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Conditional probability distribution function of "energy transfer rate" (PDF(ε|PVI)) as compared with its counterpart of temperature (PDF(T|PVI)) at the same condition of fluctuation

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Energy transfer rate of turbulence is not uniform everywhere but suggested to follow a certain distribution, e.g., lognormal distribution (Kolmogorov 1962). The inhomogeneous transfer rate leads to emergence of intermittency, which may be identified with some parameter, e.g., normalized partial variance increments (PVI) (Greco et al., 2009). Large PVI of magnetic field fluctuations are found to have a temperature distribution with the median and mean values higher than that for small PVI level (Osman et al., 2012). However, there is a large proportion of overlap between temperature distributions associated with the smaller and larger PVIs. So it is recognized that only PVI cannot fully determine the temperature, since the one-to-one mapping relationship does not exist. One may be curious about the reason responsible for the considerable overlap of conditional temperature distribution for different levels of PVI. Usually the hotter plasma with higher temperature is speculated to be heated more with more dissipation of turbulence energy corresponding to more energy cascading rate, if the temperature fluctuation of the eigen wave mode is not taken into account. To explore the statistical relationship between turbulence cascading and plasma thermal state, we aim to study and reveal, for the first time, the conditional probability function of "energy transfer rate" under different levels of PVI condition (PDF(ε|PVI)), and compare it with the conditional probability function of temperature. The conditional probability distribution function, PDF(ε|PVI), is derived from PDF(PVI|ε)·PDF(ε)/PDF(PVI) according to the Bayesian theorem. PDF(PVI) can be obtained directly from the data. PDF(ε) is derived from the conjugate-gradient inversion of PDF(PVI) by assuming reasonably that PDF(δB|σ) is a Gaussian distribution, where PVI=|δB|/ σ and $\sigma\sim$($\varepsilon\iota$)1/3. PDF(ε) can also be acquired from fitting PDF(δB) with an integral function $\int$PDF(δB|σ)PDF(σ)d σ. As a result, PDF(ε|PVI) is found to shift to higher median value of ε with increasing PVI but with a significant overlap of PDFs for different PVIs. Therefore, PDF(ε|PVI) is similar to PDF(T|PVI) in the sense of slow migration along with increasing PVI. The detailed comparison between these two conditional PDFs are also performed.