Void in cloud problem: From bridge to excursion

The distribution of the void population is given by Sheth & van de Weygaert (2004) as follows:

$$f_v \; \mathrm{d}S \approx \frac{1}{\sqrt{2\pi}} \frac{\delta_v}{S^{2/3}} \exp\left[-\frac{\delta_v^2}{2S}\right] \exp\left[-\frac{\delta_v}{\delta_\mathrm{c}} \frac{S}{4\delta_v^2 \left(\frac{\delta_\mathrm{c}}{\delta_v}+1\right)^2} - 2\frac{S^2}{\delta_v^4 \left(\frac{\delta_\mathrm{c}}{\delta_v}+1\right)^4}\right] \mathrm{d}S.$$

Here, this distribution function is taken with a partially negative random walk and makes this a complete positive excursion without changing its probability distribution. To do this by following the remark of Theorem, each excursion of the whole walk is replaced by their symmetric excursion. This happens by taking the mirror of the distribution around the *x*-axis (*S*) (see *B* in Fig. 5). However, here there is still a negative bridge crossing the negative collapse barrier which is not allowed in the EPS formalism. To solve this problem, the barriers are shifted up by $2\delta_\mathrm{C}$ with an accompanying shift in the probability distribution (see *C*–*D* in Fig. 5). Then, none of the barriers have a negative value and the resulting distribution function is given by

$$f_v \; \mathrm{d}S \approx \frac{1}{\sqrt{2\pi}} \frac{|\tilde{\delta}_v|}{S^{2/3}} \exp\left[-\frac{\tilde{\delta}_v^2}{2S}\right] \exp\left[-\frac{1}{\tilde{\gamma}} \frac{1}{(\tilde{\gamma}+1)^2} \frac{S}{4\tilde{\delta}_v^2} - 2\frac{S^2}{\tilde{\delta}_v^4 (\tilde{\gamma}+1)^4}\right] \mathrm{d}S,$$

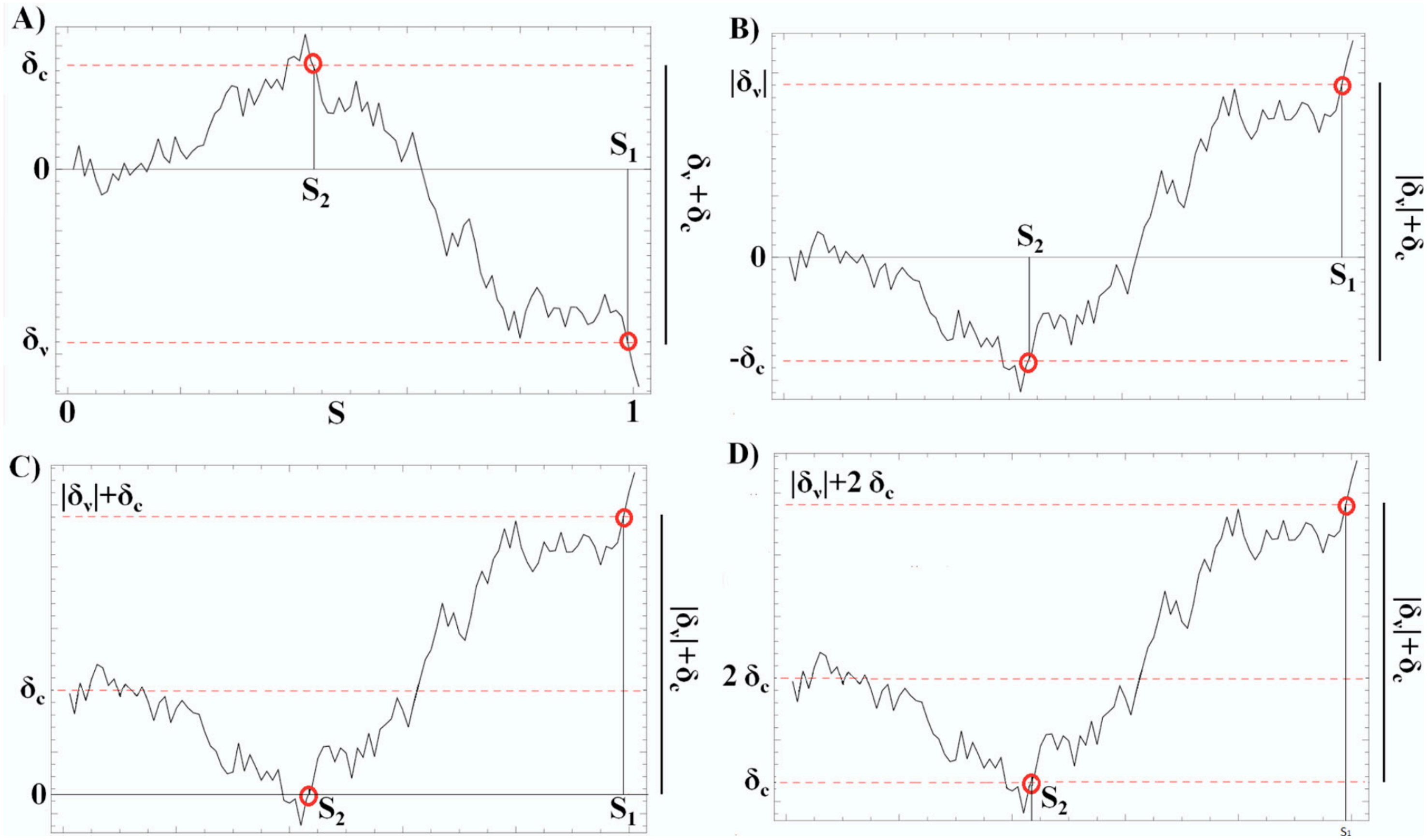

Figure 5. Steps of constructing excursion with positive barriers from the void in cloud random walk with a negative definite bridge characteristic.

where a new barrier δ_V is defined. This new barrier is given by

$$\tilde{\delta}_v \equiv |\delta_v| + 2\delta_c,$$

while the new barrier height ratio $\tilde{\gamma}$ is defined as,

$$\tilde{\gamma} \equiv \frac{\delta_c}{|\tilde{\delta}_v|}.$$

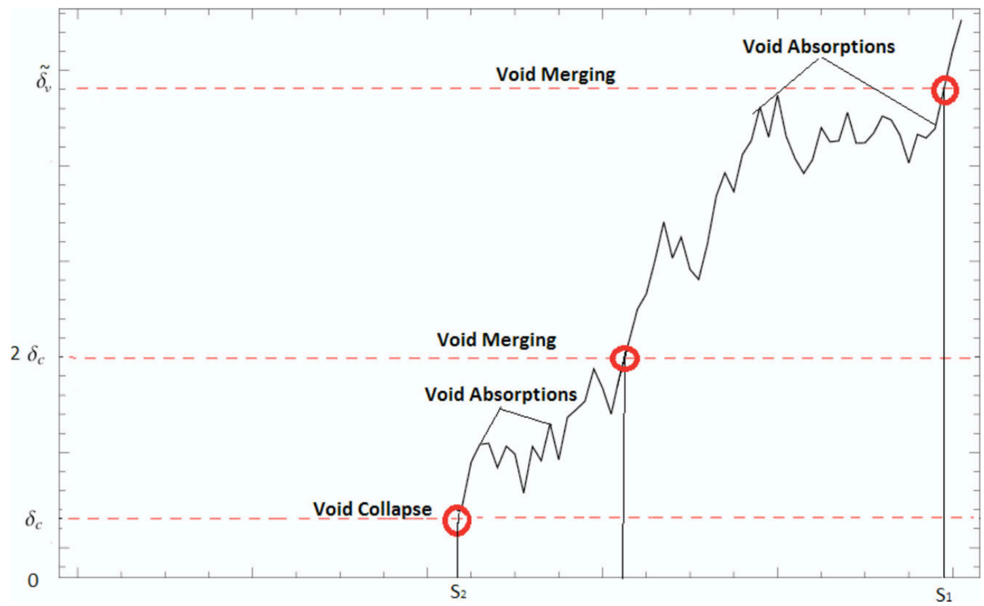

Figure 6. Excursion set interpretation of the void in cloud process. A given trajectory $\delta(S)$ describes the history of an embedded/minor void that starts merging with volume scale $S_1 = S(V_1)$ at shell crossing/merging barrier $\tilde{\delta}_v$ and later on collapses at barrier δ_c corresponding volume scale S_2.

Reference:

Esra Russell, Extended void merging tree algorithm for self-similar models. doi:10.1093/mnras/stt2309