Short Description of the MPI-M REMO

Short model name	REMO
Full model name	MPI-M REgional MOdel
Institute	Max-Planck-Institute for Meteorology, Hamburg (http://www.mpimet.mpg.de)
Model version	REMO2009
Contact person name	Armelle Reca C. Remedio
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General references	Jacob, D., U. Andrae, G. Elgered, C. Fortelius, L. P. Graham, S. D. Jackson, U. Karstens, Chr. Koepken, R. Lindau, R. Podzun, B. Rockel, F. Rubel, H.B. Sass, R.N.D. Smith, B.J.J.M. Van den Hurk, X. Yang, 2001: A Comprehensive Model Intercomparison Study Investigating the Water Budget during the BALTEX-PIDCAP Period. Meteorology and Atmospheric Physics, Vol.77, Issue 1-4, 19-43. Jacob, D., 2001: A note to the simulation of the annual and inter-annual variability of the water budget over the Baltic Sea drainage basin. Meteorology and Atmospheric Physics, Vol.77, Issue 1-4, 61-73.

Experimental setup

Name of domain	South America
Size of full grid (lon x lat x vertical)	151x181x31
Horizontal resolution	0.44 x 0.44 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)	151x181

ERA-INTERIM

Time period	1989-2008
Source of boundary condition	ERA-INTERIM
Initial condition	ERA-INERIM
Spin up period	20 years (1989-2008)
Internal reference of simulation	exp038007

Scenario: A1B

Time period	1950-2100
Source of boundary condition	ECHAM5/MPIOM run 3
Initial condition	ECHAM5/MPIOM run 3
Spin up period	1950-1959
Internal reference of simulation	

General model description

Process:	**Description:**	**Reference:**
Dynamics	Rotated spherical grid, Arakawa-C-grid, Second order horizontal and vertical differences, Leap-frog time stepping with semi-implicit correction and Asselin-filter, fourth-order linear horizontal diffusion of momentum, temperature and water content, Hybrid vertical coordinates Prognostic variables: surface pressure, temperature, horizontal wind components, water vapour content, cloud water content. Lateral boundary formulation after Davies (1976), which adjusts the prognostic variables in a boundary zone of 8 grid boxes.	Majewski, D. (1991). The Europa-Modell of the Deutscher Wetterdienst, Vol. 2 of ECMWF Seminar on numerical methods in atmospheric models .
Radiation	Radiation after Morcrette et al. (1986) with modifications for additional greenhouse gases, 14.6 µm band of ozone and various types of aerosols. Continuum absorption after Giorgetta and Wild (1995).	Roeckner, E., K. Arpe, L. Bengtsson, M. Christoph, M. Claussen, L. Dumenil, M. Esch, M. Giorgetta, U. Schlese and U. Schulzweida (1996). The atmospheric general circulation model ECHAM-4: Model description and simulation of present-day climate. Report 218, Max Planck Institute for Meteorology, Hamburg.
Cloud fraction	Fractional cloudiness is determined as a nonlinear function of relative	Roeckner, E., et al, 1996.

	humidity excess above a threshold value, following Sundqvist et al. (1989). Threshold values decrease exponentially with height (between 99% at the surface to 60% in the upper troposphere) after Xu and Krueger (1991).	
Turbulence	Vertical diffusion and surface fluxes: turbulent surface fluxes are calculated from Monin-Obukhov similarity theory (Louis, 1979) with a higher order closure scheme for the transfer coefficients of momentum, heat, moisture and cloud water within and above PBL. The eddy diffusion coefficients are calculated as functions of the turbulent kinetic energy E.	Roeckner, E., et al, 1996.
Explicit cloud and precipitation	Stratiform clouds: water content is calculated from a budget equation including sources and sinks due to phase changes and precipitation formation by coalescense of cloud droplets and gravitational settling of ice crystals (Sundquist, 1978). The convective cloud water detrained at the top of cumulus clouds is used as a source term in stratiform cloud water equation (Roeckner et al., 1996)	Pfeifer, S. (2006). Modeling cold cloud processes with the regional climate model REMO. PhD Dissertation 23, Max Planck Institute for Meteorology, Hamburg.
Convection	Cumulus convection: Mass flux convection scheme after Tiedtke (1989) with modifications after Nordeng (1994)	Pfeifer, S. (2006).
Land-surface scheme	* Soil processes heat transfer: water budget equation for three reservoirs: soil moisture, interception reservoir (vegetation), snow; runoff scheme: based on catchment considerations including sub-grid scale variations of field capacity over inhomogeneous terrain (Dümenil and Todini, 1992) * fractional surface cover: land, water, sea ice (Semmler, 2002) * freezing and thawing of soil water (Semmler, 2002) * monthly variation of vegetation parameters: background albedo, leaf area index, vegetation ratio (Rechid & Jacob, 2006)	D. Rechid and D. Jacob, Influence of monthly varying vegetation on the simulated climate in Europe, *Meteorologische Zeitschrift* **15** (2006), pp. 99–116.

Details in model description (use or modify as needed)

Land-surface processes

Specification:	Description:	Reference:
Land cover map	The vegetation cover is based on a global dataset of major ecosystem types (Global Land Cover Characteristics Database; GLCCD) according to a classification list of Olson (1994a, 1994b). The Olson ecosystem types were derived from Advanced Very High Resolution Radiometer AVHRR data at 1 km resolution, which were supplied by the International Geosphere-Biosphere Program (Eidenshink and Faundeen 1994) and constructed by the U.S. Geological Survey (USGS 1997, 2002). For each land cover type, parameter values for the vegetation properties are specified. This information is aggregated to the model grid scale averaging the vegetation parameters of all land cover types, which are located in one model grid cell. The vegetation cover is represented by parameter values for leaf area index (LAI, ratio of one-sided leaf area to ground area), fraction of green vegetation cover, background surface albedo (albedo over snow-free land surfaces), surface roughness length due to vegetation, fractional forest cover (used as a constant stem index) and water holding capacity (depending on plant	D. Rechid and D. Jacob, Influence of monthly varying vegetation on the simulated climate in Europe, *Meteorologische Zeitschrift* **15** (2006), pp. 99–116.

	rooting depths).	
Soil map	FAO data (Zobler 1986)	
Orography data	the topography and land – sea distribution based on gtopo30 (USGS GTOPO30 2002)	
No of sub surfaces (tiles)		
Overview of tiles:	a subgrid scale tile approach for land, water and sea ice surfaces was implemented (Semmler 2004)	Kotlarski, S. (2007). A Subgrid Glacier Parameterisation for Use in Regional Climate Modelling. PhD Dissertation 42, Max Planck Institute for Meteorology, Hamburg.
land	Further divided into a part covered by vegetation and bare soil fraction	
Water	Includes ocean surfaces and inland lakes	
sea-ice		
Energy balance	Calculated for each tile	
Interactive vegetation	No	
Soil temperatures	Soil temperatures are calculated from diffusion equations solved in five discrete layers with zero heat flux at the bottom (10m depth) according to the scheme of Warrilow et al. (1986). Hereby, the surface temperature is no skin temperature, but the temperature of the most upper soil layer at 3.25 cm below the earth surface. The heat diffusion in the soil depends on heat capacity and thermal conductivity of the soil.	D. Rechid and D. Jacob, (2006).
Soil hydrology	Soil hydrology is parameterized in three water budget equations for	

	the temporal alteration of water storage in the soil related water reservoirs, namely snow, vegetation and bare soil. The runoff-scheme is based on catchment considerations including sub-grid scale variations of field capacity over inhomogeneous terrain (DÜMENIL and TODINI, 1992).	

Specification of land tiles

	Range
Albedo	0.07 to 0.7
Vegetation ratio	0 to 0.96
Field capacity of soil	1.0000e-13 to 1.4510
Surface roughness length (m)	0 to 37.225

Diagnostic Output

- 2m height of the model is not the same as observed. Height corrections are done compared to observations such as CRU.
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References