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On the anomalous behaviour of the Lagrangian structure function similarity constant inside dense canopies

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The choice of the Kolmogorov constant (C_o) in Lagrangian Stochastic Models (LSM) for canopy flows remains a subject of debate and uncertainty. This uncertainty stems from the fact that canopy flows are highly dissipative, lack a well-defined inertial sub-range (ISR) in their energy cascade, and in the deeper layers of the canopy, the attenuation of turbulence can amplify finite Reynolds number effects on C_o. From the analysis here, it was shown that $C_o$inside dense canopies is reduced relative to its value in the atmospheric surface layer (ASL) primarily due to wake production (a factor of 5), followed by finite Reynolds number effects (a factor of 1.5 at most). The short-circuiting of the energy cascade tends to increase C_o though not enough to compensate for the other two reductions. These results are qualitatively consistent with theoretical predictions of a reduced $C_o$with an increased anisotropy and localized acceleration when referenced to a homogeneous isotropic stationary turbulence. Simplified scaling arguments were proposed for each of these three effects and tested using flume experiments. The fact that $C_o$may vary non-linearily inside canopies complicates inverse estimates of $C_o$that use fitting LDM models to mean concentration measurements. TheC_o values inferred from such an approach were shown to be sensitive to the source location (especially inside the canopy) and concentration sampling points. On a positive note, the fact that $C_o$may vary within the canopy does not require any revisions to the well-mixed condition because LDM are not sensitive to gradients

in C_o. A phenomenological model that accounts for the vertical variation in $C_o$as a function of the most elementary flow variables, the mean velocity and canopy adjustment length scale, is proposed but its general applicability remains to be tested.