To: June 25, 2007
Drs. D. Baldocchi
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Berkeley, CA USA 94720

From:
Dr. H. Loescher
Oregon State University
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321 Richardson Hall
Corvallis, Oregon, 97331

Dear Dennis.

Thank you for making possible the intercomparison between your eddy-covariance Vaira site and the AmeriFlux Portable eddy covariance system, April 7-12, 2007. As a result of our new QA/QC protocol which was applied to our data from the portable system, you may see some 'gaps' occurring in our time series as low-quality data were automatically excluded from the comparison. The QA/QC protocol now encompasses automated tests for stationarity and developed turbulence, and plausibility limits for all sensors. The final number of available 30-min intervals for this comparison (after the removal of low-quality data) was approximately 232 for flux estimates and meteorological data, which corresponds to ~5.5 complete days of continuous measurements. The number and magnitude of observed fluxes of latent and sensible heat, and carbon dioxide were reasonably large for a meaningful comparison.
Both flux systems were located at the same measurement height, approximately 1.7 m above the ground surface, and sensors for mean meteorological variables such as temperature and radiation were co-located to minimize any systematic bias due to sensor separation. I have included my cospectra and stationarity analyses at the end of the graphs.
I did have to remove some of your data which did not clearly pass plausibility tests (particularly flux data). You will need to work through this issue for all your datasets. I would like to focus your attention on the following recommendations:

**Summary of suggested recommendations**

- Check your processing software for use of correct boom orientation of the sonic anemometer, and if magnetic declination was accounted for.
- Revise your post-processing tasks to enhance its efficiency in checking the data quality, removing spikes from time series, and plausibility tests
- Please follow the recommendations available from the AmeriFlux homepage for calibration procedures and frequencies for open-path IRGAs.
- Please use the PPFD standard that we have provided and rport back your results.
- Need your λE WPL correction

- Do you use the Schotanus corrections for H?
- Sned you CNR-1 back for factory recalibration
- Quadruple check your IRGA calibrations and report back ASAP.

Please do not hesitate to ask if there are additional analyses you wish done. In the following you will find the details of the comparison.

Yours sincerely,

Hank Loescher

**Observations:**

A) Temperature

Dry-bulb air temperatures showed negligible scatter ($R^2 = 1.00$) and small offset of -0.2 K (Fig. 1A-B). We would like to point our that we hold several calibrated PT-100 sensors available for temporary use at AmeriFlux sites in case you want to perform your own calibration of temperature sensors and would like to have reference. The comparison of sonic temperatures also yielded a linear relationship (Fig. 1C-D), but with a significant difference in slope from unity. This may affect your H estimates and warrants closer examination by your group. The offset found to be significant, but is not expected to affect the flux estimates for sensible heat.

B) Radiation and other micromet

Your PPFD sensor preformed very similar to our calibrated sensors with insignificant offset (Figs. 2A-B). We would like to bring to your attention that calibrated PPFD sensors (PARlite from Kipp&Zonen) have been sent to you to check all your PPFD sensors as an on-site calibration reference (see email from Hank Loescher from 02/10/2007 sent to the AmeriFlux community). Please periodically check all your existing field PAR sensor, or recalibrate it against a recently calibrated standard. Similarly, your incident radiation sensor compared very well to our Eppley PSP standard (Figs 2C-D). Your reported net radiation was underestimated by your K+Z NR-lite radiometer compared to our device by up to 10 % (assuming that is the time series from that sensor, Fig. 3A-B), and your (nighttime) re-radiation seemed to have some curious systematic effect, see arrow Fig 3B. I also calculated your net radiometer estimates from your CNR-1 components (are sensors were directly next to each other), which compared much better with a slope of 1 (Fig 3C). as per your request, I also compared each of the CNR-1 component sensors separately. Your short wave sensors (CM3) compared very well, with slopes neat 1 (Figs 3D-E). The comparison of longwave sensors (CG3) showed more variability, which is not unusual. But your should look into your upward facing longwave sensor, such that its slope was 0.88 and departs significantly from a 1:1 line, (Fig 3F-G). I would recommend sending this sensor back for factory re-calibration (I suspect that the resistance potentiometer used to determine the universal coefficient is out of adjustment). Both sensors measuring atmospheric pressure compared very well, slope of 1 (Figs 2G-H) with an insignificant offset of 0.06 kPa.

C) Wind statistics

Wind directions tracked well, but had a significant offset of -88º (Figs 1F-G, and 7C). You also had issues with wind direction during the last comparison. This is curious since the open-path gold files use Vaira data and you compared well with the gold file results (work w/ Liukang). Because this offset is close to 90º, I suspect that you have one of your quadrants flipped mathematically. Please look in to this closer and get back in touch. I have included magnetic declination (14º 33’ E). I would also have

you check to see if you have the 30º correction turned on in your Windmaster Pro. We will have to take a closer look at these data. Please go through your processing software and make sure that the correct boom orientation was entered and magnetic declination was accounted for. The time series of mean rotated horizontal wind speeds of both systems tracked well with small variability (Figs 2A-B, R2 = 0.98). Directional analyses and filtered for wind directions did not improve the relationship. Friction velocity tracked well (Fig 4A), but seemed to high a slightly higher overall estimate than I usually observe, slope of 1.06, (Fig 4B). Moreover the variance did not seem to change (increase) with increasing values, i.e., heteroscedastic. I suspect this has something to do with the difference in style of sonic anemometers (Post-verse yoke style) and that they were both placed close to the ground. This may be something you wish to look further into. So, my concern was that the turbulent fluctuations in vertical windspeed would also be affected. The comparison of the variance in w' showed general good agreement (also not showing heteroscedastic relationship), but underestimating the values by ~ 8%. This may be reflected in slightly lower fluxes estimate (Figs 4C-D).

D) Trace gas concentrations

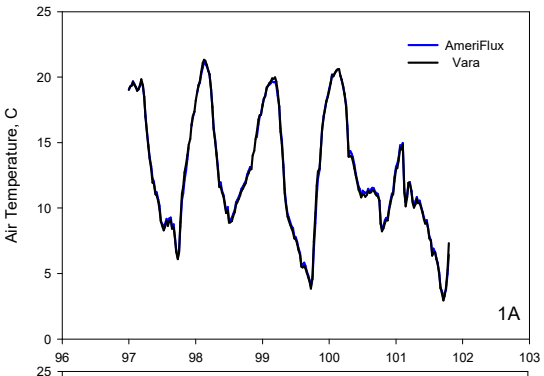
I used your dew point generator for water vapour calibrations, and we had just factory-calibration and determined the *q* and *c* polynomials in the lab. So we have high confidence in the response of our IRGAs. The comparison of mean water vapour concentrations tracked fairly well (Fig 5A), but showed large variability (Figs 5B, 5D). Offsets were insignificant. I converted your molar density estimates into units of mmol mol-1 using your air temperature and pressure estimates. Since your both Ta and atmospheric pressure compared very well with the AmeriFlux standards, I thought this was an acceptable practice. I suspect that some of variability as to do with data not properly screened out. Do you use the Diagnostic value and AGC values from your open-path sensor? There seems to be a great deal of data filtered out, that our sensors where not subject to (and conversely, there were a few 4-5 points in your data that I filtered out, clearly they did not meet plausibility tests). When I see large amounts of data removed in your dataset surrounding a few of my data points, usually signals either 1) your sensor needs to return for factory re-calibration, and/or 2) the internal desiccants have to be changes. Can you please check on this and report back to us, thanks. The CO2 estimates from boththe open- and closed-path AmeriFlux sensors tracked well, and typically agree quite well after the second field calibration (DOY 99.56, Figure 5E), and had a slope of 0.9 (Fig 5F), resulting in a difference of ~ 4 mmol mol-1 at the high range of ambient CO2.. I also converted both our molar density open-path estimates of CO2 to molar fraction, and your slope was 18% high with a significant offset of 239.6 µmol mol-1! I suspect this slope and offset affects both your flux measurements and WPL estimates. In this application, I would not consider the open-path sensor a precision CO2 sensor. I would also suggest setting up a dedicated IRGA (old 6262) to calibrate your secondary standards for field calibration. Please check your standards and protocols. AmeriFlux homepage for recommended calibration procedures and frequencies for open-path analysers.

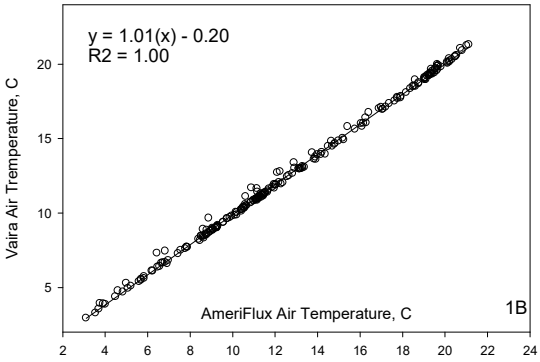
E) Flux estimates

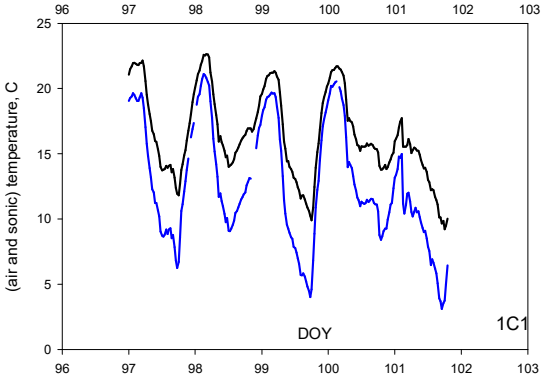
It was unclear whether you corrected your H estimates or not (Schotanus 1983). Because I plotted our corrected H fluxes against yours, and they compared very well (slope of 0.97, Figs 4E-F), I am assuming that you do use this correction. Can you please confirm, thanks.

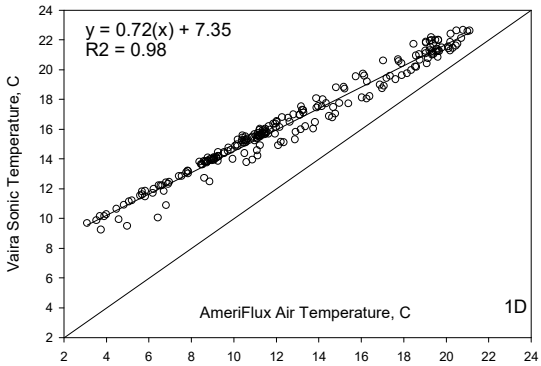
Your corrected λE fluxes were ~11-12% smaller than our estimates with little variability (Figs. 6A-D). Your lower estimate is likely due to it the decrease in gain (slope) of you water vapour measurements that affect both the covariance and your WPL correction. It would be good to examine you WPL correction, can you please send it to me, I do not think I received it, thanks (even though it compared well in your gold files). So, this is more confirmation that the gain function of q is causing this issue.

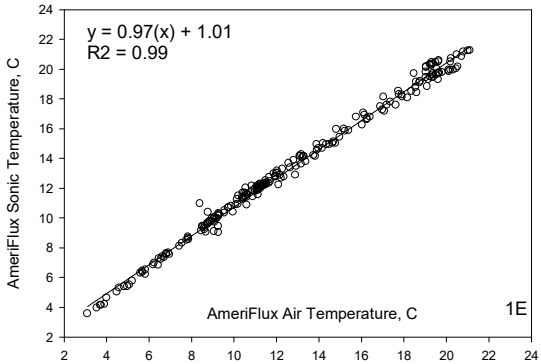
Considering the large slope and offset in between our CO2 estimates, your FCO2 estimates were agreed very well to those from the AmeriFlux portable system (Figs 6E). I interpret these results as the two errors in your response function serendipitously cancel each other out (slope/gain function verses zero/offset). How do you interpret this result? Please chat about it, thanks. You can also observe that the gain/offset problem in your calibration reduced your WPL estimate by ½ (Fig 7C) Am I interpreting this correctly?

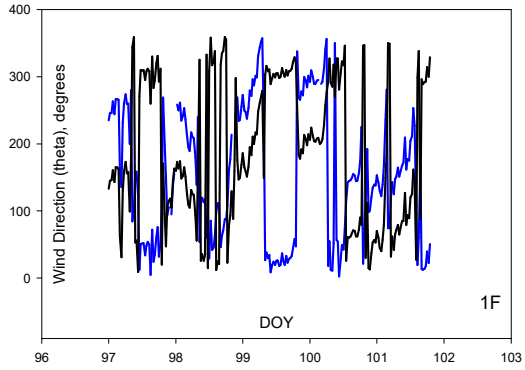

AmeriFlux
Vara
Air Temperature, C
1A

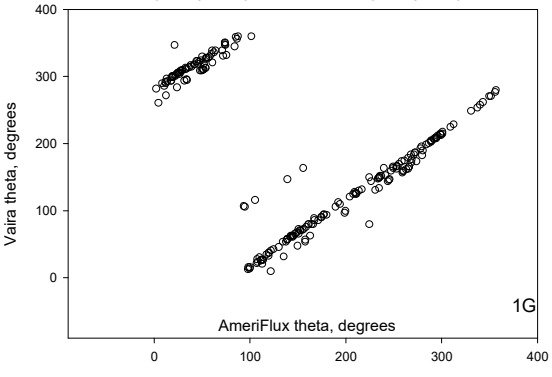

y = 1.01(x) - 0.20
R2 = 1.00
Vaira Air Trremperature, C
AmeriFlux Air Temperature, C
1B

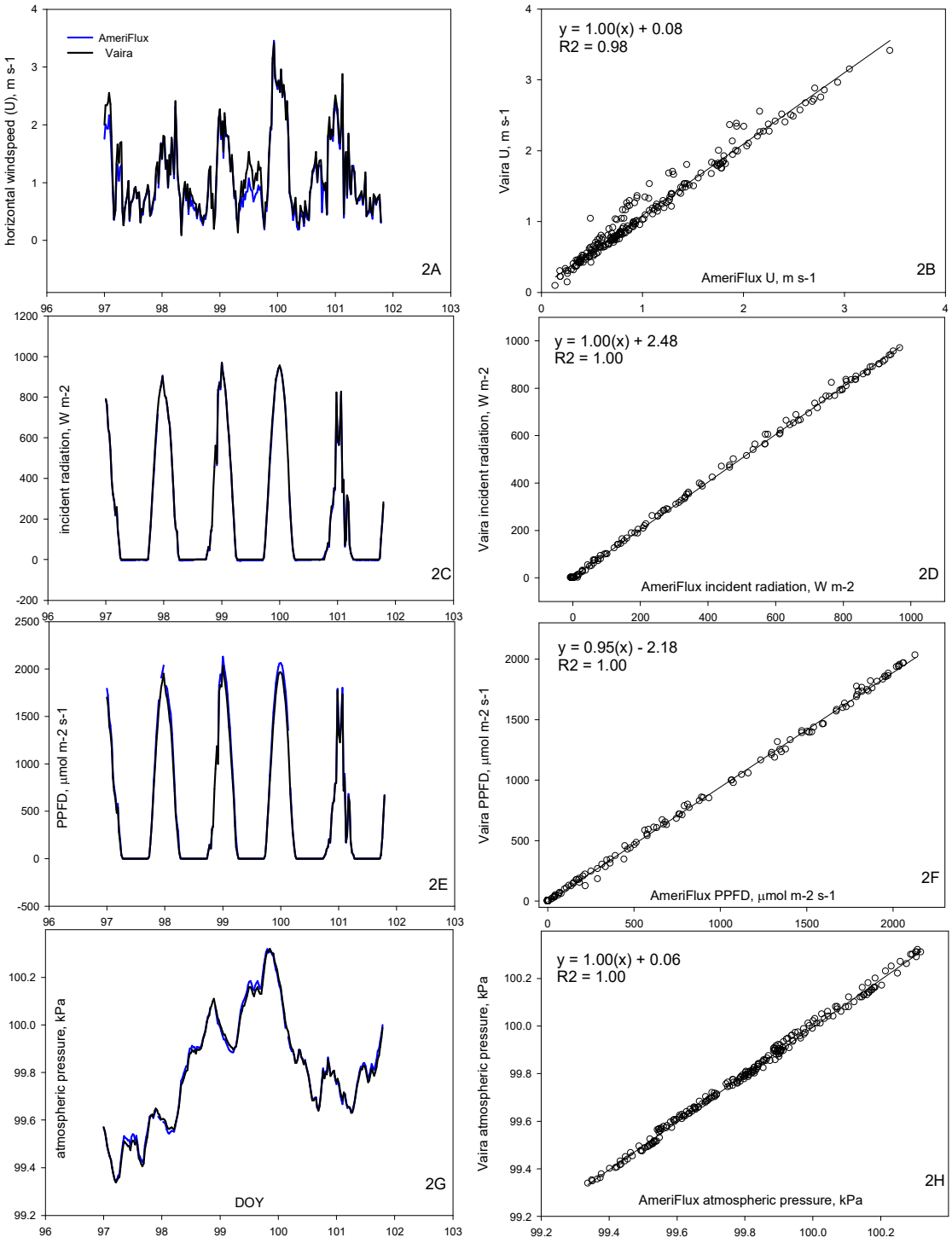

(air and sonic) temperature, C
DOY
1C1

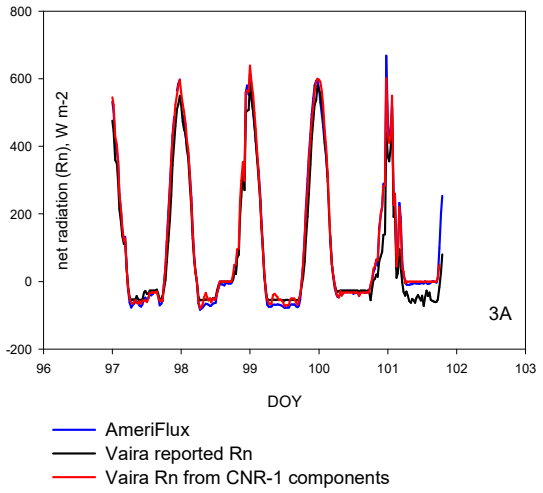

y = 0.72(x) + 7.35
R2 = 0.98
Vaira Sonic Temperature, C
AmeriFlux Air Temperature, C
1D

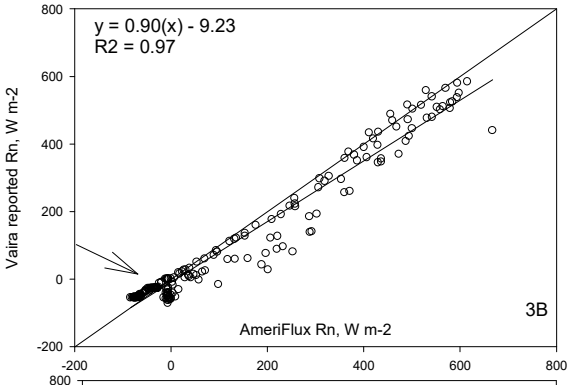

y = 0.97(x) + 1.01
R2 = 0.99
AmeriFlux Sonic Temperature, C
AmeriFlux Air Temperature, C
1E

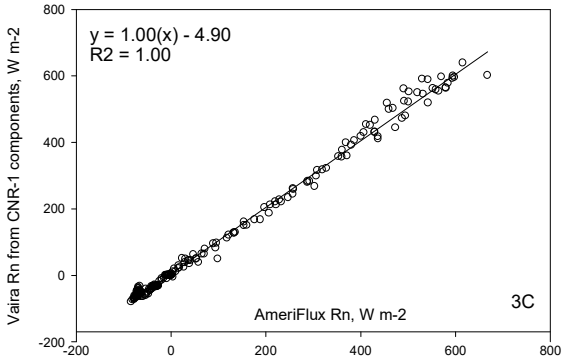

Wind Direction (theta), degrees
DOY
1F

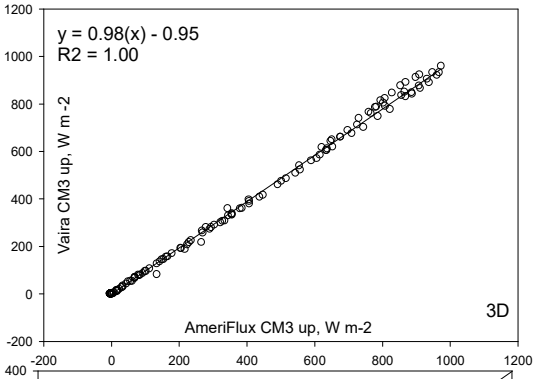

Vaira theta, degrees
AmeriFlux theta, degrees
1G

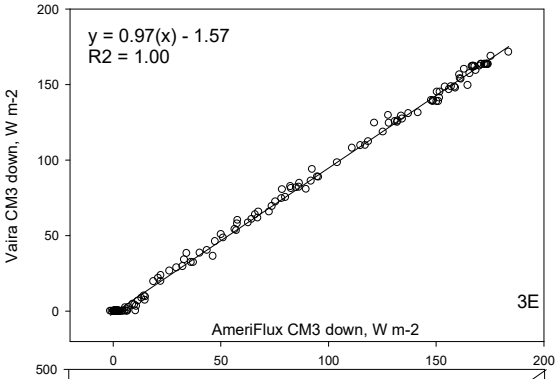

AmeriFlux
Vaira
horizontal windspeed (U), m s-1
2A
y = 1.00(x) + 0.08
R2 = 0.98
Vaira U, m s-1
AmeriFlux U, m s-1
2B
incident radiation, W m-2
2C
y = 1.00(x) + 2.48
R2 = 1.00
Vaira incident radiation, W m-2
AmeriFlux incident radiation, W m-2
2D
PPFD, µmol m-2 s-1
2E
y = 0.95(x) - 2.18
R2 = 1.00
Vaira PPFD, µmol m-2 s-1
AmeriFlux PPFD, µmol m-2 s-1
2F
atmospheric pressure, kPa
DOY
2G
y = 1.00(x) + 0.06
R2 = 1.00
Vaira atmospheric pressure, kPa
AmeriFlux atmospheric pressure, kPa
2H

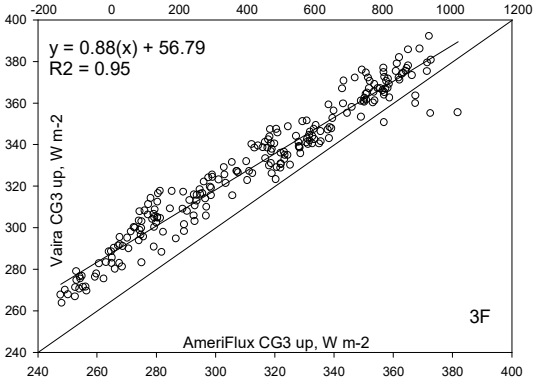

net radiation (Rn), W m-2
DOY
3A
AmeriFlux
Vaira reported Rn
Vaira Rn from CNR-1 components

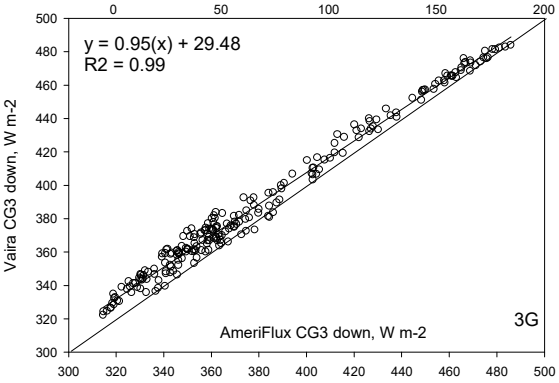

y = 0.90(x) - 9.23
R2 = 0.97
Vaira reported Rn, W m-2
AmeriFlux Rn, W m-2
3B

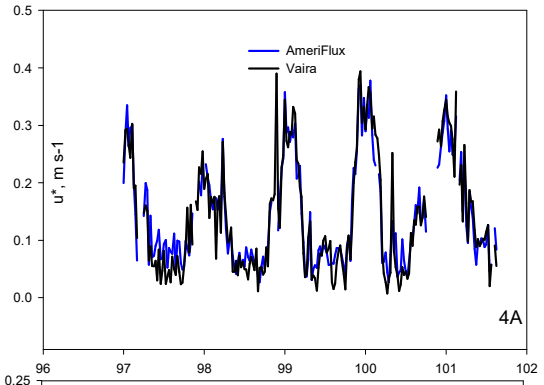

y = 1.00(x) - 4.90
R2 = 1.00
Vaira Rn from CNR-1 components, W m-2
AmeriFlux Rn, W m-2
3C

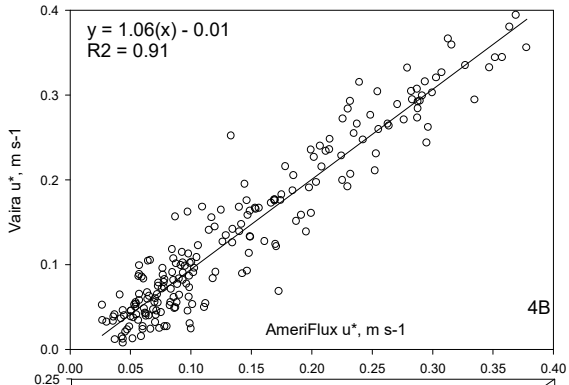

y = 0.98(x) - 0.95
R2 = 1.00
Vaira CM3 up, W m -2
AmeriFlux CM3 up, W m-2
3D

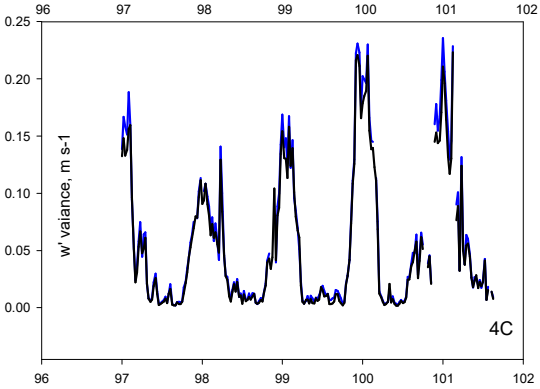

y = 0.97(x) - 1.57
R2 = 1.00
Vaira CM3 down, W m-2
AmeriFlux CM3 down, W m-2
3E

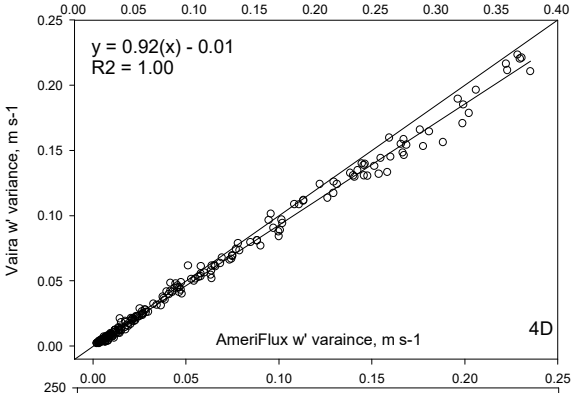

y = 0.88(x) + 56.79
R2 = 0.95
Vaira CG3 up, W m-2
AmeriFlux CG3 up, W m-2
3F

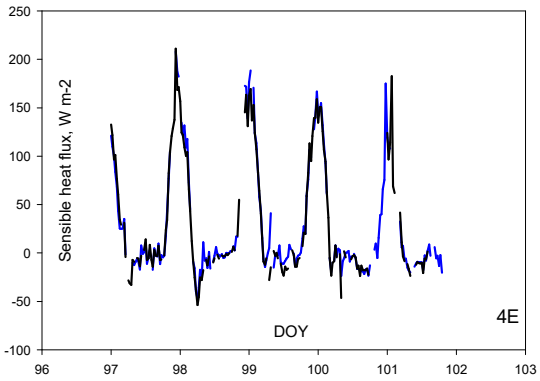

y = 0.95(x) + 29.48
R2 = 0.99
Vaira CG3 down, W m-2
AmeriFlux CG3 down, W m-2
3G

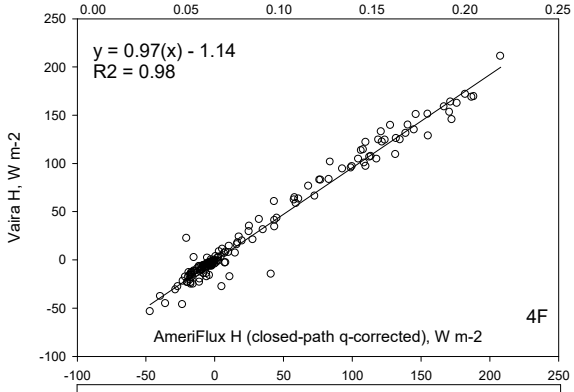

AmeriFlux
Vaira
u*, m s-1
4A

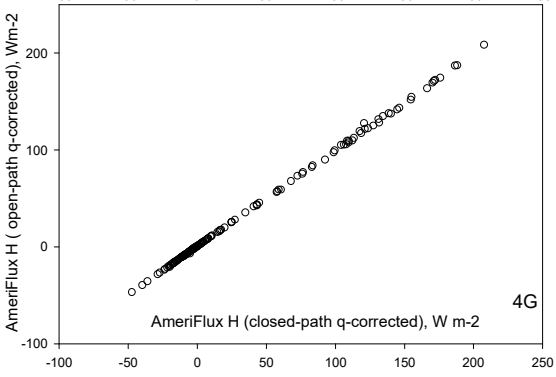

y = 1.06(x) - 0.01
R2 = 0.91
Vaira u*, m s-1
AmeriFlux u*, m s-1
4B

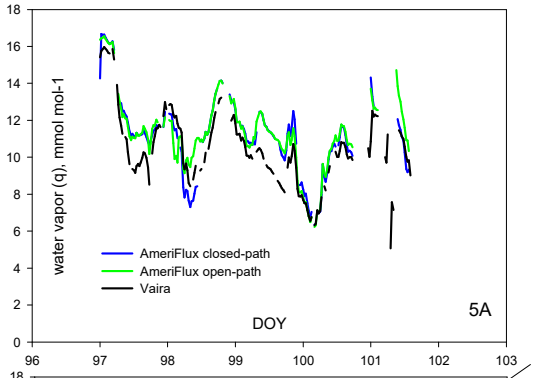

w' vaiance, m s-1
4C

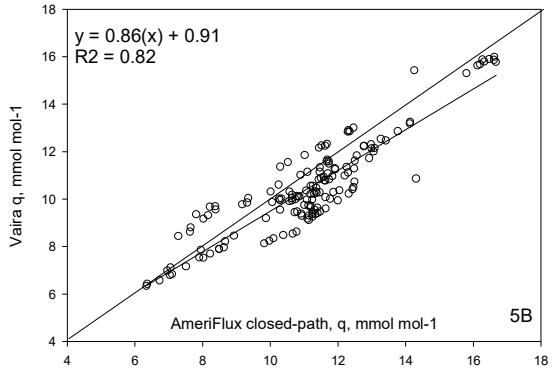

y = 0.92(x) - 0.01
R2 = 1.00
Vaira w' variance, m s-1
AmeriFlux w' varaince, m s-1
4D

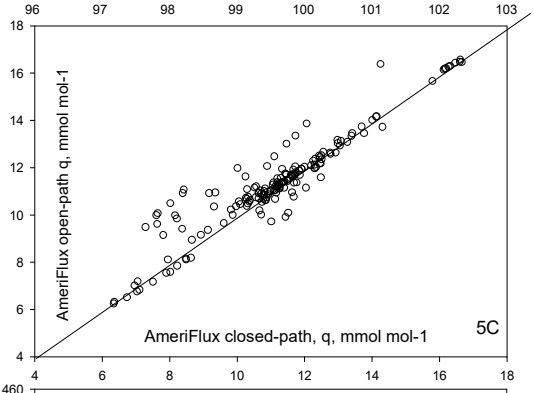

Sensible heat flux, W m-2
DOY
4E

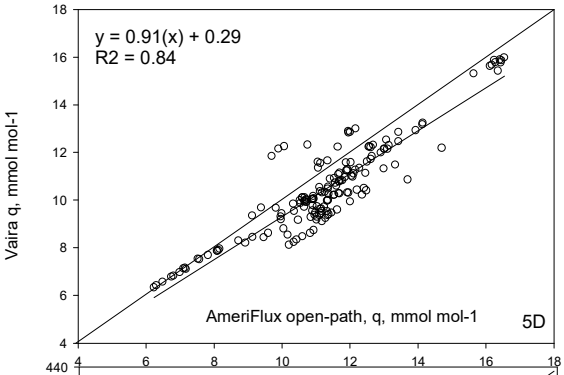

y = 0.97(x) - 1.14
R2 = 0.98
Vaira H, W m-2
AmeriFlux H (closed-path q-corrected), W m-2
4F

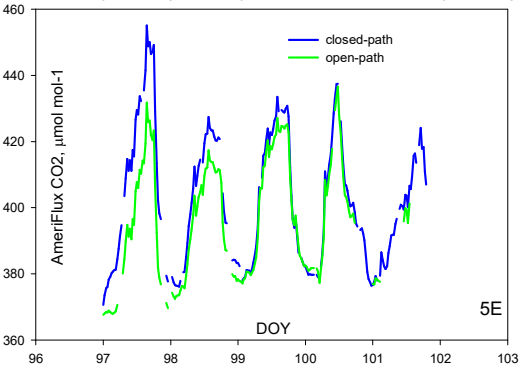

AmeriFlux H ( open-path q-corrected), Wm-2
AmeriFlux H (closed-path q-corrected), W m-2
4G

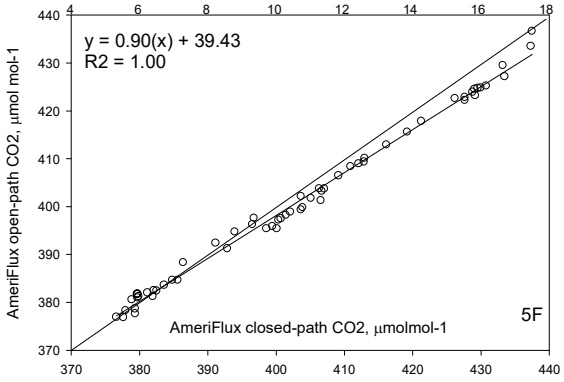

water vapor (q), mmol mol-1
AmeriFlux closed-path
AmeriFlux open-path
Vaira
DOY
5A

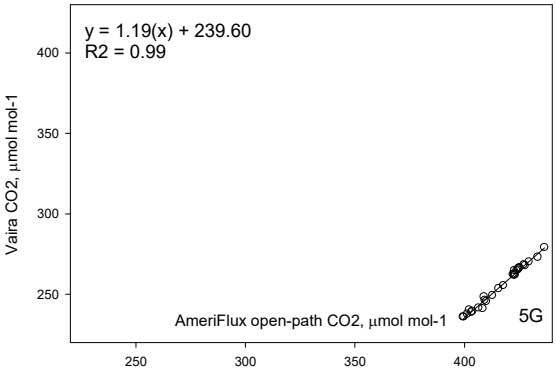

y = 0.86(x) + 0.91
R2 = 0.82
Vaira q, mmol mol-1
AmeriFlux closed-path, q, mmol mol-1
5B

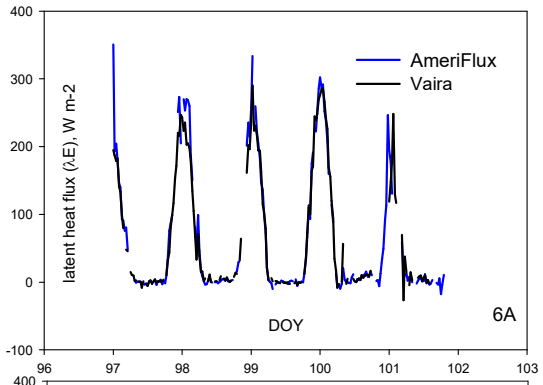

AmeriFlux open-path q, mmol mol-1
AmeriFlux closed-path, q, mmol mol-1
5C

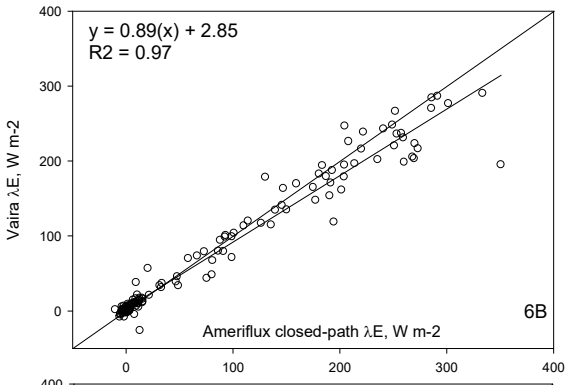

y = 0.91(x) + 0.29
R2 = 0.84
Vaira q, mmol mol-1
AmeriFlux open-path, q, mmol mol-1
5D

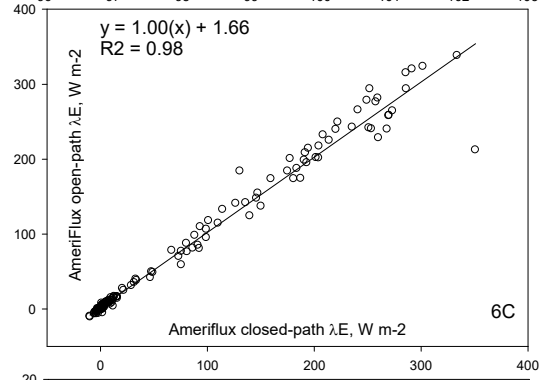

AmeriFlux CO2, µmol mol-1
closed-path
open-path
DOY
5E

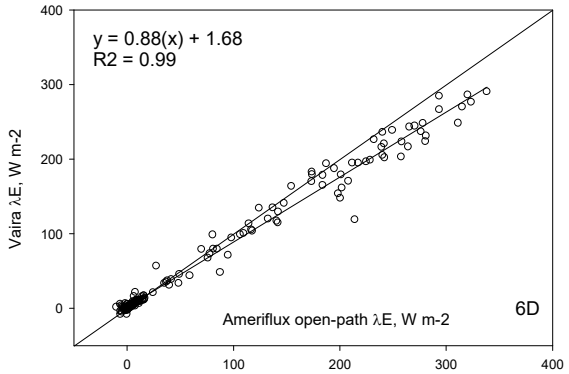

y = 0.90(x) + 39.43
R2 = 1.00
AmeriFlux open-path CO2, µmol mol-1
AmeriFlux closed-path CO2, µmolmol-1
5F

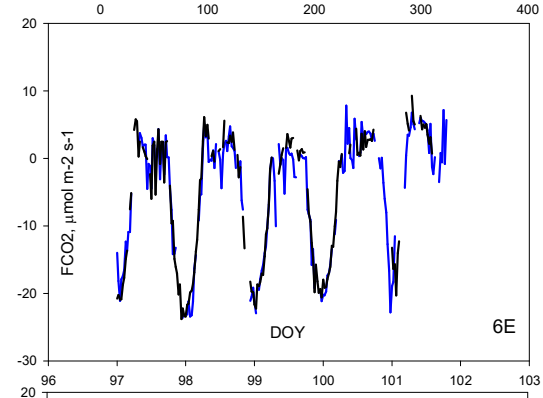

y = 1.19(x) + 239.60
R2 = 0.99
Vaira CO2, µmol mol-1
AmeriFlux open-path CO2, µmol mol-1
5G

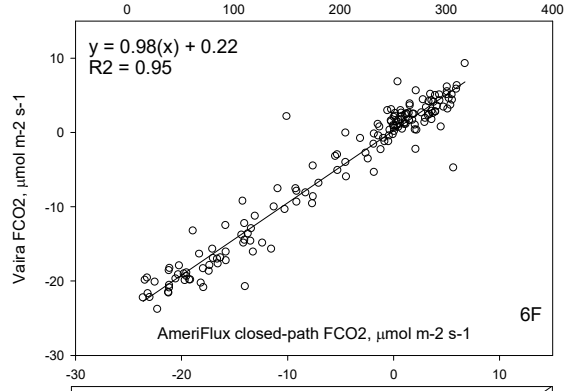

AmeriFlux
Vaira
latent heat flux (λE), W m-2
DOY
6A

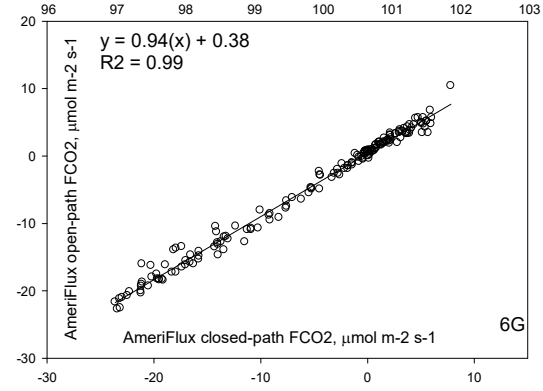

y = 0.89(x) + 2.85
R2 = 0.97
Vaira λE, W m-2
Ameriflux closed-path λE, W m-2
6B

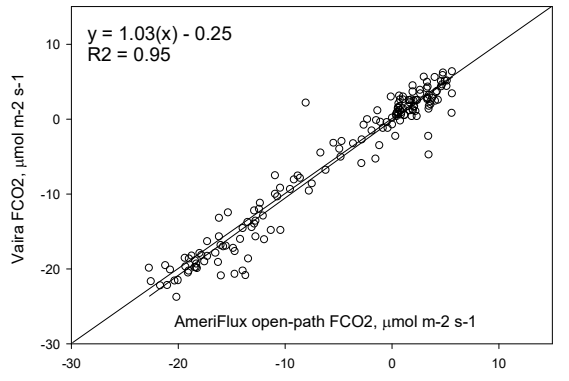

y = 1.00(x) + 1.66
R2 = 0.98
AmeriFlux open-path λE, W m-2
Ameriflux closed-path λE, W m-2
6C

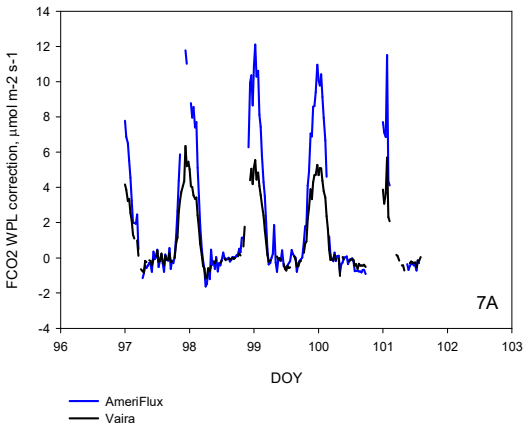

y = 0.88(x) + 1.68
R2 = 0.99
Vaira λE, W m-2
Ameriflux open-path λE, W m-2
6D

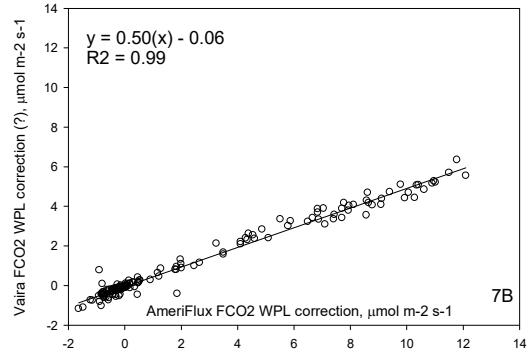

FCO2, µmol m-2 s-1
DOY
6E

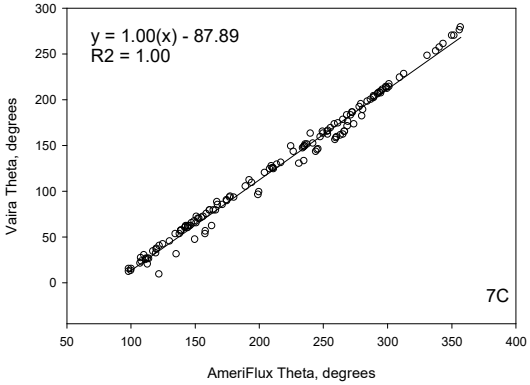

y = 0.98(x) + 0.22
R2 = 0.95
Vaira FCO2, µmol m-2 s-1
AmeriFlux closed-path FCO2, µmol m-2 s-1
6F

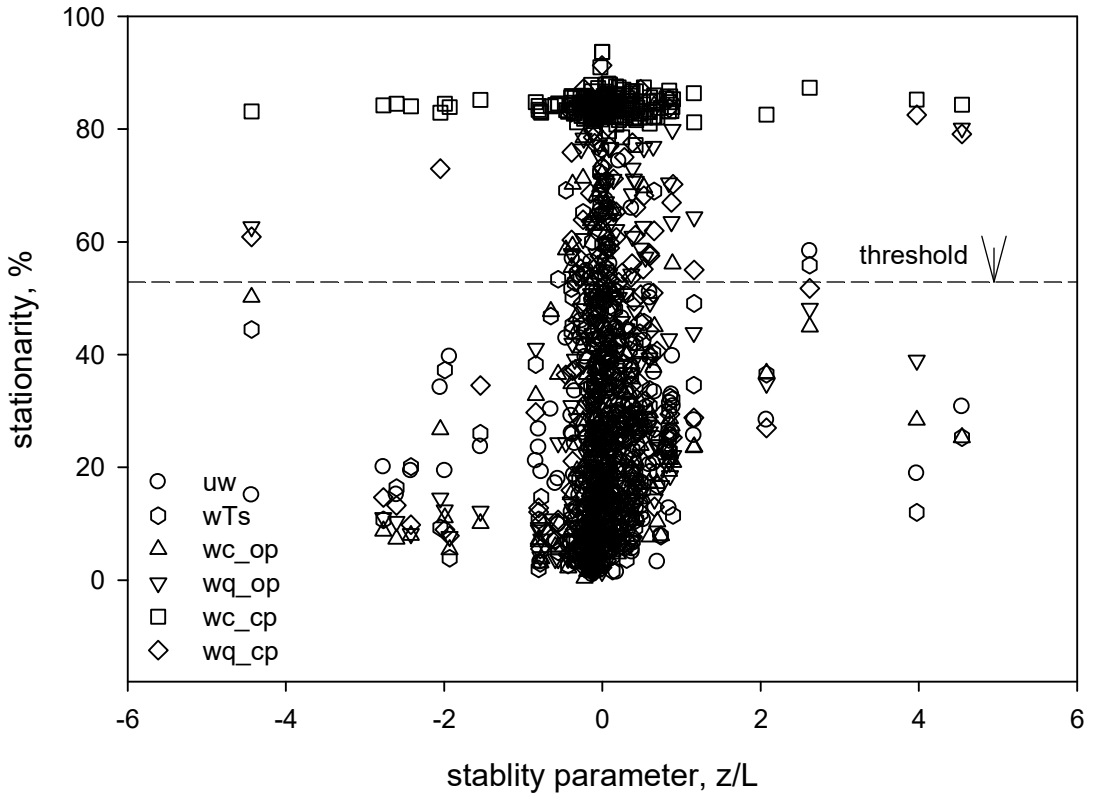

y = 0.94(x) + 0.38
R2 = 0.99
AmeriFlux open-path FCO2, µmol m-2 s-1
AmeriFlux closed-path FCO2, µmol m-2 s-1
6G

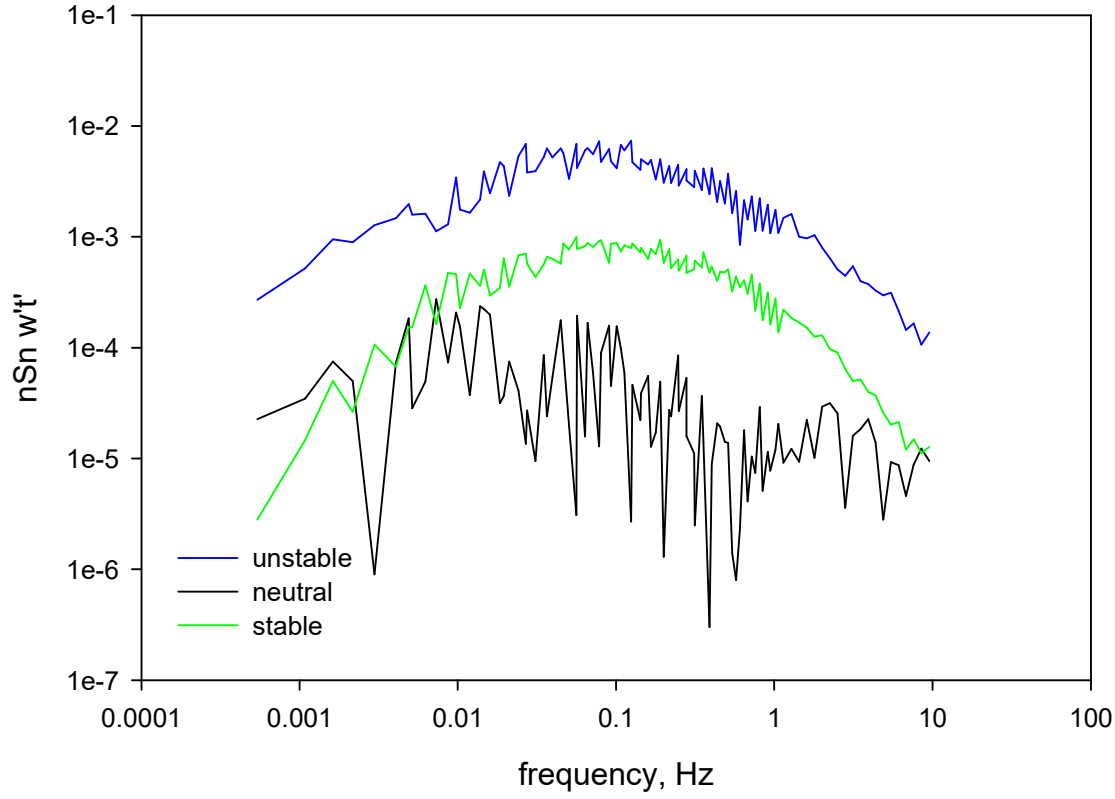

y = 1.03(x) - 0.25
R2 = 0.95
Vaira FCO2, µmol m-2 s-1
AmeriFlux open-path FCO2, µmol m-2 s-1

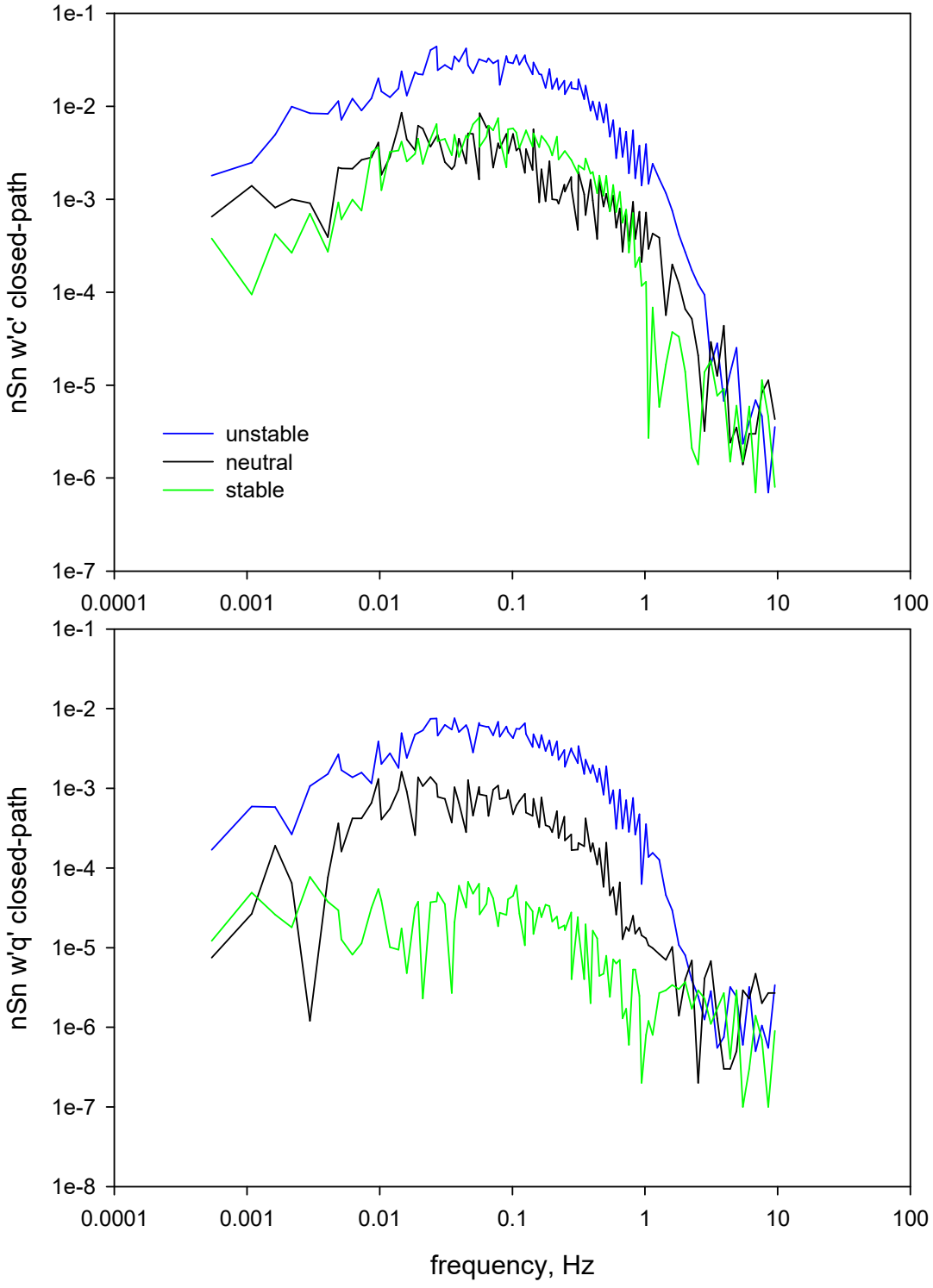

FCO2 WPL correction, µmol m-2 s-1
DOY
AmeriFlux
Vaira
7A

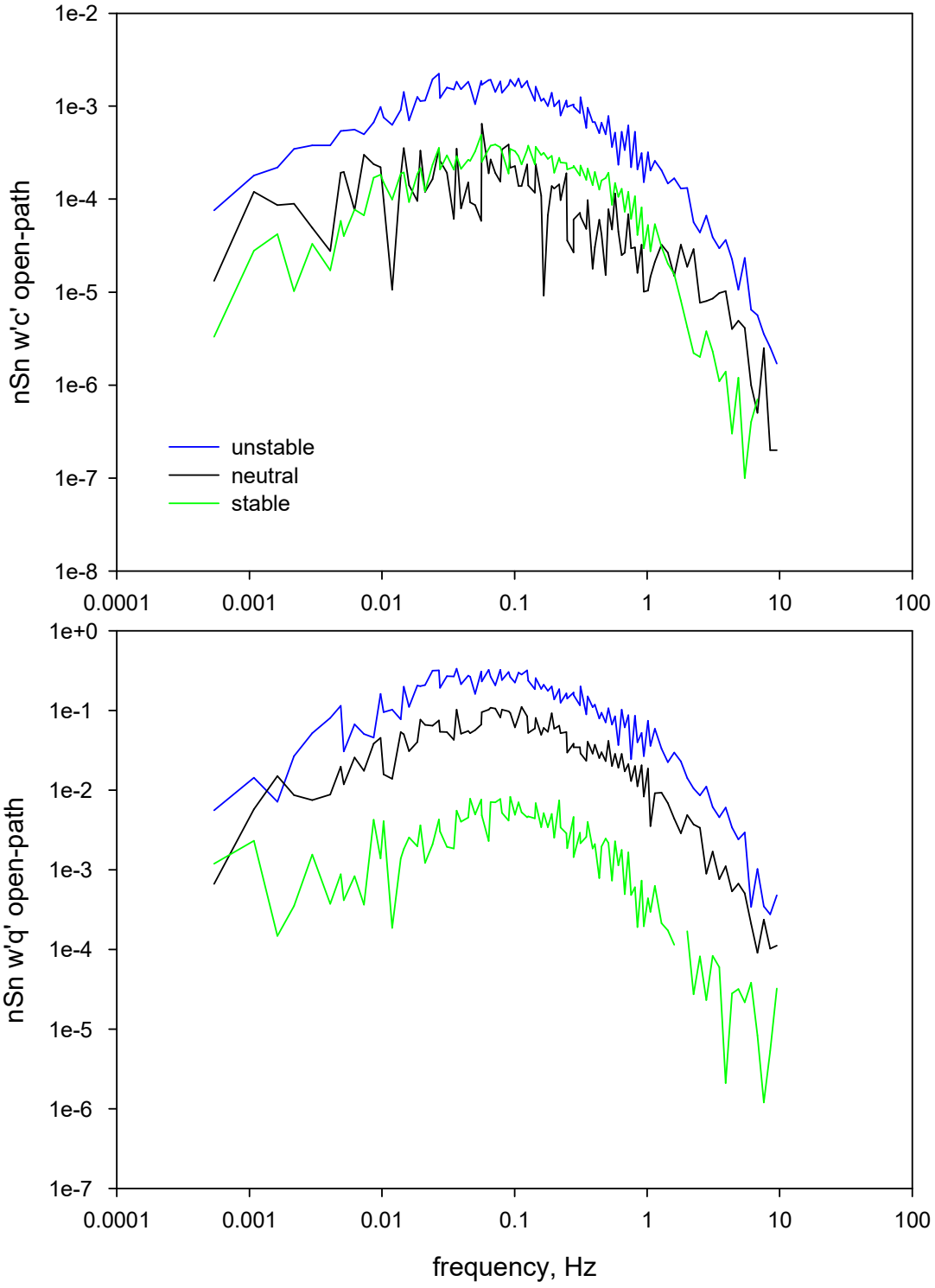

y = 0.50(x) - 0.06
R2 = 0.99
Vaira FCO2 WPL correction (?), µmol m-2 s-1
AmeriFlux FCO2 WPL correction, µmol m-2 s-1
7B


y = 1.00(x) - 87.89
R2 = 1.00
Vaira Theta, degrees
AmeriFlux Theta, degrees
7C


100
80
60
40
20
0
stationarity, %
threshold
uw
wTs
wc_op
wq_op
wc_cp
wq_cp
-6
-4
-2
0
2
4
6
stablity parameter, z/L


1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
nSn w't'
unstable
neutral
stable
0.0001
0.001
0.01
0.1
1
10
100
frequency, Hz


1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
nSn w'c' closed-path
unstable
neutral
stable
0.0001
0.001
0.01
0.1
1
10
100
1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
1e-8
nSn w'q' closed-path
0.0001
0.001
0.01
0.1
1
10
100
frequency, Hz


1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
1e-8
nSn w'c' open-path
unstable
neutral
stable
0.0001
0.001
0.01
0.1
1
10
100
1e+0
1e-1
1e-2
1e-3
1e-4
1e-5
1e-6
1e-7
nSn w'q' open-path
frequency, Hz