

# GFDL- CM4 (CMIP6)

Climate Model Report Card

**Model Name:** Geophysical Fluid Dynamics Laboratory Climate Model Version 4.0

**Developers:** National Oceanic and Atmospheric Administration's (NOAA) Geophysical Fluid Dynamics Laboratory (GFDL)

**Data Portal:** <https://data1.gfdl.noaa.gov/>



**Spatial Resolution:** 1° Land; 0.25° Ocean

**Temporal Resolution:** 3 hour, daily, monthly

**Time Periods:** Historical: 1850–2014; Future: up to 2100

**Scenario(s):** SSP1-2.6, SSP2-4.5, SSP5-8.5

## LAKE COMPONENT

**Name:** Lake Model within Land Model

**Version:** LM4.0.1

**Reference:** Zhao et al. (2018a, b)

**Description:** Lakes are represented by one or more vertical columns with density-driven stratification and overturning.

**Coupled to atmosphere:** Yes

**1D/3D/Other:** 1D

**# Layers:** 10 layers

**Lake Depths:** Varied by grid cell lake fraction: uses default mean depths.

**Lake Ice Model Description:** Energy balance-based ice formation and melt, with albedo and shortwave feedback.

## LAND COMPONENT

**Name:** Land Model

**Version:** LM4.0.1

**Reference:** Zhao et al. (2018a, b)

**# Land Cover Types:** 12

**Subgrid Lakes:** Yes

**# Soil Layers:** 6

**Soil Depths:** 0.1 m, 0.35 m, 0.75 m, 1.25 m, 2.0 m, 3.0 m (decreased depth from LM3.1 for quicker spin-up times)

**Runoff:** Runoff goes to the ocean through a grid-scale network of lakes and rivers.

**Soil Moisture Description:** Soil is dual-domain, saturated-unsaturated, soil-bedrock continuum where Richard's equation governs flow.

**Carbon Flux Description:** Diagnostic only (prescribed atmospheric CO<sub>2</sub>); interactive land carbon cycle similar to ESM2M/LM3.

**Land Use Change Incorporated (y/n):** Yes, reconstructed from CMIP5 forcing.

**Groundwater Description:** Simulated as a confined water table using a simply aquifer model with recharge and drainage.

## ATMOSPHERE COMPONENT

**Name:** Atmospheric Model, version 4 (AM4)

**Version:** AM4.0.1

**Reference:** Zhao et al. (2018a, b)

**Resolution:** 1° with 33 levels topped at 1 hPa

**Physical Parameterizations:** Includes orographic gravity wave drag, updated cloud microphysics, "double-plume" convective closure for deep and shallow convection, and cloud fraction schemes.

**Chemistry:** Improved upon AM3, has the ability to generate aerosol distribution from emissions, ozone and other oxidants are prescribed.

### References

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- Held, I. M., Guo, H., Adcroft, A., Dunne, J. P., Horowitz, L. W., Krasting, J., et al. (2019). Structure and performance of GFDL's CM4.0 climate model. *Journal of Advances in Modeling Earth Systems*, 11, 3691–3727. <https://doi.org/10.1029/2019MS001829>
- Zhao, M., Golaz, J.-C., Held, I. M., Guo, H., Balaji, V., Benson, R., et al. (2018). The GFDL global atmosphere and land model AM4.0/LM4.0: 1. Simulation characteristics with prescribed SSTs. *Journal of Advances in Modeling Earth Systems*, 10. <https://doi.org/10.1002/2017MS001208>
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