

# Evaluation of energy balance closure correction methods for multiple eddy-covariance sites in different biomes

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Ecosystem-Atmosphere Interactions/Transport Processes in the Atmospheric Boundary Layer

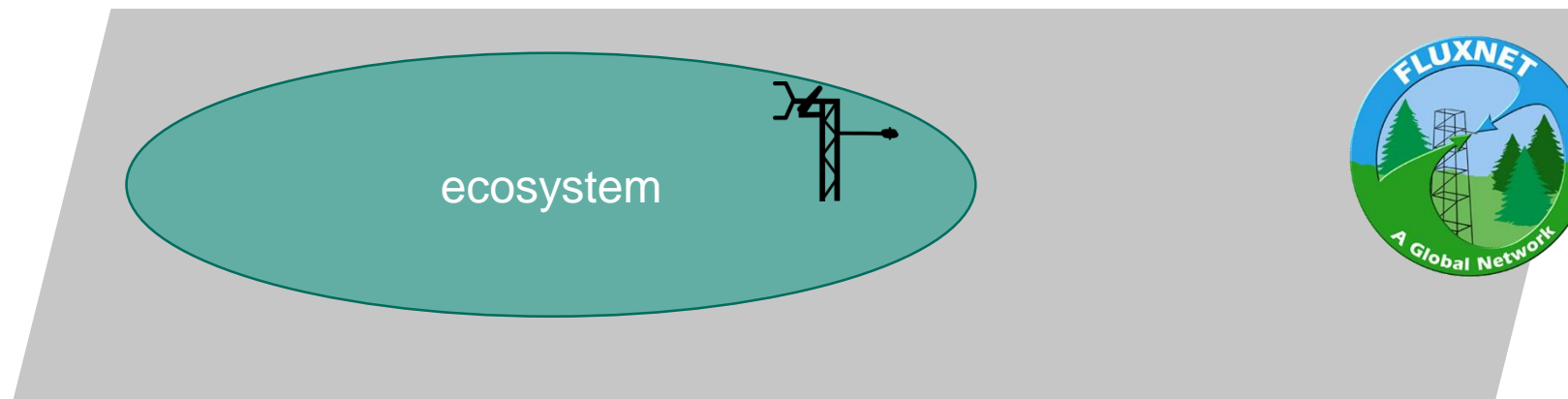
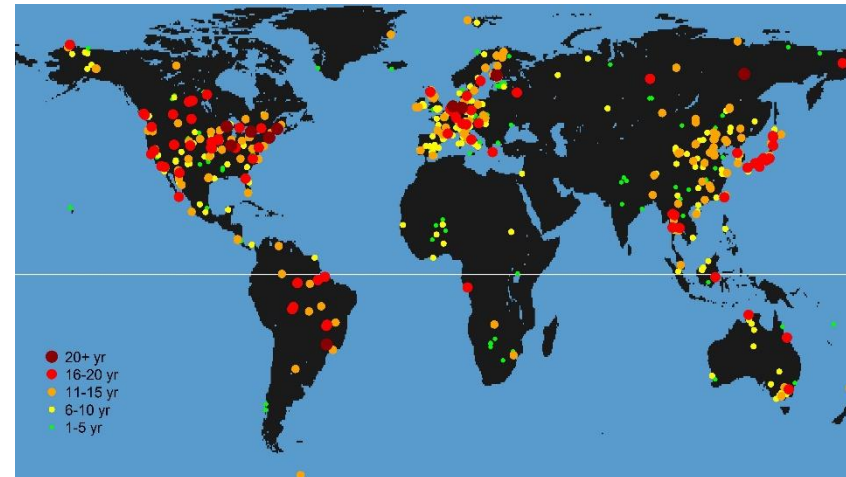


# Eddy-Covariance Measurements

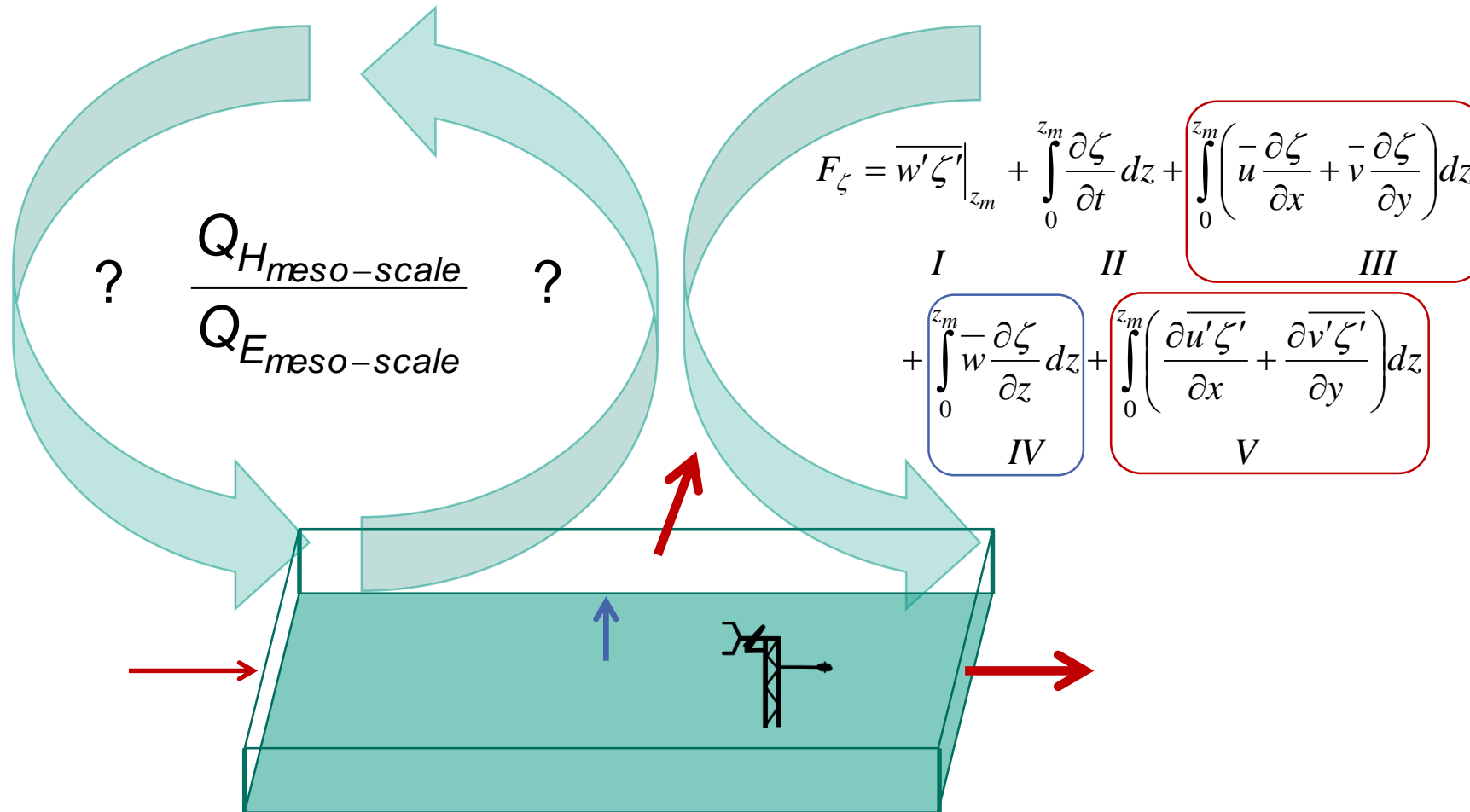


$$F_{\zeta} = \overline{w' \zeta'} \Big|_{z_m}$$

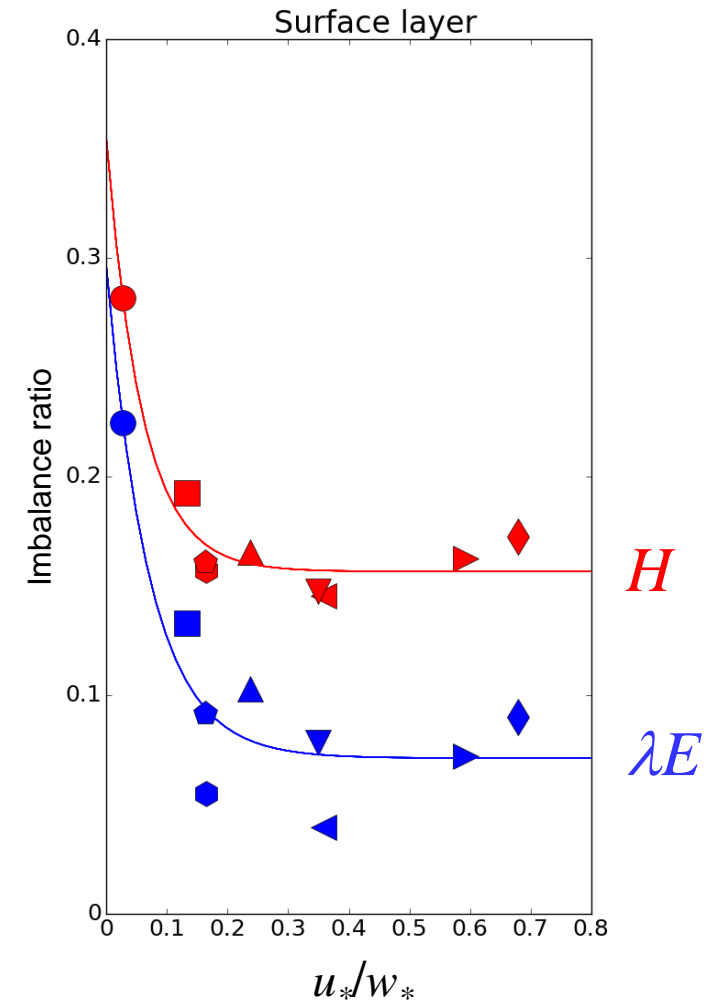
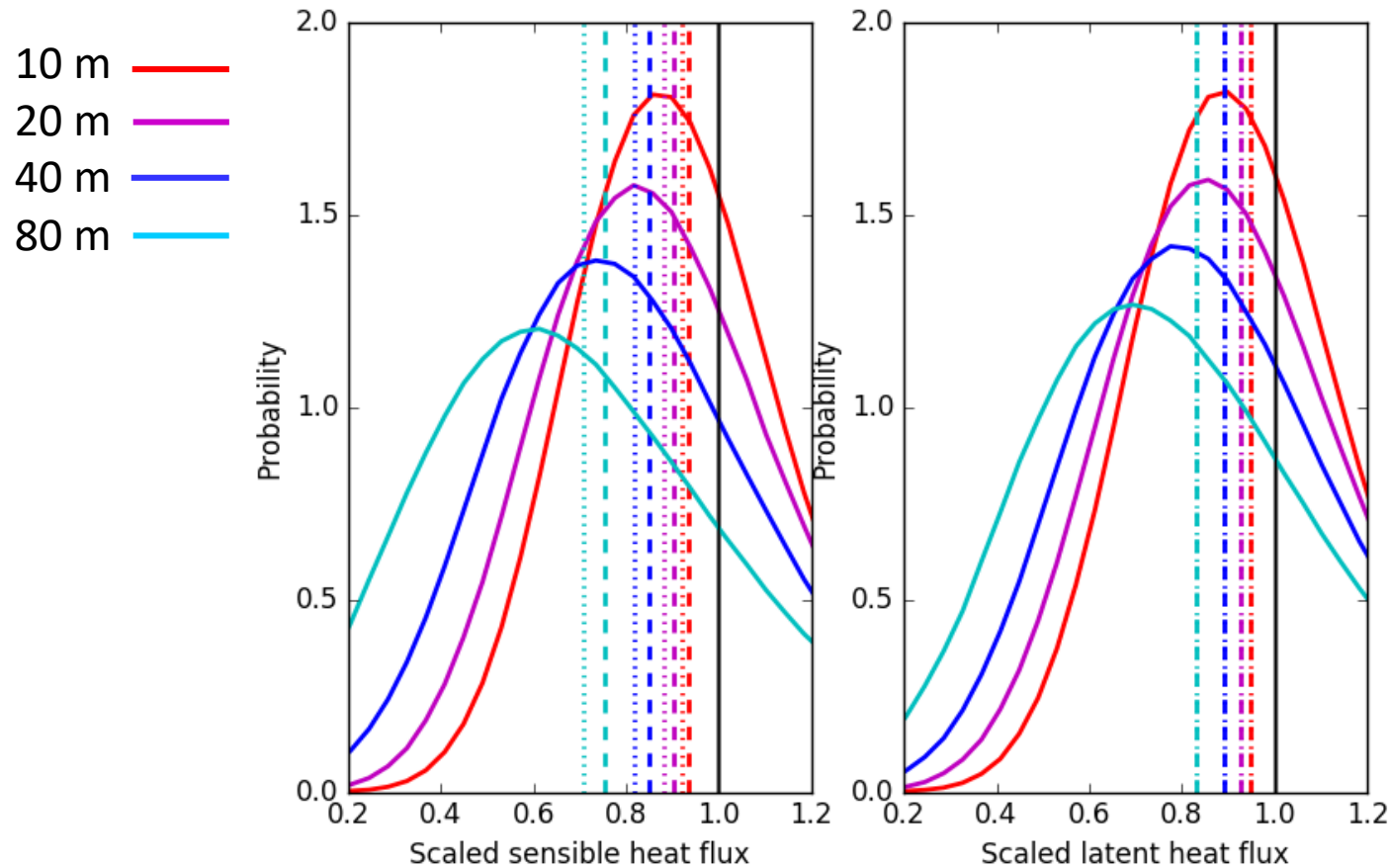
FLUXNET 2015



# Unaccounted large-scale transport



# LES study of the energy imbalance



De Roo, F., Zhang, S., Huq, S. and Mauder, M.: A semi-empirical model of the energy balance closure in the surface layer, PLoS One, doi:10.1371/journal.pone.0209022, 2018.

# LES-based energy balance correction

$$H_{tot} = \frac{H_m}{1 - F_{1H}(u_*/w_*)F_{2H}(z/z_i)}$$

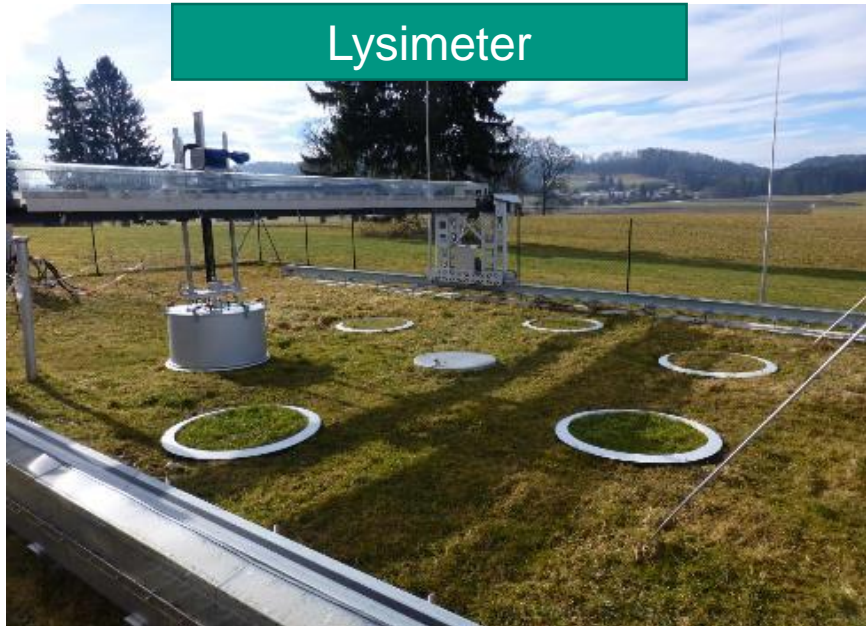
$$\lambda E_{tot} = \frac{\lambda E_m}{1 - F_{1E}(u_*/w_*)F_{2E}(z/z_i)}$$

Note: only applies for  $z > 20$  m, below, the correction is scaled with EBR, analogous to Mauder et al. (2013), only the new partitioning is different.

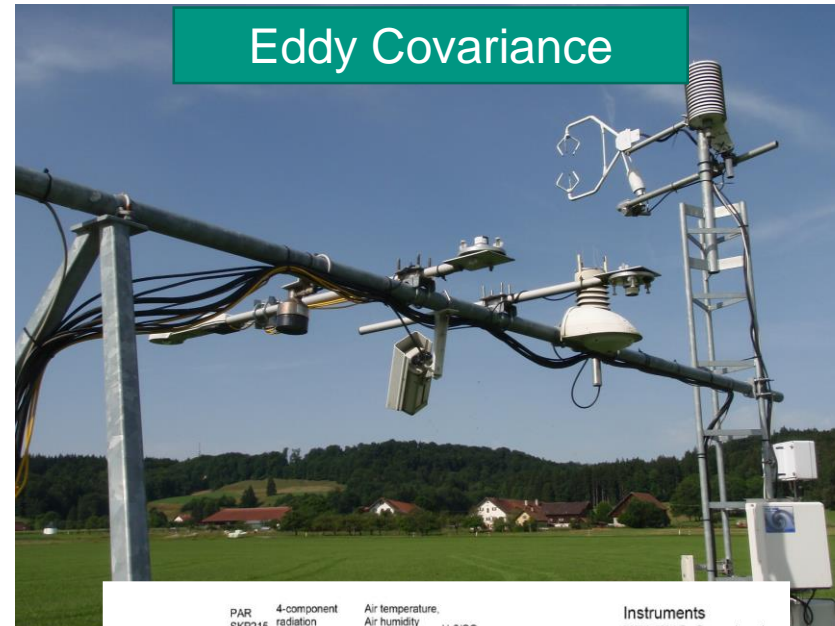
- This correction has been incorporated into the Tovi software (Licor Biosciences Inc., in order to facilitate its application for a large number of sites.



# Application to Fendt data of 2014 (DE-Fen)



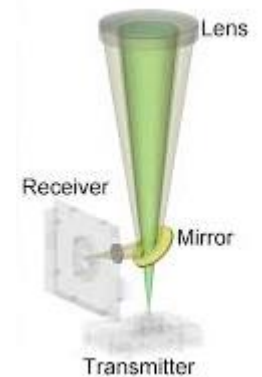
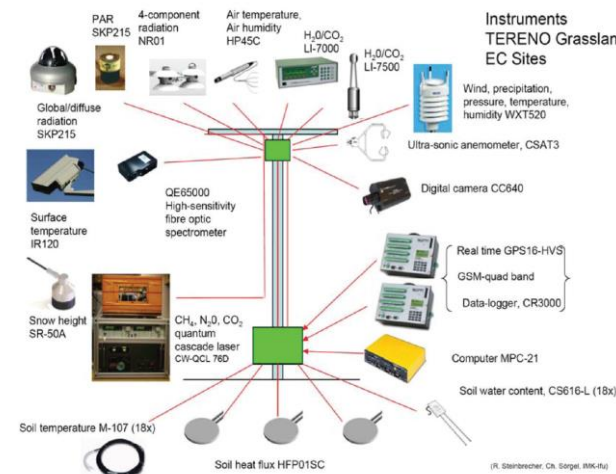
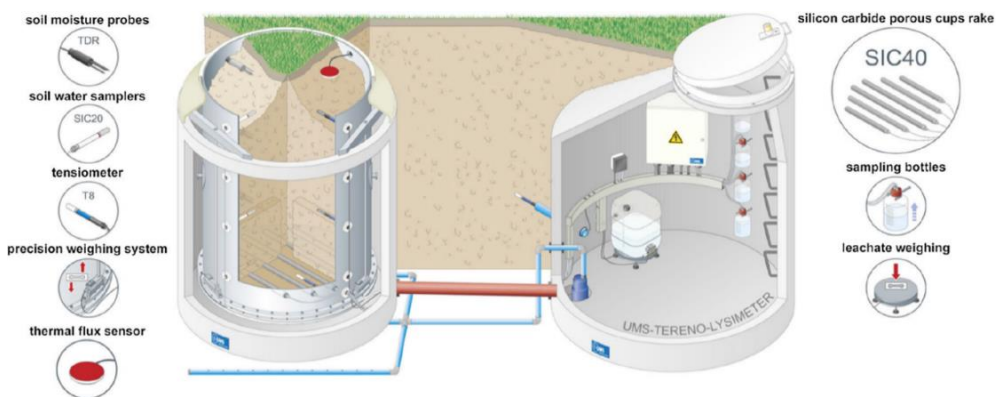
Lysimeter



Eddy Covariance

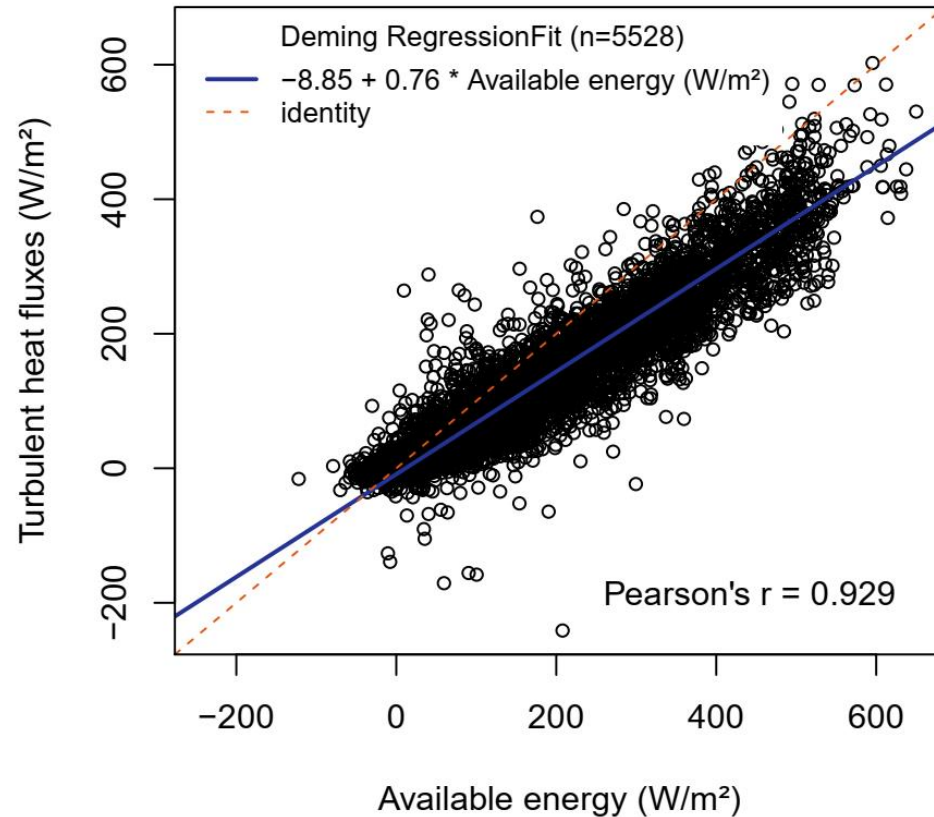


Ceilometer

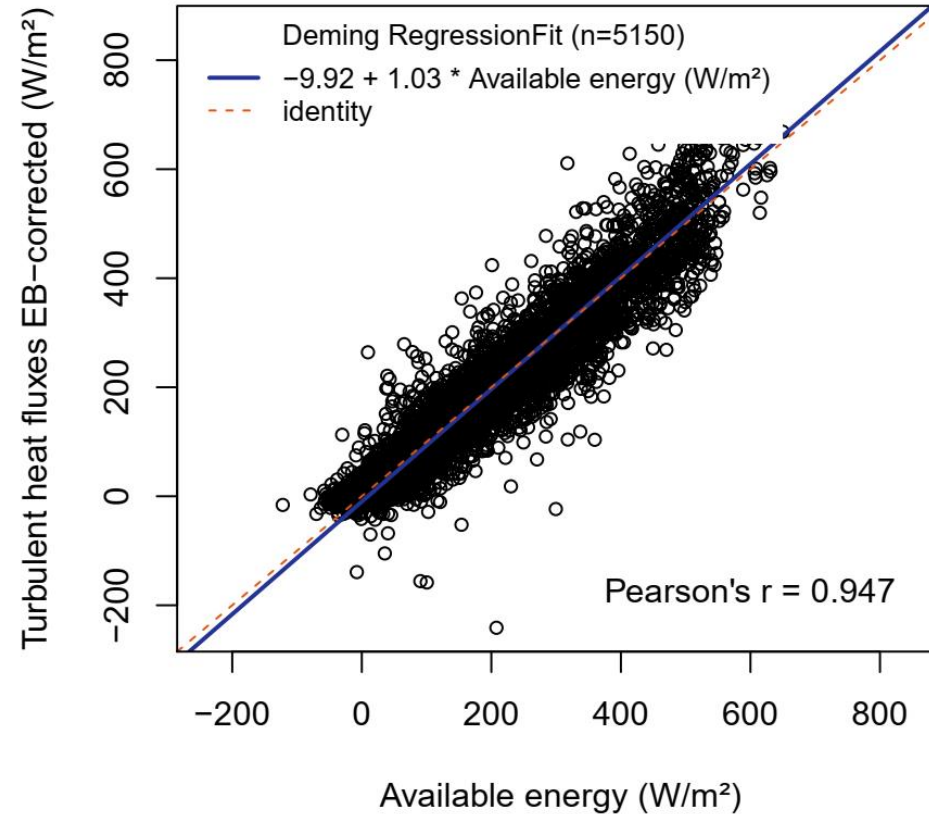


# De-Fen 30-min fluxes

## Energy Balance Closure 2014



## Energy Balance Closure corrected 2014

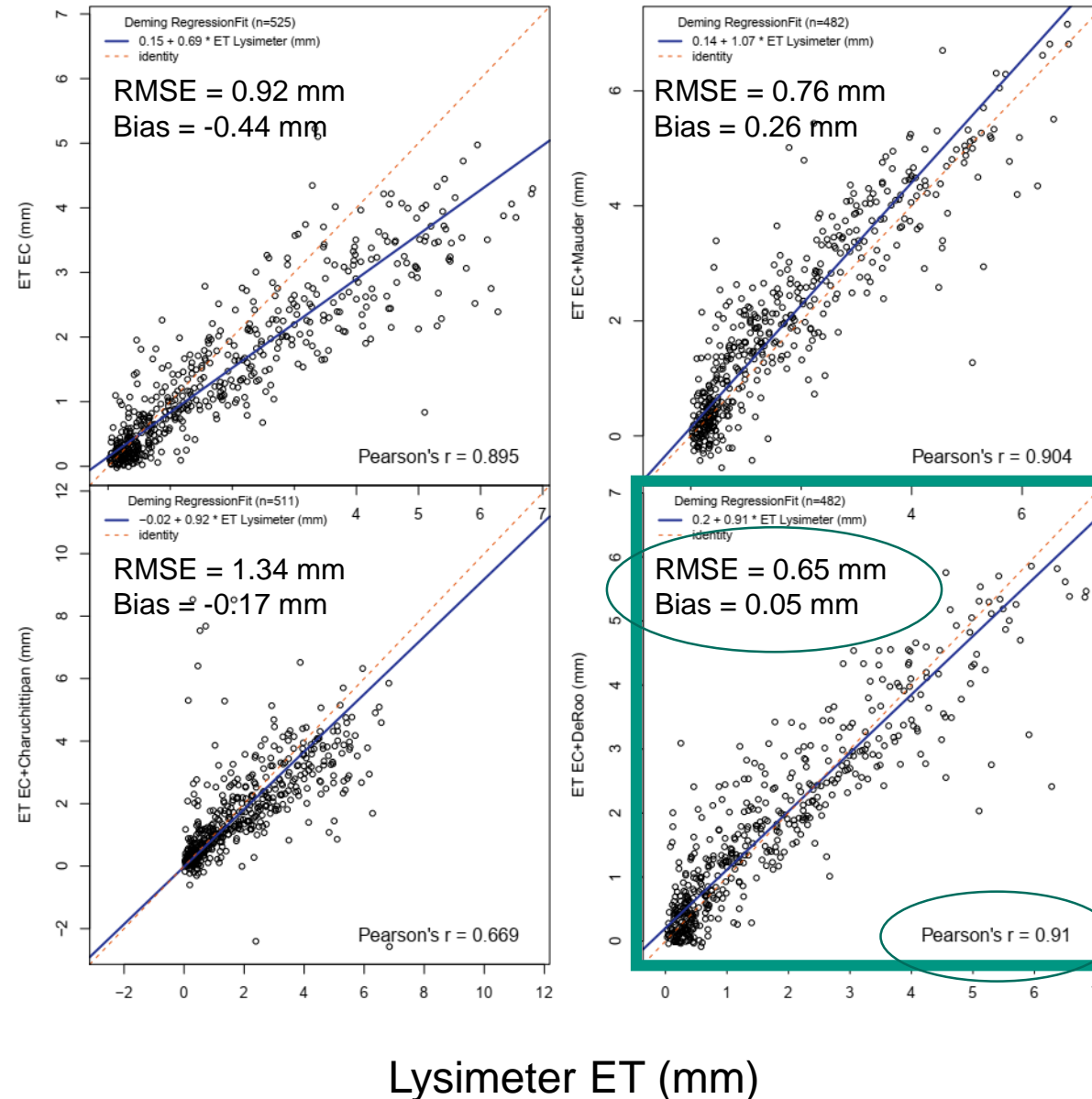


# Four correction methods are evaluated

- **Measured:** no correction is applied
- **ECcor13:** Mauder et al. (2013), daily EBR adjustment, only for unstable conditions, Bowen-ratio preserving
- **ECcor14:** Charuchittipan (2014), 30 min EBC adjustment, larger part of the imbalance attributed to H
- **ECcor18:** De Roo et al. (2018), daily EBR adjustment for  $z > 20$  m, only for unstable conditions, about 2/3 of the imbalance attributed to H, requires scaling for  $z < 20$  m



# DE-Fen Daily ET



# Data harmonization

- Group 1: measurement height  $z > 20$  m AND/OR independent measurements
- Group 2: measurement height  $z < 20$  m AND independent measurements
- Group 3: data provided, but either  $z < 20$  and NO independent measurements, implausible (meta-)data
- Group 4: no data provided yet

non-scaled  
version of  
correction

3  
sites

scaled version of  
correction

4  
sites

may join group  
1 or 2 in the  
future

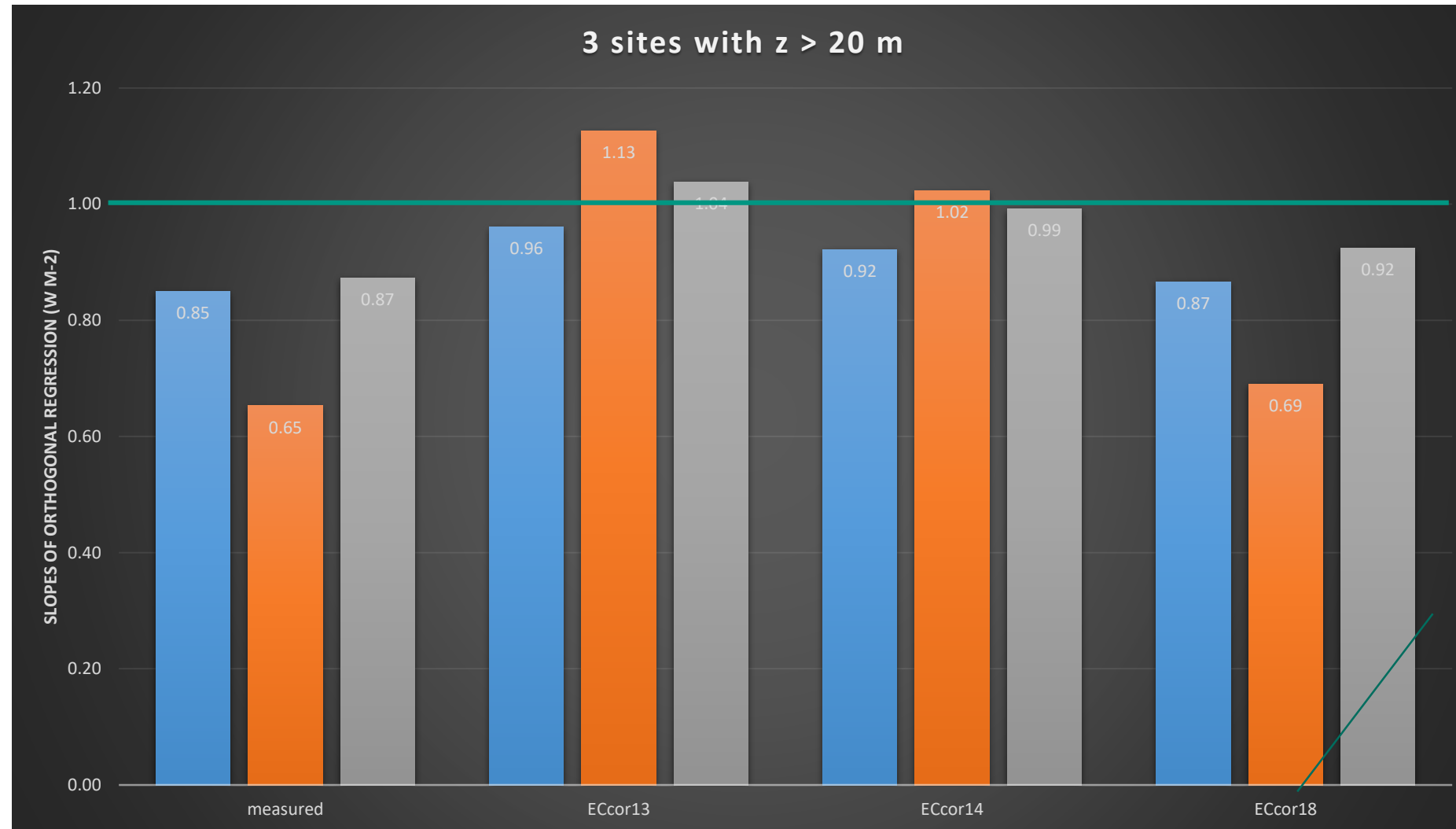
22  
sites

15  
sites

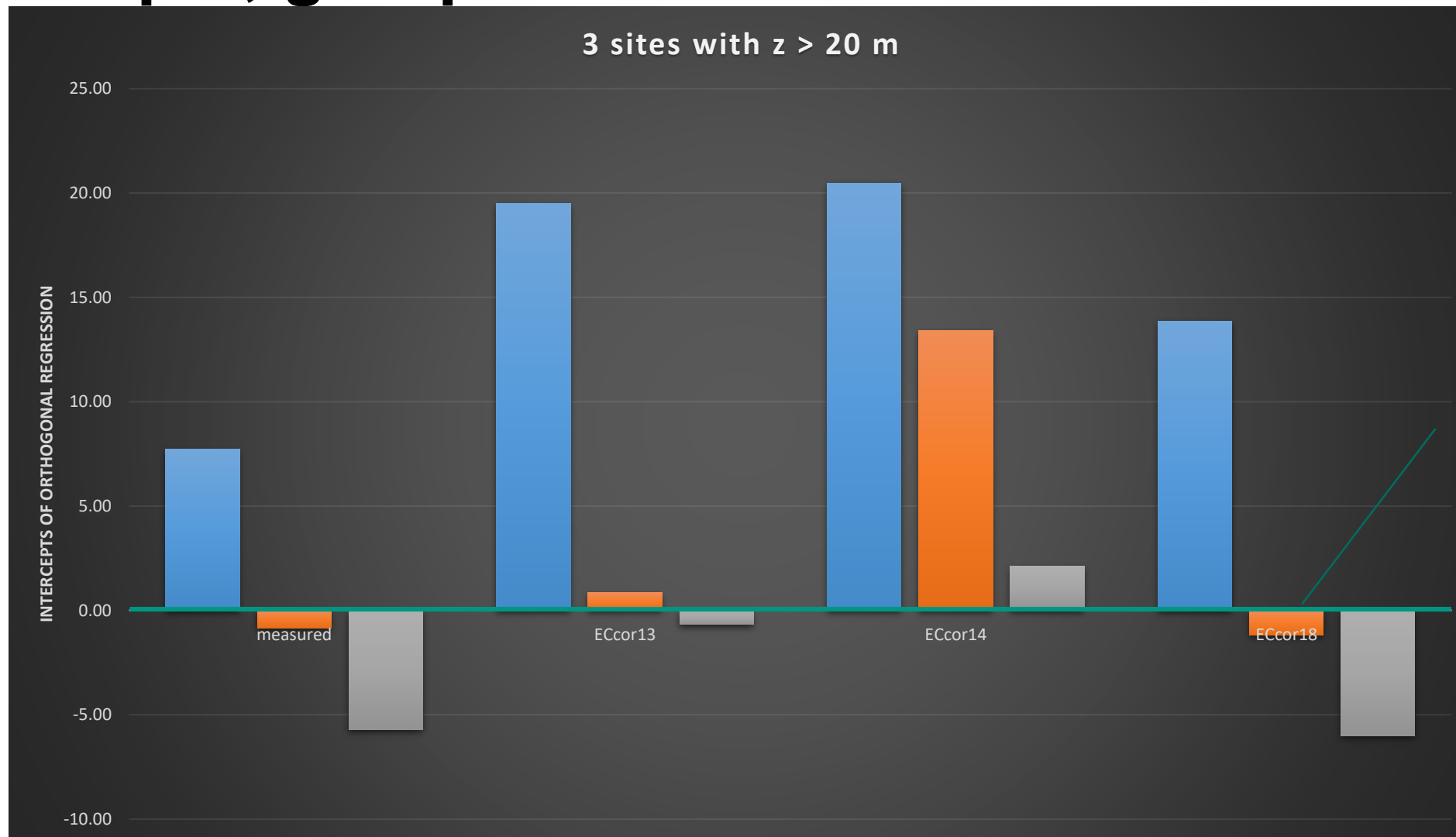
Number of participating sites in total

44

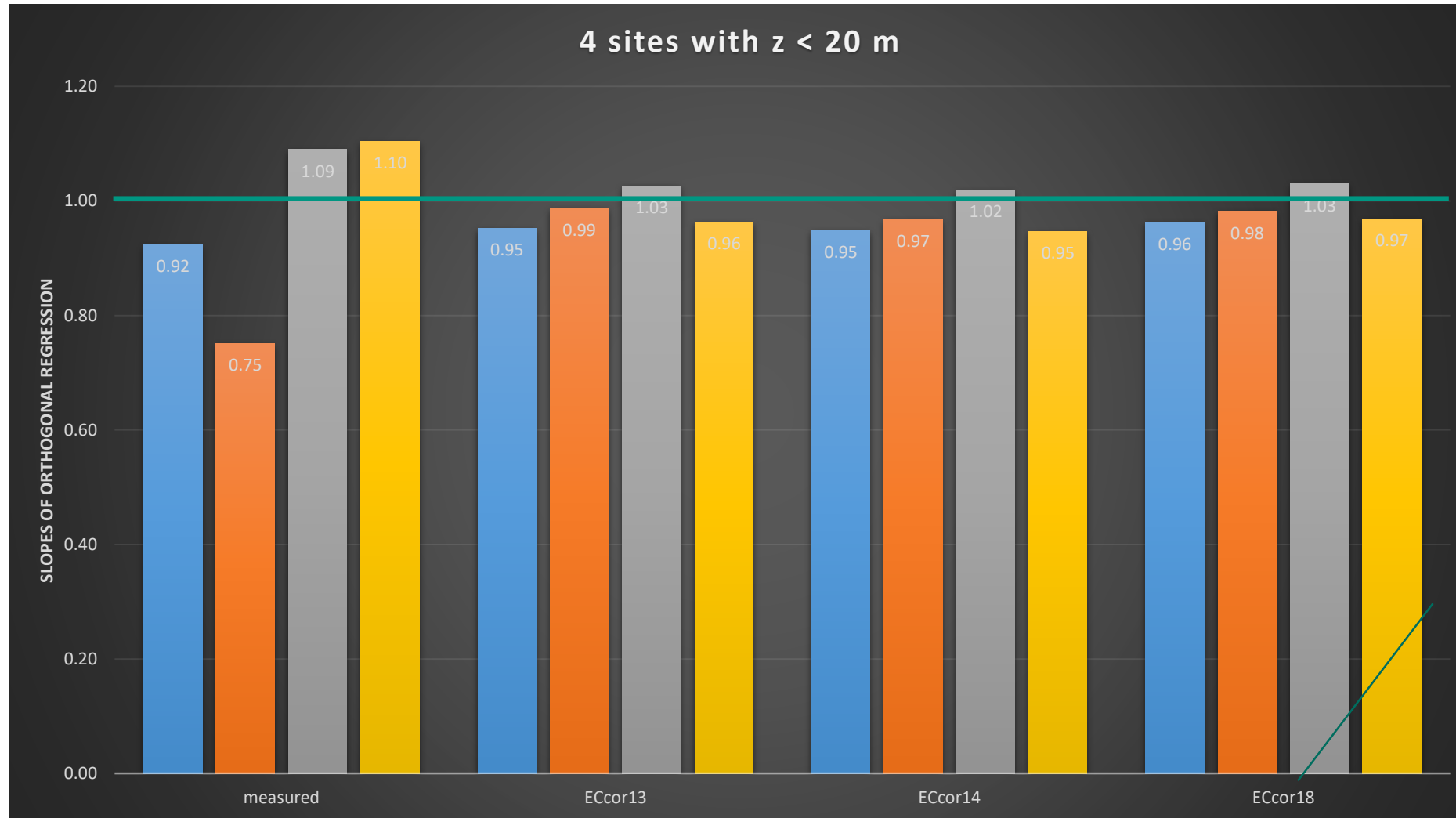
# Regression slopes, group 1



# Intercepts, group 1



# Regression slopes, group 2





# Intercepts, group 2



# Summary and Conclusions

- We evaluated a semi-empirical model of the magnitude and partitioning of the energy balance residual.
- The DeRoo method worked best for the Fendt site.
- However for sites with  $z > 20$  m, the overall magnitude of the imbalance energy balance residual was underestimated by the DeRoo method.
- A comparison with independent heat flux measurements is still pending in order to evaluate the partitioning of the imbalance by the different correction approaches. Hopefully, more datasets will be included in this analysis in the future.