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Results of calibration of the scheme for calculation of multi–layer cloudiness and precipitation for climate models of intermediate complexity

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A scheme for calculation of characteristics of multi–layer cloudiness and precipitation in climate models of intermediate complexity (EMICs) is presented. It describes three–layer stratiform cloudiness and single column convective clouds. It distinguishes between ice and droplet clouds as well. For convective clouds, an universal vertical profile of moisture content is prescribed based on observations. Precipitation is calculated by using cloud life time which depends on cloud type and phase as well as on statistics of synoptic and convective disturbances.

The scheme was calibrated off–line forced by the ERA–40–derived climatology for 1979–2001. A semi–automated procedure was applied by selecting the expert–derived ranges for parameters of the scheme and attempting to achieve a maximum of the cost function. The latter accounts for annual means and January and July values for total cloud amounts, total cloud water and ice path, and total, large–scale, and convective precipitation. Total cloud amount is evaluated using the ISCCP D2 data, cloud water and ice path is evaluated against the CERES retrievals, total precipitation is compared to the GPCP climatology, and the fractions of large–scale and convective precipitation are tested against ERA–40 data. Parameters of the scheme are sampled by using the Latin Hypercube sampling.

With the use of the above tuning procedure, the scheme realistically reproduces basic features of the fields of cloud amounts, cloud heights, cloud water and ice path, and precipitation. The simulated global and annual mean total cloud amount is 0.57 which agrees with the respective satellite-retrieved values. In agreement with observations, the highest stratiform and convective cloud amounts are simulated, respectively, in the regions of storm tracks and in the tropical regions with moisture convergence. However, subtropical minima of cloud amounts are too deep in the model. While the overall geographical structure of the precipitation rate is reproduced realistically by the scheme, precipitation is overestimated in the subtropics and in the eastern part of Eurasia. In turn, precipitation is underestimated in the regions of tropical convection. The globally averaged annual precipitation is $98\ cm/yr$ which is close to the corresponding value obtained from empirical data.

The three–layer cloud and precipitation scheme has been implemented in the statistical–dynamical atmosphere model Aeolus which is the part of the a generation of the Climber–4 EMIC, as well as in the IAP RAS EMIC.