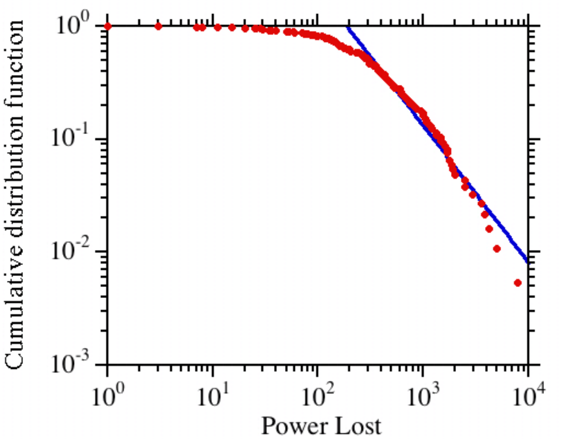

Fig. 5. Western interconnect cumulative distribution of observed blackout size in MW from NERC data.

order to give a reasonable mean value for the frequency of the blackouts. There are two other parameters p_0 and p_1 shown in Table 3 that also affect the frequency and the detailed properties of the blackout dynamics. We must determine p_0 and p_1 in order to match the historical data for the Western interconnect.

TABLE 3. Key parameters of OPA cascading dynamics

p_0	probability of random initial line outage
p_1	probability of an overloaded line outaging

4. Historical data for WECC outages

There are a number of different types of data available (or potentially available) on blackouts and outages of the WECC transmission grid. They are all important for validation of all types of modeling of the blackout dynamics. The main source of data on blackouts in the North American grid is the North American Electrical Reliability Council (NERC). This data, which is inherently filtered by reportability criteria, is available on the web [6]. Analysis of this data [13], [14], [3] shows the existence of power law regions in the probability distribution function and in the rank function of the blackout size. There are a number of different ways of characterizing the blackout size, but here, the amount of load shed associated with the blackout is the main measure used. Fig. 5 shows a plot of the cumulative distribution function of the observed blackout size for the western interconnect together with a fit to the power law region of the distribution.

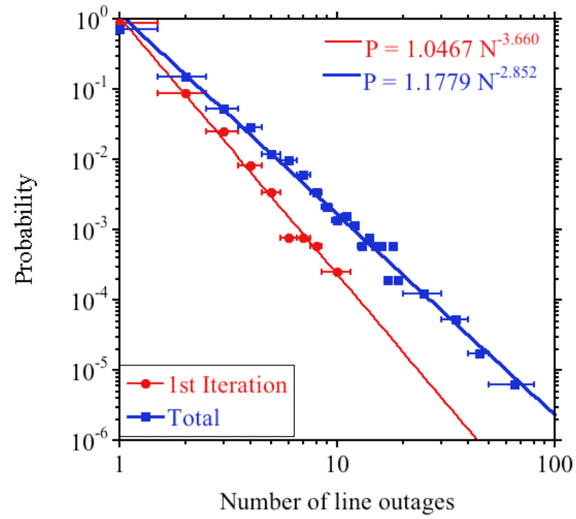

Fig. 6. Probability distribution of outages in the first generation, and the probability distribution of the total outages after cascading.

Another valuable source of information on failures is the TADS transmission line outage data for 8864 outages recorded by a WECC utility over a period of ten years [7]. The value of this TADS data for validation is noted and the authors are very grateful that this data has been made available. Because this is the only data currently available to us, we have to assume that this data for one WECC utility is representative of data across the entire WECC. The data for the WECC utility has been processed [15] to extract information on cascading events. For this analysis it is necessary to group the line outages first into different cascades, and then into different generations or stages within each cascade. One result of the grouping of the outages into cascades and generations is that there are 5227 cascades and the longest cascade has 110 generations. From this analysis, come a series of important characteristics that can be used to compare with the OPA model results. Some of these characteristics extracted from the analysis of the cascades are: the probability distribution of outages in the first generation, the probability distribution of the total number of outages after cascading, and the probability distribution of the number of generations in the cascades. These results are plotted in Figs. 6 and 7.

A third type of data used to validate the models is the λ parameter estimated from the TADS data that determines the propagation of the cascades. (This propagation parameter should be distinguished from the same symbol λ used to denote the load increase rate in the OPA input.) The way this analysis is carried out is