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Simulation of solar radiative fluxes in the atmosphere of West Siberia with the use of different continuum absorption models

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Water vapor is well known to be a critical component in many aspects of atmospheric research, such as radiative transfer and cloud and aerosol processes. This requires both improved measurements of the columnar water vapor and its profiles in the atmosphere in a wide range of conditions, and adjustment of water vapor parameterizations in radiation codes including the perfection of spectroscopic parameters.
The report compares the calculations of the broadband solar radiative fluxes in the clear-sky atmosphere, which were performed using two different models of water vapor continuum absorption: (1) the MT_CKD model which is most widely used in the radiation calculations, and (2) the CAVIAR model [1,2] based on the new experimental data. The altitude profiles of pressure, temperature, and water vapor mass fraction for the summer and winter conditions were specified according to the regional models, constructed on the basis of aerologic sensing data for different regions of West Siberia [3]. The flux simulations used an approach according to which the wavelength range 0.2-5 mm was divided into 31 intervals. Within each interval, the radiative fluxes were calculated on the basis of the Monte Carlo method; and the transmission functions of atmospheric gases were approximated by finite exponential series with the use of the HITRAN-2008 database of the spectral line parameters.
Being proportional to the square of the water vapor pressure and being strongly temperature dependent, the continuum absorption is more sensitive to the humidity profile than the selective absorption. The last studies [1,2] showed that the water vapor continuum in the transparency windows of the near-IR range is, on the average, an order of magnitude larger than the MT_CKD model data. Refinement of the continuum absorption ultimately translates into the calculations of the radiative fluxes and into their dependence on the vertical water vapor distribution.
The report also compares the fluxes of the direct S, diffuse D, and total Q solar radiation at the surface level; they were obtained on the basis of the numerical simulation and field measurements performed during summerss of 2010-2011 near Tomsk. The discrepancies between the measured and model-based radiative fluxes dX (X=S,Q,D) were analyzed taking into account the uncertainty ErX, caused by the measurement errors and the inaccuracies of calculation and specification of the input parameters. It is shown that the maximum discrepancies dS due to the use of the MT_CKD_2.4 model are comparable to ErS and equal to 6-12 W/m2 (<3%). When model [1,2] is used for the radiation calculations, these discrepancies decrease by approximately 1-1.5 W/m2 .
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