CanRCM4 (NA-CORDEX)

Climate Model Report Card

GLISA
A NOAA RISA TEAM

Model Name: Canadian Regional Climate Model 4 (CanRCM4)

Institution: Canadian Centre for Climate Modelling and Analysis (CCCma) at Environment and Climate Change Canada (ECCC)

Data Portal: https://climate-modelling.canada.ca/climatemodeldata/canrcm/CanRCM4/index_cordex.shtml and www.earthsystemgrid.org

Spatial Resolution: 0.22° grid, 0.44° grid, available data interpolated to common half (0.44°) and quarter (0.22°) degree lat-lon grids

Simulation Timestep: 20 min (0.44°), 10 min (0.22°)

Output Data Temporal Resolution: hourly (pr only), daily, monthly, seasonally, annually

GCM Driver(s): CanESM2

Reanalysis Driver: ERA-Interim

Historical Run(s): 1989-2009 (ERA-Interim), 1950-2005 (CanESM2)

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

Future Time Period(s): 2006-2100

LAKE COMPONENT

Name: Prescribed from driving GCM (CanESM2)

Reference: [1]Mailhot, E., Music, B., Nadeau, D. F., Frigon, A., & Turcotte, R. (2019). Assessment of the Laurentian Great Lakes' hydrological conditions in a changing climate. *Climatic Change, 157*(2), 243-259.

Description: Lake surface conditions over each lake grid tile are derived from the driving GCM's nearest lake tile.[1]

Vertical Layers | Depths: Undocumented

Vertical Mixing (y/n): Undocumented

Horizontal Mixing (y/n): Undocumented

Lake Ice: Ice cover is derived from the driving GCM's nearest lake tile.[1]

ATMOSPHERE COMPONENT

Name: Global Environment Multiscale (GEM3.3) model with a limited-area model (LAM) configuration

Reference: Côté, J., Gravel, S., Méthot, A., Patoine, A., Roch, M., & Staniforth, A. (1998). The operational CMC–MRB global environmental multiscale (GEM) model. Part I: Design considerations and formulation. *Monthly Weather Review, 126*(6), 1373–1395.

Physical Parameterizations: Deep convection (Zhang & McFarlane, 1995), shallow convection (von Salzen & McFarlane, 2002; von Salzen et al., 2005), correlated-K longwave and shortwave radiation schemes (Li & Barker, 2005), Monte Carlo Independent Column Approximation for radiative transfers (Barker et al., 2008; Pincus et al., 2003), planetary boundary layers (Bulk Richardson Formulation), turbulence vertical diffusion (Abdella & McFarland, 1996; von Salzen et al., 2013), microphysical processes interactive with aerosols (von Salzen & McFarlane, 2002)[2,3]

Chemistry: There is a prognostic bulk aerosol scheme (von Salzen et al., 2013) including sulfur, organic and black carbon, mineral dust, and sea salt.[2,3] The netCDF metadata also cites forcings of greenhouse gases (CO_2, CH_4, N_2O, CFC-11, effective CFC-12), ozone, and volcanic aerosols.

LAND COMPONENT

Name: Canadian Land Surface Scheme (CLASS), Version 2.7

Reference(s): [4]Verseghy, D. L., McFarlane, N. A., & Lazare, M. (1993). CLASS—A Canadian land surface scheme for GCMs, II. Vegetation model and coupled runs. *International Journal of Climatology, 13*(4), 347-370.

[5]Verseghy, D. L. (2000). The Canadian land surface scheme (CLASS): its history and future. *Atmosphere-Ocean, 38*(1), 1-13.

 # Land Cover Types: 4 sub-areas (bare soil, vegetation over soil, snow over bare soil, and vegetation over snow) and 4 vegetation types (needleleaf trees, broadleaf trees, crops, grass)[4,5]

 # Soil Layers: 3, with thicknesses of 10cm, 25cm, 3.75m, for a total depth of 4.10m[4,5]

Soil Moisture: Fluxes between soil layers are calculated using Darcy's Law. The Green-Ampt method is used to calculate infiltration in the upper soil layer.[5]

Runoff: When the surface infiltration capacity is exceeded, water ponds on the surface until the maximum ponding depth (which varies by land cover) is reached, and the overflow then evaporates or becomes surface runoff.[5]

Sub-Grid Lakes (y/n): No. A subgrid lake model (Canadian Small Lakes Model) is included in the next version: CanRCM5.[6]

Carbon Fluxes: CLASS does not include carbon budget calculations. CLASS can be coupled with the Canadian Terrestrial Ecosystem Model (CTEM, version 1), a terrestrial carbon cycle component, for the driving GCM (CanESM2), but it was not included in CanRCM4 (it is included CanRCM5).[6,7,8]

Land Use Change: Emissions from land use change can be modeled in CTEM or can be specified as an external source to the driving GCM, CanESM2[8], but no NA-CORDEX documentation mentions land use. However, the netCDF metadata cites land use forcings.

Groundwater: Groundwater is not represented in CLASS.

Additional References

[2]Diaconescu, E. P., Gachon, P., Laprise, R., & Scinocca, J. F. (2016). Evaluation of precipitation indices over North America from various configurations of regional climate models. *Atmosphere-Ocean, 54*(4), 418-439.

[3]Scinocca, J. F., Kharin, V. V., Jiao, Y., Qian, M. W., Lazare, M., Solheim, L., Flato, G. M., Biner, S., Desgagne, M., & Dugas, B. (2016). Coordinated global and regional climate modeling. *Journal of Climate, 29*(1), 17-35.

[6]*CCCma Global and Regional Climate Models.* Environment Canada CCCma. http://ccrnetwork.ca/science/workshops/scenarios-of-change/Files/CanRCM.pdf

[7]*Overview of the Canadian Terrestrial Ecosystem Model (CTEM).* (2020, February). CLASSIC: Canadian Land Surface Scheme including Biogeochemical Cycles. https://cccma.gitlab.io/classic/overviewCTEM.html

[8]*Second generation Canadian Earth System Model.* (2018, May). Environment and Climate Change Canada. https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/modeling-projections-analysis/centre-modelling-analysis/models/second-generation-earth-system-model.html