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Supplement of

Can machine learning improve the model representation of turbulent kinetic energy dissipation rate in the boundary layer for complex terrain?

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1. Proof on approximation for MYNN parameterization of TKE dissipation rate

Actual definition:

$$\frac{1}{L_M} = \frac{1}{L_S} + \frac{1}{L_T} + \frac{1}{L_B}$$

Approximation:

$$\frac{1}{L_M} \approx \frac{1}{L_S}$$

Thesis: the approximation will always overestimate L_M

Proof:

Let's compare the right-hand sides of the definition of L_M and the approximation followed in our analysis and suppose our thesis is true. Also, all length scales are strictly positive.

$$\left(\frac{1}{L_S} + \frac{1}{L_T} + \frac{1}{L_B}\right)^{-1} < L_s$$

$$\frac{L_S L_T L_B}{L_T L_B + L_S L_B + L_S L_T} < L_s$$

$$\frac{L_T L_B}{L_T L_B + L_S L_B + L_S L_T} < 1$$

$$L_T L_B < L_T L_B + L_S L_B + L_S L_T$$

$$0 < L_S L_B + L_S L_T$$

Which is always true since all length scales are strictly positive.

2. Bias in MYNN parameterization using data from the three 100-m met towers

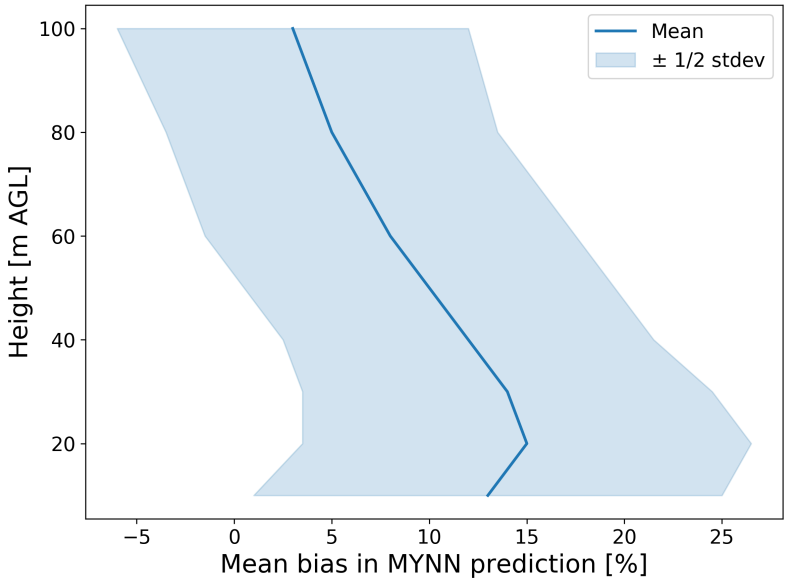

Figure S1: Mean bias in the MYNN-parameterized $\log \epsilon$ *at different heights, as calculated from the sonic anemometers on the three 100-m towers at Perdigão.*

3. Input and output features distributions

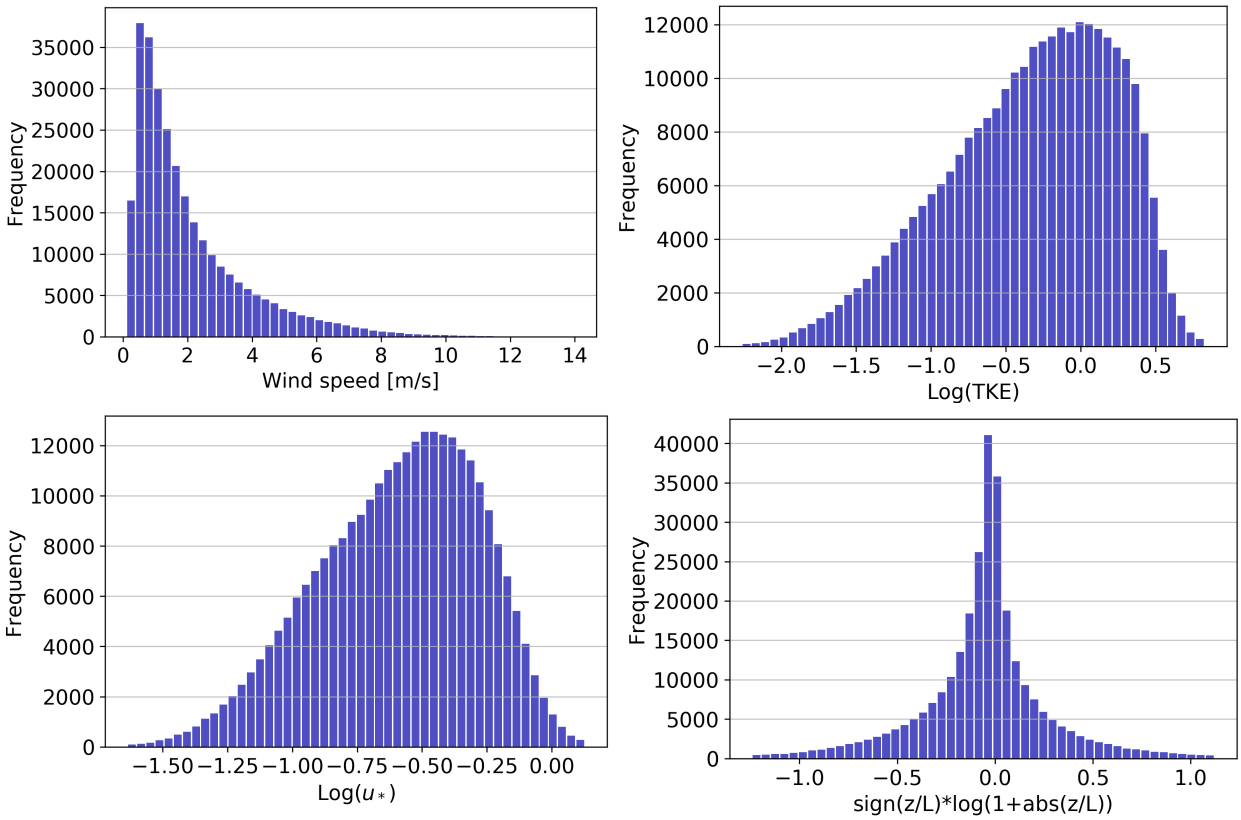

Figure S2: Distributions of 30-minute average wind speed, log(TKE), log(u_*), and sign(z/L)log(1+abs(z/L)) from the sonic anemometers at Perdigão.

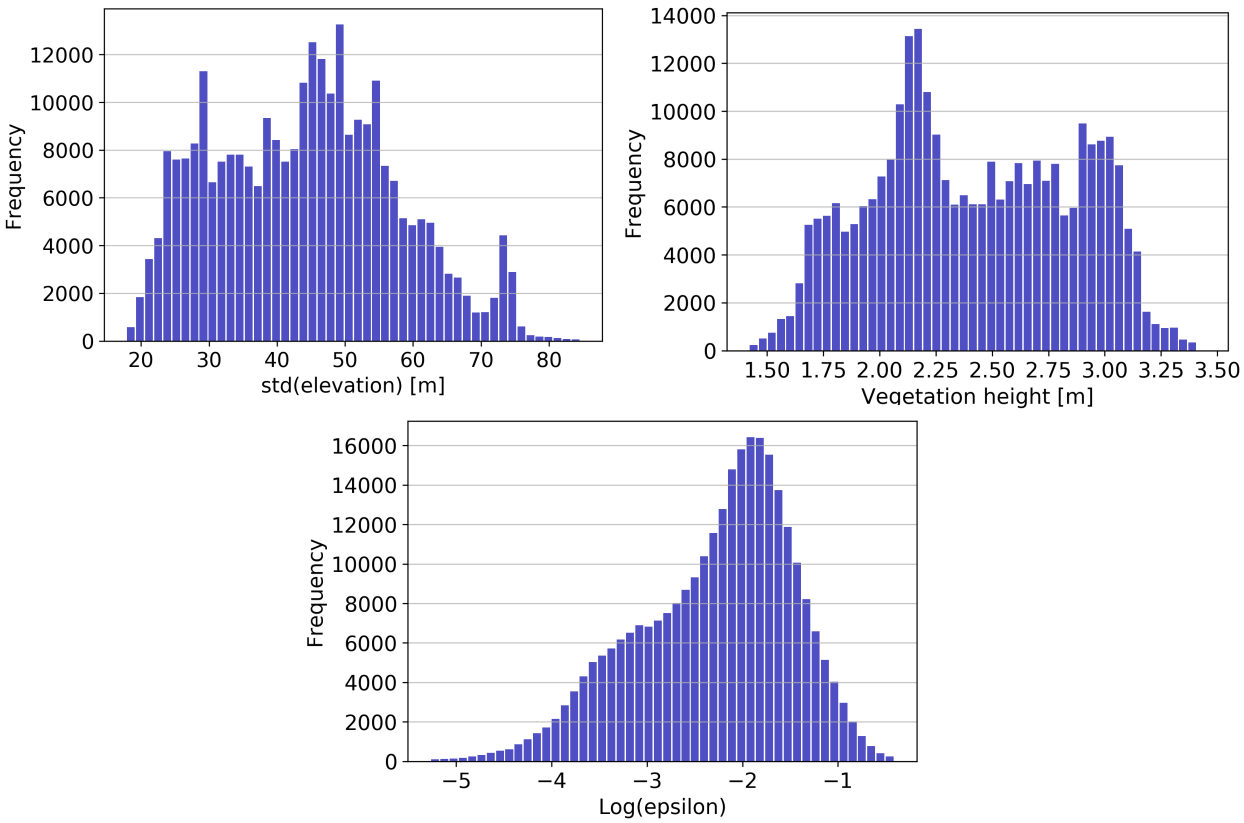

Figure S3: Distributions of $\sigma(z_{terr})$, vegetation height, and 30-minute average $\log \epsilon$ from the sonic anemometers at Perdigão.

4. Feature importance as a function of height

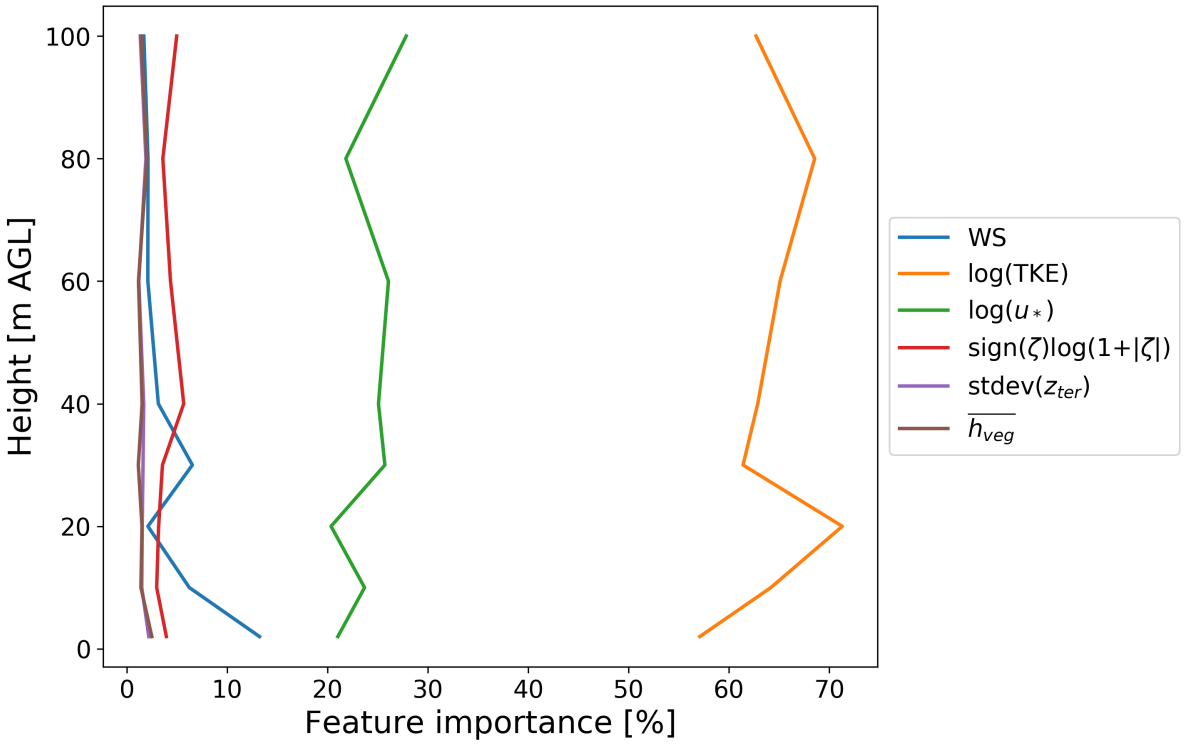

Figure S4: Variability of the random forest feature importance with height, derived from several random forests, each trained and tested with data from all the sonic anemometers at a single height only.