RCA4 (NA-CORDEX)

Climate Model Report Card

GLISA
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Model Name: Rossby Centre Regional Atmospheric Model, version 4

Institution: Swedish Meteorological and Hydrological Institute (SMHI)

Data Portal: www.earthsystemgrid.org

LAKE COMPONENT

Name: Freshwater Lake model (FLake)

Reference(s): [1]Mironov, D. V. (2005). Parameterization of lakes in numerical weather prediction. Part 1: Description of a lake model. *German Weather Service, Offenbach am Main, Germany*.

Description: Freshwater 1-D lake model with ice component capable of predicting vertical temperature structure and mixing conditions in lakes of various depths on time scales from a few hours to many years.[1] FLake performs best for shallow lakes (<40m) and has limited applicability to deep lakes.[2]

Vertical Layers | Depths: 2 vertical layers (a mixed layer with uniform temperature and an underlying thermocline extending to the bottom of the lake)[1]. Lake depths are from the database of Kourzeneva (2010), but a "virtual" maximum lake depth of 40-50m is recommended instead of the actual lake depth for FLake. Lake depths greater than 40m are set to 40m in RCA4.[3]

Vertical Mixing (y/n): Yes

Horizontal Mixing (y/n): No

Lake Ice: Ice and snow depths are developed using a simple two-layer thermodynamic model. The concept of self-similarity of the temperature-depth curve is used to describe the temperature structure of the ice and snow cover.[1] However, the version of FLake used in RCA4 had not thoroughly tested the snow-ice module and thus it is not activated. Instead, snow above the lake-ice is implicitly accounted for by varying the ice albedo and thermal conductivity of ice.[3,4] FLake does not allow for partial ice coverage, meaning lake grid cells are either entirely ice-covered or ice-free.[2]

ATMOSPHERE COMPONENT

Name: HIRLAM dynamics with RCA physics

Reference: [5]Strandberg, G., Bärring, L., Hansson, U., Jansson, C., Jones, C., Kjellström, E., ... & Ullerstig, A. (2014). CORDEX scenarios for Europe from the Rossby Centre regional climate model RCA4. *Reports Meteorology and Climatology, 116*, SMHI, SE-60176 Norrköping, Sverige

Physical Parameterizations: Turbulent kinetic energy (TKE) scheme (Lenderink & Holtslag, 2004) with diagnostic mixing length and moist processes (Frenier & Bretherton, 2001), modified deep and shallow Kain-Fritsch convection scheme (Bechtold et al., 2001), modified CAPE (convective available potential energy) profile (Jiao & Jones, 2008), prognostic equation for total cloud water mixing ratio and diagnostic cloud fraction based on threshold relative humidity loosely following (Tiedtke, 1996)[5]

Chemistry: There is a single integrated class for uniform aerosols in RCA4, with parametrized aerosol effect on radiation fluxes.[6]

Spatial Resolution: 0.44° grid, available data interpolated to common half-degree lat-lon grid

Simulation Timestep: 20 min (0.44°)

Output Data Temporal Resolution: daily, monthly, seasonally, annually

GCM Driver(s): CanESM2, EC-EARTH

Reanalysis Driver: ERA-Interim

Historical Run(s): 1980-2012 (ERA-Interim), 1951-2005 (all GCM drivers)

Future Scenario(s): RCP4.5, RCP8.5

Future Time Period(s): 2006-2100

LAND COMPONENT

Name: RCA4 Land-Surface Scheme (LSS)

Reference: [3]Samuelsson, P., Gollvik, S., Kupiainen, M., Kourzeneva, E., & van de Berg, W. J. (2015). The surface processes of the Rossby Centre regional atmospheric climate model (RCA4). *Swedish Meteorological and Hydrological Institute (SMHI), Meteorologi 157*.

 # Land Cover Types: 3 land covers (open land low vegetation, coniferous forest, broadleaf forest), 12 soil types, and 12 plant functional types (PFTs) from LPJ-GUESS vegetation model[3]

 # Soil Layers: 5 layers with respect to temperature with thicknesses: 0.01m, 0.062m, 0.21m, 0.72m, 1.89m, and 3 layers with respect to soil moisture with thicknesses: 0.072m, 0.21m, and root depth from ECOCLIMAP of 0.282m.[3]

Soil Moisture: Vertical water movement in unsaturated soil is based on Richards equation from Hillel (1980). Soil moisture is assumed to be independent on surface coverage, giving three soil moisture storages: top and deep soil moisture, where the top layer equals the first two layers (with respect to temperature).[3]

Runoff: Drainage and runoff parametrization is based off of the Beta-formulation in Lindstrom et al. (1997). Runoff formed at the bottom of the deep soil layer can be used as input to a routing scheme.[3]

Sub-Grid Lakes (y/n): Yes. The fractional area of lakes is from ECOCLIMAP. Within a grid cell, lakes can be in three categories: shallow (0-4m), medium (4-8m), and deep (>8m).[2,4]

Carbon Fluxes: Soil properties vary based on the density of organic carbon, which is provided by the Global Soil Data Task (2000).[3]

Land Use Change: Undocumented

Groundwater: Undocumented

Additional References

[2]Martynov, A., Sushama, L., & Laprise, R. (2010). Simulation of temperate freezing lakes by one-dimensional lake models: performance assessment for interactive coupling with regional climate models. *Boreal environment research, 15*, 143–164.

[4]Samuelsson, P., Kourzeneva, E., & Mironov, D. (2010). The impact of lakes on the European climate as simulated by a regional climate model. *Boreal environment research, 15*, 113–129.

[6]Gutiérrez, C., Somot, S., Nabat, P., Mallet, M., Corre, L., van Meijgaard, E., ... & Gaertner, M. Á. (2020). Future evolution of surface solar radiation and photovoltaic potential in Europe: investigating the role of aerosols. *Environmental Research Letters, 15*(3), 034035.