Activities of Marchuk Institute of Numerical Mathematics (INM RAS) in climate modelling

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A coupled atmospheric and oceanic general circulation model (INMCM) has been developed at the Institute of Numerical Mathematics Russian Academy of Sciences (INM RAS). Below is a summary of the recent research with current versions of the model.

1. Climate model versions INMCM48 and INMCM50 have equilibrium climate sensitivity (ECS) about 1.8-1.9 K that is the lowest value among all CMIP6 models (1.8-5.6 K). Now new model versions are developed (Volodin 2023) with ECS about 3.7 K that is twice higher than the earlier value and not far from CMIP6 average. The reasons of low sensitivity in previous versions and increase of ECS in the last version are studied in (Volodin 2021). In general, the new model version reproduces the present-day climate with similar quality or better than the previous version. Figure 1 shows a simulation of global mean surface temperature in an ensemble of historical runs with the new model version.

2. A seasonal forecast system has been developed on the basis of the climate model INMCM50. Verification of seasonal hindcasts shows the quality comparable with other present-day seasonal forecast systems. Figure 2 shows the anomaly correlation coefficient (ACC) for simulation of near surface temperature in DJF of 1993-2009. The global mean ACC for INMCM50 is 0.48, while ACC for a multimodel ensemble presented at http://wmolc.org is 0.52. Operative seasonal forecasts for 4-10 months with INMCM50 start in test regime each calendar month.The seasonal forecast system on the basis of the INM climate model is described in (Vorobyeva and Volodin 2021).

3. Decadal hindcasts with INMCM50 model were started from each year of 1960-2022. Evaluation of hindcasts shows that the accuracy of climate simulation is comparable with other participants of Annual-to-Decadal Climate Predictions (ADCP). Fig.3 shows ACC for 5-year mean near-surface temperature in INMCM50 hindcasts. The global mean ACC is 0.64. The global mean for other ADCP models presented at (https://hadleyserver.metoffice.gov.uk/wmolc/ -> Verification, Correlation,Year 1-5: Annual, Temperature) is 0.56-0.67.

References:

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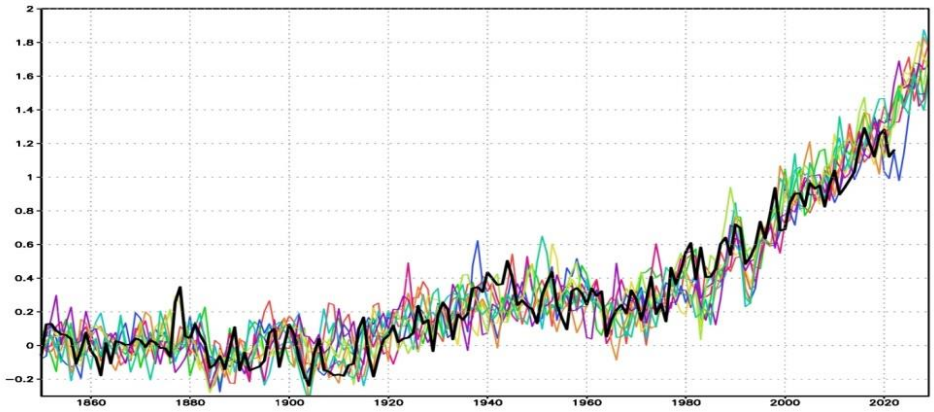

Fig.1. Simulation of global mean surface temperature anomaly with respect to 1850-1899 mean in an ensemble of INM climate model runs (different colors). Observations are shown in bold black line.

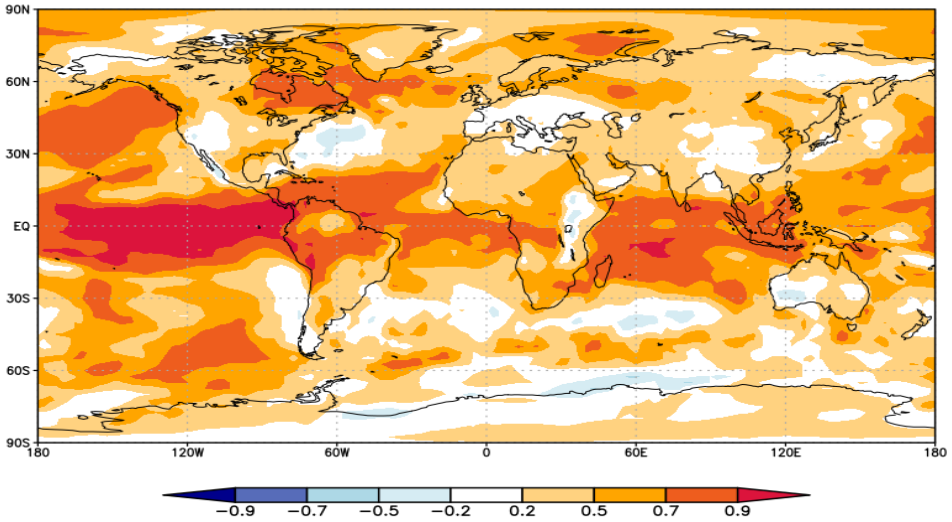

Fig.2. Anomaly correlation coefficient for near surface temperature in seasonal hindcasts with INMCM50 model calculated for DJF of 1993-2009.The global mean is 0.48.

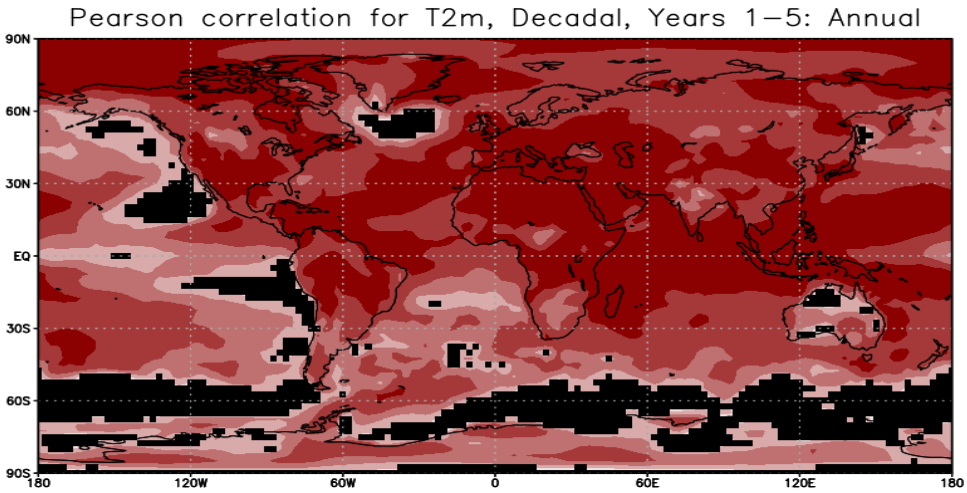

Fig.3. ACC for year 1-5 mean near surface temperature hindcasts for 1960-2017. The global mean value is 0.64.