Seasonal contrast of nighttime turbulent carbon flux at the LBA pasture/agricultural site

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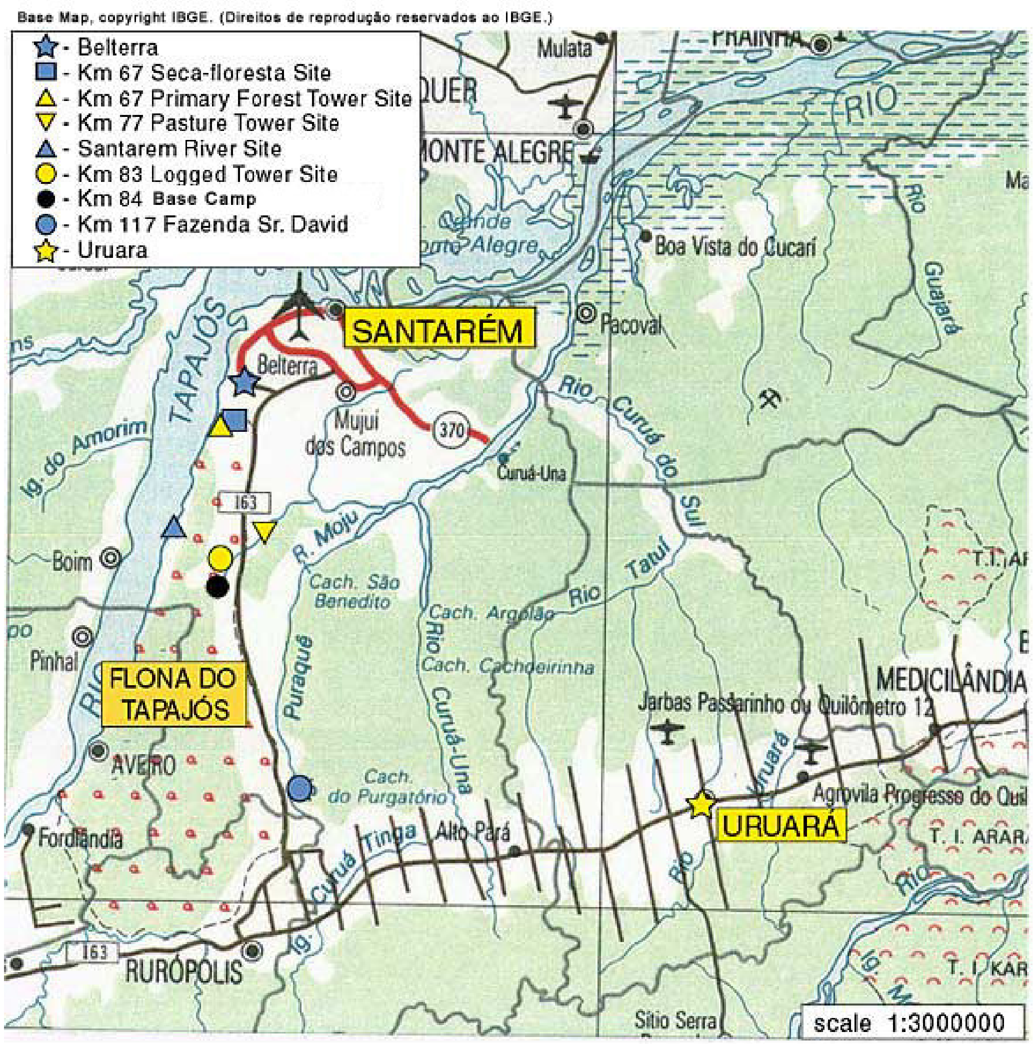
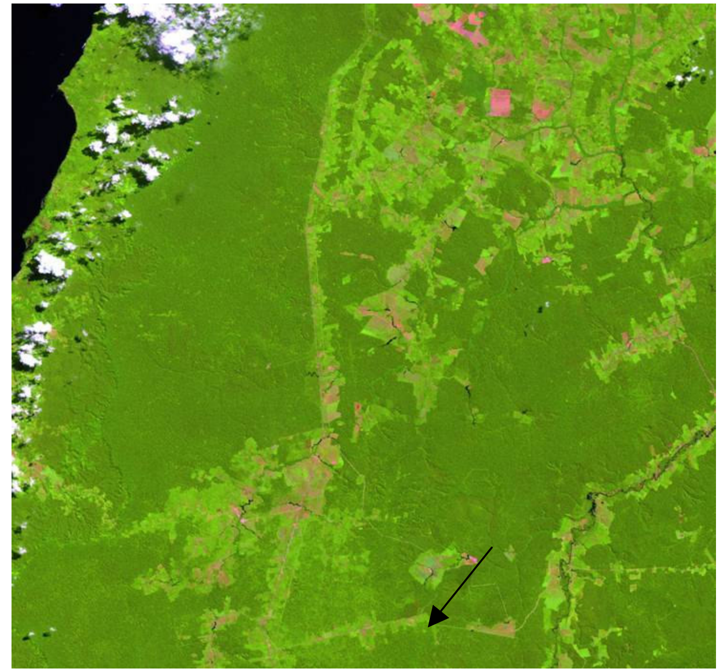
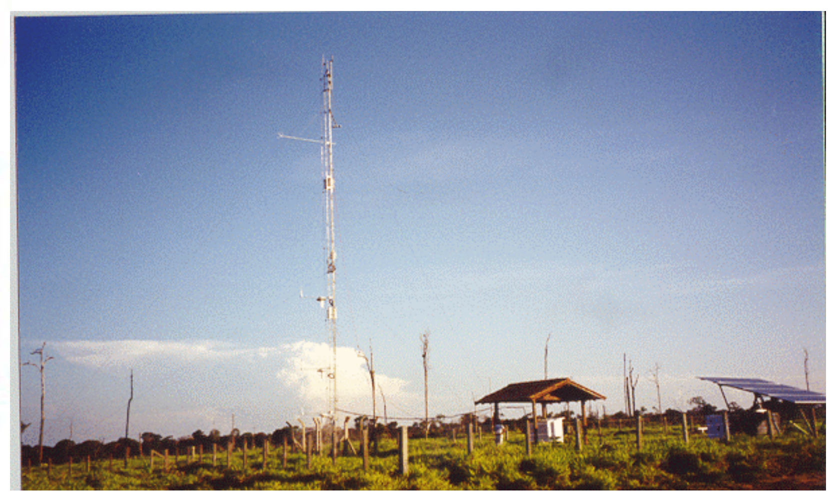
Objective: To show that usually discarded turbulent data from weak mixing conditions, can provide useful information regarding nocturnal surface fluxes.

Methodology: Recent studies by Vickers and Mahrt show that turbulent fluxes in very stable conditions can be found through the multiresolution decomposition.

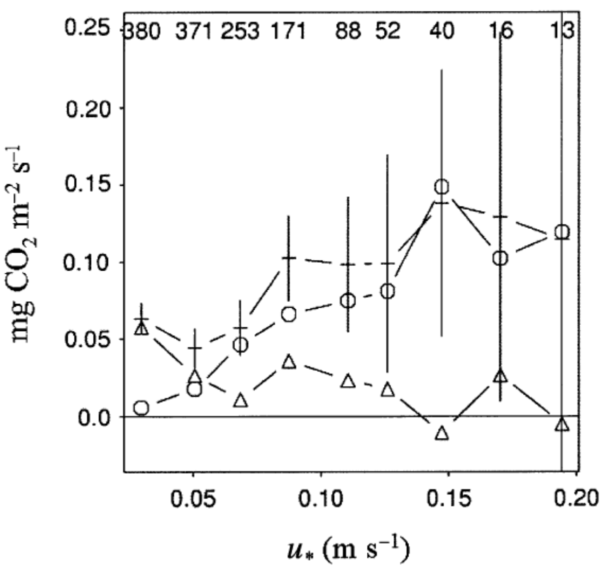
We will look at data from the pasture/agricultural site from the LBA project:

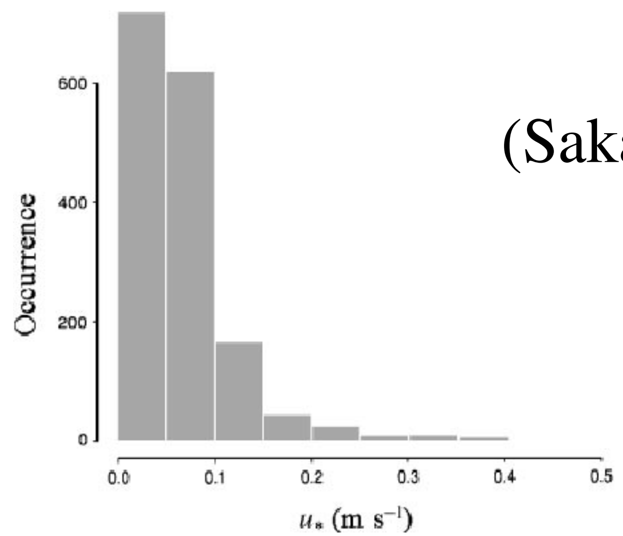






- Deforestation leads to enhanced radiative loss at the surface, forming a strongly stable layer at nighttime;
- Nocturnal turbulent mixing is extremely reduced at the site.



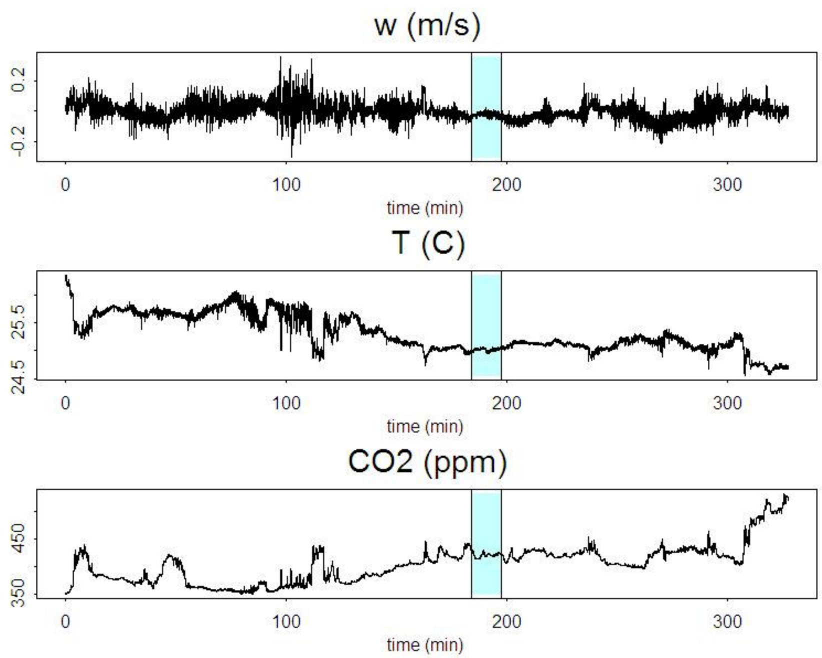


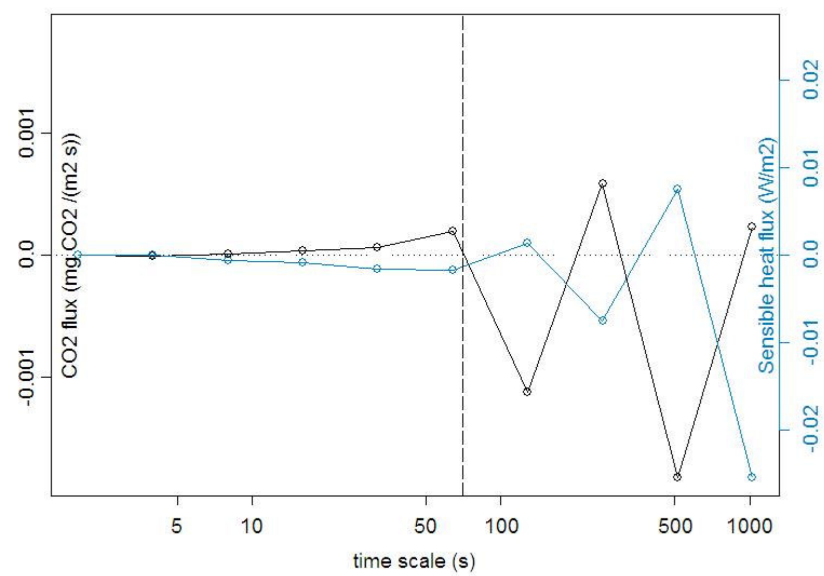
(Sakai et al., 2004)

u_*<0.2 m/s during 98% of the time;
u_*<0.08 m/s during 82% of the time;

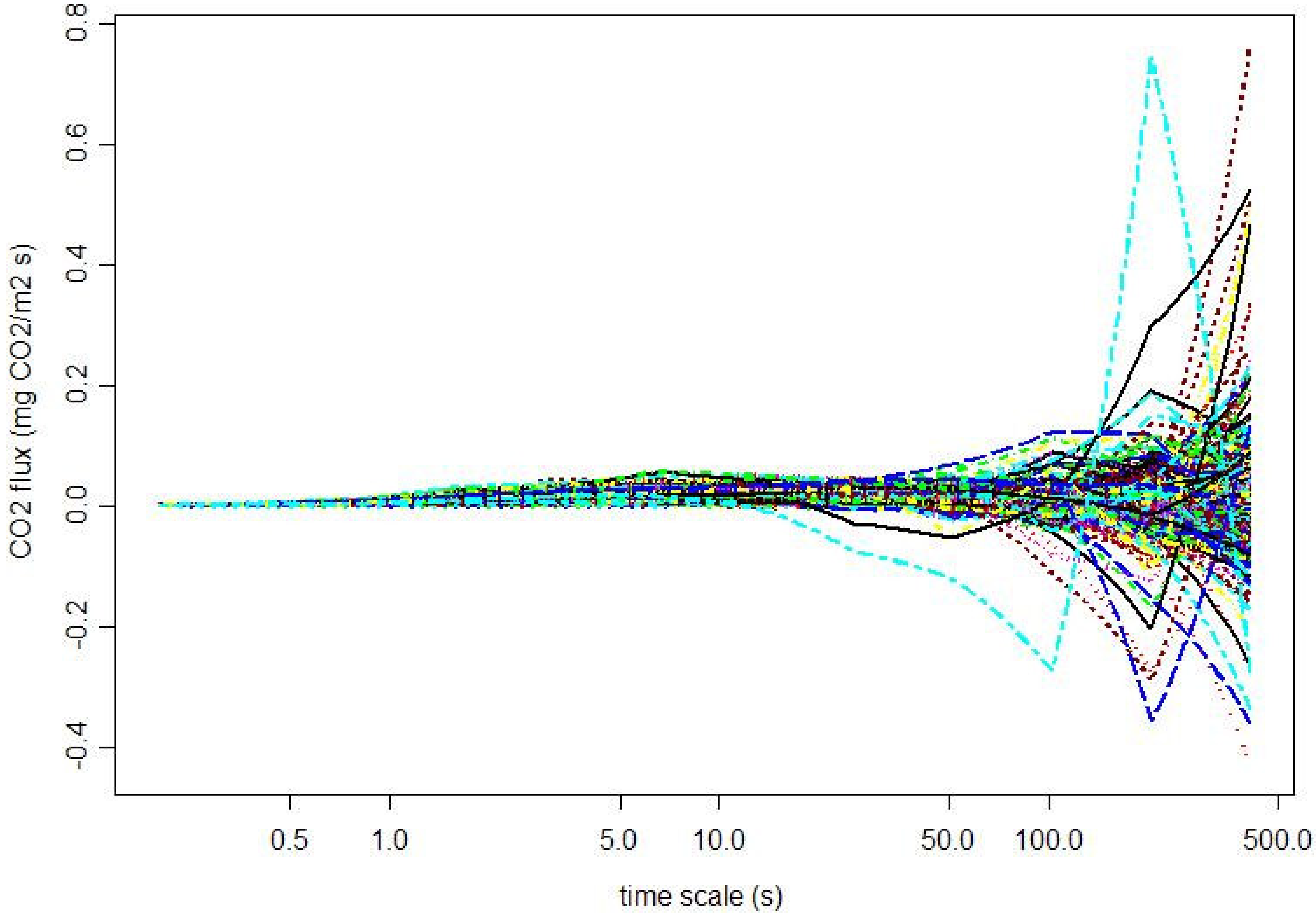
So, let's apply the multiresolution decomposition to the very stable data from the site

- Data from 83 nights from wet season 2001 and 48 nights from dry season 2001;
- The technique was applied to initial windows of 13 minutes;
- The windows were then shifted by 1 minute, and the process was repeated.
- The data were classified by the turbulent intensity, determined by σ_w

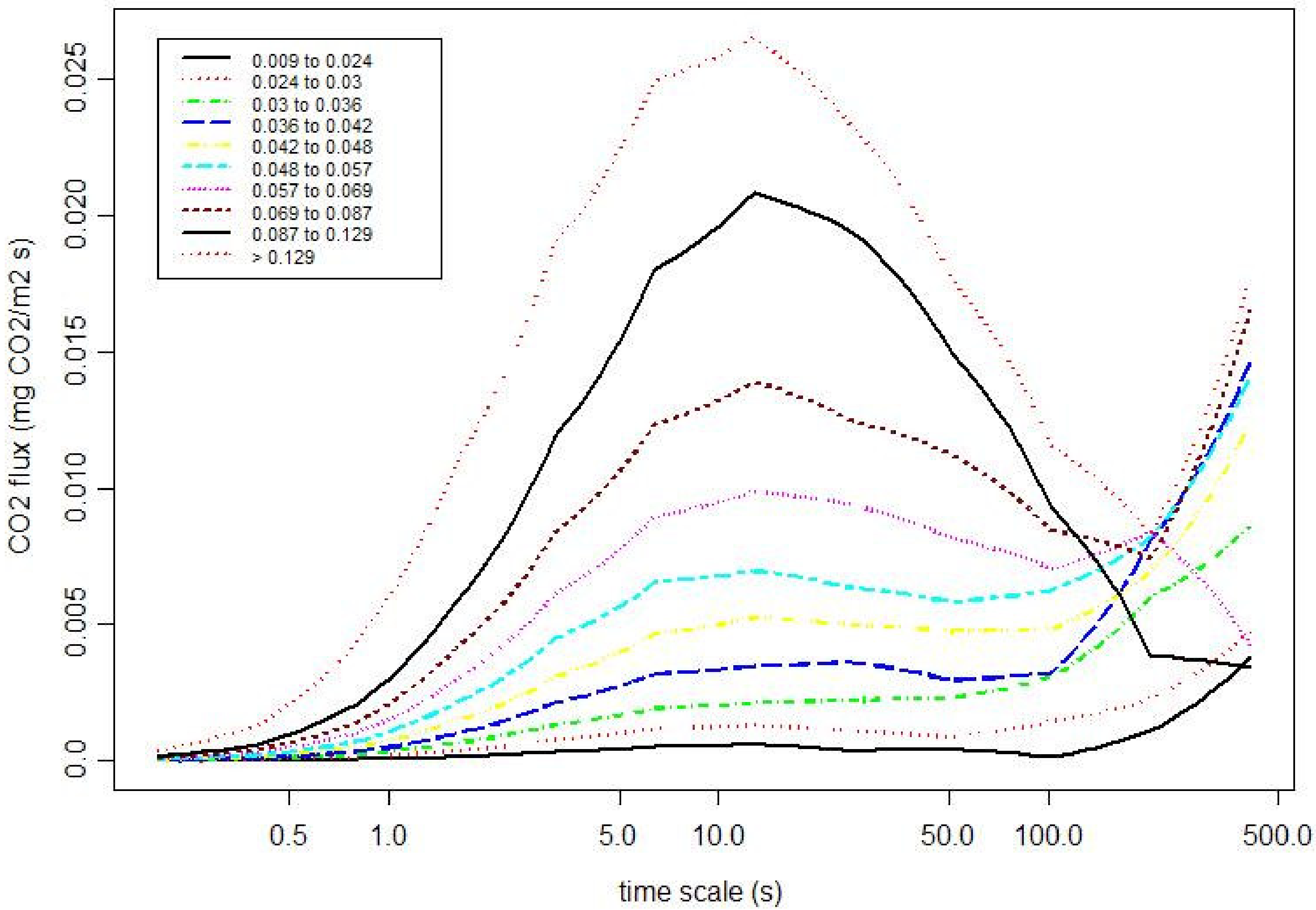




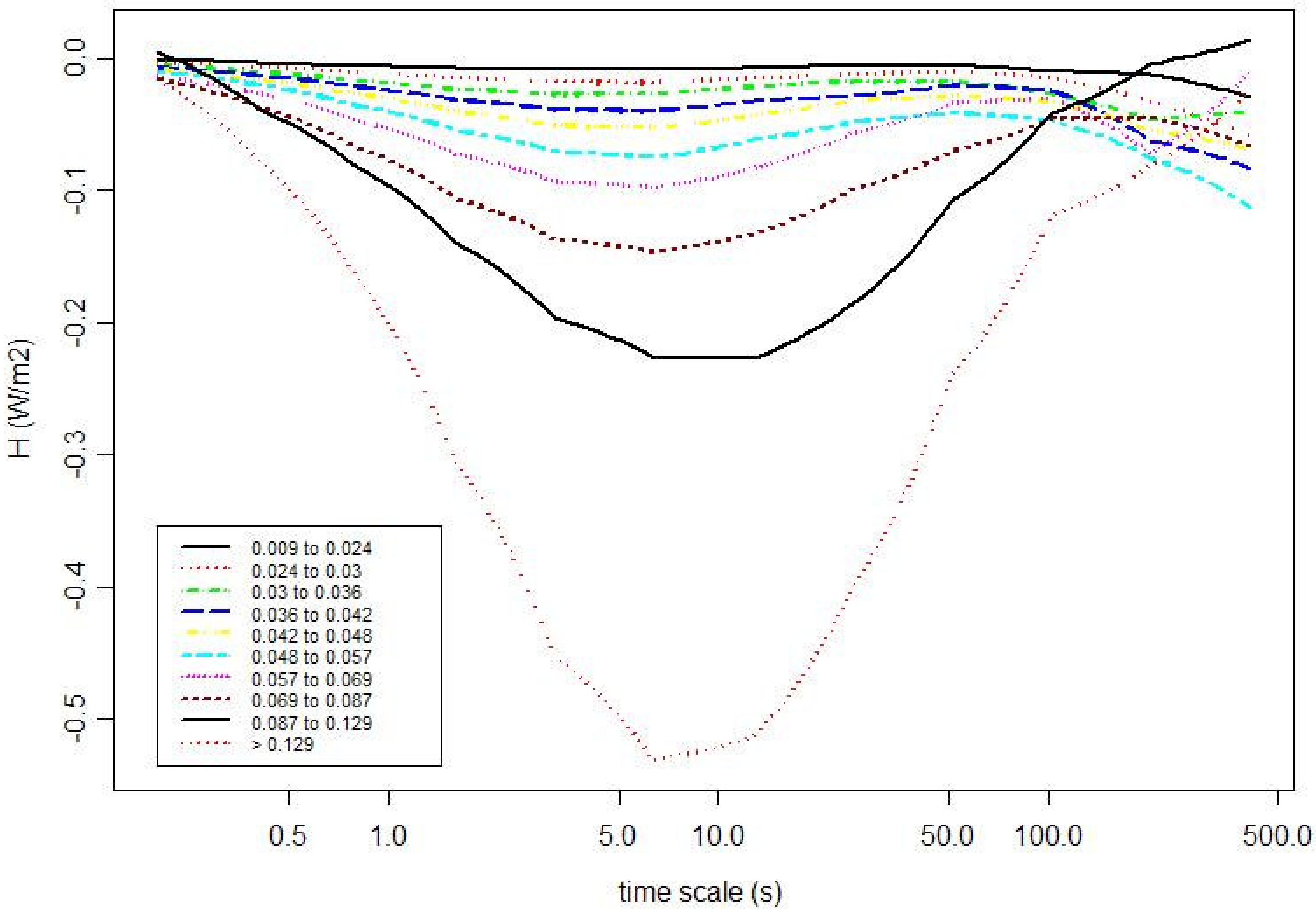
Turbulent flux X other fluxes



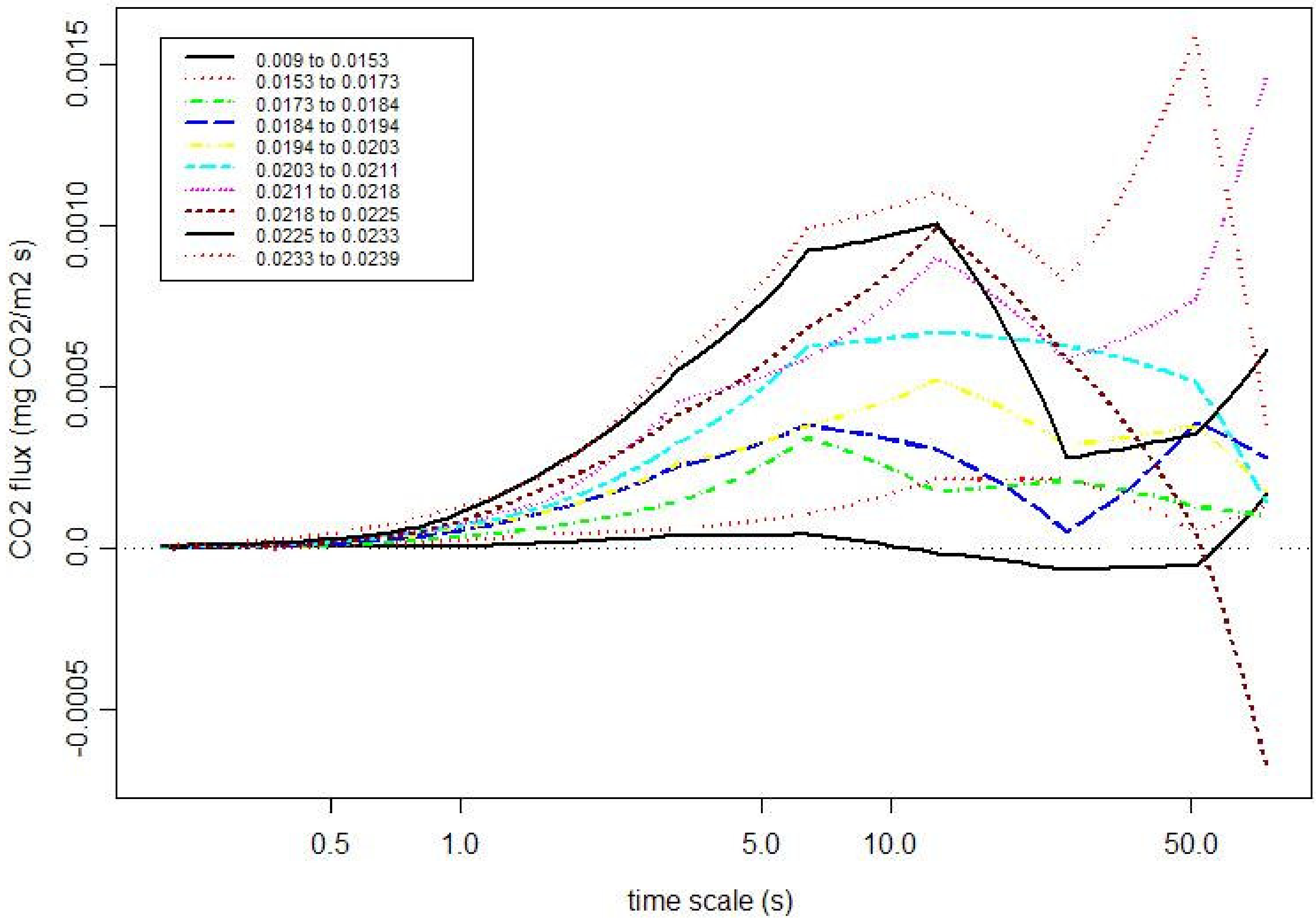
Overall behavior – WET SEASON



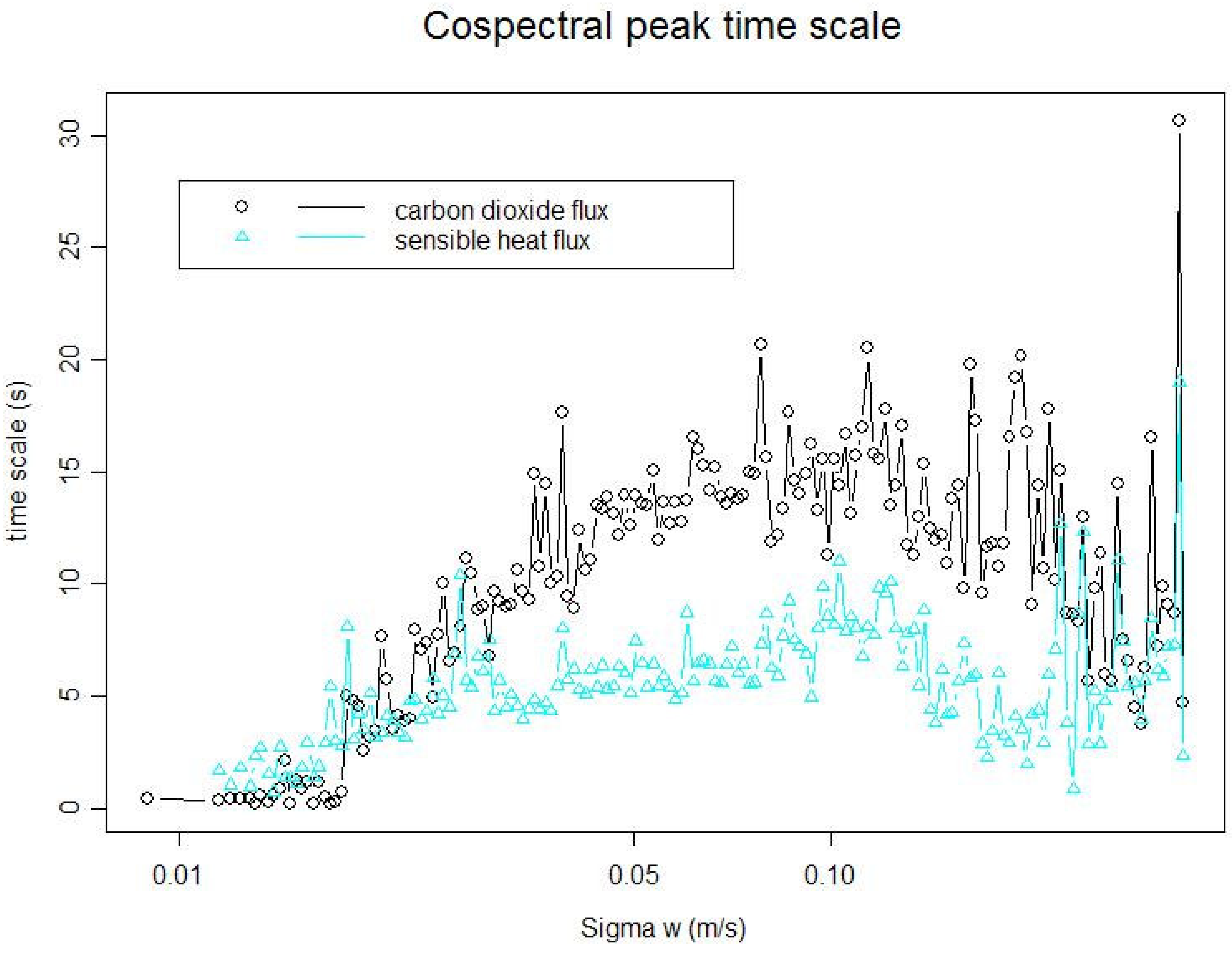
For comparison, the sensible heat fluxes:



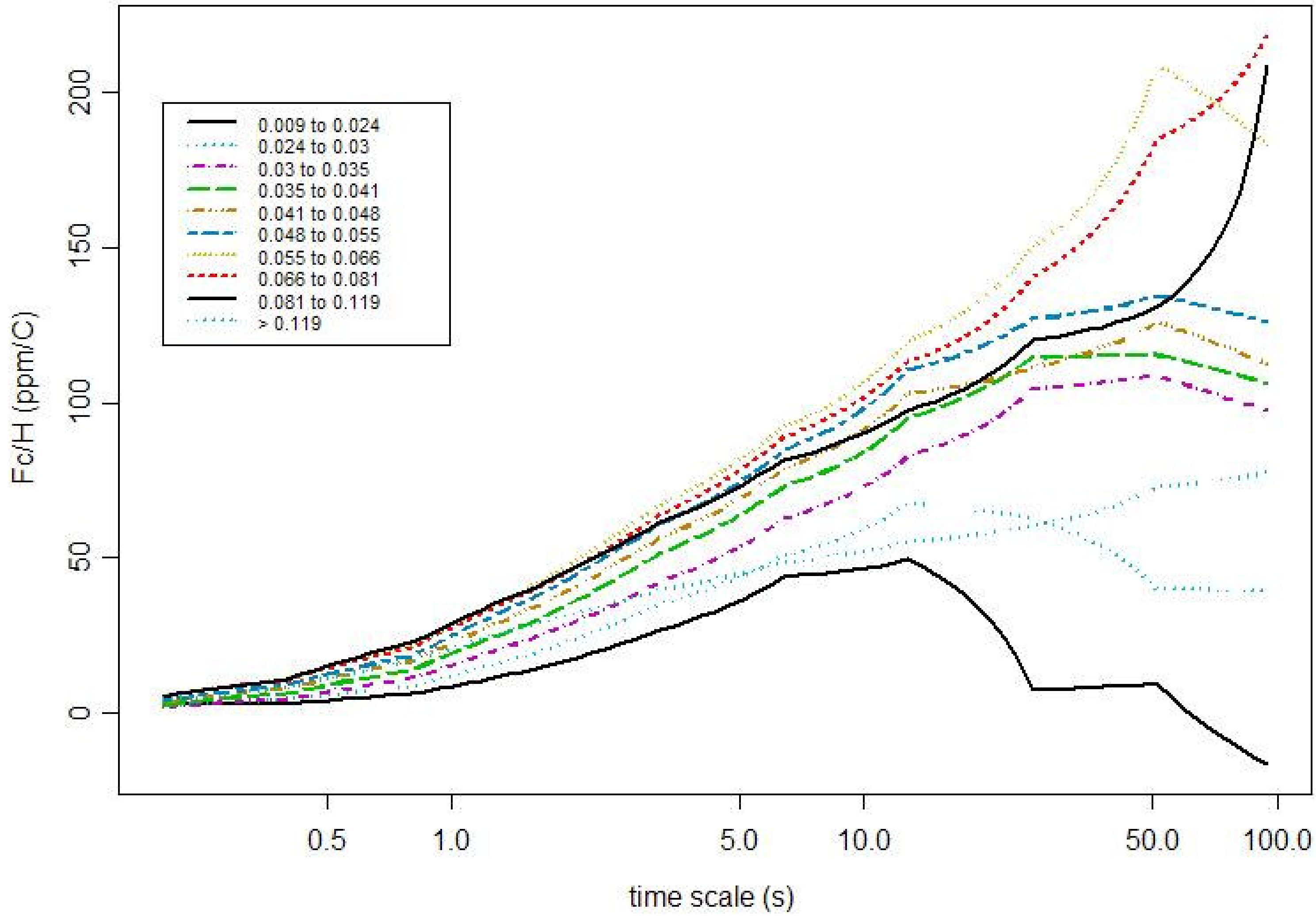
What happens in the most stable cases?



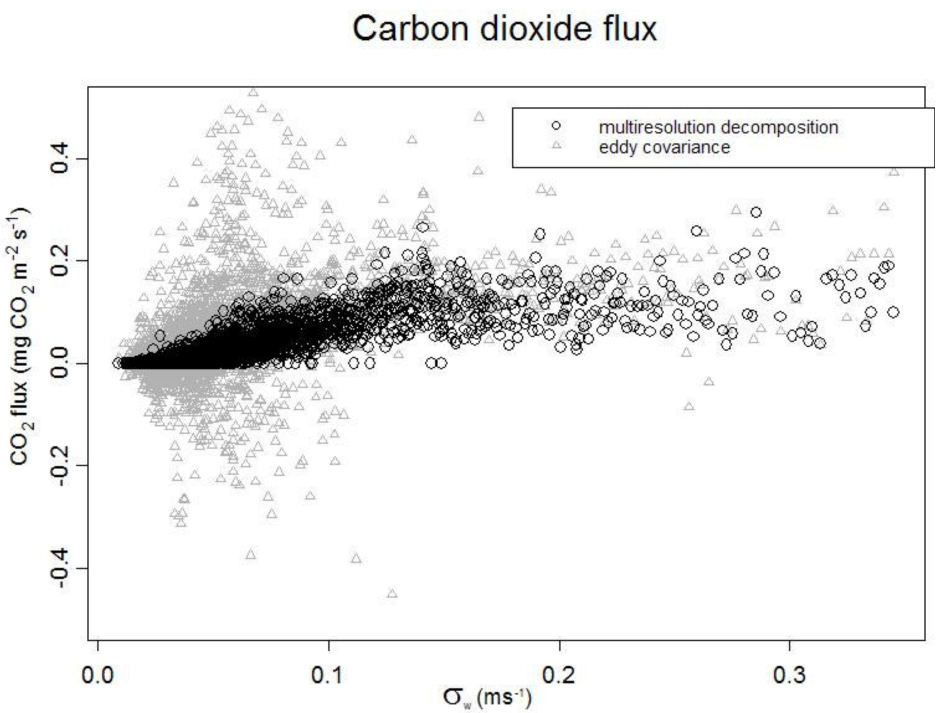
Is the scale of the carbon transport different than that for sensible heat?

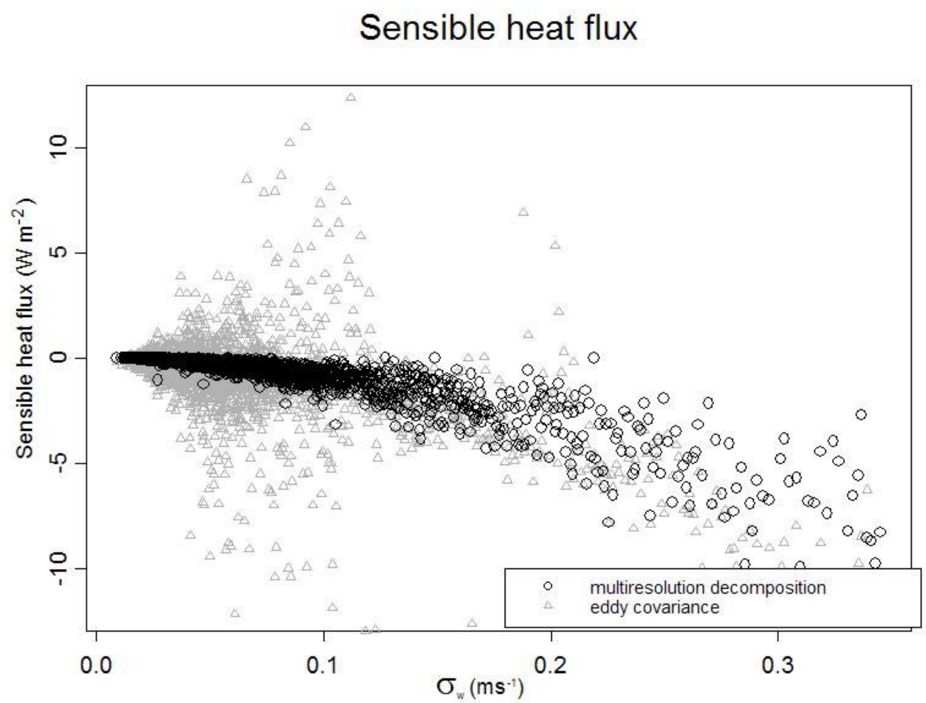


Does it mean that carbon is transported by different eddies than those transporting heat?



How do fluxes depend on turbulent intensity?

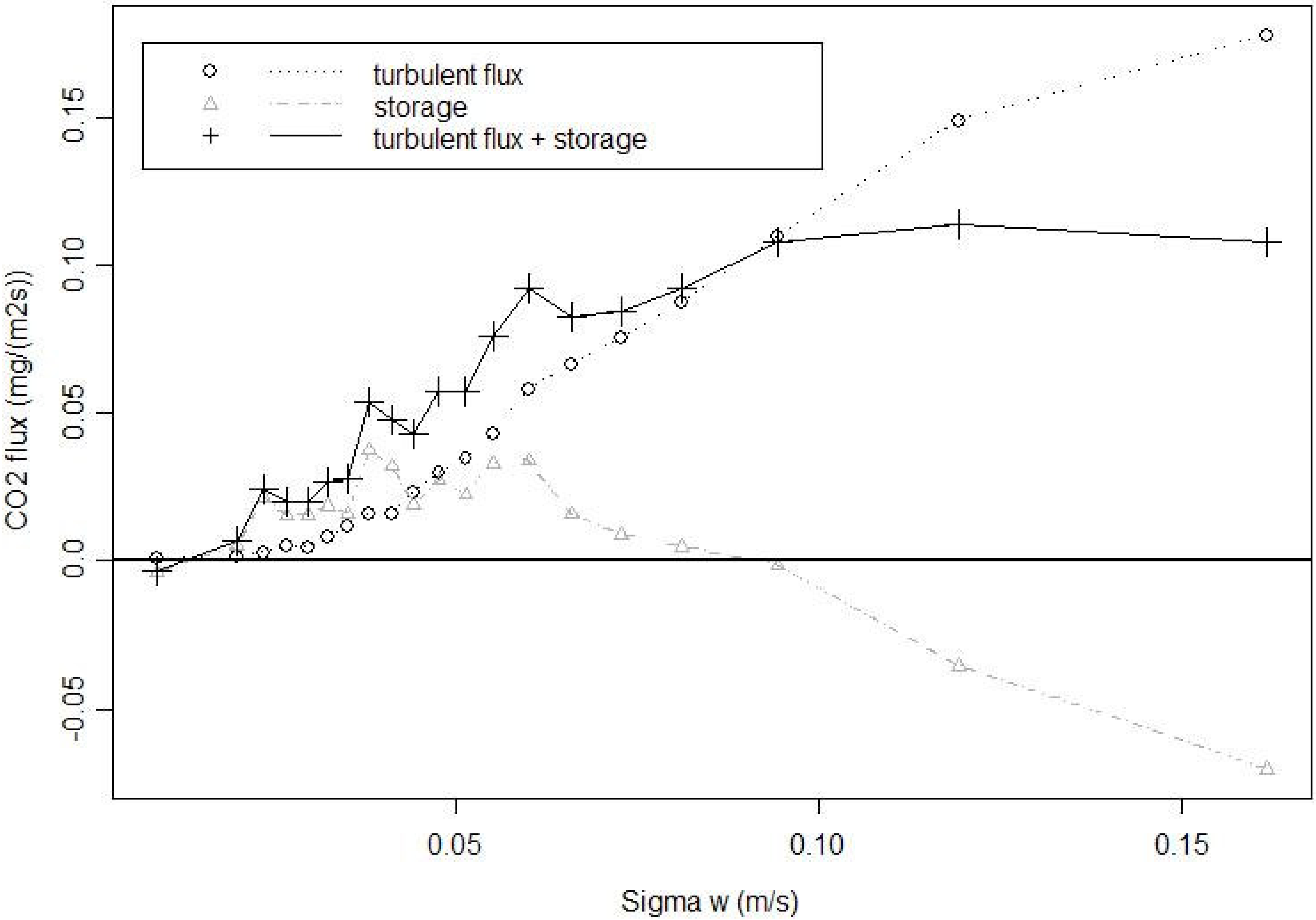




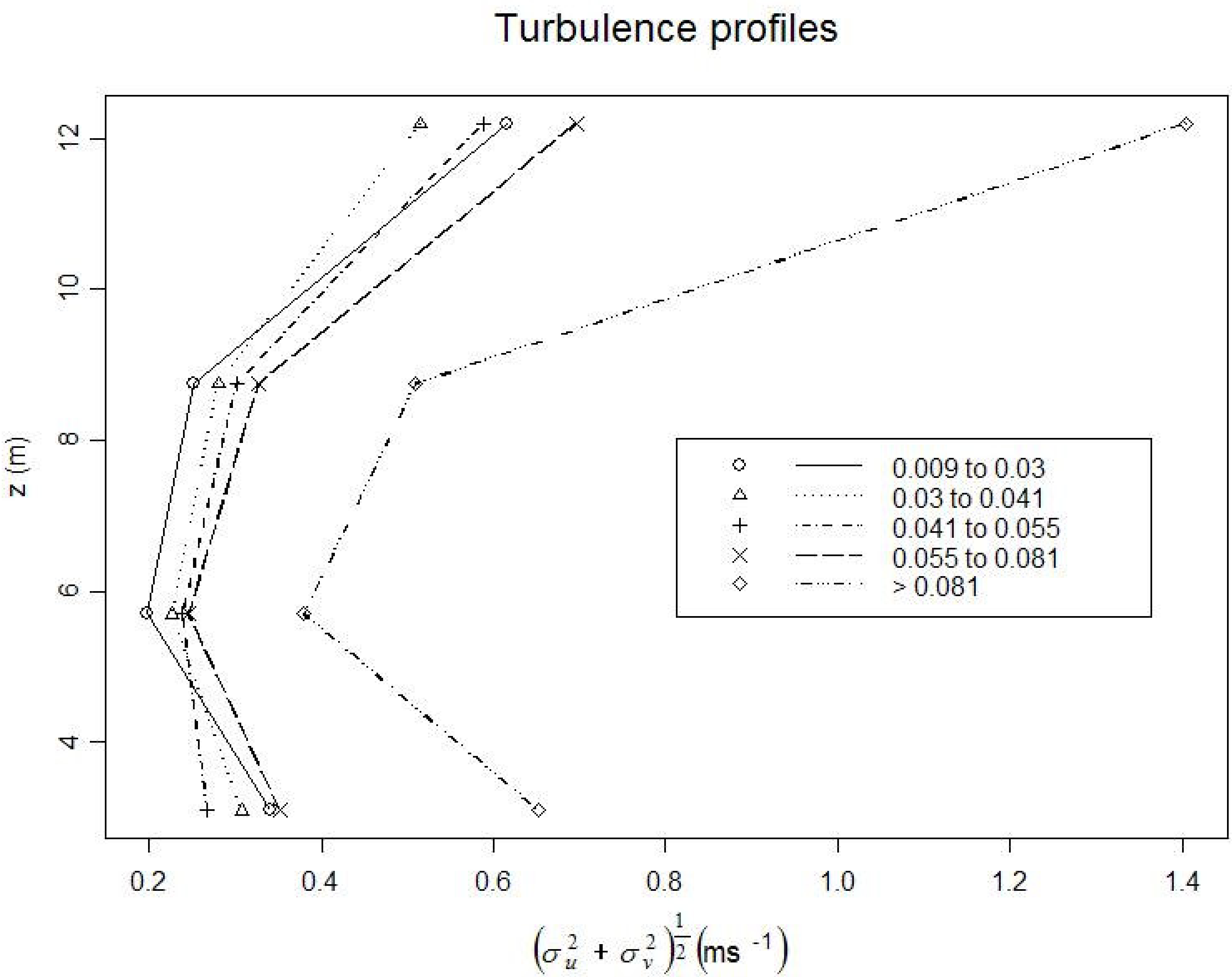
CO_2 fluxes

Sensible heat fluxes

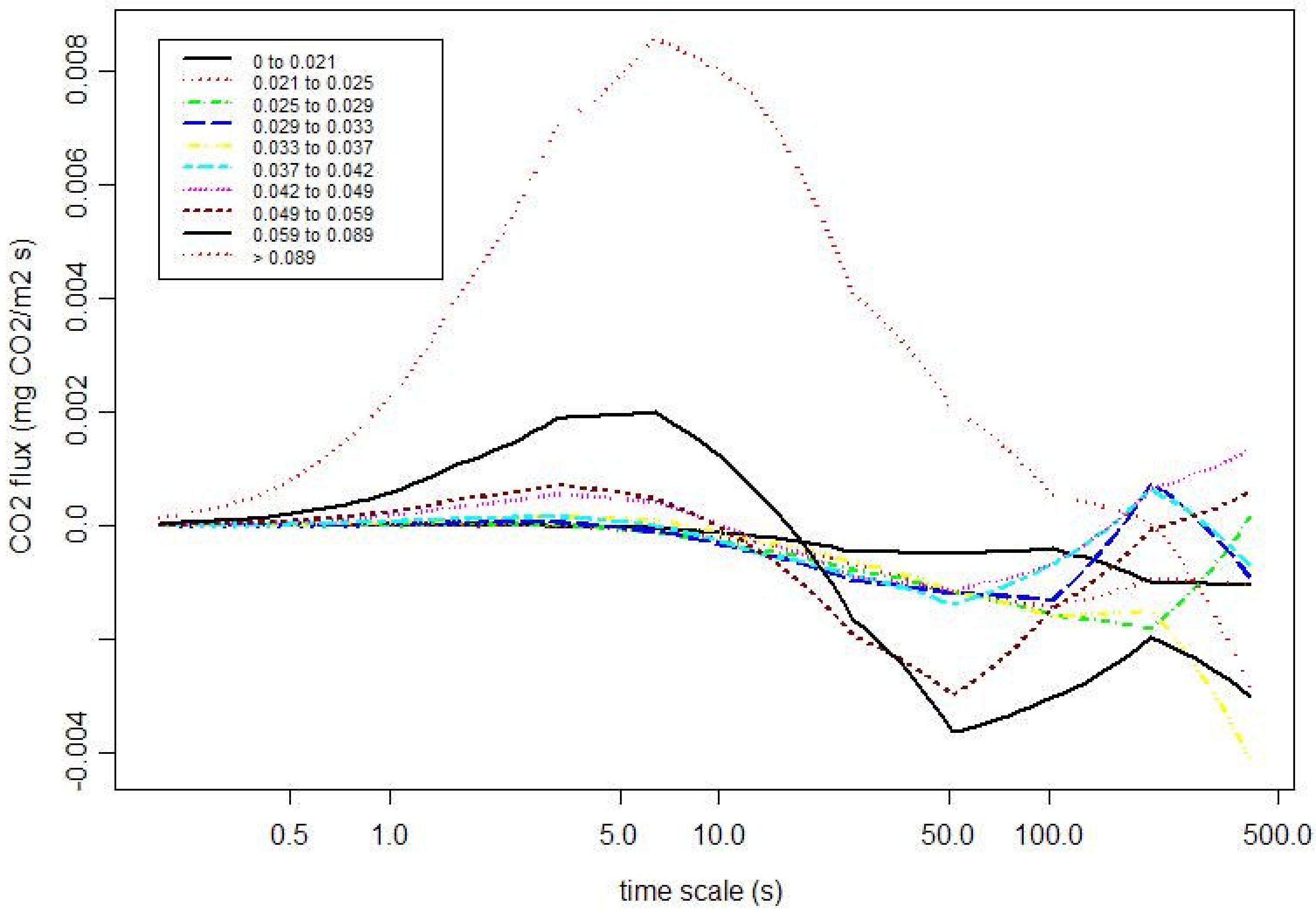
Accounting for storage:



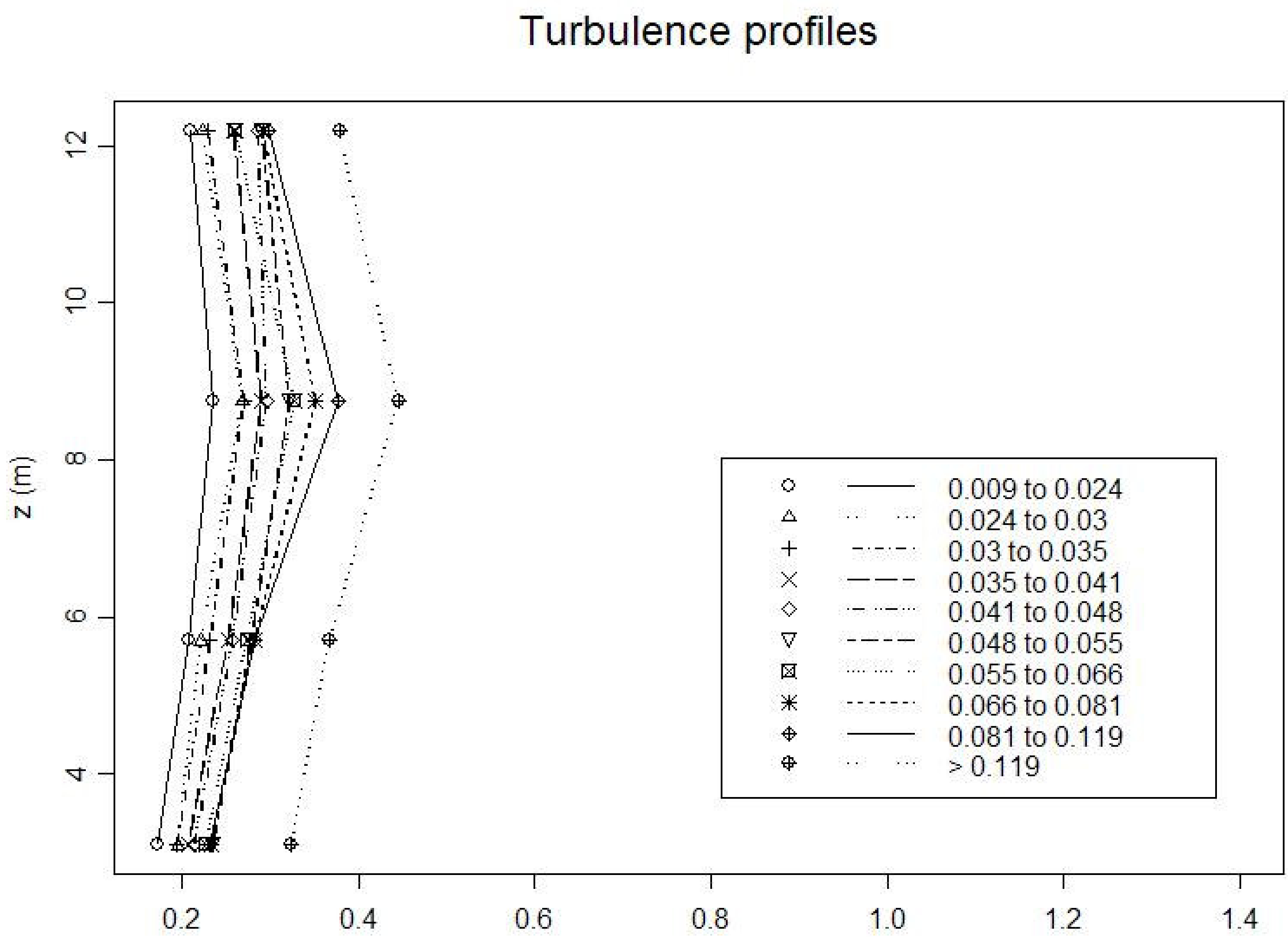
Drainage?


Turbulence profiles
z (m)
12
10
8
6
4
0.2
0.4
0.6
0.8
1.0
1.2
1.4
$\left(\sigma_u^2 + \sigma_v^2\right)^{\frac{1}{2}} \left(\mathrm{ms}^{-1}\right)$
0.009 to 0.03
0.03 to 0.041
0.041 to 0.055
0.055 to 0.081
> 0.081

Overall behavior – DRY SEASON

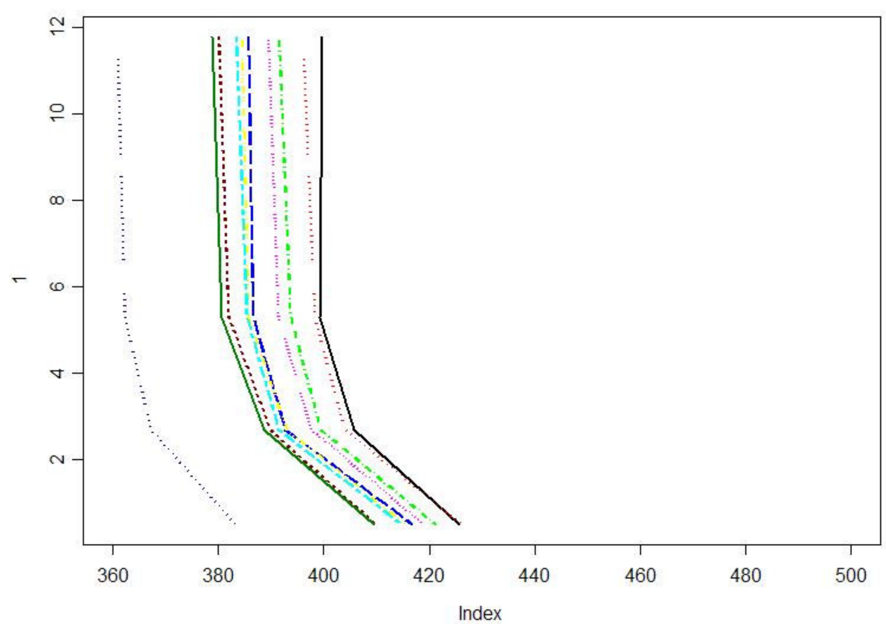


Turbulence profiles – DRY SEASON

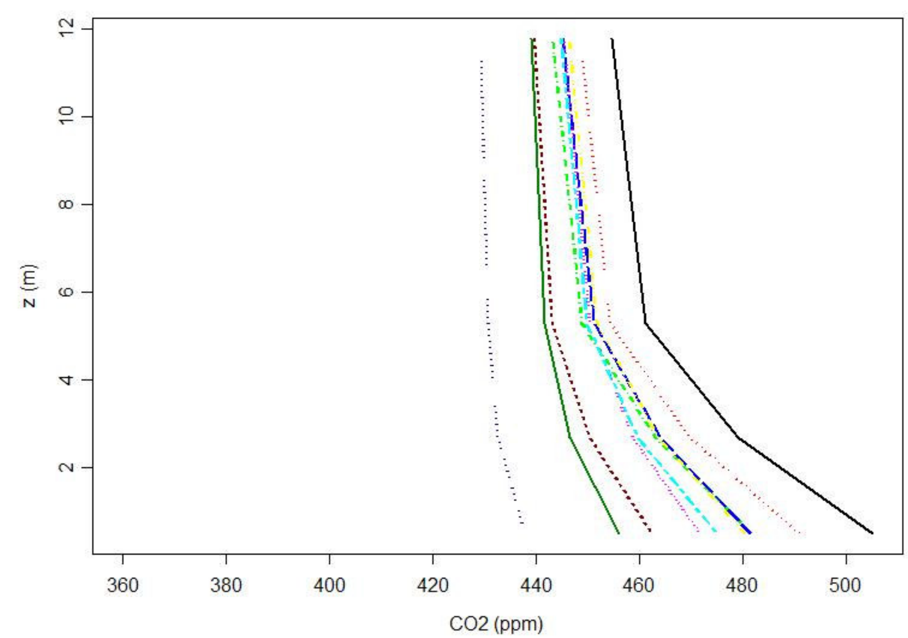


CO_2 profiles

Dry season



Wet season



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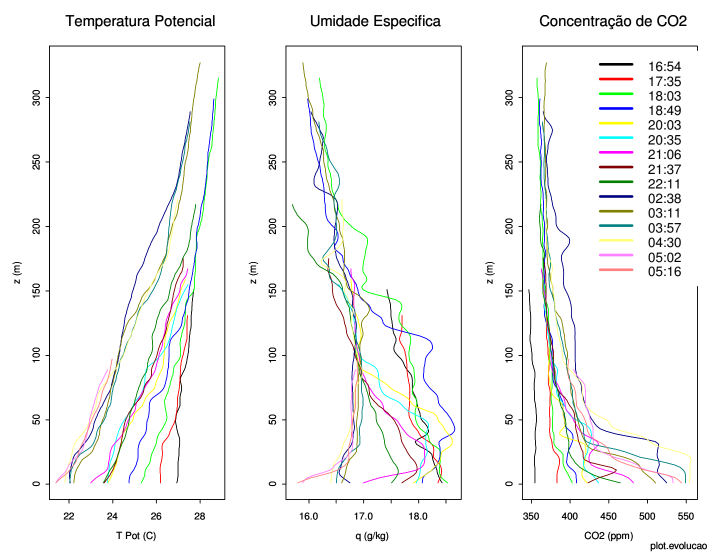

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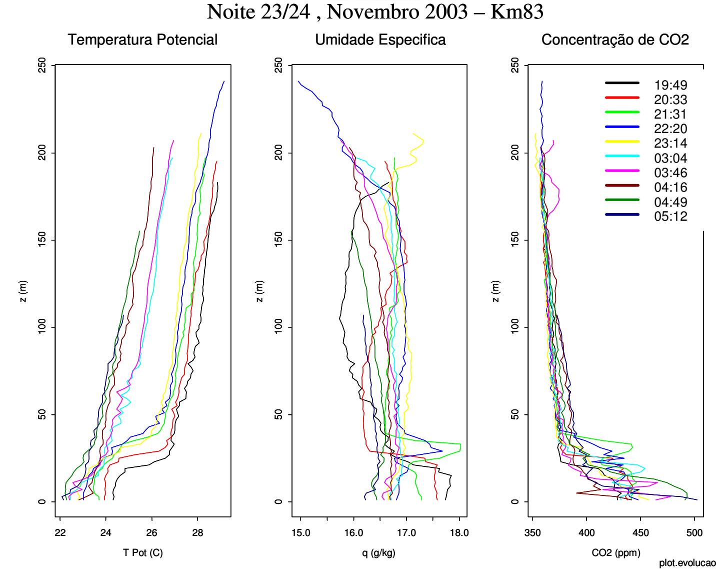

Conclusion

- Fluxes that are neglected due to lack of turbulence can be found if the proper averaging procedures are applied;

- CO_2 fluxes happen at larger scales than sensible heat fluxes;

- There is evidence that drainage is responsible for most of the CO_2 transport at very stable conditions;

- In the most stable cases, including dry season, negative fluxes are observed at scales larger than the turbulent flux.