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Impact of climatic noise on global estimates of terrestrial water balance components

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Estimates of water balance components performed by different authors in climate impact studies are characterized by a large scatter or uncertainty associated, in particular, with application of different meteorological forcing data (simulated by climate models), different estimates of model parameters, and different hydrological models. In the present work, the objective uncertainty, which cannot be reduced by means of better physical description of the processes under study or by means of improvement of the quality of input data for model simulations, and which is an internal feature of the atmosphere – hydrosphere – land surface system, is considered. This uncertainty is caused by a chaotic character of atmospheric processes (i.e. by so-called climatic noise), their instability with respect to small errors in determination of initial conditions for modeling the evolution of meteorological variables. Our study is devoted to investigating the impact of climatic noise on the estimates of terrestrial water balance components (precipitation, runoff and evapotranspiration) on a global scale.

To achieve the effect of climatic noise 45 simulations were performed by the atmospheric general circulation model ECHAM5 under identical lower boundary conditions (including sea surface temperatures and sea ice concentrations) and constant external forcing parameters. The only differences between the simulations were initial conditions of the atmosphere. Meteorological fields simulated by ECHAM5 for the period of 1979-2012 were used as forcing data (with 6-hour temporal resolution and one-degree spatial one) by the land surface model Soil Water – Atmosphere – Plants (SWAP) for hydrological simulations on a global scale. As a result, 45-member ensemble of the water balance components for the land surface of the Earth excluding Antarctica was obtained. Analysis of the obtained results allowed us to estimate the lowest level of uncertainty which can be achieved in climate impact studies on a global scale and for different continents.