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An integrated approach of auto-correlation functions and wavelet analysis applied to the wind meandering phenomenon

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Meandering is generally defined in terms of large
variation of the wind direction due to a complex mix of motions on scales between the main turbulent eddies and the smallest mesoscale motions. There is not a general consensus on the physical causes of the motions responsible of the wind meandering during low-wind speed conditions. They include internal gravity waves, quasi–2D pancake motions, cold air drainage, solitons, vortices with either a horizontal axis or a vertical axis.
In this work we present the analysis of wind and temperature data measured with two sonic anemometers in a low-wind stably stratified night observed during the Urban Turbulent Project (Torino, Italy). An original approach to estimate the meandering time scales of the wind velocity and temperature using two complementary methodologies is proposed.
In the literature the meandering time-scale is evaluated fitting the Eulerian auto-correlation functions of the wind velocity with an oscillating theoretical behaviour on hourly datasets. First we extend this method considering the dependence of the time-scale on the dataset length considering longer datasets (1, 2, 3, 4 hours) and then we compare these results with a wavelet analysis. The continuous wavelet transform based on the Morlet basis is used to detect and characterize the time-scale of the wavelike oscillations both in the wind velocity and in the temperature signals. Moreover cross-wavelet spectra are used to identify the nature of the wavy patterns in order to discriminate the presence of gravity waves.
The wavelet analysis corroborates the results obtained with the auto-correlation functions and opens new promising perspectives for the study of the meandering phenomenon.