

## Climate change in 19-22 centuries in observational and model data

Evgeny Volodin

Institute for Numerical Mathematics RAS, Moscow

E-mail: [volodin@inm.ras.ru](mailto:volodin@inm.ras.ru)

It is known from the observations that in 19-20 centuries light warming took place. The end of 20 century was warmer than the beginning by 0.6-0.7 degrees in the average over the Earth surface. To study the observed climate changes and possible future changes in the world science community the experiments with atmosphere and ocean general circulation models are performed. General circulation models include all processes responsible for climate with the highest accuracy possible today. Experiments with models show that warming observed in 20 century can be explained by increasing of concentration of greenhouse gases, whose influence probably was reduced by radiation effect of sulfate aerosols. Some events of temperature behavior in 20 century, such as warming in 1940-1950 and reducing of warming in 1960-1980 can be attributed to change of solar constant and concentration of volcanic aerosols.

Now international program for comparison of climate forecasts in 21-22 centuries with coupled atmosphere and ocean models is in progress. Models use set of scenarios for atmospheric constitutions developed in IPCC. In which extent can we believe in these forecasts assuming realization of a given scenario? Comparison of model results show that equilibrium response of near-surface temperature to doubling of CO<sub>2</sub> is equal 1.5 – 4.5 degrees for different models. Main source of the difference is cloudiness change in global warming. Models with increasing of cloudiness have smaller sensitivity than that one with decreasing of cloudiness.

Nevertheless, some features of climate change are similar for most of the models. For example, maximum warming locates in Arctic, where sea ice is melting. Warming at the continents in the northern hemisphere midlatitudes also is expected stronger than in the average over the Earth. Winter warming here is stronger then summer one. Most of the models predict increasing of precipitation in high latitudes and decreasing in subtropics. It is caused by change of atmospheric circulation: increasing of Arctic and Antarctic Oscillation index.

It is interesting to analyze the change of extremal weather situations in global warming. For example, in Russia temperature in the coldest winter months probably changes stronger, and temperature in the warmest winter months weaker than that one for all winter months. In summer vice versa warming in the hottest months can be stronger than that one for all summer months.