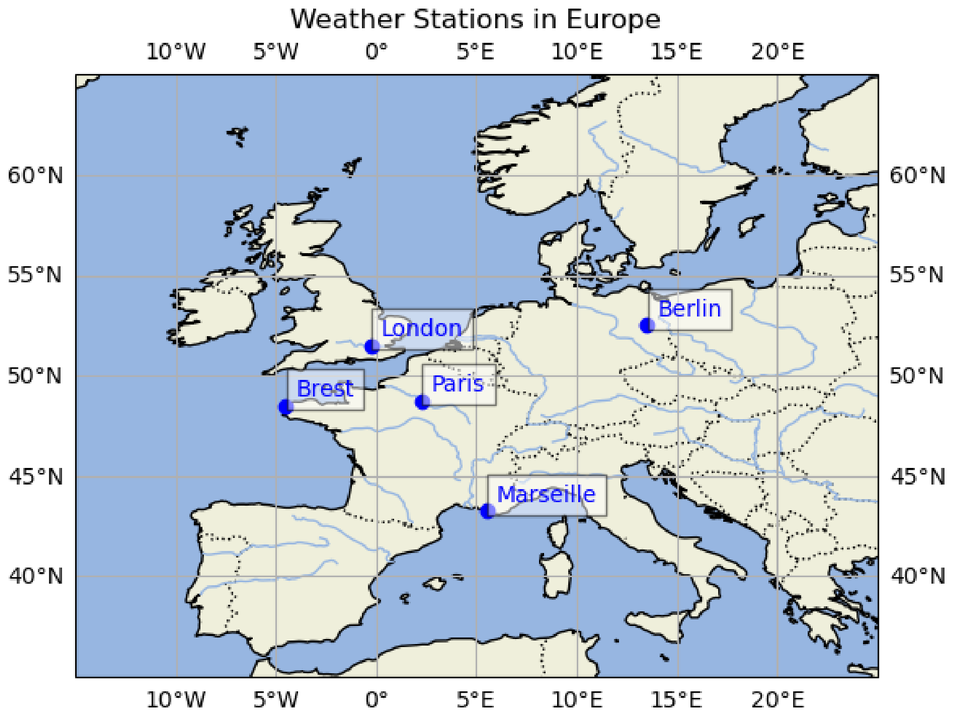
Weather station 2024-2025



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I. Project presentation

1.1 General presentation

Aim of the project :

Paris weather station was cyber-hacked, and is therefore unable to share its weather measures since the beginning of 2019.

Our task is to predict this missing data from other European weather stations measures.

I. Project presentation

1.2 Data files presentation

We are given the raw measurements of 5 weather stations in separate files, split by station and by feature.
Each « .nc » file can be loaded with the « xarray » module in a specific format.
-> To facilitate the following study, this files are merged onto « Pandas » Dataframe.

Treatment:

Given the physicial differences in the meaning and scale of each feature, we decided to **normalize** the dataset **by feature** to use them in a machine learning process. But to be able to interpret back the results of our models, the inverse transformation should be available. That's why we specifically return the scalers during the loading process.

Signification: Each of the 10 features represent a physical measurement that is studied in the next part.

II. Data Loading / preparation / study

2.4 Creation of the final dataset

To speed up the computational cost, we reduced the size of the dataset to a **daily sample, with normalized data**.

We kept only the 13 last years:

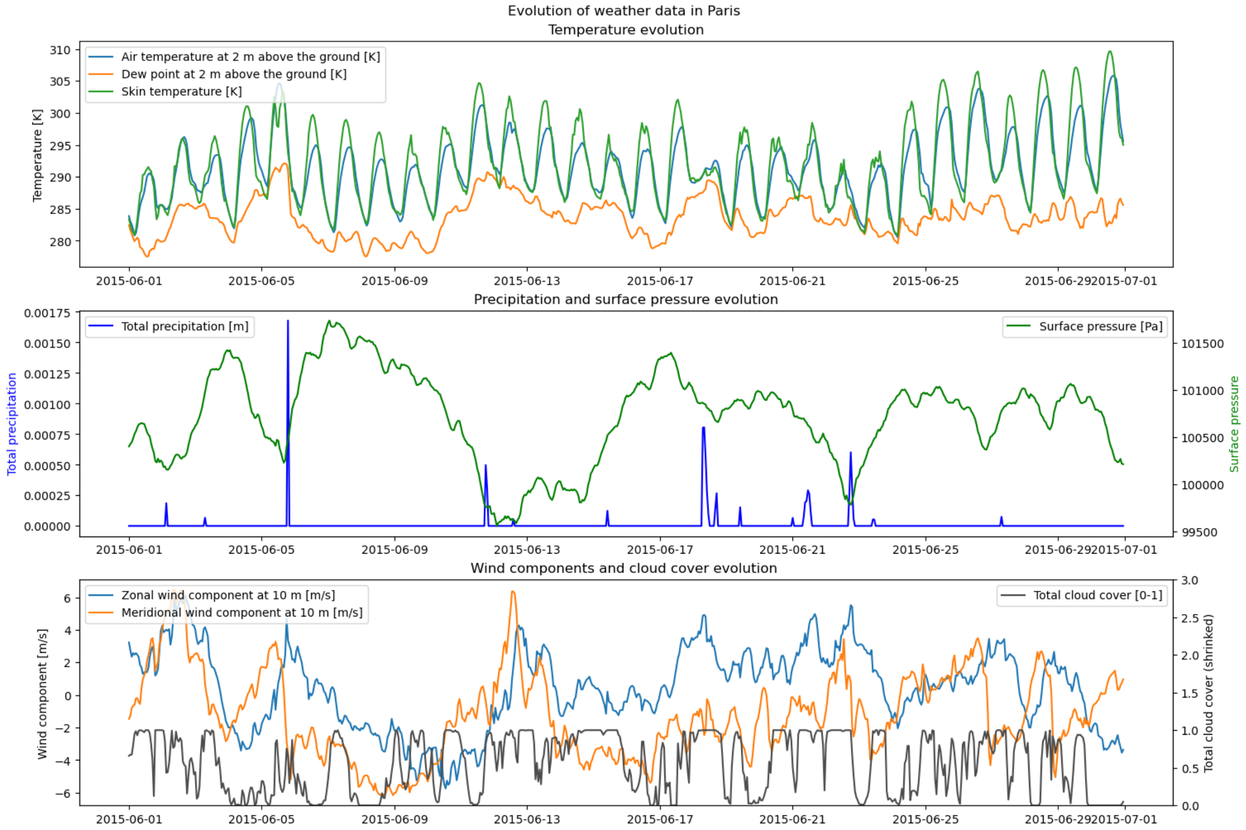
- train: 70% 2007-2015,
- test: 23% 2016-2018,
- validation: 7 % 2019

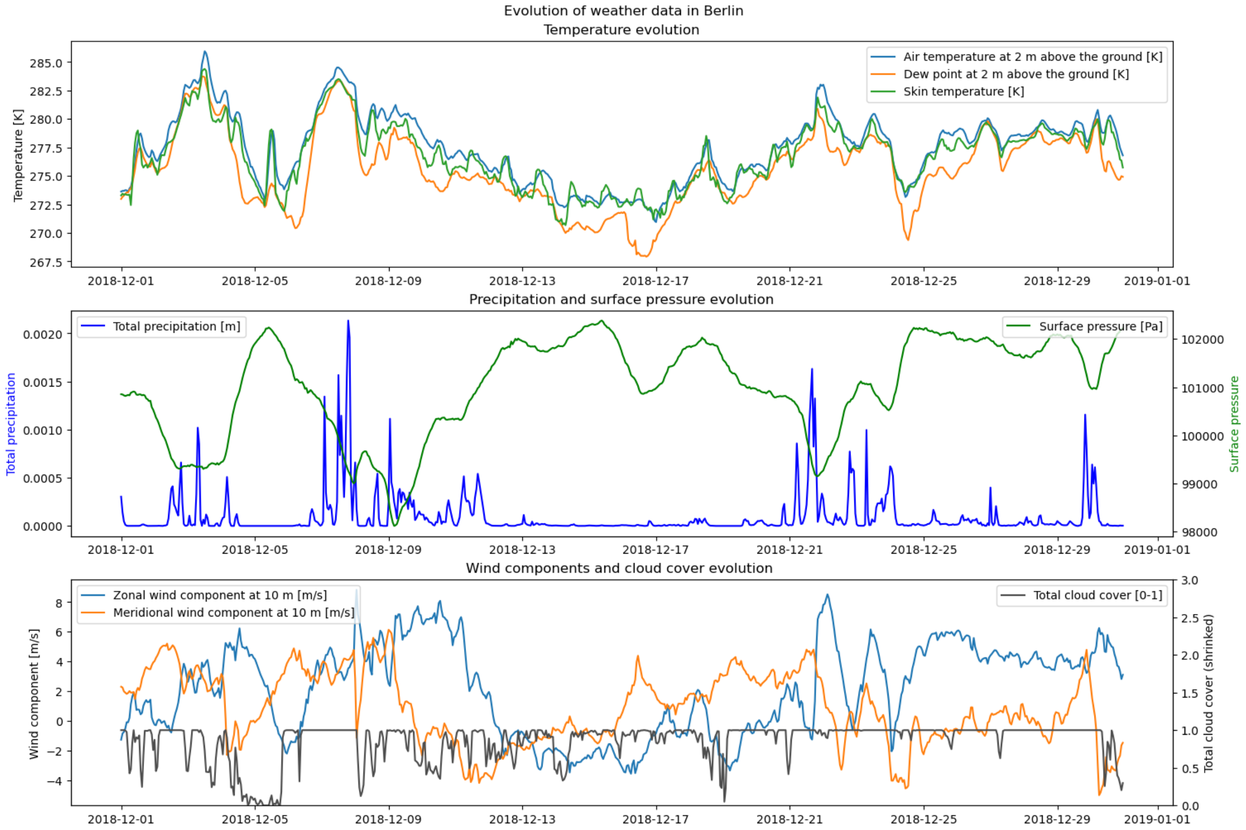
Then, all datasets have been merged in a single DataFrame gathering all variables for all cities but Paris, that is the target.

Ultimately, for **deep learning models**, add the data of the **3 previous days** to detect unlinear patterns.

II. Data Loading / preparation / study

2.1 Data exploration

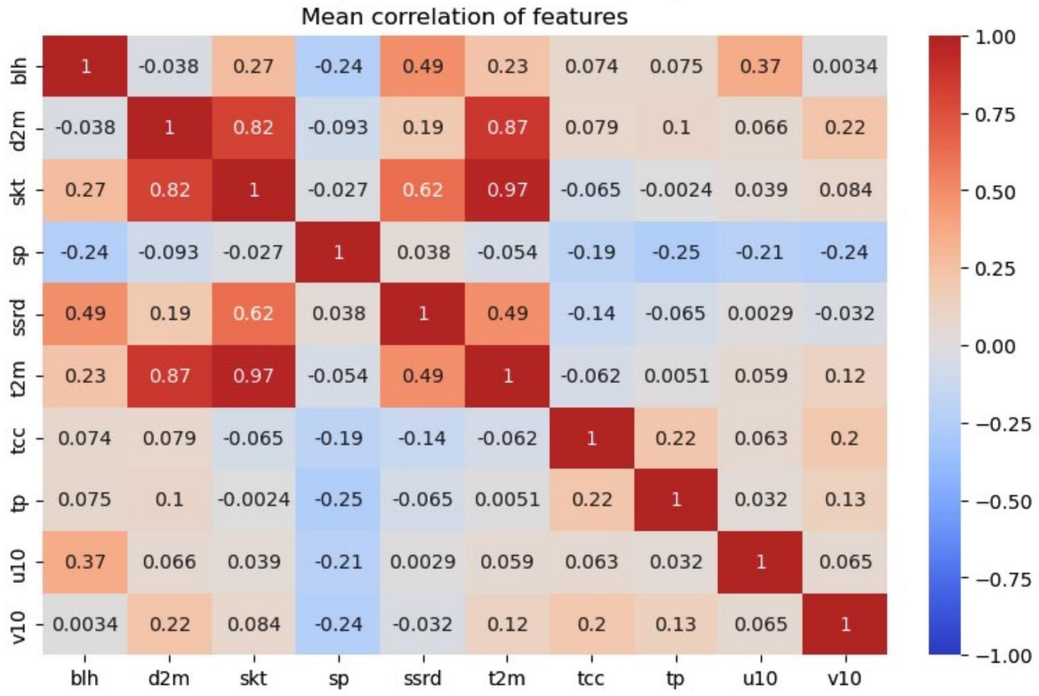




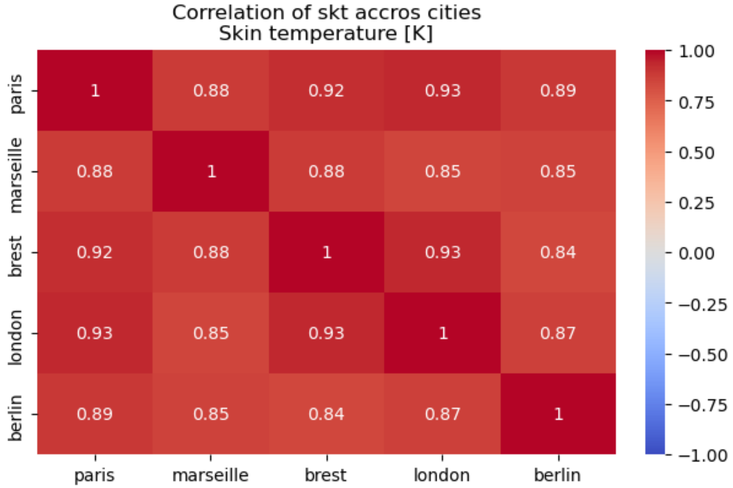
II. Data Loading / preparation / study

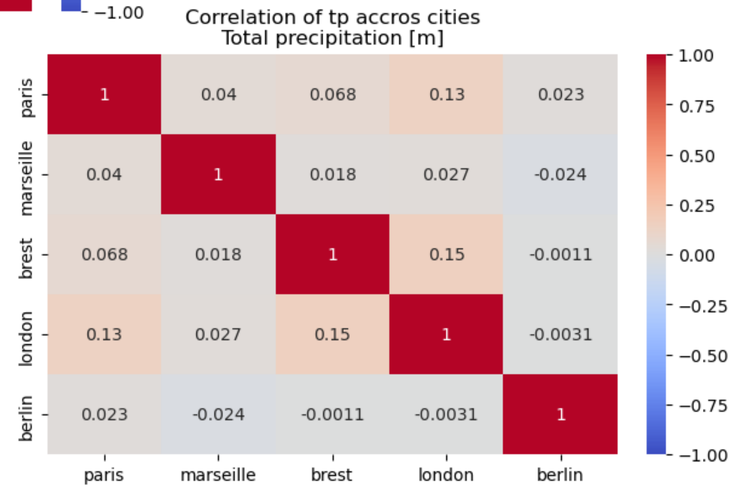
2.2 Covariance study

—> Between Features



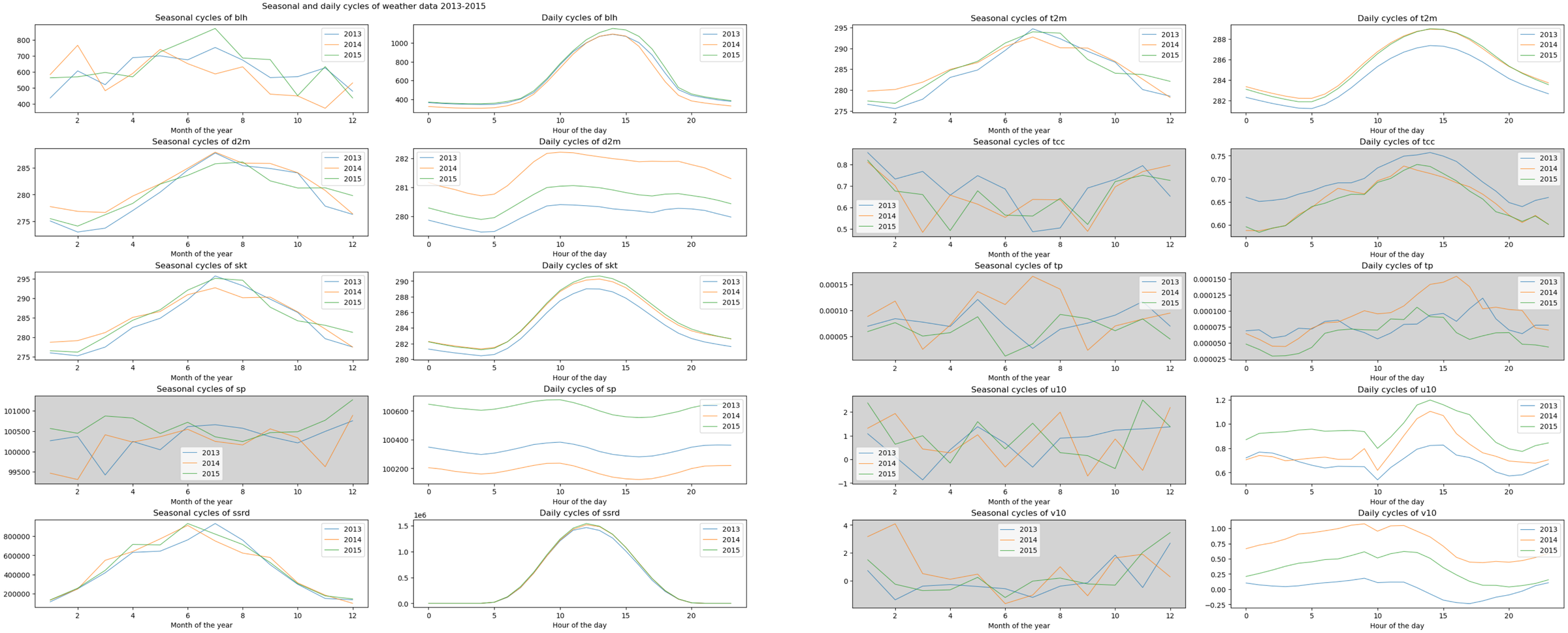
—> Between Cities





II. Data Loading / preparation / study

2.3 Cycles in features



III. Prediction of Paris Weather

3.0 Baseline : Linear regressor

Do we have different result when focusing only on one feature or are we more accurate when using all available features of the dataset?

In the following colored-gradients, we are expecting to have the most dark green / low value cells.

MSE per variable for the baseline model per variables: LinearRegression()

	paris_blh	paris_d2m	paris_skt	paris_sp	paris_ssrd	paris_t2m	paris_tcc	paris_tp	paris_u10	paris_v10
2016	0.166761	0.062701	0.039654	0.009005	0.085802	0.046109	0.248094	3.223900	0.046913	0.140415
2017	0.193160	0.051314	0.033328	0.009482	0.071674	0.043901	0.210177	3.543318	0.045133	0.129609
2018	0.178478	0.069938	0.044037	0.020020	0.074057	0.048910	0.232721	3.370375	0.054735	0.157305
all	0.179466	0.061318	0.039006	0.012836	0.077178	0.046307	0.230331	3.379198	0.048927	0.142443

MSE per variable for the baseline model global: LinearRegression()

	paris_blh	paris_d2m	paris_skt	paris_sp	paris_ssrd	paris_t2m	paris_tcc	paris_tp	paris_u10	paris_v10
2016	0.142424	0.045776	0.036308	0.001665	0.069907	0.040994	0.206956	2.554993	0.017333	0.042979
2017	0.142414	0.041109	0.024748	0.001933	0.059055	0.030950	0.177964	2.966685	0.017705	0.043503
2018	0.138695	0.059709	0.035873	0.002542	0.061844	0.044294	0.204308	2.782853	0.063525	0.133017
all	0.141178	0.048865	0.032310	0.002046	0.063602	0.038746	0.196409	2.768177	0.032854	0.073167

III. Prediction of Paris Weather

3.1 Testing models

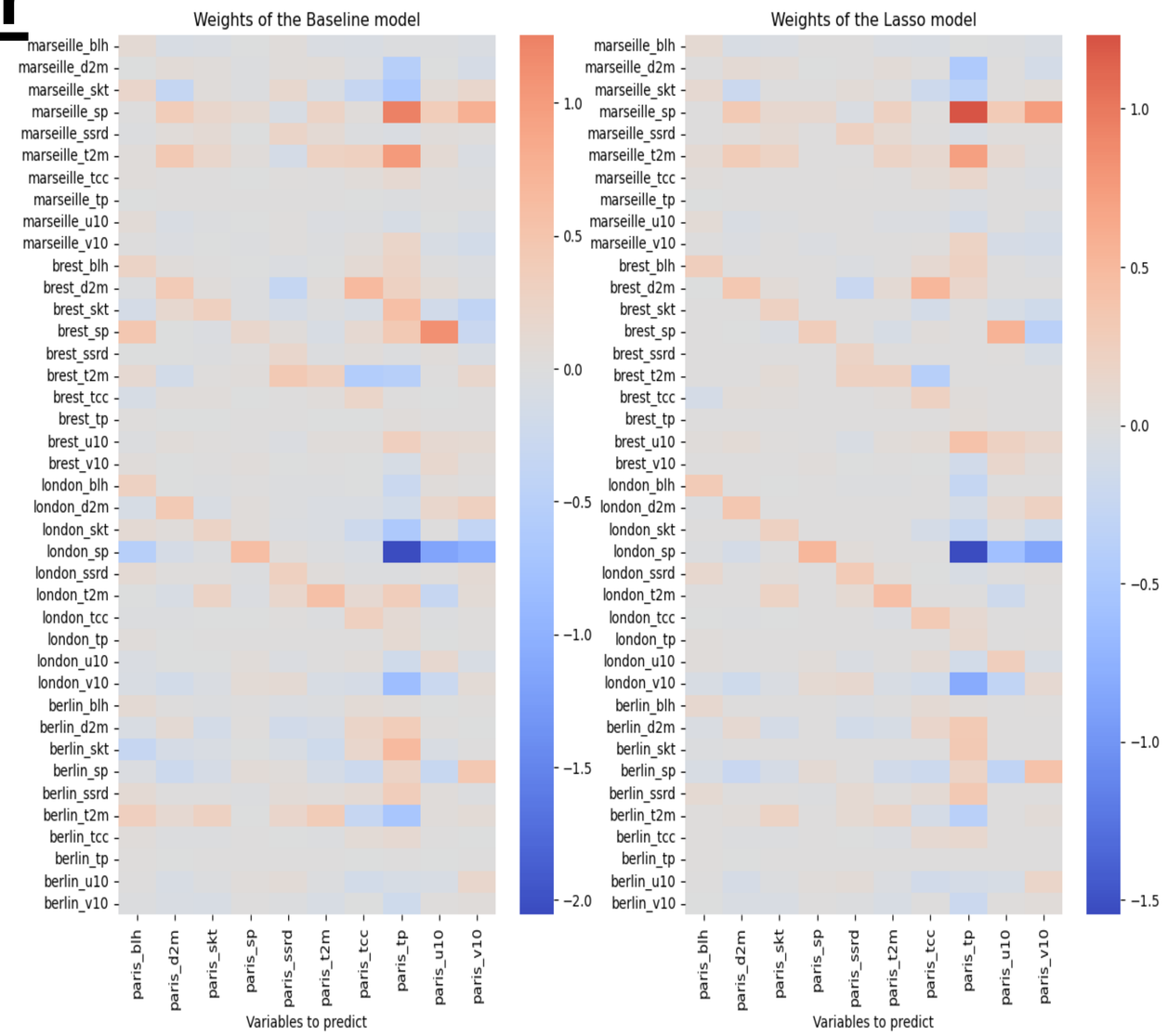
- **Linear Lasso**

Mean Squared Error (MSE) for Lasso Regression:

	paris_blh	paris_d2m	paris_skt	paris_sp	paris_ssrd	paris_t2m	paris_tcc	paris_tp	paris_u10	paris_v10
2016	0.143073	0.044610	0.036376	0.001690	0.071310	0.041248	0.209331	2.565525	0.017508	0.043377
2017	0.141890	0.040176	0.025366	0.002042	0.059067	0.031453	0.178193	2.963445	0.018364	0.043695
2018	0.135104	0.060135	0.033120	0.003115	0.061730	0.045443	0.201271	2.791260	0.046535	0.114168
all	0.140022	0.048307	0.031621	0.002282	0.064036	0.039381	0.196265	2.773410	0.027469	0.067080

Baseline vs Lasso model, reduction of MSE per variable

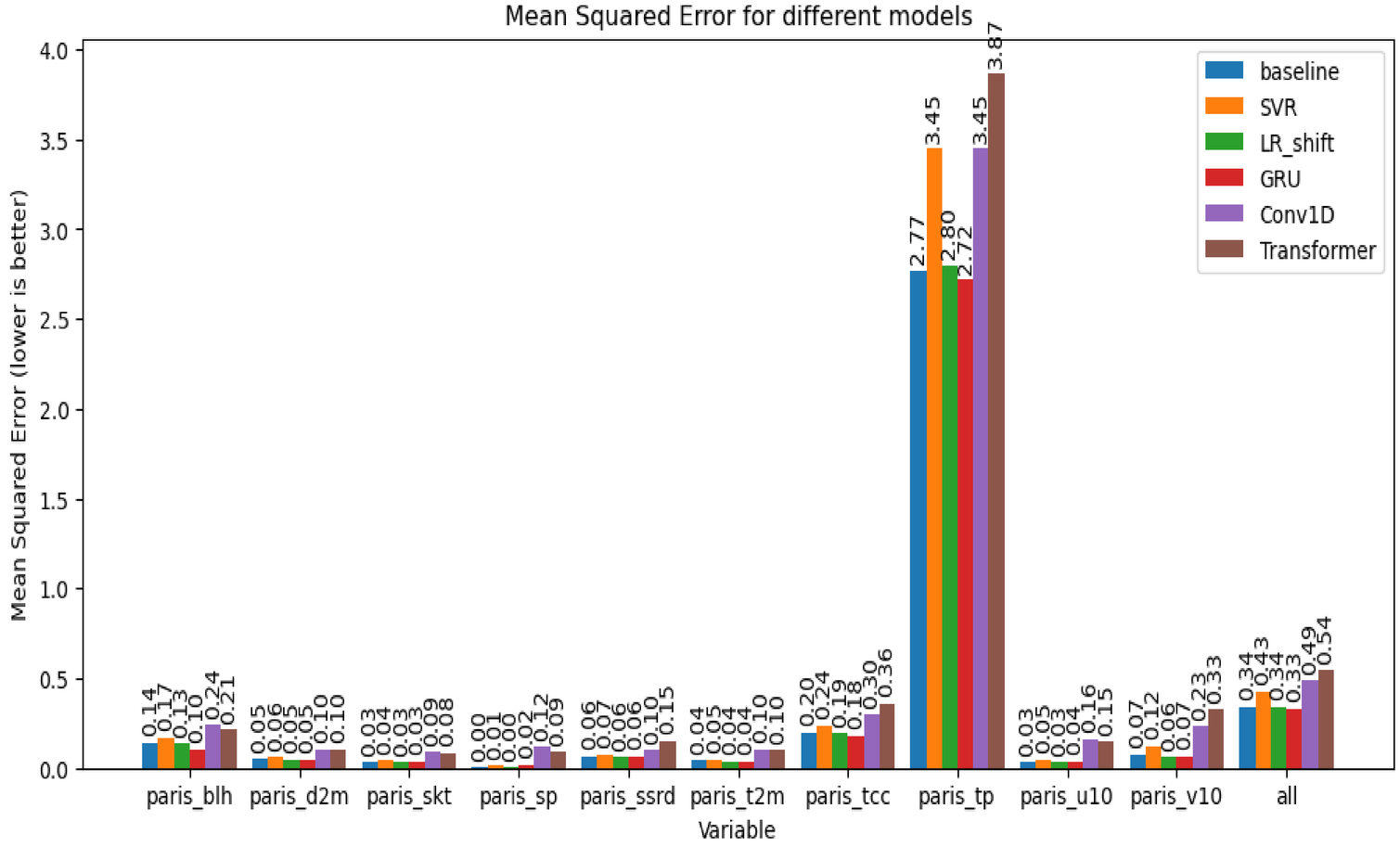
	paris_blh	paris_d2m	paris_skt	paris_sp	paris_ssrd	paris_t2m	paris_tcc	paris_tp	paris_u10	paris_v10
2016	-0.000650	0.001166	-0.000068	-0.000025	-0.001402	-0.000254	-0.002376	-0.010532	-0.000175	-0.000398
2017	0.000524	0.000933	-0.000618	-0.000110	-0.000012	-0.000502	-0.000230	0.003240	-0.000658	-0.000191
2018	0.003591	-0.000425	0.002753	-0.000573	0.000114	-0.001149	0.003036	-0.008407	0.016990	0.018849
all	0.001155	0.000558	0.000689	-0.000236	-0.000434	-0.000635	0.000144	-0.005233	0.005385	0.006087



III. Prediction of Paris Weather

3.1 Testing models

- **Tree-based models :**
  - **RandomForestRegressor**
  - **XGBoost**
- **SVR**
- **Deep learning :**
  - **GRU**
  - **CONV1D**
  - **Transformer**



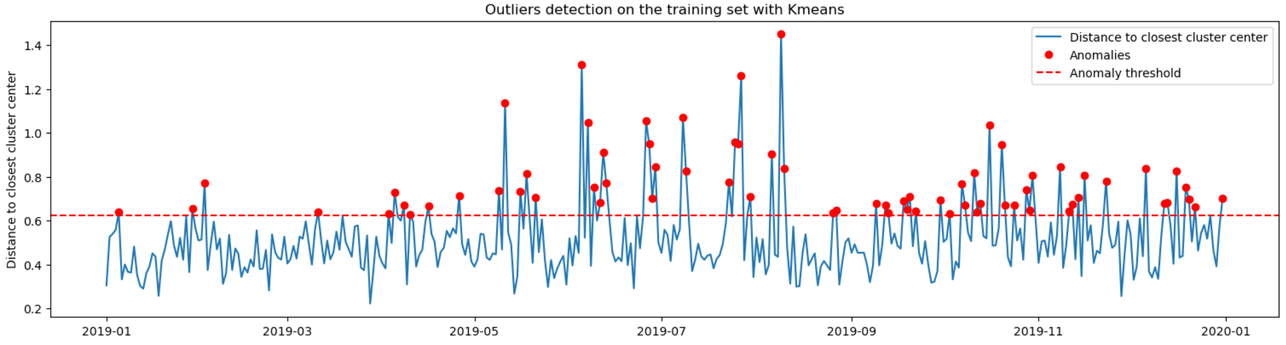
IV. Anomaly Detection

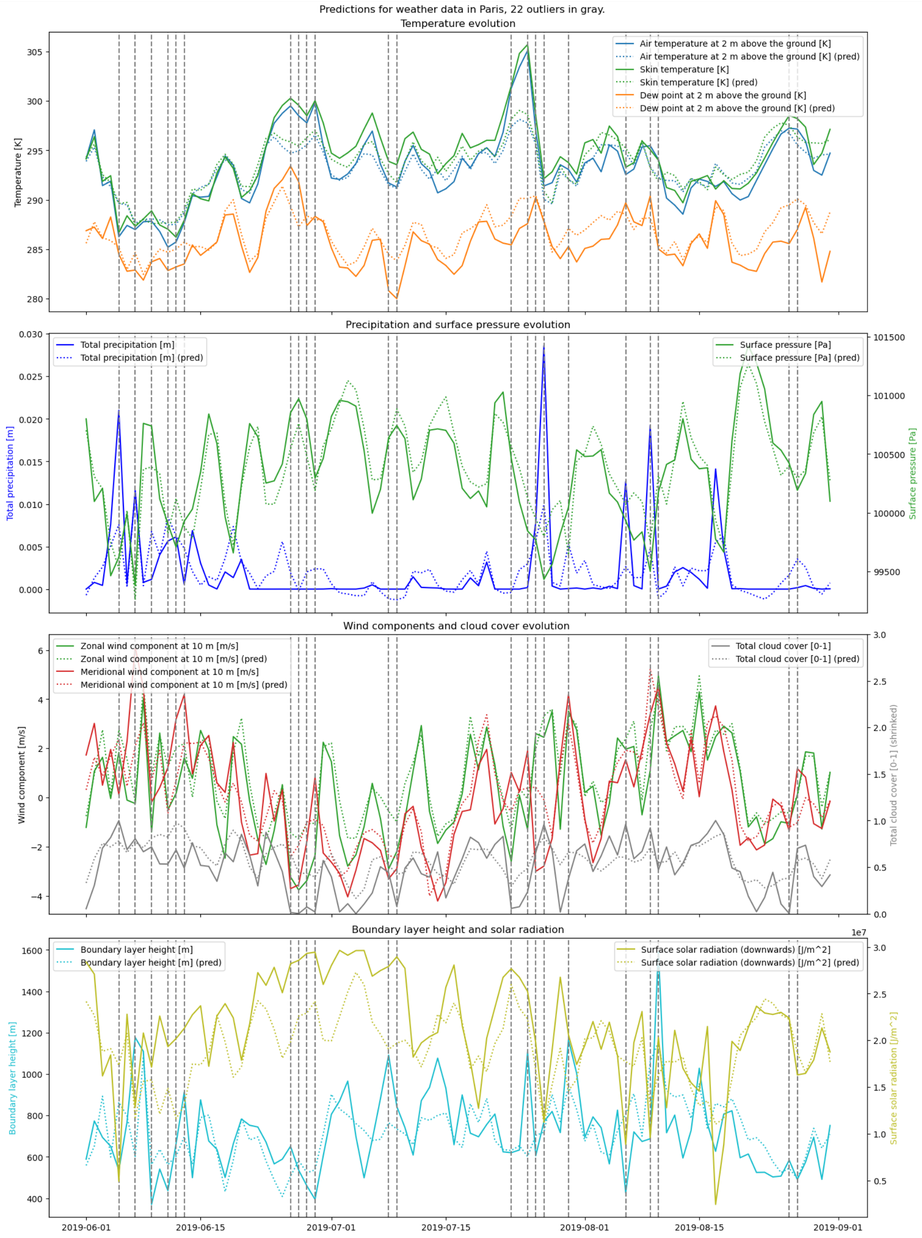
Asumption 2016-2018: 1 cyber-incident / year with Paris reports

Detect anomalies between predictions and reports:

- Best predictor= **average of the 3 best models**
- With **Kmeans --> 72 anomalies in 2019**
- With IsolationForest --> 1 anomaly in 2019

But represent extrema in weather reports ==> no cyber hack.





Conclusion

Ambitious project: Supervsied Regression + Unsupervised Classification

==> we did it !

To go further :

- times series with hourly data
- simulate a datastream with modified data