Coupled ocean - atmosphere feedbacks in Arctic and northern North Atlantic.

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The global general circulation models involved in IPCC simulations are usually too coarse or too expensive to reproduce many mesoscale processes, which could have an impact on the future climate change in regions such as Arctic and North Atlantic. We propose a novel approach to downscale climate simulations and to investigate the interactions between the North Atlantic and Arctic Ocean as well as an impact of ocean - atmosphere interaction on the climate. A global ocean – sea ice – marine biogeochemistry model with regionally high horizontal resolution is coupled to an atmospheric regional model and global terrestrial hydrology model. This art of coupling divides global ocean model setup in two different subdomains: coupled, where ocean and atmosphere are interacting, and uncoupled, where ocean model is driven by prescribed atmospheric forcing and runs in a so-called stand-alone mode. Therefore choosing a specific area for the regional atmosphere we can suppose that in this area ocean-atmosphere system is “free”, whereas in the rest of the ocean its circulation is driven by prescribed atmospheric forcing without any feedbacks.

Another problem which is closely connected to a coupled ocean - atmosphere modeling is an unpredictable impact of positive coupled feedbacks, i.e. both the ocean and the atmosphere models could be tuned quite well for "stand-alone" case, but produce unrealistic results in coupled simulations. An investigation of these feedbacks and their impact on climate variability and predictability on regional scales in North Atlantic - Arctic - North Pacific climate system is one of the topics of proposed study.

We propose to address these problems in two directions. First one is an investigation of an impact of mesoscale processes on the climate. For this purposes a set of regionally high resolution simulations is planned. It should be pointed out that by resolving the smaller scale processes we mean not only the use of higher spatial model resolution, but also a resolving of climatologically "temporally small scale" features like representation of the diurnal cycle with 1 hour ocean – atmosphere coupling time step and inclusion of the ocean tides. The impact of coupled downscaling will be investigated on different atmospheric (1/6 º, 1/3 º, 0.5 º, 2/3 º, 1º) and ocean horizontal resolutions. Finally the regionalization of two AR5 IPCC scenarios (RCP 8.5 and RCP 2.6, ECHAM6 T63 gaussian grid) of future climate change in the Arctic and northern North Atlantic will be performed.

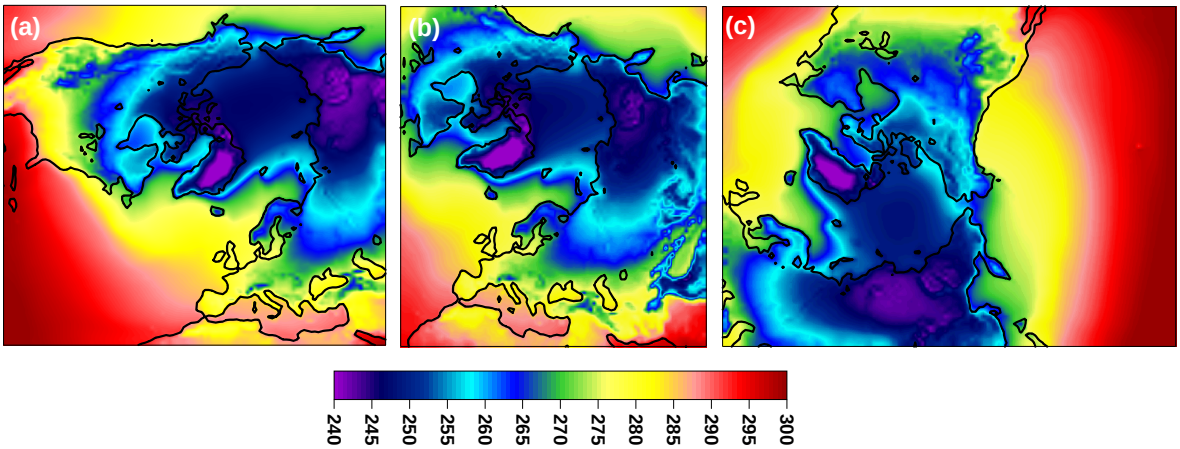

Fig.1 *Mean (1950-2007) DJF 2m temperature obtained from 3 different regionally coupled setups. The regions indicated the entire coupled ocean-atmosphere domains.*

The second direction is an estimation of regional climate variability and its dependence on the choice of the coupled ocean-atmosphere domain. Three different coupled setups were chosen for 3 ensemble simulations (5 ensemble members), covering the period 1950-2007. The choice of the coupled domains was done to estimate North Atlantic (a), Eurasian (b) and North Pacific (c) influences on the region of interest. Preliminary results of the climate simulated by these setups are shown on Fig.1.

With the proposed ensemble simulations we will try to answer the following questions:

- Do regional coupled models have their own variability? To what extent are the model results determined by the boundary conditions (external forcing)?
- How important is this ‚internal' variability? Are the regional coupled ocean – sea ice – atmosphere modes significant? Does the climate variability in a region of our interest strongly depends on its "own", internal processes, or it is predefined by the "external", large scale atmosphere and ocean circulation?
- Is it possible to estimate the contribution of internal modes to Arctic and northern North Atlantic climate variability?
- Is it possible to quantify an impact of different large scale atmospheric processes, like NAO or Siberian High on the Arctic climate and its interannual variability?

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