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Regional climate modelling at the Rossby Centre

The Rossby Centre has developed and applied climate models since 1997, when the group was established. Since then three versions of the Rossby Centre's Regional atmosphere-land climate model have been released [RCA1 (Rummukainen et al., 2001), RCA2 (Jones et al., 2004) and RCA3 (Samuelsson et al., 2011)], along with two regional ocean-ice–atmosphere-land coupled models, one for the Baltic (RCAO-Baltic, Döscher et al., 2002) and one for the Arctic (RCAO-Arctic, Döscher et al., 2009). This special issue documents a range of scientific studies based on the latest official RCA release; RCA3 (Samuelsson et al., 2011; Kjellström et al., 2005). A similar overview, based on RCA2 and associated models, was made in Rummukainen et al. (2004, and articles therein).

Regional climate models (RCMs) have become important tools for providing detailed estimates of future climate change, to support a range of studies concerned with the regional impacts of climate change on natural ecosystems, society and even government and large utility planning (Giorgi et al., 2009; Rummukainen, 2010). Institutes that apply RCMs today act as an important link between the global climate modelling (GCM) community and local end-users. This link includes the provision of downscaled products, but also expert support in local climate and climate change issues. This proved to be important with respect to the governmental Commission on Climate and Vulnerability in Sweden, where adaptation measures, in response to potential climate change, were formulated at a national, Swedish, level (SOU, 2007). In this process, not only were RCA3 simulations used as the basis for these recommendations, but also expert advice from Rossby Centre personnel was crucial in providing an informed interpretation of the climate scenarios (Persson et al., 2007).

Over the past ∼5–10 yr European RCM groups have collaborated closely in the development of a multi-model ensemble of regional climate change projections for Europe. One motivation for this was to provide climate impacts research with a range of estimates of European climate change, spanning the main uncertainties in future regional climate change. This strategy was the basis of the European Union ENSEMBLES project (van der Linden and Mitchell, 2009), where the Rossby Centre contributed simulations with RCA3 (Kjellström et al., 2011; Nikulin et al., 2011). Results based on these, and a number of other, transient RCA3 simulations covering the period 1961–2100 have been used in a wide range of climate impact studies. Examples include; hydrology and water resources (Steele-Dunne et al., 2008; Andersson et al., 2011; Olsson et al., 2011), glacier mass balance (Hock et al., 2007), climate impacts on forest and vegetation (Rammig et al., 2009; Blennow et al., 2010; Jönsson and Bärring, 2011; Smith et al., 2011) and atmospheric chemistry-climate interactions (Hole and Engardt, 2008; Klingberg et al., 2011).

Besides extensive use over Europe, RCA3 has also been applied over the Arctic (Döscher et al., 2009; Koenigk et al., 2011), Southern Africa (Andersson et al., 2011), North America (Markovic et al., 2009; He et al., 2010) and South America (Tourigny and Jones, 2009a,b; Sörensson et al., 2010; Sörensson and Menéndez, 2011). Furthermore, RCA3 has been used for palaeoclimate simulations (Graham et al., 2009; Kjellström et al., 2010; Strandberg et al., 2011) and an earlier version of RCA for downscaling of GCM seasonal forecasts over Spain (Diez et al., 2005).

In addition to the Rossby Centre, a further five institutes also develop and apply RCA3, namely the Universities of Lund (Smith et al., 2011), and Uppsala (Carlsson et al., 2009) in Sweden, Met Eireann in Ireland (Semmler et al., 2008), AEMET in Spain and CIMA at the University of Buenos Aires in Argentina (Sörensson and Menéndez, 2011).

Over the past 3 yr the Rossby Centre has played an active role in the EC-Earth consortium, a European collaboration developing the coupled seasonal prediction system from the European Centre for Medium Range Weather Forecasts (ECMWF) for application as a Global Earth System Model (Hazeleger et al., 2010). EC-Earth will make a full set of climate projections within the 5th Coupled Model Intercomparison project (CMIP5, Meehl and Hibbard, 2007). These projections will cover the period 1860–2100 and utilize a new set of scenarios for future greenhouse gas emissions, land use and a range of short-lived species, so-called Radiative Concentration Pathways (RCPs, Moss et al., 2010). Results from the EC-Earth CMIP5 projections, along with similar integrations made by other Global Climate Models, will constitute a new set of boundary data for driving future versions of RCA-models.

In particular, the Rossby Centre plays an active role in the World Climate Research Program (WCRP) sponsored activity CORDEX (A Coordinated Regional Downscaling Experiment, Giorgi et al., 2009). The overriding aim of CORDEX is to organize international efforts in downscaling of CMIP5 global

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climate projections, to provide a matrix of high-resolution, future projections of regional climate for all land regions of the globe. This data matrix should span the main axes of uncertainty in regional climate projections, in a manner similar to the ENSEMBLES data set for Europe. To this end we plan to use future RCA models to downscale a range of new CMIP5 climate projections over Europe, but also for Africa, South America, the Arctic and South Asia. Present-day CORDEX runs, forced by reanalysis boundary conditions for the period 1989–2008, have already been performed over Africa, with some initial results reported in Jones and Nikulin 2010). CORDEX projections will start to become available in the summer of 2011.

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