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Neural network for the estimation of uv erythemal irradiance using solar broadband irradiance

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We present the development of an artificial neural network (ANN) model that can be used to estimate solar UV irradiance based on optical air mass, ozone columnar content and dimensionless ratios defined from measurements of global and diffuse horizontal broadband solar irradiance. A multilayer perceptron network, MLP, consisting in an input layer, an output layer and one hidden layer was used. The learning process of the MLP network involves using the input-output data to determine the weights and biases. The training of the neural network was done using the Bayesian regulation backpropagation algorithm. In this method, the weights and biases are adjusted iteratively to achieve a minimum specified mean square error between the network output and target value using the Levenberg-Marquardt optimization.

The study was developed at four stations in the Iberian Peninsula, Madrid, La Coruña and Murcia, using data recorded in the period 2000-2002 and Zaragoza, using data recorded in 2001-2002. The UVER observations are recorded as half hour average values. The measurements were performed in the framework of the Spanish UVB radiometric network, which includes Yankee UVB-1 radiometers operated and maintained by the Spanish Meteorological Institute. In the stations selected for this study simultaneous observations of ozone columnar content were performed by means of Brewer instruments operated within the same network at the selected locations. In order to train and validate the MPL neural networks, independent subsets of data were extracted from the complete data base at each station.

The results suggest that a MLP neural network using optical air mass, ozone columnar content and the dimensionless ratios, k, ratio of diffuse to global horizontal solar

irradiance, and k_t, ratio of global horizontal irradiance to extraterrestrial horizontal irradiance, provides better results than that obtained in a previously published neural network model relying on cloud observations as input variables. In fact, the networks developed at each place when applied to an independent data set recorded at the same location provide estimates with mean bias deviation less than 3% and root mean square deviation below 15% for most of the sites. The generalization of these models is justified by the results obtained testing the neural network developed at one place with the data recorded at other locations. In this case, although there is a slight increase in mean bias deviation that could reach values about 5% the root mean square deviation are similar to those obtained in the local evaluations. According to these results the use of broadband irradiances to the estimation of ultraviolet erythemal irradiance provides a tool that can solve the difficulties associated to the retrieval of appropriate information on the cloud field by human observers. In this sense the proposed method seems appropriate to use the widespread networks of broadband irradiance to obtain ultraviolet erythemal irradiance data sets in places where this radiative flux is not measured or to extend back in time the existing data sets.