WRF (NA-CORDEX)

Climate Model Report Card

GLISA
A NOAA RISA TEAM

Model Name: Weather Research and Forecasting Model

Institution(s): National Center for Atmospheric Research (HadGEM2-ES, GFDL-ESM2M) and University of Arizona (MPI-ESM-LR, ERA-Interim)

Data Portal: www.earthsystemgrid.org

Spatial Resolution: 25km grid (approx. 0.22º), 50km grid (approx. 0.44º), available data interpolated to common half (0.44º) and quarter (0.22º) degree lat-lon grids

Simulation Timestep: 150s (25km), 5 min (50km)

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

GCM Driver(s): GFDL-ESM2M, HadGEM2-ES, MPI-ESM-LR

Reanalysis Driver: ERA-Interim

Historical Run(s): 1980-2010 (ERA-Interim, 25km), 1979-2015 (ERA-Interim, 50km), 1950-2005 (all driving GCMs)

Future Scenario(s): RCP8.5

Future Time Period(s): 2006-2100 (MPI-ESM-LR), 2006-2099 (HadGEM2-ES, GFDL-ESM2M)

LAKE COMPONENT

Name: No lake model

Reference: [1]Mallard, M. S., Nolte, C. G., Bullock, O. R., Spero, T. L., & Gula, J. (2014). Using a coupled lake model with WRF for dynamical downscaling. *Journal of Geophysical Research: Atmospheres, 119*(12), 7193-7208.

Description: Lake surface temperatures are interpolated from the nearest driving GCM water grid cell, which is usually from nearby oceans for coarse GCMs.[1] www.na-cordex.org/rcm-characteristics cites "default WRF interpolation from nearby ocean SSTs."

In Mallard et al. (2014), an example driving GCM with 1.875° × 1.875° resolution only had 3 grid cells over the Great Lakes (only over parts of Lake Superior and Lake Michigan), causing most of Lake Erie and Lake Ontario to interpolate values from the Atlantic Ocean and leading to an abrupt change in temperature. See Figure 1 in Mallard et al. (2014).

Vertical Layers | Depths: N/A

Vertical Mixing (y/n): N/A

Horizontal Mixing (y/n): N/A

Lake Ice: Ice coverage is interpolated from neighboring water grid cells in the driving GCMs. If there are no neighboring points with ice coverage, it is set to 0% (Unlike surface temperature, it does not take ice coverage from the nearest ocean).[1]

In Mallard et al. (2014), an example driving GCM with 1.875° × 1.875° resolution only contained ice coverage values for part of Lake Superior and Lake Michigan, abruptly switching to 0% ice coverage for the rest of those lakes and for the remaining lakes. See Figure 1 in Mallard et al. (2014).

ATMOSPHERE COMPONENT

Name: Advanced Research WRF physics and dynamics

Reference: [1]Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Barker, D. M., Wang, W., & Powers, J. G. (2008). A description of the Advanced Research WRF version 3. NCAR Technical note-475+ STR.

Physical Parameterizations: WSM3 moist microphysics with ice-phase processes (Hong et al., 2004), mass flux Kain-Fritsch cumulus scheme (Kain, 2004), Mellor-Yamada-Janjic (MYJ) planetary boundary layer turbulence scheme from prognostic TKE (Janjic, 1990, 1996, 2002), Rapid Radiative Transfer Model (RRTM) for longwave radiation using correlated-k method (Mlawer et al., 1997), Goddard shortwave radiation (Chou and Suarez, 1994)[1]

Chemistry: Longwave radiation schemes represent processes due to water vapor, CO_2, ozone, and trace gases and shortwave radiation scheme considers ozone.[1] www.na-cordex.org/rcm-characteristics cites uniform aerosols for WRF's CORDEX runs.

LAND COMPONENT

Name: Noah land surface model

Reference: [2]Niu, G. Y., Yang, Z. L., Mitchell, K. E., Chen, F., Ek, M. B., Barlage, M., ... & Xia, Y. (2011). The community Noah land surface model with multiparameterization options (Noah-MP): 1. Model description and evaluation with local-scale measurements. *J. Geophys. Res.*, 116, D12109.

 # Land Cover Types: 24 vegetation types (from USGS 24-category data) and 16 soil types[2]

 # Soil Layers: 4 (+1 snow) with thicknesses of 10cm, 30cm, 60cm, 100cm for a total depth of 2m.[2]

Soil Moisture: When soil moisture capacity is exceeded in the fractional area of a grid cell, the water becomes runoff or groundwater.[2]

Runoff: The TOPMODEL-based scheme from Niu et al. (2005) is used for surface runoff, which comes mainly from excess water on a saturated grid cell.[2]

Sub-Grid Lakes (y/n): No[1]

Carbon Fluxes: It cannot explicitly calculate carbon fluxes, but a dynamic leaf model (Dickinson et al., 1998) is used for vegetation carbon budgets and soil carbon pools.[2]

Land Use Change: There is an option for dynamic vegetation,[2] although it is undocumented if it was on for NA-CORDEX runs.

Groundwater: There is an unconfined aquifer underneath the 2m column of soil. Darcy's law is used when water enters the aquifer and TOPMODEL-based scheme is used for groundwater discharge.[2]