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Experimental model of intraseasonal variability of ice area in the Sea of Okhotsk

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Abstract. This paper proposes an experimental model for predicting the intraseasonal variability of ice area in the Sea of Okhotsk, implemented as a computer program. The physical and statistical model was built on the basis of the following components: the relationship of the seasonal maximum ice area in the Sea of Okhotsk with surface air and water surface temperature parameters; the relationship between short-term fluctuations in ice area influenced by cyclonic activity during lunar syzygies; and the tendency of long-term changes in ice area series in the Sea of Okhotsk. Various data series for the period 1980–2018 were analyzed in order to build a predictive physical and statistical model. The main data sources for determining parameter relationships were the ERA-Interim and ERA5 reanalysis archives, data on air temperatures from coastal hydrometeorological stations, and five-day maps of the distribution of ice concentration published by the Japan Meteorological Agency. The predictive model algorithms were implemented in the Python programming language using additional software libraries. The model allows the calculation of predicted values of ice area during the period of its fall-winter growth from November/December until its seasonal maximum (March), with a lead time of up to four months. The input data for constructing regression equations were a long-term series of air and surface water temperature parameters, dates of lunar phase changes, and values of ice area in the Sea of Okhotsk. The output data of the model were the values of the intraseasonal variability of ice area. The model was tested for the period 2001–2020, and the average relative error of the calculated and predicted values of ice area compared to the actual values was less than 7%. The accuracy of prediction during the period of maximum development growth and the seasonal maximum for temperate and mild winters in terms of the complexity of ice conditions was 79 %.

Keywords:

Sea of Okhotsk, ice area, sea ice, remote sensing, modeling, prediction

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References

1. [*Atlas of dangerous and especially dangerous for navigation and fisheries hydrometeorological phenomena: the Sea of Okhotsk, the Sea of Japan and the Bering Sea*]. **1980.** Leningrad: GUNIO MO, 251 p. (In Russ.).
2. Plotnikov V.V., Yakunin L.P., Petrov A.G. **1998.** [Ice conditions and methods of forecasting them]. In: [The Seas *Project. Marine hydrometeorology and hydrochemistry.* Vol. 9: *Sea of Okhotsk*, Iss. 1: *Hydrometeorological conditions*]. St. Petersburg: Gidrometeoizdat, p. 291–340. (In Russ.).
3. Pishchalnik V.M., Romanyuk V.A., Minervin I.G., Batukhtina A.S. **2016.** [*Analysis of the dynamics of ice cover anomalies in the Sea of Okhotsk in the period from 1882 to 2015*]. *Izvestia TINRO*, 185: 228–239. (In Russ.). https://doi.org/10.26428/1606-9919-2016-185-228-239
4. Kryndin A.N. **1964.** [Seasonal and interannual changes in ice cover and ice edge position in the Far Eastern seas due to the peculiarities of atmospheric circulation]. *Trudy GOIN*, 71: 5–80. (In Russ.).
5. Plotnikov V.V. **2002.** [*Variability of ice conditions in the Russian Far Eastern seas and their forecast*]. Vladivostok: Dalnauka, 171 p. (In Russ.).

6. Pishchalnik V.M., Ivanov V.V., Truskov P.A. **2011.** [*Forecasting the ice cover variation in the Okhotsk Sea by the method of sequential spectra*]. *Izvestia TINRO*, 165: 158–172. (In Russ.). EDN: OEUVNR
7. Belinsky N.N. **1965.** [*Marine hydrometeorological forecasts*]. Leningrad: Gidrometeoizdat, 254 p. (In Russ.).
8. Kudryavaya K.I., Seryakov E.I., Skriptunova L.I. **1974.** [*Marine hydrological forecasts*]. Leningrad: Gidrometeoizdat, 310 p. (In Russ.).
9. Kryndin A.N. **1966.** [The role of the ocean temperature field in the formation of atmospheric circulation anomalies and anomalies of winter severity in the seas based on the northwestern part of the Pacific Ocean]. *Proceedings of NIIAK*, 36: 37–45. (In Russ.).
10. Aldoshina E.I. **1964.** [On the possibility of predicting the ice edge position in the Sea of Okhotsk and the Tatar Strait in the spring months]. *Trudy GOIN*, 76: 104–127. (In Russ.).
11. Plotnikov V.V. **1982.** [Forecast of ice element fields in the Sea of Okhotsk using a physical-statistical method]. *Trudy DVNIGMI*, 96: 77–86. (In Russ.).
12. Petrov A.G. **1984.** [Numerical modeling of fall-winter hydrological processes in the Sea of Okhotsk]. In: *Abstracts of reports of the All-Union Council "Ice forecasts and calculations"*. Leningrad, p. 53–599. (In Russ.).
13. Frolov I.E., Petrov A.G. **1980.** Numerical model of autumn-winter ice phenomena. *Trudy DVNIGMI*, 91: 3–12. (In Russ.).
14. [Computer program registration certificate] No. 2023688937. *"Ice Data Processing"*. **2023.** Authors: Shumilov I.V., Romanyuk V.A., Pishchalnik V.M. No. 2023682641 from 30.10.2023; publ. 25.12.2023. (In Russ.).
15. Pishchalnik V.M. Tambovsky V.S., Truskov P.A., Minervin I.G., Melkiy V.A., Romanyuk V.A., Galtsev A.A. **2013.** Okhotsk Sea ice cover zoning. In: *Proceedings of the 28th International Symposium on Okhotsk Sea & sea ice. 17–21 February, Mombetsu, Hokkaido, Japan*, p. 312–315.
16. Minervin I.G., Romanyuk V.A., Pishchalnik V.M., Truskov P.A., Pokrashenko S.A. **2015.** Zoning the ice cover of the Sea of Okhotsk and the Sea of Japan. *Herald of the Russian Academy of Sciences*, 85: 132–139. https://doi.org/10.1134/s1019331615010049
17. Romanyuk V.A. **2019.** [*Ice regime of the Sea of Okhotsk in the context of the global trend of increasing air temperature*]: Diss. of Cand. Sci. (Geography). TOI FEB RAS, Vladivostok, 125 p. (In Russ.).
18. Fukamachi Y., Mizuta G., Ohshima K.I., Toyota T., Kimura N., Wakatsuchi M. **2006.** Sea ice thickness in the southwestern Sea of Okhotsk revealed by a moored ice-profiling sonar. *Journal of Geophysical Research: Oceans*, 111(C9). https://doi.org/10.1029/2005jc003327
19. Anderson T. **1976.** [*The statistical analysis of time series*]. Moscow: Mir, 744 p. (In Russ.). From Engl.: Anderson T. **1971.** *The statistical analysis of time series*. John Wiley & Sons, Inc. (Wiley Series in Probability and Statistics).
20. Glebova S.Yu. **2018.** Cyclones over the Pacific Ocean and Far Eastern seas in cold and warm seasons and their influence on wind and thermal regime in the last twenty-year period. *Izvestiya TINRO*. 193(2): 153–166. (In Russ.). https://doi.org/10.26428/1606-9919-2018-193-153-166
21. Timofeev S.D. **1968.** [The influence of lunar tidal forces on the atmosphere]. *Trudy GGO*, 227: 62–70. (In Russ.).
22. Shumilov I.V., Minervin I.G. **2021.** [Development of a predictive rule for ice cover variations during the beginning of ice formation in the Sea of Okhotsk]. In: *Forecasting ice conditions in the Far Eastern section of the Northern Sea Route extension using GIS technologies in the modern warming period (Yuzhno-Sakhalinsk, November 29, 2019)*: collection of round table reports. Yuzhno-Sakhalinsk: SakhSU, p. 49–56. (In Russ.).
23. Martinson L.K., Smirnov E.V. **2004.** *Quantum physics*. Moscow: Publ. House of N.E. Bauman MSTU, 496 p. (Physics at a technical university). (In Russ.).