

AN ENERGY BALANCE MODEL FOR FOREST CANOPIES: A CASE STUDY

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The use of thermal scanning devices to map underlying terrain surface temperatures has been recognized as a potential tool for estimating evapotranspiration and latent heat flux densities in forest canopies. Ecologically, knowledge of the temperature distribution of phyto-elements and the underlying soil surface is directly applicable to understanding photosynthetic, heat and mass transfer and soil decomposition rates. Such knowledge of the current state and surface characterization of terrestrial ecosystems is a critical starting point for understanding Global Change processes and modeling the underlying energy exchanges.

A steady-state thermal radiance model to compute thermal exitance and energy balance components within forest canopies is presented. The model treats fully leafed canopies as discrete ensembles of leaves partitioned into slope-angle and height classes. Short-wave energy flux absorbed within the canopy is estimated by solving simplified radiosity equations. Sensible heat exchange is estimated using a logarithmic wind profile above the canopy and a modified exponential profile within the canopy. The latent heat boundary layer resistance is estimated from site-specific measurements summarizing the effects of solar irradiance, air temperature and vapor pressure deficit on stomatal conductance. Comparisons are presented of the basic model with field measurements conducted at a dense spruce-fir forest study site at Howland, Maine. Field data included eddy correlation values of latent and sensible heats as well as IR measurements of foliage temperatures. For clear days the resulting root mean square error in modeled versus measured canopy temperatures was 1.2 °C. Corresponding errors in latent and sensible heat flux energy budget terms were 30 and 32 W m⁻², respectively. For partly cloudy days the root mean square error in predicted temperature was 1.0 °C and corresponding errors in latent and sensible heat were 40 and 110 W m⁻².

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