UW-RegCM4 Dynamically Downscaled Data Set

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Climate Model Report Card

Model Name: University of Wisconsin (UW) Dynamically Downscaled Data using Regional Climate Model version 4 (RegCM4) coupled to a 1-D Lake Model

Developers: Abdus Salam International Centre for Theoretical Physics (RegCM4) and Dr. Val Bennington, Dr. Yafang Zhong, and Dr. Michael Notaro at the Nelson Institute Center for Climatic Research, University of Madison-Wisconsin

Data Portal: https://nelson.wisc.edu/ccr/resources/dynamical-downscaling/index.php

LAKE COMPONENT

Name: 1D energy-balance lake model

Reference(s): [1]Hostetler, S. W. & Bartelin, P. J., (1990). Simulation of lake evaporation with application to modeling lake-level variations at Harney-Malheur Lake, Oregon. *Water Resour. Res., 26*, 2603-2612.

[2]Hostetler, S. W., Bates, G. T., & Giorgi, F. (1993). Interactive coupling of a lake thermal model with a regional climate model. *J. Geophys. Res. Atmos., 98*(D3), 5045-5057.

Description: The model accounts for vertical heat transfer within a column (1 meter vertical resolution) by eddy diffusion and convective mixing[1,2]

Vertical Layers | Depths: Spatially explicit lake depths are assigned using bathymetry data from a 30-arc-s Earth topography dataset (ETOPO)[3]

Vertical Mixing (y/n): Yes

Horizontal Mixing (y/n): No

Lake Ice: The partial ice cover scheme of Patterson & Hamblin (1988) is used to calculate the surface energy and heat and moisture exchanges, but grid cells are either ice-free or 100% ice covered. Snow can form above lake ice.[4]

ATMOSPHERE COMPONENT

Name: Pennsylvania State University (PSU)-National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5)

Reference: [6]Grell, G., Dudhia, J., & Stauffer, D. R. (1994). Description of the fifth generation Penn State/NCAR Mesoscale Model (MM5). NCAR Tech. Rep. TN-3981STR, 121 pp.

Physical Parameterizations: A large-scale precipitation scheme (Pal et al., 2000), a multiple cumulus convection Grell scheme (Grell, 1993) with a a cumulus closure scheme from (Fritsch & Chappell, 1980), boundary layer scheme (Holtslag, 1990), longwave and shortwave radiation scheme (Kiehl et al., 1996)[5,6]

Chemistry: Dust and aerosol emission parameterizations following Laurent et al. (2008) and Alfaro & Gomes (2001). The radiation scheme used (Kiehl et al., 1996) accounts for O_3, H_2O, CO_2, CH_4, N_2O, O_2, and CFCs.[6]

Temporal Resolution: Monthly (public), daily (available upon request - contact info on Data Portal)

Spatial Resolution: 25km grid

GCM Driver(s): ACCESS1-0, CNRM-CM5, GFDL-ESM2M, IPSL-CM5-MR, MIROC5, MRI-CGCM3

Historical Run(s): 1980-1999 (available upon request - contact info on Data Portal)

Future Scenario(s): RCP8.5

Future Time Period(s): Mid-Future: 2040-59, Late-Future: 2080-99

LAND COMPONENT

Name: The Biosphere-Atmosphere Transfer Scheme (BATS)

Reference: [7]Dickinson, R. E., Henderson-Sellers, A., & Kennedy, P. J. (1993). Biosphere-Atmosphere Transfer Scheme (BATS) version 1e as coupled to the NCAR Community Climate Model. *NCAR Tech. Note NCAR/TN-3871STR.*

 # Land Cover Types: 20 vegetation/land-cover and 12 soil types[7]

 # Soil Layers: 3 (+1 for snow), with an upper layer thickness of 0.1m, a soil rooting layer with varying thickness of 1 to 2m, based on vegetation cover and/or land use, and a third deep soil layer 3m thick[7]

Soil Moisture: Soil infiltration in BATS is written as a residual of the surface water balance equation, which is calculated from precipitation, excess water dripping from canopy, snowmelt, surface runoff, and evaporation.[3,9]

Runoff: BATS contains a simple surface runoff parameterization,[7] but was "not intended for local cite application, but was guided by the requirement that in a GCM, it should, on the average, give a similar amount of surface runoff as is observed"[9]

Sub-Grid Lakes (y/n): No

Carbon Fluxes: Undocumented

Land Use Change: Undocumented

Groundwater: Groundwater and baseflow are not represented.[3]

Additional References

[3]Notaro, M., Bennington, V., & Lofgren, B. (2015). Dynamical downscaling–based projections of Great Lakes water levels. Journal of Climate, 28(24), 9721-9745.

[4]Notaro, M., Bennington, V., & Vavrus, S. (2015). Dynamically downscaled projections of lake-effect snow in the Great Lakes basin. *Journal of Climate, 28*(4), 1661-1684.

[8]Notaro, M., Schummer, M., Zhong, Y., Vavrus, S., Van Den Elsen, L., Coluccy, J., & Hoving, C. (2016). Projected influences of changes in weather severity on autumn-winter distributions of dabbling ducks in the Mississippi and Atlantic flyways during the twenty-first century. *PloS one, 11*(12), e0167506.

[9]Yang, Z. L., & Dickinson, R. E. (1996). Description of the Biosphere-Atmosphere Transfer Scheme (BATS) for the Soil Moisture Workshop and evaluation of its performance. *Global and Planetary Change, 13*(1-4), 117-134.