<><> Time Stamp <><>

Code started: 07/10/2022 - 11:49:51
Total Run Time: 12.372 s

<><> Bore Information <><>

Bore ID: GW036872.1.1
Region: Coastal
Bore Coordinates: (-30.923963, 153.044423)
Agency: WaterNSW
Drilled Date: 01/08/1990
Bore Depth: 30.5 m
Drilled Depth: 30.5 m
Reference Elevation: nan m
Time Series Reference Elevation: nan m
Land Surface Elevation: nan m
Silo Grid Point Coordinates: (-30.9, 153.05)

<><> Model Output <><>

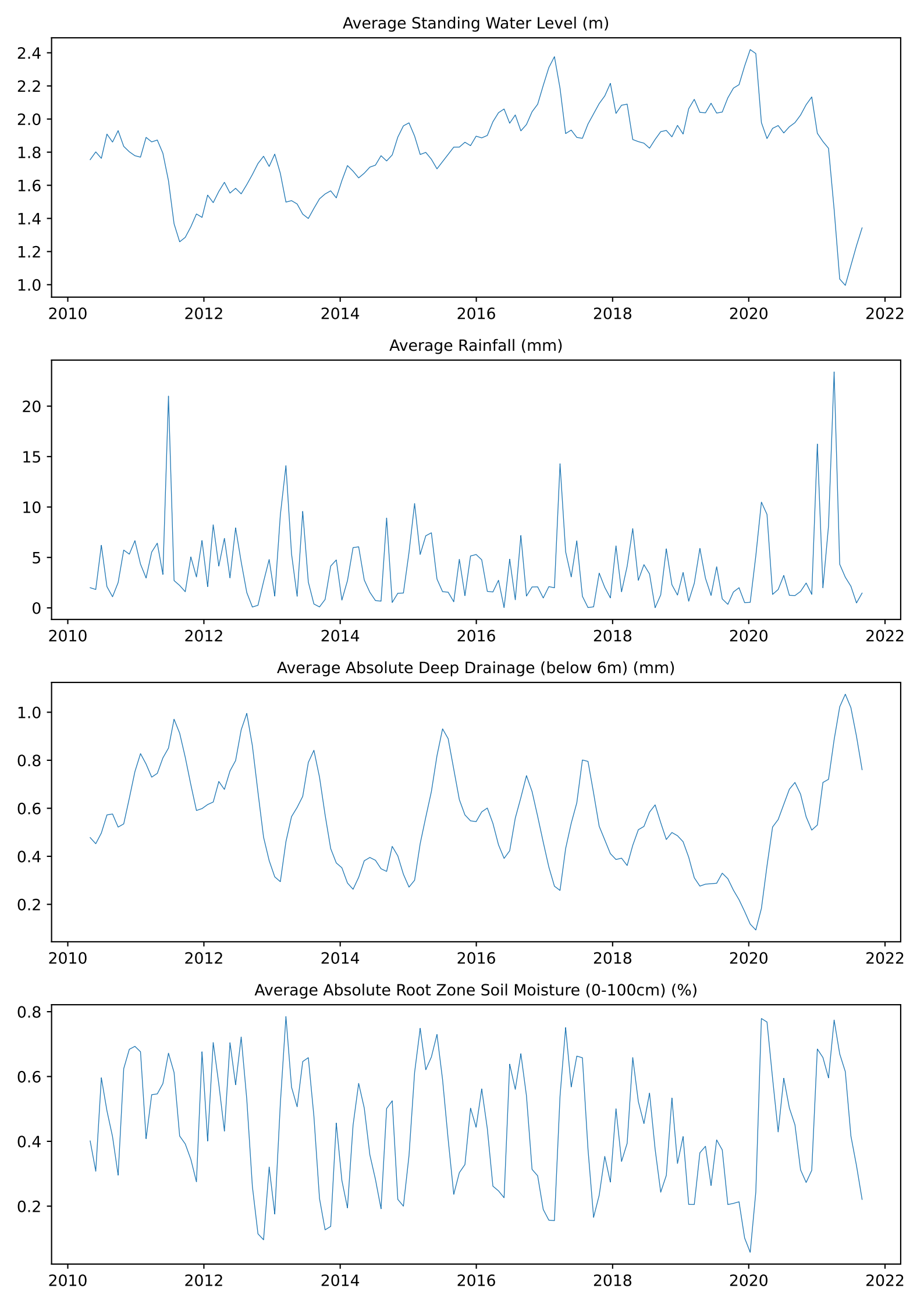
Averaged Period: 30 day(s)
Output: Average Standing Water Level (m) in 1 period(s) time

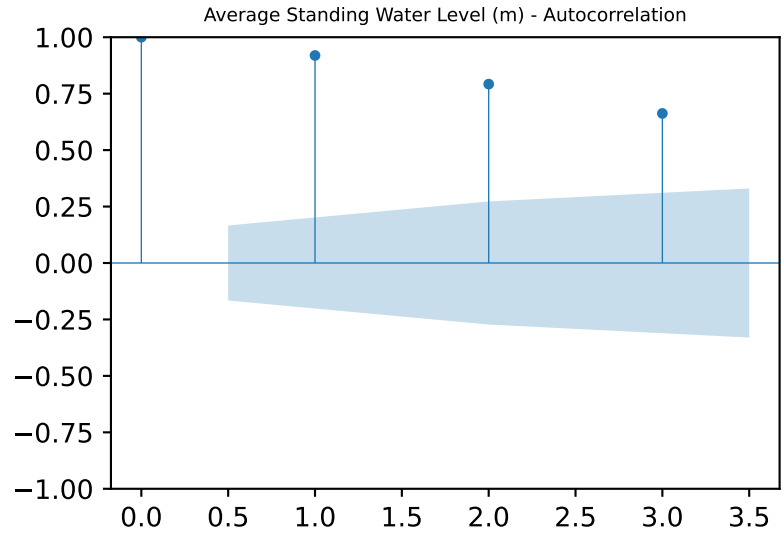
<><> Model Inputs <><>

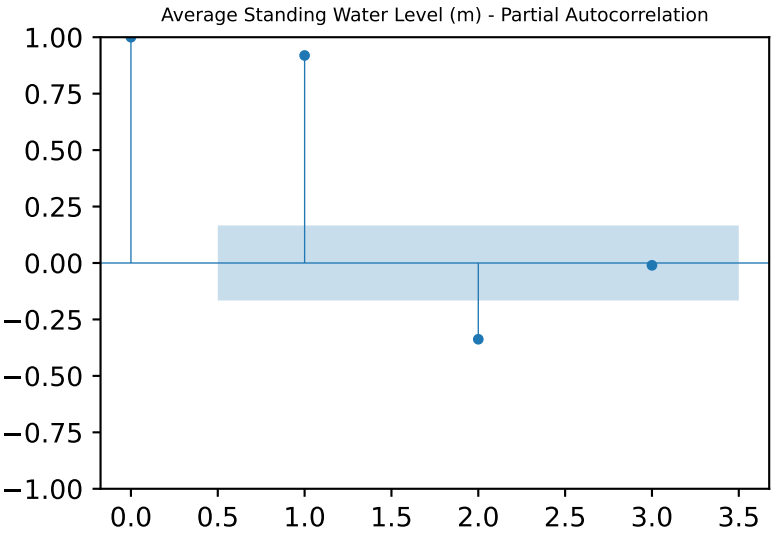
Data Range: 01/05/2010 - 31/08/2021
Train Set Size: 80.0%
Test Set Size: 20.0%
Input Timesteps: Current period + 2 preceeding period(s)
Input Variables:
    Average Standing Water Level (m)
    Average Rainfall (mm)
    Average Absolute Deep Drainage (below 6m) (mm)
    Average Absolute Root Zone Soil Moisture (0-100cm) (%)

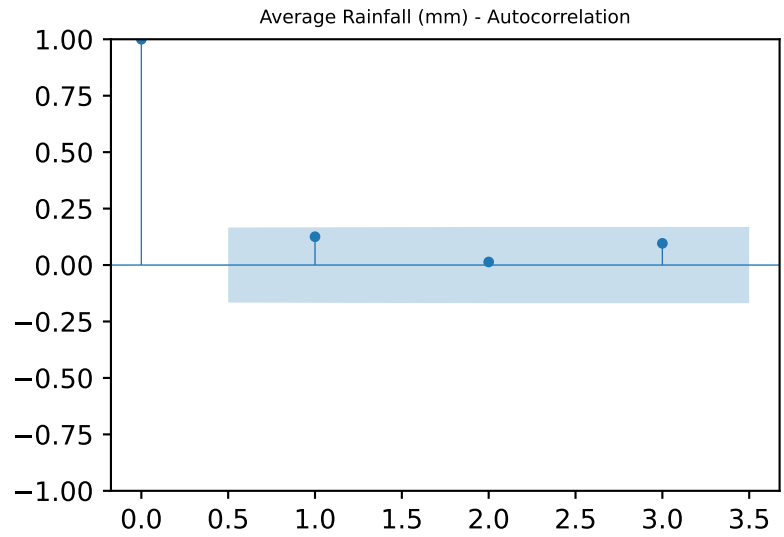
<><> Data Quality <><>

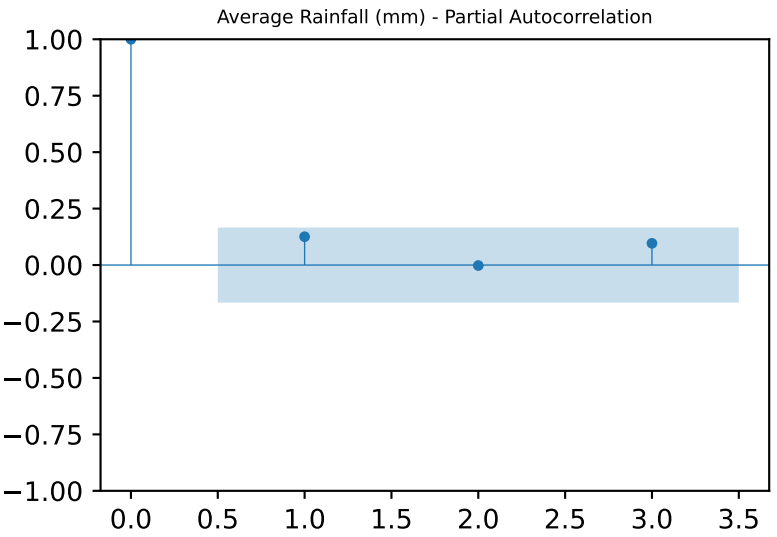
Interpolation Method: Spline
Quality Code: A,   Number: 3434,   Percentage: 82.33%
Quality Code: B,   Number: 645,   Percentage: 15.46%
Quality Code: C,   Number: 92,   Percentage: 2.21%

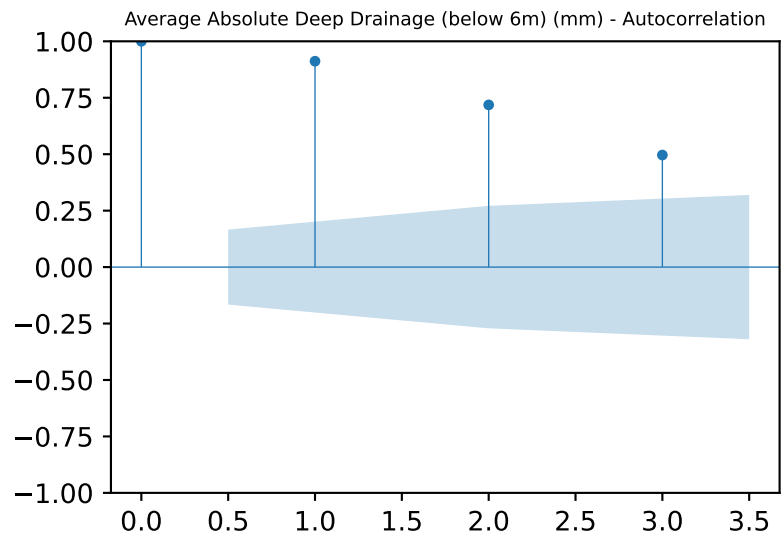

Average Standing Water Level (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2010
2012
2014
2016
2018
2020
2022
Average Rainfall (mm)
20
15
10
5
0
2010
2012
2014
2016
2018
2020
2022
Average Absolute Deep Drainage (below 6m) (mm)
1.0
0.8
0.6
0.4
0.2
2010
2012
2014
2016
2018
2020
2022
Average Absolute Root Zone Soil Moisture (0-100cm) (%)
0.8
0.6
0.4
0.2
2010
2012
2014
2016
2018
2020
2022

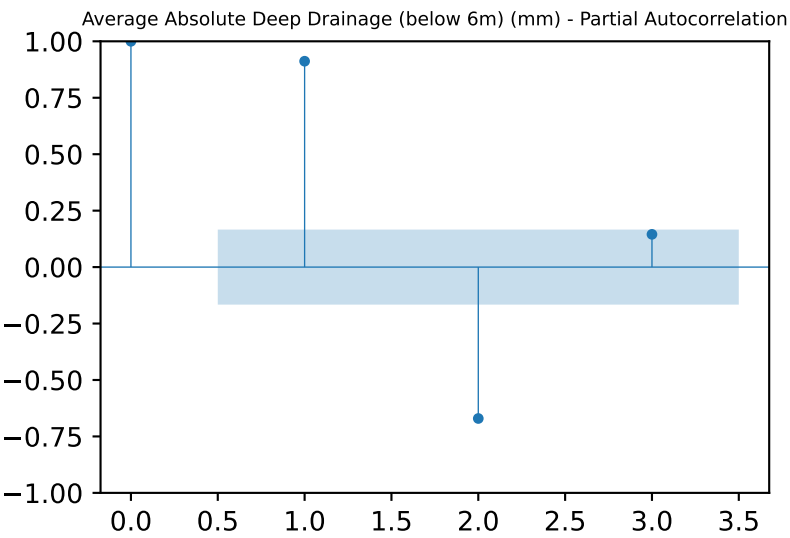

Average Standing Water Level (m) - Autocorrelation

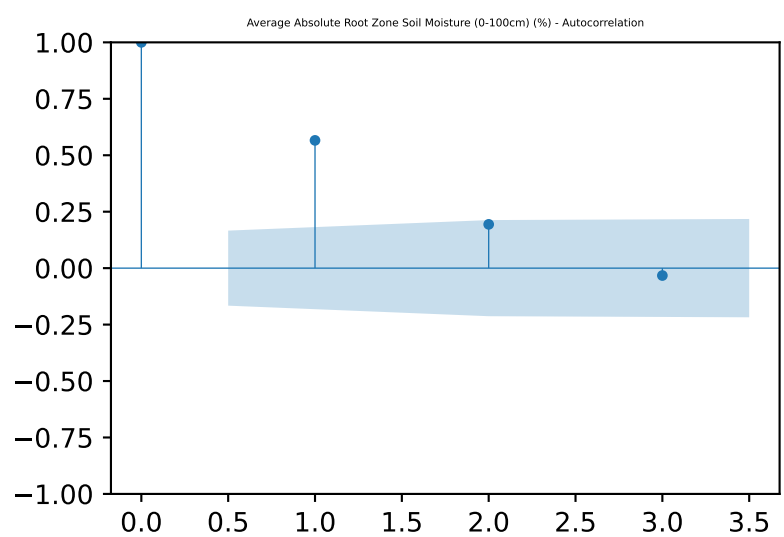

Average Standing Water Level (m) - Partial Autocorrelation

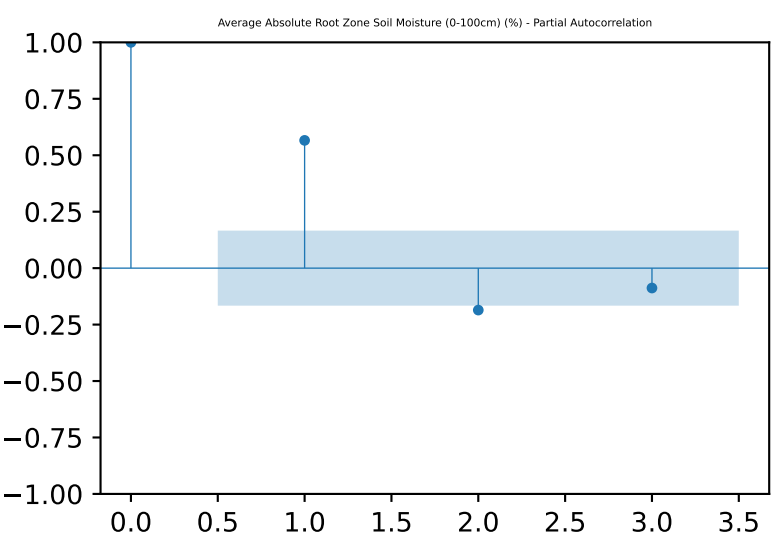

Average Rainfall (mm) - Autocorrelation

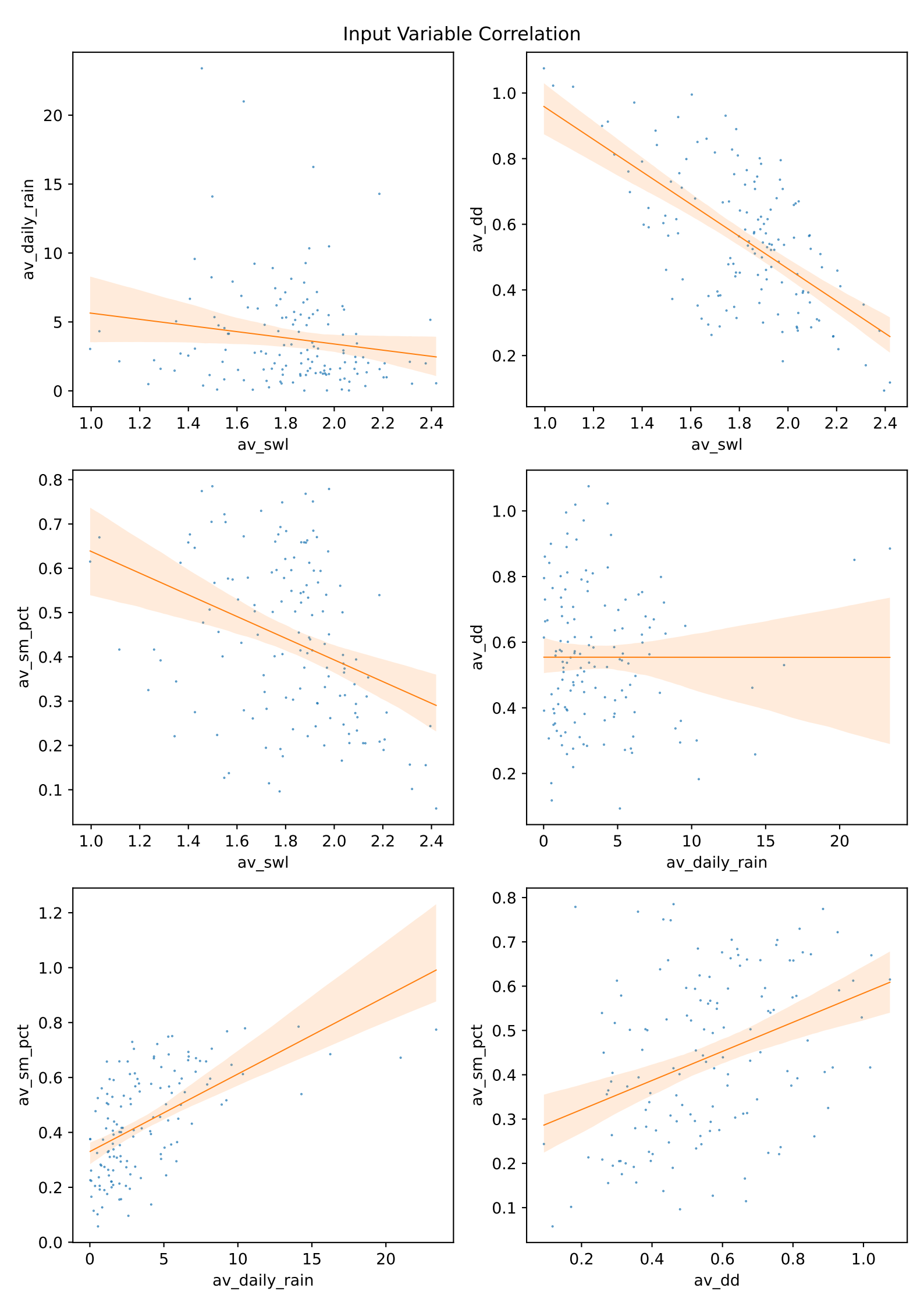

Average Rainfall (mm) - Partial Autocorrelation

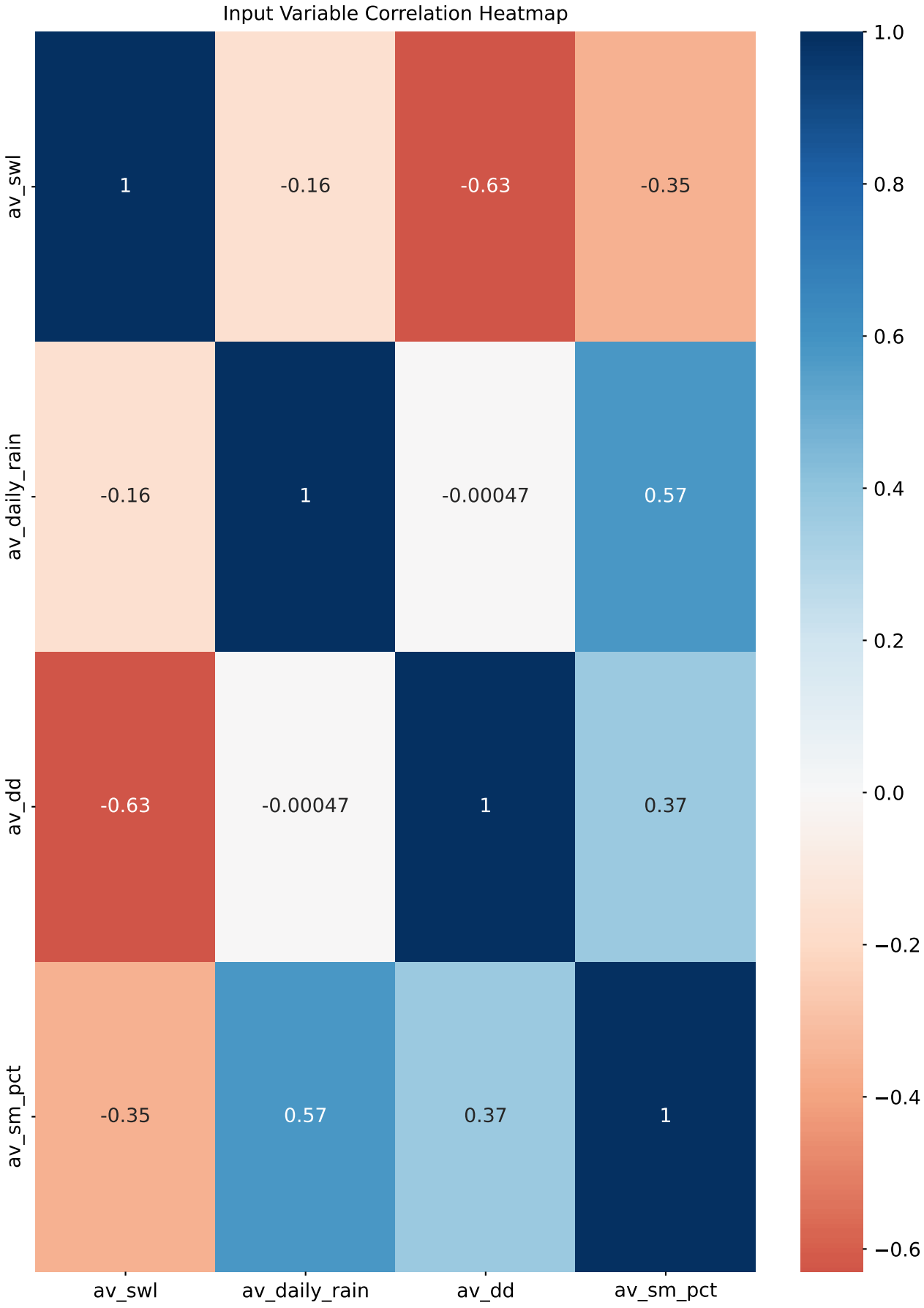

Average Absolute Deep Drainage (below 6m) (mm) - Autocorrelation


Average Absolute Deep Drainage (below 6m) (mm) - Partial Autocorrelation


Average Absolute Root Zone Soil Moisture (0-100cm) (%) - Autocorrelation


Average Absolute Root Zone Soil Moisture (0-100cm) (%) - Partial Autocorrelation


Input Variable Correlation
av_daily_rain
av_swl
av_dd
av_swl
av_sm_pct
av_swl
av_dd
av_daily_rain
av_sm_pct
av_daily_rain
av_sm_pct
av_dd


Input Variable Correlation Heatmap
av_swl
av_daily_rain
av_dd
av_sm_pct
1
-0.16
-0.63
-0.35
-0.16
1
-0.00047
0.57
-0.63
-0.00047
1
0.37
-0.35
0.57
0.37
1
av_swl
av_daily_rain
av_dd
av_sm_pct
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6

<><> TensorFlow Keras LSTM Model <><>

Optimiser: adam
Loss: mse
Number of Epochs: 100
Percentage of Training Data for Validation: 20.0%
Time Series Order: Chronological
Verbose: Off

<><> Model Architecture <><>

Input Shape (Samples, Timesteps, Features): (108, 3, 4)
LSTM Layers: 1
LSTM Cells per Layer: 64
Fully Connected Hidden Layers: 2
Fully Connected Hidden Neurons per Layer: 32
Fully Connected Output Neurons: 1
LSTM Dropout Rate: 20.0%
LSTM Recurrent Dropout Rate: 20.0%

Model: "sequential_46"

Layer (type)	Output Shape	Param #
lstm_46 (LSTM)	(None, 64)	17664
dense_138 (Dense)	(None, 32)	2080
dense_139 (Dense)	(None, 32)	1056
dense_140 (Dense)	(None, 1)	33

Total params: 20,833
Trainable params: 20,833
Non-trainable params: 0

<><> Training Loss <><>

Epoch: 10, Loss: 0.1503886729478836
Epoch: 20, Loss: 0.03315402939915657
Epoch: 30, Loss: 0.019160587340593338
Epoch: 40, Loss: 0.013090766035020351
Epoch: 50, Loss: 0.015777790918946266
Epoch: 60, Loss: 0.014202331192791462
Epoch: 70, Loss: 0.01156029012054205
Epoch: 80, Loss: 0.01388516929000616
Epoch: 90, Loss: 0.012389189563691616
Epoch: 100, Loss: 0.009792510420084

<><> Validation Loss <><>

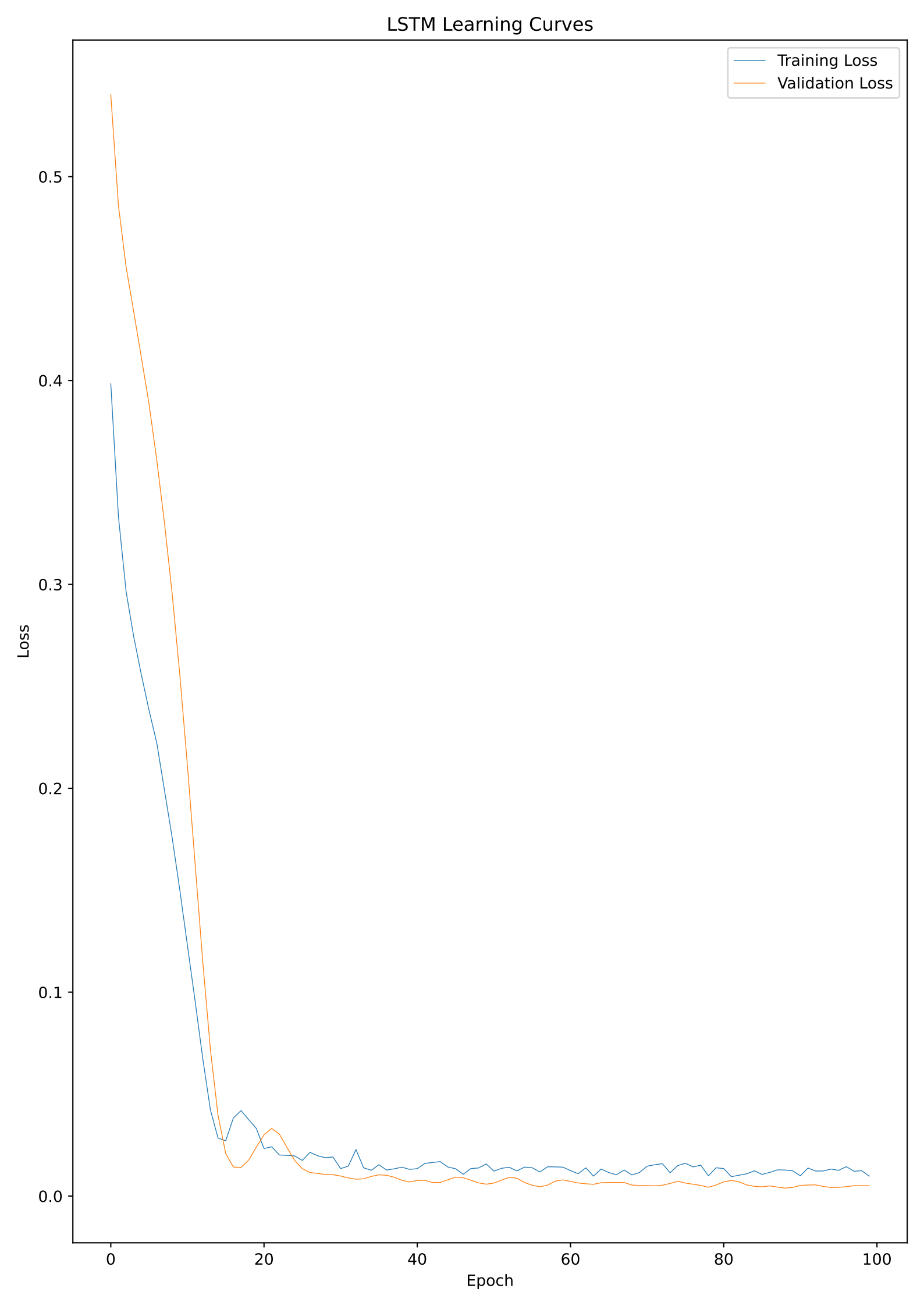
Epoch: 10,   Loss: 0.25605157017707825
Epoch: 20,   Loss: 0.024045903235673904
Epoch: 30,   Loss: 0.01047512050718069
Epoch: 40,   Loss: 0.006911067757755518
Epoch: 50,   Loss: 0.005833755247294903
Epoch: 60,   Loss: 0.007944361306726933
Epoch: 70,   Loss: 0.005196696147322655
Epoch: 80,   Loss: 0.0054094321094453335
Epoch: 90,   Loss: 0.004254915285855532
Epoch: 100,   Loss: 0.005050502251833677

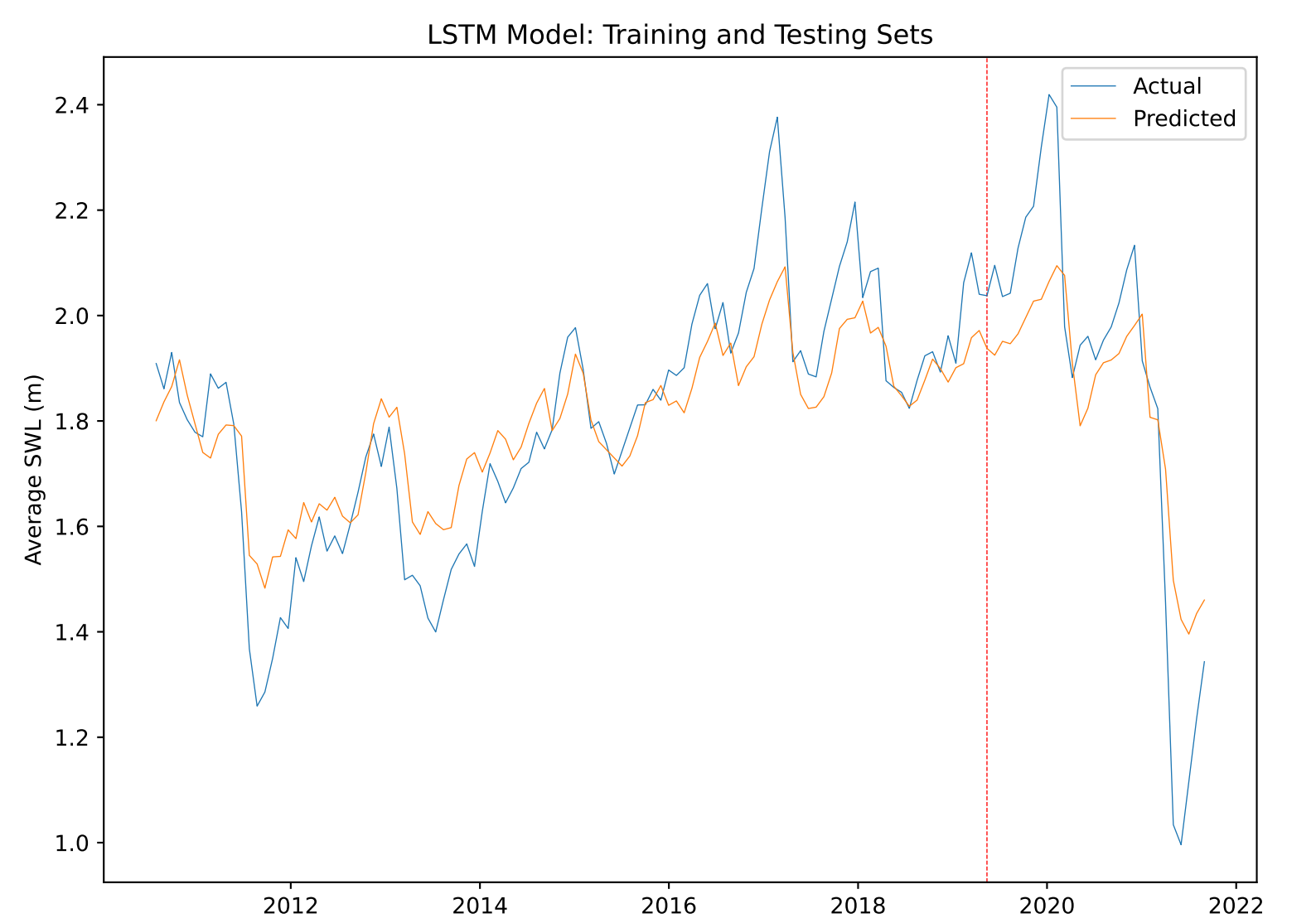
<><> Training Set Scores <><>

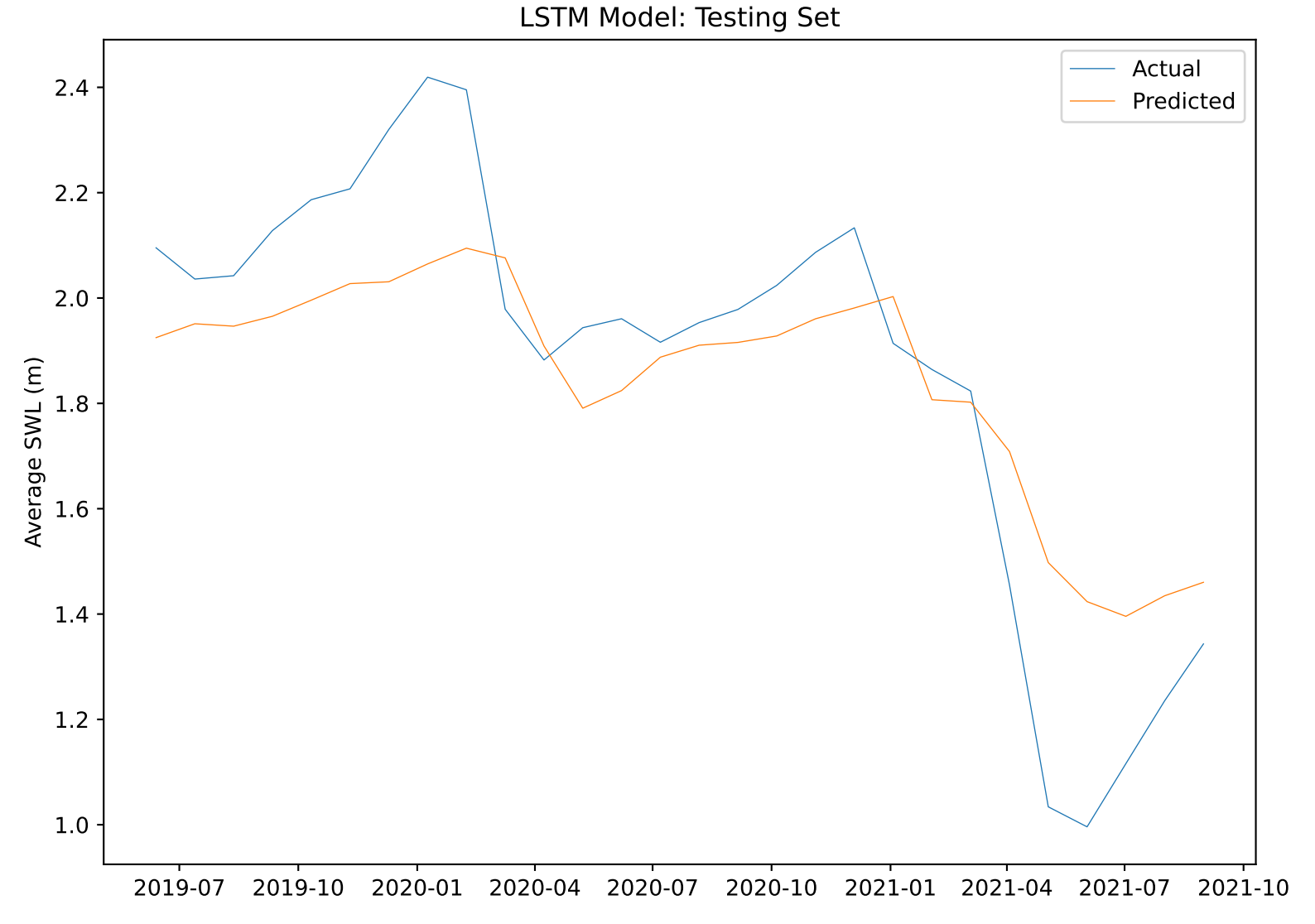
Train Root Mean Squared Error: 0.07886
Train Mean Squared Error: 0.00622
Train Normalised Root Mean Squared Error: 0.10046
Train Coefficient of Determination: 0.7507
Train Normalised Nash Sutcliffe Efficiency: 0.80045
Train Mean Absolute Error: 0.06232
Train Pearson's Correlation Coefficient: 0.93264
Train Index of Agreement: 0.89853
Train Kling-Gupta Efficiency: 0.58222
Train Mean Bias Error: -0.00185
Train Mean Absolute Percentage Error: 0.05086

<><> Test Set Scores <><>

Test Root Mean Squared Error: 0.14256
Test Mean Squared Error: 0.02032
Test Normalised Root Mean Squared Error: 0.14256
Test Coefficient of Determination: 0.72827
Test Normalised Nash Sutcliffe Efficiency: 0.78633
Test Mean Absolute Error: 0.11689
Test Pearson's Correlation Coefficient: 0.95203
Test Index of Agreement: 0.88294
Test Kling-Gupta Efficiency: 0.53223
Test Mean Bias Error: -0.01886
Test Mean Absolute Percentage Error: 0.10396


LSTM Learning Curves
Training Loss
Validation Loss
Loss
Epoch
0.0
0.1
0.2
0.3
0.4
0.5
0
20
40
60
80
100


LSTM Model: Training and Testing Sets
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2012
2014
2016
2018
2020
2022


LSTM Model: Testing Set
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10

LSTM Model: Training and Testing Sets
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2012
2014
2016
2018
2020
2022
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10

<><> Scikit Learn SVR Model <><>

Kernel Function: rbf
Kernel Coefficient: scale
Epsilon: 0.1
Stopping Criterion Tolerance: 1e-05
Regularisation Parameter: 1.0
Shrinking: True
Time Series Order: Chronological
Verbose: Off

<><> Model Architecture <><>

Number of Support Vectors: 20
Input/Support Vector Size: 12

<><> 5-Fold Cross Validation Mean Training Loss <><>

Epoch: 8,   Loss: 0.0019374427545810011
Epoch: 16,   Loss: 0.00658206100054521
Epoch: 24,   Loss: 0.005878276236353975
Epoch: 32,   Loss: 0.0053705562940711115
Epoch: 40,   Loss: 0.005025177619068231
Epoch: 48,   Loss: 0.004763305960099366
Epoch: 56,   Loss: 0.004267592007814004
Epoch: 64,   Loss: 0.004320165174492026
Epoch: 72,   Loss: 0.0043240064164985995
Epoch: 80,   Loss: 0.004055122782769806

<><> 5-Fold Cross Validation Mean Validation Loss <><>

Epoch: 8,   Loss: 0.02183136536234781
Epoch: 16,   Loss: 0.03278169737716904
Epoch: 24,   Loss: 0.03314699926910146
Epoch: 32,   Loss: 0.028628936585510485
Epoch: 40,   Loss: 0.02644091323330467
Epoch: 48,   Loss: 0.02561856809187283
Epoch: 56,   Loss: 0.017910745025780616
Epoch: 64,   Loss: 0.018026115889585415
Epoch: 72,   Loss: 0.01151435651717271
Epoch: 80,   Loss: 0.008860935177434285

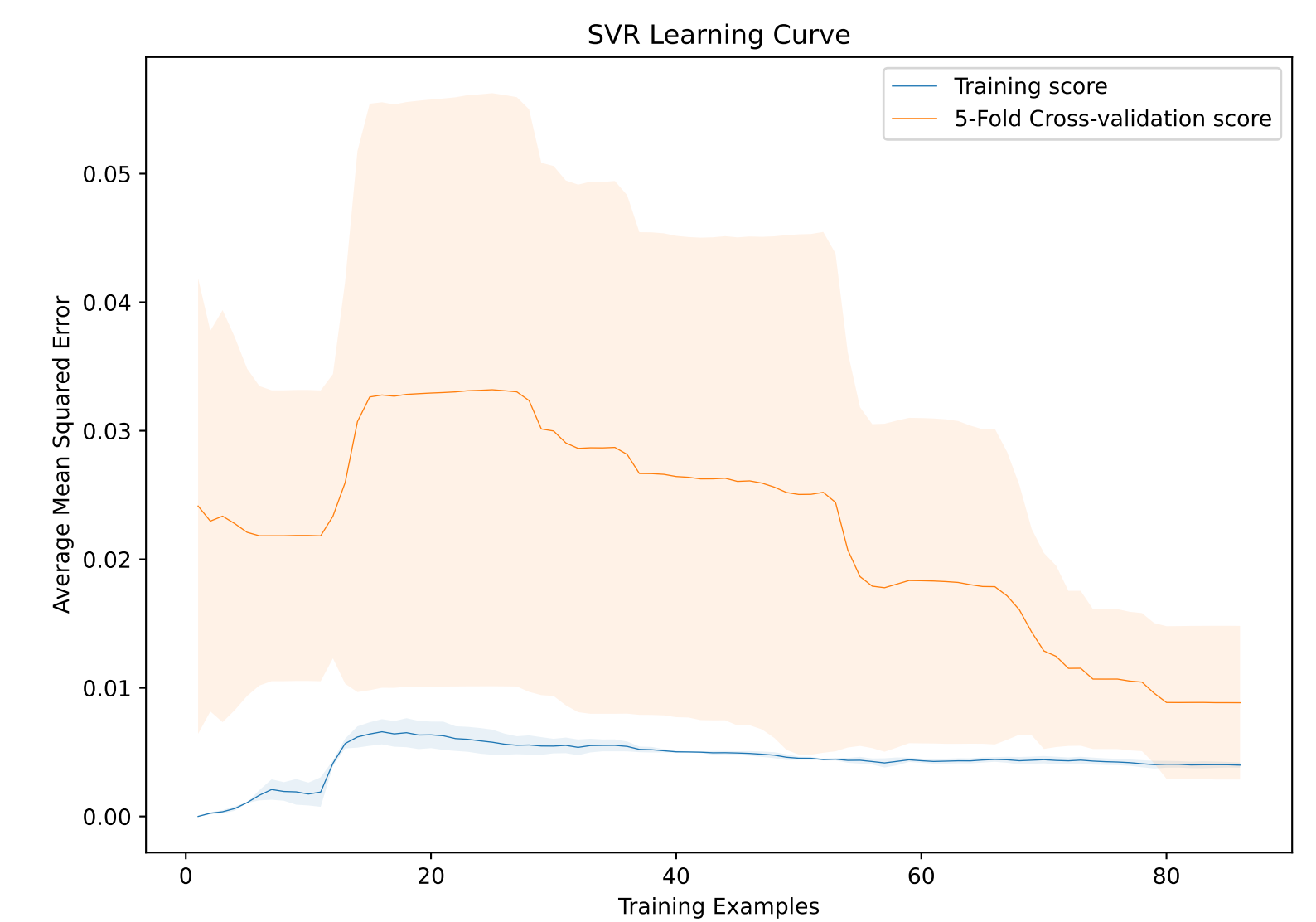
<><> Training Set Scores <><>

Train Root Mean Squared Error: 0.06136
Train Mean Squared Error: 0.00377
Train Normalised Root Mean Squared Error: 0.07817
Train Coefficient of Determination: 0.84906
Train Normalised Nash Sutcliffe Efficiency: 0.86886

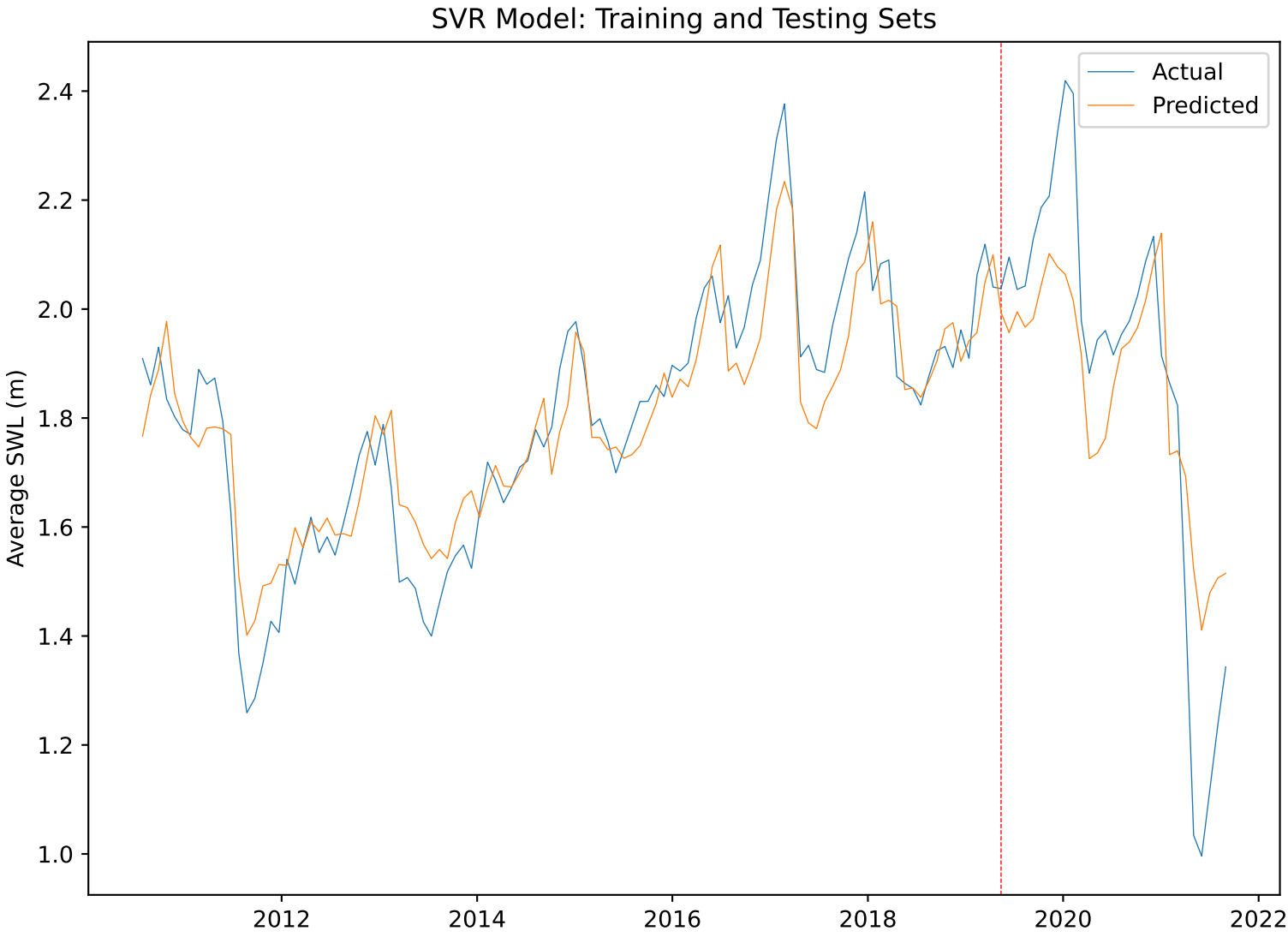
Train Mean Absolute Error: 0.05042
Train Pearson's Correlation Coefficient: 0.93395
Train Index of Agreement: 0.95126
Train Kling-Gupta Efficiency: 0.774
Train Mean Bias Error: -0.0042
Train Mean Absolute Percentage Error: 0.04072

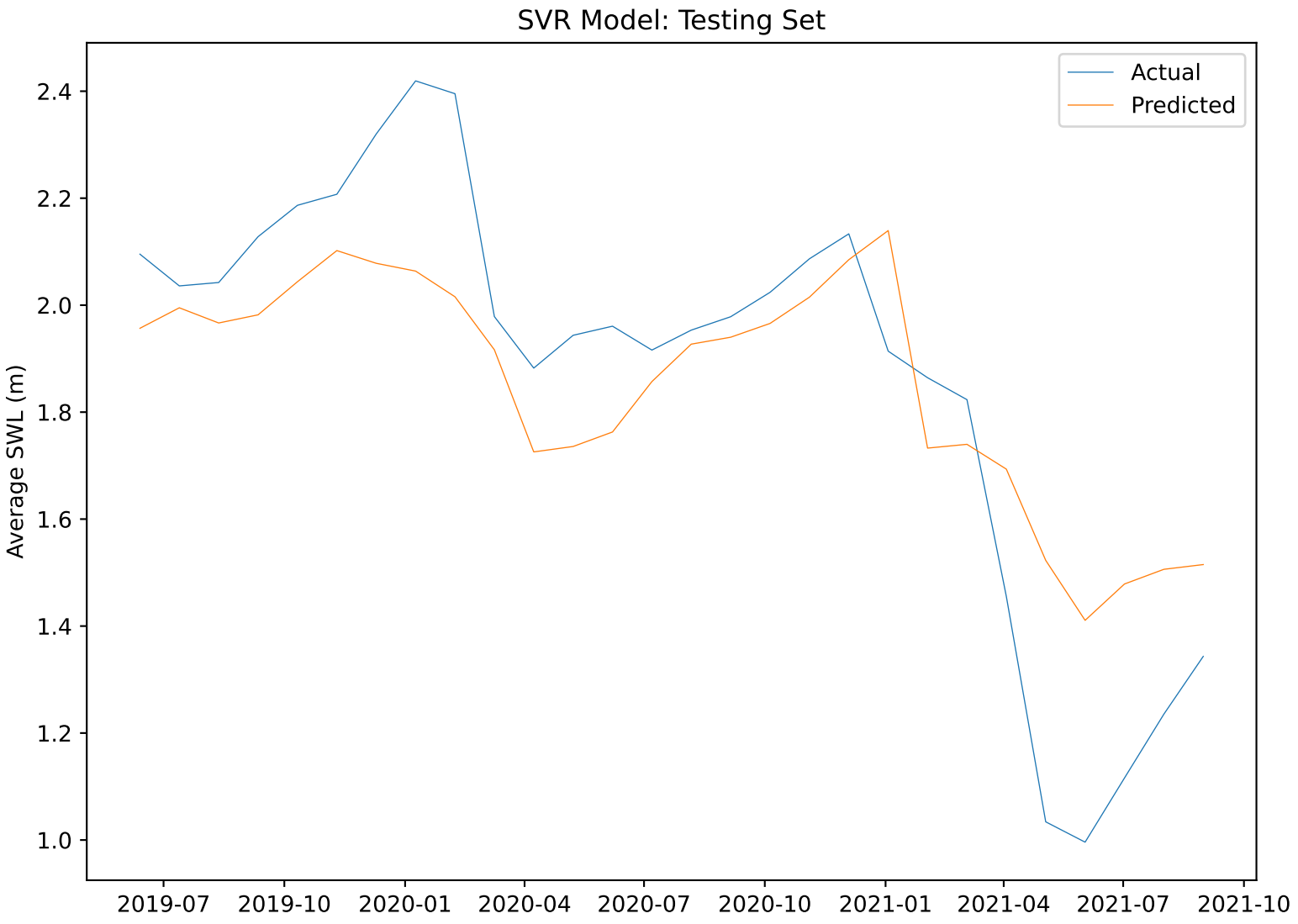
<><> Test Set Scores <><>

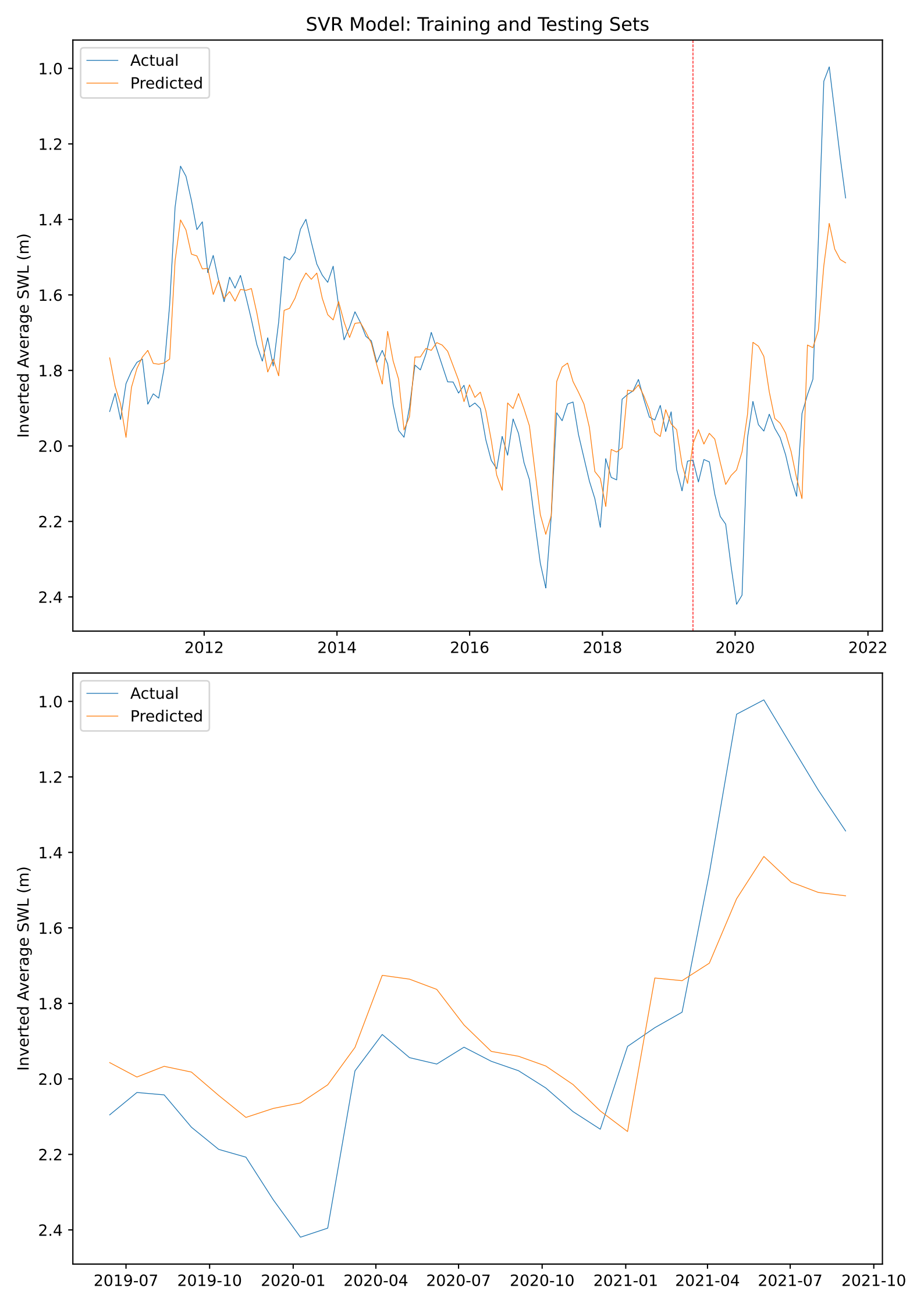
Test Root Mean Squared Error: 0.15213
Test Mean Squared Error: 0.02314
Test Normalised Root Mean Squared Error: 0.15213
Test Coefficient of Determination: 0.69054
Test Normalised Nash Sutcliffe Efficiency: 0.76368
Test Mean Absolute Error: 0.12396
Test Pearson's Correlation Coefficient: 0.91134
Test Index of Agreement: 0.86559
Test Kling-Gupta Efficiency: 0.53208
Test Mean Bias Error: -0.01495
Test Mean Absolute Percentage Error: 0.11234


SVR Learning Curve
Training score
5-Fold Cross-validation score
Average Mean Squared Error
0.05
0.04
0.03
0.02
0.01
0.00
0
20
40
60
80
Training Examples

Model Scalability
Fit Times
0.0011
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0
20
40
60
80
Training Examples


SVR Model: Training and Testing Sets
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2012
2014
2016
2018
2020
2022


SVR Model: Testing Set
Actual
Predicted
Average SWL (m)
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10


SVR Model: Training and Testing Sets
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2012
2014
2016
2018
2020
2022
Actual
Predicted
Inverted Average SWL (m)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2019-07
2019-10
2020-01
2020-04
2020-07
2020-10
2021-01
2021-04
2021-07
2021-10