# BUYER'S GUIDE

# for CLIMATE MODELS

## IN THE GREAT LAKES REGION

## Introduction

Climate information users in the Great Lakes region face unique challenges when selecting high-quality future climate projections. Lakes and lake-land-atmosphere dynamics are often over-simplified or missing from climate models. GLISA has established the following climate model requirements and model evaluation criteria to aid those who are in the market of choosing and using climate model projections in the Great Lakes region.

## Basic Model Requirements Checklist

**Checklist for Climate Model Requirements:**

- [ ] Gridded spatial coverage over the entire Great Lakes region (including Canada)
- [ ] At least 30 consecutive years of data
- [ ] A 20th century (i.e., historical) run (of at least 30 years)
- [ ] A daily or monthly time step
- [ ] Model documentation
- [ ] Downscaling documentation (where applicable)
- [ ] Basic validation of the model that has been published
- [ ] At least a 1-D lake model that simulates the Great Lakes
- [ ] Lastly, the data provider anticipated providing the data for broader/public use

GLISA
A NOAA RISA TEAM

# Model Evaluation Checklist

Evaluation of climate model simulations of the Great Lakes, lake ice, lake temperatures, and regional air temperatures and precipitation is recommended. Models that perform well in all of these categories likely offer higher quality future climate projections. Models that have large errors (biases) in any of these categories introduce greater uncertainty in their future projections.

## Lake Model

- [ ] The climate model includes a 1D or 3D lake model

Many climate models do not explicitly simulate large lakes, like the Great Lakes. Climate models that incorporate interactive lake models (1D or 3D) simulate climate feedbacks from the lakes and attempt to capture important lake-driven climate trends in the future.

## Lake Ice

- [ ] Lake ice can form in the model
- [ ] The seasonal evolution and long-term trends of ice cover in the model mimic historical observations

Lake dynamics can be highly simplified in climate models, so it is important to know whether lake ice is allowed to form within a model. Lake ice formation is critical to simulating evaporation from the lake surface and moisture fluxes to the atmosphere, which drive processes like lake-effect precipitation. Information about the spatial extent of lake ice in the model, the seasonal evolution of ice cover, and long-term ice cover trends can provide insight into how important lake-atmosphere dynamics are represented in the model.

## Lake Temperatures

- [ ] The seasonal evolution and long-term trends of lake temperatures in the model mimic historical observations

Lake temperatures influence processes like lake evaporation, lake ice formation, and lake-effect precipitation. The interaction between these processes can carry over into subsequent years, emphasizing the importance of an accurate representation of lake temperatures in the model. Evaluation of the seasonal cycle and long-term lake temperature trends, like the recent observed rapid summer lake surface warming, is recommended.

## Regional Air Temperature and Precipitation

- [ ] The seasonal evolution and long-term trends of air temperatures and precipitation in the model mimic historical observations

The model should be evaluated for how well it captures the seasonal cycle and long-term trends of air temperature and precipitation (including snow) across the region. It is recommended to assess both the spatial distribution and magnitude of temperature and precipitation to get a sense for how well the model captures local patterns.

GLISA
A NOAA RISA TEAM

# MODEL CHECKLIST

*Practitioners in the Great Lakes region can use this checklist to determine which models may be suitable for use in regional applications. Additional requirements may be necessary depending on the specific use. Models that do not meet all of these criteria likely offer lower quality information for the region.*

**The model must have:**

- [ ] Gridded spatial coverage for any state that touches a Great Lake and southern Ontario
- [ ] At least 30 consecutive years of future data
- [ ] At least 30 consecutive years of historical data (20th century)
- [ ] A daily or monthly time step in the model output (projection)
- [ ] Model documentation
- [ ] Downscaling documentation (where applicable)
- [ ] Basic validation of the data that has been published
- [ ] At least a 1-D lake model to simulate the Great Lakes
- [ ] The data provider anticipated providing the data for broader/public use

**Regional Evaluation Criteria:**

- [ ] Lake ice can form in the model
- [ ] The seasonal evolution and long-term trends of ice cover in the model mimic historical observations
- [ ] The seasonal evolution and long-term trends of lake temperatures in the model mimic historical observations
- [ ] The seasonal evolution and long-term trends of important climate variables (determined by each application but minimally including air temperature and precipitation) in the model mimic historical observations