Polar Coordinated Regional Downscaling Experiment (Polar CORDEX)

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Introduction

Polar CORDEX is part of the international CORDEX (Coordinated Regional Downscaling Experiment - Arctic and Antarctic Domains) initiative. Its primary goal is to organize an international coordinated framework to produce an improved generation of regional climate change projections for input into impact and adaptation studies. Currently, the core of Polar CORDEX consists of regional climate model (RCM) simulations over the Arctic, with both hindcast and scenario simulations being conducted. This effort is includes the Antarctic region as well. Details about the participating groups, models, and conducted/planned simulations can be found at the Polar CORDEX web page at http://www.climate-cryosphere.org/activities/targeted/polar-cordex.

Achievements for 2015

11 atmosphere-only model simulations over the Arctic CORDEX domain at ca. 50 km horizontal resolution forced by the ERA-Interim data have been conducted. Also, a few higher resolution atmosphere-only model simulations at ca. 25 km and ca. 15 km horizontal resolution are finished. More simulations are running and planned. Results from individual models have already been published (Koenigk et al., 2015; Scinocca et al., 2015). The analysis of Zentek et al. (2015) has been discussed by the Arctic CORDEX participants as a potential guide for future evaluation of added value in higher resolution simulations by investigating the spectra of wind, kinetic energy and temperature. Further, an analysis of the ensemble of atmosphere-only model simulations has been started to conduct a multi-model intercomparison. For this, the simulation results will be analyzed concerning the following three topics: (i) General performance of the Arctic RCMs. The individual model biases (compared to ERA-Interim data and CRU) and the across-model scatter of the seasonal mean temperatures and precipitation, and their interannual variability have been calculated. Temperature is better simulated than the precipitation. There is considerable variation in the models' performance depending on the variable, location and the season. (ii) Extremes. The method of self-organizing maps has been applied on the ERA-Interim data to discuss regional patterns of temperature extremes in Alaska in winter in connection with the synoptic conditions (Cassano et al., 2015). Temperature advection and anomalous longwave radiation were the primary factors that led to the extreme events. This method can help to get insights into the temporal evolution of the extreme events in the model ensemble. Additional analysis of summer temperature extremes and both winter and summer precipitation in Alaska are ongoing. Indices for

temperature extremes (e.g. cold and warm spell days) have been evaluated for the circum-Arctic domain, both for the ERA-Interim and station data (Matthes et al., 2015). This analysis has been started to be extended to the model ensemble. (iii) Cyclones. Cyclone statistics (cyclone numbers, intensity, radius) has been calculated for the models and compared with ERA-Interim data. Further, analysis of the occurrence of polar lows in the models, in comparison with a data set derived from satellite images, has been started.

Five coupled atmosphere-ice-ocean model simulations over the Arctic CORDEX domain at ca. 50 km atmospheric model resolution and ca. 9 to 50 km ocean model resolution, forced by the ERA-Interim data have been conducted. The analysis of these runs has been started by looking into the individual model results (Berg et al., 2015; Roberts et al., 2015; Sein et al., 2015). A next goal is to analyze the ensemble of coupled model simulations. This analysis will focus on the ocean/ice model performance (e.g. ocean temperature, salinity, sea-ice volume, sea-ice production) and the atmospheric feedbacks to sea-ice anomalies.

The scenario simulations covering 2006-2100 are further advanced. The focus is on the RCP8.5 scenario, although also RCP4.5 simulations are conducted. We agreed to use a set of 4 CMIP5 GCMs (EC-Earth, MPI-ESM, NorESM, CanESM) to drive the RCM simulations. Each of the GCMs will be downscaled by at least 4 RCMs. Some of the simulations (both atmosphere-alone and coupled) are finished, but others are still running or are in planning. These simulations will be complemented with the historical simulations covering 1950-2005.

An Arctic CORDEX workshop with 15 participants was held in Potsdam on October 24-26, 2015. The objective of the workshop was to present and discuss results from individual model groups, but also first results from multi-model intercomparison studies. Accordingly, we had discussion sessions on downscaling ERA-Interim (validation runs), multi-model intercomparisons, climate extremes, and downscaling CMIP5 GCMs for projections. Further, we discussed the future plans for simulations, and upcoming joint analyses.

Participants at the Arctic Cordex meeting at AWI Potsdam, Oct. 24-26, 2015.

No activity or further progress can be reported from the Antarctic CORDEX, except that new groups (from DMI, LGEE, BAS) expressed their interest to participate in this in future.

Resulting publications in 2015

Berg, P., R. Döscher, and T. Koenigk, 2015: On the effects of constraining atmospheric circulation in a coupled atmosphere‐ocean Arctic regional climate model, doi: 10.1007/s00382-015-2783-y

Cassano, E.N., J. Glisan, J.J. Cassano, W. Gutowski, and M. Seefeldt, 2015: Methodology of using the self-organizing map algorithm to characterize and analyze temperature extremes in Alaska and Canada, Clim. Res., 62, 199-219, doi:10.3354/cr01274.

Koenigk, T., P. Berg, and R. Doescher, 2015: Arctic climate change in an ensemble of regional CORDEX simulations, Polar Res., 34, 24603, doi:10.3402/polar.v34.24603

Matthes, H., A. Rinke, and K. Dethloff, 2015: Recent changes in Arctic temperature extremes: warm and cold spells during winter and summer, Environ. Res. Lett. 10, 114020, doi:10.1088/1748-9326/10/11/114020

Roberts, A., A. Craig, W. Maslowski, R. Osinski, A. DuVivier, M. Hughes, B. Nijssen, J. Cassano, and M. Brunke, 2015: Simulating transient ice-ocean Ekman transport in the Regional Arctic System Model and Community Earth System Model. Ann. Glaciol., 56, 211-228, doi:10.3189/2015AoG69A760.

Scinocca, J., S. Kharin, Y. Jiao, M. Qian, M. Lazare, L. Solheim, G. Flato, S. Biner, M. Desgagne, and B. Dugas, 2015: Coordinated Global and Regional Climate Modelling. J. Clim., doi:10.1175/JCLI-D-15-0161.1, in press.

Sein, D. V., U. Mikolajewicz, M. Gr€oger, I. Fast, W. Cabos, J. G. Pinto, S. Hagemann, T. Semmler, A. Izquierdo, and D. Jacob, 2015: Regionally coupled atmosphere-ocean-sea ice-marine biogeochemistry model ROM: 1. Description and validation, J. Adv. Model. Earth Syst., 7, 268–304, doi:10.1002/2014MS000357.

Zentek, R., G. Heinemann, and E. Sachs, 2015: Climatology of wind, kinetic energy and temperature spectra using a high-resolution climate model for mid-Europe, in press

Plans for 2016 and beyond

Arctic CORDEX

The hindcast Era-Interim driven runs from 11 atmosphere models and 5 coupled atmosphere-ocean models will be analyzed. The multi-model analysis will include: general performance and uncertainty of temperature and precipitation, temperature and precipitation extremes, and cyclone activity. We plan to include also more analysis of the coupled runs, which will include the analysis of e.g. the ocean mixed layer, sea ice and atmospheric feedbacks.

The projection runs from 10 atmosphere models (driven by 4 different GCMs; focus on RCP8.5) will be finished and the multi-model ensemble will be started to analyze. The projection runs with the existing coupled atmosphere-ocean models will further advance. Other groups continue their coupled model development.

We will keep the contact to the Arctic Council “Adaptation Actions in a Changing Arctic” (AACA) project with the aim to include results of Arctic Cordex into the final circum-Arctic AACA report.

Antarctic CORDEX

Interest for Antarctic simulations has been expressed by different groups (model HIRHAM5 by DMI; model RACMO by Univ. Utrecht/KNMI; model COSMO-CLM from Univ. Leuven; stretched-grid AGCMs (LMDz, Arpège) by CNRS/LGEE; model PolarWRF by BAS).

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