Changes of navigation period at the North Sea Route in the 21st century from the CMIP5 ensemble simulations: Bayesian estimates

Eliseev A.V.[1,2], Mokhov I.I.[1,2], Parfenova M.R.[2]

[1]Lomonosov Moscow State University

[2]A.M. Obukhov Institute of Atmospheric Physics RAS

eliseev.alexey.v@gmail.com

A significant decrease in the Arctic sea ice extent during recent decades leads to the increase of navigation period (NP) at the North Sea Route (NSR) (Khon et al., 2010; Khon et al., 2017). Here some estimates of changes in the NP duration on the NSR from the CMIP5 climate models simulations with the use of Bayesian approach (with Bayesian likelihood estimates based on Gaussian distribution) are presented (Kibanova et al., 2018). The analysis used simulations with an ensemble of 25 climate models for the Arctic sea ice concentration under scenarios RCP 4.5 and RCP 8.5 of anthropogenic forcing for the 21st century. Results of simulations were compared with satellite data (obtained from the Scanning Multichannel Microwave Radiometer on the Nimbus-7 satellite) for the period 1980-2018 (Peng et al., 2013). For adequate model estimates of expected changes it is necessary to assess model performance along with multiannual mean and linear trends also interannual variability.

Here are presented the results for the same NSR trajectory as in (Khon et al., 2017). It was assumed that the NSR part was free of ice if its concentration was less than 15%. The NP duration was determined, in particular, for cases where 80 and 90% of the total length of the NSR was free of sea ice. The corresponding analysis was carried out for different parts of the NSR, including the Barents and Kara Seas, the Vilkitsky Channel area, the Laptev and East Siberian Seas.

Figure 1 shows estimates of the NP changes for the Barents and Kara Seas (a) and Laptev and East Siberian Seas (b) from the end of the 20th century based on ensemble model simulations under the RCP 4.5 and RCP 8.5 scenarios for the 21st century in comparison with satellite data.

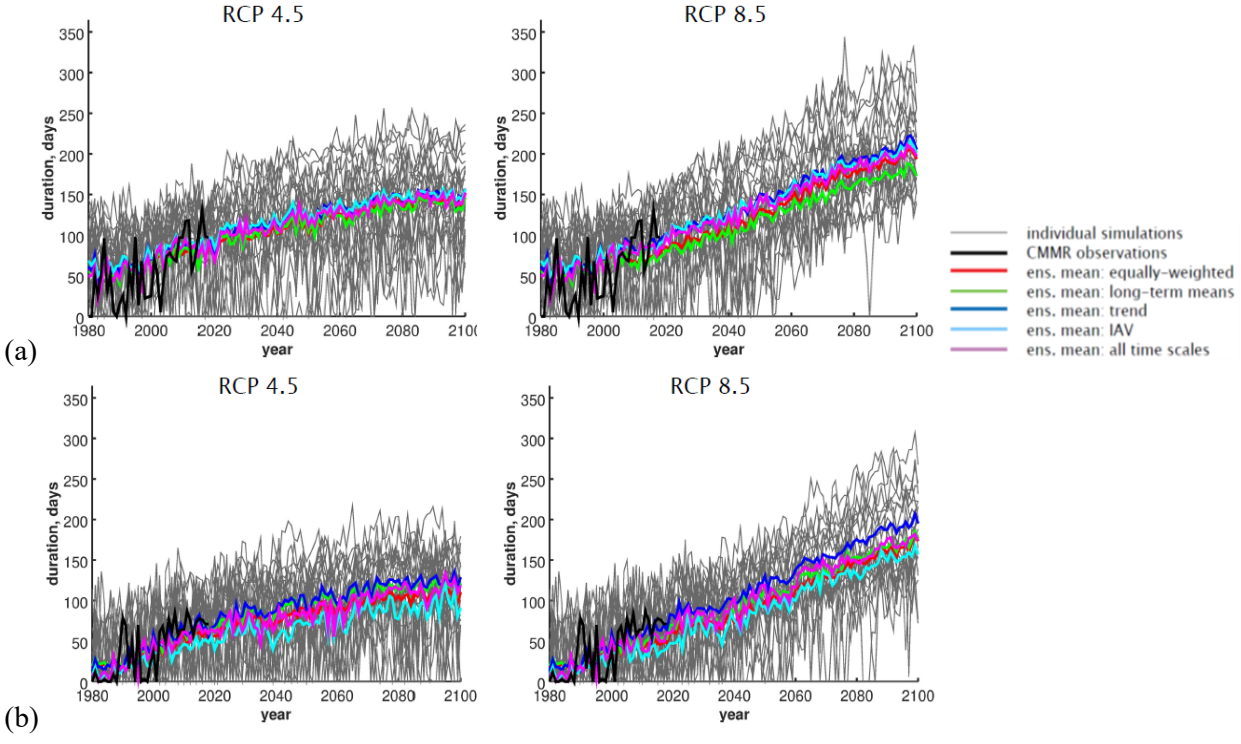

Fig. 1. Ensemble model estimates of changes in NP duration at NSR for the Barents and Kara Seas (a) and Laptev and East Siberian Seas (b) from the end of the 20th century under the RCP 4.5 and RCP 8.5 scenarios for the 21st century in comparison with satellite data.

The ensemble-mean NP duration for the Barents and Kara Seas increases from 55-65 days in 1980-2018 to 138-150 days in 2081-2100 under RCP 4.5 scenario and to 173-204 days under RCP 8.5 scenario depending on Bayesian likelihood choice. The corresponding increase for the Laptev and East-Siberian Seas is from 15-26 days to 94-118 days under RCP 4.5 scenario and to 150-187 days under RCP 8.5 scenario. The largest increase for these two NSR parts, corresponds to the trend-weighted Bayesian estimates, and the smallest increase is produced for the IAV-weighted Bayesian estimates.

It is worth to note that the change of the NP duration in the large NSR parts (Kara and Barents Seas, Laptev and East-Siberian Seas is not too sensitive to the choice of the Bayesian likelihood estimates (except Vilkitsky Channel).

This work was carried out as part of the Russian Science Foundation project 19-17-00240. Analysis of regional features of sea ice variability was supported by Russian Foundation for Basic Research (19-35-90118).

References

Khon V.C., Mokhov I.I., Latif M., Semenov V.A., Park W. (2010) Perspectives of Northern Sea Route and Northwest Passage in the 21st century. *Climatic Change.* **100** (3-4): 757-768.

Khon V.C., Mokhov I.I., Semenov V.A. (2017) Transit navigation through Northern Sea Route from satellite data and CMIP5 simulations. *Environ. Res. Lett.* **12** (2): 024010.

Kibanova O.V., Eliseev A.V., Mokhov I.I., Khon V.C. (2018) Variations in the duration of the navigation period along the Northern Sea Route in the 21st century based on simulations with an ensemble of climatic models: Bayesian estimates. *Doklady Earth Sci.* **481** (1): 909-913.

Peng G., Meier W.N., Scott D.J., Savoie M.H. (2013) A longterm and reproducible passive microwave sea ice concentration data record for climate studies and monitoring. *Earth Syst. Sci. Data*. **5**: 311–318.