

# CONTINUOUS FIELDS OF SNOW COVER CHARACTERISTICS DERIVED THROUGH COUPLING SATELLITE DATA WITH SNOWPACK MODEL: APPLICATION IN THE RIVER RUNOFF MODELING OVER NEESPI DOMAIN

## Project Proposal to NASA Terrestrial Hydrology Program

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### OBJECTIVES

- Develop and implement a new advanced automated technique for snow retrievals from combined MODIS and AMSR-E observations.
- Generate a set of enhanced satellite-based snow products (snow cover extent, snow depth, snow fraction) over Northern Eurasia
- Utilize satellite-derived data to calibrate the snow pack and the snowmelt runoff generation model
- Provide detailed characterization of snow pack physical properties (snow grain size, ice and liquid water content, snowmelt rate, sublimation loss and refreezing melt water) for several river watersheds within NEESPI area using snow pack model coupled with satellite data
- Assess benefits of using satellite information on the snow cover in river runoff and streamflow simulations and forecasts.

### FOCUS AREAS

The primary focus of the study will be on basins of three rivers: Don, Vyatka and Kolyma. Other areas may be included in the study if needed.



- (1) Upper Don region. Catchment area is 101,800 km<sup>2</sup>, 20 streamflow gauges, 12 meteorological stations.
- (2) Vyatka river region. Catchment area is 124,000 km<sup>2</sup>, 4 streamflow and 6 synoptic weather stations.
- (3) Upper Kolyma region. Catchment area is 99,400 km<sup>2</sup>, 3 streamflow gauges and 4 meteorological stations.

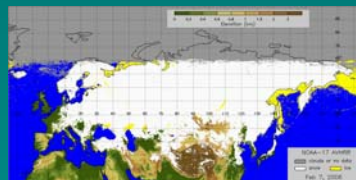
### APPROACH

#### IMPROVEMENTS IN SATELLITE SNOW COVER MONITORING AND SNOW RETRIEVALS

- Combined use of MODIS observations from Aqua and Terra satellites
- Fractional snow cover and snow depth derived from MODIS.
- Synergy of visible/infrared and microwave observations from MODIS and AMSR-E for better snow cover mapping and snow depth retrievals

Calibration and validation of satellite-based snow products will be performed via comparison with in situ observations of snow characteristics and runoff measurements.

The new technique will be implemented within an automated routine and will deliver daily maps of snow cover area extent, snow fraction and snow depth over Northern Eurasia



Daily blended snow cover map based on NOAA AVHRR data. The map is produced by retaining the latest cloud clear observation in every map grid cell. Similar snow maps will be generated from MODIS Terra and Aqua.

#### PHYSICALLY BASED MODELING OF SNOW PACK AND RUNOFF GENERATION

The system of the physically based models of runoff generation developed in the Laboratory of Hydrological Cycle of the Water Problems Institute of the Russian Academy of Sciences is based on the finite-element river basin schematization and includes the following main processes:

- Snow pack and snow cover formation, including interception, snowmelt, sublimation, metamorphism
- Freezing and thawing of soil
- Detention of water by basin relief storage
- Vertical soil moisture transfer and infiltration in frozen and thawing soil
- Overland, subsurface and channel flow



Finite element schematization of the Vyatka River basin

#### APPLICATION IN THE SNOWMELT RUNOFF ESTIMATES

- Snowmelt flood forecasts using satellite and hydrometeorological station information
- Assessment of maximum probable floods
- Estimation of the effect of possible land use and climate change on snowmelt floods

### DELIVERABLES

- New technique for snow cover mapping and estimating snowpack characteristics from Terra and Aqua satellites
- Technique for assimilating satellite data in a snowpack model. New river runoff model coupled with the snowpack model.
- Continuous daily maps of snow extent, snow fraction and snow depth over NEESPI domain derived from satellite data
- Daily maps of snow depth, snow density, snow water equivalent, snow grain size, snow melt at a 1 km grid over selected river basins
- Assessment of the effect of satellite data on the accuracy of river runoff simulations and predictions of flood hydrographs.

All products will be generated and will be made available for five consecutive winter seasons, from 2002-2003 to 2006-2007.