# prova

February 9, 2023

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mplt
import seaborn as sns
import arviz as az
import datetime
```

[2]:
```
import fit_arima
```

[3]:
```
import open_data
df = open_data.open()
```

[4]:
```
ritorno = fit_arima.compute(2, 1, catene=4, samples_per_chain=2500, burnin=1000)
```

```
20:24:12 - cmdstanpy - INFO - CmdStan start processing

chain 1 |          | 00:00 Status

chain 2 |          | 00:00 Status

chain 3 |          | 00:00 Status

chain 4 |          | 00:00 Status


20:49:49 - cmdstanpy - INFO - CmdStan done processing.
20:49:49 - cmdstanpy - WARNING - Non-fatal error during sampling:
Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in '/home/b
r1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code.stan',
line 157, column 4 to column 34)
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
        Exception: code_model_namespace::log_prob: phi[1][1] is -nan, but must
be greater than or equal to -1.000000 (in '/home/br1/PythonProjects/PythonStats/
git_bayesian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column
```

```
47)
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
Exception: normal_lpdf: Scale parameter is -1.77241, but must be positive! (in '
/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code.
stan', line 143, column 4 to column 61)
        Exception: normal_lpdf: Scale parameter is -1.33685, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
        Exception: normal_lpdf: Scale parameter is -1.88462, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
        Exception: code_model_namespace::log_prob: phi[2][49] is 1, but must be
less than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bay
esian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
        Exception: code_model_namespace::log_prob: phi[1][17] is 1, but must be
less than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bay
esian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
        Exception: normal_lpdf: Scale parameter is -1.63119, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
        Exception: code_model_namespace::log_prob: phi[1][1] is -nan, but must
be greater than or equal to -1.000000 (in '/home/br1/PythonProjects/PythonStats/
git_bayesian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column
47)
        Exception: code_model_namespace::log_prob: phi[2][24] is -nan, but must
be greater than or equal to -1.000000 (in '/home/br1/PythonProjects/PythonStats/
git_bayesian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column
47)
        Exception: normal_lpdf: Scale parameter is -0.00166804, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
        Exception: normal_lpdf: Scale parameter is -0.014183, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
Exception: normal_lpdf: Scale parameter is -1.93972, but must be positive! (in '
/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code.
stan', line 143, column 4 to column 61)
        Exception: normal_lpdf: Scale parameter is -0.38646, but must be
positive! (in '/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoC
ovariates/code.stan', line 143, column 4 to column 61)
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
```

```
        Exception: normal_lpdf: Scale parameter is 0, but must be positive! (in
'/home/br1/PythonProjects/PythonStats/git_bayesian_copie/ARIMA/NoCovariates/code
.stan', line 157, column 4 to column 34)
        Exception: code_model_namespace::log_prob: phi[1][1] is -nan, but must
be greater than or equal to -1.000000 (in '/home/br1/PythonProjects/PythonStats/
git_bayesian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column
47)
        Exception: code_model_namespace::log_prob: phi[1][5] is 1, but must be
less than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bay
esian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
Exception: code_model_namespace::log_prob: phi[2][37] is 1, but must be less
than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bayesian
_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
        Exception: code_model_namespace::log_prob: phi[2][11] is 1, but must be
less than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bay
esian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
        Exception: code_model_namespace::log_prob: phi[1][8] is -nan, but must
be greater than or equal to -1.000000 (in '/home/br1/PythonProjects/PythonStats/
git_bayesian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column
47)
        Exception: code_model_namespace::log_prob: phi[1][8] is 1, but must be
less than or equal to 1.000000 (in '/home/br1/PythonProjects/PythonStats/git_bay
esian_copie/ARIMA/NoCovariates/code.stan', line 83, column 2 to column 47)
Consider re-running with show_console=True if the above output is unclear!


/home/br1/PythonProjects/PythonStats/ARIMA_last_computation/NoCovariates/fit_ari
ma.py:37: FutureWarning: Indexing with a float is deprecated, and will raise an
IndexError in pandas 2.0. You can manually convert to an integer key instead.
  y_missing_list.append({'Stazione':df.columns[v[i]],'Data':df.index[u[i]],'Samp
les':inference_data.posterior.w.values[:,:,i].reshape(catene*samples_per_chain)}
)
```

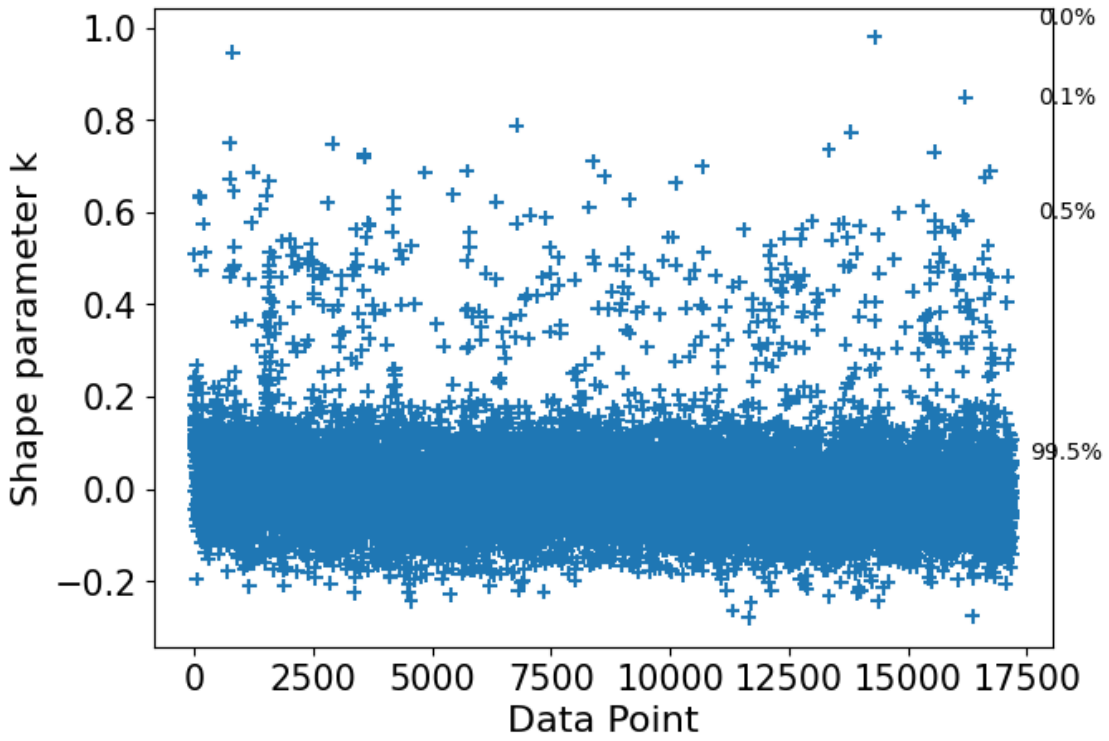
Tempo di computazione: 25:37

[5]:
```
res = az.loo(ritorno['inference_data'], var_name="log_lik", pointwise=True)
res
```

```
/home/br1/PythonProjects/PythonStats/.venv/lib/python3.10/site-
packages/arviz/stats/stats.py:803: UserWarning: Estimated shape parameter of
Pareto distribution is greater than 0.7 for one or more samples. You should
consider using a more robust model, this is because importance sampling is less
likely to work well if the marginal posterior and LOO posterior are very
different. This is more likely to happen with a non-robust model and highly
influential observations.
  warnings.warn(
```

[5]:
```
Computed from 10000 posterior samples and 17191 observations log-likelihood
matrix.

         Estimate       SE
elpd_loo  7252.62   154.96
p_loo      296.80        -

There has been a warning during the calculation. Please check the results.
------

Pareto k diagnostic values:
                         Count   Pct.
(-Inf, 0.5]   (good)     17099   99.5%
 (0.5, 0.7]   (ok)          80    0.5%
   (0.7, 1]   (bad)         12    0.1%
   (1, Inf)   (very bad)     0    0.0%
```

[6]:
```
aux_plt = az.plot_khat(res, show_bins=True, figsize=(7,5))
```



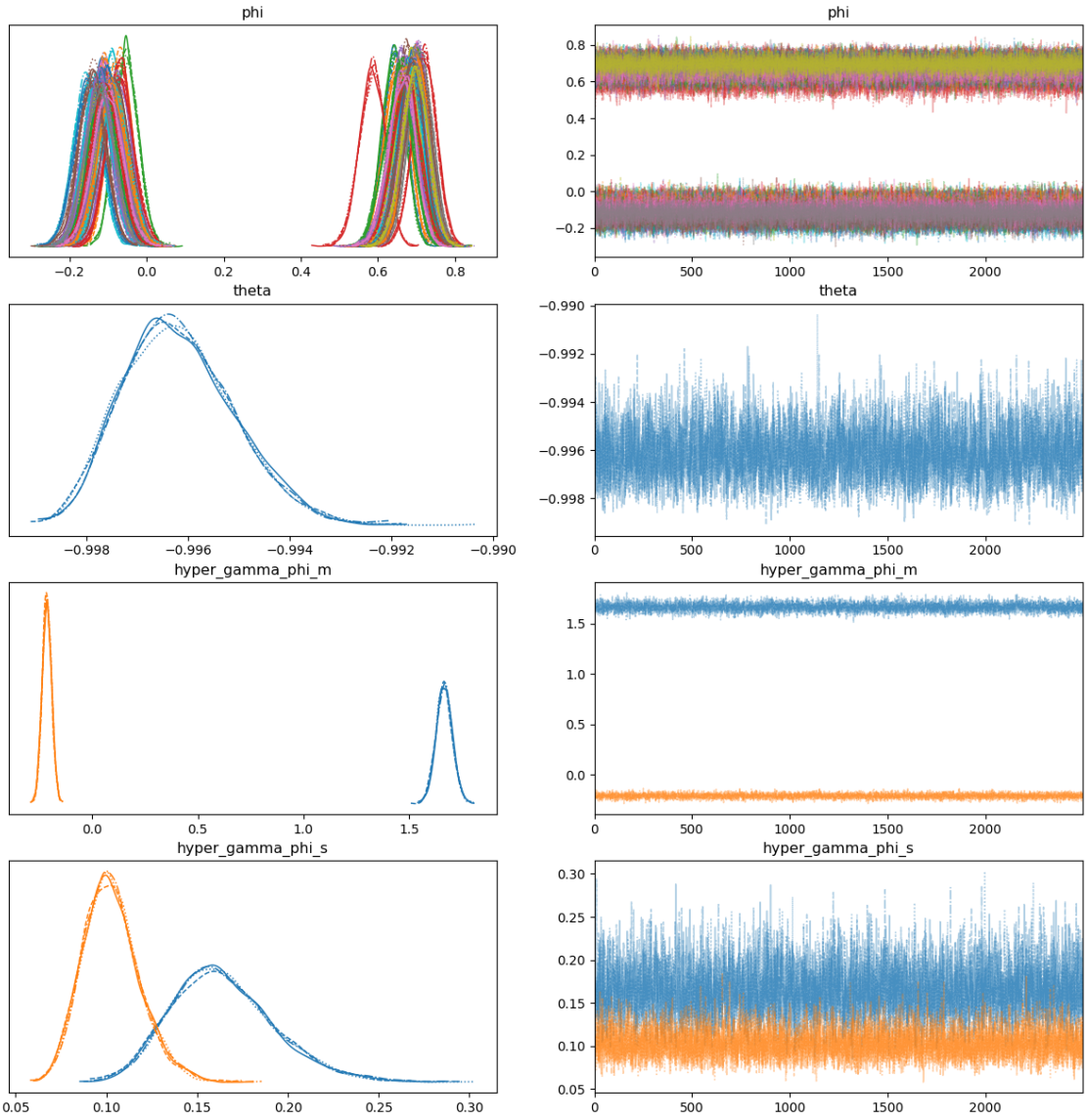

[7]:
```
res = az.waic(ritorno['inference_data'], var_name="log_lik")
res
```

```
/home/br1/PythonProjects/PythonStats/.venv/lib/python3.10/site-
```

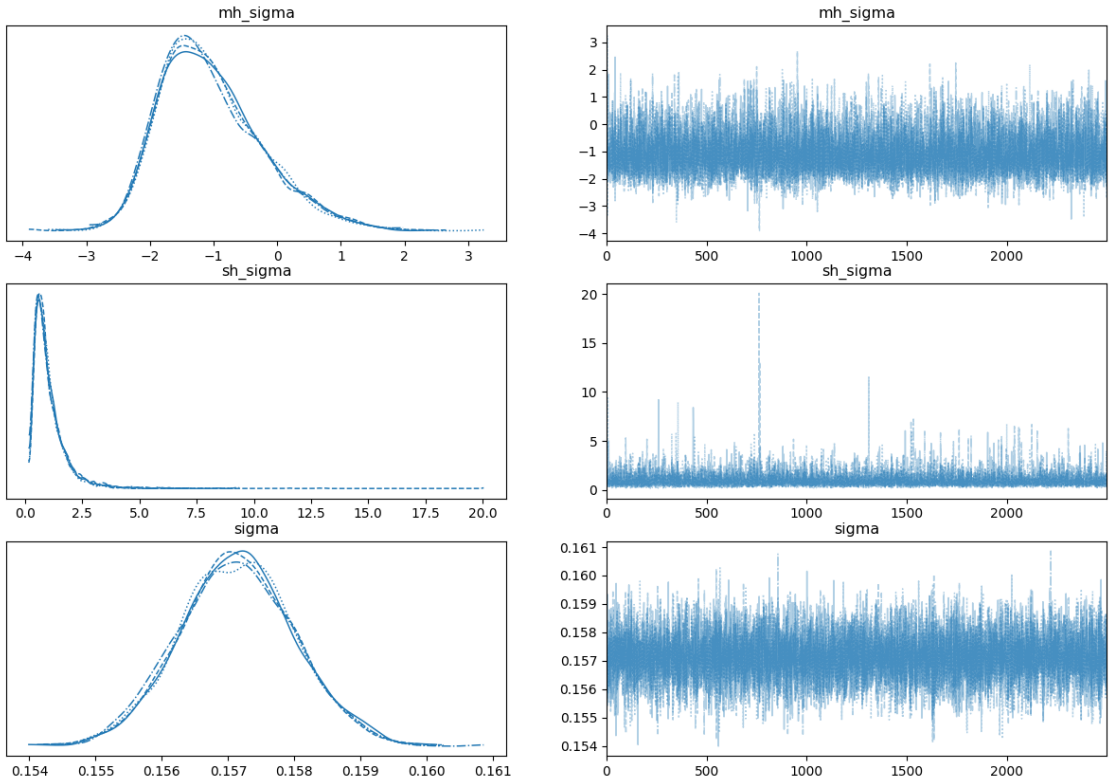
```
packages/arviz/stats/stats.py:1645: UserWarning: For one or more samples the
posterior variance of the log predictive densities exceeds 0.4. This could be
indication of WAIC starting to fail.
See http://arxiv.org/abs/1507.04544 for details
  warnings.warn(
```

[7]:
```
Computed from 10000 posterior samples and 17191 observations log-likelihood
matrix.

          Estimate       SE
elpd_waic  7264.00   154.85
p_waic      285.43        -

There has been a warning during the calculation. Please check the results.
```

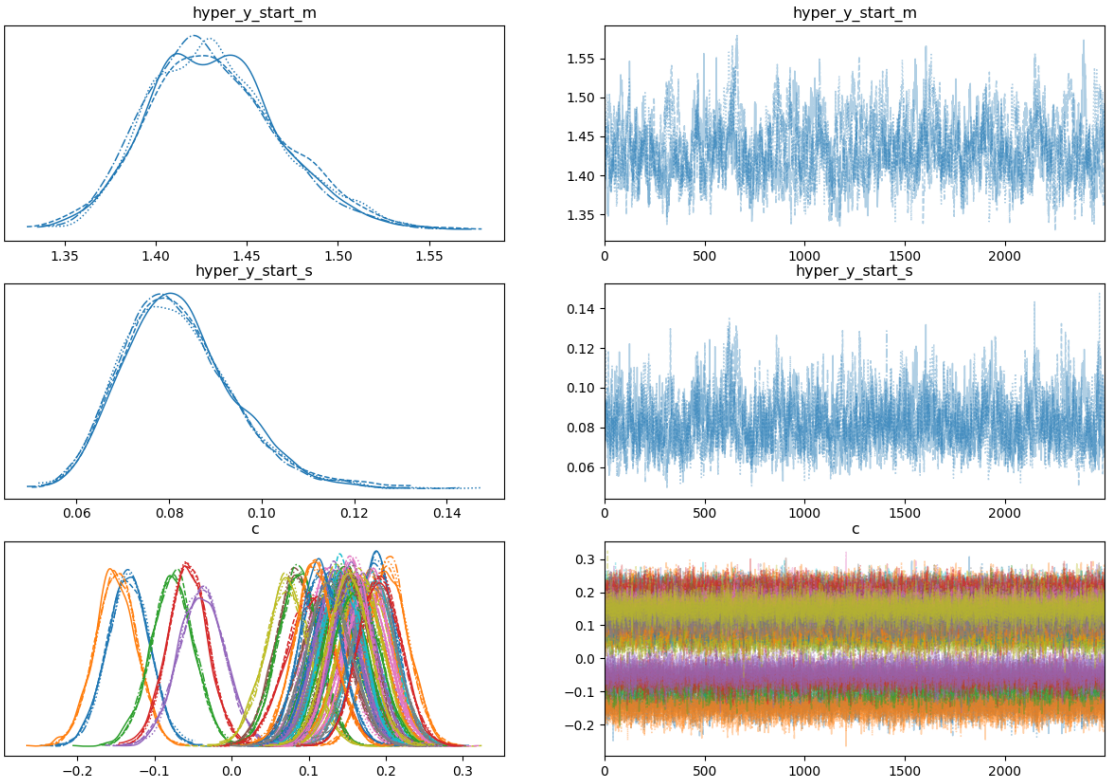
[8]:
```
plt_aux = az.plot_trace(ritorno['inference_data'],␣
↪var_names=['phi','theta','hyper_gamma_phi_m','hyper_gamma_phi_s'],␣
↪divergences=True, figsize=(15,15))
```




[9]:
```
plt_aux = az.plot_trace(ritorno['inference_data'],␣
↪var_names=['mh_sigma','sh_sigma','sigma'], divergences=True, figsize=(15,10))
```




[10]:
```
plt_aux = az.plot_trace(ritorno['inference_data'],␣
↪var_names=['hyper_y_start_m','hyper_y_start_s','c'], divergences=True,␣
↪figsize=(15,10))
```




[11]:
```
az.summary(ritorno['inference_data'],var_names=['y_start'])
```

[11]:

| | mean | sd | hdi_3% | hdi_97% | mcse_mean | mcse_sd | ess_bulk | ess_tail | r_hat |
|---|---|---|---|---|---|---|---|---|---|
| y_start[0, 0] | 1.421 | 0.089 | 1.254 | 1.588 | 0.002 | 0.001 | 2237.0 | 3725.0 | 1.0 |
| y_start[0, 1] | 1.420 | 0.089 | 1.247 | 1.586 | 0.002 | 0.001 | 2358.0 | 3599.0 | 1.0 |
| y_start[0, 2] | 1.424 | 0.093 | 1.249 | 1.597 | 0.002 | 0.001 | 2835.0 | 4100.0 | 1.0 |
| y_start[0, 3] | 1.424 | 0.090 | 1.248 | 1.588 | 0.002 | 0.001 | 3154.0 | 4000.0 | 1.0 |
| y_start[0, 4] | 1.427 | 0.091 | 1.259 | 1.600 | 0.002 | 0.001 | 2664.0 | 3541.0 | 1.0 |
| … | … | … | … | … | … | … | … | … | … |
| y_start[2, 44] | 1.445 | 0.054 | 1.346 | 1.549 | 0.001 | 0.001 | 1481.0 | | |
| y_start[2, 45] | 1.442 | 0.055 | 1.338 | 1.545 | 0.001 | 0.001 | 1620.0 | | |
| y_start[2, 46] | 1.438 | 0.054 | 1.338 | 1.538 | 0.001 | 0.001 | 1732.0 | | |
| y_start[2, 47] | 1.452 | 0.055 | 1.347 | 1.552 | 0.001 | 0.001 | 1487.0 | | |
| y_start[2, 48] | 1.459 | 0.056 | 1.355 | 1.562 | 0.001 | 0.001 | 1563.0 | | |

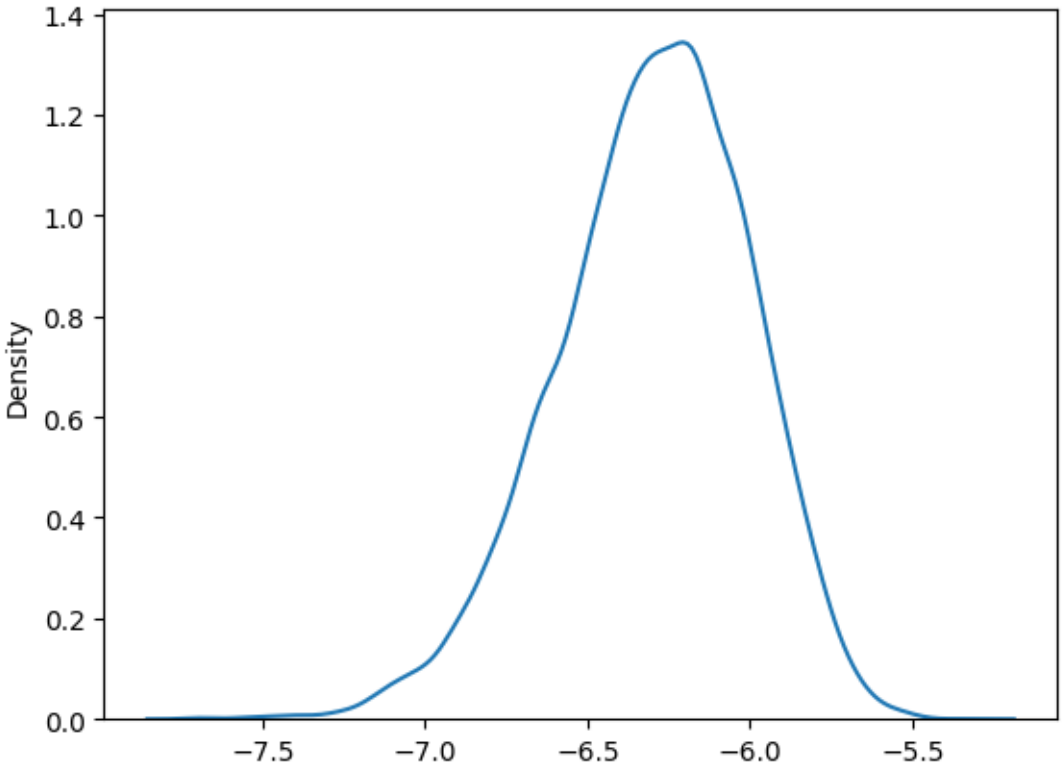
```
y_start[2, 44]    2555.0    1.0
y_start[2, 45]    2722.0    1.0
y_start[2, 46]    2540.0    1.0
y_start[2, 47]    2769.0    1.0
y_start[2, 48]    2712.0    1.0

[147 rows x 9 columns]
```

[12]:
```
az.summary(ritorno['inference_data'], var_names=['hyper_y_start_m',␣
 ↪'hyper_y_start_s'])
```

[12]:
```
                 mean     sd  hdi_3%  hdi_97%  mcse_mean  mcse_sd  ess_bulk  \
hyper_y_start_m  1.432  0.037   1.367    1.504      0.002    0.001     431.0
hyper_y_start_s  0.082  0.012   0.061    0.105      0.001    0.000     580.0

                 ess_tail  r_hat
hyper_y_start_m     772.0    1.0
hyper_y_start_s    1215.0    1.0
```

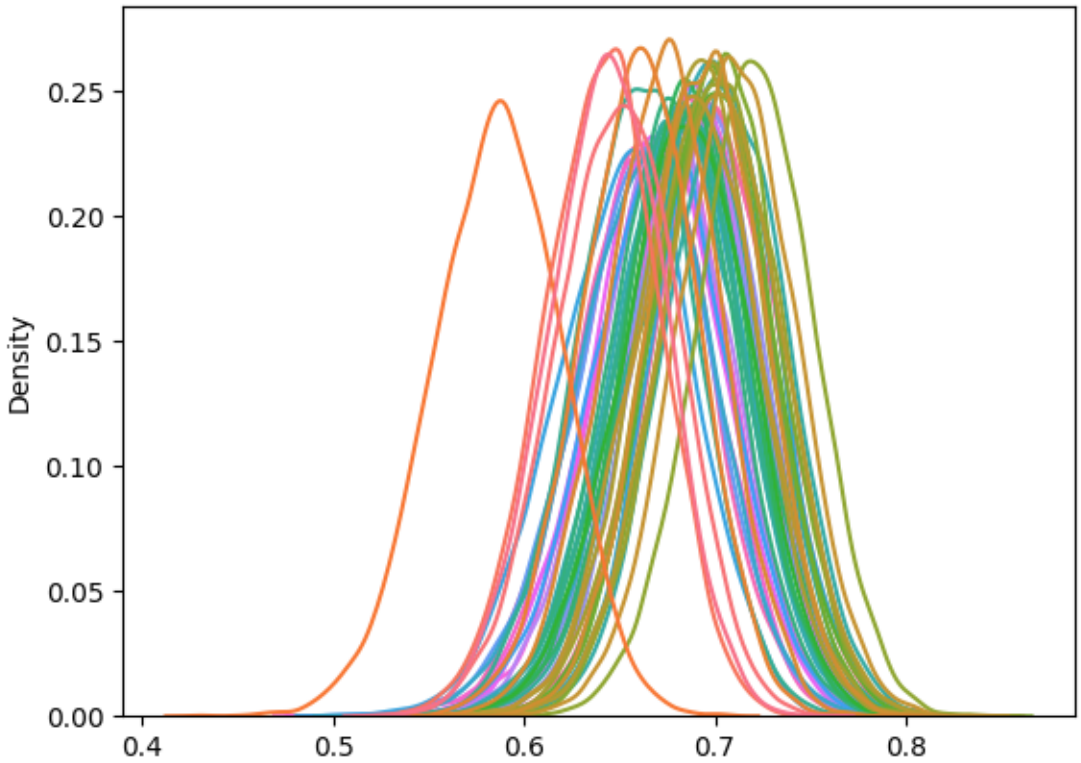
[13]:
```
aux_shape = ritorno['inference_data'].posterior.gamma_th.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.gamma_th.values.
 ↪reshape((aux_shape[0]*aux_shape[1])), legend=False)
```

[13]:
```
<AxesSubplot: ylabel='Density'>
```



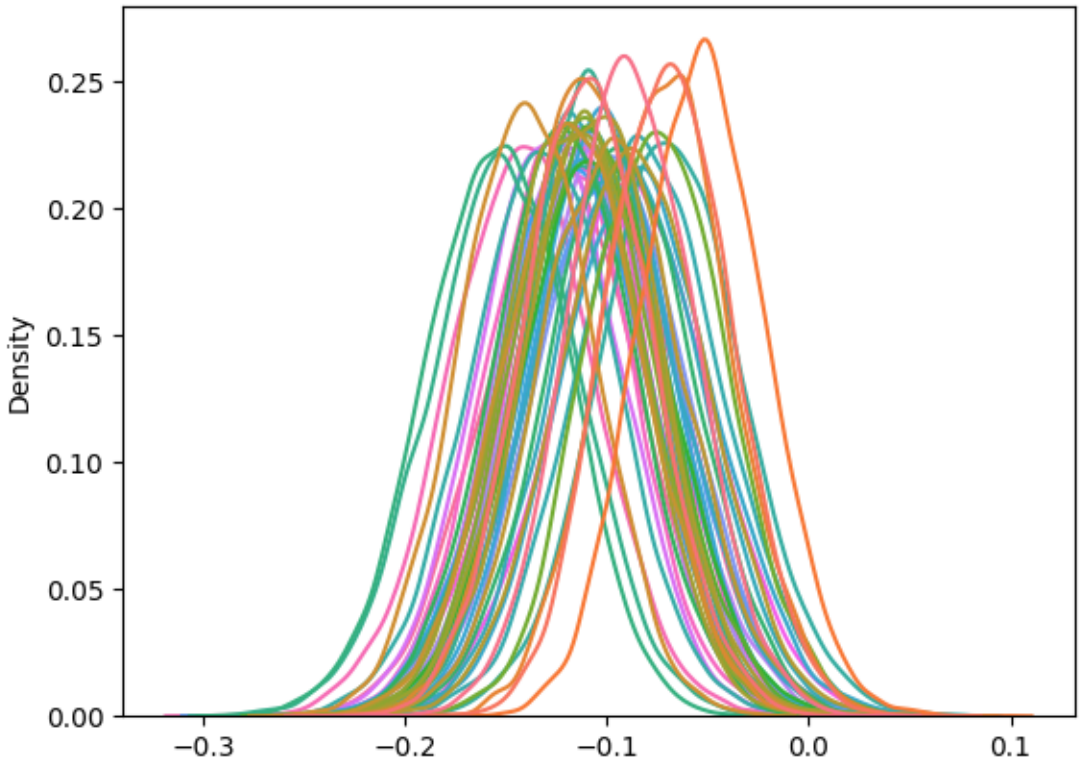
[14]:
```
aux_shape = ritorno['inference_data'].posterior.phi.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.phi.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2],aux_shape[3]))[:,0,:],␣
  ↪legend=False)
```

[14]:
```
<AxesSubplot: ylabel='Density'>
```



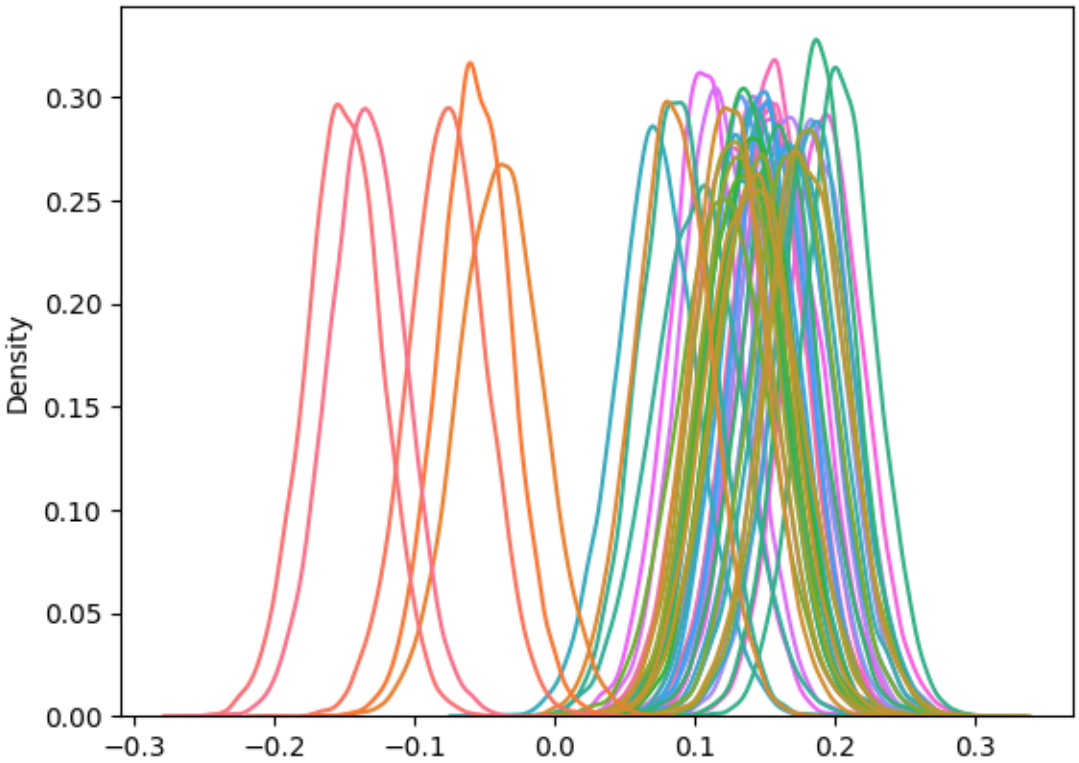

[15]:
```
aux_shape = ritorno['inference_data'].posterior.phi.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.phi.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2],aux_shape[3]))[:,1,:],␣
  ↪legend=False)
```

[15]:
```
<AxesSubplot: ylabel='Density'>
```



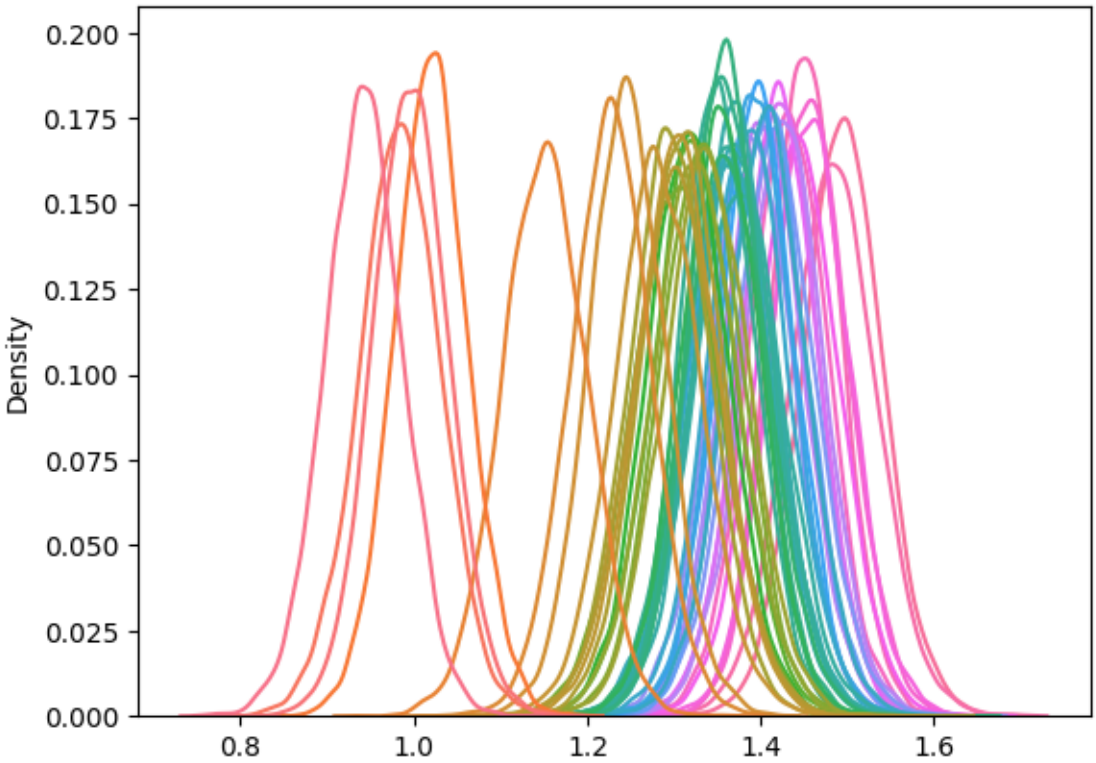

[16]:
```
aux_shape = ritorno['inference_data'].posterior.c.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.c.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), legend=False)
```

[16]: <AxesSubplot: ylabel='Density'>



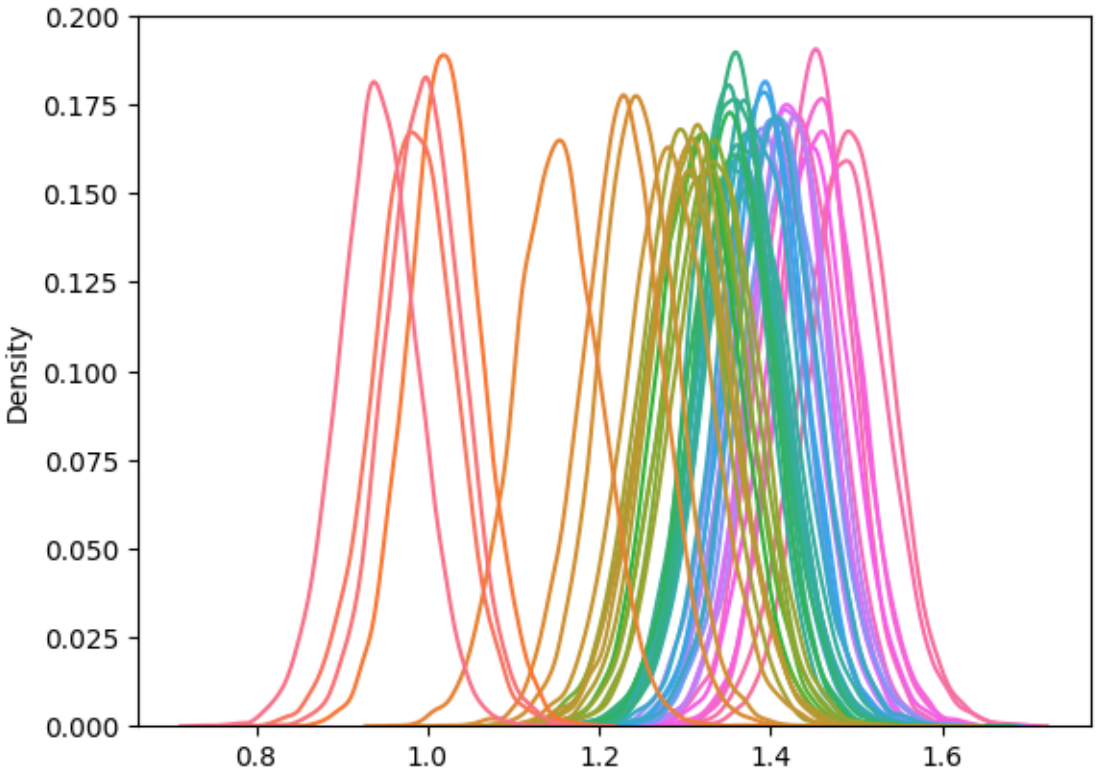

[17]:
```
aux_shape = ritorno['inference_data'].posterior.annual_mean.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.annual_mean.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), legend=False)
```

[17]: <AxesSubplot: ylabel='Density'>



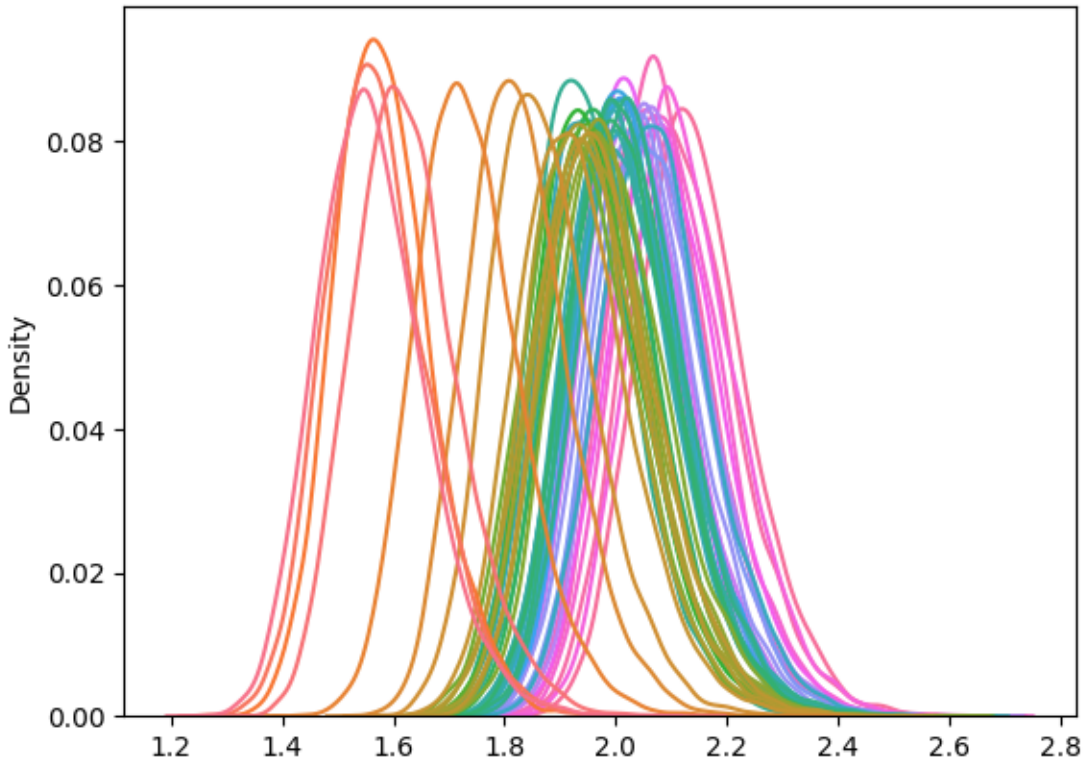

[18]:
```
aux_shape = ritorno['inference_data'].posterior.annual_median.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.annual_median.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), legend=False)
```

[18]: <AxesSubplot: ylabel='Density'>

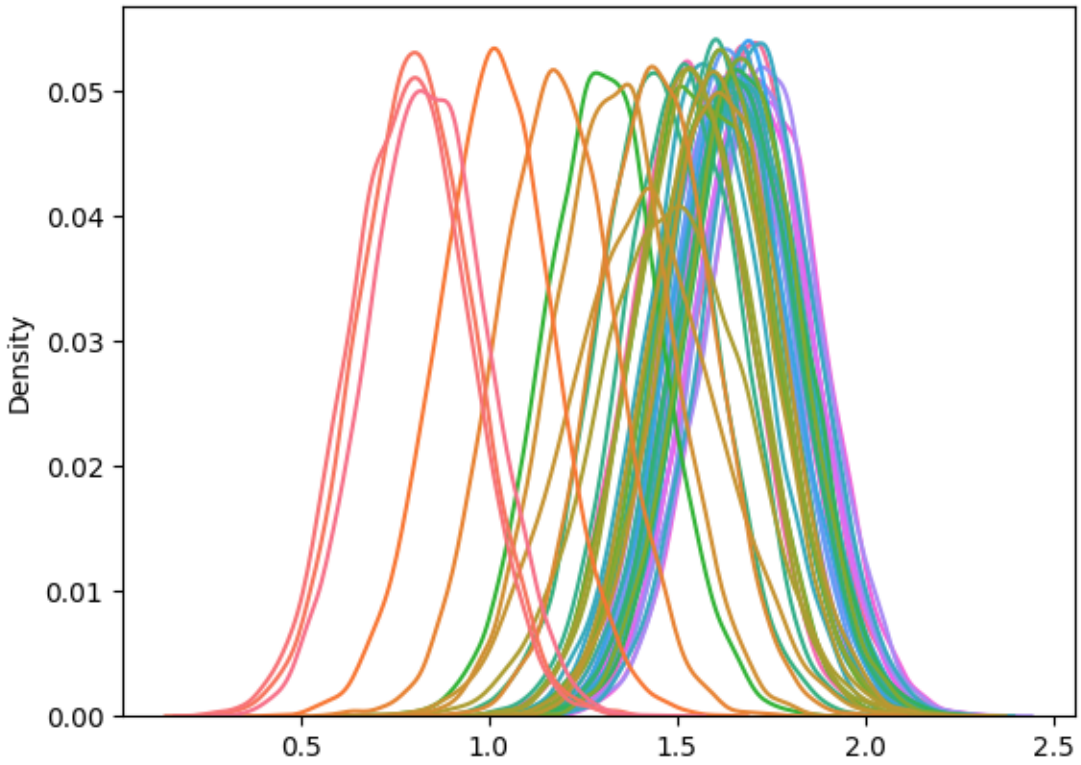



[19]:
```
aux_shape = ritorno['inference_data'].posterior.annual_max.values.shape
sns.kdeplot(ritorno['inference_data'].posterior.annual_max.values.
  ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), legend=False)
```

[19]:
```
<AxesSubplot: ylabel='Density'>
```

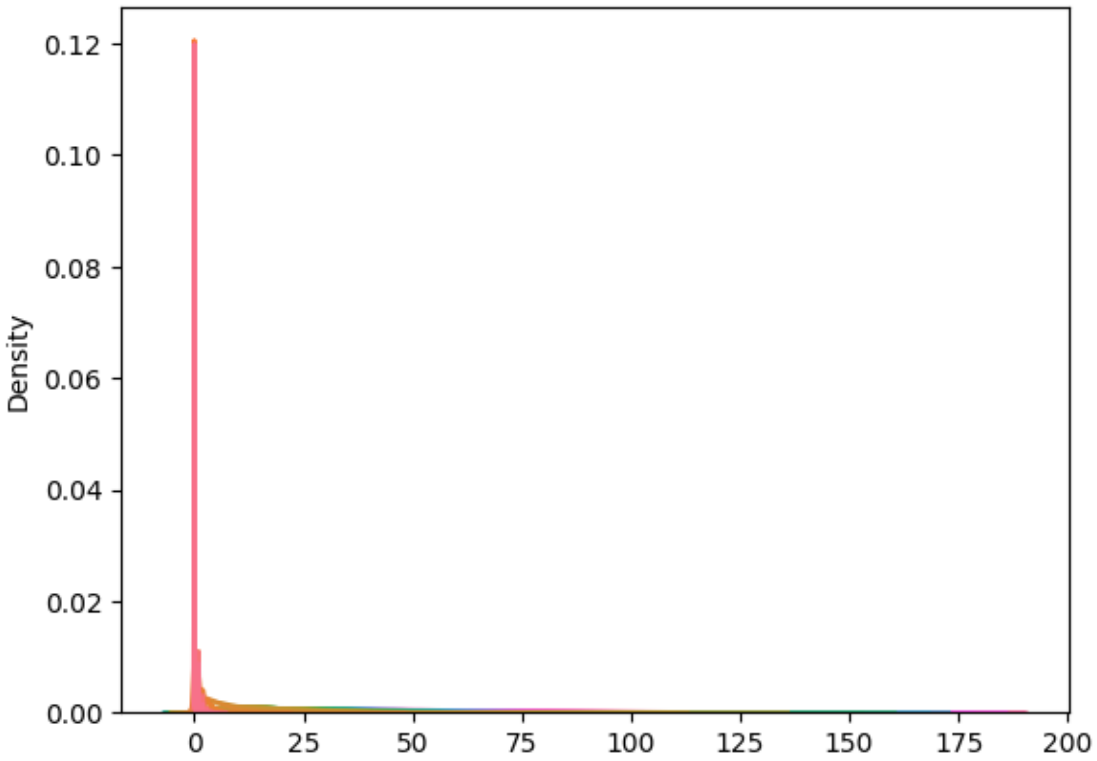



[20]:
```
valori_31_dic = []
for dizionario in ritorno['missing']:
    if dizionario['Data'] == '2018-12-31':
        valori_31_dic.append(dizionario['Samples'])

res_plot = sns.kdeplot(valori_31_dic, legend=False)
```




[21]:
```
aux_shape = ritorno['inference_data'].posterior.annual_days_over_threshold.
  ↪values.shape
sns.kdeplot(ritorno['inference_data'].posterior.annual_days_over_threshold.
  ↪values.reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), legend=False)
```

[21]:
```
<AxesSubplot: ylabel='Density'>
```




[22]:
```
pd.set_option('display.max_columns', 500)
aux_results = pd.DataFrame(ritorno['inference_data'].posterior.
 ↪annual_days_over_threshold.values.
 ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), columns=df.columns).
 ↪describe()
aux_results.sort_values('mean', axis=1, ascending=True)
```

[22]:

| | CASTELLUCCIO | SAVIGNANO DI RIGO | CORTE BRUGNATELLA | FEBBIO | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.106700 | 0.116400 | 0.119700 | 0.289000 | |
| std | 0.391574 | 0.382185 | 0.408642 | 0.673739 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| max | 5.000000 | 4.000000 | 7.000000 | 7.000000 | |

| | SAN LEO | VERUCCHIO | BADIA | GIARDINI MARGHERITA | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 1.559900 | 4.887700 | 7.687600 | 13.404600 | |
| std | 1.934473 | 4.081612 | 5.397863 | 8.422006 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |

```
25%        0.000000      2.000000      4.000000             7.000000
50%        1.000000      4.000000      7.000000            12.000000
75%        2.000000      7.000000     10.000000            18.000000
max       21.000000     46.000000     46.000000            71.000000

          MARECCHIA  SAN PIETRO CAPOFIUME  PARCO BERTOZZI     LUGAGNANO  \
count  10000.000000          10000.000000    10000.000000  10000.000000
mean      15.672500             15.793200       17.390400     17.684900
std        8.934071              9.851515       10.357901      9.836335
min        0.000000              0.000000        0.000000      0.000000
25%        9.000000              9.000000       10.000000     11.000000
50%       14.000000             14.000000       16.000000     16.000000
75%       20.000000             21.000000       23.000000     23.000000
max       82.000000            104.000000      131.000000     93.000000

          DE AMICIS  DELTA CERVIA   SAN LAZZARO  PARCO RESISTENZA  \
count  10000.000000  10000.000000  10000.000000      10000.000000
mean      17.879000     17.911000     18.899100         19.614500
std        9.548742      9.619789     10.460395         10.308885
min        0.000000      0.000000      0.000000          0.000000
25%       11.000000     11.000000     11.000000         12.000000
50%       16.000000     16.000000     17.000000         18.000000
75%       23.000000     23.000000     24.000000         25.000000
max       86.000000     84.000000     92.000000        108.000000

       FRANCHINI-ANGELONI      GHERARDI  VIA CHIARINI       GAVELLO  \
count        10000.000000  10000.000000  10000.000000  10000.000000
mean            20.996000     21.328200     21.453700     23.363100
std             11.223385     11.700238     11.404677     11.355472
min              0.000000      0.000000      0.000000      0.000000
25%             13.000000     13.000000     13.000000     15.000000
50%             19.000000     19.000000     19.000000     22.000000
75%             27.000000     28.000000     27.000000     30.000000
max            105.000000    104.000000    104.000000     99.000000

         SAVIGNANO     BESENZONE  VILLA FULVIA          ROMA  \
count  10000.00000  10000.000000  10000.000000  10000.000000
mean      23.59780     24.217700     28.324600     28.342200
std       11.55254     12.700694     13.488366     13.409634
min        0.00000      0.000000      0.000000      0.000000
25%       15.00000     15.000000     19.000000     19.000000
50%       22.00000     22.000000     26.000000     26.000000
75%       30.00000     31.000000     36.000000     36.000000
max      103.00000    108.000000    112.000000    154.000000

       PORTA SAN FELICE  CASTELLARANO        CAORLE  PARCO MONTECUCCO  \
count      10000.000000   10000.00000  10000.000000      10000.000000
```

| | | | | |
|---|---|---|---|---|
| mean | 28.789300 | 29.24280 | 29.529800 | 30.391600 |
| std | 13.087469 | 11.81637 | 14.628524 | 13.945031 |
| min | 0.000000 | 2.00000 | 0.000000 | 0.000000 |
| 25% | 19.000000 | 21.00000 | 19.000000 | 20.000000 |
| 50% | 27.000000 | 28.00000 | 27.000000 | 28.000000 |
| 75% | 36.000000 | 36.00000 | 38.000000 | 38.000000 |
| max | 110.000000 | 113.00000 | 146.000000 | 122.000000 |

| | ZALAMELLA | CENTO | PARCO EDILCARANI | BOGOLESE | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.00000 | 10000.000000 | 10000.000000 | |
| mean | 30.775400 | 31.16390 | 31.796000 | 32.263300 | |
| std | 14.034288 | 14.23678 | 12.686799 | 13.744761 | |
| min | 0.000000 | 2.00000 | 3.000000 | 2.000000 | |
| 25% | 21.000000 | 21.00000 | 23.000000 | 22.000000 | |
| 50% | 29.000000 | 29.00000 | 30.000000 | 30.000000 | |
| 75% | 39.000000 | 39.00000 | 39.000000 | 40.000000 | |
| max | 135.000000 | 127.00000 | 98.000000 | 142.000000 | |

| | SARAGAT | PARADIGNA | S. LAZZARO | MALCANTONE | REMESINA | \ |
|---|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 34.652500 | 35.675200 | 36.286400 | 36.308700 | 37.110300 | |
| std | 14.303105 | 14.884061 | 15.056349 | 15.017036 | 14.948314 | |
| min | 3.000000 | 3.000000 | 3.000000 | 3.000000 | 2.000000 | |
| 25% | 24.000000 | 25.000000 | 26.000000 | 26.000000 | 26.000000 | |
| 50% | 33.000000 | 34.000000 | 34.000000 | 34.000000 | 35.000000 | |
| 75% | 43.000000 | 44.000000 | 45.000000 | 45.000000 | 46.000000 | |
| max | 106.000000 | 136.000000 | 127.000000 | 114.000000 | 129.000000 | |

| | S. ROCCO | ISONZO | CENO | PARCO FERRARI | CITTADELLA | \ |
|---|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.00000 | 10000.000000 | |
| mean | 38.380500 | 42.287200 | 42.403800 | 42.96810 | 46.064900 | |
| std | 15.692971 | 16.041161 | 17.171483 | 16.33913 | 16.927479 | |
| min | 2.000000 | 2.000000 | 4.000000 | 5.00000 | 6.000000 | |
| 25% | 27.000000 | 31.000000 | 30.000000 | 31.00000 | 34.000000 | |
| 50% | 36.000000 | 41.000000 | 40.000000 | 41.00000 | 44.000000 | |
| 75% | 48.000000 | 52.000000 | 52.000000 | 52.00000 | 56.000000 | |
| max | 127.000000 | 144.000000 | 160.000000 | 165.00000 | 132.000000 | |

| | GIORDANI-FARNESE | SAN FRANCESCO | FLAMINIA | MONTEBELLO | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 46.171700 | 50.864500 | 51.161100 | 54.630100 | |
| std | 17.198482 | 17.002725 | 18.762461 | 18.677081 | |
| min | 3.000000 | 6.000000 | 5.000000 | 8.000000 | |
| 25% | 34.000000 | 39.000000 | 38.000000 | 41.000000 | |
| 50% | 44.000000 | 49.000000 | 49.000000 | 53.000000 | |
| 75% | 57.000000 | 61.000000 | 62.000000 | 66.000000 | |
| max | 146.000000 | 136.000000 | 177.000000 | 145.000000 | |

| | GIARDINI | GERBIDO | TIMAVO |
|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 |
| mean | 60.347000 | 63.473900 | 70.158600 |
| std | 19.584973 | 22.603575 | 21.960589 |
| min | 5.000000 | 5.000000 | 8.000000 |
| 25% | 46.000000 | 48.000000 | 55.000000 |
| 50% | 59.000000 | 61.000000 | 68.000000 |
| 75% | 72.000000 | 77.000000 | 84.000000 |
| max | 169.000000 | 179.000000 | 180.000000 |

[23]:
```
pd.set_option('display.max_columns', 500)
aux_results = pd.DataFrame(ritorno['inference_data'].posterior.
 ↪is_over_daily_limit.values.
 ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), columns=df.columns).
 ↪describe()
aux_results.sort_values('mean', axis=1, ascending=True)
```

[23]:

| | CASTELLUCCIO | FEBBIO | CORTE BRUGNATELLA | SAVIGNANO DI RIGO | SAN LEO | \ |
|---|---|---|---|---|---|---|
| count | 10000.0 | 10000.0 | 10000.0 | 10000.0 | 10000.0 | |
| mean | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| std | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| min | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 25% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 50% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 75% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| max | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

| | VERUCCHIO | BADIA | GIARDINI MARGHERITA | MARECCHIA | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.000400 | 0.001300 | 0.019800 | 0.030800 | |
| std | 0.019997 | 0.036034 | 0.139319 | 0.172784 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |

| | SAN PIETRO CAPOFIUME | DE AMICIS | DELTA CERVIA | LUGAGNANO | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.042900 | 0.051900 | 0.051900 | 0.052600 | |
| std | 0.202642 | 0.221836 | 0.221836 | 0.223245 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |

| | PARCO BERTOZZI | SAN LAZZARO | PARCO RESISTENZA | FRANCHINI-ANGELONI | \ |
|---|---|---|---|---|---|
| count | 10000.00000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.05670 | 0.072300 | 0.075800 | 0.104700 | |
| std | 0.23128 | 0.258997 | 0.264691 | 0.306182 | |
| min | 0.00000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.00000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.00000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 0.00000 | 0.000000 | 0.000000 | 0.000000 | |
| max | 1.00000 | 1.000000 | 1.000000 | 1.000000 | |

| | VIA CHIARINI | GHERARDI | GAVELLO | SAVIGNANO | BESENZONE | \ |
|---|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.110000 | 0.110300 | 0.138200 | 0.146200 | 0.164400 | |
| std | 0.312905 | 0.313279 | 0.345127 | 0.353324 | 0.370657 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |

| | ROMA | VILLA FULVIA | PORTA SAN FELICE | CASTELLARANO | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.253800 | 0.257000 | 0.262300 | 0.265700 | |
| std | 0.435206 | 0.437001 | 0.439907 | 0.441727 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |

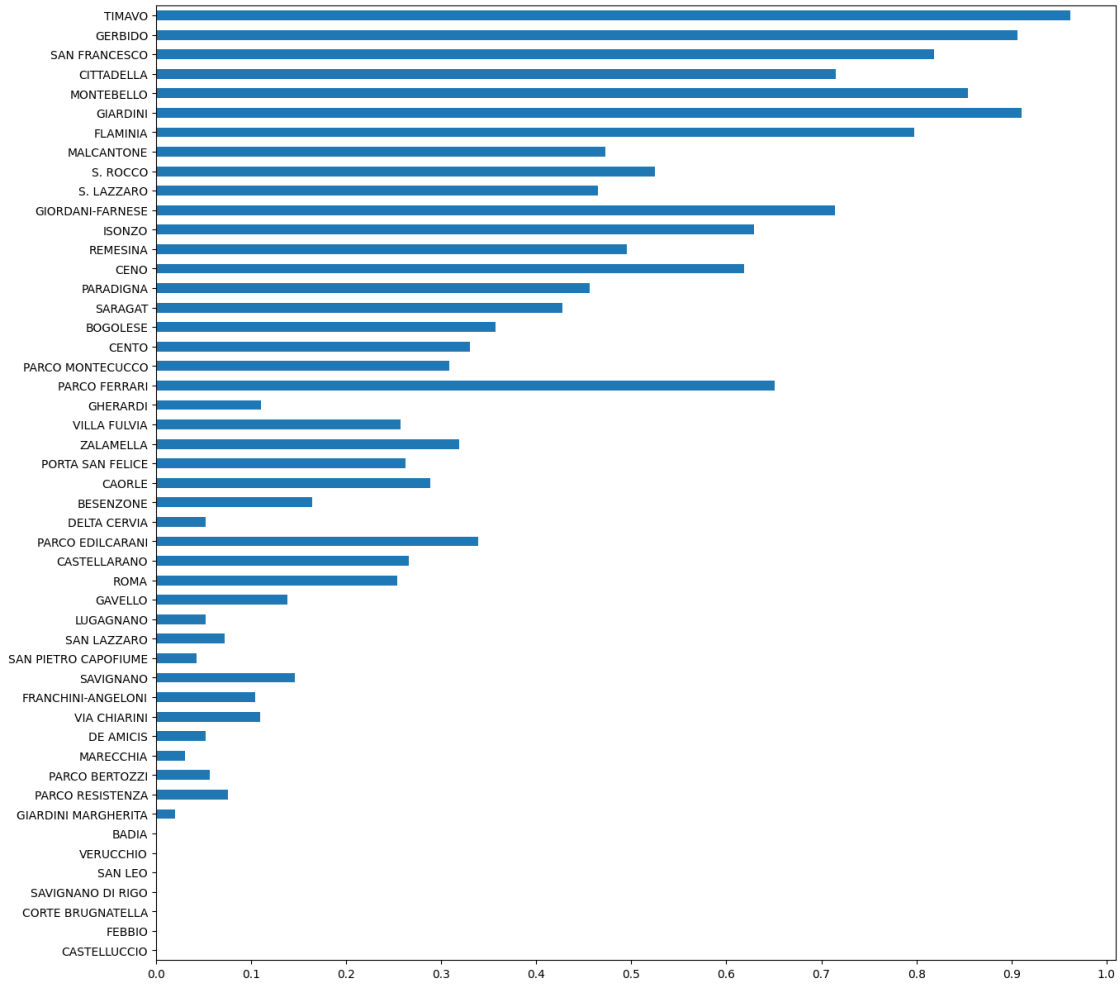
| | CAORLE | PARCO MONTECUCCO | ZALAMELLA | CENTO | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.289000 | 0.308800 | 0.318600 | 0.330200 | |
| std | 0.453321 | 0.462022 | 0.465957 | 0.470308 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 75% | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | |

| | PARCO EDILCARANI | BOGOLESE | SARAGAT | PARADIGNA | \ |
|---|---|---|---|---|---|
| count | 10000.000000 | 10000.000000 | 10000.000000 | 10000.000000 | |
| mean | 0.339400 | 0.357600 | 0.428000 | 0.456100 | |
| std | 0.473529 | 0.479317 | 0.494814 | 0.498094 | |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | |

```
50%            0.000000      0.000000      0.000000      0.000000
75%            1.000000      1.000000      1.000000      1.000000
max            1.000000      1.000000      1.000000      1.000000

         S. LAZZARO    MALCANTONE      REMESINA      S. ROCCO          CENO  \
count  10000.000000  10000.000000  10000.000000  10000.000000  10000.000000
mean       0.464900      0.472600      0.495100      0.525300      0.618500
std        0.498791      0.499274      0.500001      0.499384      0.485779
min        0.000000      0.000000      0.000000      0.000000      0.000000
25%        0.000000      0.000000      0.000000      0.000000      0.000000
50%        0.000000      0.000000      0.000000      1.000000      1.000000
75%        1.000000      1.000000      1.000000      1.000000      1.000000
max        1.000000      1.000000      1.000000      1.000000      1.000000

             ISONZO  PARCO FERRARI  GIORDANI-FARNESE    CITTADELLA  \
count  10000.000000   10000.000000      10000.000000  10000.000000
mean       0.629300       0.651200          0.714200      0.715000
std        0.483016       0.476614          0.451817      0.451437
min        0.000000       0.000000          0.000000      0.000000
25%        0.000000       0.000000          0.000000      0.000000
50%        1.000000       1.000000          1.000000      1.000000
75%        1.000000       1.000000          1.000000      1.000000
max        1.000000       1.000000          1.000000      1.000000

            FLAMINIA  SAN FRANCESCO    MONTEBELLO       GERBIDO      GIARDINI  \
count  10000.000000    10000.00000  10000.000000  10000.000000  10000.000000
mean       0.797300        0.81890      0.854000      0.906000      0.911000
std        0.402031        0.38512      0.353124      0.291843      0.284758
min        0.000000        0.00000      0.000000      0.000000      0.000000
25%        1.000000        1.00000      1.000000      1.000000      1.000000
50%        1.000000        1.00000      1.000000      1.000000      1.000000
75%        1.000000        1.00000      1.000000      1.000000      1.000000
max        1.000000        1.00000      1.000000      1.000000      1.000000

             TIMAVO
count  10000.000000
mean       0.961900
std        0.191447
min        0.000000
25%        1.000000
50%        1.000000
75%        1.000000
max        1.000000
```

[24]:
```
aux_results.loc['mean',:].plot(kind='barh', figsize=(15,15), xticks=np.
 ↪linspace(0,1,11))
#res = plt.xticks(rotation = 30)
```

[24]: <AxesSubplot: >




[25]:
```
pd.set_option('display.max_columns', 500)
aux_results = pd.DataFrame(ritorno['inference_data'].posterior.
 ↪is_over_annual_limit.values.
 ↪reshape((aux_shape[0]*aux_shape[1],aux_shape[2])), columns=df.columns).
 ↪describe()
aux_results.sort_values('mean', axis=1, ascending=True)
```

[25]:

| | CASTELLUCCIO | SARAGAT | CENTO | PARCO MONTECUCCO | S. ROCCO | GHERARDI | \ |
|---|---|---|---|---|---|---|---|
| count | 10000.0 | 10000.0 | 10000.0 | 10000.0 | 10000.0 | 10000.0 | |
| mean | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| std | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| min | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 25% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 50% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| 75% | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

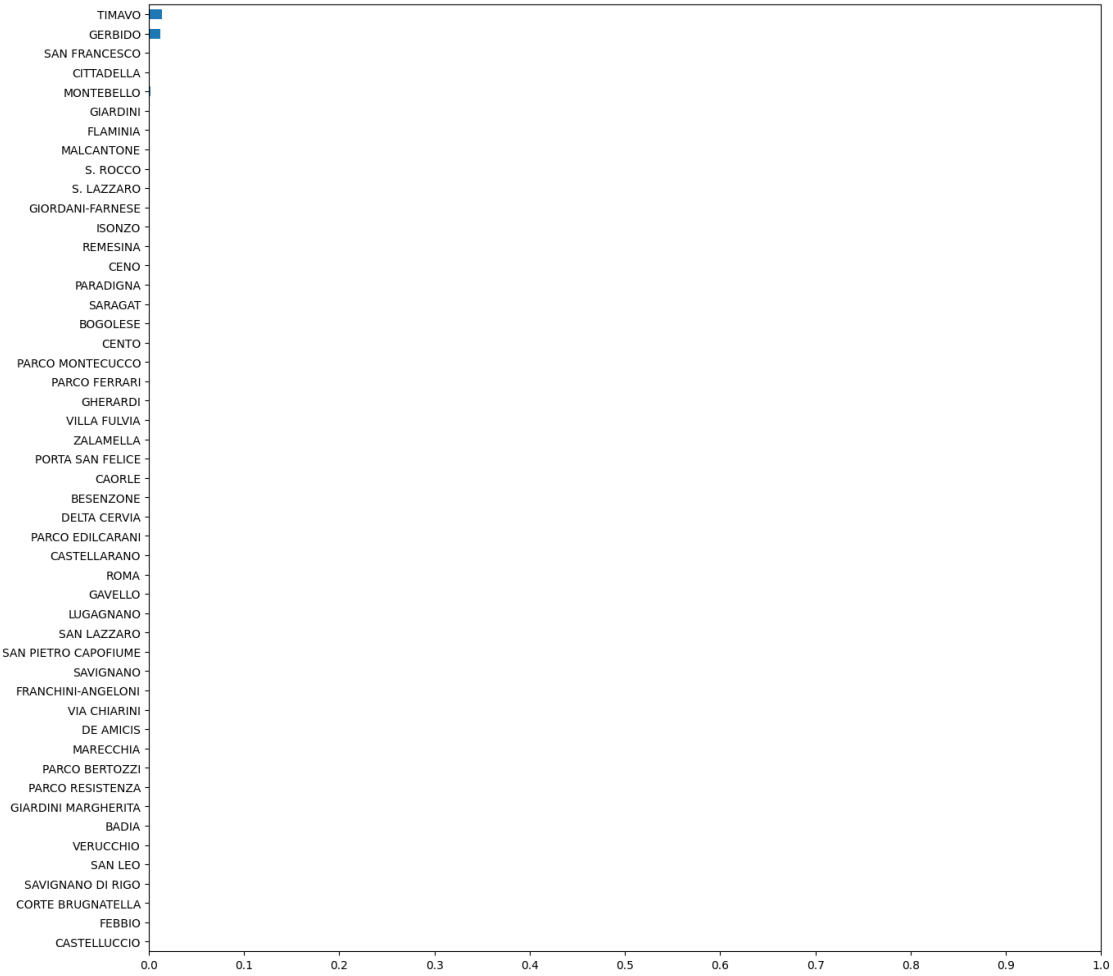
```
max            0.0      0.0      0.0              0.0       0.0       0.0

       VILLA FULVIA  PORTA SAN FELICE  MALCANTONE  BESENZONE  DELTA CERVIA  \
count       10000.0           10000.0     10000.0    10000.0       10000.0
mean            0.0               0.0         0.0        0.0           0.0
std             0.0               0.0         0.0        0.0           0.0
min             0.0               0.0         0.0        0.0           0.0
25%             0.0               0.0         0.0        0.0           0.0
50%             0.0               0.0         0.0        0.0           0.0
75%             0.0               0.0         0.0        0.0           0.0
max             0.0               0.0         0.0        0.0           0.0

       PARCO EDILCARANI  CASTELLARANO  S. LAZZARO  LUGAGNANO  SAN LAZZARO  \
count           10000.0       10000.0     10000.0    10000.0      10000.0
mean                0.0           0.0         0.0        0.0          0.0
std                 0.0           0.0         0.0        0.0          0.0
min                 0.0           0.0         0.0        0.0          0.0
25%                 0.0           0.0         0.0        0.0          0.0
50%                 0.0           0.0         0.0        0.0          0.0
75%                 0.0           0.0         0.0        0.0          0.0
max                 0.0           0.0         0.0        0.0          0.0

       GAVELLO  SAVIGNANO   FEBBIO  CORTE BRUGNATELLA  SAVIGNANO DI RIGO  \
count  10000.0    10000.0  10000.0            10000.0            10000.0
mean       0.0        0.0      0.0                0.0                0.0
std        0.0        0.0      0.0                0.0                0.0
min        0.0        0.0      0.0                0.0                0.0
25%        0.0        0.0      0.0                0.0                0.0
50%        0.0        0.0      0.0                0.0                0.0
75%        0.0        0.0      0.0                0.0                0.0
max        0.0        0.0      0.0                0.0                0.0

       SAN LEO  VERUCCHIO    BADIA  SAN PIETRO CAPOFIUME  REMESINA  \
count  10000.0    10000.0  10000.0               10000.0   10000.0
mean       0.0        0.0      0.0                   0.0       0.0
std        0.0        0.0      0.0                   0.0       0.0
min        0.0        0.0      0.0                   0.0       0.0
25%        0.0        0.0      0.0                   0.0       0.0
50%        0.0        0.0      0.0                   0.0       0.0
75%        0.0        0.0      0.0                   0.0       0.0
max        0.0        0.0      0.0                   0.0       0.0

       PARCO RESISTENZA  MARECCHIA  DE AMICIS  VIA CHIARINI  \
count           10000.0    10000.0    10000.0       10000.0
mean                0.0        0.0        0.0           0.0
std                 0.0        0.0        0.0           0.0
min                 0.0        0.0        0.0           0.0
```

```
25%                0.0        0.0        0.0           0.0
50%                0.0        0.0        0.0           0.0
75%                0.0        0.0        0.0           0.0
max                0.0        0.0        0.0           0.0

       FRANCHINI-ANGELONI  GIARDINI MARGHERITA  PARCO BERTOZZI        ROMA  \
count             10000.0              10000.0      10000.0000  10000.0000
mean                  0.0                  0.0          0.0001      0.0001
std                   0.0                  0.0          0.0100      0.0100
min                   0.0                  0.0          0.0000      0.0000
25%                   0.0                  0.0          0.0000      0.0000
50%                   0.0                  0.0          0.0000      0.0000
75%                   0.0                  0.0          0.0000      0.0000
max                   0.0                  0.0          1.0000      1.0000

         BOGOLESE   PARADIGNA   ZALAMELLA        CAORLE        ISONZO  \
count  10000.0000  10000.0000  10000.0000  10000.000000  10000.000000
mean       0.0001      0.0001      0.0001      0.000200      0.000200
std        0.0100      0.0100      0.0100      0.014141      0.014141
min        0.0000      0.0000      0.0000      0.000000      0.000000
25%        0.0000      0.0000      0.0000      0.000000      0.000000
50%        0.0000      0.0000      0.0000      0.000000      0.000000
75%        0.0000      0.0000      0.0000      0.000000      0.000000
max        1.0000      1.0000      1.0000      1.000000      1.000000

       PARCO FERRARI    CITTADELLA  GIORDANI-FARNESE  SAN FRANCESCO  \
count   10000.000000  10000.000000      10000.000000   10000.000000
mean        0.000300      0.000300          0.000400       0.000400
std         0.017319      0.017319          0.019997       0.019997
min         0.000000      0.000000          0.000000       0.000000
25%         0.000000      0.000000          0.000000       0.000000
50%         0.000000      0.000000          0.000000       0.000000
75%         0.000000      0.000000          0.000000       0.000000
max         1.000000      1.000000          1.000000       1.000000

              CENO      FLAMINIA      GIARDINI   MONTEBELLO       GERBIDO  \
count  10000.000000  10000.000000  10000.000000  10000.00000  10000.000000
mean       0.000500      0.001200      0.001400      0.00180      0.012300
std        0.022356      0.034622      0.037392      0.04239      0.110227
min        0.000000      0.000000      0.000000      0.00000      0.000000
25%        0.000000      0.000000      0.000000      0.00000      0.000000
50%        0.000000      0.000000      0.000000      0.00000      0.000000
75%        0.000000      0.000000      0.000000      0.00000      0.000000
max        1.000000      1.000000      1.000000      1.00000      1.000000

            TIMAVO
count  10000.000000
```

```
mean        0.013500
std         0.115408
min         0.000000
25%         0.000000
50%         0.000000
75%         0.000000
max         1.000000
```

[26]:
```
aux_results.loc['mean',:].plot(kind='barh', figsize=(15,15), xticks=np.
 ↪linspace(0,1,11))
#res = plt.xticks(rotation = 30)
```

[26]: <AxesSubplot: >




[27]:
```
y_post_pred = ritorno['inference_data'].posterior.y_post_pred.to_numpy()
y_post_pred = y_post_pred.reshape(y_post_pred.shape[0]*y_post_pred.shape[1],␣
 ↪y_post_pred.shape[2], y_post_pred.shape[3])
```

```
y_post_pred.shape
```

[27]:
```
(10000, 365, 49)
```

[28]:
```
import ipywidgets as widgets
from ipywidgets import HBox, VBox
from IPython.display import display
```

[29]:
```
@widgets.interact(stazione = df.columns)
def f(stazione):
    col_map = sns.light_palette((20, 75, 70), input='husl', as_cmap=True)

    plt.figure(figsize=(14,8))
    ax = plt.subplot(1,1,1)

    idx_stazione = df.columns.to_list().index(stazione)

    """
    sns.lineplot(np.transpose(y_post_pred[0:50,:,idx_stazione]))
    """

    lower_lim = np.zeros(len(df.index))
    upper_lim = np.zeros(len(df.index))
    for i in range(len(df.index)):
        lower_lim[i] = np.percentile(y_post_pred[:,i,idx_stazione],2.5)
        upper_lim[i] = np.percentile(y_post_pred[:,i,idx_stazione],97.5)


#    sns.lineplot(lower_lim)
#    sns.lineplot(upper_lim)

    for i in range(len(df.index)):
        ax.add_patch(mplt.patches.
 ↪Rectangle((i,lower_lim[i]),1,upper_lim[i]-lower_lim[i], fill=True,␣
 ↪color=col_map(180)))

    sns.lineplot(df[stazione])
    sns.lineplot(np.mean(y_post_pred[:,:,idx_stazione], axis=0))


    index = 0
    for line in ax.get_lines():
        if index == 0:
            col_map = sns.dark_palette((230,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(155))
        else:
            col_map = sns.dark_palette((10,90,65), input='husl', as_cmap=True)
```

```
            line.set_c(col_map(175))
        index += 1

    plt.ylim(bottom=0,top=2.5)

    primo_giorno = datetime.date(2018,1,1)
    date_da_segnare = []
    date_da_segnare_posizioni = []

    for i in range(12):
        date_da_segnare.append(datetime.date(2018,i+1,1))
        date_da_segnare_posizioni.append((date_da_segnare[2*i] - primo_giorno).
↪days)
        date_da_segnare.append(datetime.date(2018,i+1,15))
        date_da_segnare_posizioni.append((date_da_segnare[2*i+1] -␣
↪primo_giorno).days)
        date_da_segnare[2*i] = date_da_segnare[2*i].isoformat()
        date_da_segnare[2*i+1] = date_da_segnare[2*i+1].isoformat()

    plt.xticks(date_da_segnare_posizioni,date_da_segnare,rotation=65)
    plt.tick_params(
        axis='x',          # changes apply to the x-axis
        which='both',      # both major and minor ticks are affected
        bottom=True,      # ticks along the bottom edge are off
        top=False,         # ticks along the top edge are off
        labelbottom=True)
    plt.grid()

    """
    ax.get_legend().remove()
    col_vals = np.linspace(1,255,num=len(df.columns))
    index = 0
    for line in ax.get_lines():
        if(index == len(ax.get_lines()) - 1):
            col_map = sns.dark_palette((230,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(175))
            continue
        if(index == len(ax.get_lines()) - 2):
            col_map = sns.dark_palette((120,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(175))
            index += 1
            continue

        #line.set_c(col_map(int(np.round(col_vals[index]))))
        line.set_c(col_map(220))
        line.set_alpha(0.3)
        index += 1
```

```
    """



    plt.show()
```

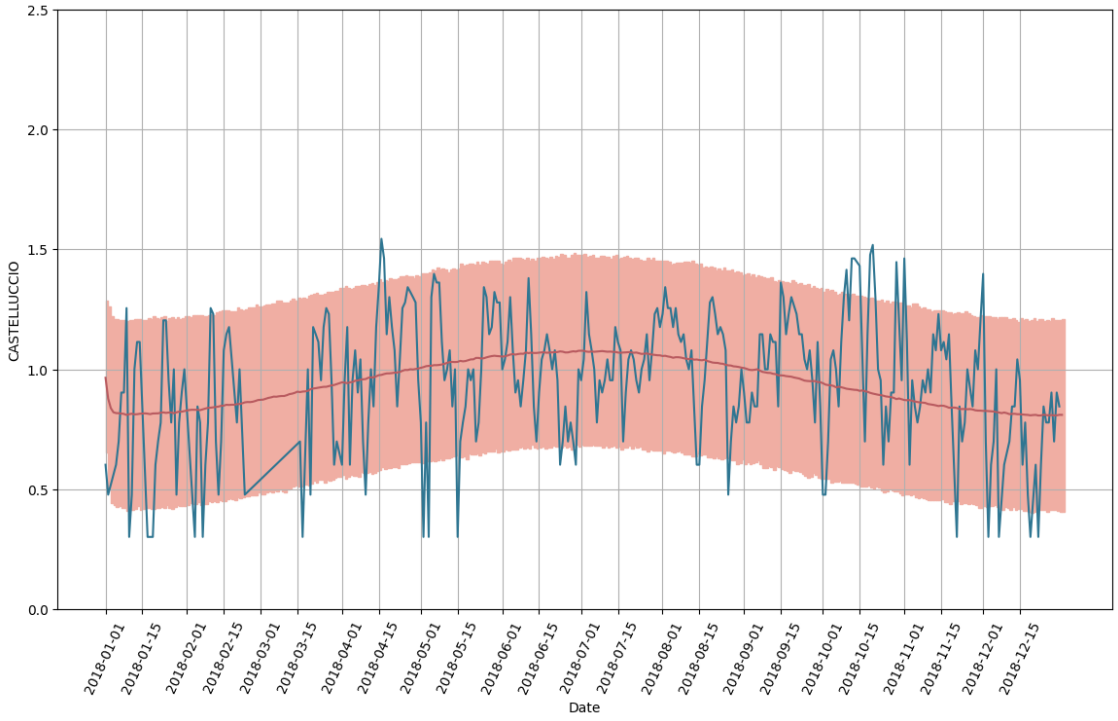
```
interactive(children=(Dropdown(description='stazione', options=('CASTELLUCCIO',␣
 ↪'FEBBIO', 'CORTE BRUGNATELLA',…
```

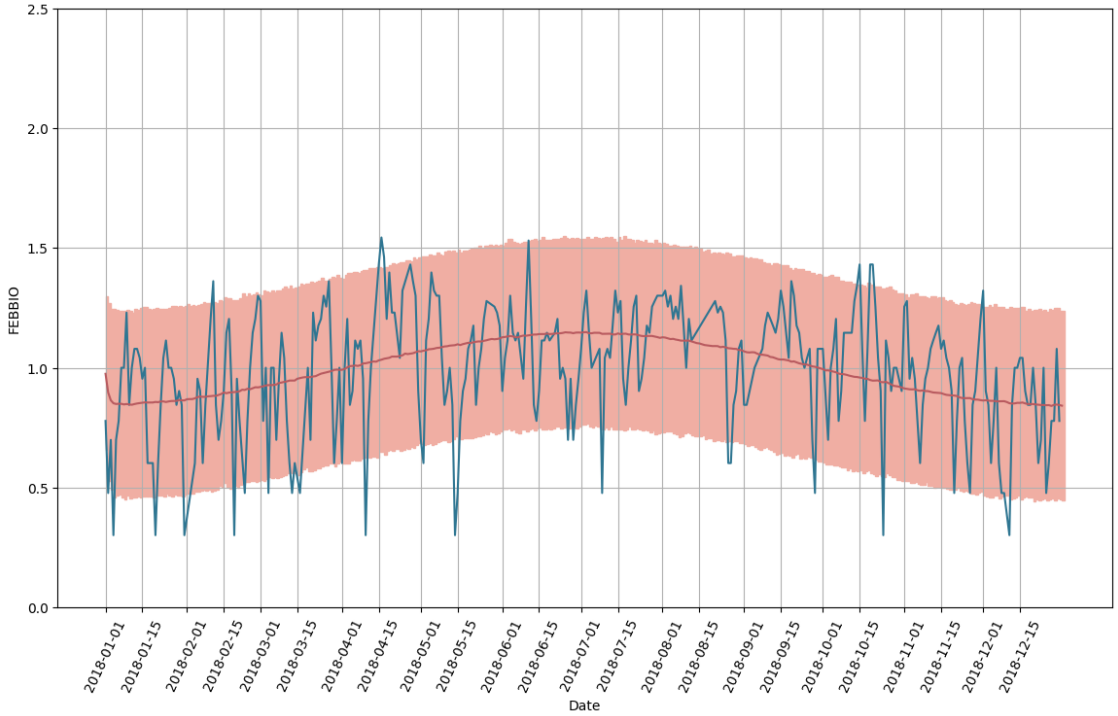
[30]:
```
def f(stazione):
    col_map = sns.light_palette((20, 75, 70), input='husl', as_cmap=True)

    plt.figure(figsize=(14,8))
    ax = plt.subplot(1,1,1)

    idx_stazione = df.columns.to_list().index(stazione)

    """
    sns.lineplot(np.transpose(y_post_pred[0:50,:,idx_stazione]))
    """

    lower_lim = np.zeros(len(df.index))
    upper_lim = np.zeros(len(df.index))
    for i in range(len(df.index)):
        lower_lim[i] = np.percentile(y_post_pred[:,i,idx_stazione],2.5)
        upper_lim[i] = np.percentile(y_post_pred[:,i,idx_stazione],97.5)


#    sns.lineplot(lower_lim)
#    sns.lineplot(upper_lim)

    for i in range(len(df.index)):
        ax.add_patch(mplt.patches.
 ↪Rectangle((i,lower_lim[i]),1,upper_lim[i]-lower_lim[i], fill=True,␣
 ↪color=col_map(180)))

    sns.lineplot(df[stazione])
    sns.lineplot(np.mean(y_post_pred[:,:,idx_stazione], axis=0))


    index = 0
    for line in ax.get_lines():
        if index == 0:
            col_map = sns.dark_palette((230,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(155))
        else:
            col_map = sns.dark_palette((10,90,65), input='husl', as_cmap=True)
```

```
            line.set_c(col_map(175))
        index += 1

    plt.ylim(bottom=0,top=2.5)

    primo_giorno = datetime.date(2018,1,1)
    date_da_segnare = []
    date_da_segnare_posizioni = []

    for i in range(12):
        date_da_segnare.append(datetime.date(2018,i+1,1))
        date_da_segnare_posizioni.append((date_da_segnare[2*i] - primo_giorno).
↪days)
        date_da_segnare.append(datetime.date(2018,i+1,15))
        date_da_segnare_posizioni.append((date_da_segnare[2*i+1] -␣
↪primo_giorno).days)
        date_da_segnare[2*i] = date_da_segnare[2*i].isoformat()
        date_da_segnare[2*i+1] = date_da_segnare[2*i+1].isoformat()

    plt.xticks(date_da_segnare_posizioni,date_da_segnare,rotation=65)
    plt.tick_params(
        axis='x',          # changes apply to the x-axis
        which='both',      # both major and minor ticks are affected
        bottom=True,      # ticks along the bottom edge are off
        top=False,         # ticks along the top edge are off
        labelbottom=True)
    plt.grid()

    """
    ax.get_legend().remove()
    col_vals = np.linspace(1,255,num=len(df.columns))
    index = 0
    for line in ax.get_lines():
        if(index == len(ax.get_lines()) - 1):
            col_map = sns.dark_palette((230,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(175))
            continue
        if(index == len(ax.get_lines()) - 2):
            col_map = sns.dark_palette((120,90,65), input='husl', as_cmap=True)
            line.set_c(col_map(175))
            index += 1
            continue

        #line.set_c(col_map(int(np.round(col_vals[index]))))
        line.set_c(col_map(220))
        line.set_alpha(0.3)
        index += 1
```

```
    """



    plt.show()
```

[31]:
```
for stazione in df.columns:
    f(stazione)
```

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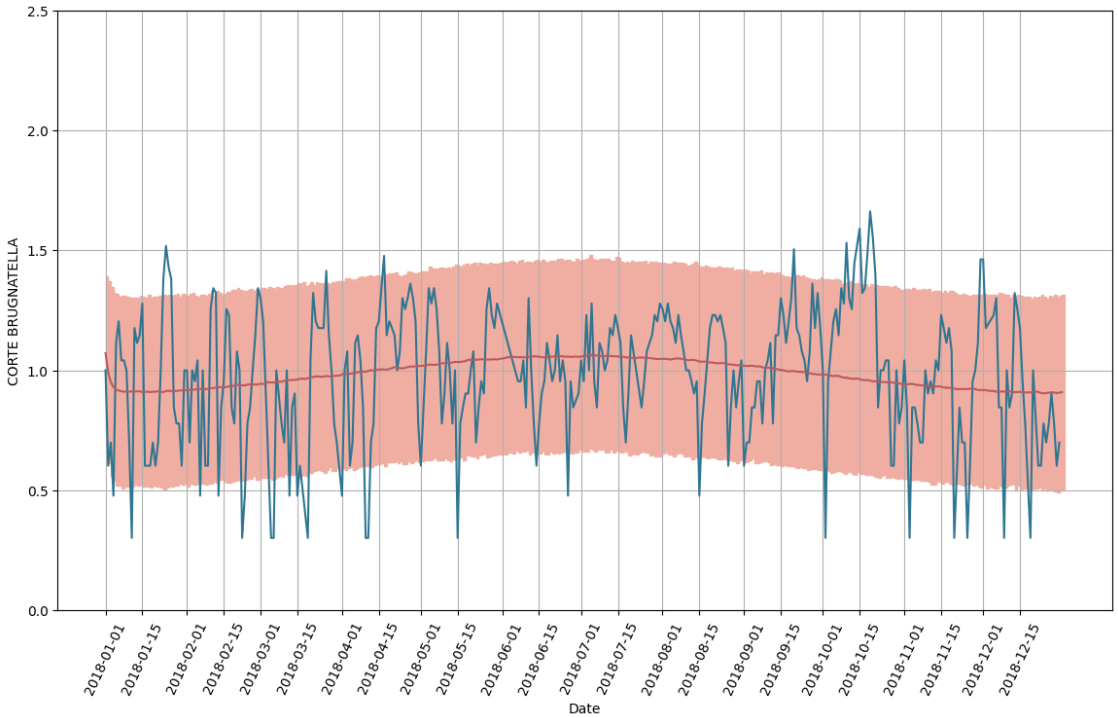
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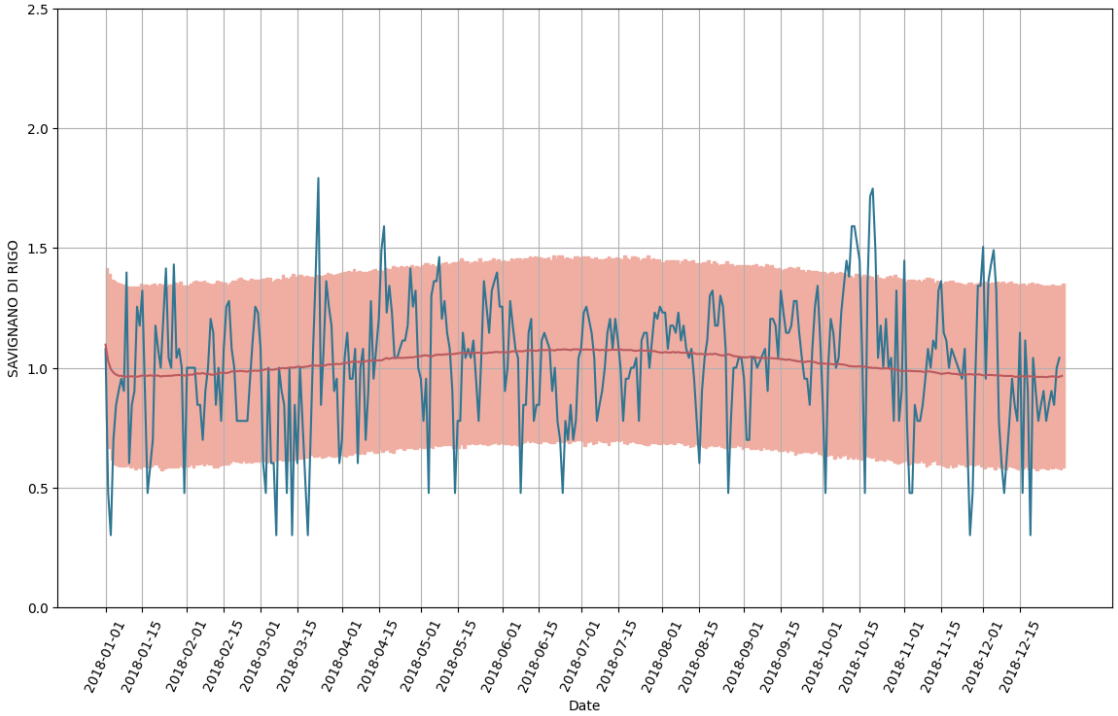
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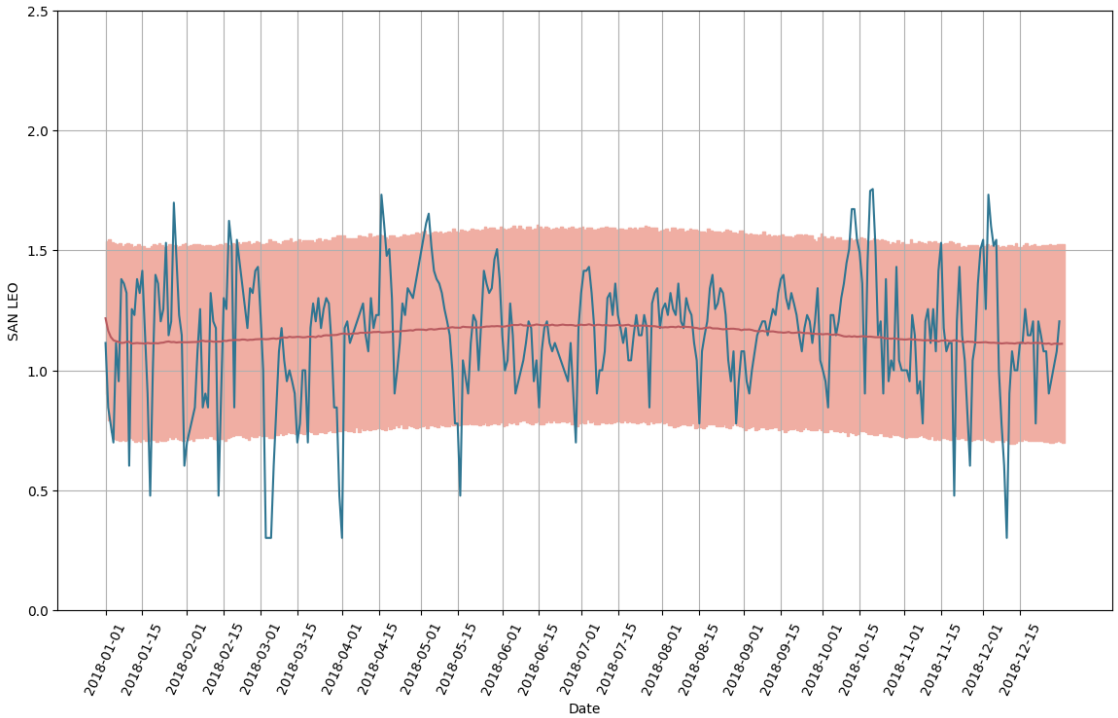
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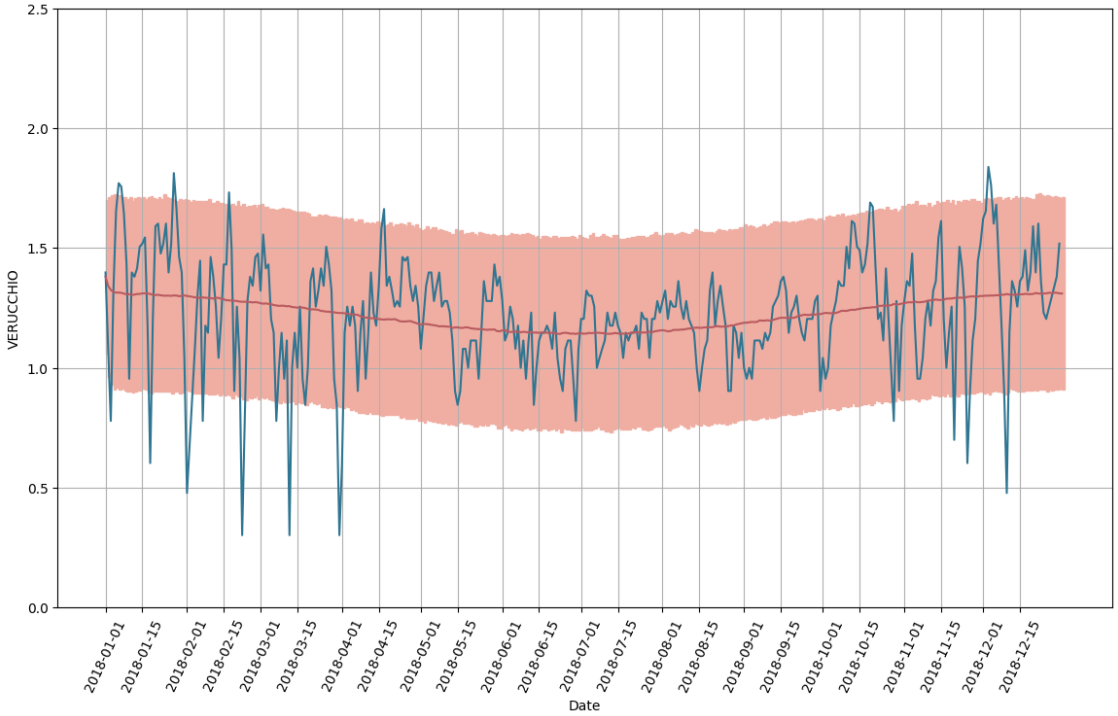
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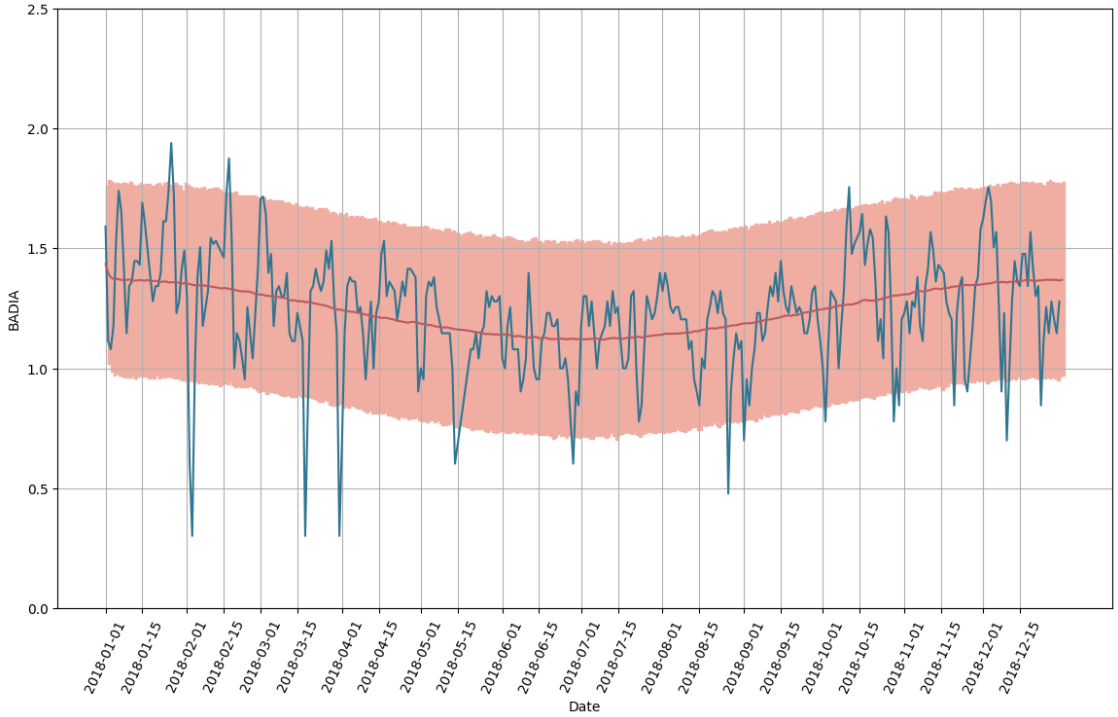
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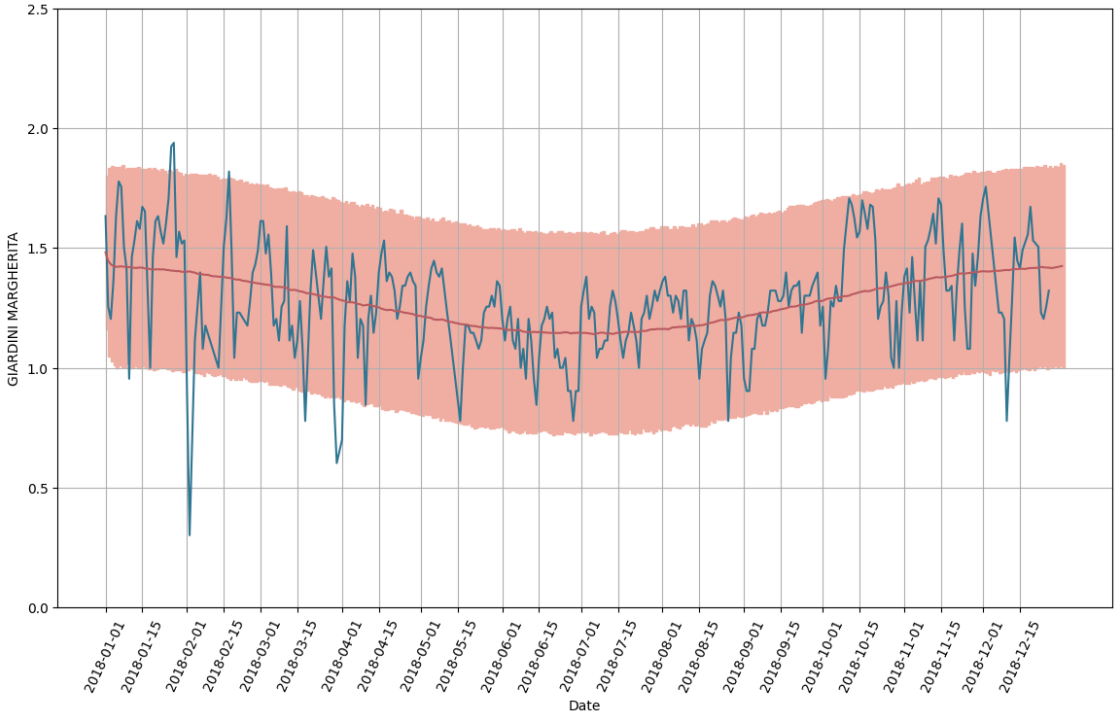
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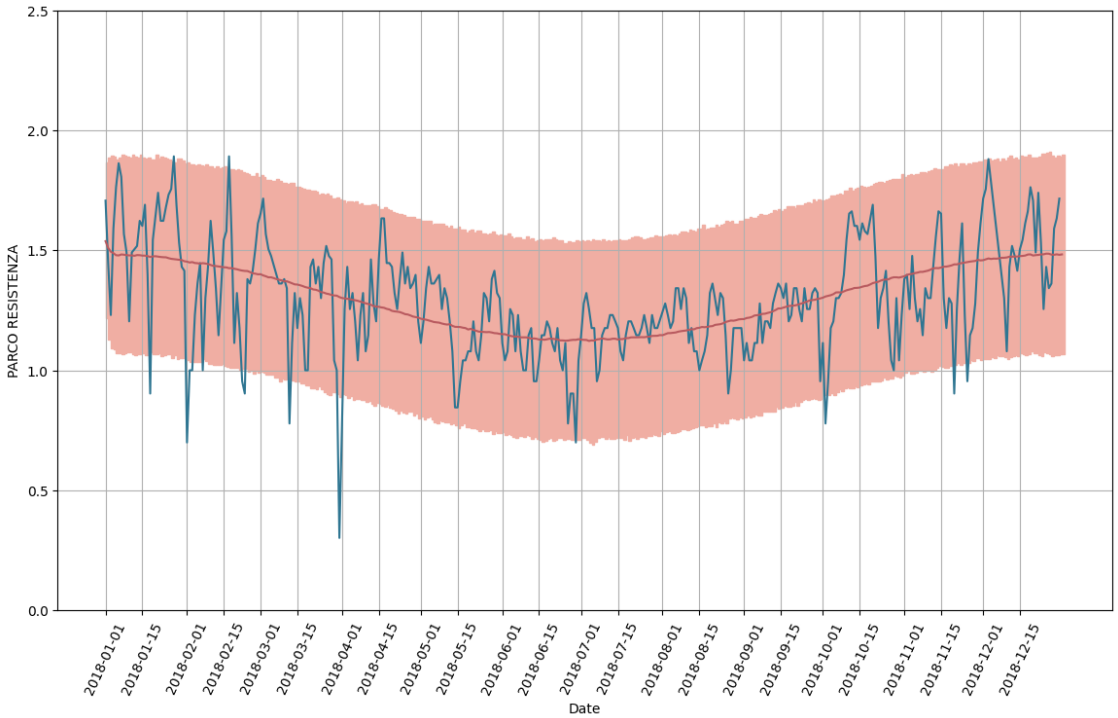
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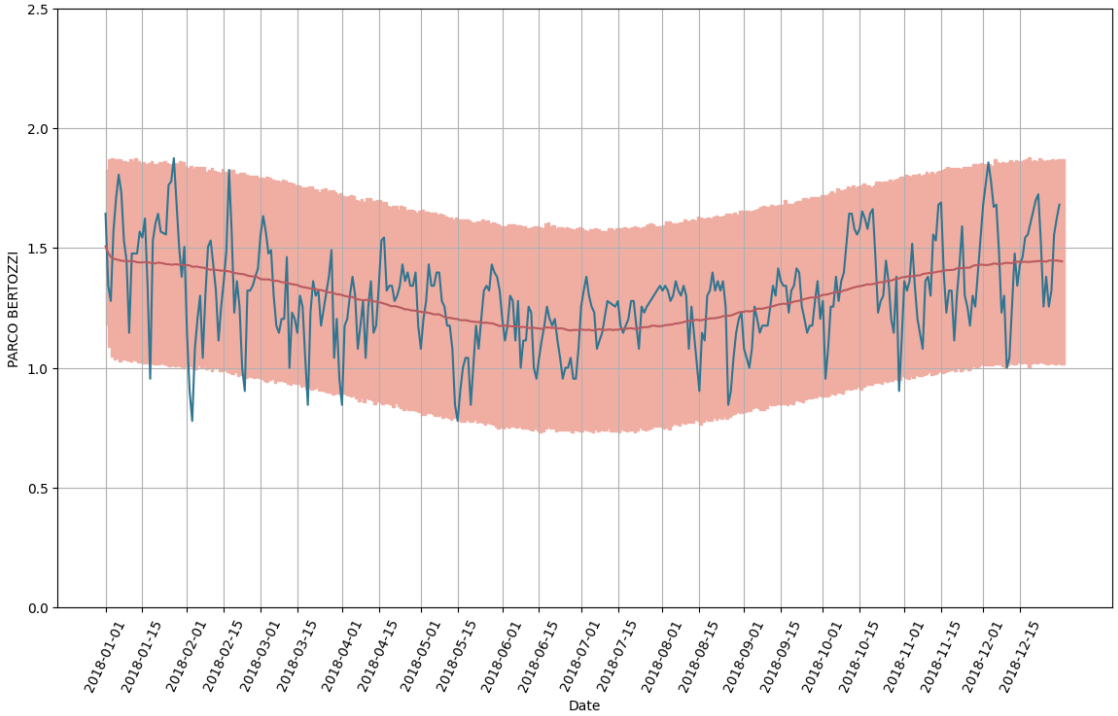
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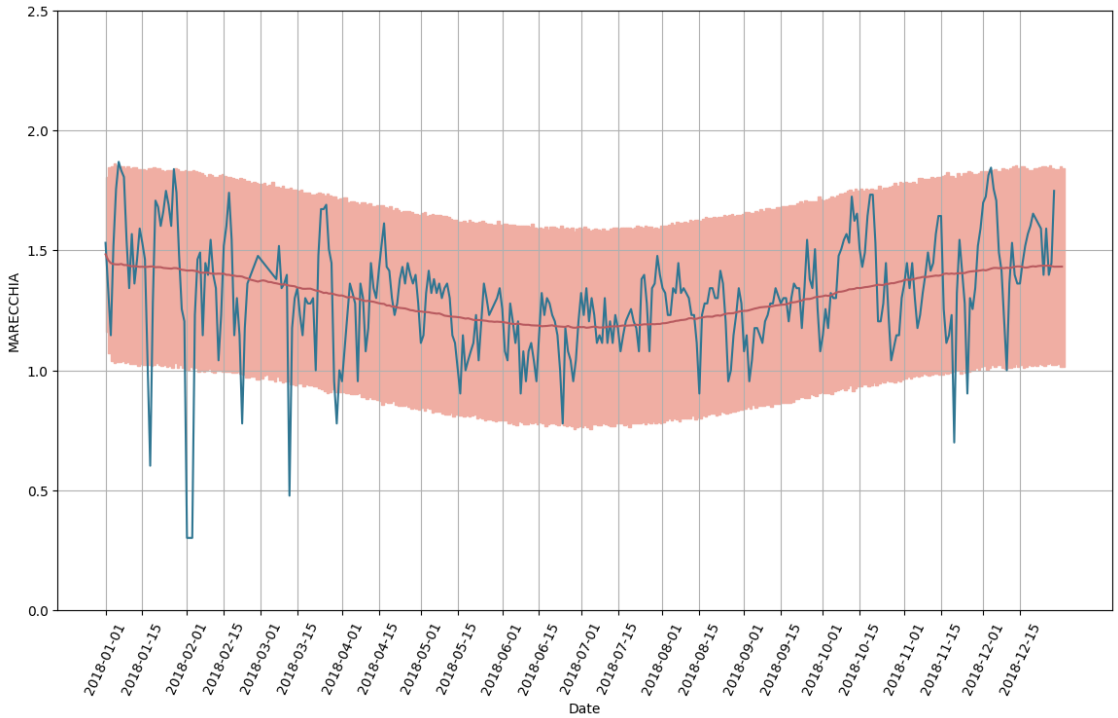
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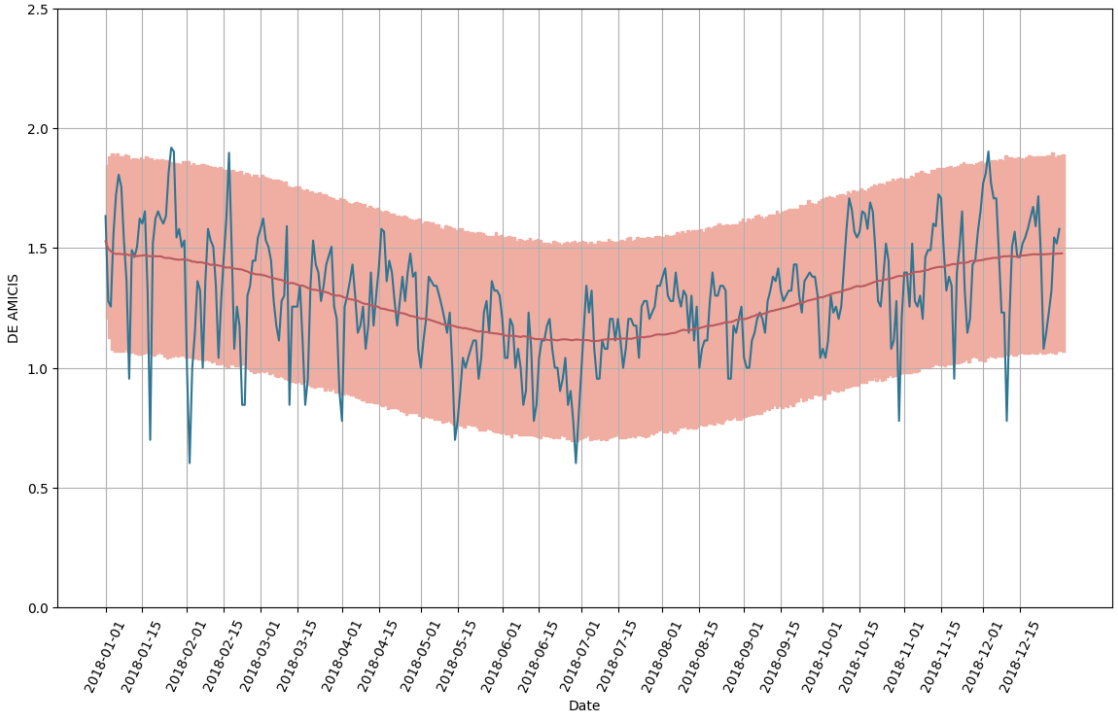
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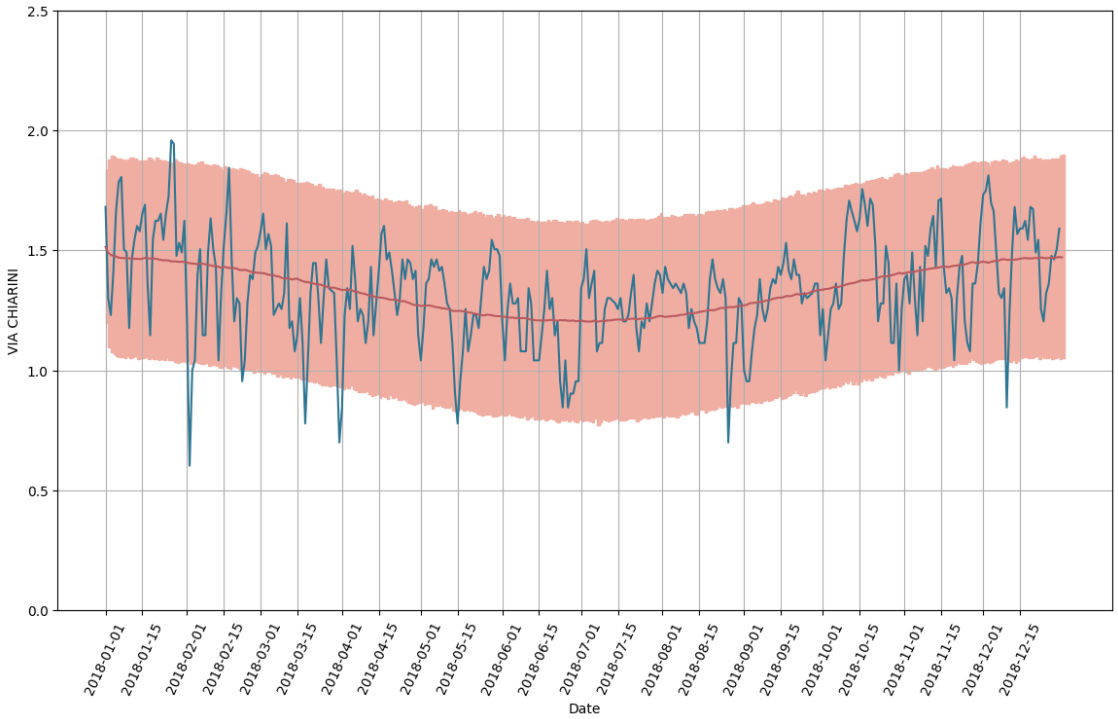
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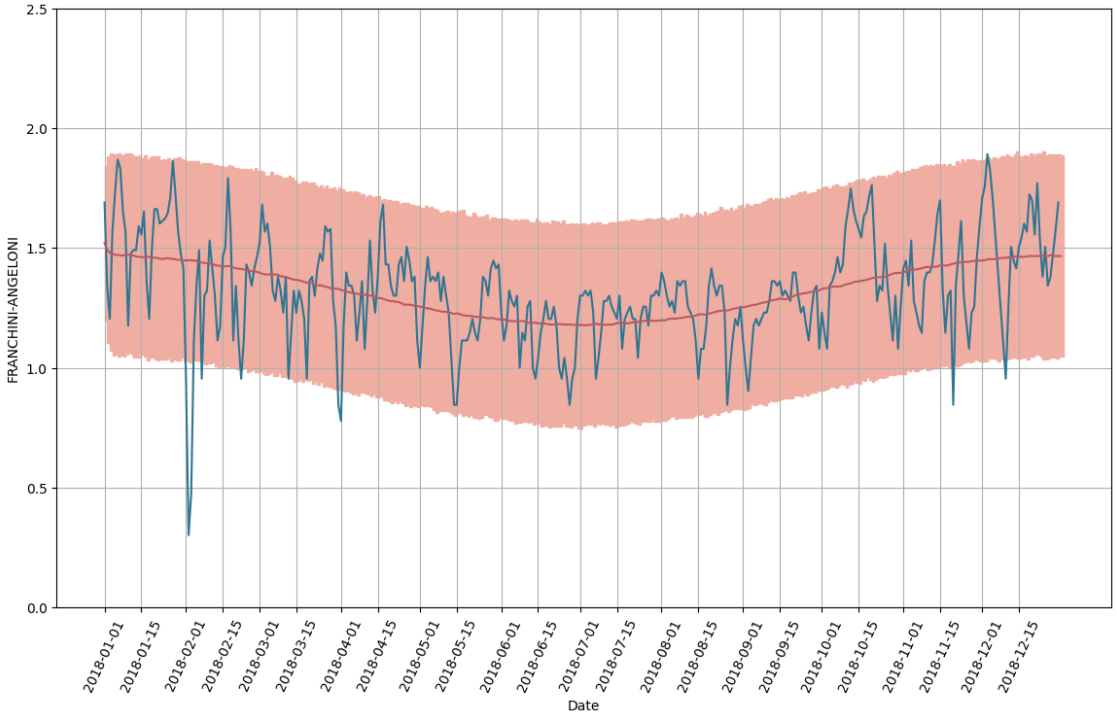
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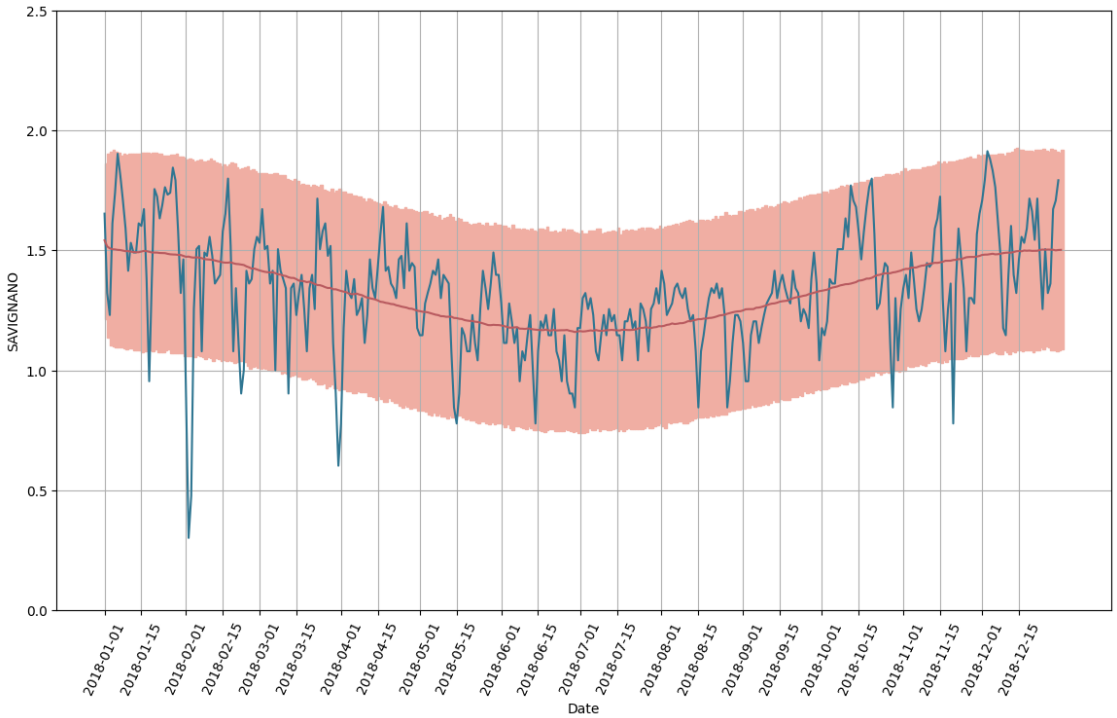
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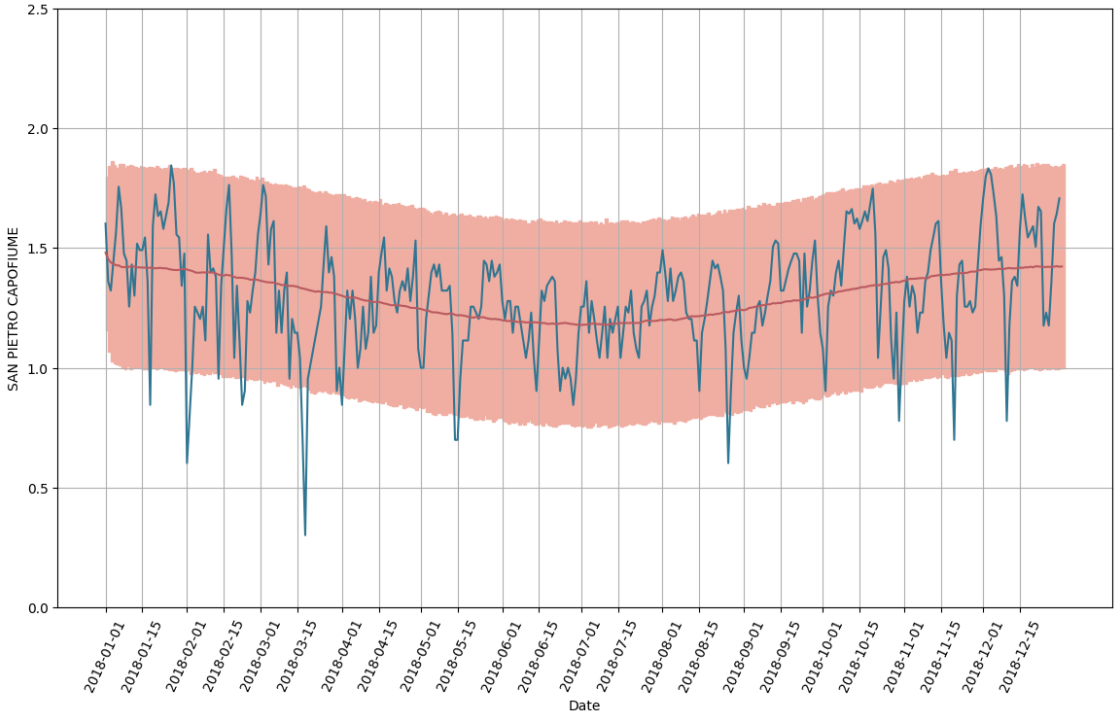
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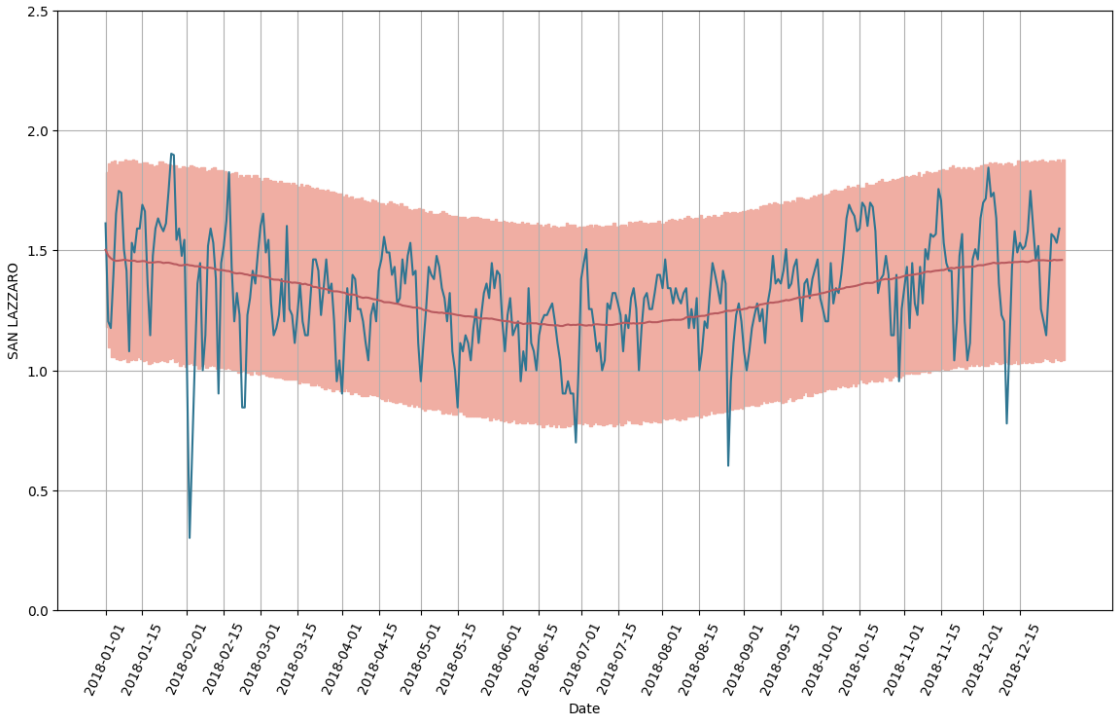
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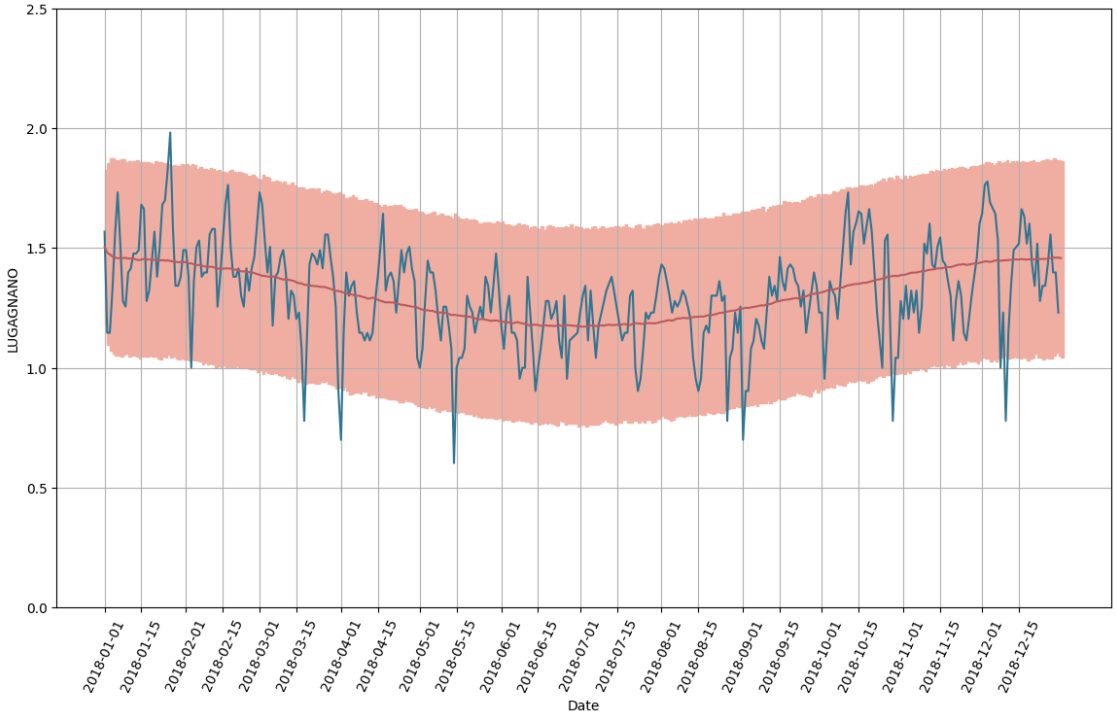
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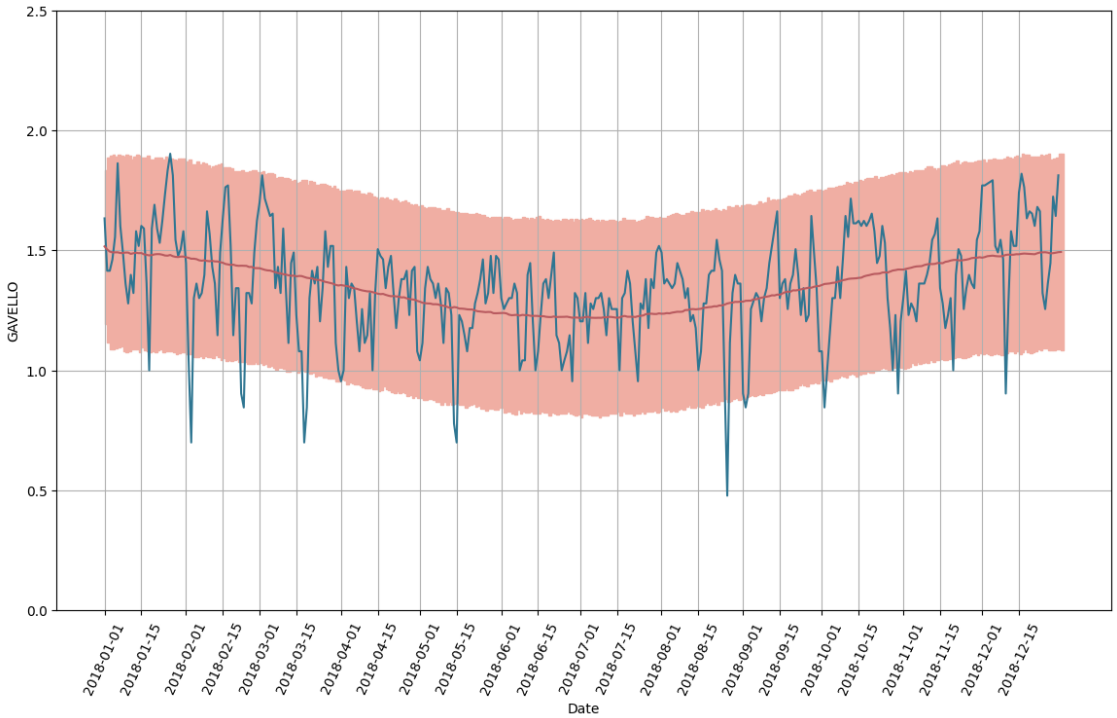
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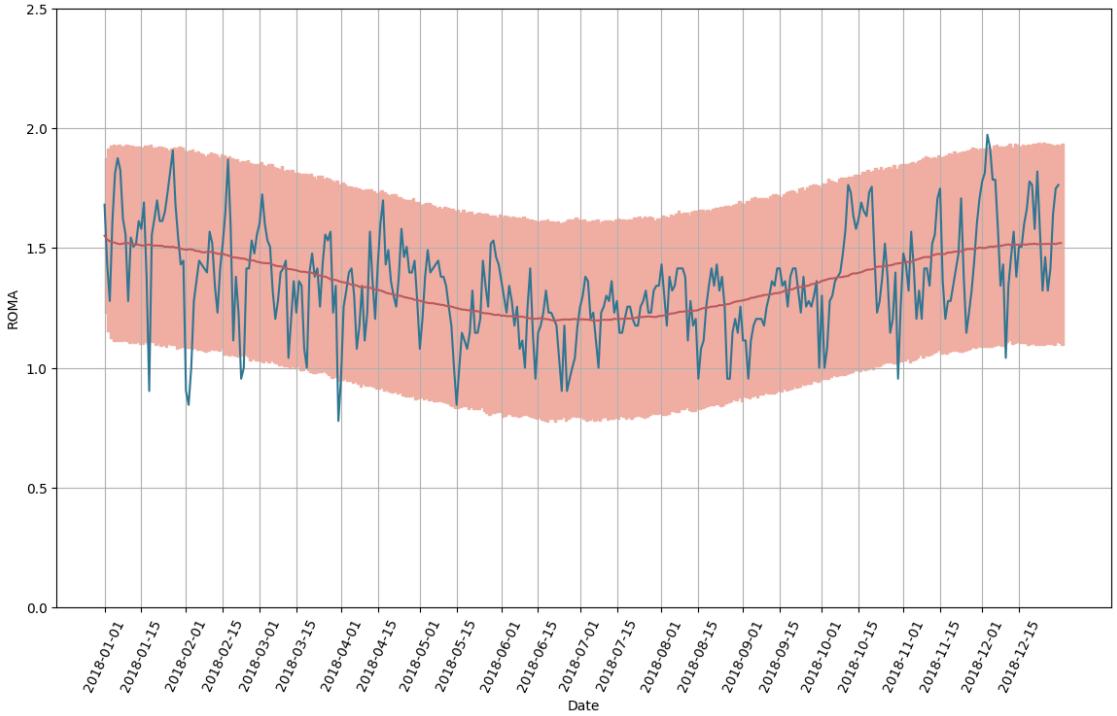
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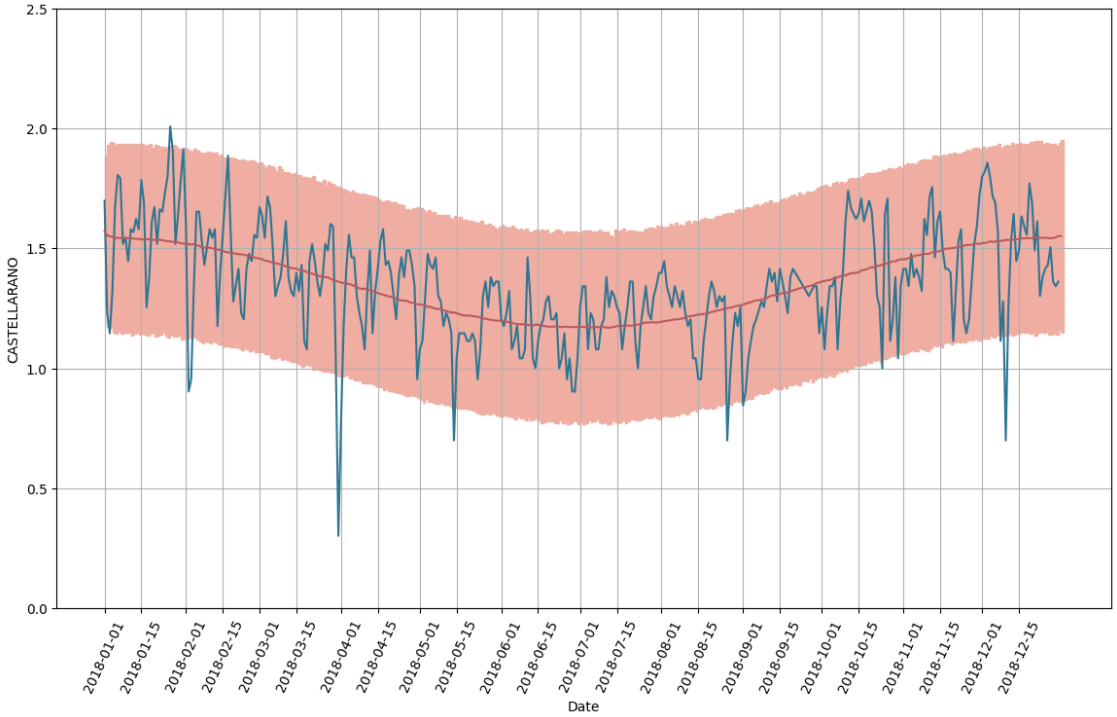
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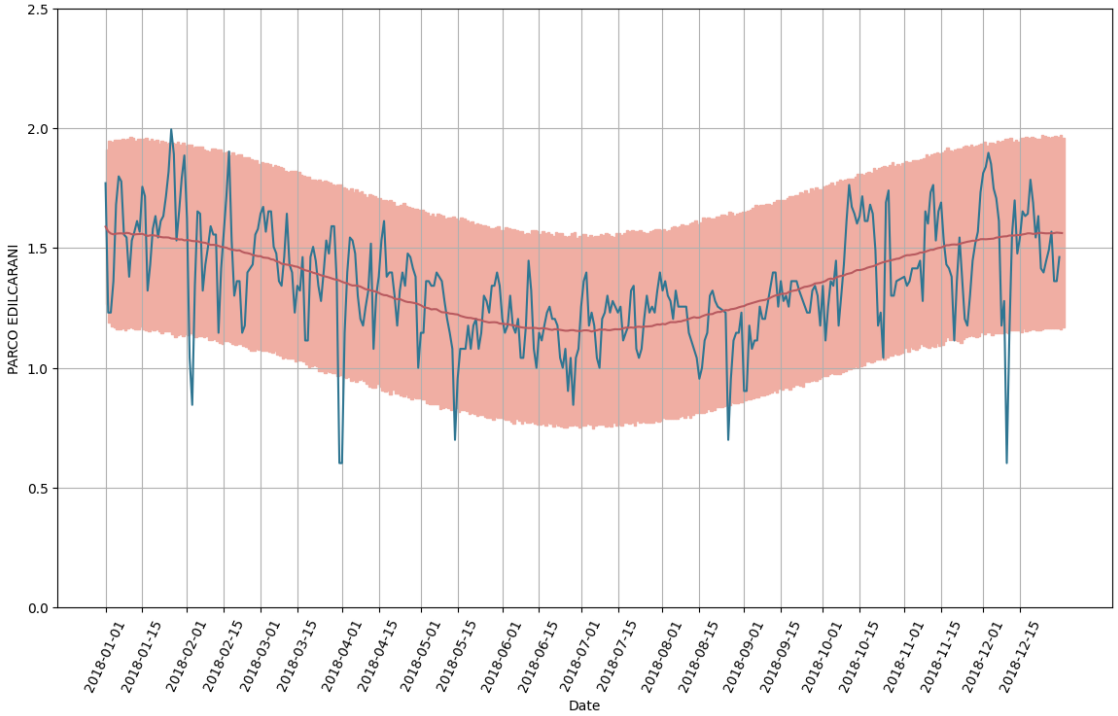
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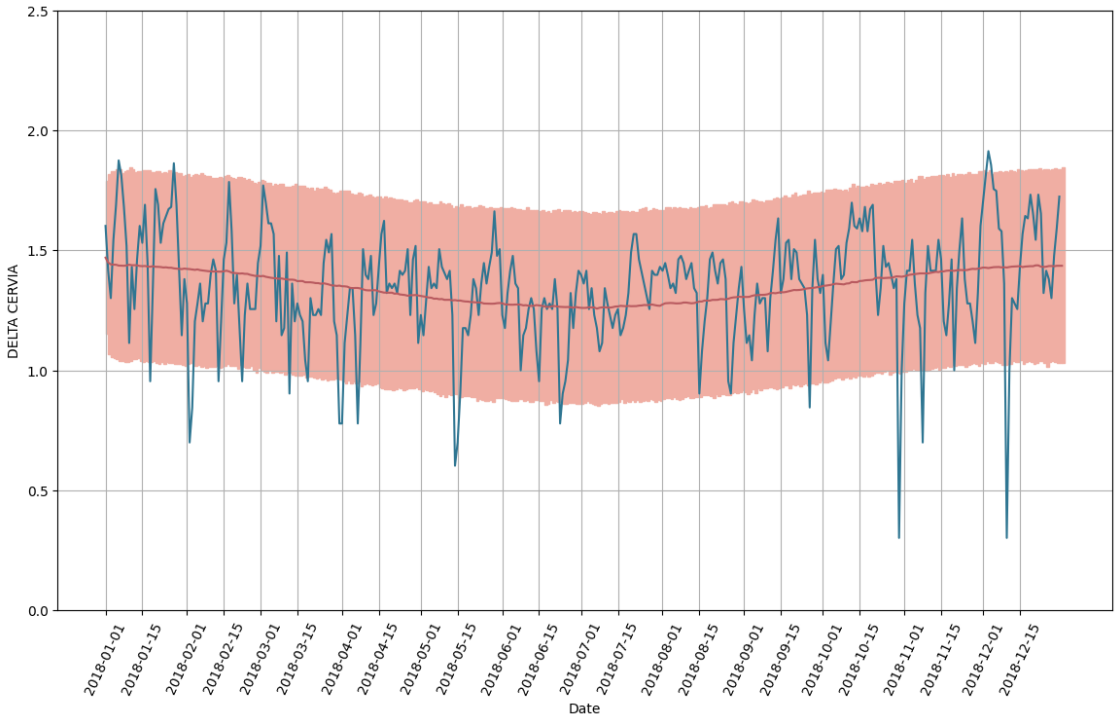
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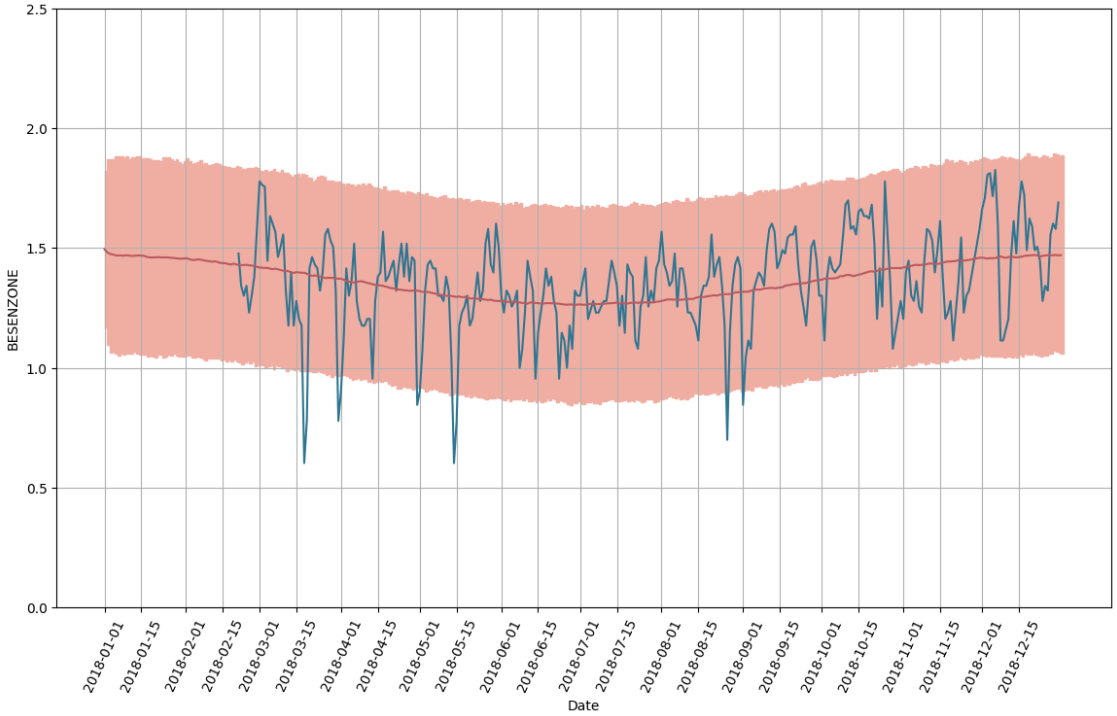
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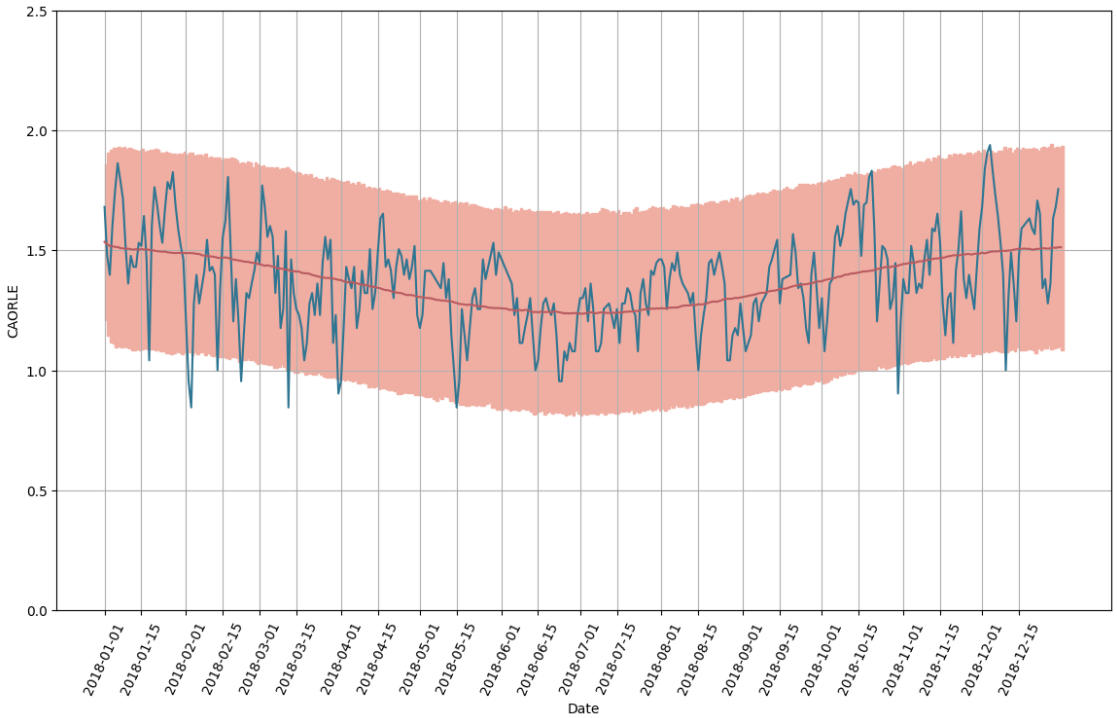
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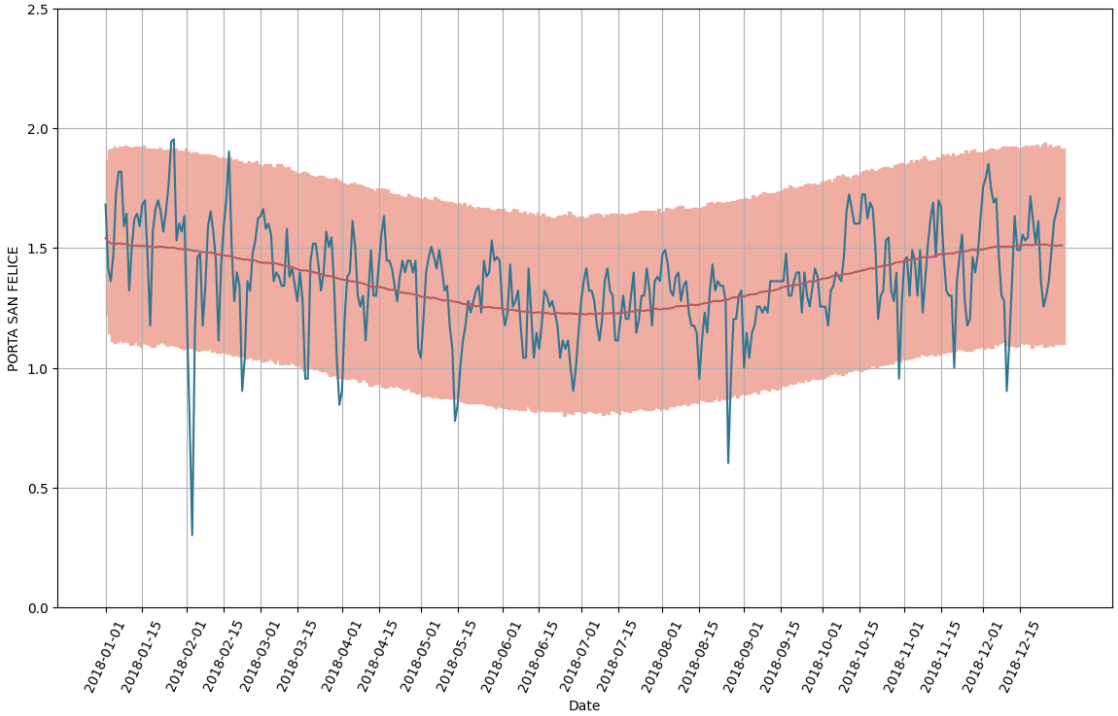
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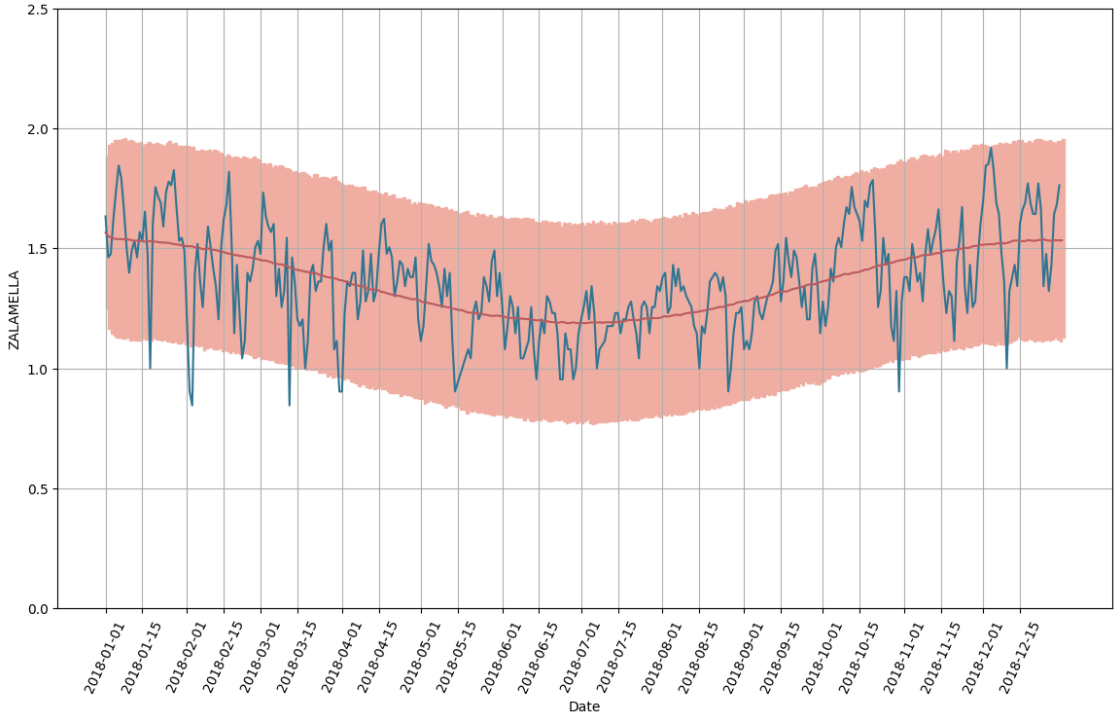
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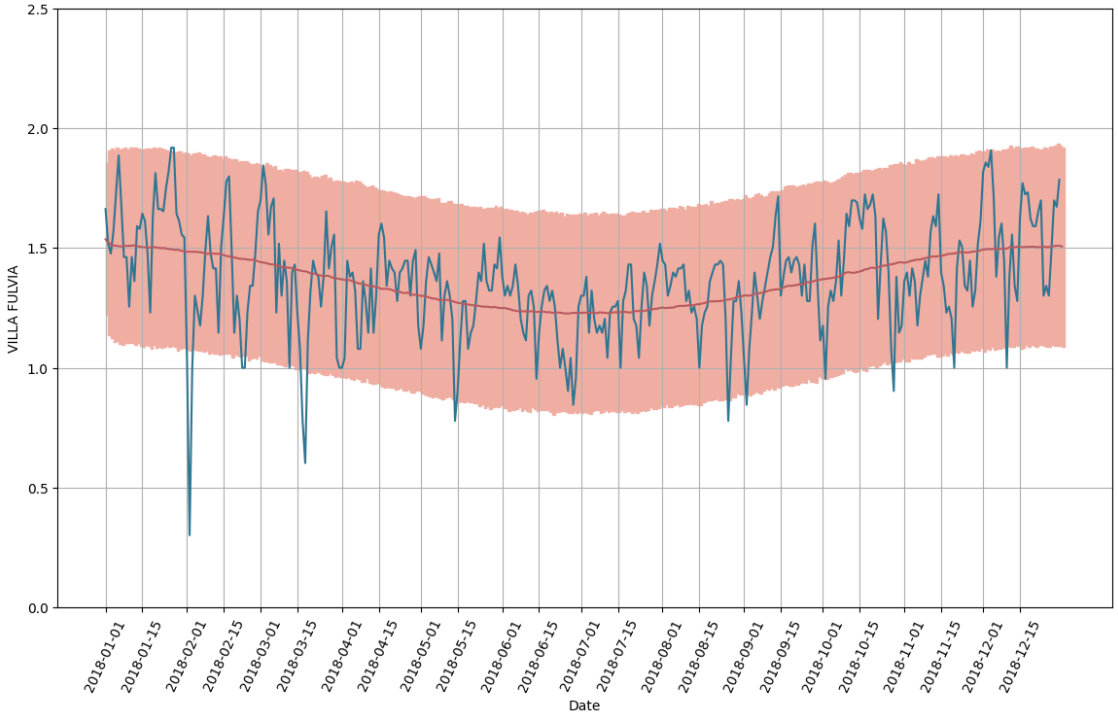
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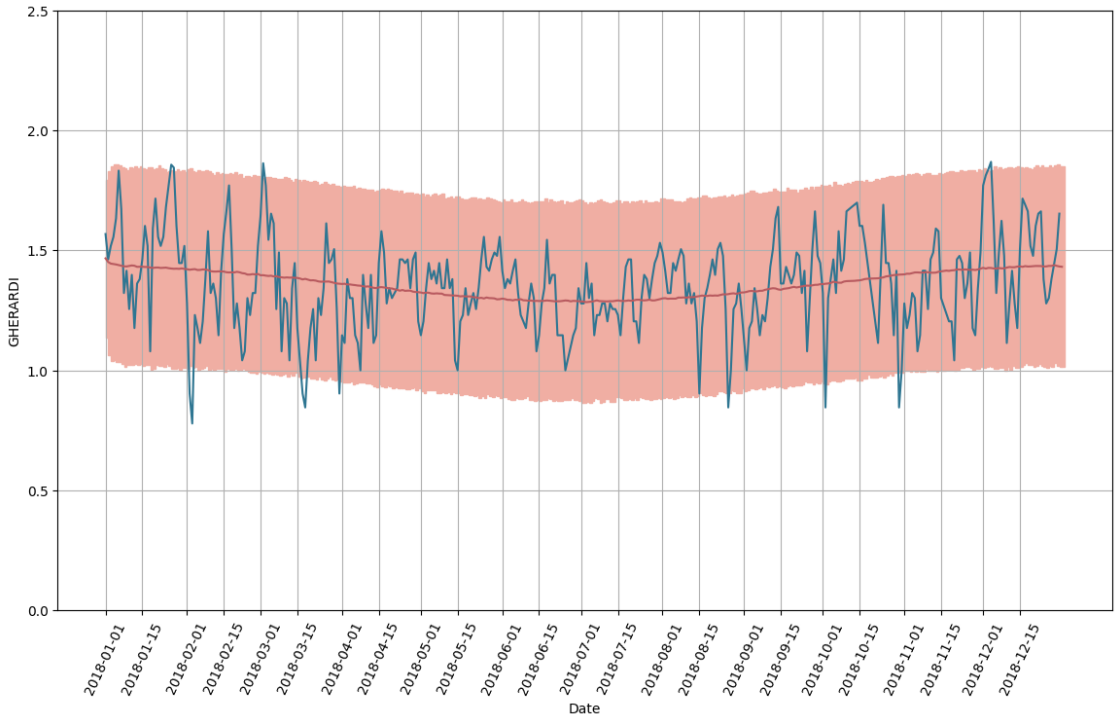
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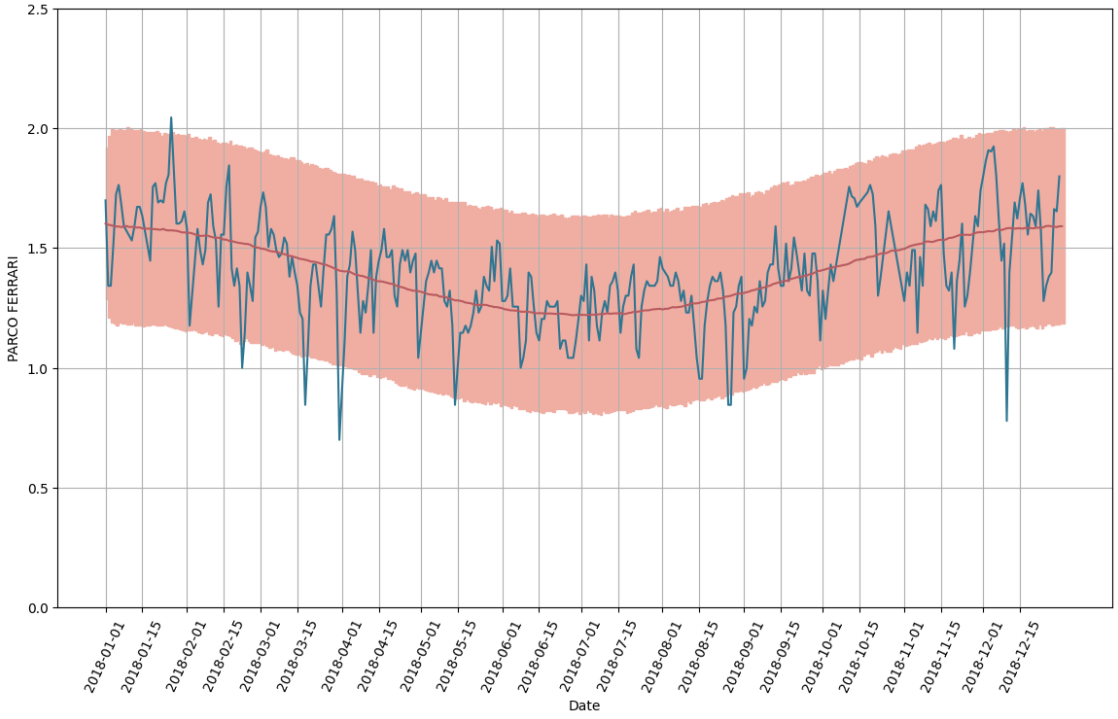
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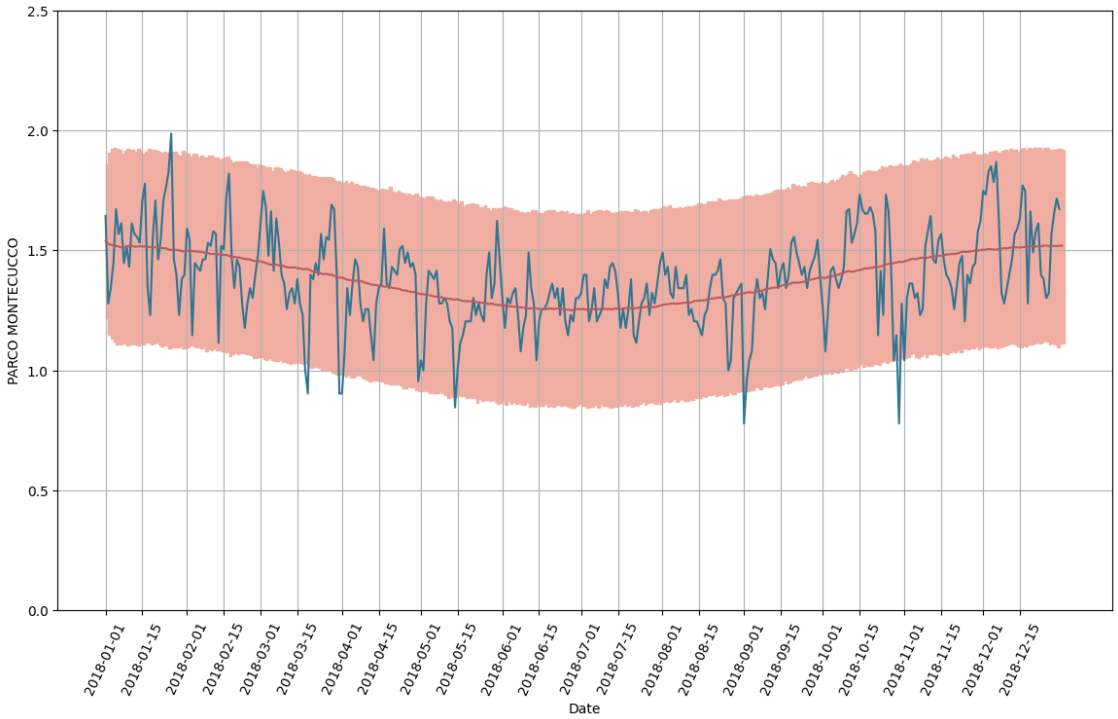
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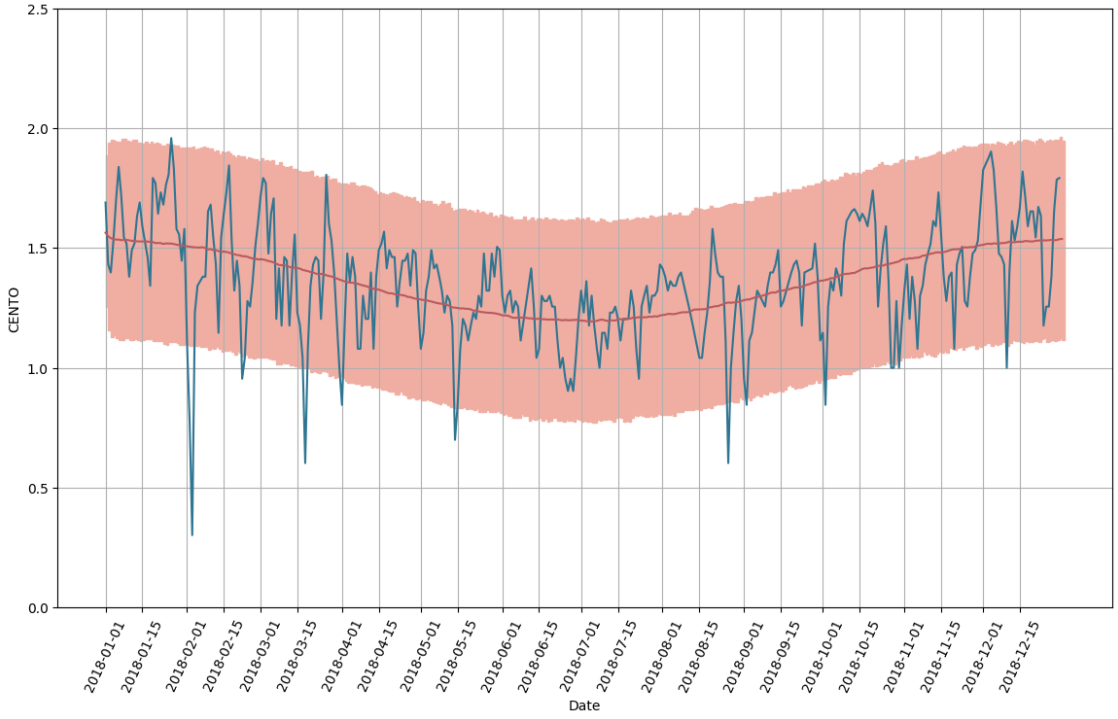
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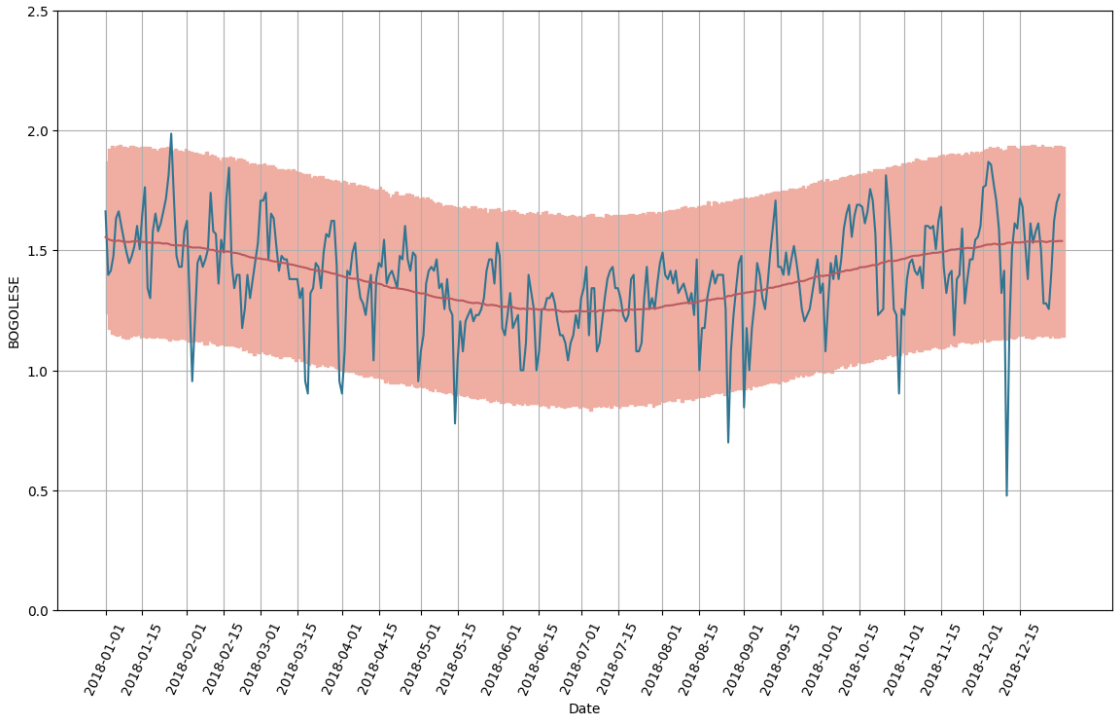
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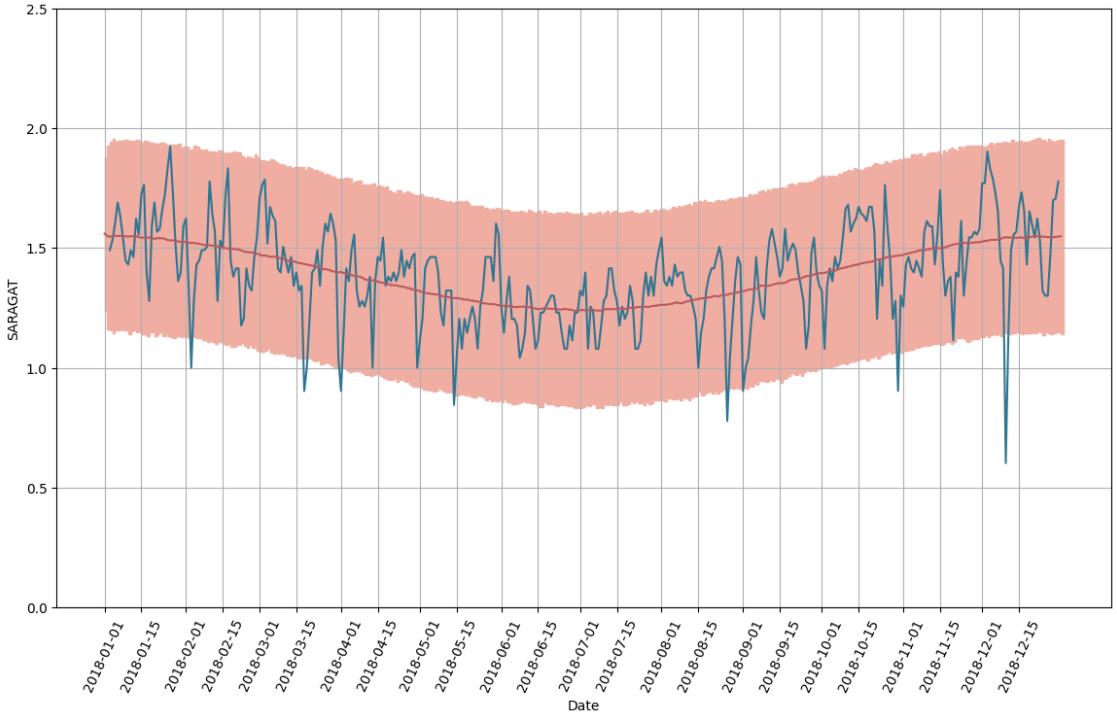
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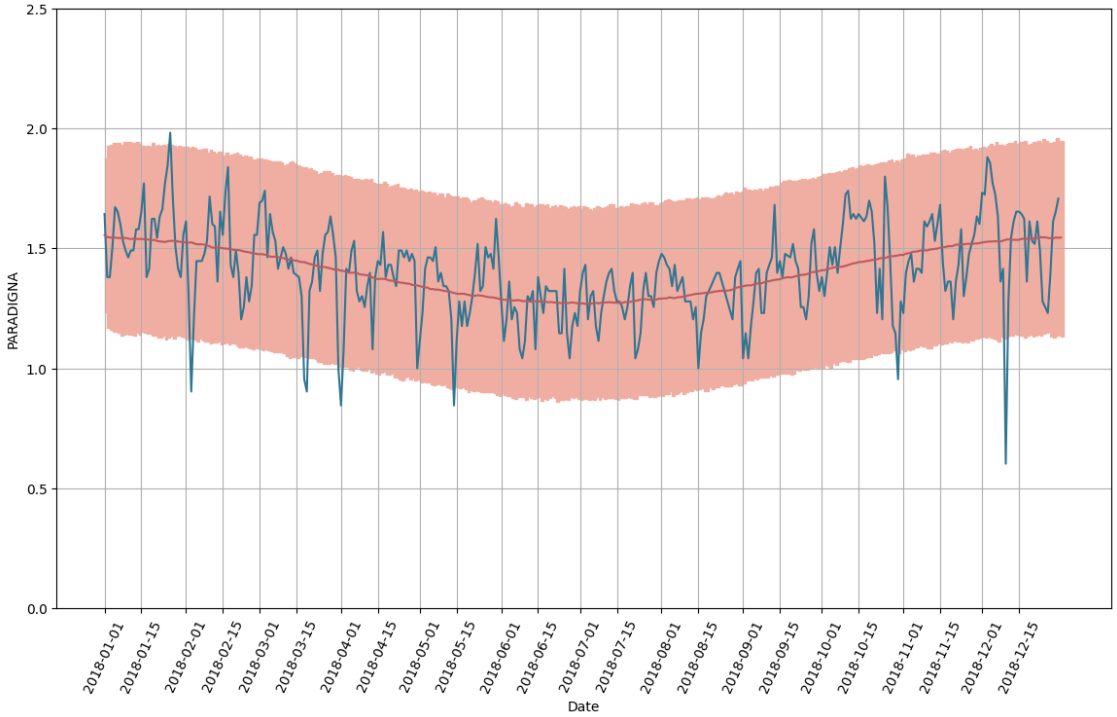
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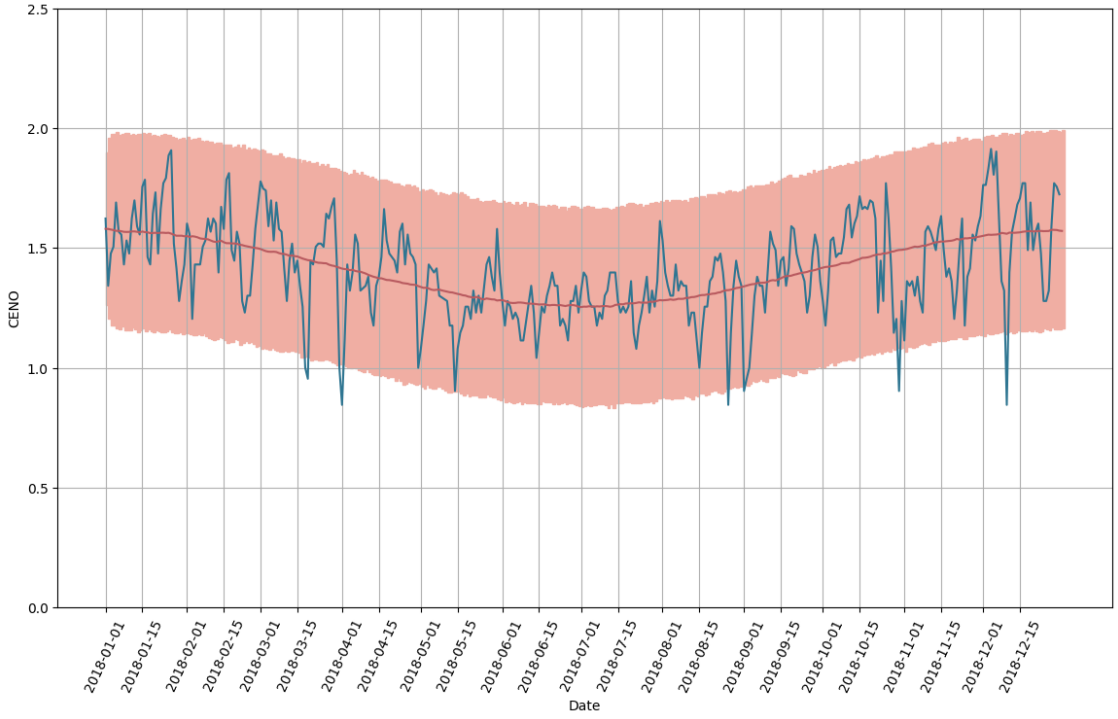
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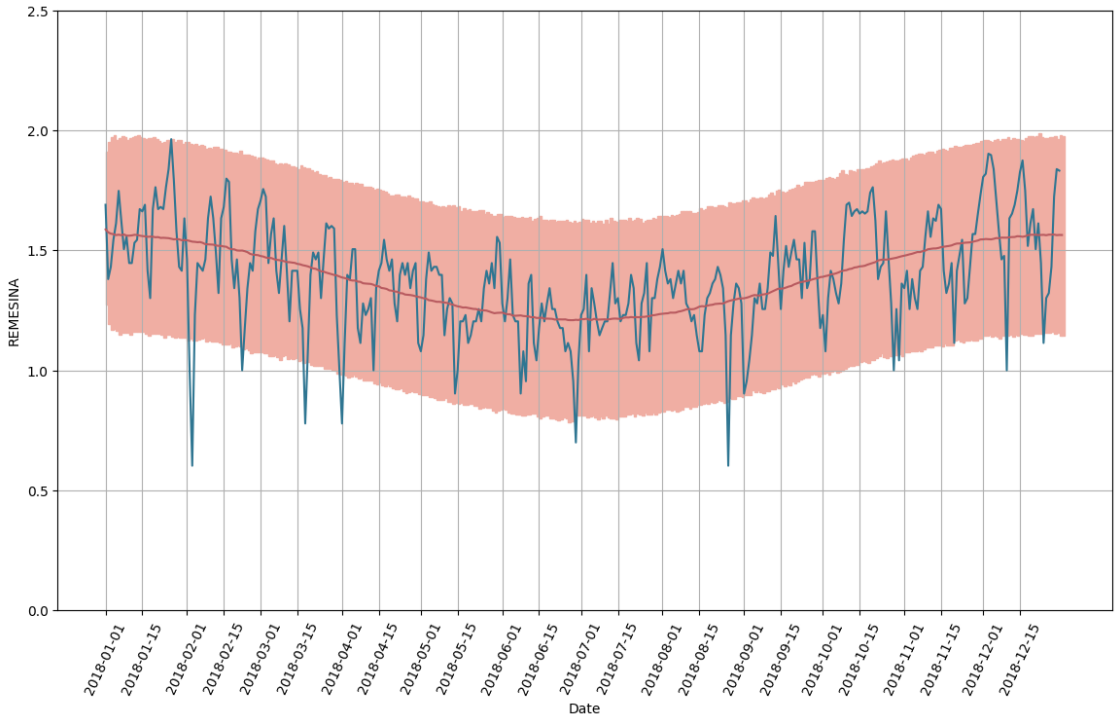
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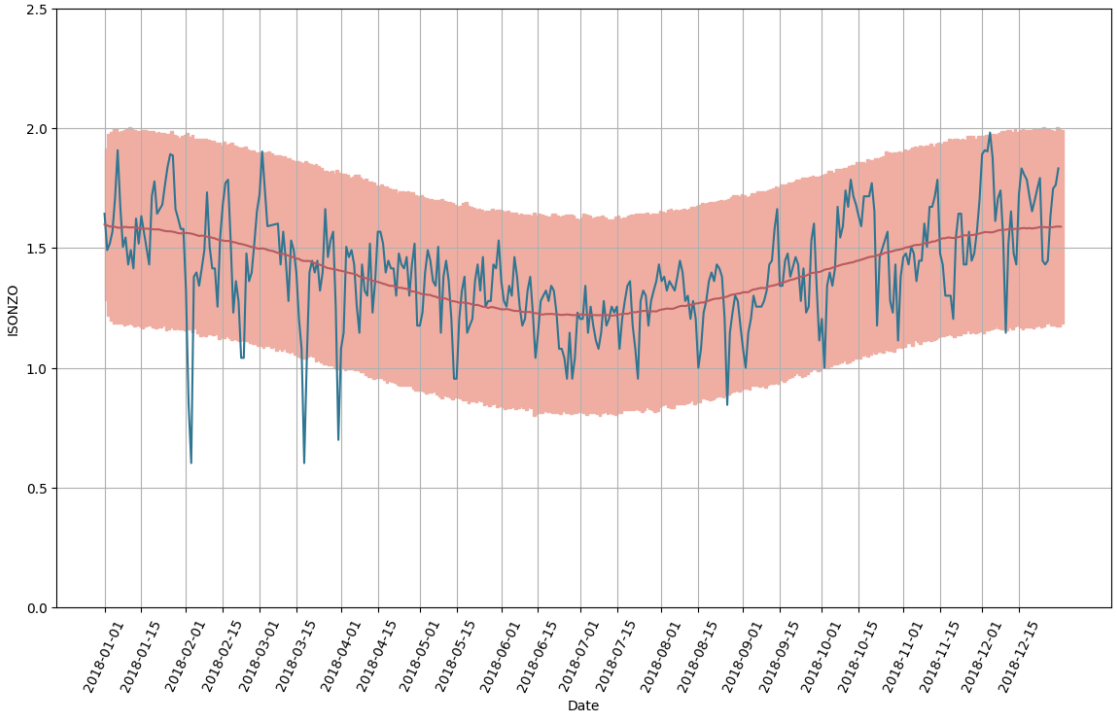
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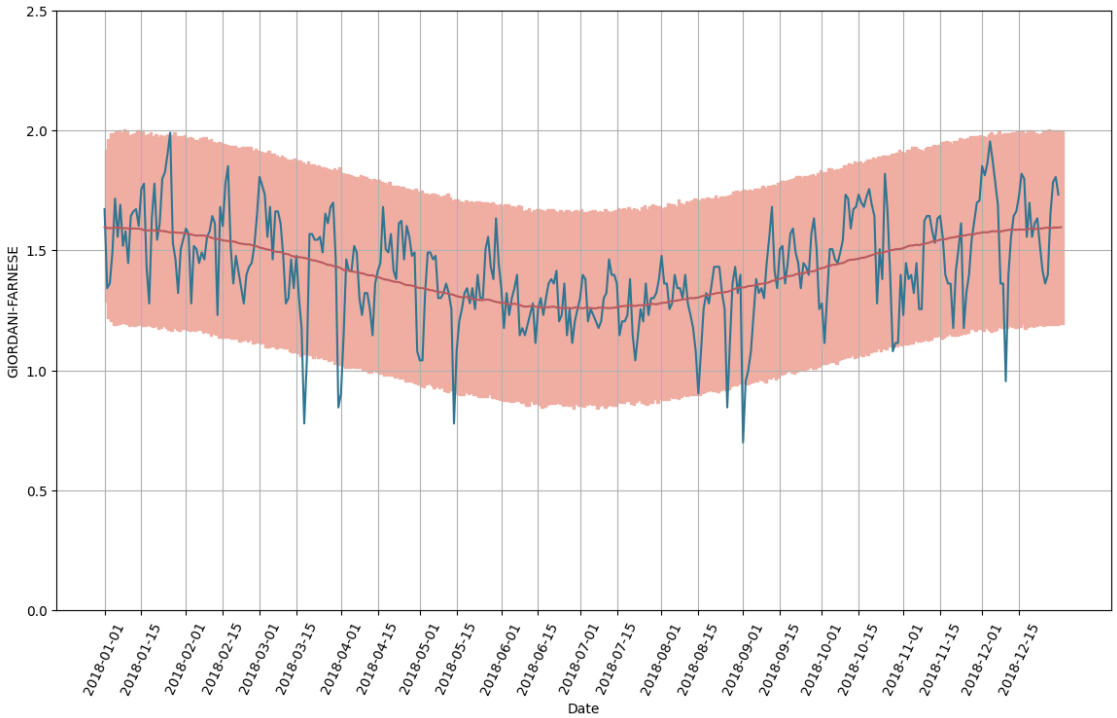
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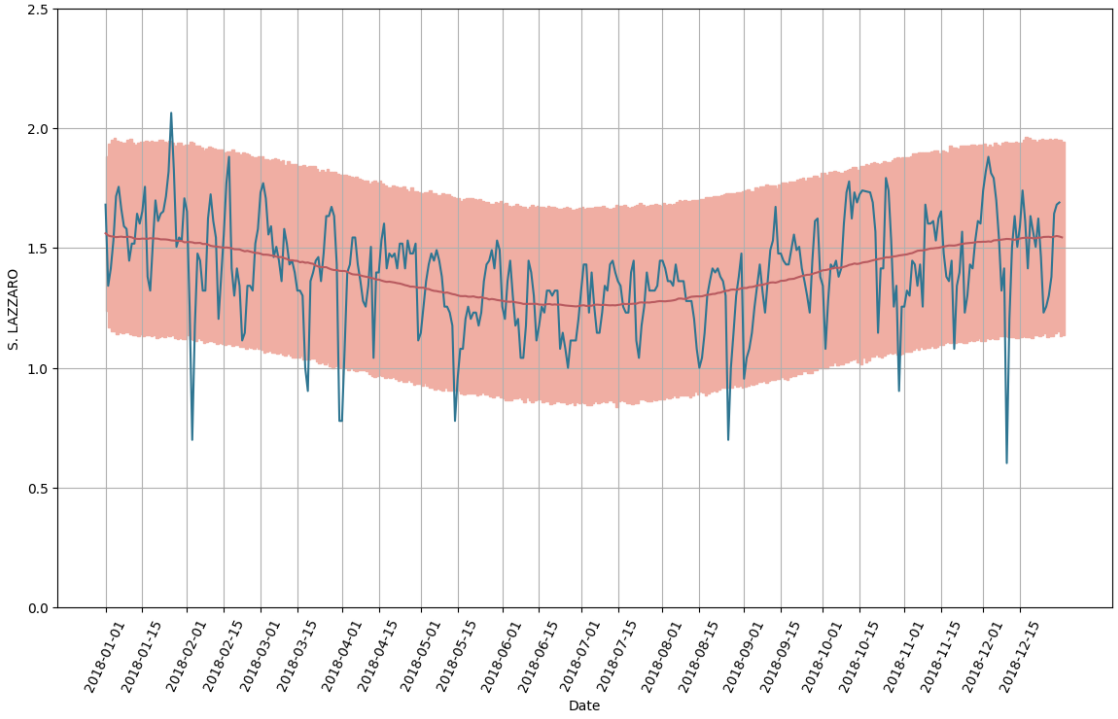
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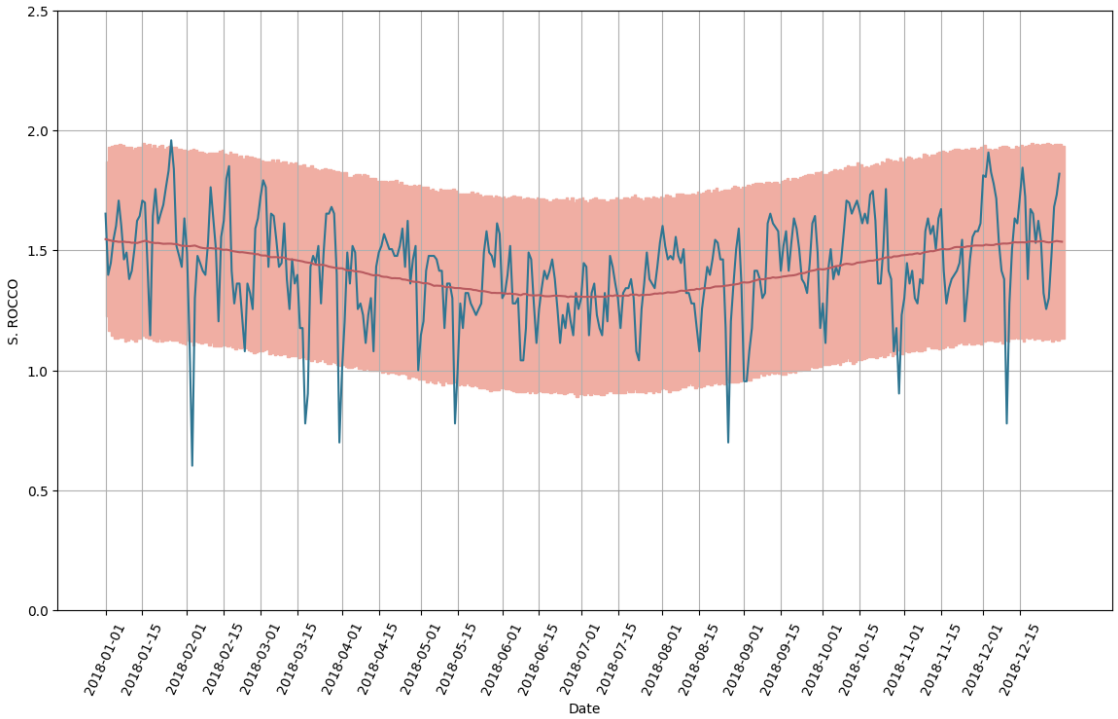
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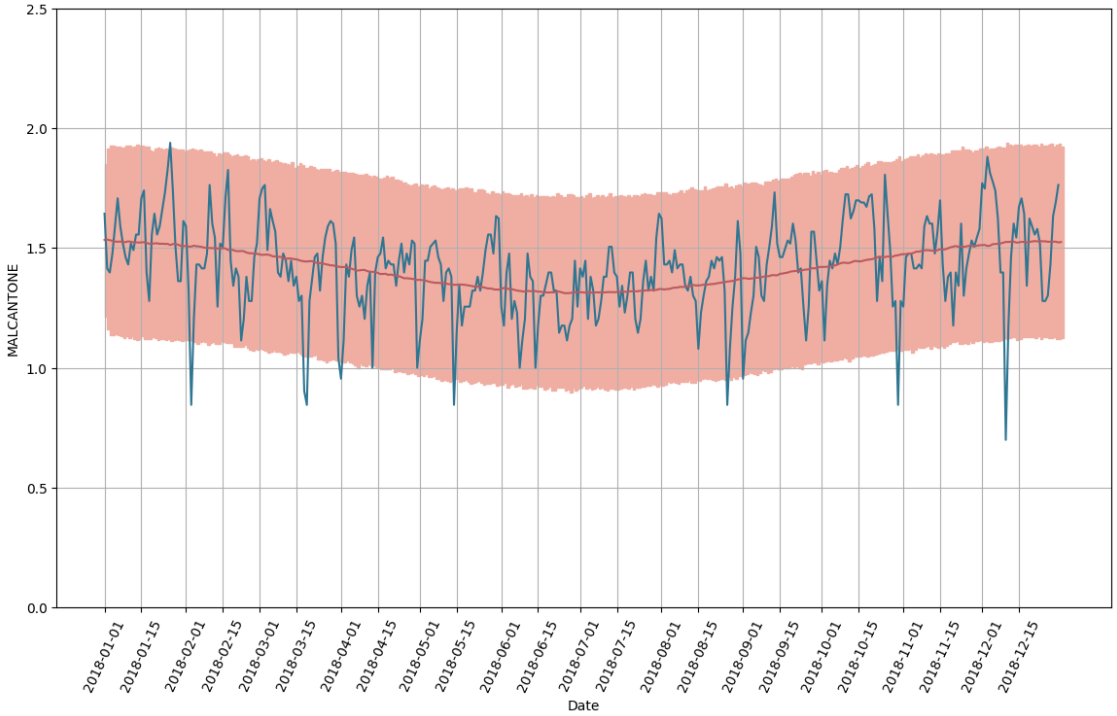
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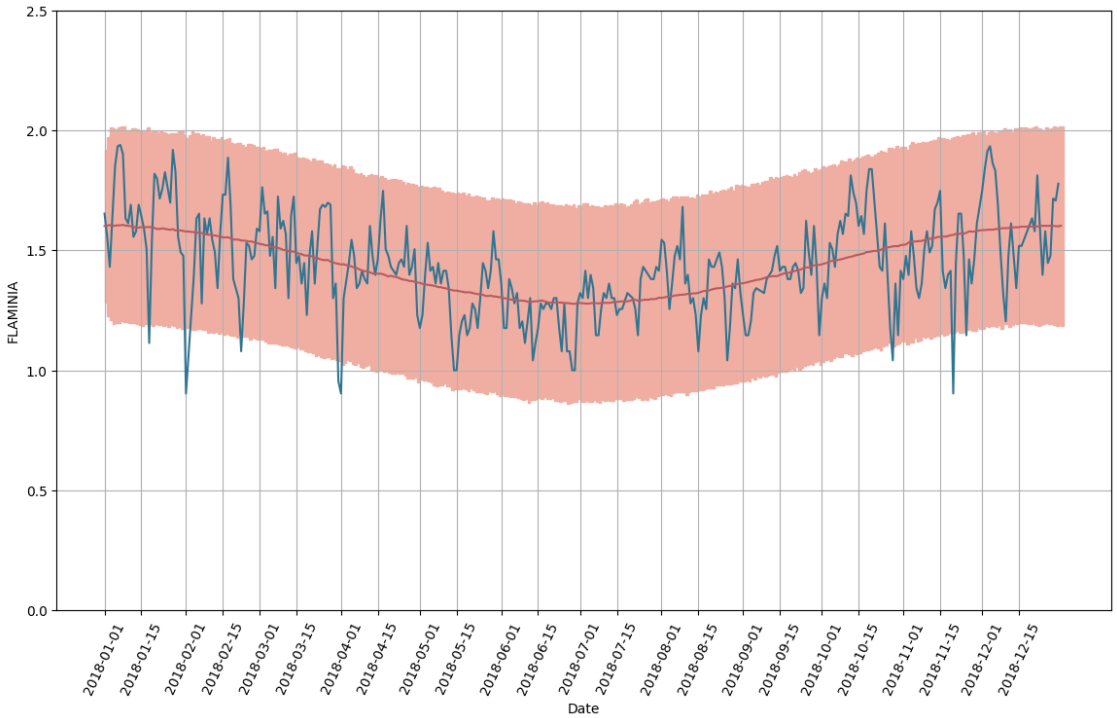
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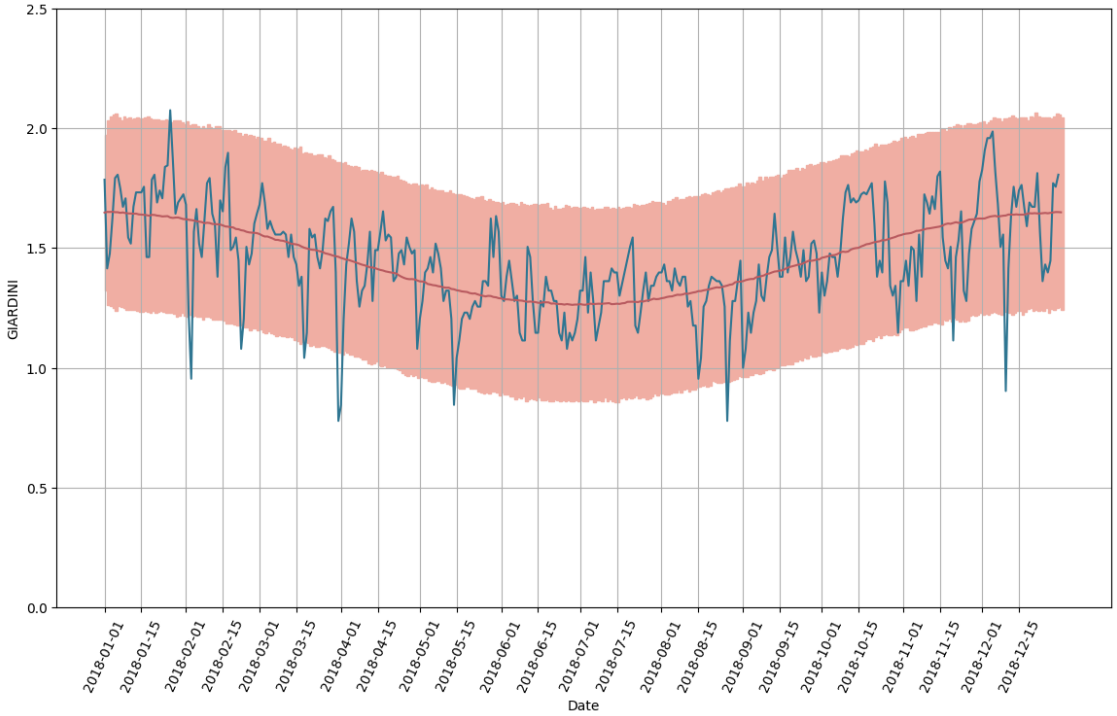
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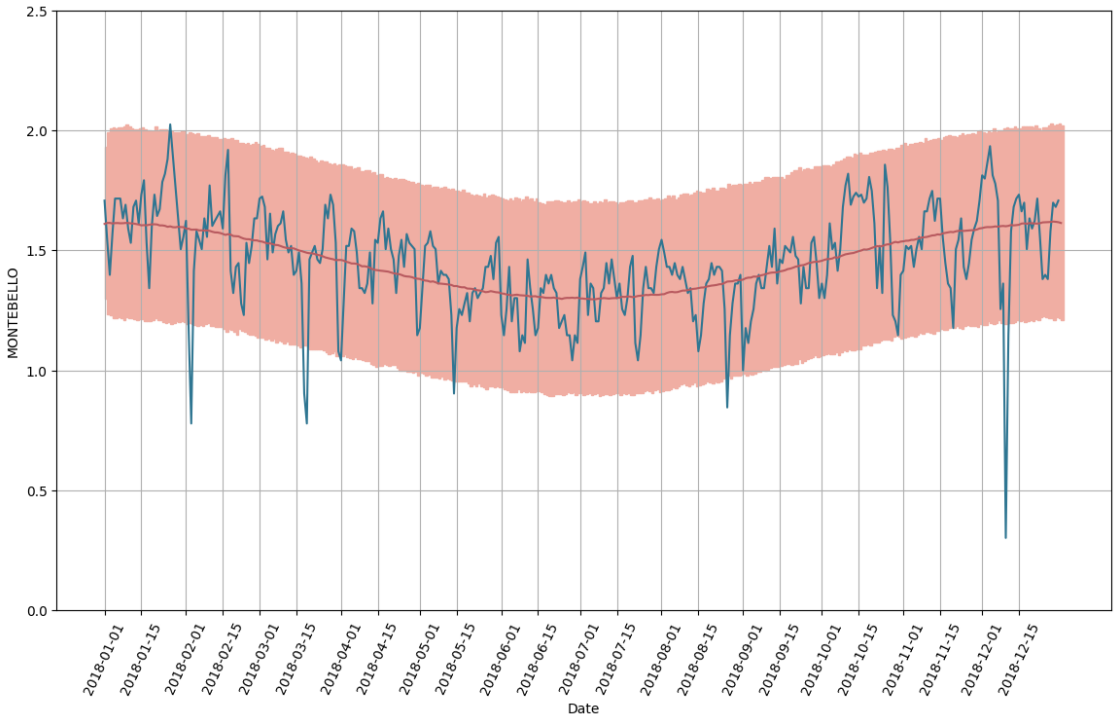
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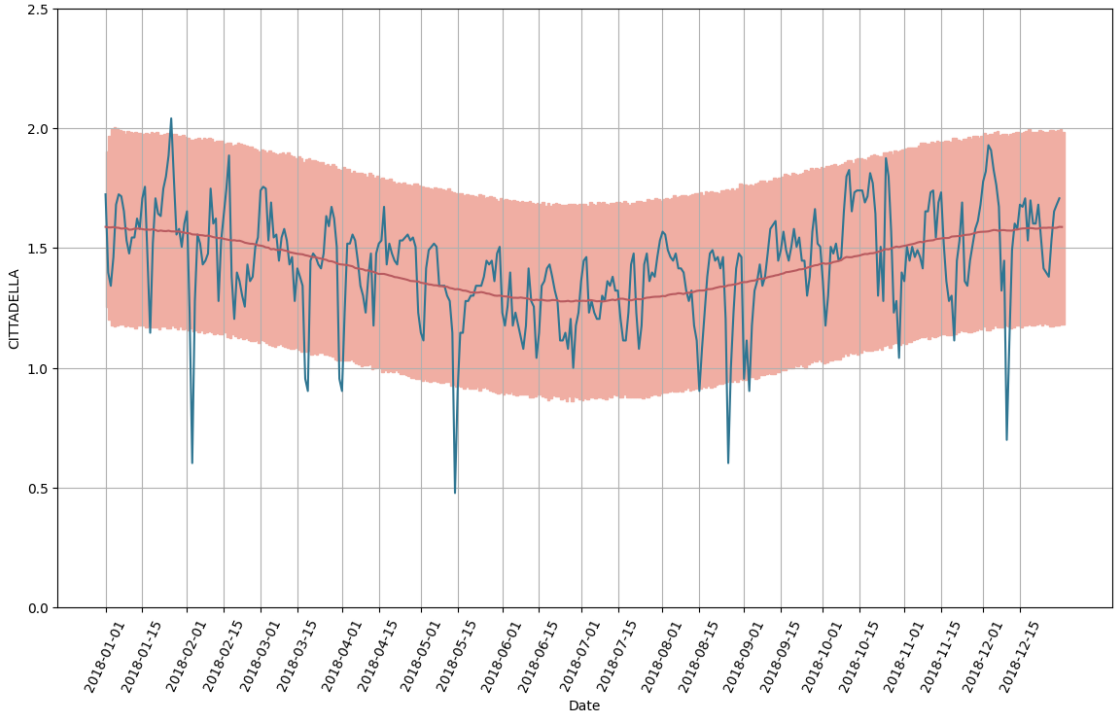
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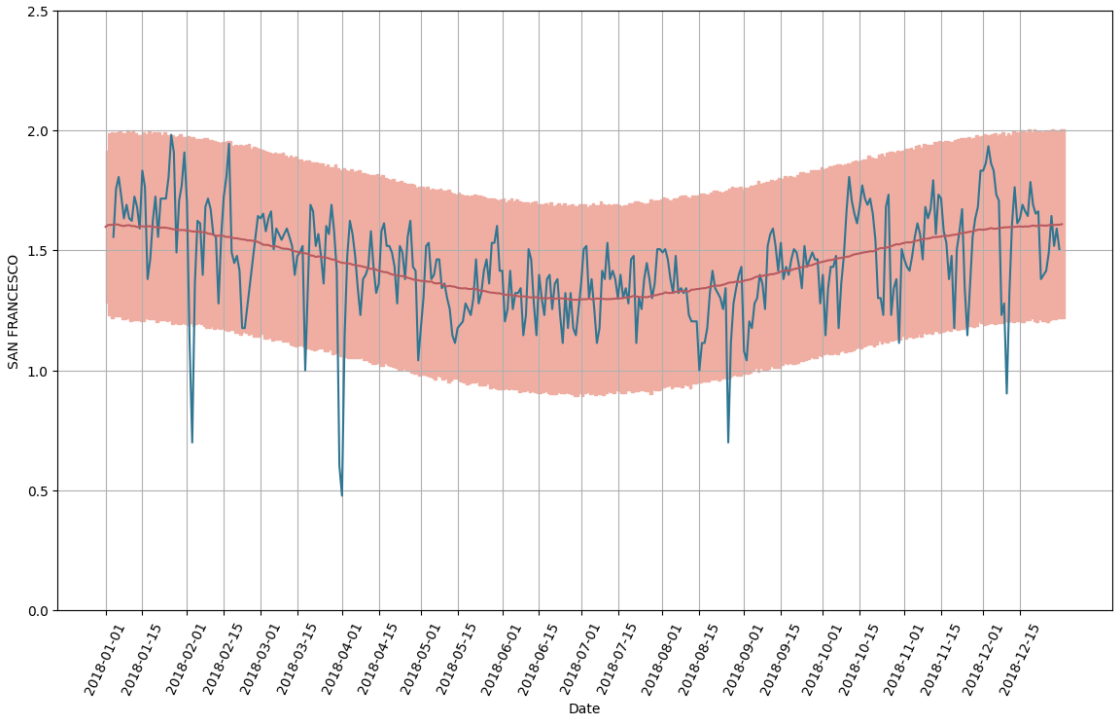
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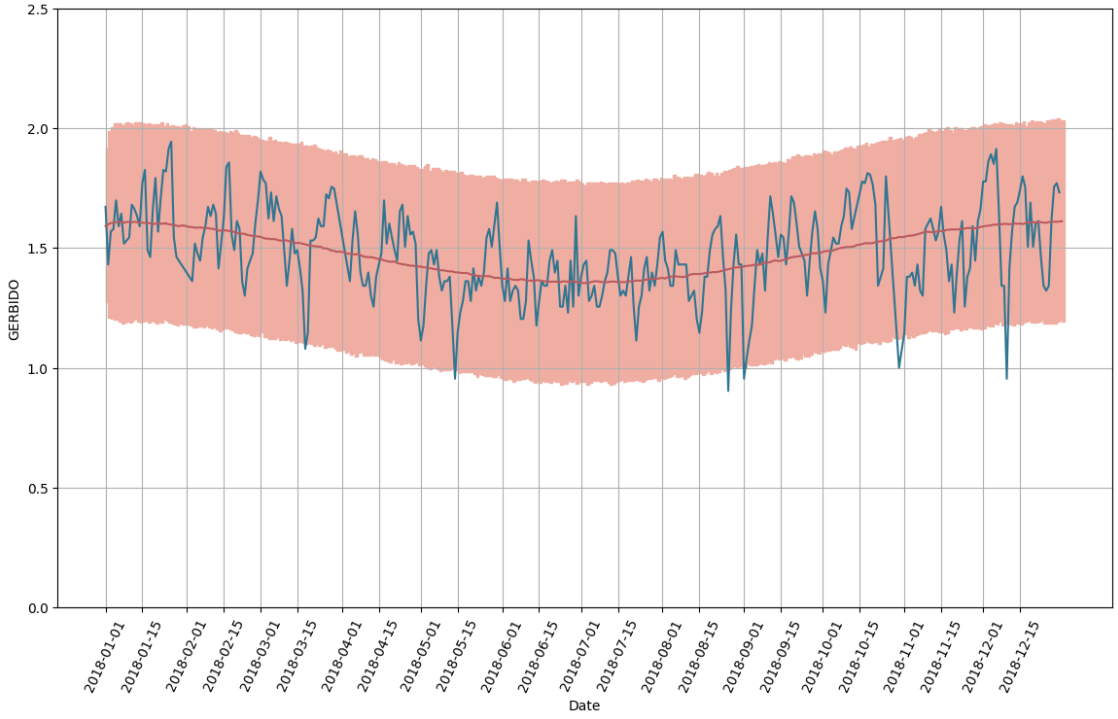
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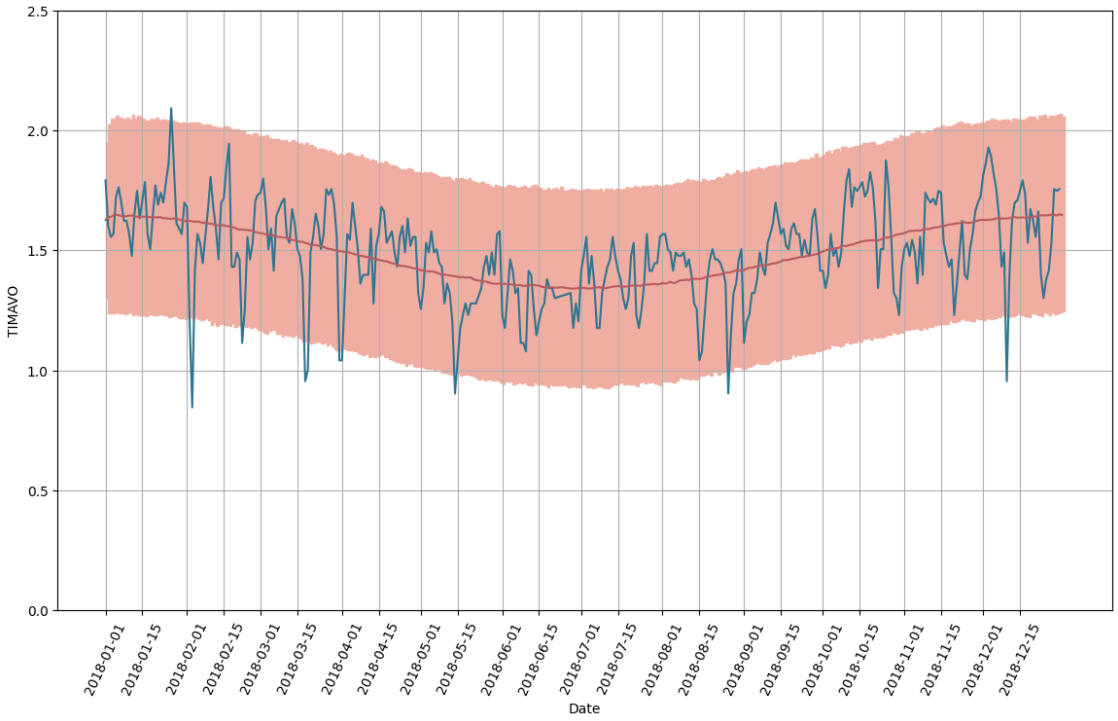
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