# Wildfire simulations

Group 19

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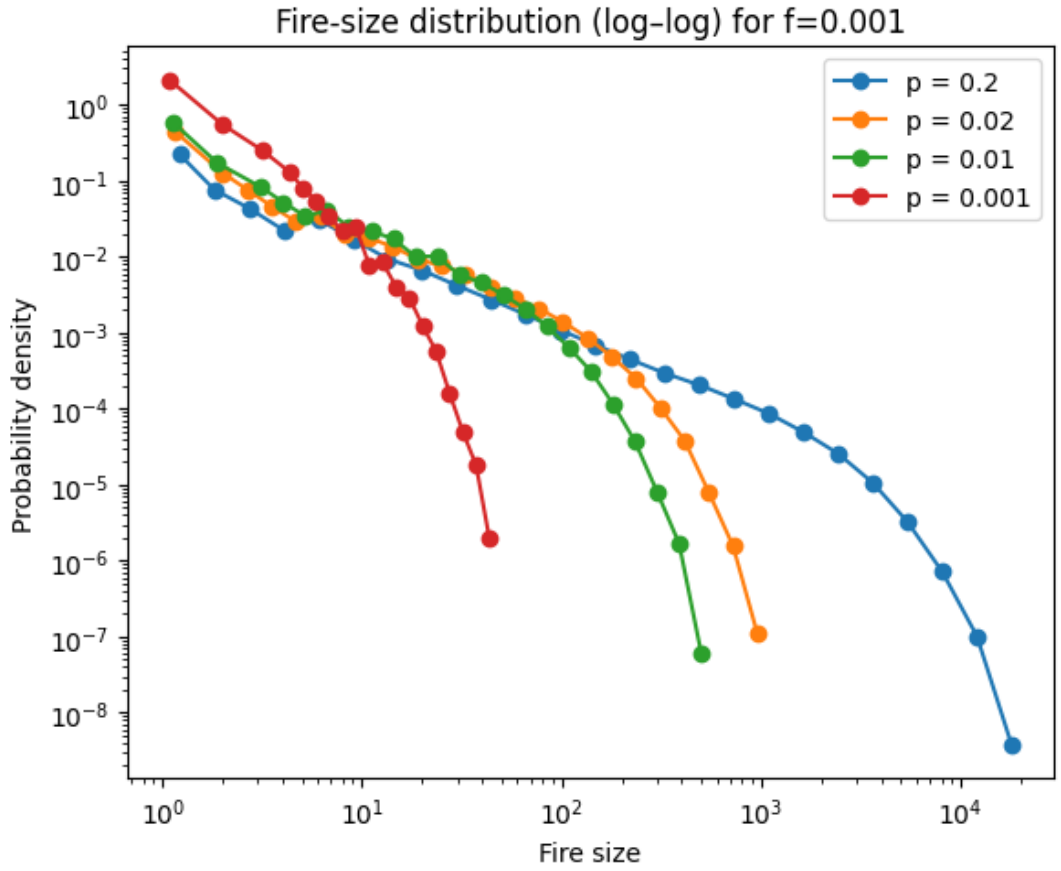
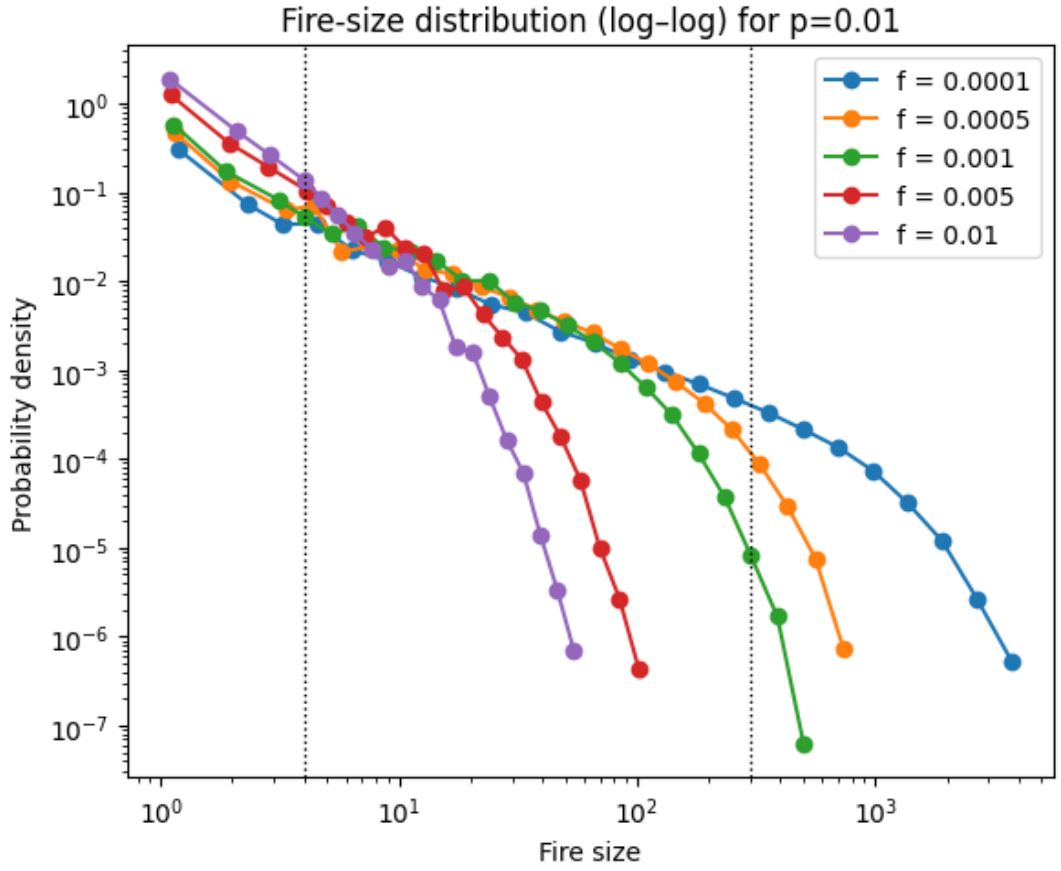
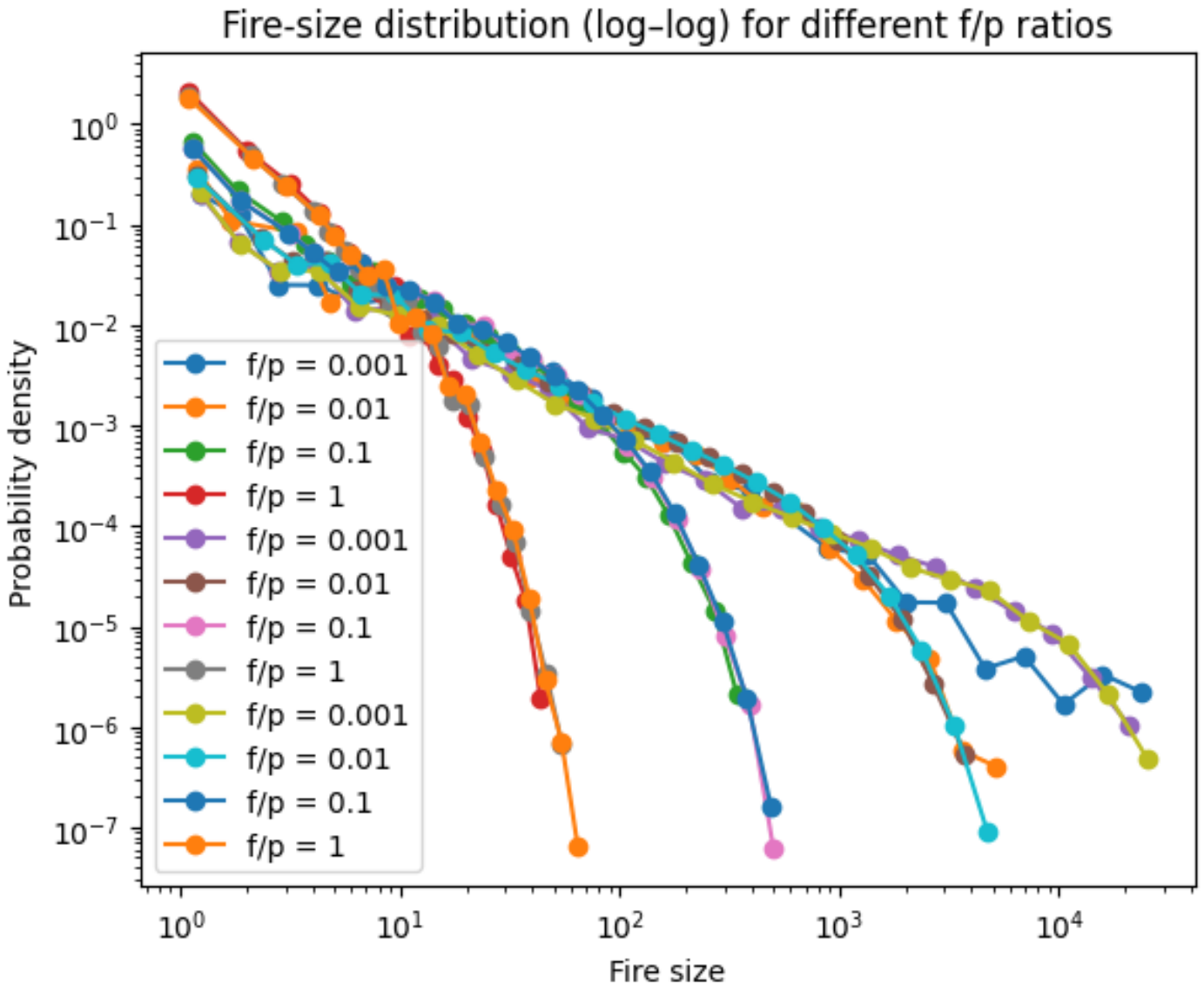
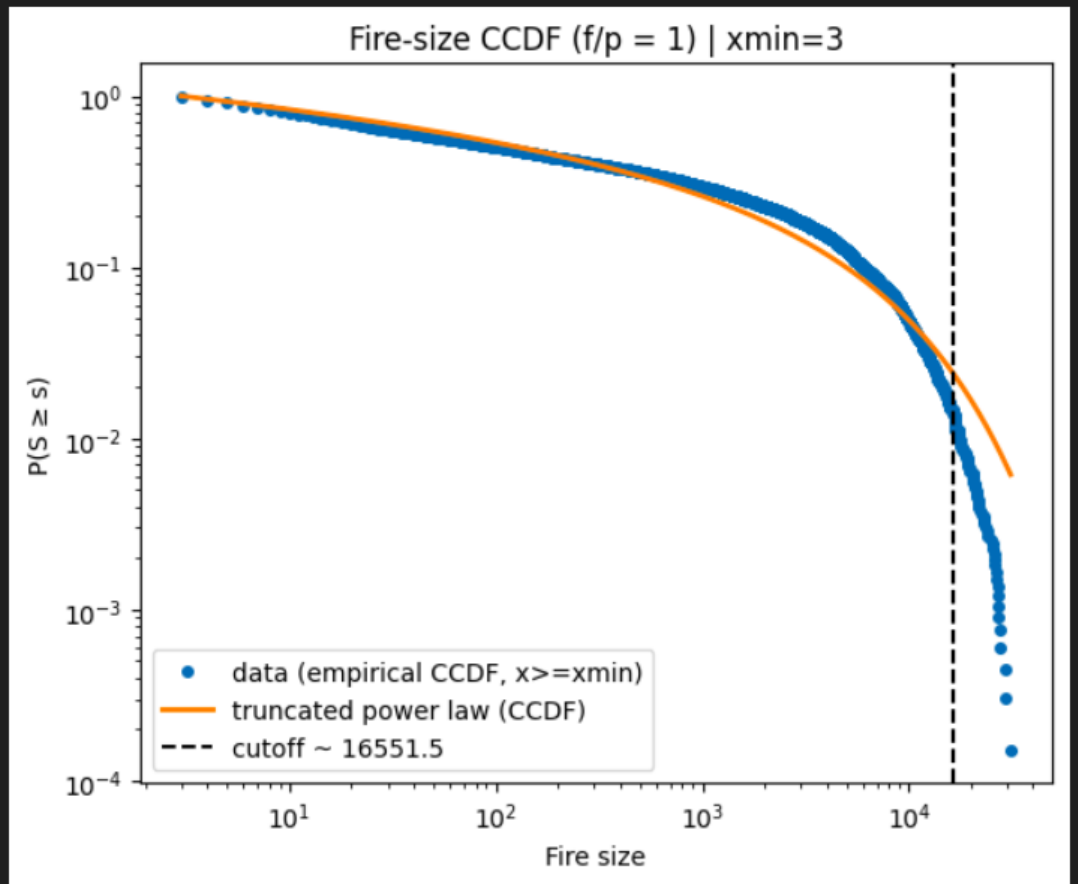
# Foundational model


Fire-size distribution (log–log) for f=0.001
p = 0.2
p = 0.02
p = 0.01
p = 0.001
Probability density
Fire size

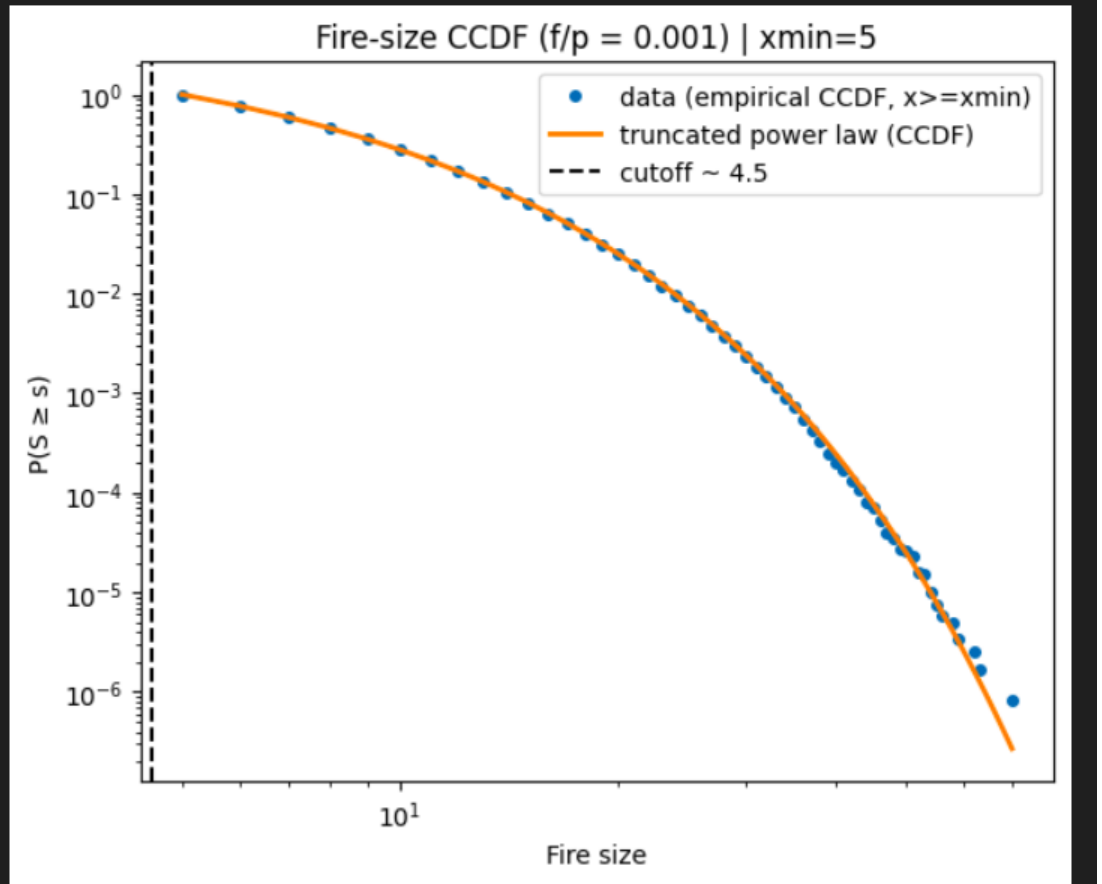

Fire-size distribution (log–log) for p=0.01
f = 0.0001
f = 0.0005
f = 0.001
f = 0.005
f = 0.01
Probability density
Fire size

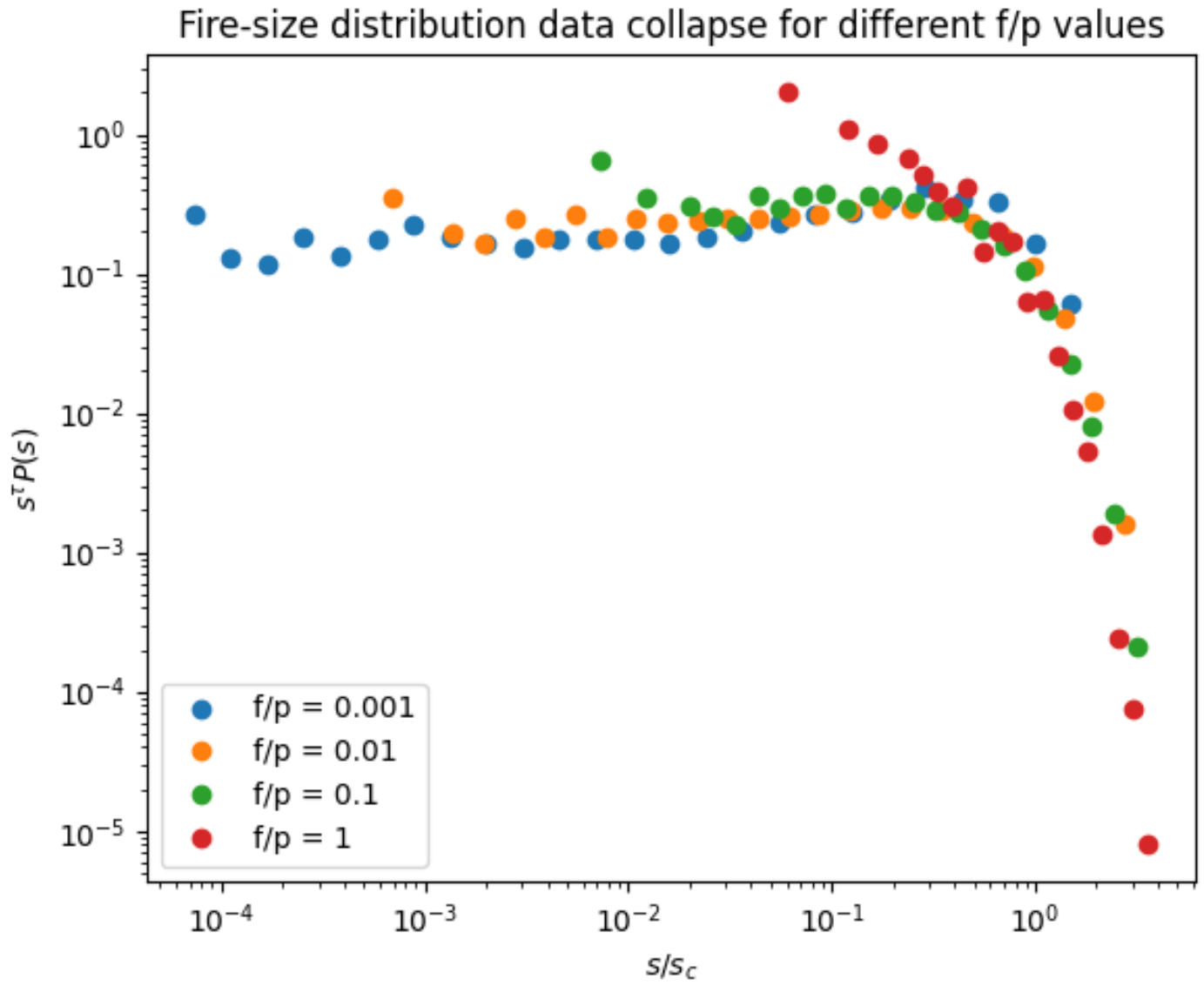

Fire-size distribution (log–log) for different f/p ratios
Probability density
Fire size
f/p = 0.001
f/p = 0.01
f/p = 0.1
f/p = 1
f/p = 0.001
f/p = 0.01
f/p = 0.1
f/p = 1
f/p = 0.001
f/p = 0.01
f/p = 0.1
f/p = 1

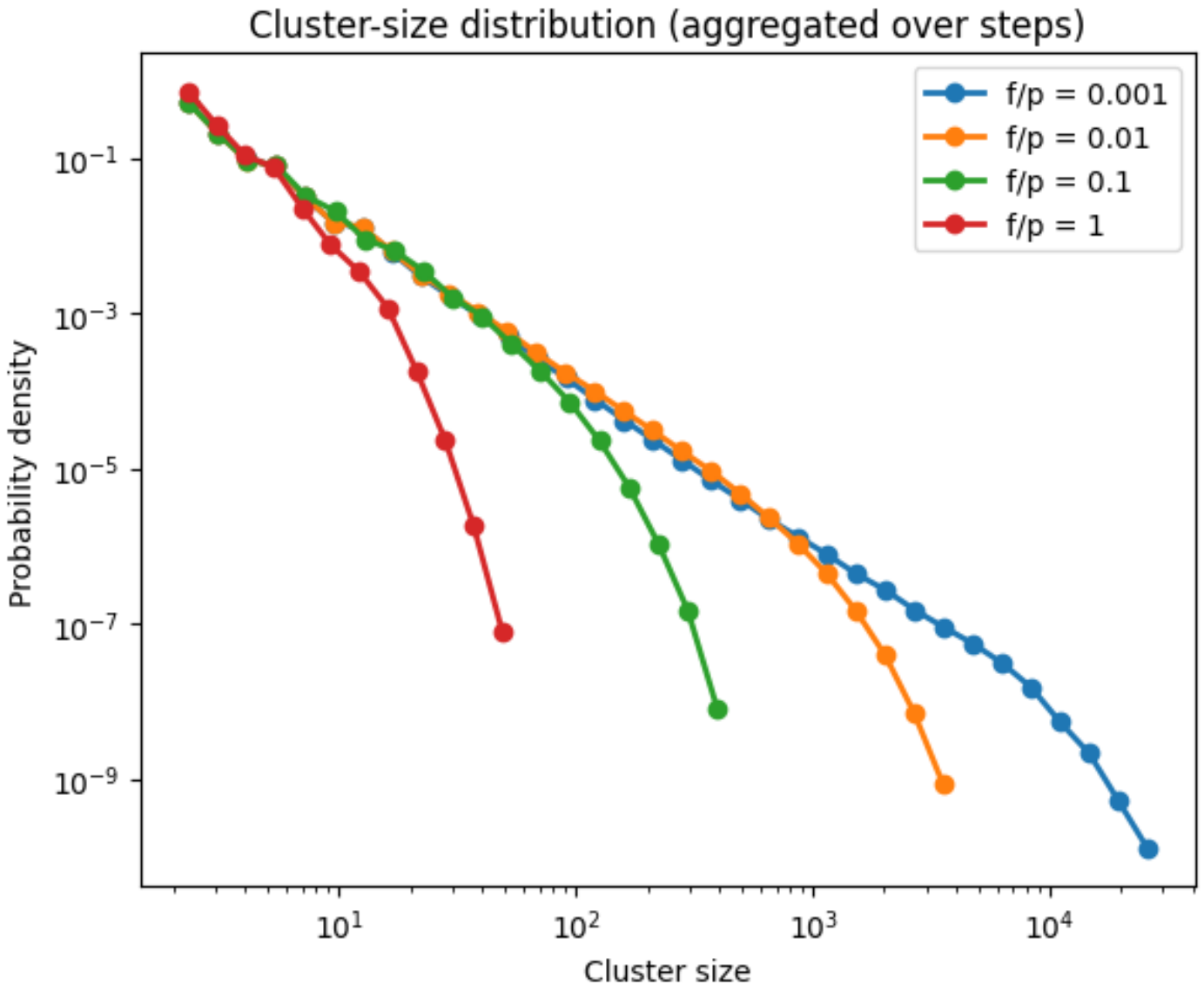
```
=== f/p = 1 ===
PL vs TPL: R= -1201.099055783743 p= 0.0
TPL vs LN: R= 466.26317756376164 p= 4.837414530137615e-215
xmin: 3.0
alpha (pure PL): 1.2485071907384593
alpha (truncated): 1.028722984802528
lambda (cutoff rate): 6.0417648254617555e-05
```

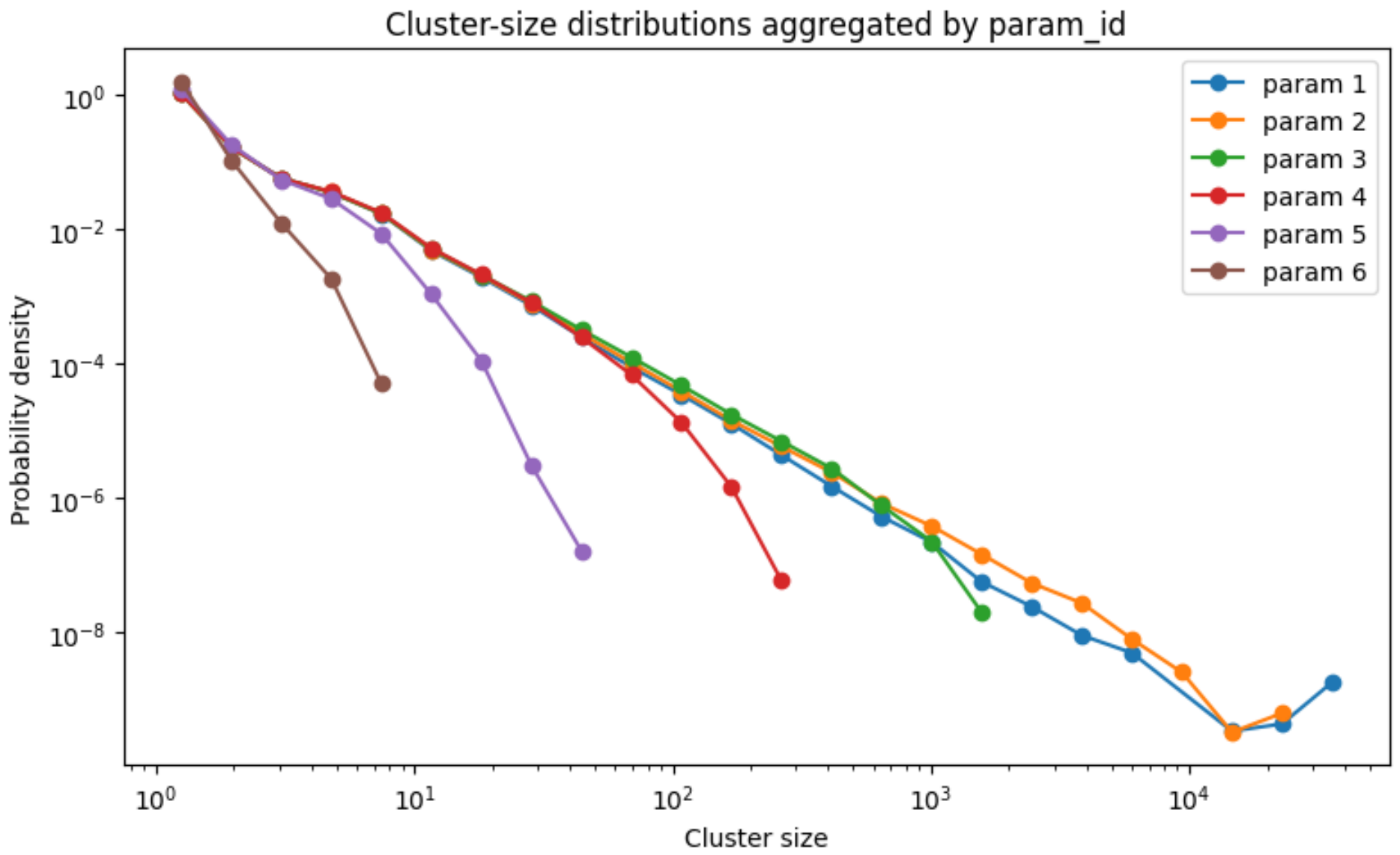



```
=== f/p = 0.001 ===
PL vs TPL: R= -67287.7050445932 p= 0.0
TPL vs LN: R= 1778.1070959894807 p= 6.660715939112051e-259
xmin: 5.0
alpha (pure PL): 2.872998046875
alpha (truncated): 0.35638451564468315
lambda (cutoff rate): 0.22079289990365952
```

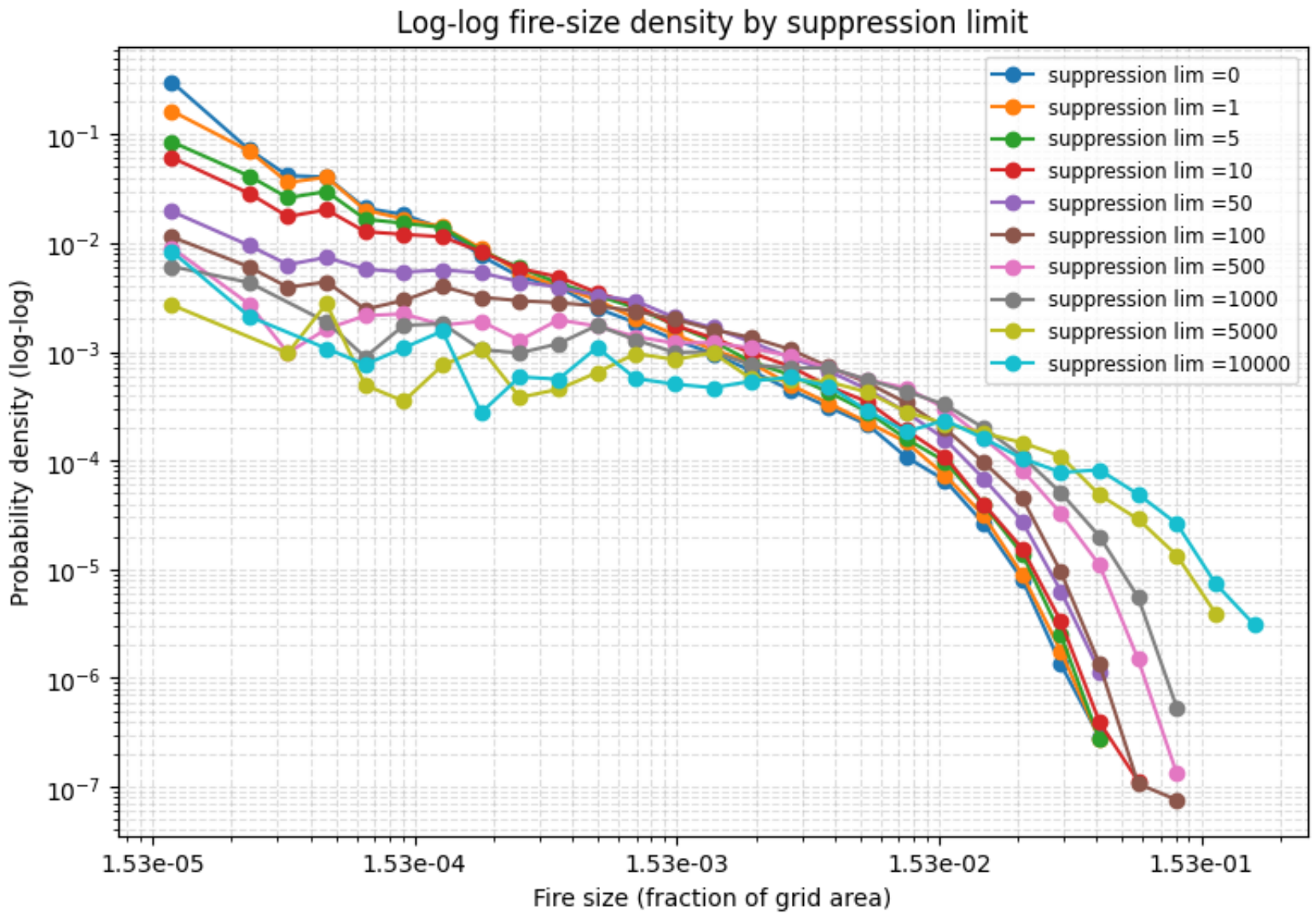


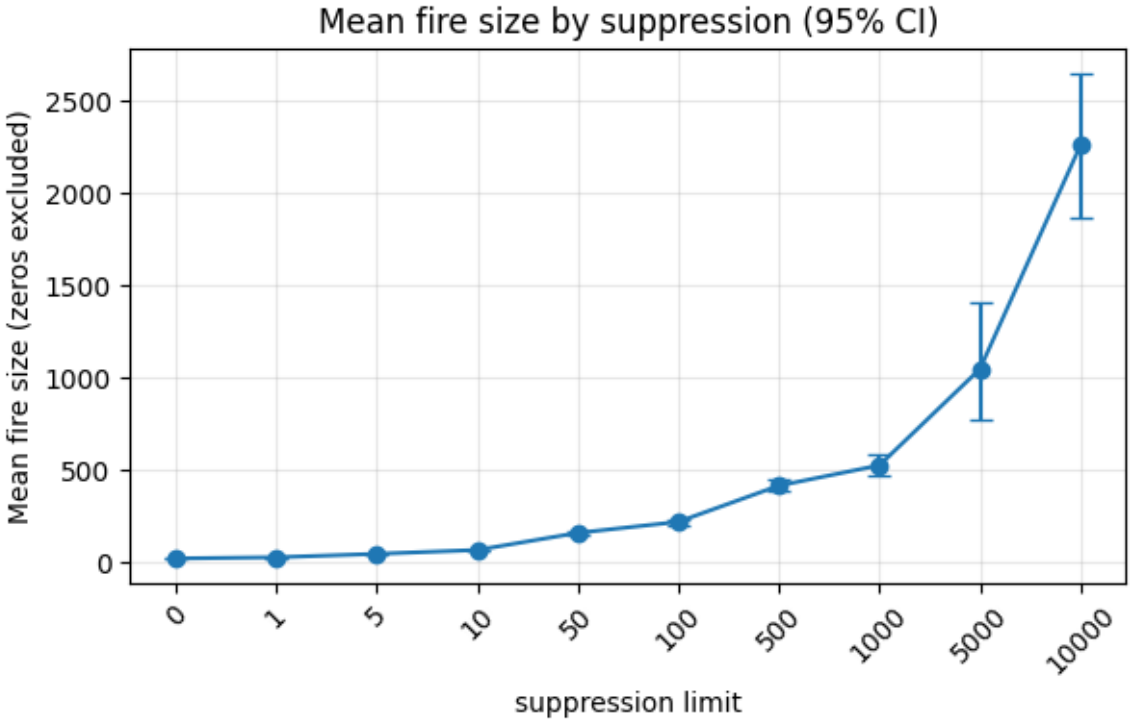

Fire-size distribution data collapse for different f/p values
$s^{\tau}P(s)$
$s/s_c$
$10^{0}$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-4}$
$10^{-3}$
$10^{-2}$
$10^{-1}$
$10^{0}$
f/p = 0.001
f/p = 0.01
f/p = 0.1
f/p = 1

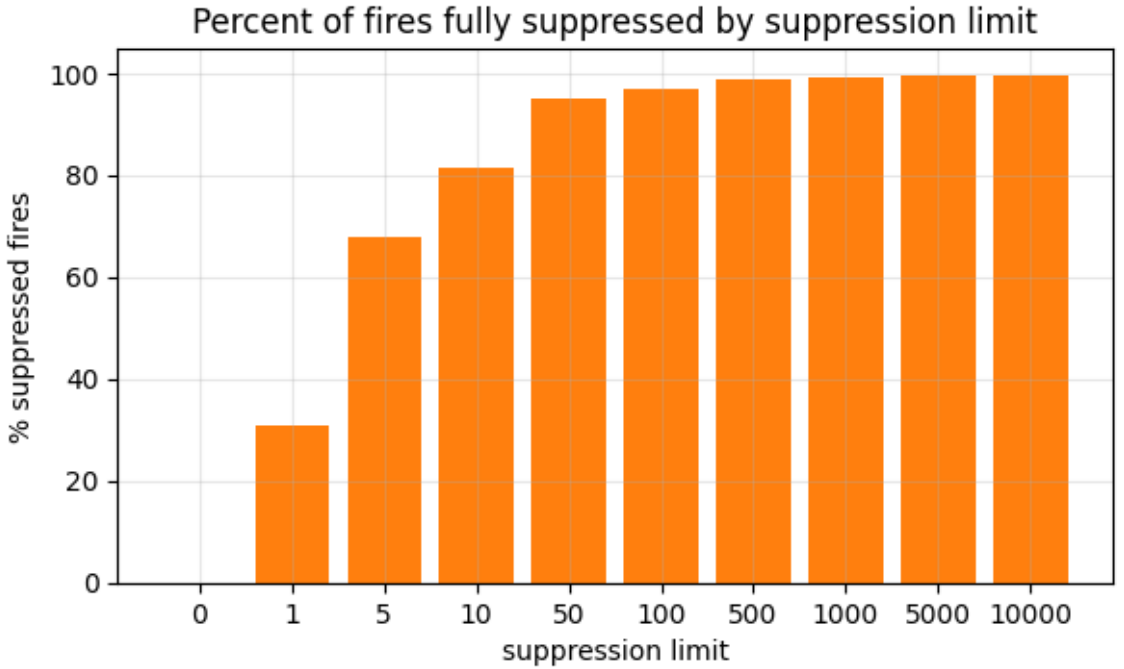

Cluster-size distribution (aggregated over steps)
f/p = 0.001
f/p = 0.01
f/p = 0.1
f/p = 1
Probability density
$10^{-1}$
$10^{-3}$
$10^{-5}$
$10^{-7}$
$10^{-9}$
$10^{1}$
$10^{2}$
$10^{3}$
$10^{4}$
Cluster size

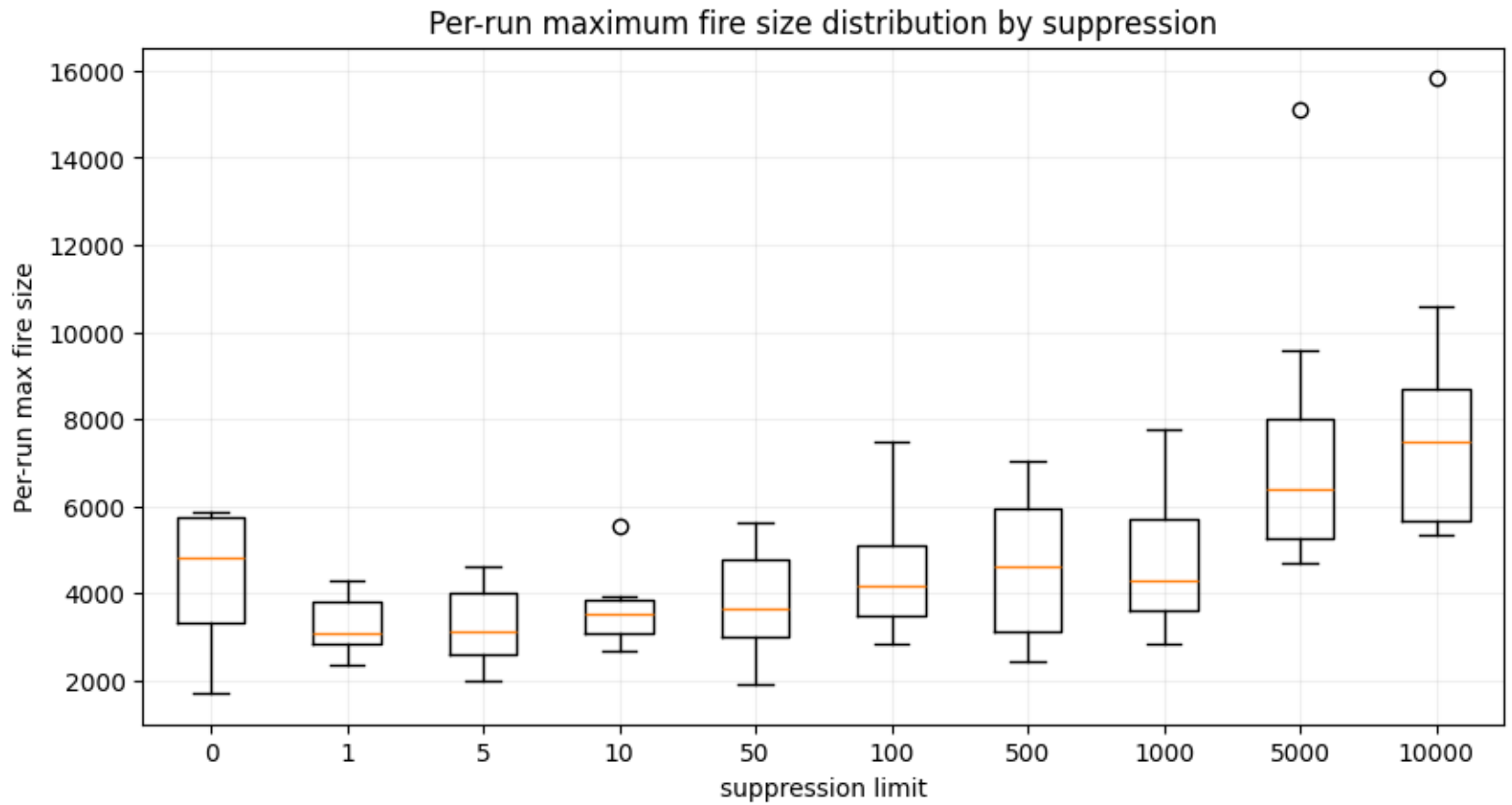

Cluster-size distributions aggregated by param_id
Probability density
Cluster size
param 1
param 2
param 3
param 4
param 5
param 6
$10^{0}$
$10^{-2}$
$10^{-4}$
$10^{-6}$
$10^{-8}$
$10^{0}$
$10^{1}$
$10^{2}$
$10^{3}$
$10^{4}$

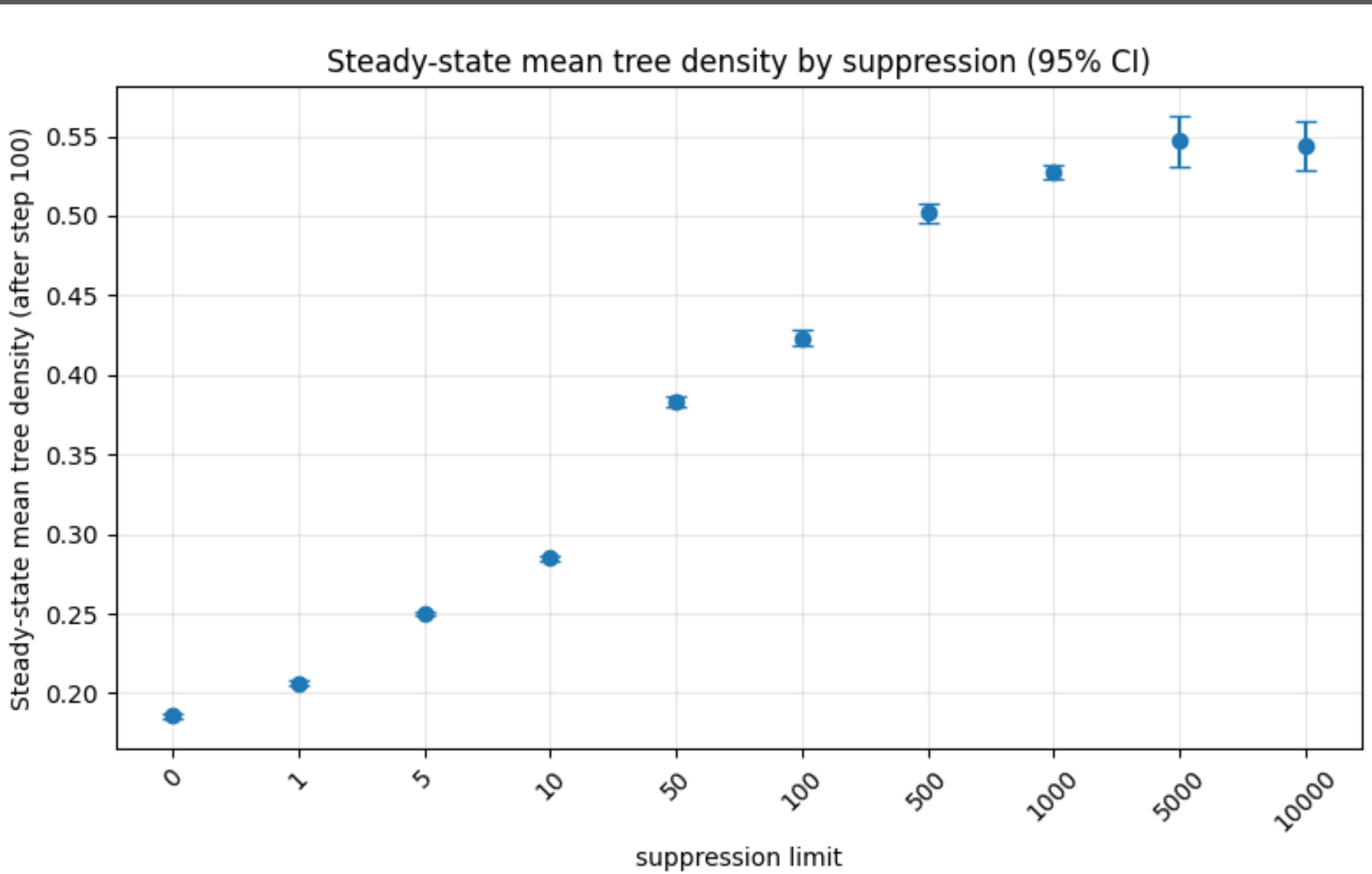
# Fire suppression


Log-log fire-size density by suppression limit
Probability density (log-log)
Fire size (fraction of grid area)
1.53e-05
1.53e-04
1.53e-03
1.53e-02
1.53e-01
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
$10^{-7}$
suppression lim =0
suppression lim =1
suppression lim =5
suppression lim =10
suppression lim =50
suppression lim =100
suppression lim =500
suppression lim =1000
suppression lim =5000
suppression lim =10000


Mean fire size by suppression (95% CI)
Mean fire size (zeros excluded)
2500
2000
1500
1000
500
0
0
1
5
10
50
100
500
1000
5000
10000
suppression limit


Percent of fires fully suppressed by suppression limit
% suppressed fires
100
80
60
40
20
0
0
1
5
10
50
100
500
1000
5000
10000
suppression limit


Per-run maximum fire size distribution by suppression
Per-run max fire size
16000
14000
12000
10000
8000
6000
4000
2000
0
1
5
10
50
100
500
1000
5000
10000
suppression limit

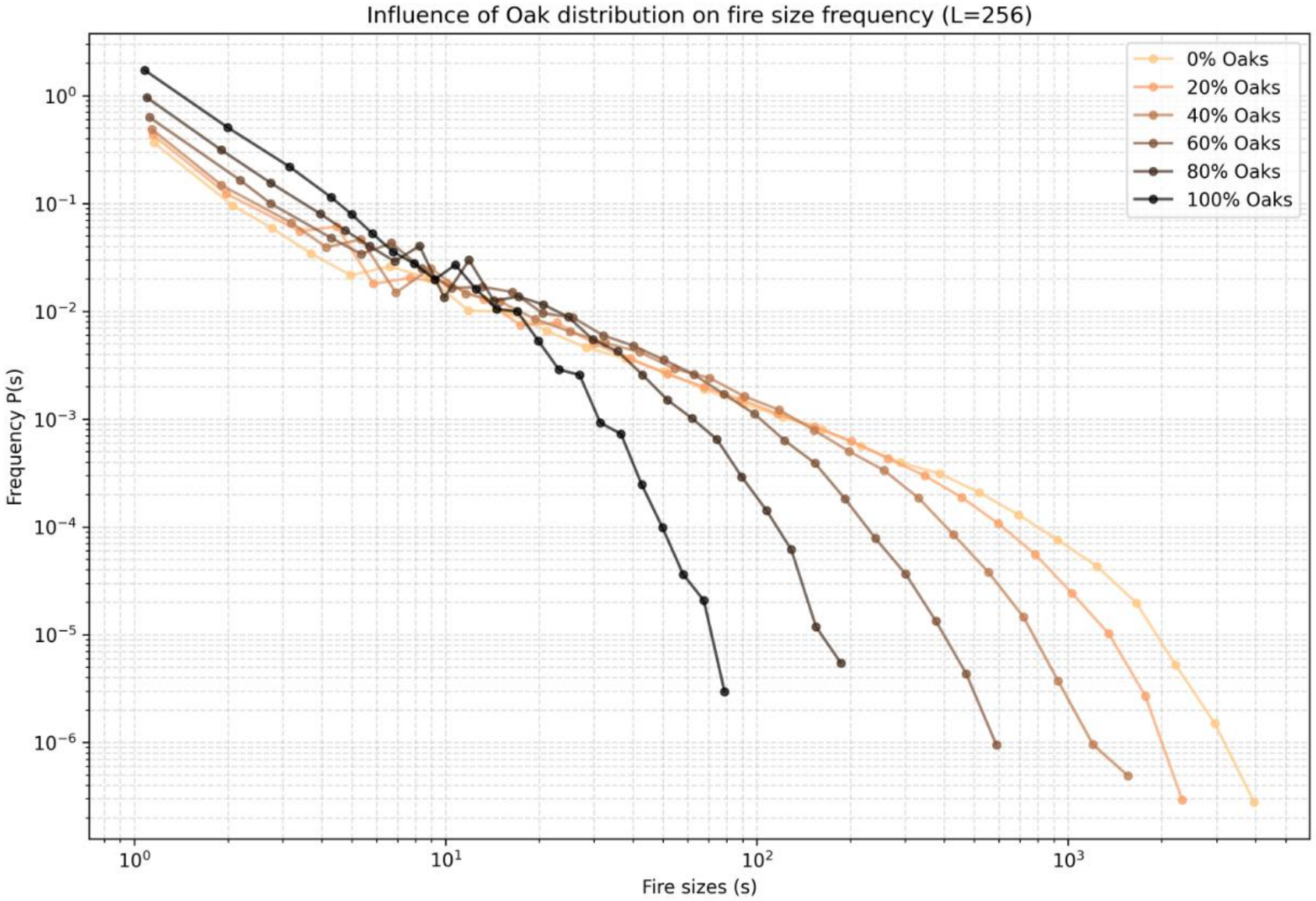

Steady-state mean tree density by suppression (95% CI)
Steady-state mean tree density (after step 100)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0
1
5
10
50
100
500
1000
5000
10000
suppression limit

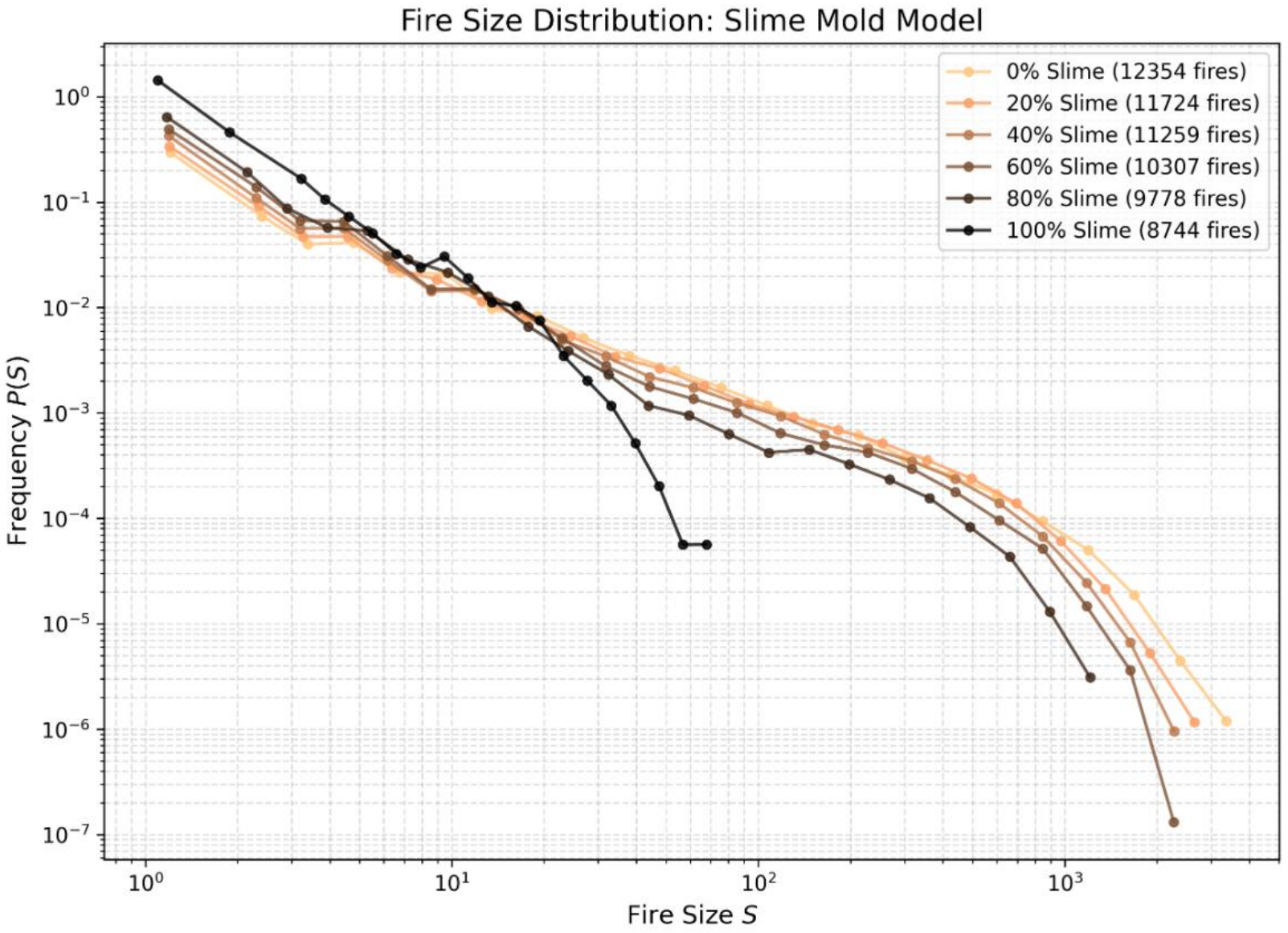
# Inhomogeneities

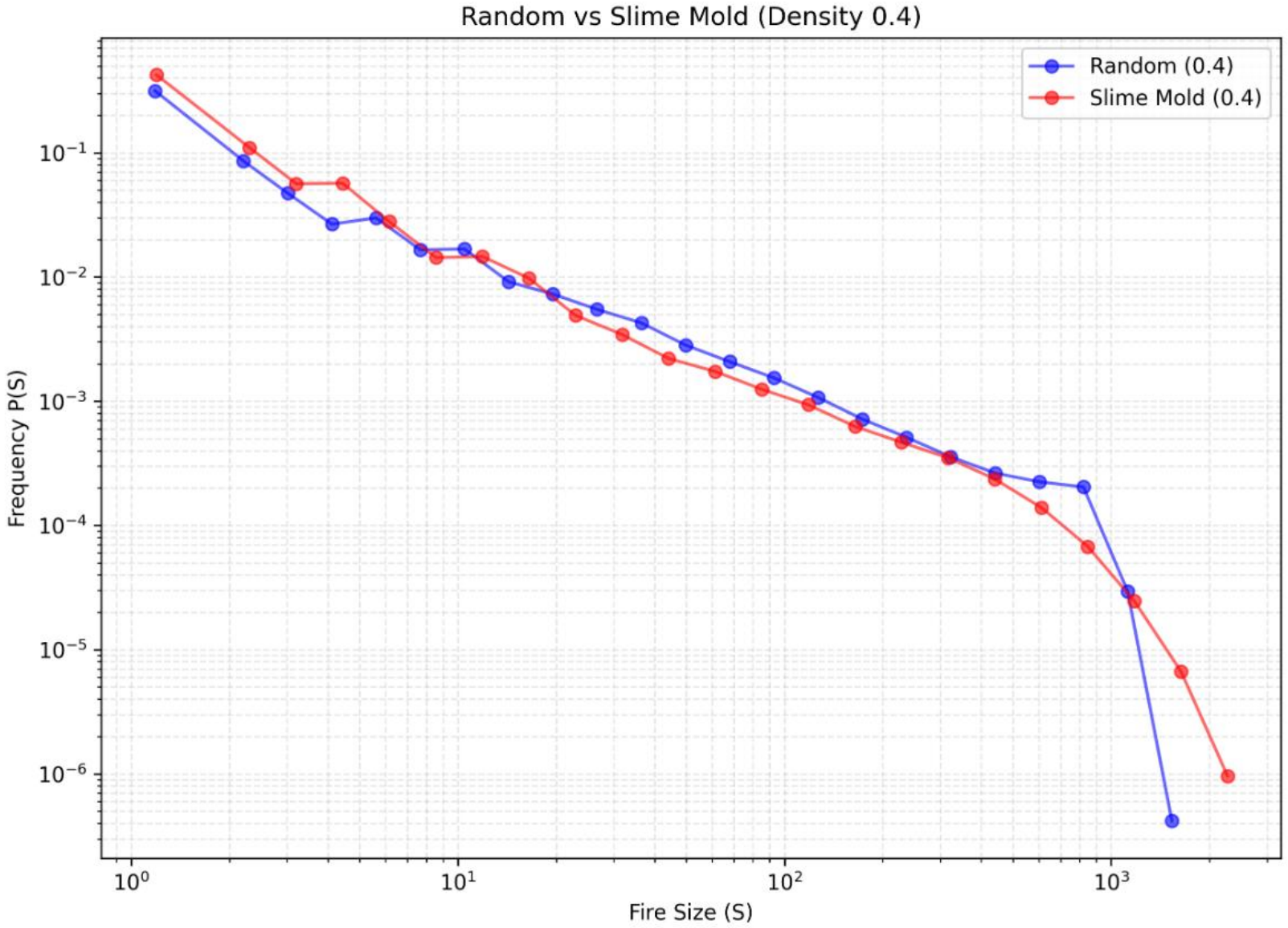
- Extending the model using different trees:
  - Oak trees (low probability of burning)
  - Pine trees (high probability of burning)

  TWO different distributions:
  - Random Distribution
  - 'Slime' Distribution (Agent-based model)

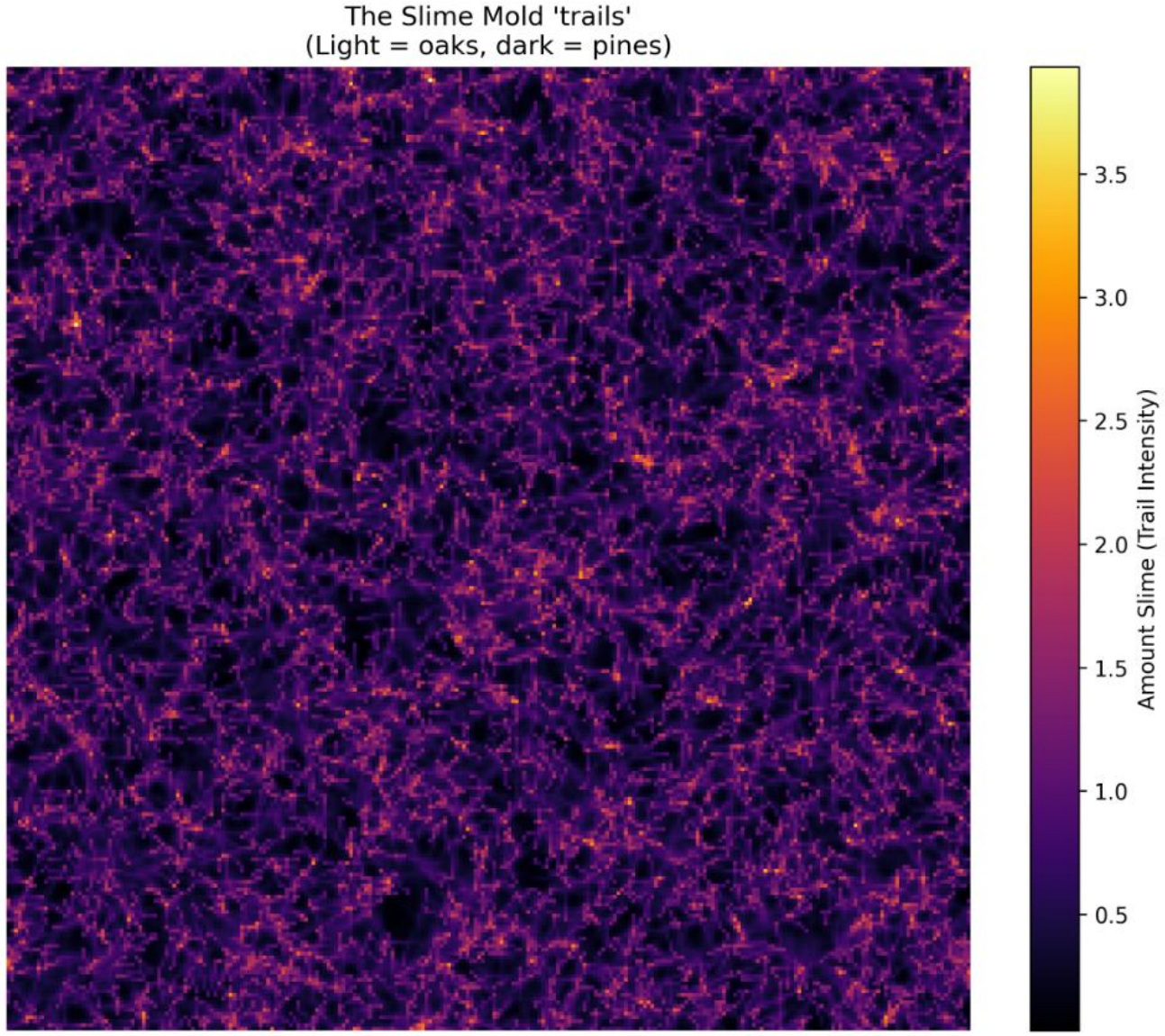
```
sensor_angle = np.pi / 2   # 45 DEGREES total vision
sensor_dist = 9.0          # How far do they look ahead?
turn_angle = np.pi / 2     # How much can they turn?
```


Influence of Oak distribution on fire size frequency (L=256)
0% Oaks
20% Oaks
40% Oaks
60% Oaks
80% Oaks
100% Oaks
Frequency P(s)
Fire sizes (s)
$10^{0}$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
$10^{0}$
$10^{1}$
$10^{2}$
$10^{3}$

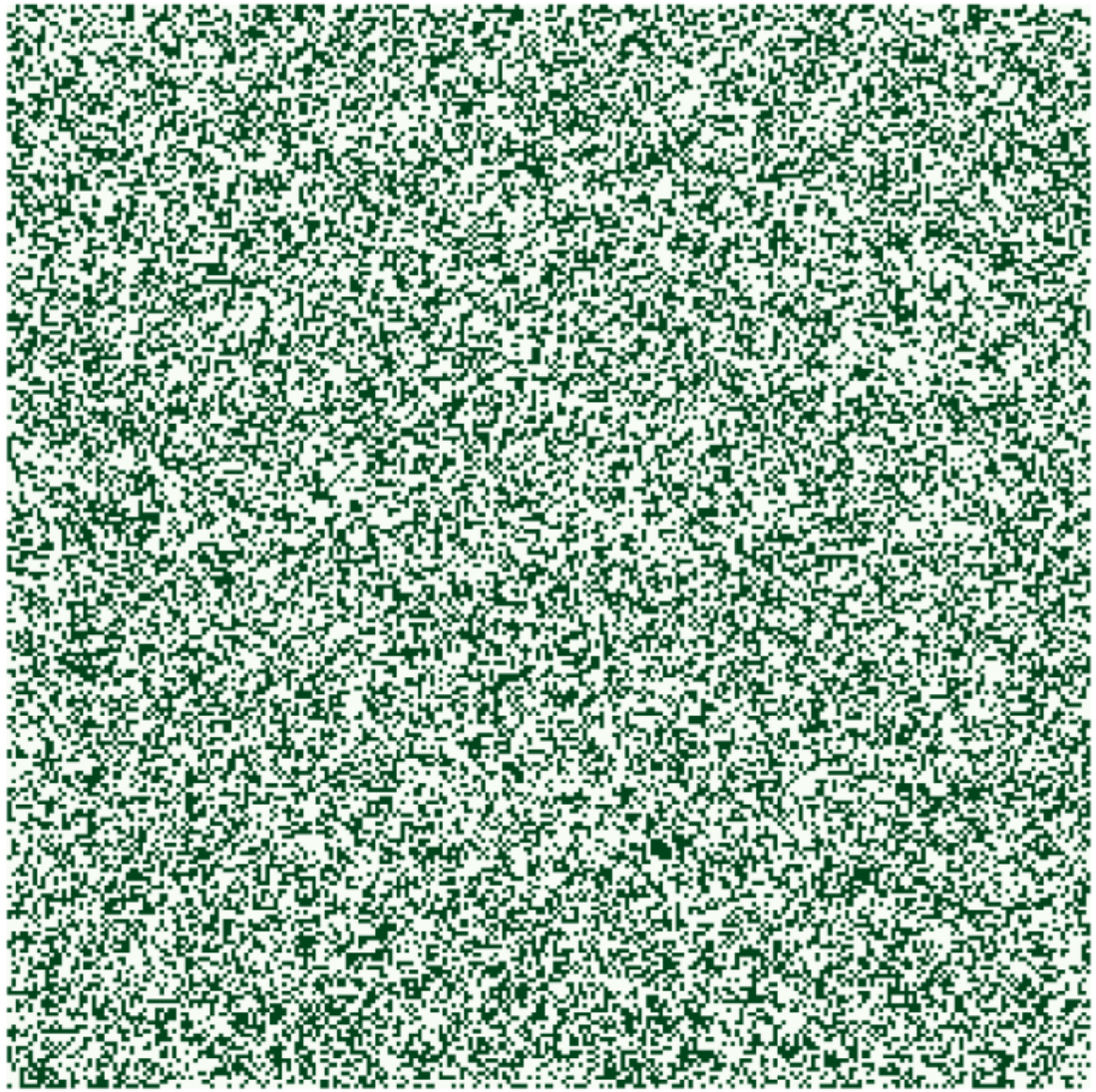
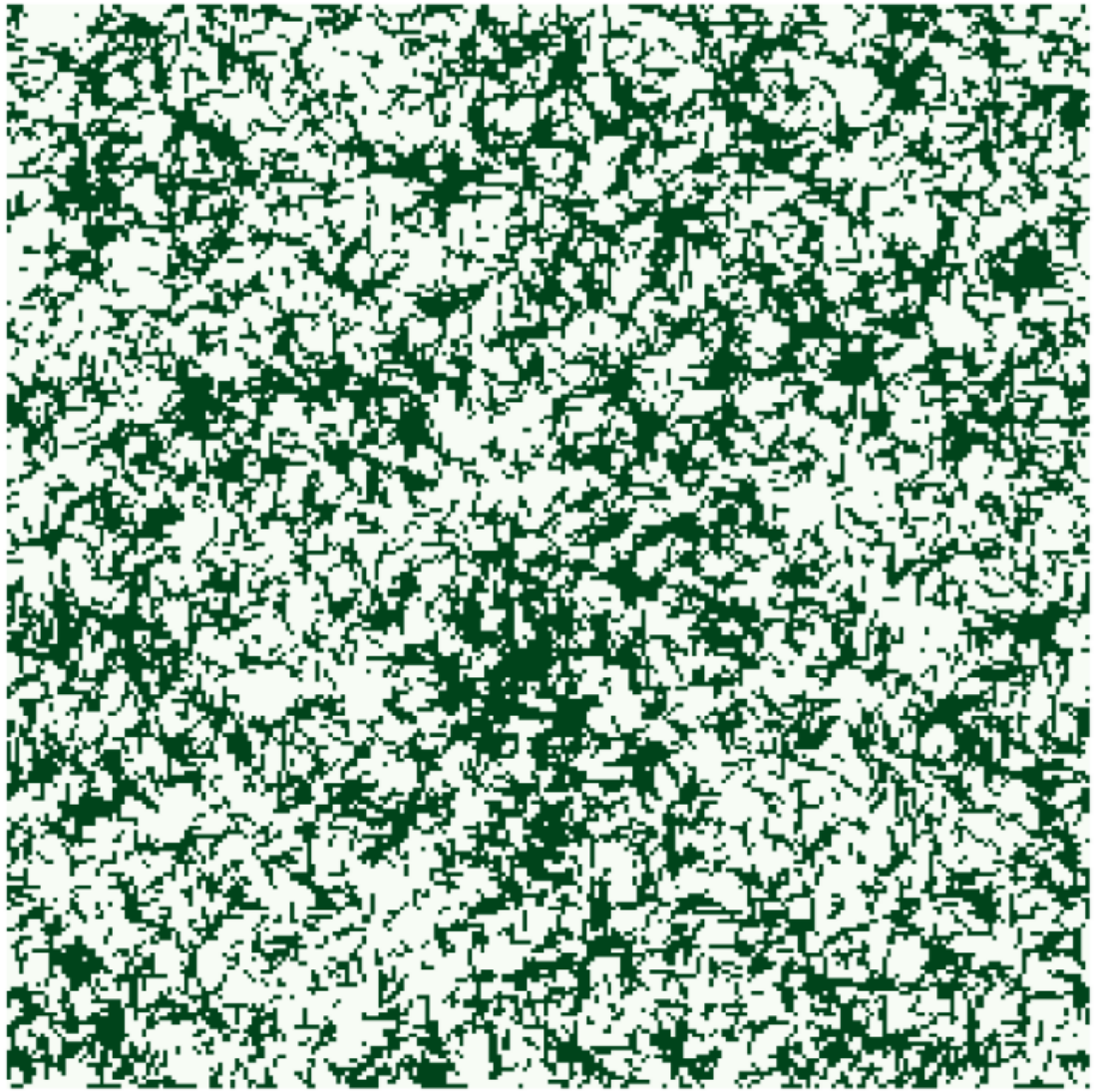
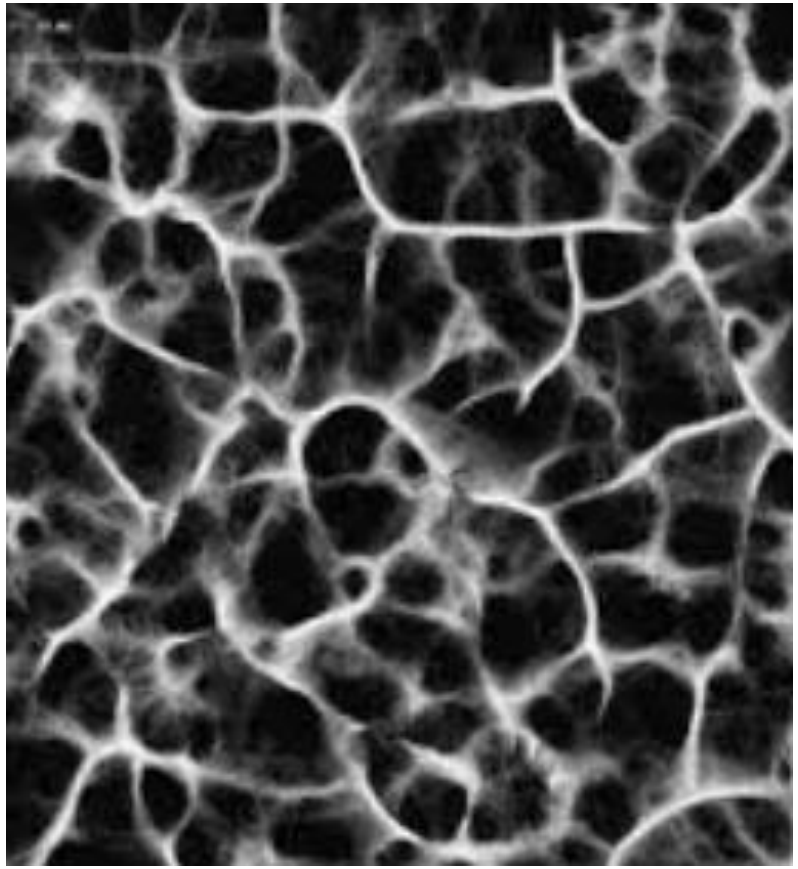

Fire Size Distribution: Slime Mold Model
0% Slime (12354 fires)
20% Slime (11724 fires)
40% Slime (11259 fires)
60% Slime (10307 fires)
80% Slime (9778 fires)
100% Slime (8744 fires)
Frequency P(S)
Fire Size S
10^0
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^0
10^1
10^2
10^3




**Kolmogorov-Smirnov** statistical test, which gave a **p-value** close to zero (`4.132893937811813e-122`)


The Slime Mold 'trails'
(Light = oaks, dark = pines)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
Amount Slime (Trail Intensity)

RANDOM Distribution (40%)
(Noise / Scattered)



SLIME MOLD Distribution (40%)
(Clustered / Network)