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# Utilizing satellite-derived estimates of land surface temperature and vegetation characteristics in modeling the vertical water and heat fluxes for a river basin

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New version of the model of vertical water and heat transfer in the "soil-vegetation-atmosphere" system (SVAT) has been developed, accounting for land surface heterogeneities in river basin. The model is specially designed to assimilate satellite data and is intended for calculation of evapotranspiration Ev, soil water content W, sensible and latent heat fluxes and other water and heat balance components as well as vertical soil moisture and temperature profiles and vegetation cover and soil surface temperatures for any time interval within vegetation season. The river basin landscape patchiness is represented in the model with soil constants, leaf area index LAI, vegetation cover fraction B, land surface albedo A, and other vegetation characteristics that were treated as model parameters. The Seim River basin was chosen for investigation, situated in forest-steppe zone of the Central Russia (Kursk region) with watershed area equal to 7460 km2.

Satellite-derived estimates of land surface characteristics have been extracted from AVHRR/NOAA (1999-2006 vegetation seasons) and MODIS/EOS Terra and Aqua (2003-2005 vegetation seasons) cloud-free data. The developed technique of AVHRR data processing provides the cloud detection and the retrieval of soil temperature sg and emissivity E, surface-air temperature at a level of vegetation cover Ta, effective radiative temperature Ts.eff (weighted linear combination of Ta and Tsg), as well as the derivation of normalized vegetation index NDVI, LAI and B. The updated multi-threshold technique of cloud detection in the AVHRR field of view has been applied to increase the reliability of cloud-free fragments selection. The algorithms of Ta, Ts.eff, Tg derivation utilize linear regression estimators similar to well-known “local” split window technique. The values of E for these regression formulas have been specified using empirical relationships between E and B, E and NDVI as well as the emissivity models for various surface types. To determine B and LAI empirical relationships with NDVI for different land covers have been employed. The comparison of satellite estimates Ta, Ts.eff , Tg with quasi-synchronous in-situ measurements during above vegetation seasons gives RMS errors in the range 2.0-2.7, 2.4-3.5, 3.4-4.8 [U+F0B0]C respectively. The MODIS-based dataset of remote sensing products, namely, the estimates of Tg, Ts.eff, NDVI, LAI, E for the region of interest and chosen vegetation seasons has been compiled using Internet resources and special technique.

While developing new version of the SVAT model, the capabilities have been investigated to calculate Ev, W, LE, H and other water and heat balance components with replacement ground and point-wise estimates of LAI and B by their AVHRR-or MODIS-based (surface-averaged) analogs. The efficiency of such approach has been proved through comparison between satellite-derived, modeled, and in-situ measured temperatures as well as through comparison the modeled and actual values of Ev, W for various soil layer under all scenarios of LAI and B specification. The discrepancies between mentioned temperatures do not exceed the RMS errors of satellite-derived estimates Ta, Tg and Ts.eff while the modeled and measured values of Ev and W have been found close to each other within a standard error of their estimations. Moreover, the ability of using satellite AVHRR- or MODIS-based land surface temperature as the SVAT model variable has been confirmed if the time-matching of satellite and ground-based observations takes place.

Thus, the results of our studies allow confirming the efficiency of satellite data utilization in modeling the vertical heat and water transfer processes for vegetation-covered territories under the lack of conventional ground measurements.

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