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Hilbert-Huang Transform in Ocean Turbulence

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Hilbert-Huang Transform is a relative novel time-frequency analysis technique for multi-scale processes. It is a wavelet-like data-driven methodology without a priori basis assumption. This meets the requirement of the analysis of the nonstationary and nonlinear data with short length or irregular sampling time interval. Since it is introduced in 1998 by Dr. N.E Huang, it has been widely applied to different scientific research fields and engineering problems, showing its simplicity and successes.

We develop further this method to characterize the scale invariance for turbulence-like/scaling processes, e.g., velocity, temperature, dissolved oxygen observed in ocean, etc. In this talk, we first present a general introduction of this method. The key feature of this Hilbert-based method is that it is free with sub-harmonics when dealing with nonstationary and nonlinear data. This is accomplished by using an Intrawave-Frequency Modulation mechanism to characterize the so-called nonlinear distortion. Therefore, unlike the Fourier based methodologies, artificial energy redistribution in spectral space is constrained. We then show several applications of this method to experimental data from wind tunnel experiments and ocean observations. The interaction between two different scales and two variables are also discussed in statistics sense. The method is general and applicable to other systems, in which the multi-scale is relevant.

Reference

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