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

Update on the IRGASON project: results from the spring field campaign in Northwest China

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Outline

- Background & Motivation
- Site & Instrumentation
- Preliminary results
  - Evaluation of air flow distortion
  - Evaluation of fluxes measurement
  - Implication for WPL correction

1. Background

IRGASON (Campbell Scientific Inc.)

IRGASON's advantages in geometry (colocation, synchronicity and aerodynamics) and low power consumption.

LI-7500A + Gill (Li-Cor Inc.)

Physical separation and self-heating.

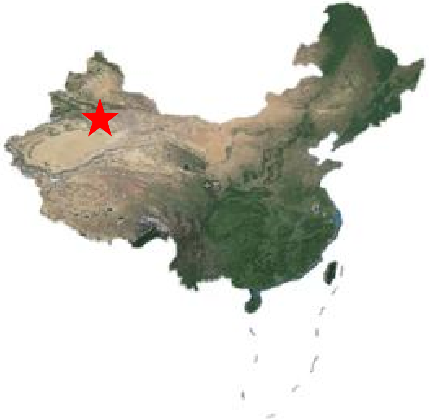
Motivation

- Does the colocation of CSAT3 and EC150 in IRGASON minimize the air flow distortion?

- How are about the performance of IRGASON in a dry and cold environment as compared to separated open-path EC system (LI-7500A+Gill)?

- Has IRGASON addressed the self-heating by co-locating the measurement volumes for wind and gas samples?

2. Site



(By Lichen Deng)

Geography		Climatology	
Latitude	40º26'02.27'' N	Air temperature	12 ^{o}C
Longitude	88º01'36.20'' E	Annual precipitation	37.2 mm
Elevation	843 m	Wind speed	2.4 m s^{-1}
Vegetation	populus euphratica	Prevailing wind	NE, NW
Canopy height	10 m	Sunshine percentage	68%

Instrumentation

Instruments	Sensors	Height/Depth (m)	Variables	Operation period
EC	EC150+CSAT3	15	H, λE, F_c, u^*, CO_2, H_2O, U, wind direction	Jun.2013-Dec.2013
	Li-7500A+Gill	15		Jun.2013-Apr.13,2014
	IRGASON	15		Dec.16,2013-Jan.3,2014, Mar.12-Apr.13,2014
Radiation	CNR4	14	$K_{\downarrow}$, $K_{\uparrow}$, $L_{\downarrow}$, $L_{\uparrow}$, R_n	Jun.2013-Apr.4,2014
	PAR LITE	14	PAR	
MET	HMP155A	11, 14	T_a, RH	Jun.2013-Apr.4,2014
	SI111	11	T_{skin}	
	TE525MM	11	Precipitation	
Soil	Hukseflux HFP01	0.08, 0.2, 0.5	Soil heat flux	Jun.2013-Apr.4,2014

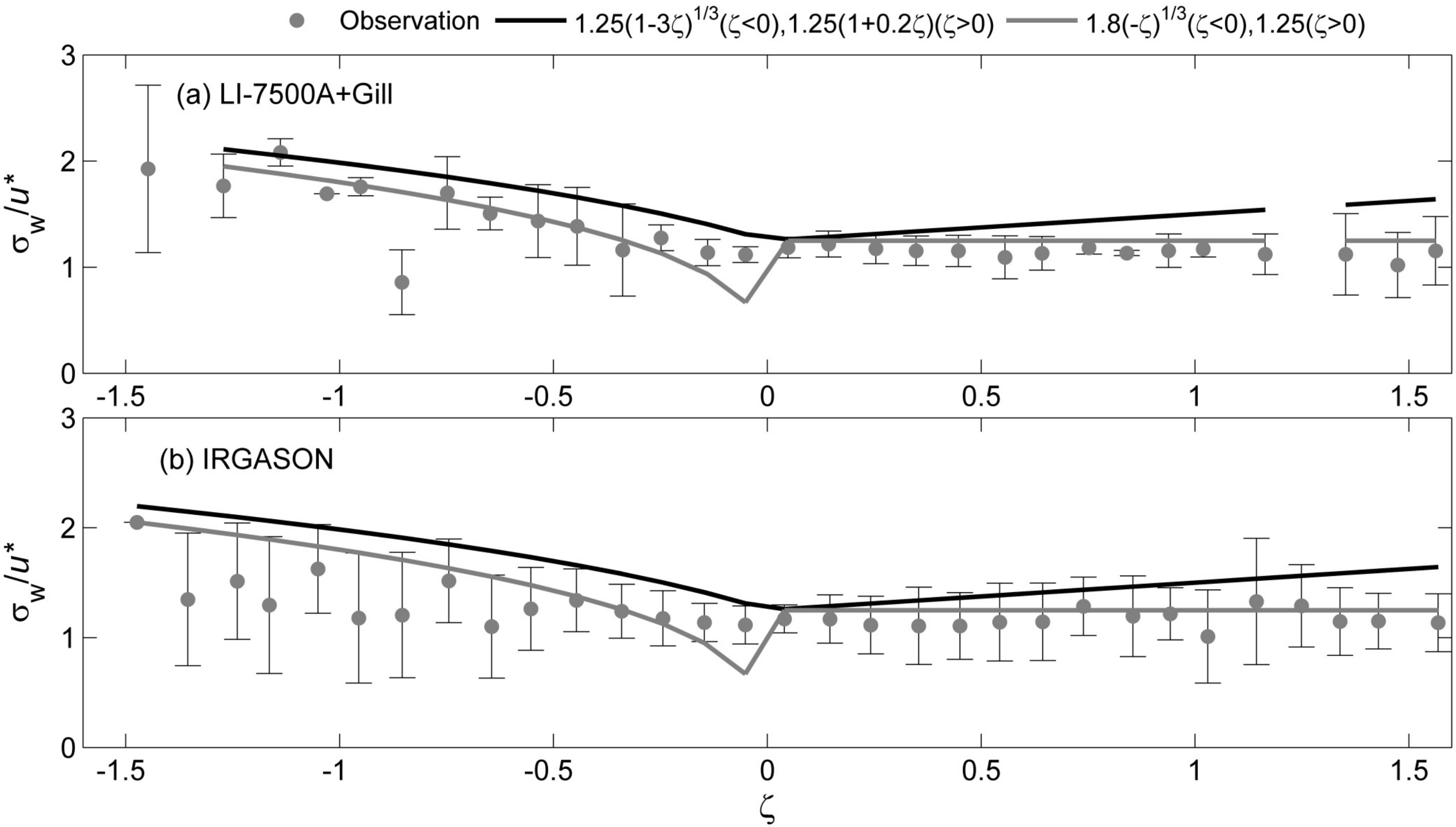
Evaluation period: Dec.24, 2013—Jan.4, 2014 (Winter)

Mar.12, 2014—Apr.13, 2014 (Spring)

Buds appear on some trees

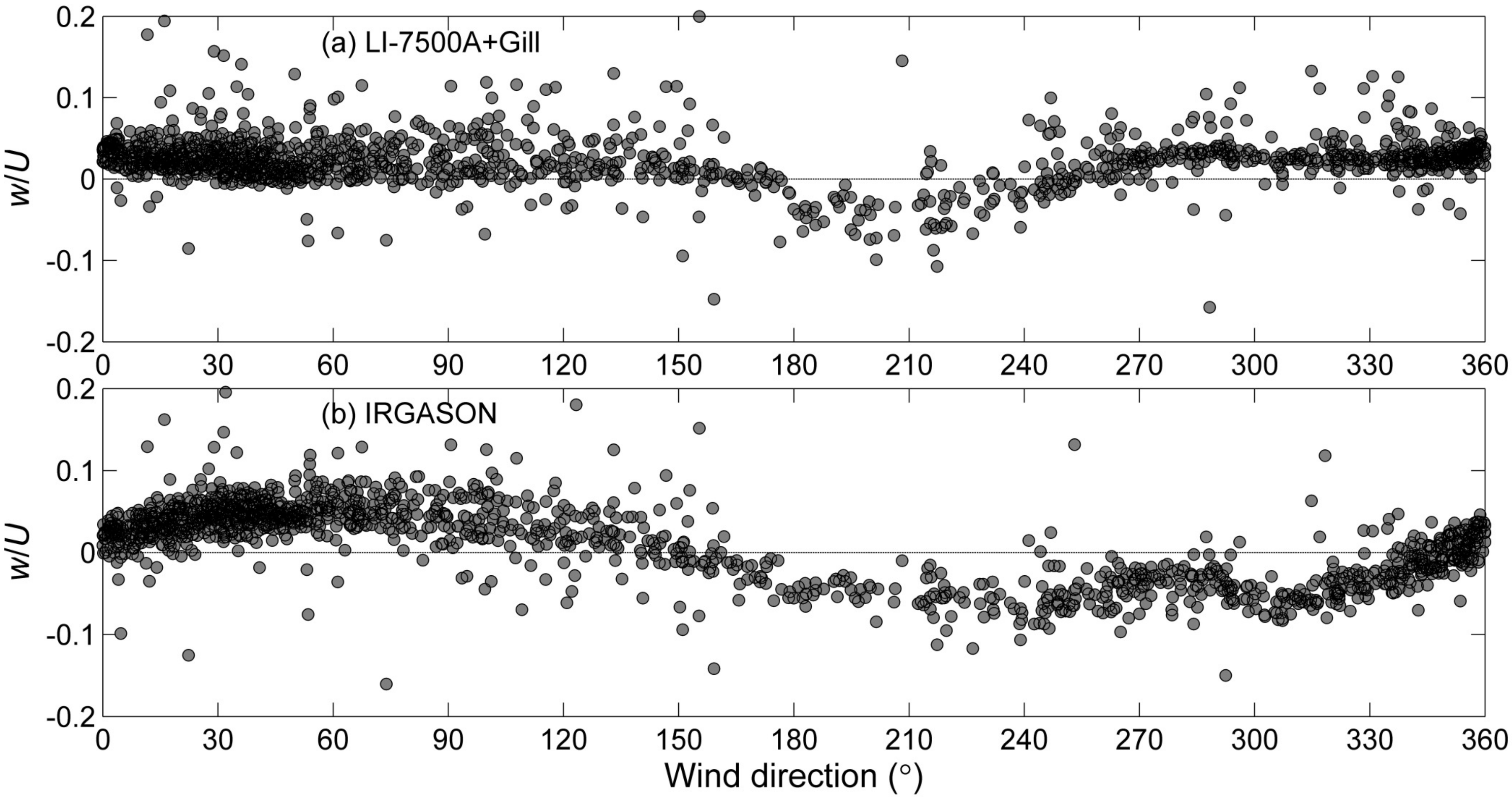
(By Jian Cui)

Monin-Obukhov scaling

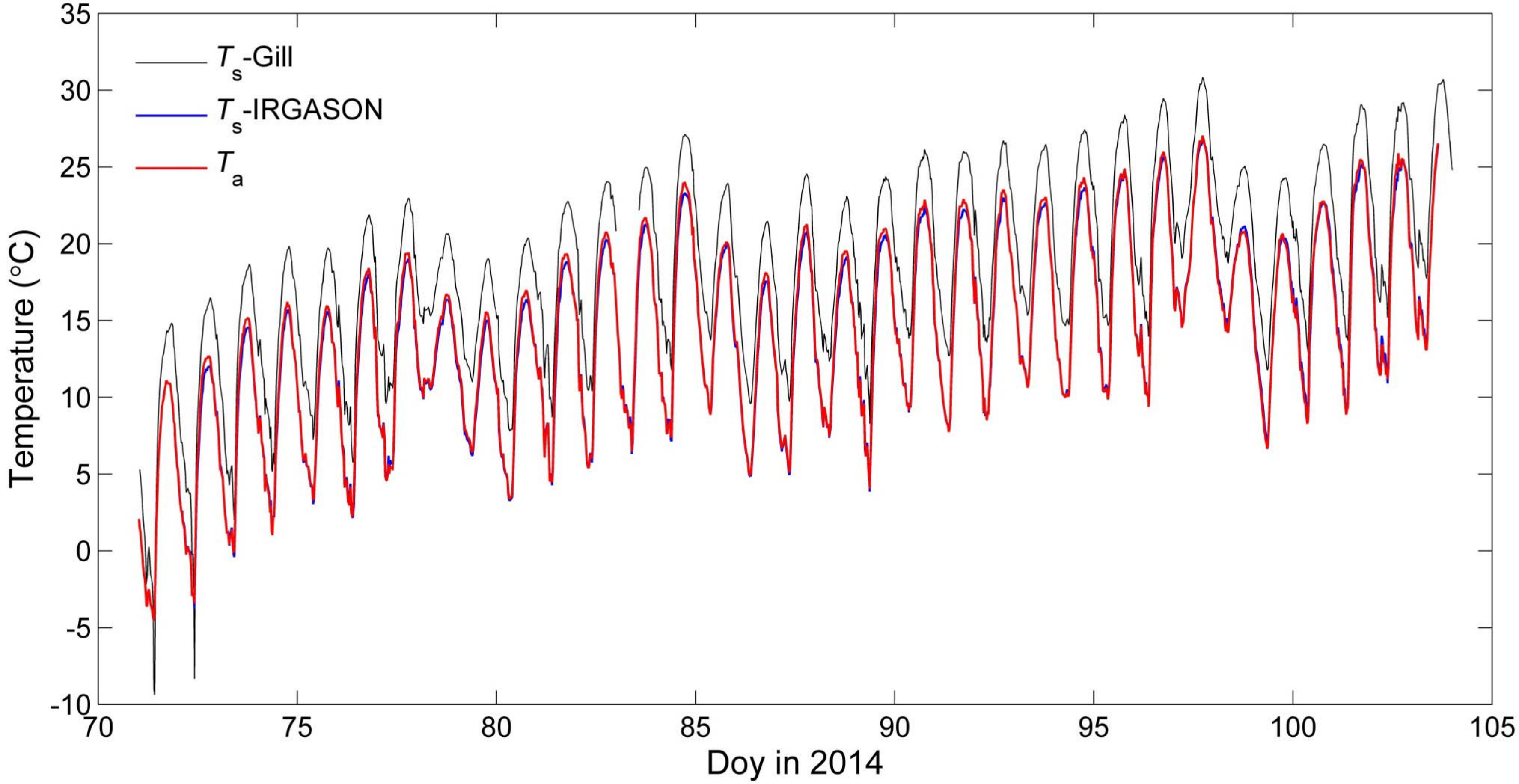


(Garratt, 1992; Kaimal and Finnigan 1994)

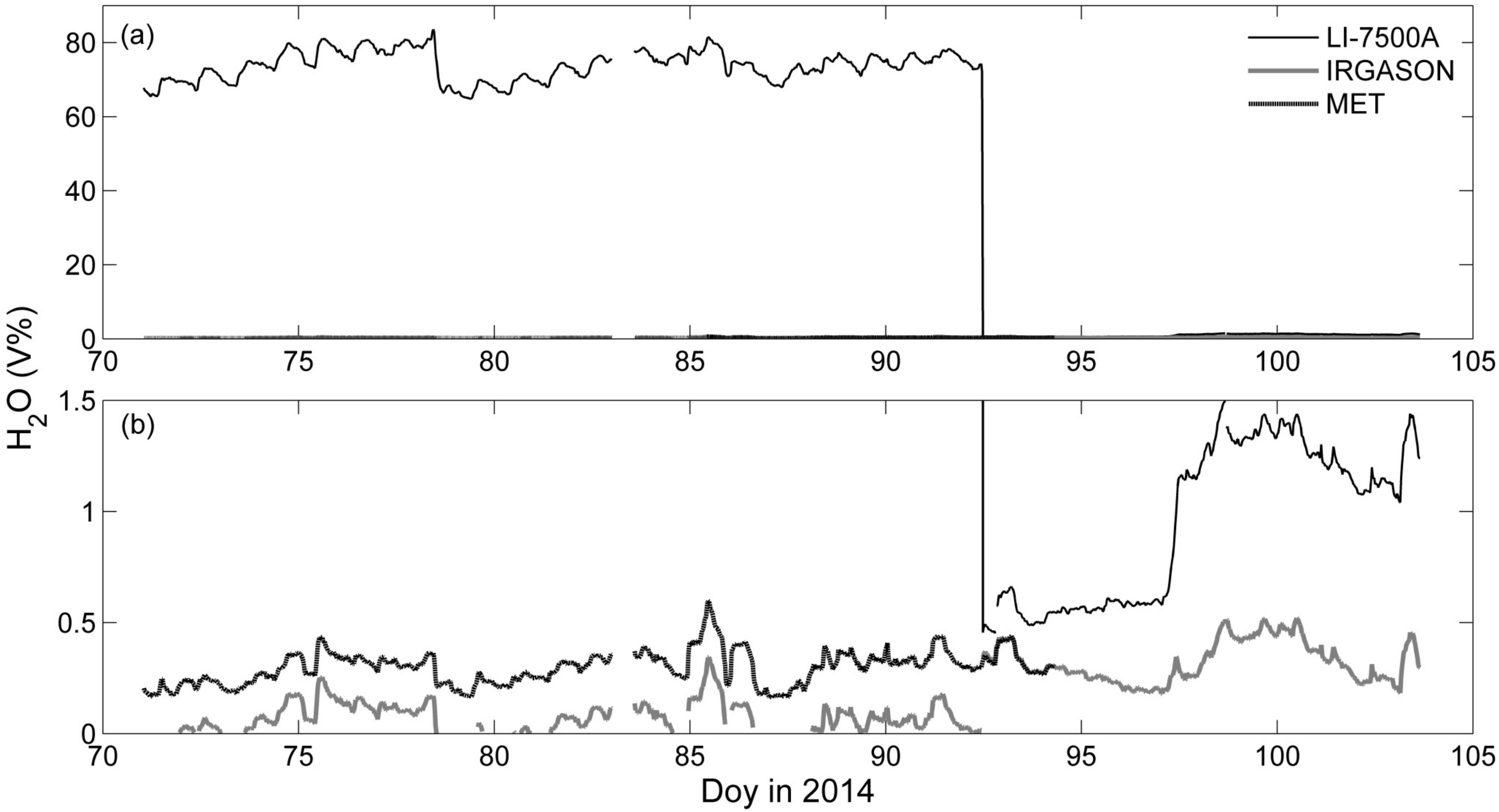
Tilt as a function of wind direction



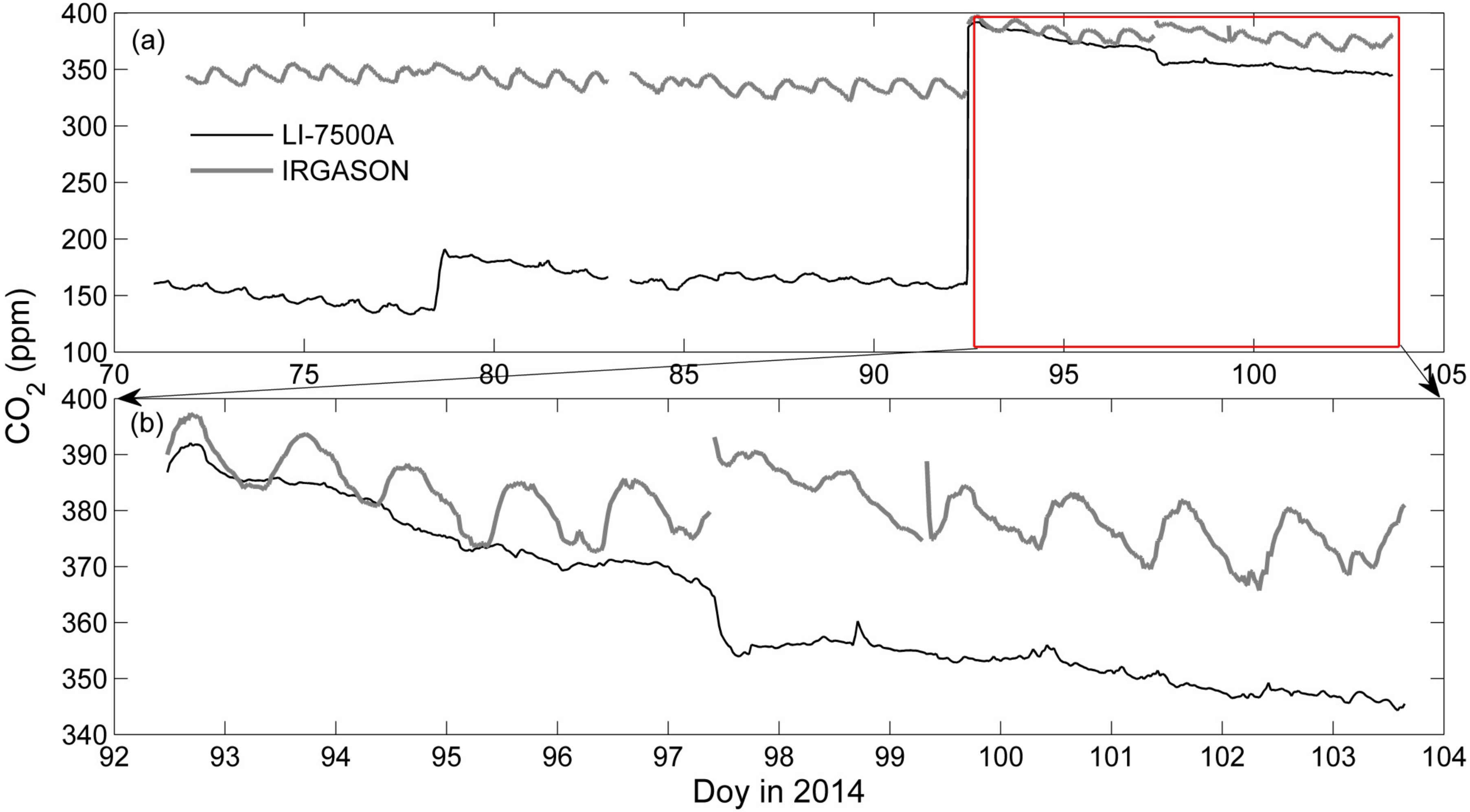
Time series of temperature



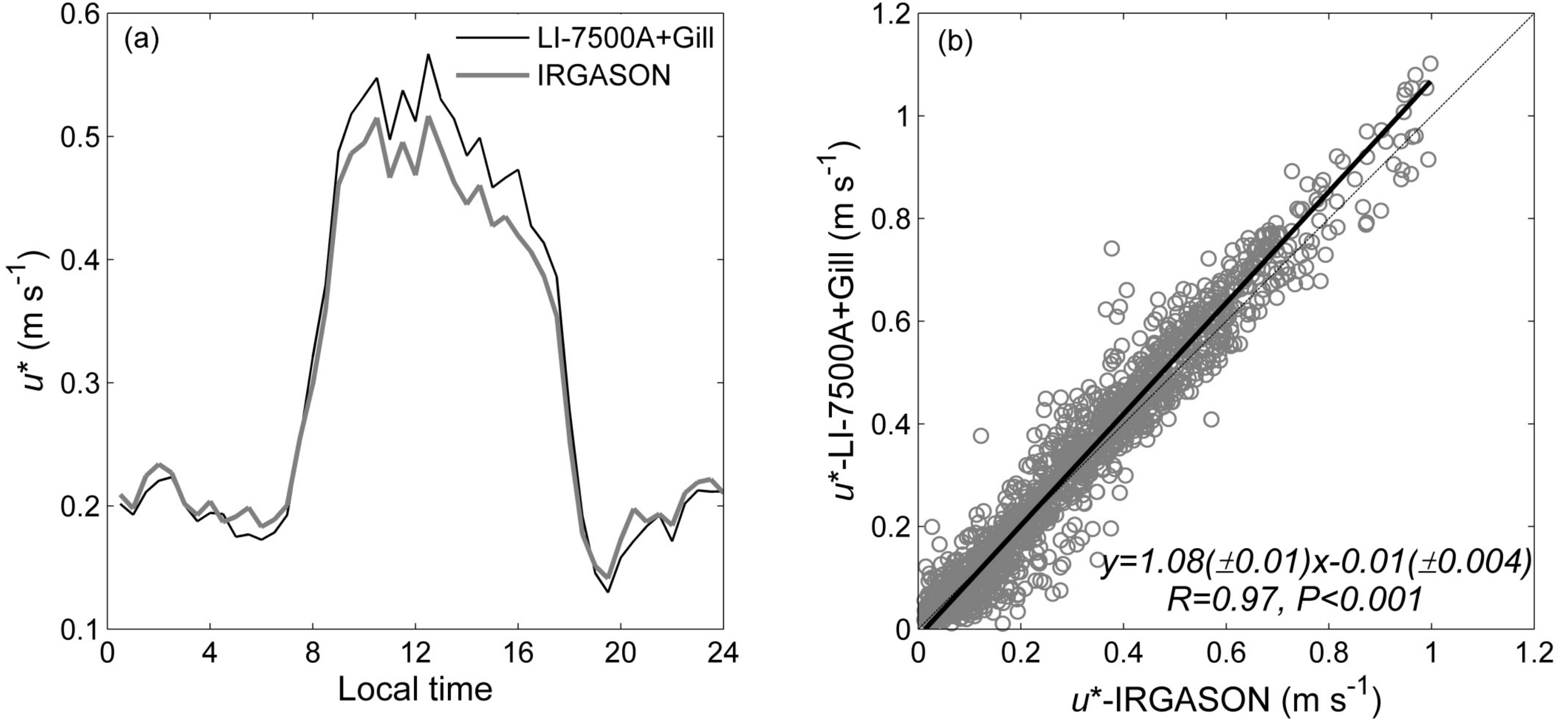
Time series of H_2O concentration



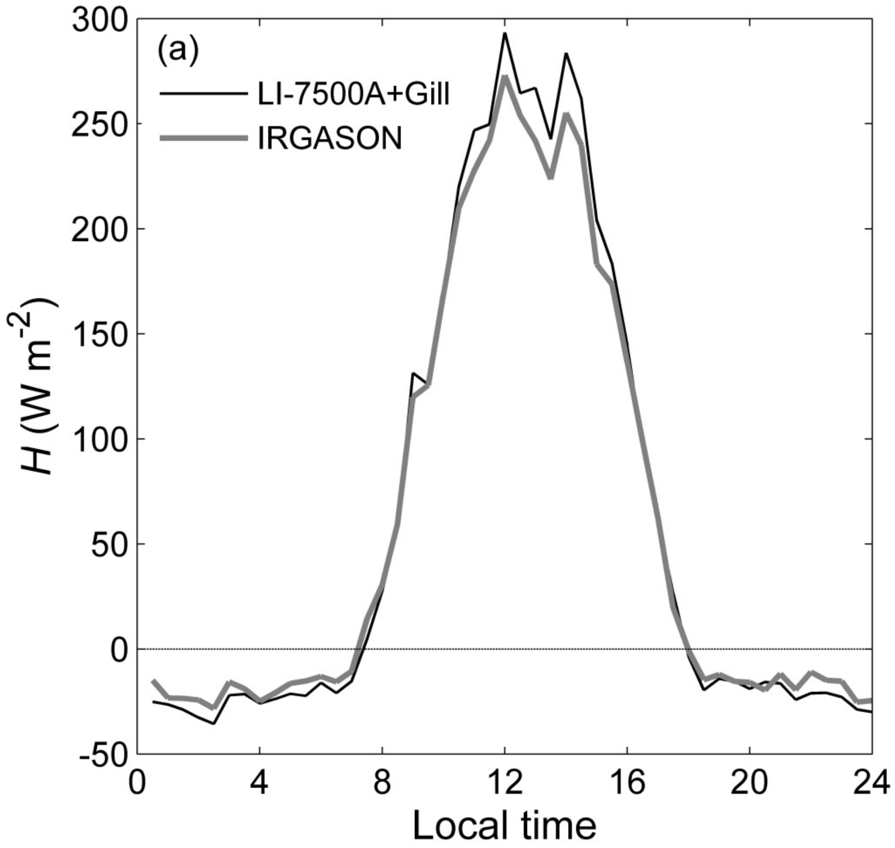
Time series of CO_2 concentration

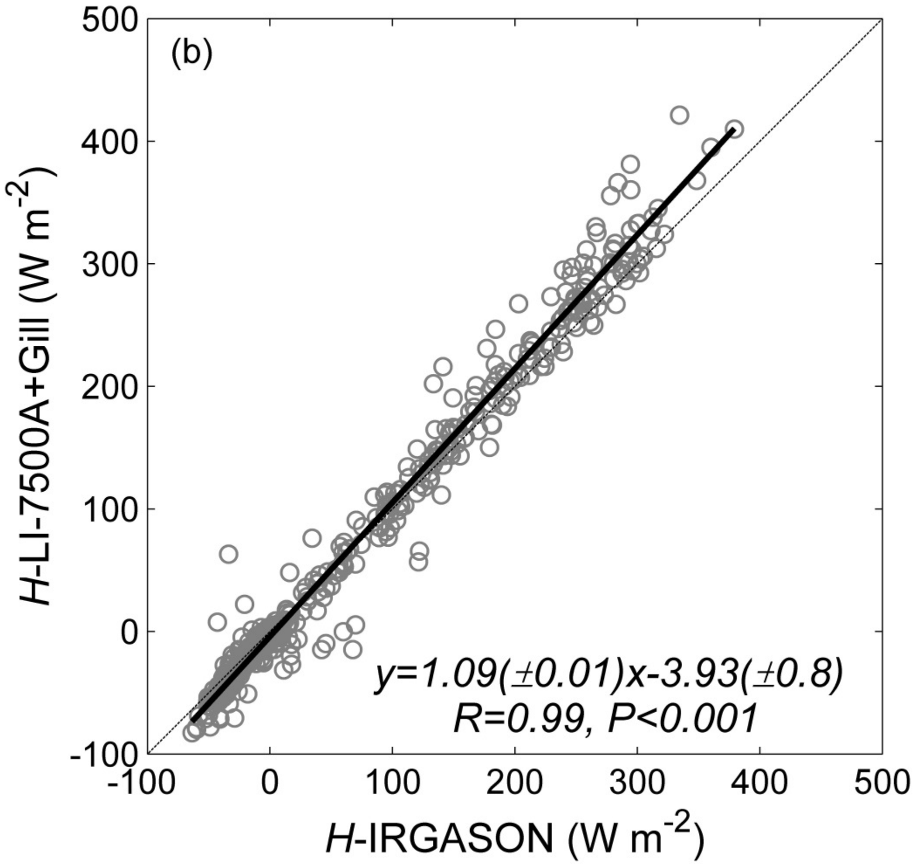


Comparison of friction velocity

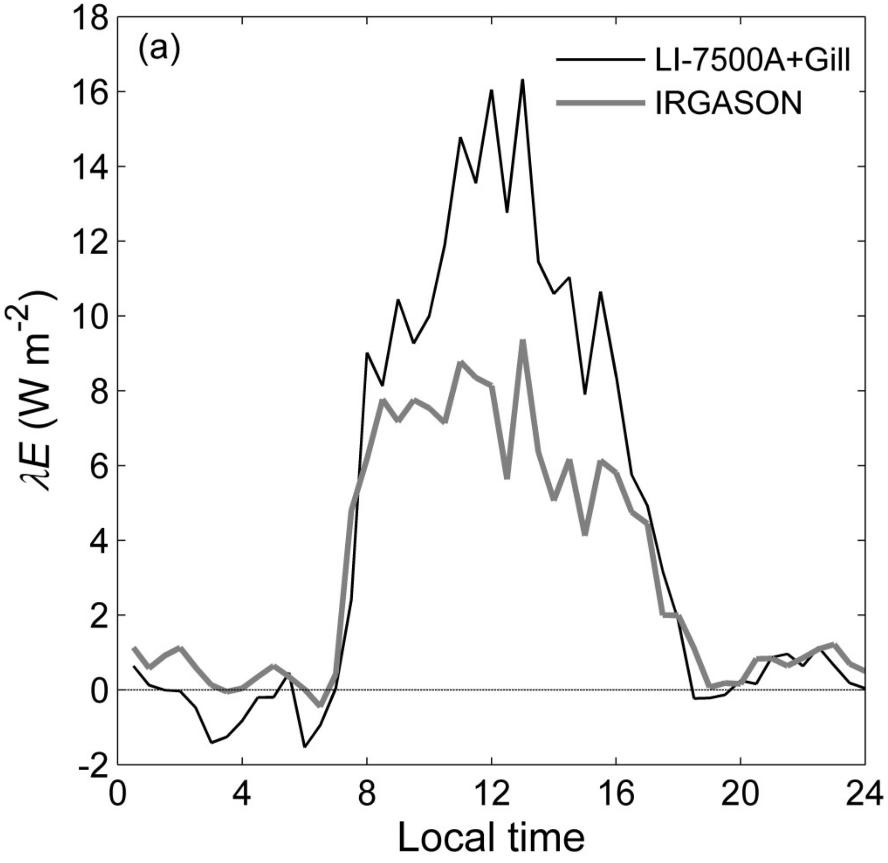


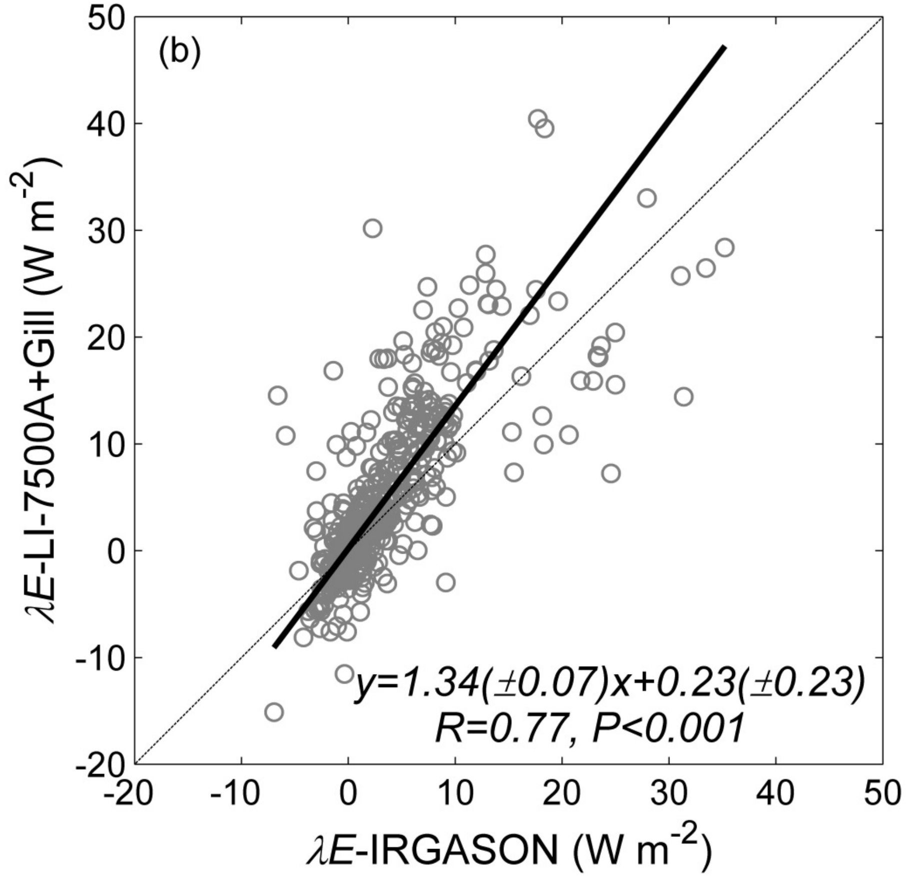
Comparison of sensible heat flux



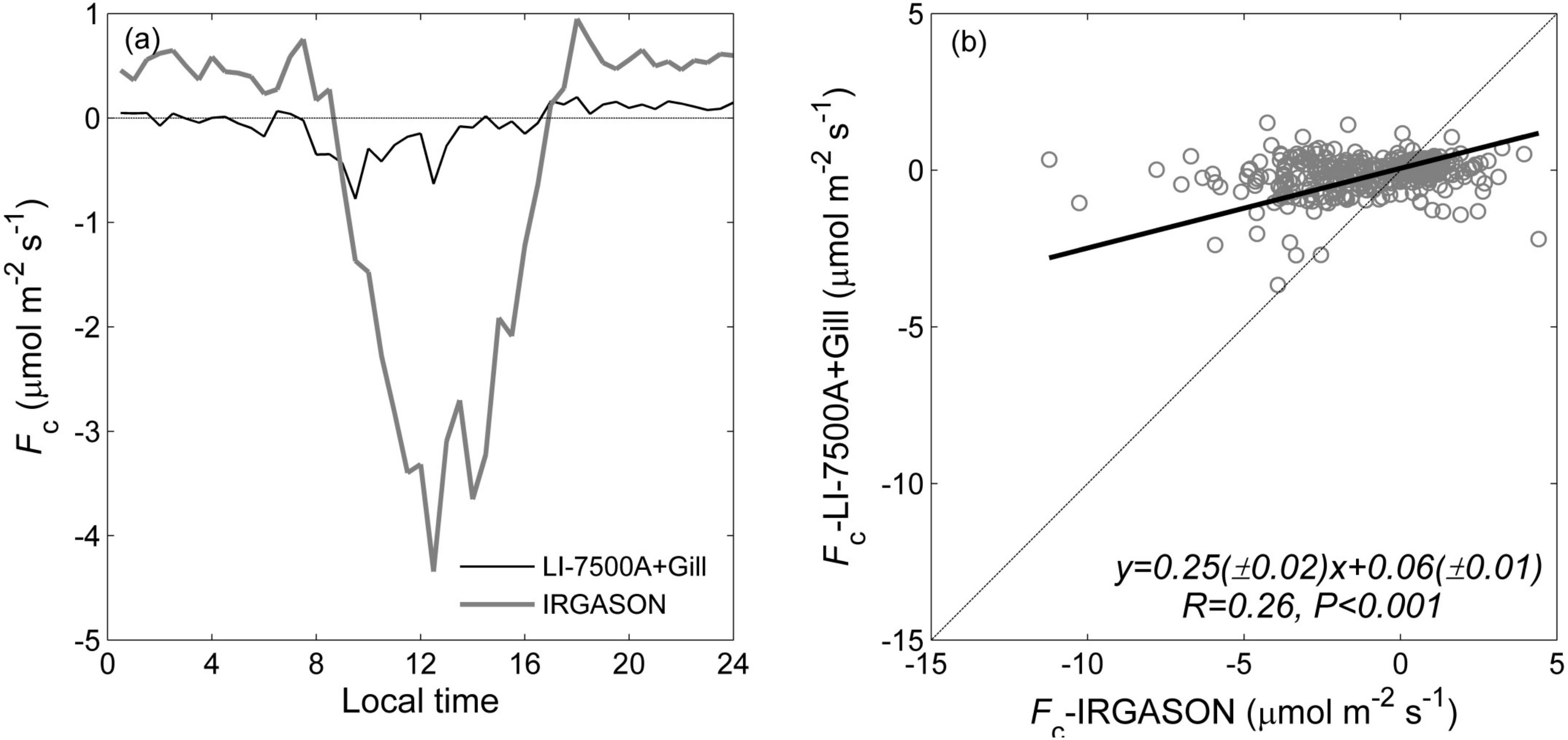


Comparison of latent heat flux





Comparison of CO_2 flux



WPL correction and development

$$\lambda E = \lambda \cdot \overline{w'\rho'_v} + \lambda \cdot \mu\sigma \cdot \overline{w'\rho'_v} + \lambda \cdot (1+\mu\sigma) \cdot \frac{\rho_v}{T_a} \cdot \frac{H}{\rho_a \cdot C_p}$$

$$F_c = \overline{w'\rho'_c} + \mu \cdot \frac{\rho_c}{\rho_d} \cdot \overline{w'\rho'_v} + (1+\mu\sigma) \cdot \frac{\rho_c}{T_a} \cdot \frac{H}{\rho_a \cdot C_p}$$

$$Fc_M = Fc_{raw} + WPL_M$$

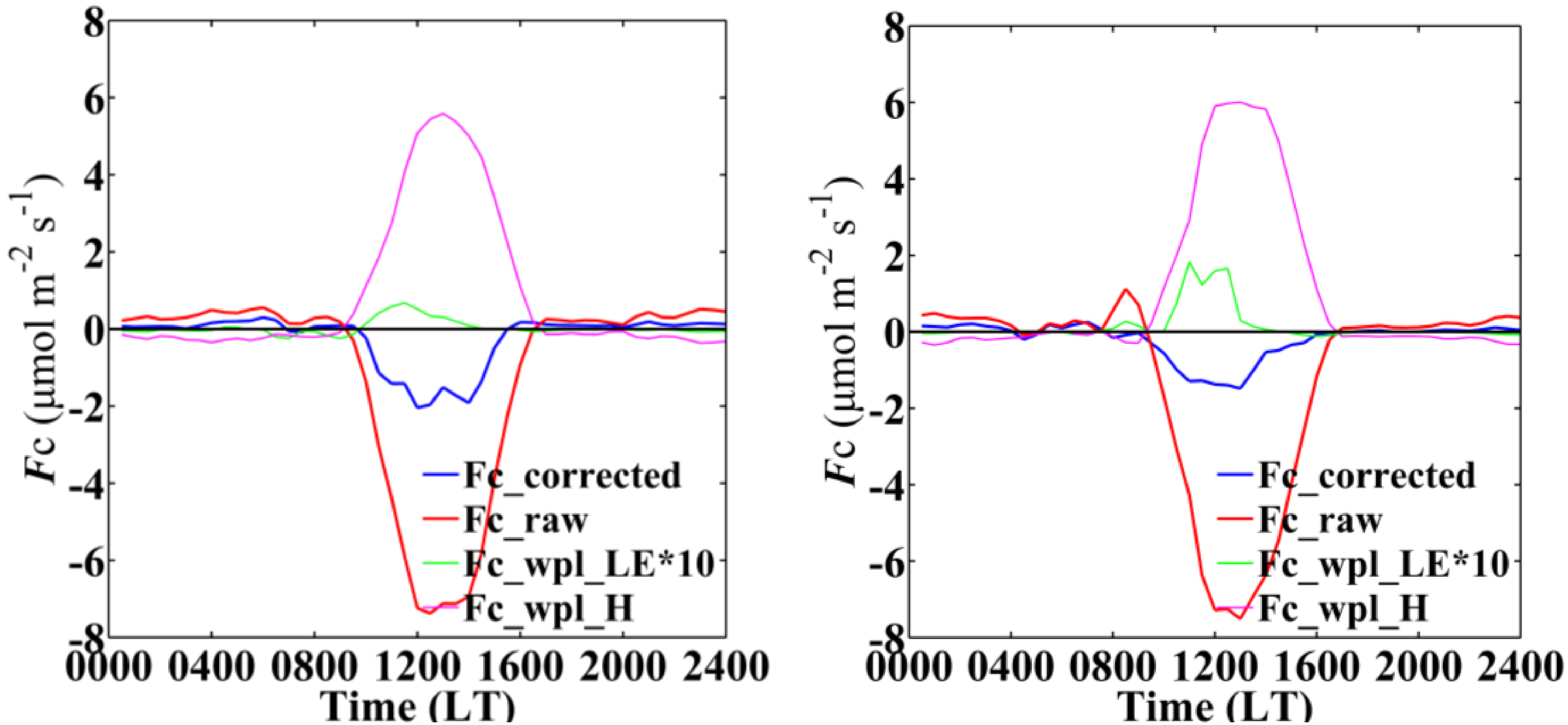
$$Fc_T = Fc_{raw} + WPL_T$$

$$WPL_T = WPL_M \times \frac{\chi_T}{\chi_{M.moist}}$$

$$Fc_T = Fc_{raw} + WPL_M \times \frac{\chi_T}{\chi_{M.moist}} = Fc_M + WPL_M \times \left(\frac{\chi_T}{\chi_{M.moist}} - 1 \right)$$

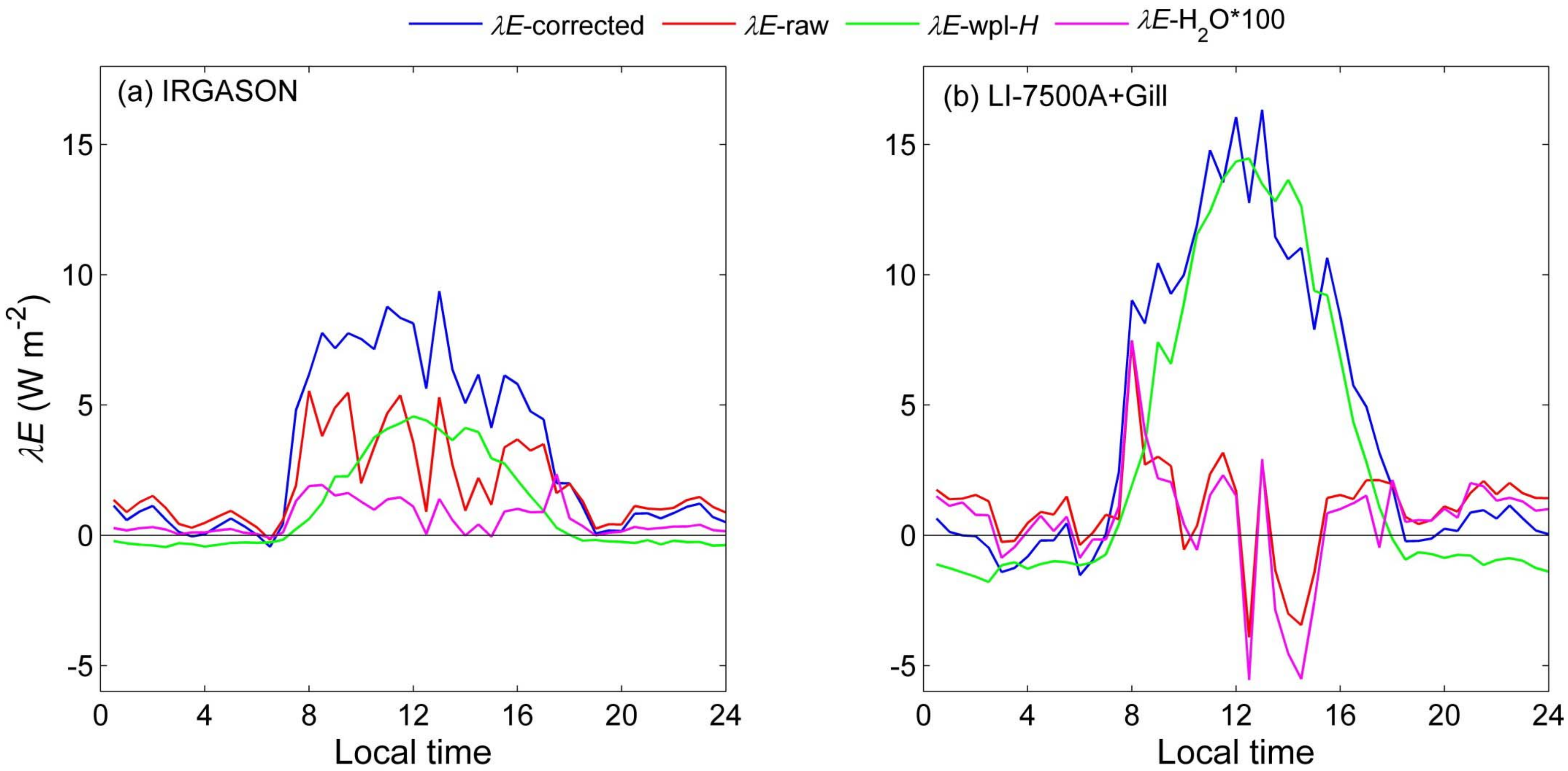
(Webb et al., 1980; Lee, 2012)

WPL correction for CO_2 flux in winter field campaign

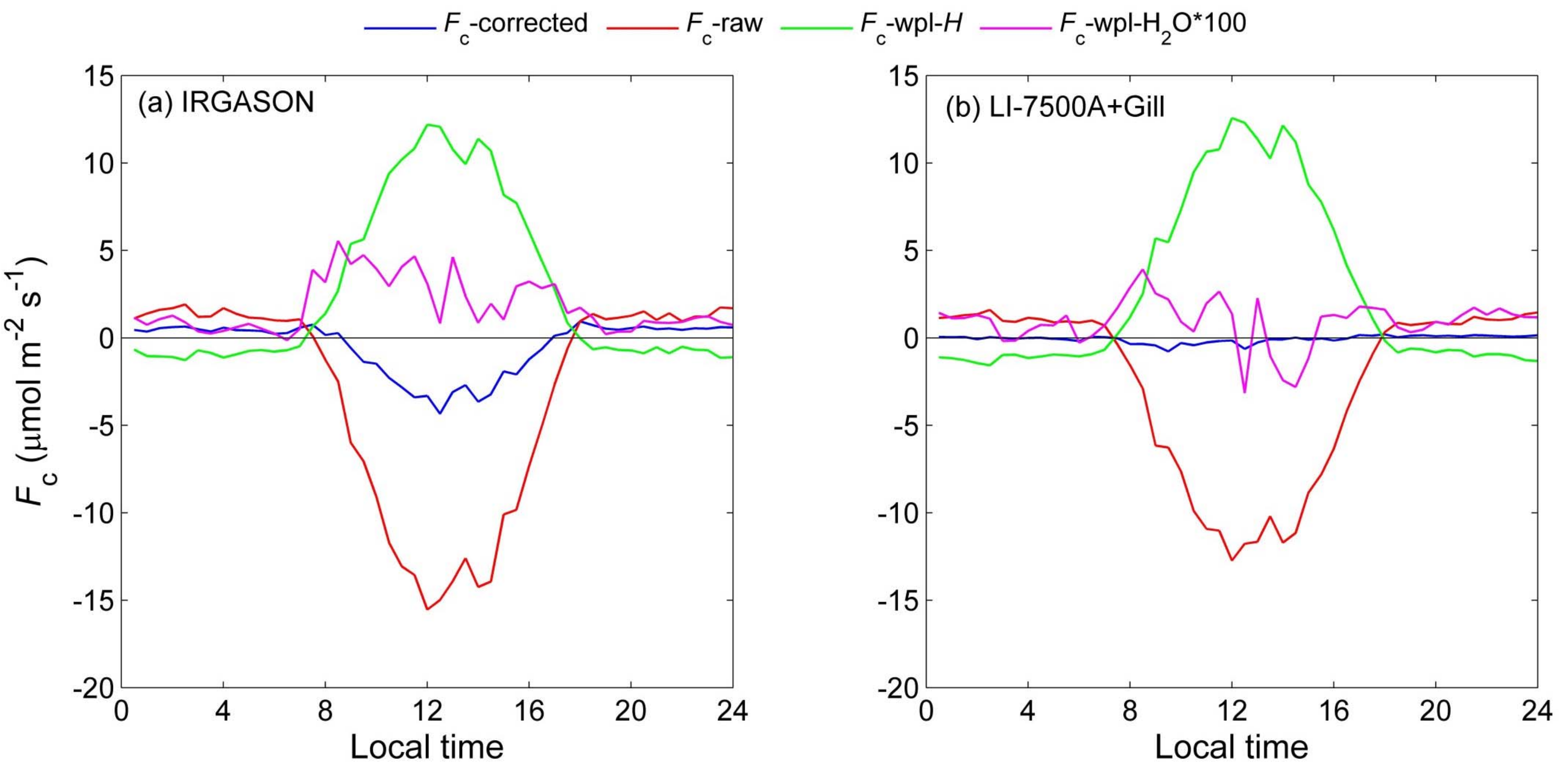


(Xu et al., 2014)

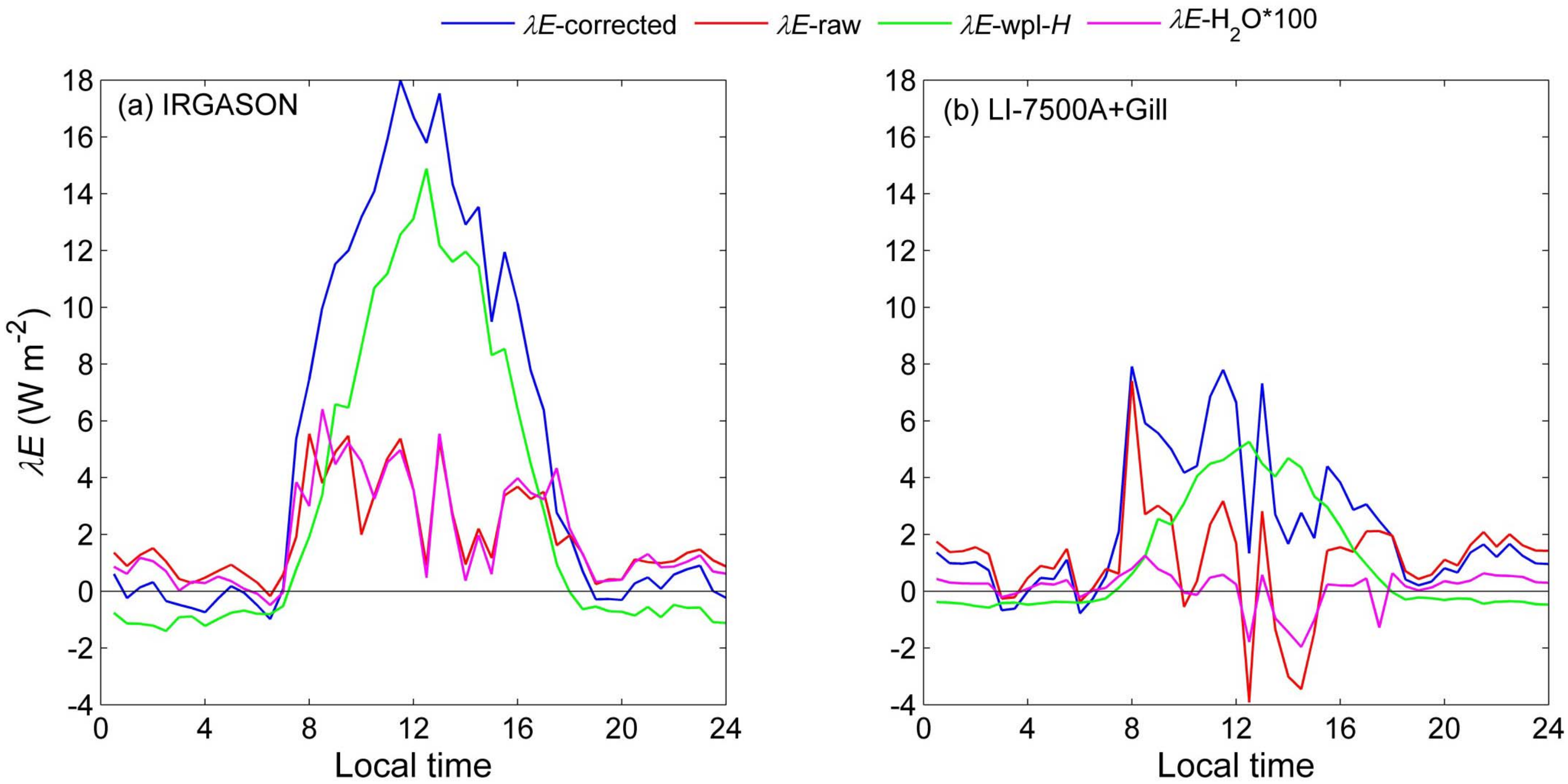
WPL correction for latent heat flux



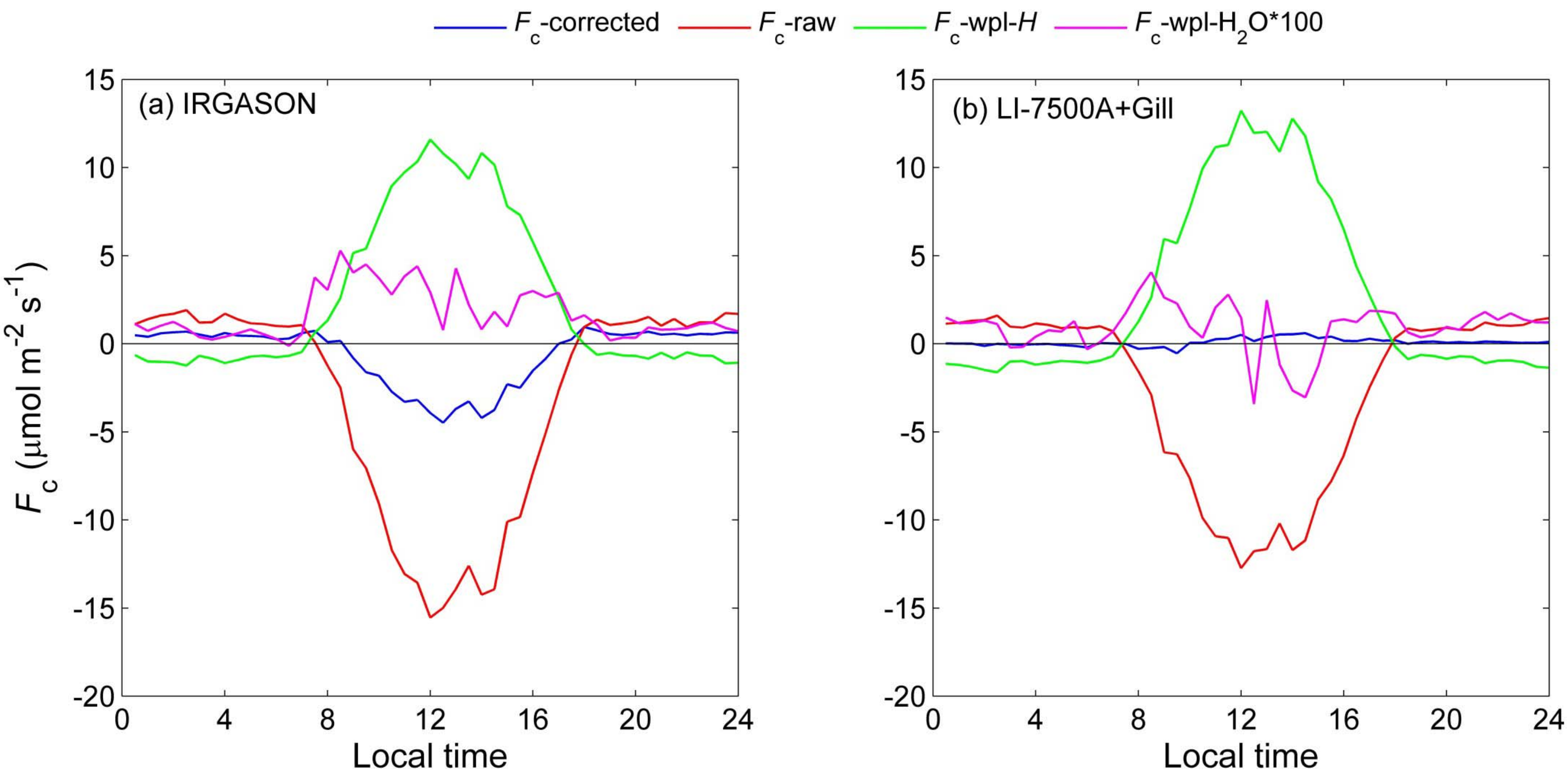
WPL correction for CO_2 flux



WPL correction for latent heat flux by exchanging the H_2O concentration



WPL correction for CO_2 flux by exchanging the CO_2 concentration



Thank you!

Date	Note	Participants
Dec.16, 2013-Jan.3, 2014,	With self-heating, pump broke down	Jiaping Xu, Lichen Deng
Mar.12, 2014	Replaced by a new IRGASON	Cheng Liu, Cheng Hu
Apr.13, 2014	Finished the IRGASON project in Xinjiang	Jian Cui, Jing Shen