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Validation of Spectral and Broadband UV-B (290 - 325 nm) Irradiance for Canada

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ABSTRACT

Stratospheric ozone depletion, as a result of increasing chlorofluorocarbons in the stratosphere, allows more UV-B irradiance (290 - 325 nm) to reach the earth ' s surface with possible detrimental biological effects. Be-cause there are few UV-B radiation stations, irradiance models are useful tools for estimating irradiances where measurements are not made. Estimates of spectral and broadband irradiances from a numerical model are compared with Brewer spectrophotometer measurements at nine Canadian stations (Alert, Resolute Bay, Churchill, Edmonton, Regina, Winnipeg, Montreal, Halifax and Toronto) and 26 years of data. The model uses either the discrete ordinate radiative transfer (DISORT) or the delta-Eddington algorithms to solve the radiative transfer equation for a 49-layer, vertically inhomogeneous, plane-parallel atmosphere, with cloud inserted between the 2 and 3 km heights. Spectral calculations are made at 1 nm intervals. The model uses extraterrestrial spectral irradiance, spectral optical properties for each atmospheric layer for ozone, air mole-cules, and aerosol and surface albedo. A fixed broadband cloud optical depth of 27 was satisfactory for cal-culating cloudy sky irradiances at all stations except in the arctic. Comparisons are made both for daily totals and for monthly averaged spectral and broadband irradiances. The delta-Eddington method is shown to be unsuitable for calculating spectral irradiances under clear skies, at wavelengths less than 305 nm where absorption by ozone is high, and at large solar zenith angles. The er-rors are smaller for overcast conditions. The method is adequate for daily total and monthly averaged spec-tral (? 305 nm) and broadband calculations for all sky conditions, although consistently overestimating ir-radiances. There is a good agreement between broadband measurements and calculations for both daily totals and monthly averages with mean bias error mainly less than 5% of the mean measured daily irradiance and root mean square error less than 25%, decreasing to below 15% for monthly averages.

KEYWORDS

Modelling UV-B Radiation, DISORT, Delta-Eddington, Spectral and Broadband Radiation, Brewer Spectrophotometer, UV-B Measurements in Canada

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