Sensitivity of Snow Water Equivalent Distribution to Variations of Critical Snow Albedo in GCM Experiments of Hydrometcentre of Russia

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Snow is a very important component of climate system. Adequate simulation of snow cover characteristics in hydrodynamical models is one of the indicators parameterization reliability of hydrological and heat balance processes of the model. Simulation of snow cover area (SCA) at global and regional scale in AMIP - type experiments was the point of special interest in a number of publications (e.g. Frei et al. 2005). Hall & Qu, 2006, Roesch 2006 showed that snow albedo feedback is critical for climate models prediction. The objective of the present study is to examine the effects related with introducing variable critical surface albedo of snow in model which is in winter time directly depend on snow cover. Information about snow density of different class of snow was obtained from Sturm, 1995 classification approach. Then own critical value of albedo is prescribed for each class of snow cover (Tudra – 0.95, Taiga – 0.95, Maritime – 0.7, Ephemeral – 0.5, Prairie – 0.76, Mountain – 0.87). In the model was introduced procedure of counting dynamics of snow classes, depending on three month mean surface air temperature, precipitation and wind. According to class of snow cover these critical snow albedo values were introduced for experiment. For comparison, in model control run the critical value of surface snow albedo is assumed as a constant (0.8). In this study the SWE parameter is validated as effect of varying of snow critical albedo on the surface.

Before evaluation process of model SWE data, we investigated which of is snow data set can be used as etalon for evaluation of model. There is no global snow water equivalent and snow depth datasets with good spatial and temporal resolution. Brown et al. (2003) developed regional gridded monthly snow depth and water equivalent data set for period from 1979 to 1996 with good spatial resolution over North America region. It is not possible elaborate the same dataset at global scale due to insufficient number of observations *in situ* over other parts of the globe. In this study we verified quality of reanalysis to adequately reproduce SWE. Validation of snow water equivalent (SWE) from 4 types of reanalysis (ERA-40 (ECMWF), NCEP/NCAR, NCEP/DOE and JRA-25) against measured SWE from snow survey routs over FSU territory for period from 1979 to 2000 using several statistical criteria was performed (Khan et al., 2007). The results of comparative analysis indicated that SWE from ECMWF is the closest to observational data for mostly FSU territory. SWE from JRA-25 reanalysis is reasonably reproducing observational data since 1986. NCEP/DOE is only able adequately simulate the long-term tendencies of SWE averaged over large regions. So, the global SWE from ERA-40, ECMWF reanalysis was used for validation of outputs from GCM of Hydrometcentre of Russia.

Both GCM experiments (control and with different albedo of classes) correspond to AMIP protocol requirements. In the second experimental run the effect of varying surface albedo tend to be closer to surface albedo climatologies from remote-sensed estimations. Preliminary results indicate that seasonal variability of SWE is reproduced well in the model for both runs, although the spatial distribution in some regions contradicts with etalon data. Figure 1. demonstrates seasonal distribution of SWE averaged over North America, Europe and Asia. Results from both control and experimental runs are close to each other over large integrated areas although they can substantially diverge at separate points. Over Europe, the seasonal variability is reproduced well by phase, but the amplitude is underestimated by model runs almost in twice. For Asia and North America, formation of snow cover is simulated very close to etalon data, but the melting processes of snow are significantly delayed. SWE from model runs overestimate SWE from ERA-40 in a range from 50%-100%.

Influence of introducing of variable critical albedo in GCM for simulation of SWE can be seen from Figure 2. Spatial distribution of RMSE of SWE from control and experimental runs exhibits geographical areas over globe most sensible to more accurate albedo description in the model.

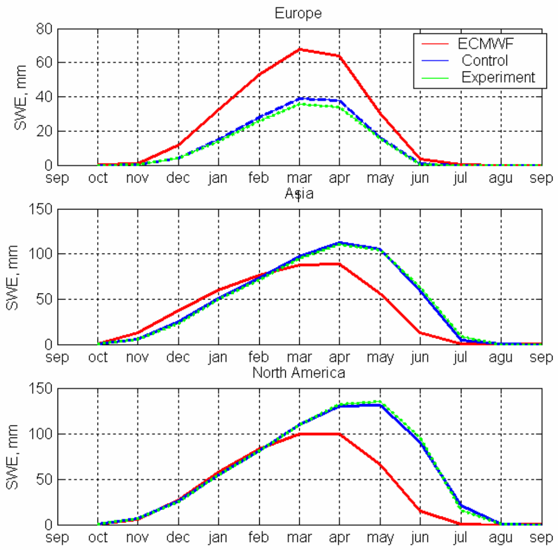

Figure1. Seasonal variability of SWE from ERA-40 reanalysis, control and albedo experiments runs averaged over Europe, Asia and North America regions

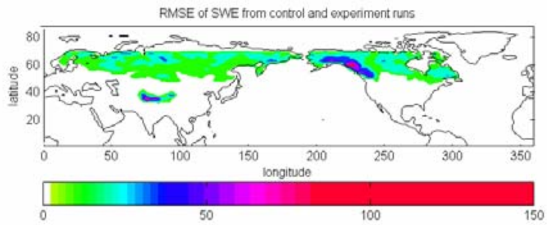

Figure2. Spatial distribution of RMSE of SWE from control and experimental runs

This work has been supported by the INTAS Project 03-51-5296 and NATO ESP CLG grant 981942.

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