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Application of global dynamic vegetation model estimation of aridity changes in drought prone region of North-Eastern Eurasia

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Dynamic global vegetation models (DGVMs) are specifically designed for an assessment of integrative continental scale soil and vegetation carbon and water pools and fluxes between these pools and the atmosphere. However, recent DGVMs still remain mainly tools for global studies, which explain limitations of these models in view of regional applications.

In this study we investigate possibility of application of state-of-the art SEVER-DGVM for description of contemporary water dynamics in semi-arid regions of North Eastern Eurasia. We suggest simple modifications of input climate and soil data and moving to irregular vector representation of basic spatial units, instead of regular grid cells, aiming increase in accuracy of simulation of water pools and fluxes.

The study area is Rostov oblast' with small parts from Stavropol krai and Kalmykia Republic (oblast' and krai are administrative units in Russia), associated with the southern part of River Don watershed. The region is rather big (approximately 800 km in direction North – South and approximately 400 km in direction East – West.

SEVER-DGVM, a dynamic global vegetation model (DGVM) was applied as a modelling tool of the study. The model was never before applied specifically for regions of Southern Russia and thus required evaluation and afterwards modification for accuracy of representation of water fluxes and pools.

For regionalization of climate data we compared time series for temperature and precipitation from the NCEP climate dataset and from the regional meteorological data. We found that temperature time series from the global dataset are close to the observed, but the NCEP dataset has tendency to underestimate precipitation in Rostov region at daily time step, while providing correct pattern of annual and monthly dynamics. This was corrected using long term daily anomalies of observed daily temperature and precipitation in the region.

For regional application of the global vegetation model we defined relatively homogenous spatial units for which validation of the model can be performed.

Overlay of soil, vegetation and watershed data was done to distinguish the homogenous units for the Rostov region. Watersheds were further sub-divided only if soil or vegetation types at their area were substantially different according to expert estimate (forest versus grassland, or solonthaks against kashtanozems) The resulting subdivision for Rostov region includes 16 units, which were named irregular grids.

Run-off as an integrative water pool was validated for all watersheds in the Rostov region and the model coefficients were slightly adjusted for better representation. SEVER DGVM was run at the daily time step for the period 1957-2006 (fifty years) after the regionalisation of the model input climate data and determination of irregular grids for the region.

It can be seen from our results that the entire simulation period can be divided for the region roughly in two periods 1957-1975 and 1976-2006. The second period is warmer and wetter. Consequently, AET is increasing, especially in the eastern part of the Rostov region. This indicates that aridity in the Rostov oblast, which constitutes a large area in North Eastern Eurasia, is decreasing.