Update on IRGASON Project

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Outline

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1. Background & Objective
In typical winter or desert, the flux is about of 0.2-0.5 mg CO$_2$·m$^{-2}$·s$^{-1}$. 
To evaluate the performance of IRGASON in low flux conditions and compare it with Gill+Li-7500A system.

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

• EddyPro 5.0 (from 10 Hz to 30 min)
• Tilt correction: double rotation
• Detrend: block average
• Time lag detection: covariance maximization
• Compensate density fluctuation: WPL correction
• FFT: Hamming (50)
• Spectra correction: low frequency (Moncrieff et al., 2004),
• high frequency (Moncrieff et al., 1997)
2. updated results
Fig. 1. Fc (IRGASON against Gill+Li-7500A) in Xinjiang.
Fig. 2. The time series of Fc in Xinjiang.
Negative Fc could be found at noon with low wind speed.

\[ u < u_{\text{avg}} \quad \rightarrow \quad u' > 0 \]
\[ w'u' < 0 \]
\[ T_a \quad \rightarrow \quad \text{CO}_2' < 0 \]
Table.1 Flux carbon in desert in winter.

<table>
<thead>
<tr>
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<th>IRGASON</th>
<th>Gill+Li-7500A</th>
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<tbody>
<tr>
<td>C (mg/(m²·s))</td>
<td>-0.516</td>
<td>-1.734</td>
</tr>
<tr>
<td>C (g/(m²·yr))</td>
<td>-92.49</td>
<td>-310.70</td>
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Fc_wpl = Fc_raw + Fc_wpl_LE + Fc_wpl_H

Fc_wpl: Carbon dioxide flux after WPL correction, mg/(m²·s)
Fc_raw: Raw carbon dioxide flux, mg/(m²·s)
Fc_wpl_LE: latent heat correction, mg/(m²·s)
Fc_wpl_H: Sensitive heat correction, mg/(m²·s)
*pressure and self-heating also will be considered in some cases.
Fig. 4. The diurnal composite of Fc_IRGASON in Xinjiang.
Fig. 5. The diurnal composite of Fc_Gill+Li-7500A in Xinjiang.
Fig. 6. $\lambda E$ and $H_c$ (IRGASON against Gill+Li-7500A) in Xinjiang.
Fig. 7. The diurnal composite of $\lambda E$ in Xinjiang.
\[
F_{c\_wpl\_H} = \left[ \left( 1 + \mu \cdot \sigma \right) \cdot CO_2/(T_a+273.15) \right] \cdot \left[ H_{c\_wpl}/(\rho_{\text{oua}} \cdot C_p) \right]
\]

\( \mu = 1.6077 \); ratio of molecular weight of dry air to that of water vapor
\( C_p = 1004.67 \); specific heat capacity of air, J/(kg.K)
\( \sigma \): \( H_2O \) density against dry air density
\( \rho_{\text{oua}} \): wet air density, g/m\(^3\)
\( \rho_{\text{oud}} \): dry air density, g/m\(^3\)
\( H_{c\_wpl} \): sensitive heat after WPL correction, w/m\(^2\)

\[
H_{c\_wpl} = (H_{s\_wpl} - \rho_{\text{oud}} \cdot C_p \cdot 0.514 \cdot (287.058 \cdot 0.001) \cdot (T_a+273.15)^2 \cdot w'H_2O'/(press)) \cdot (T_a/T_s)
\]

\[
H_{s\_wpl} = \rho_{\text{oua}} \cdot C_p \cdot w'T_s'
\]

\[T_s = (1 + 0.51q) \cdot T_a\]
First reason: $Ts$

Fig. 8. The diurnal composite of $Ts$ in Xinjiang.
Fig. 9. The time series of $T_s$ in Xinjiang.
Fig. 10. The diurnal composite of $H_c$ in Xinjiang.
Second reason: CO₂ and H₂O

Fig. 8. H₂O and CO₂ (IRGASON against Gill+Li-7500A) in Xinjiang.
Fig. 15. The diurnal composite of H$_2$O in Xinjiang.
Fig. 16. The diurnal composite of CO$_2$ in Xinjiang.
3. Conclusion

• 1. According to Fc, the performance of IRGASON was better than Gill+Li-7500A.
• 2. The error results from Ts and H bias.
4. Next step
Self heating

Same Ts, small radiation loading

Different Ts

The influence of self-heating will be explained by comparison data with and without self-heating.
Wet CO$_2$

The dry CO$_2$ can be calculated by WLG hourly data.
Fig. 1. The time series of $Ts$ in Xinjiang.
Fig. 2. The time series of $u^*$ in Xinjiang.
Fig. 3. The time series of H₂O in Xinjiang.
Fig. 4. The time series of CO$_2$ in Xinjiang.
Fig. 5. The time series of Hc in Xinjiang.
Fig. 6. The time series of $\lambda E$ in Xinjiang.
Fig. 7. The time series of $F_c$ in Xinjiang.
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Fig. 11. $\lambda E$ and $Hc$ (IRGASON against Gill+Li-7500A) in Xinjiang.
Fig. 12. Fc (IRGASON against Gill+Li-7500A) in Xinjiang.
Fig. 13. The diurnal composite of Ts in Xinjiang.
Fig. 14. The diurnal composite of $u^*$ in Xinjiang.
Fig. 15. The diurnal composite of H$_2$O in Xinjiang.
Fig. 16. The diurnal composite of CO$_2$ in Xinjiang.
Fig. 17. The diurnal composite of $H_c$ in Xinjiang.
Fig. 18. The diurnal composite of $\lambda E$ in Xinjiang.
Fig. 19. The diurnal composite of Fc_IRGASON in Xinjiang.
Fig. 20. The diurnal composite of Fc_Gill+Li-7500A in Xinjiang.
Fig. 21. The diurnal composite of wind speed in Xinjiang.