A Poisson shot-noise model for snow penetration resistance

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As a common starting point for the interpretation of SnowMicroPenetrometer (SMP) data the penetration force is regarded as a superposition of spatially uncorrelated ruptures of structural elements which follow an ideal elastic-brittle response. We re-state this idea and describe the fluctuating resistance force as a Poisson shot-noise process. This allows us to derive simple, analytical expressions for the cumulants and the covariance of the penetration force in terms of the micromechanical, force-displacement parameters of individual elements. Vice versa, the micromechanical parameters can be estimated from the statistics of the penetration force. We test our method with simulated shot-noise processes and real snow profiles. Our model unifies different, previous approaches to develop snow classification schemes based on snow penetration resistance.