Description RCM simulations in CLARIS LPB

Model

Short model name	RCA
Full model name	The Rossby Centre Regional Climate model
Institute	Rossby Centre, Swedish Meteorological and Hydrological Institute (www.smhi.se)
Model version	RCA3.5
Contact person name	Patrick Samuelsson
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General references	Kjellström et al. 2005 (http://www.smhi.se/polopoly_fs/1.2104!RMK108%5B1%5D.pdf) Samuelsson et al. 2006 (http://www.smhi.se/polopoly_fs/1.1787!meteorologi_122%5B1%5D.pdf)

Experimental setup

Name of domain	South America
Size of full grid (lon x lat x vertical)	134x155x40
Horizontal resolution	0.5x0.5 deg (~50 km)
Type of grid	Rotated lon/lat
Lateral Boundary Relaxation number of grid points	8
Nudging (if yes, provide some description spectral, variables, levels)	No
Boundary zone excluded (grid points)	8
Size of post-processed output grid (lon x lat)	118x139

ERA-INTERIM

Time period (available at CLDAC)	Jan 1990 - March 2009
Calendar	Gregorian
Source of boundary condition	ERA-INTERIM
Initial condition	ERA40 (In boundary conditions distributed by SMHI ERA40 was used for monthly surface fields)
Spin up period	Feb-Dec 1989
Internal reference of simulation	200921

ECHAM5-A1B (three simulations)

Boundary conditions are from ECHAM5/MPI-OM1 (Roeckner et al., 2006). The ECHAM data was downloaded from the Max-Planck-Institute for Meteorology in Hamburg at 1.875° horizontal resolution and 31 vertical levels. ECHAM5/MPI-OM1 was forced with greenhouse gases and sulfur according to the SRES A1B emission scenario (Nakićenović et al., 2000). RCA3.5 is forced with lateral boundaries, SSTs and sea-ice from ECHAM5/MPI-OM1. Greenhouse gases and the radiative effect of sulfur aerosolos is accounted for in terms of equivalent CO2 concentrations. Other external forcing conditions (land use, solar constant=1367 W/m2) were held constant in the simulations. ECHAM5 was run three times with different starting time around 1850. We have downscaled all three realisations r1-r3.

Time period (available at CLDAC)	Jan 1961 – Dec 2100
Calendar	Gregorian
Source of boundary condition	ECHAM5/MPI-OM1
Initial condition	ECHAM5/MPI-OM1
Spin up period	Sep 1957 – Dec 1960
Emission scenario	A1B
Realisations (initial condition)	r1, r2 r3
Internal reference of simulation	201017, 201018, 201019

General model description

Process:	**Description:**	**Reference:**
Dynamics	Two time-level, semi-lagrangian, semi-implicit scheme with 6th order horizontal diffusion applied to the prognostic variables	Jones et al. (2004)
Radiation	Highly empirical with one wavelength band each for longwave and shortwave	Savijärvi (1990) Sass et al. (1994)
Cloud fraction	Maximum random	
Turbulence	Turbulent kinetic energy (TKE) scheme, combined with a diagnostic mixing length and including moist processes	Cuxart et al. (2000) Cuijpers and Duynkerke (1993)
Explicit cloud and precipitation	Large-scale (resolved) clouds are based on a prognostic equation for the total cloud water mixing ratio and a diagnostic cloud fraction based on a threshold relative humidity.	Rasch and Kristjánsson (1998)
Convection	Described with an entraining and detraining plume model	Kain and Fritsch (1990, 1993) Kain (2004) Jones and Sanchez (2002)
Land-surface scheme	Tiled land surface with 4 land tiles (see details below)	Samuelsson et al. (2006)
Fluxes over	Prognostic roughness length	Samuelsson et al. (2011)

sea	(Charnock)	Louis et al. (1982)

Details in model description (use or modify as needed)

Land-surface processes

Specification:	**Description:**	**Reference:**
Land cover map	ECOCLIMAP	Masson et al. (2003)
Soil map	ECOCLIMAP	Masson et al. (2003)
Orography data		
No of sub surfaces (tiles)	7	
Overview of tiles:		
Sea	SST from boundary cond. Charnock roughness	Samuelsson et al. (2011)
Sea ice	Two layer prognostic temperature with constant total thickness (1.0 m).	Samuelsson et al. (2011)
Open land	Fractional cover of low vegetation	Samuelsson et al. (2006)
Snow on open land	Bulk layer with prognostic albedo and density. Including liquid water storage	Samuelsson et al. (2006)
Forest	Separate energy balance for canopy and forest floor. Canopy has specified heat capacity.	Samuelsson et al. (2006)
Snow in forest	Bulk layer with constant albedo (=0.5) and prognostic density.	Samuelsson et al. (2006)
Lake	FLake lake model including prognostic ice.	Samuelsson et al. (2010)
Energy balance	Separate for each tile	
Interactive vegetation	No	
Soil layers for temperature	Five layers with thickness 1 cm – 1.89 m. Total depth 3.0 m	
Soil layers for humidity	Three layers with thickness 7.2 cm, 21 cm and third layer given by root depth for open land and forest resp.	

Specification of land tiles

	Open land	**Snow on open land**	**Forest**	**Snow in forest**

Albedo	~0.19	0.6-0.85	0.10-0.14	0.5
LAI	1-3	-	1.5-6	-
Root depth (m)	0.3-2.7	-	2-8	
Momentum roughness	0.2-0.8 m	0.005 m	0.3-3.9 m	-

Description of diagnostic output

The diagnostic output variables listed here represent conditions over open land or water: 2-meter temperature (mean, max, min), 2-meter specific humidity, 2-meter relative humidity, 10-meter wind (U,V), 10-meter wind speed, 10-meter daily max. wind speed.

Since the RCA land-surface scheme is a tiled scheme with explicit forest description and conditions for the forest tile for some variables represents conditions at 2m above the forest floor inside the forest we have chosen to exclude the forest tile for the calculation of all these diagnostic variables. In all grid boxes where land is defined the variables represent conditions over the open land tile, otherwise they represent conditions over water (lake or sea). This is also motivated by the fact that most evaluation data represent open-land conditions and most effect studies assume or are applied for open land conditions.

References

Cuijpers, J. W. M., and Duynkerke, P. G. 1993. Large eddy simulations of trade wind with cumulus clouds. J. Atmos. Sci. 50, 3894–3908.

Cuxart, J., Bougeault, P. and Redelsperger, J.-L. 2000. A turbulence scheme allowing for mesoscale and large-eddy simulations. Quart. J. Roy. Meteorol. Soc. 126, 1–30.

Jones, C. G. and Sanchez, E. 2002. The representation of shallow cumulus convection and associated cloud fields in the Rossby Centre atmospheric model, HIRLAM Newsletter 41, SMHI, SE-601 76 Norrköping, Sweden.

Jones, C., Willén, U., Ullerstig, A. and Hansson, U. 2004. The Rossby Centre regional atmospheric climate model part I: Model climatology and performance for the present climate over europe. Ambio 33:4-5, 199–210.

Kain, J.S. 2004. The Kain–Fritsch Convective Parameterization: An Update. J. Appl. Meteor. 43, 170–181.

Kain, J. S. and Fritsch, J. M. 1990. A one-dimensional entraining/detraining plume model and its application in convective parameterization. J. Atmos. Sci. 47, 2784–2802.

Kain, J. S. and Fritsch, J. M. 1993. Convective parameterizations for mesoscale models: The Kain-Fritsch scheme, in K. A. Emanuel and D. J. Raymond (eds), The representation of cumulus convection in numerical models, American Meteorologiacl Society Monograph, Boston, USA. 246 pp.

Kjellström E., Bärring L., Gollvik S., Hansson U., Jones C., Samuelsson P., Rummukainen M., Ullerstig A., Willén U. and Wyser K. 2005. A 140-year simulation of European climate with the new version of the Rossby Centre regional atmospheric climate model (RCA3). Report in Meteorology and Climatology 108, SMHI, SE-60176 Norrköping, Sweden, 54 pp.

Louis, J.F., Tiedtke, M. and Geleyn, J.F. 1982. A short history of the PBL parameterization at ECMWF. In: Workshop on Boundary Layer Parameterization, European Centre for Medium-Range Weather Forecasts, Reading, U.K., pp. 59–79.

Masson V., Champeaux J.L., Chauvin F., Mériguet C. and Lacaze R. 2003. A global database of land surface parameters at 1km resolution for use in meteorological and climate models. J. Climate. 16.1261-1282.

Nakićenović, N., Alcamo, J., Davis, G., de Vries, B., Fenhann, J., Gaffin, S., Gregory, K., Grübler, A., et al., 2000. Emission scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, 599 pp

Rasch, P. J. and Kristjánsson, J. E. 1998. A comparison of the CCM3 model climate using diagnosed and predicted condensate parameterizations. J. Climate 11, 1587–1614.

Roeckner, E., R. Brokopf, M. Esch, M. Giorgetta, S. Hagemann, L. Kornblueh, E. Manzini, U. Schlese, and U. Schulzweida, Sensitivity of simulated climate to horizontal and vertical resolution in the ECHAM5 atmosphere model, J. Climate, 19, 3771-3791, 2006.

Samuelsson P., Gollvik S. and Ullerstig A. 2006. The land-surface scheme of the Rossby Centre regional atmospheric climate model (RCA3). Report in Meteorology 122. SMHI, SE-60176 Norrköping, Sweden, 25 pp.

Samuelsson, P., Kourzeneva, E. and Mironov, D., 2010. The impact of lakes on the European climate as simulated by a regional climate model. Boreal Env. Res. 15, 113–129.

Samuelsson, P., Jones, C. G., Willén, U., Ullerstig, A., Gollvik, S., Hansson, U., Kjellström, E., Nikulin, G. and Wyser, K. 2011. The Rossby Centre Regional Climate Model RCA3: Model description and performance. Submitted to Tellus.

Sass B.H., Rontu L., Savijärvi H. and Räisänen P. 1994. HIRLAM-2 Radiation scheme: Documentation and tests. Hirlam technical report No 16, SMHI, SE-60176 Norrköping, Sweden, 43 pp.

Savijärvi H. 1990. A fast radiation scheme for mesoscale model and short-range forecast models. J. Appl. Met. 29. 437-447.