Estimation of seasonal snow cover, glacial and lake area changes at the Ob/Yenisey river heads during the last 40 years using NASA ESE products and in situ data

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ABSTRACT

Problem statement: There is an urgent need to predict the hydrological consequences of global climatic changes that affect fresh water ecosystem at Arctic regions of Asia (*IPCCI, 2002*). The Altai mountains in Siberia define southern periphery of the Asian Arctic Basin and the Ob and Yenisey rivers are only Siberian rivers that feed by fresh water from Altai glaciers. According to Barry et al. (1993), the Siberian rivers runoff amount about 53.9% of the total freshwater into the Arctic Ocean, and the water flowing from the Ob and Yenisey rivers accounts for 40% of the total river inflow into the Arctic (*Aagaard, 1980*). The runoff from Siberian rivers plays important role in regulating the global thermohaline circulation through the hydrological cycle of the Arctic Ocean (*Wang and Cho, 1997*). We suppose that decrease of snow/glacier water resources at the head of Ob/Yenisey basin since the middle of 20th century may have a considerable influence on the freshwater budget of Arctic Ocean. Predicted summertime increases in temperature enlarge glacier recession and snow cover extension potentially changing the Siberian rivers hydrological regime. The proposed research will define these changes at the Ob/Yenisey basin for the first time. We will couple over forty years hydro-meteorological records and land-surface topographical data with NASA ESE products to bring independent 3-dimensional observationally-based information for calibrating and evaluating the river runoff simulation and prediction through initialization of distributed glacier/snowmelt modeling efforts.

Our main objective is to estimate changes in the snow- and glacial-covered areas in the head of Ob/Yenisey river basins over forty years period, and to simulate and forecast consequent snow and glacial runoff variability at annual/monthly steps. This research will focus on the dynamics of the hydrological regime, water resources, and consequential influence on the freshwater budget of Arctic Ocean.

Research approaches: (1) Collect and process currently available in-situ and NASA data; (2) Simulate the snow cover and glacial area distribution changes; (3) Calibrate, validate, and improve the snow/glacial runoff model parameters; (4) Characterize the annual to decadal variations in river runoff component and assess the climate-driven impact on future snow/glacial water resources.

Methods: (1) Check all data for homogeneity and representativeness, geo-referenced to one coordinate system all terrestrial data; (2) evaluated glacial areas by Landsat and Terra ASTER data, validate with the IKONOS and CORONA. Sub-pixel snow mapping techniques using MODIS and AVHRR data, a MODIS snow-covered area product validate using Landsat and ASTER data; (3) simulate annual means river runoff parameters with annual air temperature, precipitation and maximum snow water equivalent computed as a function of elevation using Triangulation Irregular Network (analogue of reanalyses data but more detailed). Estimate evapotranspiration as a function of potential evaporation through air temperature and precipitation using MODIS Land Classification data and maps. Simulate snow/glacier melt models with annual mean runoff through snow distribution, snow/glacier ablation and quantifying the precipitation partitioning. GIS-based distributed River Runoff Models will be validated in regional conditions; (4) Forecast of glacier retreat based on the annual Equilibrium Line Altitude determined by mean summer air temperatures and annual precipitation.

The proposed project addresses an important unifying component of the NASA IPY Program with respect to the terrestrial components of the cryosphere in the Cold Land Regions of the Northern Hemisphere research. Such modeling and predicting glacier and snow cover changes is an important component of the U.S. GCRP, WCRP, contribute to CliC, CLIVAR, and NEESPI.