

Associated with Pacific Decadal Oscillation regional natural hazards like Amur River record flood in 2013 and oceanic red tide near Kamchatka Peninsula in 2020

Mokhov I.I.

¹A.M. Obukhov Institute of Atmospheric Physics RAS

²Lomonosov Moscow State University

mokhov@ifaran.ru

In the fall 2020 an extraordinary ecological situation with mass death of hydrobionts and unnatural color and odor of oceanic water near Kamchatka Peninsula was noted. It was associated with strong positive anomalies of sea surface temperature (SST) in this region in summer-fall months which facilitated to formation of so called red tide with harmful bloom of algae, responsible for death of hydrobionts in coastal zones near Kamchatka Peninsula [1].

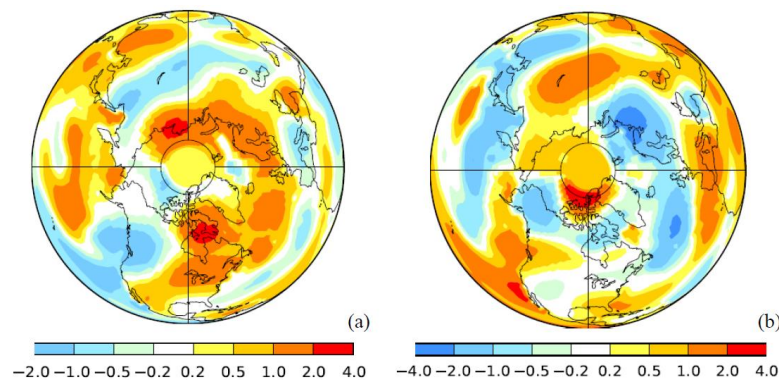


Fig. 1. Surface temperature differences [K] between 2020 and 2015 (a) and between 2015 and 2013 in summer by GISS data.

Several factors contribute to the increased risk of the formation of such regional climatic and ecological anomalies, in particular in the Pacific coastal zones. In [2,3], among the reasons for the formation of a record flood in the Amur River basin in 2013, it was noted against the background of a long-term significant tendency of global and regional warming the atmospheric blocking over the Pacific Ocean during the monsoon season (August-September) in the negative phase of the Pacific Decadal Oscillation (PDO) with positive surface temperature anomalies in the western part of the Pacific Ocean off the Asian coasts (the role of El Nino phases and West Pacific teleconnection pattern was also noted).

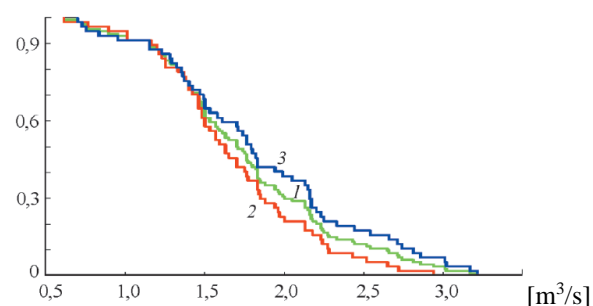


Fig. 2. Probability of exceeding the Amur River runoff [m³/s] in August of various levels from observations for the period 1900-2013 (1, green curve) and separately for the positive (2, red curve) and negative (3, blue curve) PDO phases.

The significance of regional temperature anomalies in different PDO phases is illustrated in Fig. 1, representing the temperature differences between years in the negative PDO phase (2013 and 2020) and in the positive PDO phase (2015). (In the positive phase of PDO, in particular in 2015, surface temperature anomalies in the western Pacific are negative.) Against the background of general warming, with significant positive SST anomalies in the west part of the Pacific Ocean

associated with a negative PDO phase, as in 2020 (see Fig. 1), increases the risk of formation of red tides in the coastal zones of the Far East. Connection with PDO of red tides was noted in other regions, in particular, in the coastal zones of North America [4-6].

The data obtained in [2,3] indicate the potential for the influence of PDO on the formation of the extreme runoff of the Amur River during the period of monsoon activity. In particular, 8 out of 10 years with the highest discharge of the Amur River in August since 1900 corresponded to the negative PDO phase. Figure 2 shows the probability of exceeding the Amur River runoff [m^3/s] in August of various levels from observations since 1900 and separately for the positive and negative PDO phases.

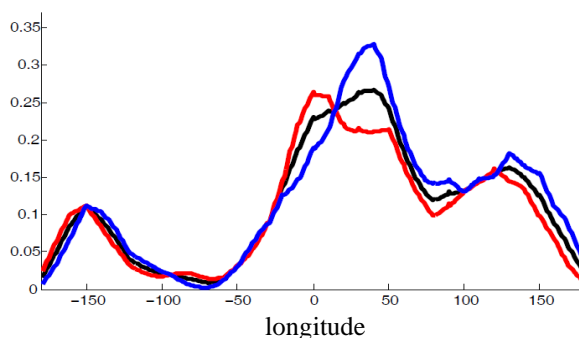


Fig. 3. Frequency of atmospheric blockings in dependence on longitude in the Northern Hemisphere in summer for the period 1969-2013 (black curve) and separately for negative (blue curve) and positive (red curve) PDO phases.

Significant role in the formation of climatic extremes like Amur River flood in 2013 is associated with atmospheric blockings. Figure 3 shows that the frequency of atmospheric blockings over west part of Pacific Ocean in the Northern Hemisphere in summer for the period 1969-2013 is highest in the negative PDO phase [3]. According to [7], atmospheric blockings, particularly in July-August-September, in the Northern Hemisphere as a whole by data for last decades are more frequent and intense in negative PDO phase.

This study was supported by the Russian Science Foundation (project no. 19-17-00240).

References

- [1] Bondur V.G., Zamshin V.V., Chvertkova O. I. Space study of a red tide-related environmental disaster near Kamchatka Peninsula in September–October 2020. *Doklady Earth Sci.* 2021 **497** (1): 255–260.
- [2] Mokhov I.I. (2014) Hydrological anomalies and tendencies of change in the basin of Amur River under global warming. *Doklady Earth. Sci.*, **455** (2): 459-462.
- [3] Mokhov I.I., Khon V.Ch., Timazhev A.V., Chernokulsky A.V., Semenov V.A. (2014) Hydrological anomalies and trends in the Amur river basin due to climatic changes. *In: Extreme Floods in the Amur River Basin: Causes, Forecasts and Recommendations*, Moscow, Roshydromet, 81-120. (in Russian)
- [4] Hooff RC, Peterson WT (2006) Copepod biodiversity as an indicator of changes in ocean and climate conditions of the northern California current ecosystem. *Limnol. Oceanogr.* **51** (6): 2607–2620.
- [5] McKibben S.M., Peterson W., Wood A.M., Trainer V.L., Hunter M., White A.E. (2017) Climatic regulation of the neurotoxin domoic acid. *Proc. N.A.S.*, **114** (2): 239–244.
- [6] Corters-Altamirano R., Alonso-Rodríguez R., Salas-de-León D.A. (2019) Historical observations of algal blooms in Mazatlan Bay, Sinaloa, Mexico (1979-2014). *PLoS ONE*, **14** (1): e0210631. <https://doi.org/10.1371/journal.pone.0210631>
- [7] Lupo A.R., Jensen A.D., Mokhov I.I., Timazhev A., Eichler T., Efe B. (2019) Changes in global blocking character during recent decades. *Atmosphere*. **10** (2): 92. <https://doi.org/10.3390/atmos10020092>