EGU General Assembly 2022

ATTO
AMAZON TALL TOWER OBSERVATORY

AS2.1

Impact of Atmospheric Stability on Vertical Propagation of Submeso and Coherent Structure in a Dense Amazon Forest

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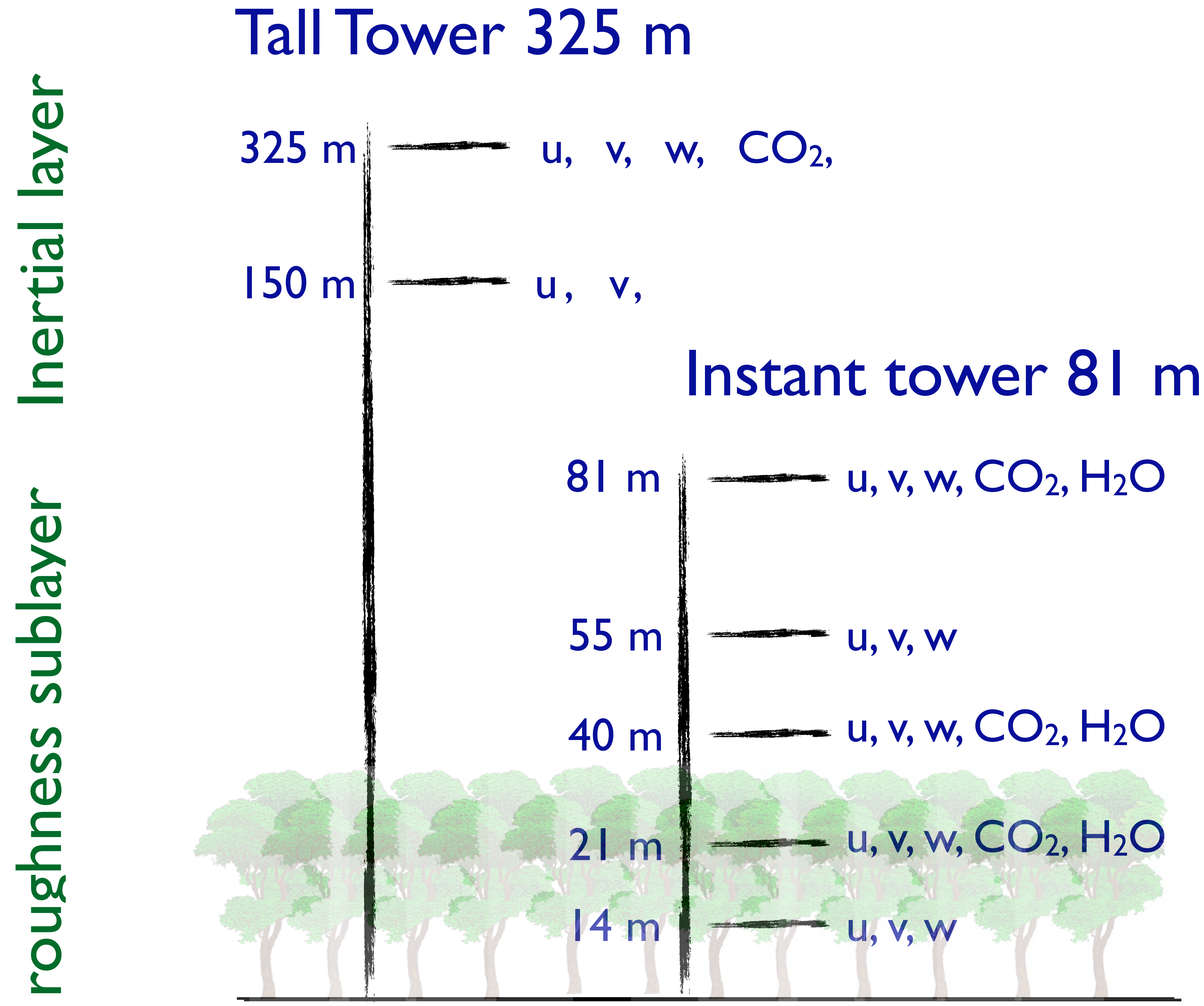
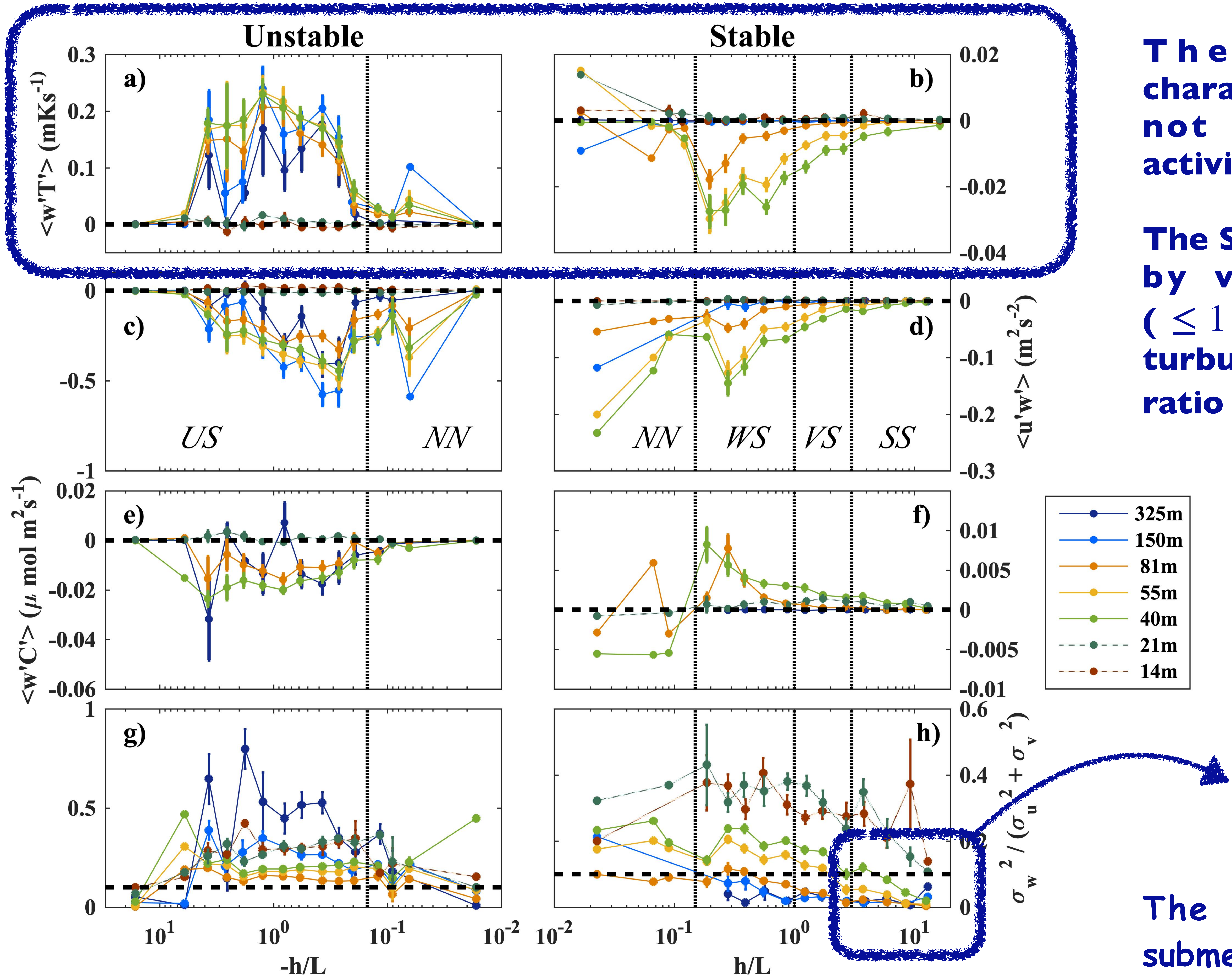
The Amazon Tall Tower Observatory

November 2015 campaign (15 days)



Identifying stability classes



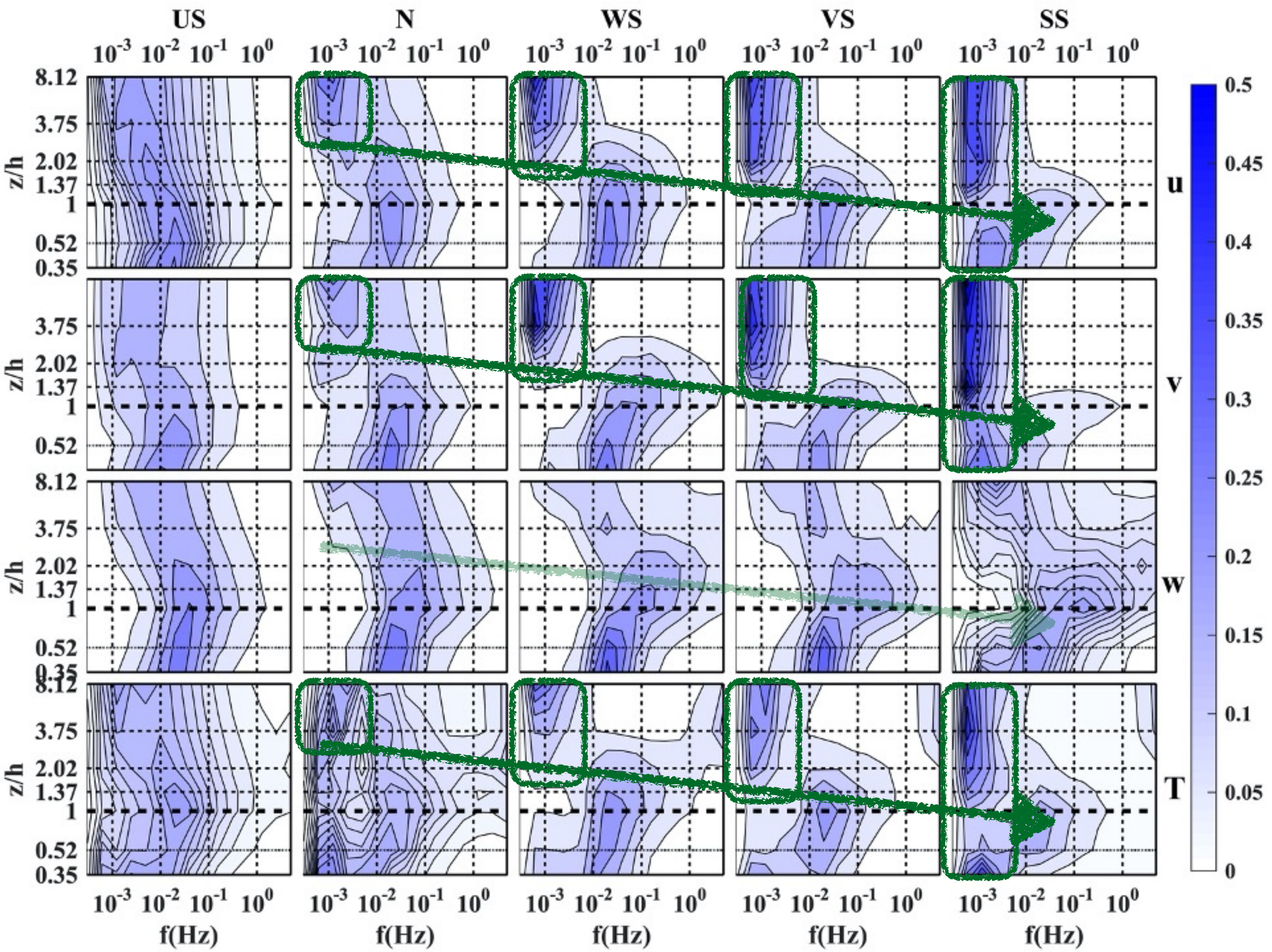
The VS regime is characterised by weak (but not negligible) turbulent activity

The SS regime is characterised by very low wind speed ($\leq 1\ ms^{-1}$), negligible turbulent fluxes and variance ratio < 0.1.

$$\frac{\sigma_w^2}{\sigma_u^2 + \sigma_v^2} < 0.1$$

The flow is dominated by submeso motions.

Spectra: Low-Frequency downward propagation



Scale of coherent structures (~60s) is almost independent from stability

Progressive lowering of the Roughness Sublayer and gradual weakening of coherent structure energy

Progressive downward propagation of low frequency energy (~20-30 min) associated to Submeso activity

In the SS regime Submeso motions may efficiently propagate inside the canopy

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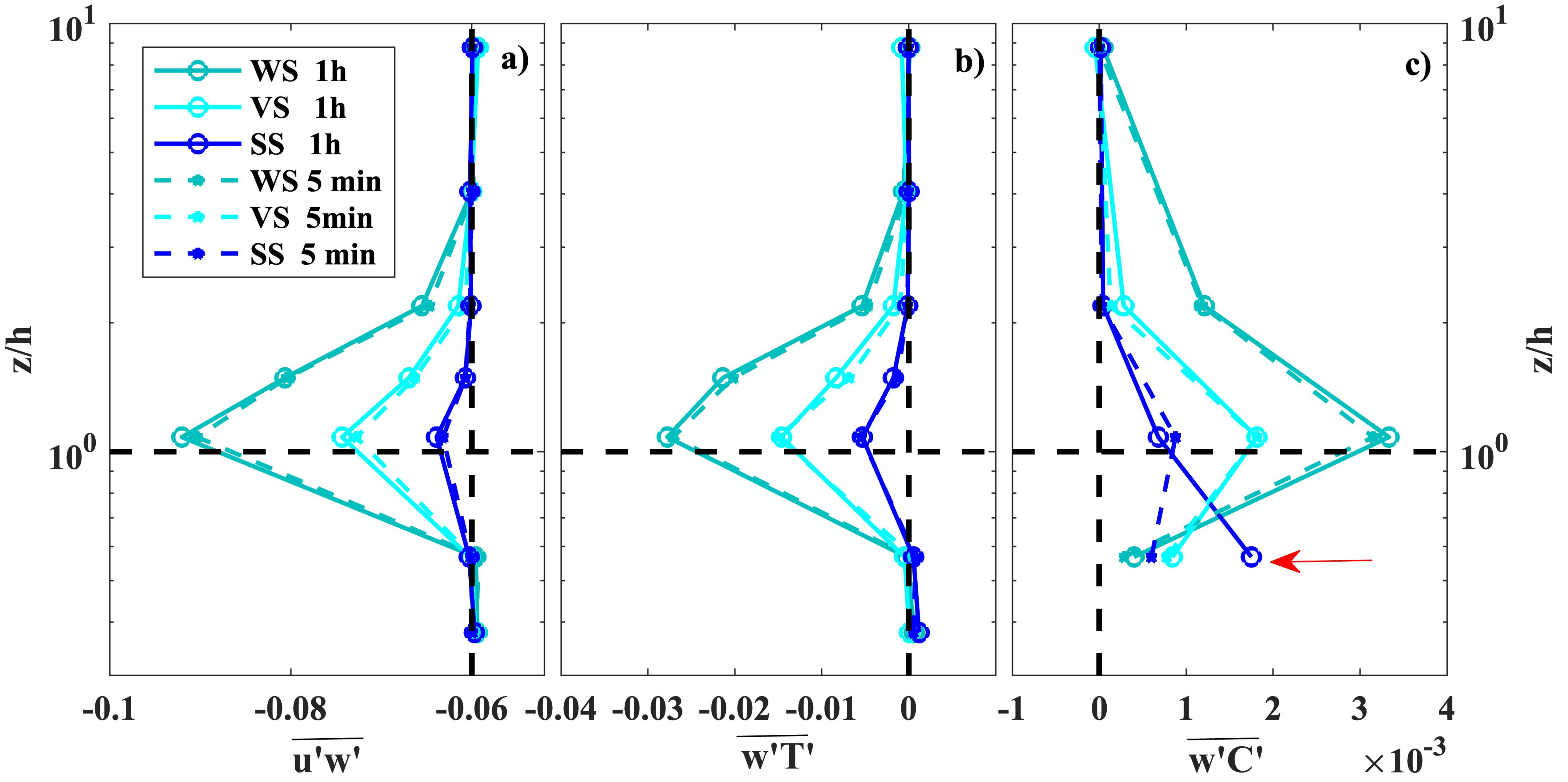

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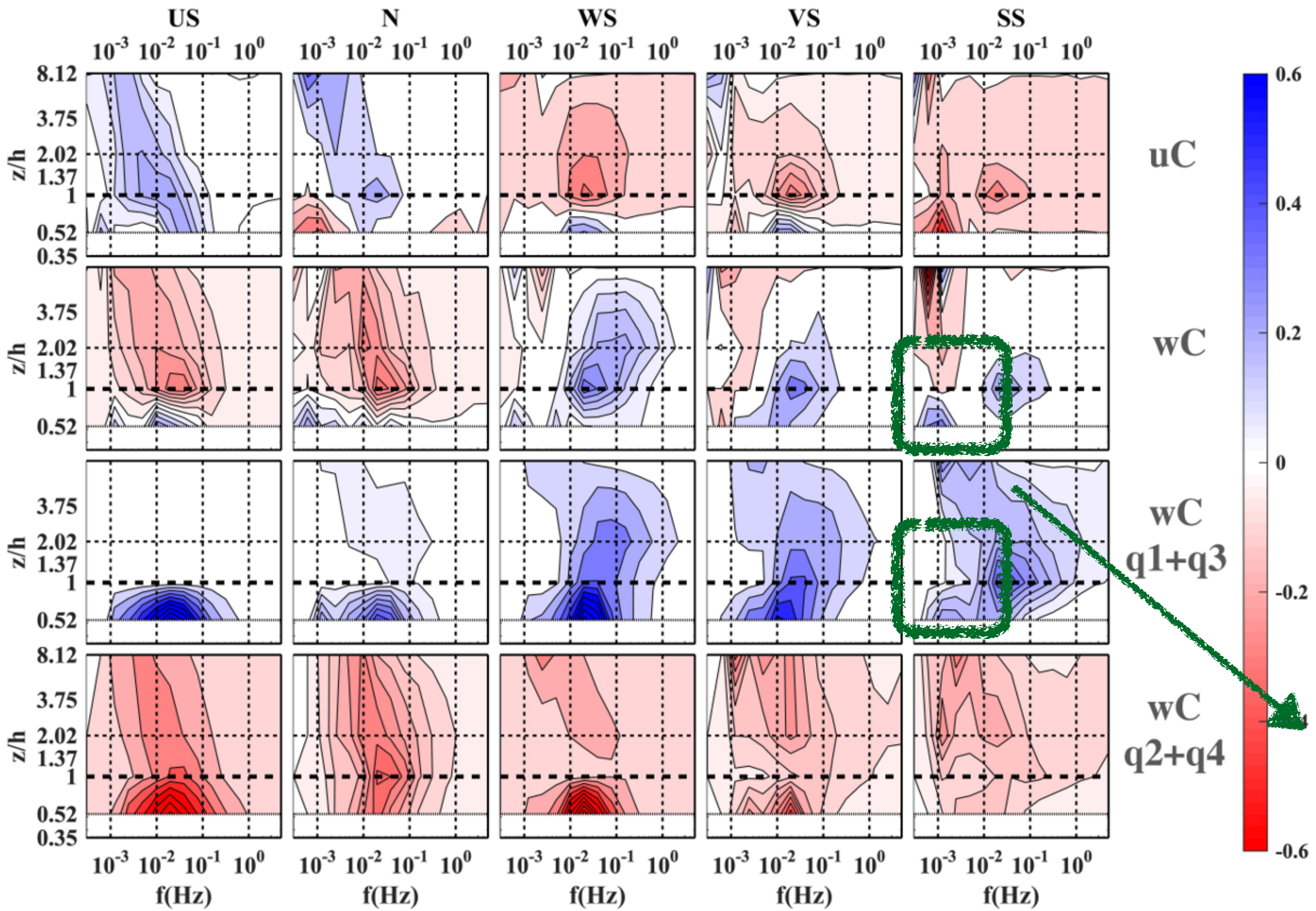
Scalar Flux Cospectra



The scalar flux cospectra confirms that the evolution with stability of mixing-layer-type coherent structures

In SS regime, above the RSL submeso motions do not contribute to the transport of momentum and scalars (odd or even quadrants equilibrate themselves)

The large positive flux of CO_2 within the forest in SS regime is completely driven by submeso flow.

Dependence of the shear length scale with stability

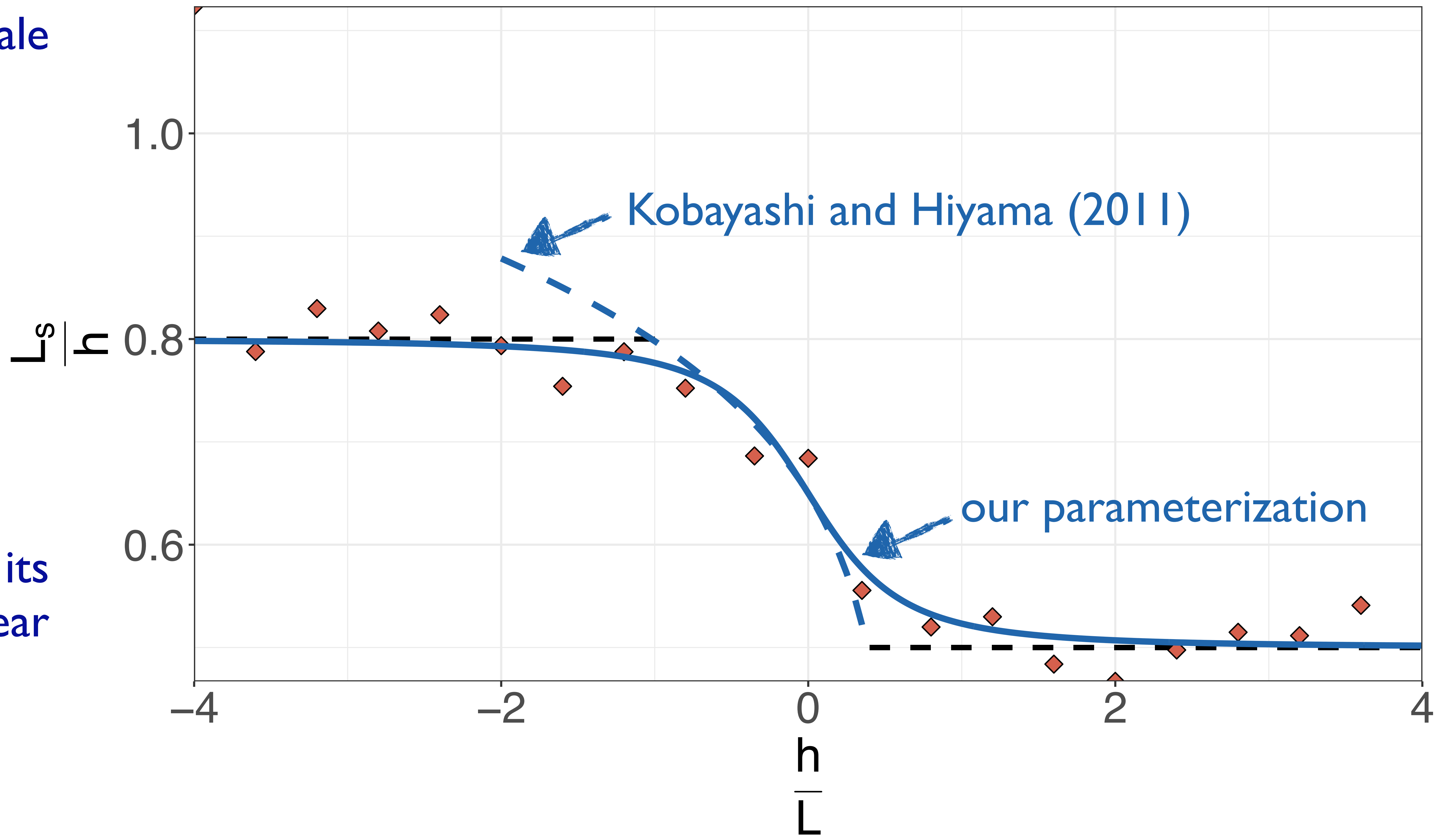
$$L_s = U_h / \left(\partial U_h / \partial z \right)$$

The shear length scale was evaluated at a fixed height above the canopy (40 m).

The dependence of the shear length scale on stability can be parameterized as:

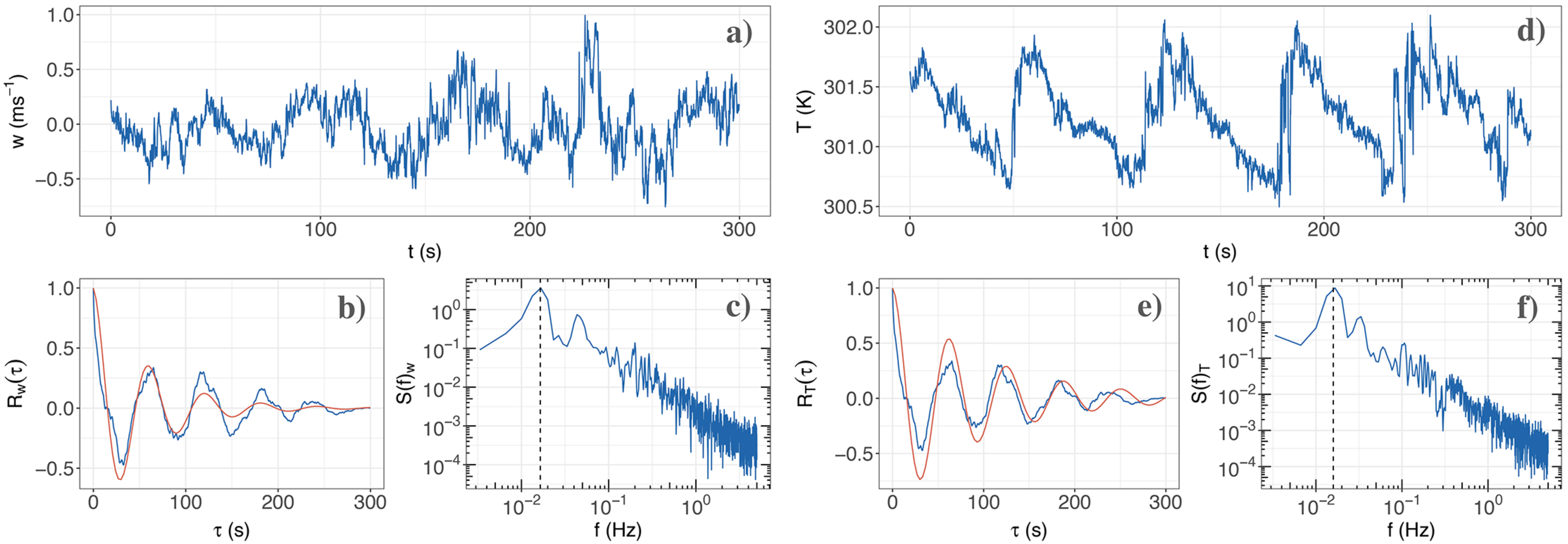
$$\begin{cases} \frac{L_s}{h}(0) & = 0.65 \\ \frac{L_s}{h}(h/L) & = \frac{L_s}{h}\Big|_{h/L=0} - 0.5\frac{|h/L|}{h/L}\sqrt{\frac{(h/L)^2}{(h/L)^2 + 0.4}} \end{cases}$$

Which is symmetric in respect to its neutral value where it shows a linear behaviour.



Coherent structures identification
Eulerian AutoCorrelation function

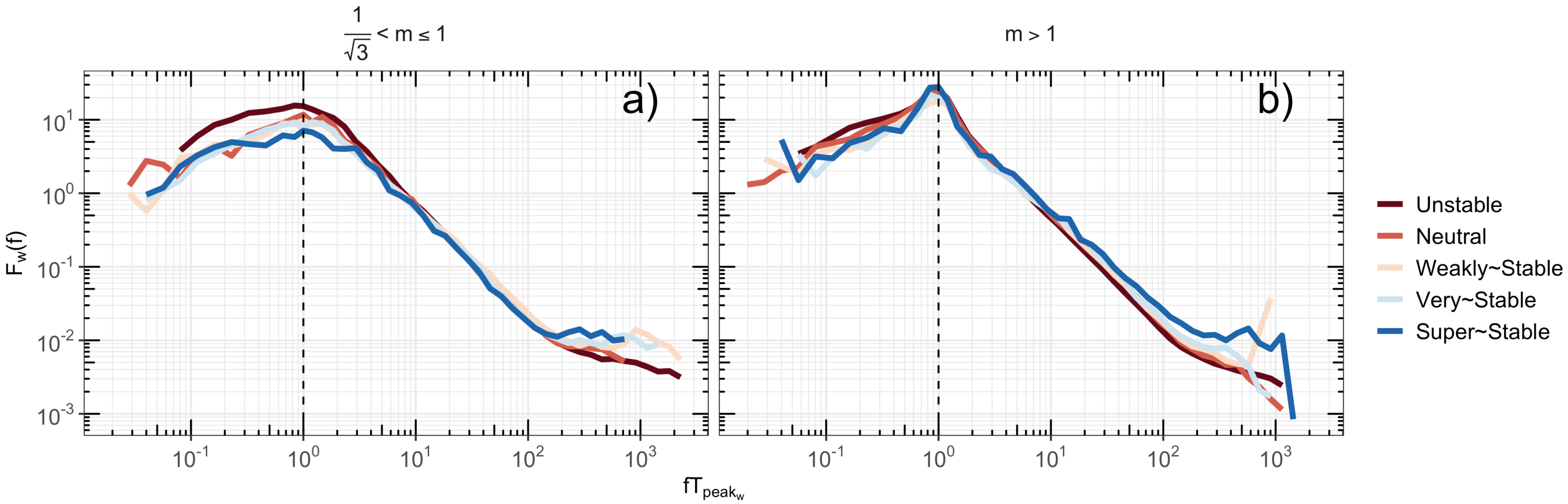
5 minutes - subsets → $$R_\chi(\tau) = \frac{\langle \chi(t)\chi(t+\tau)\rangle}{\sigma_\chi^2} = e^{-p\tau}\cos\left(\frac{2\pi}{T_*}t\right)$$

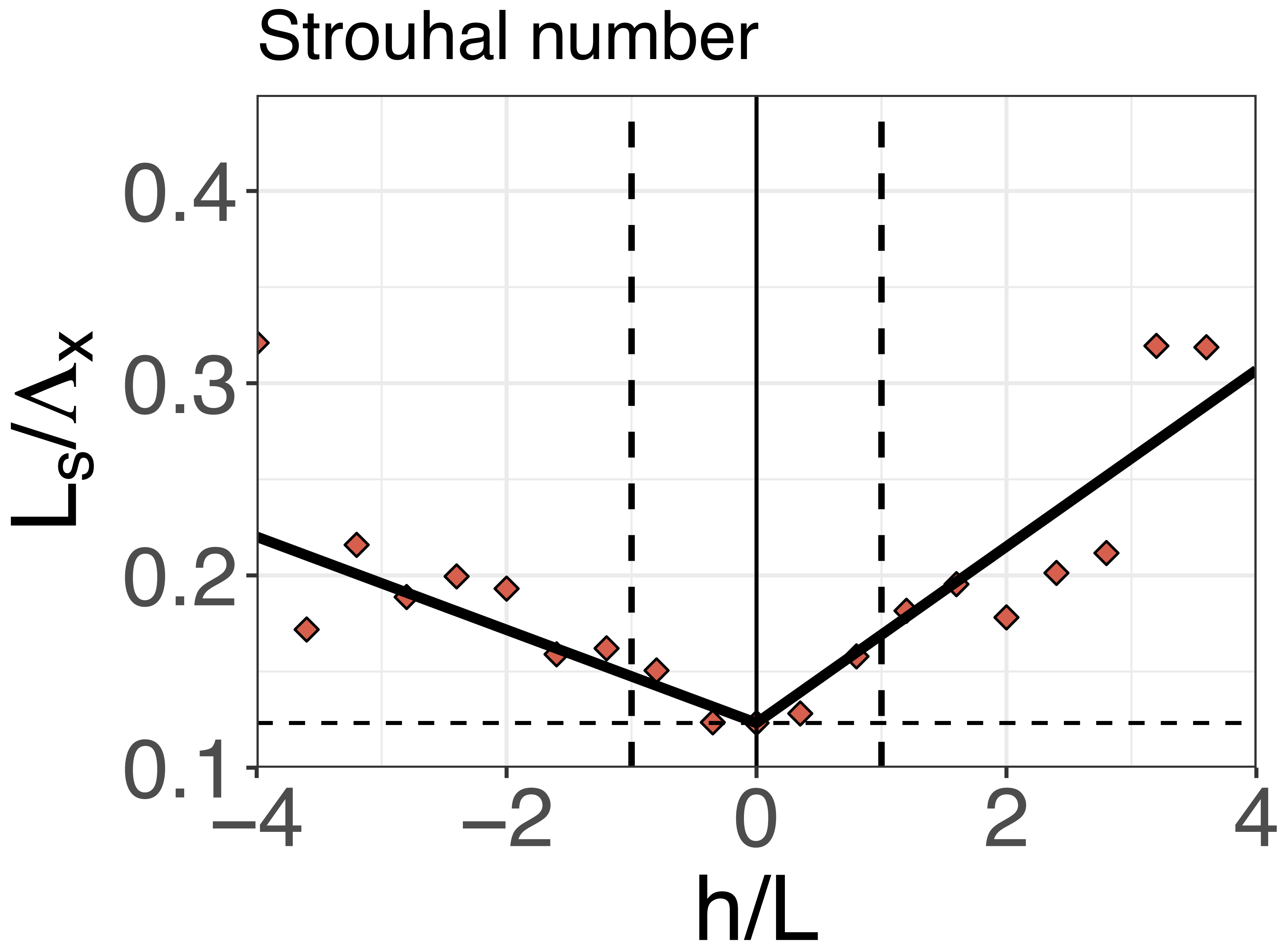


$$T_{peak} = \left[\frac{1}{2\pi}\sqrt{\sqrt{q^2\left(p^2+q^2\right)} - p^2 - q^2}\right]^{-1}$$ → $$\frac{\Lambda_x}{h} = \frac{T_{peak\ w}}{h}U_C$$

Coherent structures identification

For $m = \dfrac{q}{p} > 1$ coherent structures characterise the atmospheric flow above and within the forest.





$$\frac{L_s}{\Lambda_x} = \begin{cases} \frac{1}{8.1}\left(1 - 0.20\frac{h}{L}\right) & \frac{h}{L} < 0 \\ \frac{1}{8.1}\left(1 + 0.37\frac{h}{L}\right) & \frac{h}{L} \geq 0 \end{cases}$$

Compared to Brunet and Irvine (2000), the Strouhal number for ATTO data presents a stronger dependence on stability in the unstable case and a weaker dependence in the stable case.

Thank you!

Cava D, Dias-Júnior CQ, Acevedo O, Oliveira PES, Tsokankunku A, Sörgel M, Manzi AO, de Araújo AC, Brondani DV, Toro IMC, Giostra U, Mortarini L, Vertical propagation of submeso and coherent structure in a tall and dense Amazon Forest in different stability conditions PART I: Flow structure within and above the roughness sublayer, Agricultural and Forest Meteorology, 322, 2022, https://doi.org/10.1016/j.agrformet.2022.108983.

Mortarini L, Dias-Júnior CQ, Acevedo O, Oliveira PES, Tsokankunku A, Sörgel M, Manzi AO, de Araújo AC, Brondani DV, Toro IMC, Giostra U, Cava D, Vertical propagation of submeso and coherent structure in a tall and dense amazon forest in different stability conditions. PART II: Coherent structures analysis, Agricultural and Forest Meteorology, 322, 2022, https://doi.org/10.1016/j.agrformet.2022.108993.

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