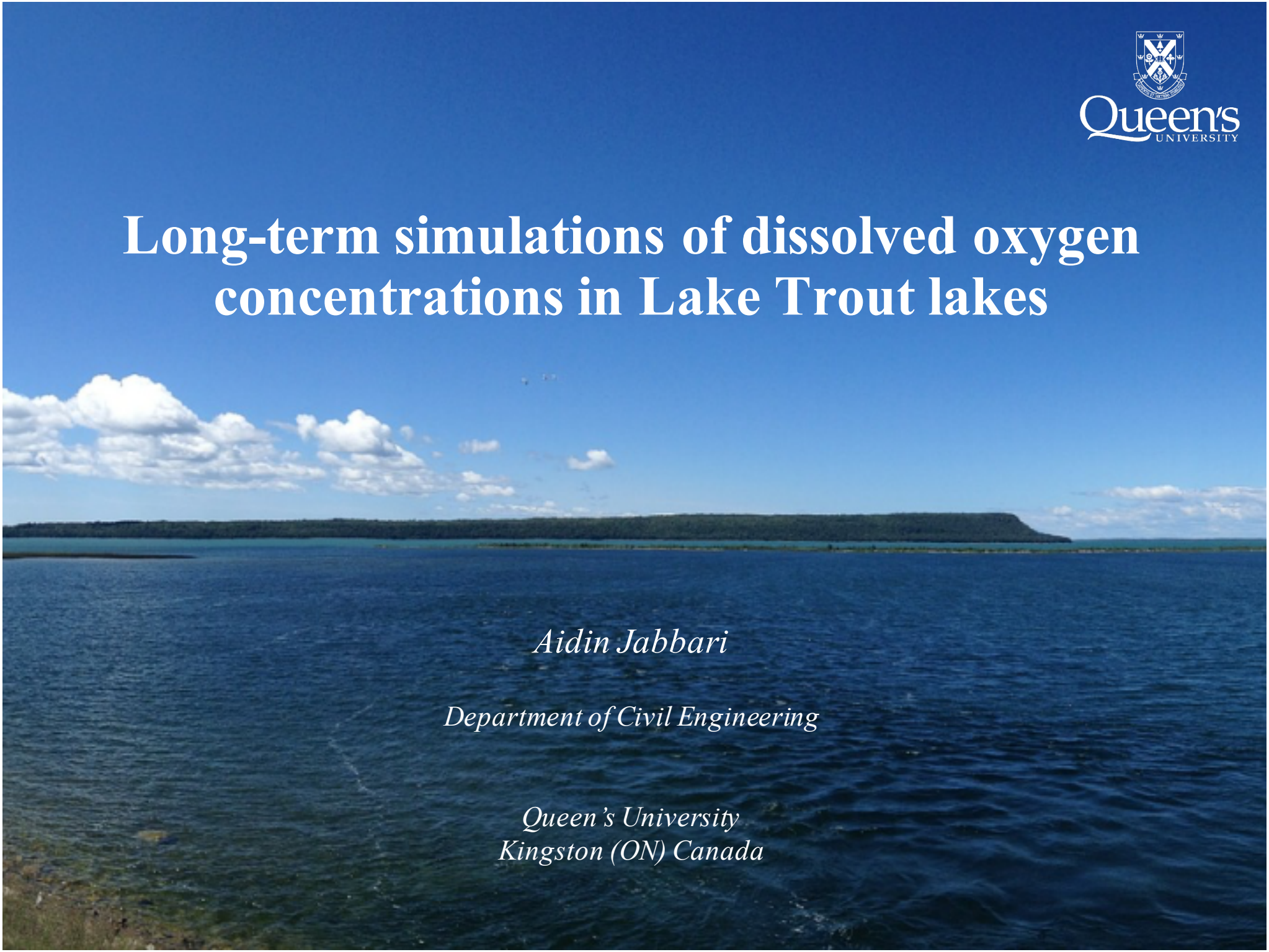

Long-term simulations of dissolved oxygen concentrations in Lake Trout lakes

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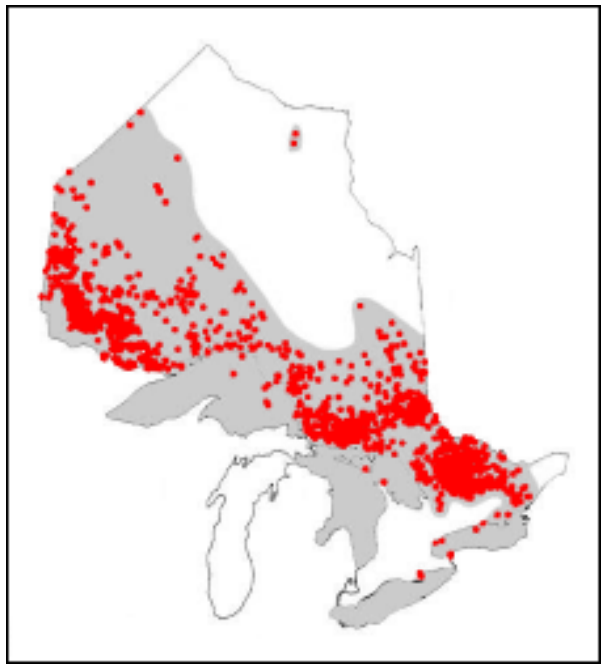
Introduction

- Lake Trout

  - *A valuable natural resource in both economic and ecological terms*
  - *length: 30-80 cm, weight: 1-5 kg*
    Ontario record: 28.6 kg
  - *Relatively rare: only 1% of Ontario lakes contain Lake Trout*
  - *20-25% of Lake Trout lakes are in Ontario*



Lake Ontario, Lake Huron, Lake Superior and across the deep, cold lakes of the Canadian Shield (www.ontario.ca)

Introduction

- *Narrow physiological tolerances for temperature and dissolved oxygen (DO)*

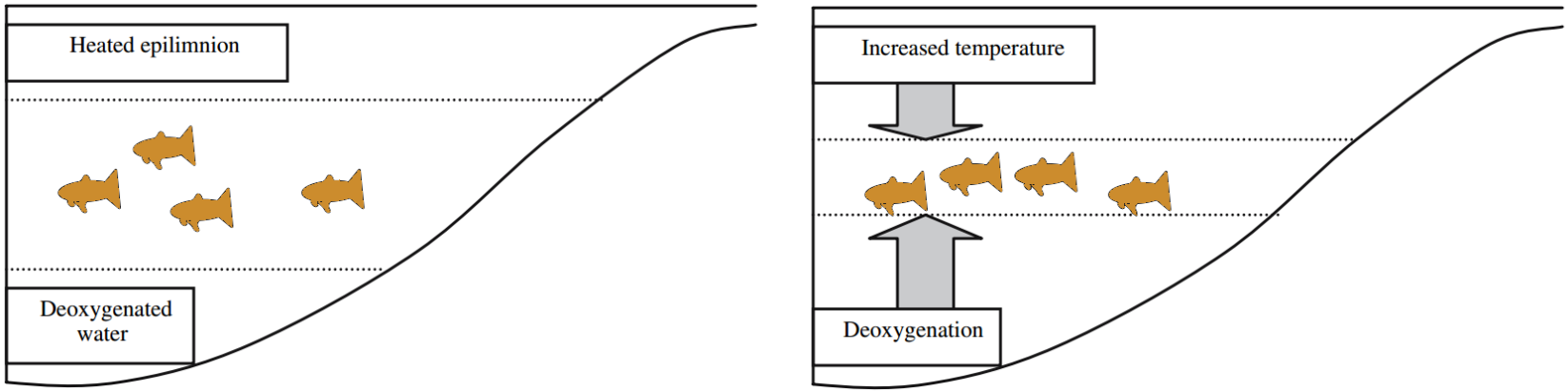
  Temperature: 6-15°C

  DO: 9-12 mg/L

- *Vulnerable to many stresses including climate warming:*

  Increased solar radiation ⇒ Thicker Epilimnion

  Increased fish metabolism ⇒ Decreased concentrations of DO



Effect of climate change on restriction of pelagic habitat availability for Lake Trout (Ficke et al., 2007)

Introduction

- *Significant weather changes in central Canada by 2100 (GCM):*

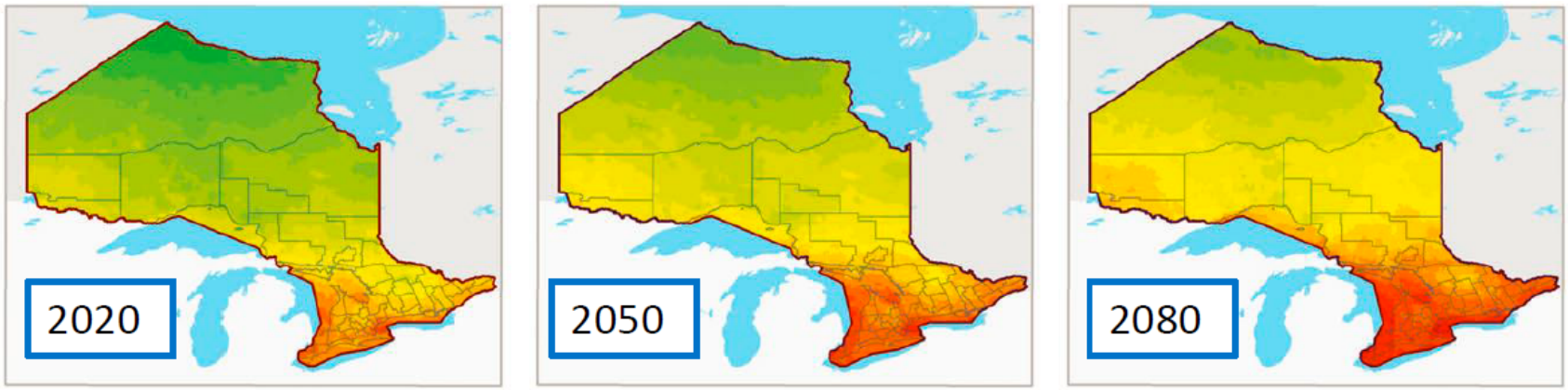
  Winter: increase by 3-5°C

  Summer: increase by 6-9°C

  Climate changes ⟹ lower water levels ⟹ less hypolimnion volumes ⟹ severe hypoxia

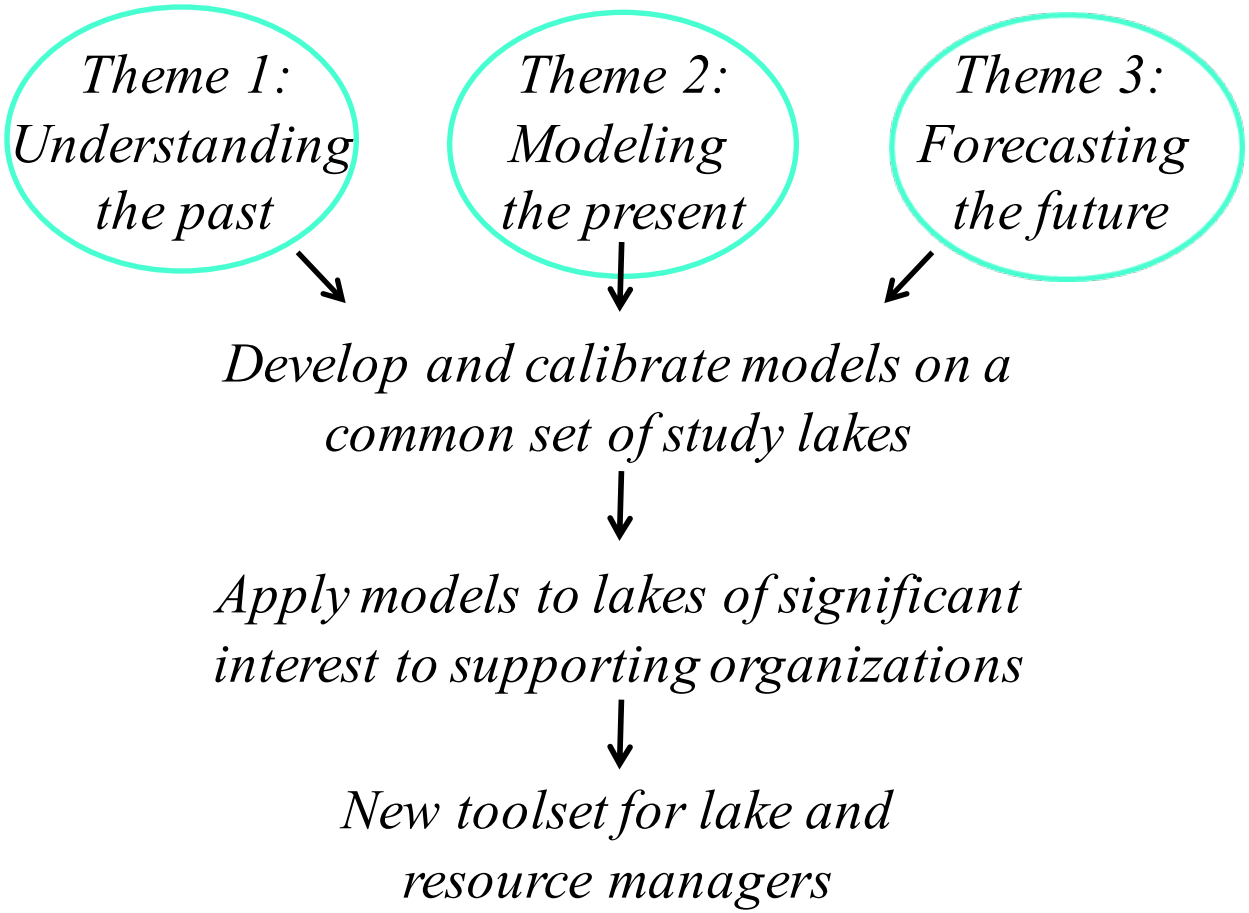
- *Kling et al. (2003):*

  Higher air temperatures ⟹ longer and stronger summer thermal stratification period ⟹ increase the duration of DO depletion in the hypolimnion & decrease the vertical DO flux



Project Overview

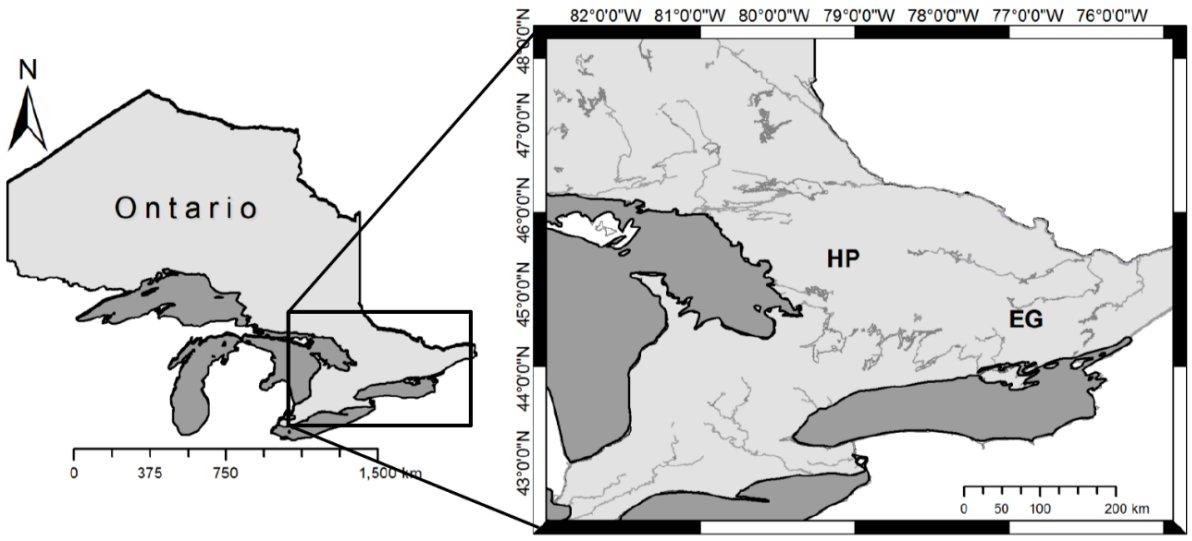
- *A 3-part study to:*
  Analyze sediment cores to understand the past
  Develop empirical formulae to model the present
  Apply computational models to forecast the future



Theme 3

- Computational modeling
  - *A simple DO sub-model has been embedded in the 1D bulk mixed-layer thermodynamic Canadian Small Lake Model (CSLM).*
  - *This model is currently being incorporated into the Canadian Land Surface Scheme (CLASS).*
  - *The model can simulate physics and biogeochemistry over timescales relevant to climate change.*
  - *Calibrated and validated by hind-casting T and DO profiles from 2 Lake Trout lakes:*

    Harp Lake & Eagle Lake



Harp Lake: model set-up

Maximum depth: 34 m

Square root of the surface are: 843 m

Extinction coefficient: 0.5 1/m

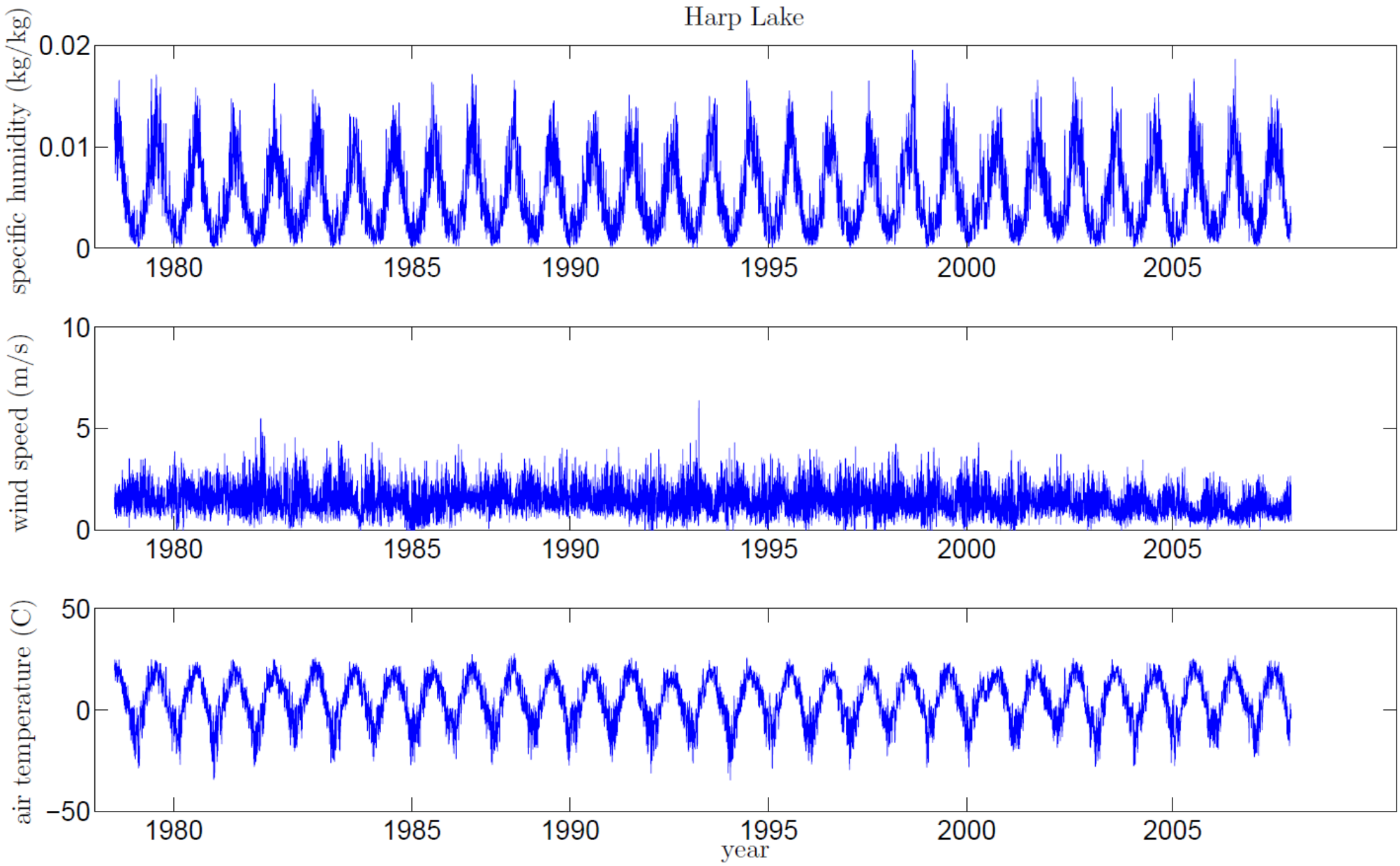
Simulations time: 1978-2008

Optimum HOD: 0.03

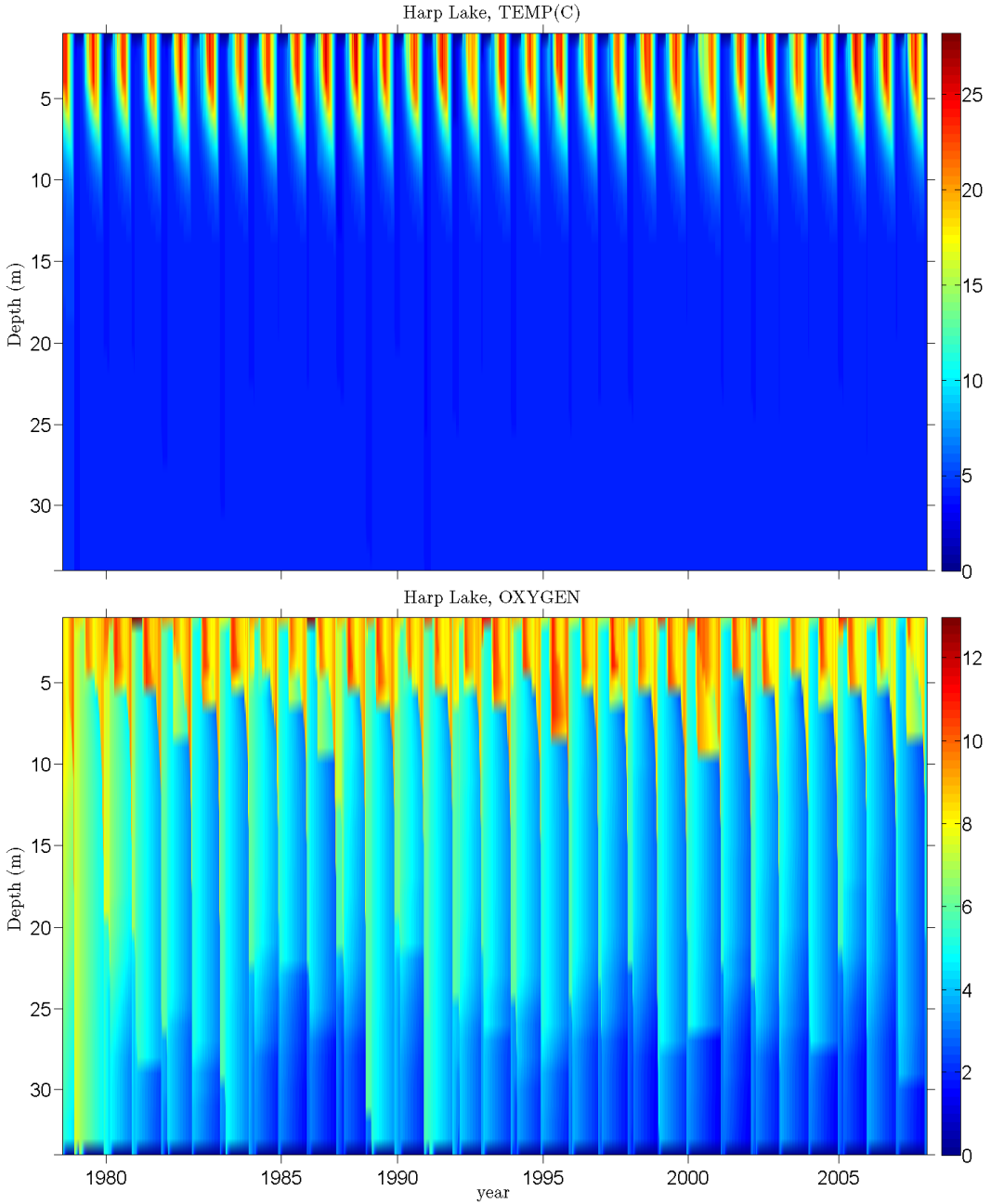
Grid spacing: 1 m

Time steps: 10 min

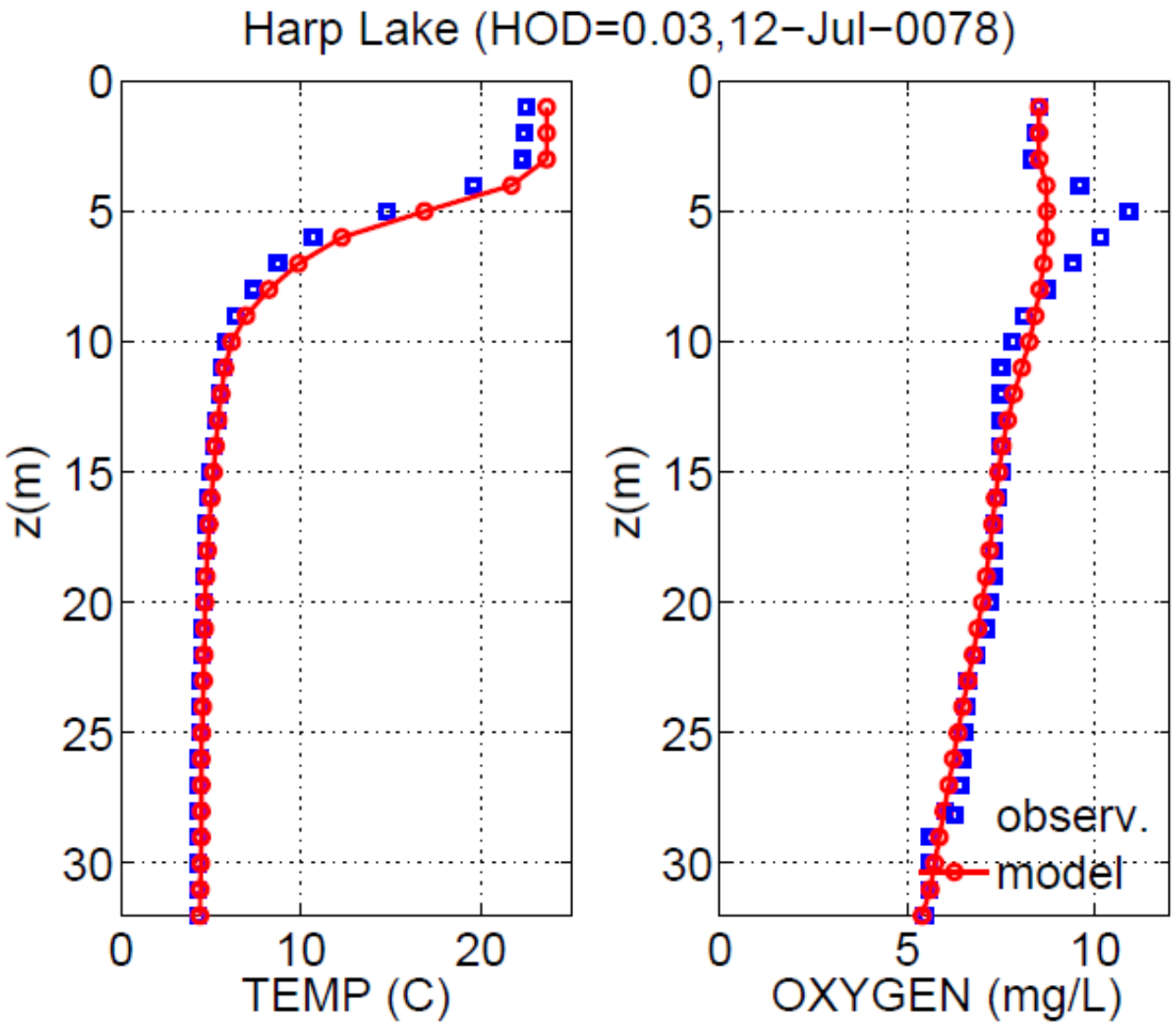
Harp Lake: Meteorology



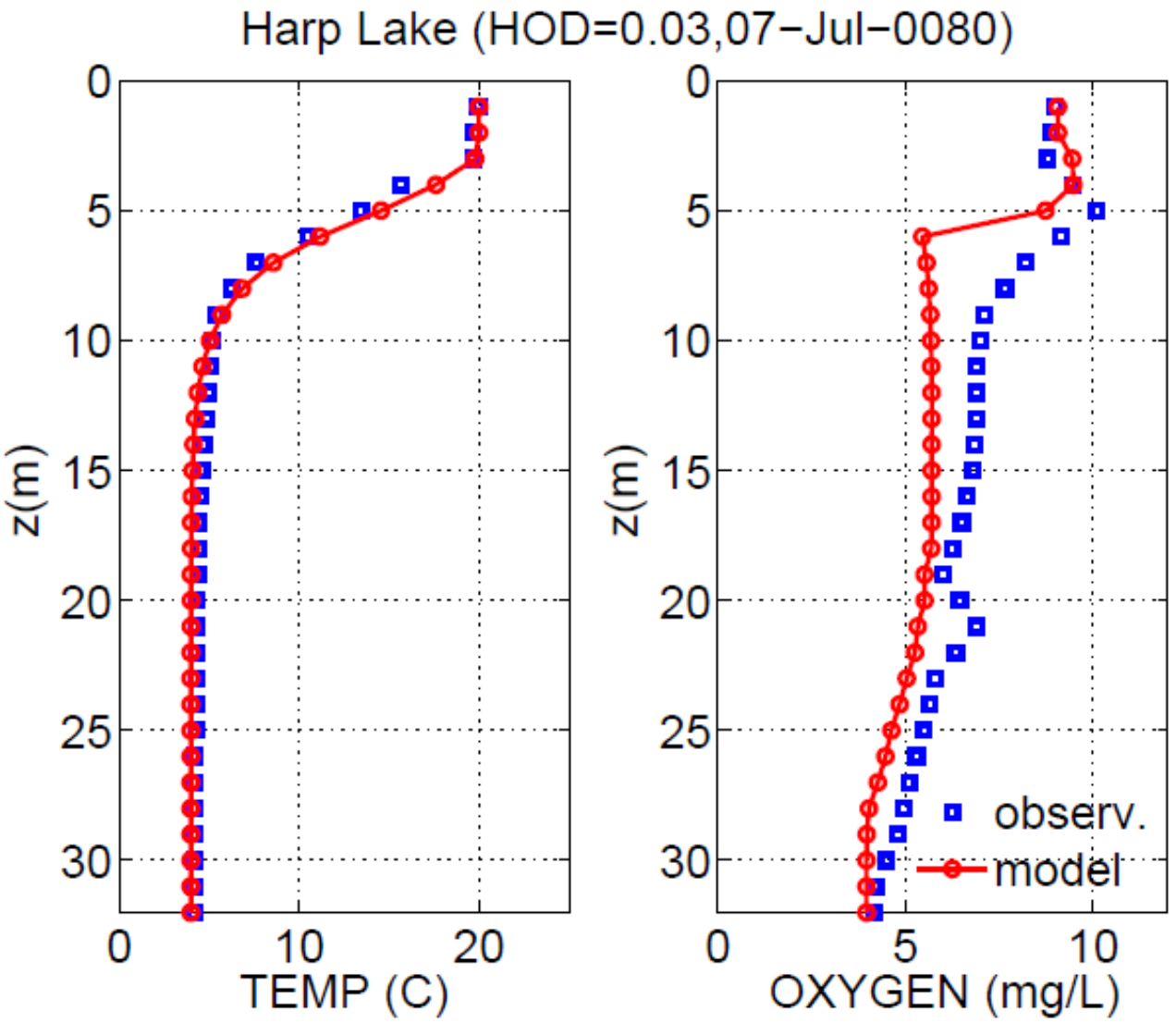
Harp Lake: Results



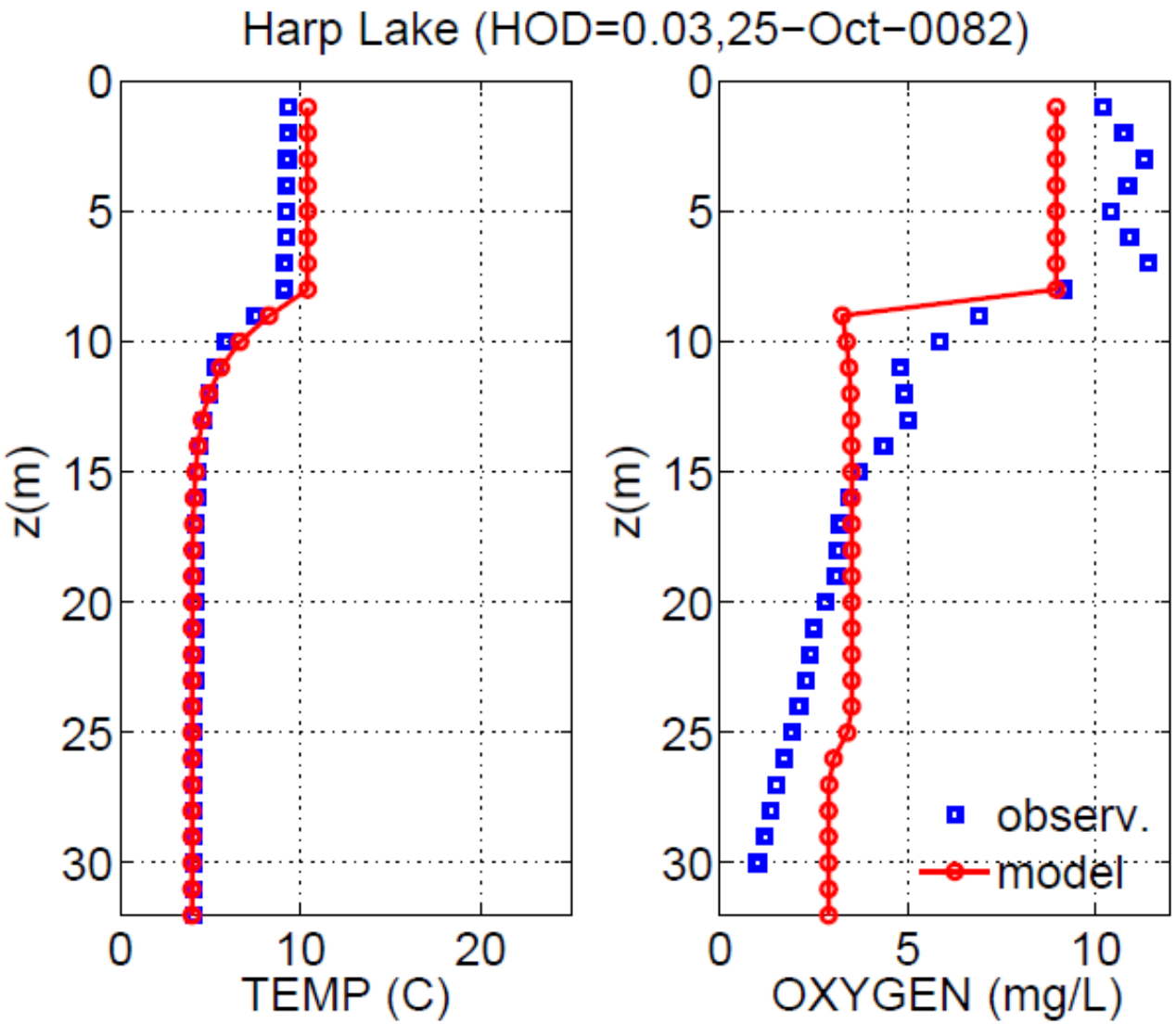
Harp Lake: Results



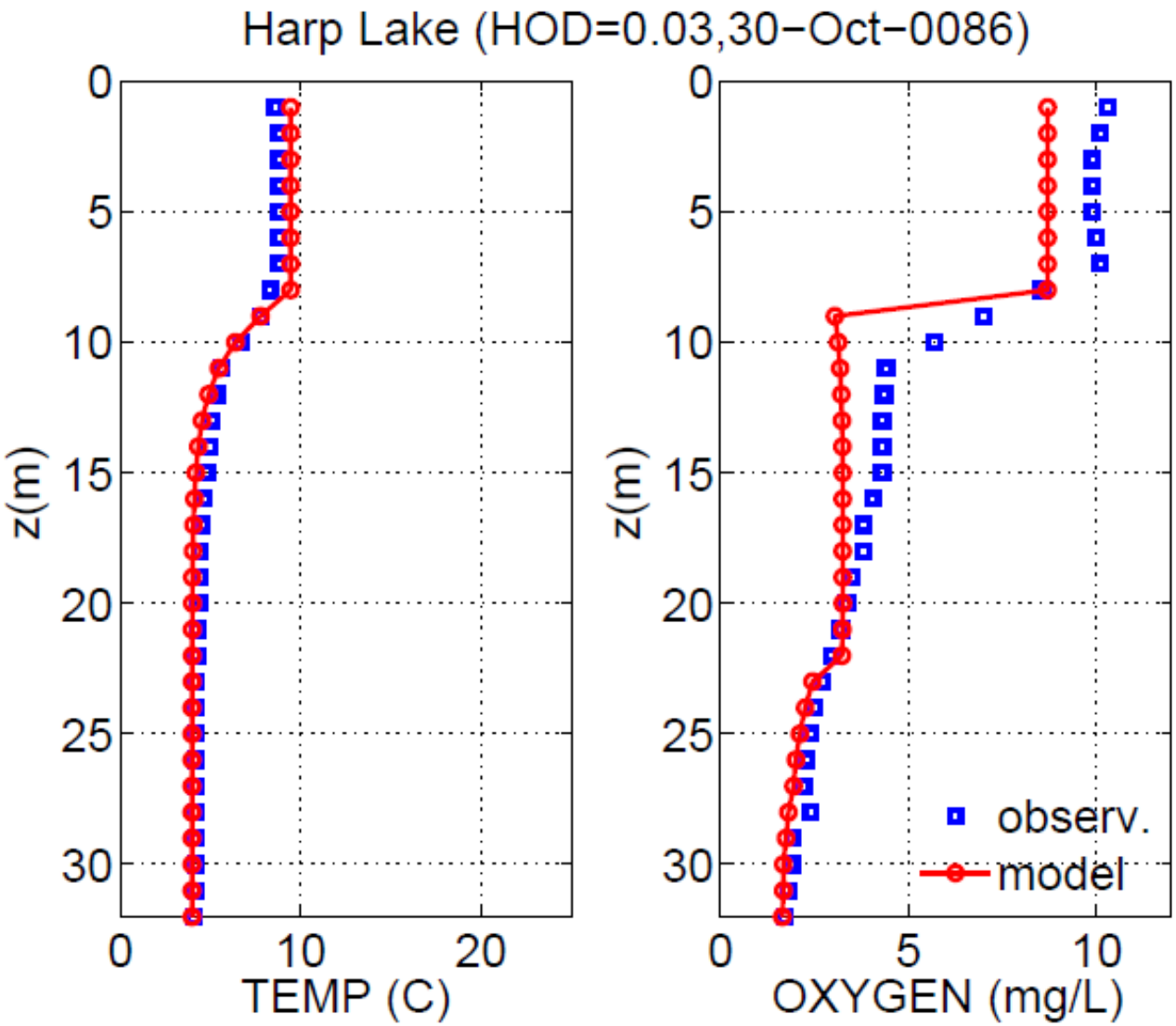
Harp Lake: Results



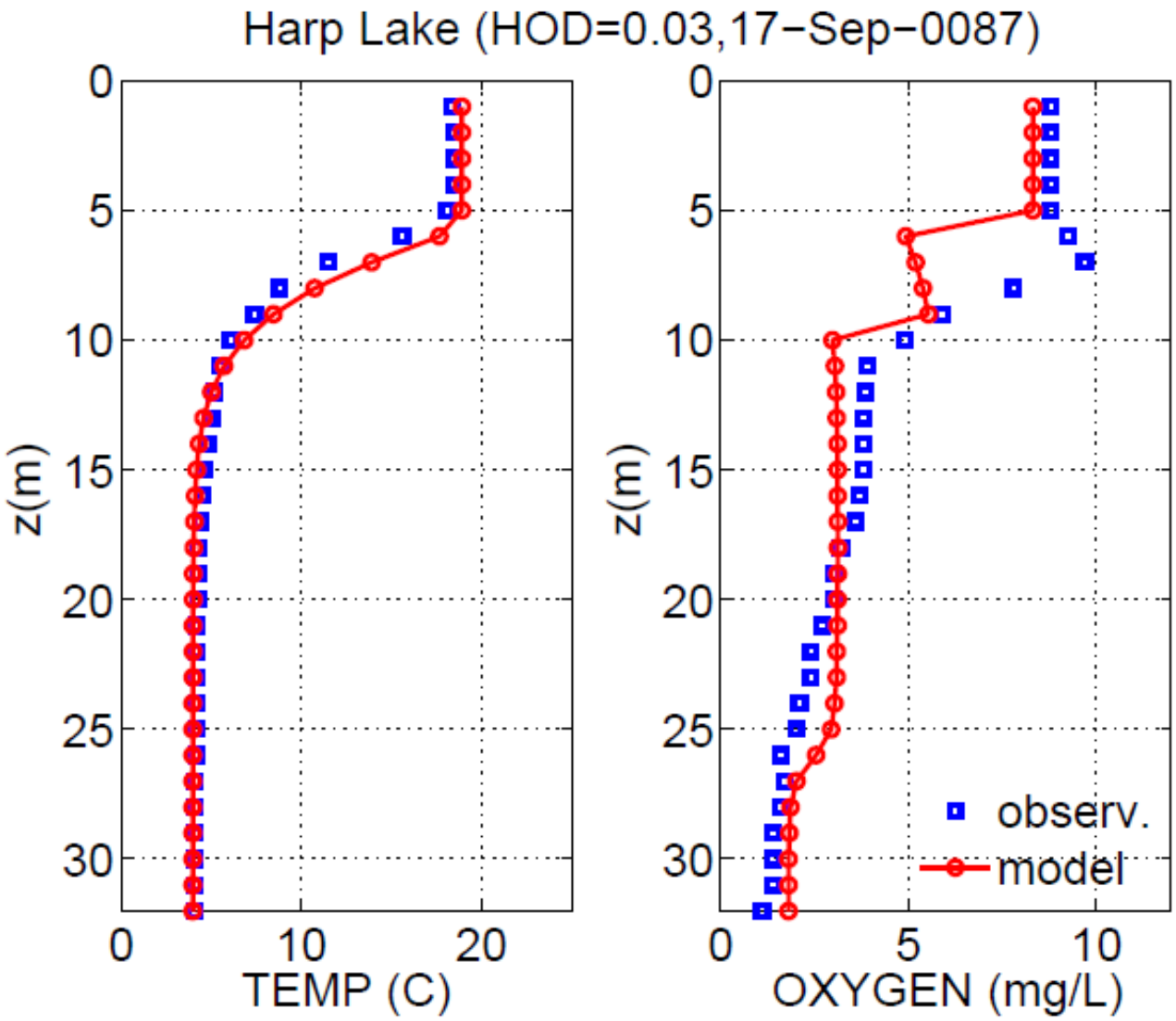
Harp Lake: Results



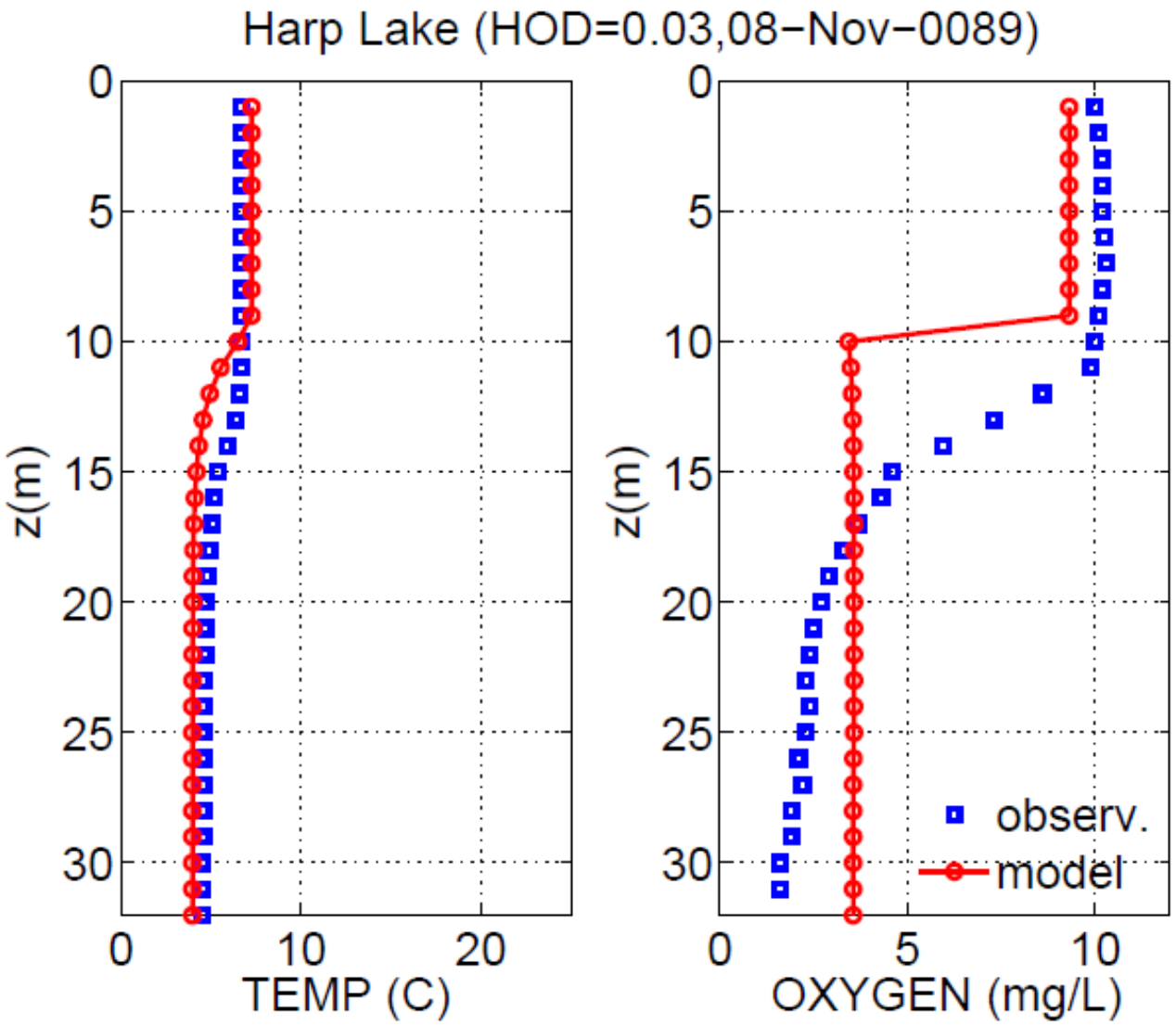
Harp Lake: Results



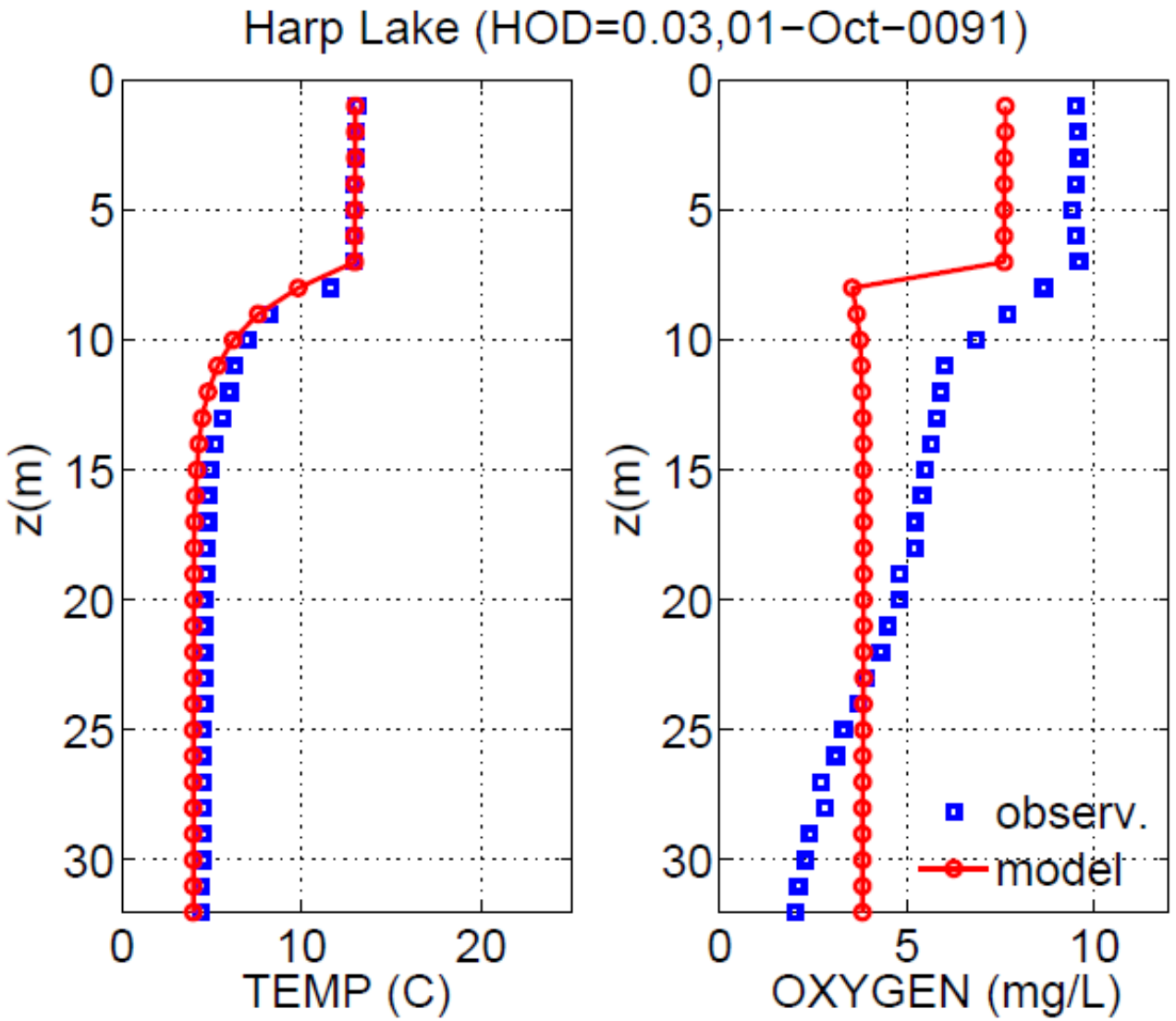
Harp Lake: Results



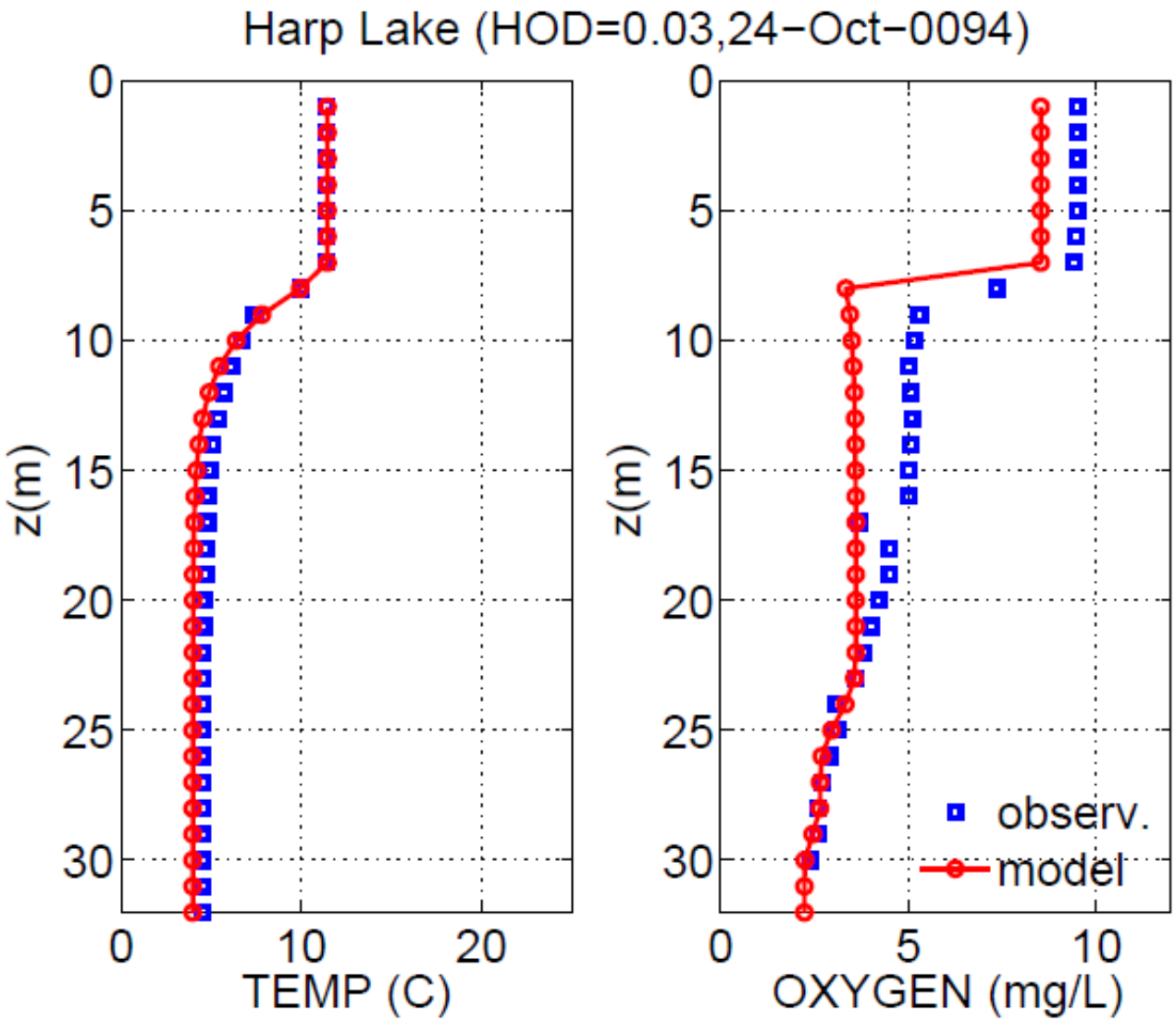
Harp Lake: Results



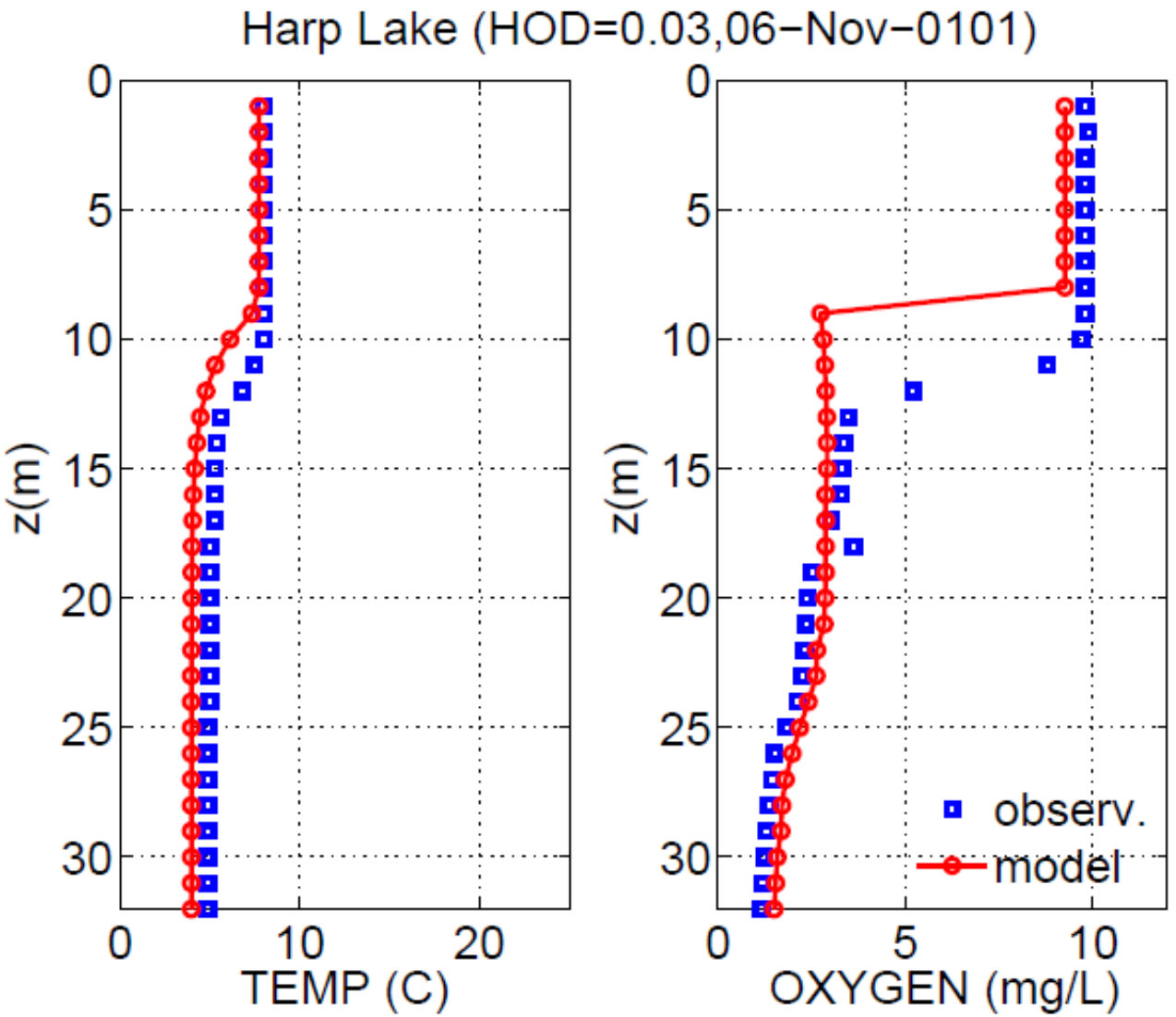
Harp Lake: Results



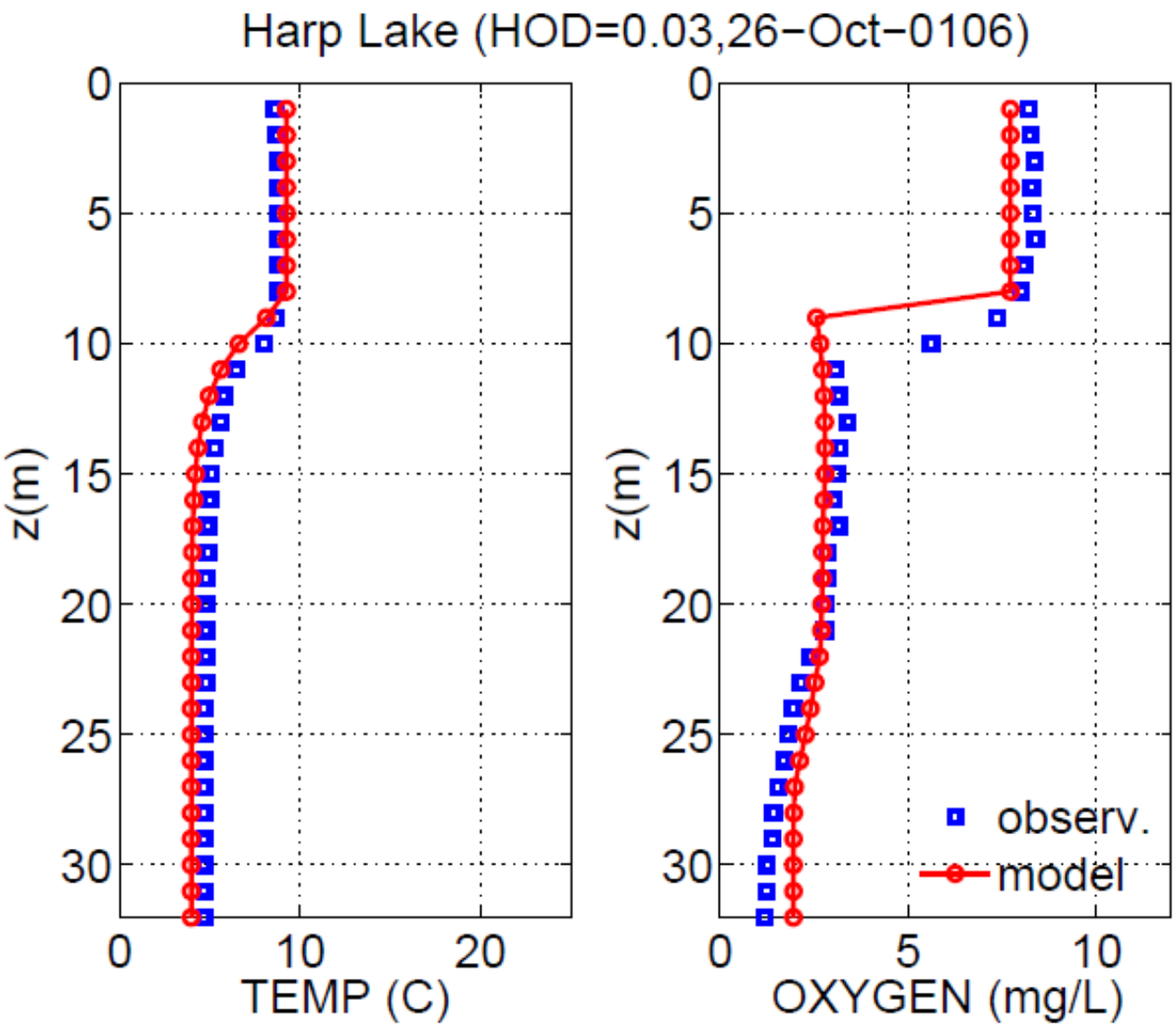
Harp Lake: Results



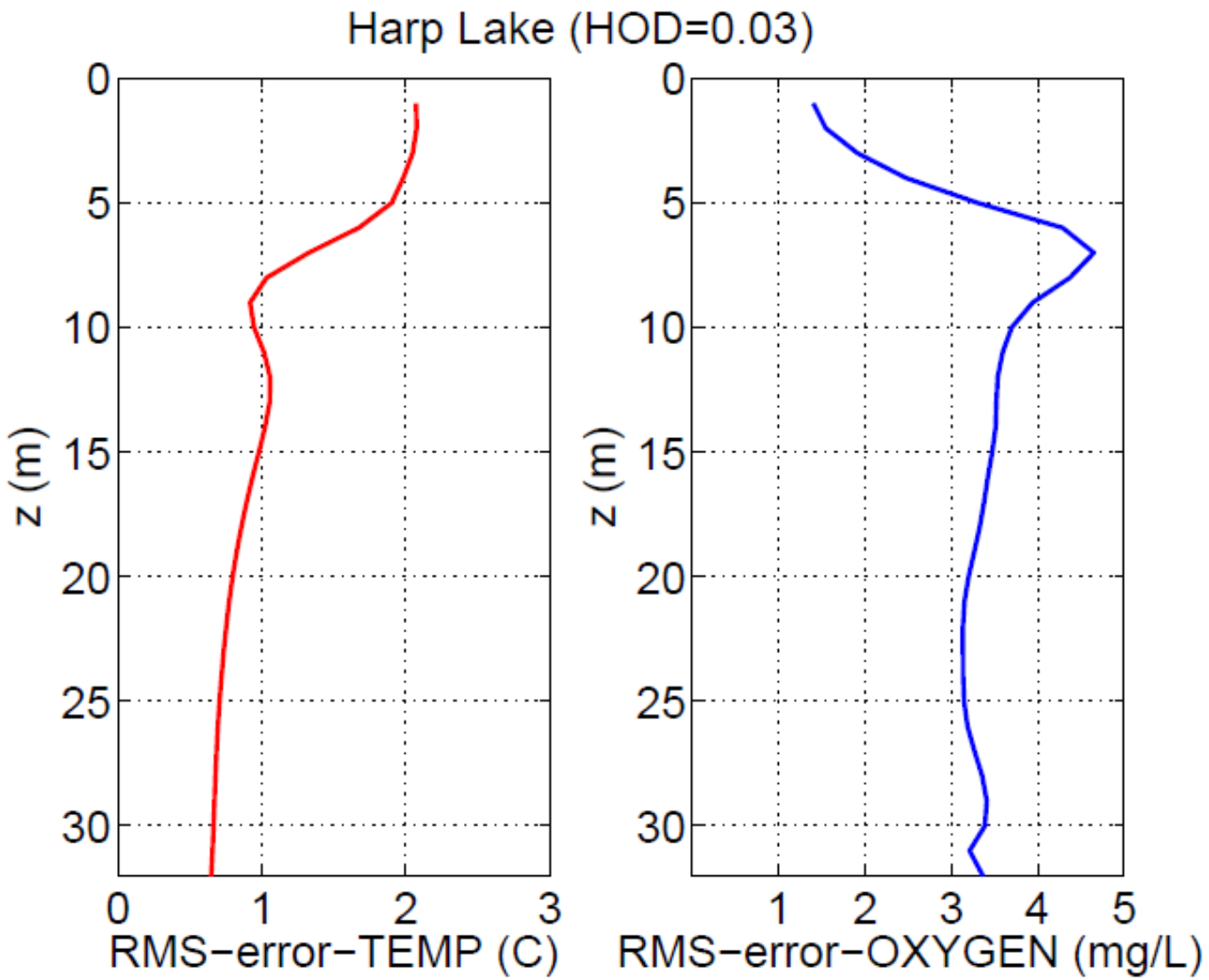
Harp Lake: Results



Harp Lake: Results



Harp Lake: Results



Eagle Lake: model set-up

Maximum depth: 30 m

Square root of the surface are: 250 m

Extinction coefficient: 0.3 1/m

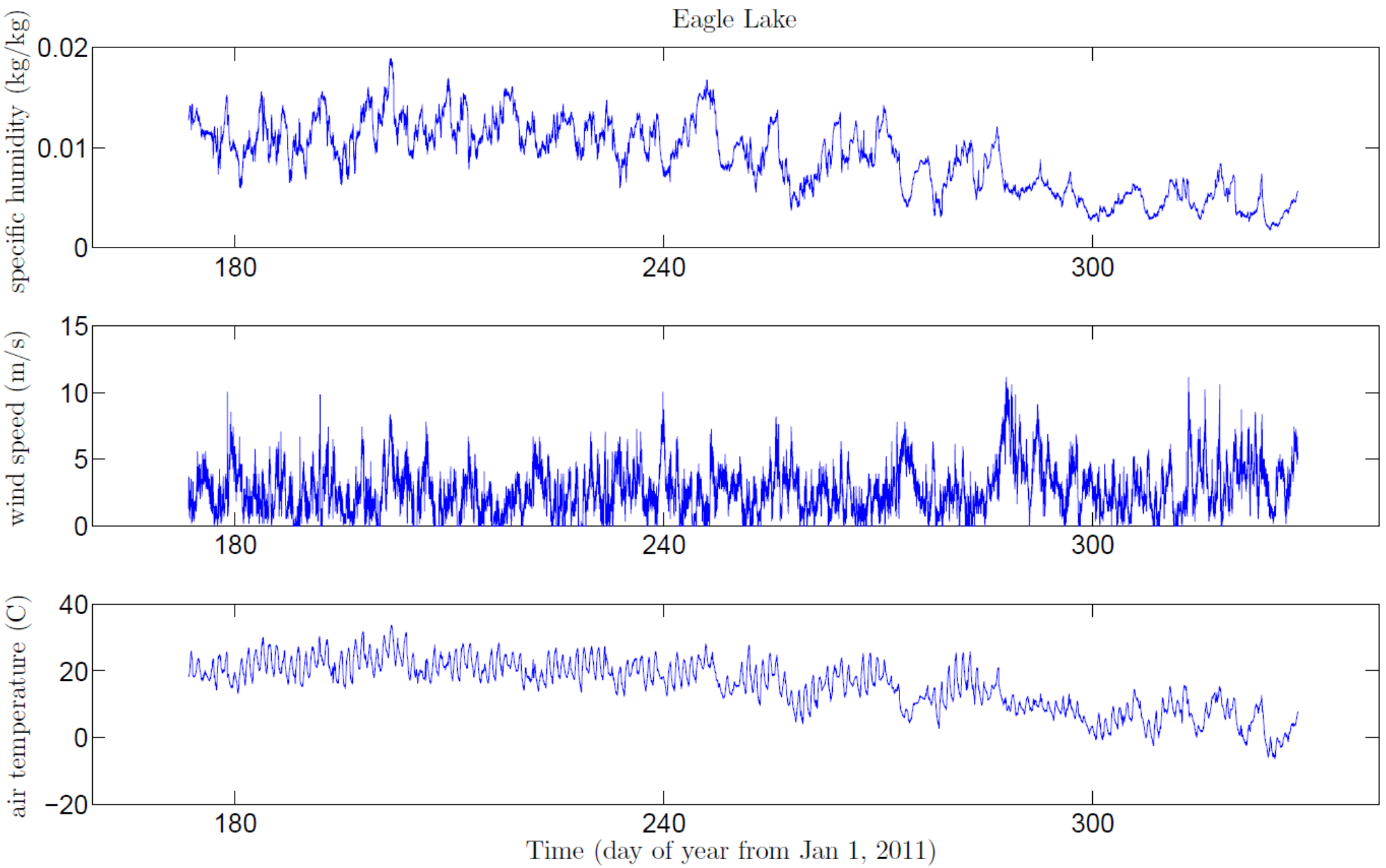
Simulations time: day 173-328, 2011

Optimum HOD: 0.085

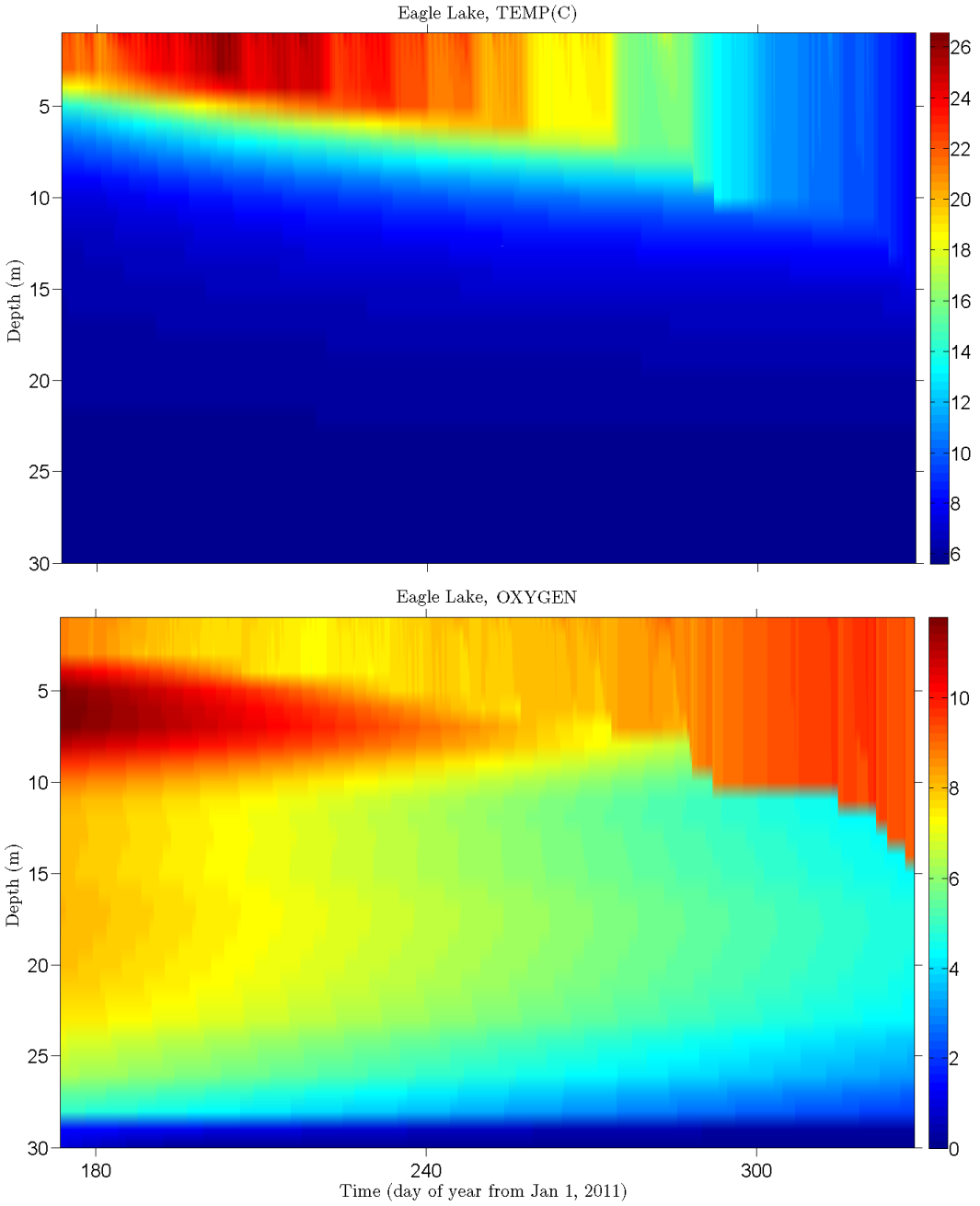
Grid spacing: 1 m

Time steps: 10 min

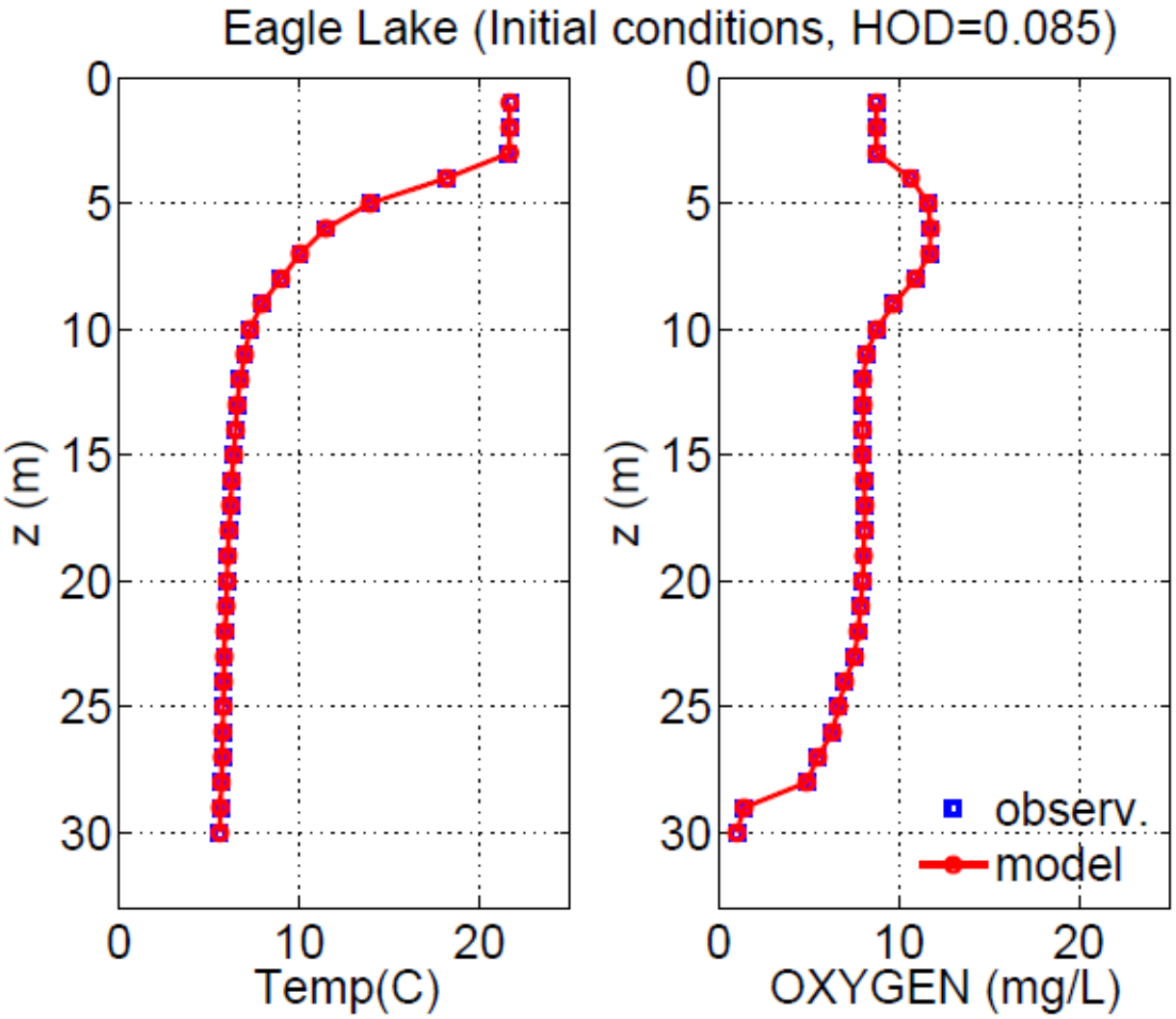
Eagle Lake: Meteorology



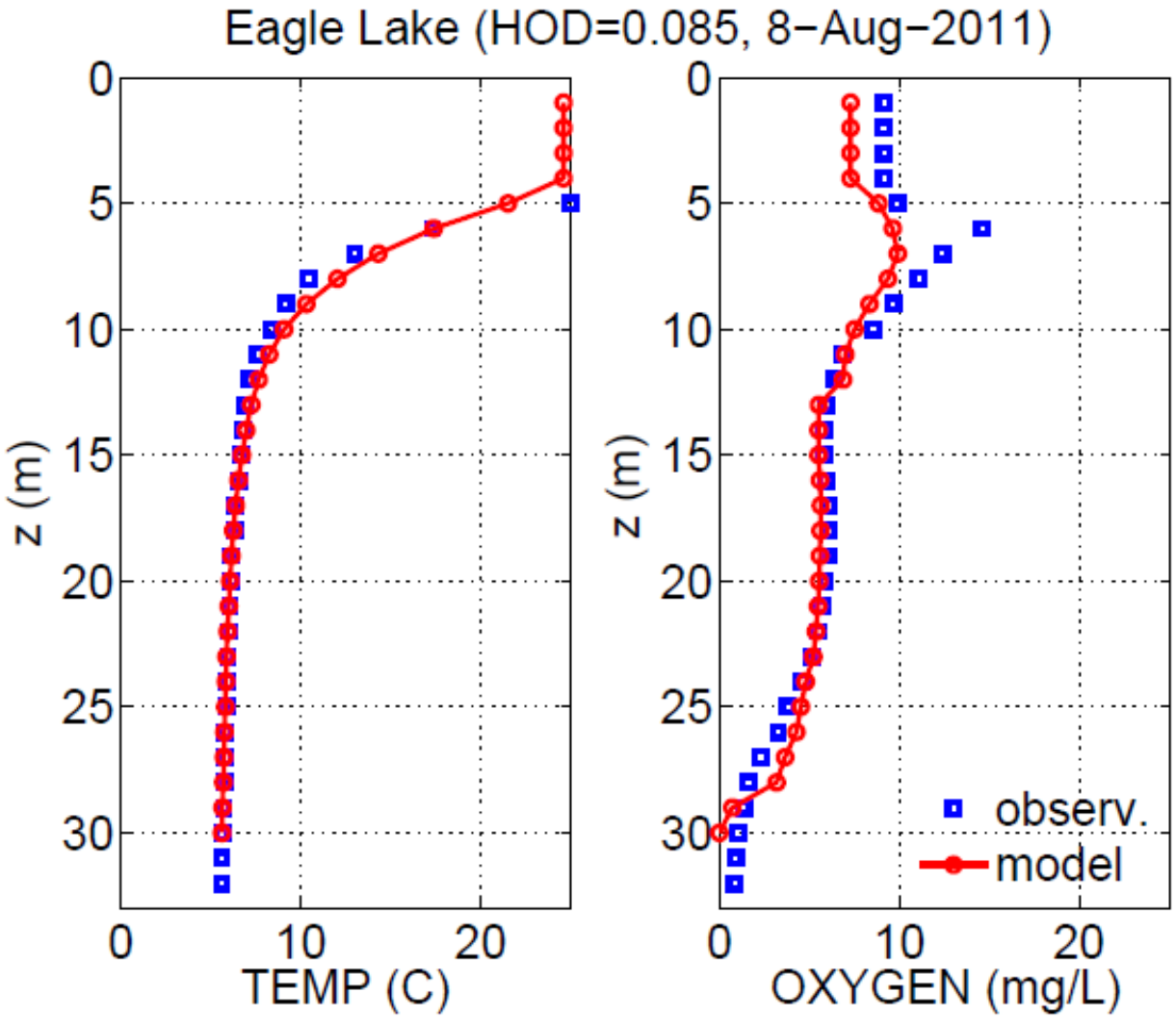
Eagle Lake: Results



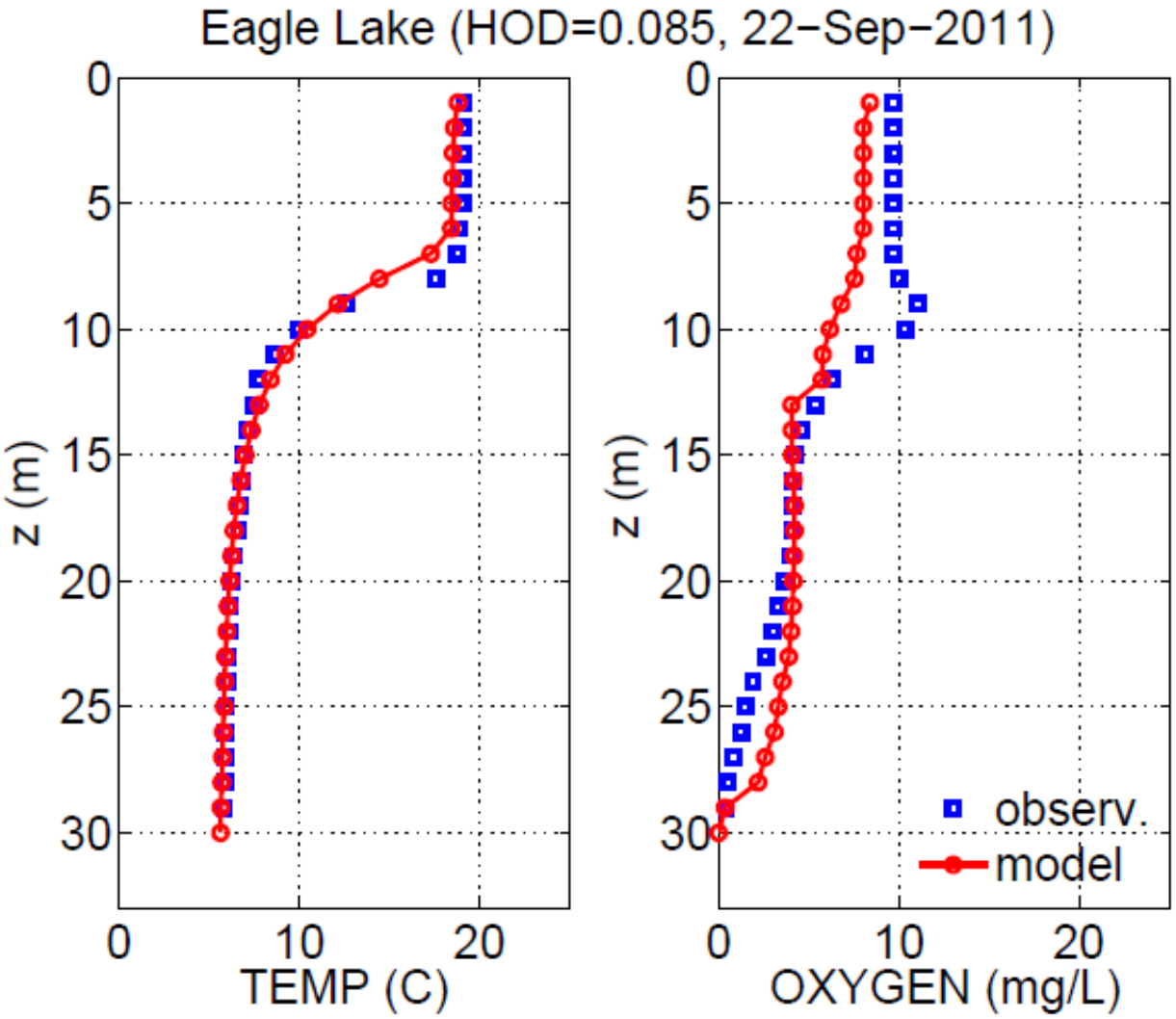
Eagle Lake: Results



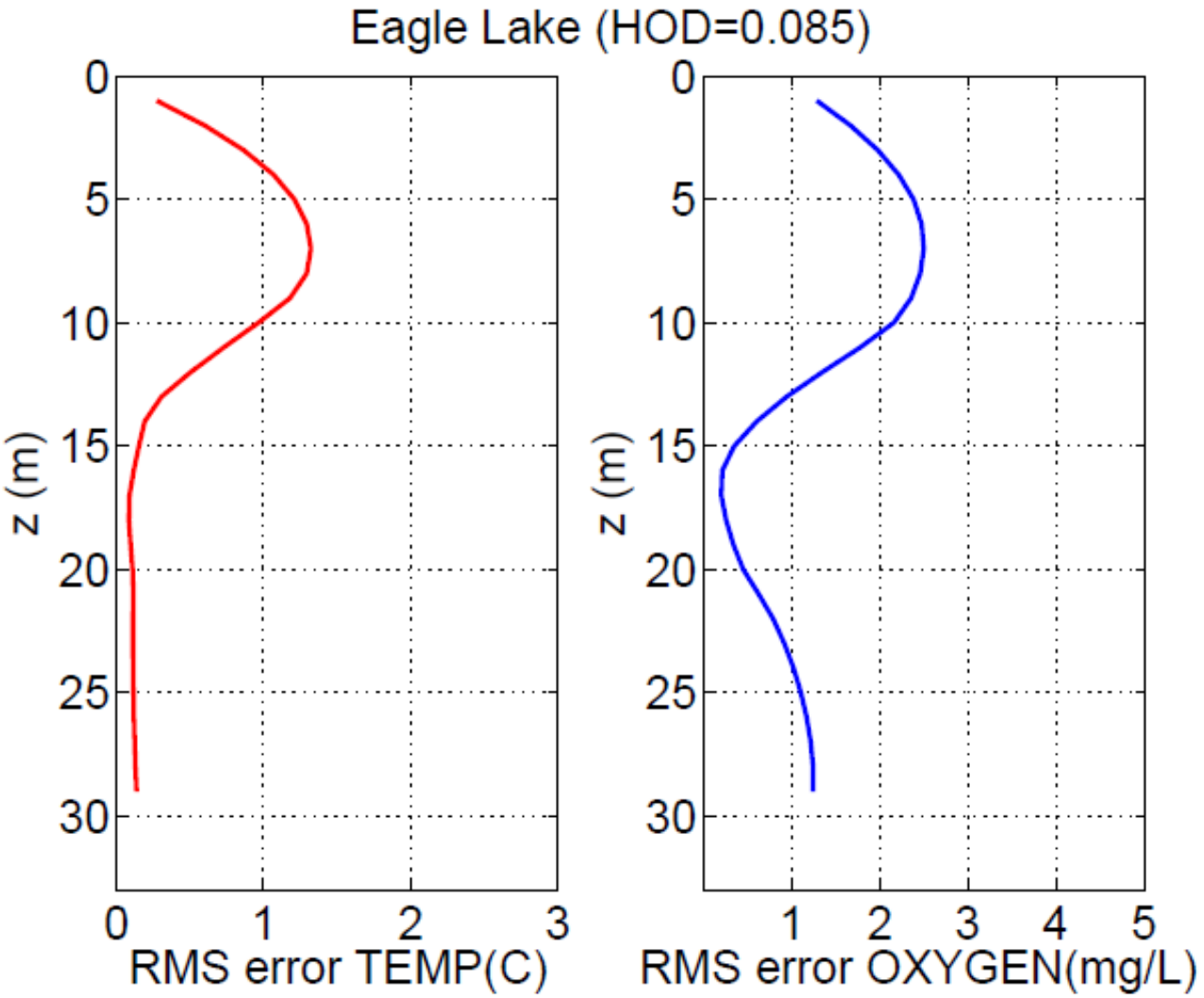
Eagle Lake: Results



Eagle Lake: Results



Eagle Lake: Results



Summary and Future works

- Summary
  - *Temperature and DO for two Lake Trout lakes are validated.*
  - *The model can predict temperature and DO with RMS error <2 °C and <4.5 mgL^{-1}, respectively.*

- Future works
  - *Modification of HOD and bottom stress*
  - *Validating the model against DO reconstructions from the sediment cores*
  - *Predicting future DO concentrations in Canadian Lake Trout lakes under future climate change scenarios.*

Thank you