

Probability distributions for macroprocesses in nature

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During the last quarter of the century there was a surge of interest to the statistical distributions of events and processes. Tsunamis, hurricanes, earthquakes, volcanos, landslides, floods and droughts all these phenomena are the real life events causing multibillion damage and many deaths. The question of natural hazard risks becomes a practical necessity. It is known from observations that many phenomena have frequency-size distributions as power laws. This talk will show that, as a rule such distributions arise in cases when a large system is under stochastic forcing whose correlation time is much shorter than the reaction time of the system. Examples are all geodynamical phenomena: earthquakes, tsunamis, volcanic eruptions, planetary surface relief, geomorphology (rivers, lakes, landslides), processes as Kolmogorov turbulence, thermal convection, etc. Physical formulas will be given for such distributions where observed (measured) quantities will be present and only numerical coefficients are determined by comparing theory with observational data. The simple analytics comes from the theory of stochastic processes with stationary increments of arbitrary order. The foundations of this theory has been laid in 1940 by A.N.Kolmogorov and further developed by A.M.Yaglom (1955). E. g. this approach readily explains the result by P. Bird (2003) that the cumulative distribution of number of lithospheric plates on their area is . We find that meteorological events have exponential number-size distributions. This author has proposed a way how the total kinetic energy of extratropical cyclones can be estimated through the pressure deficit and Coriolis parameter. The reanalysis supplied us with tens and hundreds thousands cyclones. We find that their number-energy distributions exhibit the Boltzmann-type behavior over almost three orders of their kinetic energy distributions. This may be explained by Gibbs-type of canonical ensemble arguments with ocean as a thermostat (thermal bath) and atmosphere as a fluctuating part of the system.