Sub-grid study of scaling effects to evapotranspiration of heterogeneous forest landscape at the Volga source area in Russia

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1. INTRODUCTION

A common problem of the model simulations of the land surface - atmosphere interaction is to choose the appropriate spatial scale and resolution at which the simulations are to be performed. The accuracy of energy and water exchange predictions between the land surface and the atmosphere in regional and global scale atmospheric models is mainly influenced by: model simplifications applied to describe the spatial heterogeneity of land surface properties within individual grid cells; ignoring the variability of sub-grid properties (e.g. relief, vegetation, soils), and; lacks of necessary input meteorological and biophysical data.

2. MATERIAL AND METHODS

In order to quantify effects of a sub-grid heterogeneity of relief and land-use to regional water fluxes a regional SVAT model (SVAT-Regio) has been applied to the Volgas source catchment area (56°20-57°20N, 32°10-33°20E) in Russia. SVAT-Regio model was developed to describe the vertical radiation, momentum, sensible heat, H2O and CO2 exchanges and their partitioning within the plant canopy and lower part of atmospheric boundary layer for heterogeneous areas in regional scale. It allows to dynamically couple the stomatal functioning and CO2 assimilation of the plant canopy with the microclimatic conditions of the atmospheric boundary layer, with canopy structure and with canopy and soil hydrology. It is based on main approximations applied in the one-dimensional SVAT-model (SLODSVAT) (Oltchev et al. 1996, 1997, and 1999).

3. RESULTS AND DISSCUTION

The selected upper part of the Volgas source (about 3720 km2) belongs to the central part of the large main watershed region of the Russian Plain. This watershed region includes source basins of the most important rivers of the Eastern Europe (Volga, Daugava, Neva, Dnepr). The highest point of this area is about 321 m above sea level. Boreal and temperate forests cover about 80% of Volgas source area. Mixed spruce - aspen - birch forests with age about 100-130 years are dominated and cover about 50 % of this area. Secondary broadleaf forests and deforested areas cover about 10%, spruce and pine forests - 20%, birch forests - 3%, meadow and agricultural fields - 7%, lakes and rivers - 6%, bogs - 4%.

Modelling estimations of the main water fluxes for this area were made for three summer periods of 1994, 1996 and 1999. For model experiments a different spatial model resolution (gradually decreased from maximal grid resolution 500 m 500 m to minimal - 10 km 10 km) was used. For each grid cell the hourly, daily and monthly values of different components of energy, water and carbon budgets were estimated. The atmospheric boundary conditions for each grid cells was determined using results of the spatial interpolated measurements of daily meteorological data (e.g. air temperature, relative humidity, wind speed, precipitation amount and amount of clouds (or global solar radiation)) from neighbouring meteorological stations of the Russian Weather Service. Hourly meteorological data for each individual grid cell were produced from interpolated daily data using a developed wetter generator. Digitised maps of orography, hydrography, land-use, vegetation and soils were prepared using available basis maps and modern remote sensing images from satellites.
evapotranspiration changes gradually increases with decreasing the sizes of considered catchment area and depends on relief heterogeneity and actual composition of different vegetation and soil types. Modelling results show that decreasing the spatial grid resolution of the model (from 500 m 500 m to - 10 km 10 km) results in significant disordered changes of daily and hourly evapotranspiration (up to 24%) and in insignificant decrease (up to 6%) of the monthly and total summer evapotranspiration. Sensitivity of such

This study was made for summer periods, only. It can be expected that maximal scaling contrasts will be observed in spring and autumn periods. So, this hypothesis should be examined in the future modelling experiments.

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