First Steps of a Lake Model Intercomparison Project : lakeMIP

BOREAL ENVIRONMENTAL RESEARCH
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Outline

- Introduction
- An overview of one-dimensional lake model
- Setup of model simulations
- Discussion
  - the discussion of the Sparkling Lake experiment results
  - the discussion of surface temperature simulation of Lake Michigan
- Results
- Next work

Introduction

Lake Model Intercomparison Project (LakeMIP)

- The first goal is to assess the range of applicability of existing one-dimensional model formulations and find the key physical process in lake models
- The second goal is to know the impacts of lakes on regional scale weather and climate using coupled lake-atmosphere models

An overview of one-dimensional lake model

Table 1

Bulk model	FLake	two layer similarity approach
k-ε turbulence closure model	LAKE Simstrat	$\frac{\partial k}{\partial t}=\frac{1}{A}\frac{\partial}{\partial z}\left(Av_k\frac{\partial k}{\partial z}\right)+P+P_{seiche}+B-\varepsilon$ $\frac{\partial \varepsilon}{\partial t}=\frac{1}{A}\frac{\partial}{\partial z}\left(Av_e\frac{\partial \varepsilon}{\partial z}\right)+\frac{\varepsilon}{k}(c_{\varepsilon 1}(P+P_{seiche})+c_{\varepsilon 3}B-c_{\varepsilon 2}\varepsilon)$
Eddy diffusion model	Hostetler Minlake	$K^*+(L\downarrow-L\uparrow)=Q_H+Q_E+Q_g+(1-\beta)K^*$ $\frac{dT}{dt}=\frac{d}{dz}\left[(k_m+k_e)\frac{dT}{dz}\right]+\frac{1}{C}\frac{dS}{dz}$

Setup of model simulations

Table 2

optical parameters	extinction coefficient, albedo
bottom temperature	a zero heat flux FLake: self-similarity approach to get bottom heat flux LAKE: heat transfer equation
lake bathymetry	constant Simstrat, Minlake: lateral sizes of lake
output	hourly Minlake: daily

The discussion of the Sparkling Lake experiment results

Source	Mean (min, max)	Correlation with measured data (*r*)
FLake	9.75 (0, 27.10)	0.988
Hostetler	9.59 (–0.01, 27.49)	0.995
LAKE	9.39 (–0.26, 25.71)	0.988
MINLAKE96	9.58	–
Measurements	9.41 (–3.87, 27.00)	–

Table 3 Statistics for the time series of surface temperature in Sparkling Lake intercomparison experiment (2002-2005)

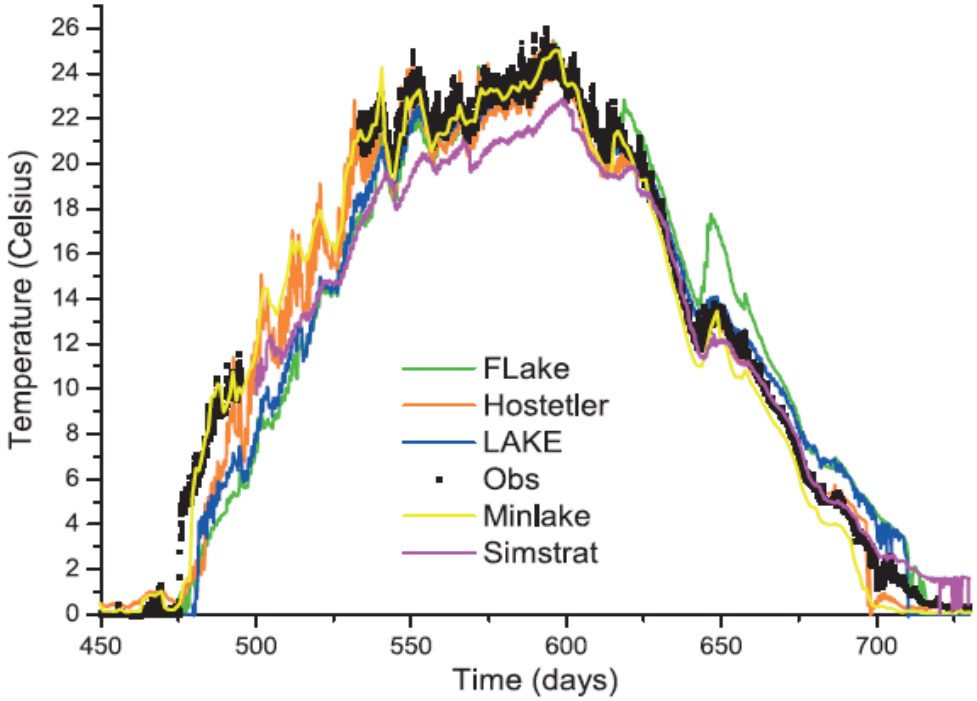


Fig.1 Time series of Sparkling Lake modeled and observed water surface temperatures in 2003

The discussion of the Sparkling Lake experiment results

Table 4 Statistics for the time series of sensible heat flux to the atmosphere in Sparkling Lake intercomparison experiment (2002-2005)

Source	Mean (min, max)	Correlation with measured data (*r*)
FLake	12.55 (–410.17, 249.10)	0.735
Hostetler	12.88 (–220.86, 368.95)	0.712
LAKE	13.23 (–219.91, 364.58)	0.611
MINLAKE96	7.38	–
Measurements	12.20 (–246.80, 140.00)	–

Table 5 Statistics for the time series of latent heat flux to the atmosphere in Sparkling Lake intercomparison experiment (2002-2005)

Source	Mean (min, max)	Correlation with measured data (*r*)
FLake	47.13 (–177.60, 334.12)	0.810
Hostetler	48.44 (–79.15, 385.15)	0.832
LAKE	41.98 (–113.59, 341.00)	0.765
MINLAKE96	43.87	–
Measurements	34.81 (–88.70, 224.90)	–

The discussion of the Sparkling Lake experiment results

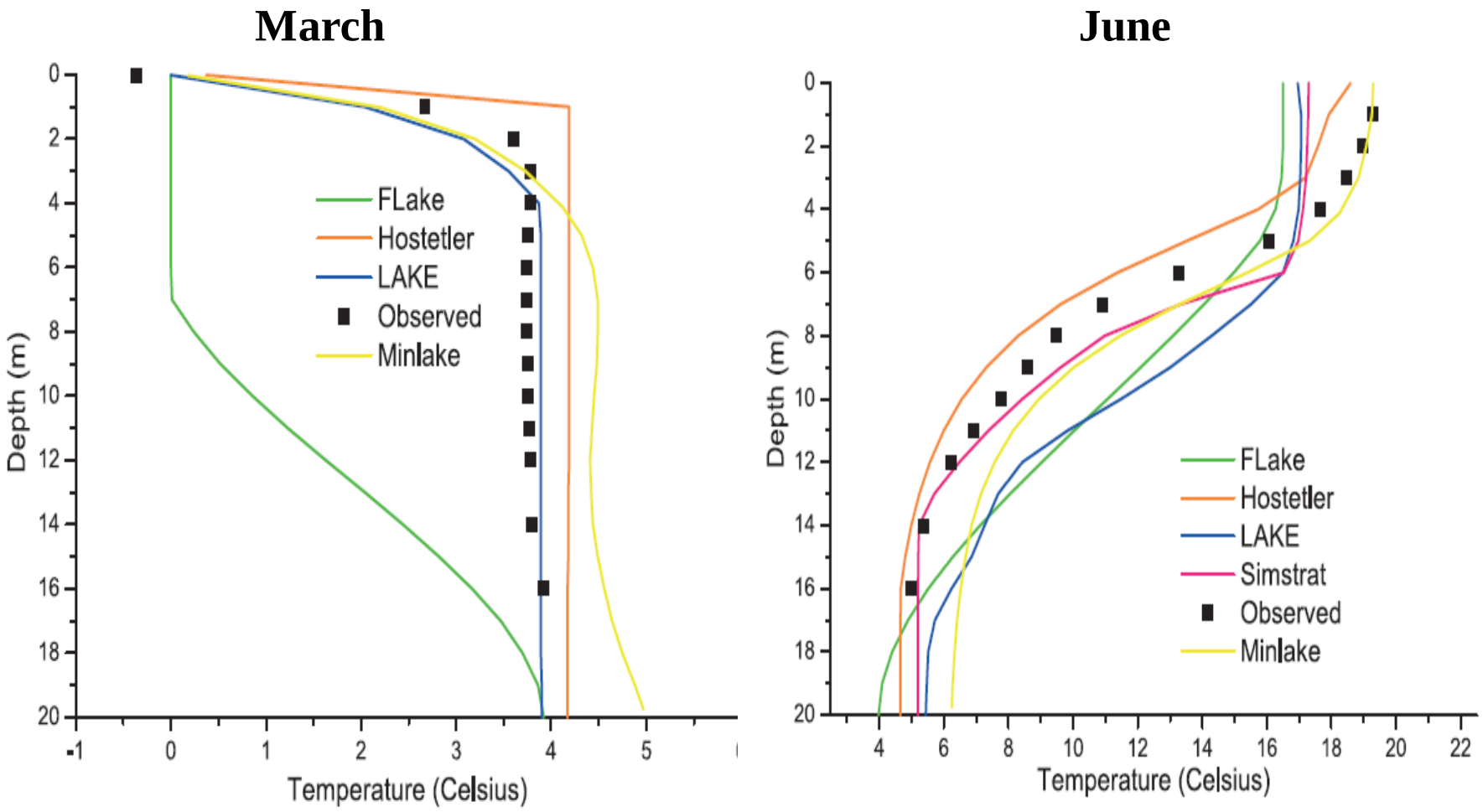


Fig 2 Observed and simulated mean monthly temperature profiles in Sparkling Lake for 2003

Surface temperature simulation of Lake Michigan

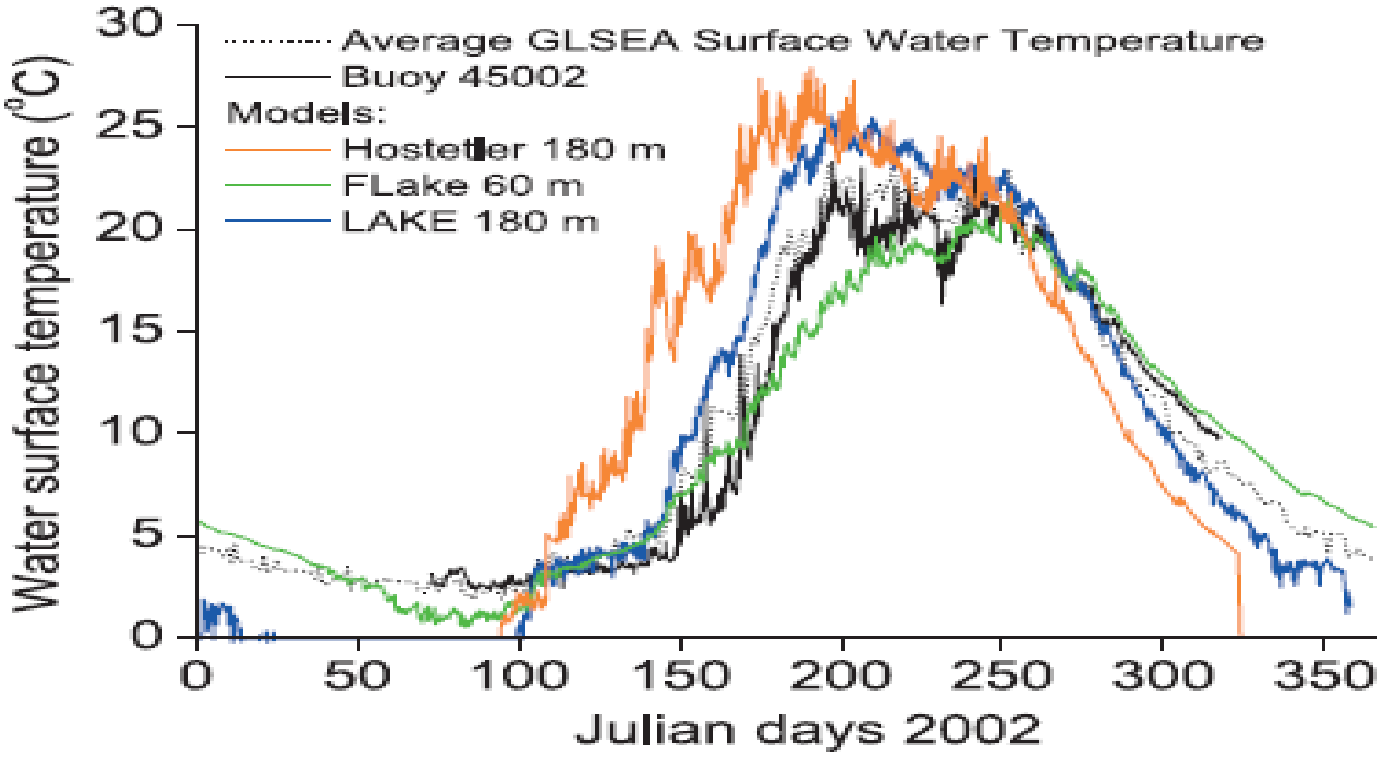
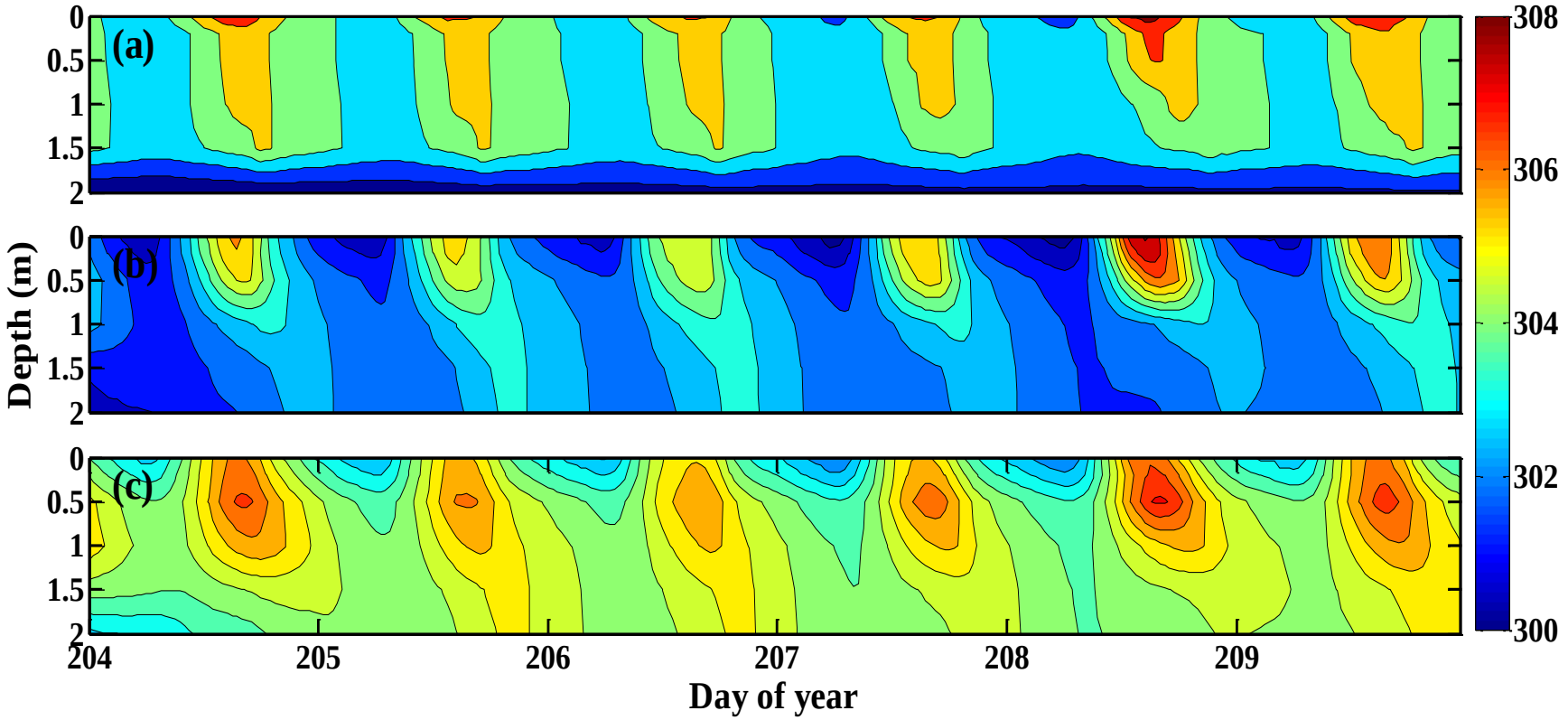


Fig 3 Observed and simulated surface temperature of Lake Michigan

Results

- For Sparkling Lake, one-dimensional models have a good performance to reproduce the surface temperature. However, in terms of sensible and latent heat fluxes, correlation coefficients range from 0.6 to 0.8. The features of monthly vertical temperature profiles are well captured by the models.
- The numerical experiment with Lake Michigan shows the large discrepancy between observed surface temperature and those modeled by one-dimensional models, and three-dimensional processes may be needed.

Next work



Temperature comparison for day 204-209(2012) :

(a) observed, (b) tuned by Deng, (c) tuned by Piao.

Next work

- Sensitivity tests of DPK site, and make a comparison between DPK and BFG. Then read more literature and gain more knowledge about Sensitivity tests

Thank you