Hydrological anomalies and trends in the Amur River basin due to climate change

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A record flood in the Amur River basin in 2013 was due to long intense rainfall in July-August. It was associated with the long atmospheric blocking anticyclone over the Pacific and with an extremely high surface temperature in the West Pacific. Key features of the Amur River basin are related to the East-Asian monsoon effects. An increase in the soil moisture during last years in the Far East regions facilitated an increase in the risk of anomalous floods in the Amur River basin [1-3].

Figure 1 shows meridional distributions of the summer blocking frequency in the Northern Hemisphere from reanalysis data for different years from 1969 to 2013 with dedicated distributions for 2013, 2010 and mean conditions [3]. The summer of 2013 (red curve) is characterized by high frequency of blocking activity over the Pacific.

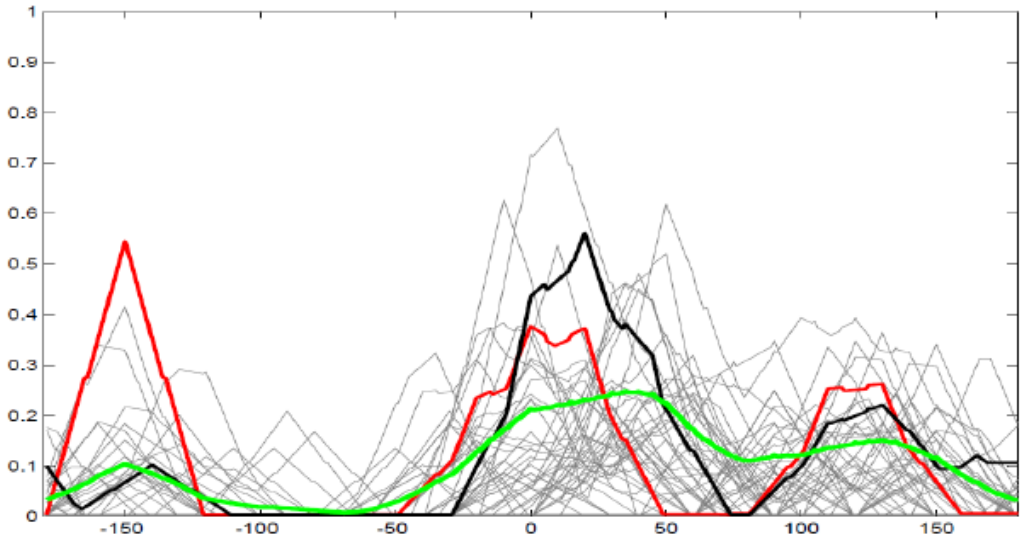

Figure 1. Meridional distributions of the summer blocking frequency in the Northern Hemisphere for different years during 1969-2013 with dedicated distributions for 2013 (red curve), 2010 (black curve) and mean conditions (green curve).

Long-lived atmospheric blockings over the Pacific during active periods of summer monsoon increase the risk of extreme phenomena in the Far East as it happened in 2013. With the general monsoons' intensification under global warming related to the increase in the atmospheric water-holding capacity and greater water vapor capacity of the atmospheric cyclones (with more intense rainfall), an increase in the risk of extreme floods in the Amur basin should be expected .

To assess possible changes, the CMIP5 multi-model simulations with RCP scenarios for the 21st century can be used. Figure 2 presents an example of estimates for trends in summer precipitation (mm/10 years) in the Northern Hemisphere from MPI-ESM-MR simulations with the RCP4.5 scenario for the 21st century (2006-2100) [3].

According to Fig. 2, the maxima of the summer precipitation trend in the 21st century are in the Far East, in particular in the Amur River basin. The obtained model estimates show an overall increase in the probability of extreme precipitation and runoff in the Amur River basin during monsoon seasons (summer - fall) under global

warming in the 21st century.

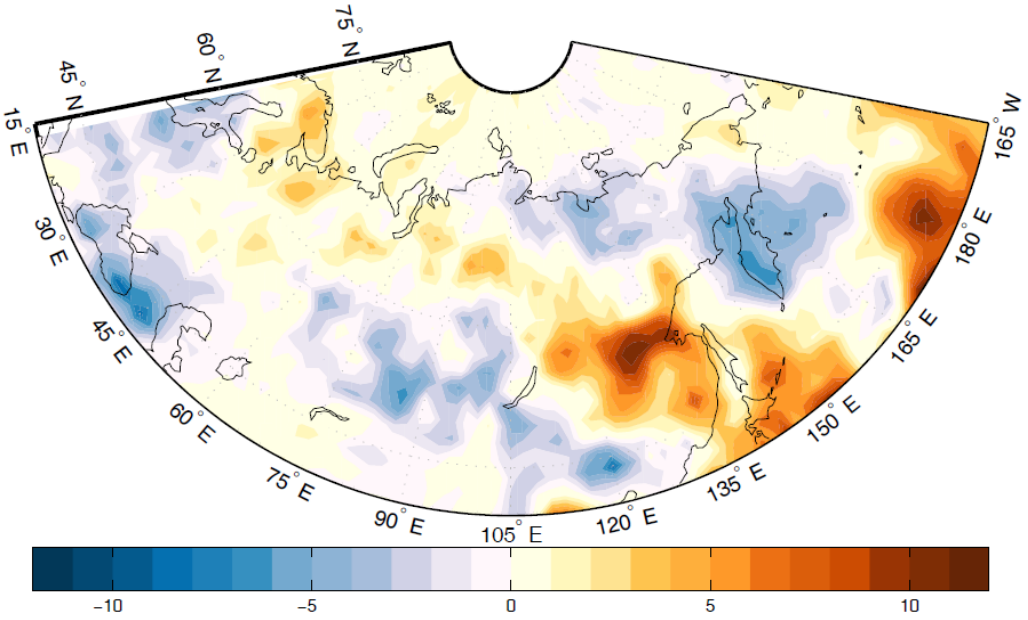

Figure 2. Estimated trends of summer precipitation (mm/10 years) in the 21st century (2006-2100) from climate model simulations (MPI-ESM-MR) with RCP4.5 scenario.

The risk of floods in the Amur River basin increases under global warming due to the possible increase of monsoon activity and total duration of summer blockings over the Pacific. A large uncertainty of the model estimates of possible hydrological changes in the Amur River basin should be also noted. It is related to the large natural variability of hydrological conditions (including runoff) in the Amur River basin observed since the end of the 19th century [3]. Significant effects associated with the Pacific Decadal Oscillation and El-Nino/Southern Oscillation are detected, in particular [3].

References

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3. Mokhov I.I., Khon V.C., Timazhev A.V., Chenokulsky A.V., Semenov V.A., 2014: Hydrological anomalies and tendencies of change in the Amur River basin in relation to climate changes. In: Extreme Floods in the Amur River Basin: Causes, Forecasts, and Recommendations. Moscow, Roshydromet, 81-120. (in Russian)