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A model that explains the nature of reconnection-related fluctuations in the open-closed magnetic field line boundary location in the ionosphere

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A number of case studies have investigated the total net balance of dayside and nightside reconnection processes within the Earth's magnetosphere through their effect on the amount of open magnetic flux threading the ionosphere and consequent motion of the open-closed magnetic field line boundary (OCB) that encloses this open magnetic flux. However, a comprehensive statistical analysis of the probability distribution of reconnection-related fluctuations in the OCB location and its variation with magnetic local time (MLT) has never been attempted. Here we do this using measurements of the OCB location, inferred from the poleward boundary of auroral luminosity as measured by the FUV instruments on the IMAGE spacecraft. We determine that this distribution is best modelled by a Student's t-distribution at all MLTs, but that the fit parameters vary with time scale and MLT illustrating a very different nature in the boundary fluctuations in the dayside and nightside ionosphere. The observed distribution of fluctuations can be understood if the reconnection process is modelled as an Ornstein-Uhlenbeck process, a mean-reverting stochastic process, consistent with the expanding-contracting polar cap model.