Comparison of 1D and 3D hydrodynamic models on the assessment of climate change scenarios impact over a small tropical lake

Barbara Pozzan dos Santos Duarte, Laís Ferrer Amorim, José Carlos de Melo Bernardino, José Rodolfo Scarati Martins – School of Engineering, University of São Paulo, Brazil
Corresponding author: barbara.pozzan.duarte@usp.br

Hydrodynamic models simulate the water and thermal regime of lakes, considering different boundary conditions. The assessment of climate change impacts, over these environments, relies on the selected models responses, their intrinsic characteristics and reliability. This paper aims to compare the thermal responses of two distinct models (GLM and DELFT3D) over two climate projections.

HEDBERG RESERVOIR

0.26 km²
~ 4.5 m depth
Tropical (Iperó - SP, Brazil)
Polimitic behavior

MONITORING

Local meteorological station + monitoring buoy
High-frequency temperature data:
2 min (accuracy: ± 0.02°C)
Depths: 0.5 m, 1.5 m, 2.5 m, 3.5 m

Figure 1 – Hedberg reservoir and the monitoring buoy placement

MATHERIALS AND METHODS

General Lake Model
(Hipsey et al., 2019)
- 1DV model
- v. (3.0.5)
- Lagrangian structure

DELFT3D
(DELTARES, 2014)
- Quasi-3D
- Eulerian structure

CLIMATE CHANGE SCENARIOS

Regional prediction: Model ETA
Simulation 2020 - 2025

(Emissions of CO2 equivalent and increase in global mean temperature by 2100)
RCP 4.5 (optimistic): 650 ppm and 1.8°C
RCP 8.5 (pessimistic): 1000 ppm and 3.6°C

(IPCC, 2014)

RESULTS AND DISCUSSION

Parameters	GLM	DELFT
Light extinction coefficient (kw)	2.45	2.43
wind drag coefficient (cd)	0.001	0.0001
Vertical diffusivity	0.3	0

Table 1 – Calibration parameters (GLM and DELFT3D)

RMSE (Calibration)	GLM	DELFT
Surface (0.5 m)	1.06	0.85
Bottom (3.5 m)	1.02	0.6

Table 2 – Calibration RMSE (GLM and DELFT3D)

RCP 4.5

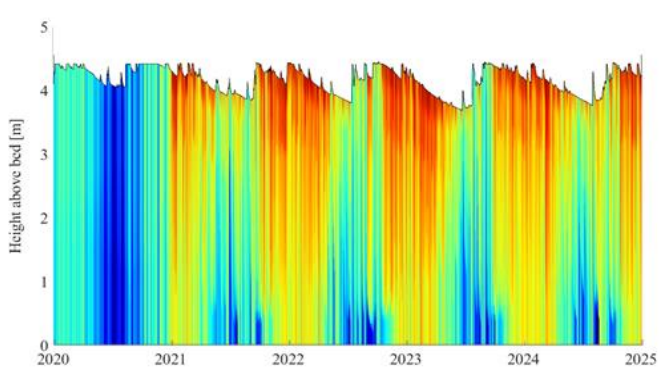

Figure 2 – Climate change simulation (RPC 4.5) - **GLM**

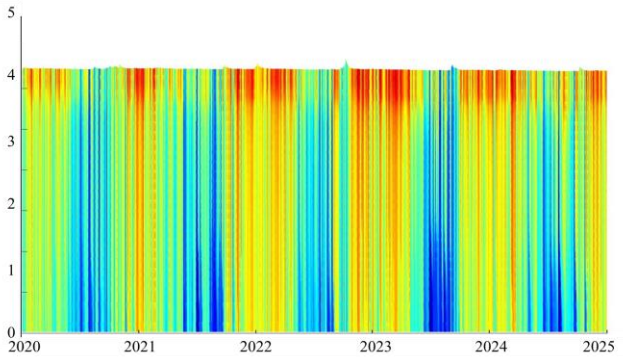

Figure 3 – Climate change simulation (RPC 4.5) - **DELFT3D**

RCP 8.5

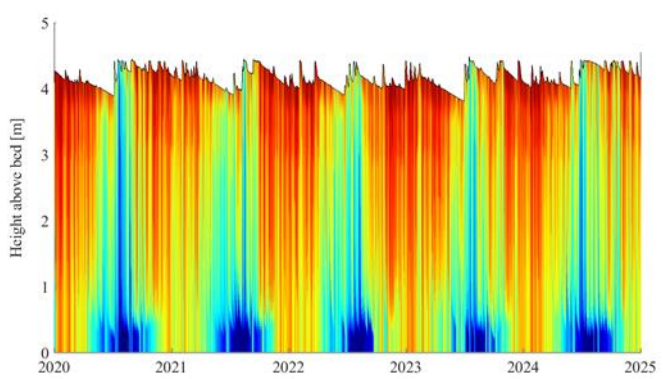

Figure 4 – Climate change simulation (RPC 8.5) - **GLM**

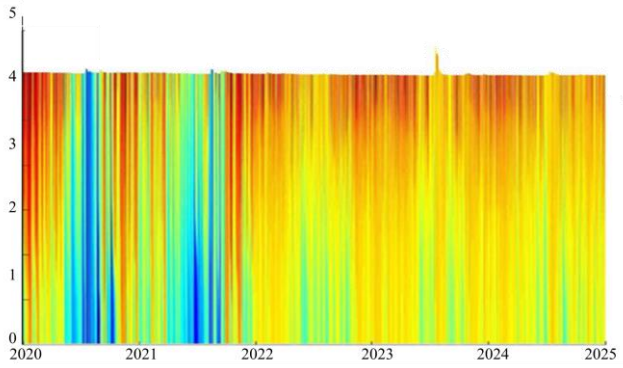

Figure 5 – Climate change simulation (RPC 8.5) - **DELFT3D**

- **Water level variations** were more intensely simulated by **GLM**;
- Changes in the thermal regime were observed on both models, increasing the lake's mixing events, with warmer temperatures along the vertical. **DELFT** presented a **stronger mixing dynamic**.
- **GLM** indicated more intensely responses for the **extreme temperatures** (warmer and colder);
- Processing time (**DELFT ~7 days; GLM < 1 min**).

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