

fitting_for_milke

October 10, 2020

```
[43]: #
import numpy as np
import numpy
import matplotlib.pyplot as pp
import matplotlib.pyplot as plt

from scipy.signal import argrelextrema
```

```
[236]: #GET DATA

import yfinance as yf

#define the ticker symbol
tickerSymbol = 'AAPL'

#get data on this ticker
tickerData = yf.Ticker(tickerSymbol)

#get the historical prices for this ticker
tickerDf = tickerData.history(period='1d', start='2010-1-1', end='2019-1-25')

#see your data
tickerDf
```

```
[236]:
```

	Open	High	Low	Close	Volume	Dividends	\
Date							
2009-12-31	6.577644	6.584433	6.498328	6.503574	352410800	0.0	
2010-01-04	6.586901	6.619924	6.554496	6.604801	493729600	0.0	
2010-01-05	6.623009	6.653562	6.581345	6.616219	601904800	0.0	
2010-01-06	6.616220	6.642453	6.504191	6.510980	552160000	0.0	
2010-01-07	6.535053	6.542769	6.451726	6.498945	477131200	0.0	
...	
2019-01-17	37.719138	38.565497	37.489202	38.125195	119284800	0.0	
2019-01-18	38.526358	38.619311	38.154547	38.360023	135004000	0.0	
2019-01-22	38.259732	38.338006	37.332651	37.498989	121576000	0.0	
2019-01-23	37.706910	37.949077	37.107611	37.650650	92522400	0.0	
2019-01-24	37.697122	37.787627	37.117393	37.352219	101766000	0.0	

Date	Stock Splits
2009-12-31	0.0
2010-01-04	0.0
2010-01-05	0.0
2010-01-06	0.0
2010-01-07	0.0
...	...
2019-01-17	0.0
2019-01-18	0.0
2019-01-22	0.0
2019-01-23	0.0
2019-01-24	0.0

[2281 rows x 7 columns]

```
[237]: plt.plot(tickerDf['Open'])
x = tickerDf['Open']
```



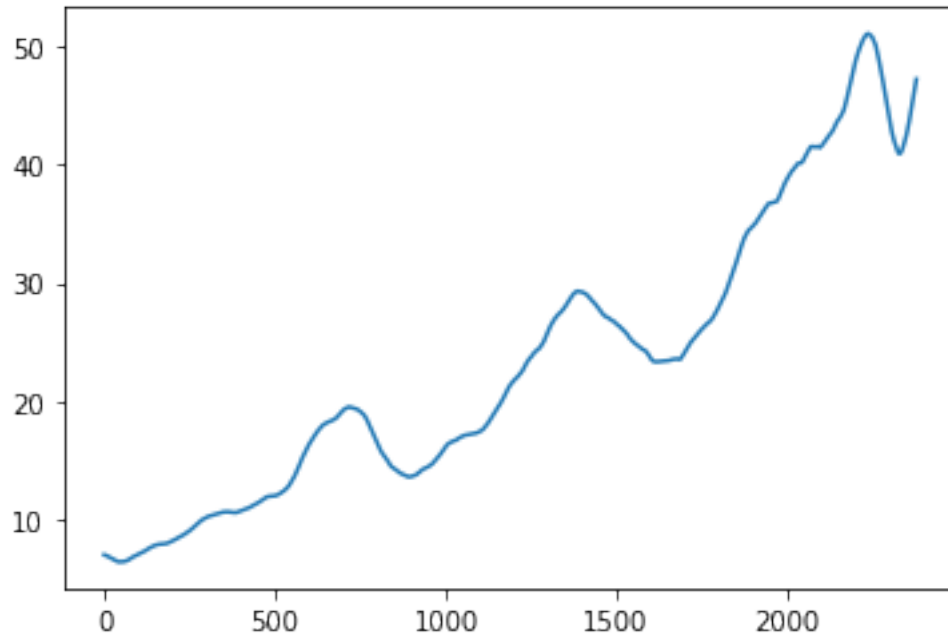
```
[ ]:
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[241]: # Smooth DATA
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```
window_len = 100
```

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s=np.r_[x[window_len-1:0:-1],x,x[-2:-window_len-1:-1]]
w=np.ones(window_len,'d')
y=np.convolve(w/w.sum(),s,mode='valid')
plt.plot(y)
```

[241]: [<matplotlib.lines.Line2D at 0x7f0e3ec458e0>]



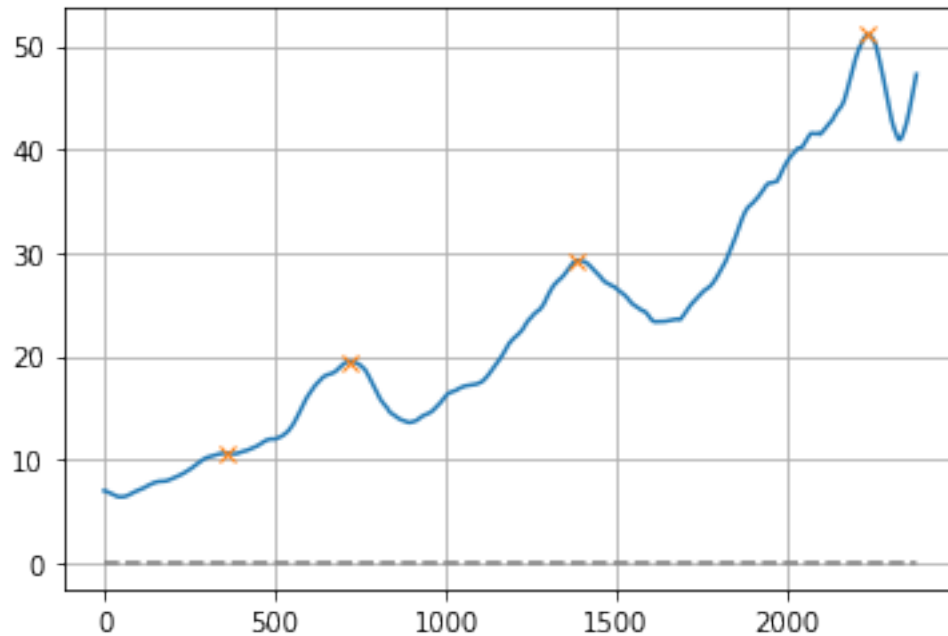
[239]: *#Find peaks*

```
from scipy.signal import find_peaks
peaks, _ = find_peaks(y, height=0 , distance=10 ,width = 15 )
```

[240]: *#fig = plt.figure(figsize = (6,8),dpi = 180)*

```
plt.plot(y)
plt.grid()
plt.plot(peaks, y[peaks], "x")
plt.plot(np.zeros_like(y), "--", color="gray")
```

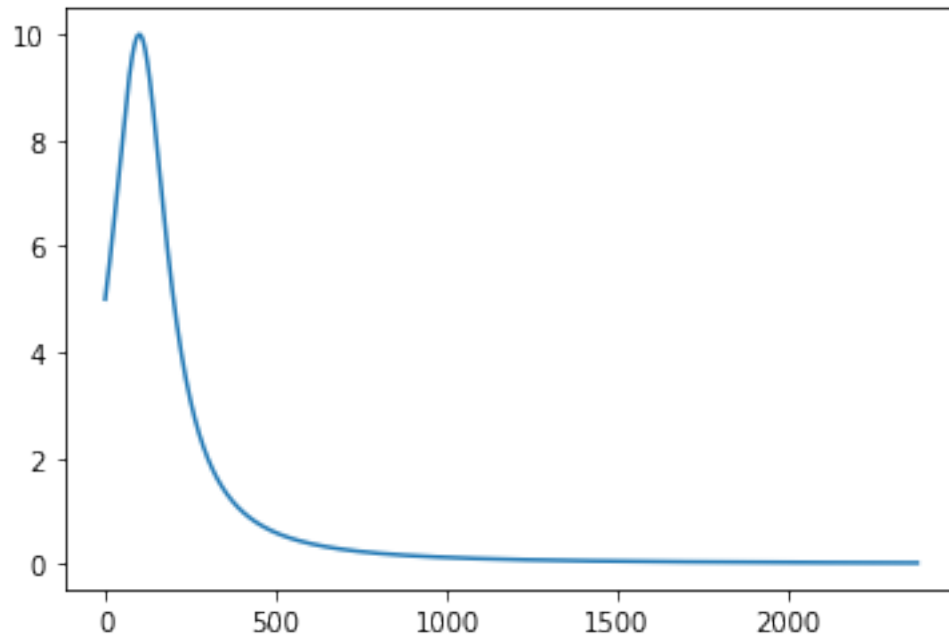
[240]: [<matplotlib.lines.Line2D at 0x7f0e3ee8f2b0>]



```
[187]: #Define lorentzian

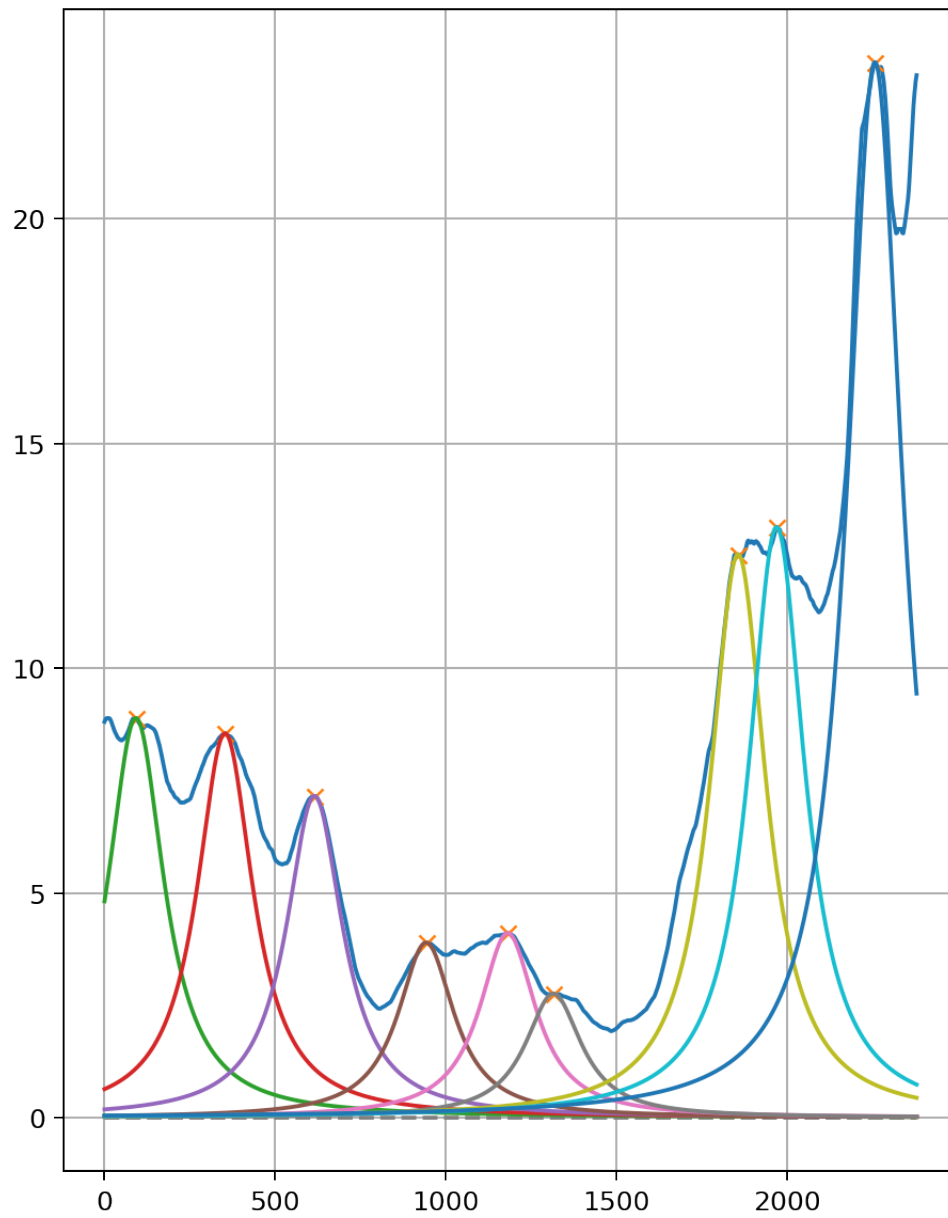
def lorentzian( x, x0, a, gam ):
    return a * gam**2 / ( gam**2 + ( x - x0 )**2)
gam_i = 100
max_x = 100
a = 10
lor = []
for i in range(len(y)):
    lor.append(lorentzian(i,max_x,a,gam_i))
plt.plot(lor)
print(lor[0])

class Lorentzian:
    def __init__(self,array, x0, a, gam):
        self.x0 = x0
        self.a = a
        self.gam = gam
        lor = []
        for i in range(len(array)):
            lor.append(lorentzian(i,x0,a,gam))
        self.lor = lor
```



```
[195]: #lorentians = [Lorentzian(y,peak,y[peak],5) for peak in peaks]
lorentians = []
for peak in peaks:
    lorentians.append( Lorentzian(y,peak, y[peak] , 100))
```

```
[196]: #PLOT PICTURE
fig = plt.figure(figsize = (6,8),dpi = 180)
plt.plot(y)
plt.grid()
plt.plot(peaks, y[peaks], "x")
plt.plot(np.zeros_like(y), "--", color="gray")
for lorenz in lorentians:
    plt.plot(lorenz.lor)
```

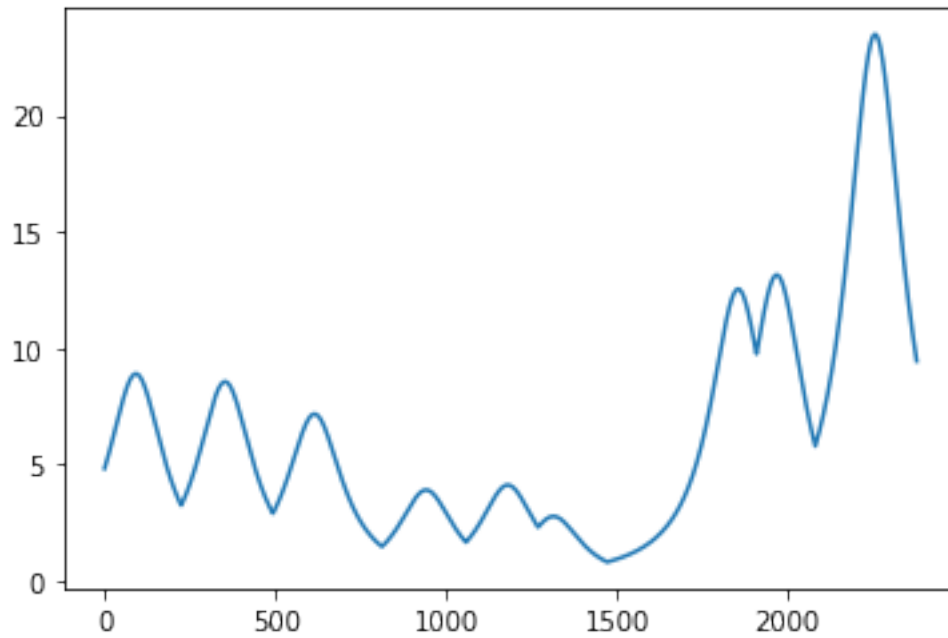


```
[197]: fit = [1]*len(y)

for x in range(len(fit)):
    current_lor = [lorenz.lor[x] for lorenz in lorentians ]
    fit[x] = max(current_lor)

plt.plot(fit)
```

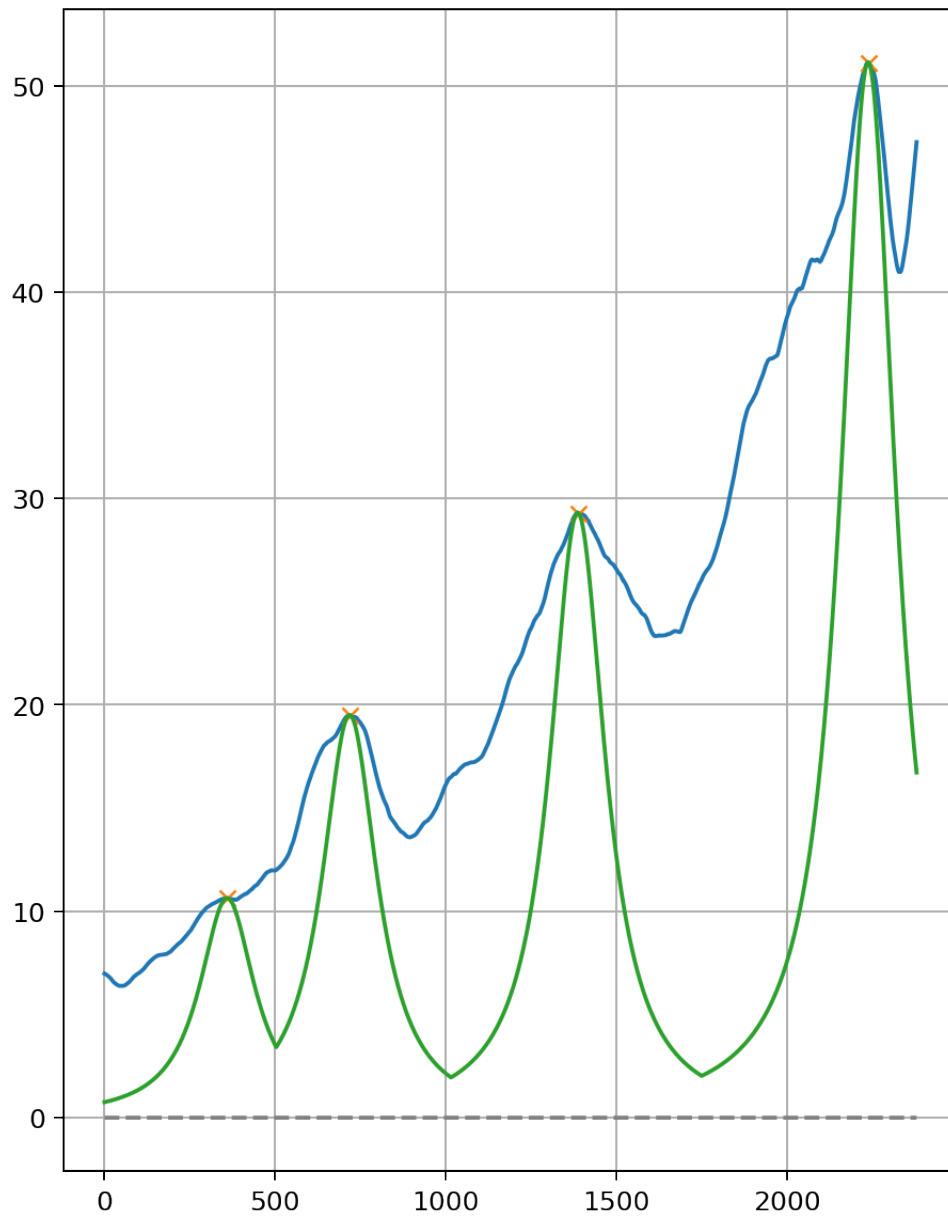
[197]: [<matplotlib.lines.Line2D at 0x7f0e457fc460>]



```
[198]: #Get fit for debug
def get_fit(lorentians):
    fit = [1]*len(y)
    for x in range(len(fit)):
        current_lor = [lorenz.lor[x] for lorenz in lorentians ]
        fit[x] = max(current_lor)
    return fit
```

```
[243]: fig = plt.figure(figsize = (6,8),dpi = 180)
plt.plot(y)
plt.grid()
plt.plot(peaks, y[peaks], "x")
plt.plot(np.zeros_like(y), "--", color="gray")
plt.plot(fit)
```

[243]: [<matplotlib.lines.Line2D at 0x7f0e3e9d09a0>]



```
[213]: def get_fit_from_gamma(gamma):
    lorentians = []
    for i in range(len(peaks)):
        lorentians.append( Lorentzian(y,peaks[i], y[peaks[i]] , gamma[i]))
    fit = get_fit(lorentians)
    return fit

def plt_diff(fit,y):
    fig = plt.figure(figsize = (6,8),dpi = 180)
    plt.plot(y)
```



```
plt.grid()
plt.plot(peaks, y[peaks], "x")
plt.plot(np.zeros_like(y), "--", color="gray")
plt.plot(fit)
```

```
[200]: #
def mse(A,B,power =2):
    return ((A - B)**power).mean(axis=0)
def sqears(A,B):
    return ((A - B)**2)
```

```
[275]: #

#Array for animation:
list_of_gamma = []

def loss_mse(gamma):
    lorentians = []
    for i in range(len(peaks)):
        lorentians.append( Lorentzian(y,peaks[i], y[peaks[i]] , gamma[i]))
    fit = get_fit(lorentians)
    loss =mse(fit,y , power = 4)
    print(f' loss = {loss}')
    print(f'gammas = {gamma}' )

    #
    list_of_gamma.append(gamma.copy())

    return loss
```

```
[247]: #
for g in range(50,100):
    gamma = [g]*9
    lorentians = []
    for i in range(len(peaks)):
        lorentians.append( Lorentzian(y,peaks[i], y[peaks[i]] , gamma[i]))
    fit = get_fit(lorentians)
    loss =mse(fit,y , power = 4)
    print(f' loss = {loss}')
    print(f'gammas = {gamma}' )
    plt.plot(fit)

plt.show()
```

```
loss = 324303.5701553428
gammas = [50, 50, 50, 50, 50, 50, 50, 50, 50]
```

```

loss = 318520.1328804217
gammas = [51, 51, 51, 51, 51, 51, 51, 51, 51]
loss = 312853.63923808426
gammas = [52, 52, 52, 52, 52, 52, 52, 52, 52]
loss = 307301.08325962897
gammas = [53, 53, 53, 53, 53, 53, 53, 53, 53]
loss = 301859.56544877595
gammas = [54, 54, 54, 54, 54, 54, 54, 54, 54]
loss = 296526.2820886221
gammas = [55, 55, 55, 55, 55, 55, 55, 55, 55]
loss = 291298.5354497593
gammas = [56, 56, 56, 56, 56, 56, 56, 56, 56]
loss = 286173.71398922737
gammas = [57, 57, 57, 57, 57, 57, 57, 57, 57]
loss = 281149.29279669054
gammas = [58, 58, 58, 58, 58, 58, 58, 58, 58]
loss = 276222.8294416398
gammas = [59, 59, 59, 59, 59, 59, 59, 59, 59]
loss = 271391.9598168994
gammas = [60, 60, 60, 60, 60, 60, 60, 60, 60]
loss = 266654.39336684457
gammas = [61, 61, 61, 61, 61, 61, 61, 61, 61]
loss = 262007.9146092011
gammas = [62, 62, 62, 62, 62, 62, 62, 62, 62]
loss = 257450.37465133125
gammas = [63, 63, 63, 63, 63, 63, 63, 63, 63]
loss = 252979.68898325652
gammas = [64, 64, 64, 64, 64, 64, 64, 64, 64]
loss = 248593.8318054062
gammas = [65, 65, 65, 65, 65, 65, 65, 65, 65]
loss = 244290.8481251091
gammas = [66, 66, 66, 66, 66, 66, 66, 66, 66]
loss = 240068.8347595355
gammas = [67, 67, 67, 67, 67, 67, 67, 67, 67]
loss = 235925.94381078987
gammas = [68, 68, 68, 68, 68, 68, 68, 68, 68]
loss = 231860.38050127937
gammas = [69, 69, 69, 69, 69, 69, 69, 69, 69]
loss = 227870.40113584278
gammas = [70, 70, 70, 70, 70, 70, 70, 70, 70]
loss = 223954.3111810572
gammas = [71, 71, 71, 71, 71, 71, 71, 71, 71]
loss = 220110.45365289698
gammas = [72, 72, 72, 72, 72, 72, 72, 72, 72]
loss = 216337.22772325473
gammas = [73, 73, 73, 73, 73, 73, 73, 73, 73]
loss = 212633.08102843087
gammas = [74, 74, 74, 74, 74, 74, 74, 74, 74]

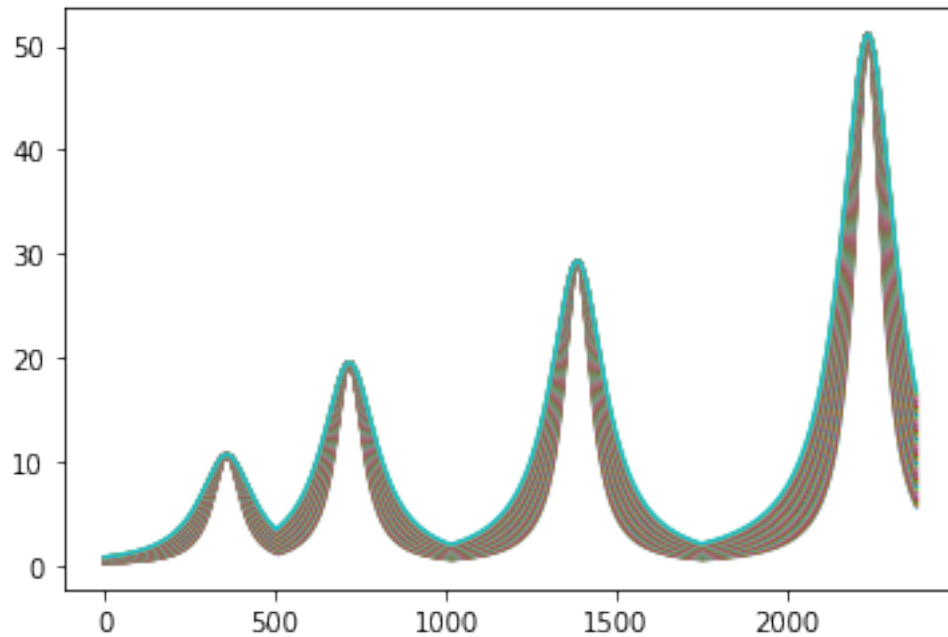
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```

loss = 208996.50147504188
gammas = [75, 75, 75, 75, 75, 75, 75, 75, 75]
loss = 205426.01504637295
gammas = [76, 76, 76, 76, 76, 76, 76, 76, 76]
loss = 201920.18737373466
gammas = [77, 77, 77, 77, 77, 77, 77, 77, 77]
loss = 198477.62242299935
gammas = [78, 78, 78, 78, 78, 78, 78, 78, 78]
loss = 195096.9612440941
gammas = [79, 79, 79, 79, 79, 79, 79, 79, 79]
loss = 191776.88029725634
gammas = [80, 80, 80, 80, 80, 80, 80, 80, 80]
loss = 188516.08277182828
gammas = [81, 81, 81, 81, 81, 81, 81, 81, 81]
loss = 185313.3229051061
gammas = [82, 82, 82, 82, 82, 82, 82, 82, 82]
loss = 182167.37726147
gammas = [83, 83, 83, 83, 83, 83, 83, 83, 83]
loss = 179077.05349919136
gammas = [84, 84, 84, 84, 84, 84, 84, 84, 84]
loss = 176041.1951341762
gammas = [85, 85, 85, 85, 85, 85, 85, 85, 85]
loss = 173058.67222272663
gammas = [86, 86, 86, 86, 86, 86, 86, 86, 86]
loss = 170128.3823758609
gammas = [87, 87, 87, 87, 87, 87, 87, 87, 87]
loss = 167249.2450327318
gammas = [88, 88, 88, 88, 88, 88, 88, 88, 88]
loss = 164420.22312401407
gammas = [89, 89, 89, 89, 89, 89, 89, 89, 89]
loss = 161640.2958632566
gammas = [90, 90, 90, 90, 90, 90, 90, 90, 90]
loss = 158908.44918102553
gammas = [91, 91, 91, 91, 91, 91, 91, 91, 91]
loss = 156223.7349063481
gammas = [92, 92, 92, 92, 92, 92, 92, 92, 92]
loss = 153585.2083759873
gammas = [93, 93, 93, 93, 93, 93, 93, 93, 93]
loss = 150991.9407405269
gammas = [94, 94, 94, 94, 94, 94, 94, 94, 94]
loss = 148443.03859768028
gammas = [95, 95, 95, 95, 95, 95, 95, 95, 95]
loss = 145937.6286891113
gammas = [96, 96, 96, 96, 96, 96, 96, 96, 96]
loss = 143474.8565132733
gammas = [97, 97, 97, 97, 97, 97, 97, 97, 97]
loss = 141053.8885414303
gammas = [98, 98, 98, 98, 98, 98, 98, 98, 98]

```

```
loss = 138673.91162972688
gammas = [99, 99, 99, 99, 99, 99, 99, 99, 99]
```



```
[276]: # Launch Optimization

from scipy.optimize import minimize

gamma0 = [10]*4
sol1 = minimize(loss_mse,gamma0, method='COBYLA' , options={'disp': True})

loss = 710220.5607529631
gammas = [10. 10. 10. 10.]
loss = 710189.6593154946
gammas = [11. 10. 10. 10.]
loss = 709888.1889500382
gammas = [11. 11. 10. 10.]
loss = 708250.8341661916
gammas = [11. 11. 11. 10.]
loss = 694666.4459984442
gammas = [11. 11. 11. 11.]
loss = 681409.5043130248
gammas = [11.00225788 11.02202754 11.11963664 11.99257079]
loss = 668565.9109867861
gammas = [11.00458686 11.04474878 11.28009085 12.97934977]
loss = 656190.5887036033
gammas = [11.00698307 11.0681259 11.52874358 13.94765736]
```

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loss = 644950.9081252558
gammas = [11.00939358 11.09164256 12.02151122 14.81749712]
loss = 634007.5322455417
gammas = [11.01138048 11.11102642 11.77622214 15.78675126]
loss = 623199.9436889429
gammas = [11.01381433 11.46902963 11.92989064 16.70773647]
loss = 612825.3343981828
gammas = [11.0160328 11.18119432 12.25858526 17.60723953]
loss = 604033.4730496268
gammas = [11.60487874 11.21374851 12.30383213 18.41356044]
loss = 593482.3274650597
gammas = [11.53358577 11.2542601 12.36032921 19.40859019]
loss = 584284.7778082071
gammas = [11.82809594 11.5074459 12.22674212 20.32035507]
loss = 574697.2709203791
gammas = [11.85422589 11.64651741 12.65956945 21.21065662]
loss = 565107.2897699885
gammas = [11.88151534 11.46693524 12.73679949 22.19098363]
loss = 556175.51705809
gammas = [12.23914483 11.57893894 12.86925462 23.10859573]
loss = 547288.0693603395
gammas = [12.02920343 11.8052189 12.90578109 24.05906288]
loss = 538307.939291735
gammas = [12.02447294 11.72856474 13.21382438 25.0073303 ]
loss = 530219.811961624
gammas = [12.30257767 12.07135786 13.42601758 25.8791816 ]
loss = 521928.2396448306
gammas = [12.35623188 11.97525865 13.32091963 26.86753406]
loss = 513547.2592375124
gammas = [12.22011236 12.06702149 13.57098944 27.82174376]
loss = 506183.39711819234
gammas = [12.35930741 12.49325327 13.53166056 28.71471881]
loss = 498357.4307650549
gammas = [12.57543438 12.39704244 13.81499101 29.6441038 ]
loss = 490550.40396928036
gammas = [12.44843926 12.38362233 13.87870909 30.63386749]
loss = 483472.8429282223
gammas = [12.72512712 12.52643312 13.76962384 31.57787454]
loss = 476129.6908145623
gammas = [12.697931 12.7291956 14.14701458 32.48104893]
loss = 468833.8846195836
gammas = [12.72120787 12.57471419 14.32999747 33.45167293]
loss = 462187.78070340055
gammas = [13.11457838 12.72789067 14.48965571 34.34403264]
loss = 455310.79247791716
gammas = [12.9644299 12.89162287 14.51872109 35.3186107 ]
loss = 448445.06588130404
gammas = [12.9589331 12.88165473 14.89011667 36.24701565]

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```

loss = 442290.3062954669
gammas = [13.19439236 13.28580668 15.10708746 37.10383758]
loss = 435788.1993753184
gammas = [13.28707549 13.18372155 15.14514472 38.09355476]
loss = 429342.3846145794
gammas = [13.12094075 13.29406578 15.3944944 39.04120878]
loss = 423516.3508598632
gammas = [13.23611292 13.64329115 15.33267688 39.96908572]
loss = 417366.91493190936
gammas = [13.39733023 13.62446678 15.69342103 40.88751823]
loss = 411316.2939606642
gammas = [13.29241466 13.56021423 15.78612121 41.8755825 ]
loss = 405839.44708734145
gammas = [13.62340546 13.67308072 15.73483957 42.81103771]
loss = 400036.83583120536
gammas = [13.55132996 13.89253221 16.06367279 43.72674229]
loss = 394313.29487717594
gammas = [13.60213393 13.75765008 16.34174334 44.67642778]
loss = 388751.1579558082
gammas = [13.48716125 13.84249467 16.387312 45.6651169 ]
loss = 383222.15027549915
gammas = [13.62360434 13.97390344 16.68754555 46.59998311]
loss = 378319.6556069062
gammas = [13.46364295 14.30778822 16.6061055 47.52534835]
loss = 373209.6792111379
gammas = [13.2137129 14.27504194 17.02903527 48.39574657]
loss = 368063.52749074576
gammas = [13.32219803 14.1529758 17.13705801 49.37639019]
loss = 362922.8332654501
gammas = [13.38580111 14.3404651 17.45963097 50.30199762]
loss = 357859.8621603436
gammas = [13.27158576 14.36761459 17.64221748 51.2781533 ]
loss = 353559.8463446902
gammas = [13.32439073 14.84081148 18.14004031 52.00304555]
loss = 348845.95533332875
gammas = [13.43090971 14.67348499 18.57948431 52.87914173]
loss = 344156.33882191486
gammas = [13.60426198 14.79135636 18.64538994 53.8546989 ]
loss = 339440.7153899424
gammas = [13.44704791 14.84897719 18.92568051 54.7998977 ]
loss = 334775.36973677477
gammas = [13.547825 14.9158196 19.25718714 55.73556827]
loss = 331247.15241188655
gammas = [12.94678156 14.8891535 19.67559236 56.4159893 ]
loss = 327016.69407965796
gammas = [12.95368379 14.63441194 19.74257712 57.38065097]
loss = 322663.28737598966
gammas = [12.92429543 14.88297789 19.89339925 58.33700027]

```

```

loss = 318327.7683068537
gammas = [12.99258595 14.88435213 20.31632575 59.24058628]
loss = 314024.1426446964
gammas = [12.93500939 14.91396331 20.53787414 60.21358393]
loss = 310803.925816836
gammas = [13.14165519 14.59995591 21.24833218 60.80851775]
loss = 307101.95120774355
gammas = [13.57947859 14.68621971 21.31886988 61.70064647]
loss = 303075.1264329369
gammas = [13.54366761 14.94181507 21.70903981 62.58447678]
loss = 299055.90856885427
gammas = [13.49590385 14.88094431 21.93092317 63.55647531]
loss = 295067.744180889
gammas = [13.56879871 14.96784522 22.26375244 64.49261592]
loss = 291486.4480703529
gammas = [13.87977345 14.8148472 22.36637311 65.42500818]
loss = 288001.1357200793
gammas = [13.77454656 15.12366311 22.31242258 66.36875039]
loss = 284228.1192279417
gammas = [13.6896805 15.09561372 22.67329773 67.29707152]
loss = 280606.4695359734
gammas = [13.88177964 15.32489287 23.05299541 68.17249066]
loss = 276934.52530165616
gammas = [13.89763276 15.33798174 23.27993694 69.14618204]
loss = 273555.90557595826
gammas = [14.20009728 15.61677509 23.51552961 70.02668506]
loss = 270112.05943493964
gammas = [14.00322849 15.83964059 23.91168826 70.89538062]
loss = 266720.6491698714
gammas = [13.99692583 15.73016424 24.03046527 71.88222773]
loss = 263394.0782895958
gammas = [14.16647421 16.01424288 24.2478951 72.80052885]
loss = 260404.66091379963
gammas = [13.72207141 16.20826777 24.65112454 73.57658717]
loss = 257462.71768159445
gammas = [13.91173928 16.04185645 25.31355011 74.2819422 ]
loss = 254142.88677827606
gammas = [13.9189073 16.09294014 25.57708645 75.24521147]
loss = 250917.30053739858
gammas = [13.96200365 16.32169915 25.97789778 76.13130531]
loss = 247708.7044825301
gammas = [13.89782168 16.31431046 26.32510993 77.06686386]
loss = 244610.90395803322
gammas = [13.9084573 16.54870332 26.80160383 77.91415391]
loss = 241557.64635012305
gammas = [13.78933591 16.43931192 27.13943717 78.8413606 ]
loss = 238565.57092024424
gammas = [13.76408585 16.64793094 27.66143471 79.66801598]

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loss = 235737.32596048663
gammas = [13.57269551 16.41163526 27.99173429 80.5615686 ]
loss = 233030.66502574272
gammas = [13.9720094 16.43775653 28.13465949 81.46679701]
loss = 230702.0754836669
gammas = [13.68672021 16.82590174 27.99050006 82.3311878 ]
loss = 227783.3562384661
gammas = [13.69041205 16.91035091 28.389962 83.24403219]
loss = 224933.87336943625
gammas = [13.69603737 16.887089 28.6538946 84.20827636]
loss = 222129.23430884097
gammas = [13.79142787 17.09598459 29.006079 85.11559628]
loss = 219401.7191551048
gammas = [13.84731708 17.19161952 29.15574671 86.09810833]
loss = 217272.95144415504
gammas = [14.10695337 17.82769358 29.53071679 86.72051995]
loss = 214633.39272786956
gammas = [13.88964839 17.92200223 29.98721279 87.57813049]
loss = 212006.0923833858
gammas = [13.87250344 18.05422233 30.14951896 88.55582195]
loss = 209750.73922548207
gammas = [13.75374007 18.63865059 30.45975074 89.29615641]
loss = 207216.80052877148
gammas = [13.96268256 18.6780911 30.96314202 90.13364354]
loss = 204643.77911540898
gammas = [13.88293922 18.72991054 31.31165948 91.06610873]
loss = 202205.91331665838
gammas = [13.79731186 18.97023646 31.87811695 91.84971408]
loss = 199722.36703219946
gammas = [13.91553903 19.12931057 32.15224773 92.79076141]
loss = 197552.4115357262
gammas = [14.07777391 19.58874987 32.70928696 93.46329592]
loss = 195129.17081809425
gammas = [14.09033995 19.54665527 33.16786325 94.35086447]
loss = 192796.64829993527
gammas = [13.8900459 19.75802144 33.42599604 95.27204529]
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gammas = [14.02179005 19.85361986 33.74519137 96.20565053]
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gammas = [13.98471646 20.01240079 34.30312982 97.0193574 ]
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gammas = [14.31063999 20.03086852 34.61220499 97.91261287]
loss = 183711.6001615917
gammas = [14.17396298 19.93410541 34.93234076 98.84506629]
loss = 181489.51339056296
gammas = [14.16865155 20.20438243 35.23631244 99.75858878]
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gammas = [ 14.21823521 20.25315672 35.73500965 100.62257004]

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loss = 177097.51300709444
gammas = [ 14.27181685  20.2951236  35.9955996  101.58561763]
loss = 175093.18333426476
gammas = [ 14.36336869  20.15367432  36.64369727  102.3283018 ]
loss = 173012.25155758305
gammas = [ 14.13202028  20.31228228  37.04470873  103.20037475]
loss = 170949.9060918498
gammas = [ 14.31103096  20.57566559  37.44498198  104.05965685]
loss = 168874.251454708
gammas = [ 14.32249913  20.56728846  37.7727714  105.00430091]
loss = 166821.6053328876
gammas = [ 14.29564445  20.69760928  38.26998851  105.86166341]
loss = 164998.73082669533
gammas = [ 14.18740282  20.42249003  38.4400751  106.80169729]
loss = 163064.86092879123
gammas = [ 14.13654889  20.71845699  38.64306901  107.73369026]
loss = 161117.5935081376
gammas = [ 14.34747507  20.77646482  39.07104172  108.61060793]
loss = 159176.30153276285
gammas = [ 14.22784869  20.86741798  39.5473728  109.47693683]
loss = 157247.52712433535
gammas = [ 14.261721  20.95645951  39.8630733  110.42100116]
loss = 155613.35561842128
gammas = [ 13.77084952  21.07085839  40.34616642  111.13694748]
loss = 153814.03923854986
gammas = [ 13.87964926  21.44322456  40.84317655  111.91314783]
loss = 151980.39002393337
gammas = [ 13.94466025  21.38527838  41.34521011  112.7736001 ]
loss = 150152.11701869994
gammas = [ 13.92064104  21.53522129  41.62877176  113.72045437]
loss = 148333.3303643113
gammas = [ 13.91229212  21.66835564  42.11379896  114.58471946]
loss = 146803.2378406582
gammas = [ 13.78793305  22.03407654  42.06311045  115.50570465]
loss = 145130.97331910545
gammas = [ 14.13916856  22.12524654  42.39220125  116.37749642]
loss = 143414.42937950906
gammas = [ 14.05452031  22.04896221  42.76151332  117.2997892 ]
loss = 141693.2887611028
gammas = [ 14.05185099  22.28202386  43.24721551  118.14226682]
loss = 139982.0594293547
gammas = [ 14.09464503  22.38542043  43.6014023  119.07072227]
loss = 138560.46541162612
gammas = [ 13.6473098  22.67185433  43.74688541  119.90539675]
loss = 136905.34575364937
gammas = [ 13.60291057  22.70359296  44.29055856  120.74291742]
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gammas = [ 13.73346832  22.74769311  44.5066675  121.70951288]

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loss = 133727.30550680516
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loss = 132113.82175311862
gammas = [ 13.7733252   23.18094421  45.41399124 123.40658851]
loss = 130559.3758083366
gammas = [ 13.70486068  23.41813104  45.6691602  124.34143813]
loss = 129066.02661134477
gammas = [ 13.62096548  23.23889986  46.17312257 125.18218762]
loss = 127536.80896241985
gammas = [ 13.83400482  23.37730486  46.59825104 126.05093619]
loss = 126044.11907541985
gammas = [ 13.73726234  23.50805427  46.82551206 127.01109134]
loss = 124662.19423567262
gammas = [ 14.11700555  23.82391873  47.16816709 127.81022355]
loss = 123237.05307283894
gammas = [ 13.96838794  24.08368188  47.79888759 128.52620368]
loss = 121756.78101595765
gammas = [ 14.00927768  24.10414575  48.23401727 129.42540968]
loss = 120298.83203593738
gammas = [ 13.98616328  24.33104289  48.59547875 130.32947218]
loss = 118855.42645400274
gammas = [ 14.07505557  24.45540459  49.12384662 131.16461273]
loss = 117463.20975007588
gammas = [ 14.03272042  24.80308311  49.46432726 132.03719528]
loss = 116071.85309799772
gammas = [ 14.16049319  24.93387685  50.05172349 132.82556879]
loss = 114746.30319722806
gammas = [ 14.13341797  25.38031262  50.42254532 133.63948107]
loss = 113441.18526671366
gammas = [ 14.33004348  25.48625974  51.10291105 134.33748973]
loss = 112142.60042208711
gammas = [ 14.07197133  25.4414522  51.52311372 135.20629395]
loss = 110913.38710555539
gammas = [ 14.35345945  25.4629311  51.65787427 136.15610587]
loss = 109573.84073646429
gammas = [ 14.35812326  25.64424235  52.12937373 137.01911962]
loss = 108266.75481407184
gammas = [ 14.40616417  25.62745098  52.63780811 137.87871523]
loss = 107063.25160534377
gammas = [ 14.27083672  26.11108008  53.09305286 138.61393056]
loss = 105785.4553566808
gammas = [ 14.21705434  26.20601132  53.41892494 139.55302742]
loss = 104596.7946243962
gammas = [ 14.26547639  26.19364647  54.15683843 140.22606983]
loss = 103372.51042627647
gammas = [ 14.51619122  26.42417131  54.54784891 141.08112023]
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gammas = [ 14.45894136  26.57391921  55.00016849 141.95844857]

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loss = 100960.15562166632
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loss = 99740.32236055388
gammas = [ 14.53082059  27.07059535  56.05666585 143.53168599]
loss = 98568.44043880551
gammas = [ 14.70850588  27.30615897  56.64040152 144.28811866]
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gammas = [ 14.75355854  27.10926884  56.94355841 145.21940833]
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gammas = [ 14.74608121  27.43468947  57.18857898 146.13265004]
loss = 95195.5028884054
gammas = [ 14.55653551  27.54520374  57.77200734 146.91461575]
loss = 94044.76621882948
gammas = [ 14.66622377  27.67833347  58.24193351 147.78030296]
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gammas = [ 14.60551124  27.78700016  58.62389514 148.69605995]
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gammas = [ 15.10882317  27.9448033  59.04669303 149.43295697]
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gammas = [ 15.06793979  28.28091327  60.13485319 151.03303916]
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gammas = [ 15.30802279  28.62057559  61.59960498 154.59880264]
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gammas = [ 15.75535939  29.53348232  62.53559203 157.12402457]
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gammas = [ 16.31397362  30.02272427  63.87535183 160.63753367]
loss = 78115.12987121081
gammas = [ 16.11491343  30.40008484  64.31299614 161.42901425]
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loss = 76229.12659750685
gammas = [ 16.22189758  30.6710059  65.31090741 163.12584055]
loss = 75307.87733005069
gammas = [ 16.1204027  30.76971182  65.74924786 164.01342918]
loss = 74403.63721965329
gammas = [ 16.24071152  31.08505939  66.16620396 164.85736597]
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gammas = [ 16.1042999  31.20847686  66.56794517 165.75445237]
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gammas = [ 16.25745244  31.62752962  66.92105199 166.57679941]
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gammas = [ 16.06761677  31.76086427  67.28128111 167.48035863]
loss = 70999.0521952691
gammas = [ 16.20732657  32.28022952  67.5403725  168.28261331]
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gammas = [ 16.45810454  32.58169318  69.24526088 170.54171409]
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gammas = [ 16.56521361  32.80733988  69.76507328 171.35866347]
loss = 66901.91897561729
gammas = [ 16.52500192  32.84758391  70.3185643  172.18957328]
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gammas = [ 16.69437493  33.07349504  70.86501966 172.97802968]
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gammas = [ 16.89218918  33.13861144  72.67159535 175.28151387]
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gammas = [ 17.43463812  34.33582993  75.5769546  179.92542348]
loss = 58746.45155462619
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loss = 57316.618953394966
gammas = [ 17.638179    34.94712752  77.30275455 182.26418123]
loss = 56625.201129646586
gammas = [ 17.69688065  35.3219169   77.65615272 183.11928168]
loss = 55941.43188423614
gammas = [ 17.81001954  35.57591457  78.32161814 183.81198691]
loss = 55306.688250761414
gammas = [ 17.88736862  36.08676927  78.55967392 184.63440654]
loss = 54646.98388195967
gammas = [ 17.68009892  36.11670969  79.00720572 185.50380756]
loss = 53981.67536297218
gammas = [ 17.74746768  36.36374334  79.67111203 186.20642   ]
loss = 53355.88161846234
gammas = [ 17.71907229  36.82922063  79.92703091 187.05319631]
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gammas = [ 17.98271652  37.22609012  80.65110463 187.55189819]
loss = 52257.62313386058
gammas = [ 18.46767688  37.0664328   80.84525684 188.38953052]
loss = 51605.732062648705
gammas = [ 18.43584225  37.23103305  81.36939349 189.22450004]
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gammas = [ 18.50146016  37.48915309  81.84441791 190.06320149]
loss = 50353.67665612125
gammas = [ 18.75645327  37.82614705  82.20739848 190.89365841]
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gammas = [ 18.81342378  37.93702558  82.80158241 191.68826887]
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gammas = [ 19.05770669  38.1113074   83.31593992 192.49162934]
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loss = 47938.312285450265
gammas = [ 19.21062888  38.44800972  83.9959769   194.29728722]
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gammas = [ 19.18931402  38.29931813  84.73995156 194.94839259]
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gammas = [ 19.07268895  38.79003767  85.31738876 195.59038885]
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gammas = [ 19.28698262  39.19663844  86.3852087   197.19848247]
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gammas = [ 19.24179609  40.01557143  88.81239783 200.19744144]

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loss = 42977.28196040165
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gammas = [ 18.95777205  40.51714341  89.51505287 201.85607634]
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gammas = [ 19.16997621  40.28679588  89.94026213 202.70525624]
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gammas = [ 19.18594404  40.52383402  90.50089464 203.4985085 ]
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gammas = [ 19.1711274   40.72532805  90.93958989 204.37413804]
loss = 40426.141499230864
gammas = [ 19.38653727  40.9830592   91.4704841  205.15216412]
loss = 39935.00948297922
gammas = [ 19.53442523  41.09351739  91.7745512  206.08676101]
loss = 39435.330732229326
gammas = [ 19.48067173  41.2074532   92.40314867 206.85422073]
loss = 38988.760898449895
gammas = [ 19.9185841   41.34779396  93.03881291 207.47427572]
loss = 38503.946146361595
gammas = [ 19.92269938  41.77161934  93.49042387 208.25938887]
loss = 38015.20271918772
gammas = [ 19.94996479  41.91221065  93.99597634 209.11021634]
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gammas = [ 20.22380496  42.17958028  94.43470727 209.92326013]
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gammas = [ 20.26227024  42.95070196  96.56046258 213.11088886]
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gammas = [ 20.13677499  43.13051638  97.13601927 213.89870369]
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gammas = [ 20.42991489  43.20417869  97.76419963 214.61566415]
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gammas = [ 20.48791305  43.62865023  98.25850053 215.37205476]
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gammas = [ 20.32624426  43.75043967  98.91187253 216.10153098]
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gammas = [ 20.38749829  43.85812312  99.20250048 217.05031315]
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gammas = [ 20.47616181  44.11694979  99.77608397 217.82242034]
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gammas = [ 20.32209084  44.47822221 100.2170171  218.62946579]
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gammas = [ 20.3398328   44.59655657 100.78101915 219.44652386]

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loss = 31904.69988428159
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loss = 31499.592998902604
gammas = [ 20.16559276  45.11854762 101.58113021 221.1243308 ]
loss = 31122.258109822113
gammas = [ 20.26165778  44.99996712 102.2124119  221.88472123]
loss = 30746.328072171604
gammas = [ 20.1856916  45.39003133 102.94338555 222.43947935]
loss = 30349.289745991897
gammas = [ 20.20874651  45.63326219 103.4336      223.27613759]
loss = 29975.828409764377
gammas = [ 20.11458539  45.62043567 104.08022981 224.03299891]
loss = 29598.805600222564
gammas = [ 20.37757642  45.86071404 104.67442265 224.75413474]
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gammas = [ 20.33656847  46.17254612 105.18483429 225.55448408]
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gammas = [ 20.32994005  46.31605453 105.86518661 226.27315098]
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gammas = [ 20.00512709  46.73855009 106.13637332 227.0746819 ]
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gammas = [ 20.15771372  46.75427586 106.45782597 228.00910055]
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gammas = [ 20.2723633  47.10894871 107.01953095 228.74771422]
loss = 27468.252753378587
gammas = [ 20.09694743  47.1306569  107.7146224  229.44456851]
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gammas = [ 20.13028949  47.40498246 108.20949936 230.26841958]
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gammas = [ 20.13294459  47.8746178  109.14538812 231.91575978]
loss = 26089.914767539387
gammas = [ 20.05674698  48.03017752 109.5995263  232.78968976]
loss = 25811.206580415645
gammas = [ 20.43252592  48.63802665 109.79535829 233.46122491]
loss = 25505.547825035886
gammas = [ 20.76555914  48.65977206 110.4986477  234.08891911]
loss = 25195.324602943627
gammas = [ 20.61926706  49.10680836 111.1878152  234.64010449]
loss = 24865.54070661037
gammas = [ 20.65664161  49.34601512 111.69395235 235.46787768]
loss = 24539.873044999462
gammas = [ 20.75551454  49.64440643 112.27159772 236.221212 ]
loss = 24250.297016546076
gammas = [ 20.90894914  50.11512386 113.01715348 236.66733926]
loss = 23940.397833315717
gammas = [ 20.82219739  50.21420392 113.6718811  237.41164364]

```

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loss = 23635.950852023598
gammas = [ 21.04262584  50.51066656 114.03889407 238.26535476]
loss = 23340.863074653327
gammas = [ 20.84595403  50.96785097 114.48165684 239.01118568]
loss = 23033.342382950425
gammas = [ 20.9219512   51.21120444 115.07860122 239.77188334]
loss = 22744.53996337817
gammas = [ 20.68993944  51.58566742 115.67600768 240.44199791]
loss = 22471.735383339514
gammas = [ 20.95107027  52.15971394 116.21935626 240.99612209]
loss = 22176.3848625633
gammas = [ 20.99924921  52.40388523 116.67608179 241.85020696]
loss = 21904.402578084148
gammas = [ 20.78893158  52.90555593 117.05686516 242.59793487]
loss = 21617.14750698274
gammas = [ 20.81453137  53.12483561 117.73561618 243.29833342]
loss = 21331.73350183245
gammas = [ 20.94037904  53.42415142 118.22110649 244.11004246]
loss = 21052.631397557878
gammas = [ 20.88994198  53.83103701 118.80117022 244.81390771]
loss = 20785.48394894646
gammas = [ 21.10000154  54.15980158 119.11906376 245.67804458]
loss = 20518.297059293458
gammas = [ 21.01302493  54.64813748 119.64387584 246.36980711]
loss = 20271.577066634505
gammas = [ 21.24046538  54.6589198  120.43525113 246.93715156]
loss = 20038.200603817364
gammas = [ 20.96047158  54.58828746 120.81903469 247.81426314]
loss = 19770.8625413302
gammas = [ 21.04925963  54.89868512 121.35668363 248.59317494]
loss = 19511.245248299892
gammas = [ 20.97410184  55.20102193 122.02350589 249.27014749]
loss = 19251.2720119107
gammas = [ 21.0797255   55.41209945 122.5780843  250.06810282]
loss = 18998.59018871016
gammas = [ 21.00914461  55.63722077 123.26526544 250.75521329]
loss = 18750.847886875177
gammas = [ 21.2114951   55.78283363 123.74400102 251.59703478]
loss = 18504.624244887193
gammas = [ 21.16179402  55.95870883 124.42988115 252.30142542]
loss = 18277.904780922487
gammas = [ 21.4711941   55.99135548 124.81398669 253.1707175 ]
loss = 18055.754924591554
gammas = [ 21.34875398  56.53163151 125.06416189 253.96477203]
loss = 17864.582621102836
gammas = [ 21.79178162  57.09322138 125.68781207 254.28005568]
loss = 17624.13306112995
gammas = [ 21.8208598   57.35079295 126.2773158  255.04510254]

```



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loss = 17387.557896658138
gammas = [ 21.93392515  57.66017977 126.77526373 255.8473144 ]
loss = 17173.252746437203
gammas = [ 22.27367147  58.10682008 127.07568767 256.61856685]
loss = 16943.052285800943
gammas = [ 22.25087305  58.48708135 127.66937529 257.32738037]
loss = 16724.109895876612
gammas = [ 22.35550594  59.04988251 128.16238774 257.9825487 ]
loss = 16501.882973455882
gammas = [ 22.54698042  59.2247488  128.79838363 258.70936953]
loss = 16286.088120480777
gammas = [ 22.8144287   59.66159008 129.32572893 259.38726927]
loss = 16074.091264469915
gammas = [ 22.73473273  59.90317755 129.69206229 260.28230218]
loss = 15860.483770140414
gammas = [ 22.67831409  60.22276551 130.389288   260.92148664]
loss = 15646.324994051773
gammas = [ 22.82822522  60.44856709 130.95143538 261.70285124]
loss = 15437.010147384222
gammas = [ 22.85642649  60.91126016 131.43587342 262.4447674 ]
loss = 15235.879046119893
gammas = [ 23.12825899  61.05120251 131.90239916 263.27475352]
loss = 15032.136866284027
gammas = [ 23.01969046  61.26049998 132.50000676 264.04109065]
loss = 14837.991831681373
gammas = [ 23.08192737  61.80508368 132.84932145 264.8010475 ]
loss = 14646.506092662648
gammas = [ 23.28845396  62.14502022 133.60747637 265.31775924]
loss = 14446.798052684328
gammas = [ 23.35425332  62.39184091 134.1518322  266.11677534]
loss = 14254.441374331864
gammas = [ 23.21966086  62.79016196 134.76527191 266.7852938 ]
loss = 14060.198371734836
gammas = [ 23.37257284  63.14999151 135.30345988 267.53194924]
loss = 13877.192810829536
gammas = [ 23.30991502  63.69474065 135.90950764 268.10816836]
loss = 13690.944034235956
gammas = [ 23.33655702  63.83058645 136.59793317 268.82014197]
loss = 13513.747013648821
gammas = [ 23.69960535  64.20382021 137.01254767 269.56645777]
loss = 13342.901707955543
gammas = [ 23.52171781  64.48439008 137.30467818 270.46328348]
loss = 13159.538059578801
gammas = [ 23.58185764  64.81574394 137.9279839  271.16902975]
loss = 12983.184164954255
gammas = [ 23.72849517  64.92171455 138.47586951 271.98578492]
loss = 12805.082216443932
gammas = [ 23.81645255  65.32240492 138.9899423  272.73907099]

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loss = 12634.528997052965
gammas = [ 23.99399204  65.49320321 139.42207643 273.60657763]
loss = 12467.146381874001
gammas = [ 24.03922729  66.066476  139.88682082 274.27987157]
loss = 12301.77506592168
gammas = [ 23.8800632  66.25042279 140.56862966 274.96977524]
loss = 12135.145016813689
gammas = [ 23.99486398  66.49734313 141.00259579 275.82856772]
loss = 11994.178067193163
gammas = [ 23.88999455  67.2643836  141.39592232 276.32449671]
loss = 11850.33159132565
gammas = [ 24.3027037  67.54108276 142.16814679 276.72044886]
loss = 11685.888597184721
gammas = [ 24.32888741  67.83443475 142.75551331 277.47427881]
loss = 11526.456925083445
gammas = [ 24.53518722  68.21015333 143.21074239 278.25469051]
loss = 11366.430755640482
gammas = [ 24.56874151  68.55557131 143.84116207 278.94904744]
loss = 11210.635685030113
gammas = [ 24.77546559  68.97273369 144.33807081 279.6813878 ]
loss = 11058.156892032881
gammas = [ 24.70753646  69.29060874 145.05133675 280.30234898]
loss = 10905.855438839659
gammas = [ 24.89796571  69.72251716 145.58263763 281.00584823]
loss = 10764.884343859303
gammas = [ 24.73595257  70.02487249 146.37294547 281.51353564]
loss = 10616.841305451506
gammas = [ 24.93684967  70.47691574 146.91084764 282.19614718]
loss = 10483.516756070492
gammas = [ 24.77909846  70.82320235 147.73115568 282.62310721]
loss = 10359.528229592
gammas = [ 24.93700971  70.60064355 148.28849143 283.40726821]
loss = 10246.977981795513
gammas = [ 24.534388  70.9286848  148.41446974 284.25249845]
loss = 10103.293166479978
gammas = [ 24.65005173  71.28501272 148.99830051 284.97277197]
loss = 9961.867369692885
gammas = [ 24.66862069  71.57230462 149.62629861 285.69577746]
loss = 9827.394534260608
gammas = [ 24.5091072  71.76606905 150.25795163 286.42927951]
loss = 9696.838694769956
gammas = [ 24.88727231  72.17525686 150.84338126 287.0182011 ]
loss = 9562.852652204056
gammas = [ 24.99050851  72.45399728 151.28346796 287.86553207]
loss = 9432.768823197668
gammas = [ 24.96056585  72.68789296 152.04450741 288.46986244]
loss = 9303.01478409762
gammas = [ 24.97507732  72.92484346 152.497102  289.32939837]

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loss = 9190.620874603677
gammas = [ 24.73230431  73.04183886 153.33779936 289.79908049]
loss = 9081.135115446908
gammas = [ 24.63369035  73.81836815 153.73028182 290.28202466]
loss = 8953.702167384814
gammas = [ 24.84228163  74.13960189 154.33824282 290.97749716]
loss = 8827.706980737292
gammas = [ 24.84068167  74.45716971 154.87758445 291.75740659]
loss = 8703.159207024684
gammas = [ 24.93840209  74.82996622 155.52740568 292.41254462]
loss = 8584.677125074188
gammas = [ 24.79456426  75.12532668 155.98889143 293.23662216]
loss = 8468.740670829175
gammas = [ 24.71139085  75.67081303 156.61475436 293.78782305]
loss = 8353.938798733028
gammas = [ 25.01568455  75.82074949 157.27484497 294.45805047]
loss = 8246.271207518135
gammas = [ 25.2866234   76.35713174 157.51308209 295.22102444]
loss = 8129.05808919874
gammas = [ 25.31338325  76.67985287 158.10726936 295.95728288]
loss = 8015.269242813388
gammas = [ 25.49841029  77.11803938 158.76266525 296.54398024]
loss = 7907.845105456135
gammas = [ 25.32341778  77.2529373  159.3550657  297.31873303]
loss = 7796.287591408124
gammas = [ 25.53771103  77.54314968 159.88343807 298.08728869]
loss = 7687.882884036255
gammas = [ 25.50711995  78.07589556 160.38165314 298.77068298]
loss = 7579.4409173274835
gammas = [ 25.60837495  78.37308057 161.09980983 299.39171396]
loss = 7471.823068344462
gammas = [ 25.67888726  78.67433178 161.60934521 300.19461458]
loss = 7375.856300335931
gammas = [ 25.4159708   79.25523433 162.16050403 300.73280703]
loss = 7274.992315071593
gammas = [ 25.74180884  79.77508582 162.6771253  301.33003937]
loss = 7170.966468313643
gammas = [ 25.81379081  80.05198612 163.32419003 302.03675858]
loss = 7070.357768330266
gammas = [ 25.87363006  80.45559308 163.72773219 302.85570572]
loss = 6968.963863444106
gammas = [ 25.96820442  80.86616858 164.36664436 303.49934746]
loss = 6872.3813174365805
gammas = [ 26.04677985  81.39422958 164.73978797 304.25812367]
loss = 6775.539811068236
gammas = [ 26.15561388  81.80387494 165.46569361 304.79979407]
loss = 6681.924109686386
gammas = [ 26.25312399  82.40230083 165.8789565  305.47919971]

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loss = 6596.0611781367425
gammas = [ 26.38274449  82.77945371 166.73902387 305.79737948]
loss = 6507.603863427644
gammas = [ 26.75735712  82.89265496 167.23824367 306.57044509]
loss = 6420.114351158741
gammas = [ 26.51999976  83.10136185 167.81172854 307.32623475]
loss = 6327.199815894759
gammas = [ 26.65247016  83.52208596 168.387366   308.01477258]
loss = 6236.1180426091205
gammas = [ 26.773229    83.79215596 169.0558374  308.69714013]
loss = 6147.412643330189
gammas = [ 26.87361633  84.14359659 169.4860707  309.52255589]
loss = 6060.078248088769
gammas = [ 26.98180633  84.32363718 170.1697828  310.22142503]
loss = 5978.112045994587
gammas = [ 27.05122903  84.5895259  170.47721021 311.13245306]
loss = 5894.546765828993
gammas = [ 26.99490977  85.15091304 171.07779331 311.69899747]
loss = 5811.620391879958
gammas = [ 27.05753969  85.30499475 171.79860011 312.3718822 ]
loss = 5731.731183548035
gammas = [ 27.0255848   85.64360471 172.14821501 313.24486078]
loss = 5666.629001028485
gammas = [ 27.18784859  85.36485791 172.80224322 313.92912519]
loss = 5594.350204774215
gammas = [ 27.74716945  85.82323775 173.24469989 314.45948374]
loss = 5512.8854409920705
gammas = [ 27.79760324  86.22850215 173.87639177 315.11840907]
loss = 5432.7669205082875
gammas = [ 27.92974672  86.5844643  174.39994247 315.88111721]
loss = 5353.8960396888315
gammas = [ 28.08260543  86.94554456 175.08812115 316.49158044]
loss = 5276.754060850063
gammas = [ 28.25121843  87.27633986 175.56464135 317.28849488]
loss = 5200.807160531782
gammas = [ 28.43591388  87.62211492 176.28951818 317.85495827]
loss = 5126.482004660916
gammas = [ 28.64160273  87.9297237  176.74044171 318.66720018]
loss = 5053.789056847606
gammas = [ 28.86142723  88.25634744 177.50097094 319.18352314]
loss = 4982.261204780491
gammas = [ 29.10487226  88.54036675 177.93080138 320.00529765]
loss = 4912.992765037831
gammas = [ 29.36569544  88.84249306 178.72027764 320.47157889]
loss = 4844.421971544037
gammas = [ 29.64849295  89.10050164 179.12546701 321.301807  ]
loss = 4778.845085871819
gammas = [ 29.95660339  89.37236146 179.93640698 321.71838419]

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loss = 4713.520011454179
gammas = [ 30.28130545  89.59979055 180.30696775 322.55834211]
loss = 4651.863021290512
gammas = [ 30.64409907  89.83500989 181.12897224 322.92896492]
loss = 4594.303381869489
gammas = [ 30.6014287   90.65994257 181.48716068 323.36412737]
loss = 4539.854525201704
gammas = [ 30.19049392  90.73110057 182.11799398 324.01843502]
loss = 4472.736565286454
gammas = [ 30.35102847  91.12426078 182.70095596 324.71111751]
loss = 4406.891121529622
gammas = [ 30.45280625  91.55164692 183.36919362 325.31148473]
loss = 4342.282553141329
gammas = [ 30.53329294  91.97127697 183.85890747 326.07149319]
loss = 4278.786002822246
gammas = [ 30.51609194  92.41296982 184.50375362 326.69501944]
loss = 4222.8992172349745
gammas = [ 30.45645159  92.7961534   184.71386141 327.59249818]
loss = 4163.957185183624
gammas = [ 30.72545054  92.88988764 185.36505716 328.29591666]
loss = 4105.391113803357
gammas = [ 31.06161158  93.48784944 185.84626303 328.841699  ]
loss = 4044.634778403244
gammas = [ 31.10282616  93.89037699 186.47893929 329.50199717]
loss = 3984.849074857458
gammas = [ 31.29606201  94.26227226 187.01363058 330.23579485]
loss = 3927.2727929103307
gammas = [ 31.51435699  94.63119016 187.76751079 330.73370198]
loss = 3870.032092383722
gammas = [ 31.79823626  94.97976165 188.25566334 331.48177789]
loss = 3818.260917194001
gammas = [ 32.20430851  95.29007417 189.03587719 331.84244092]
loss = 3762.7664848881877
gammas = [ 32.20692794  95.87047036 189.59523561 332.43426147]
loss = 3709.199443220303
gammas = [ 32.53488946  96.23530403 189.98628933 333.21298775]
loss = 3657.0550499492833
gammas = [ 32.88056171  96.71140839 190.68474575 333.62041132]
loss = 3606.350015118153
gammas = [ 32.83340557  96.80959252 191.40600975 334.30445402]
loss = 3552.5435507585225
gammas = [ 32.9440067   97.28867154 191.95774208 334.97813208]
loss = 3499.9175029300145
gammas = [ 33.21195234  97.61196646 192.56075962 335.65640589]
loss = 3448.2169789532636
gammas = [ 33.27531377  98.06088973 193.26154564 336.20718006]
loss = 3398.398379185431
gammas = [ 33.60679032  98.28554332 193.92831681 336.83572622]

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loss = 3350.3135652615833
gammas = [ 33.59375861  98.72672994 194.71792414 337.26199468]
loss = 3301.5024948277055
gammas = [ 33.60938984  99.1032666  195.17224361 338.06919331]
loss = 3253.9713896107946
gammas = [ 33.90249525  99.28127858 195.85542071 338.71391805]
loss = 3208.514927715901
gammas = [ 33.77178596  99.71258764 196.61727607 339.17917495]
loss = 3167.7025142494367
gammas = [ 33.67888651 100.02362699 196.80880815 340.10542528]
loss = 3125.5751148886316
gammas = [ 34.06527682 100.73754618 197.18163383 340.5548949 ]
loss = 3078.5405356358524
gammas = [ 34.22575087 101.1102266  197.81366182 341.21512062]
loss = 3032.542946485886
gammas = [ 34.27351474 101.61341768 198.39580288 341.85201083]
loss = 2987.2264697311844
gammas = [ 34.52210051 101.99235116 198.92860896 342.56666614]
loss = 2942.9477314243927
gammas = [ 34.55315178 102.54121571 199.46481586 343.207186  ]
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gammas = [ 34.88087245 102.88750768 199.93466567 343.95010065]
loss = 2857.2799470868054
gammas = [ 34.90328733 103.47229858 200.42637713 344.59487737]
loss = 2816.805771183962
gammas = [ 35.29774999 103.80227916 200.81358313 345.36011167]
loss = 2776.295048966281
gammas = [ 35.29118062 104.43417475 201.25568301 345.99667471]
loss = 2738.578769283003
gammas = [ 35.7274467  104.77616218 201.54484548 346.77712431]
loss = 2701.269101045239
gammas = [ 36.02390959 105.11195796 202.38959066 347.06996647]
loss = 2668.4365863621297
gammas = [ 35.82612412 105.03784034 202.99774294 347.8351712 ]
loss = 2628.055864590402
gammas = [ 35.98004077 105.50953139 203.58531441 348.47437147]
loss = 2588.549837267827
gammas = [ 36.24064619 105.85309272 204.209035  349.12630939]
loss = 2549.75589296909
gammas = [ 36.29392408 106.31320482 204.89171991 349.69146392]
loss = 2512.027914619374
gammas = [ 36.46724268 106.55692985 205.62211813 350.30553005]
loss = 2481.8656075648055
gammas = [ 36.10772844 107.06728127 206.34635324 350.59840282]
loss = 2445.343220378464
gammas = [ 36.2075453  107.52655082 206.76491951 351.3755195 ]
loss = 2409.2897302236884
gammas = [ 36.34129704 107.74370164 207.4627737  352.0448143 ]

```

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loss = 2378.1316654708394
gammas = [ 35.97537626 108.12293971 208.03783783 352.67057921]
loss = 2343.2482170549897
gammas = [ 36.22140307 108.72239998 208.65721648 353.11384921]
loss = 2307.859213709419
gammas = [ 36.41624599 109.11623405 209.20471588 353.82601166]
loss = 2273.3939139444087
gammas = [ 36.56531936 109.46523128 209.95152602 354.37213682]
loss = 2240.6564490225473
gammas = [ 36.74464285 109.76721901 210.35893918 355.21514394]
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gammas = [ 36.85518693 110.34822775 210.92870219 355.78573922]
loss = 2175.1816025152802
gammas = [ 36.98057099 110.5477558 211.72083911 356.34875475]
loss = 2144.977626644234
gammas = [ 37.09498122 110.84227356 212.05326432 357.23738463]
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gammas = [ 37.74701001 111.23977242 212.52387447 357.67940184]
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loss = 2053.2192133014464
gammas = [ 38.08660762 112.04562453 213.79505161 358.93581332]
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gammas = [ 38.28657001 112.58475632 214.28650455 359.58989738]
loss = 1992.2201428564672
gammas = [ 38.54185758 112.84657785 214.90404345 360.28626184]
loss = 1962.9514180588556
gammas = [ 38.76699783 113.43627808 215.30090863 360.95264276]
loss = 1934.2672184563237
gammas = [ 39.06498061 113.64548624 215.88458463 361.67842546]
loss = 1907.0641041399958
gammas = [ 39.32704224 114.27001452 216.16378531 362.35911271]
loss = 1879.9453160738283
gammas = [ 39.49812826 114.78864568 216.94840518 362.65257981]
loss = 1852.316548485785
gammas = [ 39.82022694 115.00988964 217.56859548 363.3327765 ]
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gammas = [ 40.10352988 115.67848697 217.91711115 363.92544325]
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gammas = [ 40.47888317 115.71185365 218.3116214 364.76351141]
loss = 1781.930211828095
gammas = [ 39.98724478 116.03416421 218.79088701 365.41521079]
loss = 1754.8542713821855
gammas = [ 40.21269259 116.48574448 219.45380977 365.96818635]
loss = 1728.2851273545102
gammas = [ 40.41923811 116.97303513 219.98604464 366.62895318]
loss = 1702.2549681432395
gammas = [ 40.60394259 117.30490451 220.68838162 367.23100777]

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loss = 1676.7579925020095
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gammas = [ 40.82866182 117.81914953 222.05207351 368.49300309]
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gammas = [ 40.93152323 118.49315933 222.70405722 368.82473726]
loss = 1606.9758000401964
gammas = [ 41.47897777 118.87026119 223.21435682 369.37033972]
loss = 1582.6275342414265
gammas = [ 41.61657996 119.31711714 223.80470795 370.02826899]
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gammas = [ 41.85163539 119.74897281 224.51095744 370.53764242]
loss = 1535.5036215413033
gammas = [ 42.09368257 120.35690608 224.98729374 371.12495326]
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gammas = [ 42.38912191 120.79164333 225.73118154 371.53768811]
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gammas = [ 42.70529481 121.49663388 226.11352609 372.04447767]
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gammas = [ 42.93440523 121.75599117 226.65774656 372.80871997]
loss = 1448.1482204975139
gammas = [ 43.29083348 122.14176645 227.42440349 373.17800779]
loss = 1427.416886197131
gammas = [ 43.66368087 122.76721368 227.78466313 373.76111462]
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gammas = [ 43.42541304 123.31013543 228.41193369 374.26608596]
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gammas = [ 43.67629062 123.69798543 229.04107539 374.89123678]
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gammas = [ 43.93336738 124.25845303 229.68368485 375.34603419]
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gammas = [ 44.10916423 124.74124787 230.18413583 376.04285083]
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gammas = [ 44.33008298 125.41563442 230.76271022 376.44490724]
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gammas = [ 44.78940874 127.23185595 232.92008694 379.01109654]
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gammas = [ 44.91302953 128.13925832 233.17472525 379.32173809]
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gammas = [ 45.65955278 128.39304077 233.5367445 379.81897 ]
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gammas = [ 45.85450868 128.82259082 234.22287189 380.37278239]

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loss = 1184.845465631117
gammas = [ 46.08435074 129.28972803 234.77789968 381.02155015]
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gammas = [ 46.47038242 129.75631667 235.03549541 381.7744904 ]
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gammas = [ 46.76900505 130.25016027 235.70084423 382.248045 ]
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gammas = [ 47.27228371 131.22440792 236.64477082 383.51347078]
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gammas = [ 47.63333732 131.22826772 237.35443496 384.11845194]
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gammas = [ 47.84927425 131.73821428 238.0293497 384.60611561]
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gammas = [ 48.16727016 132.19103704 238.55049447 385.25591425]
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gammas = [ 48.26976138 132.58435124 239.23898587 385.85656314]
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gammas = [ 49.82774234 134.59398455 242.61175489 389.73724235]
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gammas = [ 51.07894637 138.49377249 247.20051223 393.6337026 ]
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gammas = [ 51.38879301 138.70646565 247.89412244 394.24824434]

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gammas = [ 51.91731398 139.68474726 249.18819166 395.26954145]
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gammas = [ 53.25552109 141.52426656 251.34400816 397.45896642]
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gammas = [ 53.1083018 141.6829225 252.00002976 398.18200891]
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gammas = [ 53.9444455 143.14764969 253.87290123 399.75916316]
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gammas = [ 54.87912501 145.44076816 257.00846444 402.30691248]
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gammas = [ 55.06883745 145.92820332 257.47225564 403.02197463]
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gammas = [ 55.7133586 147.72687168 258.85610739 404.05781747]
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gammas = [ 56.0587214 148.12604976 259.50296569 404.60823162]
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gammas = [ 56.31458114 148.65200486 260.15909767 405.08509412]
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gammas = [ 56.45313226 149.41974881 260.73863776 405.32069142]
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gammas = [ 56.83985099 149.89301165 261.26533207 405.91150782]
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gammas = [ 57.20870366 150.57713519 261.68782884 406.37779011]

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gammas = [ 57.72506204 151.31142202 263.21630087 407.06059096]
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gammas = [ 59.25378801 153.49894126 266.58036972 409.4183454 ]
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gammas = [ 59.52647775 154.10982625 267.31511054 409.53066525]
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gammas = [ 60.11391739 154.57511674 267.68254165 410.08149537]
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gammas = [ 60.08688963 155.13294579 268.17193477 410.75126445]
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gammas = [ 61.58008306 157.13127849 270.38584562 412.83955668]
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gammas = [ 61.94150635 157.4042664 270.79659569 413.63084372]
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loss = 452.57393903933064
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gammas = [ 66.16372055 162.32529127 276.93115346 418.34889815]
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gammas = [ 66.38512415 162.86794247 277.47043793 418.95361493]
loss = 436.6155009110904
gammas = [ 66.88910837 163.27312728 278.08229857 419.40908362]
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gammas = [ 67.20133222 163.77066458 278.77498845 419.82759722]
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gammas = [ 68.00050313 163.92736925 279.26857829 420.13278335]
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gammas = [ 68.65753368 164.7229005 280.59142708 421.11780878]
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gammas = [ 68.74659466 165.04528357 281.18119625 421.85286634]
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gammas = [ 69.23392586 165.77008672 281.27502858 422.33074101]
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gammas = [ 69.70429734 166.15479206 281.9312614 422.77807864]
loss = 398.8325993074743
gammas = [ 70.02282723 166.3562773 282.37175082 423.59288627]
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gammas = [ 70.28571877 166.91518574 283.03051134 424.02247208]
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gammas = [100.65928102 191.16279534 318.89753528 446.24670609]
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gammas = [102.06500246 191.83401493 320.03185725 446.56496281]
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```

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gammas = [278.25988426 249.82391024 395.65144388 439.82162721]
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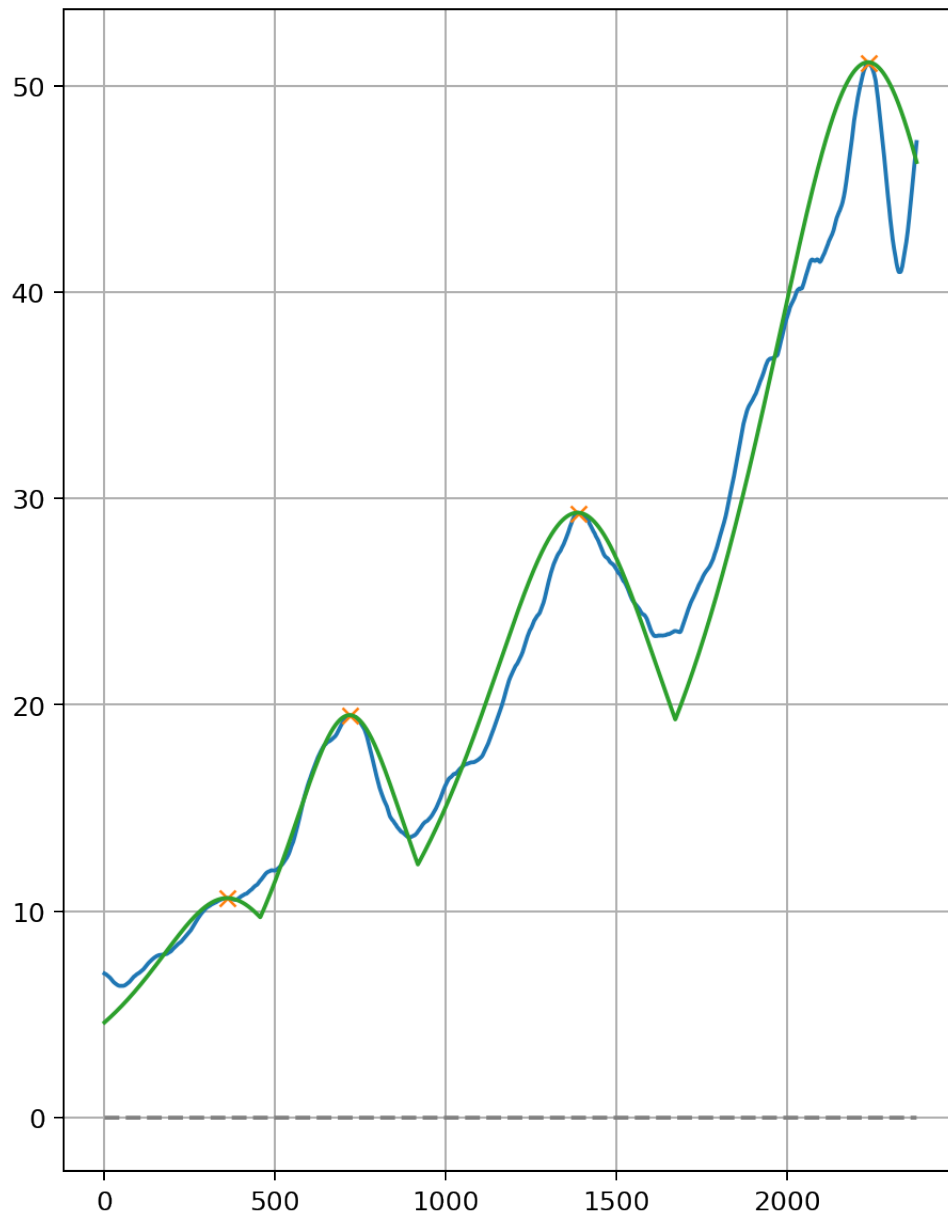
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gammas = [314.25243222 260.48300812 397.03120901 439.56706196]

```

[250]: *# Plot result Optimization*

```
plt_diff(get_fit_from_gamma(sol1.x),y)
```



1 :

```
[286]: from matplotlib.pyplot import savefig
from numpy import logspace

import matplotlib.animation as animation

from matplotlib.animation import FuncAnimation
```

```

from IPython.display import HTML

def animate(i):
    plt.cla()
    plt_diff(get_fit_from_gamma(list_off_gamma[i]),y)

ani = FuncAnimation(plt.gcf(), animate, interval=800 ,frames = 50 )

plt.tight_layout()

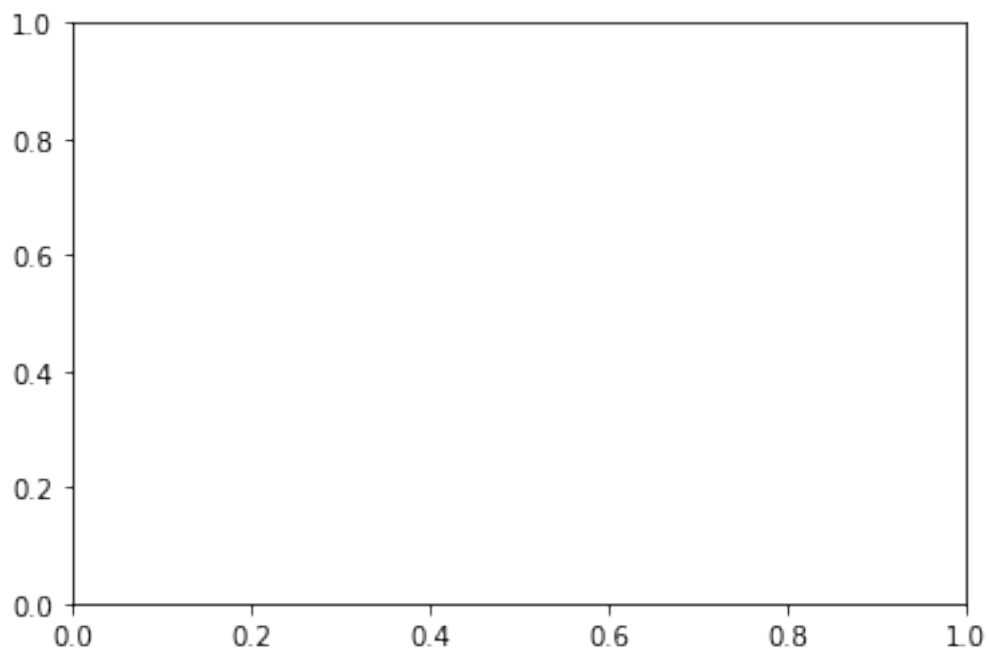
HTML(ani.to_jshtml())

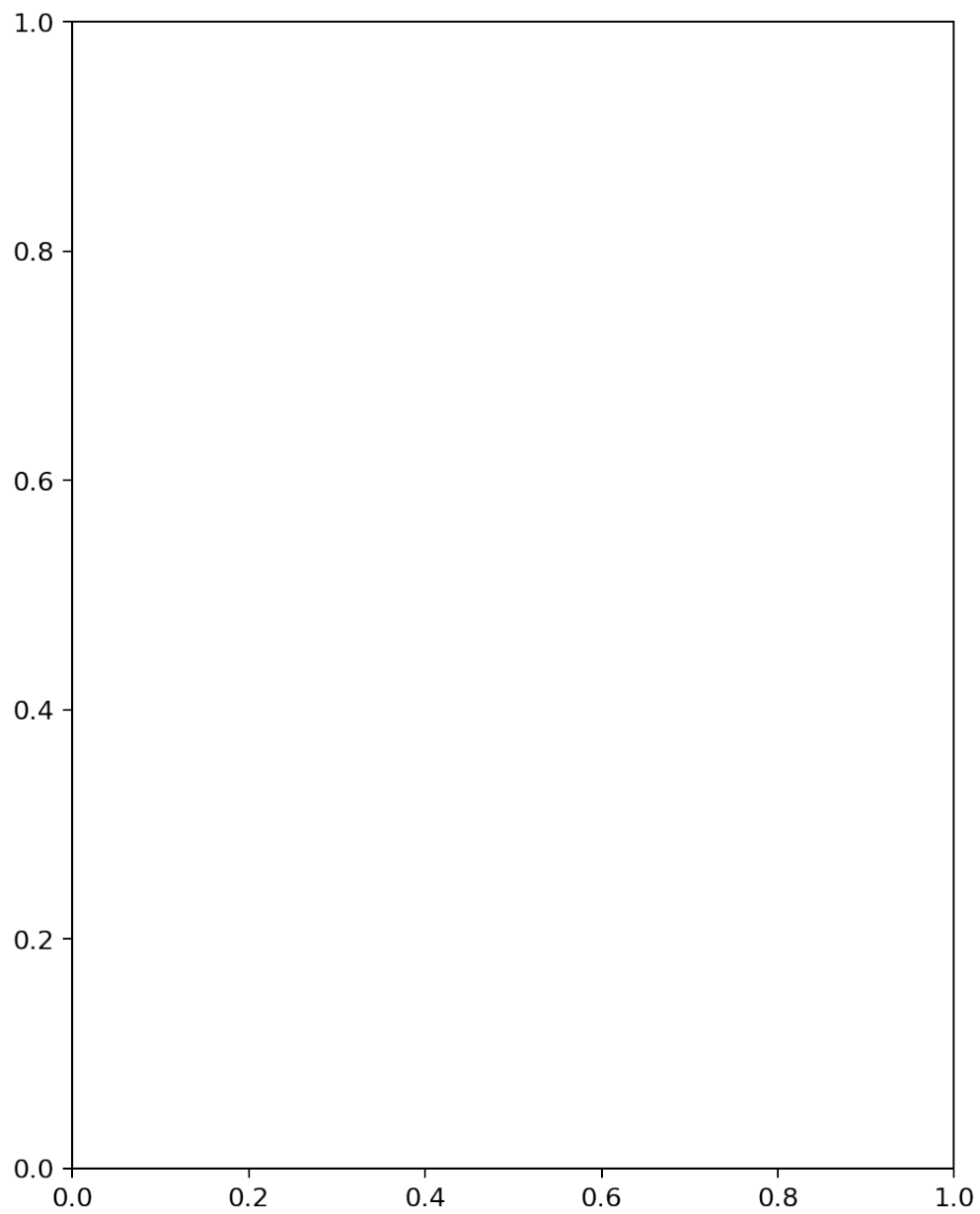
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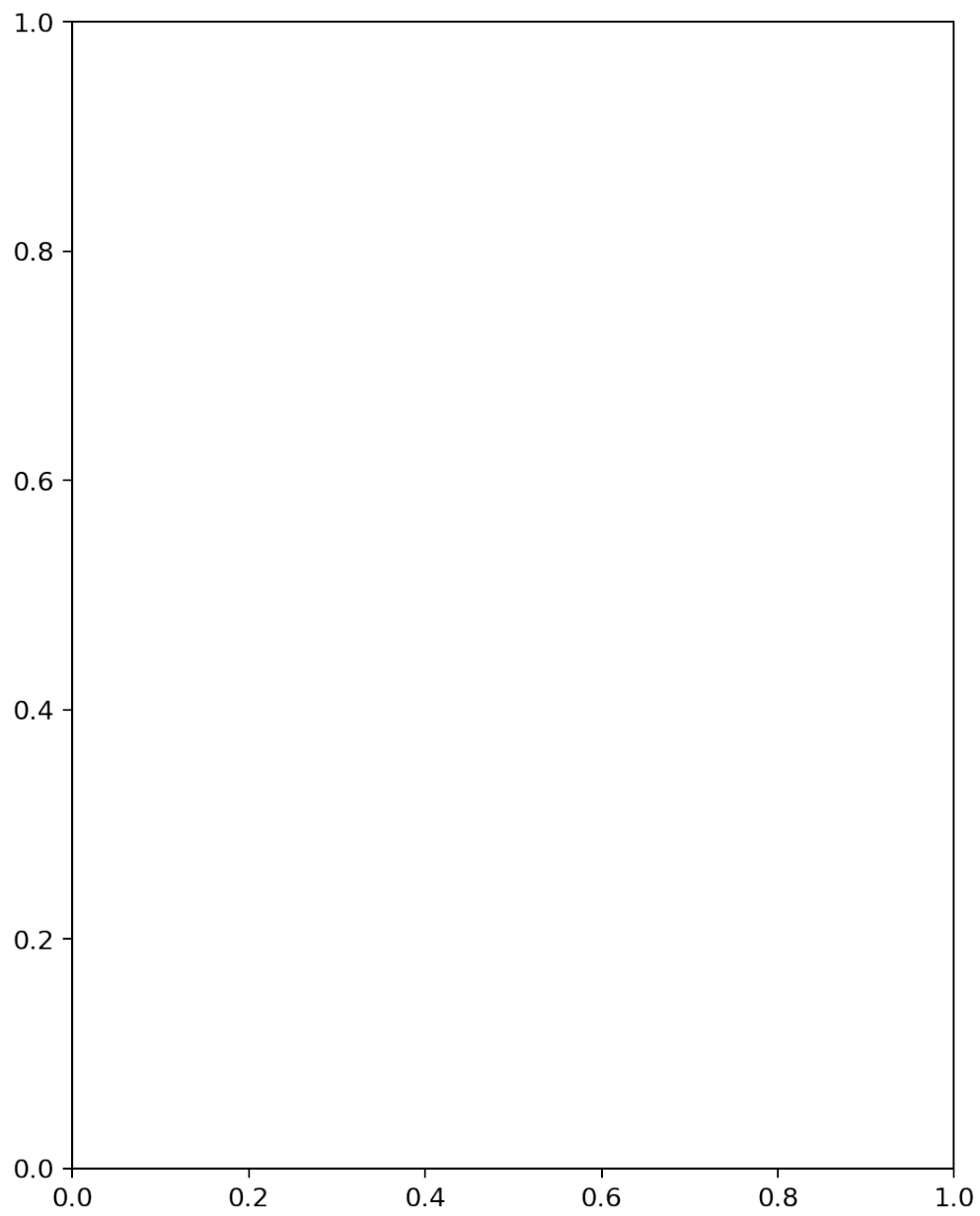
<ipython-input-213-c995350a4b53>:9: RuntimeWarning: More than 20 figures have been opened. Figures created through the pyplot interface (`matplotlib.pyplot.figure`) are retained until explicitly closed and may consume too much memory. (To control this warning, see the rcParam `figure.max_open_warning`).

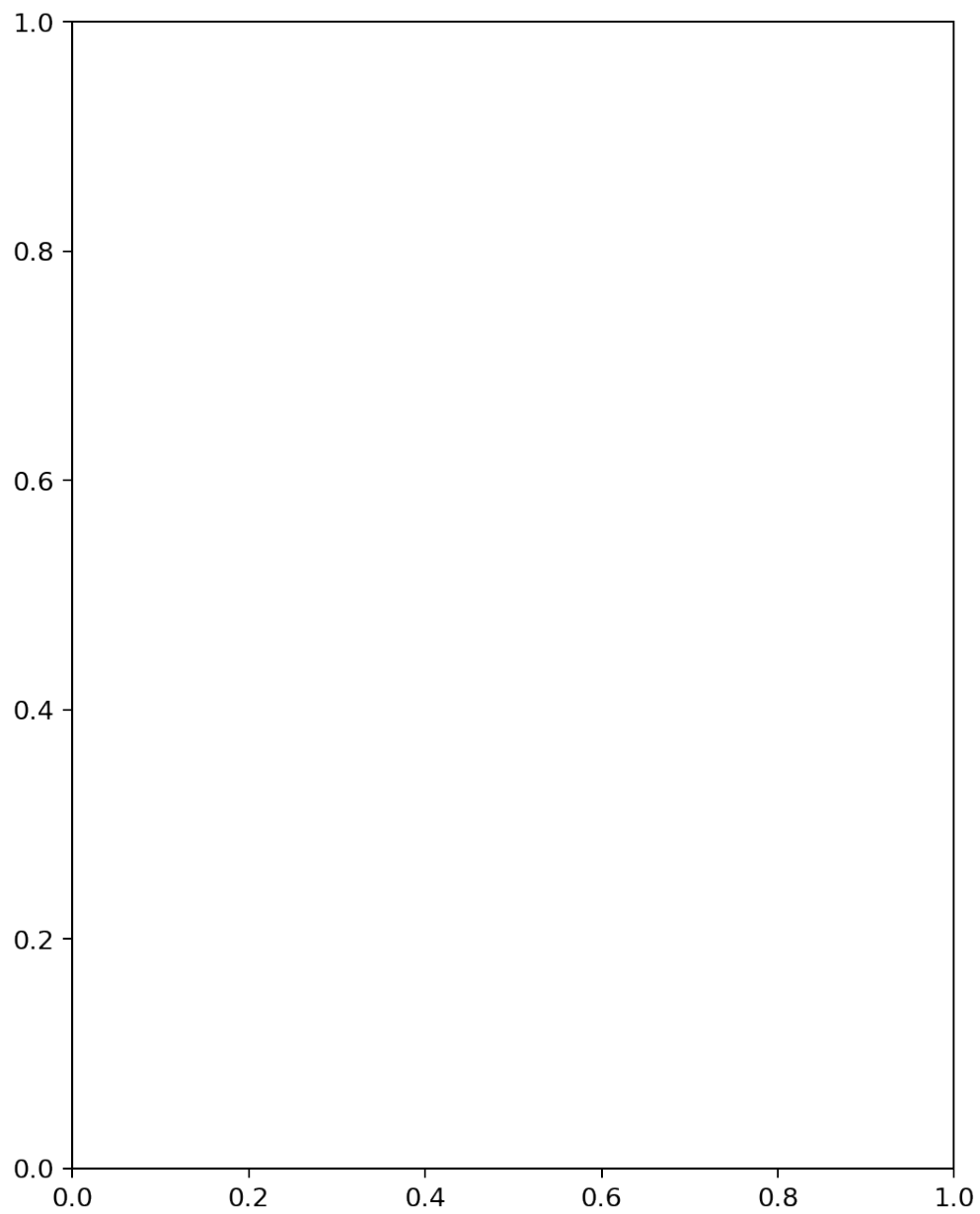
```
fig = plt.figure(figsize = (6,8),dpi = 180)
```

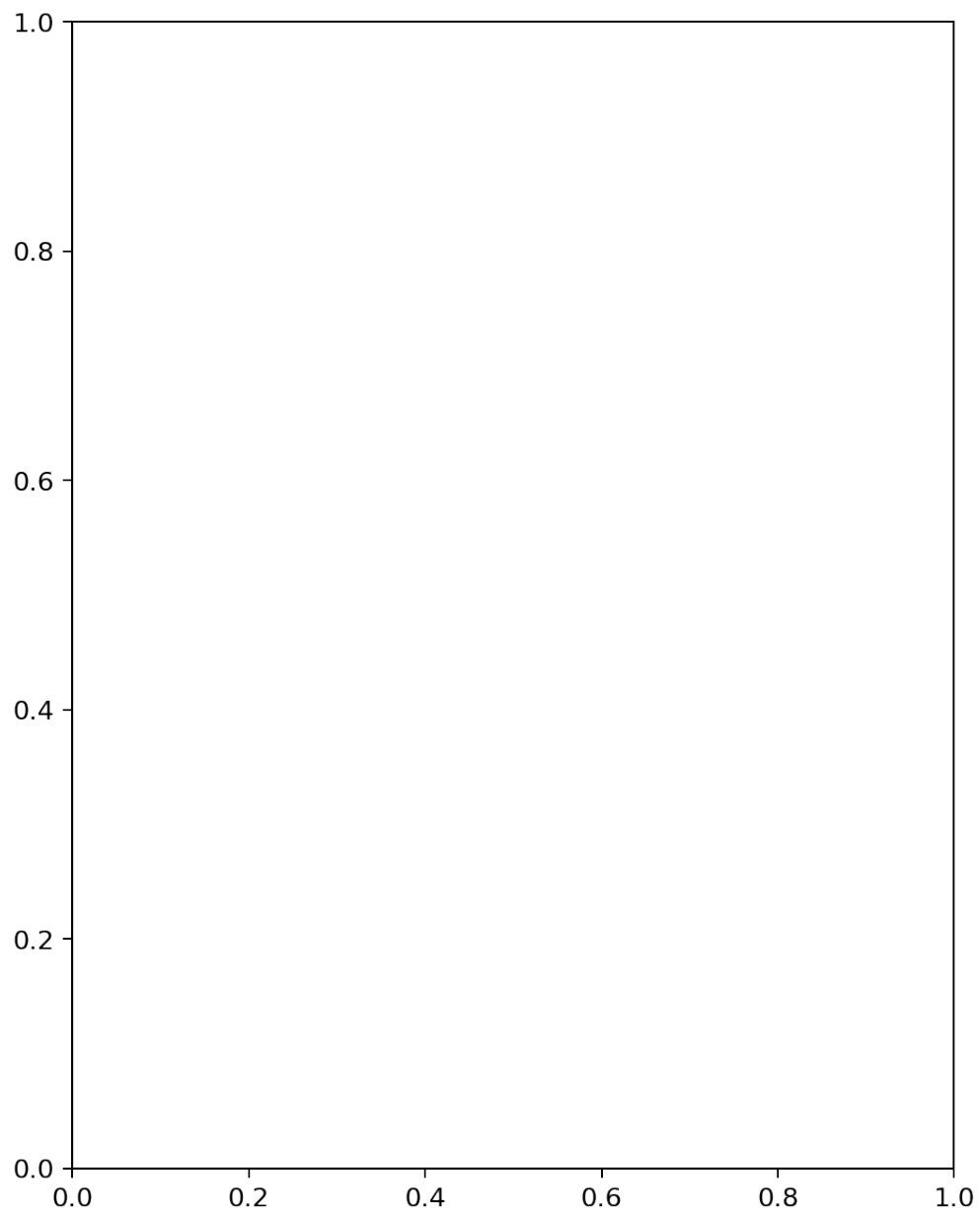
[286]: <IPython.core.display.HTML object>

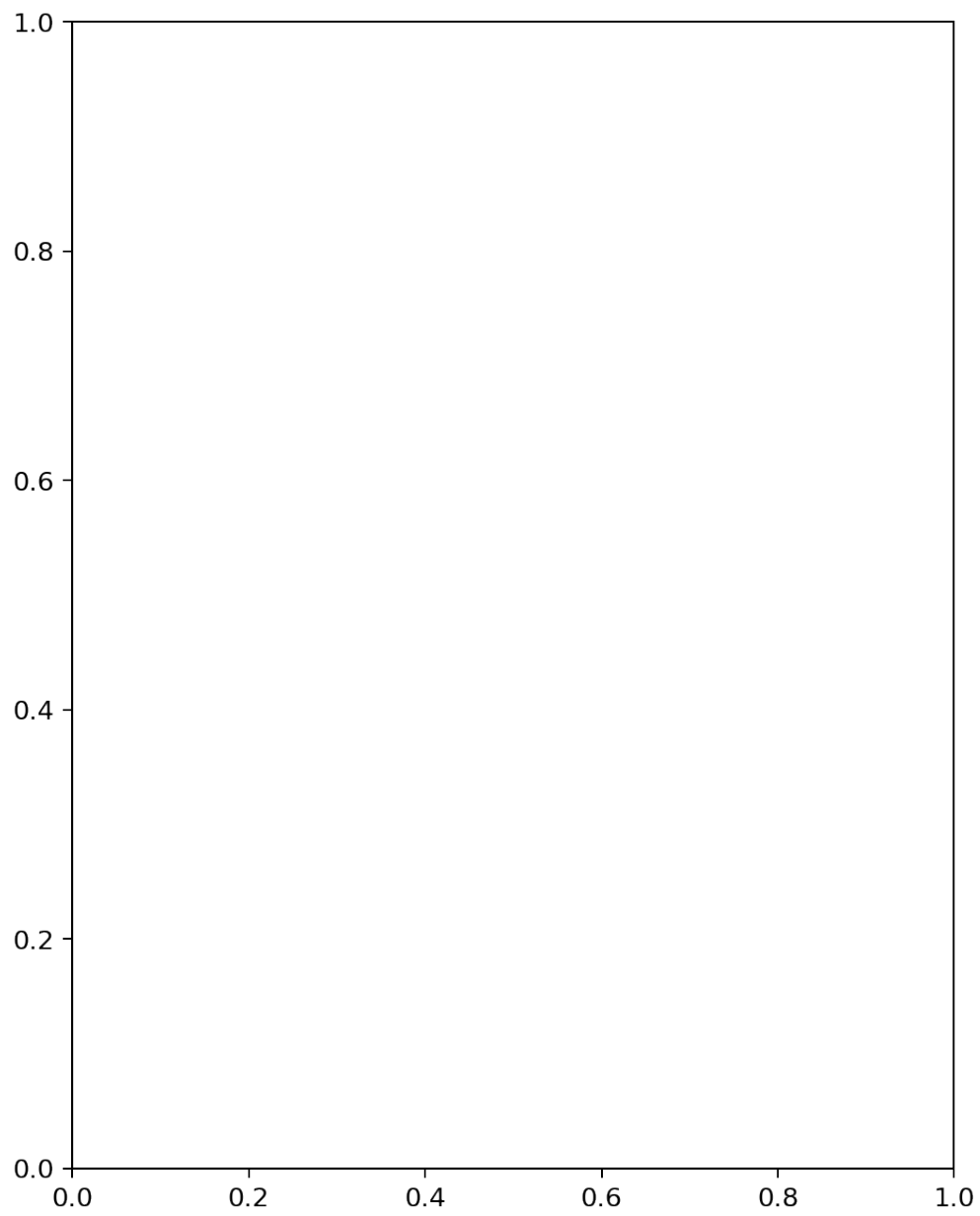


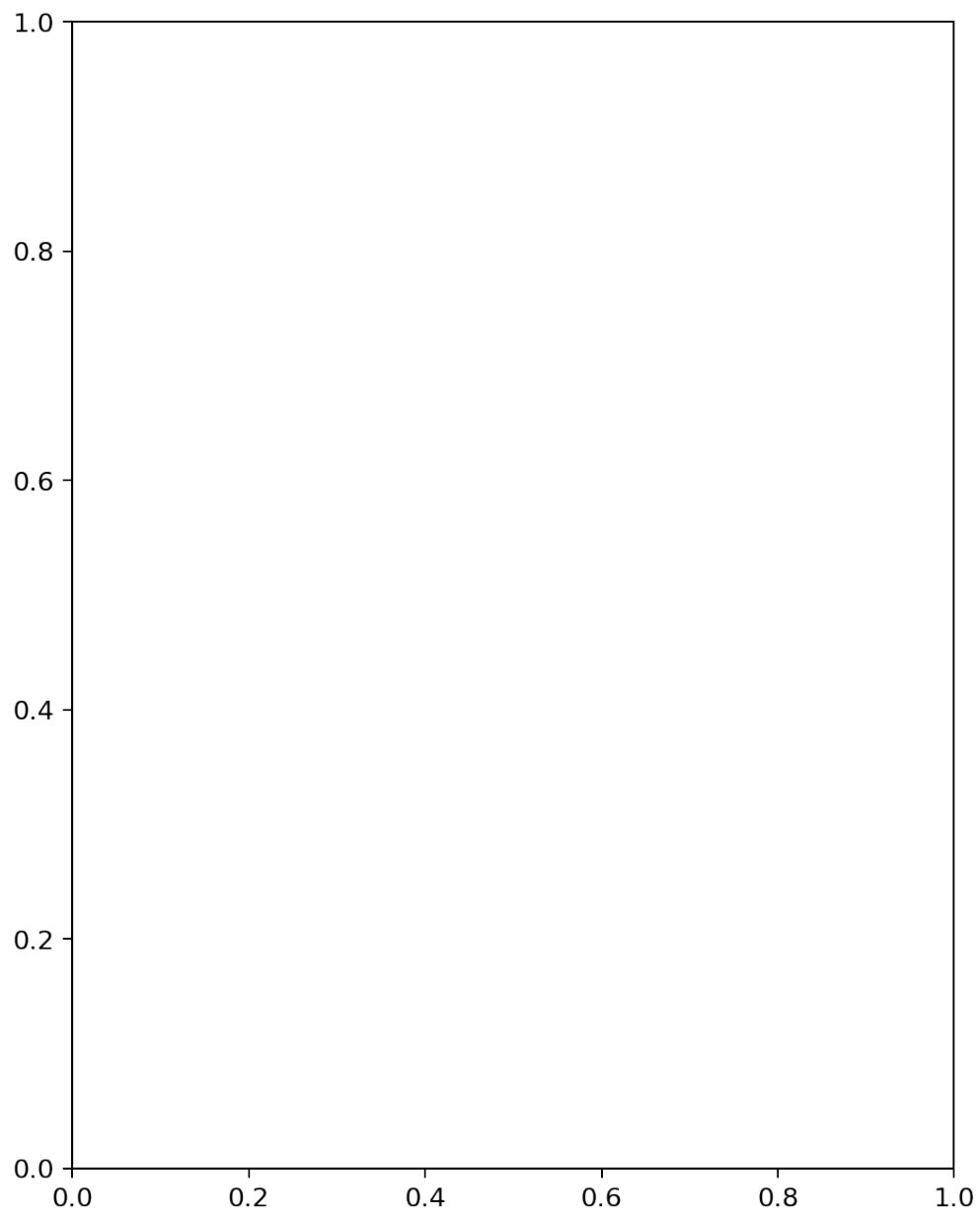


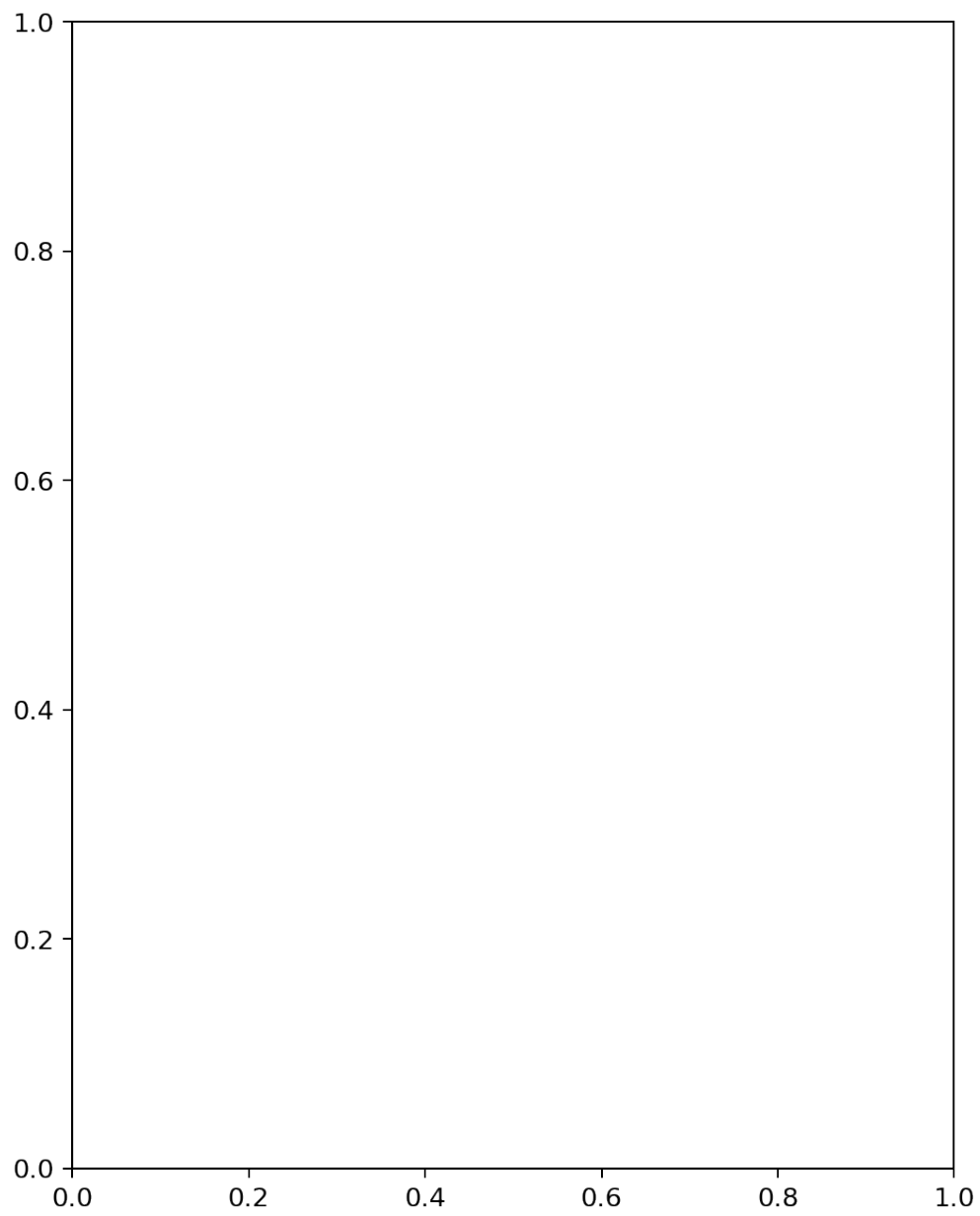


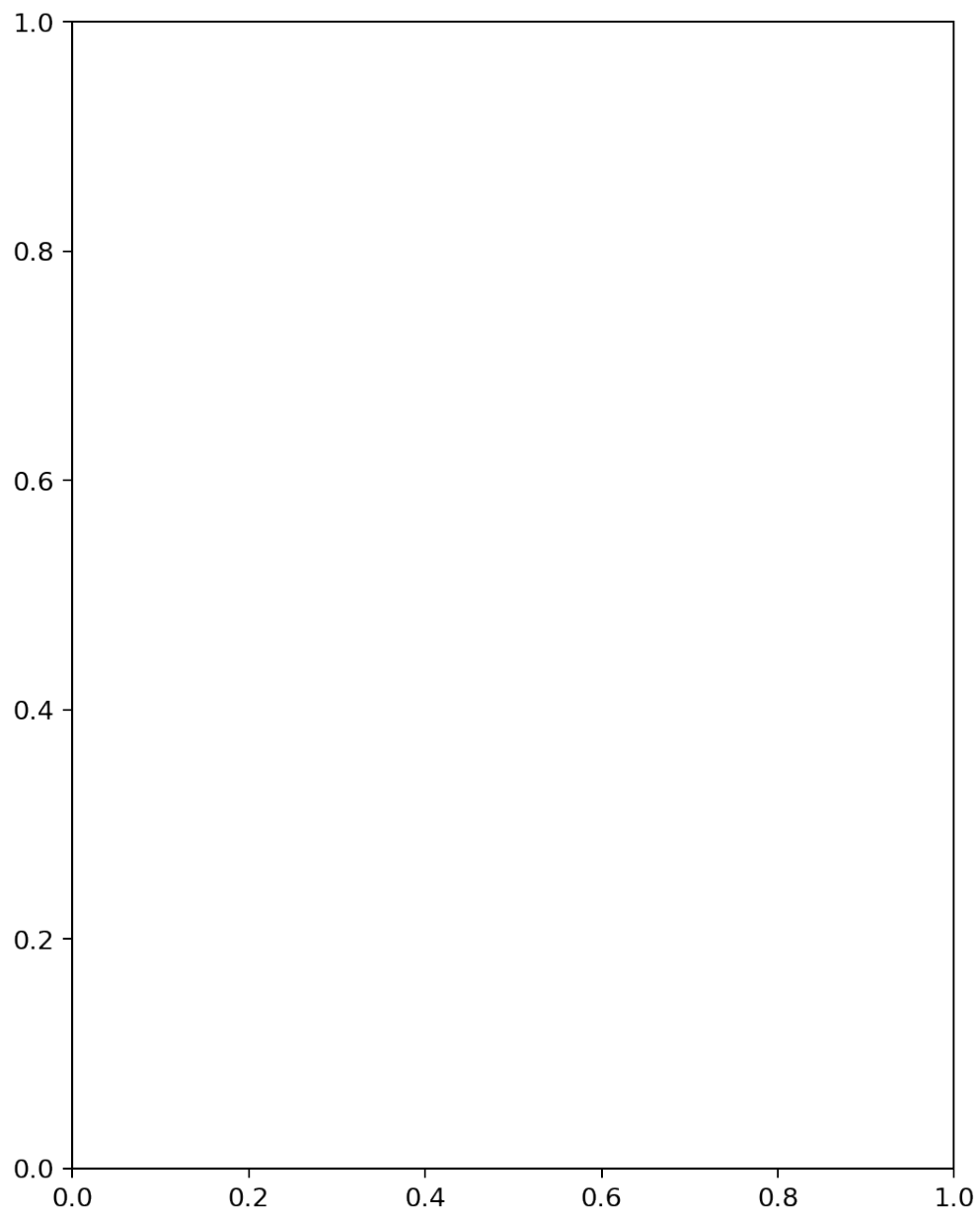


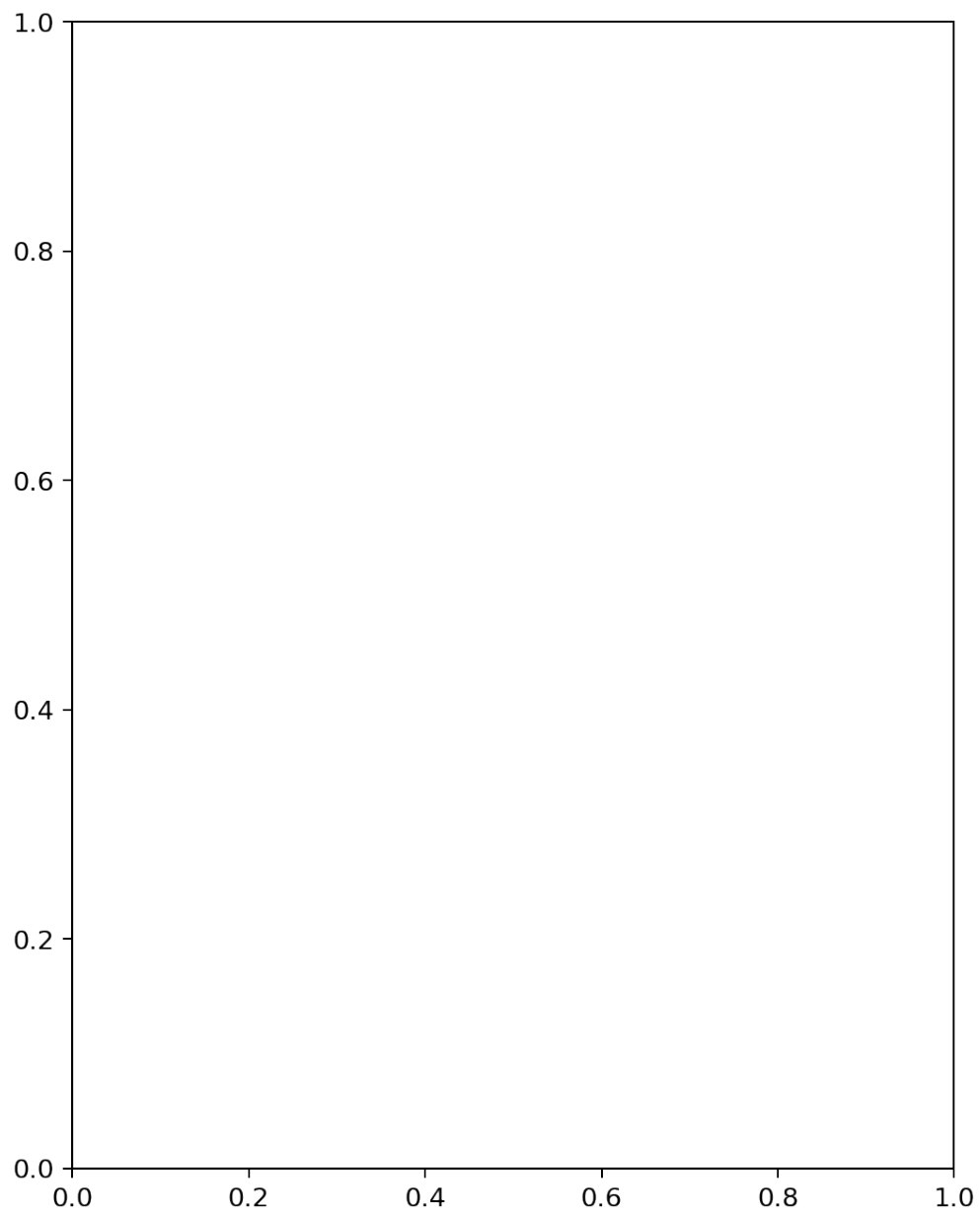


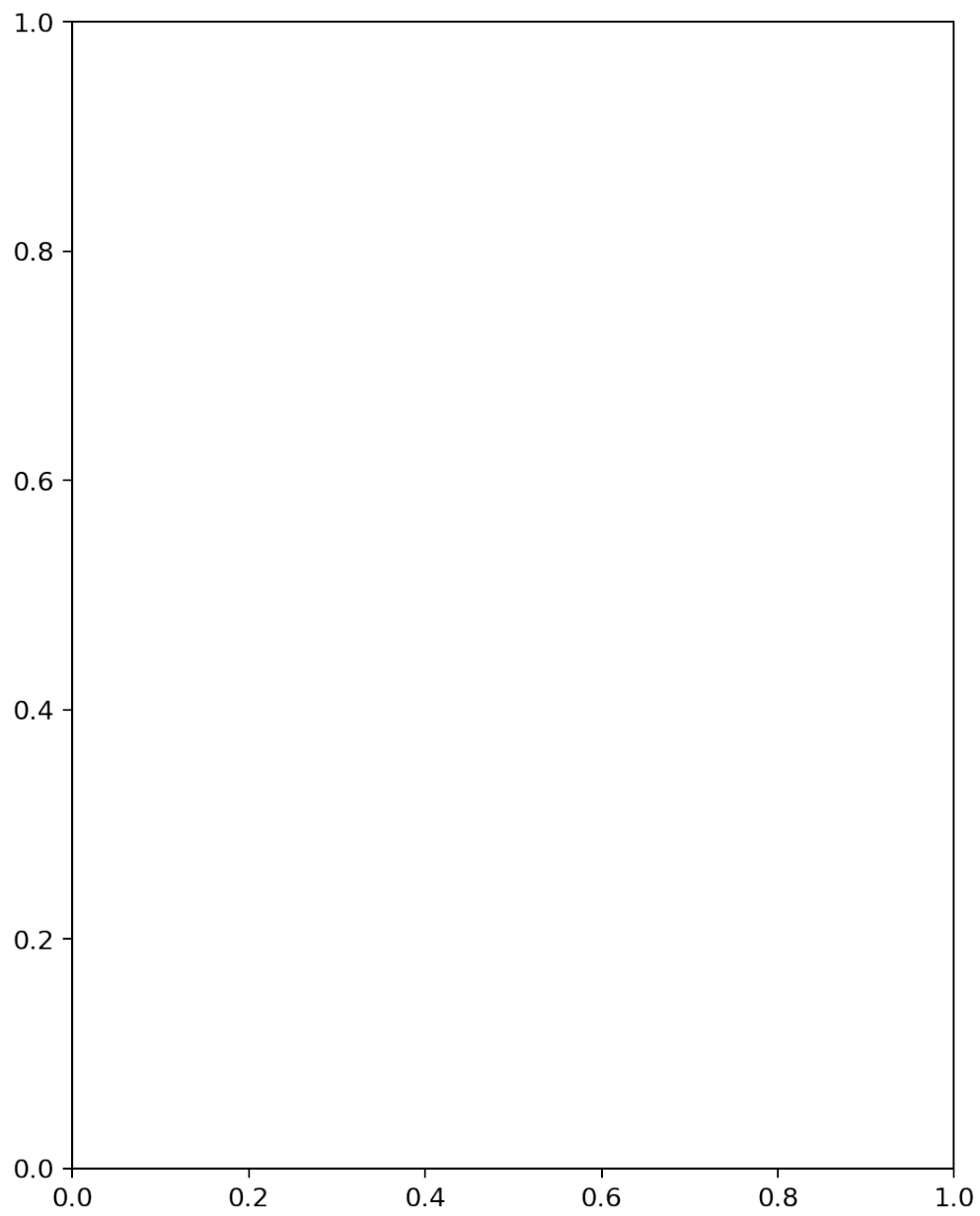


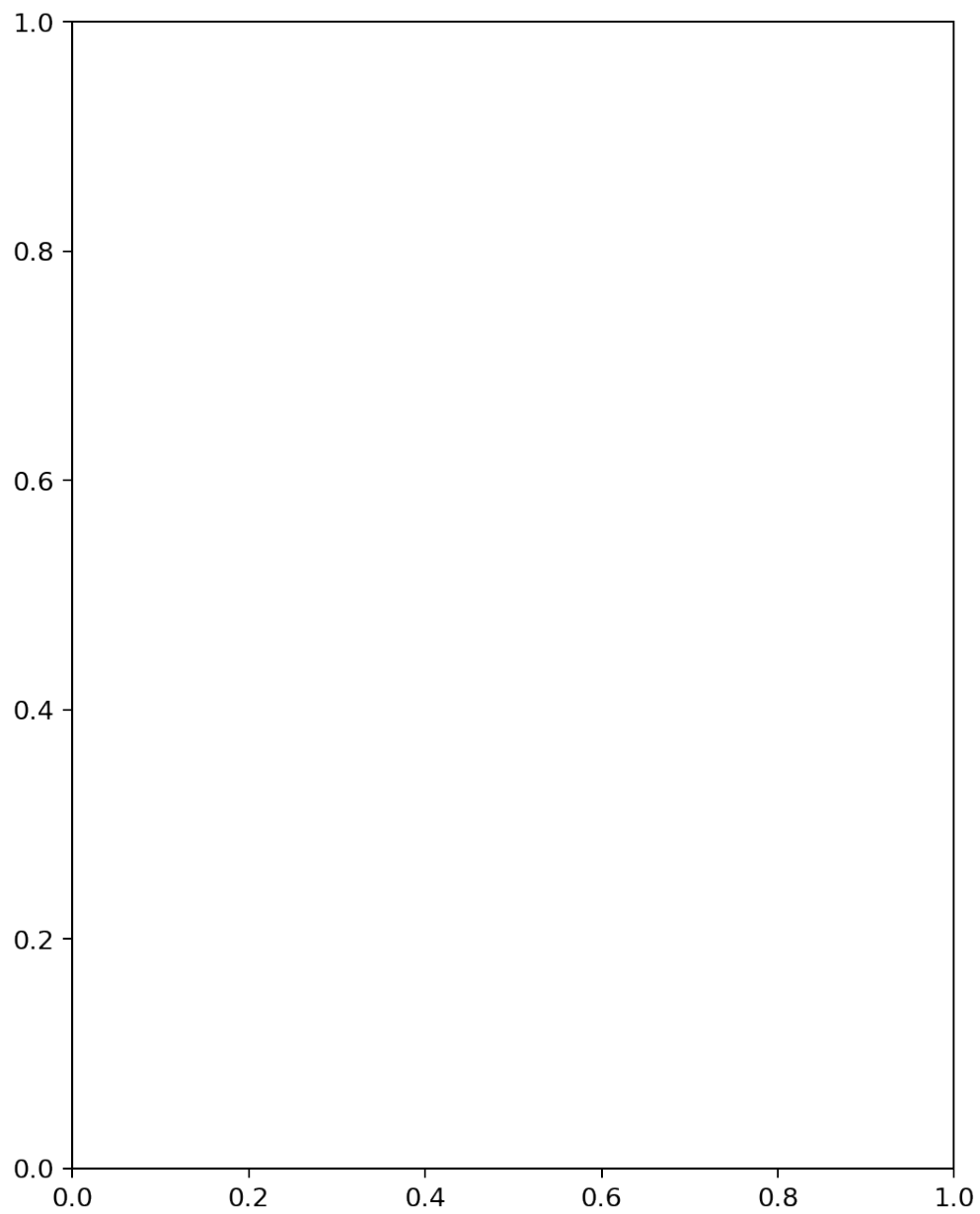


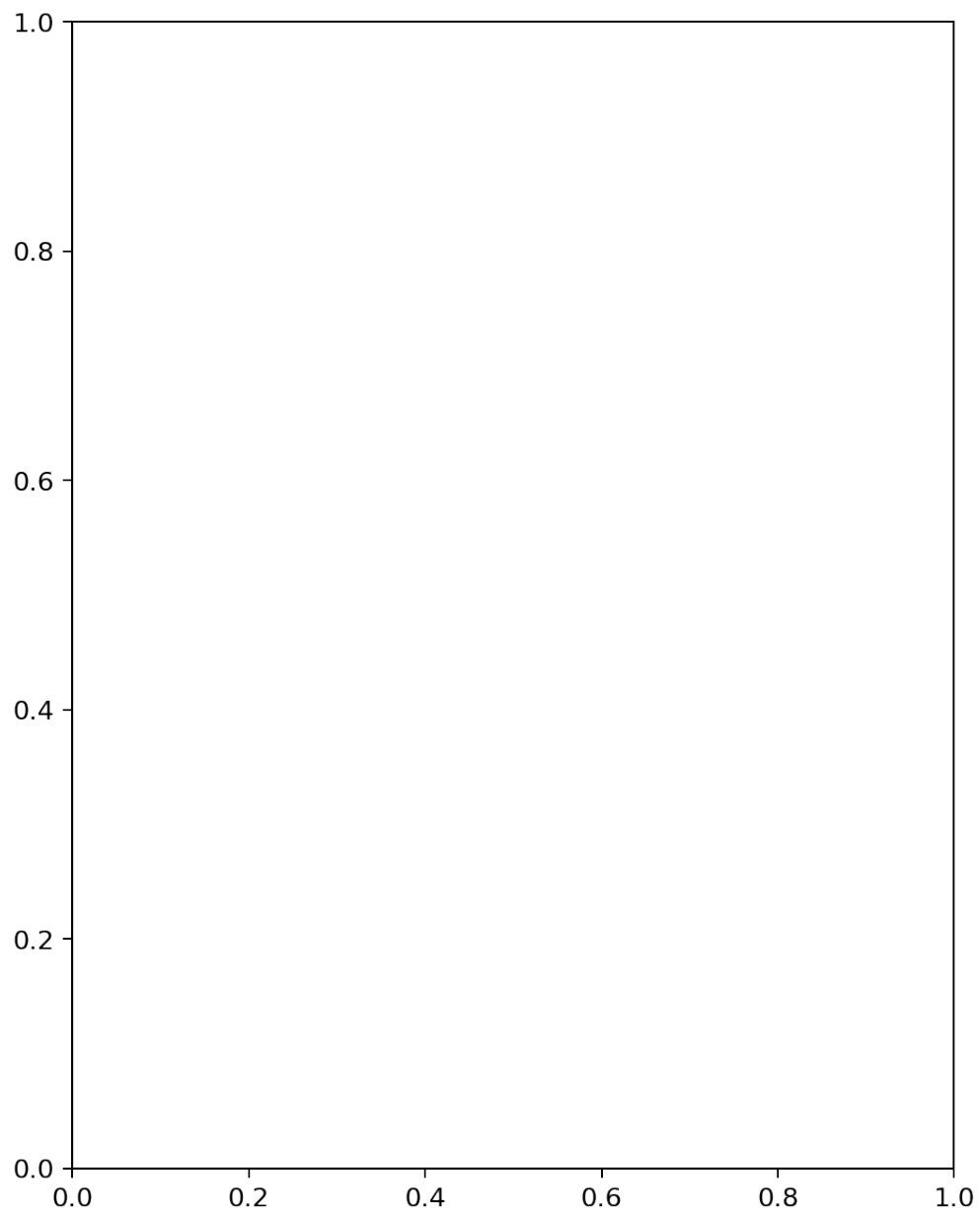


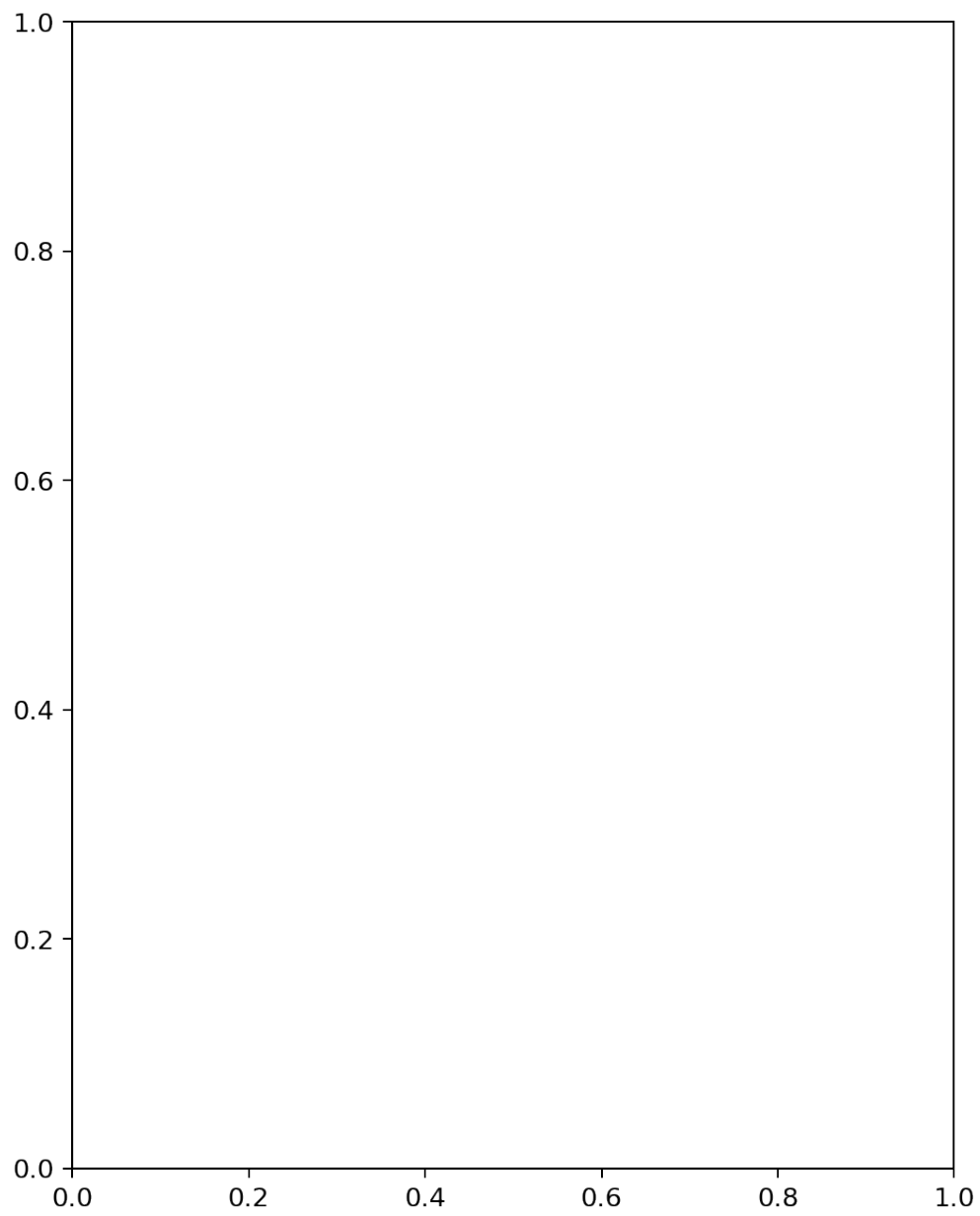


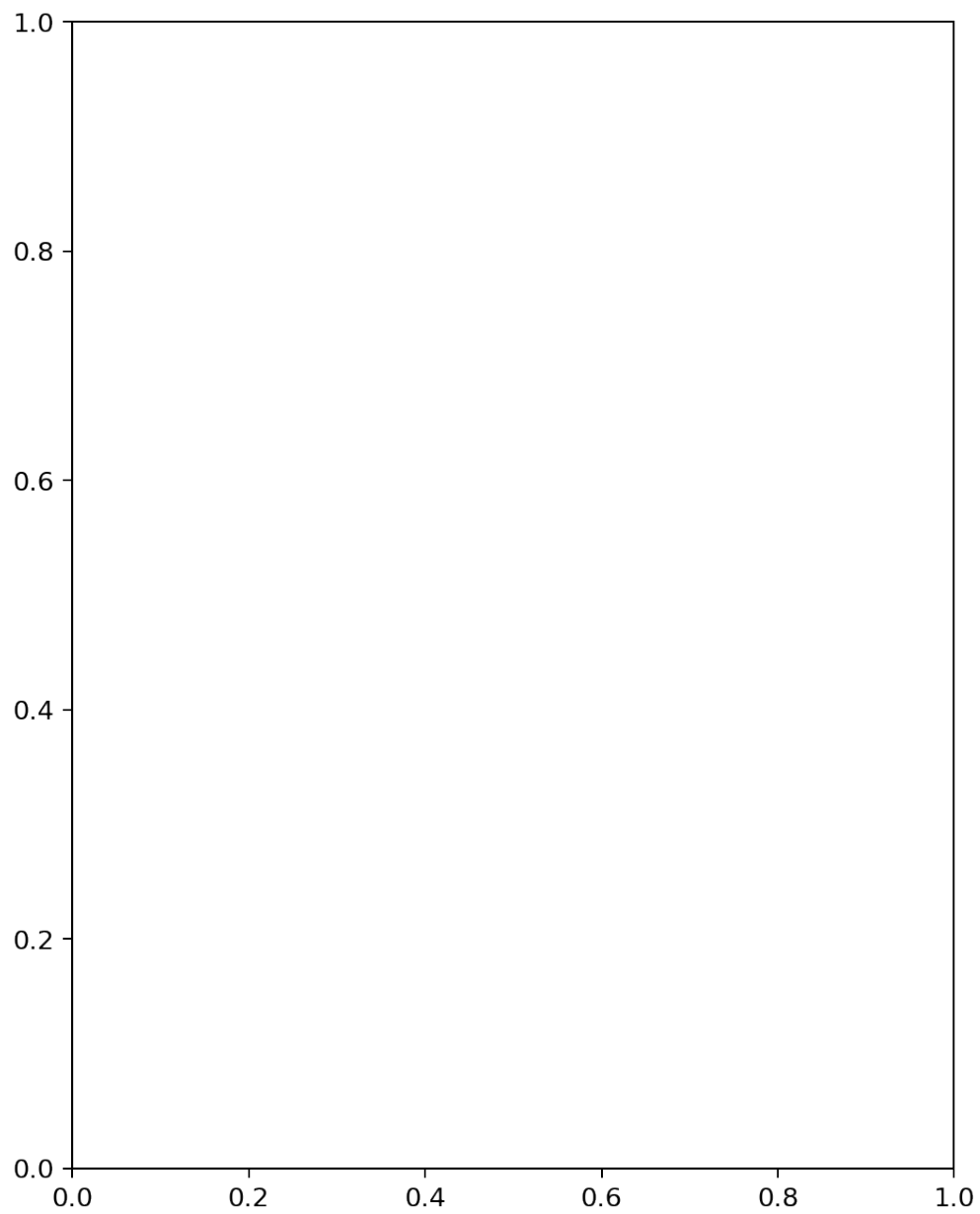


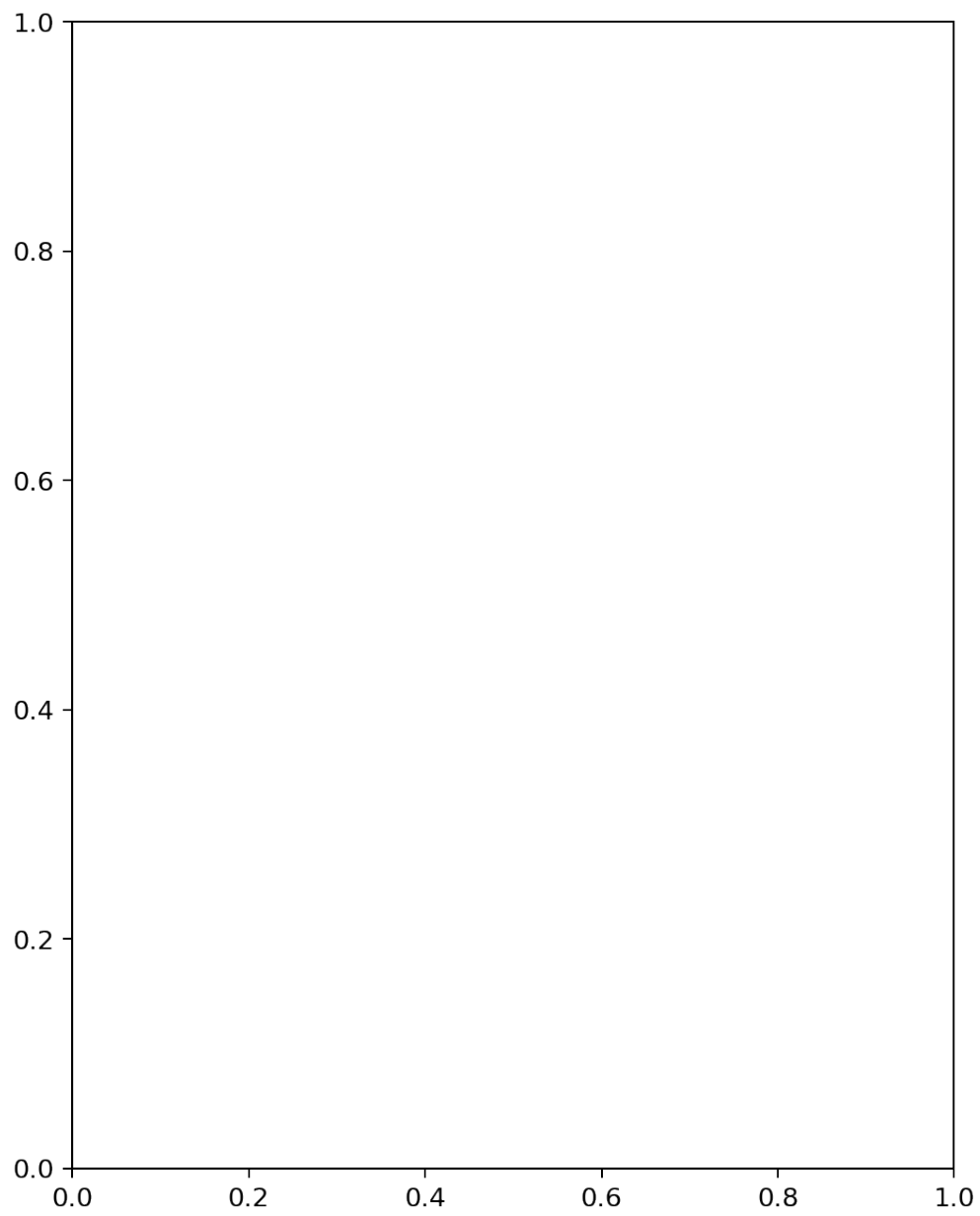


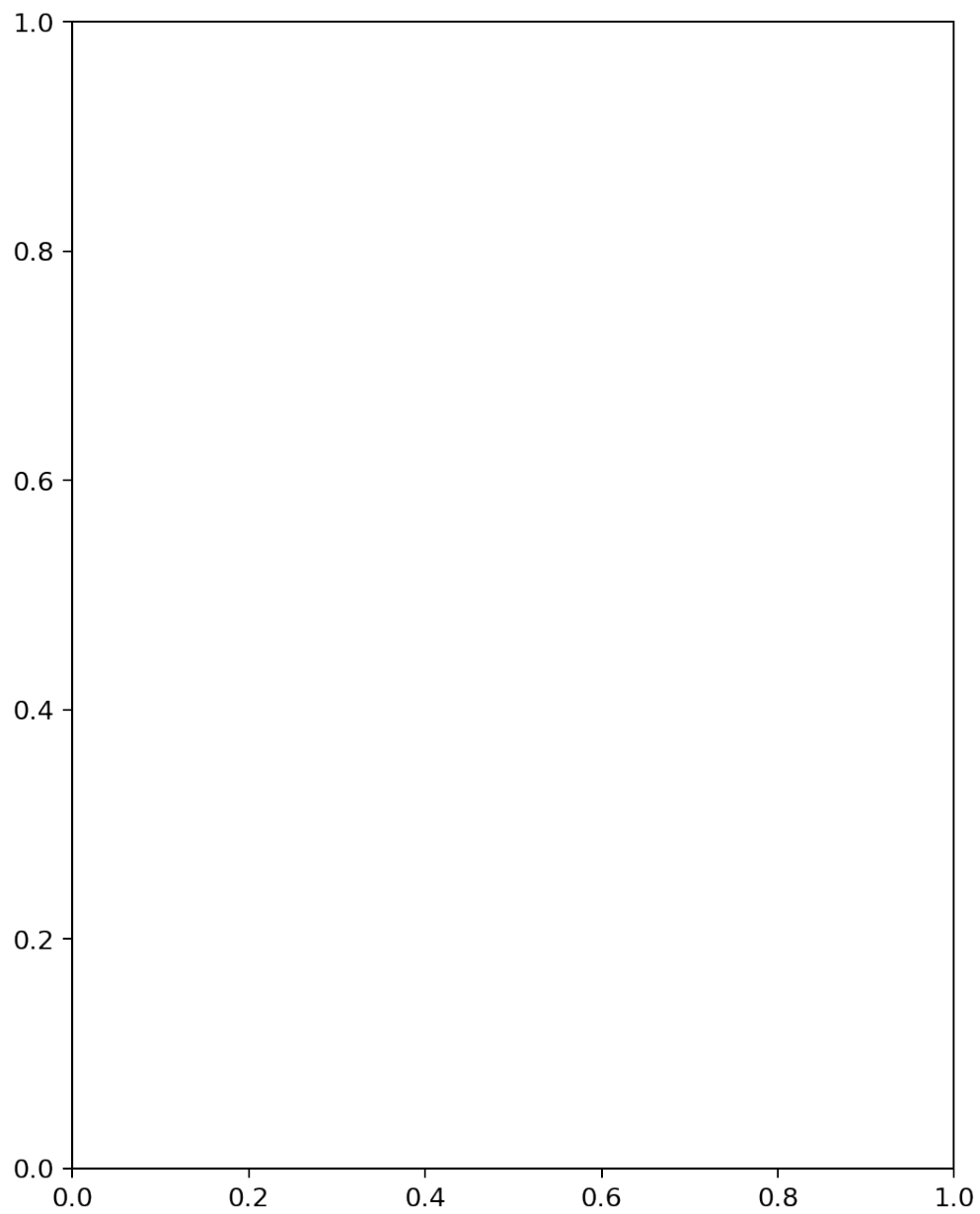


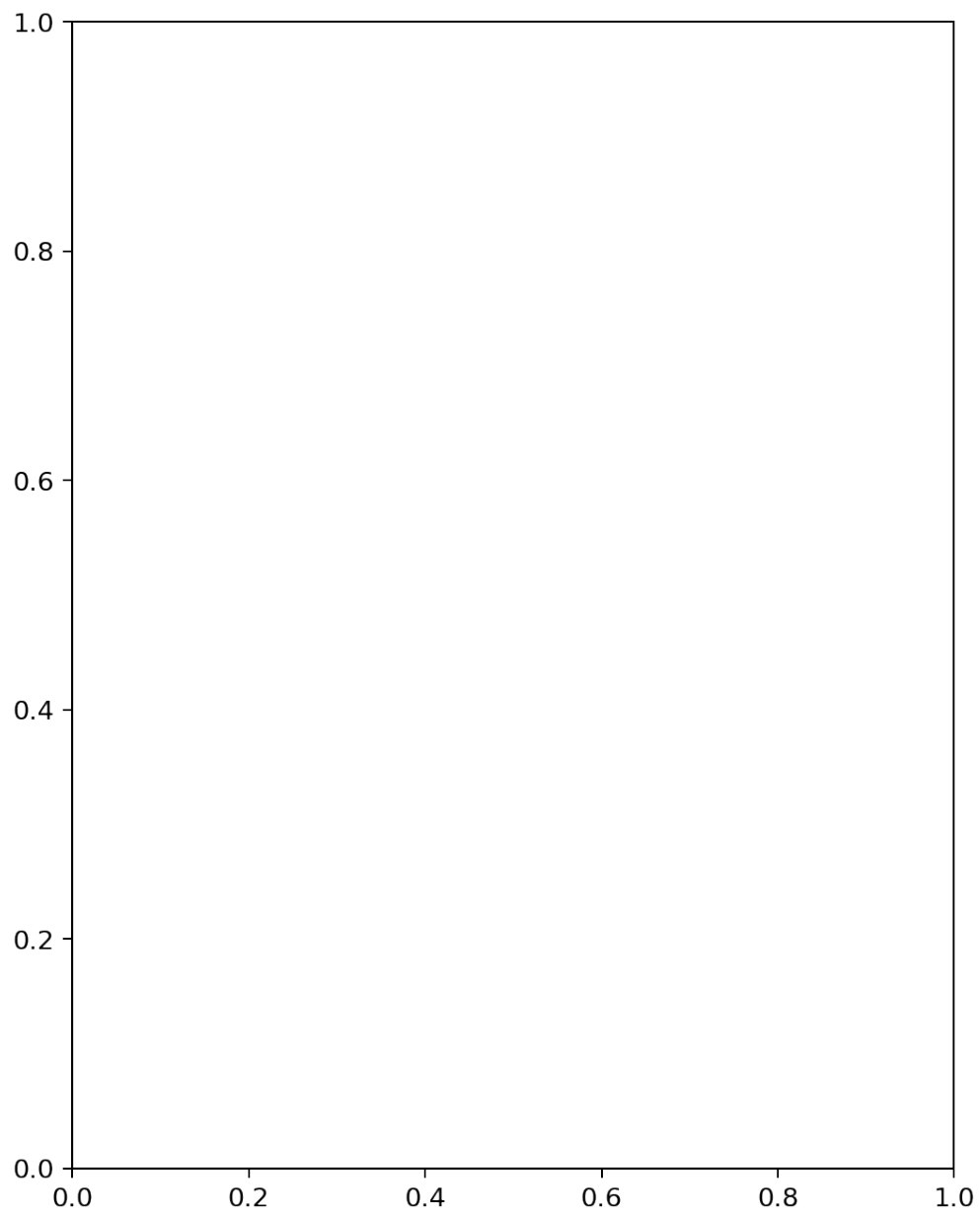


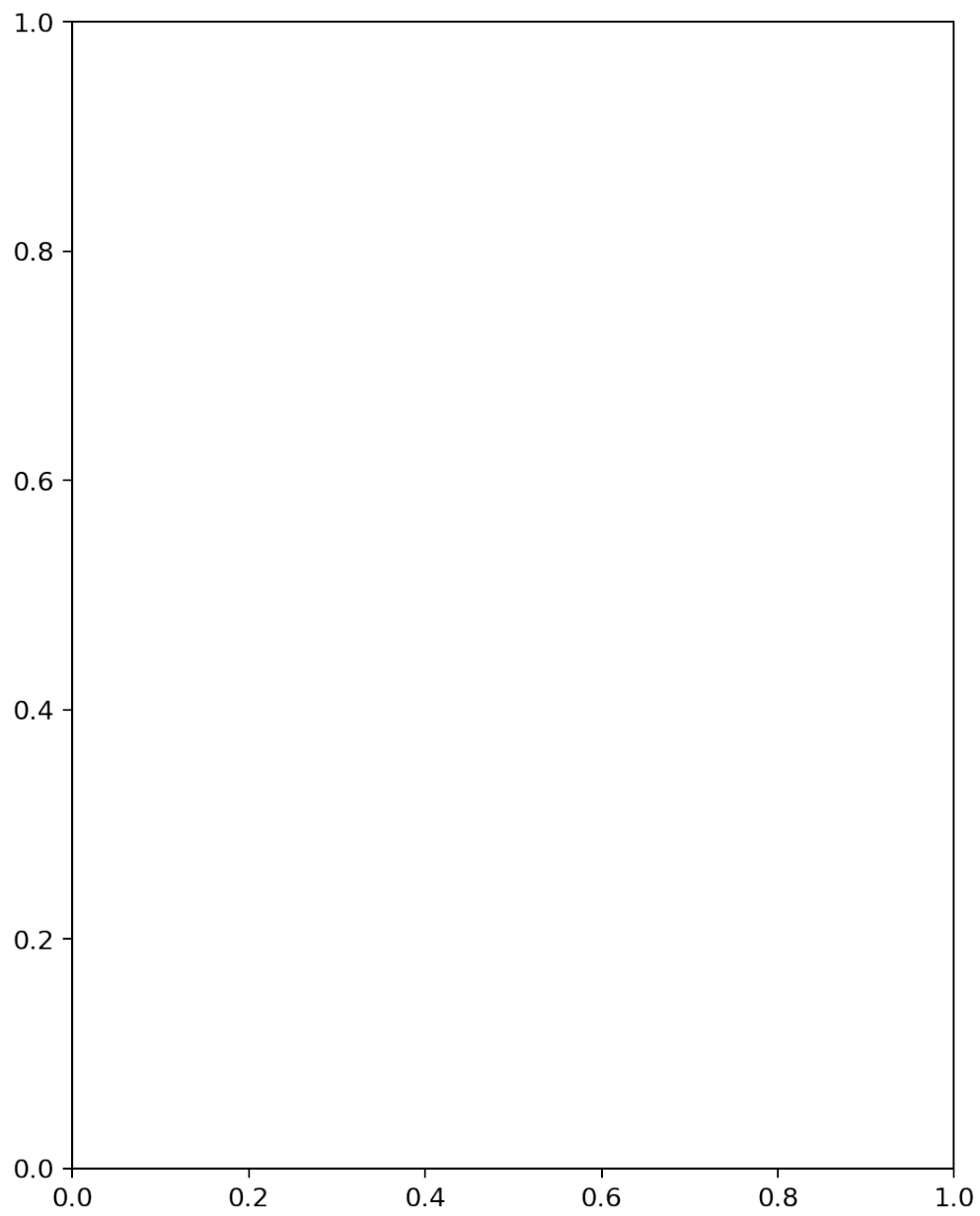


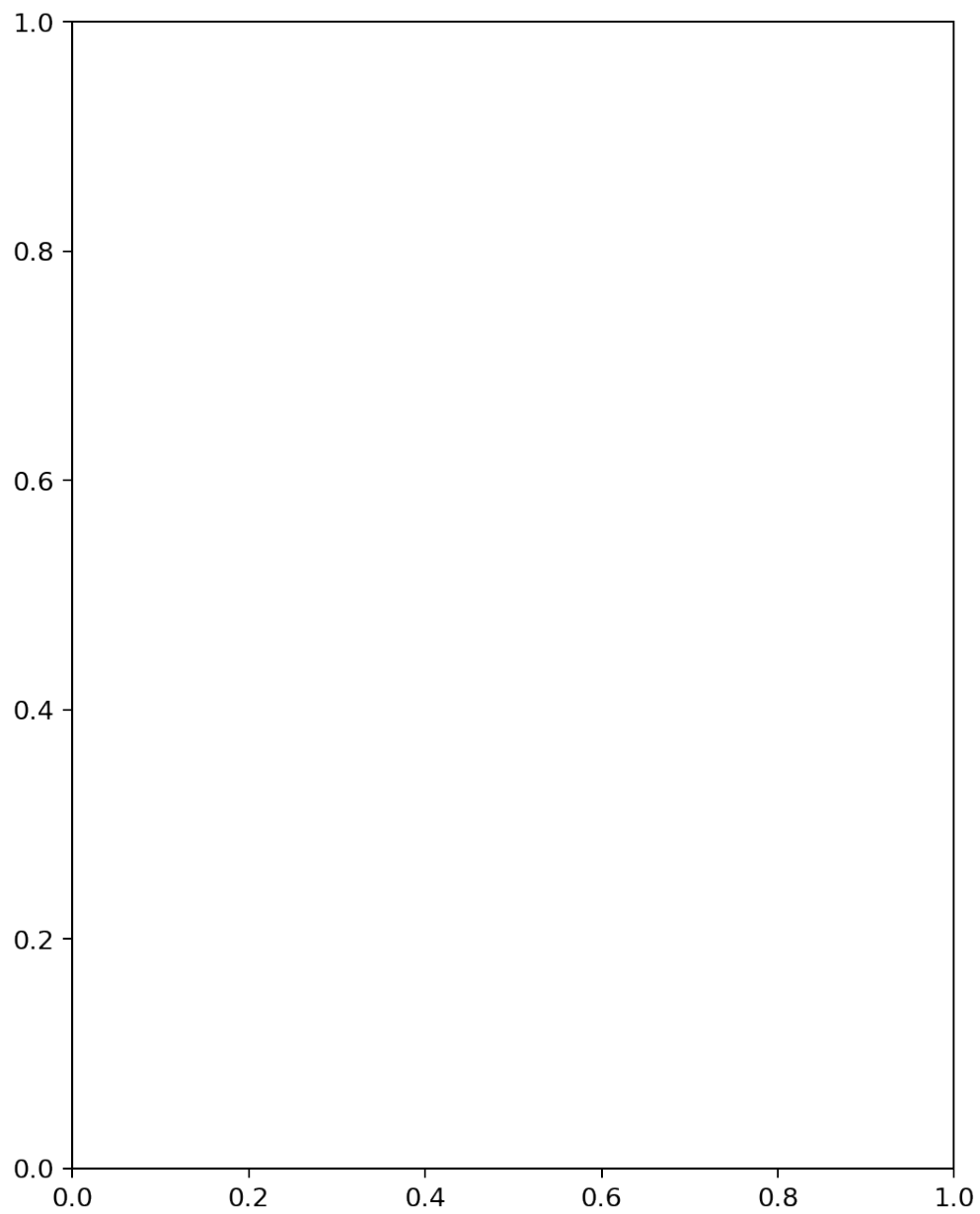


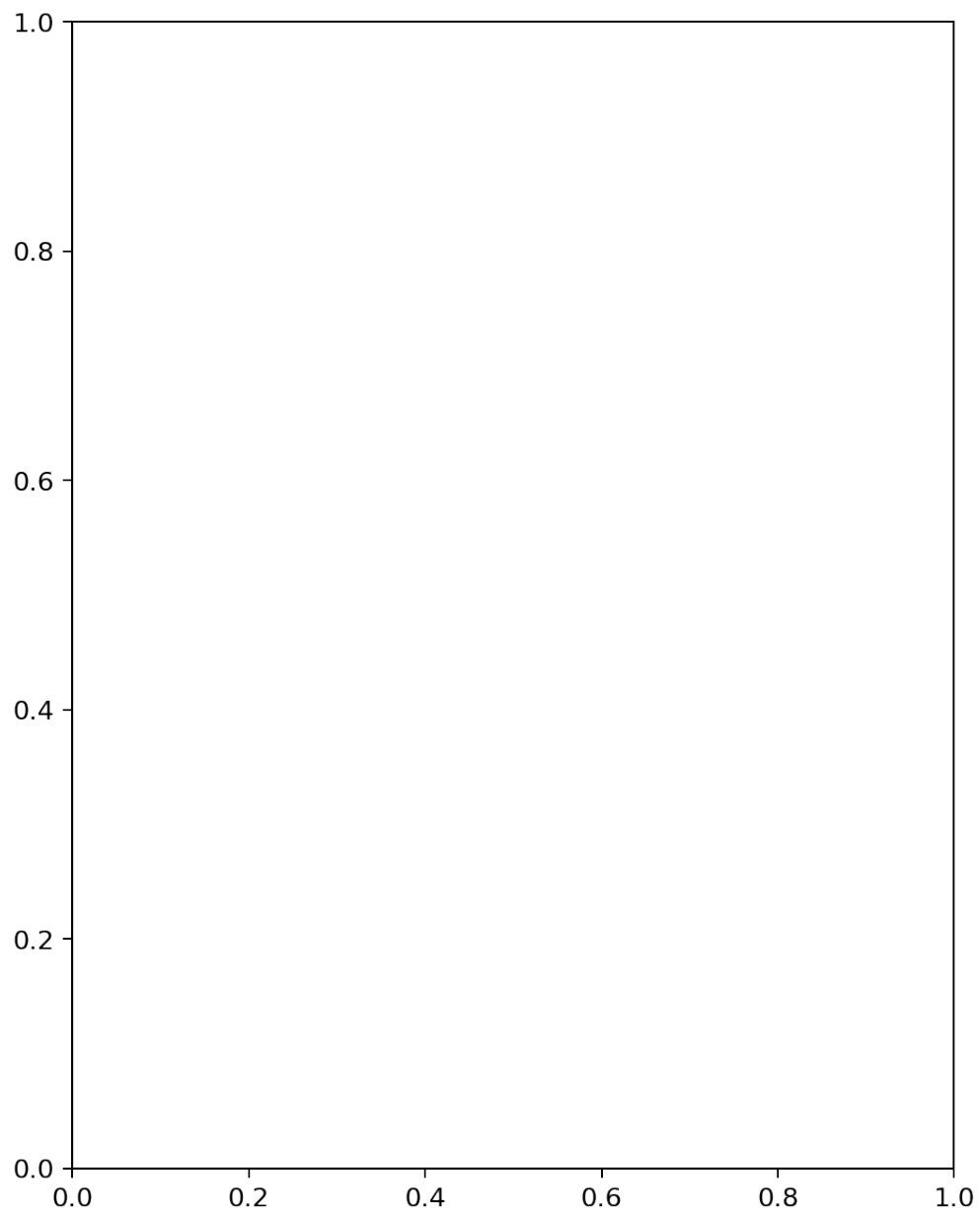


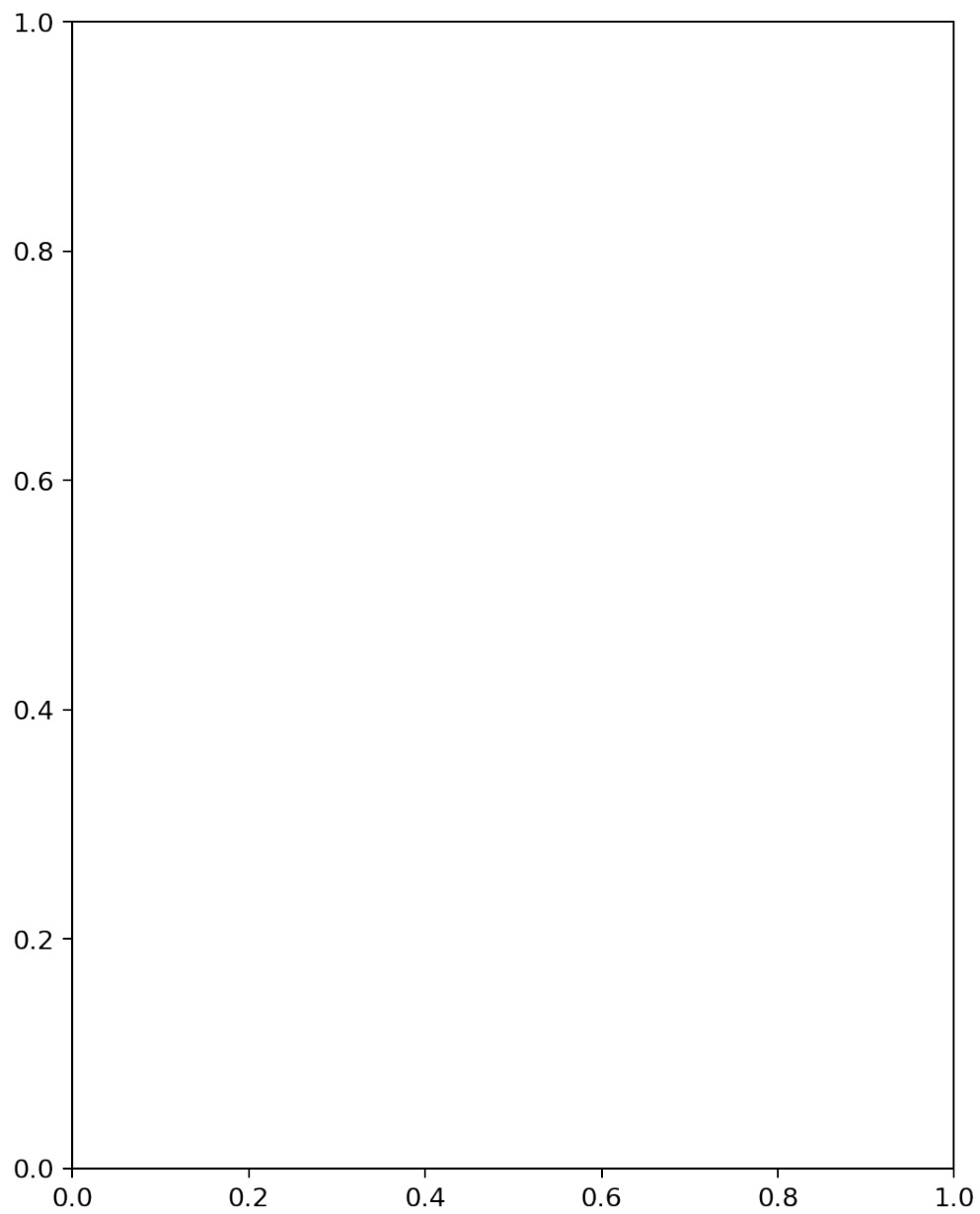


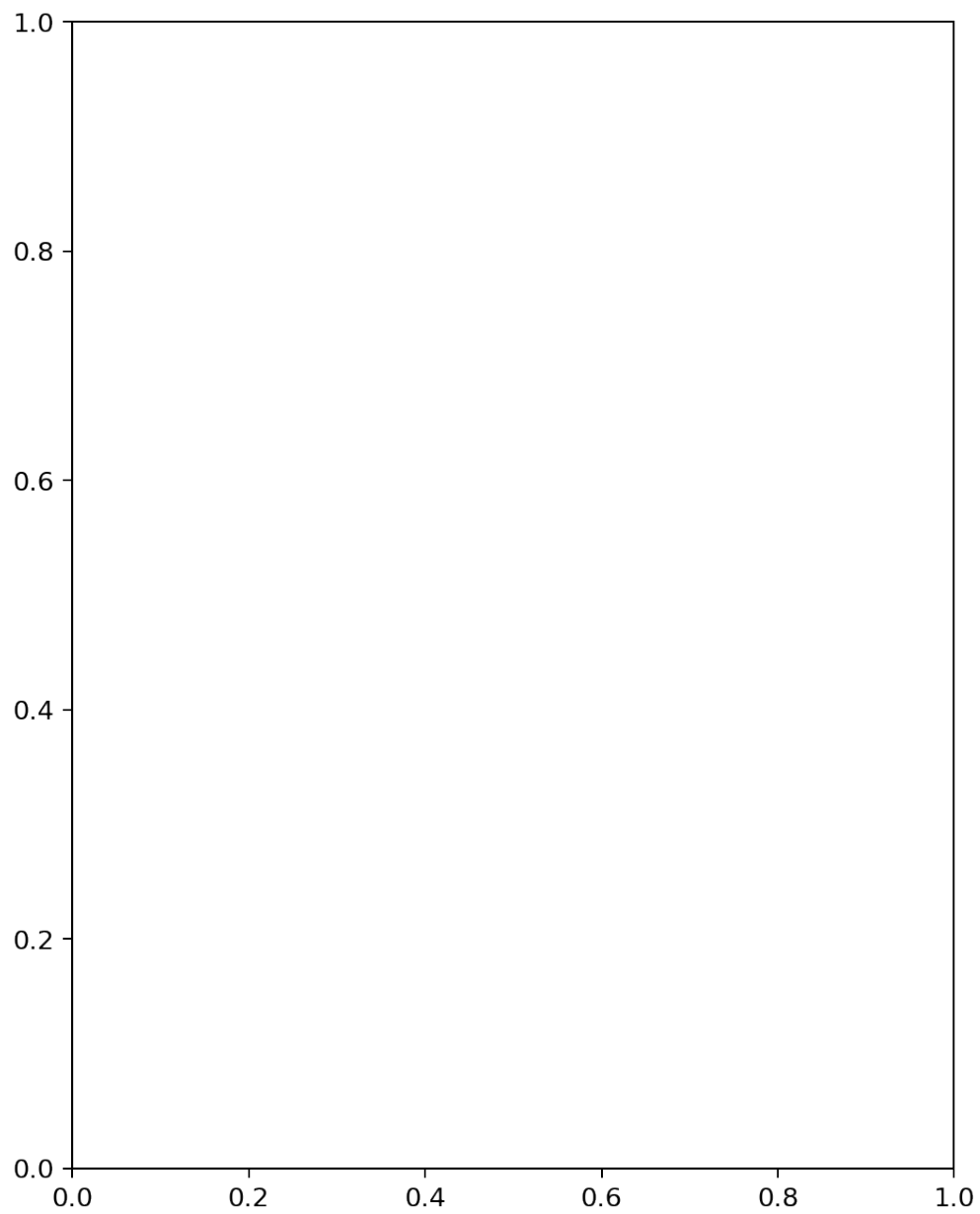


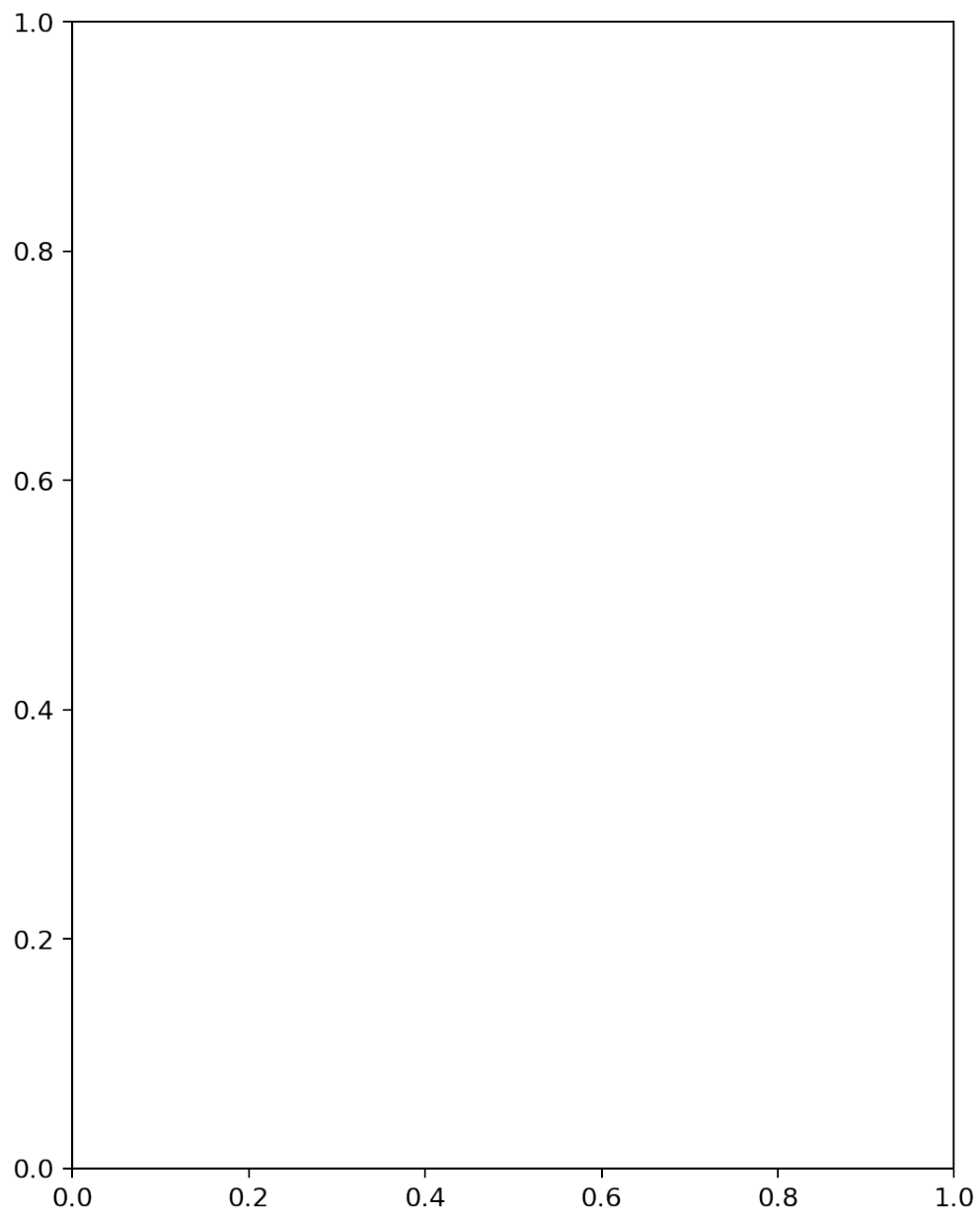


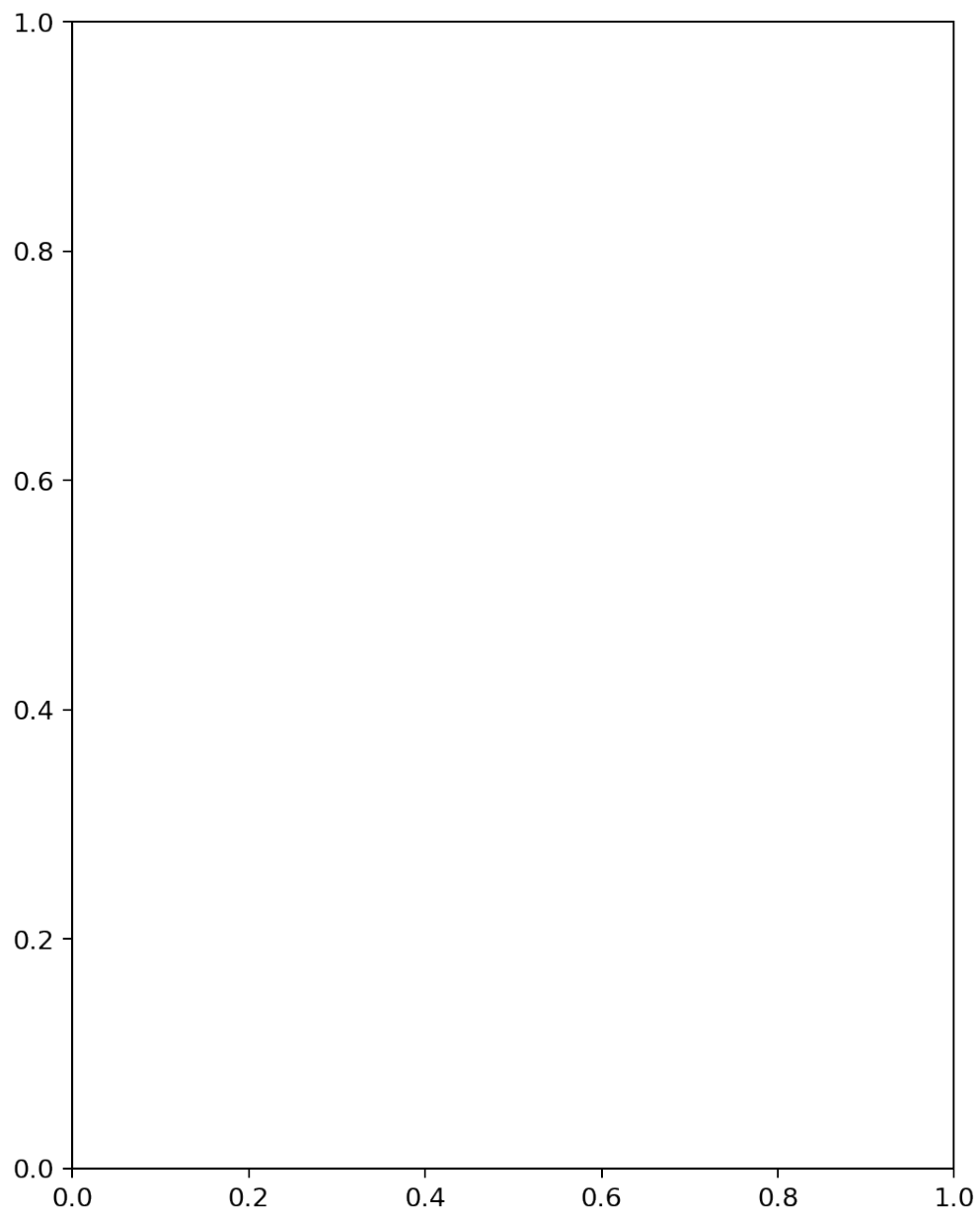


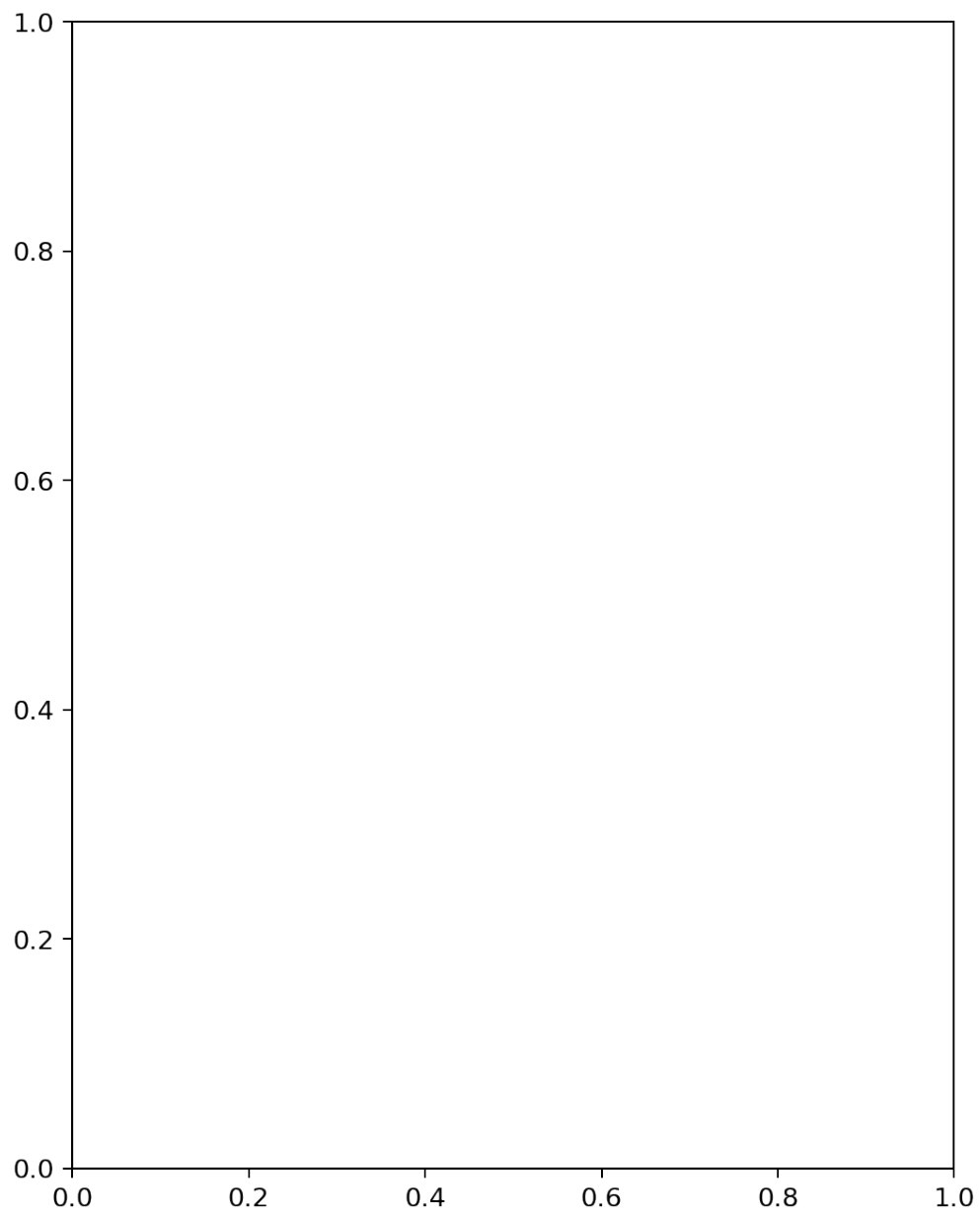


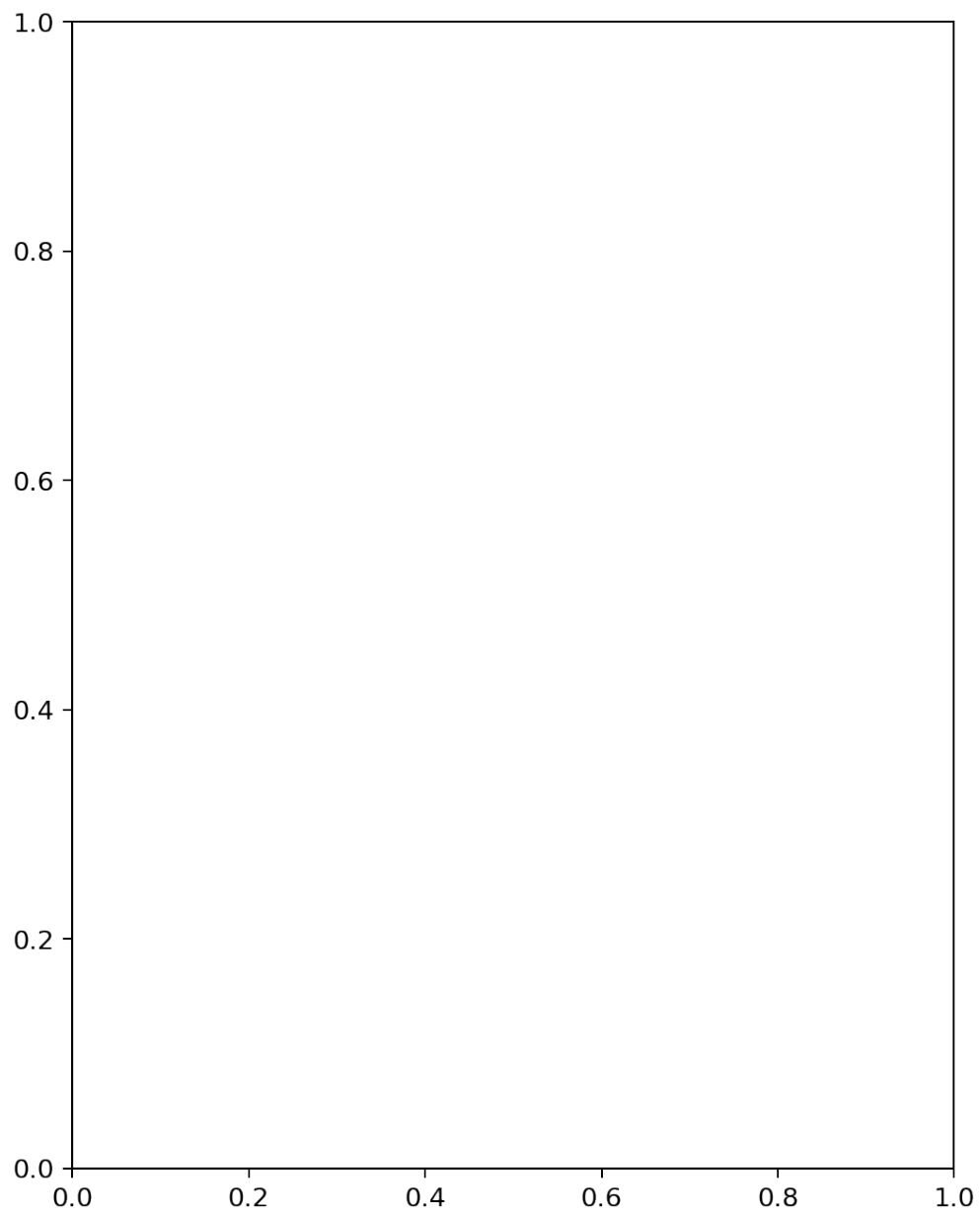


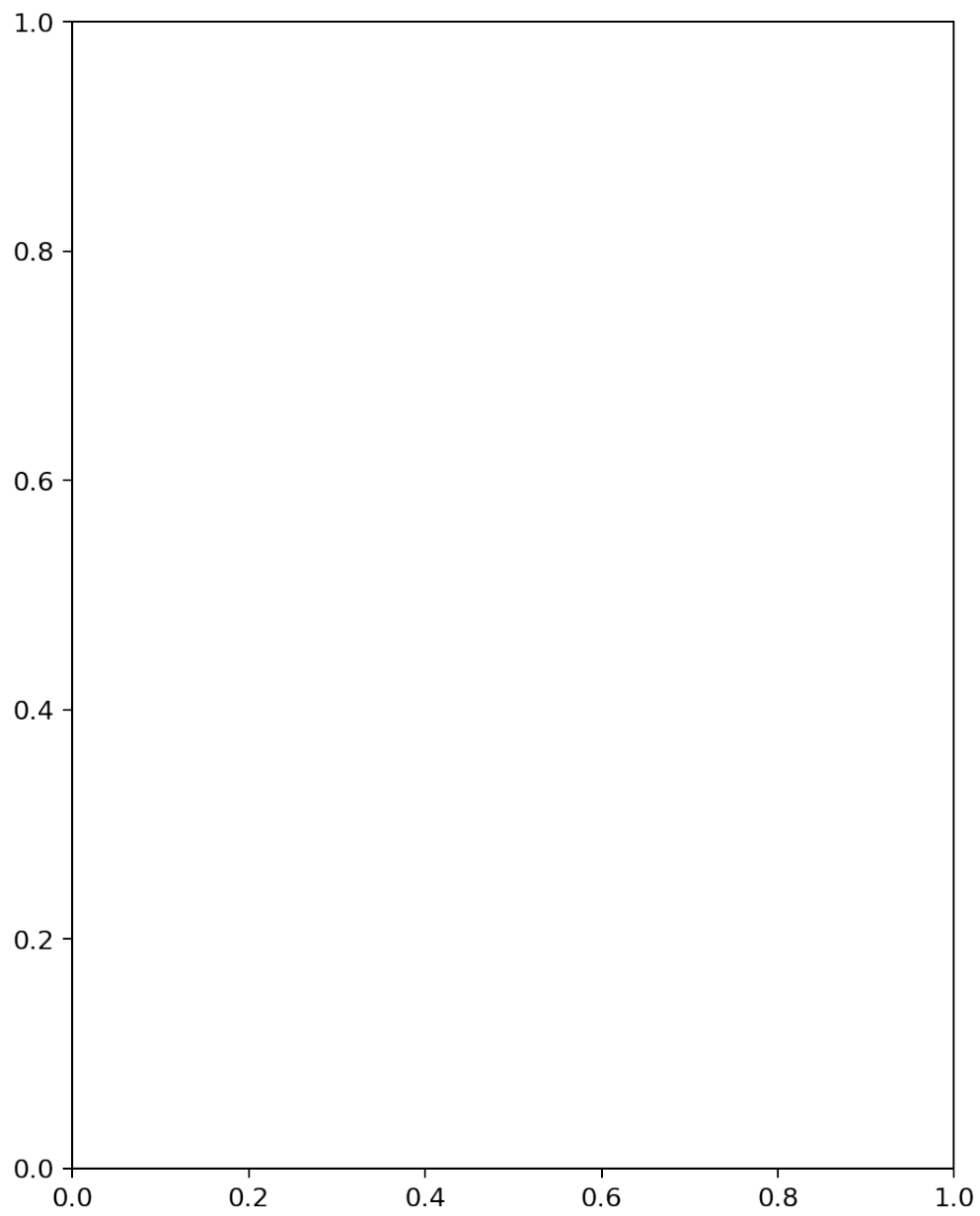


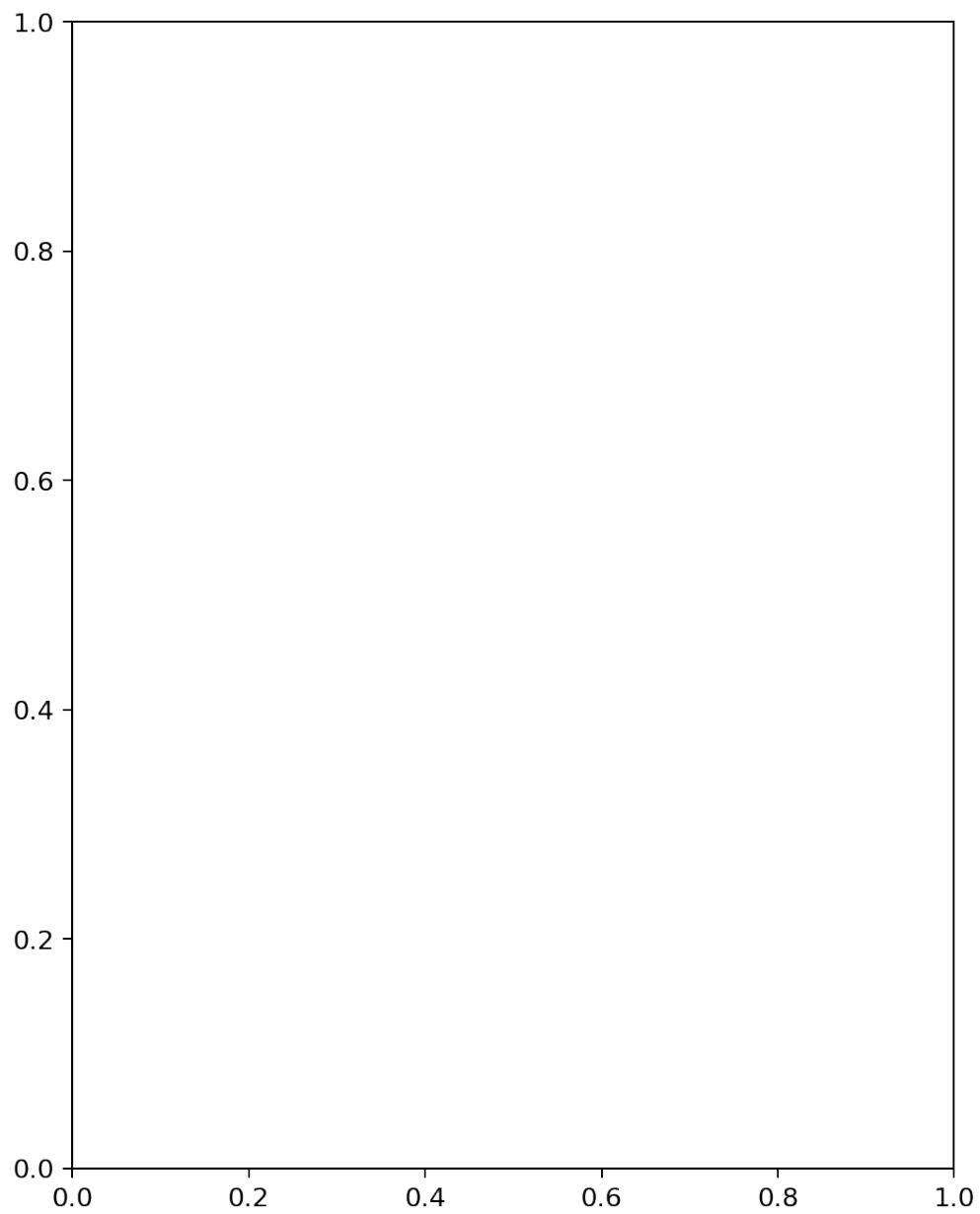


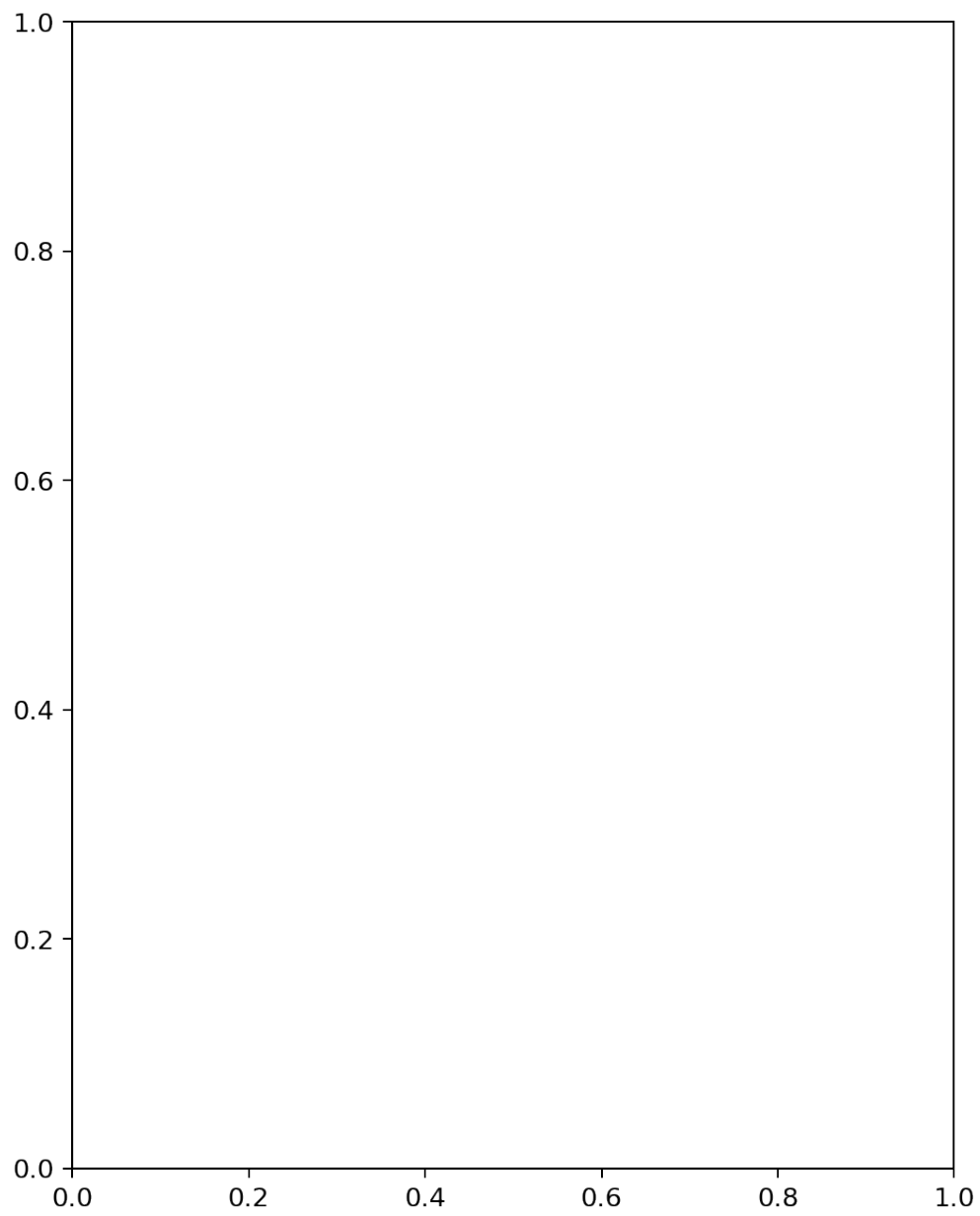


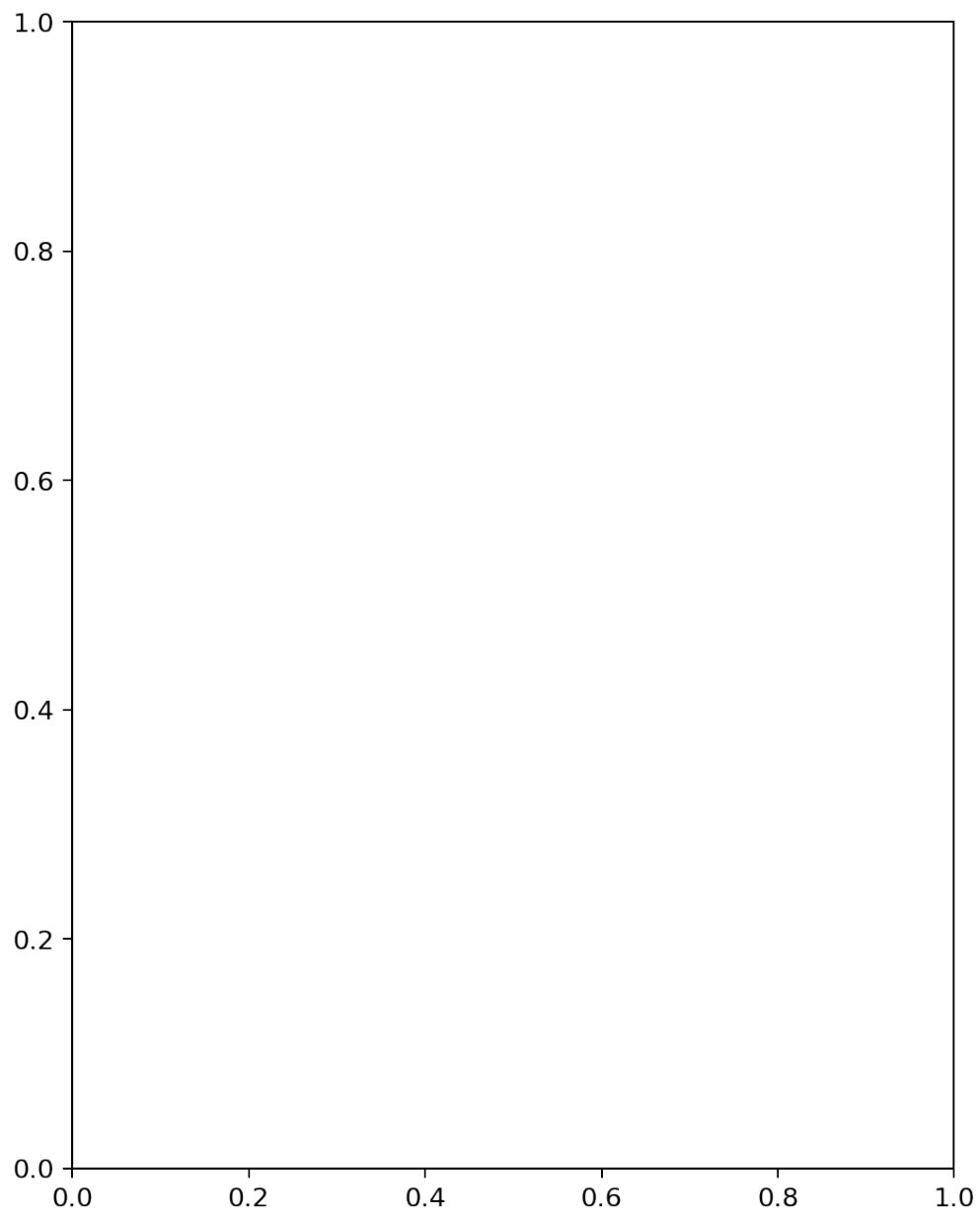


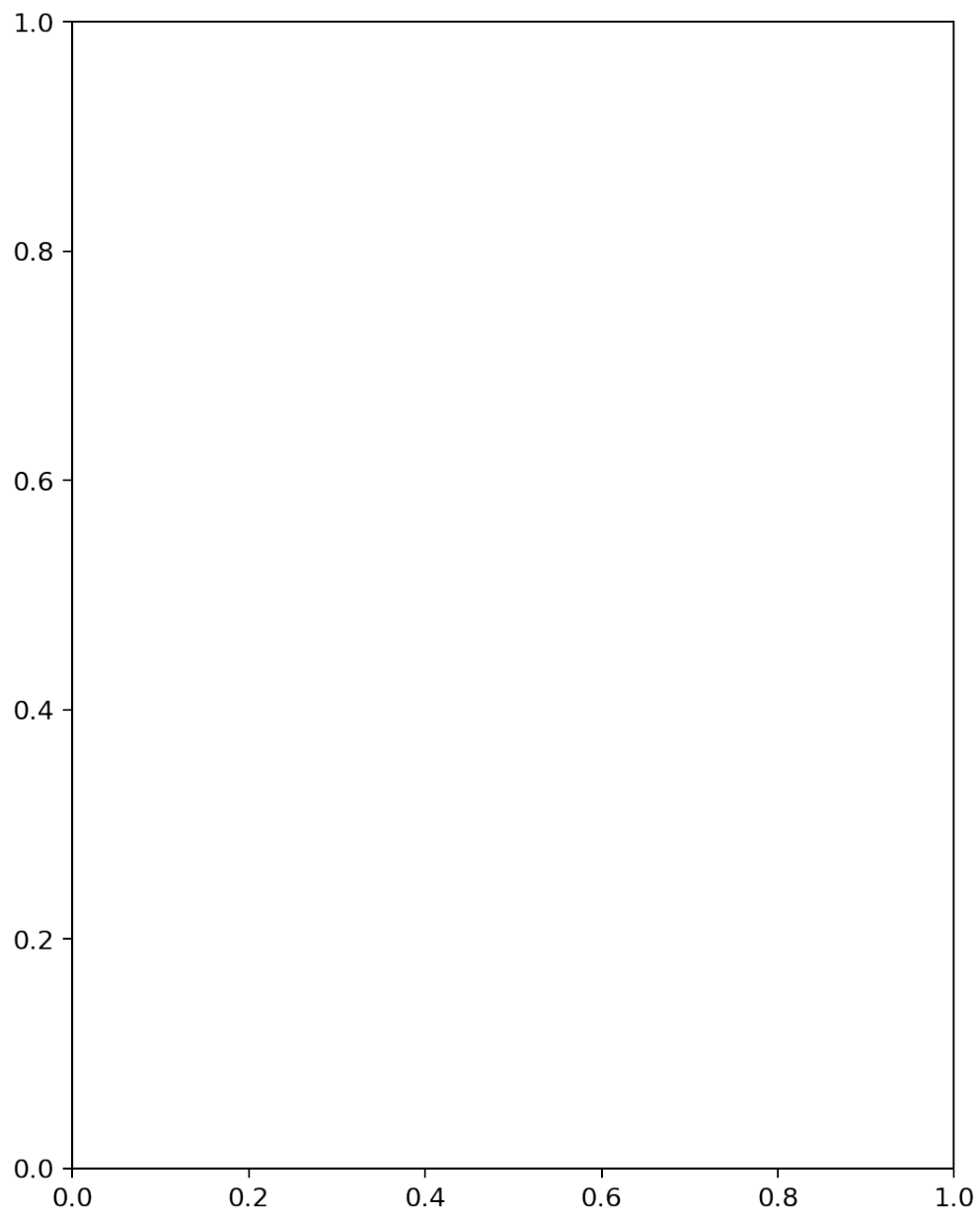


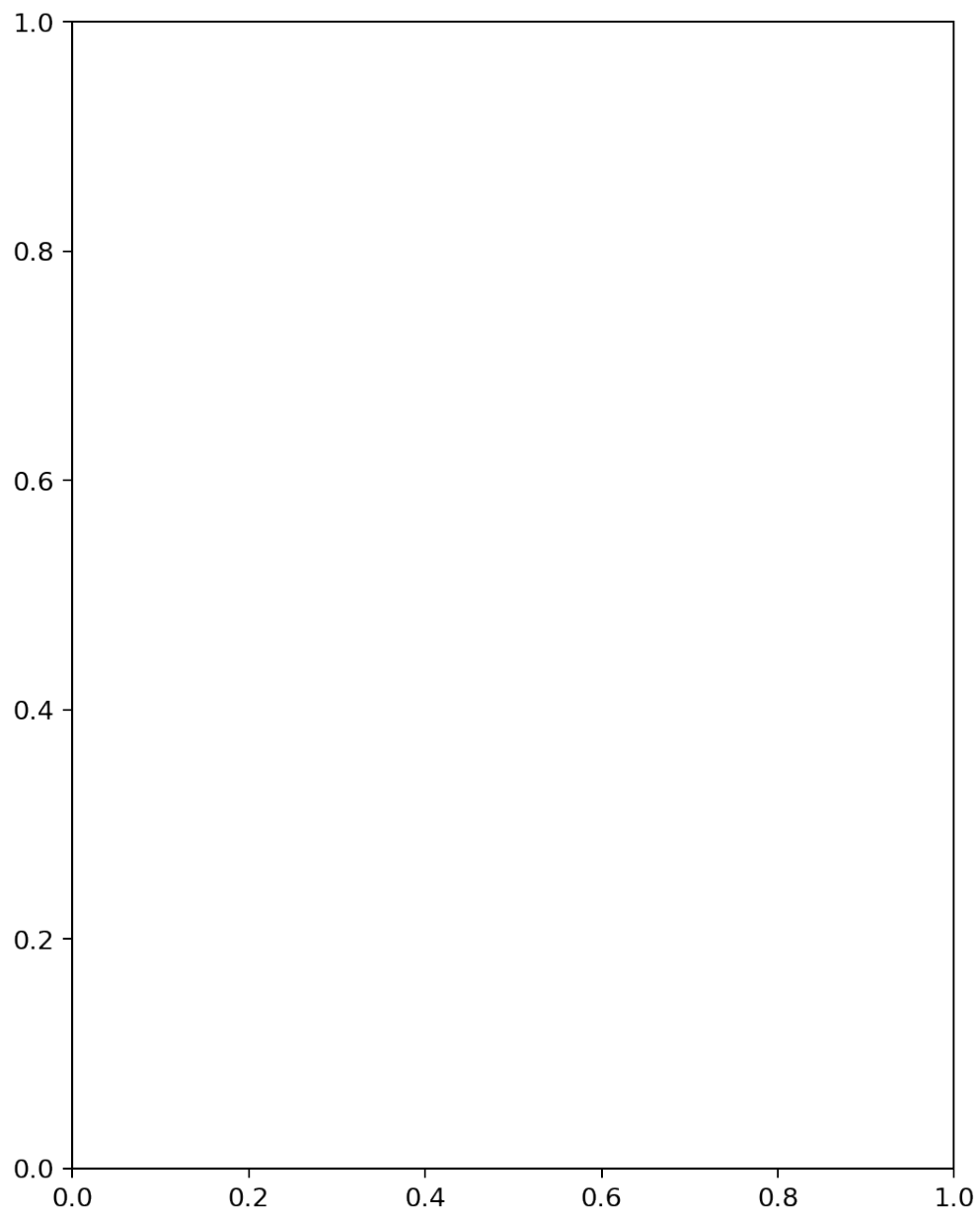


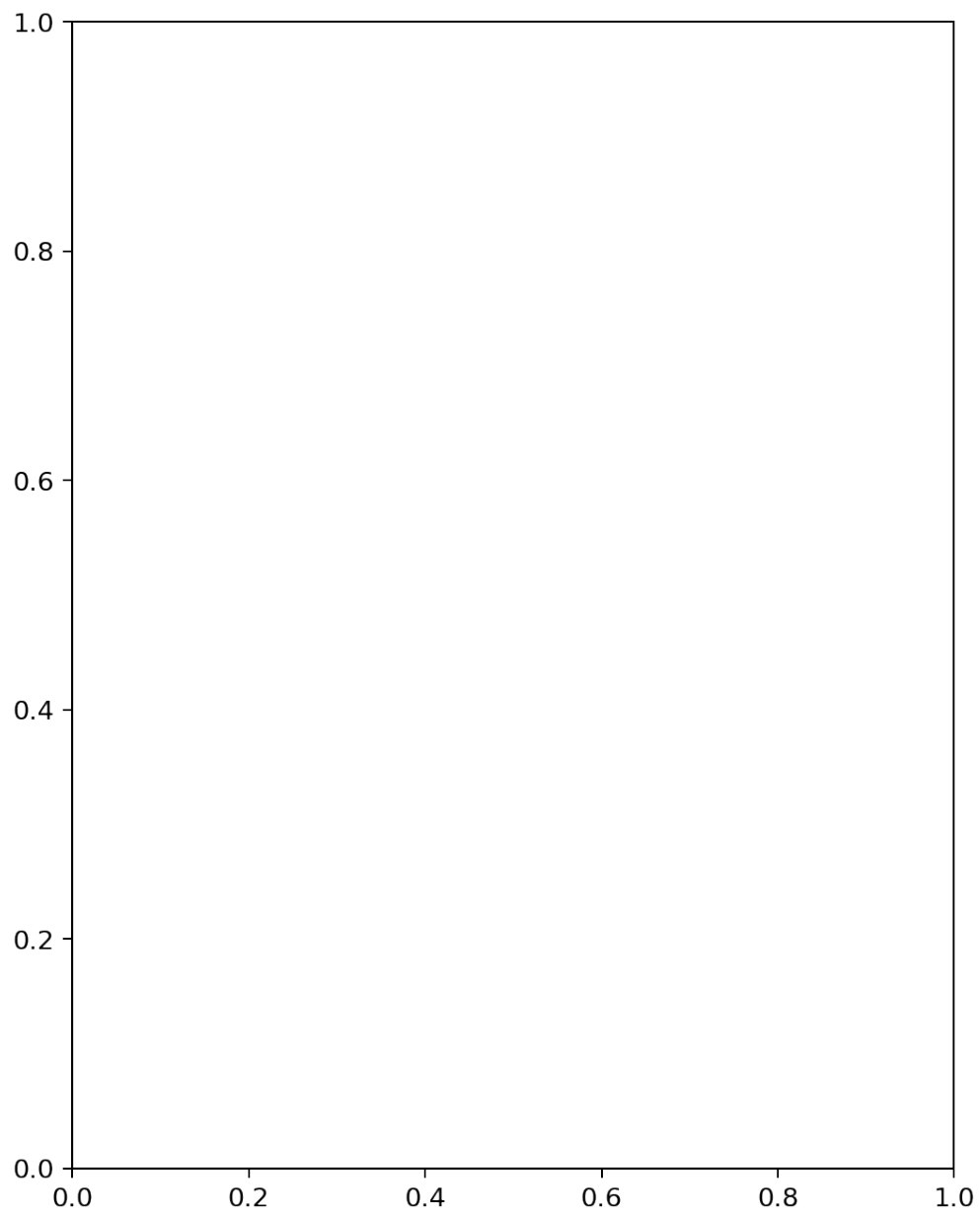


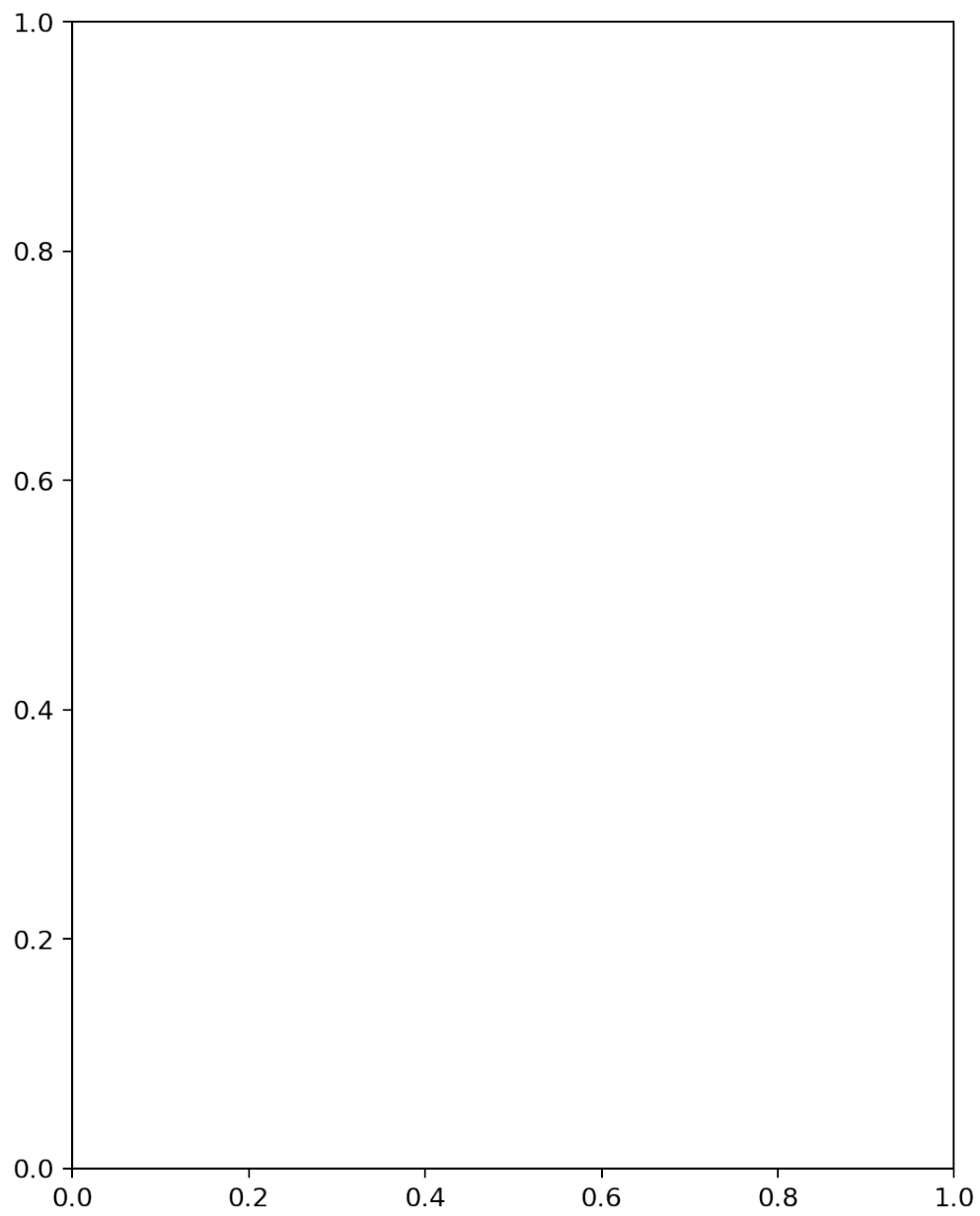


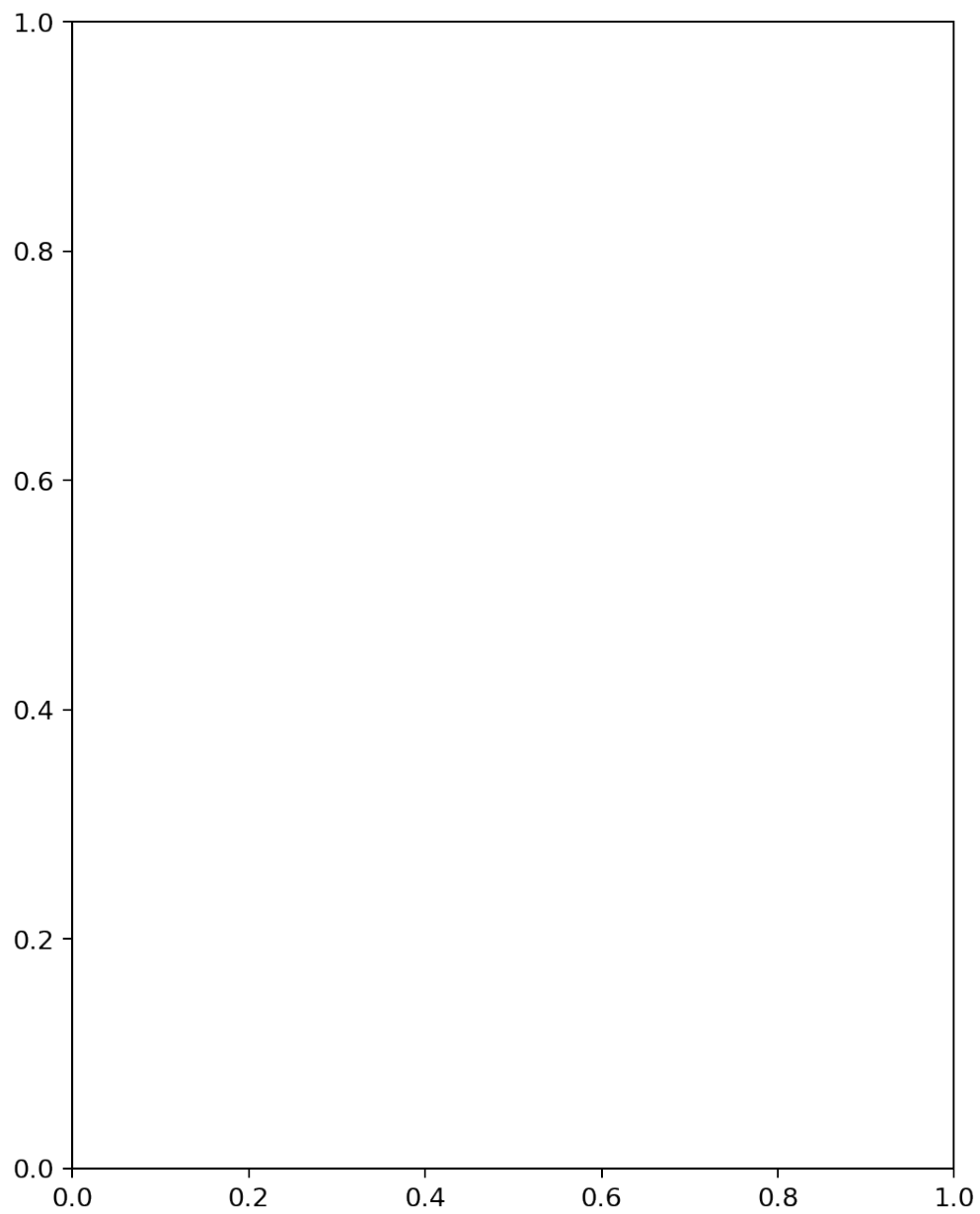


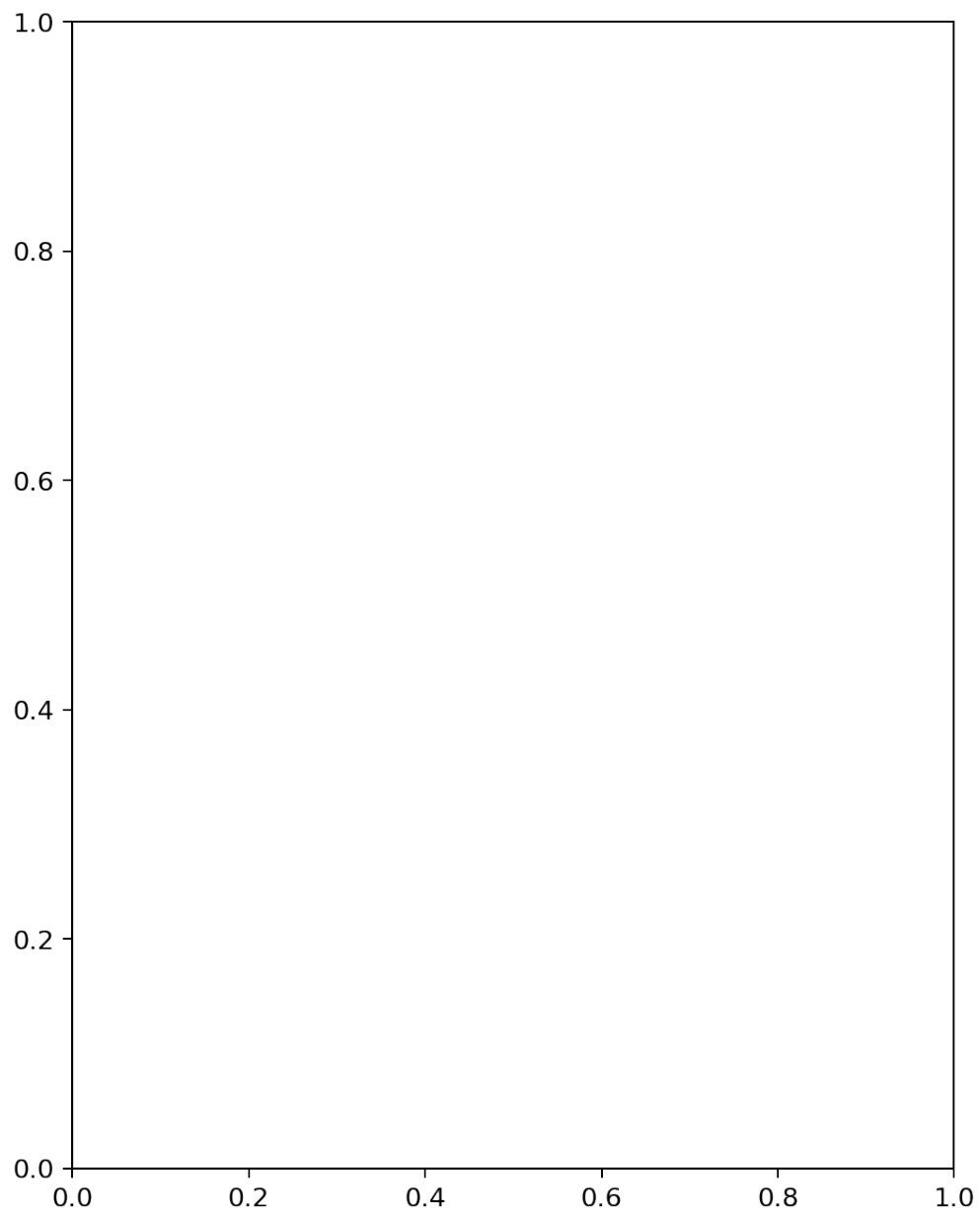


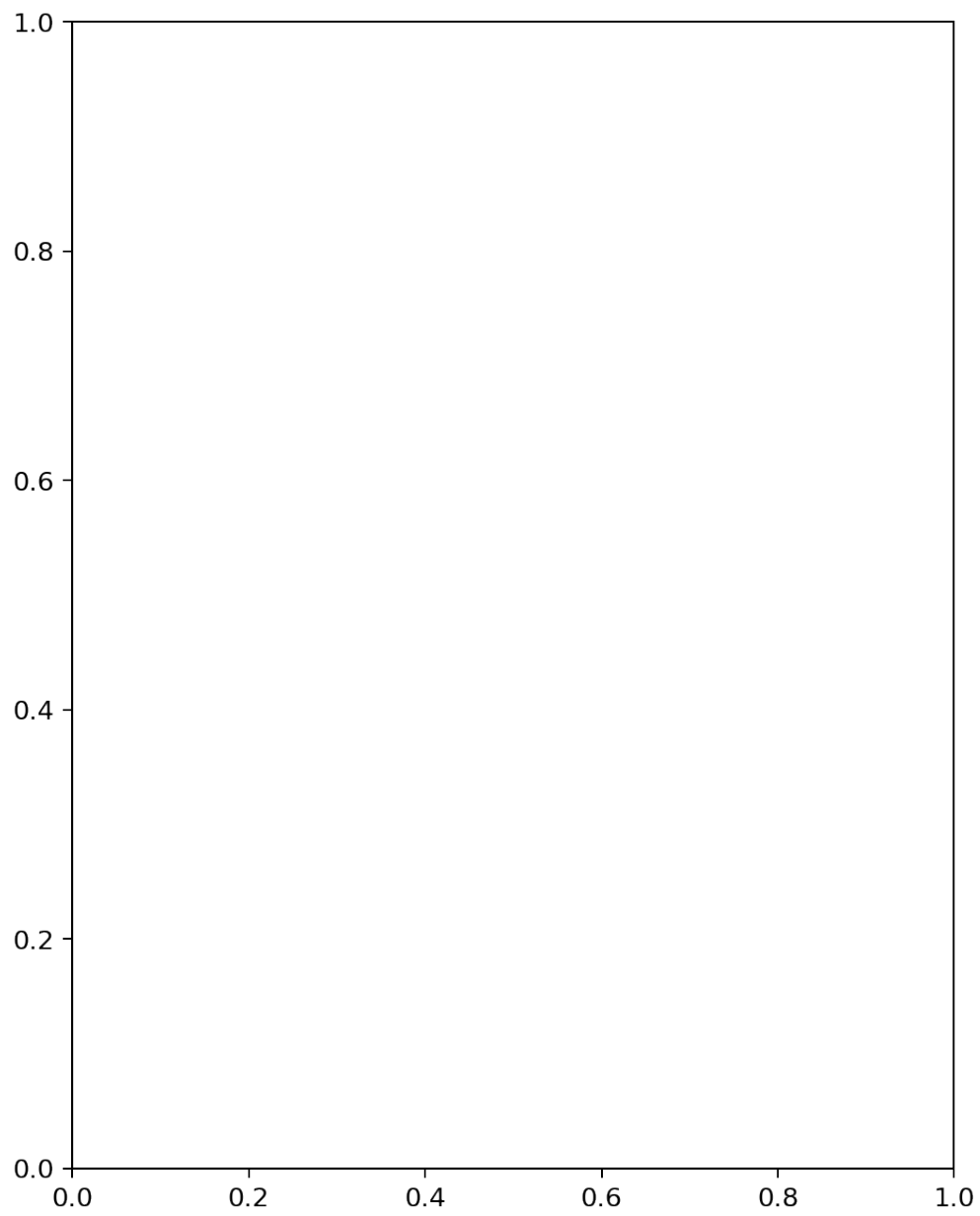


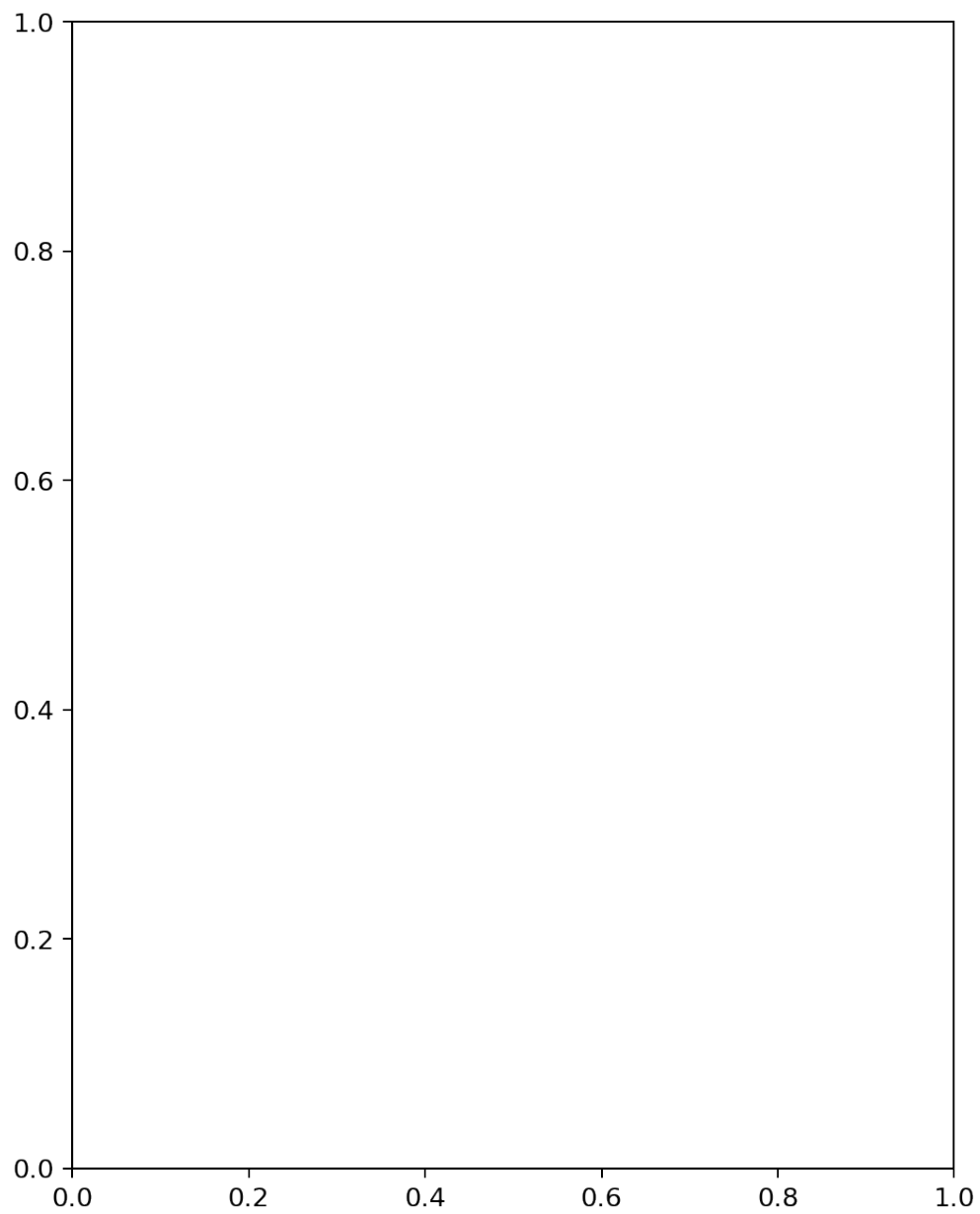


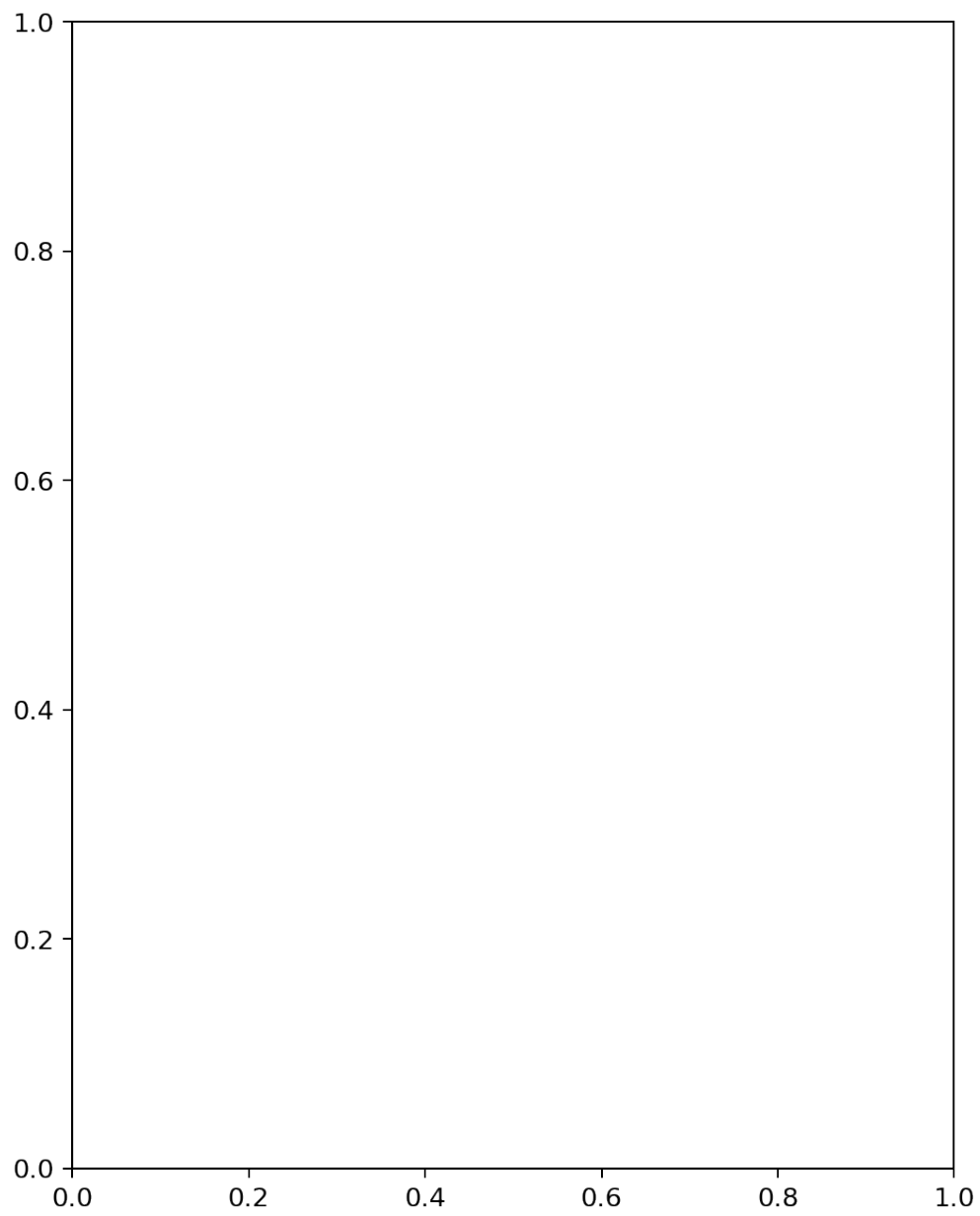


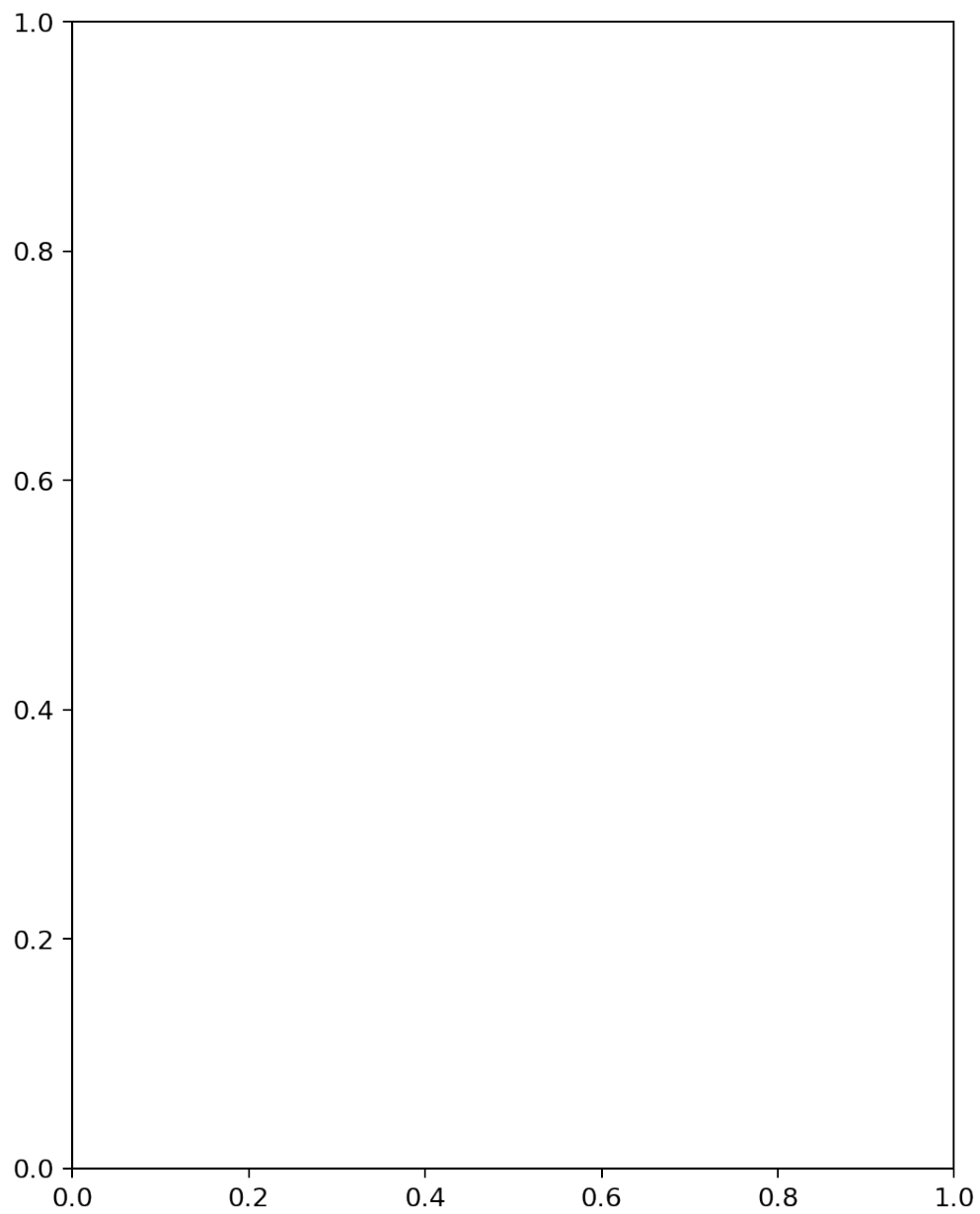


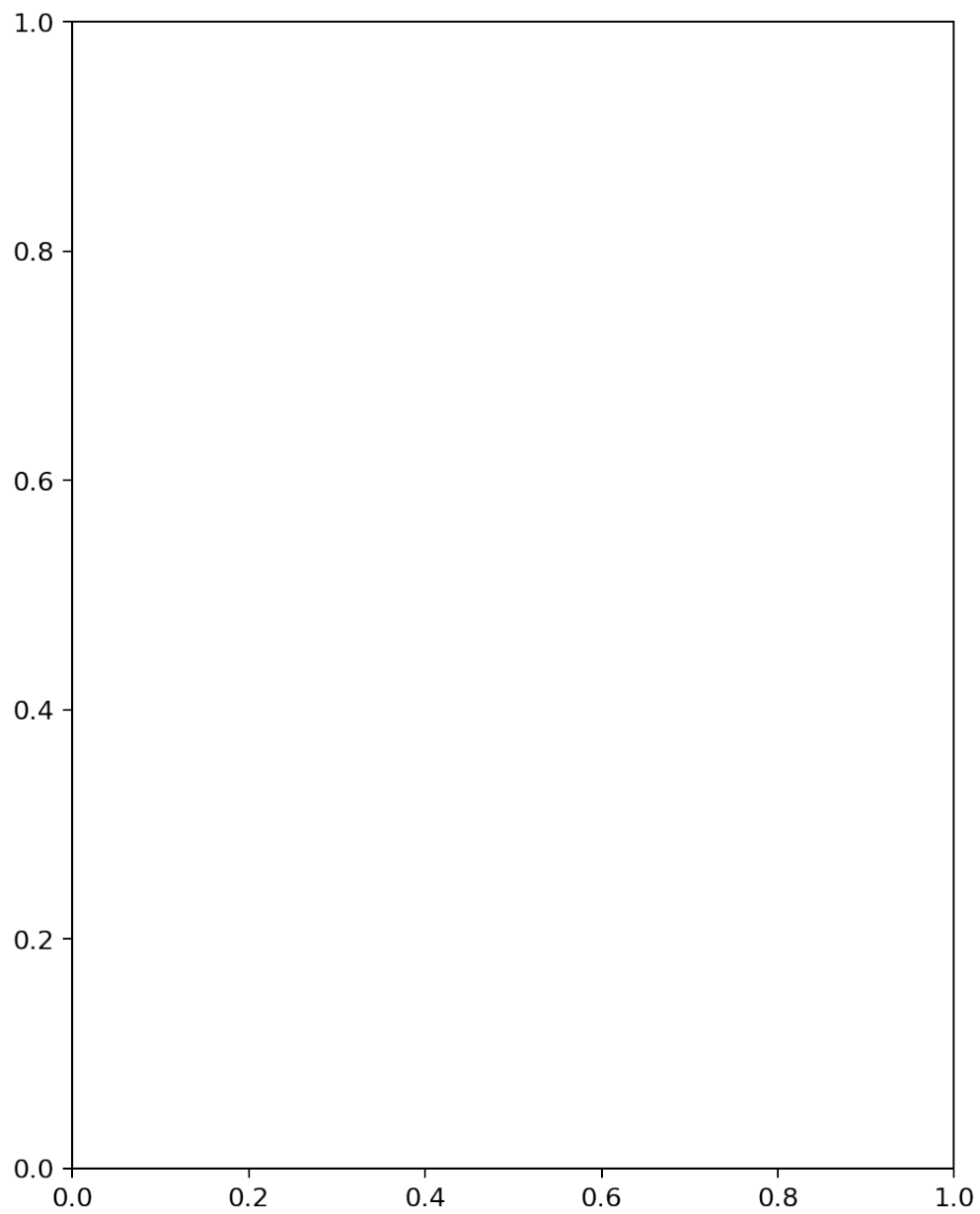


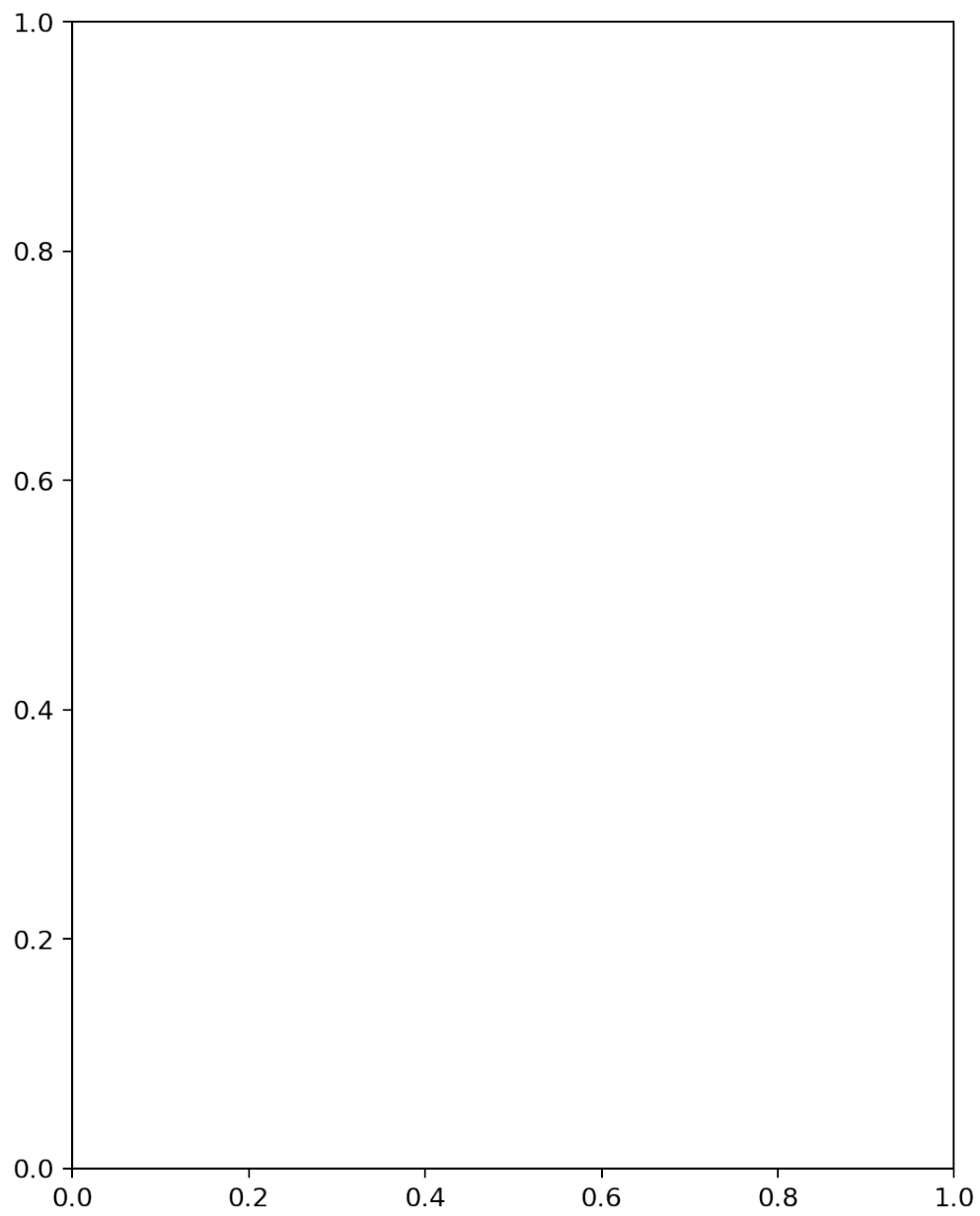


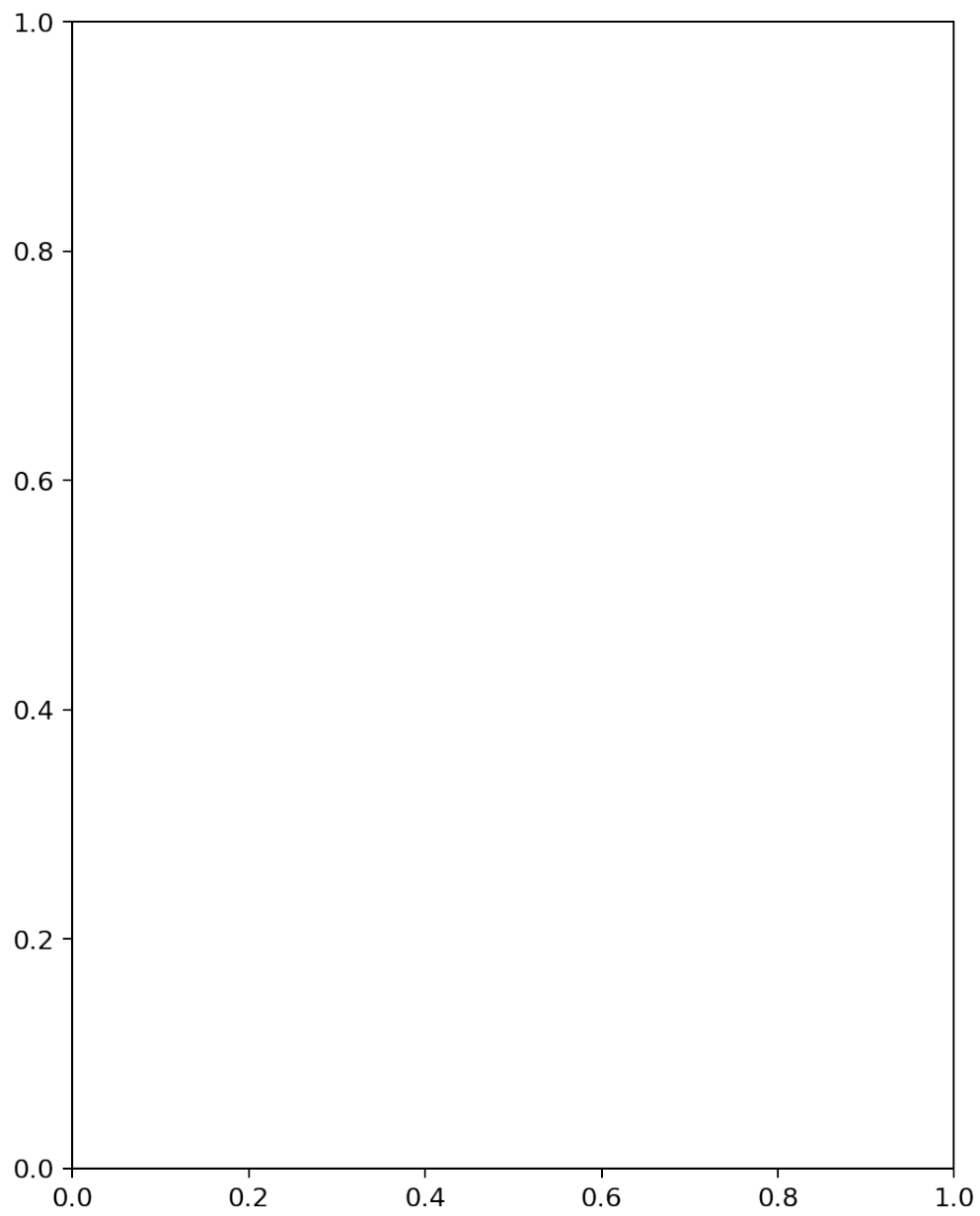


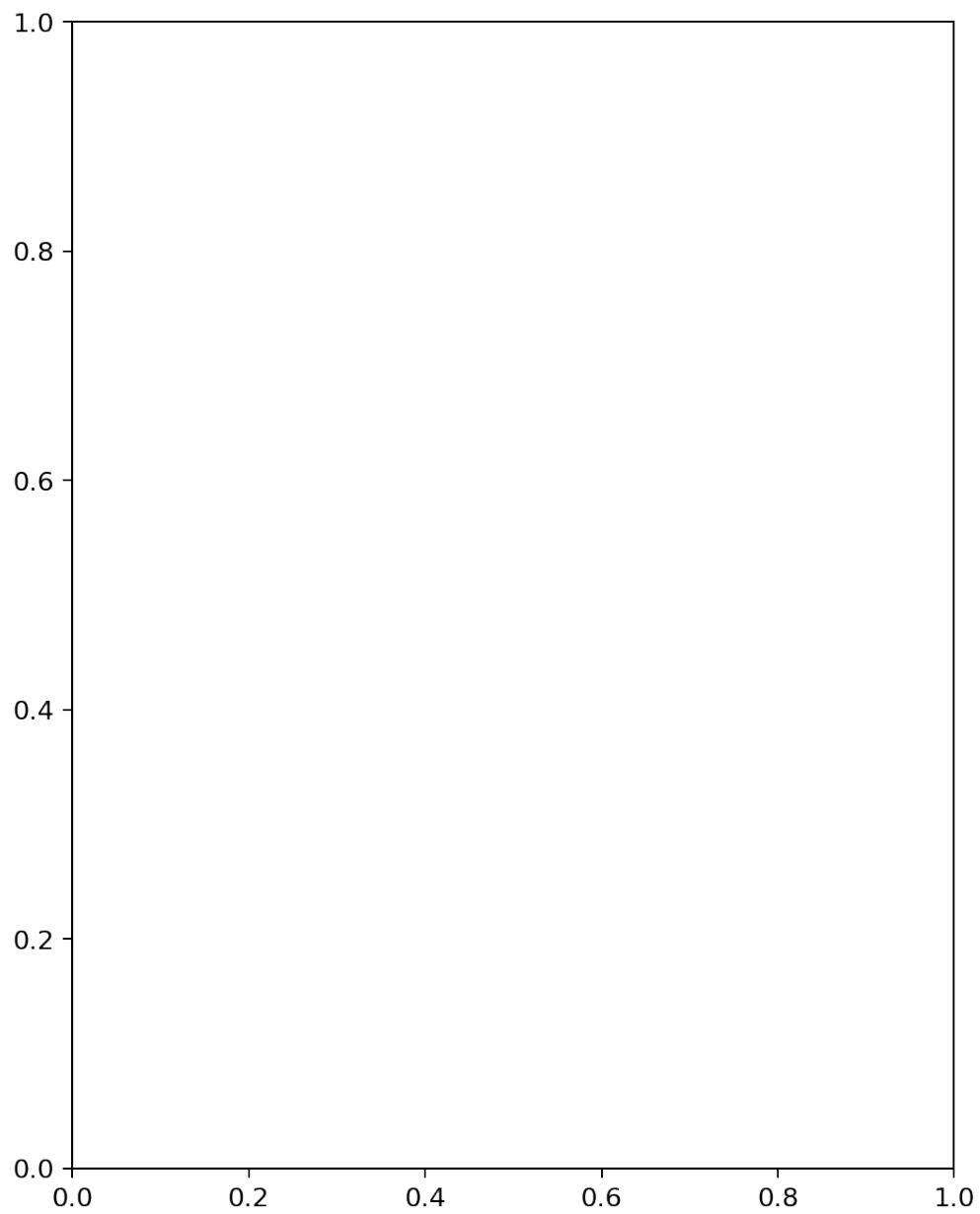


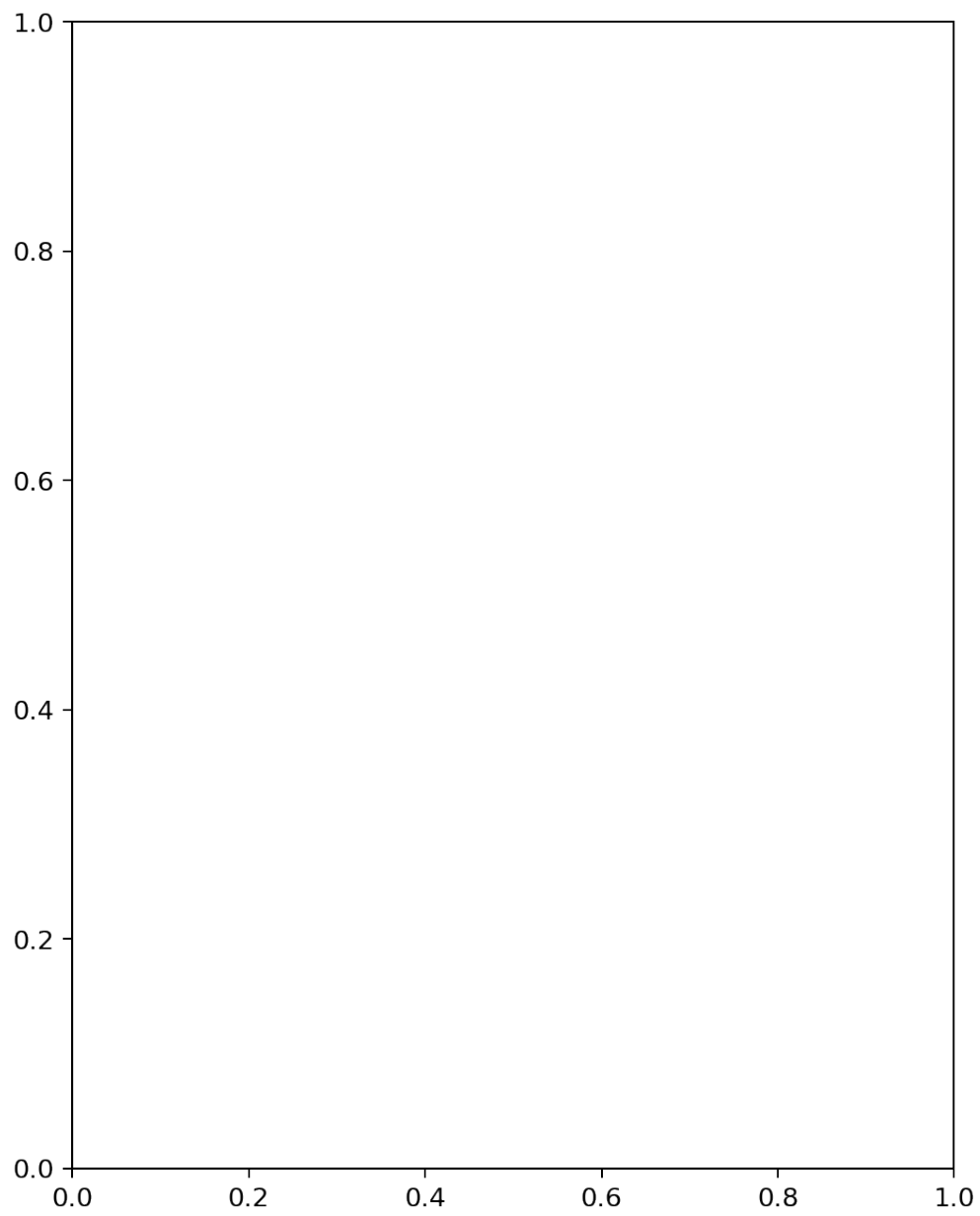


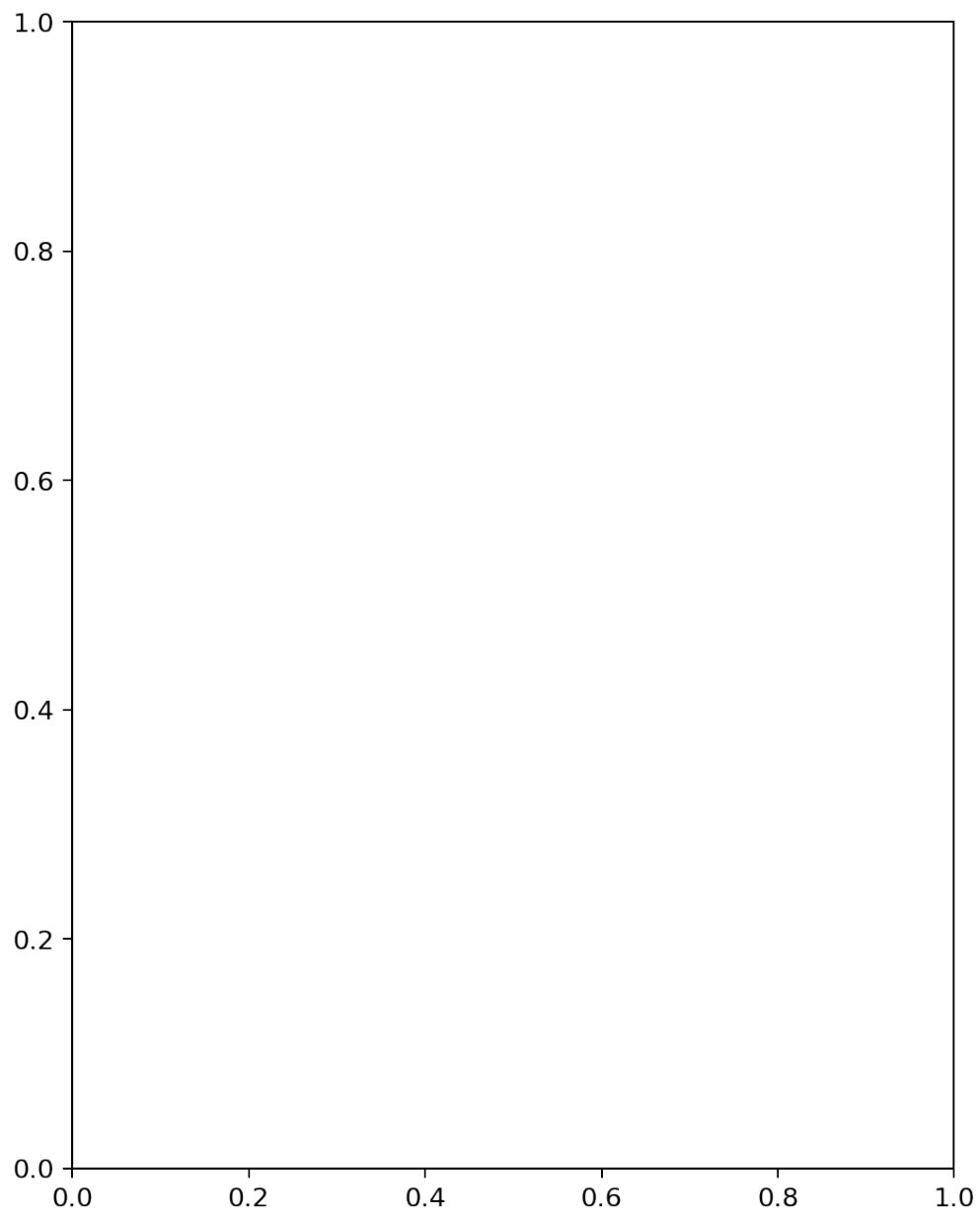


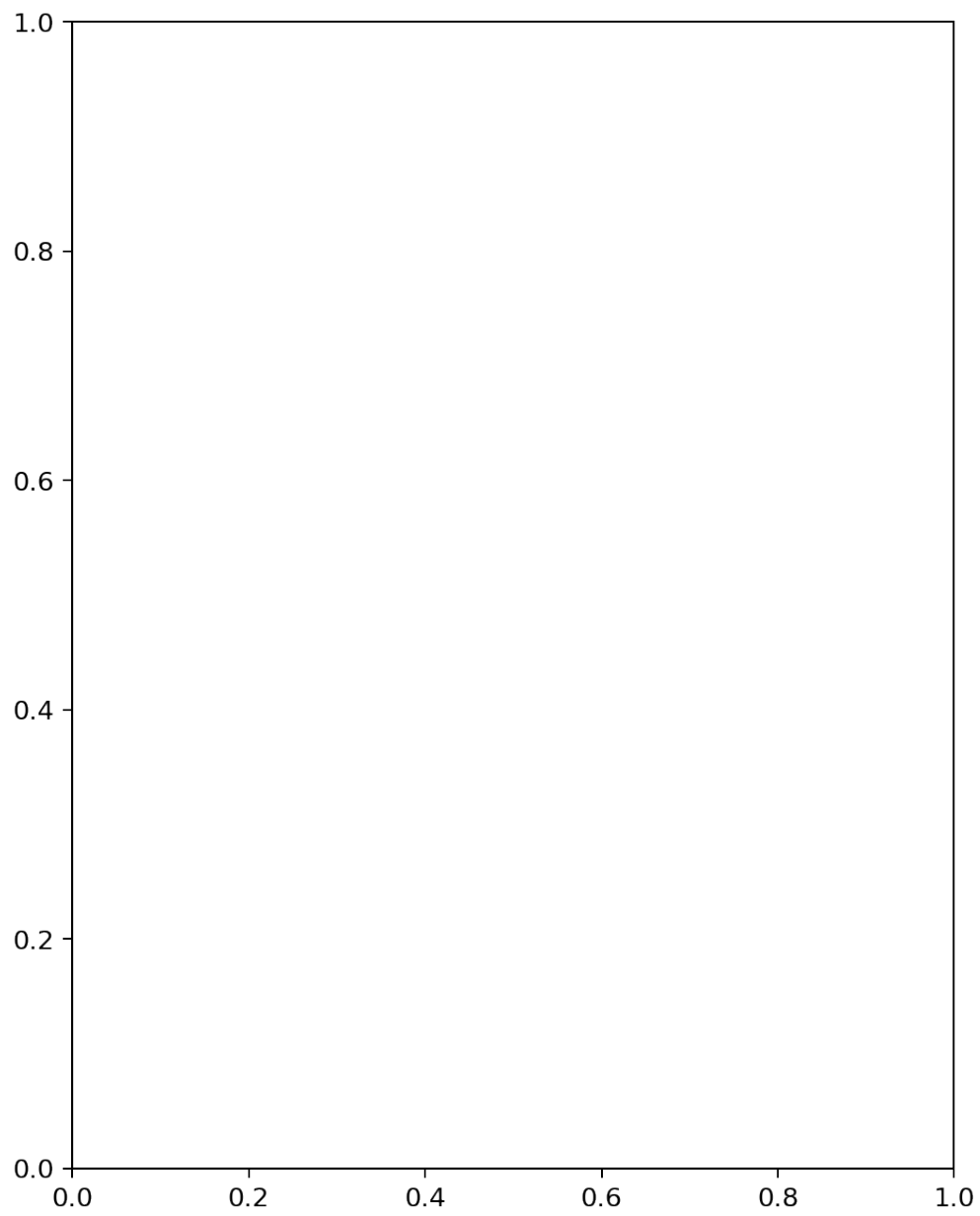


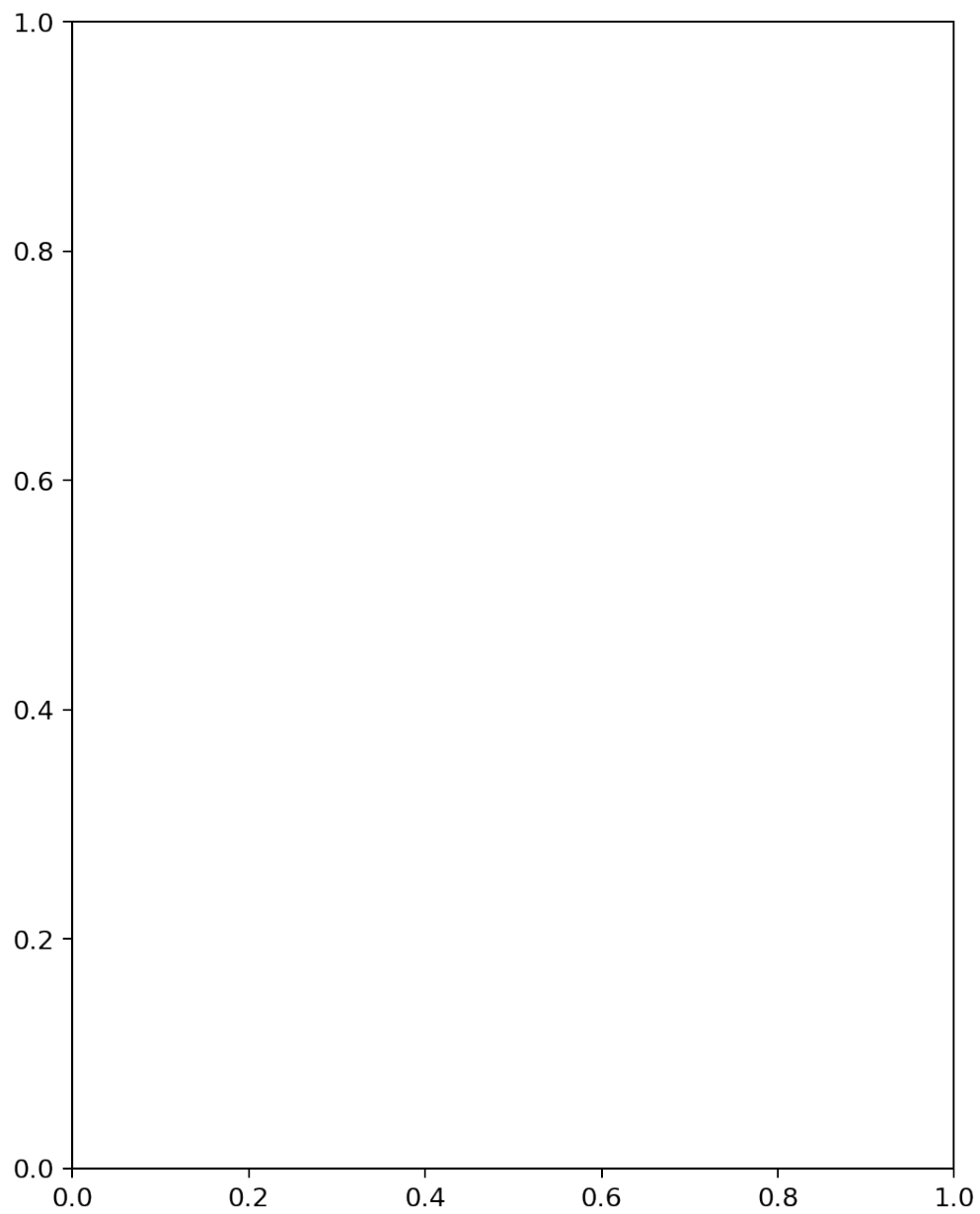


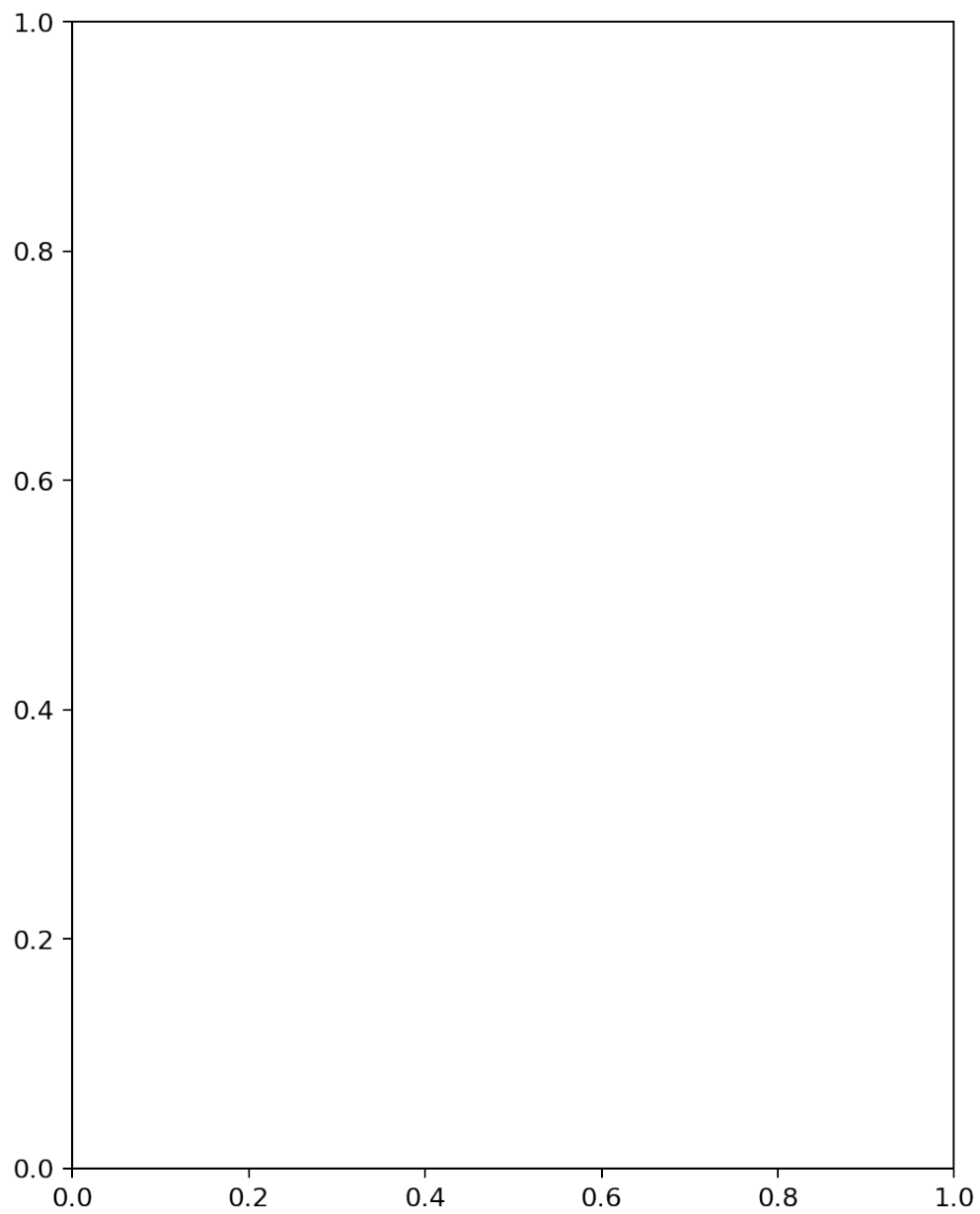


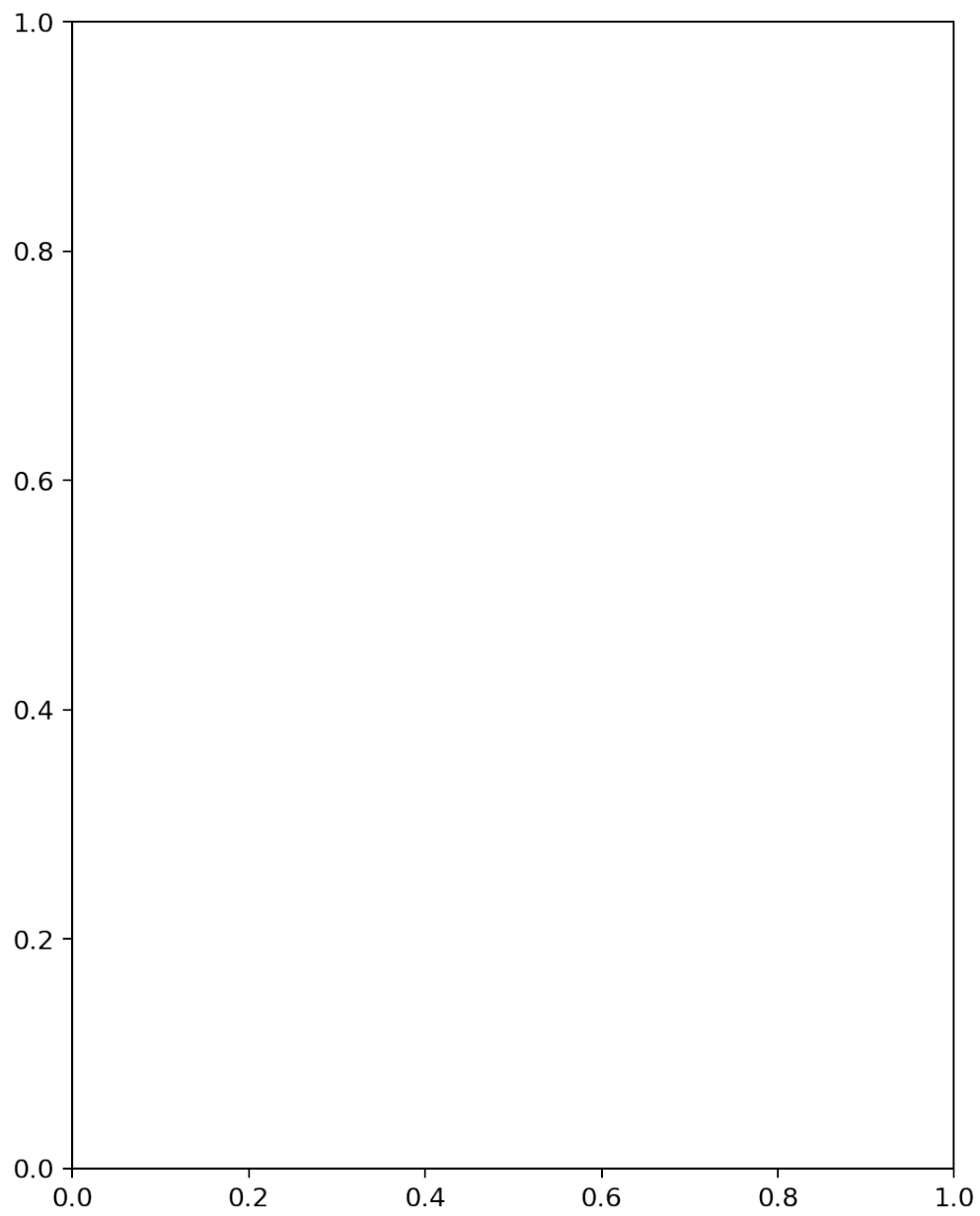


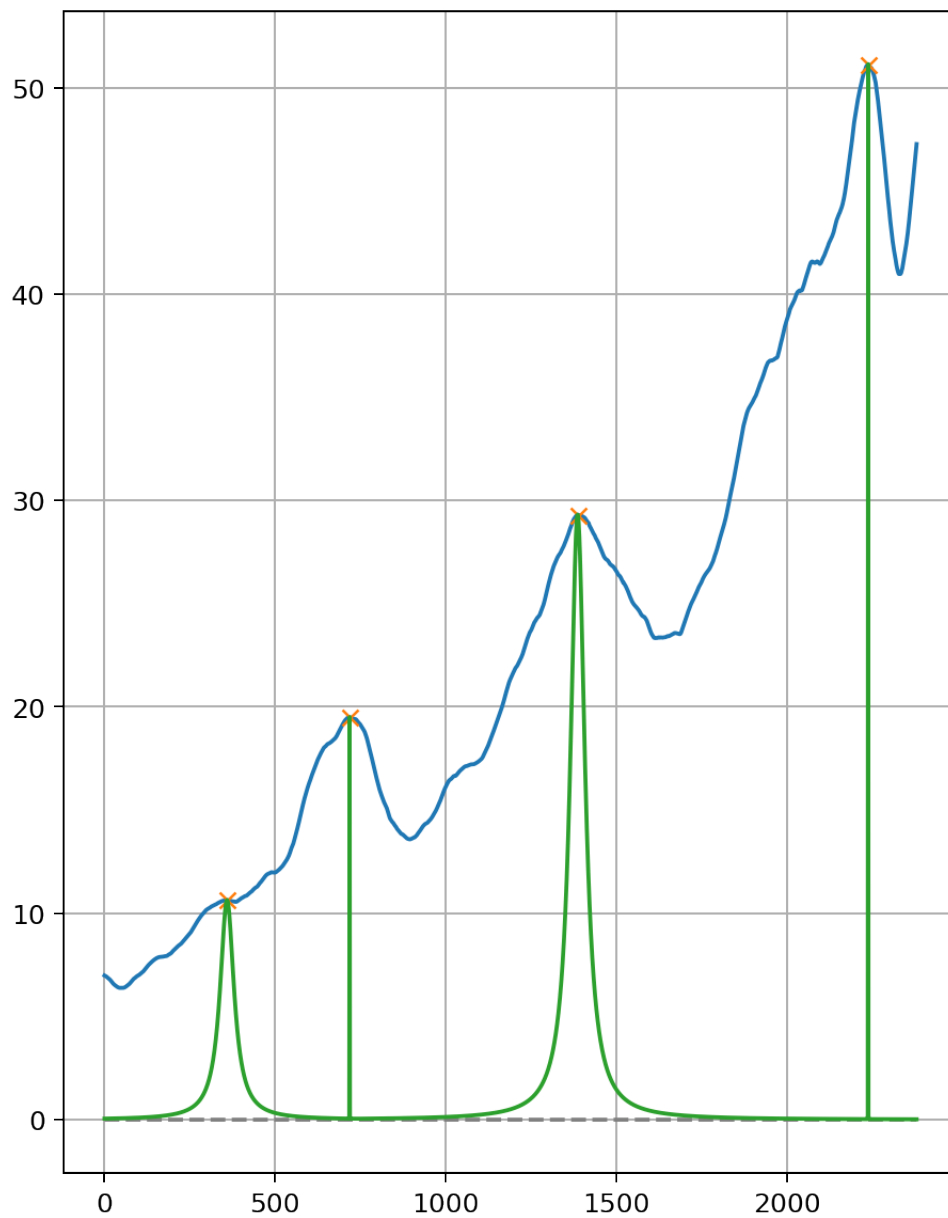












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array([312.56292974, 260.26402445, 396.99971868, 439.65104522]),
array([312.80463822, 260.30548427, 397.00439969, 439.60271117]),
array([313.0471096 , 260.35254271, 397.0143617 , 439.56537636]),

```



```

array([313.2836643 , 260.41535202, 397.04750045, 439.60408928]),
array([313.52199722, 260.46225122, 396.98970151, 439.59155269]),
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array([314.01371302, 260.50592393, 396.97919451, 439.61483752]),
array([314.25243222, 260.48300812, 397.03120901, 439.56706196]))

```

2

[]:

```

[109]: import numpy as np
import matplotlib.pyplot as plt
from scipy.optimize import leastsq

def lorentzian( x, x0, a, gam ):
    return a * gam**2 / ( gam**2 + ( x - x0 )**2)

def multi_lorentz( x, params ):
    off = params[0]
    paramsRest = params[1:]
    assert not ( len( paramsRest ) % 3 )
    return off + sum( [ lorentzian( x, *paramsRest[ i : i+3 ] ) for i in range(
↳0, len( paramsRest ), 3 ) ] )

def res_multi_lorentz( params, xData, yData ):
    diff = [ multi_lorentz( x, params ) - y for x, y in zip( xData, yData ) ]
    return diff

xData, yData = np.loadtxt('HEMAT_1.dat', unpack=True )
yData = yData / max(yData)

generalWidth = 1

yDataLoc = yData
startValues = [ max( yData ) ]
counter = 0

while max( yDataLoc ) - min( yDataLoc ) > .1:
    counter += 1
    if counter > 20: ### max 20 peak...emergency break to avoid infinite loop
        break
    minP = np.argmin( yDataLoc )
    minY = yData[ minP ]
    x0 = xData[ minP ]
    startValues += [ x0, minY - max( yDataLoc ), generalWidth ]
    popt, ier = leastsq( res_multi_lorentz, startValues, args=( xData, yData ) )

```

```

yDataLoc = [ y - multi_lorentz( x, popt ) for x,y in zip( xData, yData ) ]

print (popt)
testData = [ multi_lorentz(x, popt ) for x in xData ]

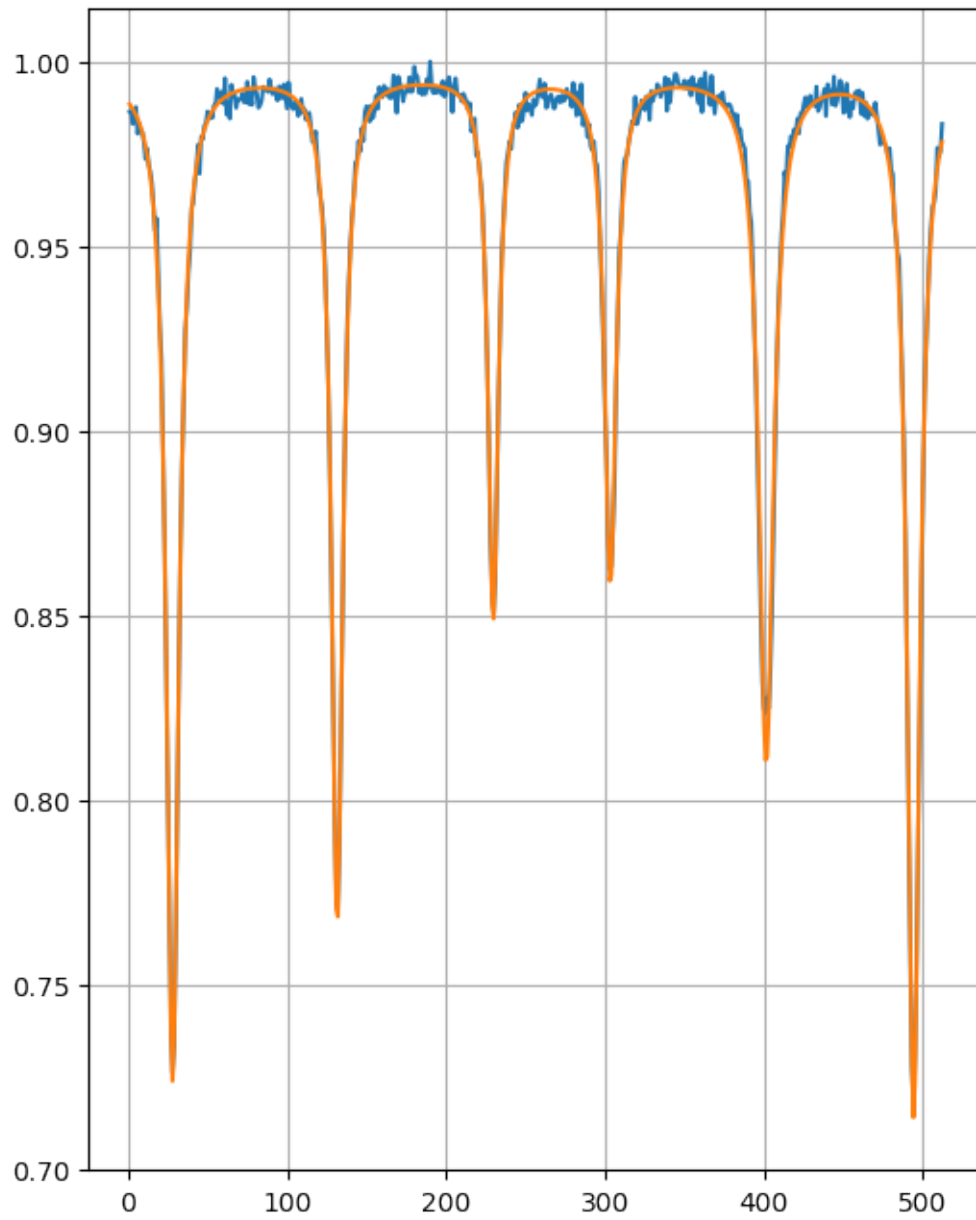
fig = plt.figure(figsize = (6,8),dpi = 100)
ax = fig.add_subplot( 1, 1, 1 )
ax.plot( xData, yData )
ax.grid()
ax.plot( xData, testData )
plt.show()

```

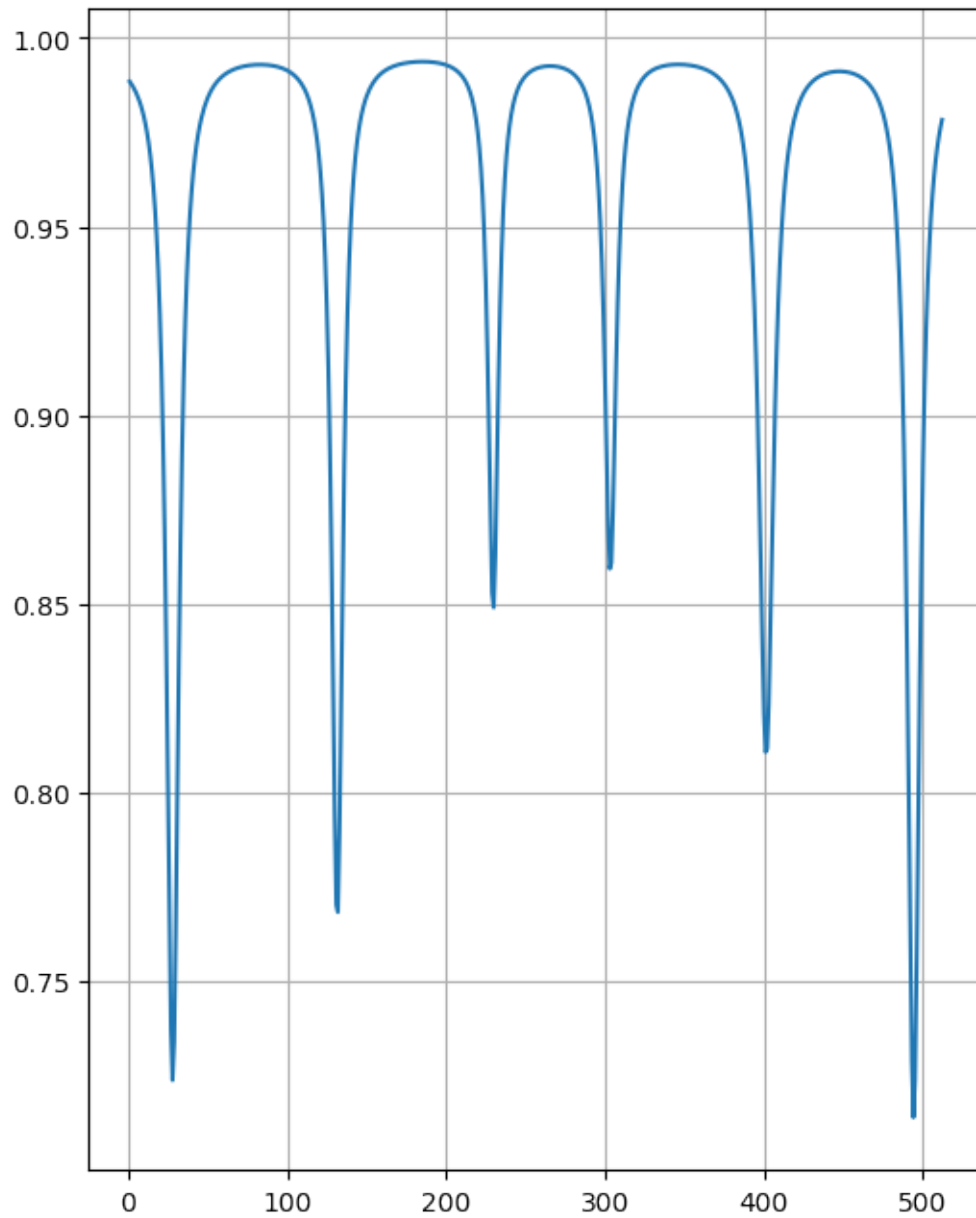
```

[ 9.96855817e-01  4.94106598e+02 -2.82103812e-01  4.66272776e+00
  2.80688160e+01 -2.72449246e-01  4.71728297e+00  1.31577189e+02
 -2.29698620e-01  4.20685231e+00  4.01421993e+02 -1.85917255e-01
  5.57859379e+00  2.29704607e+02 -1.47193791e-01  3.91112198e+00
  3.03387957e+02 -1.37127710e-01  4.39571908e+00]

```



```
[111]: fig = plt.figure(figsize = (6,8),dpi = 100)
ax = fig.add_subplot( 1, 1, 1 )
#ax.plot( xData, yData )
ax.grid()
ax.plot( xData, testData )
plt.show()
```



```
[115]: xData = range(len(y))
yData = y / max(y)
yDataLoc = yData
startValues = [ max( yData ) ]

while max( yDataLoc ) - min( yDataLoc ) > .1:
    counter += 1
    if counter > 20: ### max 20 peak...emergency break to avoid infinite loop
        break
    minP = np.argmin( yDataLoc )
```

```

minY = yData[ minP ]
x0 = xData[ minP ]
startValues += [ x0, minY - max( yDataLoc ), generalWidth ]
popt, ier = leastsq( res_multi_lorentz, startValues, args=( xData, yData ) )
yDataLoc = [ y - multi_lorentz( x, poprt ) for x,y in zip( xData, yData ) ]

print (popt)
testData = [ multi_lorentz(x, poprt ) for x in range(tickerDf['Open']) ]

fig = plt.figure(figsize = (6,8),dpi = 100)
ax = fig.add_subplot( 1, 1, 1 )
ax.plot( xData, yData )
ax.grid()
ax.plot( xData, testData )
plt.show()

```

```

/usr/local/lib/python3.8/dist-packages/scipy/optimize/minpack.py:475:
RuntimeWarning: Number of calls to function has reached maxfev = 2800.
  warnings.warn(errors[info][0], RuntimeWarning)
/usr/local/lib/python3.8/dist-packages/scipy/optimize/minpack.py:475:
RuntimeWarning: Number of calls to function has reached maxfev = 3400.
  warnings.warn(errors[info][0], RuntimeWarning)

```

KeyboardInterrupt Traceback (most recent call last)

```

<ipython-input-115-4ec13f20e6ea> in <module>
    12     x0 = xData[ minP ]
    13     startValues += [ x0, minY - max( yDataLoc ), generalWidth ]
--> 14     poprt, ier = leastsq( res_multi_lorentz, startValues, args=(
↳ xData, yData ) )
    15     yDataLoc = [ y - multi_lorentz( x, poprt ) for x,y in zip( xData,
↳ yData ) ]
    16

/usr/local/lib/python3.8/dist-packages/scipy/optimize/minpack.py in
↳ leastsq(func, x0, args, Dfun, full_output, col_deriv, ftol, xtol, gtol,
↳ maxfev, epsfcn, factor, diag)
    420         if maxfev == 0:
    421             maxfev = 200*(n + 1)
--> 422         retval = _minpack._lmdif(func, x0, args, full_output, ftol,
↳ xtol,
    423                                     gtol, maxfev, epsfcn, factor, diag)
    424     else:

```

```

<ipython-input-109-05984246cbff> in res_multi_lorentz(params, xData,
↳yData)
    13
    14 def res_multi_lorentz( params, xData, yData ):
---> 15     diff = [ multi_lorentz( x, params ) - y for x, y in zip( xData,
↳yData ) ]
    16     return diff
    17

```

```

<ipython-input-109-05984246cbff> in <listcomp>(.0)
    13
    14 def res_multi_lorentz( params, xData, yData ):
---> 15     diff = [ multi_lorentz( x, params ) - y for x, y in zip( xData,
↳yData ) ]
    16     return diff
    17

```

```

<ipython-input-109-05984246cbff> in multi_lorentz(x, params)
    10     paramsRest = params[1:]
    11     assert not ( len( paramsRest ) % 3 )
---> 12     return off + sum( [ lorentzian( x, *paramsRest[ i : i+3 ] ) for
↳i in range( 0, len( paramsRest ), 3 ) ] )
    13
    14 def res_multi_lorentz( params, xData, yData ):

```

```

<ipython-input-109-05984246cbff> in <listcomp>(.0)
    10     paramsRest = params[1:]
    11     assert not ( len( paramsRest ) % 3 )
---> 12     return off + sum( [ lorentzian( x, *paramsRest[ i : i+3 ] ) for
↳i in range( 0, len( paramsRest ), 3 ) ] )
    13
    14 def res_multi_lorentz( params, xData, yData ):

```

KeyboardInterrupt:

```
[ ]:
```

```
[ ]:
```