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On the surprising robustness of the surplus run length and size ratio formulae, and their application to bursts in natural time series

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Bursts, events that begin when a time series exceeds a threshold, and end when it drops below it, have been widely studied in models of intermittent dynamical systems such as SOC and turbulence, and in natural datasets. Analytical approaches to bursts are needed which permit handling time dependence and heavy tailed amplitudes, and make contact with mature mathematics such as the theory of random fields and level crossings. We will discuss one such technique, which we call the surplus run length ratio [SRLR] formula, which states that the expectation value of the time between successive up and down- crossings of a threshold by values of stationary time series from a stochastic process is the empirical survival function of the process divided by the time rate of upcrossings at that level [Volkonskii, 1960; Cramer and Leadbetter,1967. We show that the SRLR formula, and a similar formula relating the integrated burst to the SRLR and the mean excess function, apply surprisingly widely in highly skewed (lognormal), heavy tailed (alpha-stable) and long range dependent (fractional Gaussian) cases, among others. We demonstrate its utility on a non- Gaussian, correlated, natural example which has been previously studied using bursts, the auroral electrojet (AE) ionospheric index.