Yale 耶鲁大学–南京信息工程大学大气环境中心
Yale-NUIST Center on Atmospheric Environment

Improving NCAR's lake model for predicting lake-air fluxes of energy and momentum of a lake site with submerged macrophytes

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Oct.11, 2013

Outlines

- ☐ Motivation
- ☐ Sensitivity test
- ☐ Results
- ☐ On-going work

Motivation 1

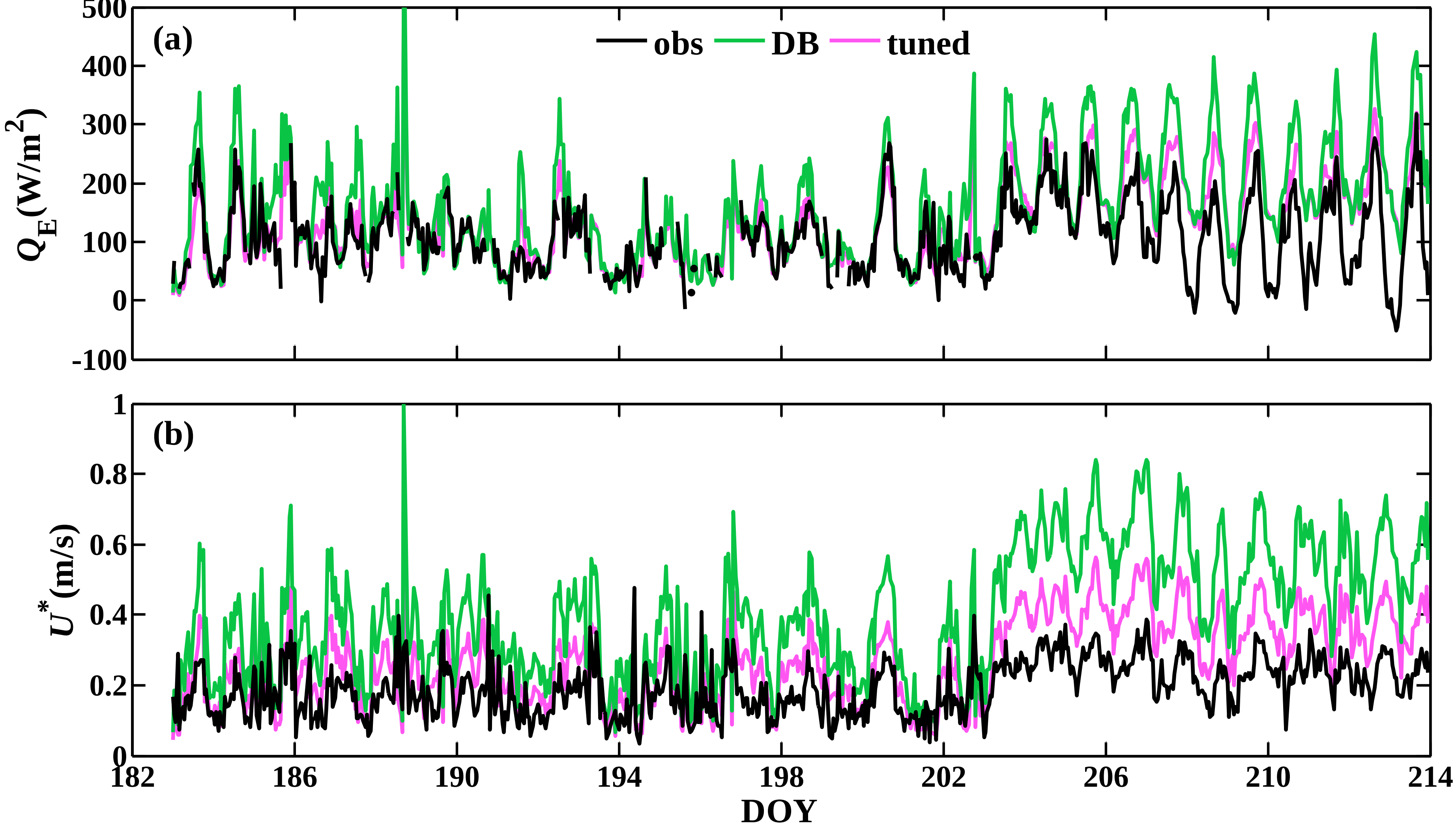

Fig.1 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 183 to 213,2012 at BFG

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Motivation 2

Wind and submerged aquatic vegetation influence bio-optical properties in large shallow Lake Taihu, China

By Xiaohan Liu, Yunlin Zhang, Yan Yin, et al.

JOURNAL OF GEOPHYSICAL RESEARCH:BIOGEOSCIENCES

Impact factor:3.021(2012)

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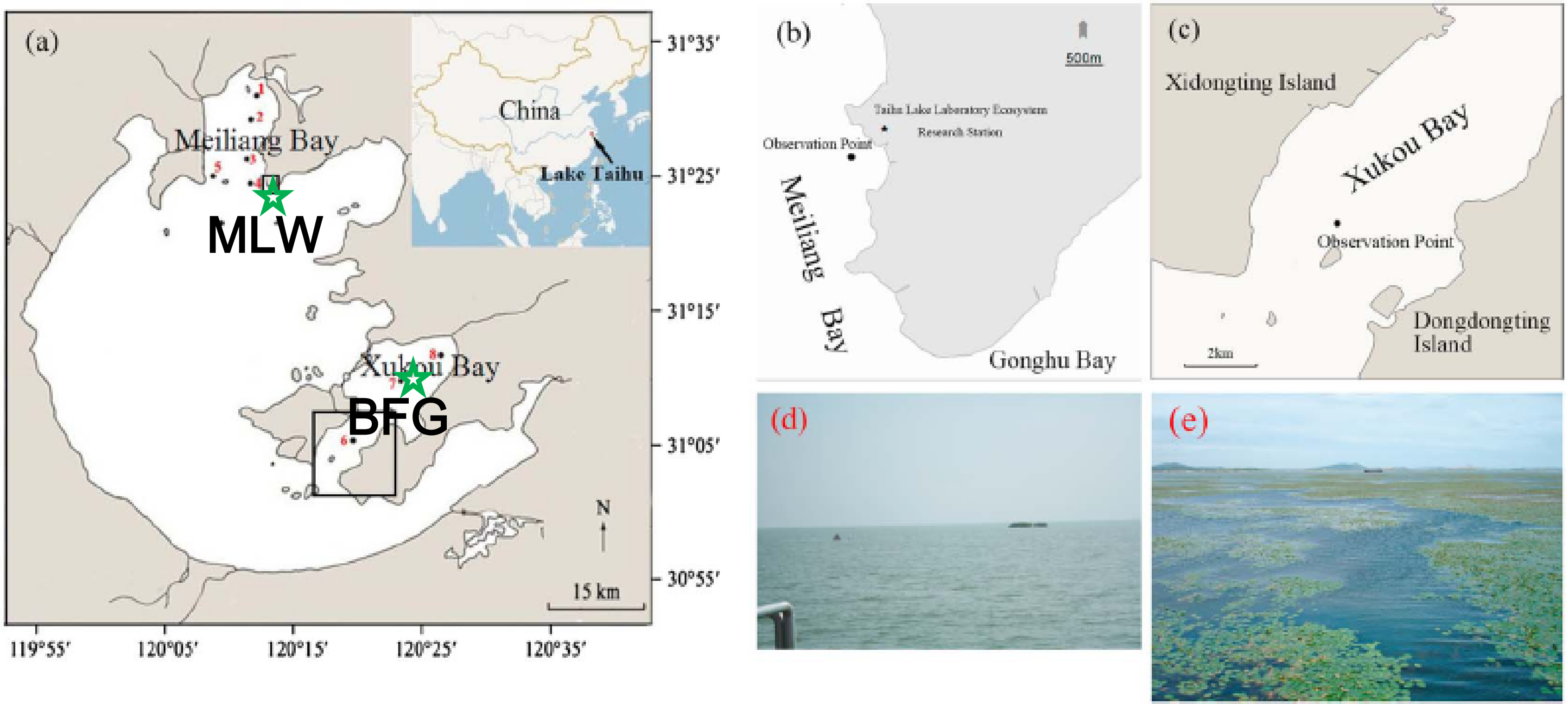

Figure 1. Location and conditions of the phytoplankton-dominated (PD) and macrophyte-dominated (MD) sampling sites in Lake Taihu. (a) Location of the long-term PD sites 1–5 in Meiliang Bay and MD sites 6–8 in Xukou Bay. Location of the short-term, high-frequency site in (b) Meiliang Bay and (c) Xukou Bay. In situ photos of the short-term, high-frequency sites in (d) Meiliang Bay and (e) Xukou Bay.

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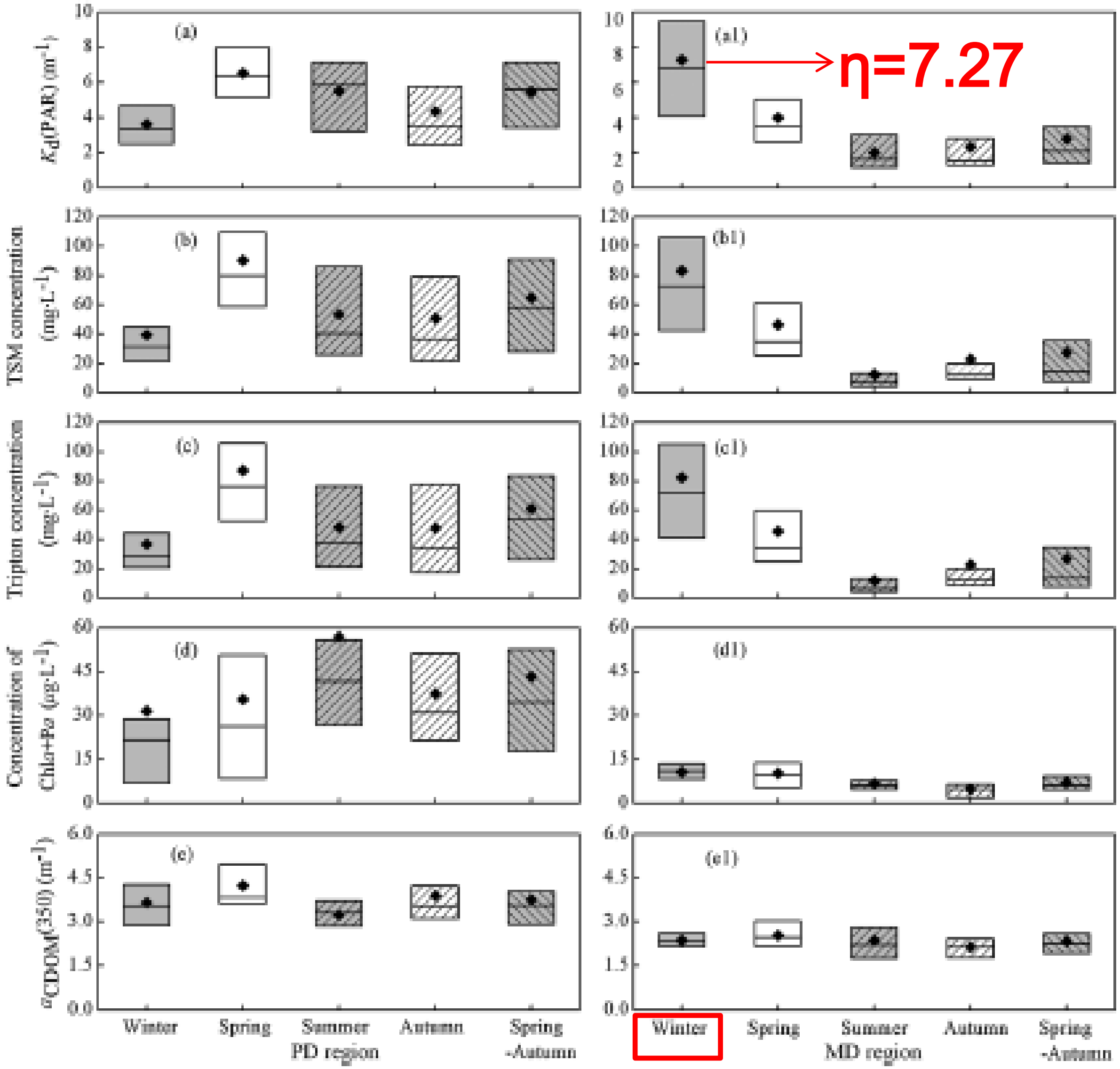

Figure 3. Box plot of seasonal variations of five physical and chemical parameters related to light attenuation in the (a–e) PD region and the (a1–e1) MD region. Data for a_{CDOM}(350) in August and November 2007 were not available. The mean values from spring to autumn were presented for the comparison of these three SAV growth seasons with winter, the non-growth season. The box is determined by the 25th and 75th percentiles, and values for median (horizontal line) and mean (diamond) are also included.

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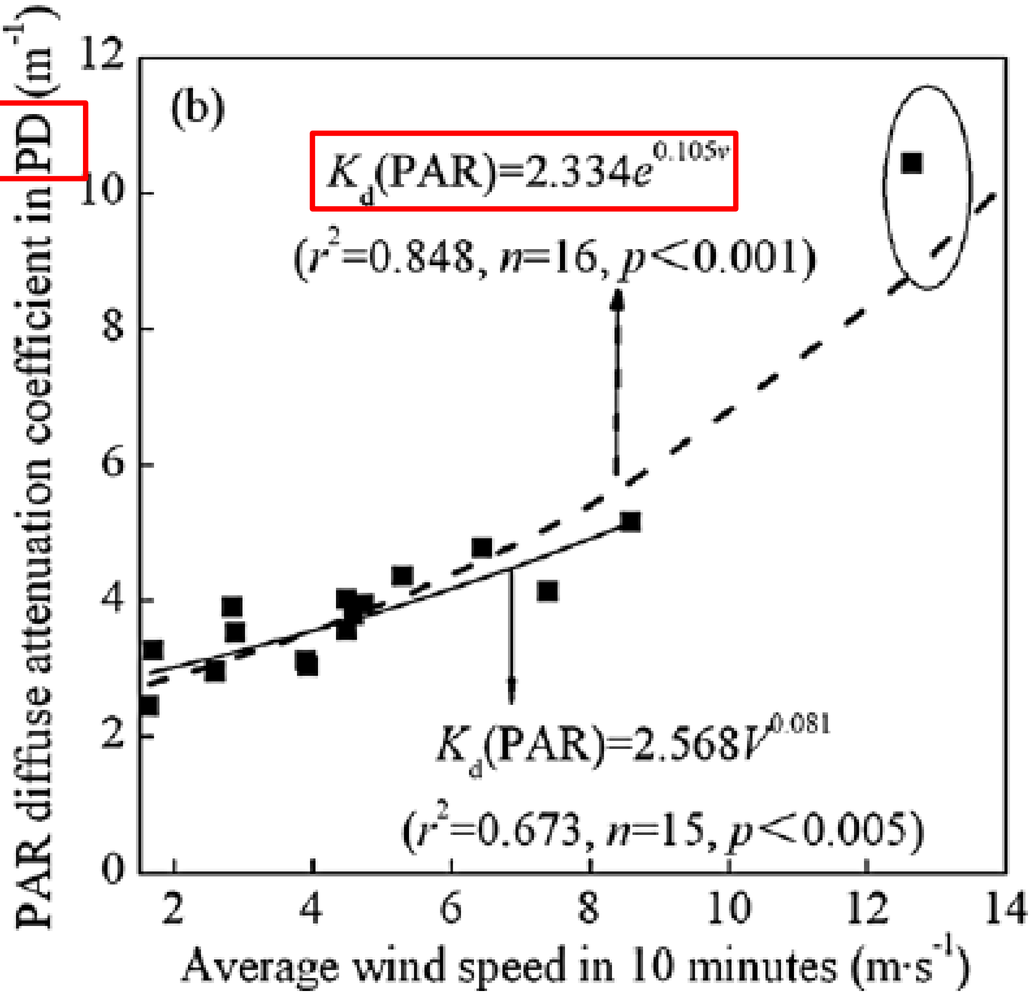

Figure 7(b). Linear model between K_d(PAR) and the 10min antecedent average wind speed in the PD region; Two linear relationships were fitted: including the highest wind speed of 12.65ms^{-1}(encircled dashed line) and excluding the highest wind speed(solid line).

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Sensitivity test

- 1.Using observed friction velocity to drive lake model and calculate Q_E .(BFG 2012.7,Tuned-summer)
- 2.Changing extinction coefficient from 3 to 7.

  (BFG 2012.1,Tuned-winter*****)
- 3.Set extinction coefficient as function of $\eta = 2.334 \cdot e^{0.105 \cdot \bar{u}}$, $\bar{\mathbf{u}}$ is horizontal wind speed.

  (MLW 2012,DOY:76-103,192-220,275-304,20-49, Deng et al.*****)

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Table1 Parameter Settings

	η (m^{-1})	β (%)	*Ke* (descale) (m^2/s)	Z_{0h} (m)	Z_{0m} (m)	Z_{0q} (m)
Deng et al.	5	63.2	0.02	1.9×10^{-6}	3.3×10^{-4}	3.9×10^{-8}
Tuned-Summer	2.5	39.3	0.014	8×10^{-5}	1.9×10^{-6}	3.9×10^{-8}
Tuned-Winter	3	45.1	0.02	8×10^{-5}	1.9×10^{-7}	3.9×10^{-8}
Tuned-Winter*	7	75.3	0.02	8×10^{-5}	1.9×10^{-7}	3.9×10^{-8}
Deng et al.*	$f(\bar{\mathbf{u}})$	$1-e^{-Z_a\eta}$	0.02 (T_{20} > 277.15K)	1.9×10^{-6}	3.3×10^{-4}	3.9×10^{-8}

T_{20} (K)	*Ke-Deng et al.* (m^2/s)	*Ke-tuned* (m^2/s)
$276<T_{20}\leq277.15$	0.1	6×10^{-6}
$T_{20}\leq276$	10000*Ke*	1×10^{-5}

Results

- Test 1
- Test 2
- Test 3

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Test 1

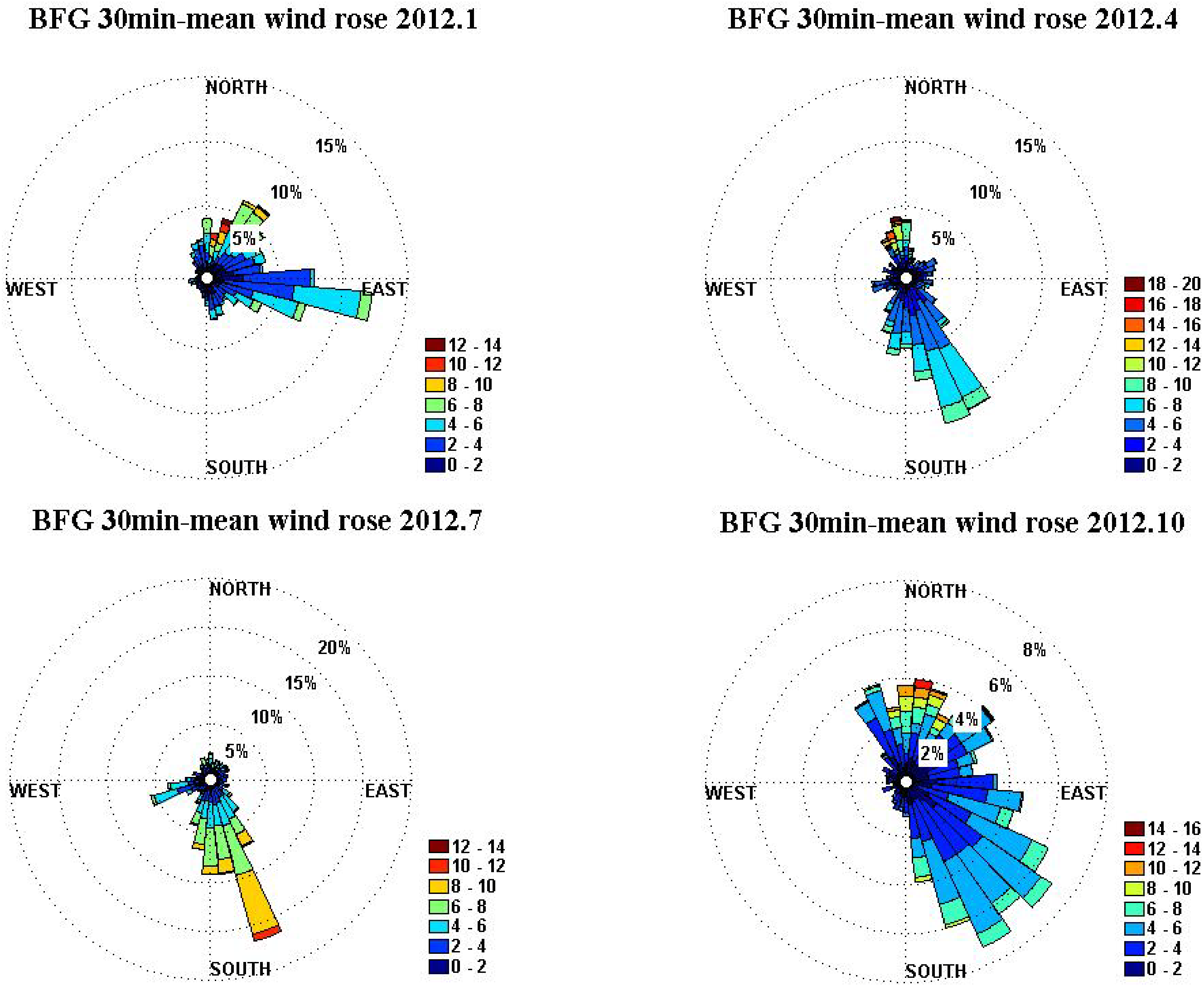

Fig.2 Wind rose for Jan., Apr., Jul., Oct. on 2012 at BFG

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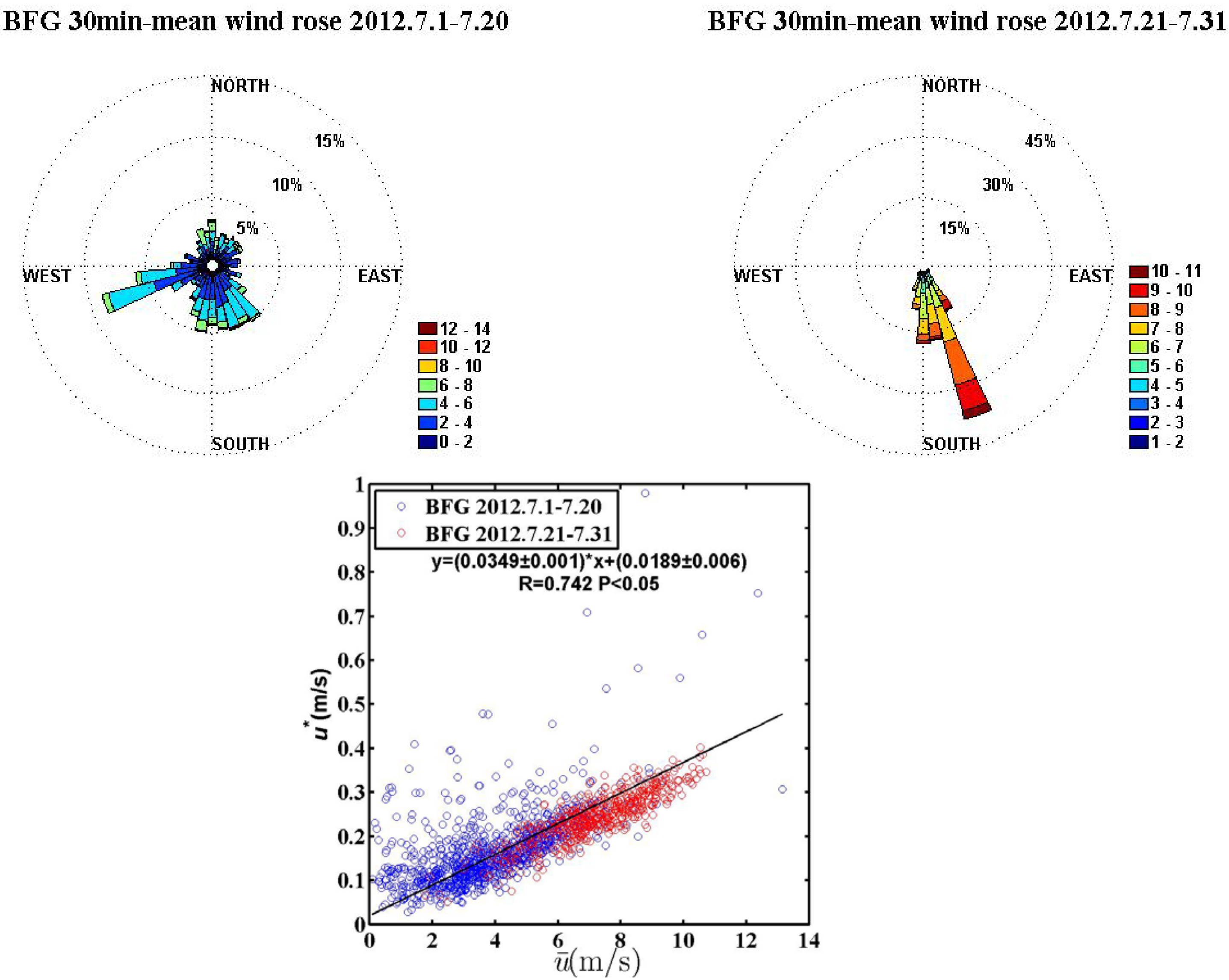

Fig.3 Wind rose and linear fitting between horizontal wind speed and friction velocity on July,2012 at BFG

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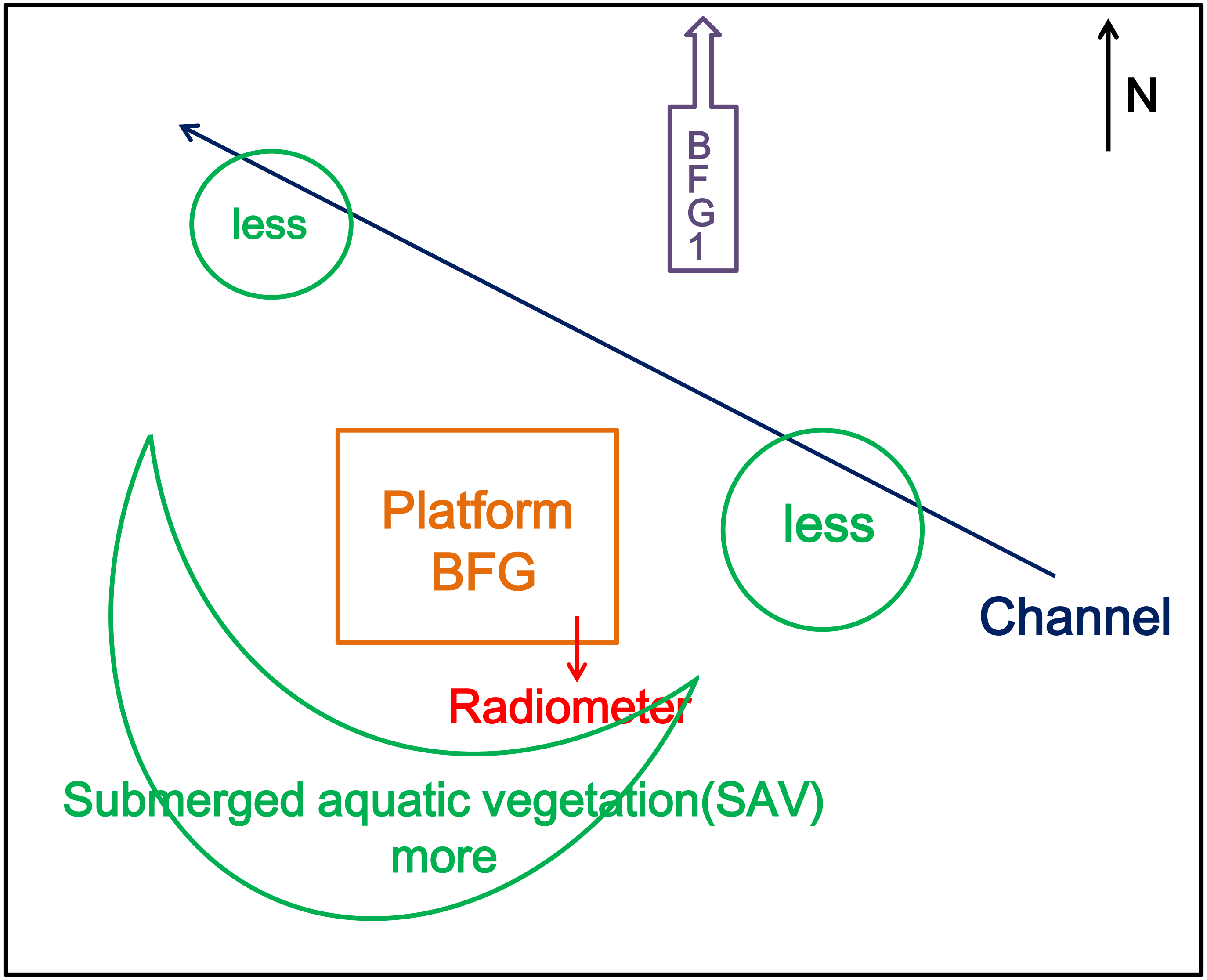

Fig.4 BFG structure chart

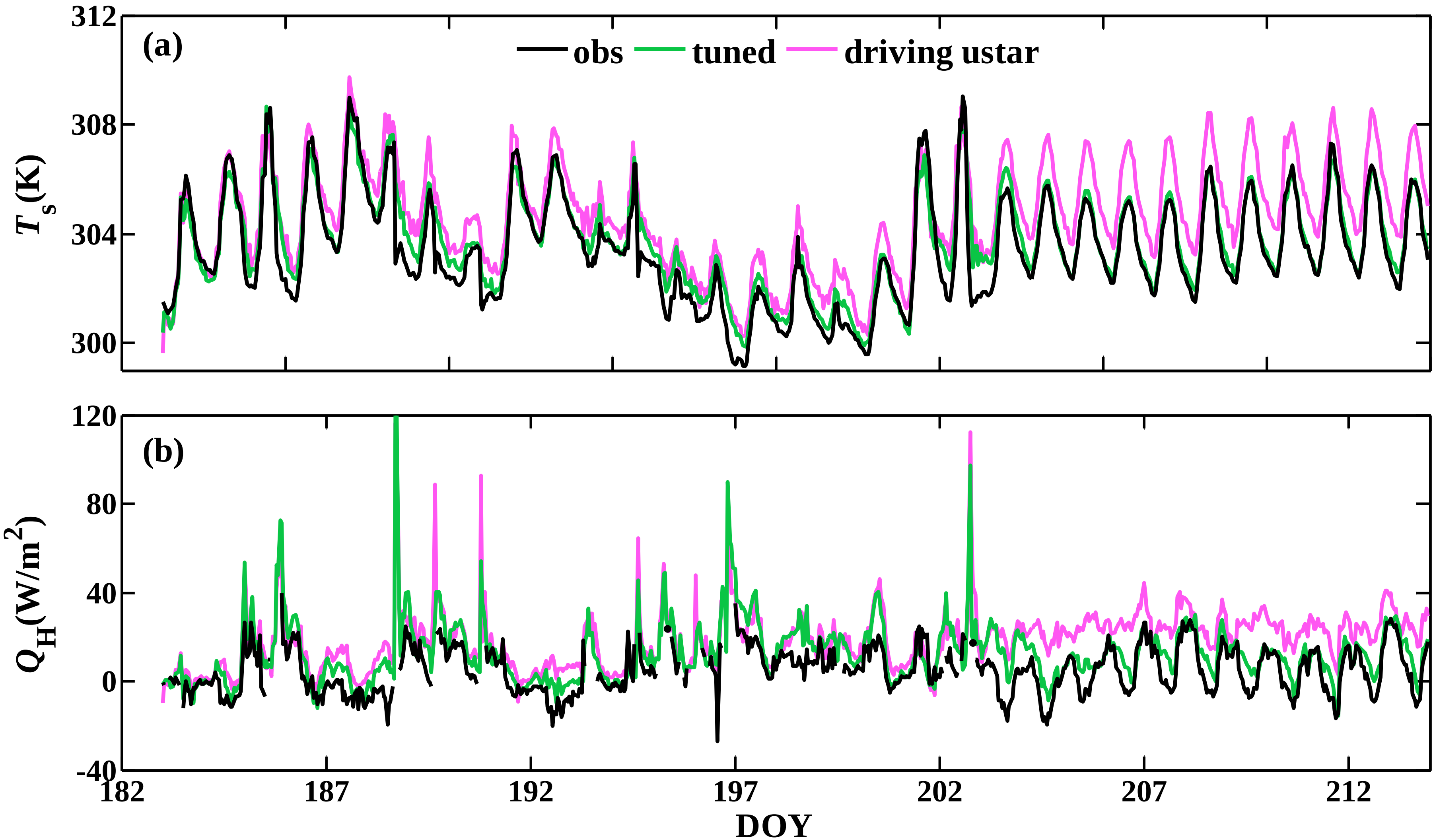

Fig.5 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 183 to 213,2012 at BFG

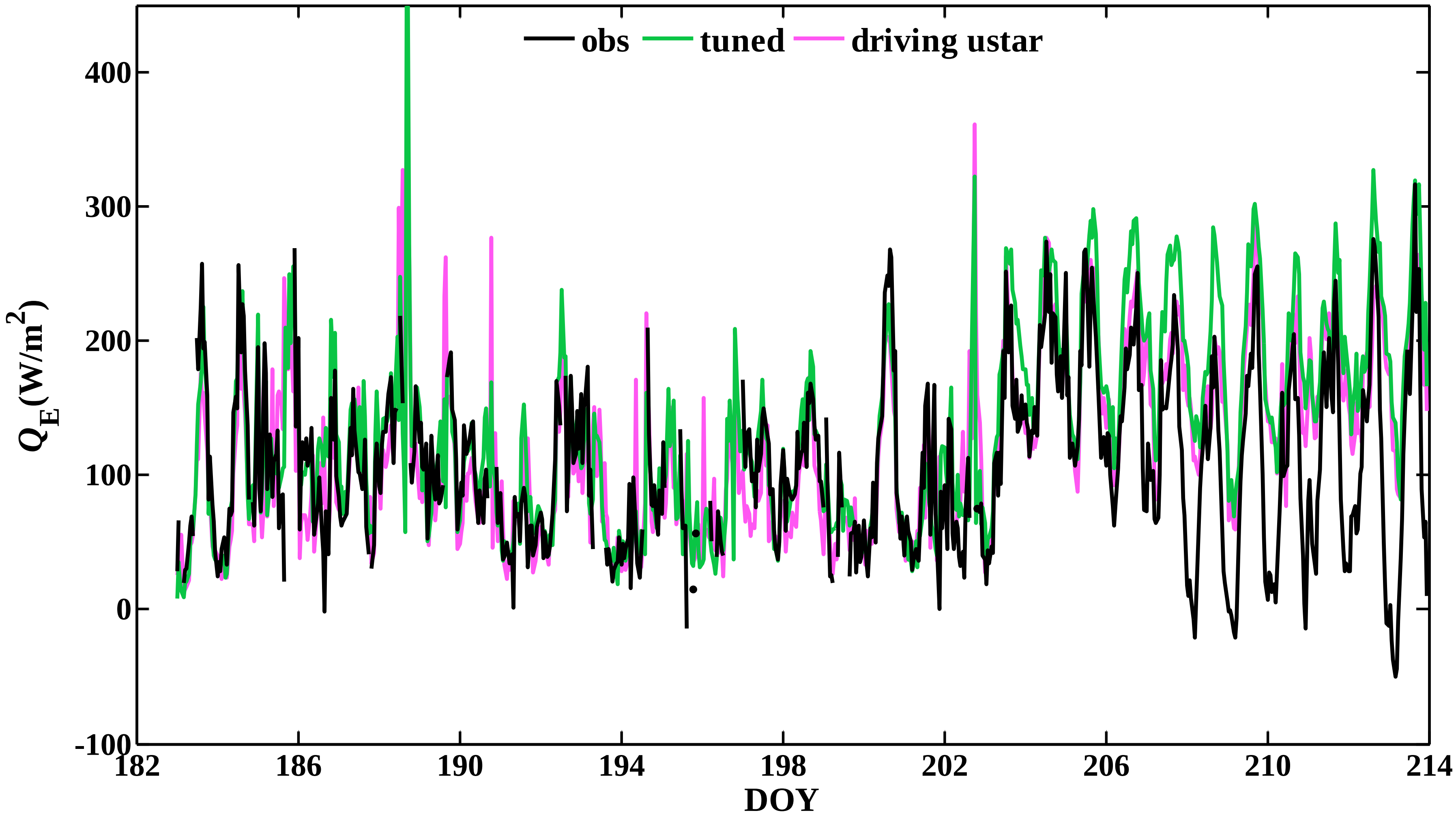

Fig.6Comparison between the observed and the model-predicted surface flux QE from DOY 183 to 213,2012 at BFG

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Test 2

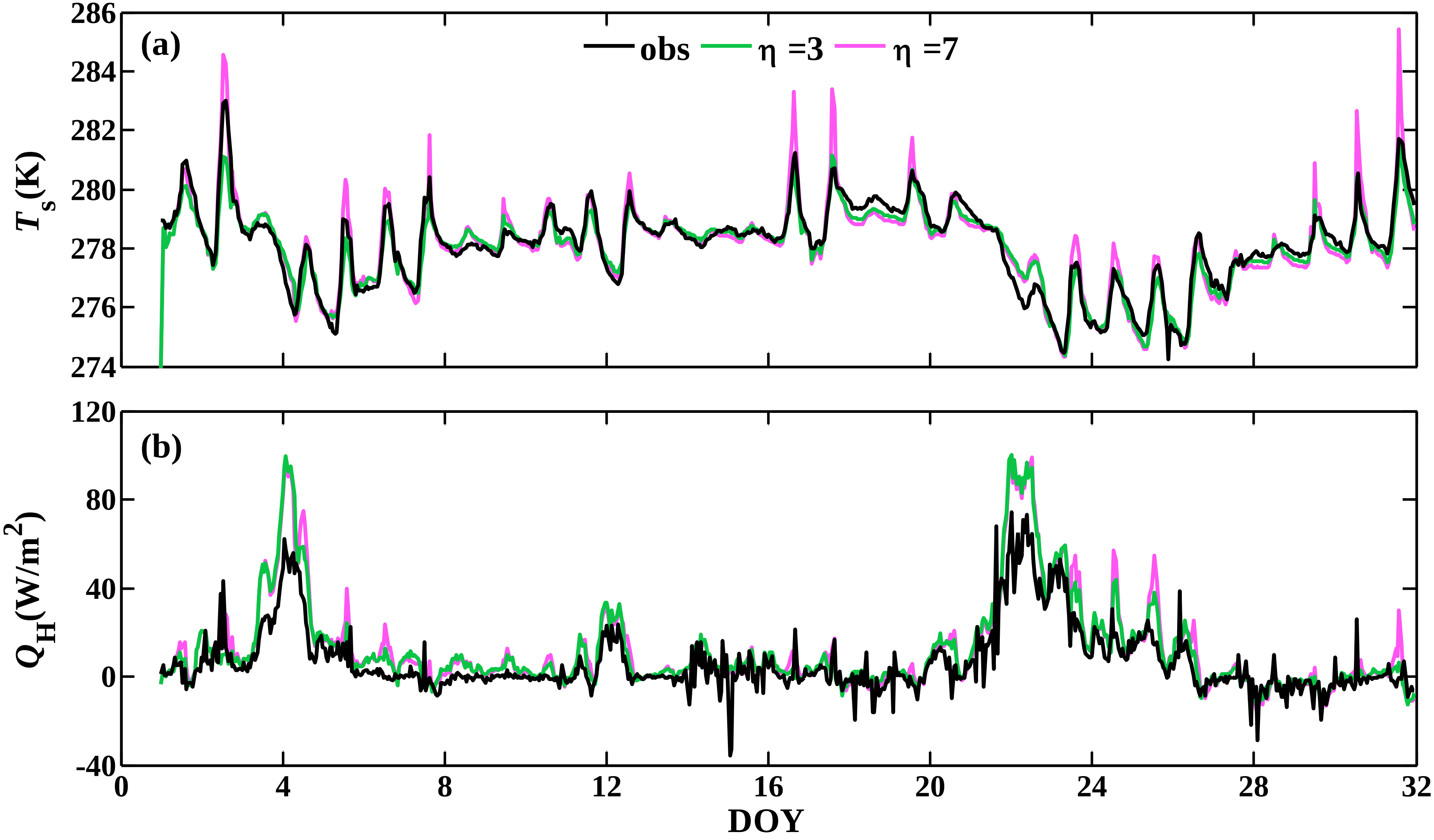

Fig.7 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 1 to 31,2012 at BFG

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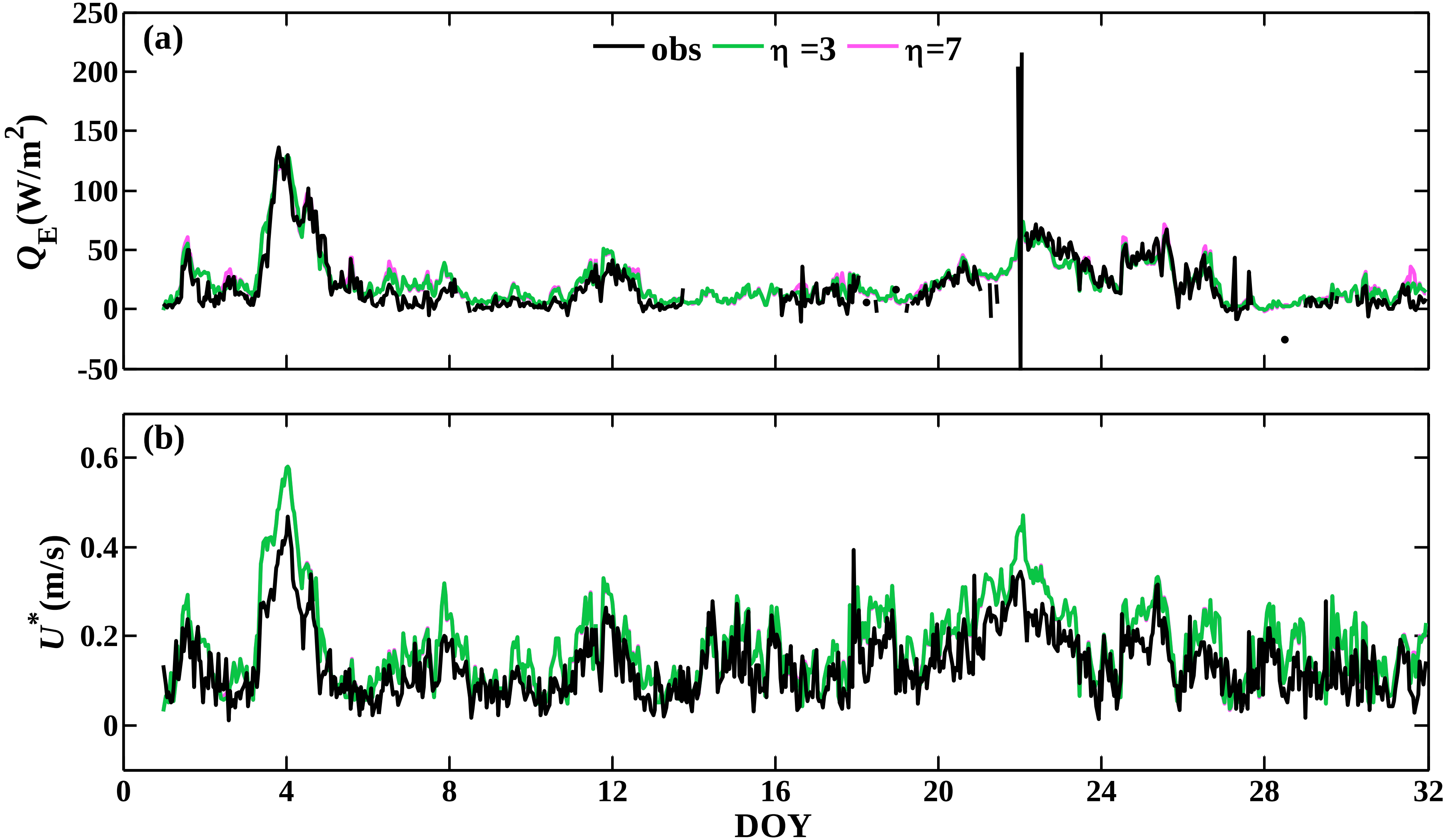

Fig.8 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 1 to 31,2012 at BFG

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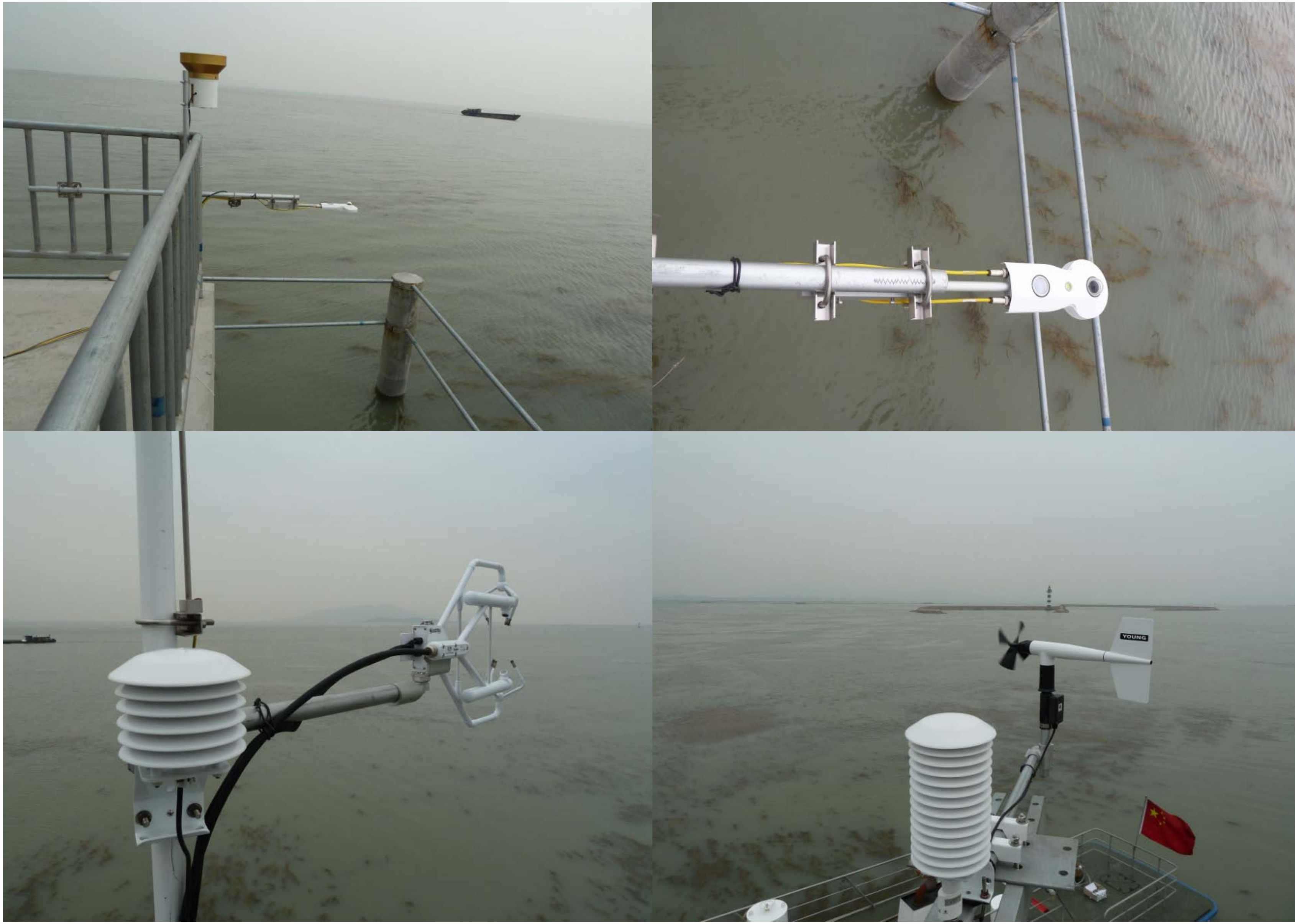

Fig.9 BFG_2011.12.13-12.15

Fig.10 BFG_2013.1.5

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Test 3-Spring

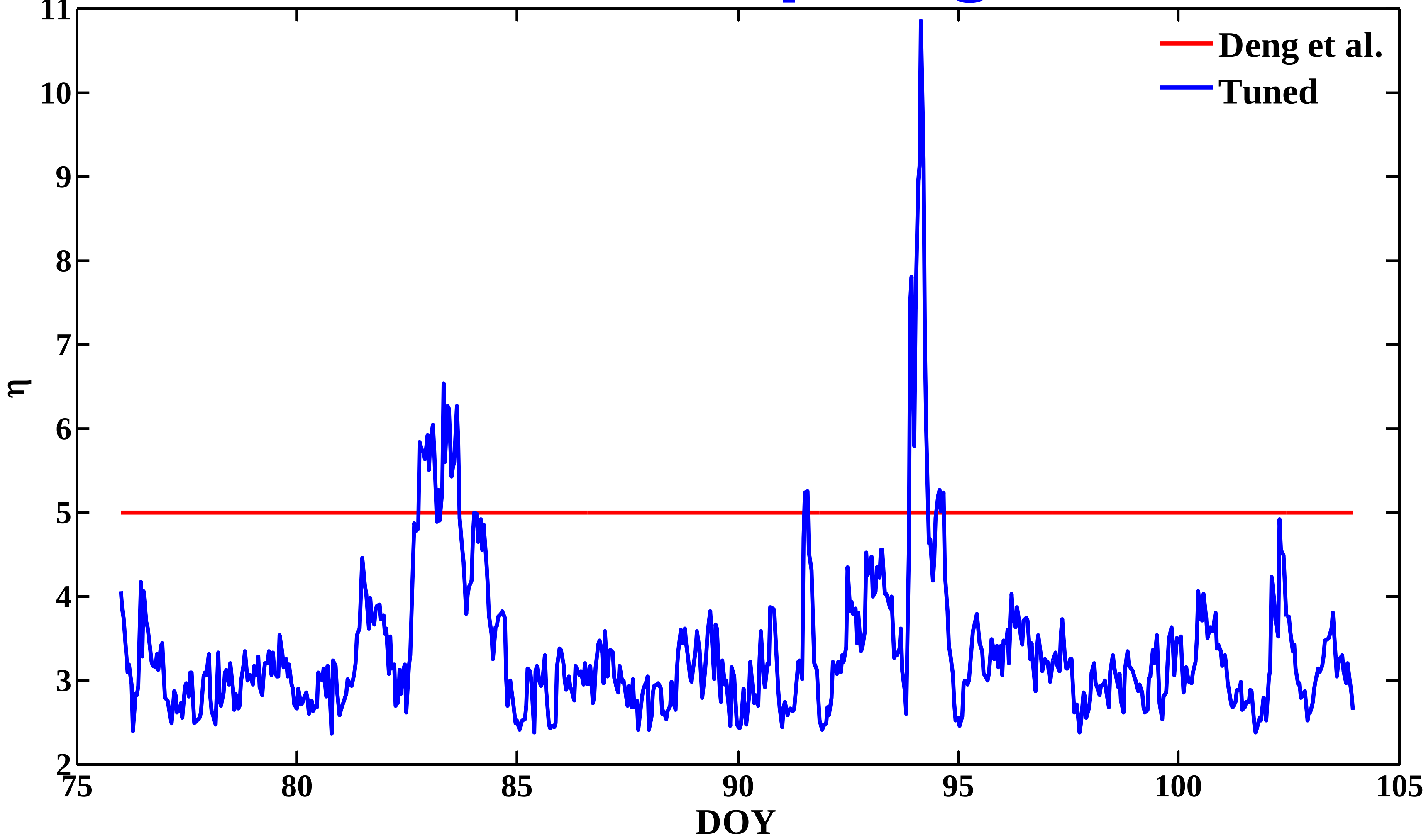

Fig.11Extinction coefficient from DOY 76 to 103,2012 at MLW

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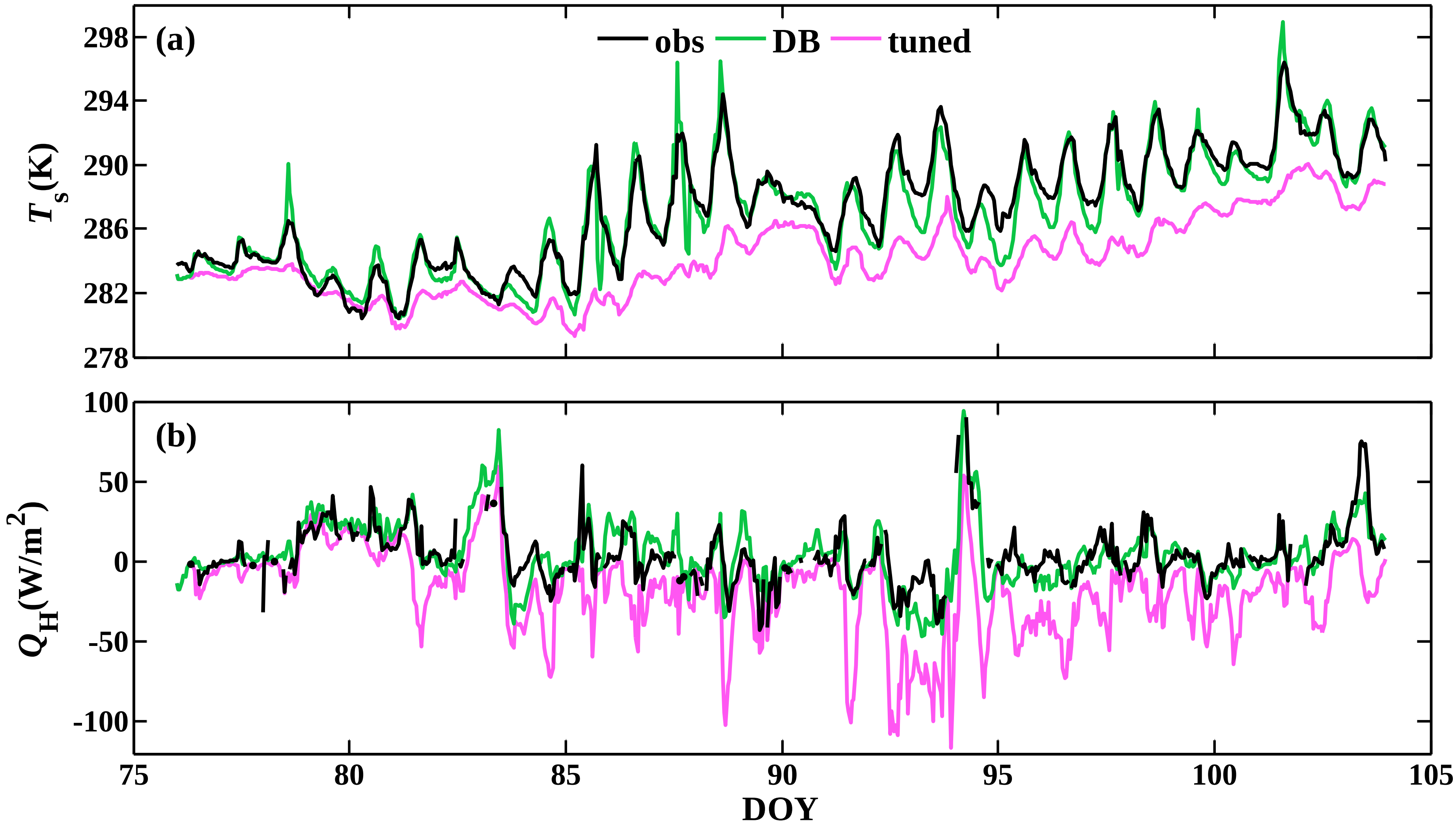

Fig.12 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 76 to 103,2012 at MLW

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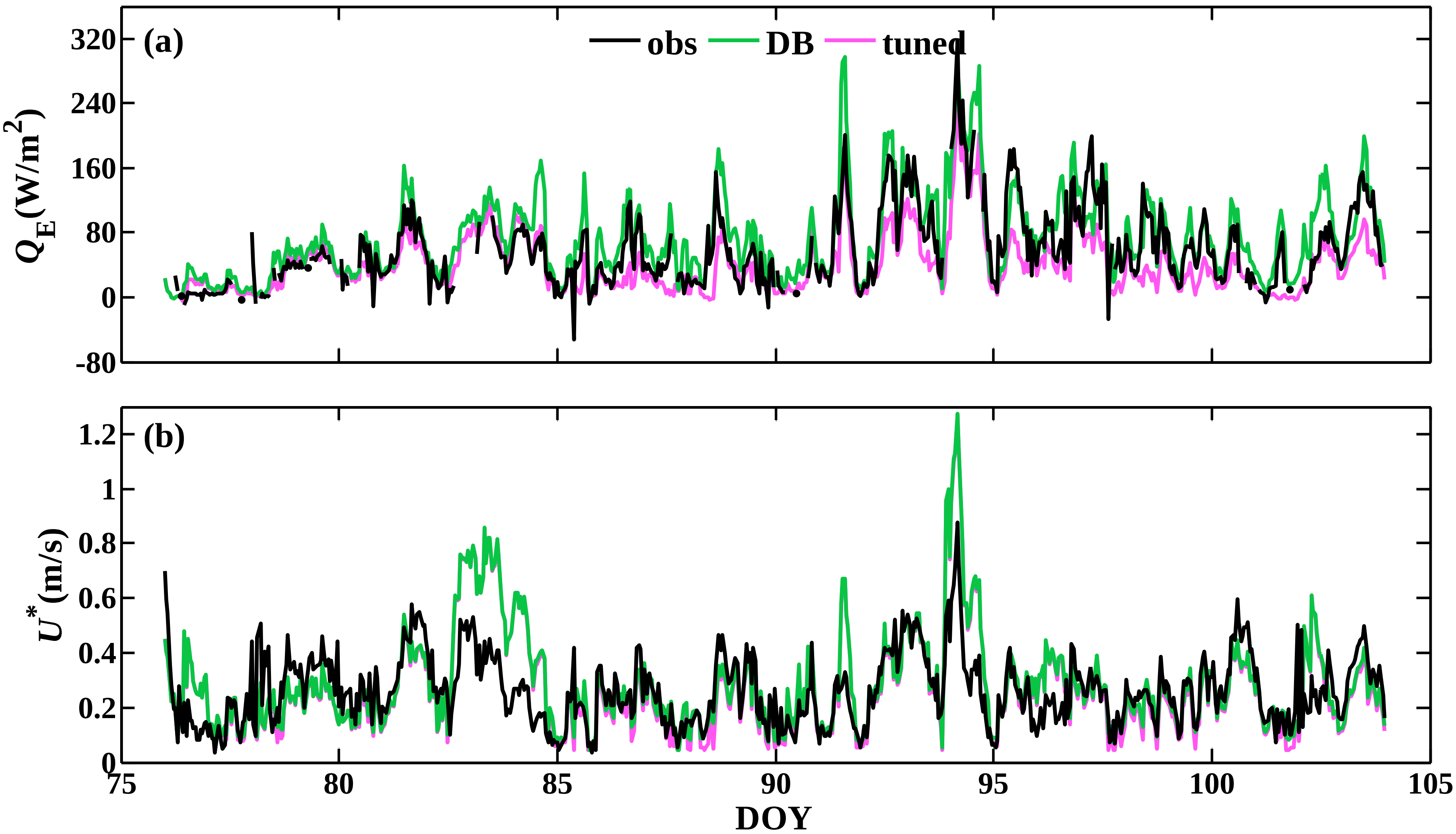

Fig.13 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 76 to 103,2012 at MLW

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Test 3-Summer

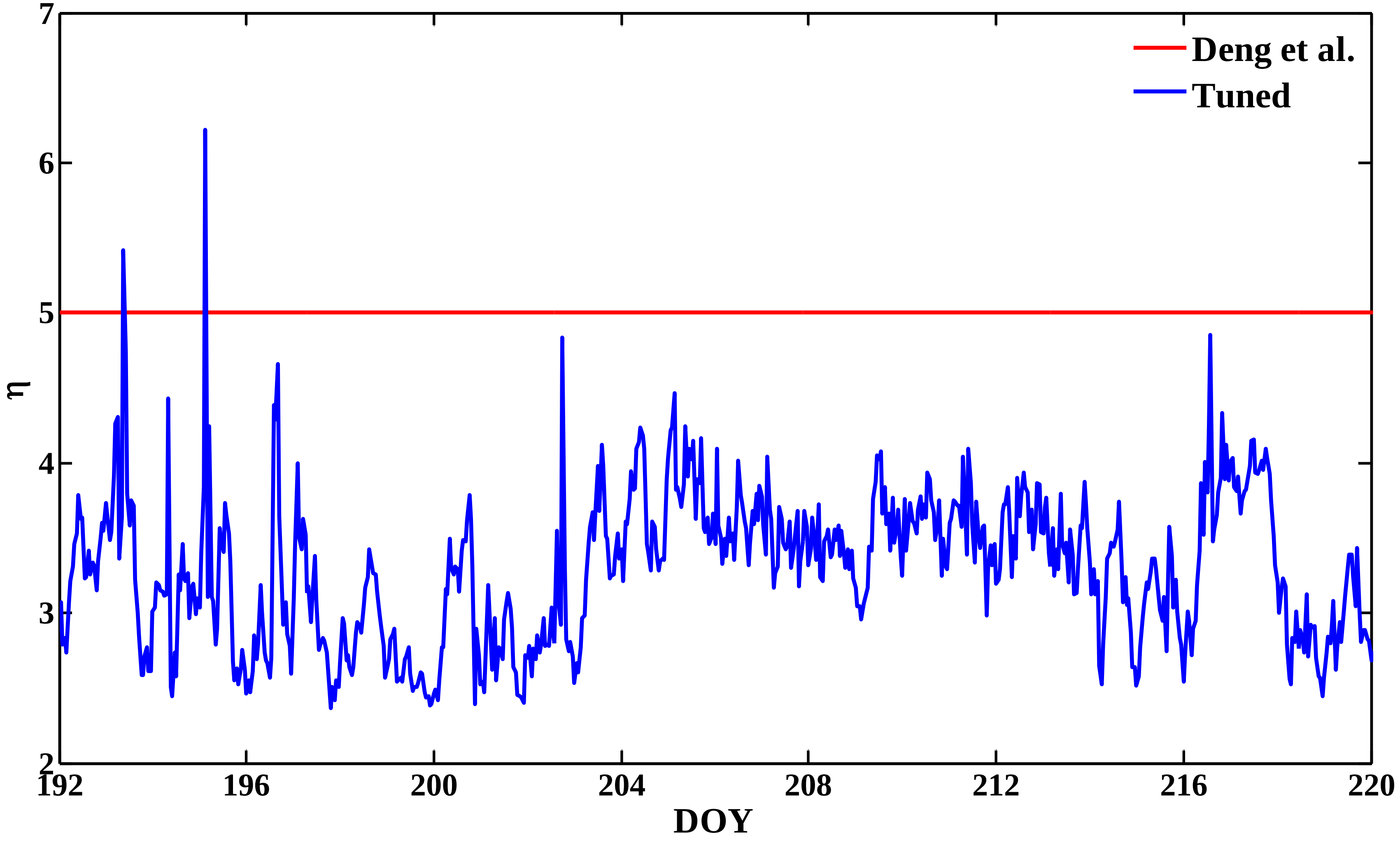

Fig.14 Extinction coefficient from DOY 192 to 220,2012 at MLW

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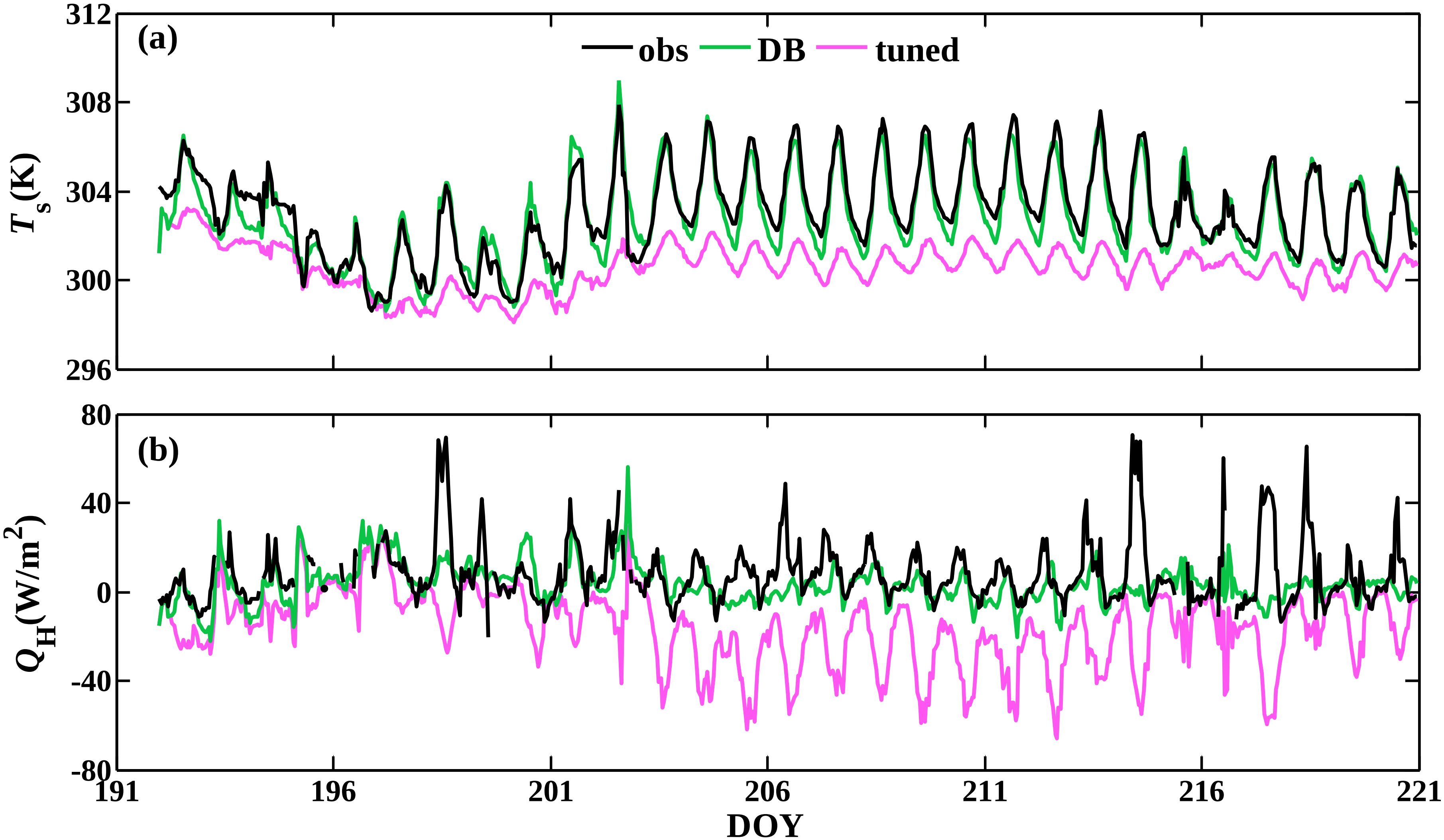

Fig.15 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 192 to 220,2012 at MLW

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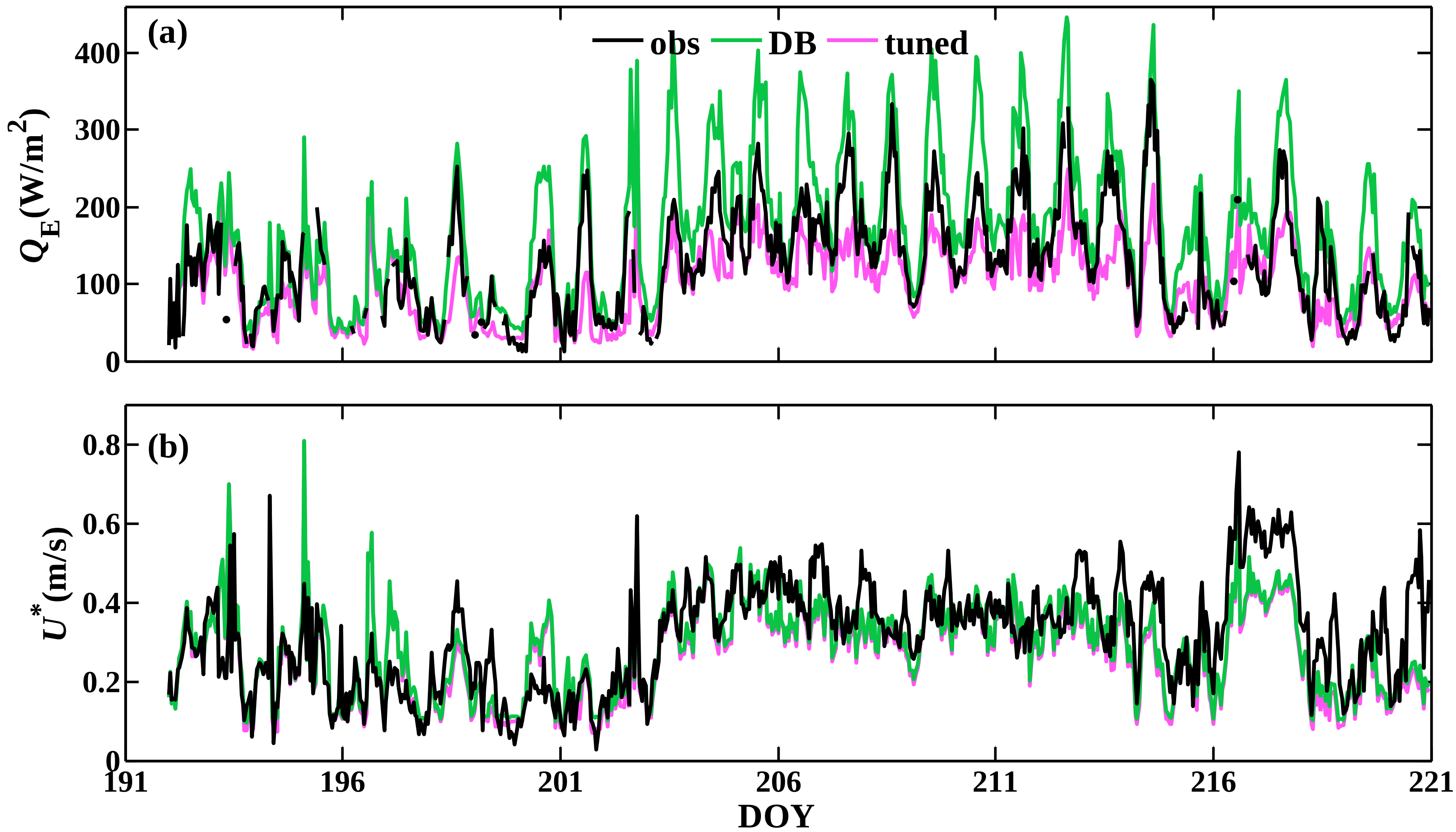

Fig.16 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 192 to 220,2012 at MLW

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Test 3-Autumn

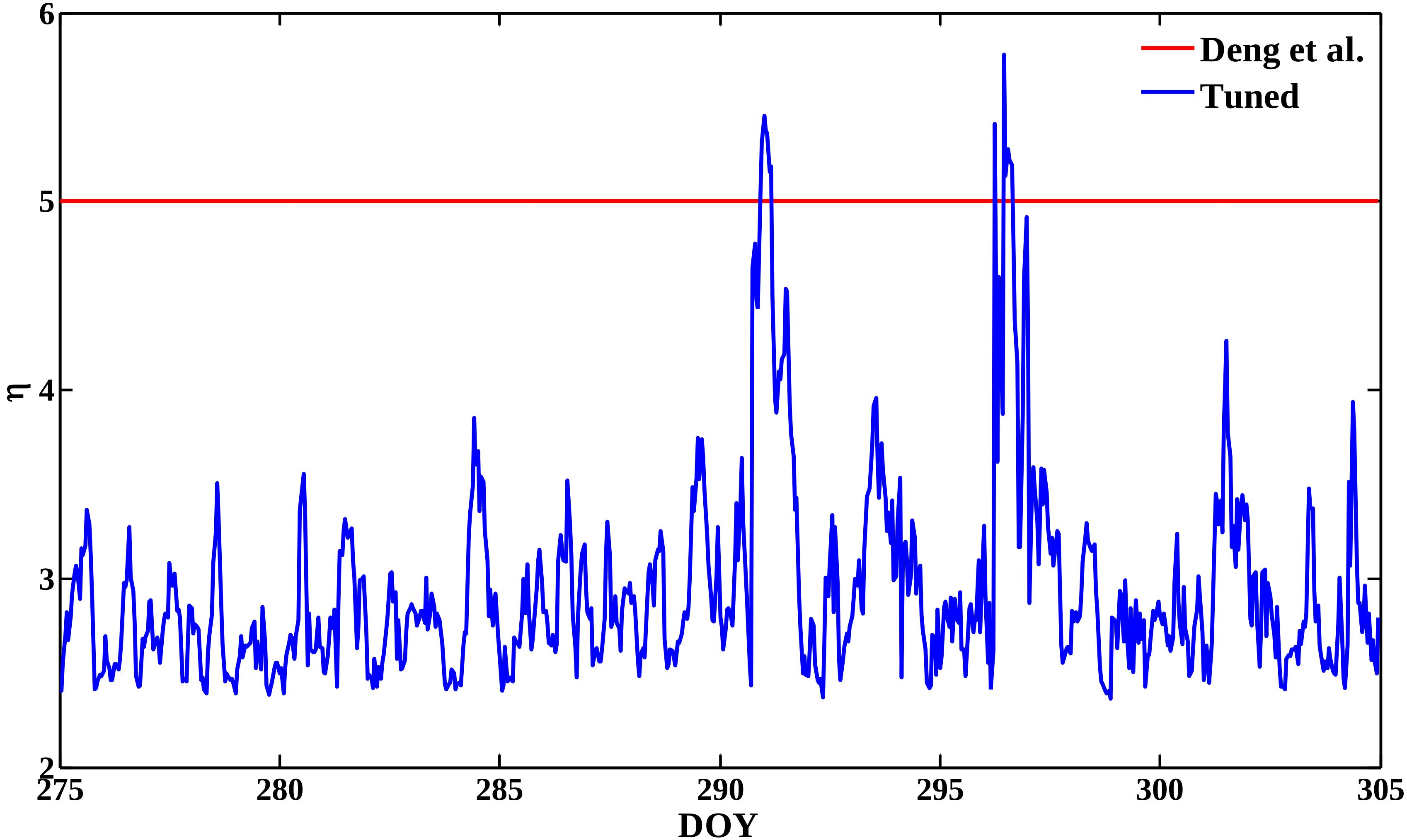

Fig.17 Extinction coefficient from DOY 275 to 304,2012 at MLW

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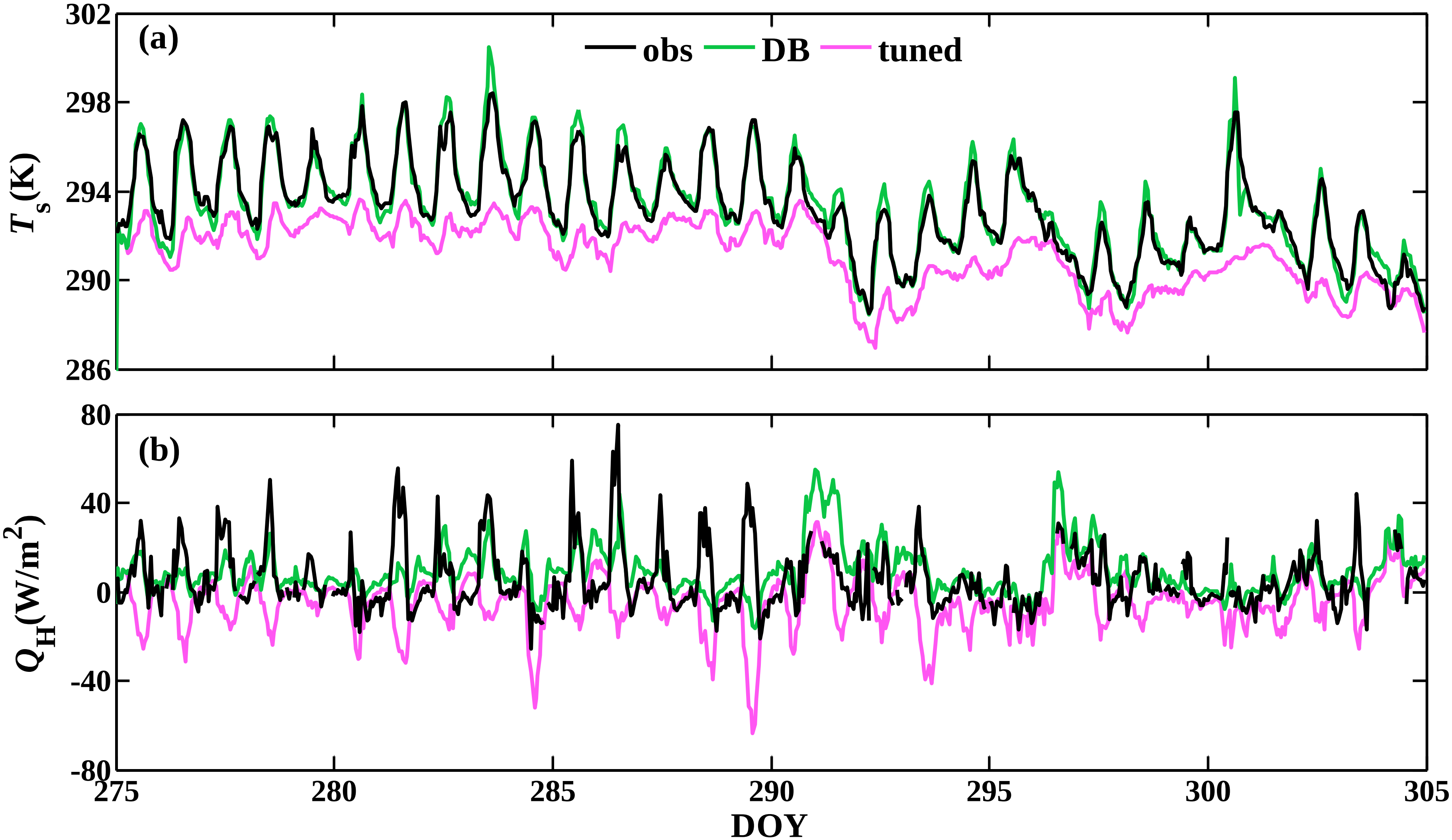

Fig.18 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 275 to 304,2012 at MLW

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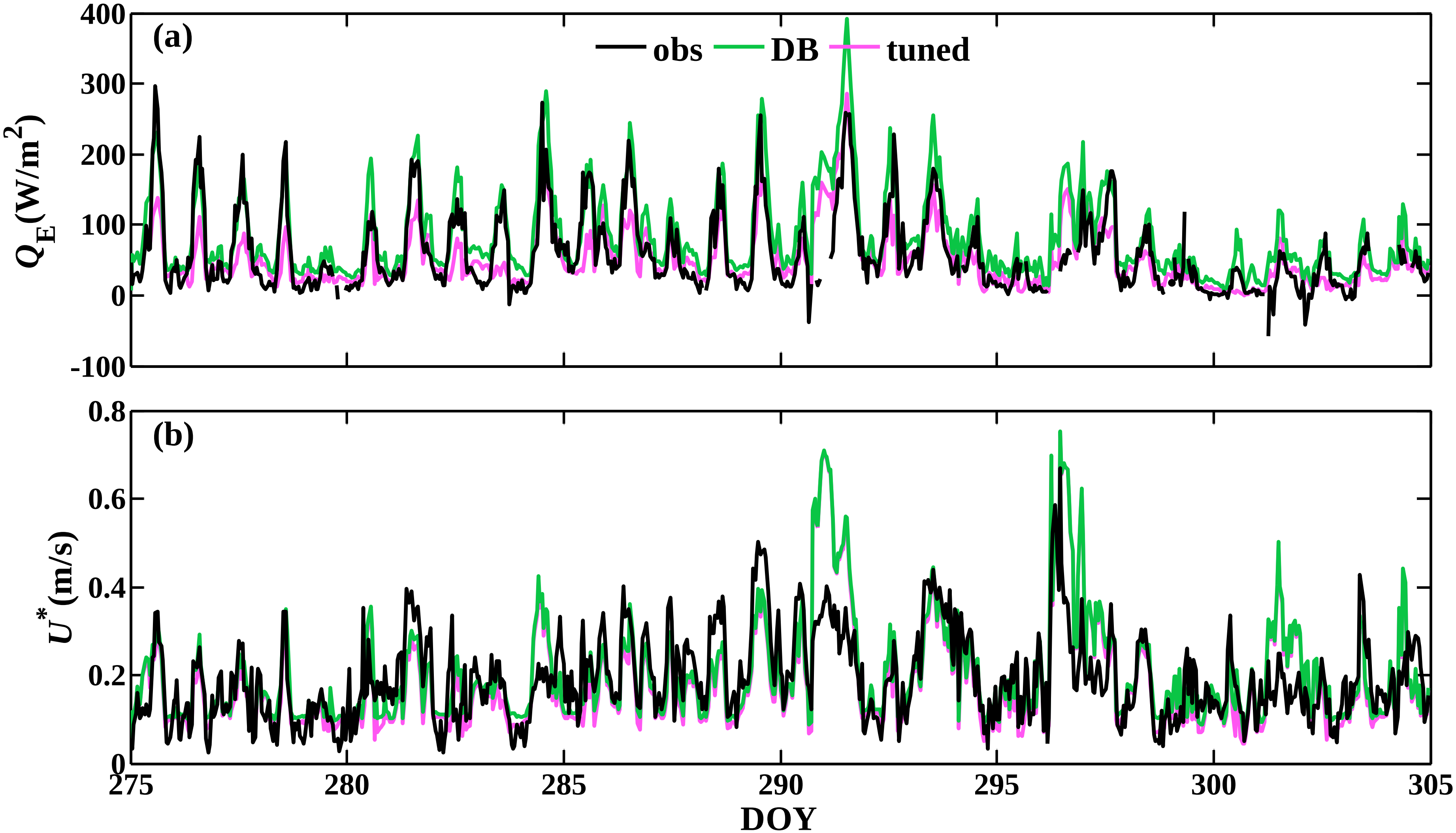

Fig.19 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 275 to 304,2012 at MLW

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Test 3-Winter

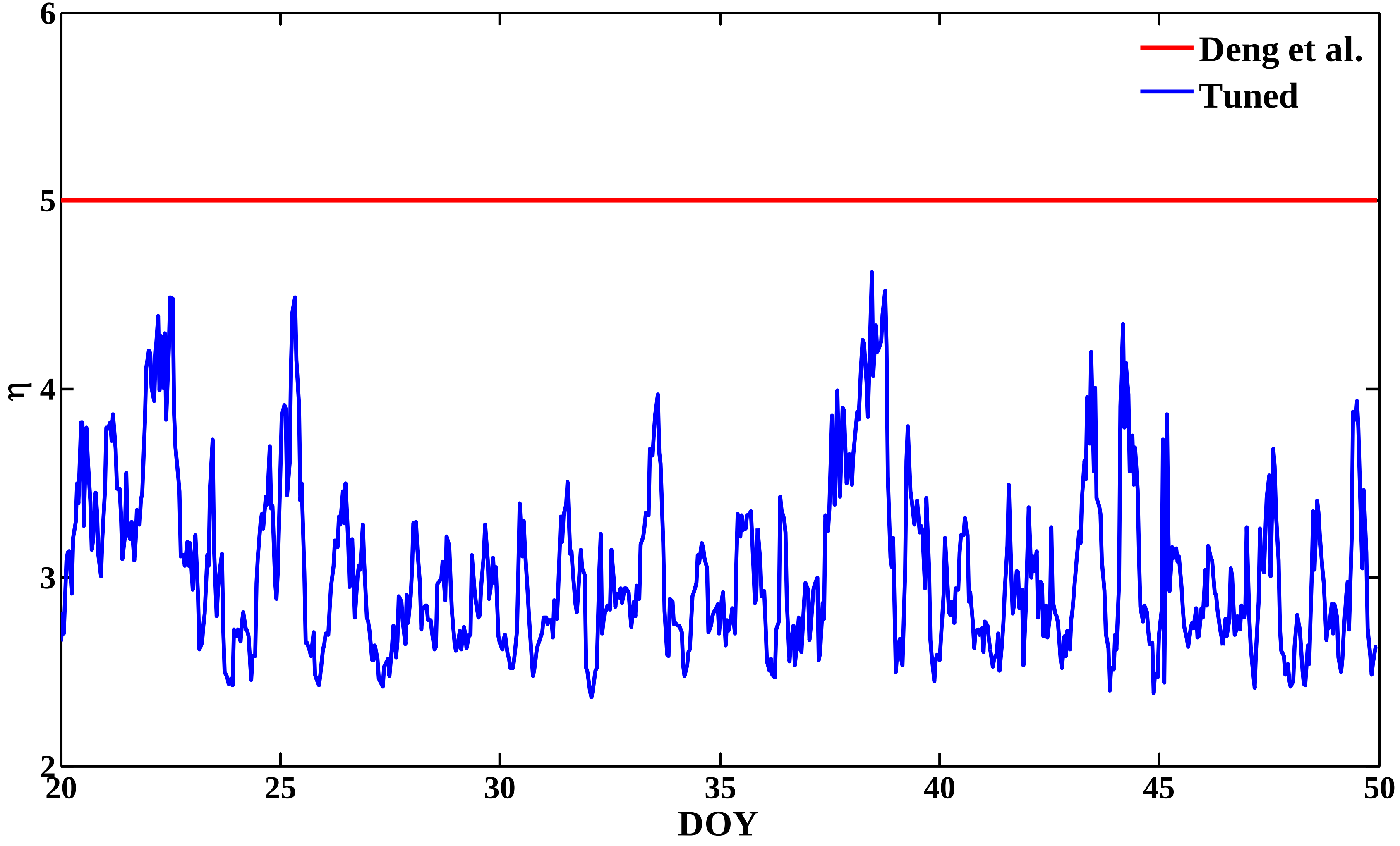

Fig.20 Extinction coefficient from DOY 20 to 49,2012 at MLW

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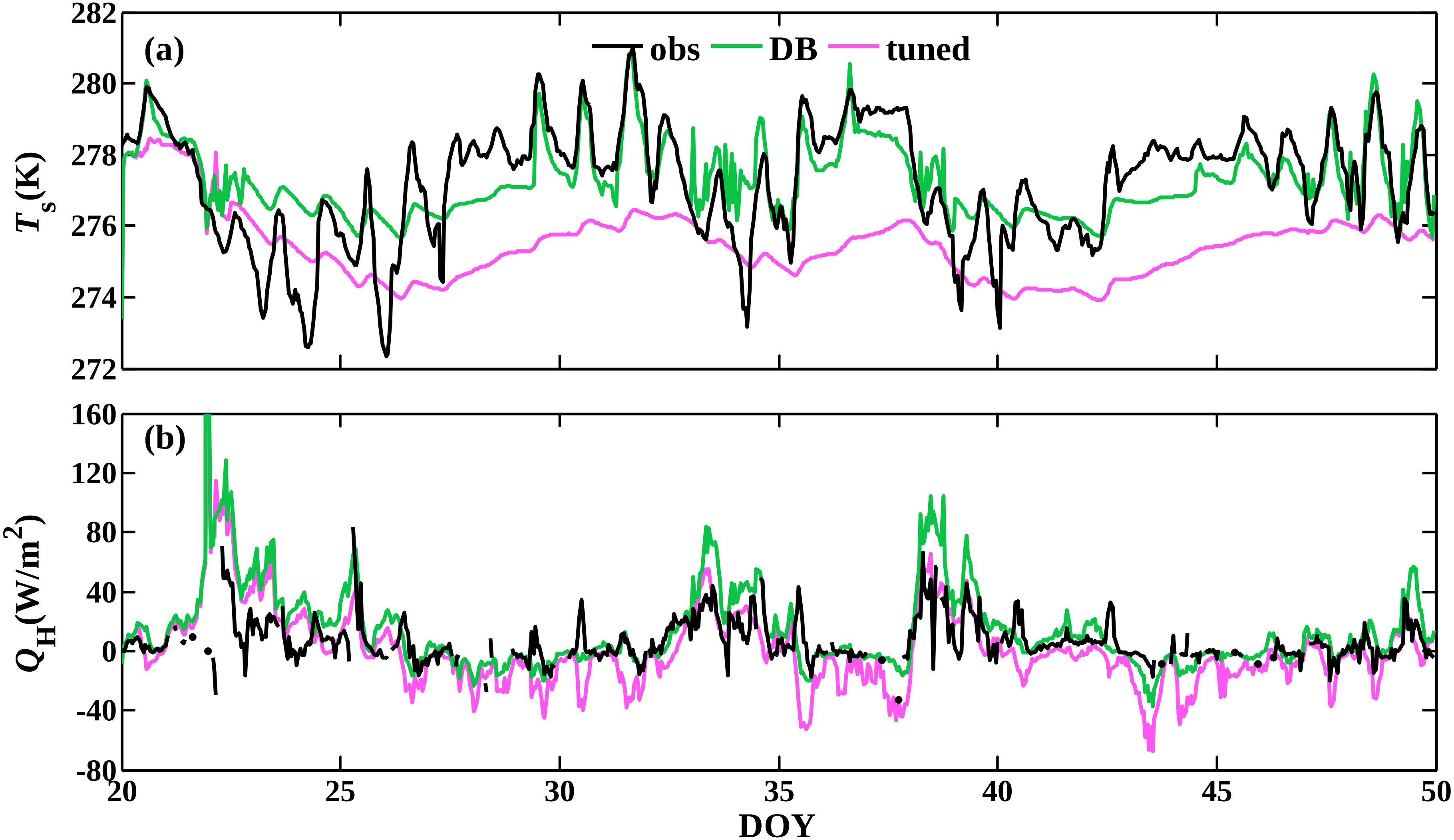

Fig.21 Comparison between the observed and the model-predicted surface temperature and surface flux QH from DOY 20 to 49,2012 at MLW

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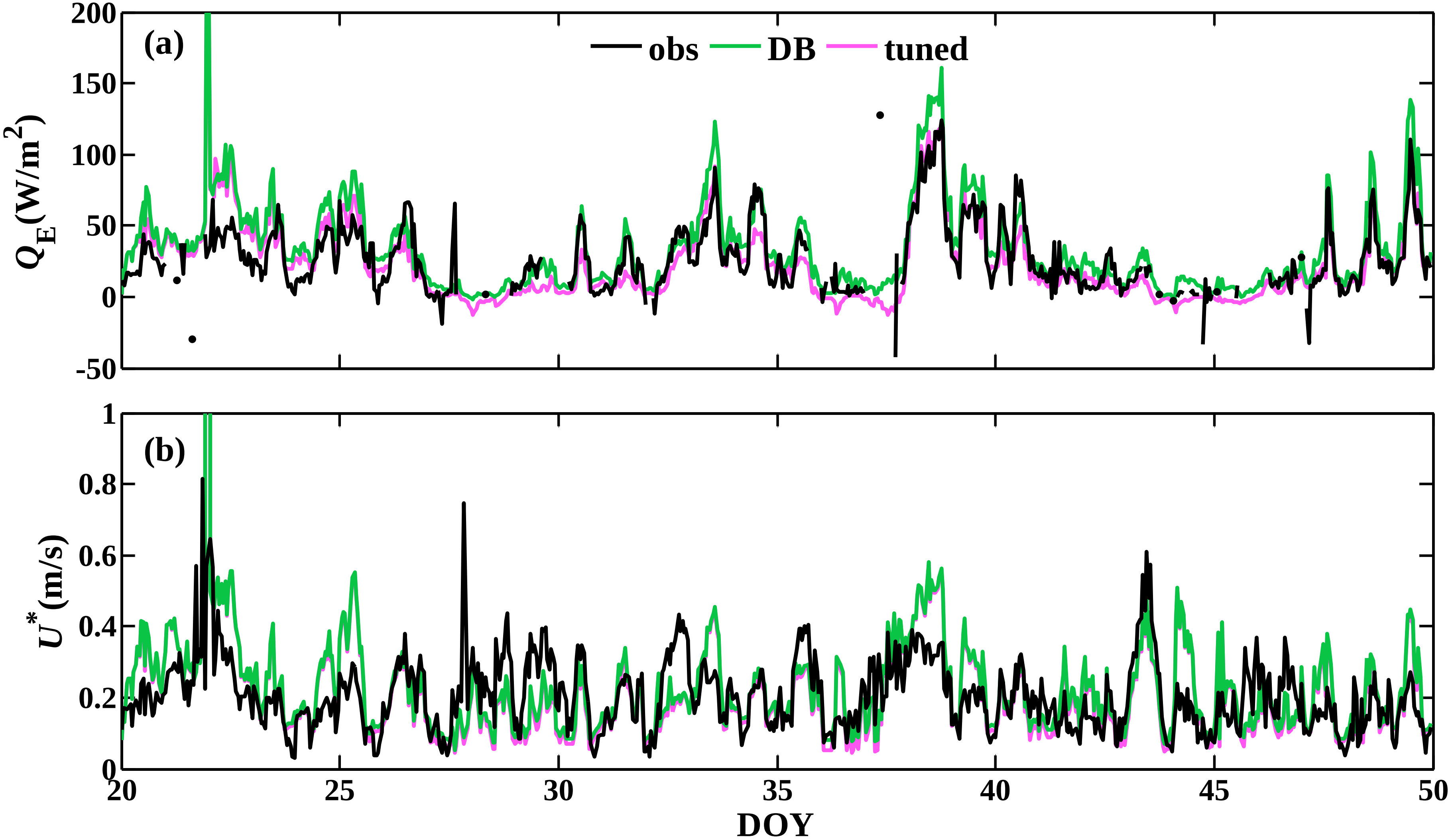

Fig.22 Comparison between the observed and the model-predicted surface flux QE and friction velocity from DOY 20 to 49,2012 at MLW

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Conclusion

- These three groups of sensitivity tests haven't got the expected results.
- Not only wind but also other factors have impact on the simulation of latent heat flux. It needs further analysis.
- The inter-annual variability of water quality varies greatly, even in the same period and at the same site, therefore finding the relationship between extinction coefficient and wind combining with the amount of vegetation may help to increase the applicability of lake model.
- The combination of the horizontal wind speed and the extinction coefficient improved the simulation results of the latent heat flux.

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On-going work

- Further tuning the simulation results and to find some valid and convincing reasons.
- Read more literature and gaining more knowledge about this aspect to accomplish a manuscript as soon as possible.

Thank You