26 October 2012

Dennis Baldocchi, Siyan Ma, and Joe Verfaillie
Department of Environmental Science, Policy and Management
University of California, Berkeley
Berkeley, CA 94720

Dear Dennis, Siyan, and Joe,

Thank you very much for hosting an AmeriFlux QA/QC site visit at Vaira Ranch (US-Var) from 19-30 March 2012 (DOY 79-89). Joe and Siyan were extremely helpful in providing logistical support, site access, and post-visit data. This report summarizes the findings and key recommendations from the comparison between the eddy covariance, radiation, and meteorological sensors at the site (Vaira) and the AmeriFlux Portable System (AmeriFlux PS).

Please disregard the previous site report. You identified that some of the data was corrupted due to a multiplexer malfunction at the site. Thank you for identifying that error and providing an updated dataset.

The AmeriFlux PS sensors were deployed to minimize separation (both horizontal and vertical) from the Vaira sensors (Table 1), to avoid interfering with existing tower infrastructure, and to prevent shadowing or wake effects. The AmeriFlux PS included two infrared gas analyzers (IRGAs). This comparison focuses on the open-path IRGA (LI-7500) which is identical to the IRGA used at Vaira Ranch.

A pair of figures is generated for each variable compared. The first is a time series of both data streams and the second figure is a scatter plot comparing both systems with a 1-to-1 line and a best fit linear regression. The enclosed figures only include periods where both datasets are available. Frequent rain events occurred during the later third of the comparison which limited some of the comparison data. Details of the AmeriFlux data processing and data screening are available on the AmeriFlux website.

Key Recommendations:

- Please consider calibrating your PAR sensor as it showed a positive bias relative to the AmeriFlux sensor. The Ameriflux QA/QC group provides reference PAR sensors for *in situ* calibrations upon request.
- The comparison of the CO_2 variances showed a consistent bias. Please check the units of the data provided, as none were given. I assumed the units were (mmol $m^{-3})^2$. Final fluxes agreed well so this may not be a significant result.

In closing, thank you for the updated dataset to recover the corrupted data from the multiplexer. For all reports, we request a summary from the site to describe how the enclosed recommendations will be addressed. I am available to provide further analysis or discussion of the results, if required. Please include any comments or feedback regarding the site visit so we can improve future AmeriFlux site visits. Thank you for working collaboratively with the AmeriFlux QA/QC group.

All the best,

W. Stephen Chan

Ameriflux QA/QC Lab
Department of Forest Ecosystems and Society
Oregon State University

Meteorological variables:

The Varia Ranch data acquisition system experienced a problem with a multiplexer during the site visit. A few data channels were unrecoverable and they were replaced with data from the nearby Tonzi Ranch AmeriFlux site. This occurred for measurements of air temperature and incoming shortwave radiation. Those comparisons are included in this report.

As mentioned above, the Varia air temperature data was substituted from a nearby site (Tonzi Ranch) and showed excellent agreement to the AmeriFlux PS (slope: 0.99, offset: 0.67^{o} C) (Figure 1). Barometric pressure measurements compared reasonably (slope: 0.94, offset: 6.02 kPa) but the time series shows that the pressure differences between the two systems fluctuated throughout the visit (Figure 2). Could this be related to the malfunctioning multiplexer? The previous dataset agreed more closely to the AmeriFlux sensor. Not a big issue, just an observation.

The AmeriFlux PS does not have a dedicated relative humidity (RH) sensor; however measurements from the Varia Ranch RH sensor (Viasala HMP45) were compared to water vapor data from the AmeriFlux open-path IRGA (LI-7500). The Vaira RH sensor and the AmeriFlux IRGA agree well on average (slope: 1.05, offset: -2.18 %) (Figure 3).

Radiation:

Varia Ranch had a four component radiometer (Kipp and Zonen CNR1), a PAR sensor, a pyranometer, and a diffuse radiation sensor. Incoming shortwave (SW_{in}) radiation (proxy data from Tonzi Ranch) agreed closely to the AmeriFlux PS (slope: 1.03, offset: 0.68 W m^{-2}) (Figure 4). The other three radiation components from the Varia Ranch CNR1 also had generally good comparisons (Figures 5-7).

The Varia photosynthetically active radiation (PAR) sensor had a positive bias relative to the AmeriFlux PS sensor (slope: 1.13, offset: 6.30 µmol m^{-2} s^{-1}) (Figure 8). I believe the Vaira PAR sensor was a Kipp & Zonen Par Lite, similar to the AmeriFlux sensor, so I do not suspect that any observed differences were due to spectral response differences between manufacturers. You may consider recalibrating your sensor. The AmeriFlux QA/QC lab provides reference PAR sensors for in-situ calibrations.

No comparison with diffuse radiation was conducted as that data was not provided. The AmeriFlux four component net radiometer and PAR sensors were calibrated in the spring 2012.

Winds and wind statistics:

The comparisons of the mean horizontal wind speed (slope: 1.01, offset: 0.01 m s^{-1}) (Figure 9) and the wind direction (slope: 1.02, offset: -3.56 ^{o}) (Figure 10) from the sonic anemometers were excellent. The variances of the wind components and sonic temperature had generally good agreement to the AmeriFlux portable system (Figures 11-14).

IRGA scalars and statistics:

Carbon dioxide and water vapor concentrations from the open-path IRGAs agreed well with only some small offsets (slope: 1.07, offset: -1.62 mmol m^{-3}, slope: 1.00, offset: -18.66 mmol m^{-3}, respectively) (Figures 15, 16). A comparison of the scalar variances was conducted to examine the response of the IRGAs. The variance of CO_2 (Figure 17) between the Varia and Ameriflux PS had a positive bias (slope: 1.40, offset: 0.01 (mmol $m^{-3})^2$). No units were provided for this variable in you Excel data so I assumed the units were the square of the ambient CO_2 measurement units. Please let me know if this is incorrect. The variance of H_2O (Figure 18) (slope: 1.09, offset: 10.30 (mmol $m^{-3})^2$) also showed a positive bias relative to the AmeriFlux sensor. What is the sampling frequency of your EC instruments?

Turbulent fluxes:

Overall, all reported fluxed values showed excellent agreement to those calculated from the AmeriFlux PS data (Figure 19-22). Comparisons of sensible heat (slope: 1.03, offset: 1.22 W m^{-2}) (Figure 19) and latent heat fluxes (slope: 0.97, offset: 1.24 W m^{-2}) (Figure 20) were very good between the two systems. Not surprisingly, the corresponding covariances for w'Ts' and w'q' agreed well (Figures 21, 22). The CO_2 fluxes from Vaira agreed closely (slope: 1.07, offset: 1.02 µmol m^{-2} s^{-2}) (Figure 23) although the covariance of w'c' was slightly underestimated on your end (Figure 24). I suspect that this might be due to a difference in sampling frequency. The AmeriFlux PS samples at 20 Hz. Since the final fluxes agree closely, the difference in w'c' appears to be well corrected. Lastly, friction velocity (Figure 25) compared well between the two systems (slope: 1.05, offset: 0.01 m s^{-1}).

Tables and Figures:

Sensor	Height (m) - AmeriFlux PS	Horizontal separation (m)	Vertical separation (m)	Orientation - AmeriFlux (°)	Orientation - Varia (°)
Eddy covariance	2.2	2.75	0.15	320	0
Radiation	1.8	8	0.8	181	168
Temperature	1.55	8	0.35	N/A	N/A

Table 1 – Measured separation and orientation between AmeriFlux PS and Vaira Ranch sensors during site intercomparison.

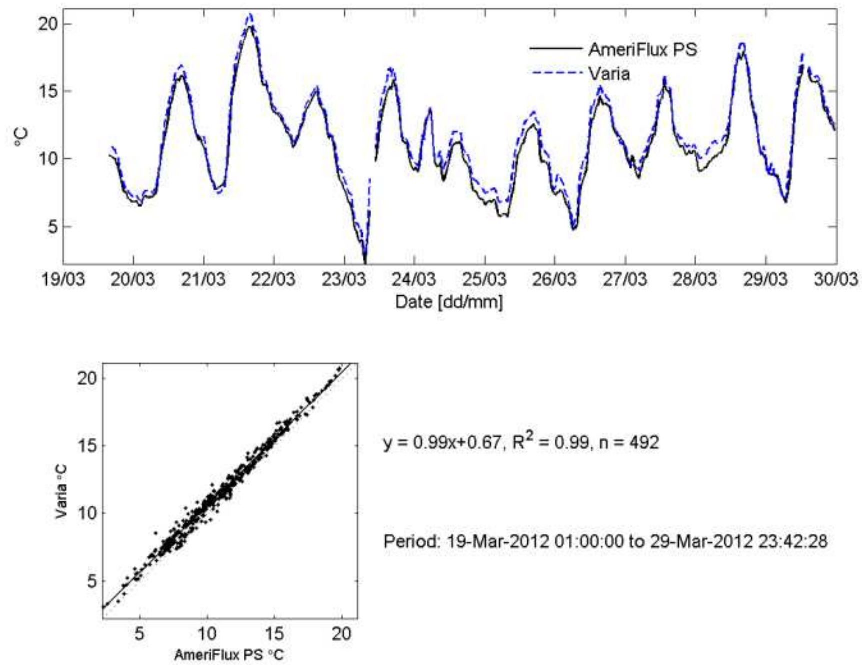

Figure 1 – Air temperature comparison. Vaira data is substituted with data from Tonzi Ranch.

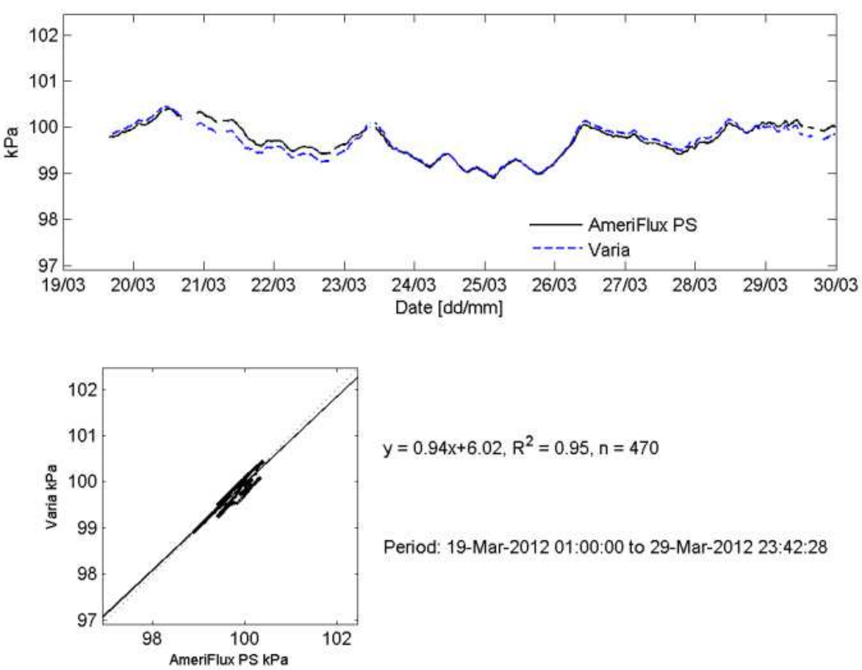

Figure 2 – Barometric pressure comparison.

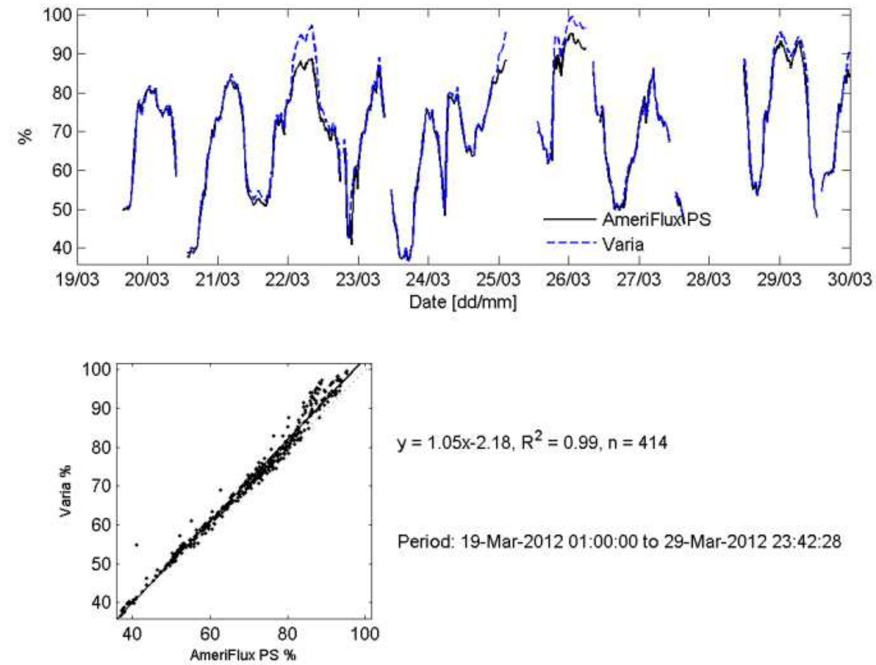

Figure 3 – Relative humidity comparison.

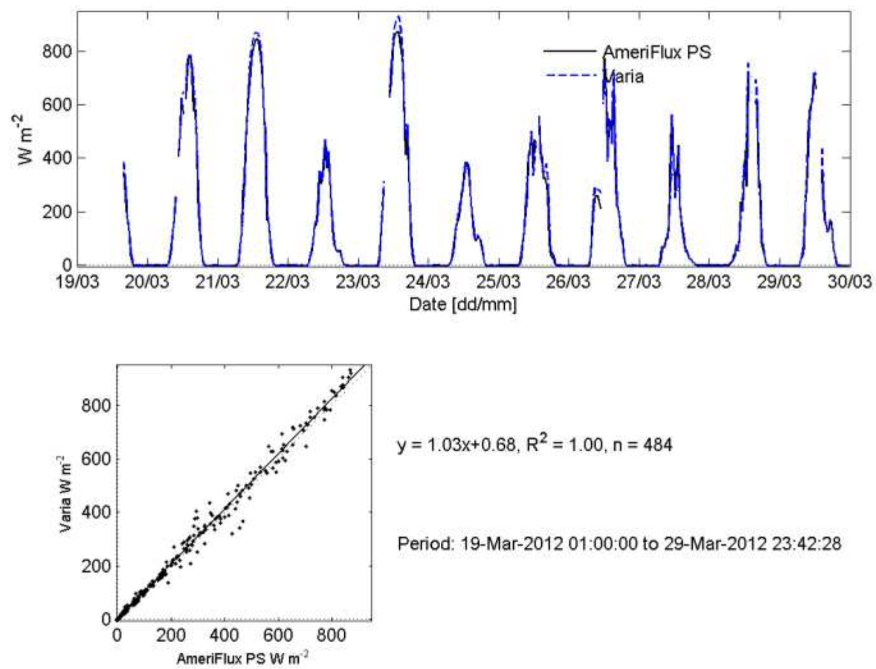

Figure 4 – Incoming shortwave comparison. Vaira data is substituted with data from Tonzi Ranch.

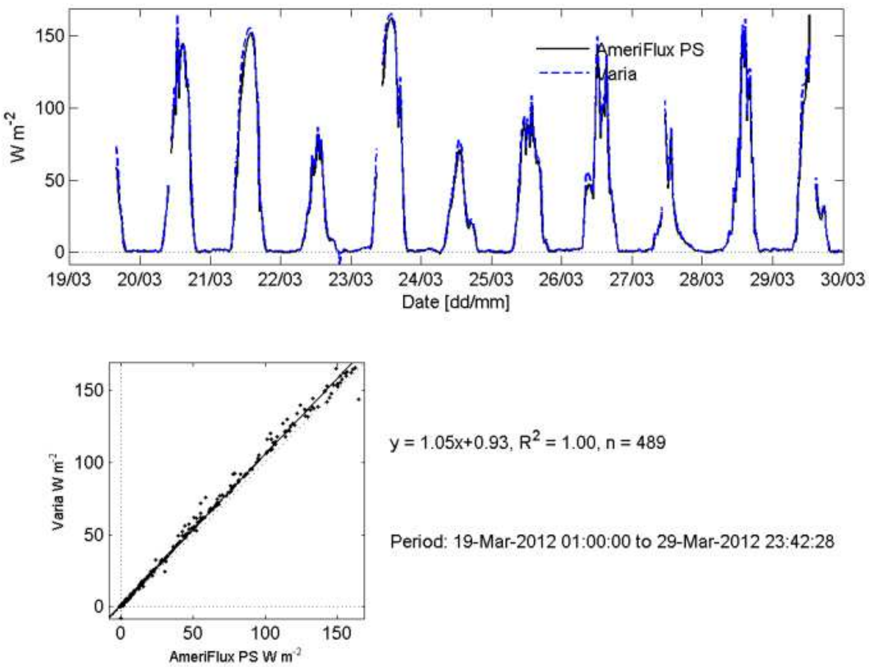

Figure 5 – Outgoing shortwave radiation.

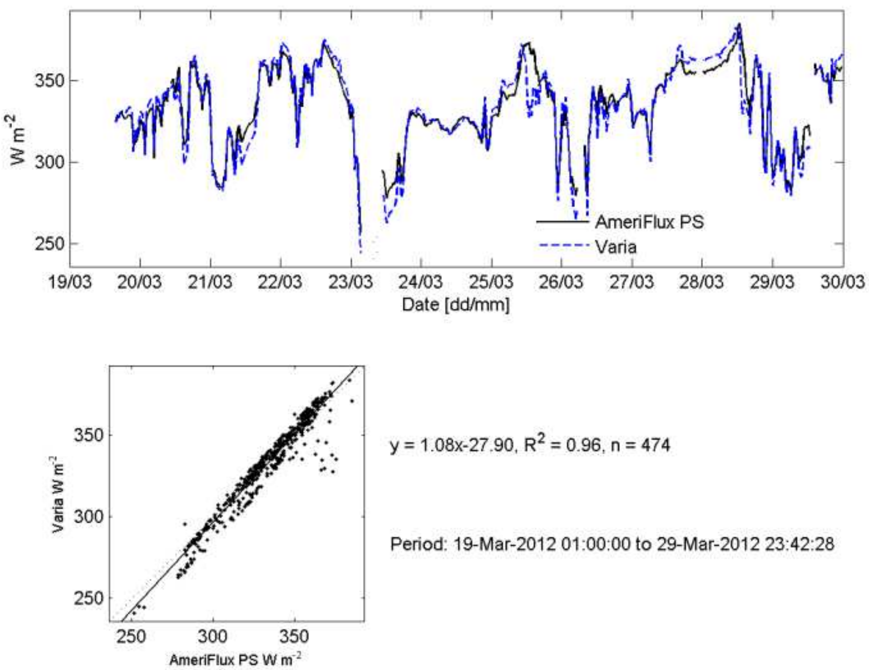

Figure 6 – Incoming longwave radiation.

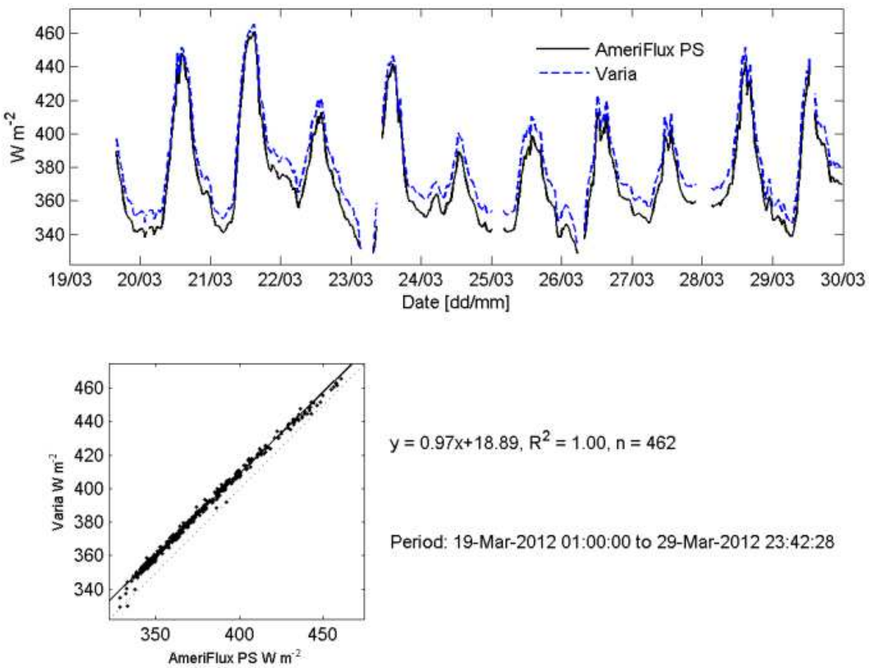

Figure 7 – Outgoing longwave radiation.

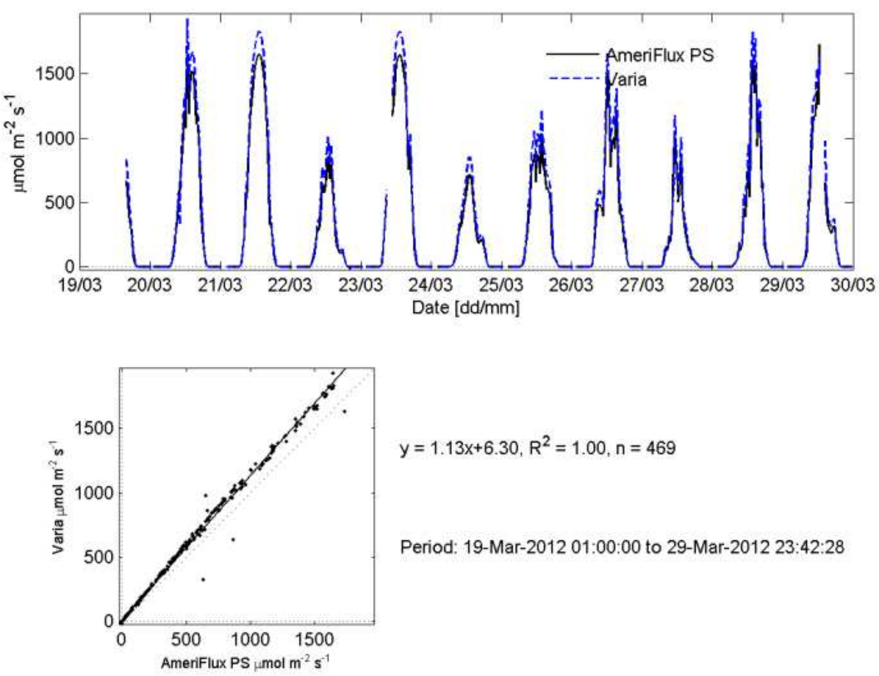

Figure 8 – Photosynthetically active radiation (PAR) comparison.

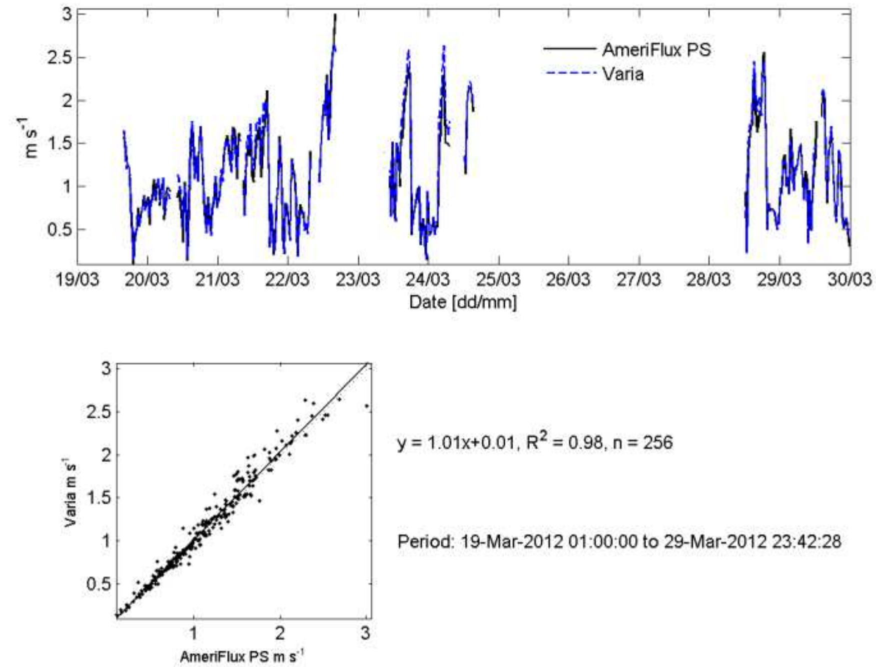

Figure 9 – Mean horizontal wind speed comparison.

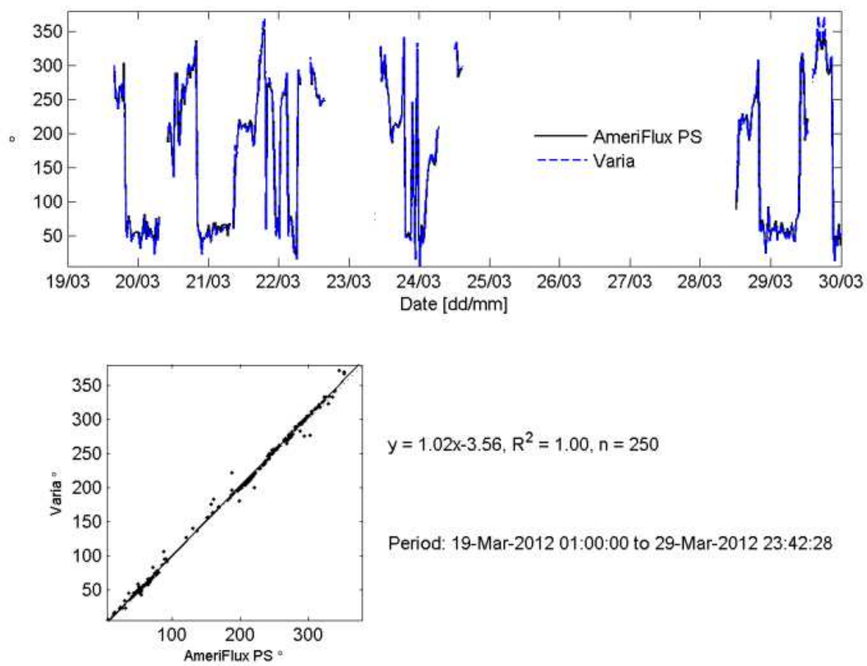

Figure 10 – Wind direction comparison.

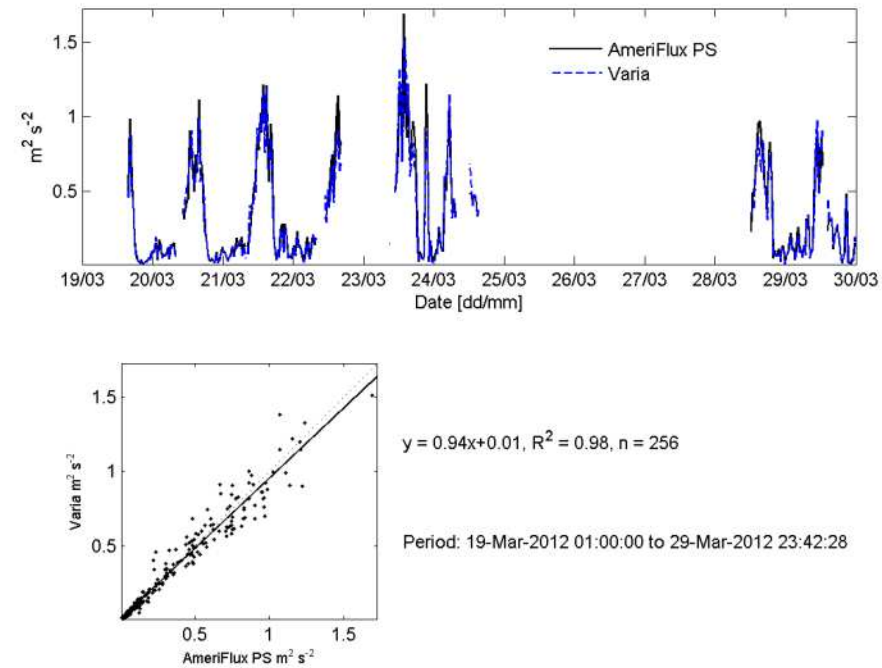

Figure 11 – Variance of u wind component.

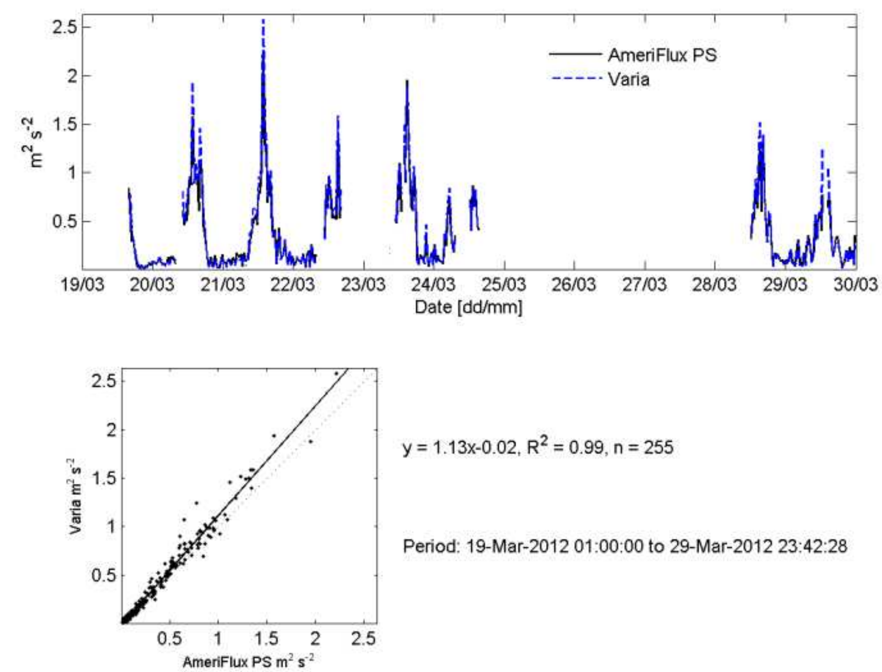

Figure 12 – Variance of v wind component.

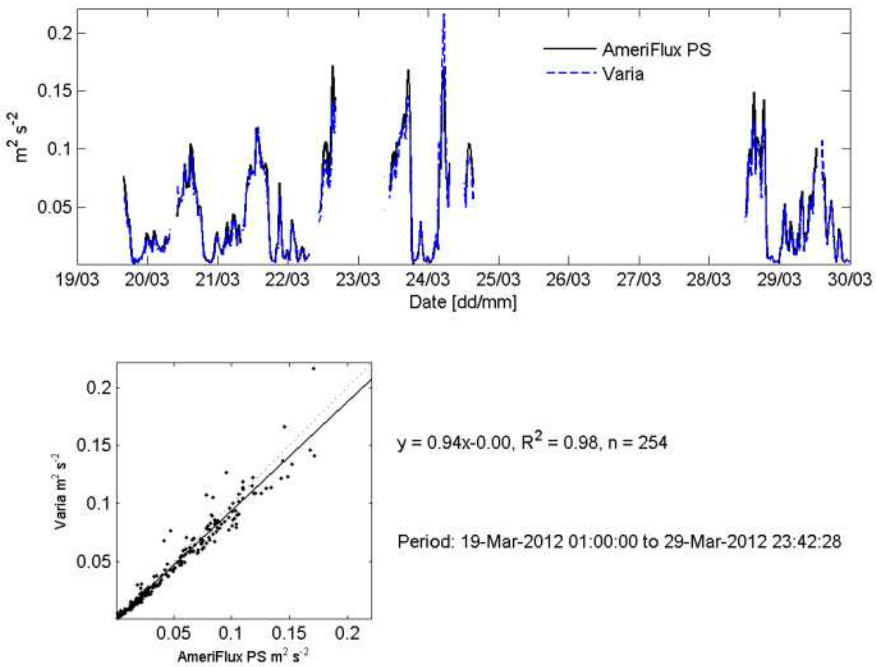

Figure 13 – Variance of w wind component.

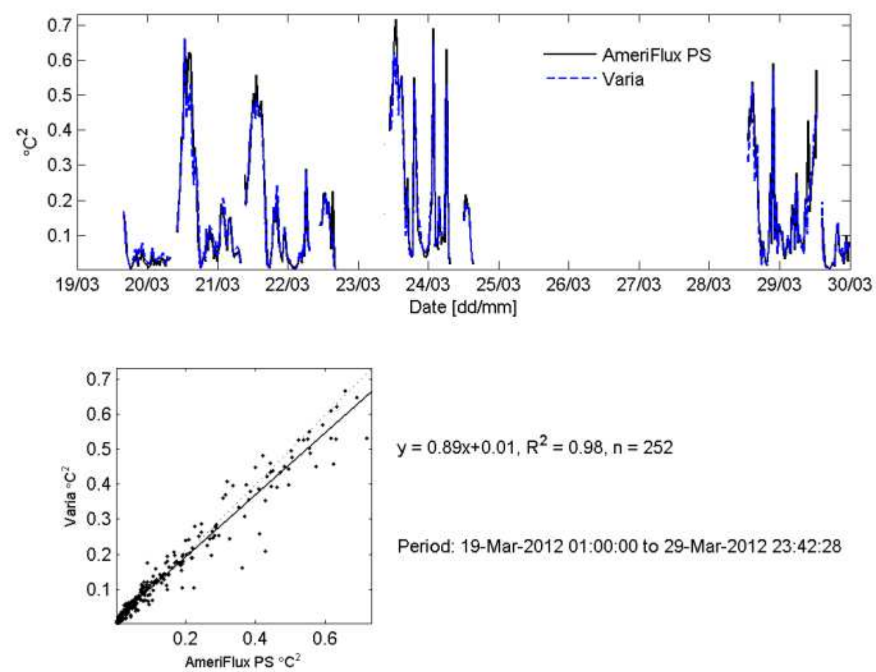

Figure 14 – Variance of sonic temperature.

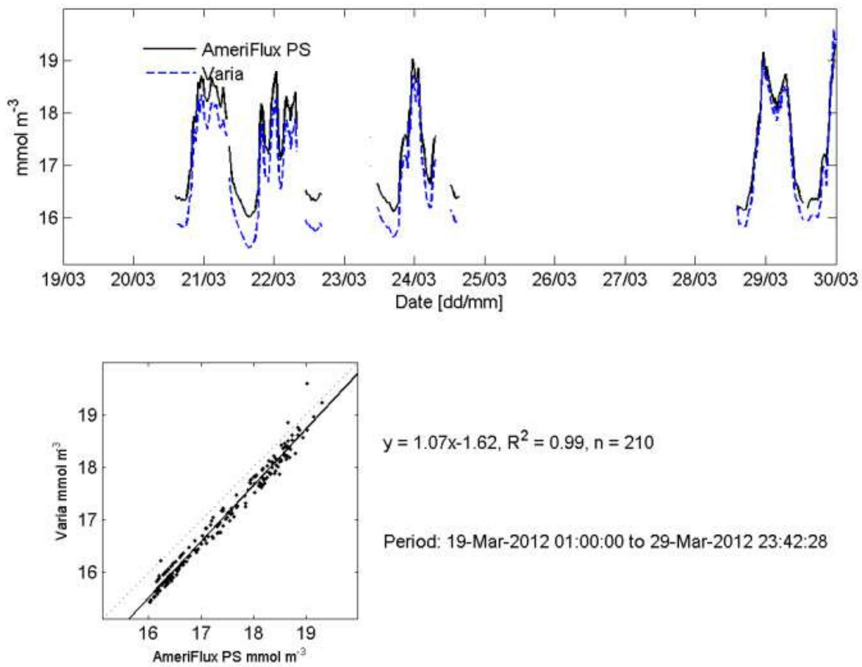

Figure 15 – Carbon dioxide concentration.

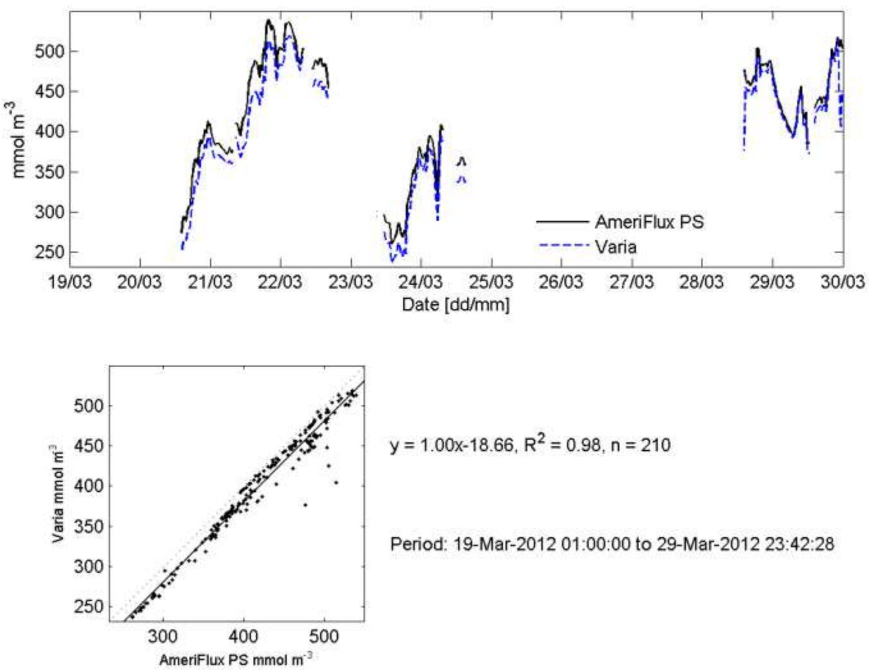

Figure 16 – Water vapor concentration.

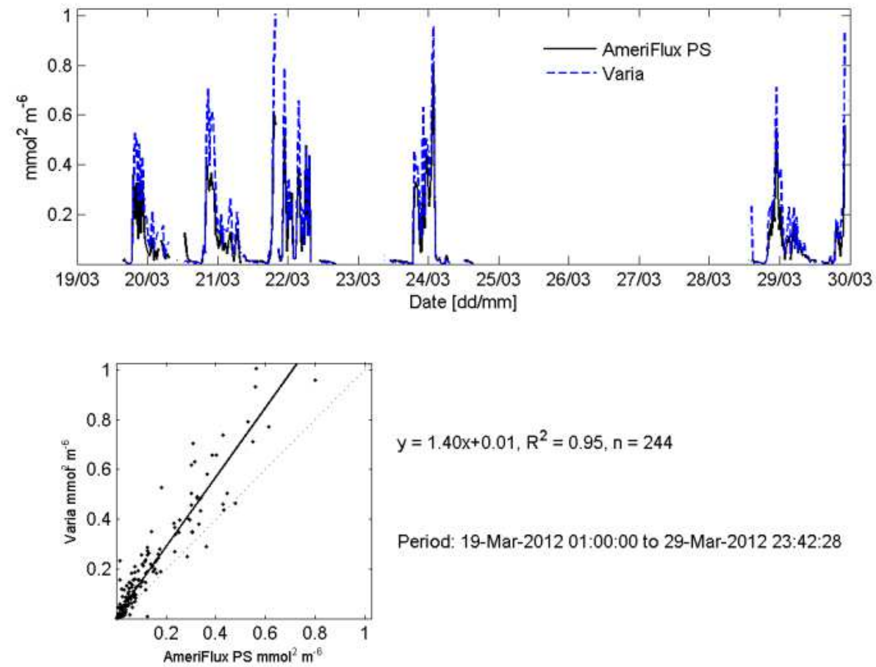

Figure 17 – Variance of carbon dioxide concentration.

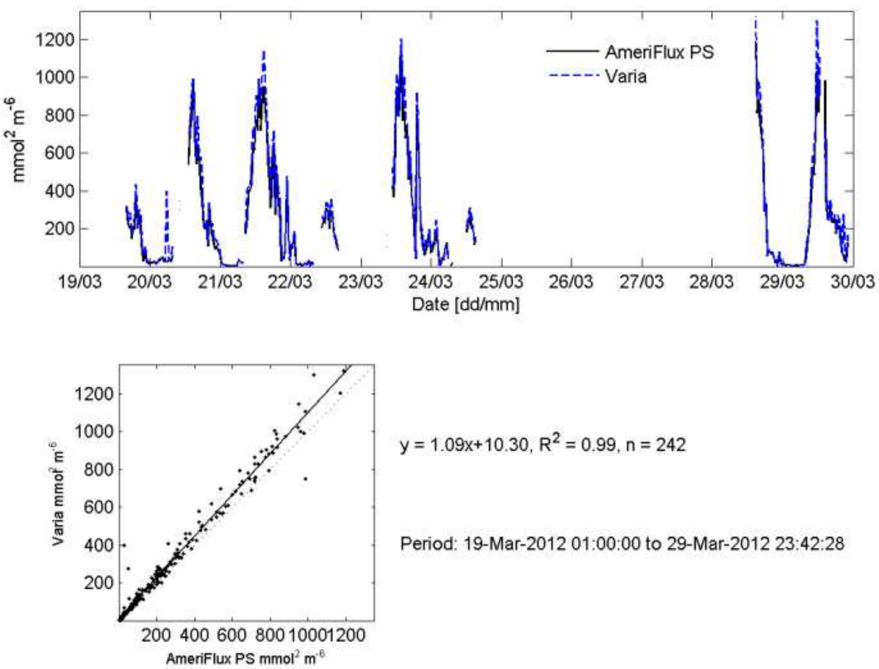

Figure 18 – Variance of water vapor concentration.

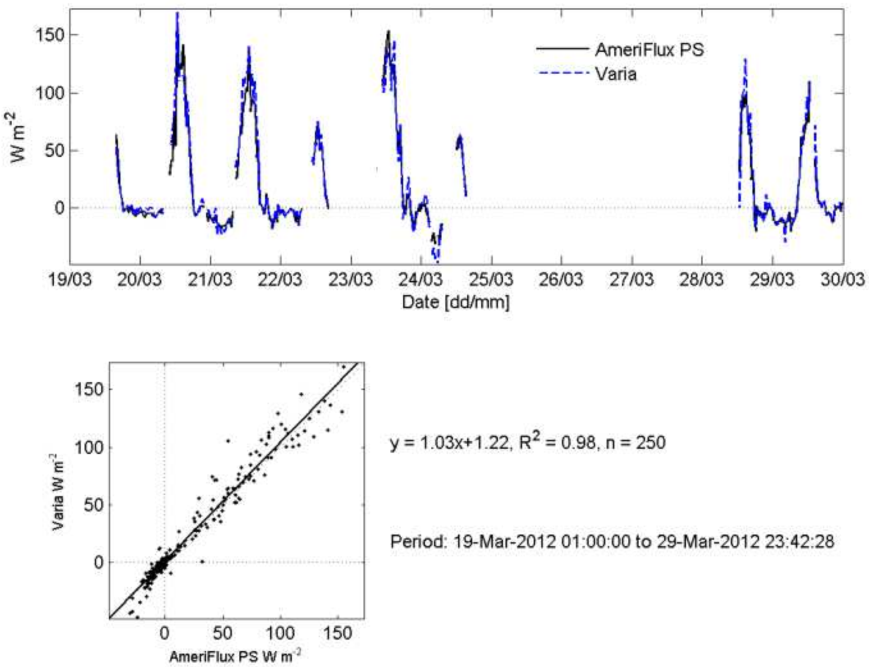

Figure 19 – Sensible heat flux comparison.

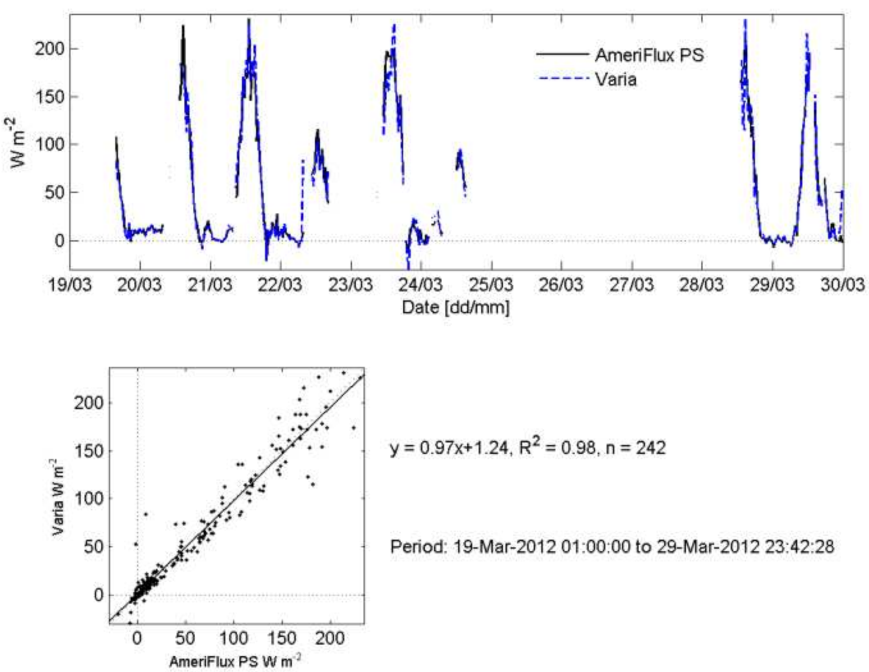

Figure 20 – Latent heat flux comparison.

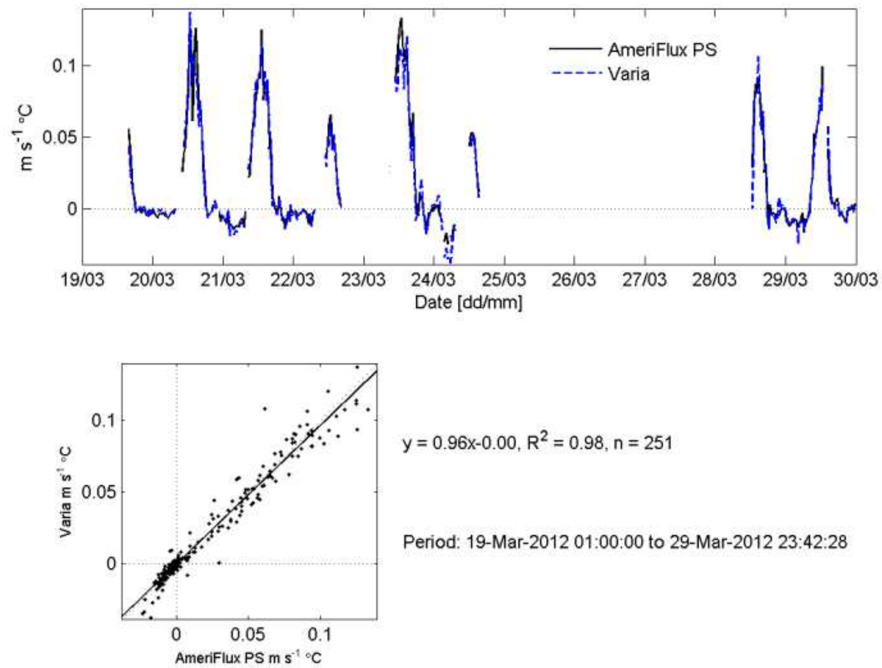

Figure 21 – Covariance of w'T's comparison.

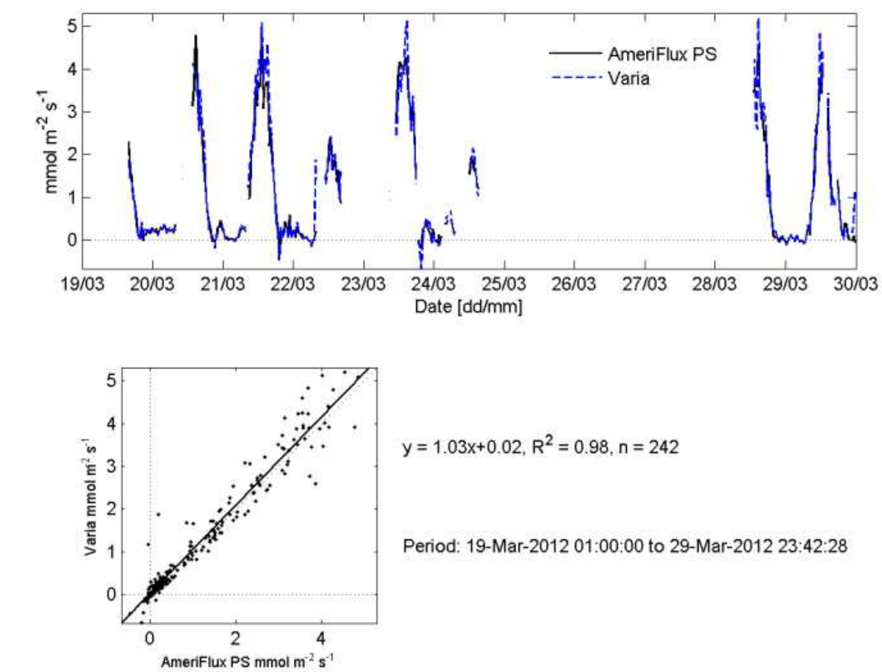

Figure 22 – Covariance of w'q' comparison.

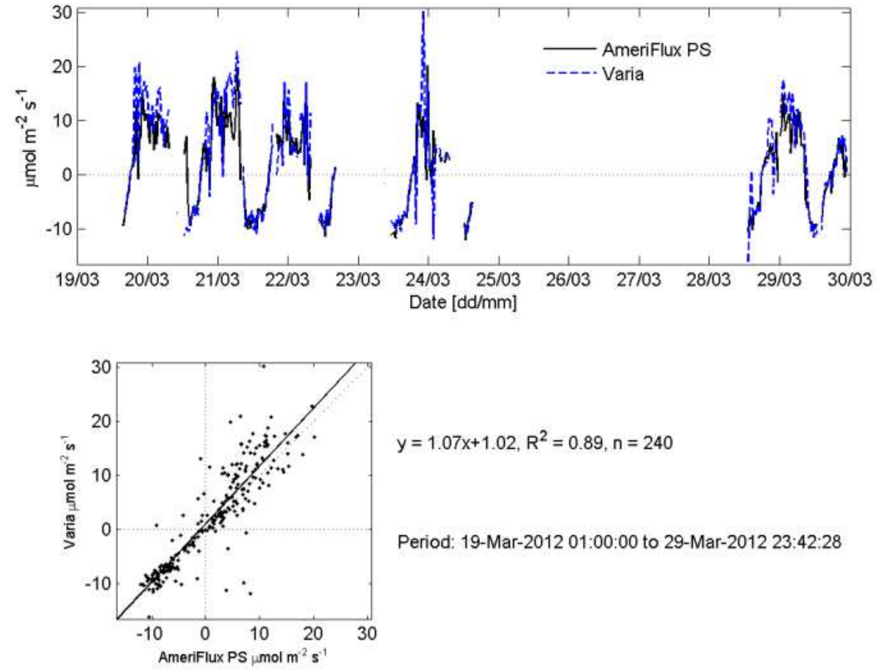

Figure 23 – Carbon dioxide fluxes.

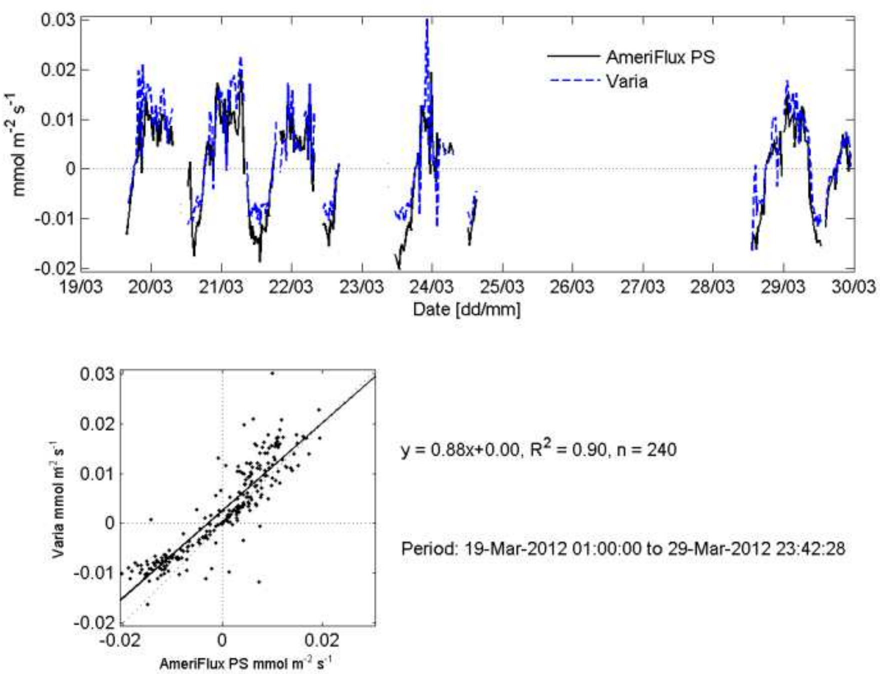

Figure 24 – Covariance of w'c' comparison.

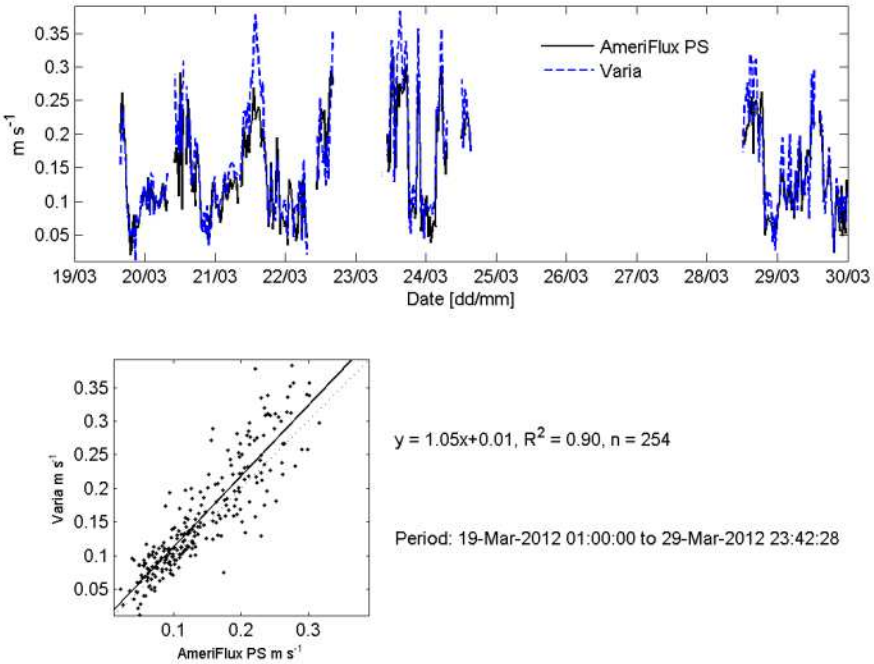

Figure 25 – Friction velocity comparisons.