Proposal Summary

This proposal focuses on the integration of NASA Earth system science and observations to understand and improve our predictive capability of future changes in biomass burning (BB) and feedbacks from BB and land cover land use change (LCLUC) on atmospheric composition and climate forcing from Northern Eurasia. Northern Eurasia is a region that is expected to and is currently experiencing some of the largest temperature increases on Earth, and this region has the size and carbon store necessary to affect regional and global climate.

This is an interdisciplinary, collaborative, international endeavor with a primary focus on IDS sub-element 1: Water and Energy Cycle Impacts of Biomass Burning, and the proposed work also has implications for IDS sub-element 1: Integrated Earth System Responses to Extreme Disturbances. This proposed research directly relates to NASA's Strategic Goals and Research Objective of advancing scientific understanding of Earth from space (strategic sub-goal 3A).

This work is significant to improving our current understanding of the feedbacks from the terrestrial environment (biomass burning and vegetation change) to atmospheric composition and climate forgings and to improving our understanding of future atmospheric composition and climate forcing (NASA research objectives 3A.1 and to a lesser degree 3A.2 and 3A.4).

The meteorological conditions that precede severe fire events show perturbations in temperature, precipitation, humidity and winds. Changes in cloudiness, temperature and humidity lead to perturbations in the surface energy fluxes including the radiative flux budgets. Additionally, large biomass burning events lead to large but temporary changes in the aerosol amounts and sudden changes in land cover, first from burn scars and then vegetative successional processes. In the long-term, models predict that many ecosystems types will not return in boreal regions. Fire is the driving force of vegetation change that forces ecosystems to move more quickly towards a new equilibrium with the climate system.

Specifically, we propose to:

(1) Improve our understanding of current feedbacks by: producing novel BB emissions that are explicitly linked to fire weather and ecosystem-specific fuels; use these emissions in GOCART and WRF-Chem chemical transport models and compare their results with solar radiation budget data (radiation) and other coincident satellite (CALIPSO, MISR, MOPPIT, MODIS) and field data (ARCTAS, INTEX-NA).

(2) Generate future BB emissions using: established relationships with fire weather; simulated ecosystems (SiBClim and FAREAST) and mean fire return intervals.

(3) Use GOCART and WRF-Chem to examine the affect of future changes (2020-2030; 2050-2060; 2090-2100) in LCLUC and BB on the quantity and distribution of atmospheric gases and aerosols, patterns of precipitation, cloud cover and the radiation balance.

(4) Quantify the integrated influence of the impact of BB and LCLUC on the energy balance (shortwave, longwave, sensible and latent heat fluxes, aerosol radiative forcing), altered patterns of precipitation, and potential changes in black carbon deposition to the Arctic due to early and more extreme fire seasons and changes in large-scale circulation using GOCART, WRF-Chem, simulated ecosystems and future BB emissions.

(5) Investigate the role of sub-grid parameterization (small-scale processes) on regional scale processes.

We are expecting unique results from this proposed work because Northern Eurasia is an understudied region with distinct plant functional types that have not been considered in an integrated framework; explicit BB emissions have not been quantified; we are using a set of chemical transport models that have the capability to span multiple scales (from meters to global); and the models have not been operated in unison and they each have distinct advantages and capabilities, as well as the ability to compare and contrast several interactive parameters.