

In [1]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from sklearn.ensemble import IsolationForest
from tensorflow.python.keras.models import Sequential
from tensorflow.python.keras.layers import Dense
from tensorflow.python.keras.wrappers.scikit_learn import KerasRegressor
```

In [2]:

```
albedo_top_half = pd.read_csv("mercury-albedo-top-half.png.csv",header=None)
albedo_bottom_half = pd.read_csv("mercury-albedo-resized-bottom-half.png.csv",header=None)
alsimap = pd.read_csv("alsimap_smooth_032015.png.csv",header=None)
casimap = pd.read_csv("casimap_smooth_032015.png.csv",header=None)
fesimap = pd.read_csv("fesimap_smooth_032015.png.csv",header=None)
mgsimap = pd.read_csv("mgsimap_smooth_032015.png.csv",header=None)
ssimap = pd.read_csv("ssimap_smooth_032015.png.csv",header=None)
```

In [3]:

```
def correlation_matrix(dataframe1,dataframe2):

    array1 = np.array(dataframe1)
    array1 = np.reshape(array1,(1036800,1))
    array2 = np.array(dataframe2)
    array2 = np.reshape(array2,(1036800,1))
    df = pd.DataFrame(array1,columns=['albedo'])
    df['concentration']= array2
    corr_matrix = df.corr()
    print("\nCorrelation between the Albedo and Concentration Map\n\n",corr_matrix)
    print("\n\nSummary of the data\n\n",df.describe())

    return df
```

In [4]:

```
def test_data(dataframe):

    xtrain = np.array(albedo_top_half)
    xtest = np.array(albedo_bottom_half)
    print(dataframe.shape)
    ytrain = np.array(dataframe)

    plt.subplots(figsize=(15,8))
    plt.subplot(1, 2, 1)
    plt.imshow(xtrain)
    plt.title("Albedo Image")

    plt.subplot(1, 2, 2)
    plt.imshow(ytrain)
    plt.title("Concentration Map")
    plt.tight_layout(6)
    plt.show()

    return ytrain , xtrain , xtest
```

In [5]:

```
def outlier_plots(dataframe):

    plt.subplots(figsize=(15,6))
    plt.subplot(1, 2, 1)
    plt.title("Scatter plot Albedo and Concentration")
    plt.scatter(df['albedo'],df['concentration'])

    plt.subplot(1, 2, 2)
    green_diamond = dict(markerfacecolor='g', marker='D')
    plt.title('Boxplot for Outlier Detection')
    plt.boxplot(df['concentration'],flierprops=green_diamond)
    plt.tight_layout(6)
    plt.show()

    plt.figure(figsize=(8,5))
    plt.title('Distribution of the Concentration')
    plt.hist(df['concentration'])
    plt.show()
```

In [6]:

```
def outlier_detection(xtrain,ytrain,contamination):

    plt.figure(figsize=(10,7))
    plt.scatter(xtrain, ytrain,s=0.05)
    plt.title('Before Outlier Removal')
    plt.show()

    iso = IsolationForest(contamination=contamination)
    yhat = iso.fit_predict(ytrain)
    mask = yhat != -1
    xtrain, ytrain = xtrain[mask, :], ytrain[mask]
    shape = xtrain.shape

    plt.figure(figsize=(10,7))
    plt.scatter(xtrain, ytrain,s=0.05)
    plt.title('After Outlier Removal')
    plt.show()

    print(shape)
    print(iso.get_params(deep=True))

    return xtrain, ytrain, shape
```

In [7]:

```
def visualise_maps(array):

    plt.figure(figsize=(10,5))
    plt.title("Concentration Map Post Outlier Removal")
    sns.heatmap(array,xticklabels=0,yticklabels=0, cmap='viridis')
```

In [8]:

```
def model_application(xtrain, xtest, ytrain):

    model = Sequential()
    model.add(Dense(32, input_shape=(1440,), kernel_initializer='normal', activation='relu'))
    model.add(Dense(16, activation='relu'))
    model.add(Dense(1440, activation='linear'))
    model.summary()
    model.compile(loss='mse', optimizer='adam', metrics=['mse','mae'])
    history = model.fit(xtrain, ytrain, epochs=150, batch_size=50, verbose=1, validation_split=0.2)
    ypredicted= model.predict(xtest)

    return history,model,ypredicted
```

In [9]:

```
def visualise_performance(model,history,xtest,ypredicted):

    print(history.history.keys())
    plt.subplots(figsize=(15,6))
    plt.subplot(1, 2, 1)
    plt.plot(history.history['loss'])
    plt.plot(history.history['val_loss'])
    plt.title('Model Loss for Training Data')
    plt.ylabel('Loss')
    plt.xlabel('Epoch')
    plt.legend(['Train', 'Validation'], loc='upper left')

    plt.subplot(1, 2, 2)
    plt.title("Predicted values for Test Data")
    plt.scatter(xtest,ypredicted,alpha=0.09,s=0.1)
    plt.legend(['Predicted'], loc='upper left')
    plt.tight_layout(4)
    plt.show()
```

In [10]:

```
def visualise_predictions(xtest,ypredicted):

    plt.subplots(figsize=(15, 10))
    plt.subplot(1, 2, 1)
    plt.imshow(xtest)
    plt.title('Bottom Half Albedo')
    plt.subplot(1, 2, 2)
    plt.imshow(ypredicted,cmap='rainbow')
    plt.title('Predicted Concentration in Bottom Half')
    plt.tight_layout(4)
    plt.show()

    plt.subplots(figsize=(15, 10))
    plt.subplot(2, 2, 1)
    plt.hist(xtest)
    plt.title('Distribution of Albedo Bottom Half')
    plt.subplot(2, 2, 2)
    plt.hist(xtrain)
    plt.title('Distribution of Albedo Top Half')
    plt.tight_layout(4)
    plt.show()

    plt.subplots(figsize=(15, 11))
    plt.subplot(3, 2, 1)
    plt.hist(ypredicted)
    plt.title('Concentration Distribution Predicted on Bottom Half')
    plt.subplot(3, 2, 2)
    plt.hist(ytrain)
    plt.title('Concentration Distribution on Top Half')
    plt.tight_layout(4)
    plt.show()
```

In [11]:

```
df = correlation_matrix(albedo_top_half,alsimap)
```

Correlation between the Albedo and Concentration Map

	albedo	concentration
albedo	1.000000	0.101683
concentration	0.101683	1.000000

Summary of the data

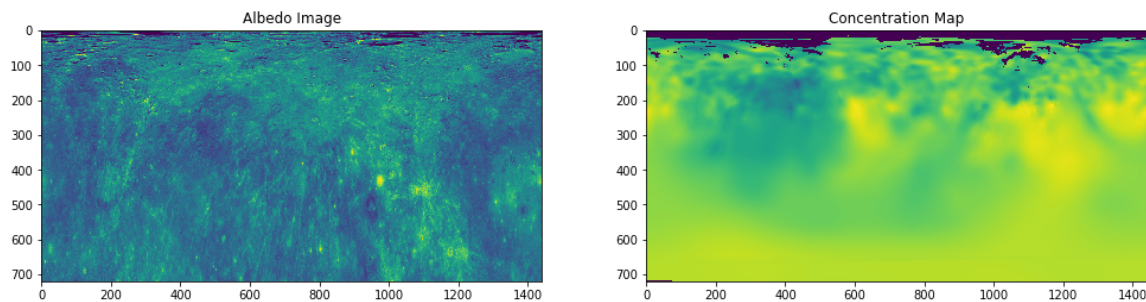
	albedo	concentration
count	1.036800e+06	1.036800e+06
mean	4.144590e-01	7.510351e-01
std	1.165033e-01	1.989632e-01
min	0.000000e+00	0.000000e+00
25%	3.372549e-01	7.137255e-01
50%	4.039216e-01	8.039216e-01
75%	4.862745e-01	8.745098e-01
max	1.000000e+00	1.000000e+00

Observation: Here we observe there is no linear correlation between the data of albedo and concentration map before the outlier removal

In [12]:

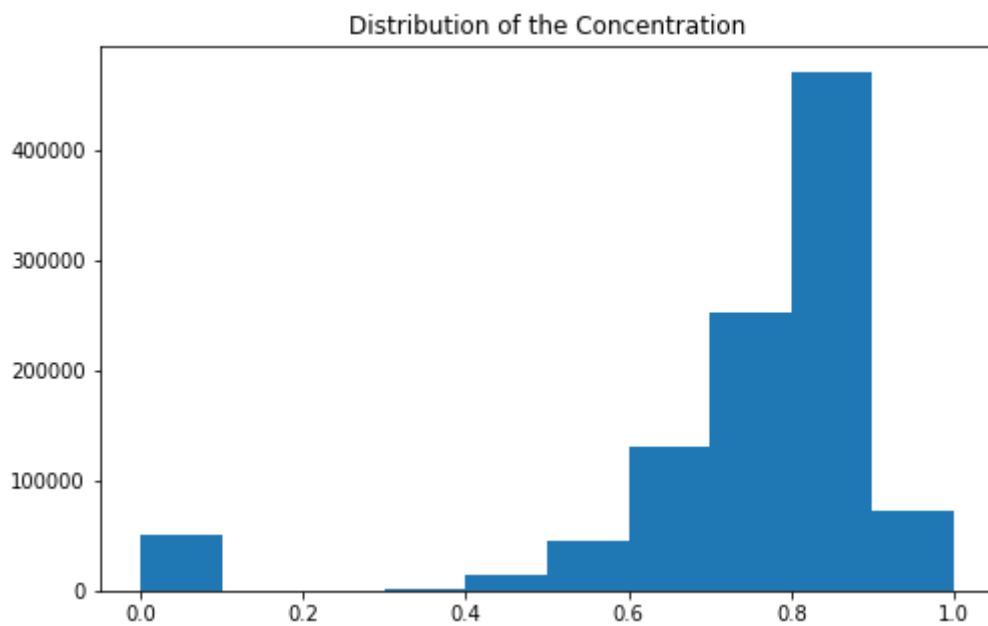
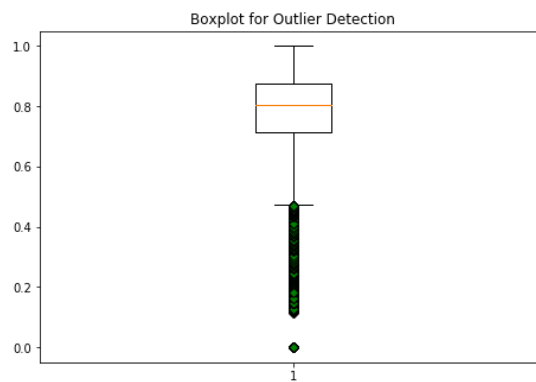
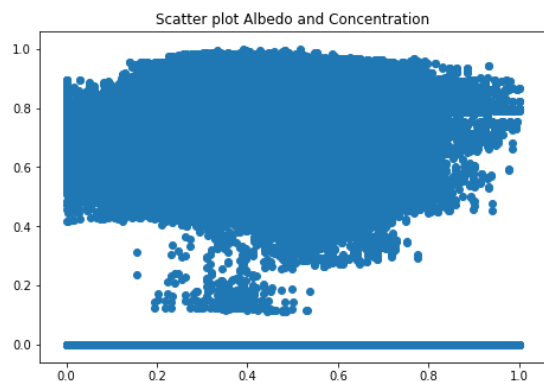
```
ytrain , xtrain , xtest = test_data(alsimap)
```

(720, 1440)



In [13]:

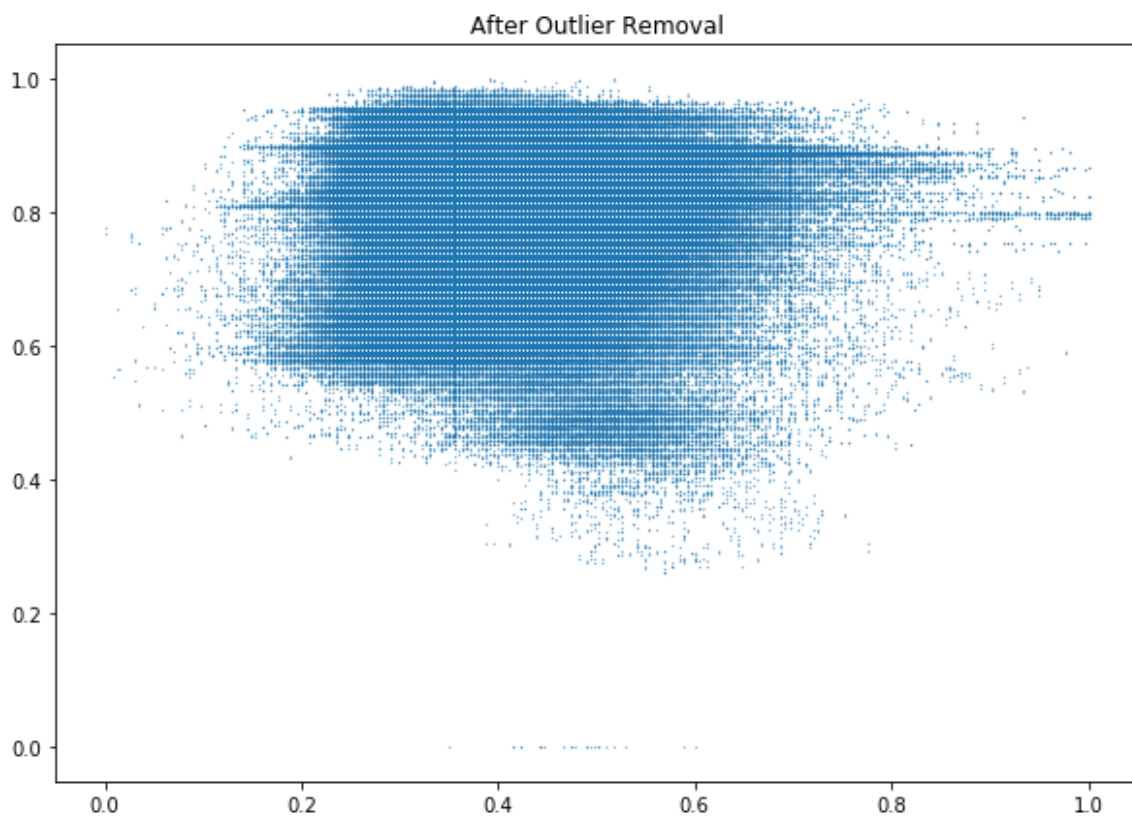
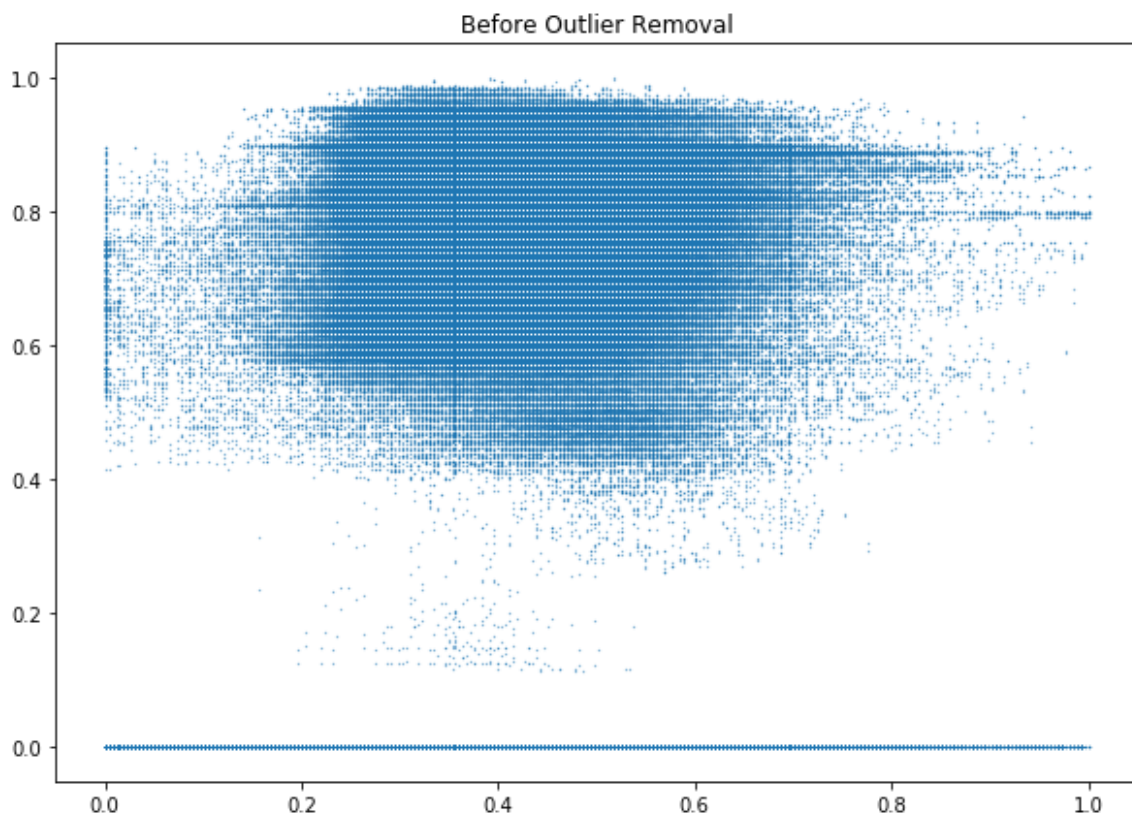
```
outlier_plots(df)
```



Observation: We see significant amount of outlier presence and observe the gaps in data through scatter plot and through histogram we observe a continuous data flow from 0.3 to 1.0 while there is some distribution near 0.0 which can create discontinuity in predictions as well.

In [14]:

```
xtrain, ytrain , shape = outlier_detection(xtrain,ytrain,0.18)
```



(590, 1440)

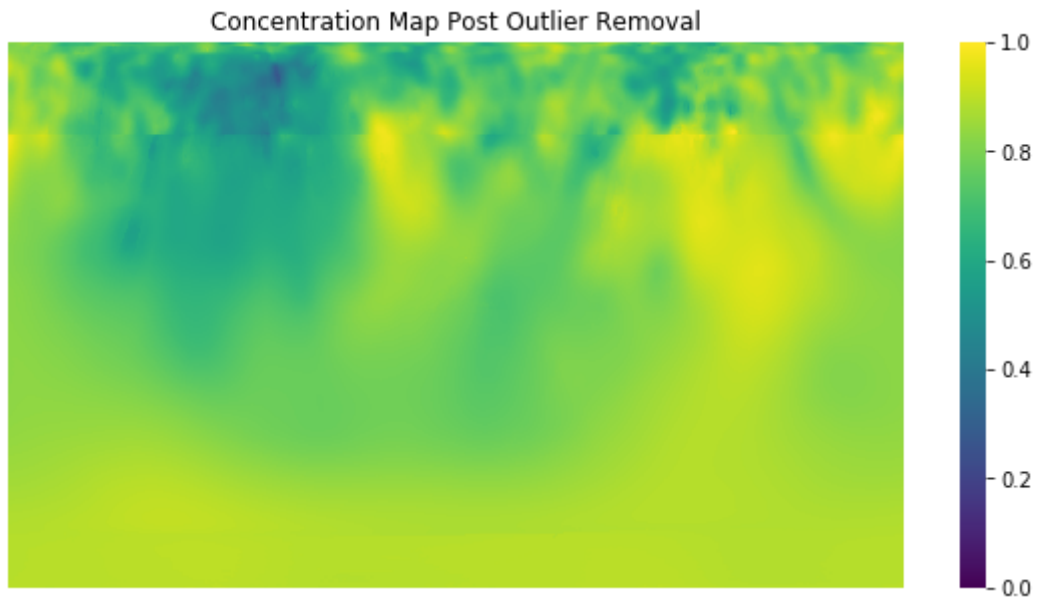
```
{'behaviour': 'deprecated', 'bootstrap': False, 'contamination': 0.18, 'max_features': 1.0, 'max_samples': 'auto', 'n_estimators': 100, 'n_jobs': None, 'random_state': None, 'verbose': 0, 'warm_start': False}
```



We observe a decent performance of Isolation Forest Outlier Removal Algorithm in case of AISi Map. The gaps are completely removed.

In [15]:

```
# Concentration Map Post Outlier Removal  
visualise_maps(ytrain)
```



In [16]:

```
history,model,ypredicted = model_application(xtrain, xtest, ytrain)
```

Model: "sequential"

Layer (type)	Output Shape	Param #
dense (Dense)	(None, 32)	46112
dense_1 (Dense)	(None, 16)	528
dense_2 (Dense)	(None, 1440)	24480

Total params: 71,120

Trainable params: 71,120

Non-trainable params: 0

Epoch 1/150

10/10 [=====] - 1s 98ms/step - loss: 0.6140 - mse: 0.6140 - mae: 0.7753 - val\_loss: 0.6908 - val\_mse: 0.6908 - val\_mae: 0.8050

Epoch 2/150

10/10 [=====] - 0s 7ms/step - loss: 0.4833 - mse: 0.4833 - mae: 0.6349 - val\_loss: 0.3655 - val\_mse: 0.3655 - val\_mae: 0.4918

Epoch 3/150

10/10 [=====] - 0s 7ms/step - loss: 0.2338 - mse: 0.2338 - mae: 0.3750 - val\_loss: 0.1257 - val\_mse: 0.1257 - val\_mae: 0.2491

Epoch 4/150

10/10 [=====] - 0s 7ms/step - loss: 0.0747 - mse: 0.0747 - mae: 0.1913 - val\_loss: 0.0437 - val\_mse: 0.0437 - val\_mae: 0.1509

Epoch 5/150

10/10 [=====] - 0s 8ms/step - loss: 0.0248 - mse: 0.0248 - mae: 0.1145 - val\_loss: 0.0239 - val\_mse: 0.0239 - val\_mae: 0.1221

Epoch 6/150

10/10 [=====] - 0s 9ms/step - loss: 0.0115 - mse: 0.0115 - mae: 0.0815 - val\_loss: 0.0171 - val\_mse: 0.0171 - val\_mae: 0.1046

Epoch 7/150

10/10 [=====] - 0s 8ms/step - loss: 0.0077 - mse: 0.0077 - mae: 0.0674 - val\_loss: 0.0149 - val\_mse: 0.0149 - val\_mae: 0.0970

Epoch 8/150

10/10 [=====] - 0s 8ms/step - loss: 0.0060 - mse: 0.0060 - mae: 0.0600 - val\_loss: 0.0190 - val\_mse: 0.0190 - val\_mae: 0.1132

Epoch 9/150

10/10 [=====] - 0s 7ms/step - loss: 0.0057 - mse: 0.0057 - mae: 0.0582 - val\_loss: 0.0145 - val\_mse: 0.0145 - val\_mae: 0.0950

Epoch 10/150

10/10 [=====] - 0s 8ms/step - loss: 0.0051 - mse: 0.0051 - mae: 0.0556 - val\_loss: 0.0167 - val\_mse: 0.0167 - val\_mae: 0.1037

Epoch 11/150

10/10 [=====] - 0s 7ms/step - loss: 0.0049 - mse: 0.0049 - mae: 0.0539 - val\_loss: 0.0146 - val\_mse: 0.0146 - val\_mae: 0.0955

Epoch 12/150

10/10 [=====] - 0s 7ms/step - loss: 0.0048 - mse: 0.0048 - mae: 0.0539 - val\_loss: 0.0140 - val\_mse: 0.0140 - val\_mae: 0.093

8

Epoch 13/150

10/10 [=====] - 0s 8ms/step - loss: 0.0048 - mse: 0.0048 - mae: 0.0541 - val\_loss: 0.0176 - val\_mse: 0.0176 - val\_mae: 0.107

3

Epoch 14/150

10/10 [=====] - 0s 8ms/step - loss: 0.0045 - mse: 0.0045 - mae: 0.0523 - val\_loss: 0.0156 - val\_mse: 0.0156 - val\_mae: 0.099

4

Epoch 15/150

10/10 [=====] - 0s 7ms/step - loss: 0.0044 - mse: 0.0044 - mae: 0.0517 - val\_loss: 0.0153 - val\_mse: 0.0153 - val\_mae: 0.098

5

Epoch 16/150

10/10 [=====] - 0s 7ms/step - loss: 0.0044 - mse: 0.0044 - mae: 0.0515 - val\_loss: 0.0153 - val\_mse: 0.0153 - val\_mae: 0.098

4

Epoch 17/150

10/10 [=====] - 0s 15ms/step - loss: 0.0041 - mse: 0.0041 - mae: 0.0500 - val\_loss: 0.0148 - val\_mse: 0.0148 - val\_mae: 0.0975

Epoch 18/150

10/10 [=====] - 0s 8ms/step - loss: 0.0043 - mse: 0.0043 - mae: 0.0515 - val\_loss: 0.0143 - val\_mse: 0.0143 - val\_mae: 0.095

1

Epoch 19/150

10/10 [=====] - 0s 7ms/step - loss: 0.0042 - mse: 0.0042 - mae: 0.0508 - val\_loss: 0.0155 - val\_mse: 0.0155 - val\_mae: 0.099

7

Epoch 20/150

10/10 [=====] - 0s 8ms/step - loss: 0.0042 - mse: 0.0042 - mae: 0.0509 - val\_loss: 0.0145 - val\_mse: 0.0145 - val\_mae: 0.096

2

Epoch 21/150

10/10 [=====] - 0s 8ms/step - loss: 0.0041 - mse: 0.0041 - mae: 0.0505 - val\_loss: 0.0154 - val\_mse: 0.0154 - val\_mae: 0.099

4

Epoch 22/150

10/10 [=====] - 0s 8ms/step - loss: 0.0041 - mse: 0.0041 - mae: 0.0500 - val\_loss: 0.0137 - val\_mse: 0.0137 - val\_mae: 0.093

6

Epoch 23/150

10/10 [=====] - 0s 8ms/step - loss: 0.0041 - mse: 0.0041 - mae: 0.0507 - val\_loss: 0.0150 - val\_mse: 0.0150 - val\_mae: 0.097

9

Epoch 24/150

10/10 [=====] - 0s 8ms/step - loss: 0.0039 - mse: 0.0039 - mae: 0.0493 - val\_loss: 0.0139 - val\_mse: 0.0139 - val\_mae: 0.094

7

Epoch 25/150

10/10 [=====] - 0s 8ms/step - loss: 0.0040 - mse: 0.0040 - mae: 0.0499 - val\_loss: 0.0141 - val\_mse: 0.0141 - val\_mae: 0.094

9

Epoch 26/150

10/10 [=====] - 0s 8ms/step - loss: 0.0039 - mse: 0.0039 - mae: 0.0494 - val\_loss: 0.0157 - val\_mse: 0.0157 - val\_mae: 0.100

8

Epoch 27/150

10/10 [=====] - 0s 7ms/step - loss: 0.0039 - mse: 0.0039 - mae: 0.0491 - val\_loss: 0.0140 - val\_mse: 0.0140 - val\_mae: 0.094

9

Epoch 28/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0040 - mse:  
0.0040 - mae: 0.0501 - val\_loss: 0.0136 - val\_mse: 0.0136 - val\_mae: 0.093  
8

Epoch 29/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0040 - mse:  
0.0040 - mae: 0.0500 - val\_loss: 0.0155 - val\_mse: 0.0155 - val\_mae: 0.099  
9

Epoch 30/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0039 - mse:  
0.0039 - mae: 0.0490 - val\_loss: 0.0148 - val\_mse: 0.0148 - val\_mae: 0.097  
8

Epoch 31/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0040 - mse:  
0.0040 - mae: 0.0496 - val\_loss: 0.0132 - val\_mse: 0.0132 - val\_mae: 0.092  
5

Epoch 32/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0041 - mse:  
0.0041 - mae: 0.0507 - val\_loss: 0.0139 - val\_mse: 0.0139 - val\_mae: 0.094  
7

Epoch 33/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0039 - mse:  
0.0039 - mae: 0.0498 - val\_loss: 0.0151 - val\_mse: 0.0151 - val\_mae: 0.098  
9

Epoch 34/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0039 - ms  
e: 0.0039 - mae: 0.0498 - val\_loss: 0.0143 - val\_mse: 0.0143 - val\_mae: 0.  
0959

Epoch 35/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse:  
0.0038 - mae: 0.0486 - val\_loss: 0.0136 - val\_mse: 0.0136 - val\_mae: 0.094  
0

Epoch 36/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0040 - mse:  
0.0040 - mae: 0.0499 - val\_loss: 0.0139 - val\_mse: 0.0139 - val\_mae: 0.095  
0

Epoch 37/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse:  
0.0038 - mae: 0.0489 - val\_loss: 0.0144 - val\_mse: 0.0144 - val\_mae: 0.096  
3

Epoch 38/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse:  
0.0038 - mae: 0.0488 - val\_loss: 0.0139 - val\_mse: 0.0139 - val\_mae: 0.095  
0

Epoch 39/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0037 - mse:  
0.0037 - mae: 0.0484 - val\_loss: 0.0134 - val\_mse: 0.0134 - val\_mae: 0.093  
4

Epoch 40/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse:  
0.0038 - mae: 0.0493 - val\_loss: 0.0148 - val\_mse: 0.0148 - val\_mae: 0.097  
7

Epoch 41/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0037 - mse:  
0.0037 - mae: 0.0487 - val\_loss: 0.0149 - val\_mse: 0.0149 - val\_mae: 0.097  
9

Epoch 42/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0036 - mse:  
0.0036 - mae: 0.0479 - val\_loss: 0.0146 - val\_mse: 0.0146 - val\_mae: 0.097  
2

Epoch 43/150

10/10 [=====] - 0s 7ms/step - loss: 0.0039 - mse:  
0.0039 - mae: 0.0495 - val\_loss: 0.0138 - val\_mse: 0.0138 - val\_mae: 0.094  
5  
Epoch 44/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0036 - mse:  
0.0036 - mae: 0.0479 - val\_loss: 0.0144 - val\_mse: 0.0144 - val\_mae: 0.096  
4  
Epoch 45/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0037 - mse:  
0.0037 - mae: 0.0485 - val\_loss: 0.0146 - val\_mse: 0.0146 - val\_mae: 0.097  
0  
Epoch 46/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse:  
0.0038 - mae: 0.0488 - val\_loss: 0.0137 - val\_mse: 0.0137 - val\_mae: 0.094  
2  
Epoch 47/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0035 - mse:  
0.0035 - mae: 0.0468 - val\_loss: 0.0132 - val\_mse: 0.0132 - val\_mae: 0.092  
6  
Epoch 48/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0035 - mse:  
0.0035 - mae: 0.0471 - val\_loss: 0.0140 - val\_mse: 0.0140 - val\_mae: 0.095  
1  
Epoch 49/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0034 - mse:  
0.0034 - mae: 0.0465 - val\_loss: 0.0137 - val\_mse: 0.0137 - val\_mae: 0.093  
9  
Epoch 50/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0035 - mse:  
0.0035 - mae: 0.0472 - val\_loss: 0.0132 - val\_mse: 0.0132 - val\_mae: 0.092  
8  
Epoch 51/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0035 - ms  
e: 0.0035 - mae: 0.0465 - val\_loss: 0.0135 - val\_mse: 0.0135 - val\_mae: 0.  
0934  
Epoch 52/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0033 - mse:  
0.0033 - mae: 0.0454 - val\_loss: 0.0131 - val\_mse: 0.0131 - val\_mae: 0.092  
1  
Epoch 53/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0032 - mse:  
0.0032 - mae: 0.0451 - val\_loss: 0.0133 - val\_mse: 0.0133 - val\_mae: 0.092  
6  
Epoch 54/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0442 - val\_loss: 0.0144 - val\_mse: 0.0144 - val\_mae: 0.096  
5  
Epoch 55/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0032 - mse:  
0.0032 - mae: 0.0443 - val\_loss: 0.0133 - val\_mse: 0.0133 - val\_mae: 0.092  
5  
Epoch 56/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0030 - mse:  
0.0030 - mae: 0.0436 - val\_loss: 0.0123 - val\_mse: 0.0123 - val\_mae: 0.089  
2  
Epoch 57/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0436 - val\_loss: 0.0122 - val\_mse: 0.0122 - val\_mae: 0.088  
8  
Epoch 58/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0028 - mse:

0.0028 - mae: 0.0416 - val\_loss: 0.0127 - val\_mse: 0.0127 - val\_mae: 0.0904  
Epoch 59/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0412 - val\_loss: 0.0135 - val\_mse: 0.0135 - val\_mae: 0.0930  
Epoch 60/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0412 - val\_loss: 0.0127 - val\_mse: 0.0127 - val\_mae: 0.0905  
Epoch 61/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0026 - mse: 0.0026 - mae: 0.0394 - val\_loss: 0.0120 - val\_mse: 0.0120 - val\_mae: 0.0877  
Epoch 62/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0024 - mse: 0.0024 - mae: 0.0373 - val\_loss: 0.0106 - val\_mse: 0.0106 - val\_mae: 0.0823  
Epoch 63/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0023 - mse: 0.0023 - mae: 0.0359 - val\_loss: 0.0113 - val\_mse: 0.0113 - val\_mae: 0.0846  
Epoch 64/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0021 - mse: 0.0021 - mae: 0.0340 - val\_loss: 0.0111 - val\_mse: 0.0111 - val\_mae: 0.0834  
Epoch 65/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0319 - val\_loss: 0.0114 - val\_mse: 0.0114 - val\_mae: 0.0845  
Epoch 66/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0321 - val\_loss: 0.0106 - val\_mse: 0.0106 - val\_mae: 0.0814  
Epoch 67/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0017 - mse: 0.0017 - mae: 0.0292 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_mae: 0.0783  
Epoch 68/150  
10/10 [=====] - 0s 13ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0307 - val\_loss: 0.0107 - val\_mse: 0.0107 - val\_mae: 0.0821  
Epoch 69/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0017 - mse: 0.0017 - mae: 0.0294 - val\_loss: 0.0102 - val\_mse: 0.0102 - val\_mae: 0.0799  
Epoch 70/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse: 0.0016 - mae: 0.0288 - val\_loss: 0.0088 - val\_mse: 0.0088 - val\_mae: 0.0735  
Epoch 71/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0015 - mse: 0.0015 - mae: 0.0283 - val\_loss: 0.0083 - val\_mse: 0.0083 - val\_mae: 0.0714  
Epoch 72/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse: 0.0016 - mae: 0.0286 - val\_loss: 0.0089 - val\_mse: 0.0089 - val\_mae: 0.0740  
Epoch 73/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0273 - val\_loss: 0.0088 - val\_mse: 0.0088 - val\_mae: 0.073

4

Epoch 74/150

10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0274 - val\_loss: 0.0088 - val\_mse: 0.0088 - val\_mae: 0.073

4

Epoch 75/150

10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0273 - val\_loss: 0.0093 - val\_mse: 0.0093 - val\_mae: 0.075

8

Epoch 76/150

10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0271 - val\_loss: 0.0102 - val\_mse: 0.0102 - val\_mae: 0.079

6

Epoch 77/150

10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0269 - val\_loss: 0.0093 - val\_mse: 0.0093 - val\_mae: 0.075

5

Epoch 78/150

10/10 [=====] - 0s 7ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0258 - val\_loss: 0.0090 - val\_mse: 0.0090 - val\_mae: 0.074

1

Epoch 79/150

10/10 [=====] - 0s 7ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0260 - val\_loss: 0.0095 - val\_mse: 0.0095 - val\_mae: 0.076

5

Epoch 80/150

10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0269 - val\_loss: 0.0089 - val\_mse: 0.0089 - val\_mae: 0.073

7

Epoch 81/150

10/10 [=====] - 0s 7ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0260 - val\_loss: 0.0091 - val\_mse: 0.0091 - val\_mae: 0.074

2

Epoch 82/150

10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0254 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_mae: 0.078

1

Epoch 83/150

10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0255 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_mae: 0.076

9

Epoch 84/150

10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0250 - val\_loss: 0.0092 - val\_mse: 0.0092 - val\_mae: 0.074

8

Epoch 85/150

10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0250 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_mae: 0.076

3

Epoch 86/150

10/10 [=====] - 0s 14ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0255 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_mae: 0.0766

Epoch 87/150

10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0245 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.077

9

Epoch 88/150

10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0247 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.075

7



Epoch 89/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0247 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.075  
4

Epoch 90/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0249 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.078  
3

Epoch 91/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0246 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.075  
3

Epoch 92/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0247 - val\_loss: 0.0095 - val\_mse: 0.0095 - val\_mae: 0.075  
7

Epoch 93/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0246 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.075  
5

Epoch 94/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0238 - val\_loss: 0.0110 - val\_mse: 0.0110 - val\_mae: 0.082  
2

Epoch 95/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0246 - val\_loss: 0.0091 - val\_mse: 0.0091 - val\_mae: 0.074  
3

Epoch 96/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0242 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_mae: 0.076  
2

Epoch 97/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0237 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_mae: 0.076  
6

Epoch 98/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0247 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_mae: 0.077  
1

Epoch 99/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0244 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.075  
0

Epoch 100/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0239 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_mae: 0.077  
3

Epoch 101/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0010 - mse:  
0.0010 - mae: 0.0236 - val\_loss: 0.0102 - val\_mse: 0.0102 - val\_mae: 0.078  
8

Epoch 102/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0241 - val\_loss: 0.0091 - val\_mse: 0.0091 - val\_mae: 0.073  
9

Epoch 103/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0010 - mse:  
0.0010 - mae: 0.0236 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.077  
6

Epoch 104/150

10/10 [=====] - 0s 13ms/step - loss: 0.0010 - mse: 0.0010 - mae: 0.0233 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_mae: 0.0763  
Epoch 105/150  
10/10 [=====] - 0s 7ms/step - loss: 9.9846e-04 - mse: 9.9846e-04 - mae: 0.0229 - val\_loss: 0.0091 - val\_mse: 0.0091 - val\_mae: 0.0736  
Epoch 106/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0237 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_mae: 0.0769  
Epoch 107/150  
10/10 [=====] - 0s 7ms/step - loss: 9.9860e-04 - mse: 9.9860e-04 - mae: 0.0228 - val\_loss: 0.0092 - val\_mse: 0.0092 - val\_mae: 0.0743  
Epoch 108/150  
10/10 [=====] - 0s 7ms/step - loss: 9.9968e-04 - mse: 9.9968e-04 - mae: 0.0229 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_mae: 0.0767  
Epoch 109/150  
10/10 [=====] - 0s 7ms/step - loss: 9.6170e-04 - mse: 9.6170e-04 - mae: 0.0227 - val\_loss: 0.0108 - val\_mse: 0.0108 - val\_mae: 0.0814  
Epoch 110/150  
10/10 [=====] - 0s 7ms/step - loss: 9.4337e-04 - mse: 9.4337e-04 - mae: 0.0225 - val\_loss: 0.0092 - val\_mse: 0.0092 - val\_mae: 0.0737  
Epoch 111/150  
10/10 [=====] - 0s 7ms/step - loss: 9.6730e-04 - mse: 9.6730e-04 - mae: 0.0227 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_mae: 0.0768  
Epoch 112/150  
10/10 [=====] - 0s 7ms/step - loss: 9.3200e-04 - mse: 9.3200e-04 - mae: 0.0223 - val\_loss: 0.0109 - val\_mse: 0.0109 - val\_mae: 0.0815  
Epoch 113/150  
10/10 [=====] - 0s 7ms/step - loss: 9.7571e-04 - mse: 9.7571e-04 - mae: 0.0228 - val\_loss: 0.0089 - val\_mse: 0.0089 - val\_mae: 0.0728  
Epoch 114/150  
10/10 [=====] - 0s 7ms/step - loss: 9.4787e-04 - mse: 9.4787e-04 - mae: 0.0226 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.0746  
Epoch 115/150  
10/10 [=====] - 0s 7ms/step - loss: 9.7902e-04 - mse: 9.7902e-04 - mae: 0.0228 - val\_loss: 0.0104 - val\_mse: 0.0104 - val\_mae: 0.0794  
Epoch 116/150  
10/10 [=====] - 0s 7ms/step - loss: 9.9111e-04 - mse: 9.9111e-04 - mae: 0.0229 - val\_loss: 0.0089 - val\_mse: 0.0089 - val\_mae: 0.0727  
Epoch 117/150  
10/10 [=====] - 0s 7ms/step - loss: 9.9802e-04 - mse: 9.9802e-04 - mae: 0.0230 - val\_loss: 0.0105 - val\_mse: 0.0105 - val\_mae: 0.0794  
Epoch 118/150  
10/10 [=====] - 0s 7ms/step - loss: 9.1119e-04 - mse: 9.1119e-04 - mae: 0.0218 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_mae: 0.0781  
Epoch 119/150  
10/10 [=====] - 0s 7ms/step - loss: 9.5117e-04 -

mse: 9.5117e-04 - mae: 0.0223 - val\_loss: 0.0094 - val\_mse: 0.0094 - val\_mae: 0.0748  
Epoch 120/150  
10/10 [=====] - 0s 7ms/step - loss: 9.1524e-04 - mse: 9.1524e-04 - mae: 0.0220 - val\_loss: 0.0093 - val\_mse: 0.0093 - val\_mae: 0.0744  
Epoch 121/150  
10/10 [=====] - 0s 7ms/step - loss: 9.1671e-04 - mse: 9.1671e-04 - mae: 0.0219 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_mae: 0.0779  
Epoch 122/150  
10/10 [=====] - 0s 13ms/step - loss: 9.4267e-04 - mse: 9.4267e-04 - mae: 0.0222 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.0771  
Epoch 123/150  
10/10 [=====] - 0s 7ms/step - loss: 9.6517e-04 - mse: 9.6517e-04 - mae: 0.0225 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_mae: 0.0765  
Epoch 124/150  
10/10 [=====] - 0s 8ms/step - loss: 8.8619e-04 - mse: 8.8619e-04 - mae: 0.0217 - val\_loss: 0.0089 - val\_mse: 0.0089 - val\_mae: 0.0724  
Epoch 125/150  
10/10 [=====] - 0s 7ms/step - loss: 9.1601e-04 - mse: 9.1601e-04 - mae: 0.0220 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_mae: 0.0777  
Epoch 126/150  
10/10 [=====] - 0s 8ms/step - loss: 9.1533e-04 - mse: 9.1533e-04 - mae: 0.0220 - val\_loss: 0.0095 - val\_mse: 0.0095 - val\_mae: 0.0750  
Epoch 127/150  
10/10 [=====] - 0s 7ms/step - loss: 9.6660e-04 - mse: 9.6660e-04 - mae: 0.0224 - val\_loss: 0.0106 - val\_mse: 0.0106 - val\_mae: 0.0798  
Epoch 128/150  
10/10 [=====] - 0s 7ms/step - loss: 9.2177e-04 - mse: 9.2177e-04 - mae: 0.0221 - val\_loss: 0.0092 - val\_mse: 0.0092 - val\_mae: 0.0734  
Epoch 129/150  
10/10 [=====] - 0s 7ms/step - loss: 9.3801e-04 - mse: 9.3801e-04 - mae: 0.0222 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_mae: 0.0757  
Epoch 130/150  
10/10 [=====] - 0s 7ms/step - loss: 8.5074e-04 - mse: 8.5074e-04 - mae: 0.0212 - val\_loss: 0.0102 - val\_mse: 0.0102 - val\_mae: 0.0779  
Epoch 131/150  
10/10 [=====] - 0s 8ms/step - loss: 9.1856e-04 - mse: 9.1856e-04 - mae: 0.0218 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_mae: 0.0768  
Epoch 132/150  
10/10 [=====] - 0s 7ms/step - loss: 8.3877e-04 - mse: 8.3877e-04 - mae: 0.0211 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_mae: 0.0779  
Epoch 133/150  
10/10 [=====] - 0s 7ms/step - loss: 8.5352e-04 - mse: 8.5352e-04 - mae: 0.0212 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.0769  
Epoch 134/150  
10/10 [=====] - 0s 7ms/step - loss: 8.7822e-04 - mse: 8.7822e-04 - mae: 0.0214 - val\_loss: 0.0093 - val\_mse: 0.0093 - val\_mae: 0.0748

ae: 0.0739  
Epoch 135/150  
10/10 [=====] - 0s 7ms/step - loss: 9.1851e-04 -  
mse: 9.1851e-04 - mae: 0.0220 - val\_loss: 0.0104 - val\_mse: 0.0104 - val\_m  
ae: 0.0795  
Epoch 136/150  
10/10 [=====] - 0s 7ms/step - loss: 9.4009e-04 -  
mse: 9.4009e-04 - mae: 0.0223 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_m  
ae: 0.0751  
Epoch 137/150  
10/10 [=====] - 0s 7ms/step - loss: 8.3642e-04 -  
mse: 8.3642e-04 - mae: 0.0211 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_m  
ae: 0.0774  
Epoch 138/150  
10/10 [=====] - 0s 7ms/step - loss: 8.9958e-04 -  
mse: 8.9958e-04 - mae: 0.0216 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_m  
ae: 0.0751  
Epoch 139/150  
10/10 [=====] - 0s 8ms/step - loss: 9.1113e-04 -  
mse: 9.1113e-04 - mae: 0.0217 - val\_loss: 0.0095 - val\_mse: 0.0095 - val\_m  
ae: 0.0750  
Epoch 140/150  
10/10 [=====] - 0s 14ms/step - loss: 8.2771e-04 -  
mse: 8.2771e-04 - mae: 0.0208 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_m  
ae: 0.0756  
Epoch 141/150  
10/10 [=====] - 0s 8ms/step - loss: 8.3960e-04 -  
mse: 8.3960e-04 - mae: 0.0209 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_m  
ae: 0.0763  
Epoch 142/150  
10/10 [=====] - 0s 7ms/step - loss: 8.5268e-04 -  
mse: 8.5268e-04 - mae: 0.0210 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_m  
ae: 0.0755  
Epoch 143/150  
10/10 [=====] - 0s 7ms/step - loss: 8.8976e-04 -  
mse: 8.8976e-04 - mae: 0.0217 - val\_loss: 0.0095 - val\_mse: 0.0095 - val\_m  
ae: 0.0744  
Epoch 144/150  
10/10 [=====] - 0s 7ms/step - loss: 8.2745e-04 -  
mse: 8.2745e-04 - mae: 0.0209 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_m  
ae: 0.0773  
Epoch 145/150  
10/10 [=====] - 0s 7ms/step - loss: 8.4366e-04 -  
mse: 8.4366e-04 - mae: 0.0211 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_m  
ae: 0.0749  
Epoch 146/150  
10/10 [=====] - 0s 7ms/step - loss: 8.2921e-04 -  
mse: 8.2921e-04 - mae: 0.0208 - val\_loss: 0.0098 - val\_mse: 0.0098 - val\_m  
ae: 0.0761  
Epoch 147/150  
10/10 [=====] - 0s 7ms/step - loss: 8.4321e-04 -  
mse: 8.4321e-04 - mae: 0.0211 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_m  
ae: 0.0757  
Epoch 148/150  
10/10 [=====] - 0s 7ms/step - loss: 8.0385e-04 -  
mse: 8.0385e-04 - mae: 0.0206 - val\_loss: 0.0097 - val\_mse: 0.0097 - val\_m  
ae: 0.0755  
Epoch 149/150  
10/10 [=====] - 0s 7ms/step - loss: 7.9798e-04 -  
mse: 7.9798e-04 - mae: 0.0205 - val\_loss: 0.0093 - val\_mse: 0.0093 - val\_m  
ae: 0.0736

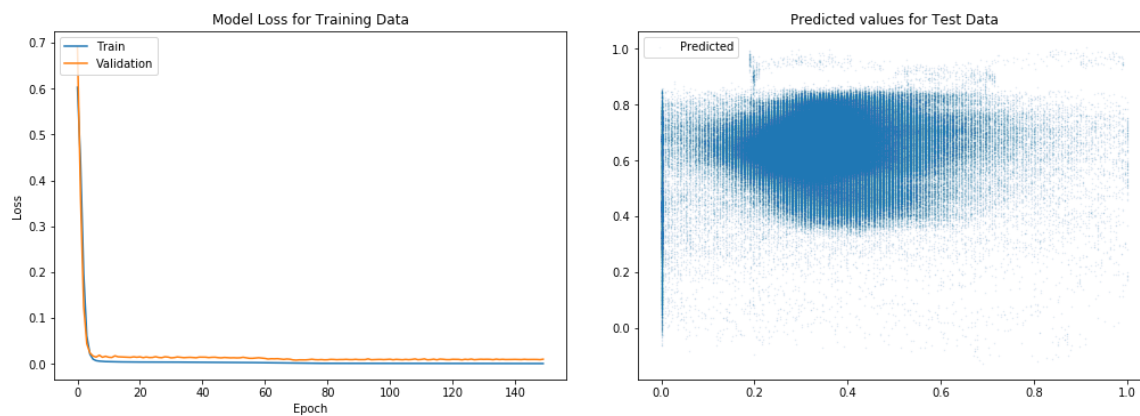
Epoch 150/150

10/10 [=====] - 0s 7ms/step - loss: 8.0378e-04 -  
mse: 8.0378e-04 - mae: 0.0206 - val\_loss: 0.0103 - val\_mse: 0.0103 - val\_mae: 0.0783

In [17]:

```
visualise_performance(model,history,xtest,ypredicted)
```

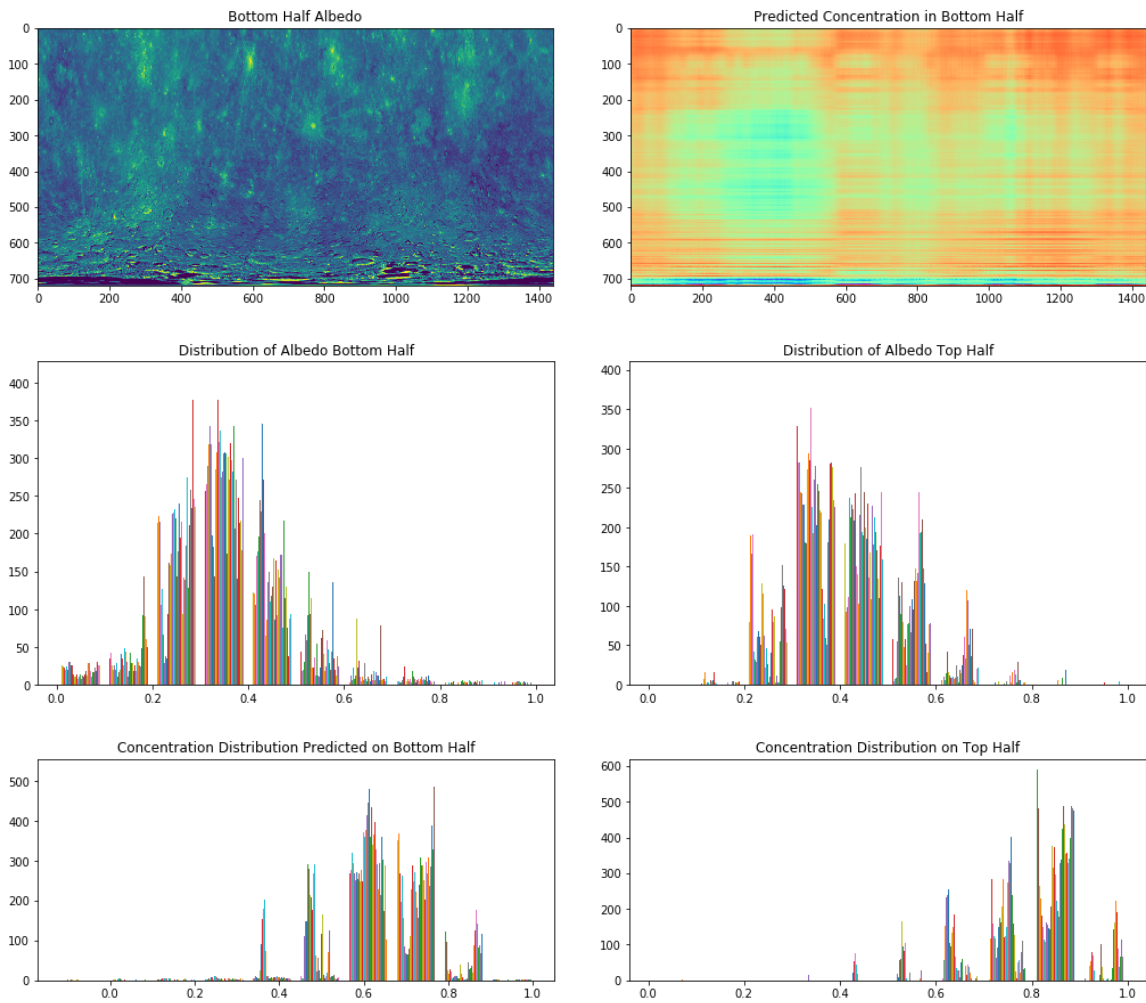
```
dict_keys(['loss', 'mse', 'mae', 'val_loss', 'val_mse', 'val_mae'])
```



The loss for validation and training is fairly less and generates a gradually decreasing curve

In [18]:

```
visualise_predictions(xtest,ypredicted)
```



CaSi Map

In [19]:

```
df = correlation_matrix(albedo_top_half,casimap)
```

Correlation between the Albedo and Concentration Map

	albedo	concentration
albedo	1.000000	0.002648
concentration	0.002648	1.000000

Summary of the data

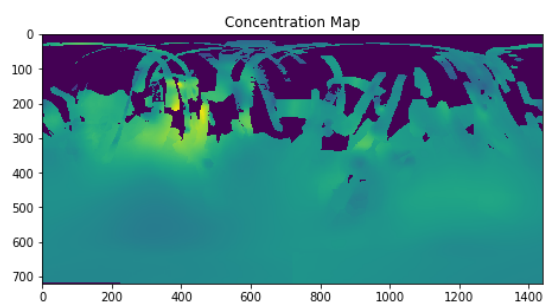
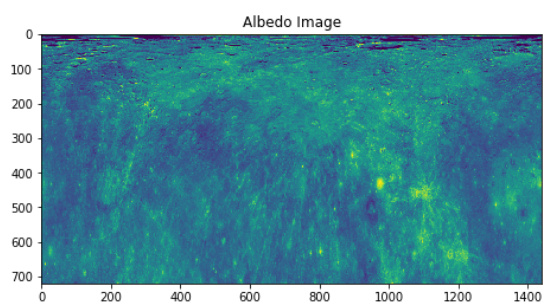
	albedo	concentration
count	1.036800e+06	1.036800e+06
mean	4.144590e-01	4.086300e-01
std	1.165033e-01	2.254984e-01
min	0.000000e+00	0.000000e+00
25%	3.372549e-01	4.274510e-01
50%	4.039216e-01	4.941176e-01
75%	4.862745e-01	5.333334e-01
max	1.000000e+00	1.000000e+00

Observation: Here we observe there is no linear correlation between the data of albedo and concentration map before the outlier removal

In [20]:

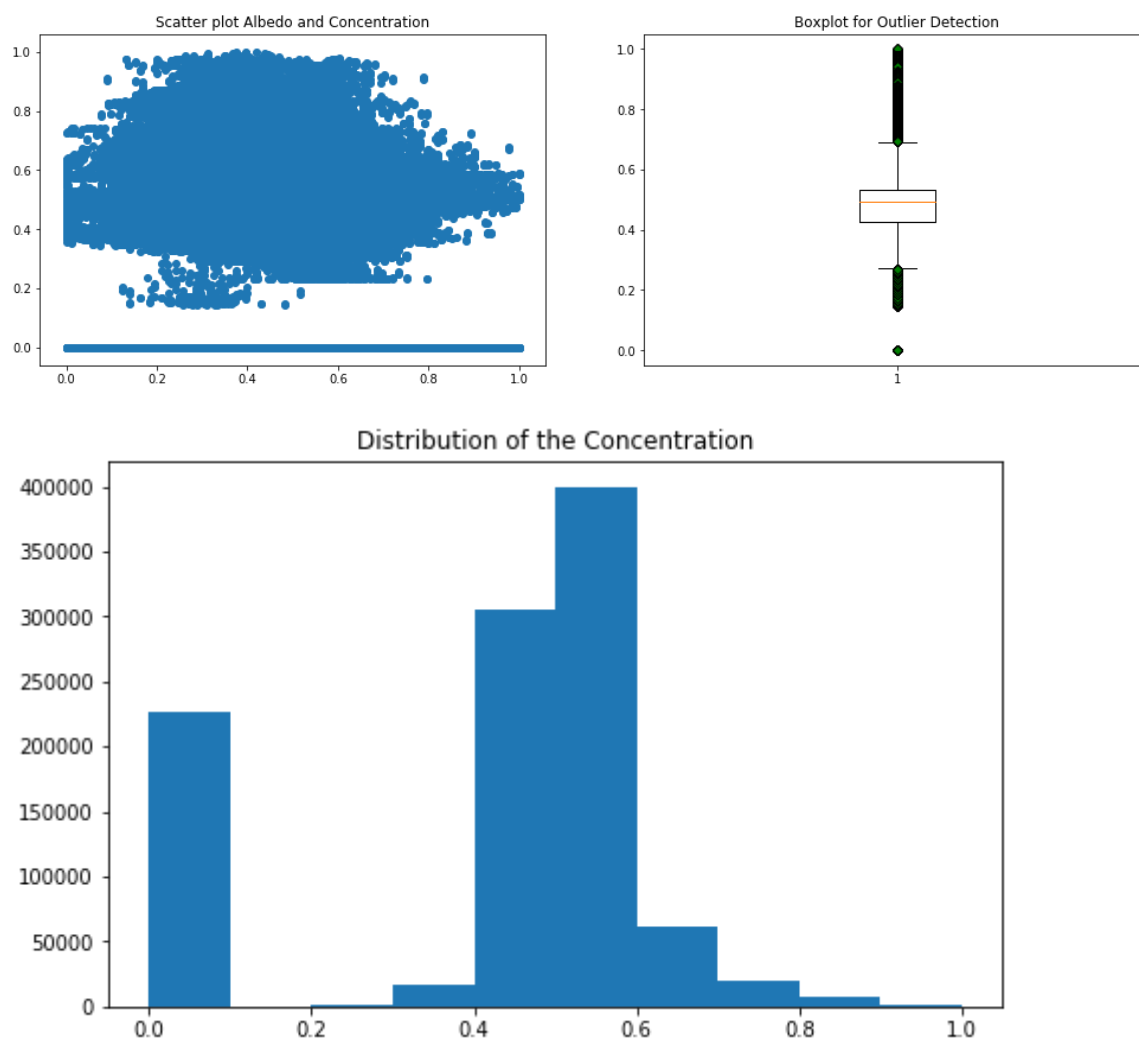
```
ytrain , xtrain , xtest = test_data(casimap)
```

(720, 1440)



In [21]:

```
outlier_plots(df)
```



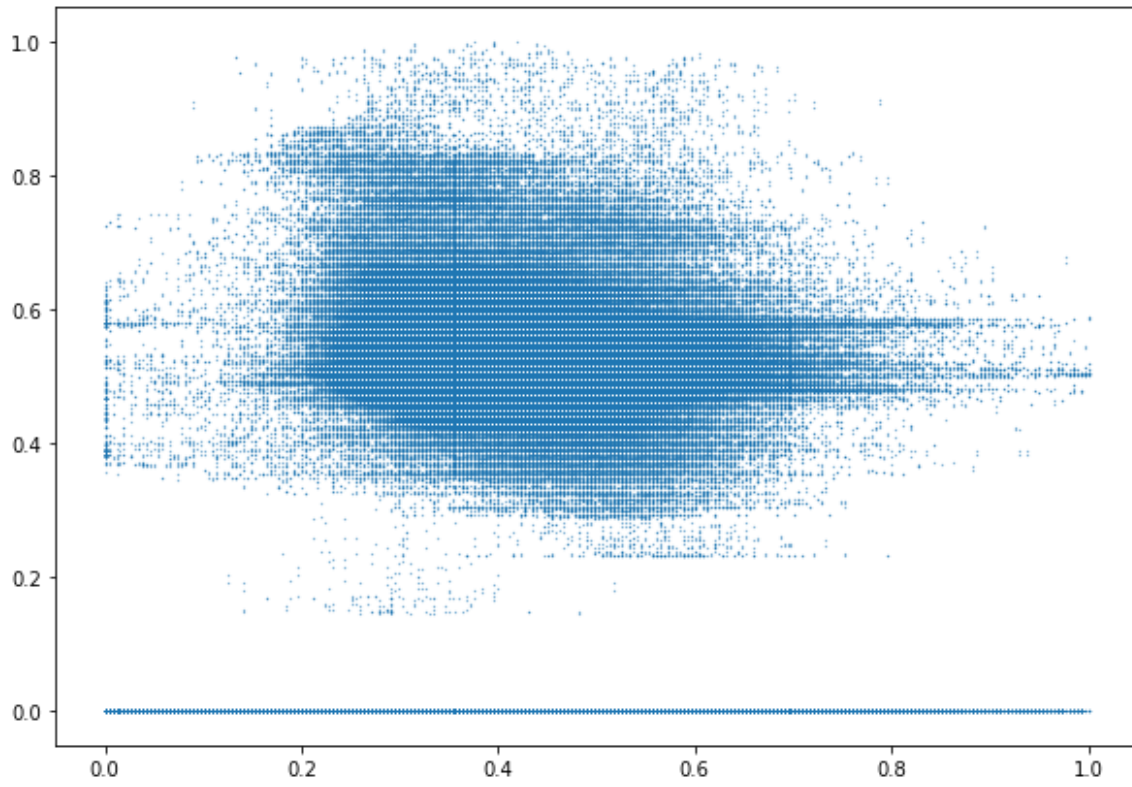
Observation: We see significant amount of outlier presence and observe the gaps in data through scatter plot and through histogram we observe a continuous data flow from 0.2 to 1.0 while there is some distribution near 0.0 which can create discontinuity in predictions as well.

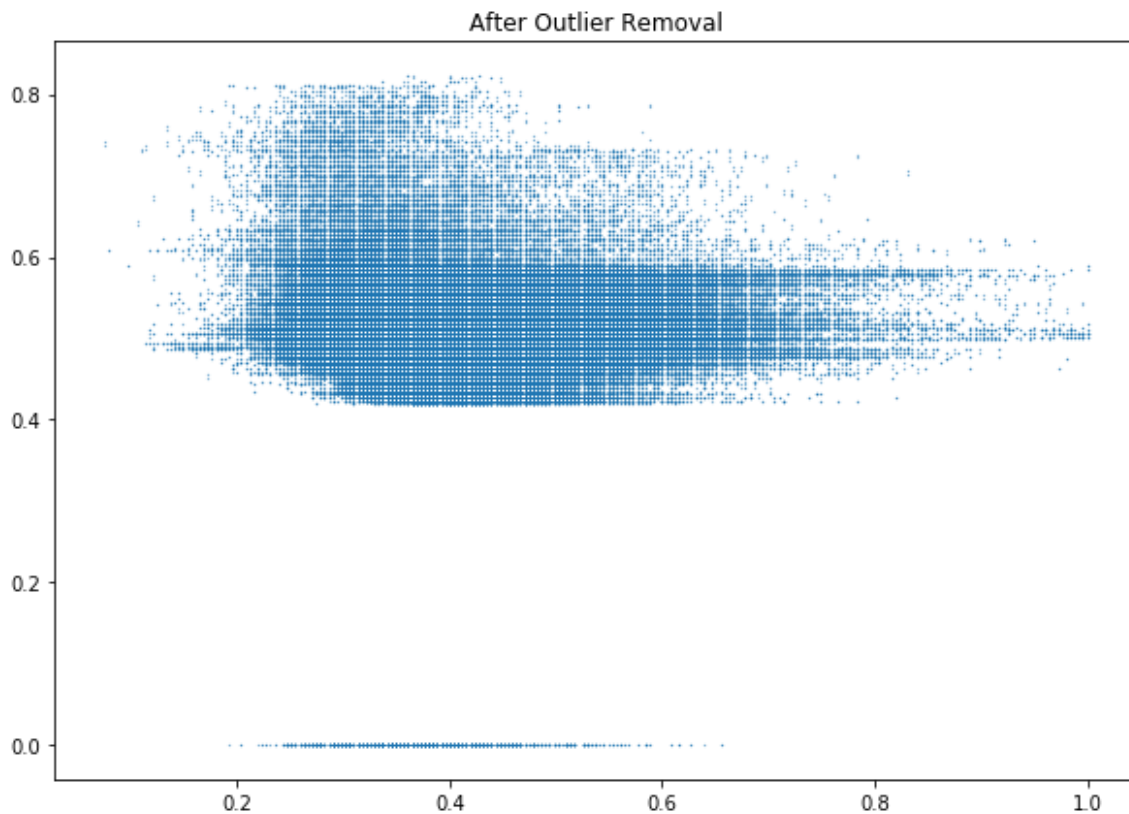


In [22]:

```
xtrain, ytrain , shape = outlier_detection(xtrain,ytrain,'auto')
```

Before Outlier Removal





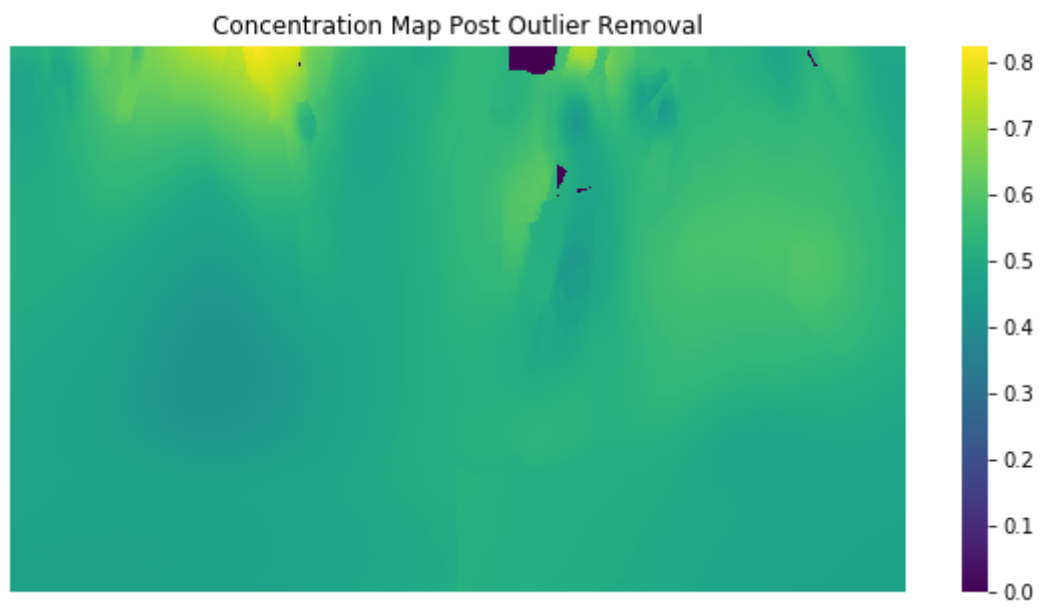
(402, 1440)

```
{'behaviour': 'deprecated', 'bootstrap': False, 'contamination': 'auto',  
'max_features': 1.0, 'max_samples': 'auto', 'n_estimators': 100, 'n_jobs':  
None, 'random_state': None, 'verbose': 0, 'warm_start': False}
```

We observe a not a great performance of Isolation Forest Outlier Removal Algorithm in case of CaSi Map. The gaps are removed to some extent and lot of training data around dense plot is removed which may cause biased predictions. Other Outlier Removal Algorithm like Minimum Covariance Determinant, Local Outlier Factor, One-Class SVM do not work properly in this case.

In [23]:

```
visualise_maps(ytrain)
```



In [24]:

```
history,model,ypredicted = model_application(xtrain, xtest, ytrain)
```

Model: "sequential\_1"

Layer (type)	Output Shape	Param #
dense_3 (Dense)	(None, 32)	46112
dense_4 (Dense)	(None, 16)	528
dense_5 (Dense)	(None, 1440)	24480

Total params: 71,120

Trainable params: 71,120

Non-trainable params: 0

Epoch 1/150

7/7 [=====] - 0s 33ms/step - loss: 0.2653 - mse: 0.2653 - mae: 0.5064 - val\_loss: 0.1900 - val\_mse: 0.1900 - val\_mae: 0.3948

Epoch 2/150

7/7 [=====] - 0s 14ms/step - loss: 0.1991 - mse: 0.1991 - mae: 0.3957 - val\_loss: 0.1177 - val\_mse: 0.1177 - val\_mae: 0.2753

Epoch 3/150

7/7 [=====] - 0s 14ms/step - loss: 0.1176 - mse: 0.1176 - mae: 0.2720 - val\_loss: 0.0581 - val\_mse: 0.0581 - val\_mae: 0.1836

Epoch 4/150

7/7 [=====] - 0s 11ms/step - loss: 0.0586 - mse: 0.0586 - mae: 0.1783 - val\_loss: 0.0249 - val\_mse: 0.0249 - val\_mae: 0.1125

Epoch 5/150

7/7 [=====] - 0s 9ms/step - loss: 0.0257 - mse: 0.0257 - mae: 0.1090 - val\_loss: 0.0114 - val\_mse: 0.0114 - val\_mae: 0.0783

Epoch 6/150

7/7 [=====] - 0s 11ms/step - loss: 0.0131 - mse: 0.0131 - mae: 0.0784 - val\_loss: 0.0055 - val\_mse: 0.0055 - val\_mae: 0.0559

Epoch 7/150

7/7 [=====] - 0s 10ms/step - loss: 0.0074 - mse: 0.0074 - mae: 0.0587 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0398

Epoch 8/150

7/7 [=====] - 0s 11ms/step - loss: 0.0049 - mse: 0.0049 - mae: 0.0469 - val\_loss: 0.0017 - val\_mse: 0.0017 - val\_mae: 0.0324

Epoch 9/150

7/7 [=====] - 0s 10ms/step - loss: 0.0040 - mse: 0.0040 - mae: 0.0411 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0278

Epoch 10/150

7/7 [=====] - 0s 11ms/step - loss: 0.0033 - mse: 0.0033 - mae: 0.0370 - val\_loss: 9.8126e-04 - val\_mse: 9.8126e-04 - val\_mae: 0.0255

Epoch 11/150

7/7 [=====] - 0s 11ms/step - loss: 0.0032 - mse: 0.0032 - mae: 0.0350 - val\_loss: 8.2972e-04 - val\_mse: 8.2972e-04 - val\_mae: 0.0236

Epoch 12/150

7/7 [=====] - 0s 22ms/step - loss: 0.0032 - mse: 0.0032 - mae: 0.0345 - val\_loss: 7.8878e-04 - val\_mse: 7.8878e-04 - val\_mae: 0.0236

e: 0.0233  
Epoch 13/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0343 - val\_loss: 8.2777e-04 - val\_mse: 8.2777e-04 - val\_mae:  
e: 0.0238  
Epoch 14/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0029 - mse:  
0.0029 - mae: 0.0334 - val\_loss: 7.5326e-04 - val\_mse: 7.5326e-04 - val\_mae:  
e: 0.0227  
Epoch 15/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0030 - mse:  
0.0030 - mae: 0.0333 - val\_loss: 7.2948e-04 - val\_mse: 7.2948e-04 - val\_mae:  
e: 0.0225  
Epoch 16/150  
7/7 [=====] - 0s 13ms/step - loss: 0.0030 - mse:  
0.0030 - mae: 0.0332 - val\_loss: 6.8929e-04 - val\_mse: 6.8929e-04 - val\_mae:  
e: 0.0219  
Epoch 17/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0029 - mse:  
0.0029 - mae: 0.0323 - val\_loss: 6.6413e-04 - val\_mse: 6.6413e-04 - val\_mae:  
e: 0.0214  
Epoch 18/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0319 - val\_loss: 6.3233e-04 - val\_mse: 6.3233e-04 - val\_mae:  
e: 0.0210  
Epoch 19/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0315 - val\_loss: 6.3780e-04 - val\_mse: 6.3780e-04 - val\_mae:  
e: 0.0210  
Epoch 20/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0321 - val\_loss: 6.1236e-04 - val\_mse: 6.1236e-04 - val\_mae:  
e: 0.0206  
Epoch 21/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0030 - mse:  
0.0030 - mae: 0.0328 - val\_loss: 7.2950e-04 - val\_mse: 7.2950e-04 - val\_mae:  
e: 0.0226  
Epoch 22/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0315 - val\_loss: 6.0598e-04 - val\_mse: 6.0598e-04 - val\_mae:  
e: 0.0205  
Epoch 23/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0335 - val\_loss: 6.1681e-04 - val\_mse: 6.1681e-04 - val\_mae:  
e: 0.0204  
Epoch 24/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0334 - val\_loss: 6.2247e-04 - val\_mse: 6.2247e-04 - val\_mae:  
e: 0.0208  
Epoch 25/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0312 - val\_loss: 5.7933e-04 - val\_mse: 5.7933e-04 - val\_mae:  
e: 0.0200  
Epoch 26/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0031 - mse:  
0.0031 - mae: 0.0329 - val\_loss: 6.0907e-04 - val\_mse: 6.0907e-04 - val\_mae:  
e: 0.0205  
Epoch 27/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0025 - mse:  
0.0025 - mae: 0.0314 - val\_loss: 6.3888e-04 - val\_mse: 6.3888e-04 - val\_mae:  
e: 0.0211

Epoch 28/150

7/7 [=====] - 0s 11ms/step - loss: 0.0030 - mse: 0.0030 - mae: 0.0324 - val\_loss: 6.0463e-04 - val\_mse: 6.0463e-04 - val\_mae: 0.0204

Epoch 29/150

7/7 [=====] - 0s 11ms/step - loss: 0.0031 - mse: 0.0031 - mae: 0.0331 - val\_loss: 5.9136e-04 - val\_mse: 5.9136e-04 - val\_mae: 0.0203

Epoch 30/150

7/7 [=====] - 0s 11ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0322 - val\_loss: 5.8510e-04 - val\_mse: 5.8510e-04 - val\_mae: 0.0202

Epoch 31/150

7/7 [=====] - 0s 10ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0314 - val\_loss: 5.7430e-04 - val\_mse: 5.7430e-04 - val\_mae: 0.0199

Epoch 32/150

7/7 [=====] - 0s 10ms/step - loss: 0.0026 - mse: 0.0026 - mae: 0.0314 - val\_loss: 5.6775e-04 - val\_mse: 5.6775e-04 - val\_mae: 0.0198

Epoch 33/150

7/7 [=====] - 0s 10ms/step - loss: 0.0026 - mse: 0.0026 - mae: 0.0313 - val\_loss: 6.2558e-04 - val\_mse: 6.2558e-04 - val\_mae: 0.0209

Epoch 34/150

7/7 [=====] - 0s 19ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0324 - val\_loss: 6.2716e-04 - val\_mse: 6.2716e-04 - val\_mae: 0.0208

Epoch 35/150

7/7 [=====] - 0s 10ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0321 - val\_loss: 5.6204e-04 - val\_mse: 5.6204e-04 - val\_mae: 0.0196

Epoch 36/150

7/7 [=====] - 0s 10ms/step - loss: 0.0029 - mse: 0.0029 - mae: 0.0320 - val\_loss: 5.7814e-04 - val\_mse: 5.7814e-04 - val\_mae: 0.0200

Epoch 37/150

7/7 [=====] - 0s 10ms/step - loss: 0.0026 - mse: 0.0026 - mae: 0.0312 - val\_loss: 5.6211e-04 - val\_mse: 5.6211e-04 - val\_mae: 0.0198

Epoch 38/150

7/7 [=====] - 0s 10ms/step - loss: 0.0025 - mse: 0.0025 - mae: 0.0301 - val\_loss: 6.0091e-04 - val\_mse: 6.0091e-04 - val\_mae: 0.0204

Epoch 39/150

7/7 [=====] - 0s 9ms/step - loss: 0.0029 - mse: 0.0029 - mae: 0.0318 - val\_loss: 5.7873e-04 - val\_mse: 5.7873e-04 - val\_mae: 0.0200

Epoch 40/150

7/7 [=====] - 0s 10ms/step - loss: 0.0024 - mse: 0.0024 - mae: 0.0300 - val\_loss: 5.4037e-04 - val\_mse: 5.4037e-04 - val\_mae: 0.0193

Epoch 41/150

7/7 [=====] - 0s 10ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0307 - val\_loss: 6.0147e-04 - val\_mse: 6.0147e-04 - val\_mae: 0.0205

Epoch 42/150

7/7 [=====] - 0s 9ms/step - loss: 0.0026 - mse: 0.0026 - mae: 0.0308 - val\_loss: 5.7826e-04 - val\_mse: 5.7826e-04 - val\_mae: 0.0200

Epoch 43/150



7/7 [=====] - 0s 9ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0304 - val\_loss: 5.5033e-04 - val\_mse: 5.5033e-04 - val\_mae: 0.0195  
Epoch 44/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0310 - val\_loss: 5.9336e-04 - val\_mse: 5.9336e-04 - val\_mae: 0.0201  
Epoch 45/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0024 - mse:  
0.0024 - mae: 0.0303 - val\_loss: 5.6738e-04 - val\_mse: 5.6738e-04 - val\_mae: 0.0198  
Epoch 46/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0023 - mse:  
0.0023 - mae: 0.0295 - val\_loss: 5.7846e-04 - val\_mse: 5.7846e-04 - val\_mae: 0.0199  
Epoch 47/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0304 - val\_loss: 5.7339e-04 - val\_mse: 5.7339e-04 - val\_mae: 0.0199  
Epoch 48/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0023 - mse:  
0.0023 - mae: 0.0291 - val\_loss: 5.3992e-04 - val\_mse: 5.3992e-04 - val\_mae: 0.0193  
Epoch 49/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0026 - mse:  
0.0026 - mae: 0.0294 - val\_loss: 6.0607e-04 - val\_mse: 6.0607e-04 - val\_mae: 0.0204  
Epoch 50/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0024 - mse:  
0.0024 - mae: 0.0295 - val\_loss: 5.8147e-04 - val\_mse: 5.8147e-04 - val\_mae: 0.0200  
Epoch 51/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0024 - mse:  
0.0024 - mae: 0.0294 - val\_loss: 6.1248e-04 - val\_mse: 6.1248e-04 - val\_mae: 0.0204  
Epoch 52/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0021 - mse:  
0.0021 - mae: 0.0285 - val\_loss: 5.7833e-04 - val\_mse: 5.7833e-04 - val\_mae: 0.0199  
Epoch 53/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0022 - mse:  
0.0022 - mae: 0.0277 - val\_loss: 5.9938e-04 - val\_mse: 5.9938e-04 - val\_mae: 0.0202  
Epoch 54/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0018 - mse:  
0.0018 - mae: 0.0264 - val\_loss: 5.3907e-04 - val\_mse: 5.3907e-04 - val\_mae: 0.0193  
Epoch 55/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0022 - mse:  
0.0022 - mae: 0.0285 - val\_loss: 6.3922e-04 - val\_mse: 6.3922e-04 - val\_mae: 0.0209  
Epoch 56/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0298 - val\_loss: 6.6674e-04 - val\_mse: 6.6674e-04 - val\_mae: 0.0213  
Epoch 57/150  
7/7 [=====] - 0s 18ms/step - loss: 0.0022 - mse:  
0.0022 - mae: 0.0273 - val\_loss: 5.9838e-04 - val\_mse: 5.9838e-04 - val\_mae: 0.0201  
Epoch 58/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0022 - mse:

0.0022 - mae: 0.0270 - val\_loss: 6.1239e-04 - val\_mse: 6.1239e-04 - val\_mae: 0.0205  
Epoch 59/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0267 - val\_loss: 6.3803e-04 - val\_mse: 6.3803e-04 - val\_mae: 0.0208  
Epoch 60/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0264 - val\_loss: 6.0937e-04 - val\_mse: 6.0937e-04 - val\_mae: 0.0204  
Epoch 61/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0258 - val\_loss: 5.8831e-04 - val\_mse: 5.8831e-04 - val\_mae: 0.0201  
Epoch 62/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0261 - val\_loss: 5.7809e-04 - val\_mse: 5.7809e-04 - val\_mae: 0.0200  
Epoch 63/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0256 - val\_loss: 7.4106e-04 - val\_mse: 7.4106e-04 - val\_mae: 0.0224  
Epoch 64/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0255 - val\_loss: 6.3625e-04 - val\_mse: 6.3625e-04 - val\_mae: 0.0206  
Epoch 65/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0243 - val\_loss: 6.3835e-04 - val\_mse: 6.3835e-04 - val\_mae: 0.0206  
Epoch 66/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0016 - mse: 0.0016 - mae: 0.0239 - val\_loss: 8.2271e-04 - val\_mse: 8.2271e-04 - val\_mae: 0.0234  
Epoch 67/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0017 - mse: 0.0017 - mae: 0.0240 - val\_loss: 7.0832e-04 - val\_mse: 7.0832e-04 - val\_mae: 0.0217  
Epoch 68/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae: 0.0232 - val\_loss: 6.4743e-04 - val\_mse: 6.4743e-04 - val\_mae: 0.0209  
Epoch 69/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0015 - mse: 0.0015 - mae: 0.0232 - val\_loss: 6.8260e-04 - val\_mse: 6.8260e-04 - val\_mae: 0.0215  
Epoch 70/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0017 - mse: 0.0017 - mae: 0.0236 - val\_loss: 7.2773e-04 - val\_mse: 7.2773e-04 - val\_mae: 0.0221  
Epoch 71/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0016 - mse: 0.0016 - mae: 0.0229 - val\_loss: 7.3062e-04 - val\_mse: 7.3062e-04 - val\_mae: 0.0220  
Epoch 72/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0016 - mse: 0.0016 - mae: 0.0228 - val\_loss: 6.5808e-04 - val\_mse: 6.5808e-04 - val\_mae: 0.0211  
Epoch 73/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0218 - val\_loss: 7.9194e-04 - val\_mse: 7.9194e-04 - val\_mae:

e: 0.0229  
Epoch 74/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0014 - mse:  
0.0014 - mae: 0.0218 - val\_loss: 7.3059e-04 - val\_mse: 7.3059e-04 - val\_mae:  
0.0220  
Epoch 75/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0014 - mse:  
0.0014 - mae: 0.0215 - val\_loss: 8.9268e-04 - val\_mse: 8.9268e-04 - val\_mae:  
0.0243  
Epoch 76/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0014 - mse:  
0.0014 - mae: 0.0216 - val\_loss: 7.8921e-04 - val\_mse: 7.8921e-04 - val\_mae:  
0.0230  
Epoch 77/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0013 - mse:  
0.0013 - mae: 0.0208 - val\_loss: 7.8192e-04 - val\_mse: 7.8192e-04 - val\_mae:  
0.0227  
Epoch 78/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0014 - mse:  
0.0014 - mae: 0.0211 - val\_loss: 7.8931e-04 - val\_mse: 7.8931e-04 - val\_mae:  
0.0228  
Epoch 79/150  
7/7 [=====] - 0s 22ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0204 - val\_loss: 7.1698e-04 - val\_mse: 7.1698e-04 - val\_mae:  
0.0219  
Epoch 80/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0200 - val\_loss: 9.5126e-04 - val\_mse: 9.5126e-04 - val\_mae:  
0.0252  
Epoch 81/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0013 - mse:  
0.0013 - mae: 0.0205 - val\_loss: 7.8128e-04 - val\_mse: 7.8128e-04 - val\_mae:  
0.0225  
Epoch 82/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0204 - val\_loss: 9.5081e-04 - val\_mse: 9.5081e-04 - val\_mae:  
0.0252  
Epoch 83/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0200 - val\_loss: 9.3146e-04 - val\_mse: 9.3146e-04 - val\_mae:  
0.0250  
Epoch 84/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0199 - val\_loss: 9.7966e-04 - val\_mse: 9.7966e-04 - val\_mae:  
0.0257  
Epoch 85/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0200 - val\_loss: 8.0767e-04 - val\_mse: 8.0767e-04 - val\_mae:  
0.0231  
Epoch 86/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0012 - mse:  
0.0012 - mae: 0.0201 - val\_loss: 8.4237e-04 - val\_mse: 8.4237e-04 - val\_mae:  
0.0236  
Epoch 87/150  
7/7 [=====] - 0s 10ms/step - loss: 0.0010 - mse:  
0.0010 - mae: 0.0193 - val\_loss: 8.7131e-04 - val\_mse: 8.7131e-04 - val\_mae:  
0.0242  
Epoch 88/150  
7/7 [=====] - 0s 12ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0194 - val\_loss: 7.7818e-04 - val\_mse: 7.7818e-04 - val\_mae:  
0.0226

Epoch 89/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0197 - val\_loss: 8.6100e-04 - val\_mse: 8.6100e-04 - val\_mae: 0.0239

Epoch 90/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0194 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0270

Epoch 91/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0196 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0267

Epoch 92/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0193 - val\_loss: 7.8407e-04 - val\_mse: 7.8407e-04 - val\_mae: 0.0228

Epoch 93/150  
7/7 [=====] - 0s 10ms/step - loss: 9.9072e-04 - mse:  
9.9072e-04 - mae: 0.0191 - val\_loss: 8.9807e-04 - val\_mse: 8.9807e-04 - val\_mae: 0.0245

Epoch 94/150  
7/7 [=====] - 0s 10ms/step - loss: 9.8381e-04 - mse:  
9.8381e-04 - mae: 0.0187 - val\_loss: 9.8186e-04 - val\_mse: 9.8186e-04 - val\_mae: 0.0258

Epoch 95/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0192 - val\_loss: 9.0259e-04 - val\_mse: 9.0259e-04 - val\_mae: 0.0246

Epoch 96/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0010 - mse:  
0.0010 - mae: 0.0193 - val\_loss: 7.9701e-04 - val\_mse: 7.9701e-04 - val\_mae: 0.0229

Epoch 97/150  
7/7 [=====] - 0s 11ms/step - loss: 9.5668e-04 - mse:  
9.5668e-04 - mae: 0.0192 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0273

Epoch 98/150  
7/7 [=====] - 0s 10ms/step - loss: 9.4652e-04 - mse:  
9.4652e-04 - mae: 0.0186 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0271

Epoch 99/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0194 - val\_loss: 9.4834e-04 - val\_mse: 9.4834e-04 - val\_mae: 0.0251

Epoch 100/150  
7/7 [=====] - 0s 10ms/step - loss: 9.0267e-04 - mse:  
9.0267e-04 - mae: 0.0187 - val\_loss: 8.5133e-04 - val\_mse: 8.5133e-04 - val\_mae: 0.0239

Epoch 101/150  
7/7 [=====] - 0s 22ms/step - loss: 9.8832e-04 - mse:  
9.8832e-04 - mae: 0.0192 - val\_loss: 0.0013 - val\_mse: 0.0013 - val\_mae: 0.0296

Epoch 102/150  
7/7 [=====] - 0s 9ms/step - loss: 0.0010 - mse:  
0.0010 - mae: 0.0194 - val\_loss: 9.0016e-04 - val\_mse: 9.0016e-04 - val\_mae: 0.0247

Epoch 103/150  
7/7 [=====] - 0s 11ms/step - loss: 0.0011 - mse:  
0.0011 - mae: 0.0195 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0270

Epoch 104/150

7/7 [=====] - 0s 10ms/step - loss: 9.1192e-04 - mse: 9.1192e-04 - mae: 0.0189 - val\_loss: 8.2225e-04 - val\_mse: 8.2225e-04 - val\_mae: 0.0236  
Epoch 105/150  
7/7 [=====] - 0s 10ms/step - loss: 8.9854e-04 - mse: 8.9854e-04 - mae: 0.0183 - val\_loss: 0.0013 - val\_mse: 0.0013 - val\_mae: 0.0292  
Epoch 106/150  
7/7 [=====] - 0s 9ms/step - loss: 9.7441e-04 - mse: 9.7441e-04 - mae: 0.0192 - val\_loss: 9.2250e-04 - val\_mse: 9.2250e-04 - val\_mae: 0.0250  
Epoch 107/150  
7/7 [=====] - 0s 9ms/step - loss: 9.8084e-04 - mse: 9.8084e-04 - mae: 0.0192 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0276  
Epoch 108/150  
7/7 [=====] - 0s 10ms/step - loss: 9.2966e-04 - mse: 9.2966e-04 - mae: 0.0186 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0269  
Epoch 109/150  
7/7 [=====] - 0s 9ms/step - loss: 9.3639e-04 - mse: 9.3639e-04 - mae: 0.0187 - val\_loss: 8.8874e-04 - val\_mse: 8.8874e-04 - val\_mae: 0.0246  
Epoch 110/150  
7/7 [=====] - 0s 10ms/step - loss: 9.4859e-04 - mse: 9.4859e-04 - mae: 0.0190 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0272  
Epoch 111/150  
7/7 [=====] - 0s 10ms/step - loss: 8.5240e-04 - mse: 8.5240e-04 - mae: 0.0182 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0263  
Epoch 112/150  
7/7 [=====] - 0s 9ms/step - loss: 8.6787e-04 - mse: 8.6787e-04 - mae: 0.0183 - val\_loss: 9.6429e-04 - val\_mse: 9.6429e-04 - val\_mae: 0.0255  
Epoch 113/150  
7/7 [=====] - 0s 9ms/step - loss: 9.1571e-04 - mse: 9.1571e-04 - mae: 0.0191 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0266  
Epoch 114/150  
7/7 [=====] - 0s 10ms/step - loss: 8.6118e-04 - mse: 8.6118e-04 - mae: 0.0185 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0261  
Epoch 115/150  
7/7 [=====] - 0s 9ms/step - loss: 8.0814e-04 - mse: 8.0814e-04 - mae: 0.0180 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0279  
Epoch 116/150  
7/7 [=====] - 0s 12ms/step - loss: 8.5801e-04 - mse: 8.5801e-04 - mae: 0.0183 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0267  
Epoch 117/150  
7/7 [=====] - 0s 9ms/step - loss: 9.1669e-04 - mse: 9.1669e-04 - mae: 0.0186 - val\_loss: 9.7441e-04 - val\_mse: 9.7441e-04 - val\_mae: 0.0255  
Epoch 118/150  
7/7 [=====] - 0s 10ms/step - loss: 8.6667e-04 - mse: 8.6667e-04 - mae: 0.0186 - val\_loss: 9.7840e-04 - val\_mse: 9.7840e-04 - val\_mae: 0.0256  
Epoch 119/150  
7/7 [=====] - 0s 9ms/step - loss: 8.4837e-04 - mse:

e: 8.4837e-04 - mae: 0.0185 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0275  
Epoch 120/150  
7/7 [=====] - 0s 9ms/step - loss: 9.3627e-04 - mse: 9.3627e-04 - mae: 0.0189 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0286  
Epoch 121/150  
7/7 [=====] - 0s 9ms/step - loss: 8.6454e-04 - mse: 8.6454e-04 - mae: 0.0183 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0262  
Epoch 122/150  
7/7 [=====] - 0s 9ms/step - loss: 8.6969e-04 - mse: 8.6969e-04 - mae: 0.0182 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0262  
Epoch 123/150  
7/7 [=====] - 0s 10ms/step - loss: 8.6029e-04 - mse: 8.6029e-04 - mae: 0.0184 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0286  
Epoch 124/150  
7/7 [=====] - 0s 17ms/step - loss: 8.2146e-04 - mse: 8.2146e-04 - mae: 0.0180 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0280  
Epoch 125/150  
7/7 [=====] - 0s 9ms/step - loss: 9.2960e-04 - mse: 9.2960e-04 - mae: 0.0191 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0280  
Epoch 126/150  
7/7 [=====] - 0s 9ms/step - loss: 8.3003e-04 - mse: 8.3003e-04 - mae: 0.0182 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0276  
Epoch 127/150  
7/7 [=====] - 0s 10ms/step - loss: 7.8862e-04 - mse: 7.8862e-04 - mae: 0.0179 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0278  
Epoch 128/150  
7/7 [=====] - 0s 9ms/step - loss: 8.3375e-04 - mse: 8.3375e-04 - mae: 0.0181 - val\_loss: 9.8412e-04 - val\_mse: 9.8412e-04 - val\_mae: 0.0257  
Epoch 129/150  
7/7 [=====] - 0s 11ms/step - loss: 8.2151e-04 - mse: 8.2151e-04 - mae: 0.0182 - val\_loss: 0.0013 - val\_mse: 0.0013 - val\_mae: 0.0292  
Epoch 130/150  
7/7 [=====] - 0s 10ms/step - loss: 7.9172e-04 - mse: 7.9172e-04 - mae: 0.0181 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0271  
Epoch 131/150  
7/7 [=====] - 0s 10ms/step - loss: 8.0997e-04 - mse: 8.0997e-04 - mae: 0.0182 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0287  
Epoch 132/150  
7/7 [=====] - 0s 9ms/step - loss: 8.1706e-04 - mse: 8.1706e-04 - mae: 0.0181 - val\_loss: 0.0013 - val\_mse: 0.0013 - val\_mae: 0.0295  
Epoch 133/150  
7/7 [=====] - 0s 11ms/step - loss: 8.0598e-04 - mse: 8.0598e-04 - mae: 0.0182 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0261  
Epoch 134/150  
7/7 [=====] - 0s 10ms/step - loss: 8.6464e-04 - mse: 8.6464e-04 - mae: 0.0187 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0286

e: 0.0286  
Epoch 135/150  
7/7 [=====] - 0s 10ms/step - loss: 8.3924e-04 - mse: 8.3924e-04 - mae: 0.0180 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0267  
Epoch 136/150  
7/7 [=====] - 0s 9ms/step - loss: 8.5504e-04 - mse: 8.5504e-04 - mae: 0.0186 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0267  
Epoch 137/150  
7/7 [=====] - 0s 10ms/step - loss: 8.4985e-04 - mse: 8.4985e-04 - mae: 0.0185 - val\_loss: 9.3974e-04 - val\_mse: 9.3974e-04 - val\_mae: 0.0250  
Epoch 138/150  
7/7 [=====] - 0s 9ms/step - loss: 8.0257e-04 - mse: 8.0257e-04 - mae: 0.0180 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0267  
Epoch 139/150  
7/7 [=====] - 0s 9ms/step - loss: 8.7237e-04 - mse: 8.7237e-04 - mae: 0.0185 - val\_loss: 0.0014 - val\_mse: 0.0014 - val\_mae: 0.0306  
Epoch 140/150  
7/7 [=====] - 0s 9ms/step - loss: 7.9722e-04 - mse: 7.9722e-04 - mae: 0.0179 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0268  
Epoch 141/150  
7/7 [=====] - 0s 10ms/step - loss: 8.4230e-04 - mse: 8.4230e-04 - mae: 0.0182 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0273  
Epoch 142/150  
7/7 [=====] - 0s 10ms/step - loss: 7.8040e-04 - mse: 7.8040e-04 - mae: 0.0177 - val\_loss: 0.0012 - val\_mse: 0.0012 - val\_mae: 0.0282  
Epoch 143/150  
7/7 [=====] - 0s 10ms/step - loss: 7.5556e-04 - mse: 7.5556e-04 - mae: 0.0173 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0276  
Epoch 144/150  
7/7 [=====] - 0s 10ms/step - loss: 8.0998e-04 - mse: 8.0998e-04 - mae: 0.0178 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0269  
Epoch 145/150  
7/7 [=====] - 0s 9ms/step - loss: 7.6768e-04 - mse: 7.6768e-04 - mae: 0.0177 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0269  
Epoch 146/150  
7/7 [=====] - 0s 21ms/step - loss: 7.8258e-04 - mse: 7.8258e-04 - mae: 0.0179 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0271  
Epoch 147/150  
7/7 [=====] - 0s 9ms/step - loss: 7.5638e-04 - mse: 7.5638e-04 - mae: 0.0176 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0274  
Epoch 148/150  
7/7 [=====] - 0s 9ms/step - loss: 7.4936e-04 - mse: 7.4936e-04 - mae: 0.0173 - val\_loss: 0.0010 - val\_mse: 0.0010 - val\_mae: 0.0261  
Epoch 149/150  
7/7 [=====] - 0s 10ms/step - loss: 7.4172e-04 - mse: 7.4172e-04 - mae: 0.0174 - val\_loss: 0.0011 - val\_mse: 0.0011 - val\_mae: 0.0275

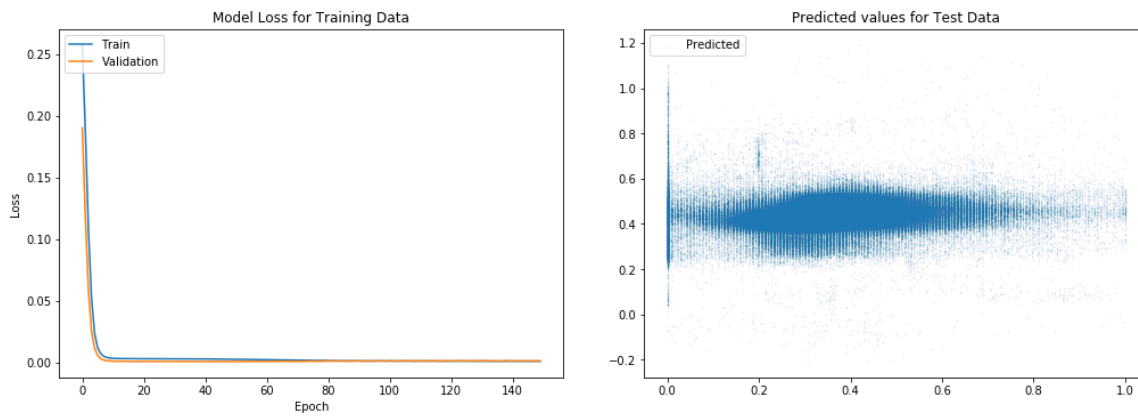
Epoch 150/150

7/7 [=====] - 0s 9ms/step - loss: 7.6672e-04 - mse:  
e: 7.6672e-04 - mae: 0.0176 - val\_loss: 0.0011 - val\_mse:  
e: 0.0273

In [25]:

```
visualise_performance(model,history,xtest,ypredicted)
```

```
dict_keys(['loss', 'mse', 'mae', 'val_loss', 'val_mse', 'val_mae'])
```

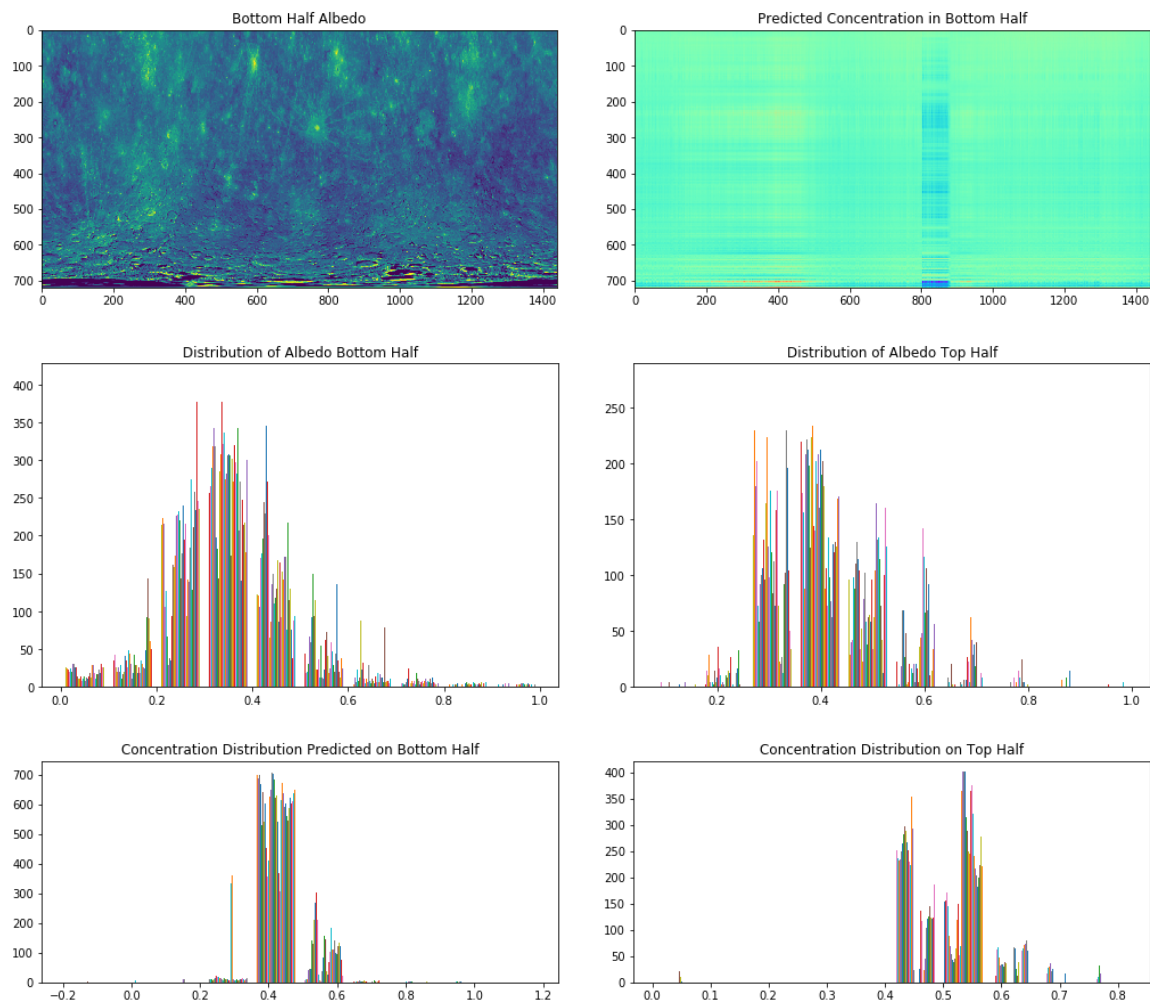


The loss for validation and training is fairly less and generates a steeply decreasing curve



In [26]:

```
visualise_predictions(xtest,ypredicted)
```



FeSi Map

In [27]:

```
df = correlation_matrix(albedo_top_half,fesimap)
```

Correlation between the Albedo and Concentration Map

	albedo	concentration
albedo	1.000000	-0.045356
concentration	-0.045356	1.000000

Summary of the data

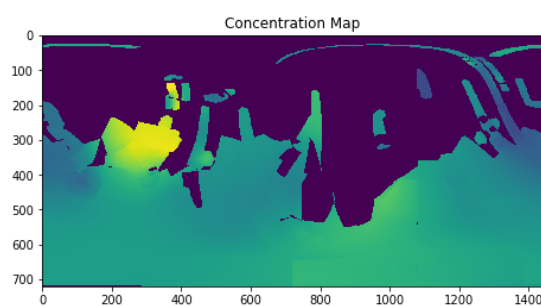
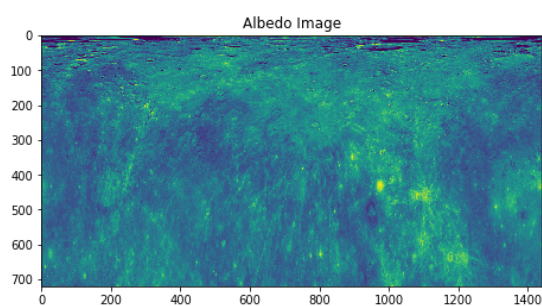
	albedo	concentration
count	1.036800e+06	1.036800e+06
mean	4.144590e-01	3.138895e-01
std	1.165033e-01	2.891811e-01
min	0.000000e+00	0.000000e+00
25%	3.372549e-01	0.000000e+00
50%	4.039216e-01	4.549020e-01
75%	4.862745e-01	5.607843e-01
max	1.000000e+00	1.000000e+00

Observation: Here we observe there is no linear correlation between the data of albedo and concentration map before the outlier removal

In [28]:

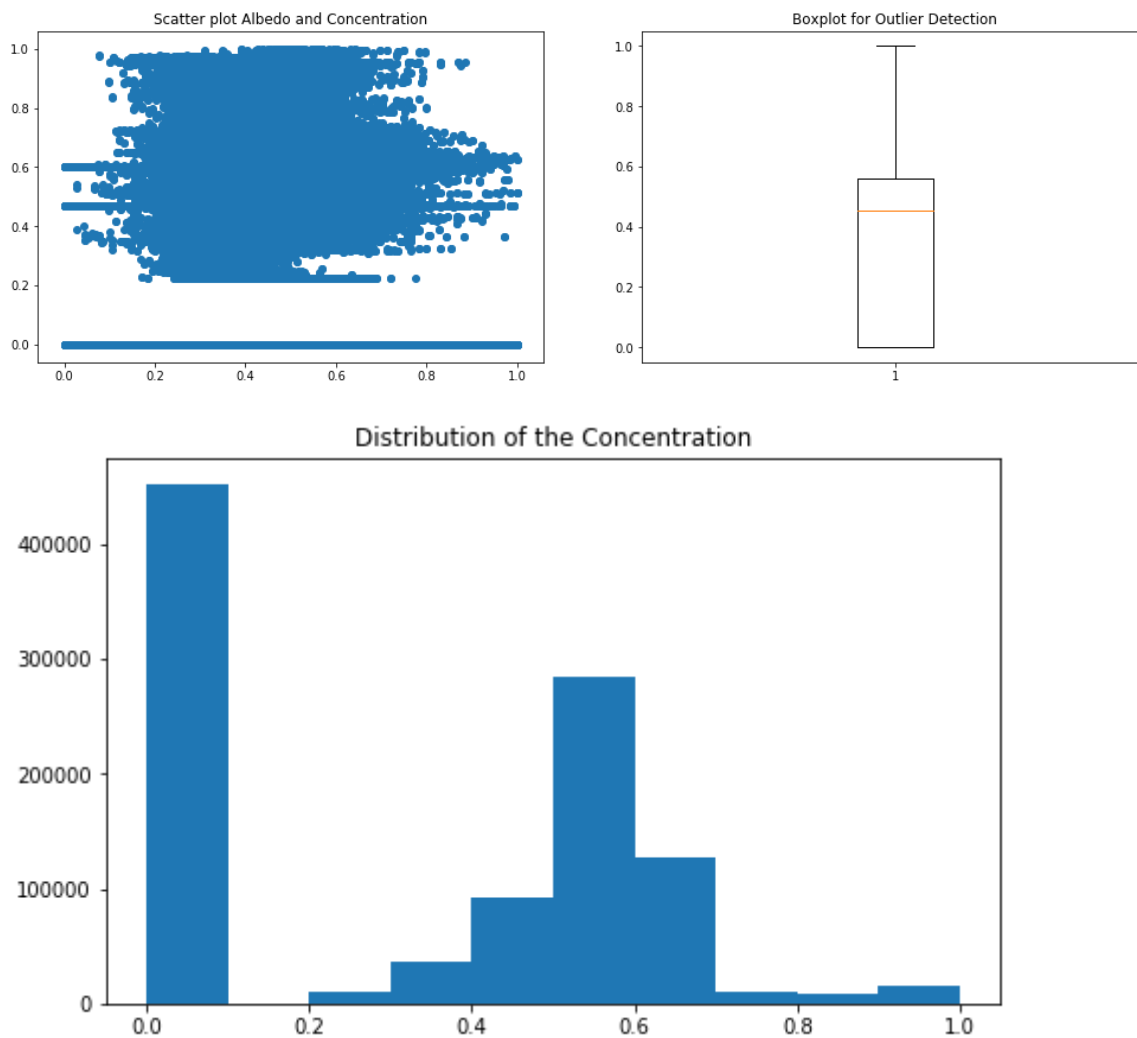
```
ytrain , xtrain , xtest = test_data(fesimap)
```

(720, 1440)



In [29]:

```
outlier_plots(df)
```

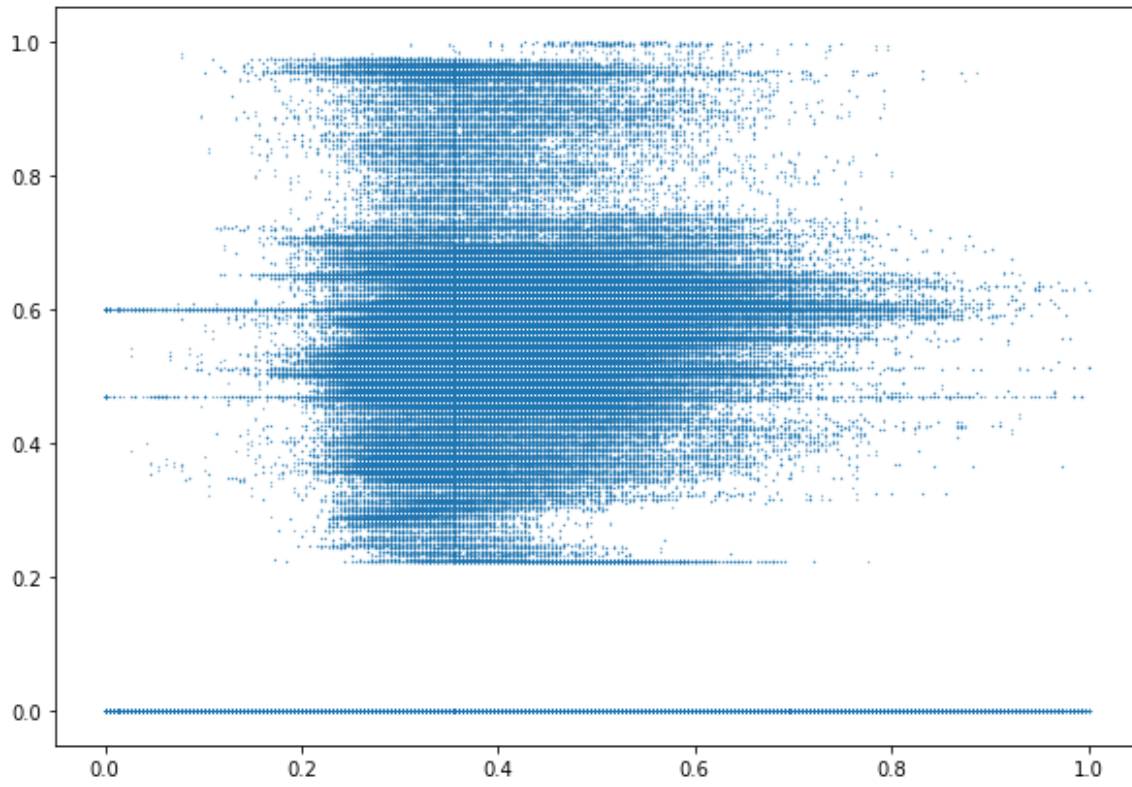


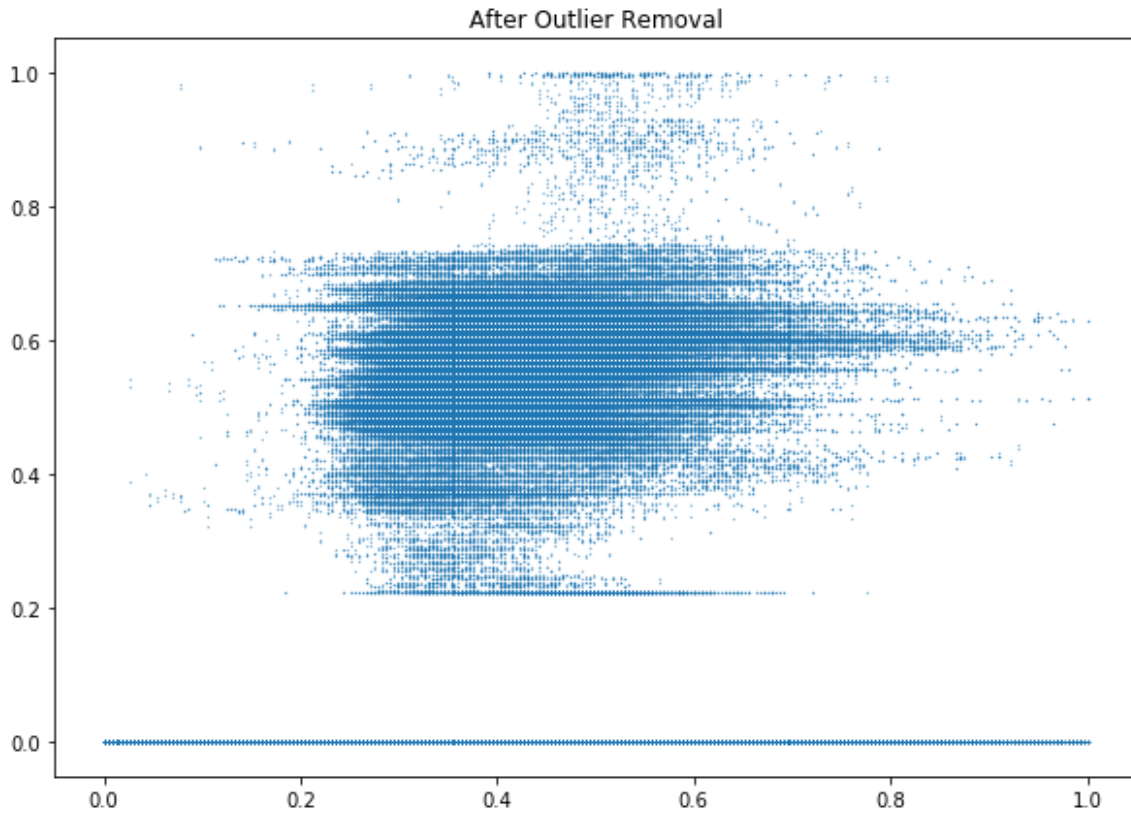
Observation: We see significant amount of outlier presence and observe the gaps in data through scatter plot and through histogram we observe a continuous data flow from 0.2 to 1.0 while there is some distribution near 0.0 which can create discontinuity in predictions as well.

In [30]:

```
xtrain, ytrain , shape = outlier_detection(xtrain,ytrain,'auto')
```

Before Outlier Removal





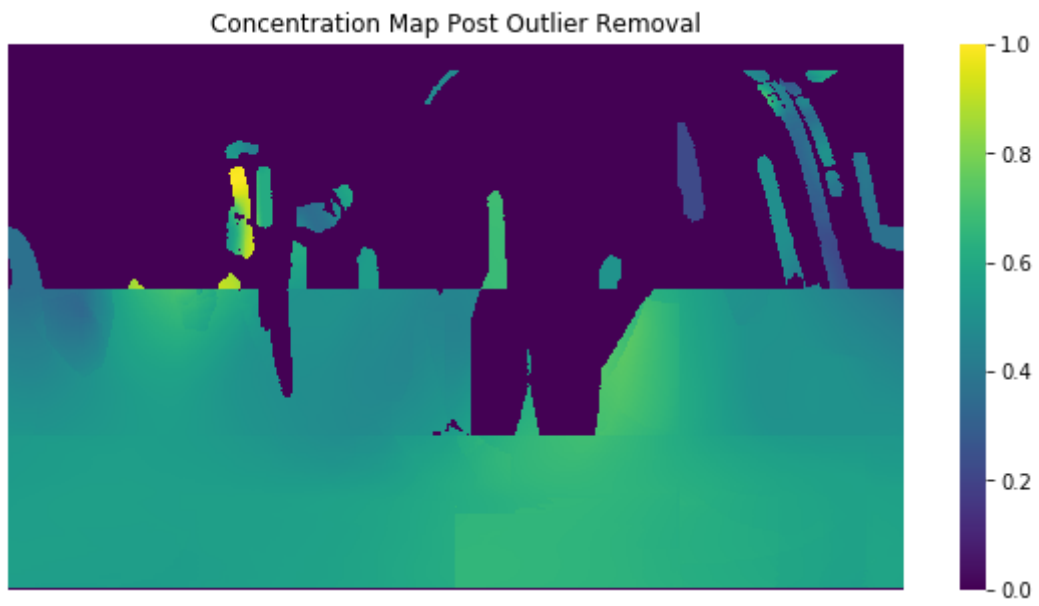
(471, 1440)

```
{'behaviour': 'deprecated', 'bootstrap': False, 'contamination': 'auto',  
'max_features': 1.0, 'max_samples': 'auto', 'n_estimators': 100, 'n_jobs':  
None, 'random_state': None, 'verbose': 0, 'warm_start': False}
```

We do not observe a great performance of Isolation Forest Outlier Removal Algorithm in case of FeSi Map. The gaps are not removed at all and lot of training data around dense plot is removed which may cause biased and wrong predictions. Other Outlier Removal Algorithm like Minimum Covariance Determinant, Local Outlier Factor, One-Class SVM also do not work properly in this case.

In [31]:

```
visualise_maps(ytrain)
```



In [32]:

```
history,model,ypredicted = model_application(xtrain, xtest, ytrain)
```



Model: "sequential\_2"

Layer (type)	Output Shape	Param #
dense_6 (Dense)	(None, 32)	46112
dense_7 (Dense)	(None, 16)	528
dense_8 (Dense)	(None, 1440)	24480

=====  
Total params: 71,120

Trainable params: 71,120

Non-trainable params: 0

Epoch 1/150

8/8 [=====] - 0s 26ms/step - loss: 0.1301 - mse:  
0.1301 - mae: 0.2594 - val\_loss: 0.3320 - val\_mse: 0.3320 - val\_mae: 0.570  
9

Epoch 2/150

8/8 [=====] - 0s 12ms/step - loss: 0.1186 - mse:  
0.1186 - mae: 0.2493 - val\_loss: 0.2775 - val\_mse: 0.2775 - val\_mae: 0.512  
5

Epoch 3/150

8/8 [=====] - 0s 11ms/step - loss: 0.1063 - mse:  
0.1063 - mae: 0.2575 - val\_loss: 0.2322 - val\_mse: 0.2322 - val\_mae: 0.468  
0

Epoch 4/150

8/8 [=====] - 0s 9ms/step - loss: 0.0832 - mse:  
0.0832 - mae: 0.2356 - val\_loss: 0.1868 - val\_mse: 0.1868 - val\_mae: 0.417  
5

Epoch 5/150

8/8 [=====] - 0s 9ms/step - loss: 0.0683 - mse:  
0.0683 - mae: 0.2208 - val\_loss: 0.1468 - val\_mse: 0.1468 - val\_mae: 0.366  
0

Epoch 6/150

8/8 [=====] - 0s 10ms/step - loss: 0.0531 - mse:  
0.0531 - mae: 0.1960 - val\_loss: 0.1193 - val\_mse: 0.1193 - val\_mae: 0.325  
4

Epoch 7/150

8/8 [=====] - 0s 10ms/step - loss: 0.0455 - mse:  
0.0455 - mae: 0.1782 - val\_loss: 0.1105 - val\_mse: 0.1105 - val\_mae: 0.313  
7

Epoch 8/150

8/8 [=====] - 0s 9ms/step - loss: 0.0357 - mse:  
0.0357 - mae: 0.1502 - val\_loss: 0.1152 - val\_mse: 0.1152 - val\_mae: 0.321  
3

Epoch 9/150

8/8 [=====] - 0s 9ms/step - loss: 0.0287 - mse:  
0.0287 - mae: 0.1257 - val\_loss: 0.1092 - val\_mse: 0.1092 - val\_mae: 0.310  
4

Epoch 10/150

8/8 [=====] - 0s 8ms/step - loss: 0.0273 - mse:  
0.0273 - mae: 0.1179 - val\_loss: 0.1175 - val\_mse: 0.1175 - val\_mae: 0.325  
1

Epoch 11/150

8/8 [=====] - 0s 12ms/step - loss: 0.0253 - mse:  
0.0253 - mae: 0.1093 - val\_loss: 0.1277 - val\_mse: 0.1277 - val\_mae: 0.341  
3

Epoch 12/150

8/8 [=====] - 0s 20ms/step - loss: 0.0233 - mse:  
0.0233 - mae: 0.1019 - val\_loss: 0.1118 - val\_mse: 0.1118 - val\_mae: 0.314

1  
Epoch 13/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0222 - mse:  
0.0222 - mae: 0.0978 - val\_loss: 0.0934 - val\_mse: 0.0934 - val\_mae: 0.279  
1  
Epoch 14/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0220 - mse:  
0.0220 - mae: 0.0969 - val\_loss: 0.1142 - val\_mse: 0.1142 - val\_mae: 0.318  
3  
Epoch 15/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0203 - mse:  
0.0203 - mae: 0.0906 - val\_loss: 0.1080 - val\_mse: 0.1080 - val\_mae: 0.306  
3  
Epoch 16/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0208 - mse:  
0.0208 - mae: 0.0920 - val\_loss: 0.0902 - val\_mse: 0.0902 - val\_mae: 0.271  
1  
Epoch 17/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0195 - mse:  
0.0195 - mae: 0.0877 - val\_loss: 0.0904 - val\_mse: 0.0904 - val\_mae: 0.271  
9  
Epoch 18/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0199 - mse:  
0.0199 - mae: 0.0877 - val\_loss: 0.0862 - val\_mse: 0.0862 - val\_mae: 0.262  
4  
Epoch 19/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0189 - mse:  
0.0189 - mae: 0.0845 - val\_loss: 0.0962 - val\_mse: 0.0962 - val\_mae: 0.282  
8  
Epoch 20/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0185 - mse:  
0.0185 - mae: 0.0823 - val\_loss: 0.0958 - val\_mse: 0.0958 - val\_mae: 0.281  
5  
Epoch 21/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0188 - mse:  
0.0188 - mae: 0.0823 - val\_loss: 0.0912 - val\_mse: 0.0912 - val\_mae: 0.271  
2  
Epoch 22/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0185 - mse:  
0.0185 - mae: 0.0808 - val\_loss: 0.0886 - val\_mse: 0.0886 - val\_mae: 0.266  
2  
Epoch 23/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0180 - mse:  
0.0180 - mae: 0.0811 - val\_loss: 0.0945 - val\_mse: 0.0945 - val\_mae: 0.276  
7  
Epoch 24/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0193 - mse:  
0.0193 - mae: 0.0830 - val\_loss: 0.0910 - val\_mse: 0.0910 - val\_mae: 0.270  
1  
Epoch 25/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0182 - mse:  
0.0182 - mae: 0.0811 - val\_loss: 0.0768 - val\_mse: 0.0768 - val\_mae: 0.238  
2  
Epoch 26/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0181 - mse:  
0.0181 - mae: 0.0795 - val\_loss: 0.0915 - val\_mse: 0.0915 - val\_mae: 0.269  
3  
Epoch 27/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0170 - mse:  
0.0170 - mae: 0.0757 - val\_loss: 0.0852 - val\_mse: 0.0852 - val\_mae: 0.255  
2

Epoch 28/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0169 - mse:  
0.0169 - mae: 0.0753 - val\_loss: 0.0804 - val\_mse: 0.0804 - val\_mae: 0.245  
9

Epoch 29/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0170 - mse:  
0.0170 - mae: 0.0771 - val\_loss: 0.0826 - val\_mse: 0.0826 - val\_mae: 0.251  
4

Epoch 30/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0172 - mse:  
0.0172 - mae: 0.0769 - val\_loss: 0.0798 - val\_mse: 0.0798 - val\_mae: 0.244  
7

Epoch 31/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0170 - mse:  
0.0170 - mae: 0.0761 - val\_loss: 0.0806 - val\_mse: 0.0806 - val\_mae: 0.245  
3

Epoch 32/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0168 - mse:  
0.0168 - mae: 0.0741 - val\_loss: 0.0874 - val\_mse: 0.0874 - val\_mae: 0.259  
9

Epoch 33/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0164 - mse:  
0.0164 - mae: 0.0742 - val\_loss: 0.0878 - val\_mse: 0.0878 - val\_mae: 0.259  
2

Epoch 34/150  
8/8 [=====] - 0s 17ms/step - loss: 0.0162 - mse:  
0.0162 - mae: 0.0744 - val\_loss: 0.0866 - val\_mse: 0.0866 - val\_mae: 0.257  
3

Epoch 35/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0164 - mse:  
0.0164 - mae: 0.0739 - val\_loss: 0.0845 - val\_mse: 0.0845 - val\_mae: 0.255  
2

Epoch 36/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0163 - mse:  
0.0163 - mae: 0.0738 - val\_loss: 0.0917 - val\_mse: 0.0917 - val\_mae: 0.269  
1

Epoch 37/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0161 - mse:  
0.0161 - mae: 0.0739 - val\_loss: 0.0779 - val\_mse: 0.0779 - val\_mae: 0.239  
4

Epoch 38/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0163 - mse:  
0.0163 - mae: 0.0762 - val\_loss: 0.0857 - val\_mse: 0.0857 - val\_mae: 0.258  
0

Epoch 39/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0156 - mse:  
0.0156 - mae: 0.0745 - val\_loss: 0.0934 - val\_mse: 0.0934 - val\_mae: 0.273  
3

Epoch 40/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0156 - mse:  
0.0156 - mae: 0.0739 - val\_loss: 0.0849 - val\_mse: 0.0849 - val\_mae: 0.256  
7

Epoch 41/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0154 - mse:  
0.0154 - mae: 0.0730 - val\_loss: 0.0787 - val\_mse: 0.0787 - val\_mae: 0.244  
0

Epoch 42/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0155 - mse:  
0.0155 - mae: 0.0734 - val\_loss: 0.0885 - val\_mse: 0.0885 - val\_mae: 0.264  
6

Epoch 43/150

8/8 [=====] - 0s 8ms/step - loss: 0.0153 - mse:  
0.0153 - mae: 0.0725 - val\_loss: 0.0826 - val\_mse: 0.0826 - val\_mae: 0.253  
6  
Epoch 44/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0149 - mse:  
0.0149 - mae: 0.0711 - val\_loss: 0.0798 - val\_mse: 0.0798 - val\_mae: 0.248  
8  
Epoch 45/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0146 - mse:  
0.0146 - mae: 0.0716 - val\_loss: 0.0801 - val\_mse: 0.0801 - val\_mae: 0.251  
6  
Epoch 46/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0149 - mse:  
0.0149 - mae: 0.0721 - val\_loss: 0.0851 - val\_mse: 0.0851 - val\_mae: 0.262  
0  
Epoch 47/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0142 - mse:  
0.0142 - mae: 0.0706 - val\_loss: 0.0804 - val\_mse: 0.0804 - val\_mae: 0.252  
2  
Epoch 48/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0145 - mse:  
0.0145 - mae: 0.0709 - val\_loss: 0.0827 - val\_mse: 0.0827 - val\_mae: 0.258  
0  
Epoch 49/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0138 - mse:  
0.0138 - mae: 0.0691 - val\_loss: 0.0686 - val\_mse: 0.0686 - val\_mae: 0.228  
3  
Epoch 50/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0136 - mse:  
0.0136 - mae: 0.0689 - val\_loss: 0.0775 - val\_mse: 0.0775 - val\_mae: 0.246  
8  
Epoch 51/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0130 - mse:  
0.0130 - mae: 0.0665 - val\_loss: 0.0849 - val\_mse: 0.0849 - val\_mae: 0.262  
6  
Epoch 52/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0136 - mse:  
0.0136 - mae: 0.0675 - val\_loss: 0.0746 - val\_mse: 0.0746 - val\_mae: 0.241  
8  
Epoch 53/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0129 - mse:  
0.0129 - mae: 0.0651 - val\_loss: 0.0810 - val\_mse: 0.0810 - val\_mae: 0.255  
3  
Epoch 54/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0126 - mse:  
0.0126 - mae: 0.0651 - val\_loss: 0.0739 - val\_mse: 0.0739 - val\_mae: 0.241  
5  
Epoch 55/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0127 - mse:  
0.0127 - mae: 0.0643 - val\_loss: 0.0787 - val\_mse: 0.0787 - val\_mae: 0.251  
3  
Epoch 56/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0124 - mse:  
0.0124 - mae: 0.0637 - val\_loss: 0.0774 - val\_mse: 0.0774 - val\_mae: 0.248  
5  
Epoch 57/150  
8/8 [=====] - 0s 16ms/step - loss: 0.0123 - mse:  
0.0123 - mae: 0.0625 - val\_loss: 0.0773 - val\_mse: 0.0773 - val\_mae: 0.248  
1  
Epoch 58/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0118 - mse:

0.0118 - mae: 0.0614 - val\_loss: 0.0698 - val\_mse: 0.0698 - val\_mae: 0.233  
6  
Epoch 59/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0118 - mse:  
0.0118 - mae: 0.0608 - val\_loss: 0.0756 - val\_mse: 0.0756 - val\_mae: 0.245  
4  
Epoch 60/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0117 - mse:  
0.0117 - mae: 0.0603 - val\_loss: 0.0688 - val\_mse: 0.0688 - val\_mae: 0.231  
7  
Epoch 61/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0116 - mse:  
0.0116 - mae: 0.0597 - val\_loss: 0.0731 - val\_mse: 0.0731 - val\_mae: 0.239  
8  
Epoch 62/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0114 - mse:  
0.0114 - mae: 0.0596 - val\_loss: 0.0746 - val\_mse: 0.0746 - val\_mae: 0.242  
4  
Epoch 63/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0118 - mse:  
0.0118 - mae: 0.0595 - val\_loss: 0.0719 - val\_mse: 0.0719 - val\_mae: 0.236  
5  
Epoch 64/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0113 - mse:  
0.0113 - mae: 0.0579 - val\_loss: 0.0691 - val\_mse: 0.0691 - val\_mae: 0.230  
9  
Epoch 65/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0115 - mse:  
0.0115 - mae: 0.0593 - val\_loss: 0.0775 - val\_mse: 0.0775 - val\_mae: 0.247  
2  
Epoch 66/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0115 - mse:  
0.0115 - mae: 0.0588 - val\_loss: 0.0703 - val\_mse: 0.0703 - val\_mae: 0.232  
8  
Epoch 67/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0115 - mse:  
0.0115 - mae: 0.0591 - val\_loss: 0.0725 - val\_mse: 0.0725 - val\_mae: 0.236  
4  
Epoch 68/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0111 - mse:  
0.0111 - mae: 0.0571 - val\_loss: 0.0745 - val\_mse: 0.0745 - val\_mae: 0.239  
9  
Epoch 69/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0107 - mse:  
0.0107 - mae: 0.0567 - val\_loss: 0.0711 - val\_mse: 0.0711 - val\_mae: 0.232  
3  
Epoch 70/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0115 - mse:  
0.0115 - mae: 0.0590 - val\_loss: 0.0743 - val\_mse: 0.0743 - val\_mae: 0.239  
1  
Epoch 71/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0107 - mse:  
0.0107 - mae: 0.0565 - val\_loss: 0.0673 - val\_mse: 0.0673 - val\_mae: 0.225  
2  
Epoch 72/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0106 - mse:  
0.0106 - mae: 0.0560 - val\_loss: 0.0818 - val\_mse: 0.0818 - val\_mae: 0.253  
3  
Epoch 73/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0107 - mse:  
0.0107 - mae: 0.0562 - val\_loss: 0.0728 - val\_mse: 0.0728 - val\_mae: 0.235

4

Epoch 74/150

8/8 [=====] - 0s 8ms/step - loss: 0.0102 - mse:  
0.0102 - mae: 0.0543 - val\_loss: 0.0712 - val\_mse: 0.0712 - val\_mae: 0.232

8

Epoch 75/150

8/8 [=====] - 0s 8ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0556 - val\_loss: 0.0799 - val\_mse: 0.0799 - val\_mae: 0.249

2

Epoch 76/150

8/8 [=====] - 0s 9ms/step - loss: 0.0108 - mse:  
0.0108 - mae: 0.0566 - val\_loss: 0.0661 - val\_mse: 0.0661 - val\_mae: 0.222

3

Epoch 77/150

8/8 [=====] - 0s 8ms/step - loss: 0.0111 - mse:  
0.0111 - mae: 0.0585 - val\_loss: 0.0903 - val\_mse: 0.0903 - val\_mae: 0.267

9

Epoch 78/150

8/8 [=====] - 0s 9ms/step - loss: 0.0109 - mse:  
0.0109 - mae: 0.0581 - val\_loss: 0.0674 - val\_mse: 0.0674 - val\_mae: 0.224

5

Epoch 79/150

8/8 [=====] - 0s 17ms/step - loss: 0.0106 - mse:  
0.0106 - mae: 0.0547 - val\_loss: 0.0816 - val\_mse: 0.0816 - val\_mae: 0.252

4

Epoch 80/150

8/8 [=====] - 0s 8ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0552 - val\_loss: 0.0687 - val\_mse: 0.0687 - val\_mae: 0.227

3

Epoch 81/150

8/8 [=====] - 0s 9ms/step - loss: 0.0104 - mse:  
0.0104 - mae: 0.0546 - val\_loss: 0.0714 - val\_mse: 0.0714 - val\_mae: 0.232

4

Epoch 82/150

8/8 [=====] - 0s 9ms/step - loss: 0.0106 - mse:  
0.0106 - mae: 0.0554 - val\_loss: 0.0795 - val\_mse: 0.0795 - val\_mae: 0.247

5

Epoch 83/150

8/8 [=====] - 0s 8ms/step - loss: 0.0109 - mse:  
0.0109 - mae: 0.0557 - val\_loss: 0.0676 - val\_mse: 0.0676 - val\_mae: 0.224

7

Epoch 84/150

8/8 [=====] - 0s 8ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0551 - val\_loss: 0.0763 - val\_mse: 0.0763 - val\_mae: 0.242

0

Epoch 85/150

8/8 [=====] - 0s 9ms/step - loss: 0.0101 - mse:  
0.0101 - mae: 0.0536 - val\_loss: 0.0671 - val\_mse: 0.0671 - val\_mae: 0.223

2

Epoch 86/150

8/8 [=====] - 0s 9ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0559 - val\_loss: 0.0757 - val\_mse: 0.0757 - val\_mae: 0.240

5

Epoch 87/150

8/8 [=====] - 0s 8ms/step - loss: 0.0106 - mse:  
0.0106 - mae: 0.0550 - val\_loss: 0.0710 - val\_mse: 0.0710 - val\_mae: 0.230

9

Epoch 88/150

8/8 [=====] - 0s 8ms/step - loss: 0.0102 - mse:  
0.0102 - mae: 0.0539 - val\_loss: 0.0830 - val\_mse: 0.0830 - val\_mae: 0.254

0

Epoch 89/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0106 - mse:  
0.0106 - mae: 0.0548 - val\_loss: 0.0706 - val\_mse: 0.0706 - val\_mae: 0.230  
7

Epoch 90/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0103 - mse:  
0.0103 - mae: 0.0539 - val\_loss: 0.0818 - val\_mse: 0.0818 - val\_mae: 0.252  
0

Epoch 91/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0104 - mse:  
0.0104 - mae: 0.0543 - val\_loss: 0.0671 - val\_mse: 0.0671 - val\_mae: 0.223  
1

Epoch 92/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0107 - mse:  
0.0107 - mae: 0.0555 - val\_loss: 0.0801 - val\_mse: 0.0801 - val\_mae: 0.249  
1

Epoch 93/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0103 - mse:  
0.0103 - mae: 0.0547 - val\_loss: 0.0745 - val\_mse: 0.0745 - val\_mae: 0.238  
4

Epoch 94/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0103 - mse:  
0.0103 - mae: 0.0536 - val\_loss: 0.0731 - val\_mse: 0.0731 - val\_mae: 0.235  
3

Epoch 95/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0101 - mse:  
0.0101 - mae: 0.0529 - val\_loss: 0.0744 - val\_mse: 0.0744 - val\_mae: 0.237  
8

Epoch 96/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0099 - mse:  
0.0099 - mae: 0.0528 - val\_loss: 0.0778 - val\_mse: 0.0778 - val\_mae: 0.244  
2

Epoch 97/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0102 - mse:  
0.0102 - mae: 0.0540 - val\_loss: 0.0763 - val\_mse: 0.0763 - val\_mae: 0.241  
2

Epoch 98/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0102 - mse:  
0.0102 - mae: 0.0531 - val\_loss: 0.0743 - val\_mse: 0.0743 - val\_mae: 0.237  
9

Epoch 99/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0095 - mse:  
0.0095 - mae: 0.0510 - val\_loss: 0.0744 - val\_mse: 0.0744 - val\_mae: 0.238  
5

Epoch 100/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0101 - mse:  
0.0101 - mae: 0.0533 - val\_loss: 0.0769 - val\_mse: 0.0769 - val\_mae: 0.242  
4

Epoch 101/150  
8/8 [=====] - 0s 17ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0529 - val\_loss: 0.0730 - val\_mse: 0.0730 - val\_mae: 0.234  
8

Epoch 102/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0528 - val\_loss: 0.0720 - val\_mse: 0.0720 - val\_mae: 0.232  
6

Epoch 103/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0104 - mse:  
0.0104 - mae: 0.0538 - val\_loss: 0.0845 - val\_mse: 0.0845 - val\_mae: 0.257  
1

Epoch 104/150

8/8 [=====] - 0s 8ms/step - loss: 0.0103 - mse:  
0.0103 - mae: 0.0541 - val\_loss: 0.0677 - val\_mse: 0.0677 - val\_mae: 0.224  
3  
Epoch 105/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0099 - mse:  
0.0099 - mae: 0.0525 - val\_loss: 0.0868 - val\_mse: 0.0868 - val\_mae: 0.260  
6  
Epoch 106/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0109 - mse:  
0.0109 - mae: 0.0563 - val\_loss: 0.0662 - val\_mse: 0.0662 - val\_mae: 0.220  
6  
Epoch 107/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0104 - mse:  
0.0104 - mae: 0.0548 - val\_loss: 0.0810 - val\_mse: 0.0810 - val\_mae: 0.250  
1  
Epoch 108/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0546 - val\_loss: 0.0664 - val\_mse: 0.0664 - val\_mae: 0.221  
9  
Epoch 109/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0099 - mse:  
0.0099 - mae: 0.0528 - val\_loss: 0.0802 - val\_mse: 0.0802 - val\_mae: 0.248  
8  
Epoch 110/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0522 - val\_loss: 0.0710 - val\_mse: 0.0710 - val\_mae: 0.230  
4  
Epoch 111/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0099 - mse:  
0.0099 - mae: 0.0530 - val\_loss: 0.0730 - val\_mse: 0.0730 - val\_mae: 0.235  
2  
Epoch 112/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0099 - mse:  
0.0099 - mae: 0.0530 - val\_loss: 0.0716 - val\_mse: 0.0716 - val\_mae: 0.232  
3  
Epoch 113/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0097 - mse:  
0.0097 - mae: 0.0524 - val\_loss: 0.0774 - val\_mse: 0.0774 - val\_mae: 0.243  
9  
Epoch 114/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0529 - val\_loss: 0.0725 - val\_mse: 0.0725 - val\_mae: 0.234  
3  
Epoch 115/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0529 - val\_loss: 0.0732 - val\_mse: 0.0732 - val\_mae: 0.235  
3  
Epoch 116/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0096 - mse:  
0.0096 - mae: 0.0519 - val\_loss: 0.0698 - val\_mse: 0.0698 - val\_mae: 0.228  
9  
Epoch 117/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0525 - val\_loss: 0.0745 - val\_mse: 0.0745 - val\_mae: 0.238  
0  
Epoch 118/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0538 - val\_loss: 0.0684 - val\_mse: 0.0684 - val\_mae: 0.226  
9  
Epoch 119/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0097 - mse:



0.0097 - mae: 0.0525 - val\_loss: 0.0750 - val\_mse: 0.0750 - val\_mae: 0.239  
4  
Epoch 120/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0526 - val\_loss: 0.0705 - val\_mse: 0.0705 - val\_mae: 0.230  
3  
Epoch 121/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0097 - mse:  
0.0097 - mae: 0.0525 - val\_loss: 0.0767 - val\_mse: 0.0767 - val\_mae: 0.241  
8  
Epoch 122/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0533 - val\_loss: 0.0692 - val\_mse: 0.0692 - val\_mae: 0.227  
3  
Epoch 123/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0532 - val\_loss: 0.0754 - val\_mse: 0.0754 - val\_mae: 0.239  
8  
Epoch 124/150  
8/8 [=====] - 0s 18ms/step - loss: 0.0095 - mse:  
0.0095 - mae: 0.0515 - val\_loss: 0.0701 - val\_mse: 0.0701 - val\_mae: 0.229  
5  
Epoch 125/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0098 - mse:  
0.0098 - mae: 0.0532 - val\_loss: 0.0736 - val\_mse: 0.0736 - val\_mae: 0.236  
8  
Epoch 126/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0097 - mse:  
0.0097 - mae: 0.0530 - val\_loss: 0.0729 - val\_mse: 0.0729 - val\_mae: 0.235  
4  
Epoch 127/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0095 - mse:  
0.0095 - mae: 0.0522 - val\_loss: 0.0701 - val\_mse: 0.0701 - val\_mae: 0.229  
1  
Epoch 128/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0093 - mse:  
0.0093 - mae: 0.0514 - val\_loss: 0.0765 - val\_mse: 0.0765 - val\_mae: 0.242  
0  
Epoch 129/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0094 - mse:  
0.0094 - mae: 0.0518 - val\_loss: 0.0663 - val\_mse: 0.0663 - val\_mae: 0.222  
1  
Epoch 130/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0095 - mse:  
0.0095 - mae: 0.0514 - val\_loss: 0.0765 - val\_mse: 0.0765 - val\_mae: 0.241  
8  
Epoch 131/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0100 - mse:  
0.0100 - mae: 0.0533 - val\_loss: 0.0688 - val\_mse: 0.0688 - val\_mae: 0.227  
4  
Epoch 132/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0096 - mse:  
0.0096 - mae: 0.0528 - val\_loss: 0.0707 - val\_mse: 0.0707 - val\_mae: 0.231  
3  
Epoch 133/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0093 - mse:  
0.0093 - mae: 0.0518 - val\_loss: 0.0722 - val\_mse: 0.0722 - val\_mae: 0.234  
0  
Epoch 134/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0094 - mse:  
0.0094 - mae: 0.0515 - val\_loss: 0.0700 - val\_mse: 0.0700 - val\_mae: 0.229

3  
Epoch 135/150  
8/8 [=====] - 0s 8ms/step - loss: 0.0091 - mse:  
0.0091 - mae: 0.0508 - val\_loss: 0.0680 - val\_mse: 0.0680 - val\_mae: 0.226  
2  
Epoch 136/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0090 - mse:  
0.0090 - mae: 0.0509 - val\_loss: 0.0672 - val\_mse: 0.0672 - val\_mae: 0.224  
4  
Epoch 137/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0091 - mse:  
0.0091 - mae: 0.0509 - val\_loss: 0.0698 - val\_mse: 0.0698 - val\_mae: 0.229  
4  
Epoch 138/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0094 - mse:  
0.0094 - mae: 0.0523 - val\_loss: 0.0704 - val\_mse: 0.0704 - val\_mae: 0.230  
9  
Epoch 139/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0091 - mse:  
0.0091 - mae: 0.0518 - val\_loss: 0.0696 - val\_mse: 0.0696 - val\_mae: 0.229  
3  
Epoch 140/150  
8/8 [=====] - 0s 10ms/step - loss: 0.0093 - mse:  
0.0093 - mae: 0.0516 - val\_loss: 0.0685 - val\_mse: 0.0685 - val\_mae: 0.227  
0  
Epoch 141/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0089 - mse:  
0.0089 - mae: 0.0502 - val\_loss: 0.0692 - val\_mse: 0.0692 - val\_mae: 0.228  
3  
Epoch 142/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0090 - mse:  
0.0090 - mae: 0.0509 - val\_loss: 0.0715 - val\_mse: 0.0715 - val\_mae: 0.232  
7  
Epoch 143/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0087 - mse:  
0.0087 - mae: 0.0501 - val\_loss: 0.0690 - val\_mse: 0.0690 - val\_mae: 0.228  
0  
Epoch 144/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0089 - mse:  
0.0089 - mae: 0.0504 - val\_loss: 0.0748 - val\_mse: 0.0748 - val\_mae: 0.238  
9  
Epoch 145/150  
8/8 [=====] - 0s 12ms/step - loss: 0.0087 - mse:  
0.0087 - mae: 0.0500 - val\_loss: 0.0658 - val\_mse: 0.0658 - val\_mae: 0.222  
0  
Epoch 146/150  
8/8 [=====] - 0s 25ms/step - loss: 0.0088 - mse:  
0.0088 - mae: 0.0501 - val\_loss: 0.0767 - val\_mse: 0.0767 - val\_mae: 0.242  
9  
Epoch 147/150  
8/8 [=====] - 0s 11ms/step - loss: 0.0085 - mse:  
0.0085 - mae: 0.0498 - val\_loss: 0.0774 - val\_mse: 0.0774 - val\_mae: 0.243  
7  
Epoch 148/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0085 - mse:  
0.0085 - mae: 0.0499 - val\_loss: 0.0649 - val\_mse: 0.0649 - val\_mae: 0.219  
4  
Epoch 149/150  
8/8 [=====] - 0s 9ms/step - loss: 0.0087 - mse:  
0.0087 - mae: 0.0506 - val\_loss: 0.0740 - val\_mse: 0.0740 - val\_mae: 0.237  
6

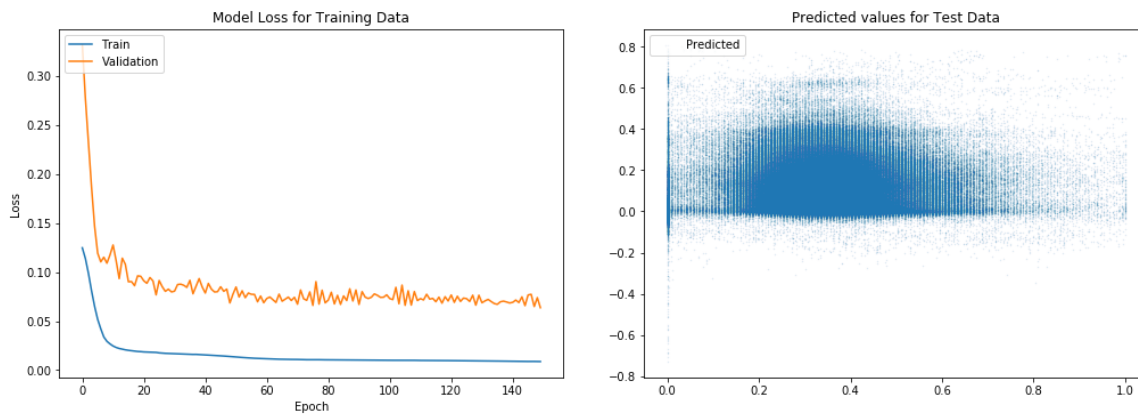
Epoch 150/150

8/8 [=====] - 0s 11ms/step - loss: 0.0087 - mse:  
0.0087 - mae: 0.0505 - val\_loss: 0.0637 - val\_mse: 0.0637 - val\_mae: 0.217  
9

In [33]:

```
visualise_performance(model,history,xtest,ypredicted)
```

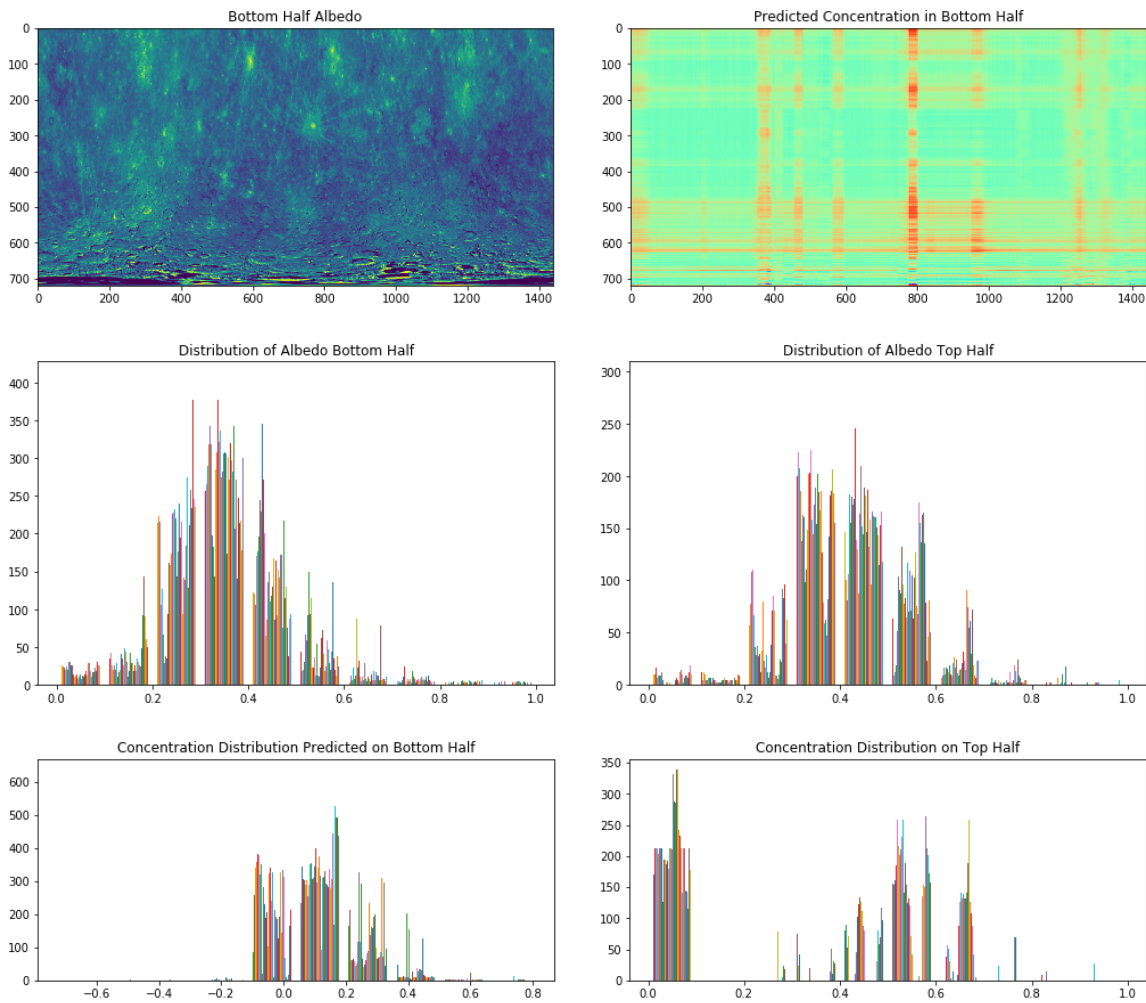
```
dict_keys(['loss', 'mse', 'mae', 'val_loss', 'val_mse', 'val_mae'])
```



The loss for validation and training is a decreasing curve but highly noisy and fluctuating depicting poor performance of the deep learning model.

In [34]:

```
visualise_predictions(xtest,ypredicted)
```



MgSi Map

In [35]:

```
df = correlation_matrix(albedo_top_half, mgsimap)
```

Correlation between the Albedo and Concentration Map

	albedo	concentration
albedo	1.000000	0.084904
concentration	0.084904	1.000000

Summary of the data

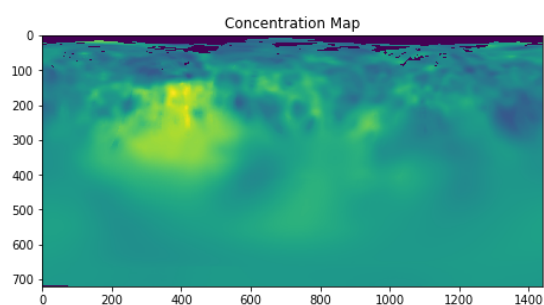
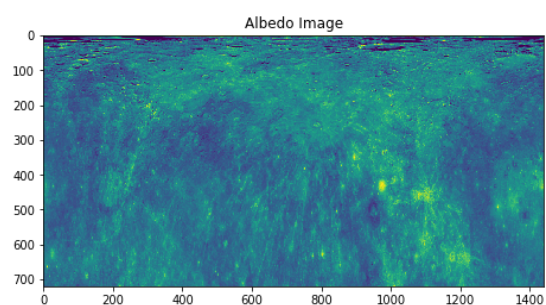
	albedo	concentration
count	1.036800e+06	1.036800e+06
mean	4.144590e-01	5.303197e-01
std	1.165033e-01	1.432387e-01
min	0.000000e+00	0.000000e+00
25%	3.372549e-01	4.980392e-01
50%	4.039216e-01	5.411765e-01
75%	4.862745e-01	5.803922e-01
max	1.000000e+00	1.000000e+00

Observation: Here we observe there is no linear correlation between the data of albedo and concentration map before the outlier removal

In [36]:

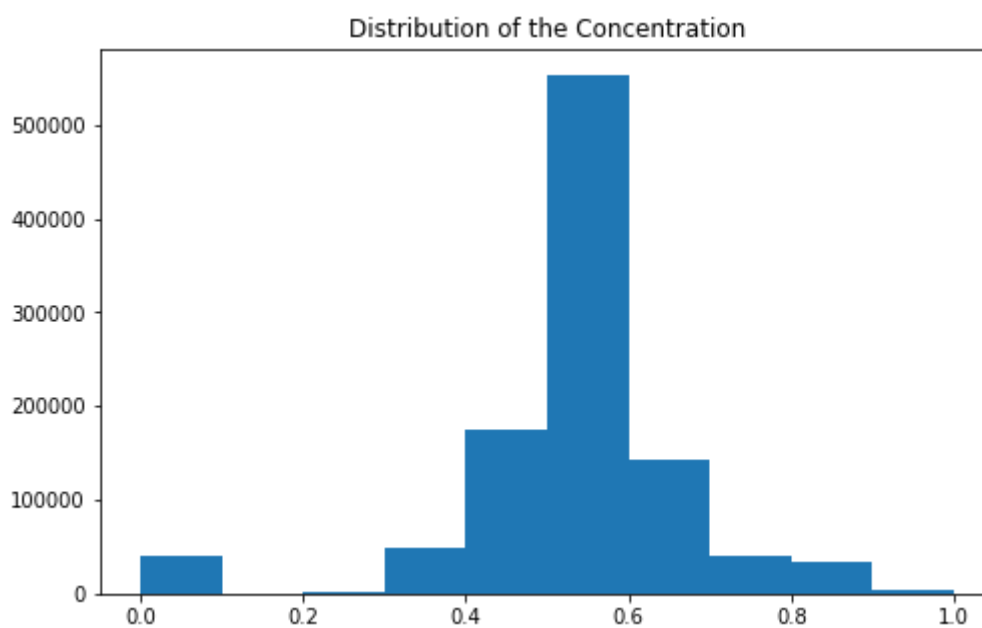
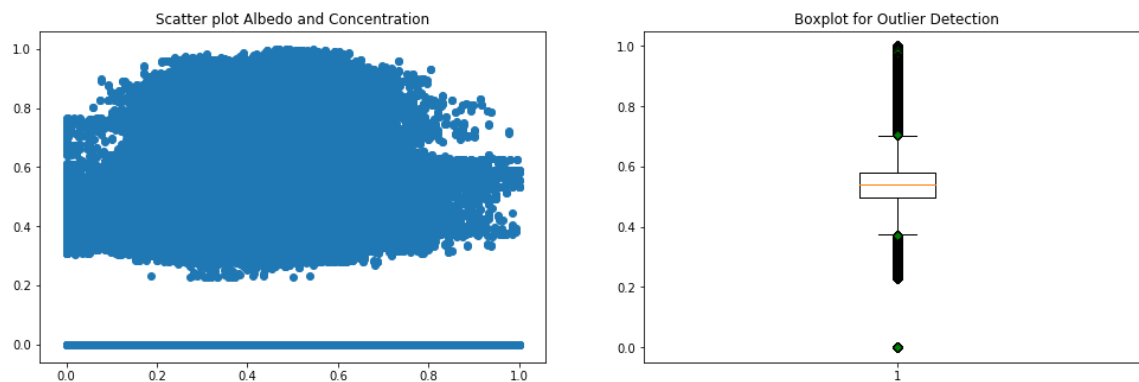
```
ytrain, xtrain, xtest = test_data(mgsimap)
```

(720, 1440)



In [37]:

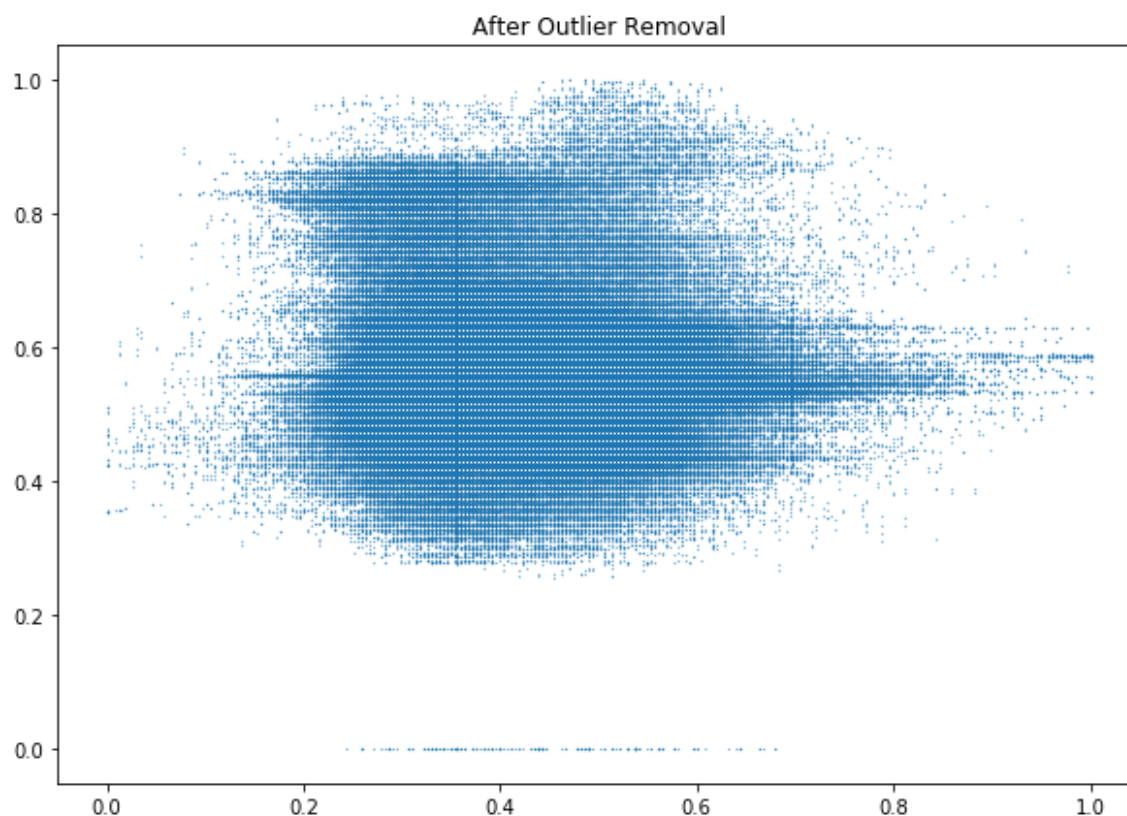
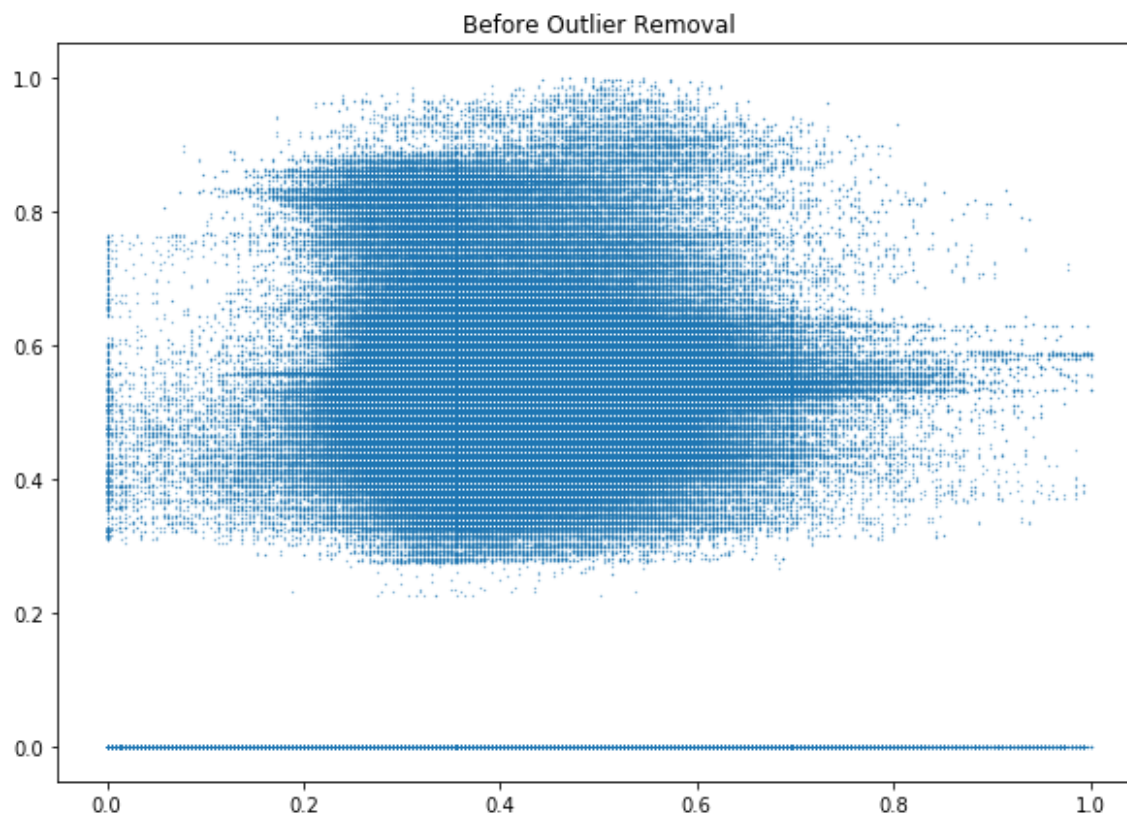
```
outlier_plots(df)
```



Observation: We see significant amount of outlier presence and observe the gaps in data through scatter plot and through histogram we observe a continuous data flow from 0.2 to 1.0 while there is some distribution near 0.0 which can create discontinuity in predictions as well.

In [38]:

```
xtrain, ytrain, shape = outlier_detection(xtrain, ytrain, 0.18)
```



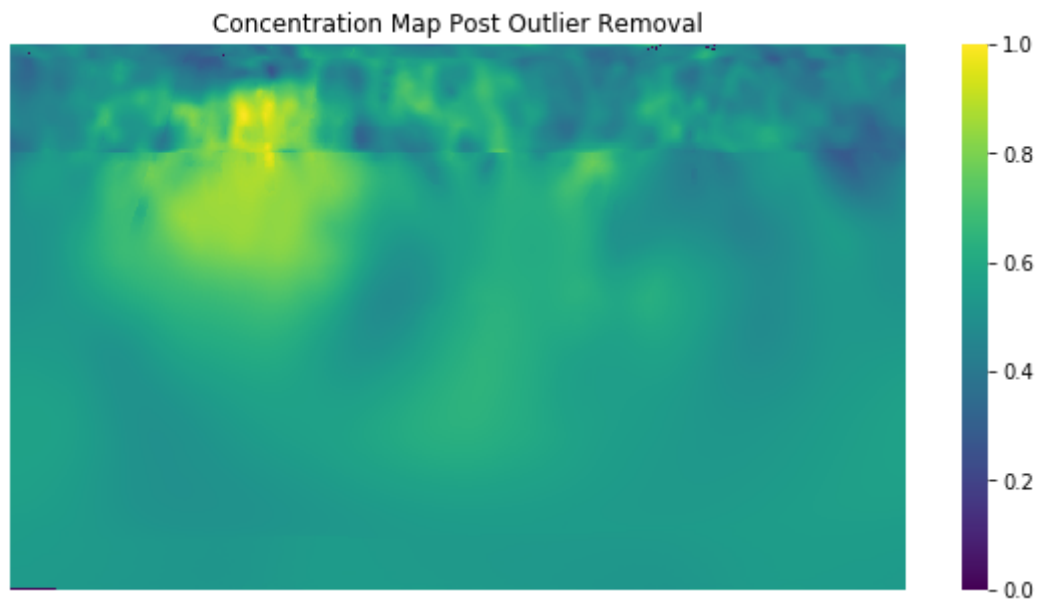
(590, 1440)

```
{'behaviour': 'deprecated', 'bootstrap': False, 'contamination': 0.18, 'max_features': 1.0, 'max_samples': 'auto', 'n_estimators': 100, 'n_jobs': None, 'random_state': None, 'verbose': 0, 'warm_start': False}
```

We observe a decent performance of Isolation Forest Outlier Removal Algorithm in case of MgSi Map. The gaps are completely removed.

In [39]:

```
visualise_maps(ytrain)
```





In [40]:

```
history,model,ypredicted = model_application(xtrain, xtest, ytrain)
```

Model: "sequential\_3"

Layer (type)	Output Shape	Param #
dense_9 (Dense)	(None, 32)	46112
dense_10 (Dense)	(None, 16)	528
dense_11 (Dense)	(None, 1440)	24480

Total params: 71,120

Trainable params: 71,120

Non-trainable params: 0

Epoch 1/150

10/10 [=====] - 1s 24ms/step - loss: 0.3136 - mse: 0.3136 - mae: 0.5411 - val\_loss: 0.1791 - val\_mse: 0.1791 - val\_mae: 0.3543

Epoch 2/150

10/10 [=====] - 0s 10ms/step - loss: 0.1715 - mse: 0.1715 - mae: 0.3353 - val\_loss: 0.0576 - val\_mse: 0.0576 - val\_mae: 0.1770

Epoch 3/150

10/10 [=====] - 0s 10ms/step - loss: 0.0565 - mse: 0.0565 - mae: 0.1713 - val\_loss: 0.0180 - val\_mse: 0.0180 - val\_mae: 0.0990

Epoch 4/150

10/10 [=====] - 0s 7ms/step - loss: 0.0201 - mse: 0.0201 - mae: 0.1036 - val\_loss: 0.0099 - val\_mse: 0.0099 - val\_mae: 0.0770

Epoch 5/150

10/10 [=====] - 0s 9ms/step - loss: 0.0114 - mse: 0.0114 - mae: 0.0810 - val\_loss: 0.0063 - val\_mse: 0.0063 - val\_mae: 0.0616

Epoch 6/150

10/10 [=====] - 0s 9ms/step - loss: 0.0081 - mse: 0.0081 - mae: 0.0686 - val\_loss: 0.0051 - val\_mse: 0.0051 - val\_mae: 0.0562

Epoch 7/150

10/10 [=====] - 0s 8ms/step - loss: 0.0071 - mse: 0.0071 - mae: 0.0651 - val\_loss: 0.0050 - val\_mse: 0.0050 - val\_mae: 0.0548

Epoch 8/150

10/10 [=====] - 0s 6ms/step - loss: 0.0064 - mse: 0.0064 - mae: 0.0614 - val\_loss: 0.0049 - val\_mse: 0.0049 - val\_mae: 0.0542

Epoch 9/150

10/10 [=====] - 0s 10ms/step - loss: 0.0061 - mse: 0.0061 - mae: 0.0610 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.0566

Epoch 10/150

10/10 [=====] - 0s 8ms/step - loss: 0.0058 - mse: 0.0058 - mae: 0.0593 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0566

Epoch 11/150

10/10 [=====] - 0s 10ms/step - loss: 0.0057 - mse: 0.0057 - mae: 0.0582 - val\_loss: 0.0051 - val\_mse: 0.0051 - val\_mae: 0.0568

Epoch 12/150

10/10 [=====] - 0s 21ms/step - loss: 0.0056 - mse: 0.0056 - mae: 0.0582 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.

0568

Epoch 13/150

10/10 [=====] - 0s 6ms/step - loss: 0.0054 - mse: 0.0054 - mae: 0.0576 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0570

Epoch 14/150

10/10 [=====] - 0s 8ms/step - loss: 0.0055 - mse: 0.0055 - mae: 0.0578 - val\_loss: 0.0052 - val\_mse: 0.0052 - val\_mae: 0.0575

Epoch 15/150

10/10 [=====] - 0s 6ms/step - loss: 0.0054 - mse: 0.0054 - mae: 0.0577 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0572

Epoch 16/150

10/10 [=====] - 0s 9ms/step - loss: 0.0054 - mse: 0.0054 - mae: 0.0572 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0585

Epoch 17/150

10/10 [=====] - 0s 10ms/step - loss: 0.0053 - mse: 0.0053 - mae: 0.0573 - val\_loss: 0.0058 - val\_mse: 0.0058 - val\_mae: 0.0582

Epoch 18/150

10/10 [=====] - 0s 11ms/step - loss: 0.0054 - mse: 0.0054 - mae: 0.0572 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.0577

Epoch 19/150

10/10 [=====] - 0s 9ms/step - loss: 0.0050 - mse: 0.0050 - mae: 0.0552 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0583

Epoch 20/150

10/10 [=====] - 0s 7ms/step - loss: 0.0050 - mse: 0.0050 - mae: 0.0551 - val\_loss: 0.0057 - val\_mse: 0.0057 - val\_mae: 0.0581

Epoch 21/150

10/10 [=====] - 0s 8ms/step - loss: 0.0051 - mse: 0.0051 - mae: 0.0559 - val\_loss: 0.0054 - val\_mse: 0.0054 - val\_mae: 0.0591

Epoch 22/150

10/10 [=====] - 0s 8ms/step - loss: 0.0049 - mse: 0.0049 - mae: 0.0547 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.0578

Epoch 23/150

10/10 [=====] - 0s 8ms/step - loss: 0.0050 - mse: 0.0050 - mae: 0.0556 - val\_loss: 0.0055 - val\_mse: 0.0055 - val\_mae: 0.0583

Epoch 24/150

10/10 [=====] - 0s 7ms/step - loss: 0.0047 - mse: 0.0047 - mae: 0.0535 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.0582

Epoch 25/150

10/10 [=====] - 0s 8ms/step - loss: 0.0047 - mse: 0.0047 - mae: 0.0539 - val\_loss: 0.0056 - val\_mse: 0.0056 - val\_mae: 0.0605

Epoch 26/150

10/10 [=====] - 0s 8ms/step - loss: 0.0049 - mse: 0.0049 - mae: 0.0551 - val\_loss: 0.0057 - val\_mse: 0.0057 - val\_mae: 0.0581

Epoch 27/150

10/10 [=====] - 0s 10ms/step - loss: 0.0046 - mse: 0.0046 - mae: 0.0530 - val\_loss: 0.0052 - val\_mse: 0.0052 - val\_mae: 0.0584

Epoch 28/150  
10/10 [=====] - 0s 11ms/step - loss: 0.0047 - mse: 0.0047 - mae: 0.0536 - val\_loss: 0.0053 - val\_mse: 0.0053 - val\_mae: 0.0570

Epoch 29/150  
10/10 [=====] - 0s 11ms/step - loss: 0.0043 - mse: 0.0043 - mae: 0.0510 - val\_loss: 0.0051 - val\_mse: 0.0051 - val\_mae: 0.0573

Epoch 30/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0043 - mse: 0.0043 - mae: 0.0511 - val\_loss: 0.0051 - val\_mse: 0.0051 - val\_mae: 0.0566

Epoch 31/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0045 - mse: 0.0045 - mae: 0.0518 - val\_loss: 0.0049 - val\_mse: 0.0049 - val\_mae: 0.0558

Epoch 32/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0042 - mse: 0.0042 - mae: 0.0505 - val\_loss: 0.0050 - val\_mse: 0.0050 - val\_mae: 0.0570

Epoch 33/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0042 - mse: 0.0042 - mae: 0.0500 - val\_loss: 0.0047 - val\_mse: 0.0047 - val\_mae: 0.0546

Epoch 34/150  
10/10 [=====] - 0s 13ms/step - loss: 0.0041 - mse: 0.0041 - mae: 0.0491 - val\_loss: 0.0048 - val\_mse: 0.0048 - val\_mae: 0.0546

Epoch 35/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0038 - mse: 0.0038 - mae: 0.0467 - val\_loss: 0.0044 - val\_mse: 0.0044 - val\_mae: 0.0528

Epoch 36/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0036 - mse: 0.0036 - mae: 0.0456 - val\_loss: 0.0043 - val\_mse: 0.0043 - val\_mae: 0.0520

Epoch 37/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0034 - mse: 0.0034 - mae: 0.0445 - val\_loss: 0.0040 - val\_mse: 0.0040 - val\_mae: 0.0503

Epoch 38/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0033 - mse: 0.0033 - mae: 0.0432 - val\_loss: 0.0043 - val\_mse: 0.0043 - val\_mae: 0.0524

Epoch 39/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0033 - mse: 0.0033 - mae: 0.0433 - val\_loss: 0.0037 - val\_mse: 0.0037 - val\_mae: 0.0478

Epoch 40/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0031 - mse: 0.0031 - mae: 0.0414 - val\_loss: 0.0039 - val\_mse: 0.0039 - val\_mae: 0.0495

Epoch 41/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0030 - mse: 0.0030 - mae: 0.0406 - val\_loss: 0.0038 - val\_mse: 0.0038 - val\_mae: 0.0483

Epoch 42/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0028 - mse: 0.0028 - mae: 0.0392 - val\_loss: 0.0035 - val\_mse: 0.0035 - val\_mae: 0.0472

Epoch 43/150

10/10 [=====] - 0s 7ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0384 - val\_loss: 0.0036 - val\_mse: 0.0036 - val\_mae: 0.046  
7  
Epoch 44/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0027 - mse:  
0.0027 - mae: 0.0382 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_mae: 0.044  
6  
Epoch 45/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0028 - mse:  
0.0028 - mae: 0.0383 - val\_loss: 0.0033 - val\_mse: 0.0033 - val\_mae: 0.045  
7  
Epoch 46/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0025 - mse:  
0.0025 - mae: 0.0364 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_mae: 0.046  
0  
Epoch 47/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0025 - mse:  
0.0025 - mae: 0.0364 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.043  
7  
Epoch 48/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0024 - ms  
e: 0.0024 - mae: 0.0355 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.  
0433  
Epoch 49/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0026 - ms  
e: 0.0026 - mae: 0.0368 - val\_loss: 0.0033 - val\_mse: 0.0033 - val\_mae: 0.  
0447  
Epoch 50/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0025 - mse:  
0.0025 - mae: 0.0359 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.042  
3  
Epoch 51/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0024 - mse:  
0.0024 - mae: 0.0351 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.042  
5  
Epoch 52/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0021 - mse:  
0.0021 - mae: 0.0332 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.041  
4  
Epoch 53/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0023 - mse:  
0.0023 - mae: 0.0346 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.043  
9  
Epoch 54/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0023 - mse:  
0.0023 - mae: 0.0349 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.043  
2  
Epoch 55/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0023 - mse:  
0.0023 - mae: 0.0348 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
5  
Epoch 56/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0022 - mse:  
0.0022 - mae: 0.0333 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.041  
5  
Epoch 57/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0022 - ms  
e: 0.0022 - mae: 0.0335 - val\_loss: 0.0025 - val\_mse: 0.0025 - val\_mae: 0.  
0397  
Epoch 58/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0022 - mse:

0.0022 - mae: 0.0338 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0408  
Epoch 59/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0022 - mse: 0.0022 - mae: 0.0338 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0414  
Epoch 60/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0022 - mse: 0.0022 - mae: 0.0334 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0423  
Epoch 61/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0022 - mse: 0.0022 - mae: 0.0331 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0422  
Epoch 62/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0323 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0416  
Epoch 63/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0323 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0411  
Epoch 64/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0324 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0404  
Epoch 65/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0021 - mse: 0.0021 - mae: 0.0326 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0399  
Epoch 66/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0021 - mse: 0.0021 - mae: 0.0323 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0409  
Epoch 67/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0311 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0409  
Epoch 68/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0319 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0405  
Epoch 69/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0311 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0405  
Epoch 70/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0313 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0418  
Epoch 71/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0320 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0423  
Epoch 72/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0310 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0404  
Epoch 73/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0311 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.040

9

Epoch 74/150

10/10 [=====] - 0s 7ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0310 - val\_loss: 0.0025 - val\_mse: 0.0025 - val\_mae: 0.0398

Epoch 75/150

10/10 [=====] - 0s 8ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0310 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0404

Epoch 76/150

10/10 [=====] - 0s 10ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0321 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0406

Epoch 77/150

10/10 [=====] - 0s 10ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0314 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0411

Epoch 78/150

10/10 [=====] - 0s 10ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0316 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0401

Epoch 79/150

10/10 [=====] - 0s 15ms/step - loss: 0.0020 - mse: 0.0020 - mae: 0.0320 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0408

Epoch 80/150

10/10 [=====] - 0s 7ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0307 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0408

Epoch 81/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0299 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0409

Epoch 82/150

10/10 [=====] - 0s 7ms/step - loss: 0.0019 - mse: 0.0019 - mae: 0.0314 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0408

Epoch 83/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0298 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0421

Epoch 84/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0307 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0410

Epoch 85/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0307 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.0405

Epoch 86/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0302 - val\_loss: 0.0025 - val\_mse: 0.0025 - val\_mae: 0.0399

Epoch 87/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0305 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0414

Epoch 88/150

10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse: 0.0018 - mae: 0.0302 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0408

Epoch 89/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse:  
0.0018 - mae: 0.0301 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.040  
8

Epoch 90/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse:  
0.0018 - mae: 0.0306 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.041  
0

Epoch 91/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0017 - mse:  
0.0017 - mae: 0.0296 - val\_loss: 0.0026 - val\_mse: 0.0026 - val\_mae: 0.040  
8

Epoch 92/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0018 - mse:  
0.0018 - mae: 0.0304 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
5

Epoch 93/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0018 - mse:  
0.0018 - mae: 0.0307 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
1

Epoch 94/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0017 - mse:  
0.0017 - mae: 0.0290 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.042  
1

Epoch 95/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0287 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.042  
2

Epoch 96/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0289 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
7

Epoch 97/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0285 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
6

Epoch 98/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0285 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
7

Epoch 99/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0284 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
5

Epoch 100/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0287 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
6

Epoch 101/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0016 - ms  
e: 0.0016 - mae: 0.0286 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.  
0420

Epoch 102/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0281 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.041  
7

Epoch 103/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0016 - mse:  
0.0016 - mae: 0.0285 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.042  
1

Epoch 104/150



10/10 [=====] - 0s 7ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0267 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0426  
Epoch 105/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0015 - mse: 0.0015 - mae: 0.0273 - val\_loss: 0.0027 - val\_mse: 0.0027 - val\_mae: 0.0414  
Epoch 106/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0015 - mse: 0.0015 - mae: 0.0276 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0425  
Epoch 107/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0268 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.0433  
Epoch 108/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0271 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0436  
Epoch 109/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0259 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0438  
Epoch 110/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0014 - mse: 0.0014 - mae: 0.0268 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.0434  
Epoch 111/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0256 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0428  
Epoch 112/150  
10/10 [=====] - 0s 11ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0255 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0424  
Epoch 113/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0258 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0424  
Epoch 114/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0251 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0424  
Epoch 115/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0013 - mse: 0.0013 - mae: 0.0251 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0429  
Epoch 116/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0246 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0426  
Epoch 117/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0012 - mse: 0.0012 - mae: 0.0241 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0438  
Epoch 118/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0240 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_mae: 0.0444  
Epoch 119/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0012 - ms

e: 0.0012 - mae: 0.0243 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0443  
Epoch 120/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0237 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_mae: 0.0449  
Epoch 121/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0237 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0441  
Epoch 122/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0239 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0440  
Epoch 123/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0233 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0438  
Epoch 124/150  
10/10 [=====] - 0s 15ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0237 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_mae: 0.0451  
Epoch 125/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0234 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0425  
Epoch 126/150  
10/10 [=====] - 0s 12ms/step - loss: 0.0011 - mse: 0.0011 - mae: 0.0232 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.0431  
Epoch 127/150  
10/10 [=====] - 0s 8ms/step - loss: 9.9484e-04 - mse: 9.9484e-04 - mae: 0.0226 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.0432  
Epoch 128/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0010 - mse: 0.0010 - mae: 0.0227 - val\_loss: 0.0028 - val\_mse: 0.0028 - val\_mae: 0.0431  
Epoch 129/150  
10/10 [=====] - 0s 9ms/step - loss: 9.4097e-04 - mse: 9.4097e-04 - mae: 0.0218 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0441  
Epoch 130/150  
10/10 [=====] - 0s 10ms/step - loss: 9.6314e-04 - mse: 9.6314e-04 - mae: 0.0220 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_mae: 0.0454  
Epoch 131/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0010 - mse: 0.0010 - mae: 0.0224 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_mae: 0.0443  
Epoch 132/150  
10/10 [=====] - 0s 10ms/step - loss: 9.6681e-04 - mse: 9.6681e-04 - mae: 0.0221 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_mae: 0.0436  
Epoch 133/150  
10/10 [=====] - 0s 11ms/step - loss: 9.7222e-04 - mse: 9.7222e-04 - mae: 0.0222 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_mae: 0.0455  
Epoch 134/150  
10/10 [=====] - 0s 11ms/step - loss: 9.8650e-04 - mse: 9.8650e-04 - mae: 0.0222 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_m

ae: 0.0450  
Epoch 135/150  
10/10 [=====] - 0s 10ms/step - loss: 8.9928e-04 -  
mse: 8.9928e-04 - mae: 0.0212 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_m  
ae: 0.0448  
Epoch 136/150  
10/10 [=====] - 0s 10ms/step - loss: 9.3509e-04 -  
mse: 9.3509e-04 - mae: 0.0217 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0442  
Epoch 137/150  
10/10 [=====] - 0s 10ms/step - loss: 9.1907e-04 -  
mse: 9.1907e-04 - mae: 0.0214 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_m  
ae: 0.0454  
Epoch 138/150  
10/10 [=====] - 0s 11ms/step - loss: 8.6443e-04 -  
mse: 8.6443e-04 - mae: 0.0211 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0440  
Epoch 139/150  
10/10 [=====] - 0s 11ms/step - loss: 8.5666e-04 -  
mse: 8.5666e-04 - mae: 0.0209 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_m  
ae: 0.0432  
Epoch 140/150  
10/10 [=====] - 0s 10ms/step - loss: 9.3227e-04 -  
mse: 9.3227e-04 - mae: 0.0218 - val\_loss: 0.0032 - val\_mse: 0.0032 - val\_m  
ae: 0.0452  
Epoch 141/150  
10/10 [=====] - 0s 10ms/step - loss: 8.7571e-04 -  
mse: 8.7571e-04 - mae: 0.0210 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0442  
Epoch 142/150  
10/10 [=====] - 0s 11ms/step - loss: 8.1374e-04 -  
mse: 8.1374e-04 - mae: 0.0203 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0437  
Epoch 143/150  
10/10 [=====] - 0s 10ms/step - loss: 8.5376e-04 -  
mse: 8.5376e-04 - mae: 0.0208 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_m  
ae: 0.0438  
Epoch 144/150  
10/10 [=====] - 0s 9ms/step - loss: 8.4769e-04 -  
mse: 8.4769e-04 - mae: 0.0207 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0442  
Epoch 145/150  
10/10 [=====] - 0s 11ms/step - loss: 8.4837e-04 -  
mse: 8.4837e-04 - mae: 0.0207 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_m  
ae: 0.0452  
Epoch 146/150  
10/10 [=====] - 0s 20ms/step - loss: 8.2519e-04 -  
mse: 8.2519e-04 - mae: 0.0202 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0443  
Epoch 147/150  
10/10 [=====] - 0s 11ms/step - loss: 8.1077e-04 -  
mse: 8.1077e-04 - mae: 0.0203 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0440  
Epoch 148/150  
10/10 [=====] - 0s 13ms/step - loss: 8.0820e-04 -  
mse: 8.0820e-04 - mae: 0.0202 - val\_loss: 0.0029 - val\_mse: 0.0029 - val\_m  
ae: 0.0435  
Epoch 149/150  
10/10 [=====] - 0s 11ms/step - loss: 7.5684e-04 -  
mse: 7.5684e-04 - mae: 0.0195 - val\_loss: 0.0030 - val\_mse: 0.0030 - val\_m  
ae: 0.0439

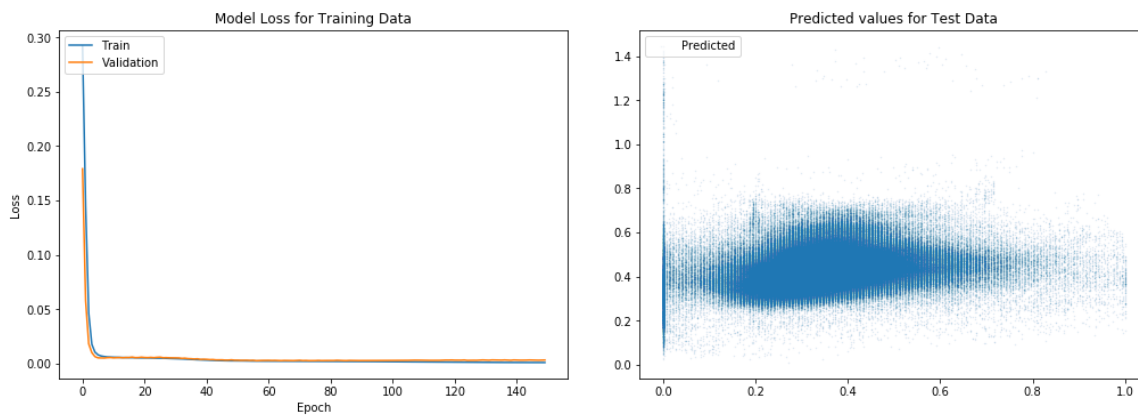
Epoch 150/150

10/10 [=====] - 0s 11ms/step - loss: 8.0863e-04 -  
mse: 8.0863e-04 - mae: 0.0202 - val\_loss: 0.0031 - val\_mse: 0.0031 - val\_mae: 0.0449

In [41]:

```
visualise_performance(model,history,xtest,ypredicted)
```

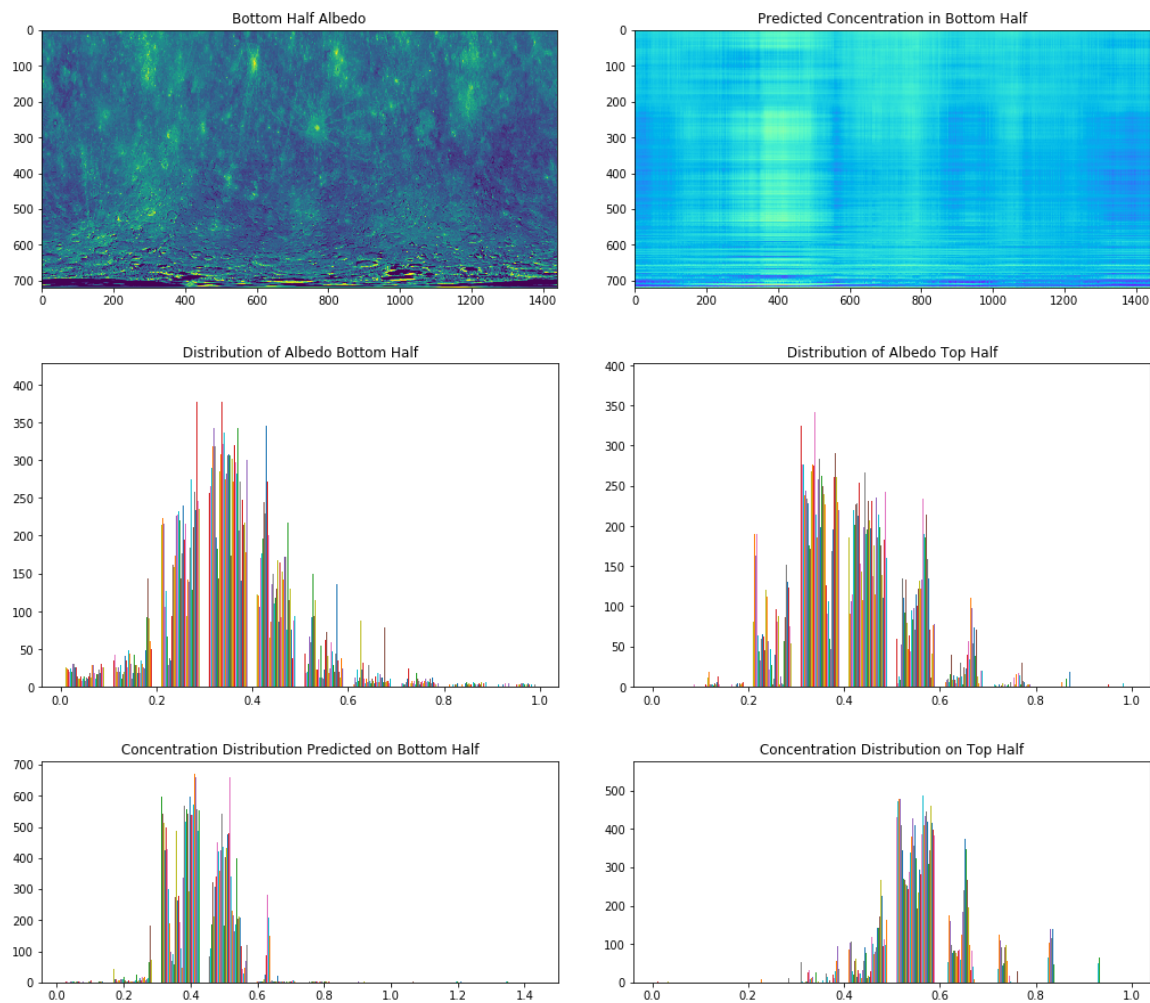
```
dict_keys(['loss', 'mse', 'mae', 'val_loss', 'val_mse', 'val_mae'])
```



The loss for validation and training is fairly less and generates a steeply decreasing curve. Overfitting could be an issue here as there is flatness in the graph.

In [42]:

```
visualise_predictions(xtest,ypredicted)
```



Ssi Map

In [43]:

```
df = correlation_matrix(albedo_top_half,ssimap)
```

Correlation between the Albedo and Concentration Map

	albedo	concentration
albedo	1.00000	-0.02485
concentration	-0.02485	1.00000

Summary of the data

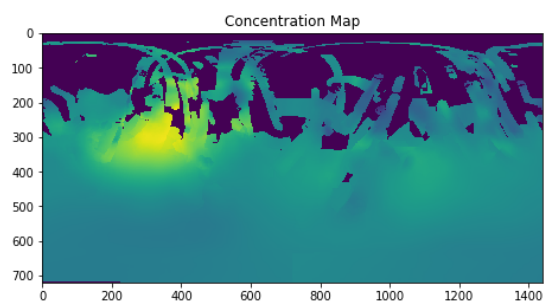
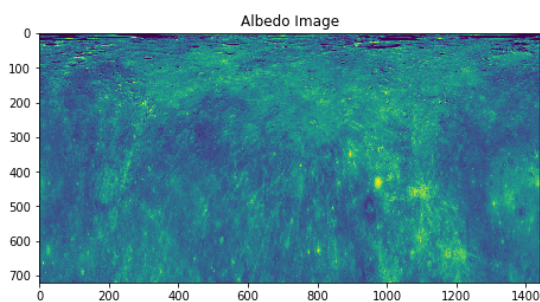
	albedo	concentration
count	1.036800e+06	1.036800e+06
mean	4.144590e-01	3.859588e-01
std	1.165033e-01	2.304556e-01
min	0.000000e+00	0.000000e+00
25%	3.372549e-01	3.529412e-01
50%	4.039216e-01	4.509804e-01
75%	4.862745e-01	5.098040e-01
max	1.000000e+00	1.000000e+00

Observation: Here we observe there is no linear correlation between the data of albedo and concentration map before the outlier removal

In [44]:

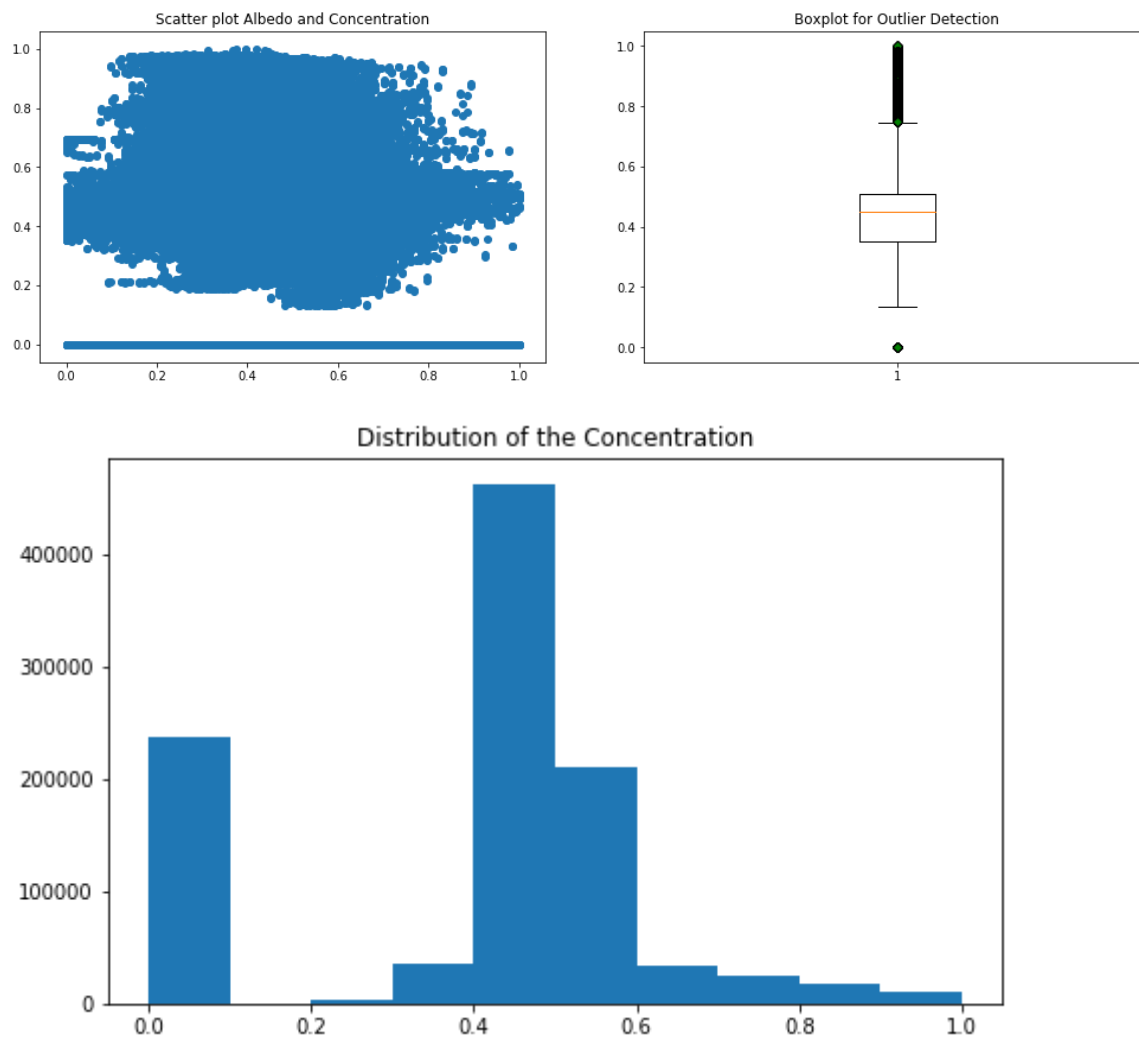
```
ytrain , xtrain , xtest = test_data(ssimap)
```

(720, 1440)



In [45]:

```
outlier_plots(df)
```



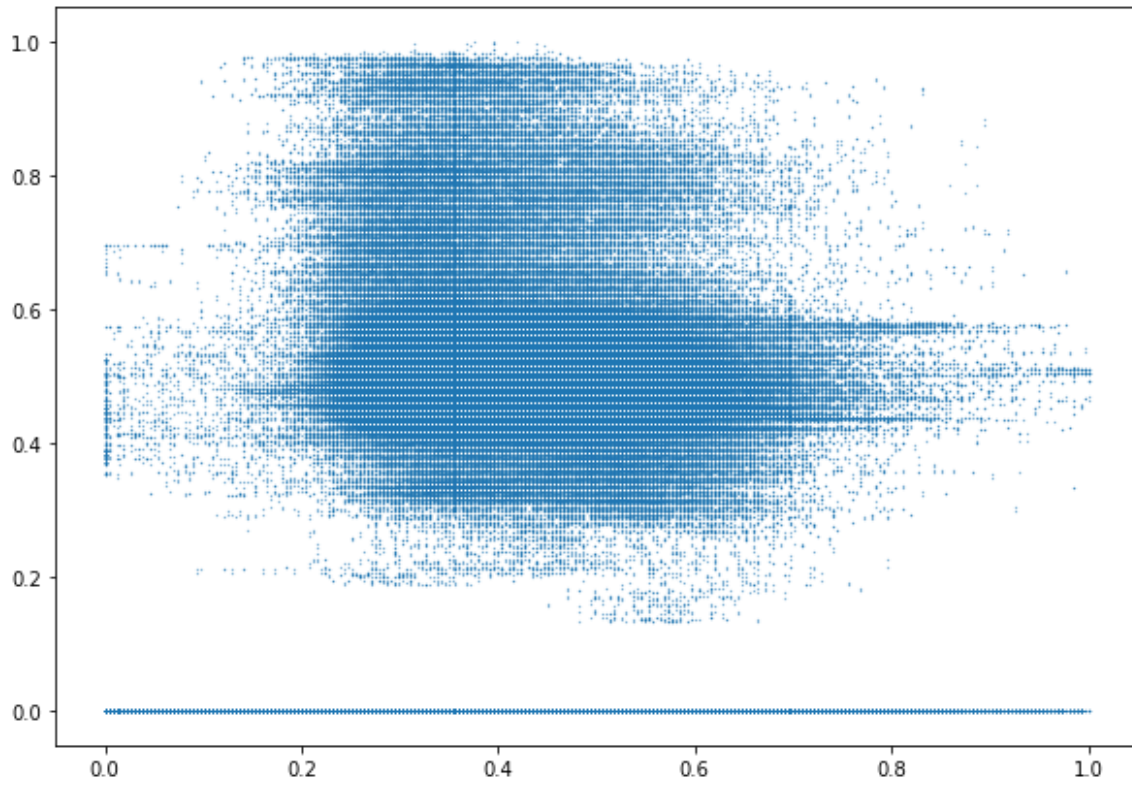
Observation: We see significant amount of outlier presence and observe the gaps in data through scatter plot and through histogram we observe a continuous data flow from 0.2 to 1.0 while there is some distribution near 0.0 which can create discontinuity in predictions as well.

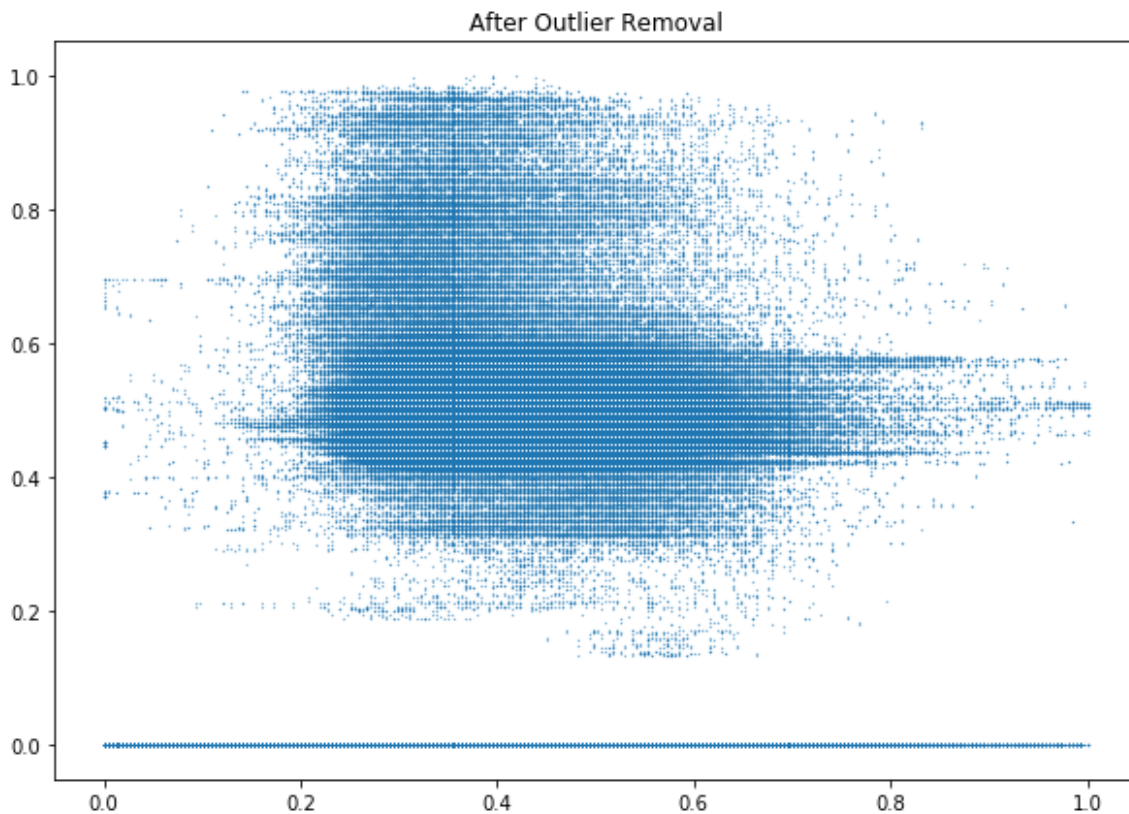
In [46]:

```
xtrain, ytrain , shape = outlier_detection(xtrain,ytrain,0.2)
```



Before Outlier Removal





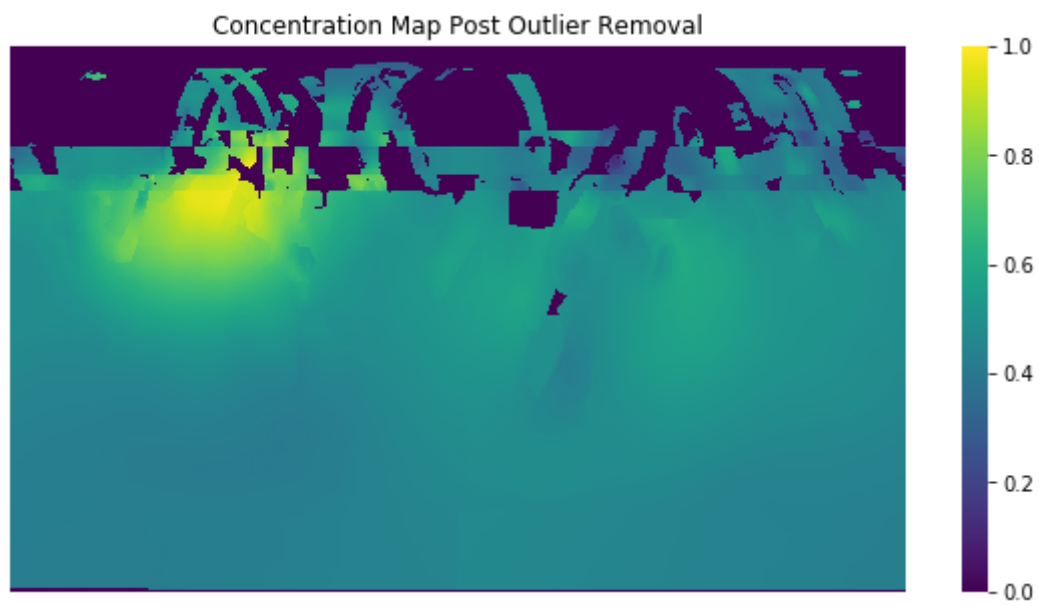
(576, 1440)

```
{'behaviour': 'deprecated', 'bootstrap': False, 'contamination': 0.2, 'max_features': 1.0, 'max_samples': 'auto', 'n_estimators': 100, 'n_jobs': None, 'random_state': None, 'verbose': 0, 'warm_start': False}
```

We do not observe a great performance of Isolation Forest Outlier Removal Algorithm in case of SSi Map. The gaps are not removed and training data around dense plot is not removed which may cause biased and wrong predictions. Other Outlier Removal Algorithm like Minimum Covariance Determinant, Local Outlier Factor, One-Class SVM do not work properly in this case.

In [47]:

```
visualise_maps(ytrain)
```



In [48]:

```
history,model,ypredicted = model_application(xtrain, xtest, ytrain)
```

Model: "sequential\_4"

Layer (type)	Output Shape	Param #
dense_12 (Dense)	(None, 32)	46112
dense_13 (Dense)	(None, 16)	528
dense_14 (Dense)	(None, 1440)	24480

Total params: 71,120

Trainable params: 71,120

Non-trainable params: 0

Epoch 1/150

10/10 [=====] - 0s 20ms/step - loss: 0.2157 - mse: 0.2157 - mae: 0.4114 - val\_loss: 0.1363 - val\_mse: 0.1363 - val\_mae: 0.3278

Epoch 2/150

10/10 [=====] - 0s 8ms/step - loss: 0.1539 - mse: 0.1539 - mae: 0.3313 - val\_loss: 0.0580 - val\_mse: 0.0580 - val\_mae: 0.1884

Epoch 3/150

10/10 [=====] - 0s 7ms/step - loss: 0.0840 - mse: 0.0840 - mae: 0.2288 - val\_loss: 0.0239 - val\_mse: 0.0239 - val\_mae: 0.1241

Epoch 4/150

10/10 [=====] - 0s 8ms/step - loss: 0.0494 - mse: 0.0494 - mae: 0.1715 - val\_loss: 0.0212 - val\_mse: 0.0212 - val\_mae: 0.1298

Epoch 5/150

10/10 [=====] - 0s 8ms/step - loss: 0.0414 - mse: 0.0414 - mae: 0.1659 - val\_loss: 0.0135 - val\_mse: 0.0135 - val\_mae: 0.1008

Epoch 6/150

10/10 [=====] - 0s 8ms/step - loss: 0.0314 - mse: 0.0314 - mae: 0.1404 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.0861

Epoch 7/150

10/10 [=====] - 0s 8ms/step - loss: 0.0273 - mse: 0.0273 - mae: 0.1220 - val\_loss: 0.0184 - val\_mse: 0.0184 - val\_mae: 0.1235

Epoch 8/150

10/10 [=====] - 0s 8ms/step - loss: 0.0263 - mse: 0.0263 - mae: 0.1206 - val\_loss: 0.0110 - val\_mse: 0.0110 - val\_mae: 0.0909

Epoch 9/150

10/10 [=====] - 0s 9ms/step - loss: 0.0231 - mse: 0.0231 - mae: 0.1065 - val\_loss: 0.0096 - val\_mse: 0.0096 - val\_mae: 0.0837

Epoch 10/150

10/10 [=====] - 0s 8ms/step - loss: 0.0246 - mse: 0.0246 - mae: 0.1110 - val\_loss: 0.0100 - val\_mse: 0.0100 - val\_mae: 0.0855

Epoch 11/150

10/10 [=====] - 0s 8ms/step - loss: 0.0234 - mse: 0.0234 - mae: 0.1063 - val\_loss: 0.0176 - val\_mse: 0.0176 - val\_mae: 0.1196

Epoch 12/150

10/10 [=====] - 0s 16ms/step - loss: 0.0228 - mse: 0.0228 - mae: 0.1060 - val\_loss: 0.0160 - val\_mse: 0.0160 - val\_mae: 0.

1122

Epoch 13/150

10/10 [=====] - 0s 8ms/step - loss: 0.0221 - mse:  
0.0221 - mae: 0.1042 - val\_loss: 0.0113 - val\_mse: 0.0113 - val\_mae: 0.090  
9

Epoch 14/150

10/10 [=====] - 0s 8ms/step - loss: 0.0214 - mse:  
0.0214 - mae: 0.1000 - val\_loss: 0.0101 - val\_mse: 0.0101 - val\_mae: 0.084  
2

Epoch 15/150

10/10 [=====] - 0s 8ms/step - loss: 0.0207 - mse:  
0.0207 - mae: 0.0984 - val\_loss: 0.0133 - val\_mse: 0.0133 - val\_mae: 0.099  
7

Epoch 16/150

10/10 [=====] - 0s 8ms/step - loss: 0.0213 - mse:  
0.0213 - mae: 0.0999 - val\_loss: 0.0128 - val\_mse: 0.0128 - val\_mae: 0.096  
8

Epoch 17/150

10/10 [=====] - 0s 8ms/step - loss: 0.0217 - mse:  
0.0217 - mae: 0.1000 - val\_loss: 0.0103 - val\_mse: 0.0103 - val\_mae: 0.083  
7

Epoch 18/150

10/10 [=====] - 0s 8ms/step - loss: 0.0198 - mse:  
0.0198 - mae: 0.0959 - val\_loss: 0.0190 - val\_mse: 0.0190 - val\_mae: 0.121  
6

Epoch 19/150

10/10 [=====] - 0s 8ms/step - loss: 0.0213 - mse:  
0.0213 - mae: 0.1018 - val\_loss: 0.0143 - val\_mse: 0.0143 - val\_mae: 0.101  
6

Epoch 20/150

10/10 [=====] - 0s 8ms/step - loss: 0.0183 - mse:  
0.0183 - mae: 0.0910 - val\_loss: 0.0138 - val\_mse: 0.0138 - val\_mae: 0.098  
8

Epoch 21/150

10/10 [=====] - 0s 8ms/step - loss: 0.0191 - mse:  
0.0191 - mae: 0.0945 - val\_loss: 0.0182 - val\_mse: 0.0182 - val\_mae: 0.116  
2

Epoch 22/150

10/10 [=====] - 0s 7ms/step - loss: 0.0191 - mse:  
0.0191 - mae: 0.0939 - val\_loss: 0.0179 - val\_mse: 0.0179 - val\_mae: 0.113  
8

Epoch 23/150

10/10 [=====] - 0s 8ms/step - loss: 0.0188 - mse:  
0.0188 - mae: 0.0934 - val\_loss: 0.0126 - val\_mse: 0.0126 - val\_mae: 0.091  
3

Epoch 24/150

10/10 [=====] - 0s 8ms/step - loss: 0.0195 - mse:  
0.0195 - mae: 0.0960 - val\_loss: 0.0191 - val\_mse: 0.0191 - val\_mae: 0.117  
3

Epoch 25/150

10/10 [=====] - 0s 8ms/step - loss: 0.0180 - mse:  
0.0180 - mae: 0.0905 - val\_loss: 0.0151 - val\_mse: 0.0151 - val\_mae: 0.101  
3

Epoch 26/150

10/10 [=====] - 0s 8ms/step - loss: 0.0187 - mse:  
0.0187 - mae: 0.0916 - val\_loss: 0.0233 - val\_mse: 0.0233 - val\_mae: 0.129  
2

Epoch 27/150

10/10 [=====] - 0s 9ms/step - loss: 0.0187 - mse:  
0.0187 - mae: 0.0929 - val\_loss: 0.0140 - val\_mse: 0.0140 - val\_mae: 0.095  
5

Epoch 28/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0178 - mse: 0.0178 - mae: 0.0901 - val\_loss: 0.0175 - val\_mse: 0.0175 - val\_mae: 0.1087

Epoch 29/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0169 - mse: 0.0169 - mae: 0.0865 - val\_loss: 0.0178 - val\_mse: 0.0178 - val\_mae: 0.1096

Epoch 30/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0170 - mse: 0.0170 - mae: 0.0865 - val\_loss: 0.0231 - val\_mse: 0.0231 - val\_mae: 0.1269

Epoch 31/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0169 - mse: 0.0169 - mae: 0.0871 - val\_loss: 0.0194 - val\_mse: 0.0194 - val\_mae: 0.1143

Epoch 32/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0176 - mse: 0.0176 - mae: 0.0889 - val\_loss: 0.0217 - val\_mse: 0.0217 - val\_mae: 0.1217

Epoch 33/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0165 - mse: 0.0165 - mae: 0.0849 - val\_loss: 0.0211 - val\_mse: 0.0211 - val\_mae: 0.1194

Epoch 34/150  
10/10 [=====] - 0s 15ms/step - loss: 0.0171 - mse: 0.0171 - mae: 0.0871 - val\_loss: 0.0180 - val\_mse: 0.0180 - val\_mae: 0.1081

Epoch 35/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0148 - mse: 0.0148 - mae: 0.0786 - val\_loss: 0.0230 - val\_mse: 0.0230 - val\_mae: 0.1246

Epoch 36/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0155 - mse: 0.0155 - mae: 0.0807 - val\_loss: 0.0233 - val\_mse: 0.0233 - val\_mae: 0.1258

Epoch 37/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0157 - mse: 0.0157 - mae: 0.0813 - val\_loss: 0.0158 - val\_mse: 0.0158 - val\_mae: 0.0997

Epoch 38/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0139 - mse: 0.0139 - mae: 0.0743 - val\_loss: 0.0206 - val\_mse: 0.0206 - val\_mae: 0.1159

Epoch 39/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0159 - mse: 0.0159 - mae: 0.0798 - val\_loss: 0.0209 - val\_mse: 0.0209 - val\_mae: 0.1172

Epoch 40/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0145 - mse: 0.0145 - mae: 0.0751 - val\_loss: 0.0235 - val\_mse: 0.0235 - val\_mae: 0.1253

Epoch 41/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0145 - mse: 0.0145 - mae: 0.0747 - val\_loss: 0.0199 - val\_mse: 0.0199 - val\_mae: 0.1137

Epoch 42/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0145 - mse: 0.0145 - mae: 0.0744 - val\_loss: 0.0179 - val\_mse: 0.0179 - val\_mae: 0.1062

Epoch 43/150

10/10 [=====] - 0s 9ms/step - loss: 0.0147 - mse:  
0.0147 - mae: 0.0744 - val\_loss: 0.0189 - val\_mse: 0.0189 - val\_mae: 0.109  
6  
Epoch 44/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0129 - mse:  
0.0129 - mae: 0.0686 - val\_loss: 0.0211 - val\_mse: 0.0211 - val\_mae: 0.116  
5  
Epoch 45/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0137 - mse:  
0.0137 - mae: 0.0716 - val\_loss: 0.0240 - val\_mse: 0.0240 - val\_mae: 0.125  
9  
Epoch 46/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0152 - mse:  
0.0152 - mae: 0.0752 - val\_loss: 0.0195 - val\_mse: 0.0195 - val\_mae: 0.110  
7  
Epoch 47/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0133 - mse:  
0.0133 - mae: 0.0689 - val\_loss: 0.0194 - val\_mse: 0.0194 - val\_mae: 0.110  
4  
Epoch 48/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0136 - mse:  
0.0136 - mae: 0.0707 - val\_loss: 0.0208 - val\_mse: 0.0208 - val\_mae: 0.115  
7  
Epoch 49/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0132 - mse:  
0.0132 - mae: 0.0686 - val\_loss: 0.0214 - val\_mse: 0.0214 - val\_mae: 0.116  
8  
Epoch 50/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0123 - mse:  
0.0123 - mae: 0.0649 - val\_loss: 0.0215 - val\_mse: 0.0215 - val\_mae: 0.117  
6  
Epoch 51/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0128 - mse:  
0.0128 - mae: 0.0667 - val\_loss: 0.0188 - val\_mse: 0.0188 - val\_mae: 0.108  
5  
Epoch 52/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0122 - mse:  
0.0122 - mae: 0.0646 - val\_loss: 0.0221 - val\_mse: 0.0221 - val\_mae: 0.119  
4  
Epoch 53/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0135 - mse:  
0.0135 - mae: 0.0693 - val\_loss: 0.0200 - val\_mse: 0.0200 - val\_mae: 0.112  
6  
Epoch 54/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0116 - mse:  
0.0116 - mae: 0.0615 - val\_loss: 0.0187 - val\_mse: 0.0187 - val\_mae: 0.108  
1  
Epoch 55/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0124 - mse:  
0.0124 - mae: 0.0652 - val\_loss: 0.0193 - val\_mse: 0.0193 - val\_mae: 0.109  
8  
Epoch 56/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0133 - mse:  
0.0133 - mae: 0.0682 - val\_loss: 0.0161 - val\_mse: 0.0161 - val\_mae: 0.099  
2  
Epoch 57/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0120 - ms  
e: 0.0120 - mae: 0.0642 - val\_loss: 0.0164 - val\_mse: 0.0164 - val\_mae: 0.  
1000  
Epoch 58/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0129 - mse:



0.0129 - mae: 0.0668 - val\_loss: 0.0190 - val\_mse: 0.0190 - val\_mae: 0.108  
8  
Epoch 59/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0131 - mse:  
0.0131 - mae: 0.0677 - val\_loss: 0.0215 - val\_mse: 0.0215 - val\_mae: 0.117  
8  
Epoch 60/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0124 - mse:  
0.0124 - mae: 0.0651 - val\_loss: 0.0228 - val\_mse: 0.0228 - val\_mae: 0.121  
5  
Epoch 61/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0120 - mse:  
0.0120 - mae: 0.0639 - val\_loss: 0.0222 - val\_mse: 0.0222 - val\_mae: 0.119  
7  
Epoch 62/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0111 - mse:  
0.0111 - mae: 0.0615 - val\_loss: 0.0219 - val\_mse: 0.0219 - val\_mae: 0.119  
1  
Epoch 63/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0127 - mse:  
0.0127 - mae: 0.0662 - val\_loss: 0.0196 - val\_mse: 0.0196 - val\_mae: 0.110  
9  
Epoch 64/150  
10/10 [=====] - 0s 10ms/step - loss: 0.0111 - ms  
e: 0.0111 - mae: 0.0609 - val\_loss: 0.0255 - val\_mse: 0.0255 - val\_mae: 0.  
1313  
Epoch 65/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0122 - mse:  
0.0122 - mae: 0.0659 - val\_loss: 0.0260 - val\_mse: 0.0260 - val\_mae: 0.132  
4  
Epoch 66/150  
10/10 [=====] - 0s 9ms/step - loss: 0.0131 - mse:  
0.0131 - mae: 0.0696 - val\_loss: 0.0238 - val\_mse: 0.0238 - val\_mae: 0.124  
8  
Epoch 67/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0125 - mse:  
0.0125 - mae: 0.0667 - val\_loss: 0.0218 - val\_mse: 0.0218 - val\_mae: 0.118  
7  
Epoch 68/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0118 - mse:  
0.0118 - mae: 0.0636 - val\_loss: 0.0192 - val\_mse: 0.0192 - val\_mae: 0.109  
1  
Epoch 69/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0109 - mse:  
0.0109 - mae: 0.0607 - val\_loss: 0.0214 - val\_mse: 0.0214 - val\_mae: 0.116  
9  
Epoch 70/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0105 - mse:  
0.0105 - mae: 0.0595 - val\_loss: 0.0183 - val\_mse: 0.0183 - val\_mae: 0.106  
1  
Epoch 71/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0114 - mse:  
0.0114 - mae: 0.0618 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.119  
6  
Epoch 72/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0112 - mse:  
0.0112 - mae: 0.0613 - val\_loss: 0.0184 - val\_mse: 0.0184 - val\_mae: 0.106  
5  
Epoch 73/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0102 - mse:  
0.0102 - mae: 0.0587 - val\_loss: 0.0148 - val\_mse: 0.0148 - val\_mae: 0.093

7

Epoch 74/150

10/10 [=====] - 0s 7ms/step - loss: 0.0113 - mse: 0.0113 - mae: 0.0646 - val\_loss: 0.0166 - val\_mse: 0.0166 - val\_mae: 0.099

9

Epoch 75/150

10/10 [=====] - 0s 7ms/step - loss: 0.0104 - mse: 0.0104 - mae: 0.0601 - val\_loss: 0.0259 - val\_mse: 0.0259 - val\_mae: 0.129

2

Epoch 76/150

10/10 [=====] - 0s 7ms/step - loss: 0.0108 - mse: 0.0108 - mae: 0.0614 - val\_loss: 0.0200 - val\_mse: 0.0200 - val\_mae: 0.111

3

Epoch 77/150

10/10 [=====] - 0s 7ms/step - loss: 0.0106 - mse: 0.0106 - mae: 0.0605 - val\_loss: 0.0187 - val\_mse: 0.0187 - val\_mae: 0.106

3

Epoch 78/150

10/10 [=====] - 0s 7ms/step - loss: 0.0096 - mse: 0.0096 - mae: 0.0558 - val\_loss: 0.0227 - val\_mse: 0.0227 - val\_mae: 0.119

8

Epoch 79/150

10/10 [=====] - 0s 14ms/step - loss: 0.0098 - mse: 0.0098 - mae: 0.0560 - val\_loss: 0.0228 - val\_mse: 0.0228 - val\_mae: 0.1201

Epoch 80/150

10/10 [=====] - 0s 7ms/step - loss: 0.0105 - mse: 0.0105 - mae: 0.0590 - val\_loss: 0.0206 - val\_mse: 0.0206 - val\_mae: 0.111

9

Epoch 81/150

10/10 [=====] - 0s 7ms/step - loss: 0.0087 - mse: 0.0087 - mae: 0.0534 - val\_loss: 0.0201 - val\_mse: 0.0201 - val\_mae: 0.110

7

Epoch 82/150

10/10 [=====] - 0s 7ms/step - loss: 0.0092 - mse: 0.0092 - mae: 0.0548 - val\_loss: 0.0218 - val\_mse: 0.0218 - val\_mae: 0.116

1

Epoch 83/150

10/10 [=====] - 0s 7ms/step - loss: 0.0097 - mse: 0.0097 - mae: 0.0559 - val\_loss: 0.0218 - val\_mse: 0.0218 - val\_mae: 0.115

3

Epoch 84/150

10/10 [=====] - 0s 7ms/step - loss: 0.0092 - mse: 0.0092 - mae: 0.0541 - val\_loss: 0.0234 - val\_mse: 0.0234 - val\_mae: 0.120

0

Epoch 85/150

10/10 [=====] - 0s 7ms/step - loss: 0.0101 - mse: 0.0101 - mae: 0.0582 - val\_loss: 0.0249 - val\_mse: 0.0249 - val\_mae: 0.124

4

Epoch 86/150

10/10 [=====] - 0s 7ms/step - loss: 0.0091 - mse: 0.0091 - mae: 0.0538 - val\_loss: 0.0230 - val\_mse: 0.0230 - val\_mae: 0.117

1

Epoch 87/150

10/10 [=====] - 0s 7ms/step - loss: 0.0091 - mse: 0.0091 - mae: 0.0542 - val\_loss: 0.0194 - val\_mse: 0.0194 - val\_mae: 0.105

6

Epoch 88/150

10/10 [=====] - 0s 7ms/step - loss: 0.0089 - mse: 0.0089 - mae: 0.0534 - val\_loss: 0.0243 - val\_mse: 0.0243 - val\_mae: 0.121

5

Epoch 89/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0089 - mse:  
0.0089 - mae: 0.0528 - val\_loss: 0.0249 - val\_mse: 0.0249 - val\_mae: 0.121  
9

Epoch 90/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0082 - mse:  
0.0082 - mae: 0.0512 - val\_loss: 0.0202 - val\_mse: 0.0202 - val\_mae: 0.109  
2

Epoch 91/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0092 - mse:  
0.0092 - mae: 0.0546 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.114  
5

Epoch 92/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0089 - mse:  
0.0089 - mae: 0.0530 - val\_loss: 0.0219 - val\_mse: 0.0219 - val\_mae: 0.114  
7

Epoch 93/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0089 - mse:  
0.0089 - mae: 0.0531 - val\_loss: 0.0210 - val\_mse: 0.0210 - val\_mae: 0.110  
6

Epoch 94/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0085 - mse:  
0.0085 - mae: 0.0514 - val\_loss: 0.0209 - val\_mse: 0.0209 - val\_mae: 0.109  
3

Epoch 95/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0083 - mse:  
0.0083 - mae: 0.0514 - val\_loss: 0.0189 - val\_mse: 0.0189 - val\_mae: 0.103  
0

Epoch 96/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0500 - val\_loss: 0.0231 - val\_mse: 0.0231 - val\_mae: 0.116  
5

Epoch 97/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0494 - val\_loss: 0.0229 - val\_mse: 0.0229 - val\_mae: 0.115  
7

Epoch 98/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0081 - mse:  
0.0081 - mae: 0.0500 - val\_loss: 0.0212 - val\_mse: 0.0212 - val\_mae: 0.110  
3

Epoch 99/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0492 - val\_loss: 0.0245 - val\_mse: 0.0245 - val\_mae: 0.120  
7

Epoch 100/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0493 - val\_loss: 0.0215 - val\_mse: 0.0215 - val\_mae: 0.111  
4

Epoch 101/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0081 - ms  
e: 0.0081 - mae: 0.0505 - val\_loss: 0.0229 - val\_mse: 0.0229 - val\_mae: 0.  
1165

Epoch 102/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0086 - mse:  
0.0086 - mae: 0.0513 - val\_loss: 0.0242 - val\_mse: 0.0242 - val\_mae: 0.119  
1

Epoch 103/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0084 - mse:  
0.0084 - mae: 0.0515 - val\_loss: 0.0173 - val\_mse: 0.0173 - val\_mae: 0.097  
9

Epoch 104/150

10/10 [=====] - 0s 7ms/step - loss: 0.0077 - mse:  
0.0077 - mae: 0.0507 - val\_loss: 0.0192 - val\_mse: 0.0192 - val\_mae: 0.103  
3  
Epoch 105/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0086 - mse:  
0.0086 - mae: 0.0535 - val\_loss: 0.0218 - val\_mse: 0.0218 - val\_mae: 0.111  
3  
Epoch 106/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0081 - mse:  
0.0081 - mae: 0.0515 - val\_loss: 0.0256 - val\_mse: 0.0256 - val\_mae: 0.123  
6  
Epoch 107/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0083 - mse:  
0.0083 - mae: 0.0514 - val\_loss: 0.0225 - val\_mse: 0.0225 - val\_mae: 0.114  
6  
Epoch 108/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0078 - mse:  
0.0078 - mae: 0.0495 - val\_loss: 0.0207 - val\_mse: 0.0207 - val\_mae: 0.110  
5  
Epoch 109/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0075 - mse:  
0.0075 - mae: 0.0492 - val\_loss: 0.0271 - val\_mse: 0.0271 - val\_mae: 0.127  
9  
Epoch 110/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0075 - mse:  
0.0075 - mae: 0.0484 - val\_loss: 0.0230 - val\_mse: 0.0230 - val\_mae: 0.115  
7  
Epoch 111/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0074 - mse:  
0.0074 - mae: 0.0474 - val\_loss: 0.0206 - val\_mse: 0.0206 - val\_mae: 0.108  
2  
Epoch 112/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0077 - mse:  
0.0077 - mae: 0.0484 - val\_loss: 0.0218 - val\_mse: 0.0218 - val\_mae: 0.111  
5  
Epoch 113/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0078 - mse:  
0.0078 - mae: 0.0483 - val\_loss: 0.0245 - val\_mse: 0.0245 - val\_mae: 0.119  
8  
Epoch 114/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0071 - mse:  
0.0071 - mae: 0.0467 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.113  
6  
Epoch 115/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0492 - val\_loss: 0.0231 - val\_mse: 0.0231 - val\_mae: 0.115  
2  
Epoch 116/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0074 - mse:  
0.0074 - mae: 0.0471 - val\_loss: 0.0241 - val\_mse: 0.0241 - val\_mae: 0.118  
3  
Epoch 117/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0068 - mse:  
0.0068 - mae: 0.0455 - val\_loss: 0.0268 - val\_mse: 0.0268 - val\_mae: 0.128  
0  
Epoch 118/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0080 - mse:  
0.0080 - mae: 0.0503 - val\_loss: 0.0254 - val\_mse: 0.0254 - val\_mae: 0.122  
9  
Epoch 119/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0070 - mse:

0.0070 - mae: 0.0459 - val\_loss: 0.0224 - val\_mse: 0.0224 - val\_mae: 0.113  
5  
Epoch 120/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0071 - mse:  
0.0071 - mae: 0.0462 - val\_loss: 0.0236 - val\_mse: 0.0236 - val\_mae: 0.116  
1  
Epoch 121/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0068 - mse:  
0.0068 - mae: 0.0448 - val\_loss: 0.0231 - val\_mse: 0.0231 - val\_mae: 0.115  
2  
Epoch 122/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0075 - mse:  
0.0075 - mae: 0.0478 - val\_loss: 0.0232 - val\_mse: 0.0232 - val\_mae: 0.115  
2  
Epoch 123/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0067 - mse:  
0.0067 - mae: 0.0443 - val\_loss: 0.0197 - val\_mse: 0.0197 - val\_mae: 0.104  
6  
Epoch 124/150  
10/10 [=====] - 0s 14ms/step - loss: 0.0074 - ms  
e: 0.0074 - mae: 0.0476 - val\_loss: 0.0212 - val\_mse: 0.0212 - val\_mae: 0.  
1092  
Epoch 125/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0074 - mse:  
0.0074 - mae: 0.0475 - val\_loss: 0.0233 - val\_mse: 0.0233 - val\_mae: 0.115  
9  
Epoch 126/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0066 - mse:  
0.0066 - mae: 0.0437 - val\_loss: 0.0222 - val\_mse: 0.0222 - val\_mae: 0.111  
9  
Epoch 127/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0071 - mse:  
0.0071 - mae: 0.0458 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.113  
2  
Epoch 128/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0066 - mse:  
0.0066 - mae: 0.0443 - val\_loss: 0.0228 - val\_mse: 0.0228 - val\_mae: 0.114  
7  
Epoch 129/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0070 - mse:  
0.0070 - mae: 0.0456 - val\_loss: 0.0248 - val\_mse: 0.0248 - val\_mae: 0.120  
1  
Epoch 130/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0071 - mse:  
0.0071 - mae: 0.0459 - val\_loss: 0.0204 - val\_mse: 0.0204 - val\_mae: 0.107  
3  
Epoch 131/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0069 - mse:  
0.0069 - mae: 0.0447 - val\_loss: 0.0232 - val\_mse: 0.0232 - val\_mae: 0.115  
7  
Epoch 132/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0069 - mse:  
0.0069 - mae: 0.0450 - val\_loss: 0.0211 - val\_mse: 0.0211 - val\_mae: 0.109  
0  
Epoch 133/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0069 - mse:  
0.0069 - mae: 0.0443 - val\_loss: 0.0225 - val\_mse: 0.0225 - val\_mae: 0.112  
8  
Epoch 134/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0072 - mse:  
0.0072 - mae: 0.0461 - val\_loss: 0.0226 - val\_mse: 0.0226 - val\_mae: 0.114

1  
Epoch 135/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0067 - mse:  
0.0067 - mae: 0.0445 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.112  
4  
Epoch 136/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0073 - mse:  
0.0073 - mae: 0.0466 - val\_loss: 0.0212 - val\_mse: 0.0212 - val\_mae: 0.109  
1  
Epoch 137/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0065 - mse:  
0.0065 - mae: 0.0437 - val\_loss: 0.0228 - val\_mse: 0.0228 - val\_mae: 0.114  
2  
Epoch 138/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0070 - mse:  
0.0070 - mae: 0.0447 - val\_loss: 0.0223 - val\_mse: 0.0223 - val\_mae: 0.112  
1  
Epoch 139/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0065 - mse:  
0.0065 - mae: 0.0436 - val\_loss: 0.0211 - val\_mse: 0.0211 - val\_mae: 0.109  
3  
Epoch 140/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0066 - mse:  
0.0066 - mae: 0.0435 - val\_loss: 0.0224 - val\_mse: 0.0224 - val\_mae: 0.112  
7  
Epoch 141/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0065 - mse:  
0.0065 - mae: 0.0434 - val\_loss: 0.0213 - val\_mse: 0.0213 - val\_mae: 0.109  
5  
Epoch 142/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0065 - mse:  
0.0065 - mae: 0.0437 - val\_loss: 0.0258 - val\_mse: 0.0258 - val\_mae: 0.123  
4  
Epoch 143/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0067 - mse:  
0.0067 - mae: 0.0444 - val\_loss: 0.0245 - val\_mse: 0.0245 - val\_mae: 0.118  
1  
Epoch 144/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0065 - mse:  
0.0065 - mae: 0.0438 - val\_loss: 0.0228 - val\_mse: 0.0228 - val\_mae: 0.114  
3  
Epoch 145/150  
10/10 [=====] - 0s 8ms/step - loss: 0.0061 - mse:  
0.0061 - mae: 0.0419 - val\_loss: 0.0198 - val\_mse: 0.0198 - val\_mae: 0.103  
9  
Epoch 146/150  
10/10 [=====] - 0s 15ms/step - loss: 0.0062 - ms  
e: 0.0062 - mae: 0.0430 - val\_loss: 0.0238 - val\_mse: 0.0238 - val\_mae: 0.  
1168  
Epoch 147/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0064 - mse:  
0.0064 - mae: 0.0428 - val\_loss: 0.0257 - val\_mse: 0.0257 - val\_mae: 0.122  
9  
Epoch 148/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0064 - mse:  
0.0064 - mae: 0.0429 - val\_loss: 0.0251 - val\_mse: 0.0251 - val\_mae: 0.120  
7  
Epoch 149/150  
10/10 [=====] - 0s 7ms/step - loss: 0.0059 - mse:  
0.0059 - mae: 0.0407 - val\_loss: 0.0239 - val\_mse: 0.0239 - val\_mae: 0.116  
6

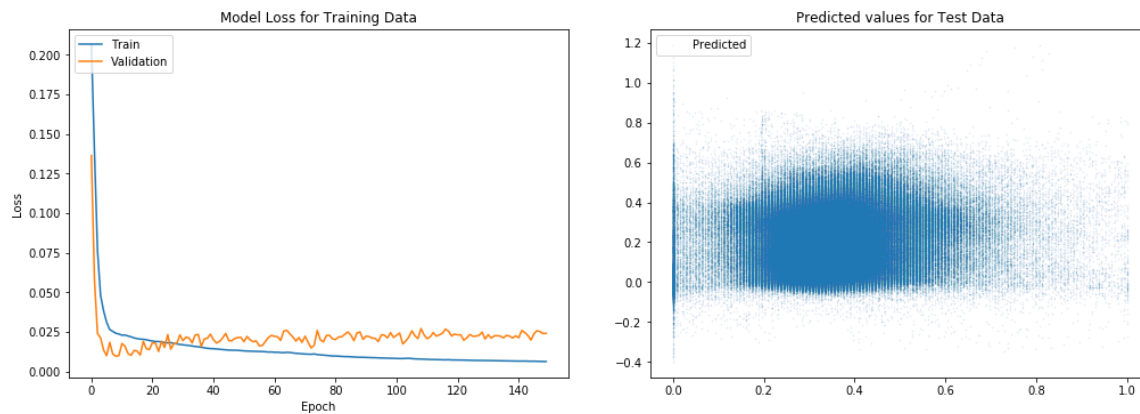
Epoch 150/150

10/10 [=====] - 0s 7ms/step - loss: 0.0062 - mse: 0.0062 - mae: 0.0417 - val\_loss: 0.0241 - val\_mse: 0.0241 - val\_mae: 0.1175

In [49]:

```
visualise_performance(model,history,xtest,ypredicted)
```

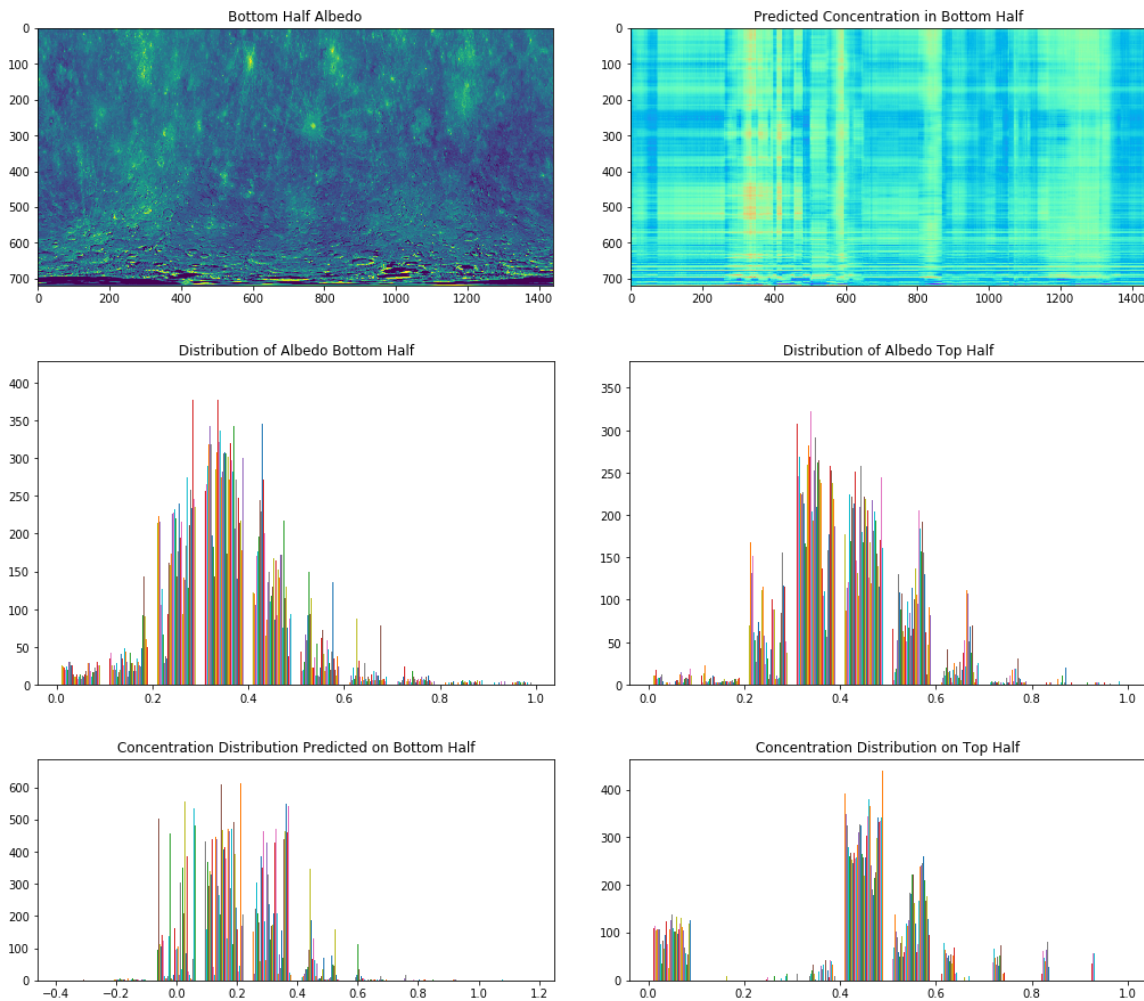
```
dict_keys(['loss', 'mse', 'mae', 'val_loss', 'val_mse', 'val_mae'])
```



The loss for validation and training is a decreasing curve but highly noisy and fluctuating depicting poor performance of the deep learning model.

In [50]:

```
visualise_predictions(xtest,ypredicted)
```



## Deductions

- The presence of gaps makes the predictions susceptible to error if not removed.
- No linear relationship was observed before outlier removal.
- Isolation Forest Outlier Removal Algorithm does well for Al and Mg while it does an average job for Ca (in auto contamination) partially. Other Outlier Removal Algorithm like Minimum Covariance Determinant, Local Outlier Factor, One-Class SVM do not work properly with any maps.
- In future we can opt for manual outlier removal methods like Z-Score, IQR method etc. observe the performance for deep learning models. Also we might see a change in linear relationship after removal which could help us in trying the performance of other regression models like Linear Regression etc.
- Data visualisation can be significantly improved and scaling can be better.