Study of unstable atmosphere in ice-free period over Ngoring lake in the Tibetan Plateau

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Outline

1. Motivation
2. Study area , observations and models
3. Unstable atmosphere in spring and early summer
4. Factors for the unstable atmosphere
5. Regional climate effect of Ngoring lake
6. Conclusions

Motivation

- **Heating over the Tibetan Plateau affects Asian and remote climate.**
- **Lakes significantly affect local climate.**
- **Thousands of lakes distribute in the Tibetan Plateau.**
- **Few studies focused on lake effects in the Tibetan Plateau**

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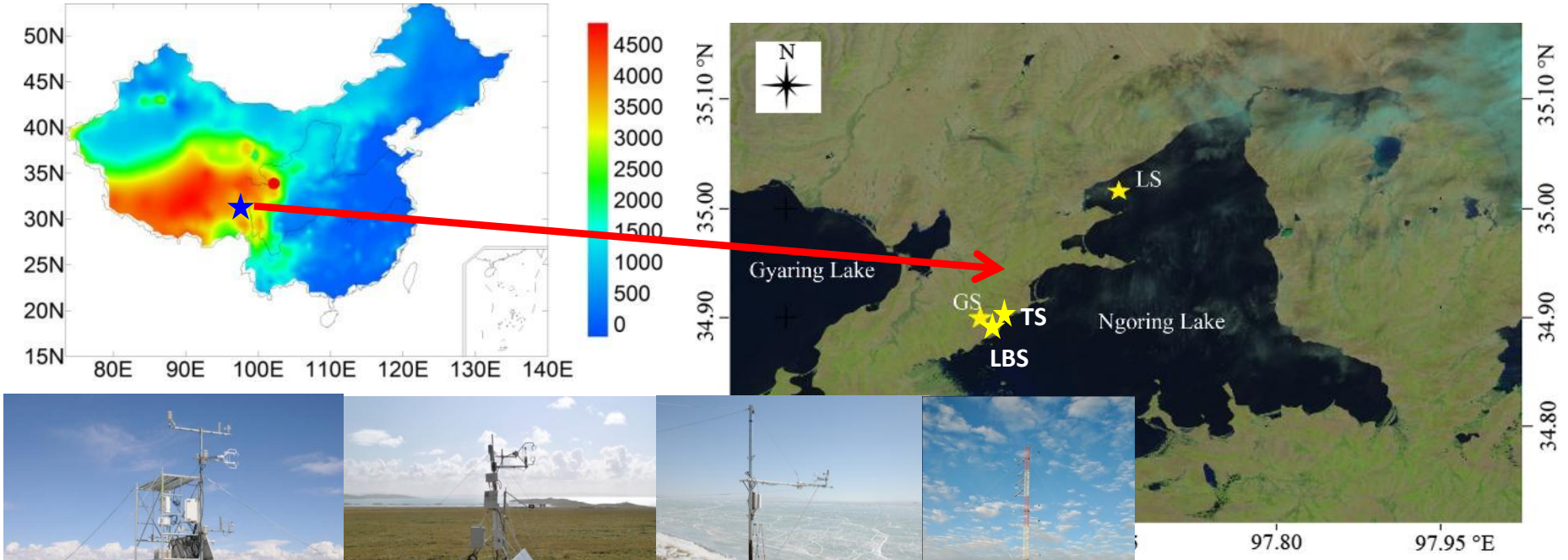
Study area and observations



Area: 610 km^2
Mean depth: 17 m
Max depth:32 m
Elevation:4274 m
Length: 32 km
Width: 31 km

Stations:

LS: Lake Station, terrain height: 4274m,
observation: 2011.6.28-2011.12.8, 2012.6.7-2012.10.12, 2013.5.12-2013.11.6.

GS: Grassland Station, terrain height: 4282m, built on 2011.8.5

LBS: Lake Border Station, terrain height: 4282m, , built on 2012.10.12

TS: Tower Station, built in 2010.10

Observations

Broken instruments：1 CSAT3; 1 LI-7500 1 CNR-1; 1 CR3000; 3 CR1000; 2 HMP45C;2 HOBO for water temperature ; 1 device for lake level and water temperature ; 1 HOBO for lake level, etc.

Models

◆**Offline lake module,** almost same with that in the CLM (Community Land model) version 4.5 , except inputting with net solar radiation (Gu et al, 2013) rather than downward solar radiation

◆**Regional atmospheric model:** The WRF_CLM model (Weather Research and Forecasting model coupled with the CLM model version 3.5) were employed in the study.

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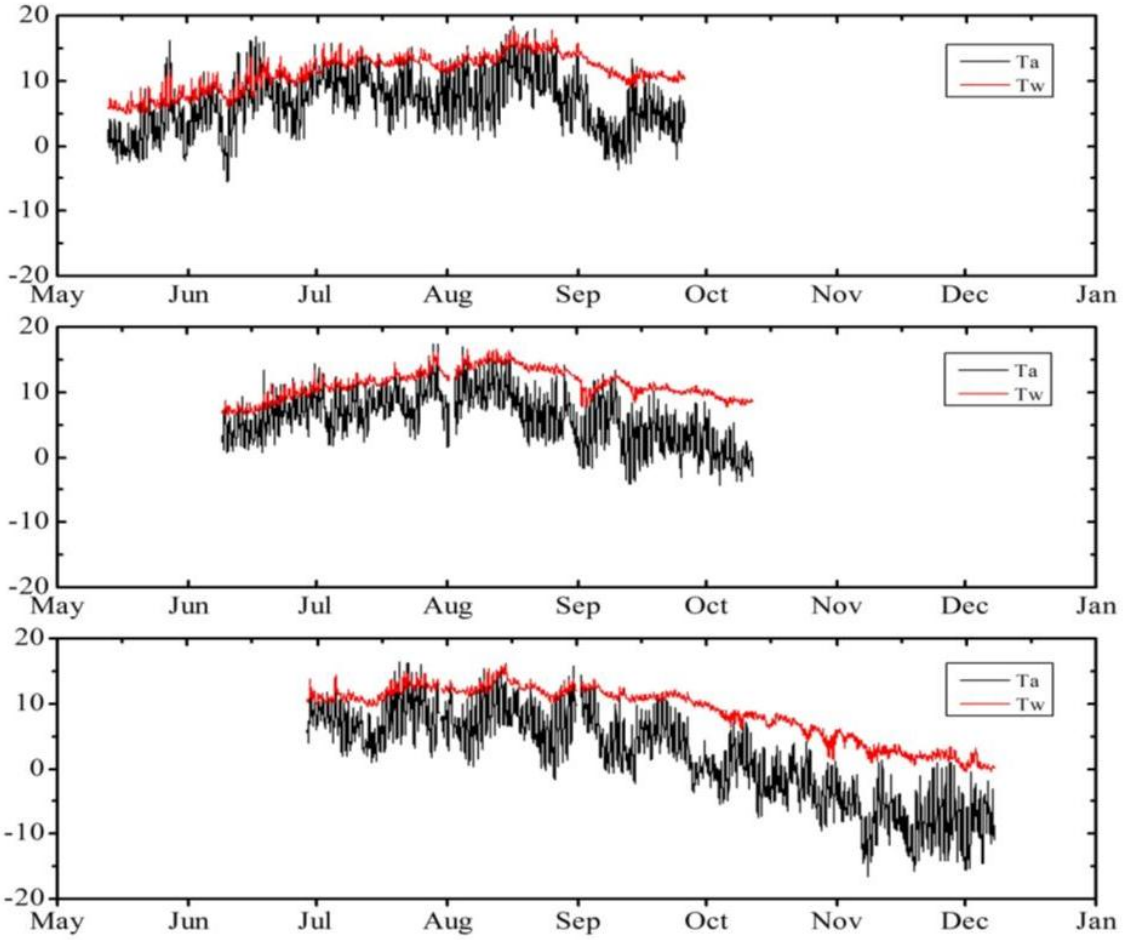
Observed unstable atmosphere in spring and early summer

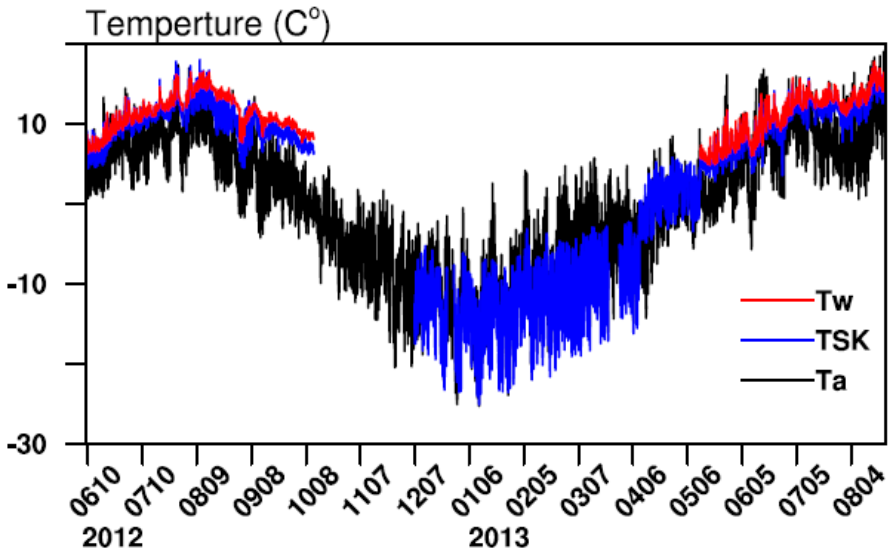


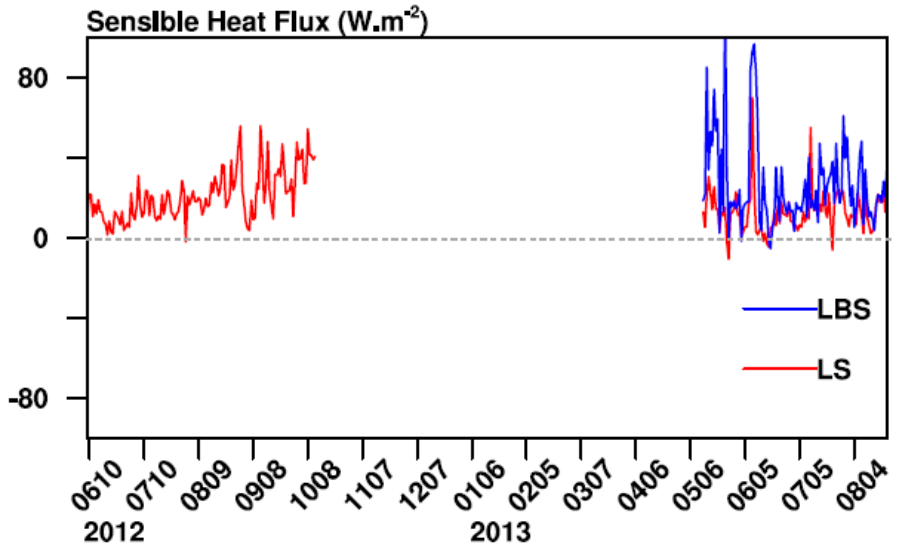
2013

2012

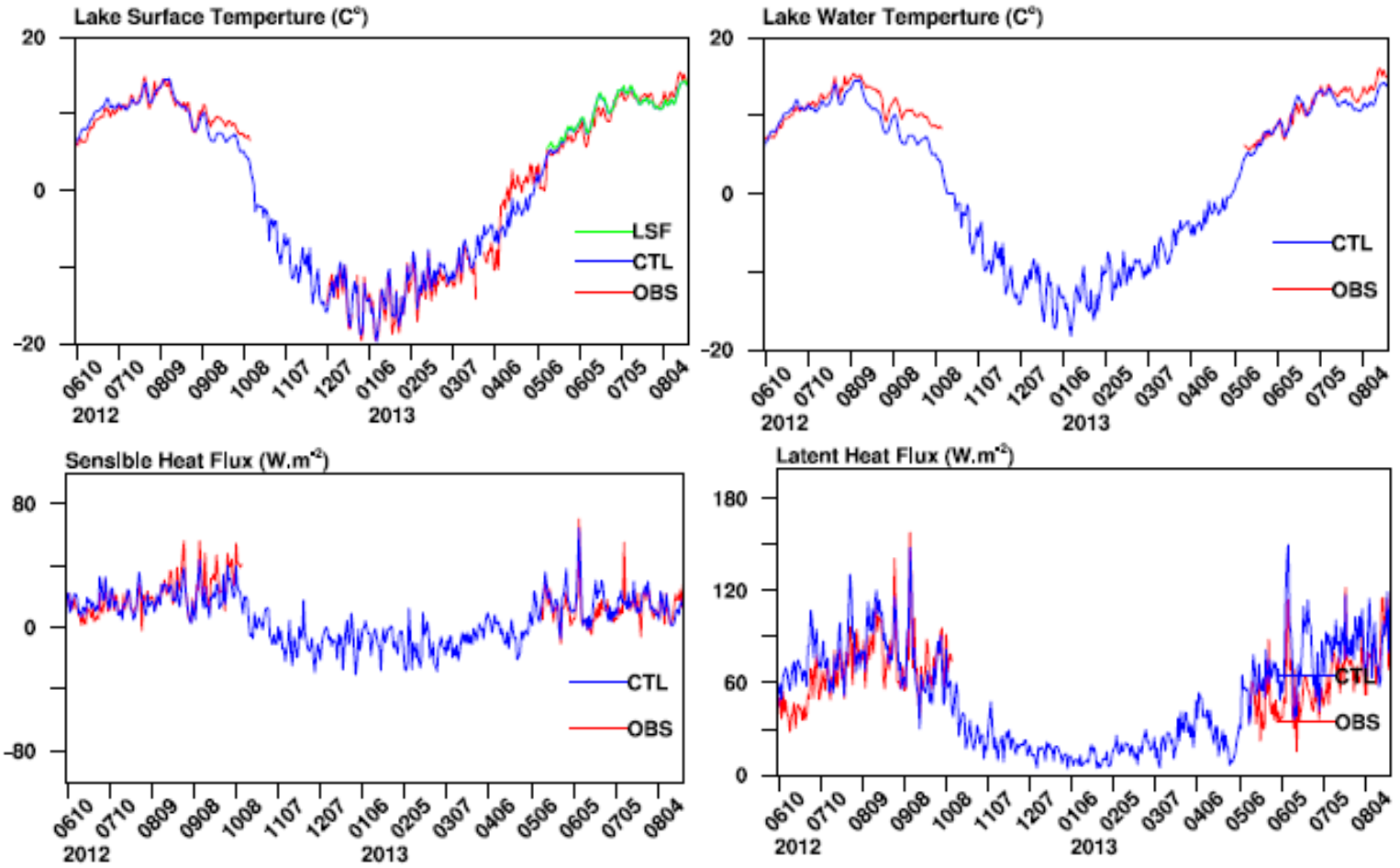
2011

Observed unstable atmosphere in spring and early summer

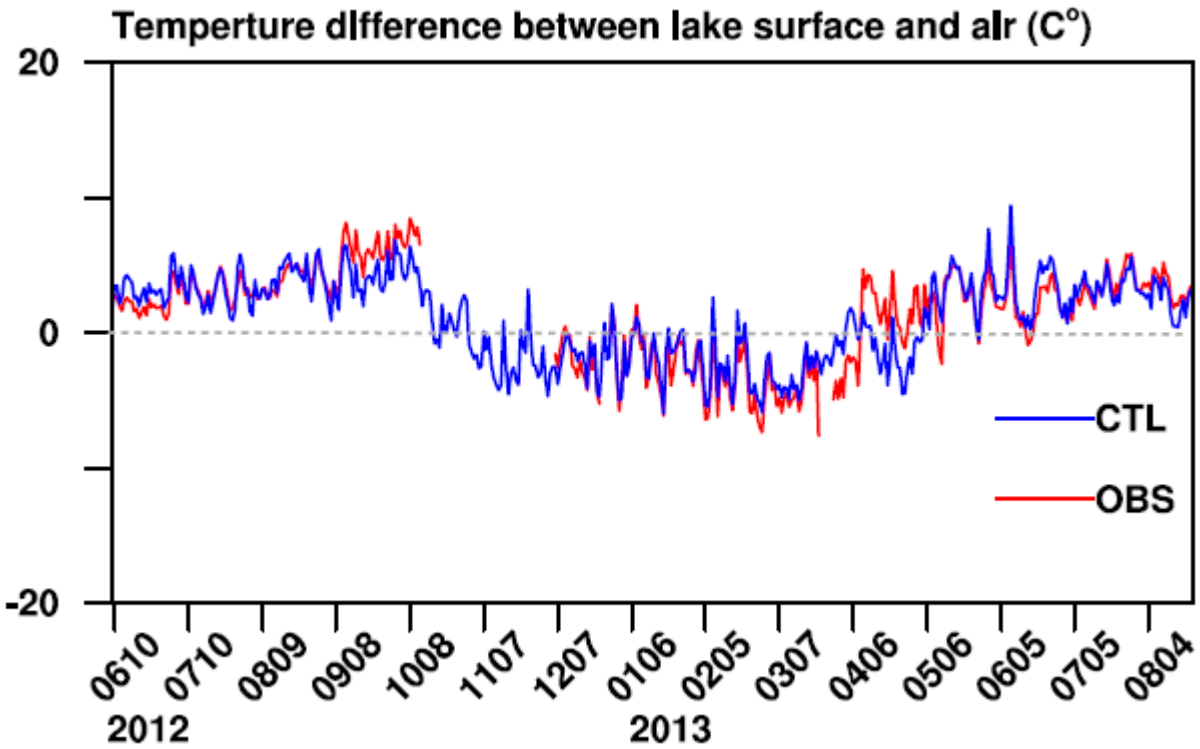




Simulation with offline lake module



Positive temperature difference between lake surface and atmosphere in ice-free period



The model could represent the temperature difference between lake surface and atmosphere in ice-free period.

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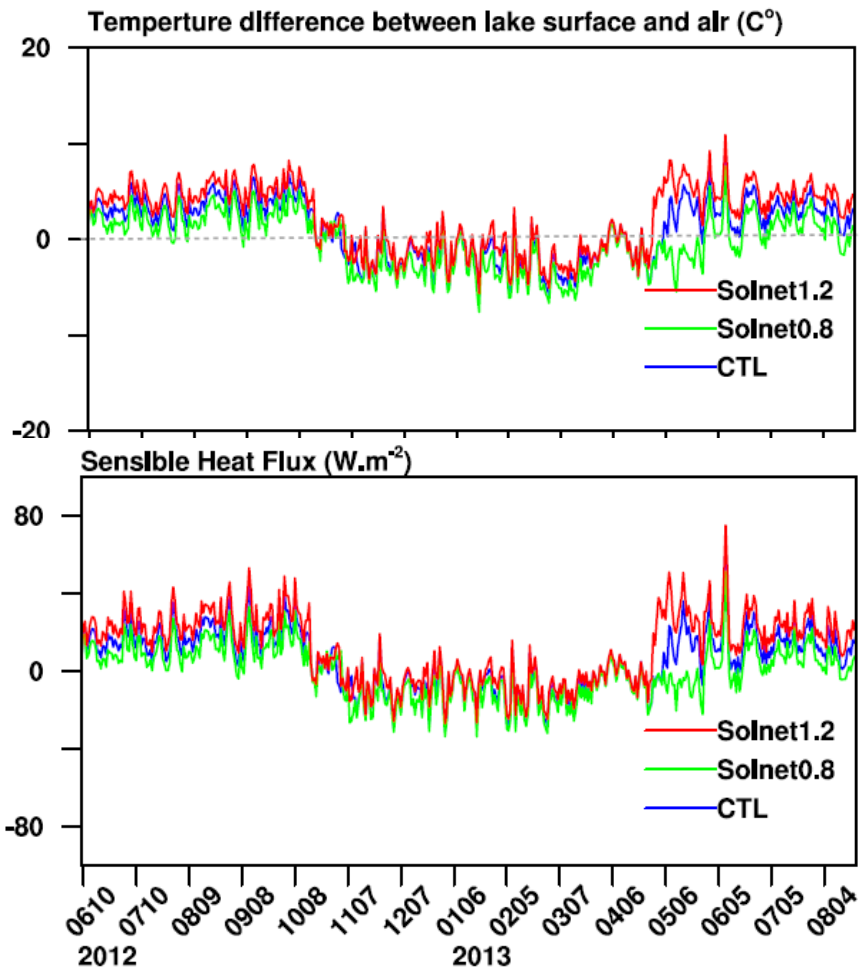
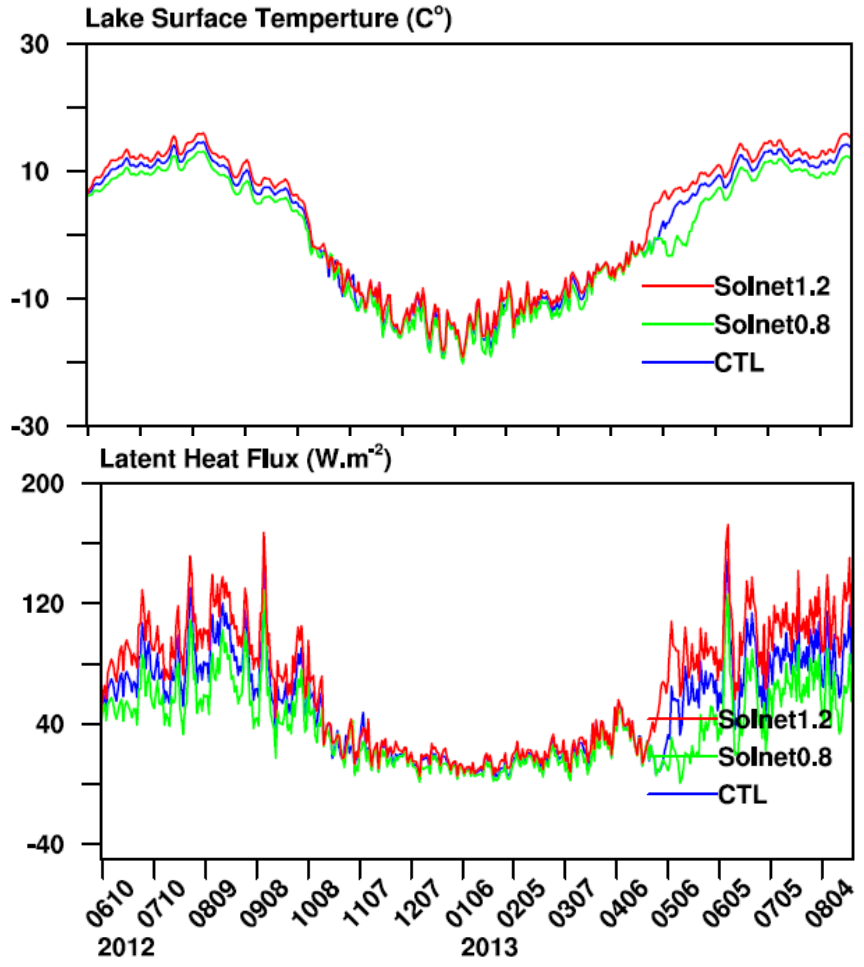
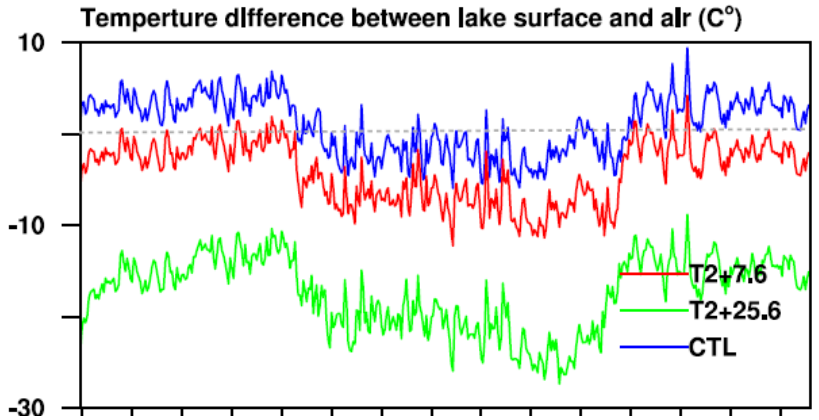
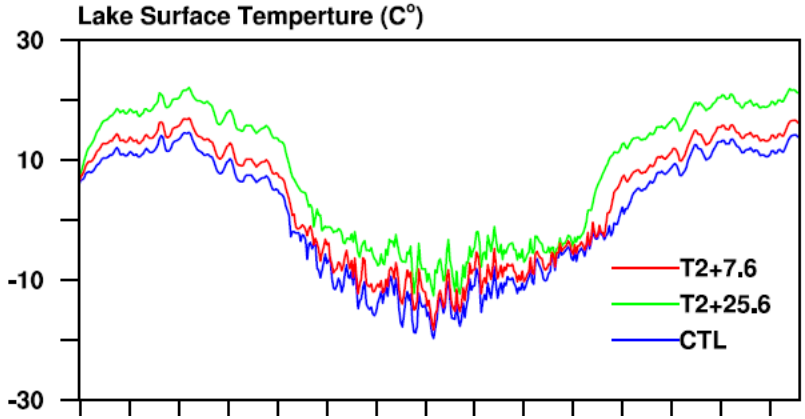
Effect of net solar radiation

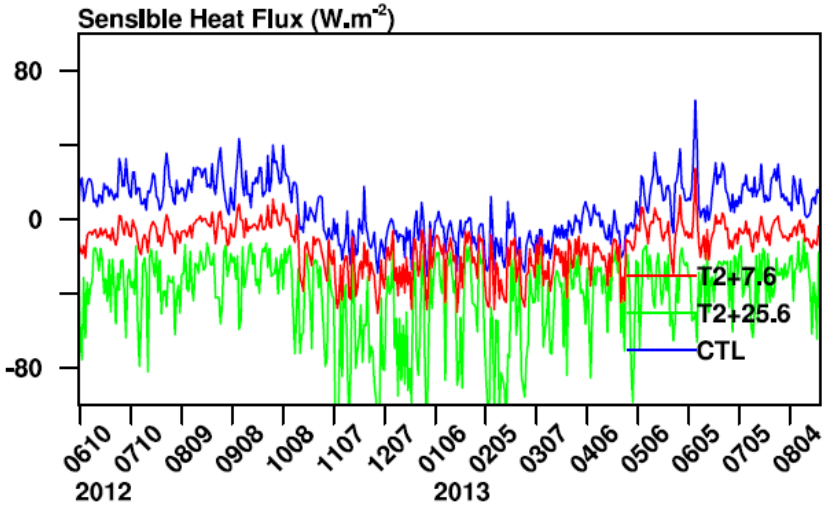


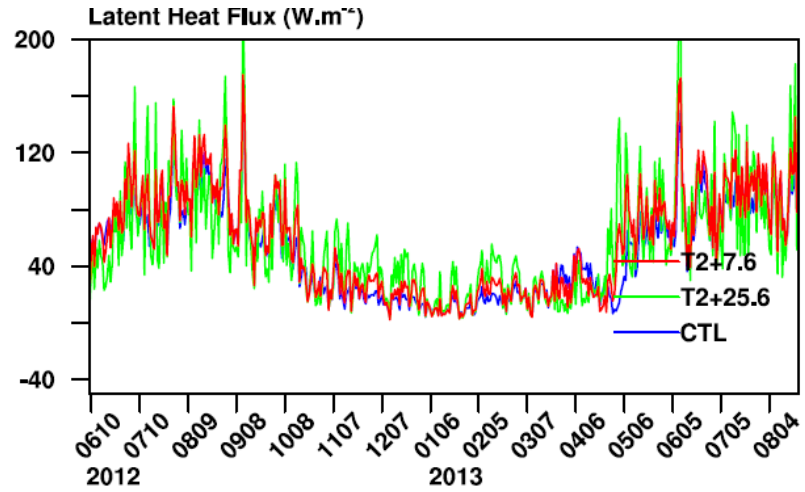


Effect of air temperature

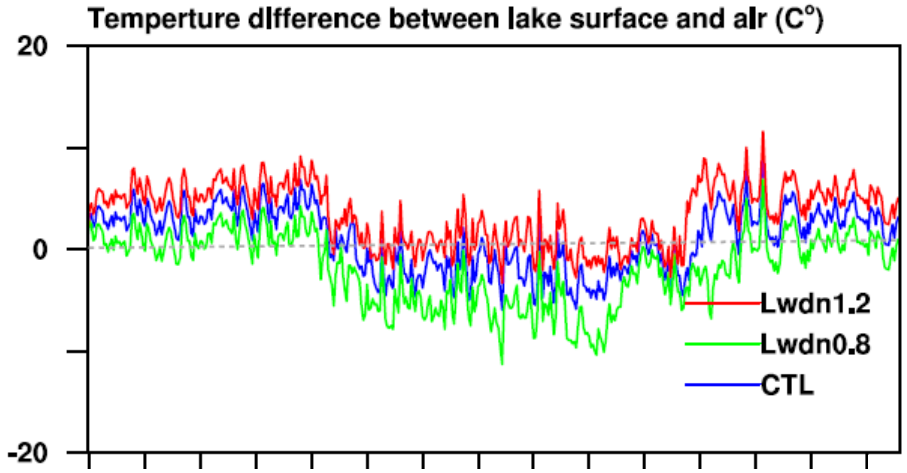


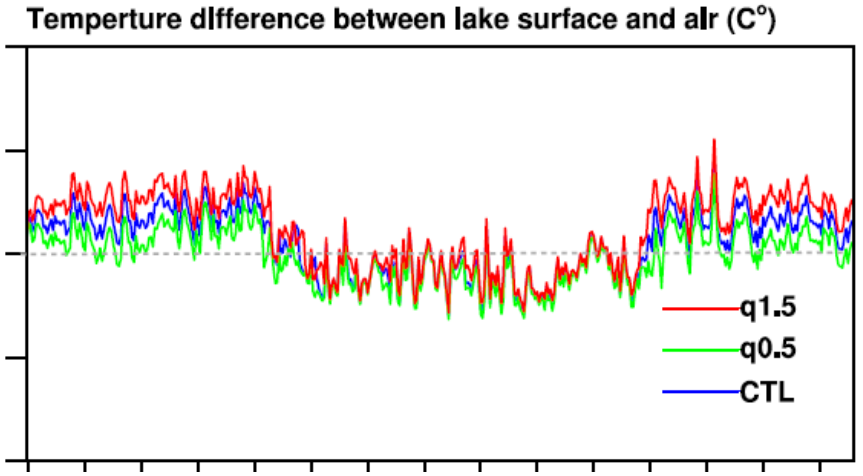


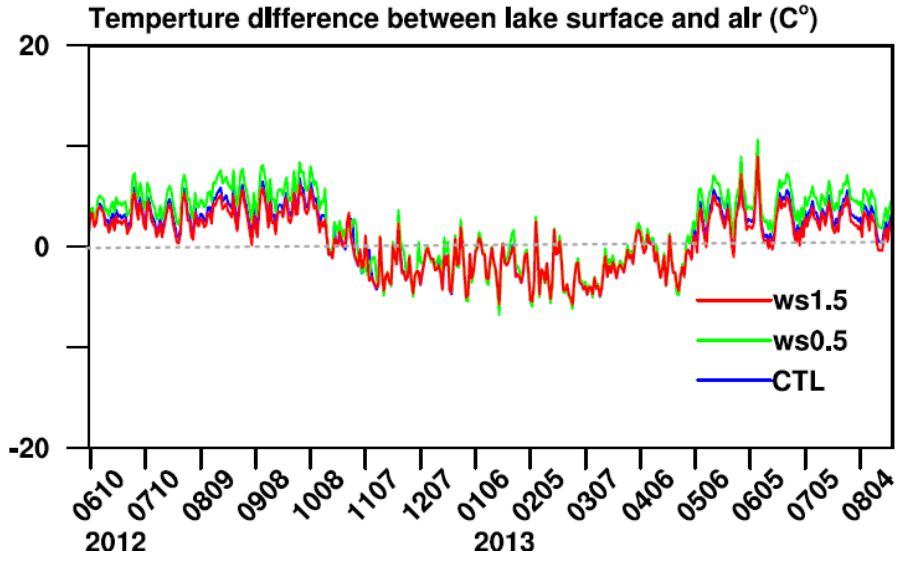


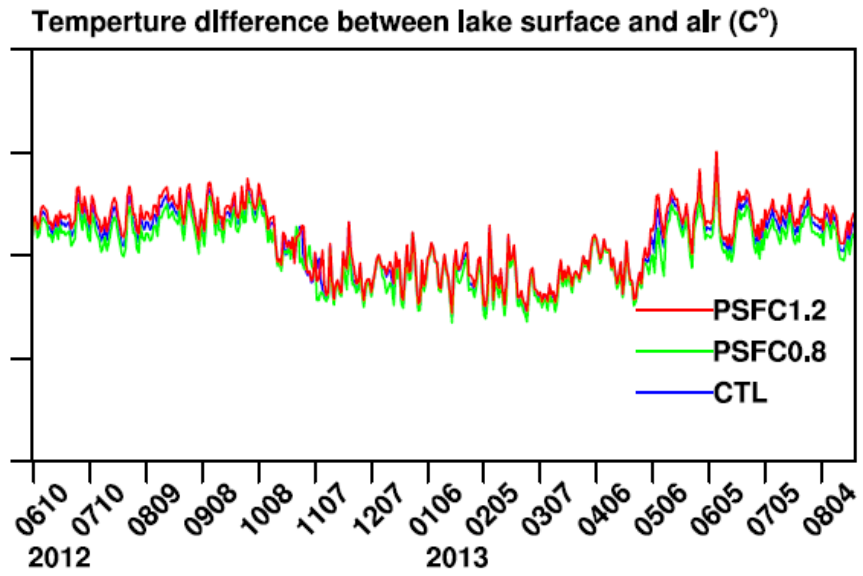


Effects of other forcing variables in ice-free period









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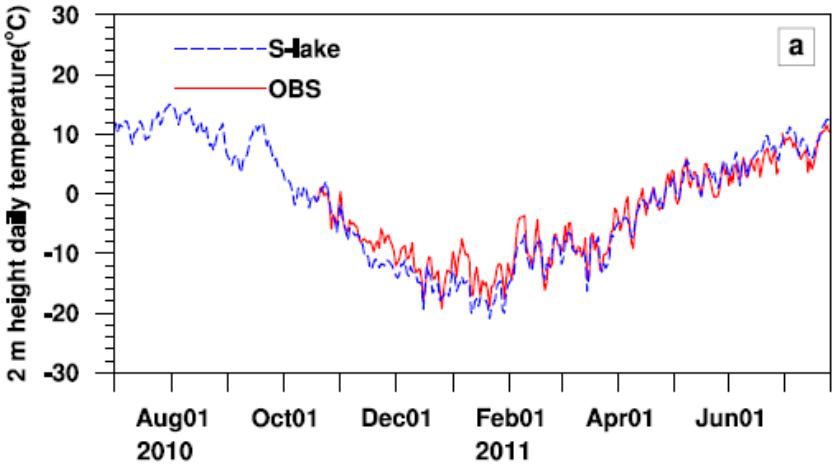
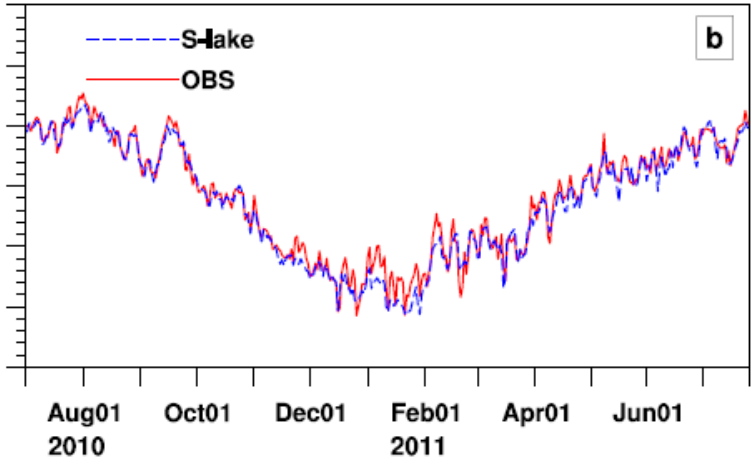
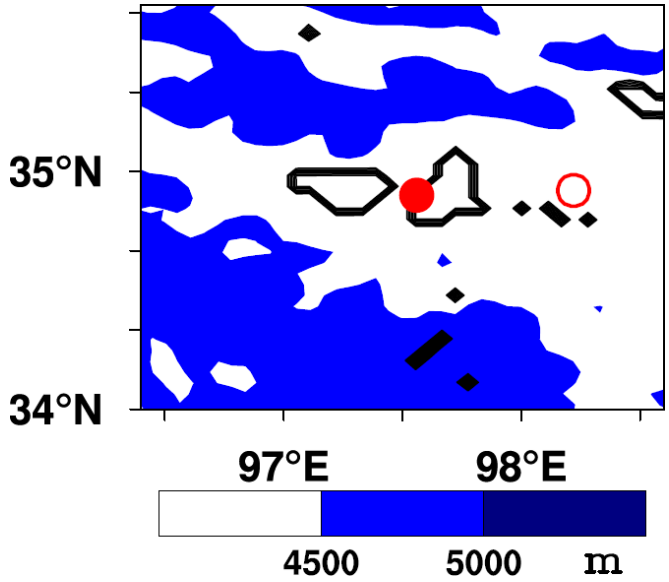
Observation and simulation with WRF-CLM

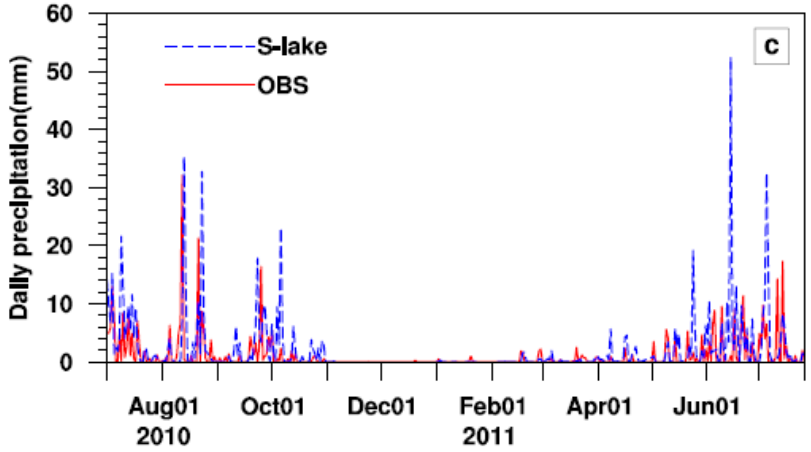
LBS



Maduo station







S-lake: simulation with lake.

RMSE between observation and simulation with and without lake

	T2 at Maduo	PCP at Maduo	T2 at LS	T2 at GS	T2 at TS	LSST at TS
S-lake	1.7	5.1	2.2	0.9	0.7	1.2
S-nolake	1.7	5.4	2.3	1.0	0.7	1.3

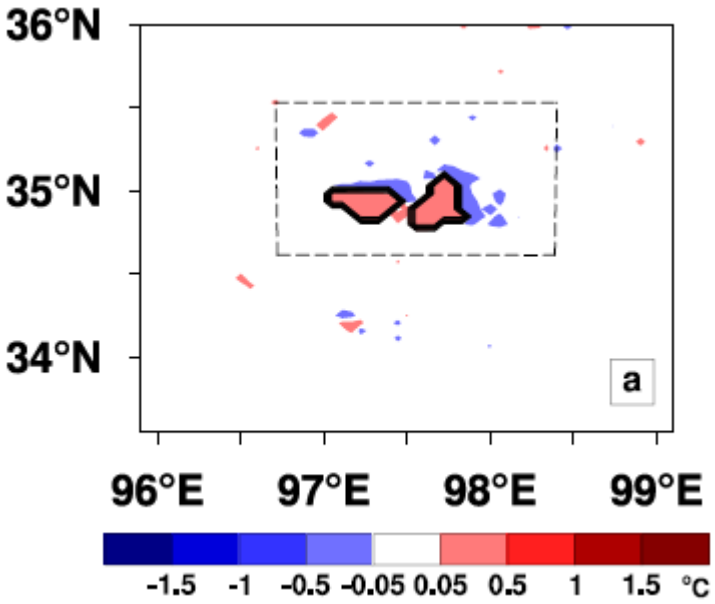
RMSE: Root mean square error.

S-nolake: simulation without lake.

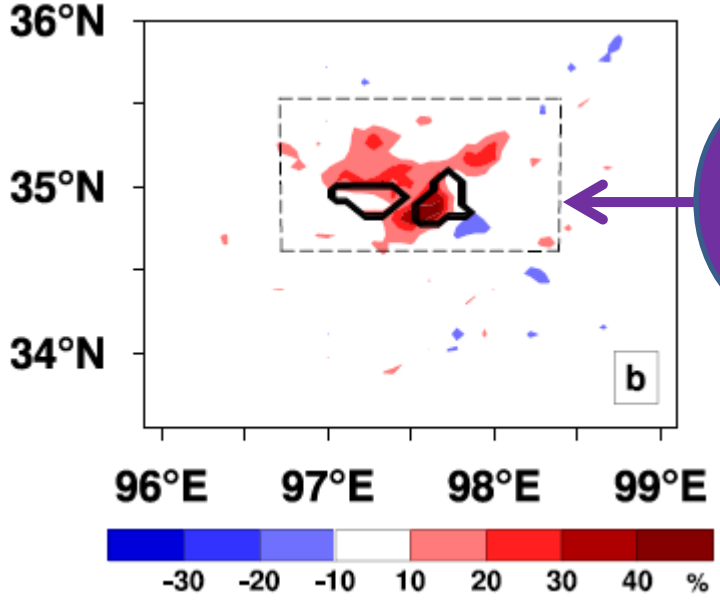
The experiment including lakes has better simulation.

Lake effect

Annual temperature difference between simulations with and without lakes



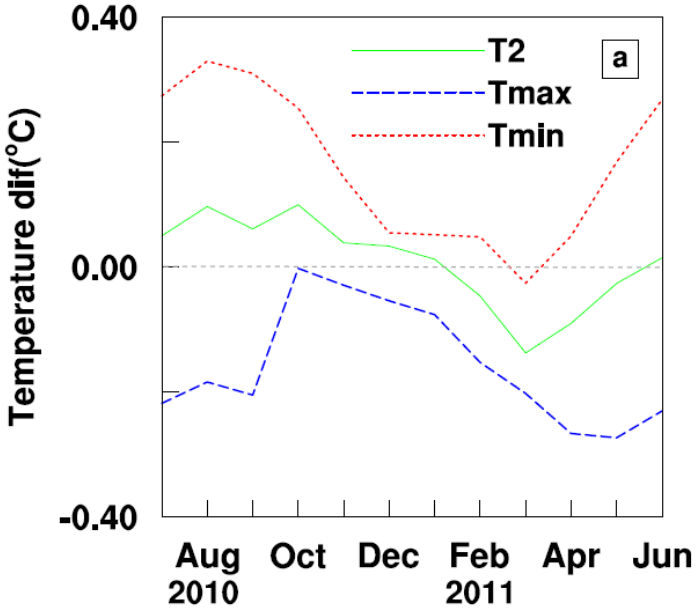
Annual precipitation difference between simulations with and without lakes



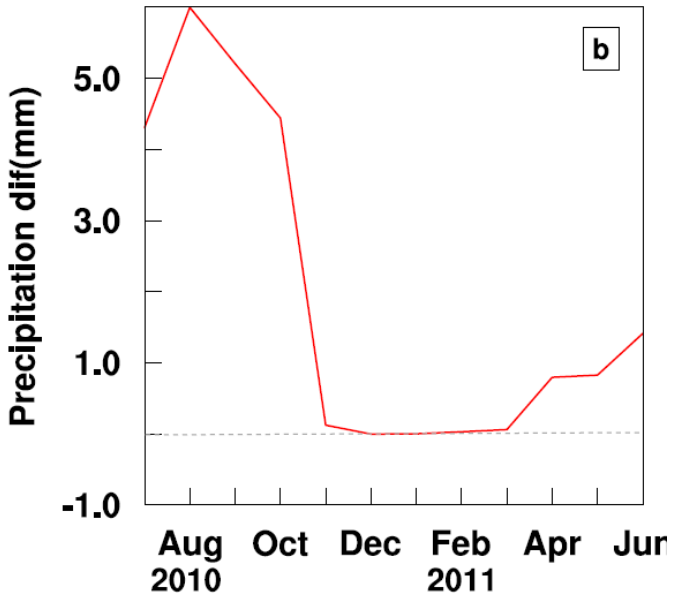
- **Annual averaged temperature over lakes is 0.05-0.5 ºC higher than that over land, and lakes decrease 0.05-0.5 ºC annual temperature of their nearby downwind land.**
- **Lakes could annually increase up to 49% precipitation over lake and nearby.**

Lake effect

Temperature difference between simulations with and without lakes



Precipitation difference between simulations with and without lakes



- ✓ Averagely, the lake is warm from June to January of next year compared to land . Lakes increase Tmin throughout the year except March, while the lakes have no warm effects on Tmax during the year.
- ✓ Lake will not decrease monthly precipitation. 86% increased annual precipitation by lake effect happens from July to October.

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Conclusions

- Three years' observation show that Ngoring Lake water was warmer than air over it in the ice-free period.

- The main contribution for the warmer temperature in spring and early summer is from the low air temperature owing to the high altitude.

- Averagely, the lake is warm from June to January of next year compared to land . Lakes increase *T*min throughout the year except March, while the lakes have no warm effects on *T*max during the year.

- Lake will not decrease monthly precipitation. 86% increased annual precipitation by lake effect happens from July to October.


Thanks for your attention!!!