reg_year_r_2007_prod

February 1, 2024

0.1 Importing

[ ]:
```
import xarray as xr
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

from sklearn.ensemble import BaggingRegressor
from sklearn.tree import ExtraTreeRegressor
from sklearn.model_selection import train_test_split
from sklearn import preprocessing

from sklearn.metrics import mean_squared_error as mse

import os
from tqdm.auto import tqdm
```

```
/home/ibougoudis/conda_envs/analysis-ilias/lib/python3.11/site-
packages/tqdm/auto.py:21: TqdmWarning: IProgress not found. Please update
jupyter and ipywidgets. See
https://ipywidgets.readthedocs.io/en/stable/user_install.html
  from .autonotebook import tqdm as notebook_tqdm
```

0.2 Datasets Preparation (Training)

[ ]:
```
def datasets_preparation ():

    # Dataset and date
    ds_name = ('/results2/SalishSea/nowcast-green.202111/' + i + '/
↪SalishSea_1d_' + '20' + str(i[5:7]) + str(dict_month[i[2:5]])+str(i[0:2]) +␣
↪'_' + '20' + str(i[5:7]) + str(dict_month[i[2:5]]) + str(i[0:2]) + '_grid_T.
↪nc')

    ds_bio_name = ('/results2/SalishSea/nowcast-green.202111/' + i + '/
↪SalishSea_1d_'  + '20' + str(i[5:7]) + str(dict_month[i[2:5]])+str(i[0:2]) +␣
↪'_' + '20' + str(i[5:7]) + str(dict_month[i[2:5]]) + str(i[0:2]) + '_biol_T.
↪nc')
```

```
    ds_prod_name = ('/results2/SalishSea/nowcast-green.202111/' + i + '/
↪SalishSea_1d_'  + '20' + str(i[5:7]) + str(dict_month[i[2:5]])+str(i[0:2]) +␣
↪'_' + '20' + str(i[5:7]) + str(dict_month[i[2:5]]) + str(i[0:2]) + '_prod_T.
↪nc')

    ds = xr.open_dataset (ds_name)
    ds_bio = xr.open_dataset (ds_bio_name)
    ds_prod = xr.open_dataset(ds_prod_name)

    temp_i1 = (ds.votemper.where(mask==1)[0,0:15] * ds.e3t.where(mask==1)
              [0,0:15]).sum('deptht', skipna = True, min_count = 15) / mesh.
↪gdepw_0[0,15]
    temp_i2 = (ds.votemper.where(mask==1)[0,15:27] * ds.e3t.where(mask==1)
              [0,15:27]).sum('deptht', skipna = True, min_count = 12) / (mesh.
↪gdepw_0[0,27] - mesh.gdepw_0[0,14])
    saline_i1 = (ds.vosaline.where(mask==1)[0,0:15] * ds.e3t.where(mask==1)
                   [0,0:15]).sum('deptht', skipna = True, min_count = 15) /␣
↪mesh.gdepw_0[0,15]
    saline_i2 = (ds.vosaline.where(mask==1)[0,15:27] * ds.e3t.where(mask==1)
                   [0,15:27]).sum('deptht', skipna = True, min_count = 12) /␣
↪(mesh.gdepw_0[0,27] - mesh.gdepw_0[0,14])

    diat_i = (ds_prod.PPDIAT.where(mask==1)[0,0:27] * ds.e3t.where(mask==1)
              [0,0:27]).sum('deptht', skipna = True, min_count = 27) / mesh.
↪gdepw_0[0,27]
    # flag_i = (ds_prod.PPPHY.where(mask==1)[0,0:27] * ds.e3t.where(mask==1)
    #            [0,0:27]).sum('deptht', skipna = True, min_count = 27) / mesh.
↪gdepw_0[0,27]

    return (temp_i1, temp_i2, saline_i1, saline_i2, diat_i)
```

0.3 Regressor

```
[ ]: def regressor (inputs, targets, variable_name):

         inputs = inputs.transpose()

         # Regressor
         scale = preprocessing.StandardScaler()
         inputs2 = scale.fit_transform(inputs)
         X_train, X_test, y_train, y_test = train_test_split(inputs2, targets)

         extra_tree = ExtraTreeRegressor(criterion='poisson')
         regr = BaggingRegressor(extra_tree, n_estimators=10, max_features=4).
     ↪fit(X_train, y_train)
```

```
    outputs_test = regr.predict(X_test)

    m = scatter_plot(y_test, outputs_test, variable_name + ' (Testing dataset)')
    r = np.round(np.corrcoef(y_test, outputs_test)[0][1],3)
    rms = np.round(mse(y_test, outputs_test),4)


    return (r, rms, m, regr)
```

1 Printing

```
[ ]: def printing (targets, outputs, m):

         print ('The amount of data points is', outputs.size)
         print ('The slope of the best fitting line is ', np.round(m,3))
         print ('The correlation coefficient is:', np.round(np.corrcoef(targets,␣
       ↪outputs)[0][1],3))
         print (' The mean square error is:', np.round(mse(targets,outputs),5))
```

1.1 Scatter Plot

```
[ ]: def scatter_plot(targets, outputs, variable_name):

         # compute slope m and intercept b
         m, b = np.polyfit(targets, outputs, deg=1)

         printing (targets, outputs, m)

         fig, ax = plt.subplots()

         plt.scatter(targets,outputs, alpha = 0.2, s = 10)
         plt.xlabel('targets')
         plt.ylabel('outputs')

         lims = [
             np.min([ax.get_xlim(), ax.get_ylim()]),  # min of both axes
             np.max([ax.get_xlim(), ax.get_ylim()]),  # max of both axes
         ]

         # plot fitted y = m*x + b
         plt.axline(xy1=(0, b), slope=m, color='r')

         ax.set_aspect('equal')
         ax.set_xlim(lims)
         ax.set_ylim(lims)

```

```
    ax.plot(lims, lims,linestyle = '--',color = 'k')

    fig.suptitle(str(year) + ', ' + variable_name)

    plt.show()

    return (m)
```

1.2 Plotting

[ ]:
```
def plotting (variable, name):

    plt.plot(years,variable, marker = '.', linestyle = '')
    plt.legend(['diatom','flagellate'])
    plt.xlabel('Years')
    plt.ylabel(name)
    plt.show()
```

1.3 Regressor 2

[ ]:
```
def regressor2 (inputs, targets, variable_name):

    inputs = inputs.transpose()

    # Regressor
    scale = preprocessing.StandardScaler()
    inputs2 = scale.fit_transform(inputs)

    outputs_test = regr.predict(inputs2)

    m = scatter_plot(targets, outputs_test, variable_name + ' (Testing␣
 ↪dataset)')
    r = np.round(np.corrcoef(targets, outputs_test)[0][1],3)
    rms = np.round(mse(targets, outputs_test),4)

    return (r, rms, m)
```

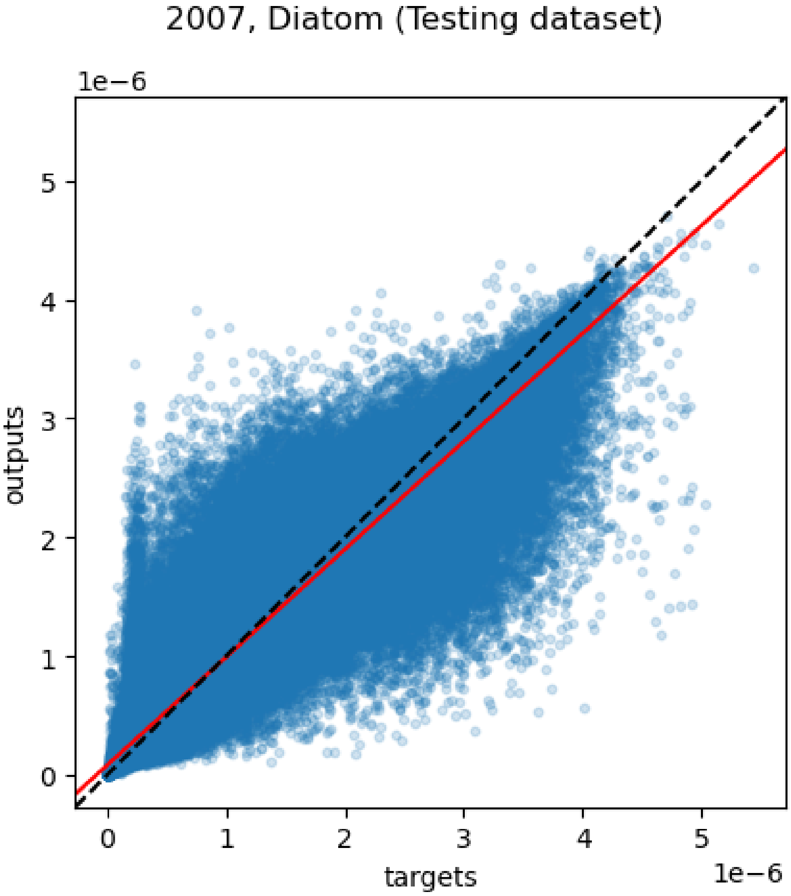
1.4 Training of 2007

[ ]:
```
dict_month = {'jan': '01',
         'feb': '02',
         'mar': '03',
         'apr': '04',
         'may': '05',
         'jun': '06',
         'jul': '07',
          'aug': '08',
          'sep': '09',
          'oct': '10',
          'nov': '11',
          'dec': '12'}

path = os.listdir('/results2/SalishSea/nowcast-green.202111/')

# Open the mesh mask
mesh = xr.open_dataset('/home/sallen/MEOPAR/grid/mesh_mask202108.nc')
mask = mesh.tmask.to_numpy()

year = 2007

year_str = str(year)[2:4]

folders = [x for x in path if ((x[2:5]=='mar' or x[2:5]=='apr' or (x[2:
 ↪5]=='feb' and x[0:2] > '14')) and (x[5:7]==year_str))]
indx_dates=(np.argsort(pd.to_datetime(folders, format="%d%b%y")))
folders = [folders[i] for i in indx_dates]

drivers_all = np.array([[],[],[],[]])
diat_all = np.array([])

print ('Gathering days for year ' + str(year))

for i in tqdm(folders):

    temp_i1, temp_i2, saline_i1, saline_i2, diat_i = datasets_preparation()

    drivers = np.stack([np.ravel(temp_i1), np.ravel(temp_i2), np.
 ↪ravel(saline_i1), np.ravel(saline_i2)])
    indx = np.where(~np.isnan(drivers).any(axis=0))
    drivers = drivers[:,indx[0]]
    drivers_all = np.concatenate((drivers_all,drivers),axis=1)

    diat = np.ravel(diat_i)
    diat = diat[indx[0]]
    diat_all = np.concatenate((diat_all,diat))

print ('Done gathering, building the prediction model')
print ('\n')

r, rms, m, regr = regressor(drivers_all, diat_all, 'Diatom')
```

```
Gathering days for year 2007
```

```
100%|     | 75/75 [02:53<00:00,  2.31s/it]
```

```
Done gathering, building the prediction model


The amount of data points is 871482
The slope of the best fitting line is  0.908
The correlation coefficient is: 0.958
 The mean square error is: 0.0
```

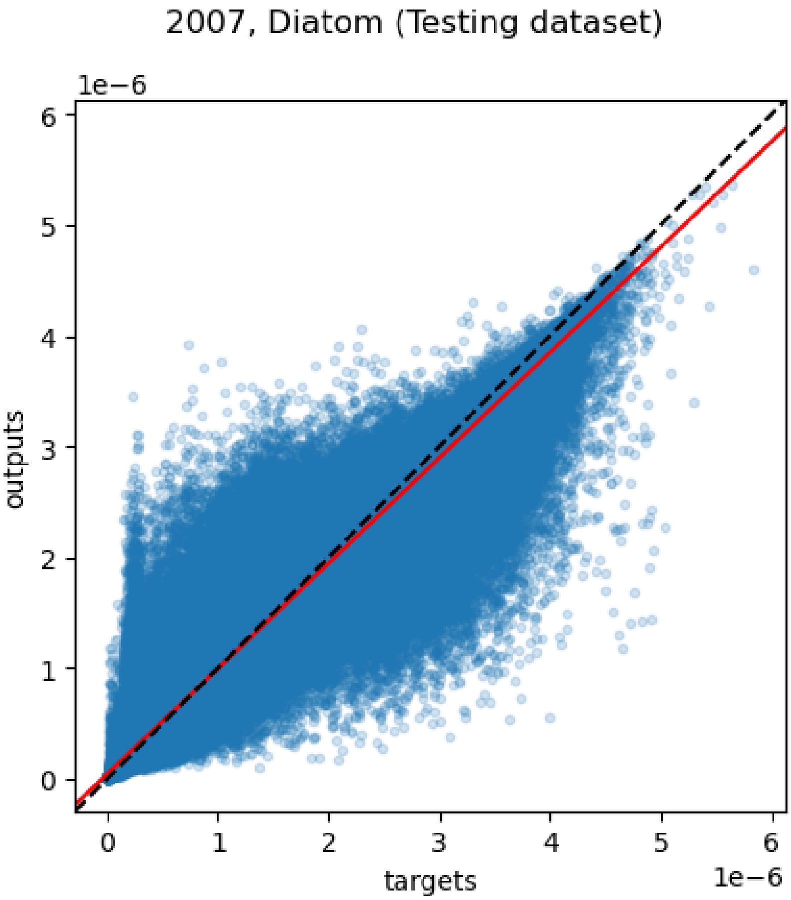


1.5 Other Years

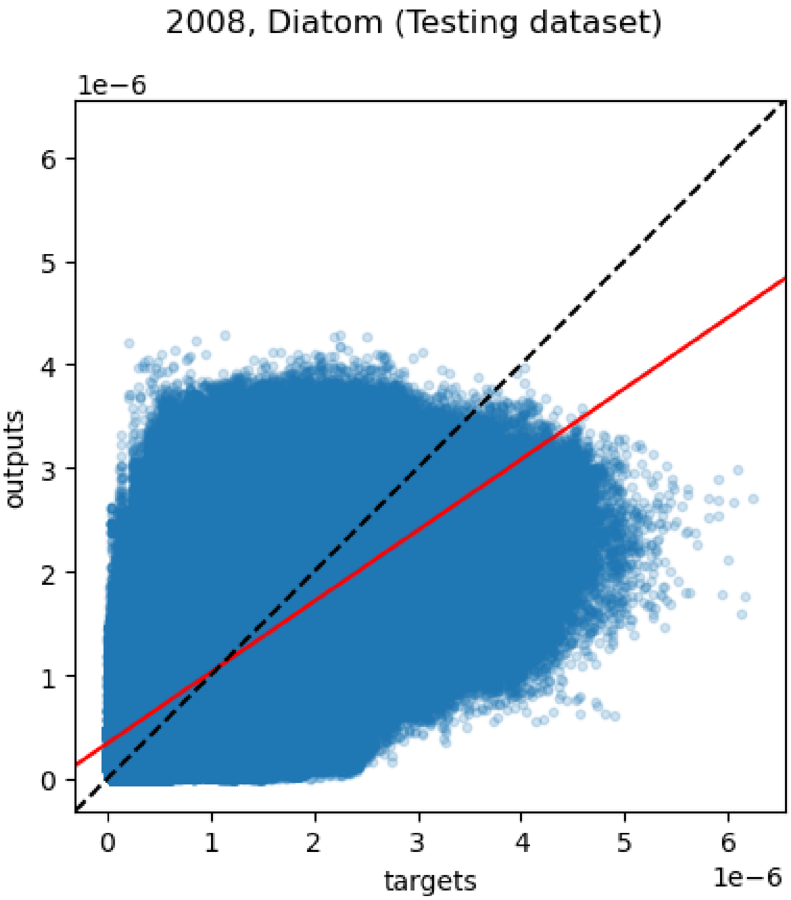
```
[ ]: years = range (2007,2024)

     r_all = []
     rms_all = []
     slope_all = []

     for year in range (2007,2024):
```

```
    year_str = str(year)[2:4]

    folders = [x for x in path if ((x[2:5]=='mar' or x[2:5]=='apr' or (x[2:
 ↪5]=='feb' and x[0:2] > '14')) and (x[5:7]==year_str))]
    indx_dates=(np.argsort(pd.to_datetime(folders, format="%d%b%y")))
    folders = [folders[i] for i in indx_dates]

    drivers_all = np.array([[],[],[],[]])
    diat_all = np.array([])

    print ('Gathering days for year ' + str(year))

    for i in tqdm(folders):

        temp_i1, temp_i2, saline_i1, saline_i2, diat_i = datasets_preparation()

        drivers = np.stack([np.ravel(temp_i1), np.ravel(temp_i2), np.
 ↪ravel(saline_i1), np.ravel(saline_i2)])
        indx = np.where(~np.isnan(drivers).any(axis=0))
        drivers = drivers[:,indx[0]]
        drivers_all = np.concatenate((drivers_all,drivers),axis=1)

        diat = np.ravel(diat_i)
        diat = diat[indx[0]]
        diat_all = np.concatenate((diat_all,diat))

    r, rms, m = regressor2(drivers_all, diat_all, 'Diatom')
    r_all.append(r)
    rms_all.append(rms)
    slope_all.append(m)

plotting(np.transpose(r_all), 'Correlation Coefficient')
plotting(np.transpose(rms_all), 'Mean Square Error')
plotting (np.transpose(slope_all), 'Slope of the best fitting line')
```

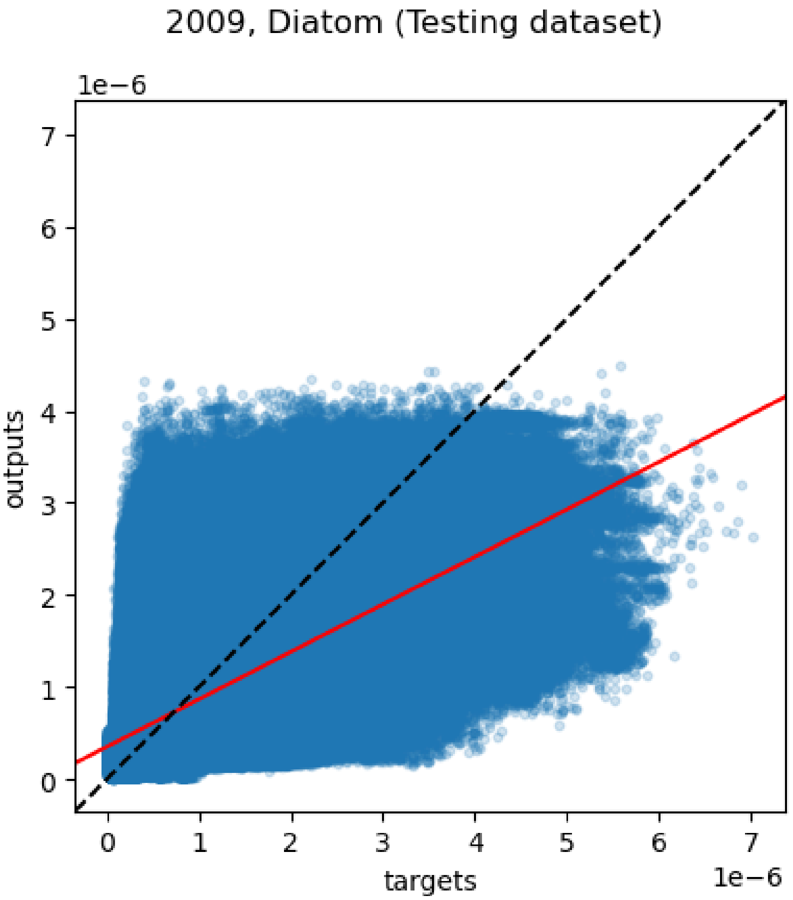
```
Gathering days for year 2007

100%|      | 75/75 [02:02<00:00,  1.63s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.951
The correlation coefficient is: 0.984
 The mean square error is: 0.0
```



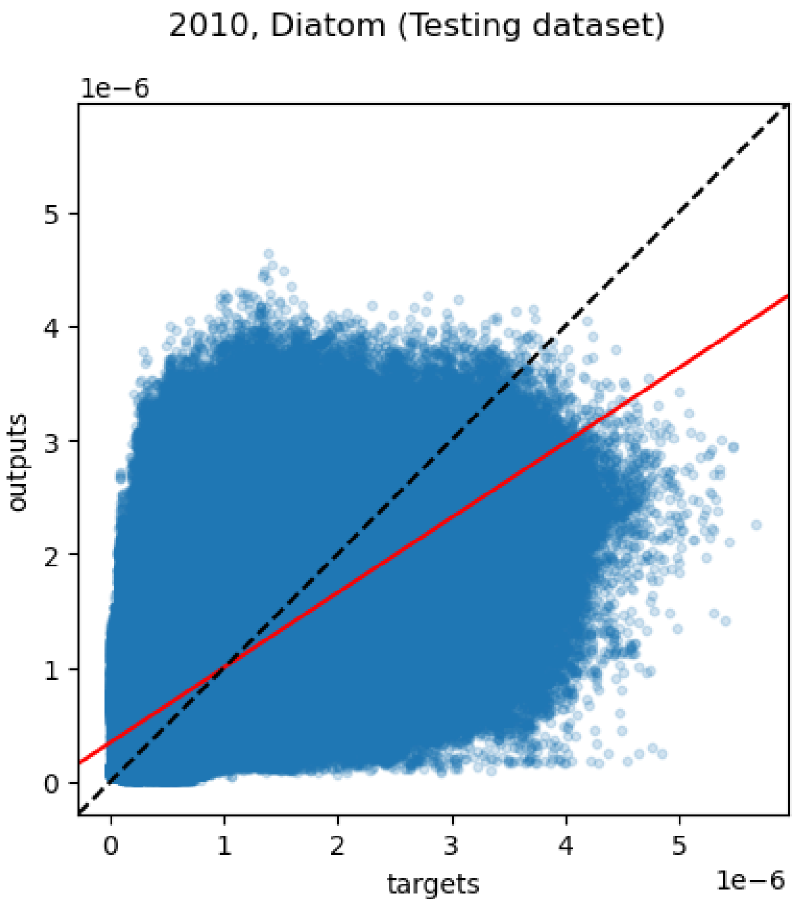
```
Gathering days for year 2008

100%|      | 76/76 [02:52<00:00,  2.28s/it]

The amount of data points is 3532404
The slope of the best fitting line is  0.685
The correlation coefficient is: 0.664
 The mean square error is: 0.0
```



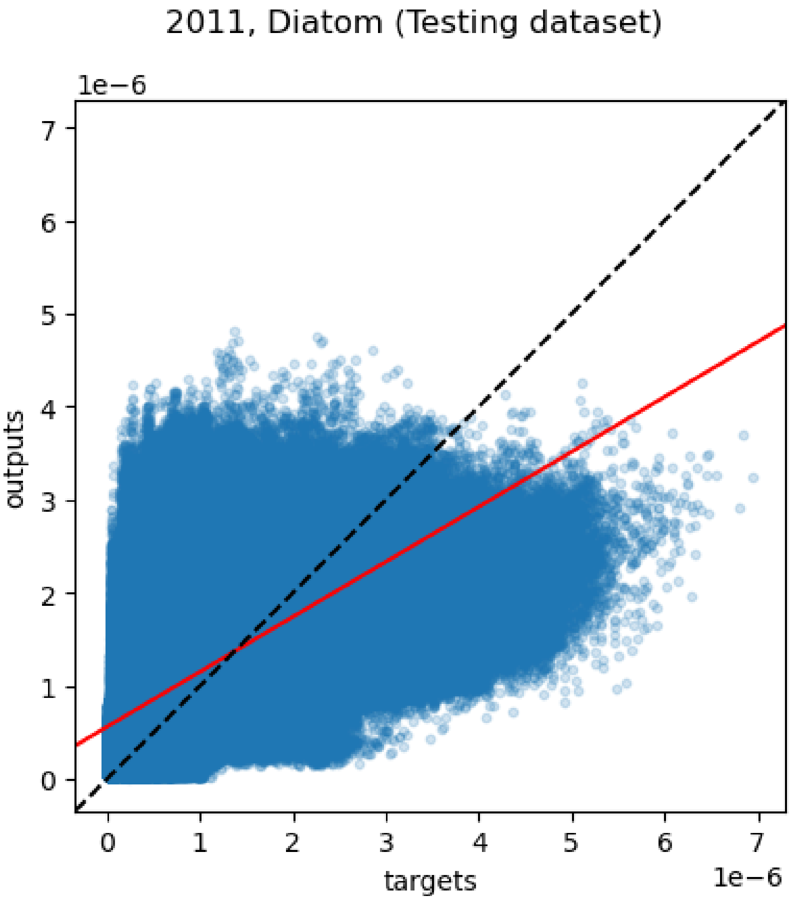
```
Gathering days for year 2009

100%|      | 75/75 [02:56<00:00,  2.36s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.515
The correlation coefficient is: 0.684
 The mean square error is: 0.0
```



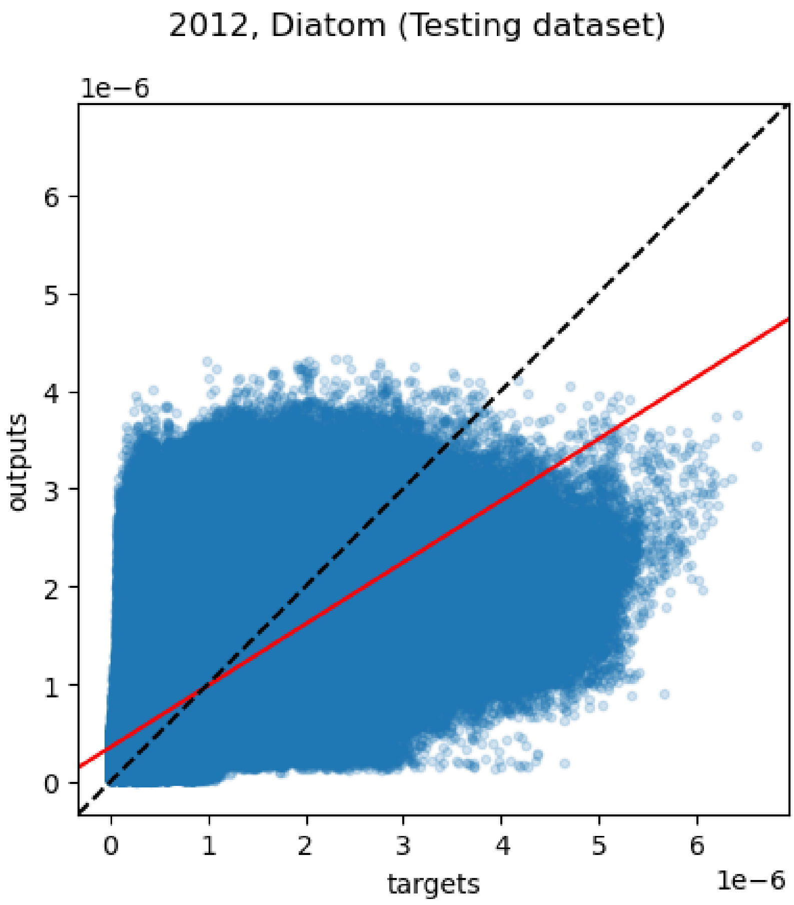
```
Gathering days for year 2010

100%|      | 75/75 [02:55<00:00,  2.34s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.658
The correlation coefficient is: 0.64
 The mean square error is: 0.0
```



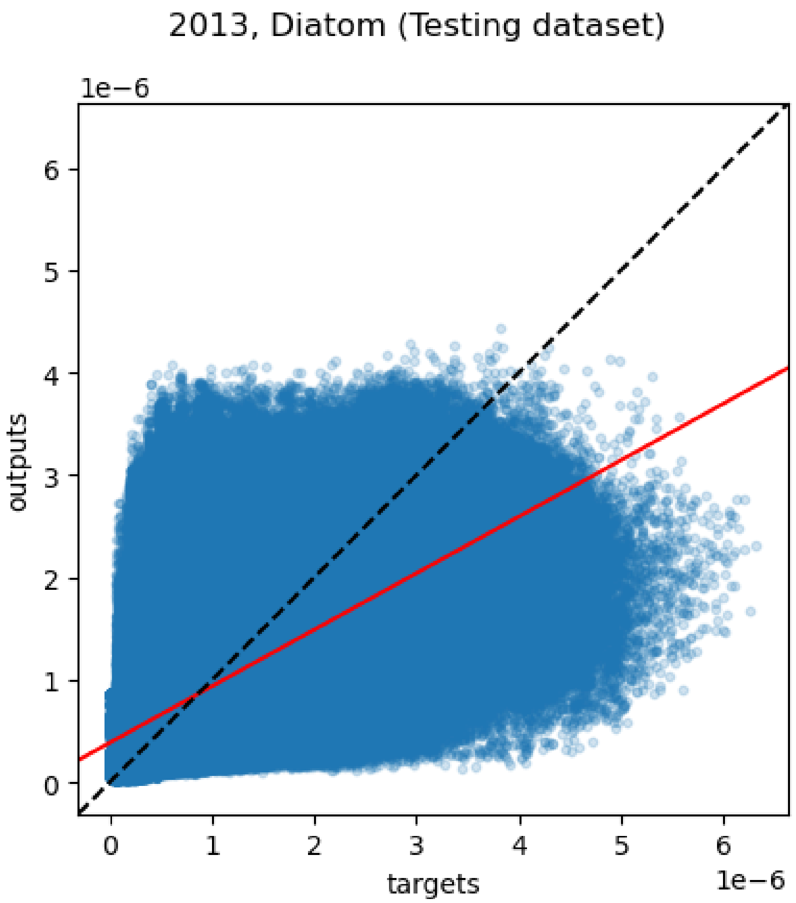
```
Gathering days for year 2011

100%|      | 75/75 [02:54<00:00,  2.33s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.591
The correlation coefficient is: 0.626
 The mean square error is: 0.0
```



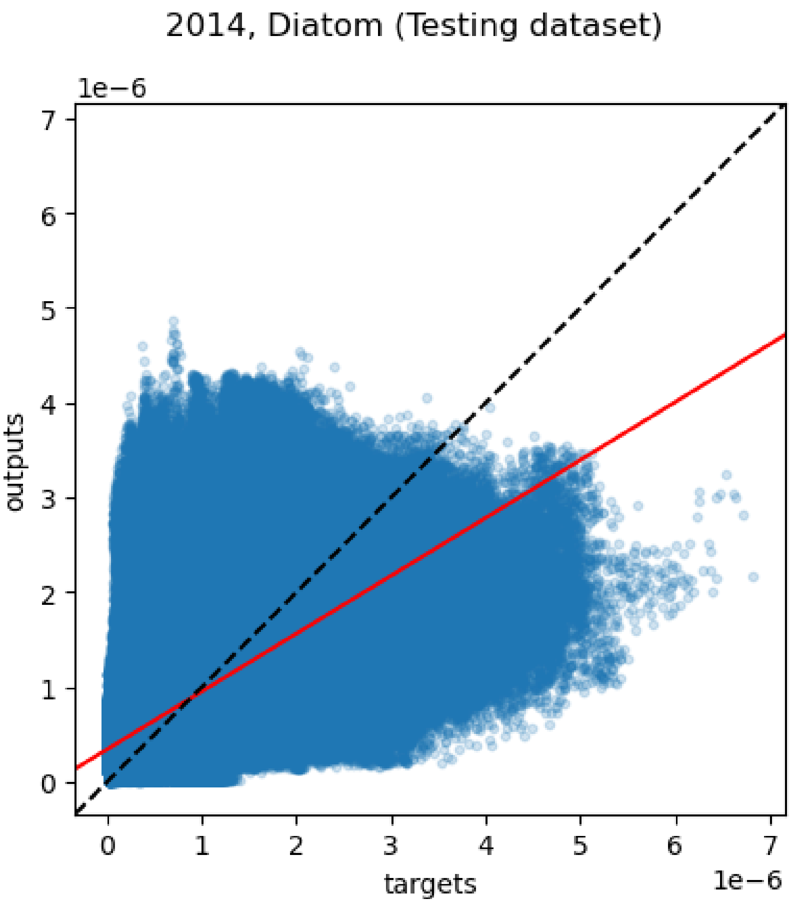
```
Gathering days for year 2012

100%|      | 76/76 [02:56<00:00,  2.32s/it]

The amount of data points is 3532404
The slope of the best fitting line is  0.631
The correlation coefficient is: 0.691
 The mean square error is: 0.0
```



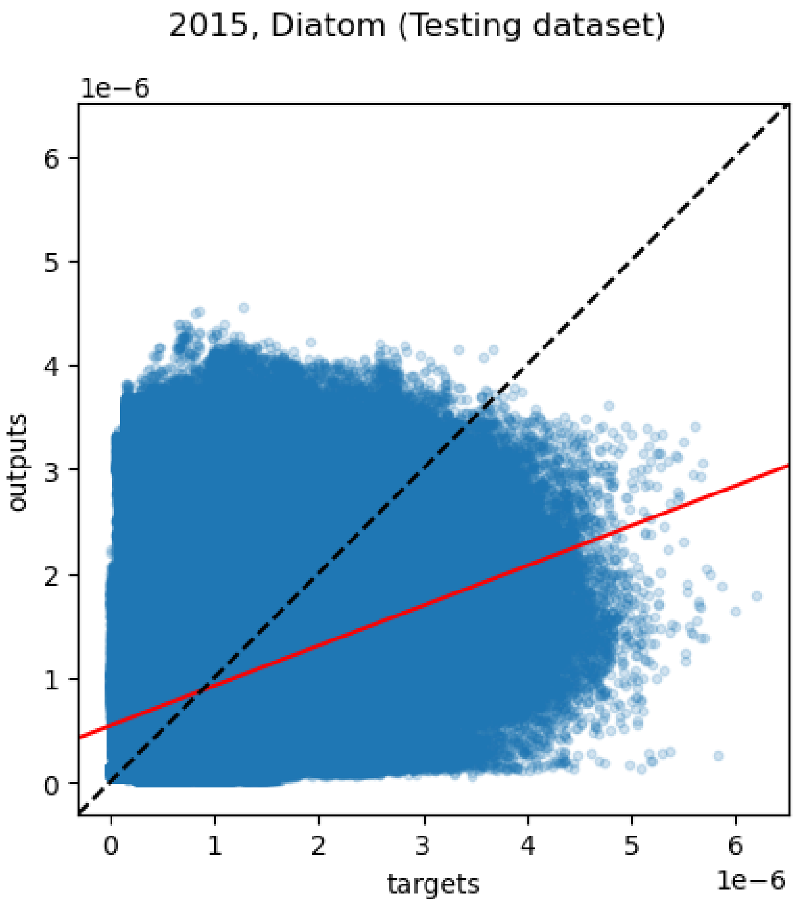
```
Gathering days for year 2013

100%|      | 75/75 [02:55<00:00,  2.34s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.552
The correlation coefficient is: 0.642
 The mean square error is: 0.0
```



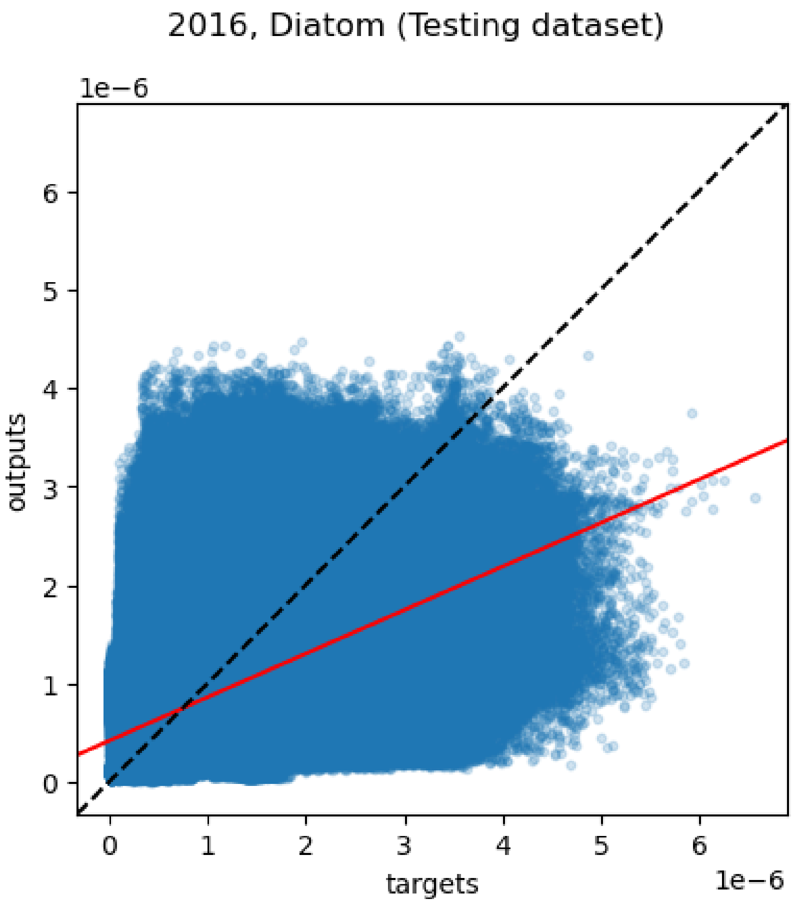
```
Gathering days for year 2014

100%|      | 75/75 [02:55<00:00,  2.34s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.61
The correlation coefficient is: 0.611
 The mean square error is: 0.0
```



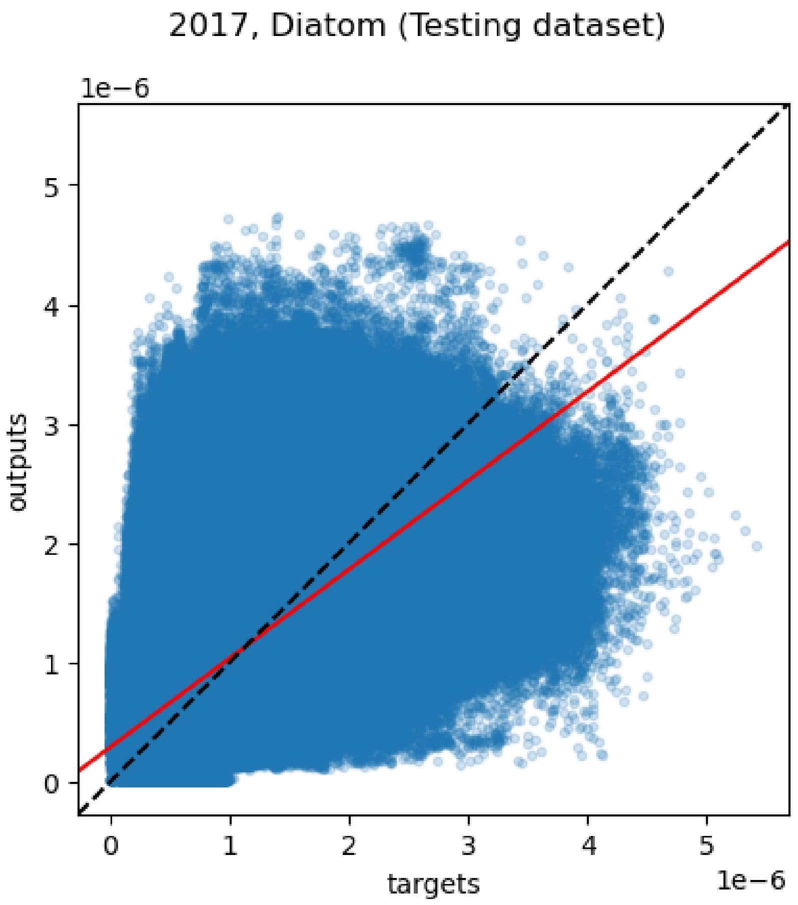
```
Gathering days for year 2015

100%|      | 75/75 [02:43<00:00,  2.18s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.383
The correlation coefficient is: 0.358
 The mean square error is: 0.0
```



```
Gathering days for year 2016

100%|      | 76/76 [02:55<00:00,  2.31s/it]

The amount of data points is 3532404
The slope of the best fitting line is  0.442
The correlation coefficient is: 0.528
 The mean square error is: 0.0
```

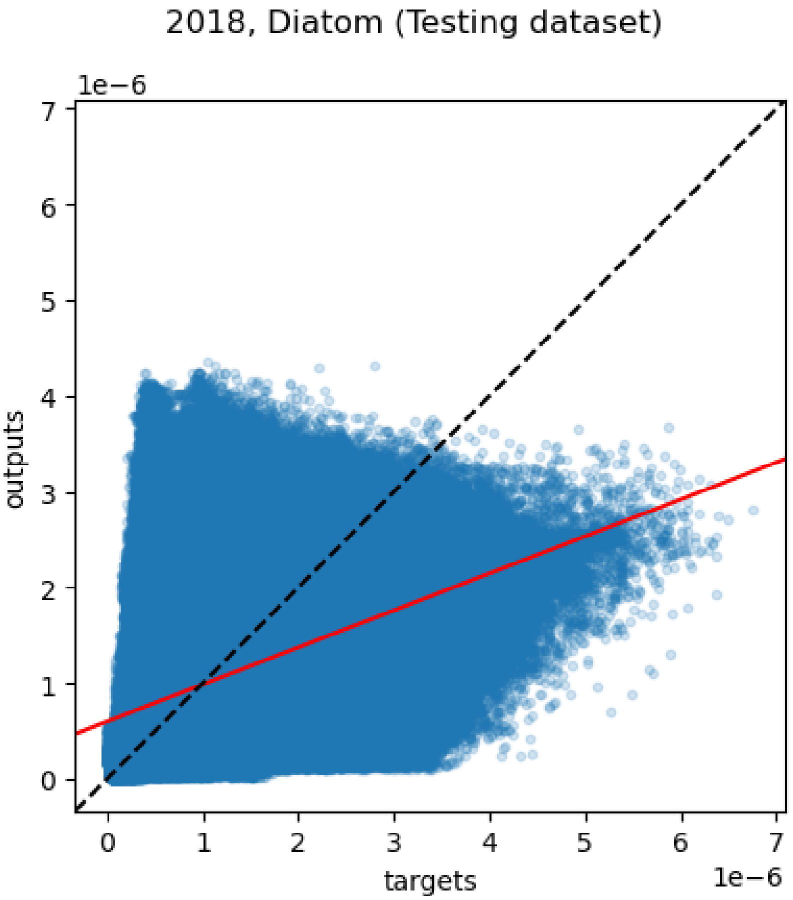


```
Gathering days for year 2017

100%|      | 75/75 [02:59<00:00,  2.39s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.744
The correlation coefficient is: 0.667
 The mean square error is: 0.0
```

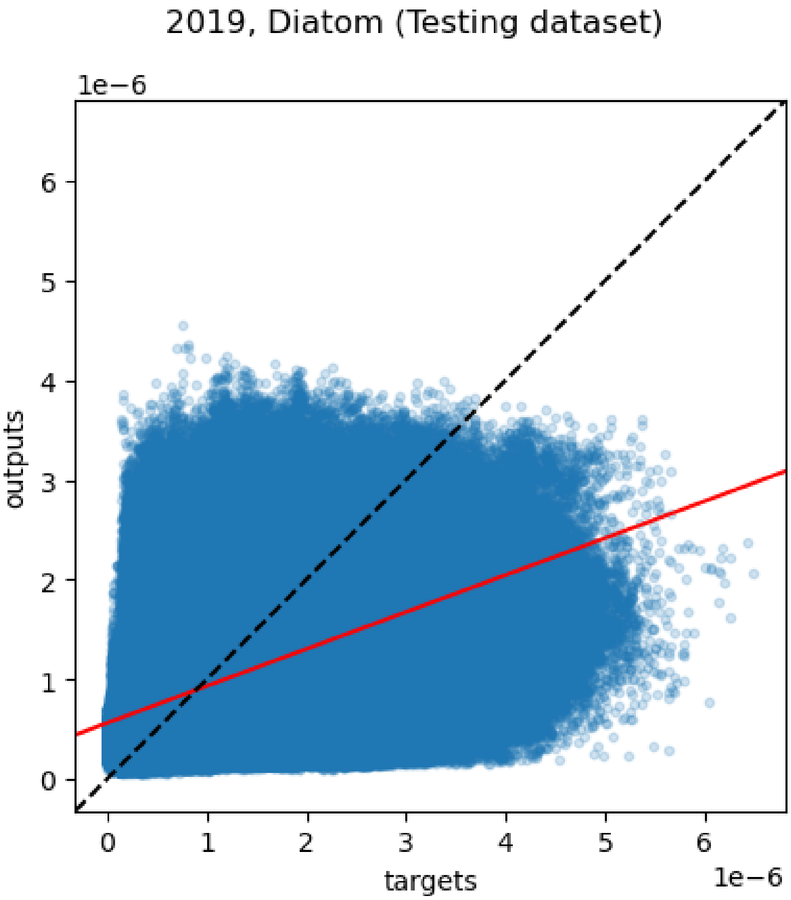


2017, Diatom (Testing dataset)

```
Gathering days for year 2018

100%|      | 75/75 [03:00<00:00,  2.41s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.387
The correlation coefficient is: 0.377
 The mean square error is: 0.0
```

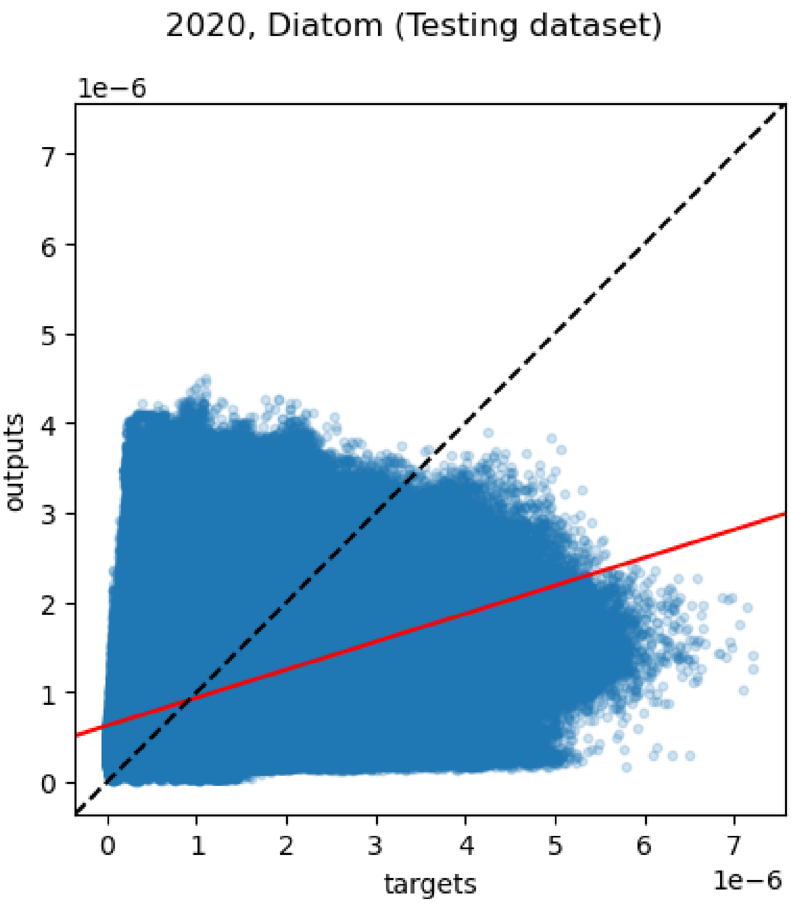


```
Gathering days for year 2019

100%|      | 75/75 [02:56<00:00,  2.35s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.371
The correlation coefficient is: 0.444
 The mean square error is: 0.0
```

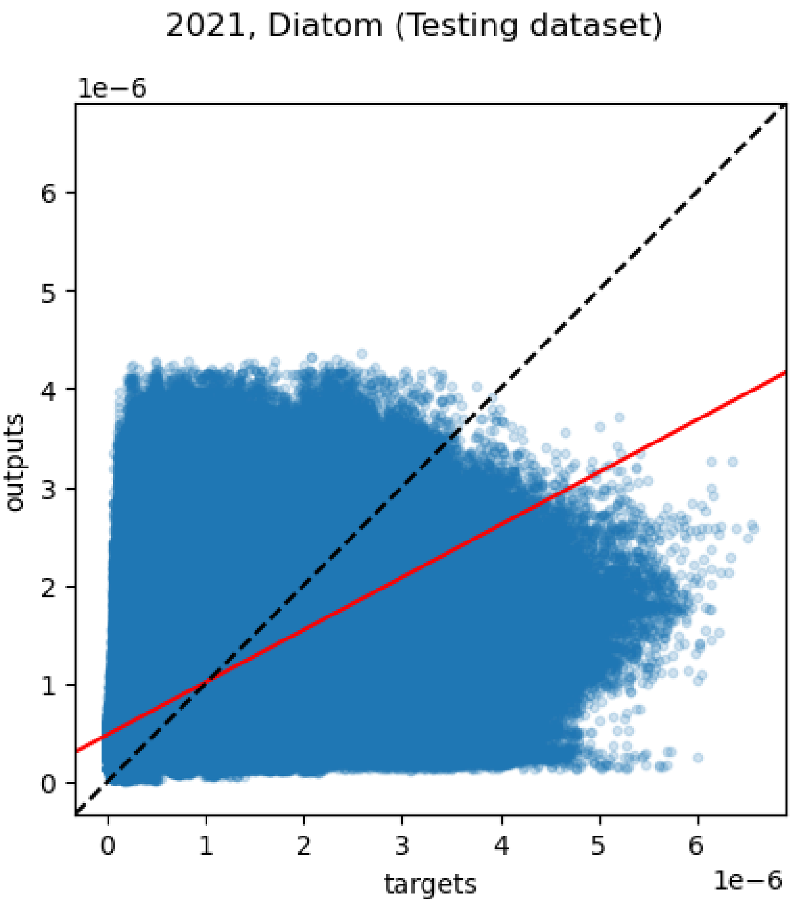


2019, Diatom (Testing dataset)

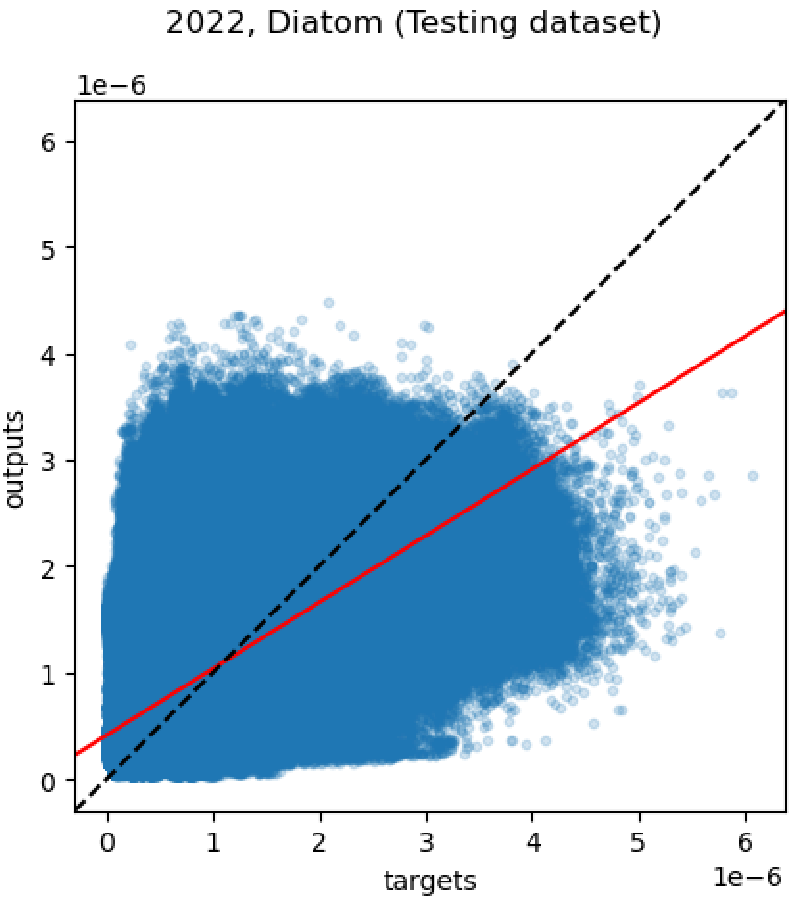
```
Gathering days for year 2020

100%|      | 76/76 [02:44<00:00,  2.16s/it]

The amount of data points is 3532404
The slope of the best fitting line is  0.312
The correlation coefficient is: 0.36
 The mean square error is: 0.0
```



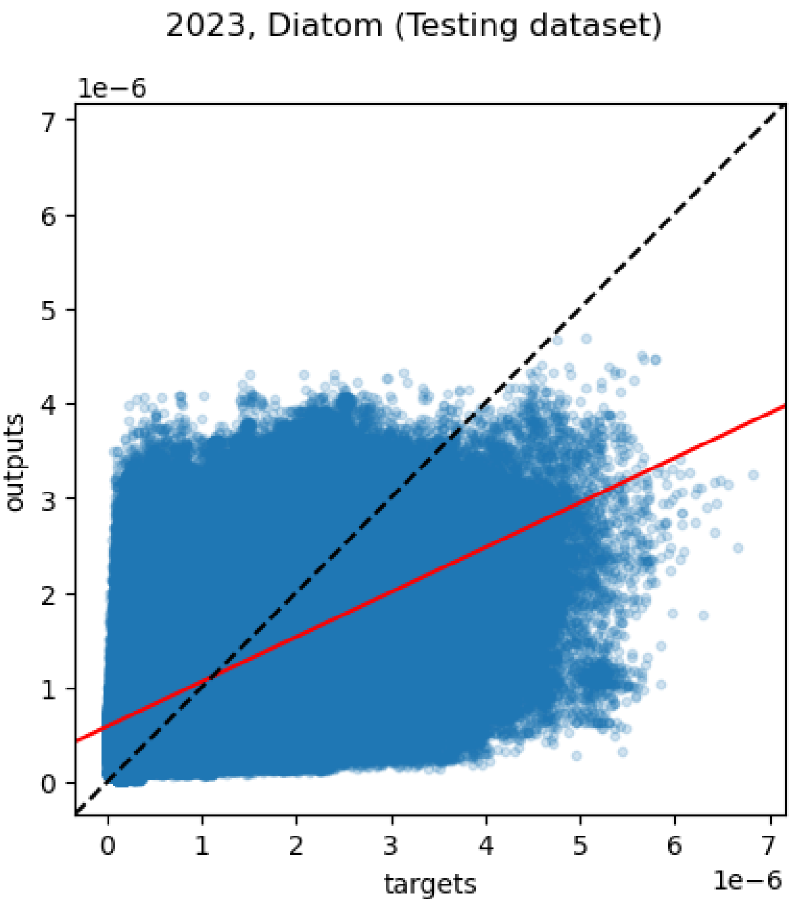
```
Gathering days for year 2021

100%|      | 75/75 [02:45<00:00,  2.21s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.533
The correlation coefficient is: 0.594
 The mean square error is: 0.0
```

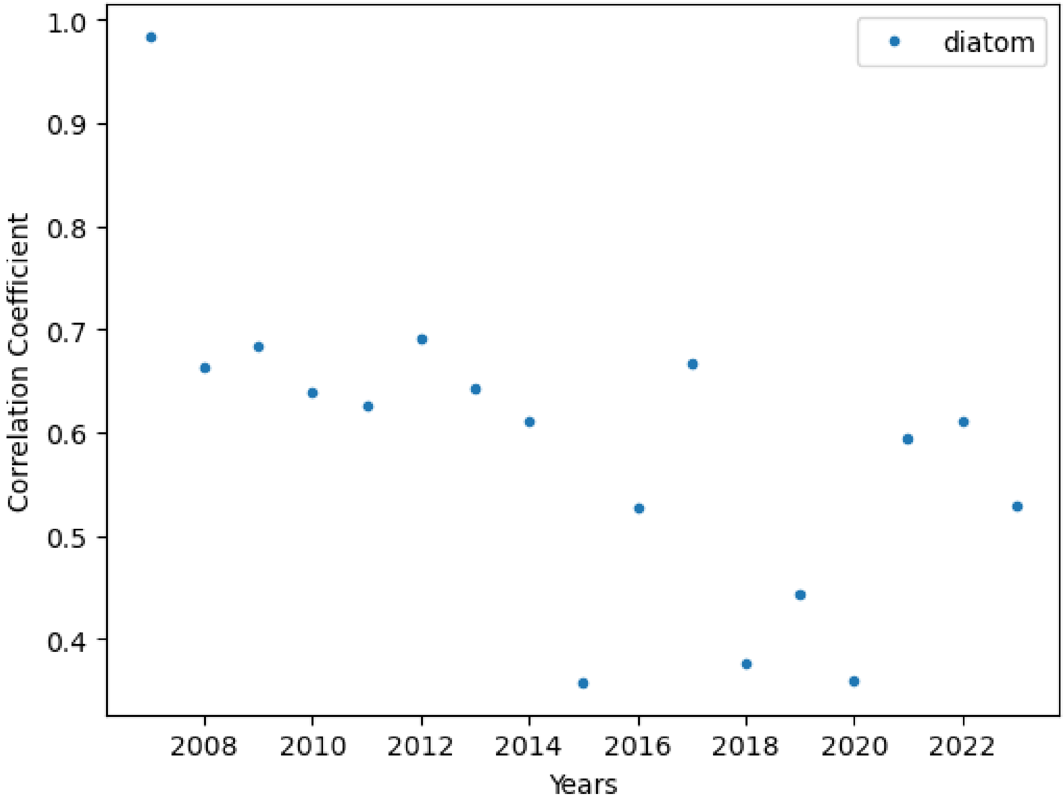


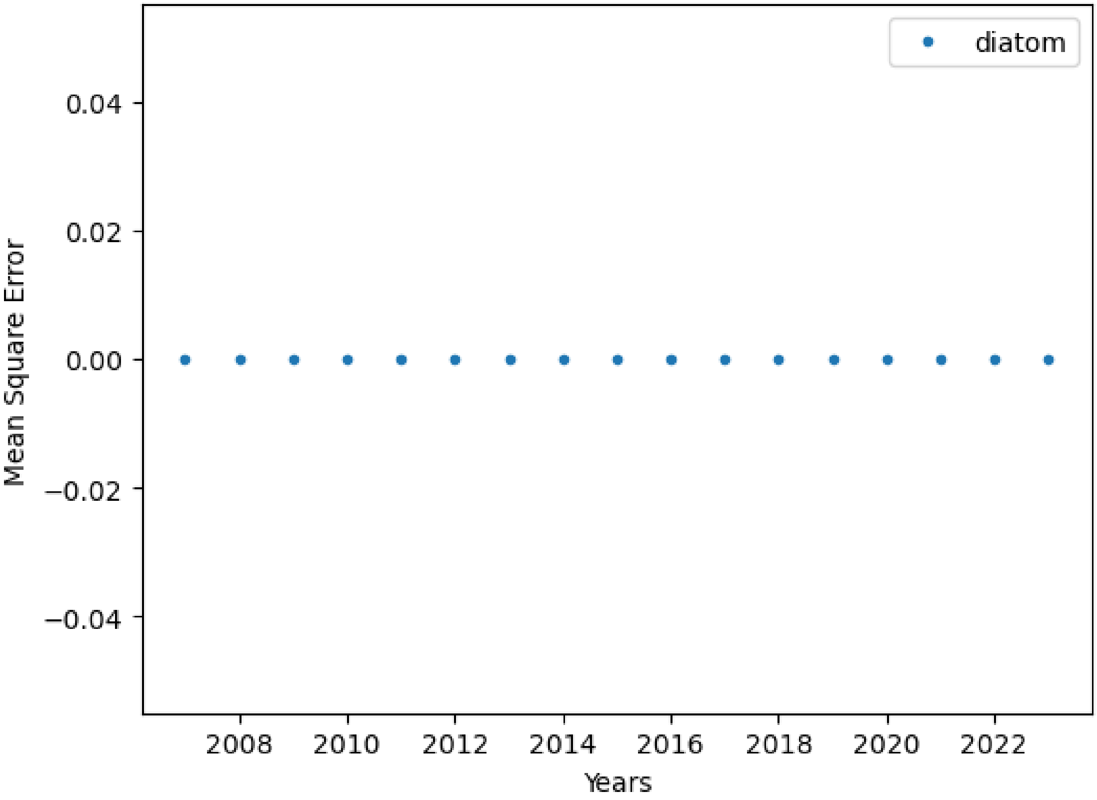
```
Gathering days for year 2022

100%|      | 75/75 [02:54<00:00,  2.32s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.624
The correlation coefficient is: 0.611
 The mean square error is: 0.0
```

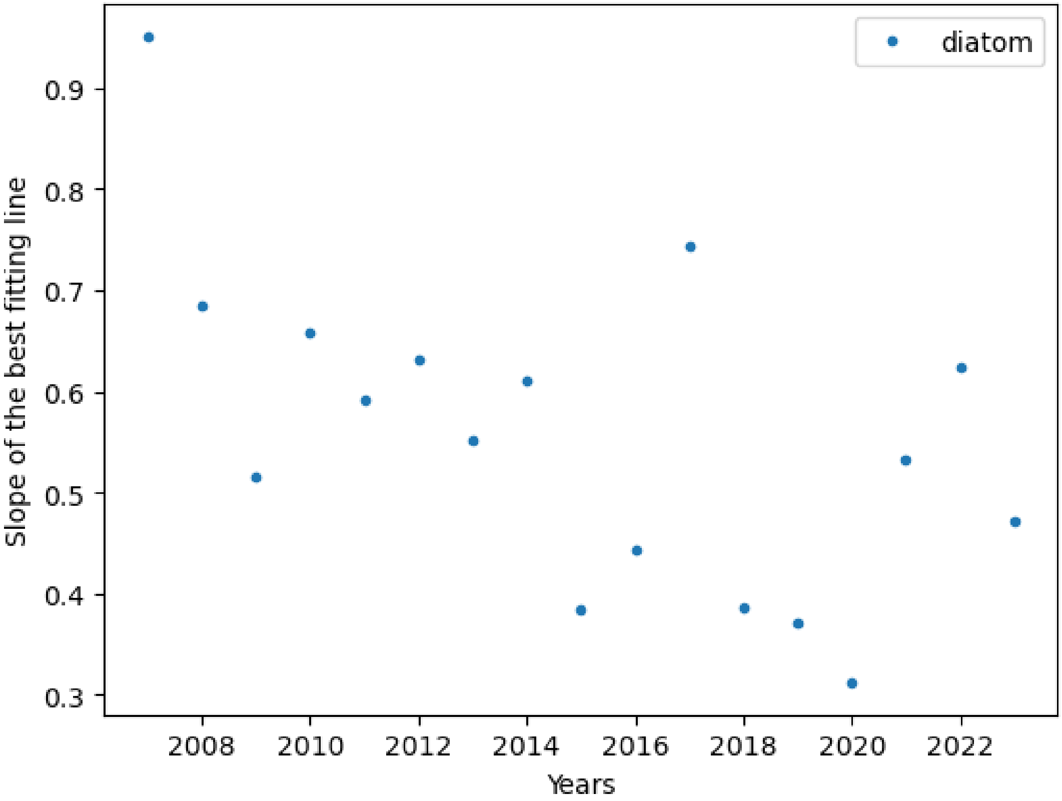


```
Gathering days for year 2023

100%|      | 75/75 [03:00<00:00,  2.41s/it]

The amount of data points is 3485925
The slope of the best fitting line is  0.473
The correlation coefficient is: 0.53
 The mean square error is: 0.0
```


2023, Diatom (Testing dataset)
1e−6
7
6
5
4
3
2
1
0
outputs
0
1
2
3
4
5
6
7
targets
1e−6


1.0
0.9
0.8
0.7
0.6
0.5
0.4
Correlation Coefficient
● diatom
2008
2010
2012
2014
2016
2018
2020
2022
Years


diatom
0.04
0.02
0.00
−0.02
−0.04
Mean Square Error
2008
2010
2012
2014
2016
2018
2020
2022
Years


diatom
Slope of the best fitting line
0.3
0.4
0.5
0.6
0.7
0.8
0.9
2008
2010
2012
2014
2016
2018
2020
2022
Years