Abstracts of presentations at the RESMoNA meeting in Oslo 14th-15th May 2003

1. Multi-model ensembles of climate scenarios: an overview,

by R.E. Benestad, Norwegian Meteorological Institute, Oslo, Norway.

Comparisons of climatic trends from GCMs and historical station series show that one GCM integration cannot give a reliable reproduction of the past climatic change on time scales of several decades (Benestad 2001, 2002, 2003). A multi-model ensemble consisting of GCM integrations following the ICC IS92a scenarios (including sulphate forcing), however, described an evolution that tends to span the past observed temperatures. In order to carry out the evaluation against the observations, the GCM results have been downscaled empirically, using common EOFs as a reference frame. The common EOF method extracts identical spatial pattern in the model results and the observations, and utilizes time series of weights describing their evolution in time. Thus, the common EOFs also involve a type of model evaluation. Empirical downscaling is fast an inexpensive, and therefore suitable for comparing long time series derived from many GCMs. Although the downscaling is done for individual stations, the results from several stations can be combined through spatial interpolation to produce spatial maps. The spatial interpolation can be further elaborated by taking into account geographical parameters such as distance from the coast, altitude, latitude and longitude if the values are sensitive to these parameters. The residuals from a multiple regression are used as input for spatial interpolation schemes such as Kriging. The mapping of the downscaled results can be done for multi-model ensemble mean temperature trends as well as probabilities of exceeding certain threshold values. Although all downscaled temperature trends project a future warming, scenarios for precipitation are more ambiguous. So far, the precipitation scenarios have only been derived from SLP-fields, and do not take into account increases in humidity. Different GCMs yield trends ranging from drier to wetter future for a given location.

R.E. Benestad (2001), The cause of warming over Norway in the ECHAM4/OPYC3 GHG integration, *Int. J. Clim.* 15 March **Vol 21** 371-387.
R.E. Benestad (2002), Empirically downscaled multi-model ensemble temperature and precipitation scenarios for Norway, *Journal of Climate* **Vol 51**, No. 21, 3008-3027
R.E. Benestad (2003) What can present climate models tell us about climate change? *Climatic Change* in press.

2. Investigations of differences in the scenarioes from MPI and the Hadley centre for Norwegian regions

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Dynamical downscaling of the climate simulations from the MPI ECHAM4 model and the Hadley Centre AM3 run on a subarea covering Northern Europe and the North Atlantic shows differences both in the simulations of present climate and future climate. The results of the downscaling are analyzed on a monthly basis for five regions in the Norwegian land area with the scope of presenting a common analysis of the data. The regions are defined on the basis of model climate, which shows large variation over Norway, from inland to coast and from north to south.

The simulations of future climate from the two runs are valid for different time periods. In order to compare the results it has been suggested to scale in time with the global temperature tendency as a scaling factor. The tendencies of temperature are positive in all regions and all months, but highest in the winter and in the most northern regions. The tendencies in wind force and precipitation rate are close to zero and negative in some regions and some months. It was chosen to use the local monthly temperature tendency as a scaling factor for the temperature from the runs forced with the Hadley Centre data, while precipitation rate and wind force are kept unscaled.

Negative tendencies in wind force and precipitation rate are seen in the Hadley runs in August and September in the southern coastal region and in January in the northern coastal region. This is due to different mslp-patterns in the simulations in the two scenarios in the autumn. The density of monthly means is not a normal distribution, neither from the separate datasets nor from the combined dataset. The present and the future climate are therefore presented in terms of median and quantiles. For all regions an increase in temperature is predicted, and the inter quantile range is larger in the winter. The latter is also the case for precipitation and 10m wind speed.

3. Snow Cover Changes Over Northern Eurasia

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The snow extent over Northern Eurasia influences the air temperature through the positive albedo feedback, which has been demonstrated by many diagnostic and modeling studies. According to the recent report by the Intergovernmental Panel on Climate Change satellite data show that there are very likely to have been decreases of about 10% in the extent of snow cover since the late 1960s.

An INTAS-funded research project has been initiated to study the possible trends in snow cover during the last century over Northern Eurasia and the relation between snow cover variability and variations in atmospheric circulation patterns. A quality-checked database of snow-related parameters is being established covering the northern part of the Eurasian continent for further use by the scientific community.

4. Natural climate variability of the Arctic atmosphere, the impact of Greenland and PBL stability changes

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Unforced and forced long-term model integrations from 500 to 1000 years with global coupled atmosphere-ocean-sea-ice models have been analysed in order to find out whether the different models are able to simulate the North Atlantic Oscillation (NAO) similar to the real atmosphere. A regional atmospheric model have been applied for simulations of the Arctic climate. The regional dimension of Arctic winter climate changes in consequence of regime changes of the North Atlantic Oscillation have been analysed. The regional model has been forced with boundary data of positive and negative NAO phases from NCEP data and from a ECHAM4 control simulation as well as from a time dependent greenhouse gas and aerosol scenario simulation. Global changes of the atmospheric composition and natural circulation changes are in competition to each other in determining the Arctic surface climate.

In sensitivity experiments the influence of removed orography of Greenland on the Arctic flow patterns and cyclone tracks during winter have been determined using a global coupled model and a dynamical downscaling with the regional atmospheric model HIRHAM. In simulations with the orography of Greenland removed, the Icelandic low became deeper and shifted north-eastwards compared to the control simulation. The strength of the Siberian high decreased and the storm tracks, usually entering the central Arctic shifted towards Eurasia. One major storm track stretching from the south along the western coast of Greenland into the Baffin Bay disappeared and a tendency to stronger zonality occurred in the simulations with removed Greenland orography.

The influence of additional vertical layers in the planetary boundary layer below 1000 meters on the Arctic climate has been investigated. A decoupling of the surface climate from that of the free troposphere occurs connected with changes in the surface climate and the vertical stability.

5. THE BALTIC SEA IN RECENT REGIONAL CLIMATE-SCENARIO EXPERIMENTS: IMPACT OF DIFFERENT DRIVING GCM's.

By Ralf Döscher and H.E.Markus Meier
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Six regional coupled 30 year time slice simulations with the Rossby Centre Atmosphere Ocean model for a European domain have been carried out: two control runs based on the HadAm3 (HC) and ECHAM4/OPYC (MPI) GCM's, followed by two A2 scenarios (2071-2100) and two B2 scenarios. Sea surface salinity (SSS) of the HC control run matches observations, but is much too low for the MPI control case (1.2 psu). This is related to an overestimation of freshwater supply caused by a positive precipitation anomaly over Northern Europe, indicating a deficiency of the MPI cases. The Runoff is even more increased for the scenarios. The vertical structure shows frequent renewal even at the bottom for HC control and scenarios whereas the MPI based runs all show a catastrophic freshening due to strong freshwater supply, efficiently blocking deep water renewal. Even after 30 years of integration, no equilibrium for the deep salinity is reached. The extra runoff in the MPI cases is related to a northward shift of cyclone activity. The SST and sea ice extent of the Baltic Sea is well reproduced in both control runs (1961-1990). The scenarios show a warming of 1.9 - 3.8 K. Sea ice extent is distinctly reduced in the scenarios.

6. PRUDENCE Simulations of European Climate Change

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The EU project PRUDENCE aims at investigating sources of uncertainty in climate projections through an exploration of various combinations of global and regional models and of emission scenario and resolution. We now have results for 6 different regional models run with identical boundary conditions for two 30-year periods covering a control period 1961-90 and a scenario period 2071-2100 according to the SRES scenario A2 as simulated with global models from the Hadley Centre.

Seasonal mean temperature and precipitation from these models will be compared and validated here. Generally, several model biases are shared among the models. The largest inter-model spread occurs in summer; this is expected, as the model physics plays a larger role in this season.

7. An ensemble CMIP2 runs with the Bergen Climate Model

by Sigbjørn Grønås, Geophysical Department, University in Bergen & Asgeir Sorteberg, Bjerknes Centre for Climate Research, Bergen, Norway.

An ensemble CMIP2 integrations - runs for 80 years with CO_2 increasing 1 % per year; doubling of CO_2 is obtained after 70 year; the results from the last 20 years are compared with a control run - is presently being run with the Bergen Climate Model (BCM). So far four members are completed, and the preliminary results from these will be given. The resolution of the atmospheric part is T63, linear grid, which means that linear terms and topography are resolved in T63, while non-linear terms and "physics" are computed in T42. The ocean grid has a similar resolution, but it is somewhat focused towards the tropics.

As normal for such runs, the initial states are taken from a control run, which in our case has been for 300 years with the same resolution (constant CO_2 and constant solar forcing). In this run the meridional overturning circulation in the North-Atlantic varied on a multidecadal timescale. The strategy for picking initial states has been to select states in different phases of these variations. Further, the comparison of the results from the last 20 years of the 80 years integrations has been against results for the same period - after the initial state - in the control run.

Results for temperature and precipitation over Europe are presented. The "normal" decrease in precipitation in south and increase in precipitation in north is evident. However, there are significant differences between the different runs. In particular, it is interesting to note that one case shows precipitation patterns over Scandinavia that are similar to those in a future scenario from the Hadley Centre used by RegClim for dynamical downscaling, while other cases are more in accordance with the scenario from MPI also used by RegClim. This indicates that both the downscaled scenarios in RegClim might be interpreted as equal members of an ensemble of possible future climate states.

All four members show an increased NAO-index for double CO_2 conditions. The change is both a result from a deeper Icelandic Low and small displacements of the low towards northeast. The overturning circulation in the Atlantic is decreasing in all runs, but only slightly (about 2 Sv). More runs will be made, and the results will be analysed according to the starting phase in the overturning circulation.