CURRENT STATE AND PROJECTION OF HYDROLOGICAL CYCLE OF LAND SURFACE AND ATMOSPHERE IN THE NORTHERN EURASIA

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Fast loss of sea ice in the Arctic indicates that a new distinct climate will be established in several decades when polar basin becomes sea ice free in summer. Besides significant amplification of global warming in the polar region it is also expected that some change of hydrologic cycle will occur in the atmosphere and on land surface over Northern Eurasia. Climate simulation of the 21st century reveals that 45% of the CMIP5 models reproduce sea ice free condition in the Arctic by the end of the 21st century with RCP4.5 scenario and 90% models reproduce similar condition with RCP8.5 scenario. Change of annual variation of precipitation in both solid and liquid phases and components of hydrological cycle (precipitation, snow melt, evaporation and water discharge) on land were evaluated from ensemble simulation with atmospheric general circulation model and prescribed boundary condition on the ocean at control period (1980-1989) and in sea ice free period. The boundary condition (sea ice cover and thickness) were chosen from CMIP5 AOGCMs after test of their performance against simulation of sea ice and SST in the current climate. Boundary condition from three CMIP5 models were used in the study: ACCESS1-0, CESM1 CAM5 and MPI ESM MR.

Hydrological processes very much depend on annual variation of air temperature in Northern Eurasia. About one third of precipitation falls out in solid phase and accumulates during cold season on the Earth. Model computation reveals that evolution of hydrological cycle over Northern Eurasia occurs due to two factors – substantial decrease of sea ice in the Arctic and SST growth. It is found that annual mean surface air temperature during sea ice free period will increase at about 7º C over the polar region (60N-90N) and at 3-4º C over the land of Northern Eurasia. Total precipitation and its liquid potion will significantly increase throughout the year mainly due to growth of moisture storage capacity of the atmosphere. Furthermore, snow precipitation will decrease in the Eastern Europe and will increase in Western and Eastern Siberia during cold seasons.

Important changes of different signs is also expected in intensity of snow melt and water discharge during spring over large river catchments of western and eastern regions. Amplification (weakening) of high discharge will depend on amount of accumulated snow mass through cold season and how far melting period will displace to early date of the year. Probability of intensive flooding is expected to decrease in the western regions and to increase in the eastern regions of the Eurasia. The frequency and intensity of precipitation associated with synoptic scale atmospheric processes will be also enhanced throughout the year.

Results of the simulation show that response of the atmosphere to reduction of sea ice extent and growth of global SST might be dependent on chosen atmospheric model. It implies that similar simulation with other independent models would be required to properly comprehend range of uncertainty in variation of water balance components on regional scale.