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An assessment of methods for calculating solar radiation in the non-hydrostatic mesoscale ICON model in heterogeneous cloudy conditions

Marina V. Shatunova[1] , Julia O. Shuvalova[1] , Natalia Y. Chubarova[2,1]

[1] Hydrometeorological Research Center of the Russian Federation
[2] Lomonosov Moscow State University

shatunova@mecom.ru

The radiation calculation methods used in modern numerical weather prediction (NWP) and climate models make it possible to take into account the heterogeneity of cloud properties within the computational grid cell.One of these methods is the stochastic McICA[1] (MonteCarloIndependent ColumnApproximation) method, which is widely used in NWP models due to its computational efficiency. Alongwiththis, the TripleClouds [2,3] method has recently been used in the advanced forecasting models like IFS ECMWF and ICON.

Non-hydrostatic mesoscale ICON model is used for operational weather forecasts in a number of national meteorological services in Europe, and since 2024 - in the Hydrometeorological Research Center of Russia. The optical cloud thicknesses and global radiation calculated in the ICON model using two methods, McICA and TripleClouds, were estimated against CERES and MODIS satellite data for several days during the warm period of 2021, for which, in addition to satellite data, there are observations ofradiation (BSRN station in Lindenberg) and cloud (CLOUDNET station in Lindenberg) characteristics. On average, calculations using McICA and TripleClouds yielded similar results. However, after10-12 h ours of model simulation, the spatial distributions of predictive values of water content, optical thickness, cloud cover, and global radiation obtained by the two methods have significant differences. The standard deviation of the difference between the two calculation options was equal, e.g.,to 100 g/m^2 for the water content, 8 for the optical thickness of the cloud cover, and about 100 W/m^2 for the global radiation.

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