The Distribution of Sea Spray Spume Particles above Actively Breaking Wind-Waves in the Laboratory

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Oceanflux Green House Gas Project: Science Workshop
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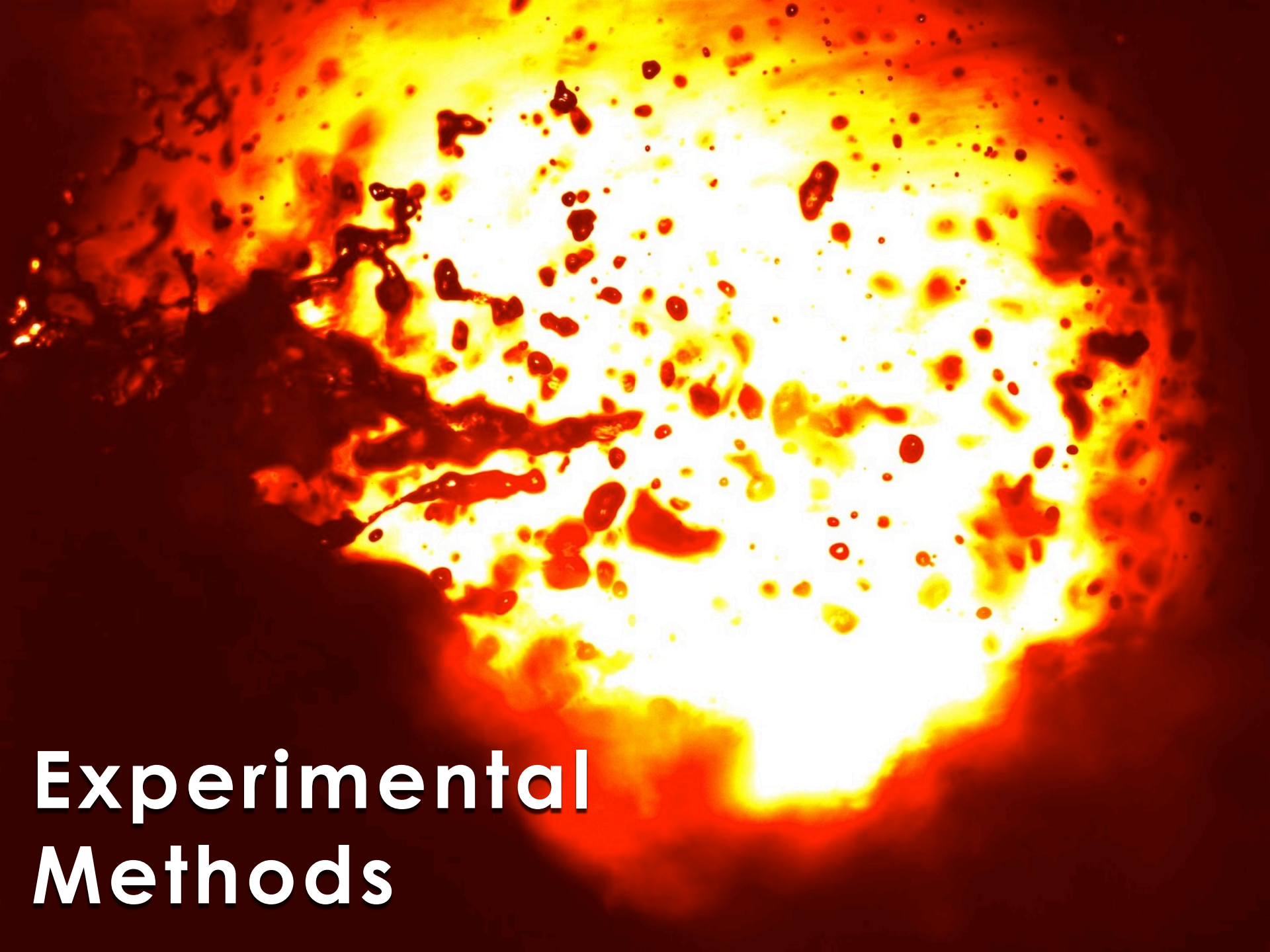
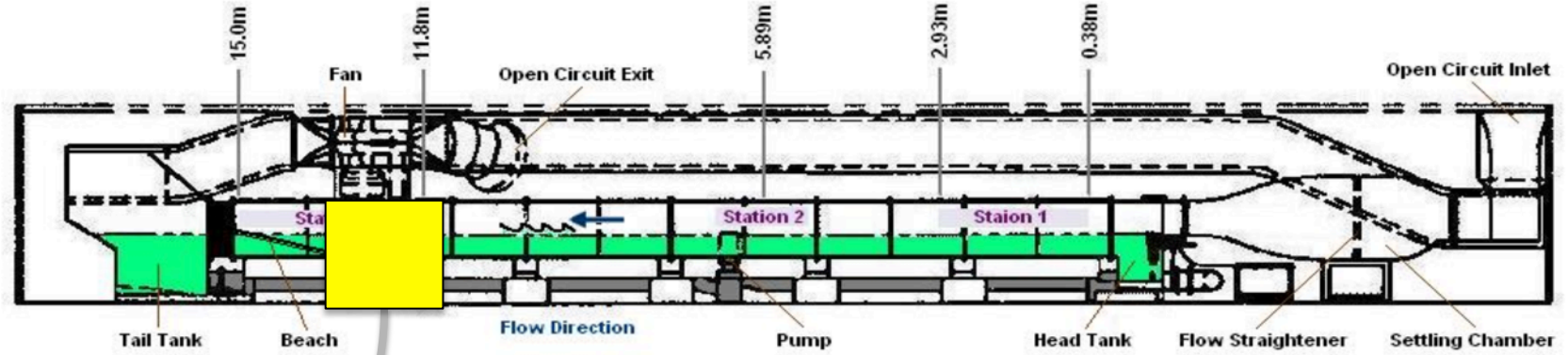
Brest | France


Experimental
Methods



DAQ

55 x 74 x 70 mm sample volume

→ ~42 µm / pixel

→ All external sampling

Data acquisition system:

- DynamicStudio (Dantec) → PIV acquisition system
- Laser + Camera + Acquisition timing control
- Shadow imaging system
- JAI CV-MSCL 1.9 MP, 30 fps

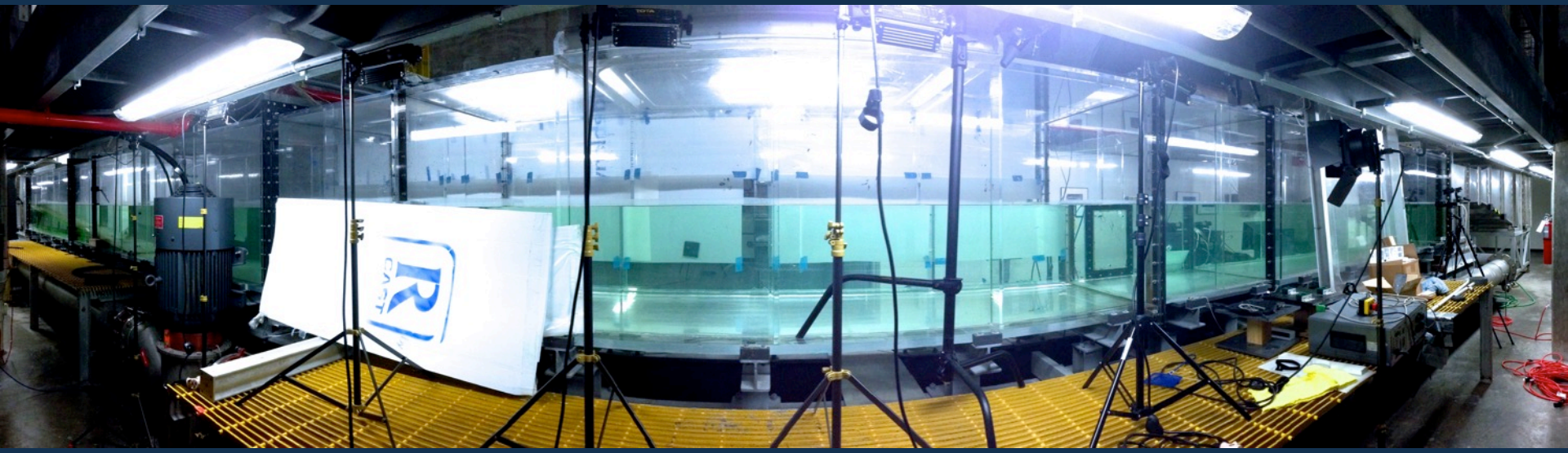
Air-Sea Interaction Salt water Tank (ASIST)

18 m x 1 m x 1 m test section

Wind waves

Mechanical Waves

Open channel current



145 mm

95 mm

60 – 180 mm

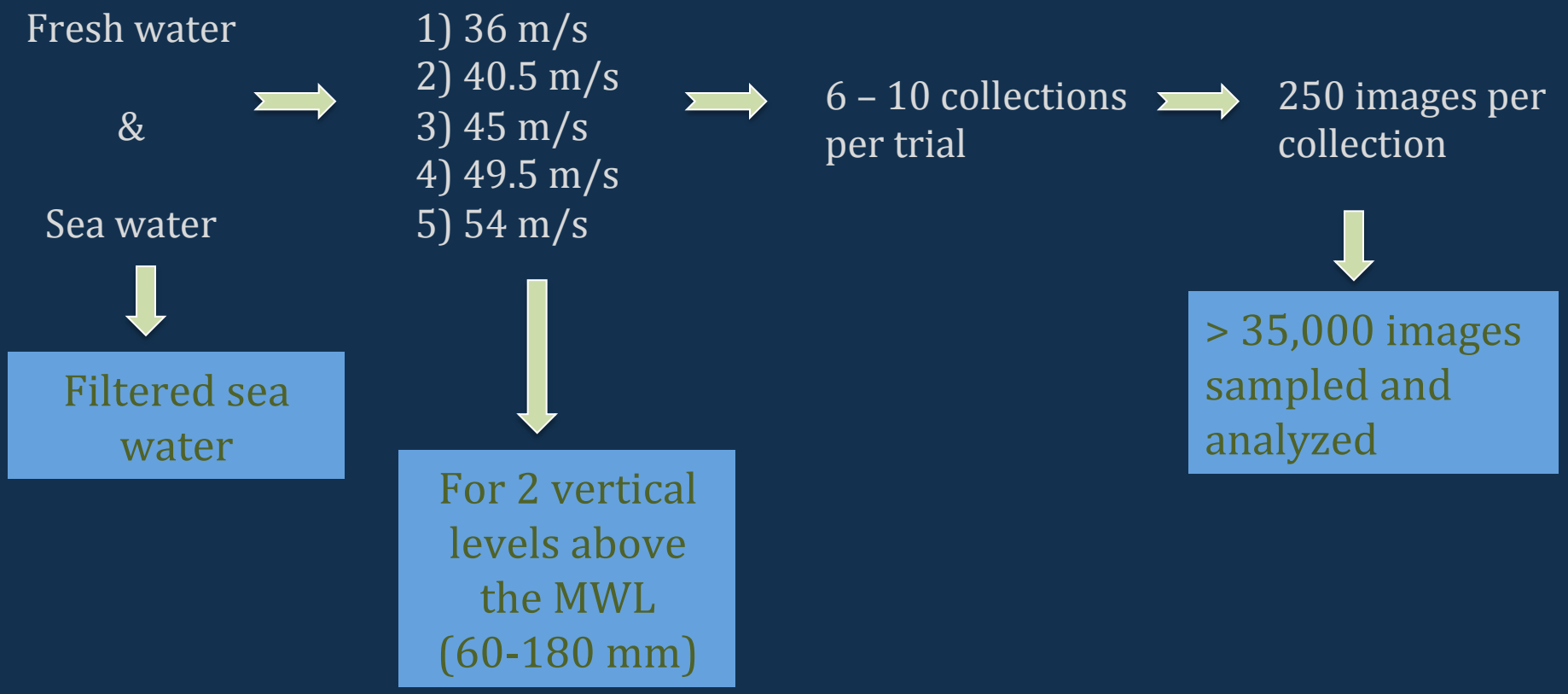
$> 5H_S$

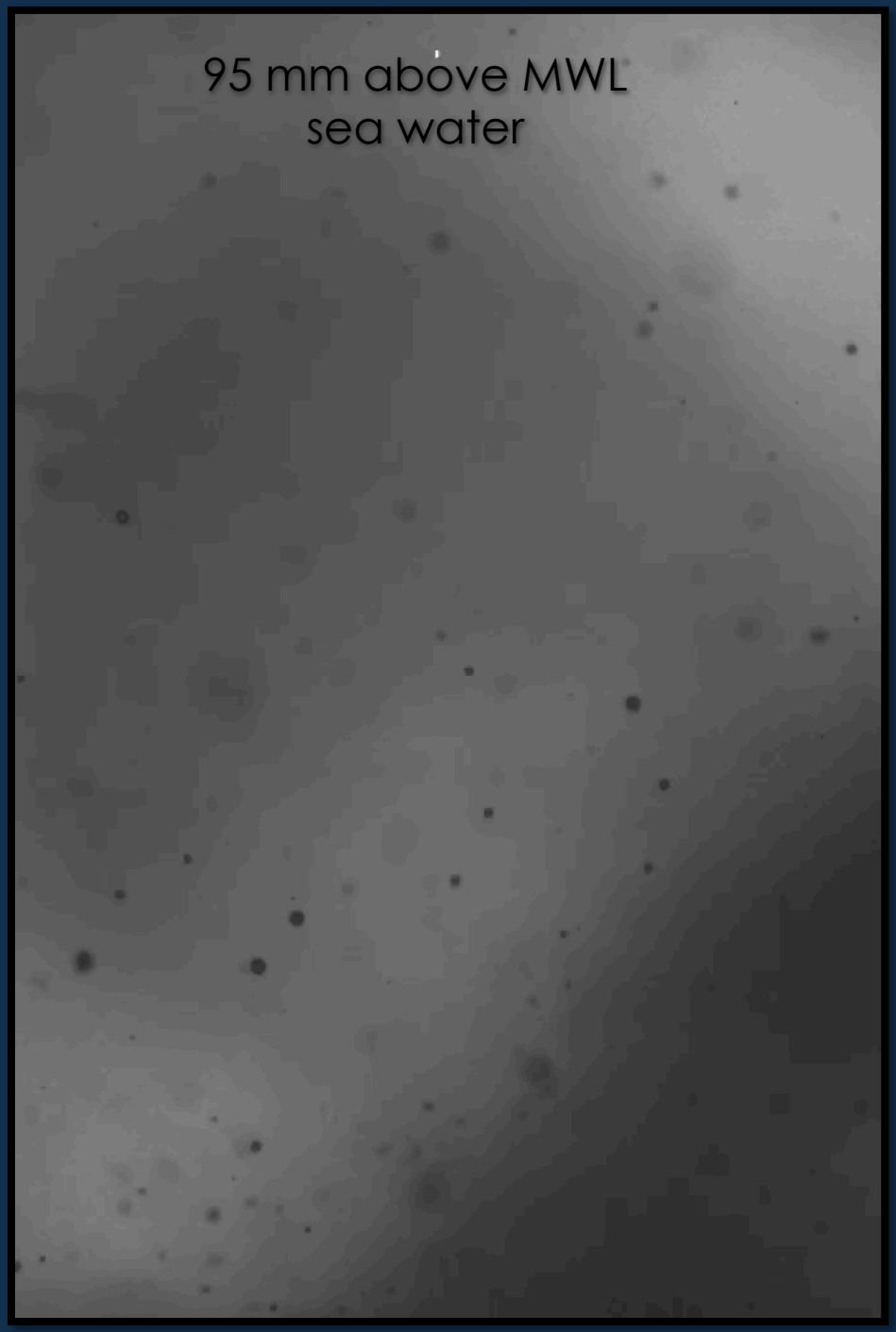
Water depth

420 mm

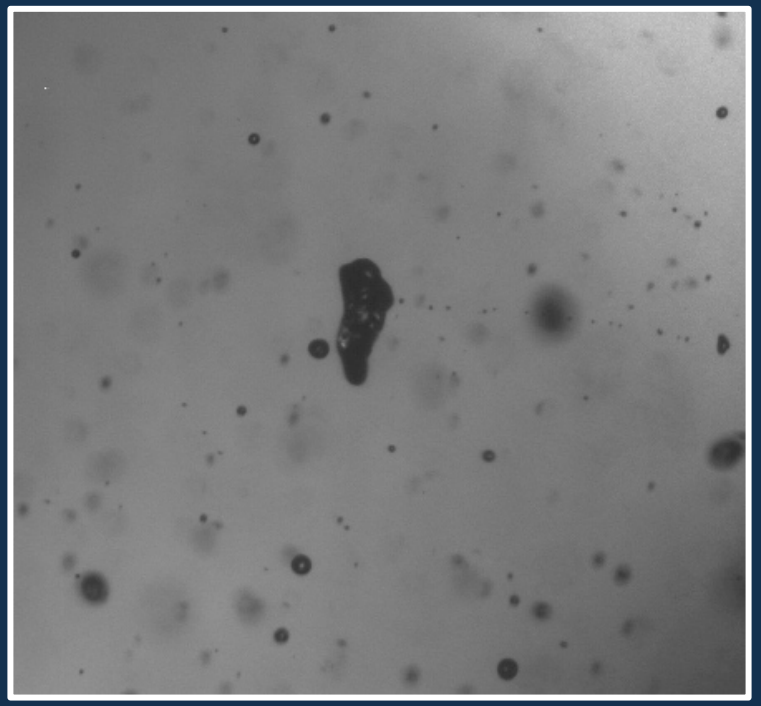
ASIST cross-section: 1 x 1 m

Sampling strategy



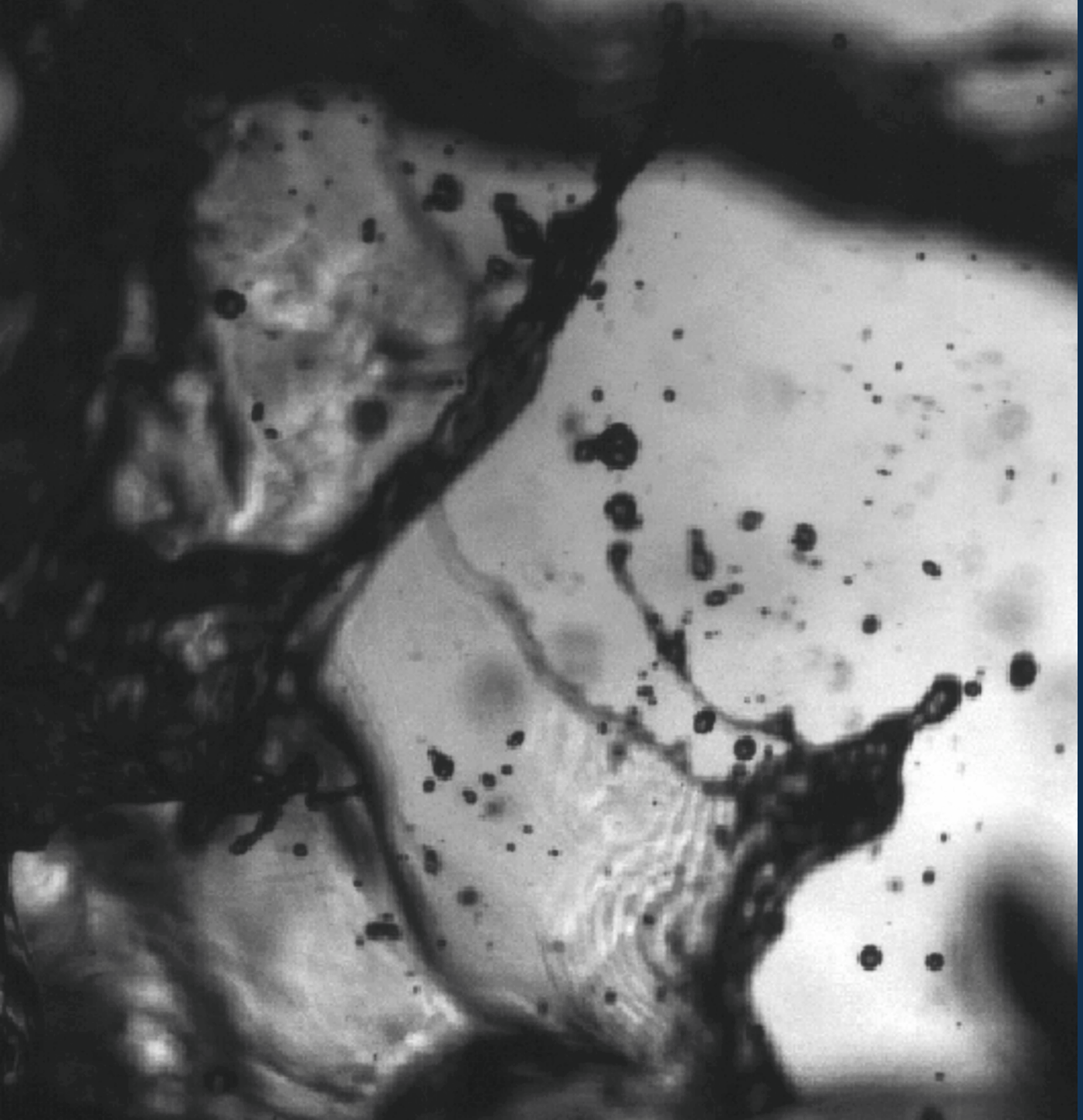

95 mm above MWL
sea water


1470 x 3066 µm



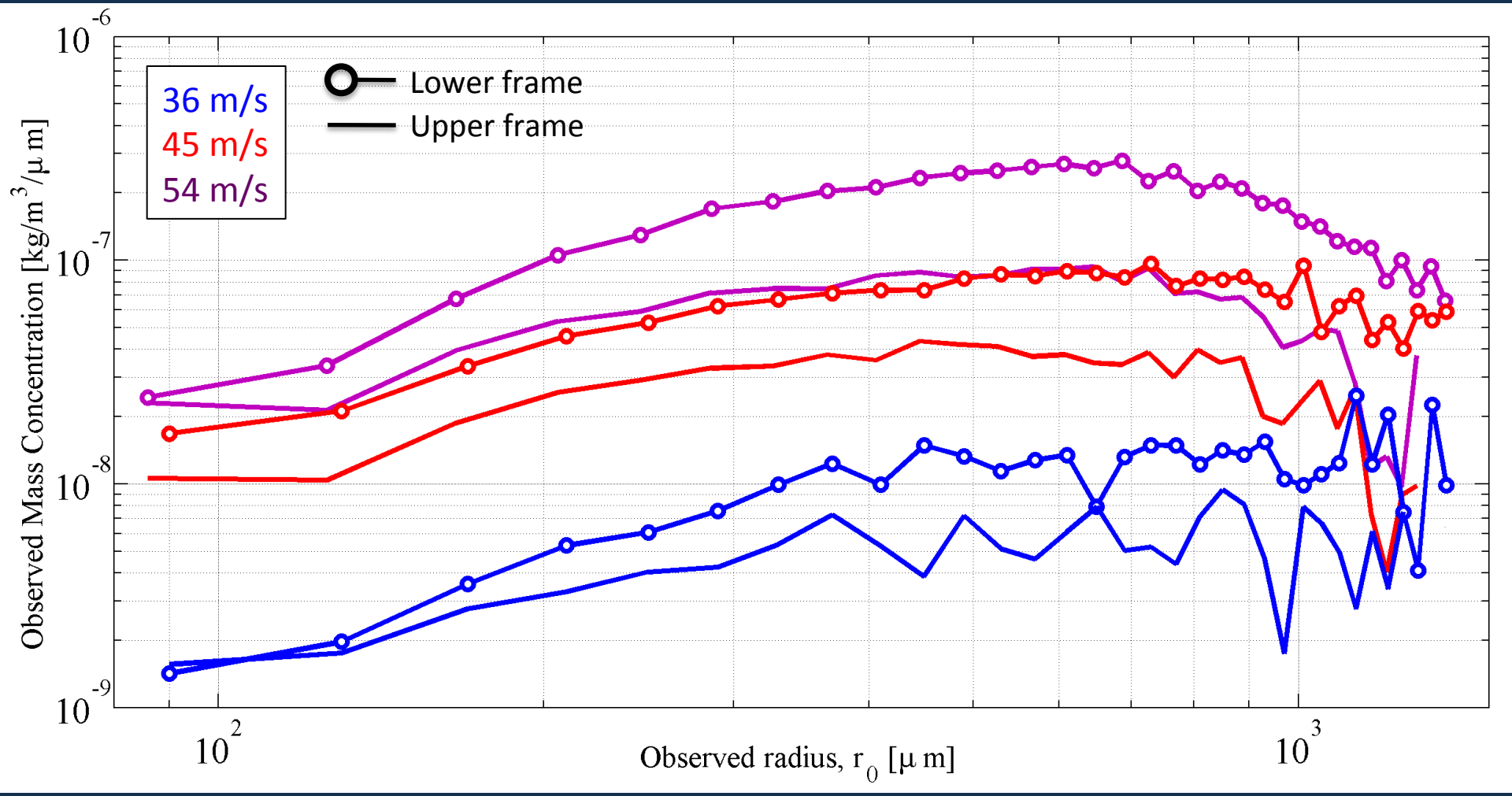
n ⟶ Number of discrete particles per unit air volume

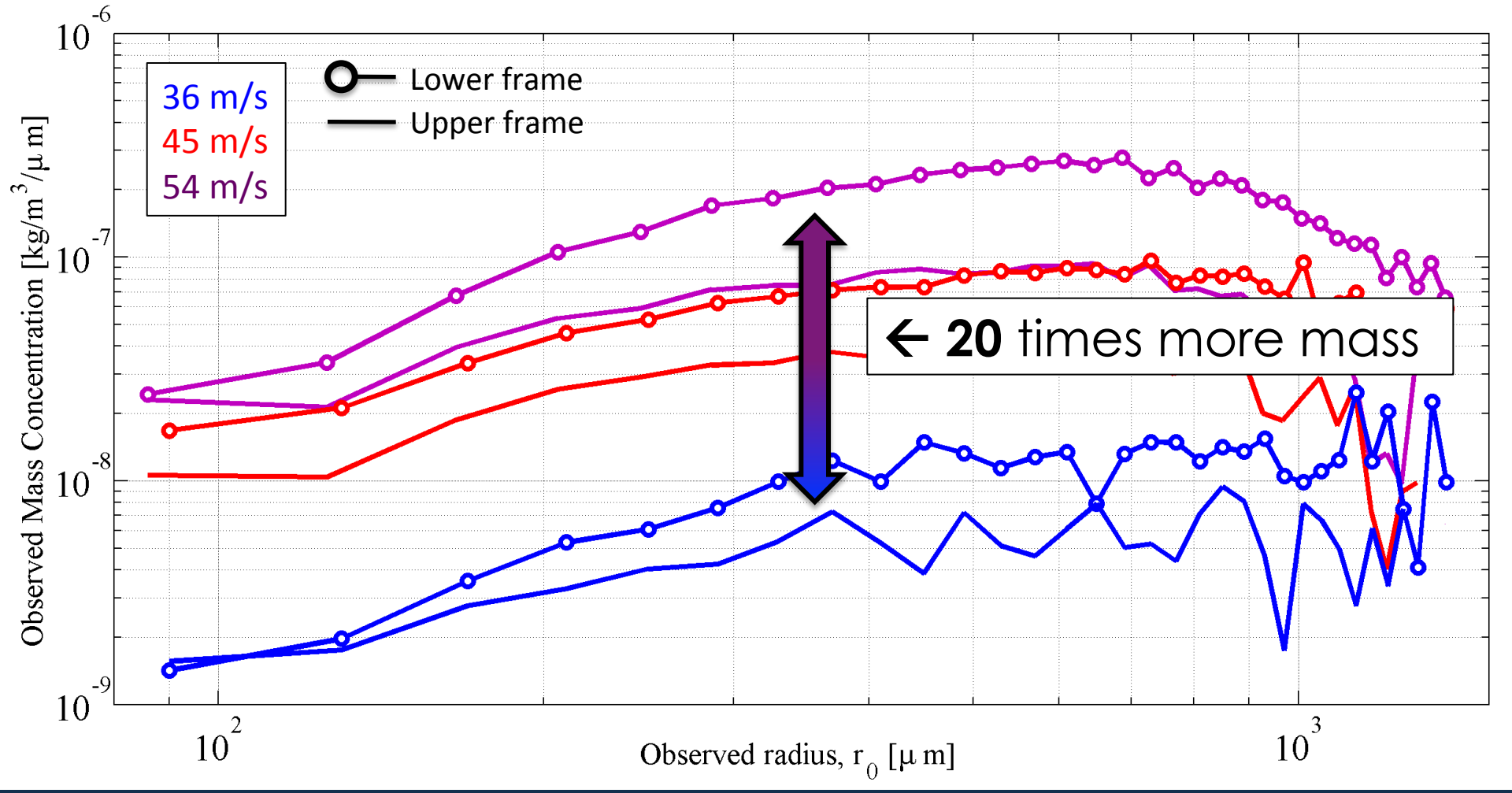
- Function of position, time, and droplet radius
- “Concentration function”

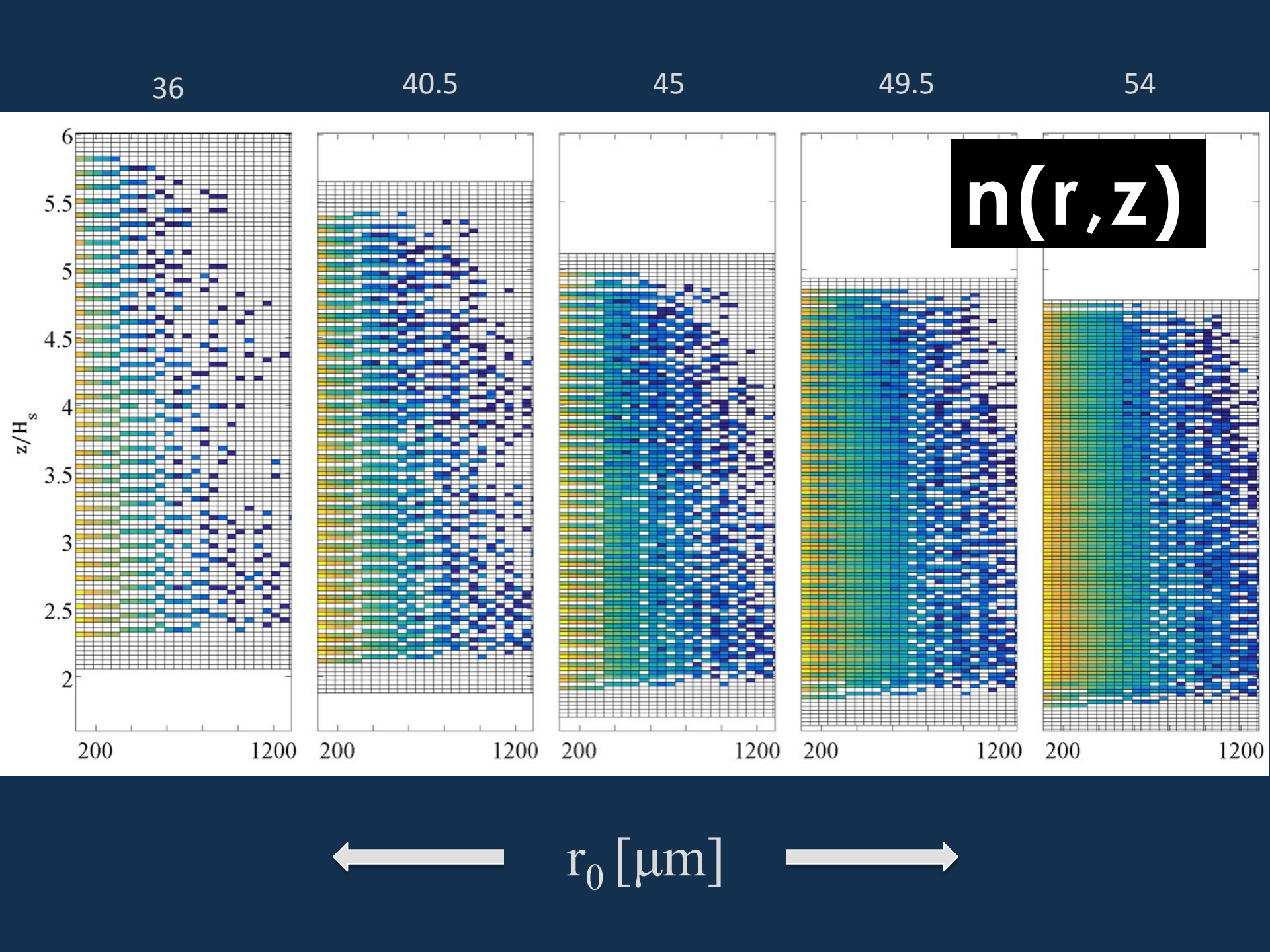


Results: n(r,z)

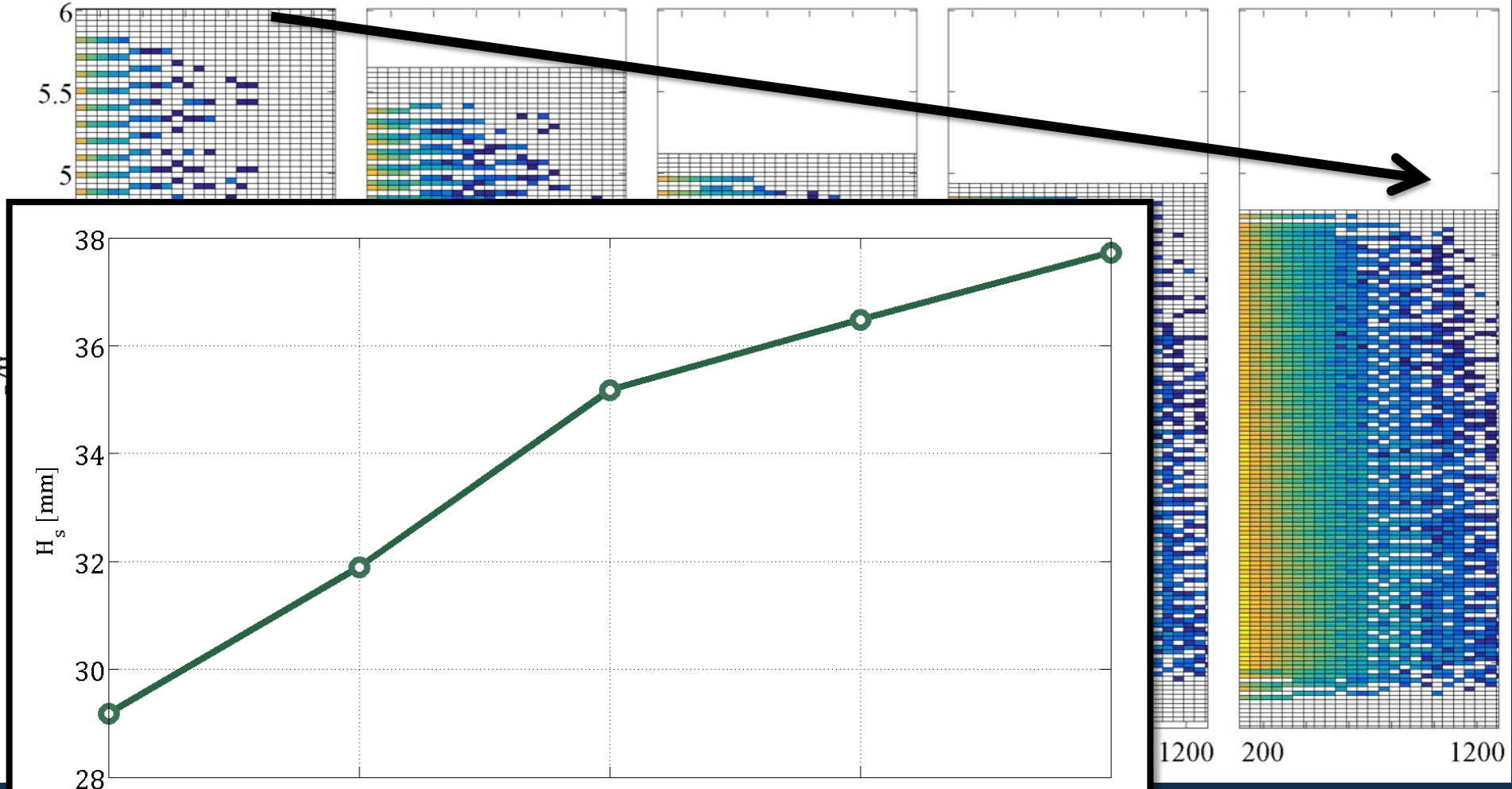
Ortiz-Suslow et al. 2016
JAS, *in press*


36 m/s
45 m/s
54 m/s
Lower frame
Upper frame
Observed Mass Concentration [kg/m3/μ m]
10-6
10-7
10-8
10-9
102
103
Observed radius, r0 [μ m]

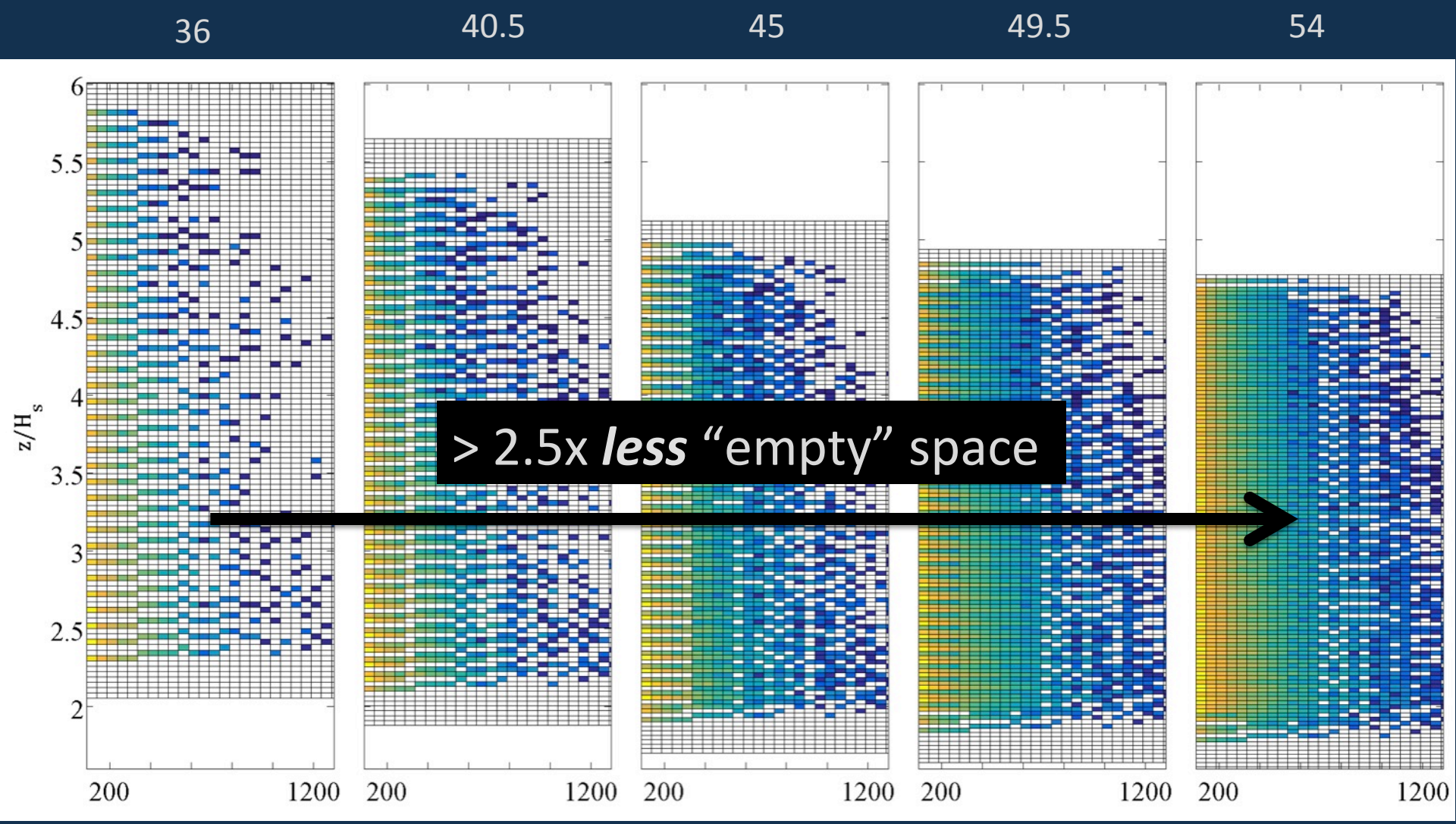

36 m/s
45 m/s
54 m/s
Lower frame
Upper frame
← 20 times more mass
Observed Mass Concentration [kg/m3/μ m]
Observed radius, r0 [μ m]
10-6
10-7
10-8
10-9
102
103

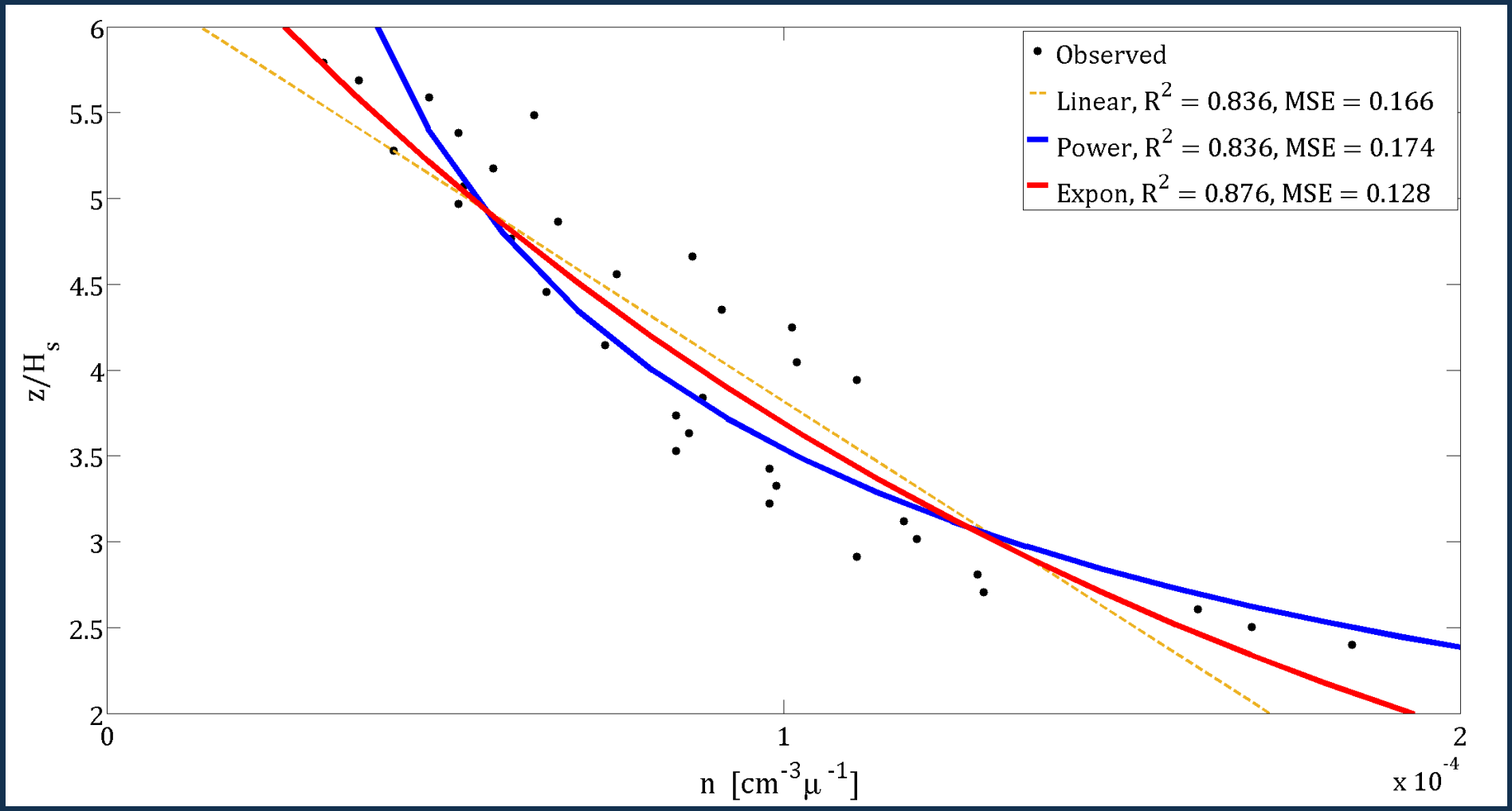

36
40.5
45
49.5
54
n(r,z)
z/H_s
6
5.5
5
4.5
4
3.5
3
2.5
2
200
1200
r_0 [μm]

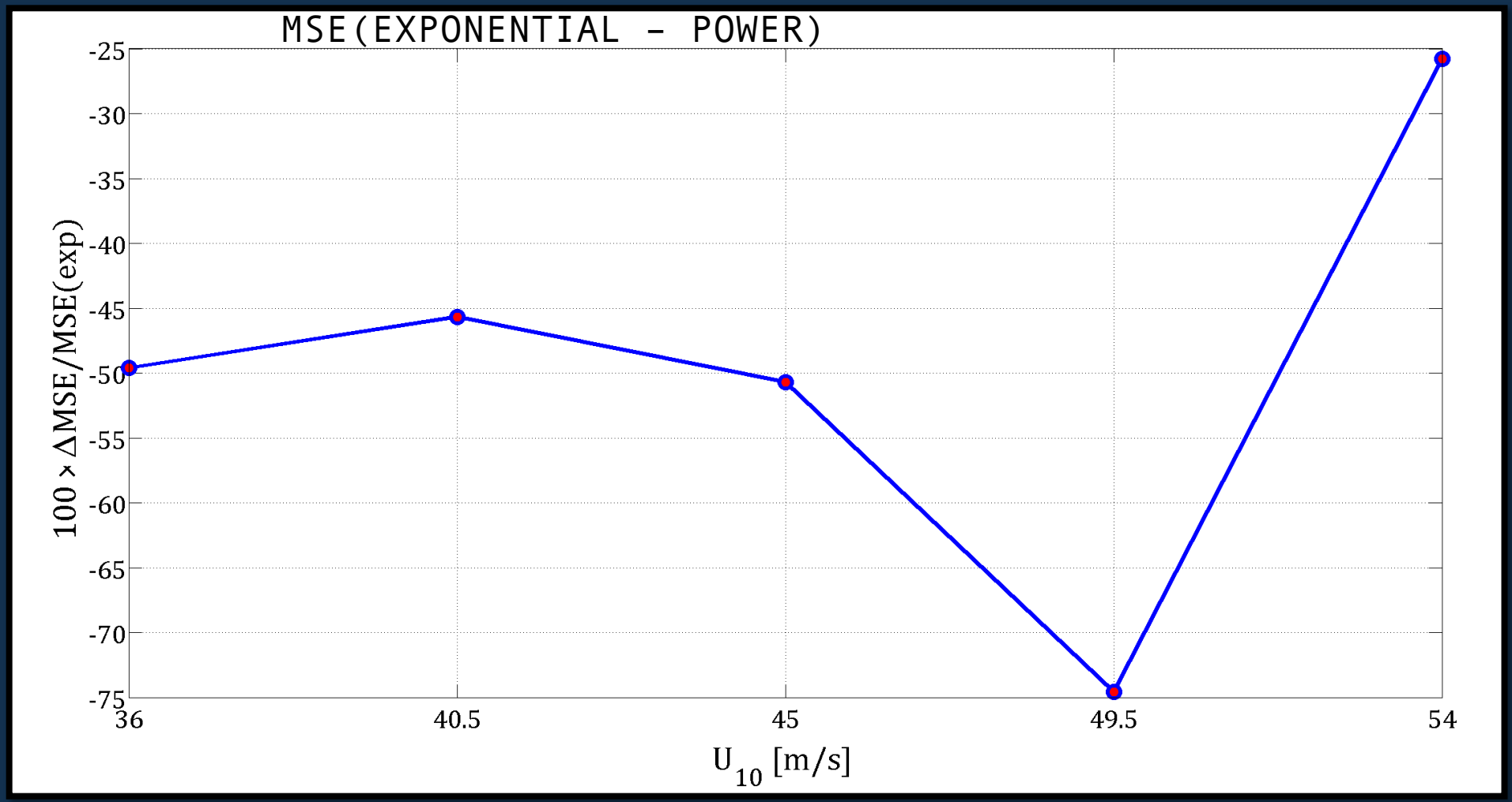
36 40.5 45 49.5 54



r_0 [μm]


36
40.5
45
49.5
54
z/H_s
6
5.5
5
4.5
4
3.5
3
2.5
2
200
1200
> 2.5x *less* "empty" space
r_0 [μm]


Observed
Linear, R2 = 0.836, MSE = 0.166
Power, R2 = 0.836, MSE = 0.174
Expon, R2 = 0.876, MSE = 0.128
z/Hs
n [cm-3μ-1]
x 10-4
6
5.5
5
4.5
4
3.5
3
2.5
2
0
1
2


MSE(EXPONENTIAL - POWER)
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
100 x ΔMSE/MSE(exp)
36
40.5
45
49.5
54
U10 [m/s]

$$n(\zeta, r) = n_{\zeta=1}\zeta^{-V_d/K_p}$$

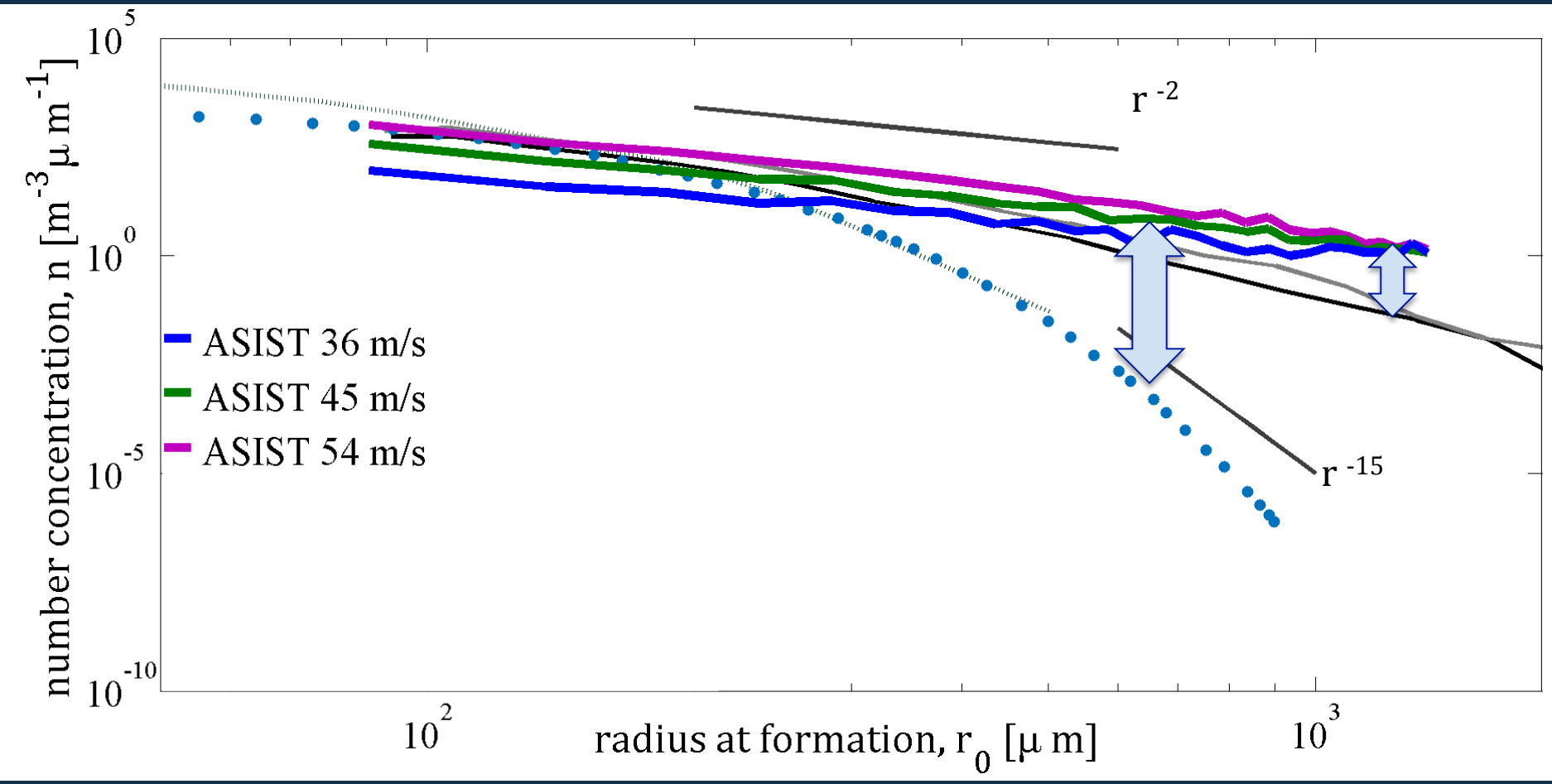
Fairall et al. 2009, Veron 2015

$$\zeta = z/H_s$$

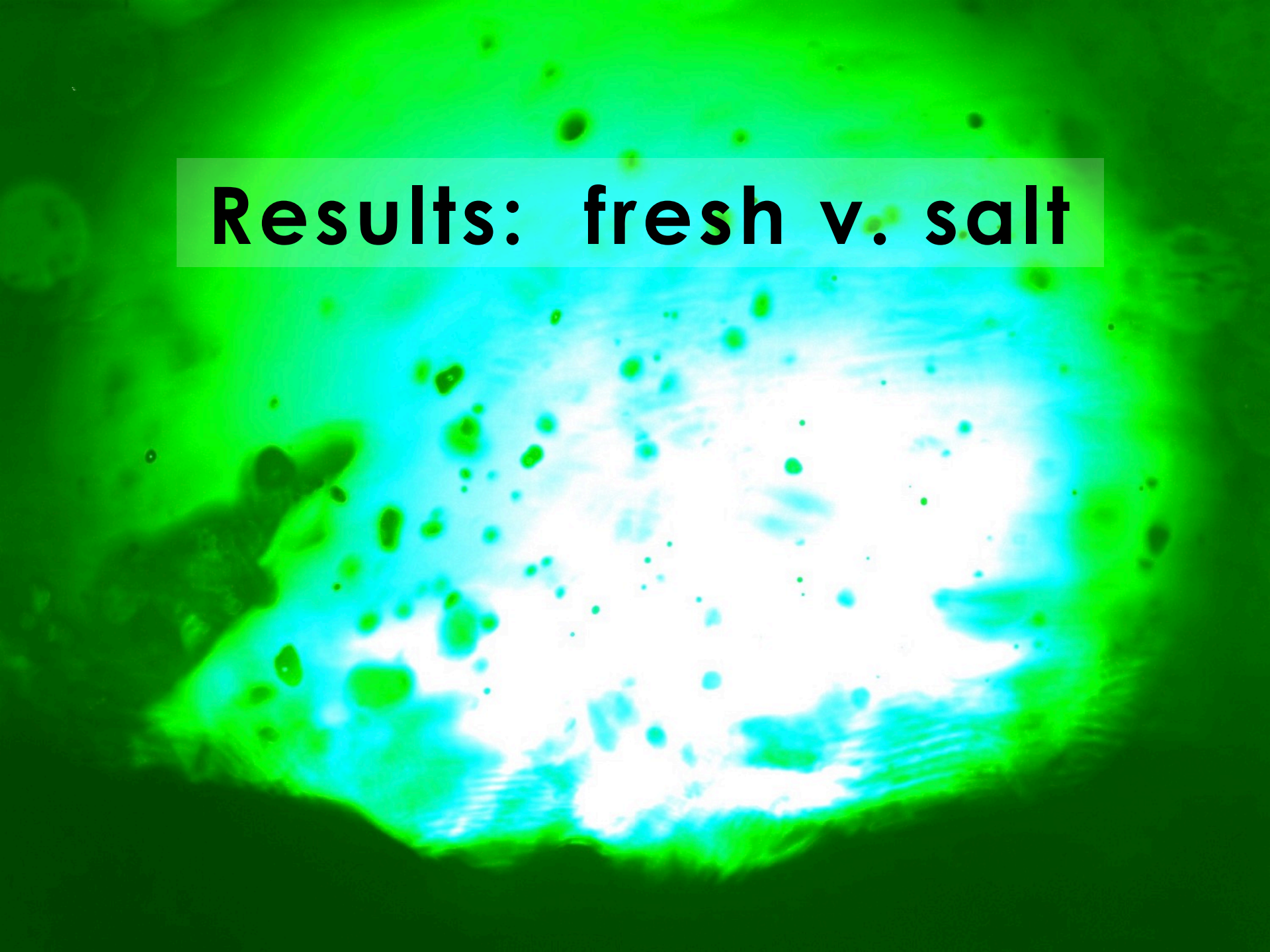
For a *particular radius* ***class*** the concentration **profile** is a *Power Law*

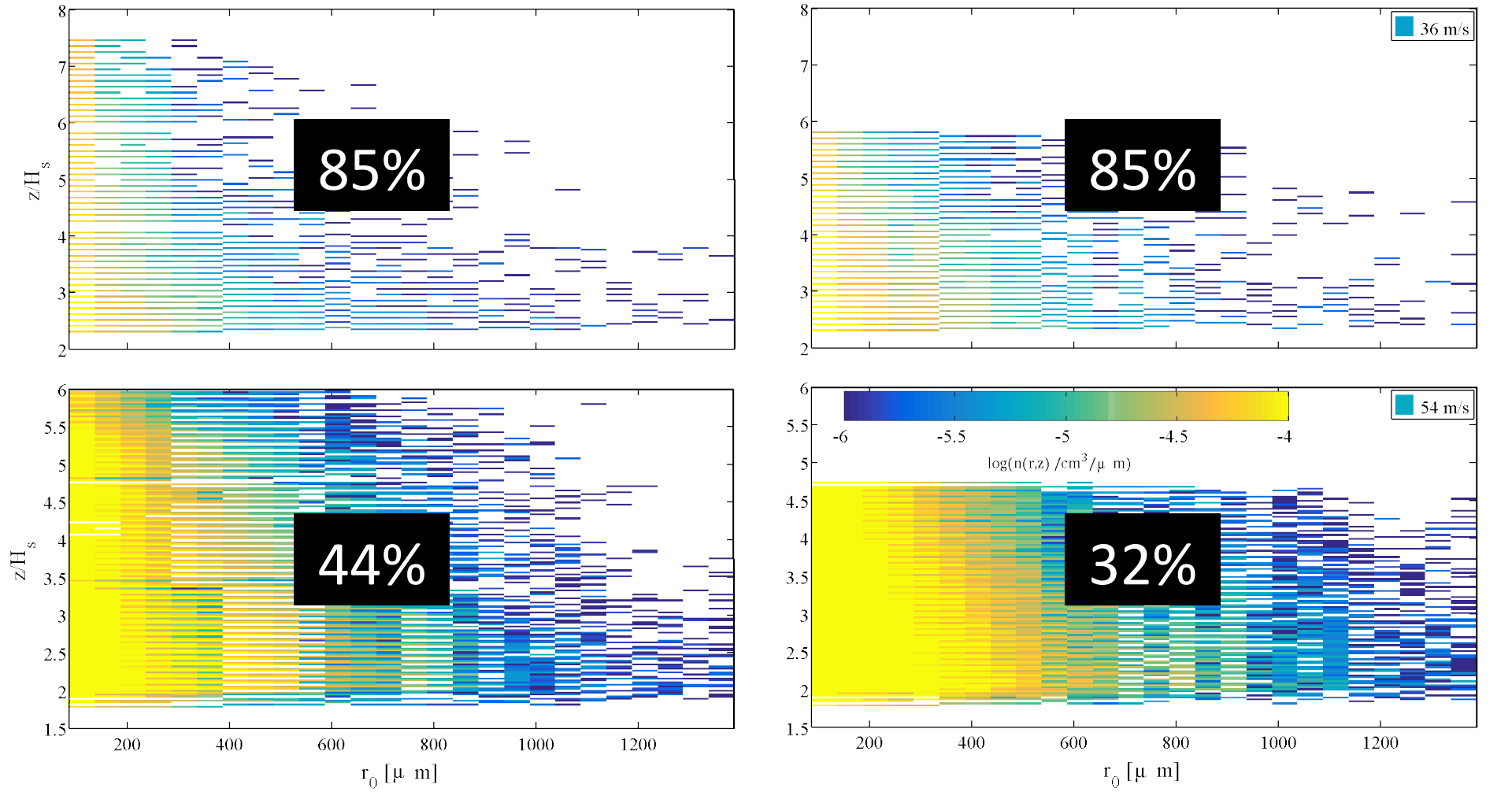
The results from the exponential profile suggest →

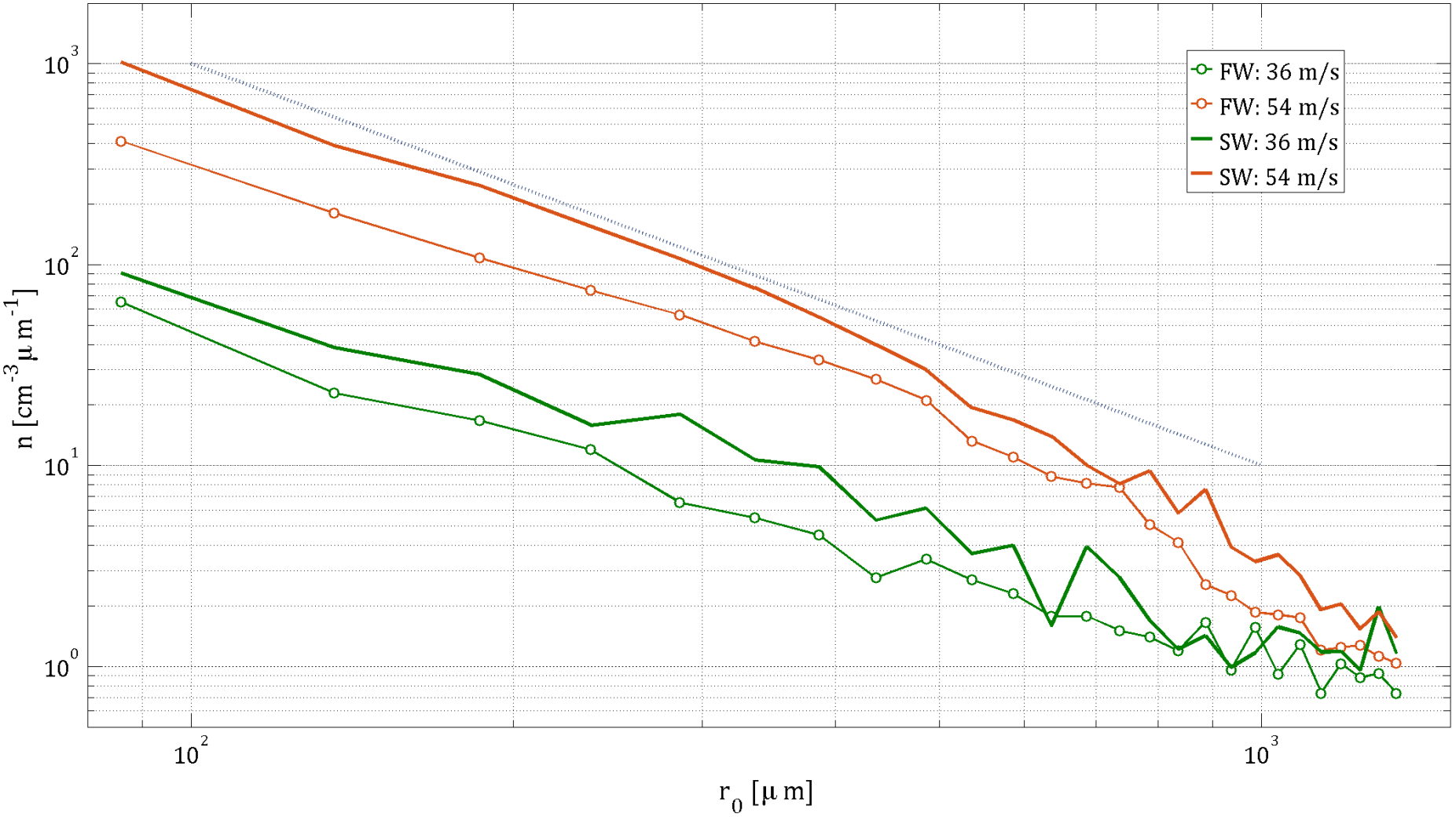
$$n(\zeta) \propto m\log(\zeta)$$

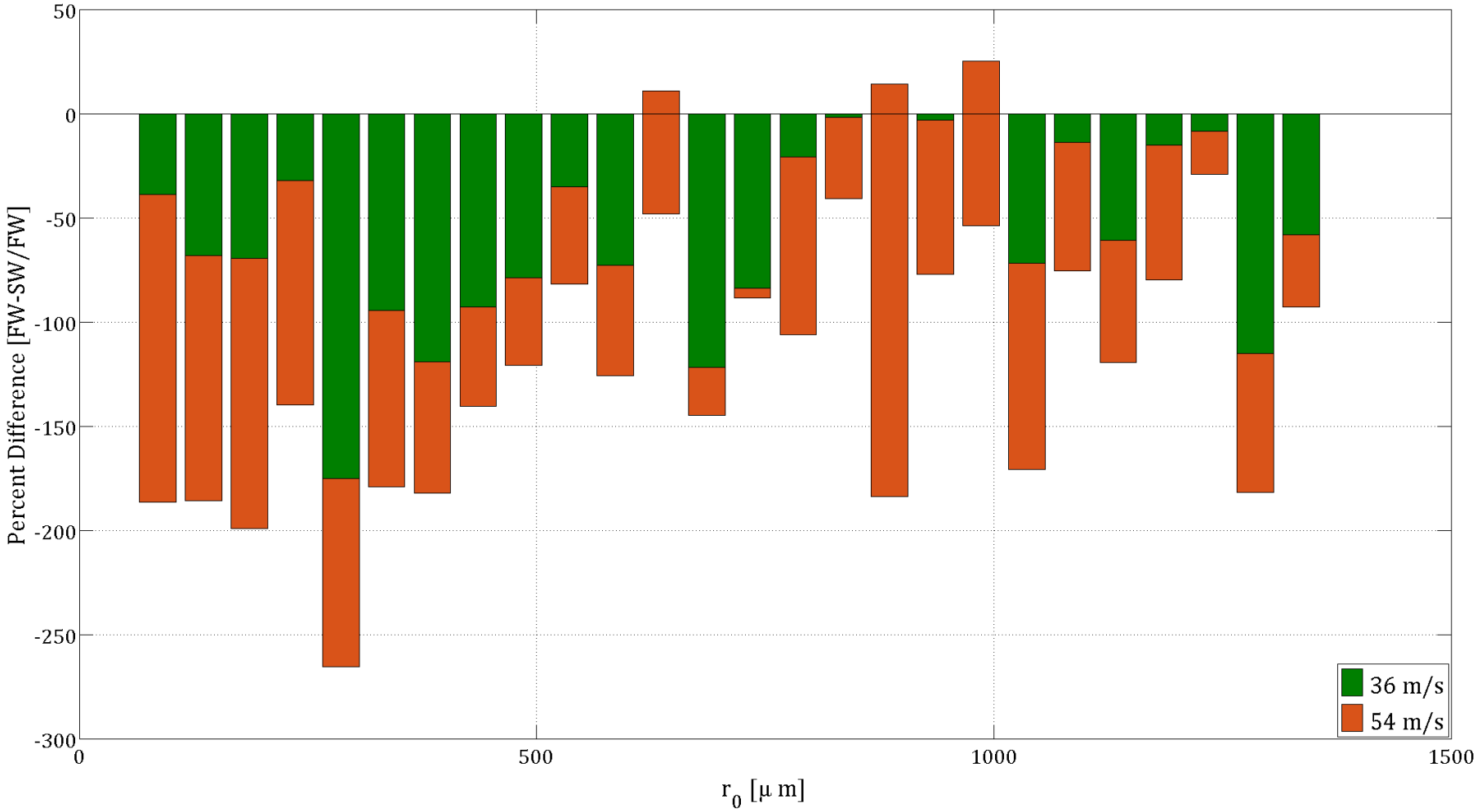

number concentration, n [m-3 μ m-1]
10^5
10^0
10^-5
10^-10
r -2
r -15
ASIST 36 m/s
ASIST 45 m/s
ASIST 54 m/s
10^2
radius at formation, r0 [μ m]
10^3

Results: fresh v. salt




85%
85%
44%
32%
36 m/s
54 m/s
-6
-5.5
-5
-4.5
-4
log(n(r,z) /cm^3/μ m)
z/H$_s$
r$_0$ [μ m]
200
400
600
800
1000
1200


FW: 36 m/s
FW: 54 m/s
SW: 36 m/s
SW: 54 m/s
10^3
10^2
10^1
10^0
n [cm^{-3} µ m^{-1}]
10^2
10^3
r$_0$ [µ m]


50
0
-50
-100
-150
-200
-250
-300
Percent Difference [FW-SW/FW]
0
500
1000
1500
r0 [μm]
36 m/s
54 m/s