Radiative distribution over complex topography

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Resumo

Neste trabalho utilizam-se três diferentes parametrizações para calcular a radiação global e difusa incidente sobre a superfície terrestre. Propõe-se a utilização dessas metodologias para investigação do papel da topografia sobre a incidência do fluxo radiativo de onda-curta e sobre o sombreamento associado a horizontes locais de terrenos complexos.

Abstract

In this work, direct, diffuse and global radiation over the complete solar spectrum incident on the earth’s surface was calculated using three parameterization methods. The topography effects on solar irradiance are associated with variations in illumination angle and shadowing due to the local horizon of complex terrains.

1. Introduction

Incident solar radiation is a driving force for many ecological and hydrological processes [1, 2], its influence over the energy and water balances of the earth surface, affects processes like air and soil heating, evapotranspiration, photosynthesis, wind, snow thawing, etc. Solar radiation energy depends mostly on incidence angle, which is defined by astronomical and surface parameters. The sky is usually not completely clear, so a set of meteorological variables must be considered. Despite the importance of topographical features to radiative and hydrological distributions they are rarely represented properly in mesoscale modeling nowadays.

2. Broadband method for short-wave solar radiation

For most energy balance problems and other meteorological...
applications, determining of radiation over the complete solar spectrum is required. The parameterization method calculates rapidly the radiant energy for clear sky, under specified atmospheric parameters. In the parameterizations, an overall spectrally integrated transmittance for each atmospheric constituent is employed to compute the total transmittance of the atmosphere, as a broad band approach over the short-wave range. We have used three parameterizations here called A[3], B[4], and C[5]. All of these approaches propose separate expressions for direct, diffuse and global irradiance. For each one, the global irradiance on a horizontal surface can be written by \( I = I_n \cos(\theta_z) + I_{dn} + I_{da} + I_{dm} \), where \( I \) is the global irradiance incoming on a horizontal surface; \( I_n \) is the normal direct irradiance, \( \theta_z \) is the zenith angle of Sun, and \( I_{dn}, I_{da} \) and \( I_{dm} \) are, respectively, the broadband diffuse irradiance on the ground due to the Rayleigh scattering, aerosols scattering and absorption, and also multiple reflections between surface and atmosphere. Further, geometric equations[3] for director cosines of the Sun and the normal to tilted planes are employed (not shown here) for the topography of the Metropolitan Area of Rio de Janeiro (MARJ).

3. Conclusions and perspectives

Three radiative schemes for short-wave have been prepared to use in high resolution mesoscale simulations over complex terrains addressed to research in micro and hydrometeorology. The irradiance schemes are verified against available curves in the solar radiation literature (Figure 1). In Figure 1(a) and 1(b) the irradiances are indicated by: top of the atmosphere value (ib); Rayleigh scattering contribution (ir); aerosol scattering (ia); terrain reflections (idt), and the resulting surface value (itot). In Figure 1(c) and 1(d) the atmospheric transmittance are modified by Rayleigh scattering (tr), Ozone absorption (to), mixture of gases effects (tg), water vapor absorption (tw), aerosol scattering and absorption (ta), resulting the surface value (ttot).
Figure 1. Modeled direct, diffuse components and global solar irradiances and atmospheric transmittances for a clear sky, in the solstices of winter and summer at MARJ.
References


