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Integrated irradiance modelling in the urban environment based on remotely sensed data

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Abstract

The complexity of built form and land cover has often limited detailed model estimates of solar irradiance in the urban canopy. These limitations arise largely from difficulties in generating contiguous detailed spatial representations of solar obstructing features such as buildings and trees. This study presents a method that integrates remotely sensed datasets across spatial scales for estimating irradiance in urban areas. The method draws largely on airborne Light Detection and Ranging (LiDAR) technology with specific focus on estimating radiation transmission through urban vegetation. The incoming irradiance above the urban canopy is determined using atmospheric transmission derived from geostationary satellite imagery to provide a long-term record of seasonal fluctuations in cloud cover, and the associated direct and diffuse irradiance. Individual model components are analyzed for three urban study areas to assess the interactions between input model parameters and patterns of different urban form. Results indicate that representations of trees as opaque objects substantially underestimate solar irradiance across urban form types, demonstrating up to a 18% underestimate of direct irradiance in treed residential areas. Both atmospheric transmittance and urban form are also shown to be critical model parameters, and are discussed with reference to unique considerations for generating estimates of urban irradiance.

Highlights

► Remote sensing data are integrated across spatial scales to model irradiance. ► A procedure for estimating vegetation transmission through the urban vegetation is presented. ► Treating vegetation as an opaque feature results in a substantial underestimate of irradiance.

Keywords

Urban; LiDAR; Remote sensing; Vegetation; Transmission; Gap probability