields aimed to address this complex problem focusing on the NEESPI study domain. The main goal of this study is to investigate how and to what extent land-use/land-cover changes and varying dust loadings and their interactions have been affecting climate of drylands in the NEESPI study domain over the past 50 years. Our strategy is to integrate the diverse satellite and ground based data on land-use/land-cover, Asian dust, and climatic variables that will enable us to perform spatio-temporal statistical analysis as well as to guide the modeling efforts. The specific objectives are as follows:

Objective 1. Reconstruct land-use/land cover changes and dust storm events in Central and East Asia over the past 50 years by merging available data from satellite, weather and monitoring stations, and historical records.
Objective 2. Investigate the spatio-temporal structure relating the dynamics of LCLUC, dust events, and climatic variables (surface temperature, winds, precipitation, humidity, cloud coverage, drought indices) by conducting statistical analysis at a range of spatial and temporal scales using a combination of the statistical methods.
Objective 3. Based on the analyses described above, assess the individual and coupled effects of land-use and Asian dust changes on regional climate via their impacts on energy- and water-budgets. Determine the formulation of these effects for further quantifications through climate

modeling. Such formulations will be both as simple prescriptions for forcing scenarios and as including the coupled dynamics of the land-dust system.

Our proposed research directly targets the NASA LCLUC program solicitation that requests the proposals in support of the Northern Eurasia Earth Science Partnership Initiative (NEESPI). This proposal in particular addresses the mineral dust, the key component of atmospheric aerosol in Northern Eurasia, which is involved in important interactions with LCLUC and climate change via a complex and still poorly understood series of direct impacts and feedbacks. We seek to gain a better understanding of those interactions that are central to answering the key NEESPI science questions highlighted by the LCLUC program solicitation. Furthermore, our proposal contributes to the overall goals of NASA and its vision on "…To understand and protect our home planet.."