Metolius Mature Pine (US-Me2):

Comparison of PI processing and L4 standardized (Dario&Markus)
for period 2002-2007

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Preface

I performed an analysis comparing our own data sets for the US-Me2 site (labeled “PI process” or “Site processing”) to the L4 data product generated by the FLUXNET algorithm based on Reichstein et al. (2005, GCB) and Papale et al. (2006, BGS) (labeled L4 standardized) for the period 2002-2007 focusing on carbon cycle components NEE, GEP and RE.

The L4 data were downloaded from the CDIAC data server. The basis for the comparison were the data matrices contained in the30-min elements (labeled as ‘_h’ in the structure array) for each year.

Meteorological input variables for parameterizations (air temperature, radiation, vpd, precipitation) and heat (sensible and latent) fluxes were compared up-front yielding no major differences (see summary graphs on first slides).

For ecosystem respiration (RE), both the PI_process and L4_standardized data were compared to concurrent estimates of RE based on measured soil respiration from chambers and modeled wood and foliage respiration (labeled ‘PI chamber’ in plots)

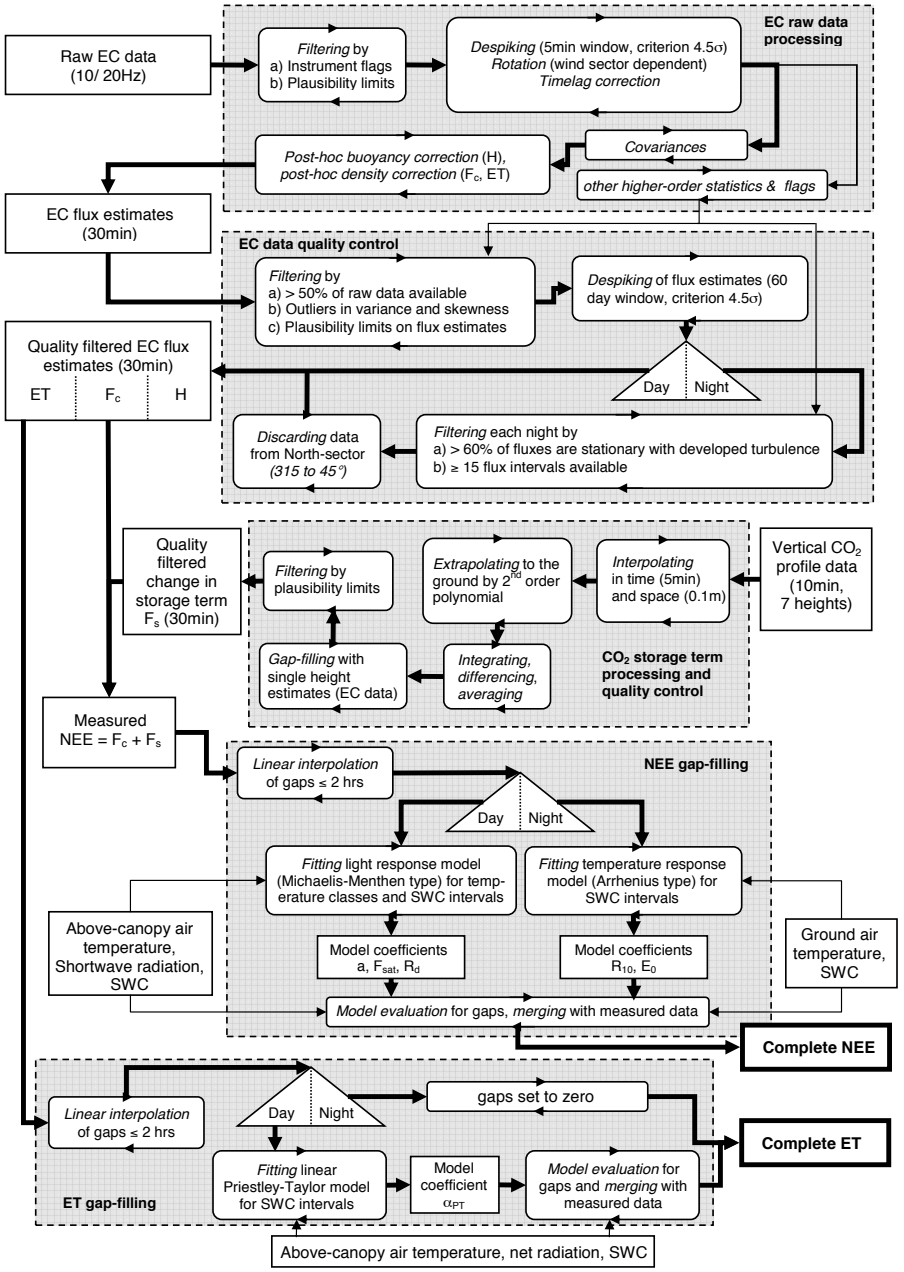
The processing algorithm used for the “PI processing” is documented in Thomas, C.K., Law, B.E., Irvine, J., Martin, J.G., Pettijohn, J.C. and Davis, K.J., 2009. Interannual and seasonal variation in carbon and water exchange at a semi-arid mature Ponderosa Pine site in Central Oregon. Global Change Biol.: submitted., and is included here as a reference

In general, a small summary statement of the results is given at the end of each section rather than writing a complete, coherent text. This being said, this document is more meant to be a basis for discussion than a formal report.

But first we would like to thank you for taking on this enormous challenge and providing the standardized data set!

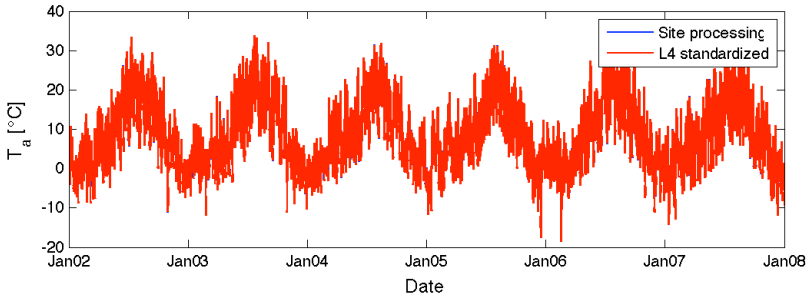
Flowchart of PI processing

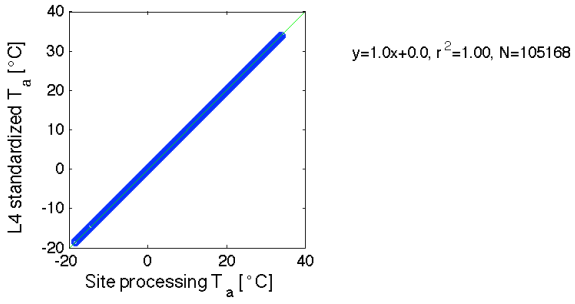
Source: Thomas, C.K., Law, B.E., Irvine, J., Martin, J.G., Pettijohn, J.C. and Davis, K.J., 2009. Interannual and seasonal variation in carbon and water exchange at a semi-arid mature Ponderosa Pine site in Central Oregon. Global Change Biol.: submitted.



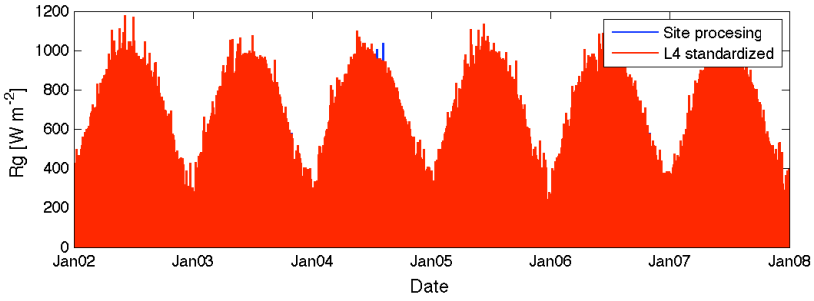
Meteorological data: comparison

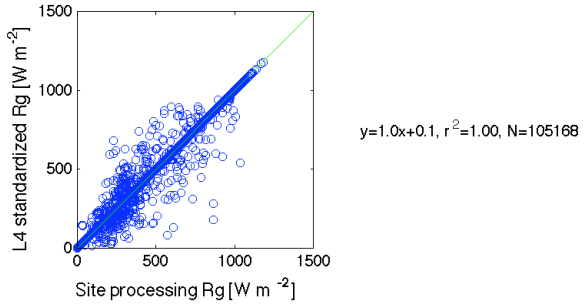
Air temperature



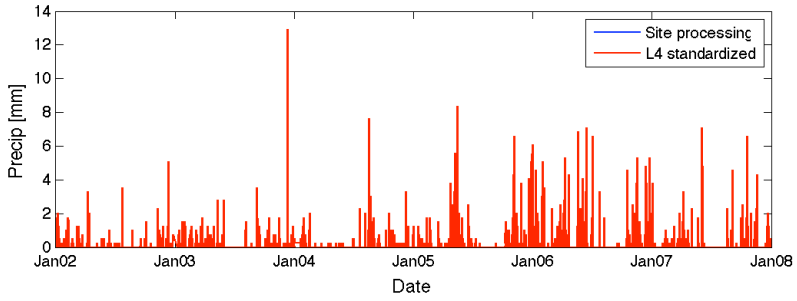


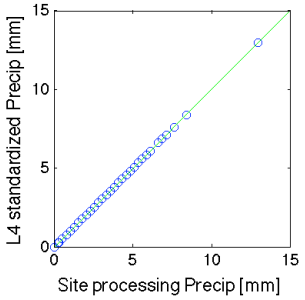
Global radiation





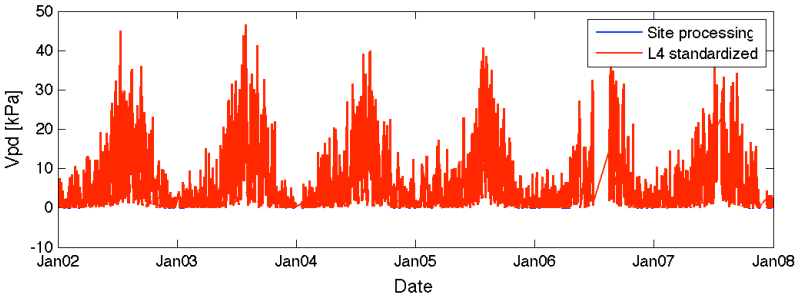
Precipitation

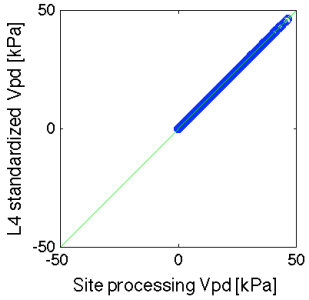




y=1.0x+0.0, r^2=1.00, N=100912

Vapor pressure deficit

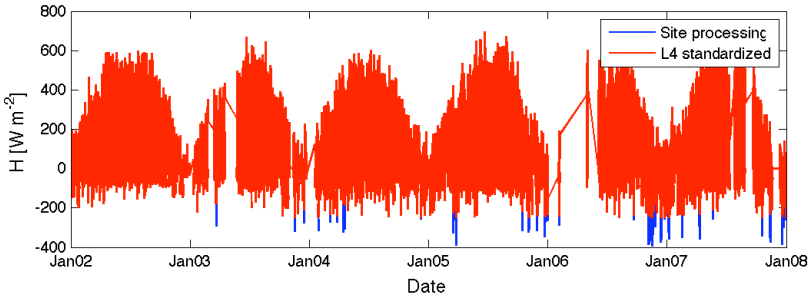


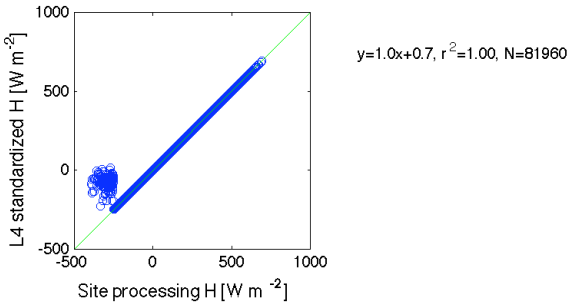


y=1.0x-0.0, r^2=1.00, N=98132

Heat fluxes: comparison

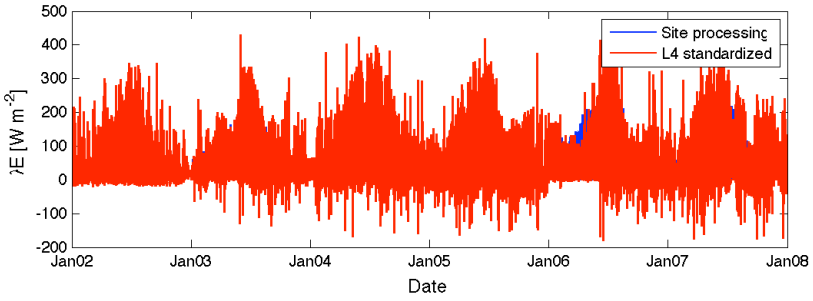
Sensible heat flux

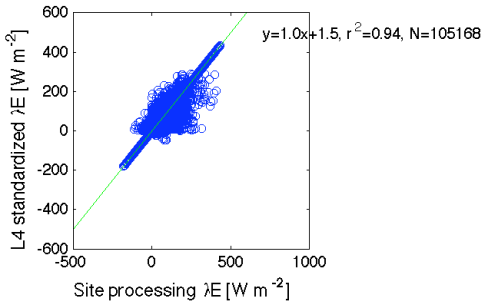




→ L4 processing seems to be applying a plausibility limit that cutting out some of the nighttime data (which I think are real)

Latent heat flux





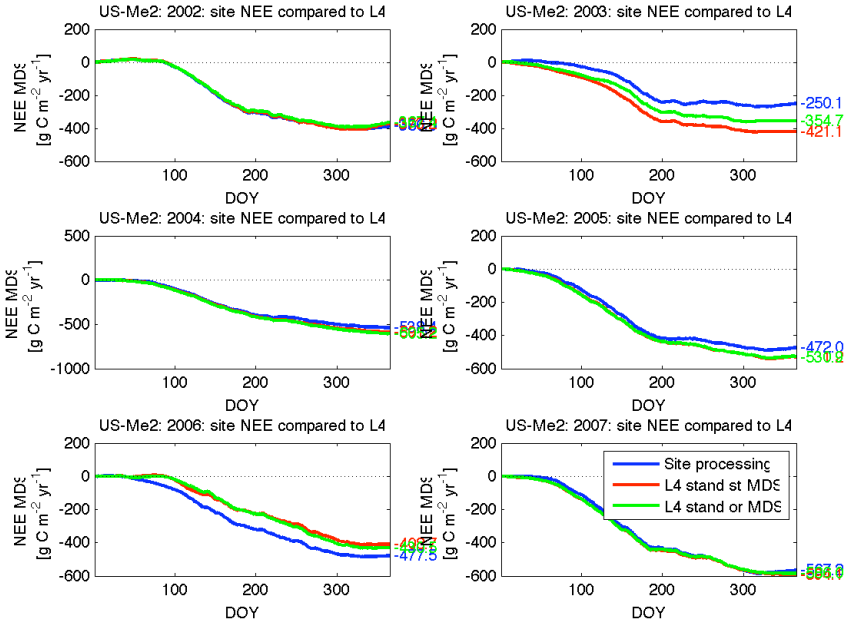
→ Differences mainly observed in first half of 2006 when no flux data were available (raw data loss), and can thus be attributed to different parameterizations

Comparison of carbon cycle components NEE, GEP, RE

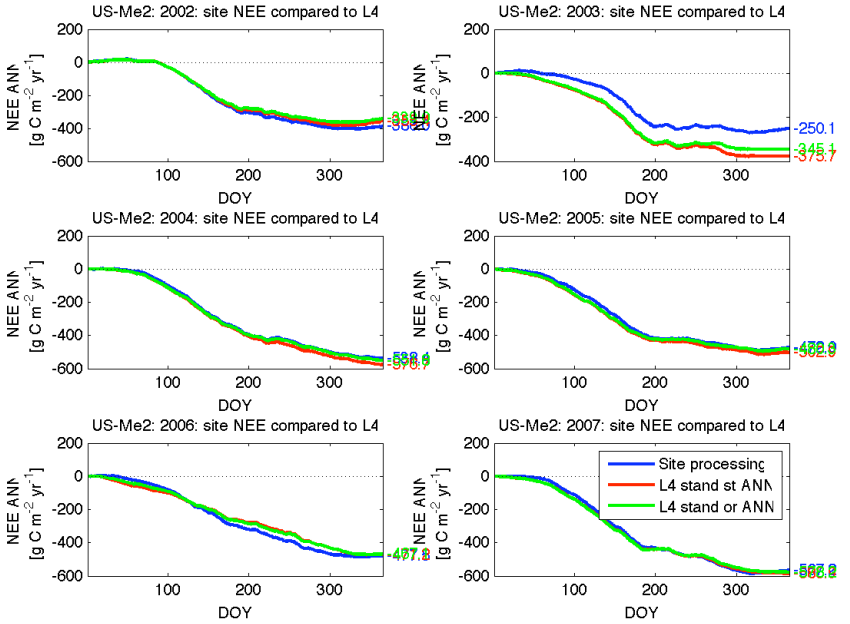
Note: not all results for any combination of L4 standard processing (ANN, MDS) and '_st' and '_or' are shown to reduce the amount of plots, but some representative were selected. No information about differences between '_or' and '_st' could be gleaned from the two reference papers mentioned in the preface, so there is an urgent need to document the L4 processing better to facilitate comparison and identification of processes that lead to differences

NEE: annual budgets

MDS

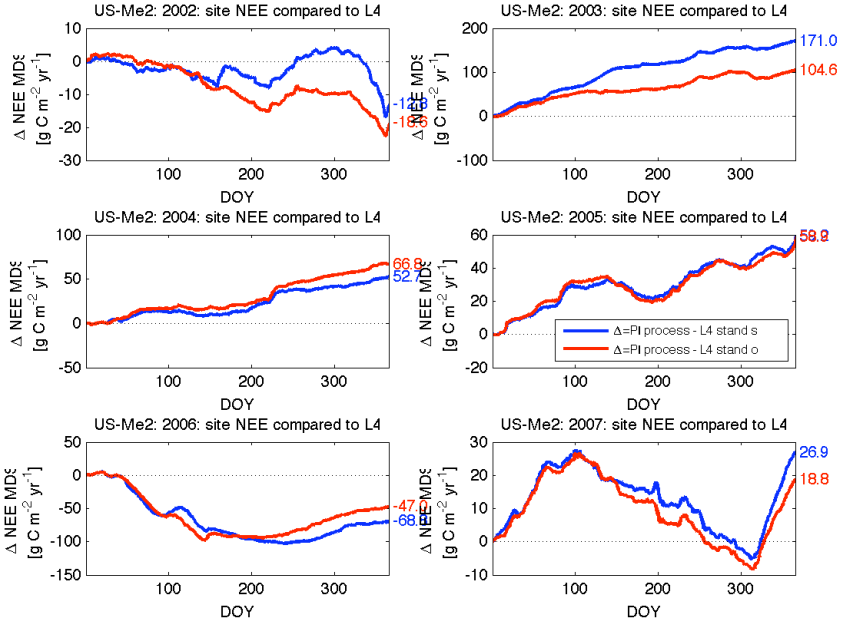


ANN

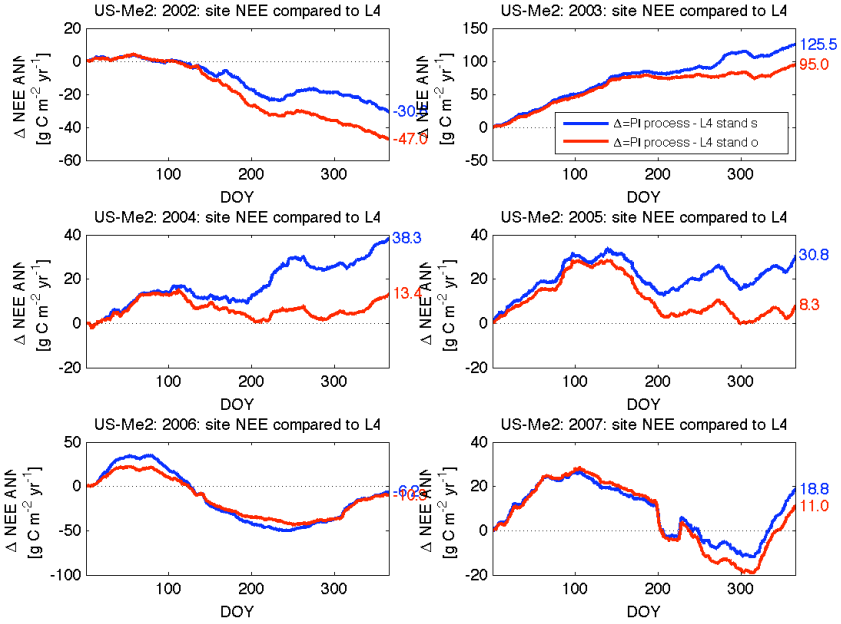


NEE: cumulative residuals in annual budgets

MDS



ANN



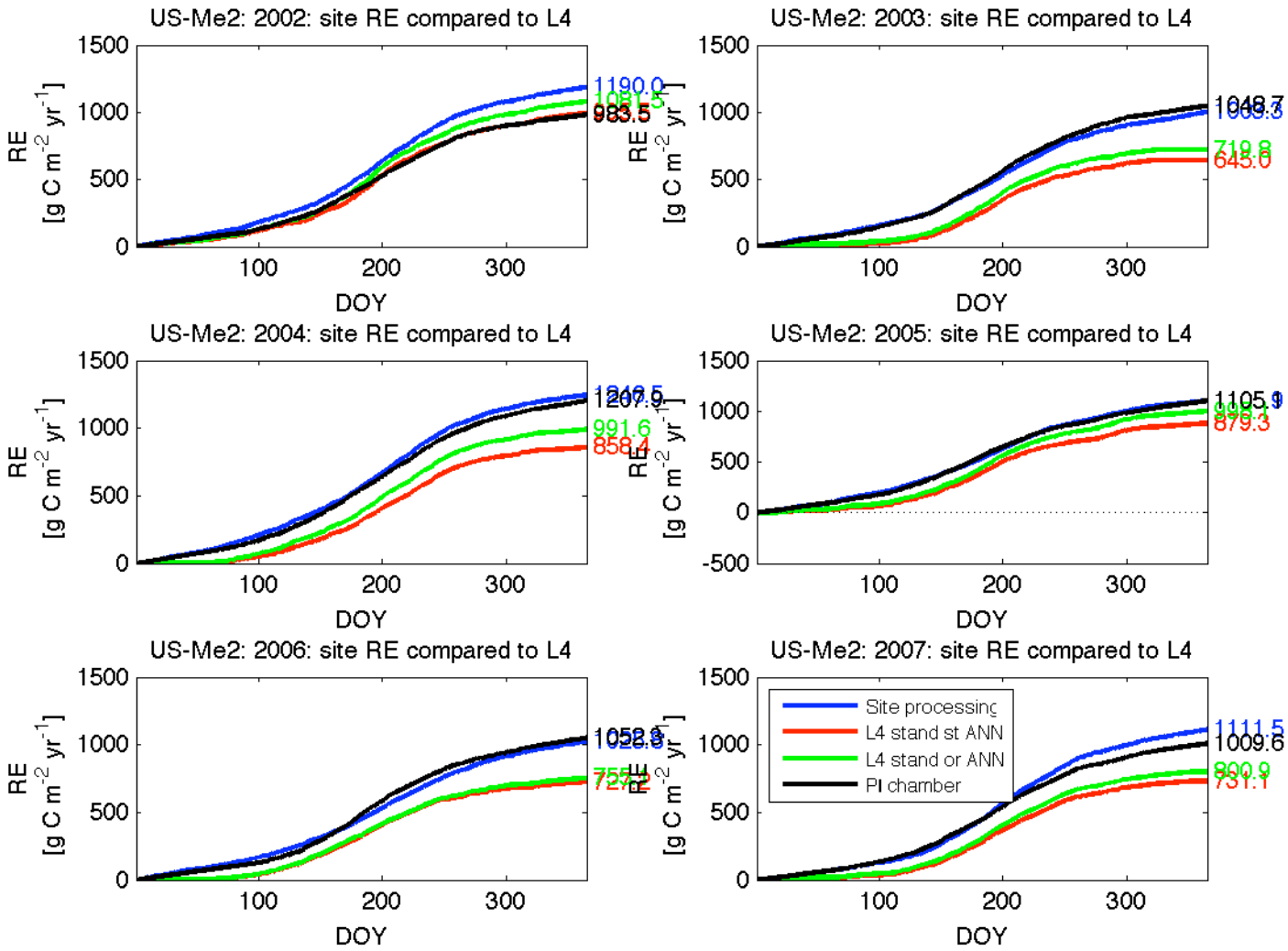
→Biggest differences in early spring and fall, not during active period

→Differences in annual NEE budgets are on the order of 12 to 70 gC m-2 yr-1, except for 2003 when differences are a factor of 3 larger (100 to 170 gC m-2 yr-1)

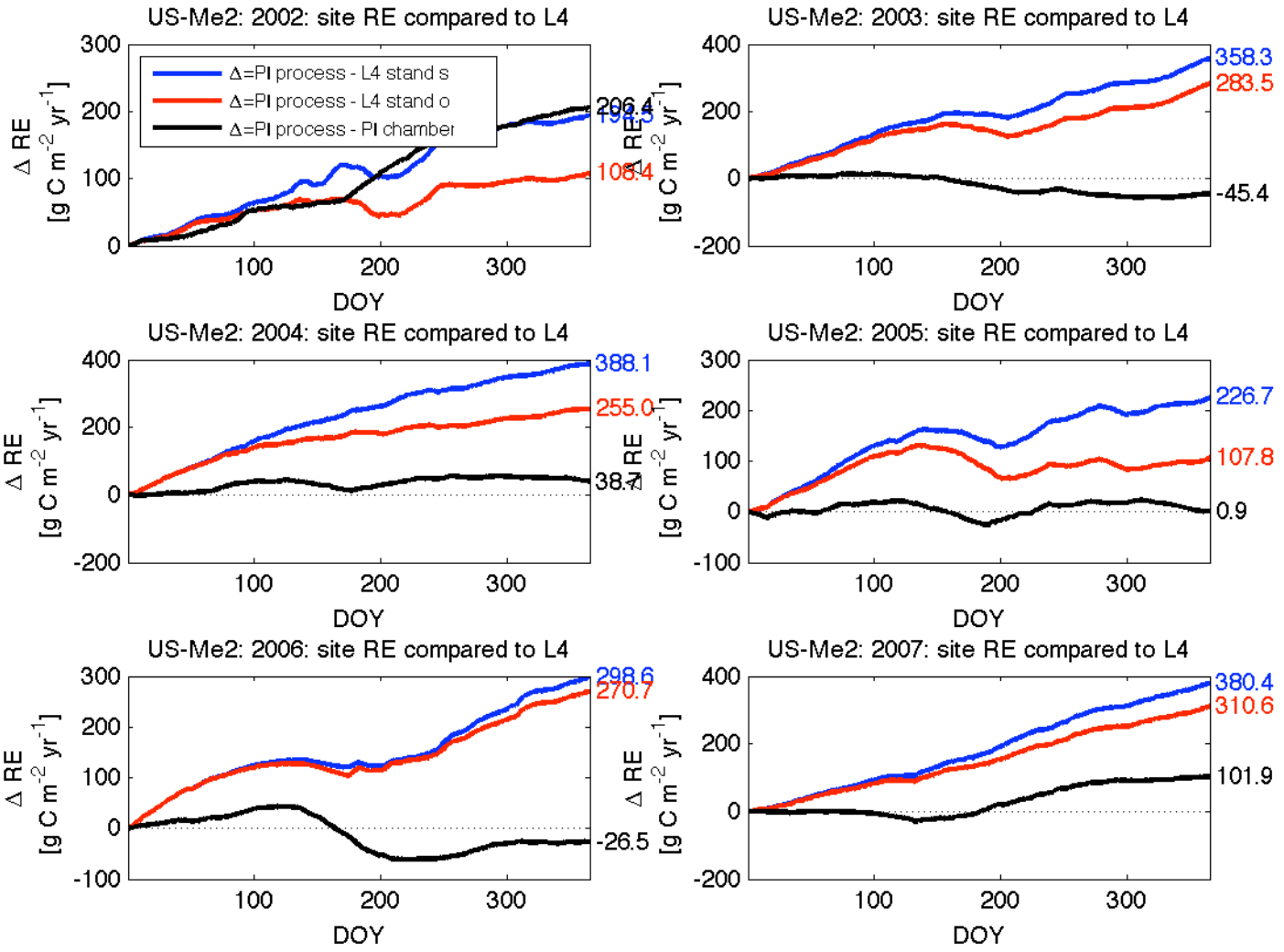
→Large year-to-year differences

→ Agreement with ANN is slightly better than for MDS

RE: annual budgets



RE: cumulative residuals in annual budgets

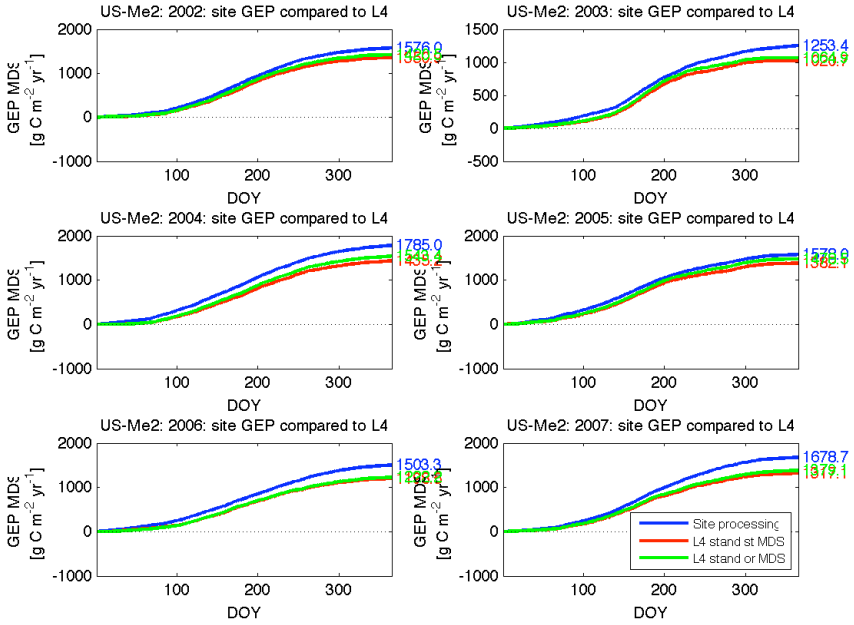


→Differences between PI EC and L4_stand are on the order of 200 to 400 gC m-2 yr-1, the PI EC data being always higher. The agreement with L4_stand _or processing is generally better than for _st

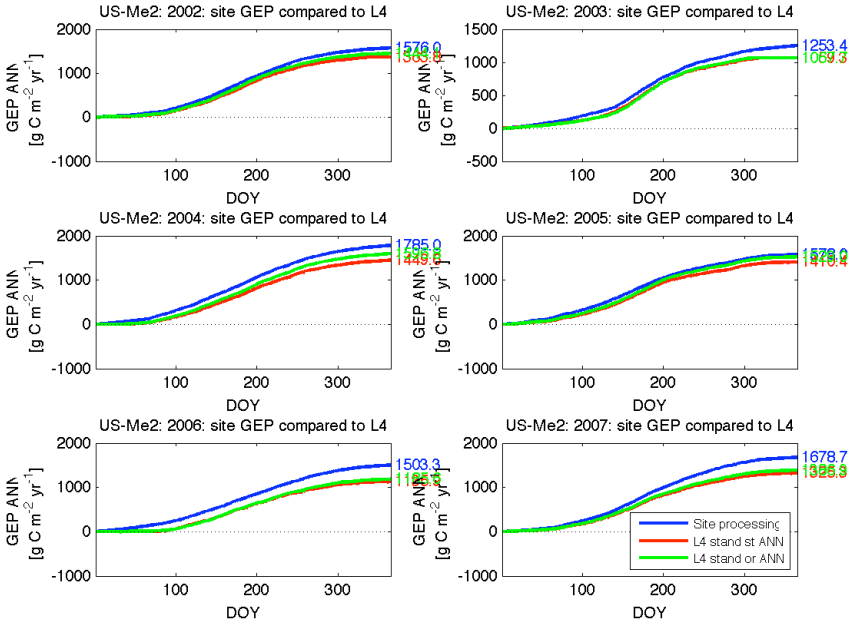
→Remarkable agreement between PI EC and PI chamber except for 2002 (noted also in Thomas et al. 2009, GCB)

GEP: annual budgets

MDS

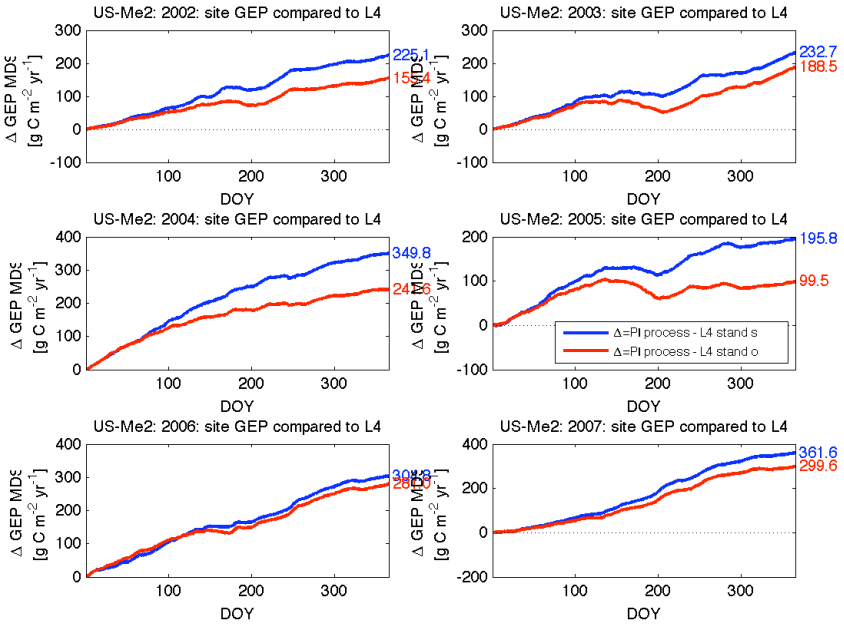


ANN

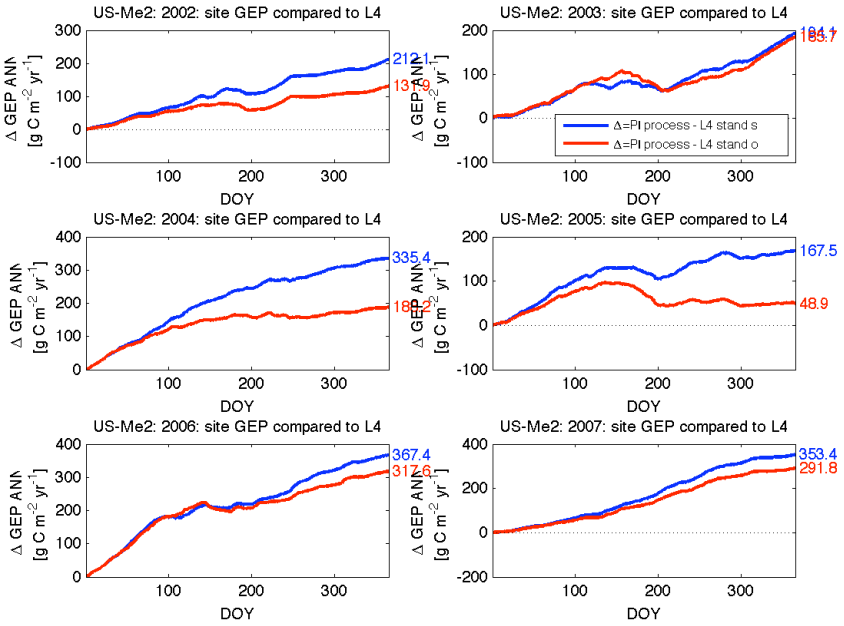


GEP: differences in annual budgets

MDS



ANN

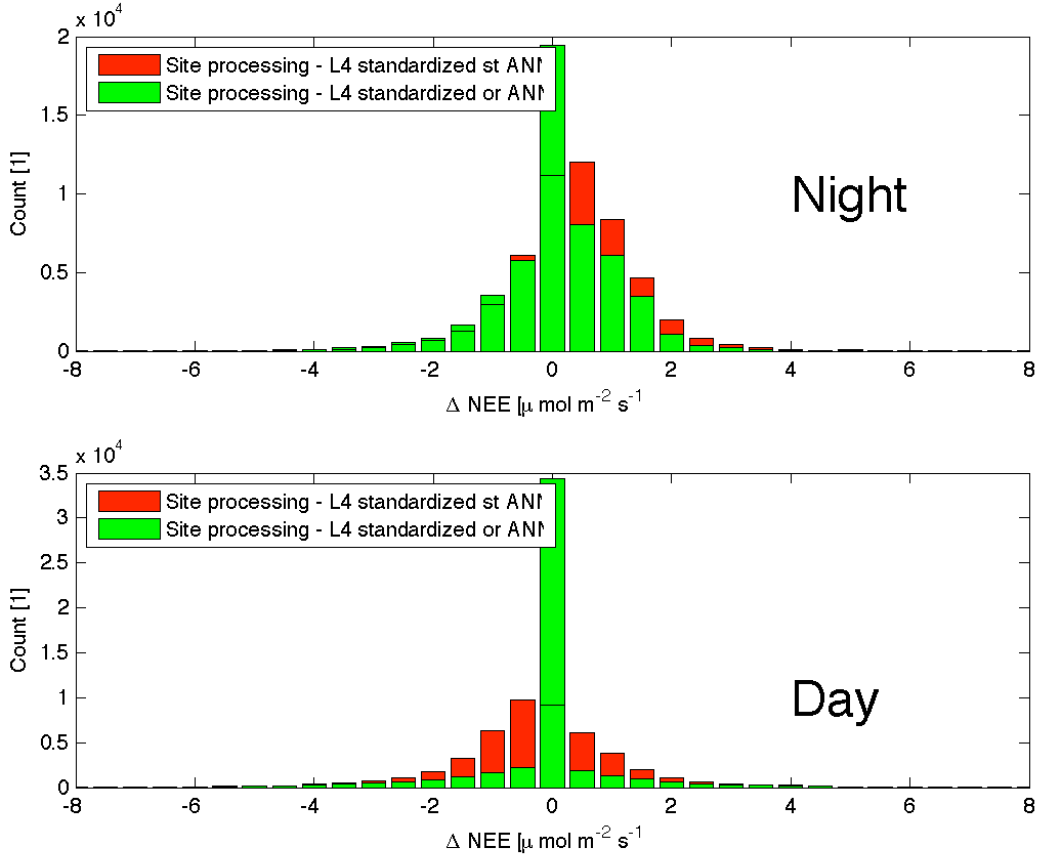


→Very similar pattern than in NEE, largest differences in early spring and fall

→ cumulative differences are on the order of 100 to 400 gC m-2 yr-1, which seems logical based on the fact that differences in cumulative NEE were relatively small and differences in RE are mirrored into GEP due to the deployed flux partitioning algorithm.

→Agreement with L4_stand '_or' processing appears to be better

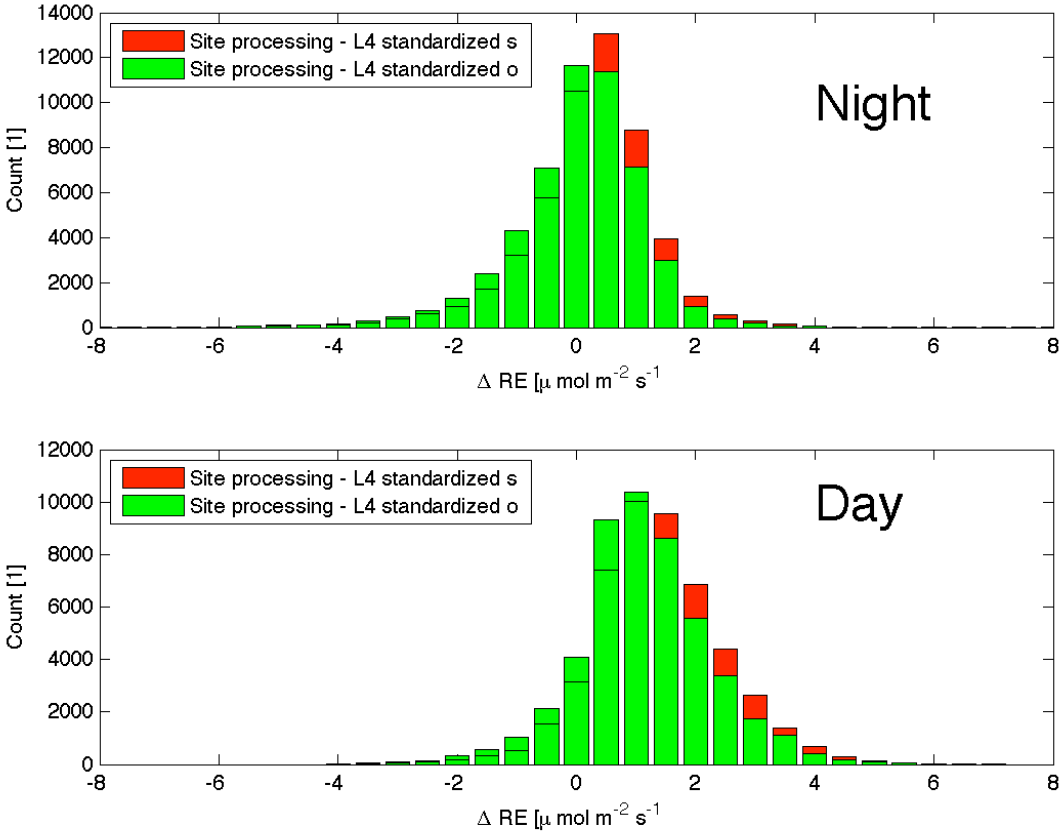
NEE: ANN diurnal bias



→No systematic bias for daytime data, but nighttime pdfs are more asymmetric and median is >0 suggesting that PI EC data are larger than any L4_stand method

→ Agreement with L4_stand '_or' processing appears to be better

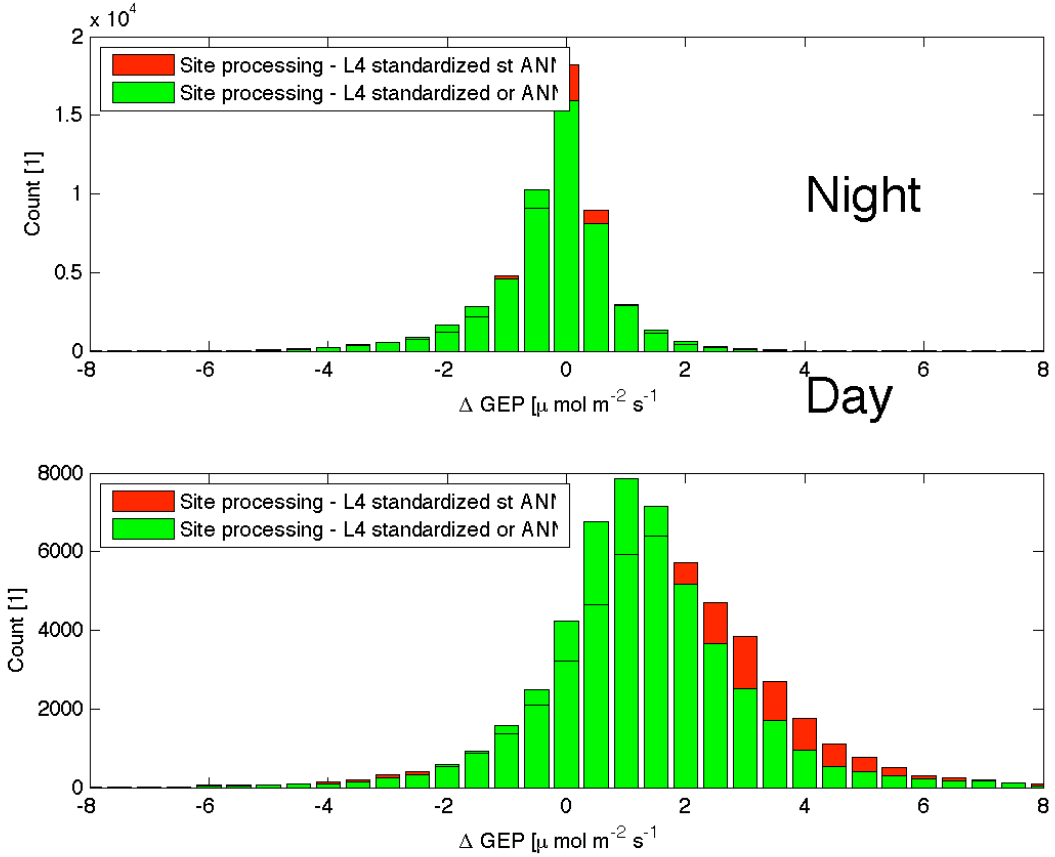
RE: diurnal bias



→Systematic bias observed for day and nighttime data, suggesting that our RE is generally larger (supported by results comparing the cumulative annual budgets)

→ Agreement with L4_stand '_or' processing appears to be better

GEP: ANN diurnal bias

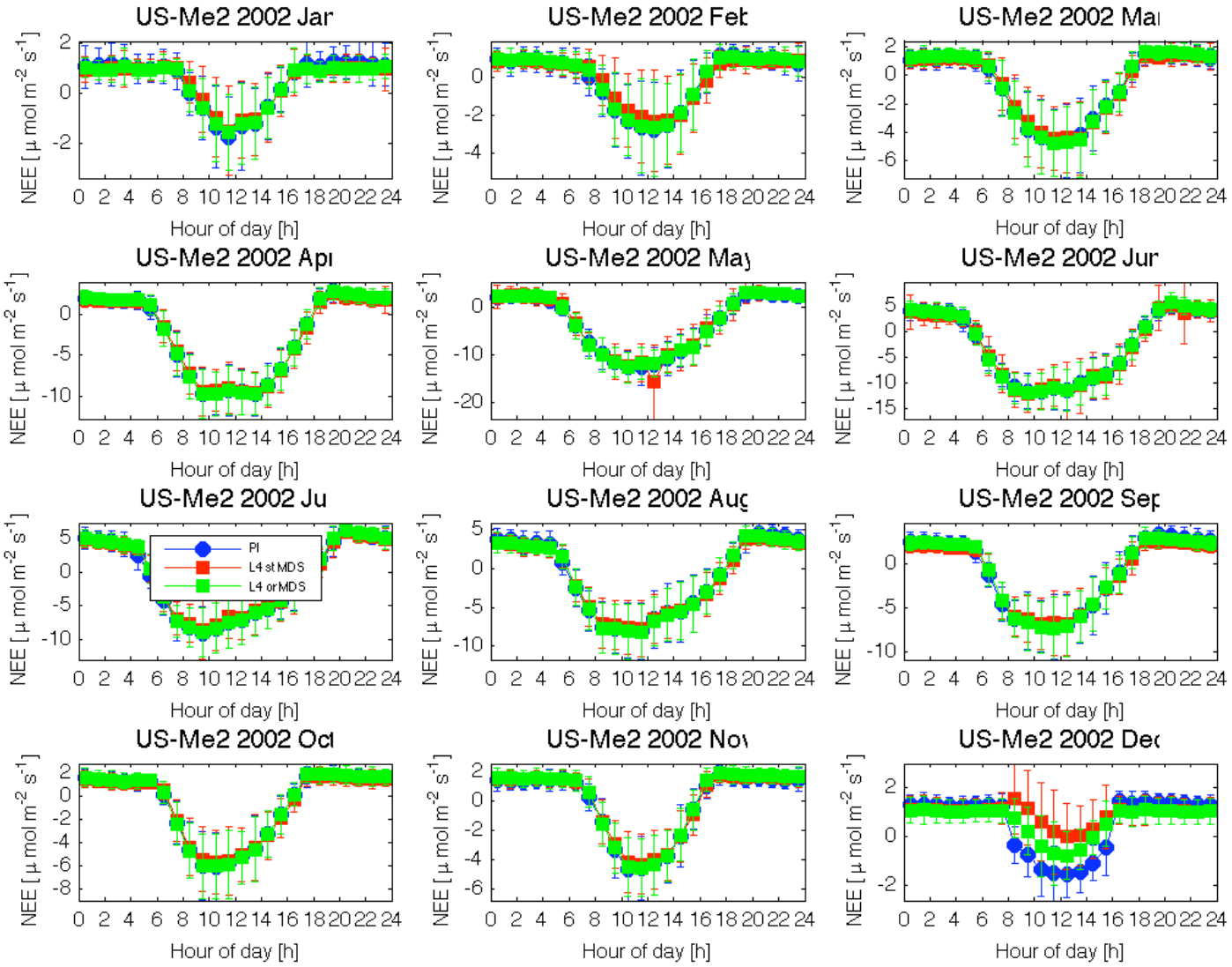


→All three compared methods have a few GEP values ≠ 0 at nigh, otherwise all differences would have to be zero

→ Large bias during the day toward higher GEP for PI_process (in agreement with annual bugets)

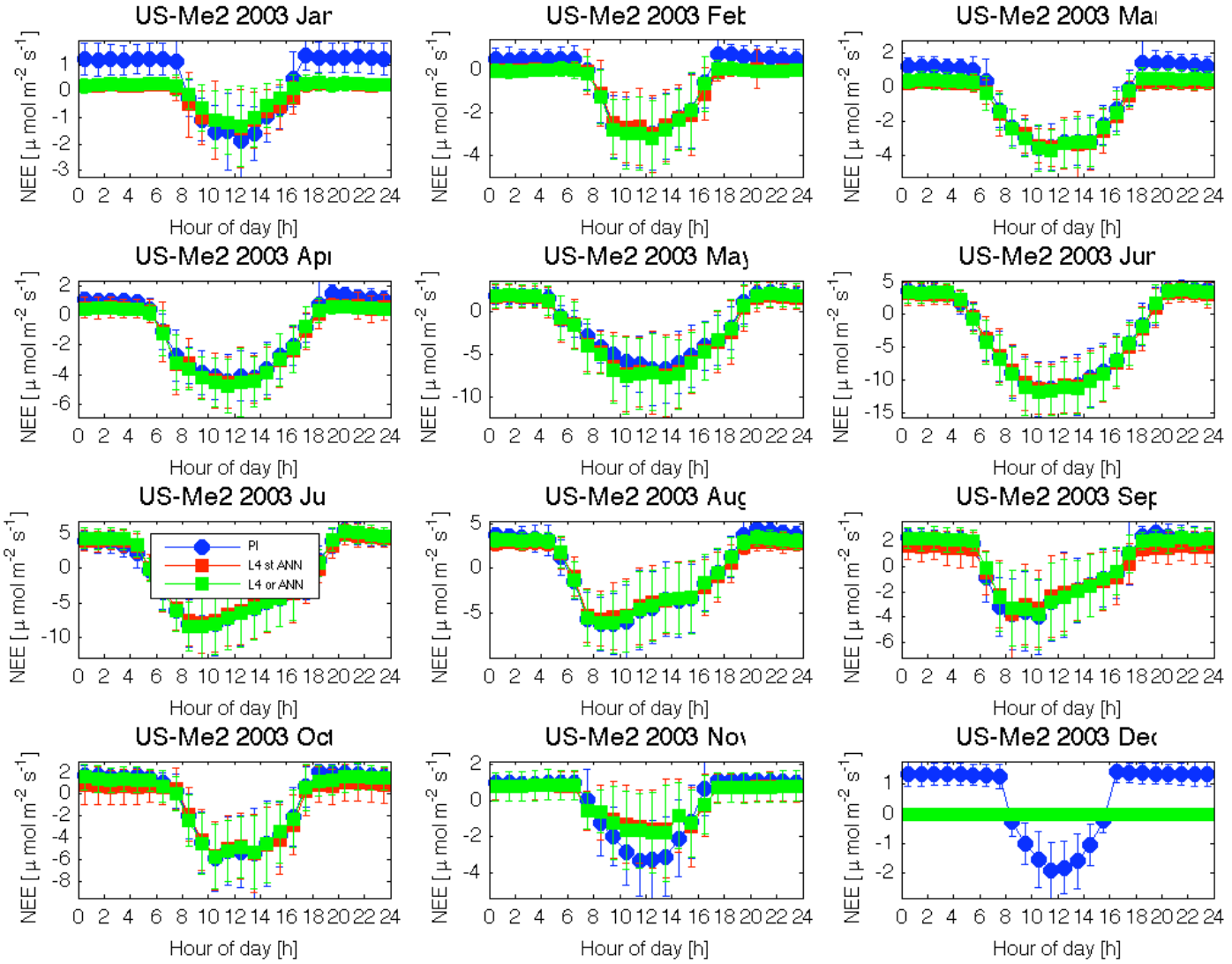
→ Agreement with L4_stand '_or' is better

NEE: MDS, diel course of monthly ensemble average for 2002



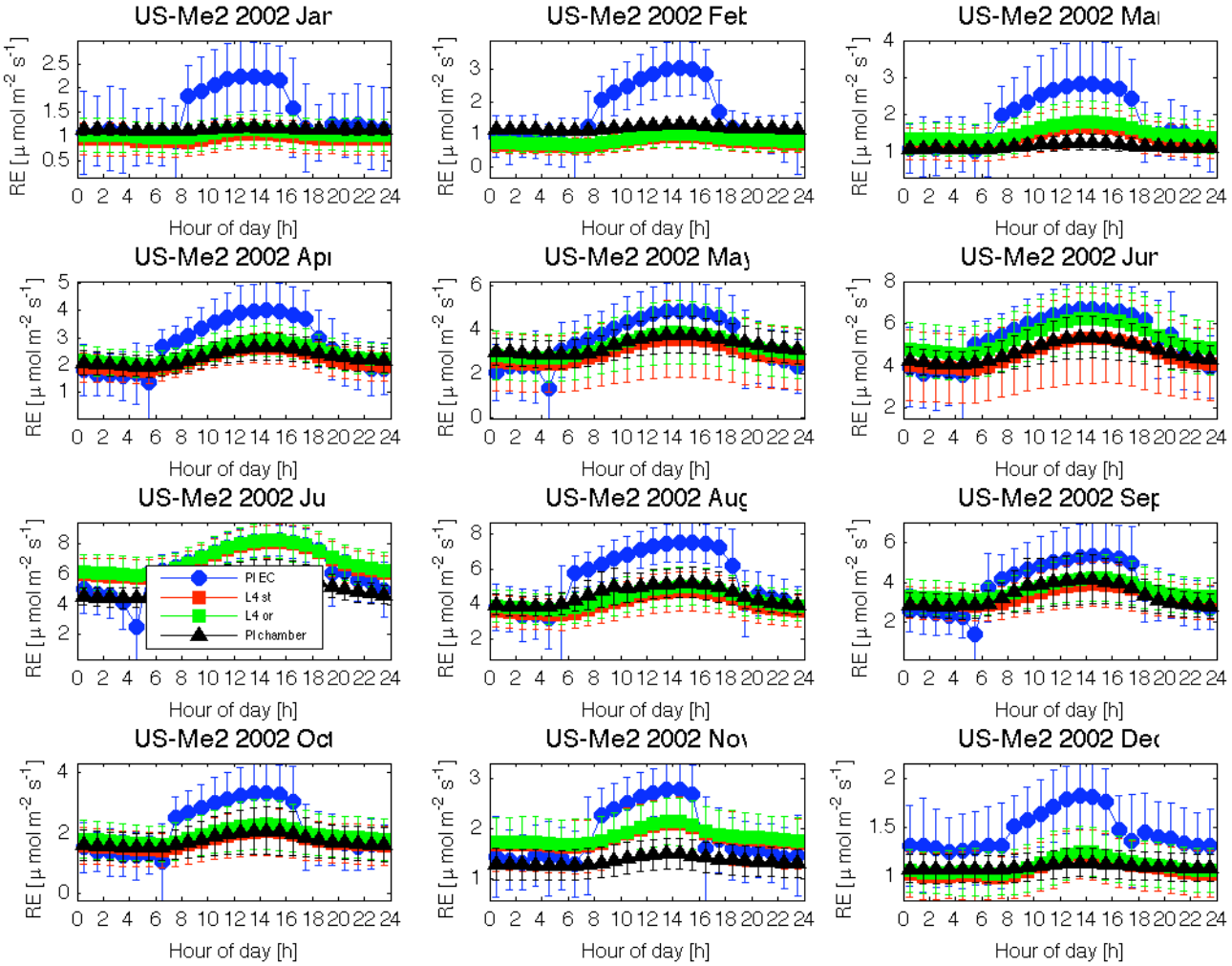
→ As observed before, differences can be found mainly in the cooler months Jan/Dec, spring/summer values agree well when uptake is at its maximum

NEE: ANN, diel course of monthly ensemble average for 2003



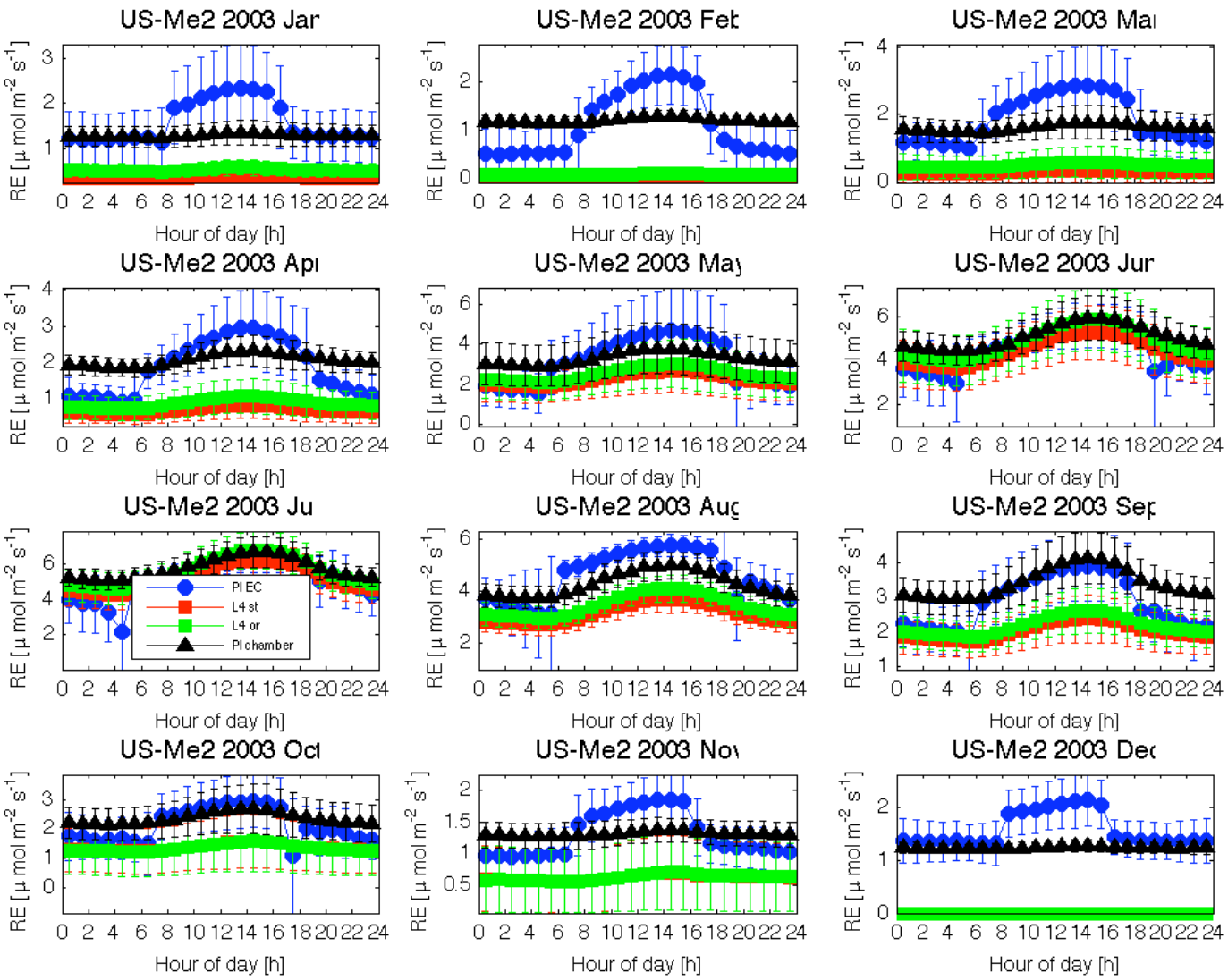
→ Year with the largest differences in annual NEE. L4_stand does not show any respiration in period Jan through April and December resulting in too negative annual NEE (sink too strong) as respiration is underestimated. Other months agree well.

RE: diel course of monthly ensemble average for 2002



→Respiration in L4_stand product nicely resembles course of PI_chambers, PI_EC data overestimate daytime respiration because of differences in short- and long-term temperature sensitivity (discussed in Reichstein et al. (2005, GCB), and underestimate nighttime data (unknown reason). However, PI_EC and PI_chamber data agree very well starting at daily scales. Subdaily scales should only be used with caution. I will have to work on our respiration models to fix that.

RE: diel course of monthly ensemble average for 2003

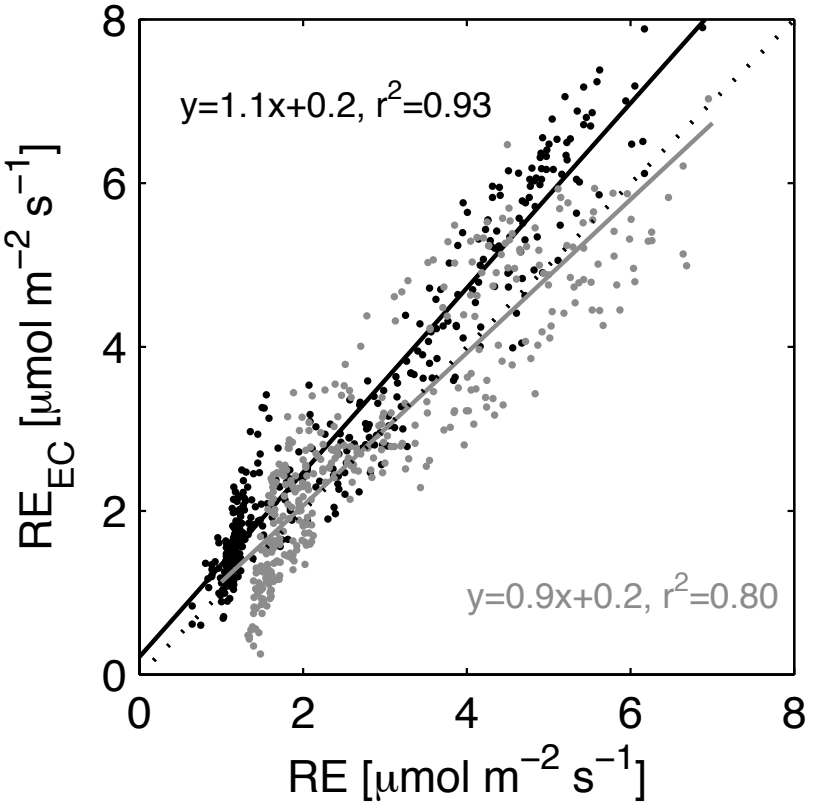


→As mentioned before: L4_stand processing largely underestimates the respiration in period Jan-Apr and Sep-Dec in 2003, so cumulative budgets are much smaller.

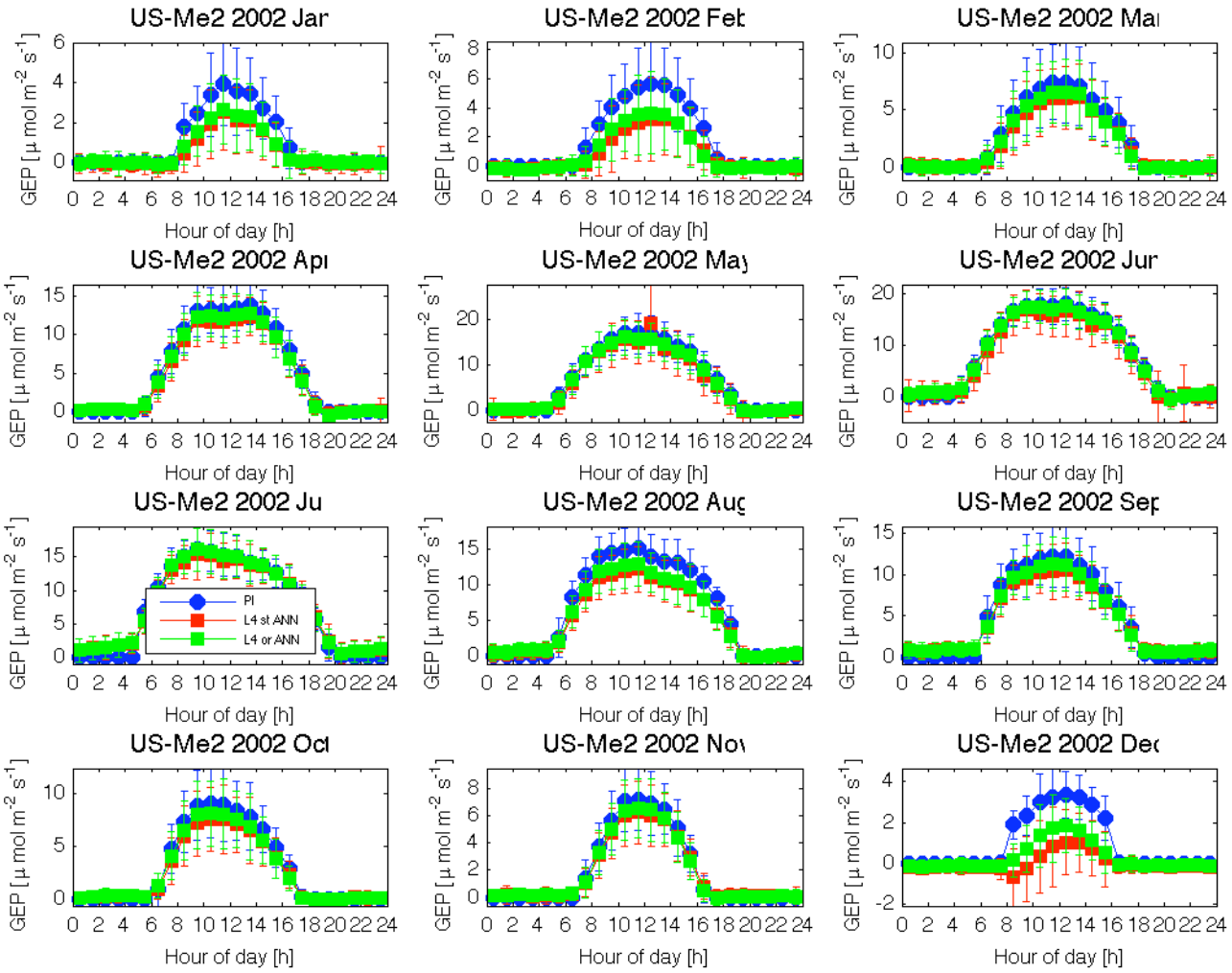
Comparison of daily ecosystem respiration from PI_EC data (RE_{EC}, y-axis) and PI_chambers (RE, x-axis) for 2002 (black) and 2005 (grey).

Source: Thomas, C.K., Law, B.E., Irvine, J., Martin, J.G., Pettijohn, J.C. and Davis, K.J., 2009. Interannual and seasonal variation in carbon and water exchange at a semi-arid mature Ponderosa Pine site in Central Oregon. Global Change Biol.: submitted.

→Daily respiration values agree very well for the PI data (EC and chambers), differences were found only for subdaily scales (see previous slides)

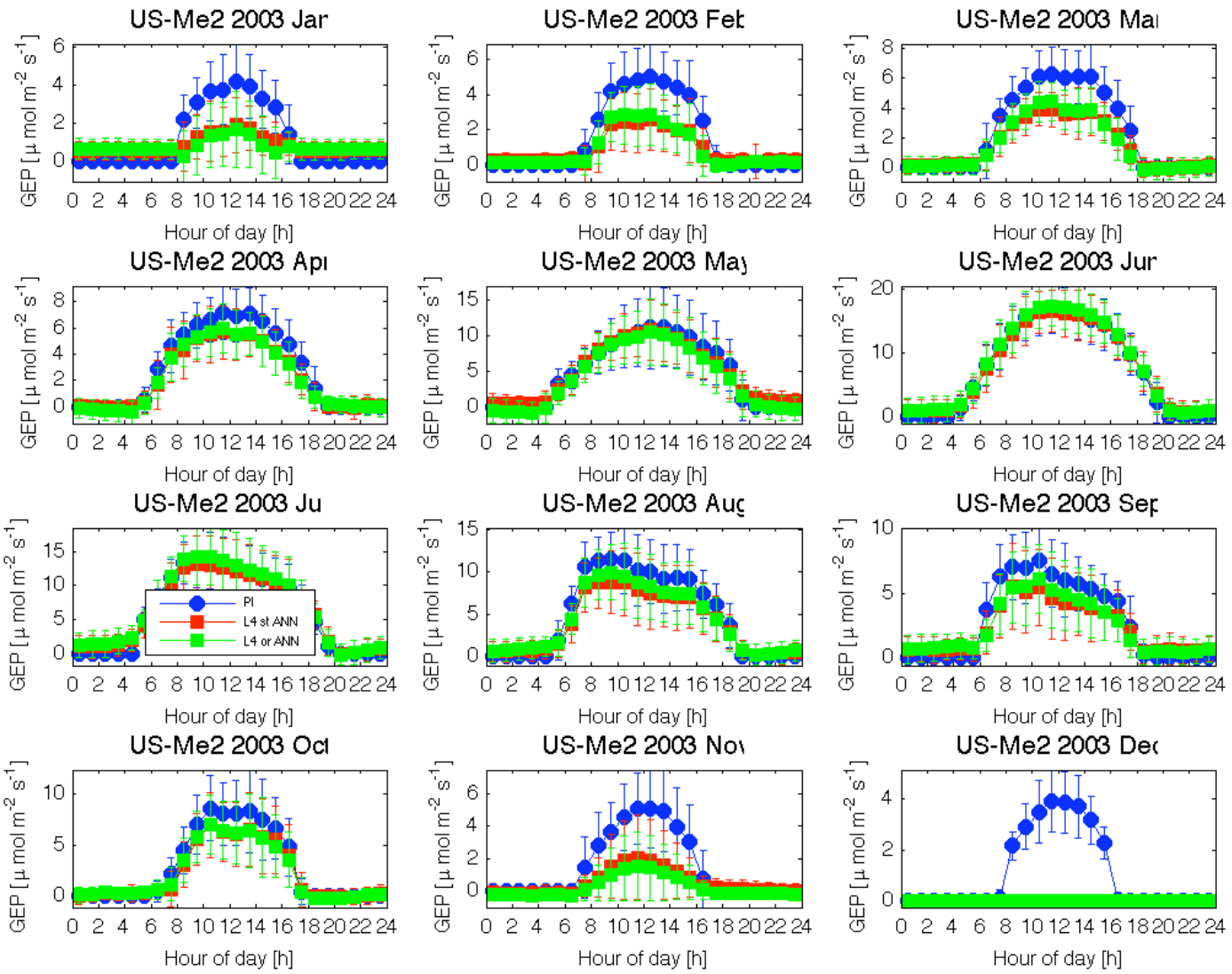


GEP: ANN, diel course of monthly ensemble average for 2002



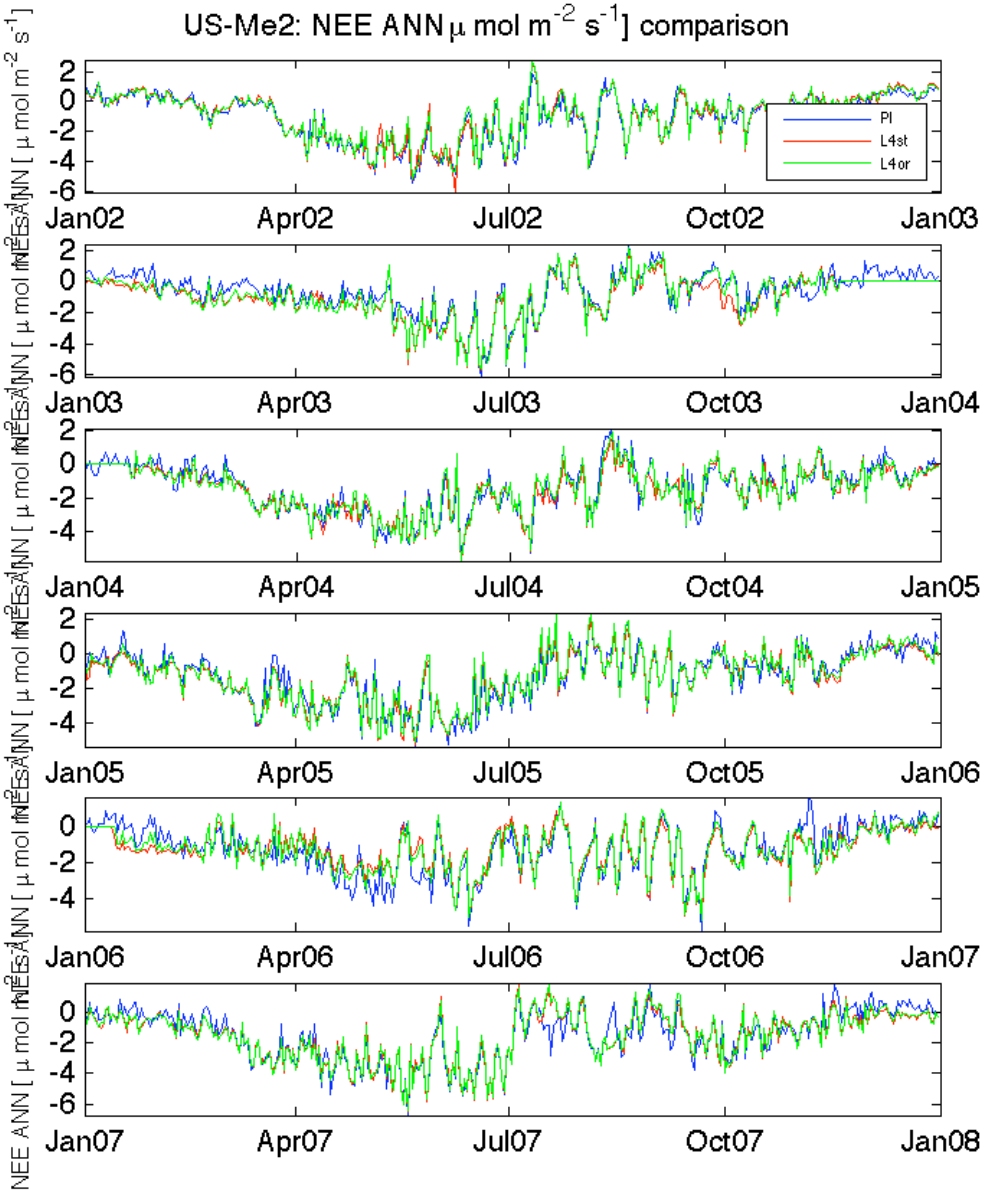
→ As observed before: differences in RE lead to differences in GEP, while NEE compares reasonably well

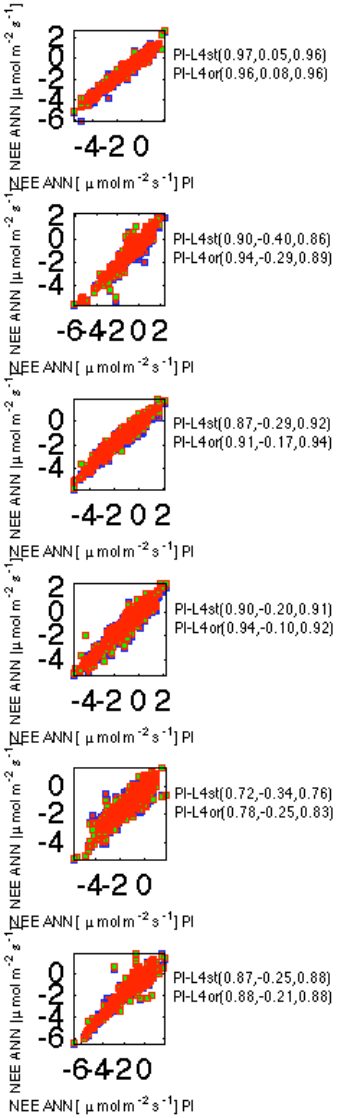
GEP: ANN, diel course of monthly ensemble average for 2003



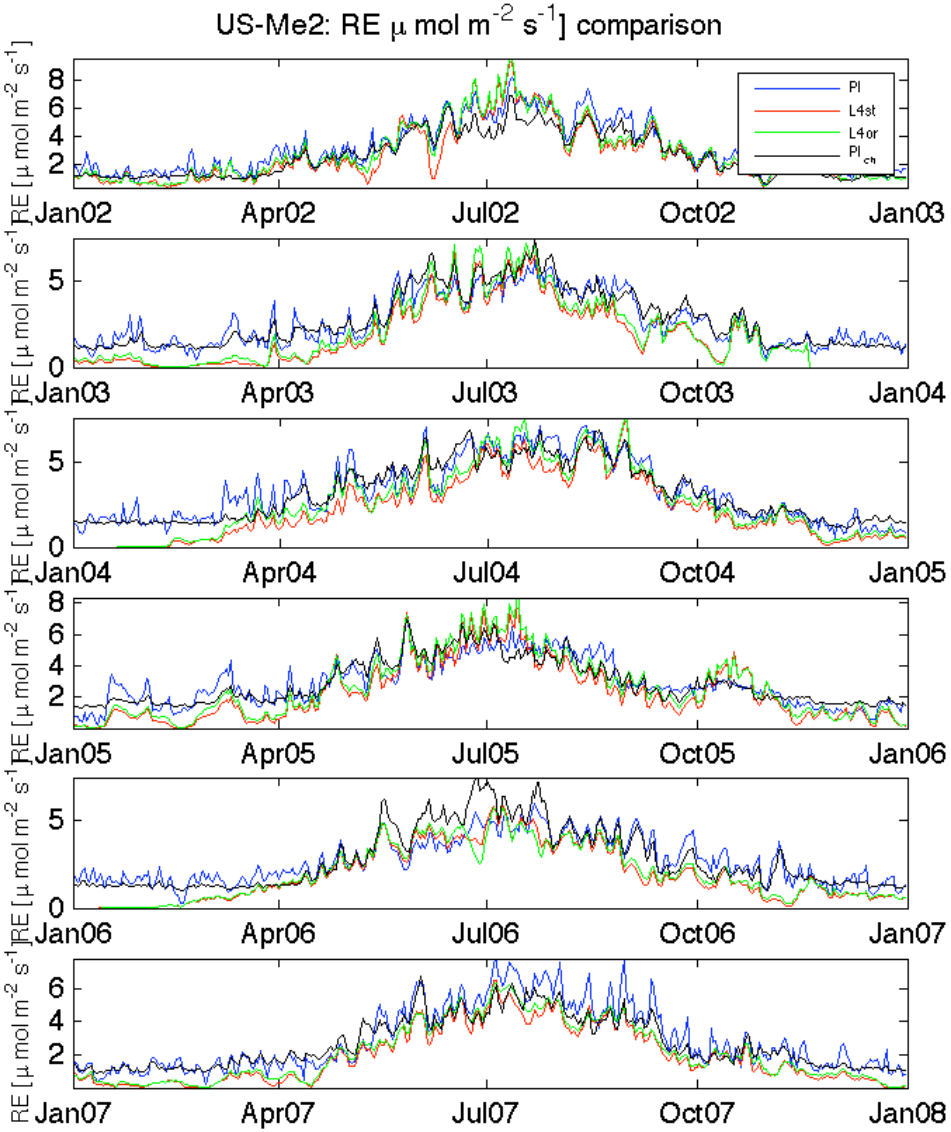
→ Again, underestimation of RE for L4_stand lead to underestimation of GEP

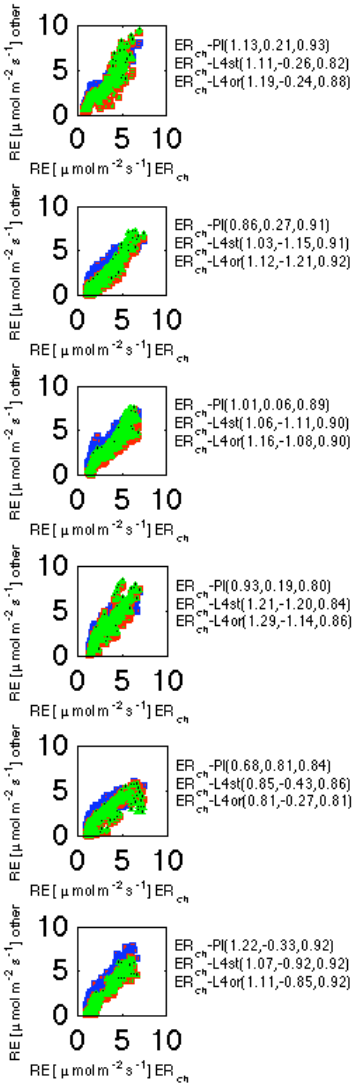
NEE: ANN, daily mean values, for entire period 2002-2007



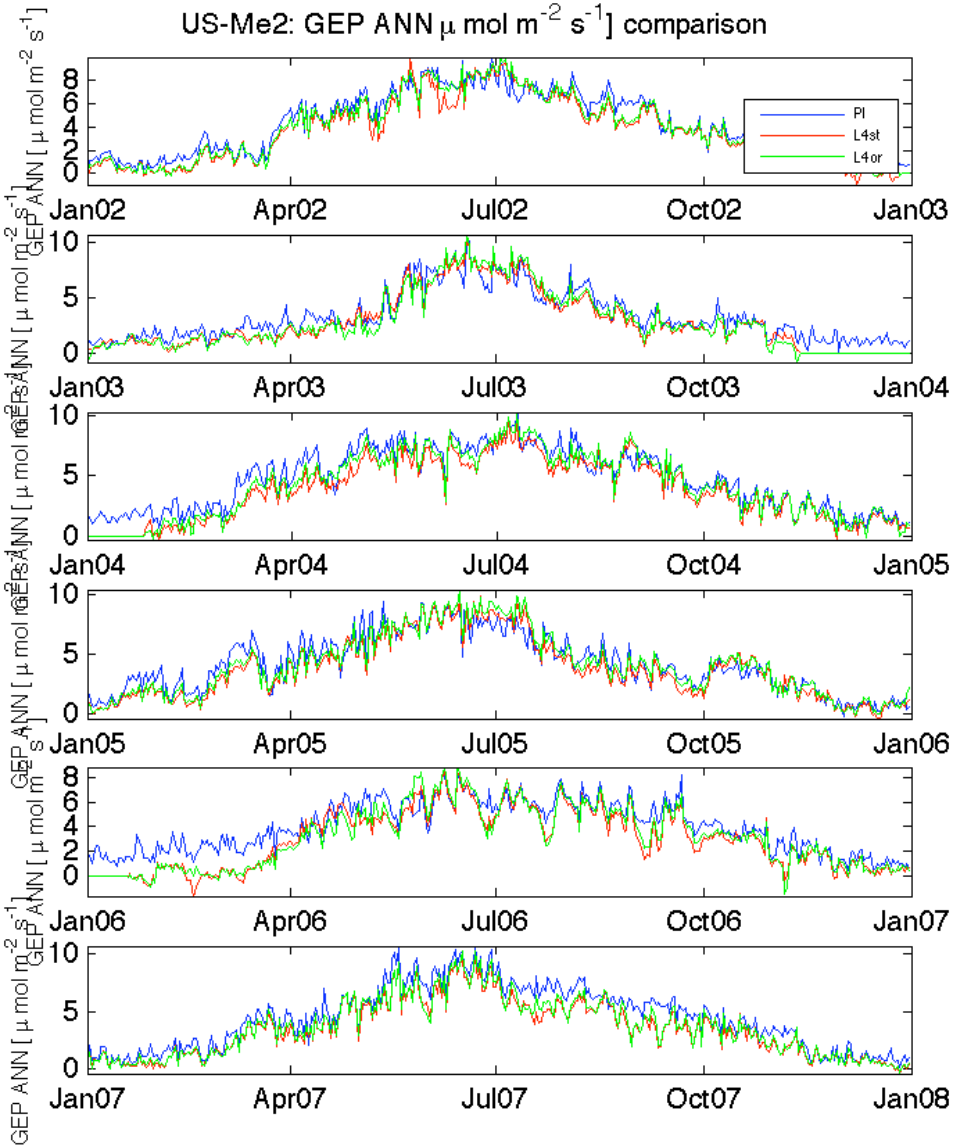


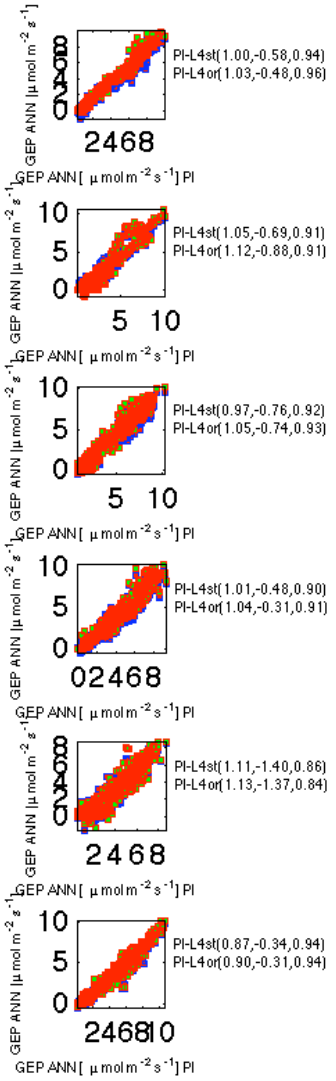
RE: daily mean values, for entire period 2002-2007





GEP: ANN, daily mean values, for entire period 2002-2007





Preliminary conclusions:

→This L4_stand processing is much better than the previous (done in 2007)
→ L4_stand generally underestimates RE in the cooler season, reasons not clear, maybe too few data to reliably determine the short-and long term respiration base rates and temperature sensitivities
→ Agreement between PI_process and L4_stand '_or' in general better than with '_st'
→ Differences in RE lead to differences in GEP due to the flux partitioning
→ PI_process EC data have unrealistic RE on subdaily time scales, but show very good agreement against concurrent, independent chamber-based RE estimates starting from daily scales up

Recommendations:

→L4_stand products can be left on CDIAC ftp server, BUT NEED TO BE CLEARLY LABELED AS SUCH for years 2002 and 2004-2007 in addition to the PI_process data
→L4_stand data for 2003 should be removed completely until RE issue is resolved
→L4_stand processing needs additional and complete documentation of all error codes (not listed in the two reference papers) and methods (_or and _st).
→ This presentation should be added to the CDIAC data archive as an integral part of the data set and needs to ve VERSIONED as it evolves in time. Users need to know which data they get and what problems to expect.
→ Add warning statement of using PI processed RE data on subdaily scales in the current documentation file
→ PI_process data (gap-filled and flux partitioned) are only available through the L2 web interface (and data download). This is confusing as a users looking into the L4 data folder at CDIAC will only find the L4_stand data sets. A clear link pointing to the L2 PI_process data needs to be implemented with VERSIONING

Again, we would like to thank all, particularly Dario and Markus, for investing so much time and resources into the L4 standardized processing. We as PIs definitely benefitted from the comparison already and look forward to working with you to resolve the observed differences.