

Simulation of canopy radiation transfer and surface albedo in the EALCO model

Shusen Wang

Senior Research Scientist, Canada Centre for Remote Sensing, 588 Booth St.

Abstract

EALCO (Ecological Assimilation of Land and Climate Observations) is a land surface model that simulates land surface radiation, energy, water, carbon, and nitrogen cycles using remote sensing data as input. The canopy radiation transfer and surface albedo scheme in EALCO uses a gap probability-based successive orders of scattering approach that explicitly includes the heterogeneities of stands and crown elements and the radiation multiple scattering. The model uses the optical parameters of ecosystem elements and physically represents ecosystem processes in surface albedo dynamics. Model tests using measurements from a boreal aspen forest show that the model well reproduced the observed diurnal and seasonal albedo dynamics under different weather and ecosystem conditions. The annual mean absolute errors between modelled and measured daily albedo and reflected radiation are 0.01 and 1.33 W m⁻², respectively. The model results provide a quantitative assessment of the impacts of plant shading and sky conditions on surface albedo observed in high-latitude ecosystems. The contribution of ground snow to surface albedo in winter was found to be less than 0.1 even though the canopy is leafless during this time. The interception of snow by the leafless canopy can increase the surface albedo by 0.1-0.15. The model results show that the spectral properties of albedo have large seasonal variations. In summer, the near infrared component is substantially larger than visible, and surface albedo is less sensitive to sky conditions. In winter, the visible band component is markedly increased and can exceed the near infrared proportion under cloudy conditions or when snow exists on the canopy. The spectral properties of albedo are also found to have large diurnal variations under the clear-sky conditions in winter. This seasonal variation in wavelength-albedo relationship could have profound influences in remote sensing applications such as radiance ratio based vegetation indices. Model sensitivity analyses of surface albedo to canopy architecture parameters, such as stand crown shape, stand density, and leaf inclination angle, and variations in LAI, wood area index, bark reflectance, and soil reflectance are also conducted.

Corresponding Author: Shusen Wang

Shusen Wang

Mailing address: Senior Research Scientist, Canada Centre for Remote Sensing, 588 Booth St.,
Ottawa, ON, K1A 0Y7, Canada

E-mail: ShuWang@NRCan.gc.ca