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Using remote sensing data on land surface characteristics in the water and heat balance components modeling for river basin

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The refined model of vertical heat and water transfer in the "soil-vegetation-atmosphere" system (SVAT) has been developed and tested to calculate evapotranspiration Ev, soil water content W, vertical latent and heat fluxes LE and H together with other components of water and heat balances for river basin. Besides, the model allows assessing vertical soil moisture and temperature distributions, as well as soil surface and vegetation cover temperatures. It accounts for the soil and vegetation heterogeneities and is adopted to assimilate remote sensing data on land surface characteristics. These data are usually inferred from clear–sky measurements of satellite-based radiometers AVHRR/NOAA and (more recently) from MODIS /EOS Terra and Aqua.

In our study the earlier developed methodology and software package have been applied for AVHRR/3 (NOAA-18) data processing and retrieval of remote sensing products for the central region of Russia (including the Seim River basin chosen for investigation) and 2003-2005 vegetation seasons. This river basin with watershed area equal to 7460 km^2 is situated in forest-steppe zone of the Central Russia (Kursk region). The satellite-derived land surface characteristics include: soil surface temperature T_{sg} and emissivity E, surface-air temperature (at the level of vegetation cover) T_a, effective ra-

diation temperature $T_{s.eff}$ (weighted linear combination of T_a and T_{sg}), normalized vegetation index NDVI, leaf area index LAI, and a vegetation cover fraction B. To determine $T_{s.eff}$, T_{sg} and T_a, the linear regression estimators have been built. Both LAI and B were estimated using empirical relationships with NDVI. The error statistics of T_a, $T_{s.eff}$ and T_{sg} derivation has been investigated using comparison with in-situ measurements, RMS errors were in the range 2.0-2.5, 2.4 -3.5, and 3.4-4.8˚C respectively.

In addition, on the base of special technology and Internet resources the set of remote sensing products ($T_{s.eff}$, E, NDVI, LAI) derived from MODIS (EOS/Terra and Aqua) data has been compiled for Kursk region and the same vegetation seasons. Comparison of MODIS-based $T_{s.eff}$ estimates (for separate dates of 2003-2004 vegetation seasons) with similar quasi-synchronous and collocated AVHRR/3-based estimates as well as the results of in-situ measurements confirms their reliability.

Different types of soil are characterized by soil constants while vegetation is represented with LAI, B and other characteristics. All these values can be utilized as model parameters using finite-element schematization of the river basin. Beforehand they have been adjusted by calibration against measured vertical soil moisture and temperature profiles, soil surface temperature, soil water content and evapotranspiration as well as through comparison the modeled and satellite-derived soil and surface-air temperatures. The ability is confirmed to assimilate in the SVAT model AVHRR- and MODIS-derived estimates LAI, B and $T_{s.eff}$ instead of their ground-based estimates (if the satellite and ground-based observations are synchronous) when calculating Ev, W, LE, H and other water and heat balance components for 2003-2005 vegetation seasons. This conclusion is justified by comparison the modeled soil- and surface-air temperatures with their satellite-derived analogues as well as by comparison the calculated and measured values of Ev and W. The discrepancies between modeled and satellite-derived temperatures do not exceed the error magnitudes of respective remote sensing products, while the modeled and measured values of Ev and W are found close to each other within a standard error of their estimation under all scenarios of LAI and B specification (from AVHRR/3, MODIS, and ground-based data).

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