Geophysical Research Abstracts
Vol. 15, EGU2013-8776, 2013
EGU General Assembly 2013


# Desiccation of the Aral Sea and climate change in Central Asia: Interplay and mutual feedbacks

Peter Zavialov (1) and Huei-Ping Huang (2)

(1) Shirshov Institute of Oceanology, Physical Oceanography, Moscow, Russian Federation (peter@ocean.ru, 7499 1245983), (2) Arizona State University, Arizona, USA

In this presentation, we report results of a research project supported by US Civil Research and Development Foundation aimed at investigating the interplays between the Aral Sea desiccation, anthropogenic impacts, and climate change in Central Asia, and quantify principal feedbacks in the climatic system of the Aral Sea region by means of numerical model experiments as well as analyses of historical and newly obtained observational data. Aral Sea desiccation has been recognized as one of the worst anthropogenic ecological disasters ever. However, it is believed that a part of the desiccation may have been due to the natural climate variability manifested in larger scale warming trends across the Central Asia. The interaction between the lake and the climate change is a "two-way street": the shrinking of the Aral Sea leads to reduction in evaporation and precipitation, thus affecting regional moisture and temperature regimes, and atmospheric circulation. The altered meteorological condition may, in turn, induce further changes in the Aral Sea. In this study, we attempted to quantify the relative contribution from the alterations in the lake's hydrology and surface area to the regional climate change, and, reciprocally, from the large-scale and regional climate trends to the desiccation of the Aral Sea. We show, in particular, that the Aral Sea desiccation has led to significant changes in the regional precipitation, snow cover, and air temperature regimes. On the other hand, the large-scale variability of climate across Central Asia has modulated the hydrology of the lake and caused at least a part of the water level drop.

We assessed the long-term trends of air temperature at different isobaric surfaces in the Aral Sea region basing on reanalysis and historical data. Temperature and rainfall daily measurements from 223 meteorological stations of the former USSR in period from 1936 to 1990 were used, as well as the NCAR/NCEP reanalysis data. The differences between the 1980-1990 and the 1990-2000 decades exhibited positive trend in the winter season, as well as in autumn. In contrast, a negative temperature trend was detected for spring and summer. We also investigated the vertical structure of the trends in the air temperature data. A negative trend was established for the low and middle troposphere during the pre-desiccation period and, oppositely, positive trend was evident in the top parts of troposphere. During the desiccation period, these trends reversed. Positive trends dominated in the desiccation period, with the highest trend values corresponding to winter season.
Two new hydrographic surveys were conducted in the Aral Sea during the implementation of the project. During the study period, the hydrological structure of the western basin of the lake exhibited a three-layered pattern with two salinity maxima in the near-surface and near-bottom layers, separated by the relatively "fresh" intermediate layer. In autumn 2012, the difference in salinity between surface and bottom layers was less than 4 g/kg, constituting significant decrease with respect to 2011 and earlier times.

We also explored the impacts of the desiccation of Aral Sea and large-scale climate change on the regional climate of Central Asia in the post-1960 era. To this end, WRF numerical modeling and the regional observational data were combined to conduct the simulation experiments to investigate the influence of Aral Sea desiccation on climate. The observed local meteorological datasets were used to change the land mask and surface height of the desiccated region and modification of land cover. Simulation results for winter and summer seasons in 1960 and 2000 decades pointed on a decrease in precipitation (in the form of both rain and snow) accompanying the desiccation of the Sea. There was a positive trend in overall warming in Central Asia after 1960s till present. The largest warming trend is for the winter season. The amount of rainfall over Aral Sea has reduced considerably due to the desiccation. If the desiccation had happened alone, the total amount of winter rainfall would have increased. This possibly means that there is a significant influence of warming in Central Asia.
The study was supported by US Civil Research and Development Foundation and also EU FP7 through CLIMSEAS Project.