

CLIMATE EXTREMES AND NET PRIMARY PRODUCTION IN EASTERN EUROPE: CHANGES IN XIX-XXI CENTURIES FROM MODEL SIMULATIONS

I.I. Mokhov (1), J.-L. Dufresne (2), H. Le Treut (2), V.A. Tikhonov (1)

(1) A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow, Russia

(2) Laboratoire Meteorologie Dynamique du CNRS, Paris, France

Regional anthropogenic changes of climate extremes from simulations of a coupled atmosphere-ocean general circulation model IPSL-CM2 with a carbon cycle (Friedlingstein et al., 2001; Dufresne et al., 2002) for the 1860-2100 period are analyzed (Mokhov et al., 2002). In particular, relationships of net primary production (NPP) and drought and extreme wet conditions during spring-summer seasons are studied. Model simulations are based on anthropogenic scenario with carbon dioxide emissions due to fossil and land use from observations up to 1990 and the IPCC SRES98-A2 emission scenario from 1990 to 2100.

Model results were tested in comparison with observations from the end of the XIX century up to the end of the XX century (Meshcherskaya and Blazhevich, 1997) for Eurasian regions in the middle latitudes (Mokhov et al., 2002). For instance, model simulations reproduce quite well the decrease of precipitation anomalies with the increase of temperature anomalies during the most important period for crop development (May-July) in the Eastern European region (EER).

Different indices are used to characterize anomalously warm and dry (or cold and wet) conditions (Meshcherskaya and Blazhevich, 1997; Mokhov et al., 2002). In particular, the drought index D can be defined by the negative precipitation (normalized on the long-term mean value of precipitation) and positive surface air temperature anomalies larger than some critical values (20% for precipitation and 1K for temperature, for instance). The index W of the wet regimes can be defined by the opposite sign anomalies. The D and W values characterize the portions of total area under corresponding conditions. Two additional indices can be used: D-W and S determined by the difference of normalized temperature and precipitation anomalies (normalized on respective standard deviations).

Model results display for EER during May-July, in particular, that the increase of temperature in the XXI century relative to the XX century is accompanied in both regions by the decrease of precipitation and wet regime index and by the increase of drought indices. Simulations show the interannual variability decrease in the XXI for precipitation in EER. Drought indices display the general variability increase, while wet conditions index shows the interannual variability decrease.

Simulations show for EER significant decrease of NPP in May-July with the increase of drought index D in the XX century. No statistically significant correlation is found between NPP and D during vegetation season in EER from simulations for the XXI century. It can be interpreted as a decrease of meteorological droughts influence on NPP in EER due to the increase of the carbon dioxide atmospheric concentration in the XXI century (fertilization effect). Figure 1 shows the coefficients of correlation of NPP with precipitation (a) and with soil water content (b) for different 60-years running periods for EER from model simulations. According to Fig.1 the weakening of relationship of NPP with precipitation is accompanied by a general strengthening of NPP relationship with soil water content for EER in May-July. It is related with the change of relative contribution to NPP variations of meteorological and soil droughts.

This work was supported by the CNRS/RAS Joint Agreement Program, Russian Foundation for Basic Research and Russian Program for Supporting the Leading Scientific Schools.

References

- Dufresne, J.-L., P. Friedlingstein, M. Berthelot, L. Bopp, P. Ciais, L. Fairhead, H. Le Treut, and P. Monfray, 2002: On the magnitude of positive feedback between future climate change and the carbon cycle. *Geophys. Res. Lett.*, **29**, 1405, doi:10.1029/2001GL013777.
- Friedlingstein P., L. Bopp, P. Ciais, J.-L Dufresne, L. Fairhead, H. LeTreut, P. Monfray, and J. Orr, 2001: Positive feedback between future climate change and the carbon cycle. *Geophys. Res. Lett.*, **28**, 1543-1546.
- Meshcherskaya A.V., and V.G. Blazhevich, 1997: The drought and excessive moisture indices in a historical perspective in the principal grain-producing regions of the Former Soviet Union. *J. Climate*, **10**, 2670-2682.
- Mokhov, I.I., J.-L. Dufresne, V.Ch. Khon, H. Le Treut, and V.A. Tikhonov, 2002: Regional regimes with drought and extreme wet conditions: Possible changes in XXI century from IPSL-CM2 simulations. *Research Activities in Atmospheric and Oceanic Modelling*, H. Ritchie (ed.), WMO/TD-No.1105, 07.31-07.32.

Figure 1. Coefficients of correlation of NPP in EER with precipitation (a) and with soil water content in May-July for different 60-years running periods.

