Climate Services for the Hydropower sector

Turning Climate Science into solutions for Hydropower production

Webinar Thursday 12 November 2020

Smart Climate hydropower Tool

An artificial intelligence-based service for hydropower production seasonal forecast

SECLI FIRM

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Turning Climate Science into solutions for Hydropower production
Webinar Thursday 12 November 2020

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Smart Climate Hydropower Tool (SCHT)

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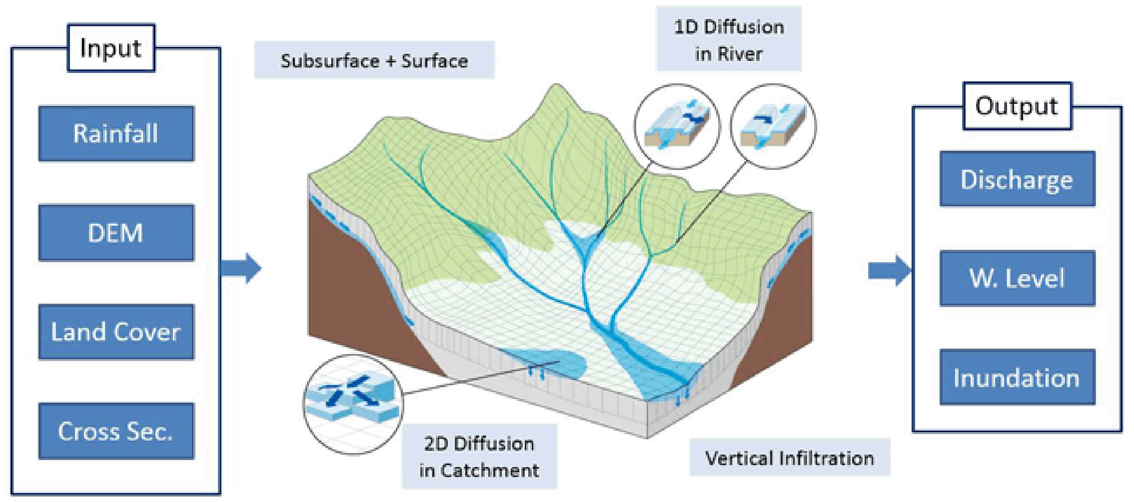
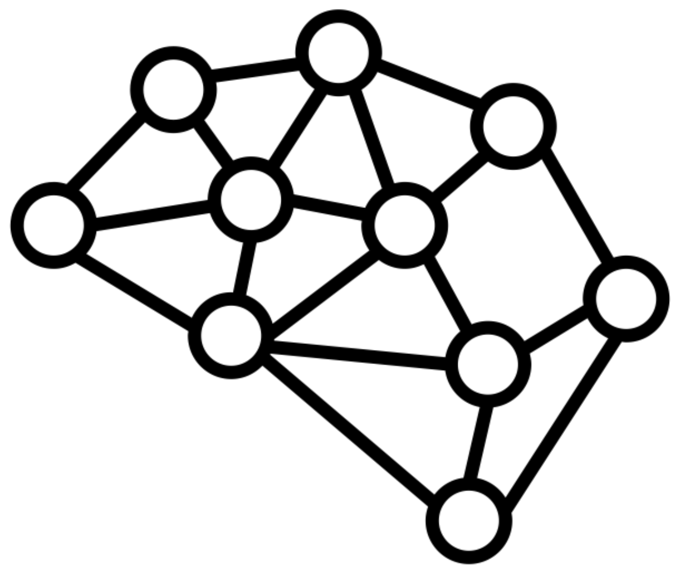
Climate forecast enabled knowledge services

SCHT: AI-based Climate Services (CS)

- **THE NEEDS**: Energy and Water Management requires climate service to cope with climate challenges
- **PURPOSE**: Evaluate how much Copernicus Seasonal Forecasts and AI algorithms may contribute to reduce uncertainty of hydropower production due to natural inflows variability
- **STANDARD CS**: Feed Seasonal ECV Forecast into complex hydrological Deterministic Models (EHYPE):
  - Time and data consuming (topo, landuse, soil)
  - requires the involvement of hydrological modeling expert
  - Multiple sites = Multiple Models



- **INNOVATIVE AI-based** : Combination of Copernicus Seasonal Forecast with Data Science (AI and ML) Time Series algorithms.
  - Democratize the practical use of seasonal-forecast-based climate services
  - Less time and data requirements – No background in hydraulics requested
  - Suitable for multiple site applications
  - Web App



Case Studies- by EGP
Where is the value in forecasting for HP ?

GUAVIO

5500 GWh/year

BETANIA

2000 GWh/year

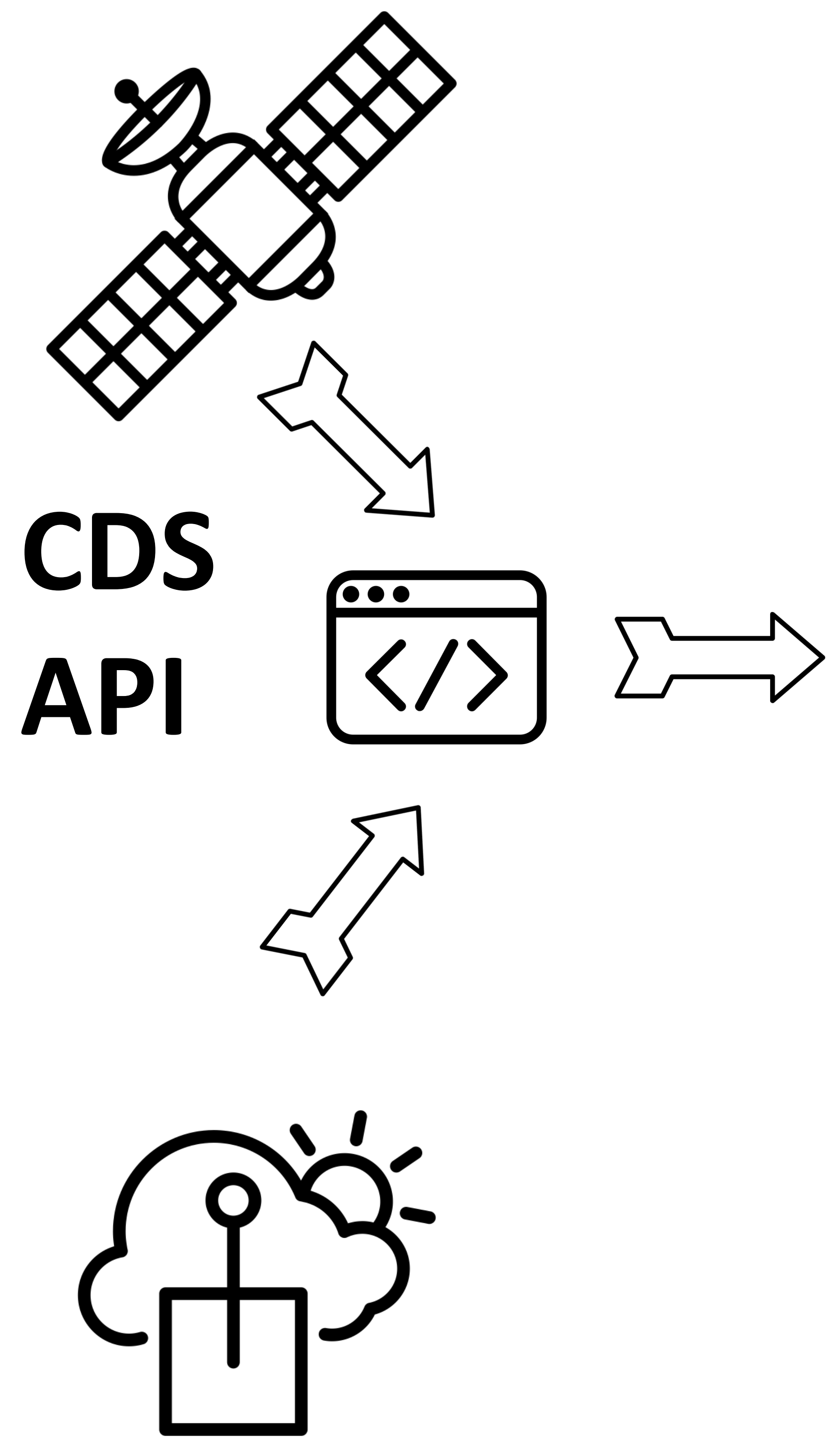
<u>Problems</u>

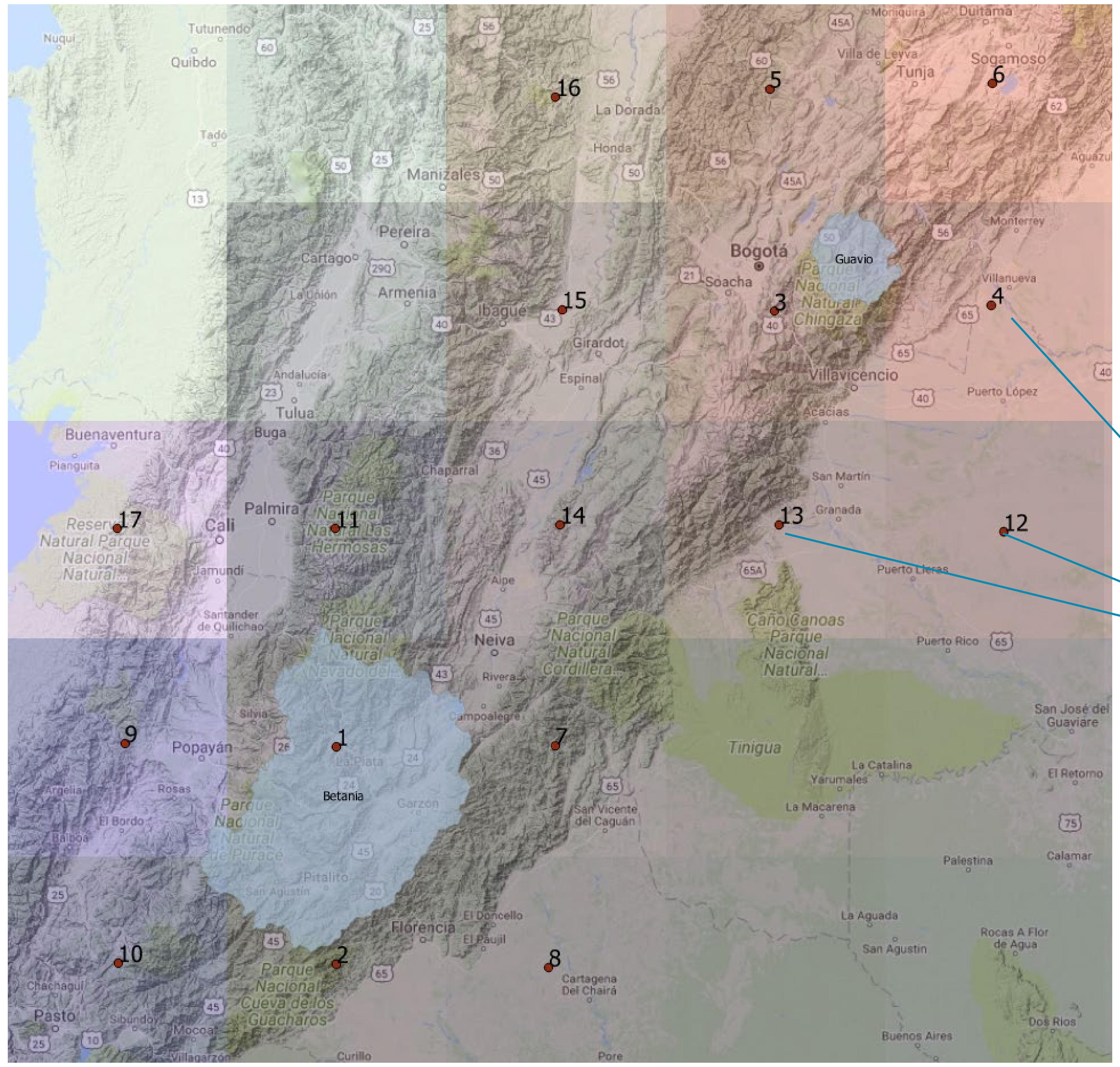
- The Technical point of view: Knowing in advance means planning **management** of the reservoir to increase production
- The **Financial** one = Deviation between the scheduled annual production and actually achievable production requires:
  - Corrective sales / purchase of energy
    - If you buy increasing unit costs during the year
    - If you sell redundancies have decreasing benefits in the year round.

<u>Objective</u>

- Knowing as early as possible deviation at the year end between budget producibility and final production to be able to undertake the most advantageous corrective actions.

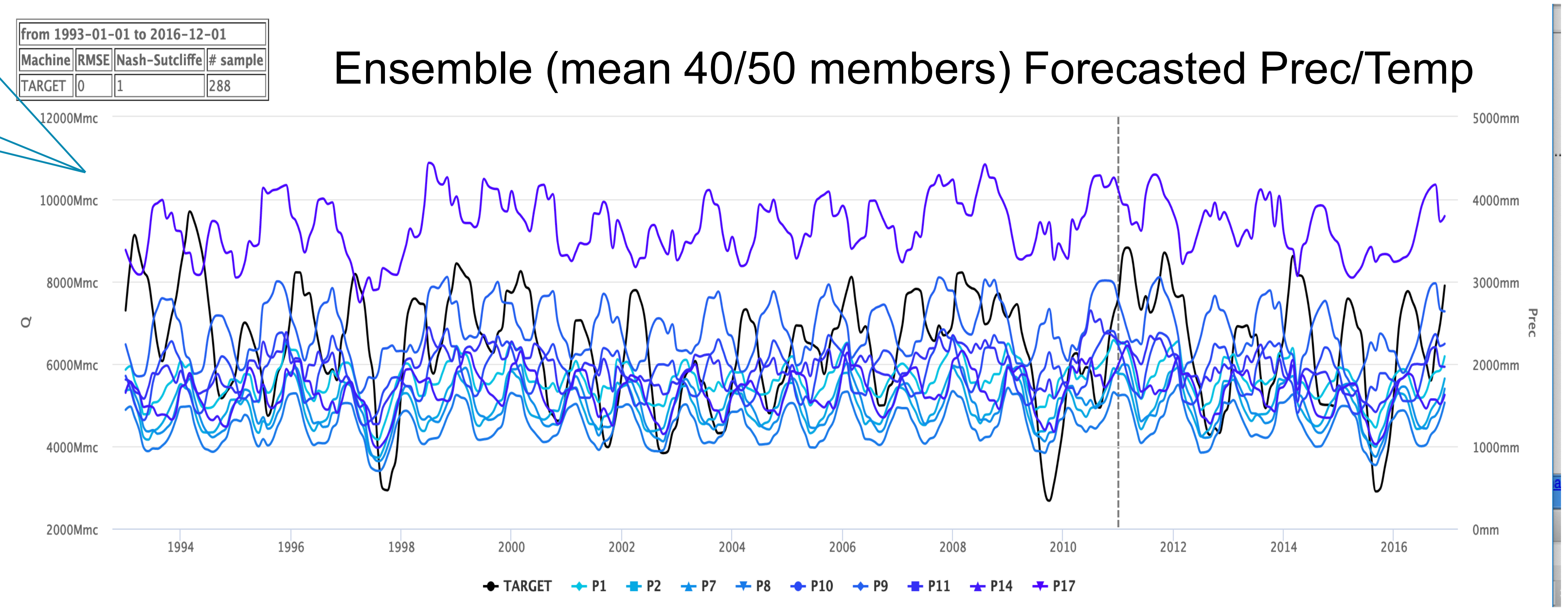
How we did it- preprocessing





- (monthly) Copernicus Seasonal Hindcast (P,T)
- @100 km resolution

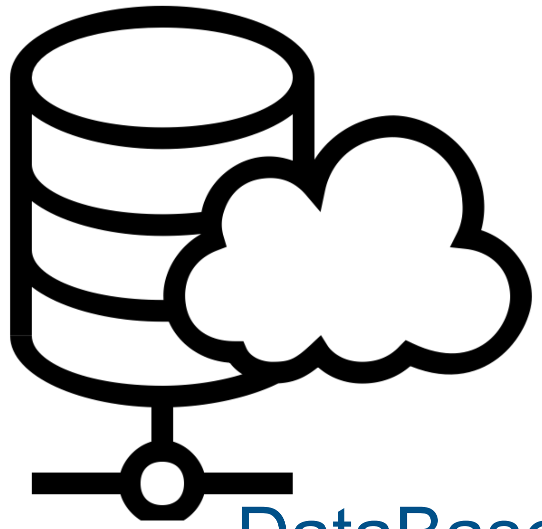
Are this signals (cor)related to target volumes ?



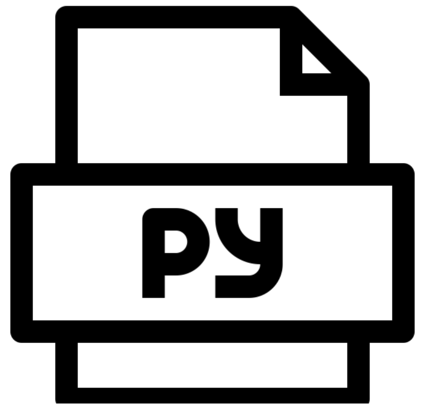
Correlation between cumulated volumes
and hindcasted rainfall (anomalies from average climatology)

How we did it- Features selection

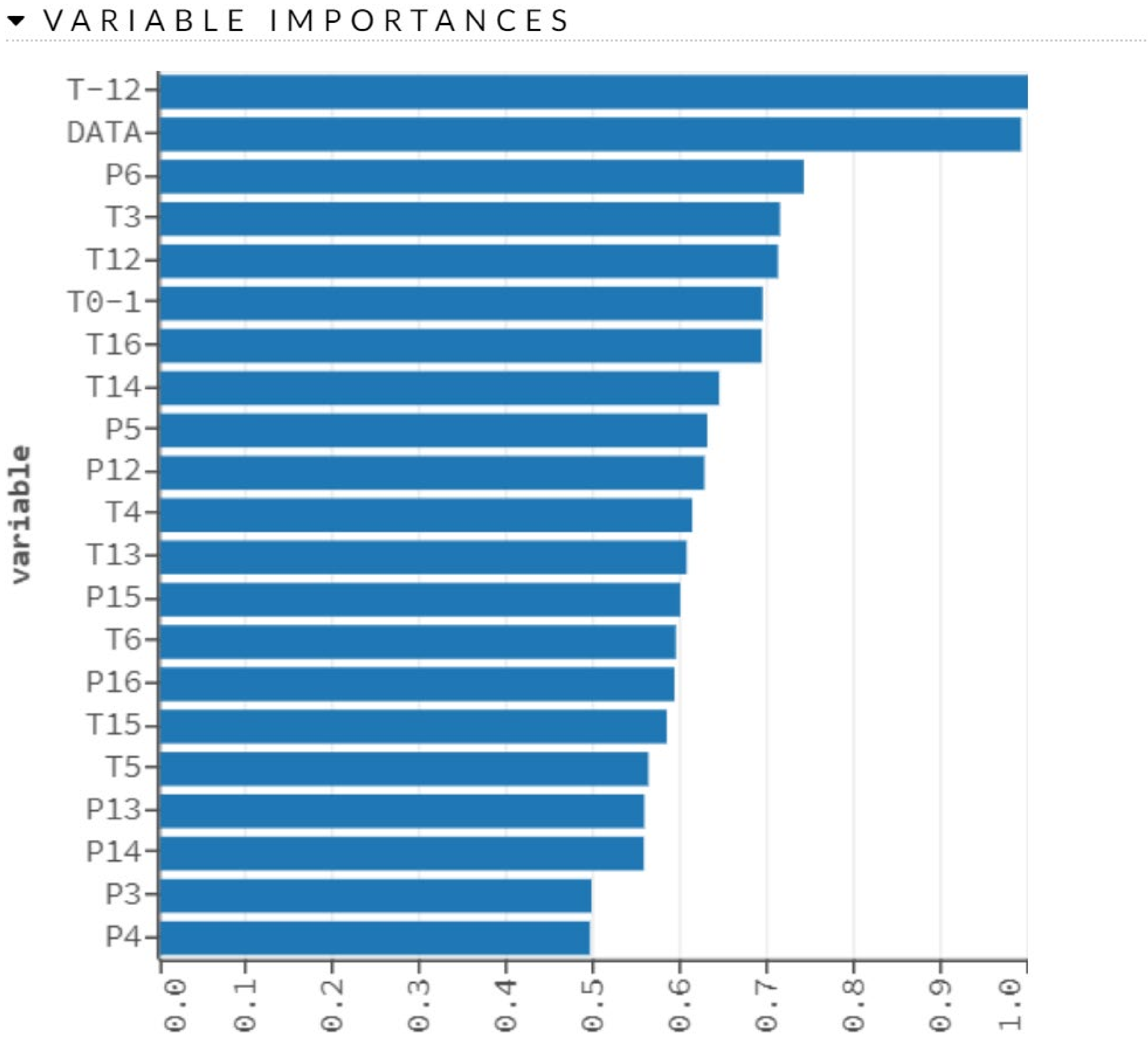
- Selecting among available features to get most informative ones available operationally



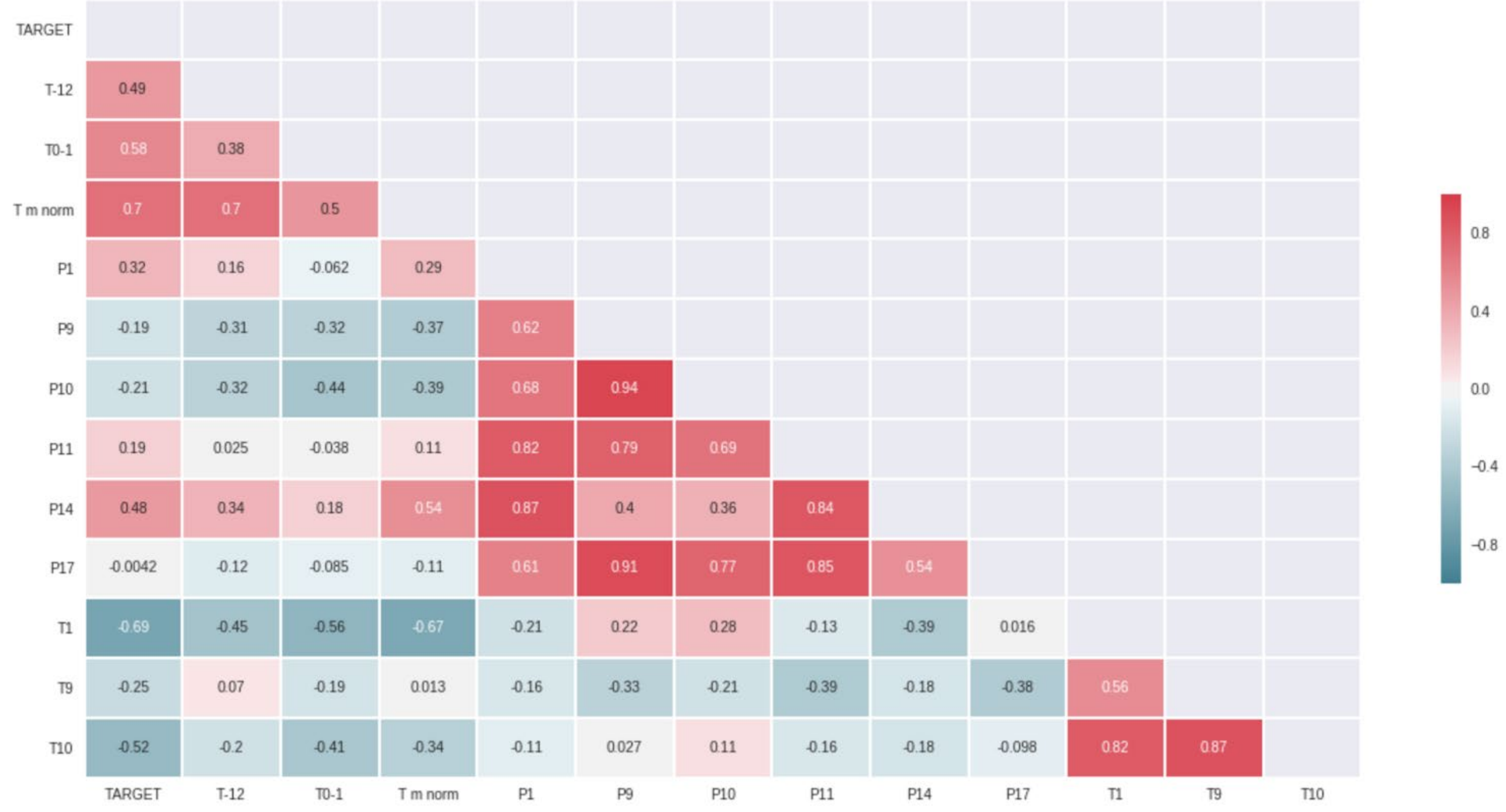
DataBase



Pre-processing



Tree based relative variable importance



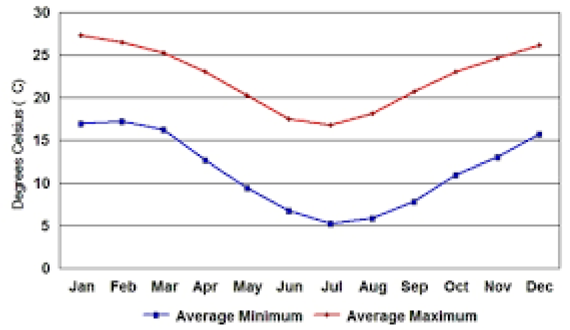
Correlation matrix to select among available features

How we did it- ML training

- Test an **AUTOML** platform among available ones OR train an algorithm using open libraries

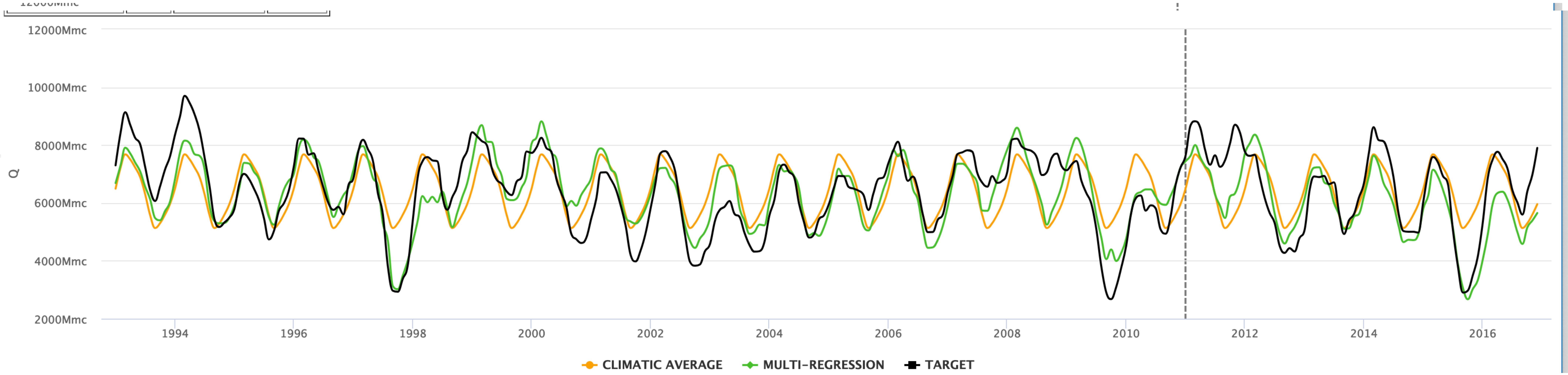
model_id	*mean_residual_deviance*	*rmse*
GBM_grid_1_AutoML_20190404_203847_model_91	751935.437897656	867.14
DRF_1_AutoML_20190404_203847	812327.5612870641	901.29
XRT_1_AutoML_20190404_203847	851252.1116687973	922.63
GBM_grid_1_AutoML_20190404_203847_model_71	851279.4798175697	922.64
GBM_grid_1_AutoML_20190404_203847_model_88	860670.2604317574	927.72
GBM_grid_1_AutoML_20190404_203847_model_78	872708.6184079287	934.18
StackedEnsemble_BestOfFamily_AutoML_20190404_203847	881258.2452519641	938.75
GBM_grid_1_AutoML_20190404_203847_model_75	884550.7750331265	940.50
GBM_grid_1_AutoML_20190404_203847_model_105	895843.8989916794	946.49
GBM_grid_1_AutoML_20190404_203847_model_50	904389.176157908	950.99
GBM_grid_1_AutoML_20190404_203847_model_1	911340.8085015629	954.64

Baseline and Benchmark



BASELINE : What you have for free : trivial bench - climatic average

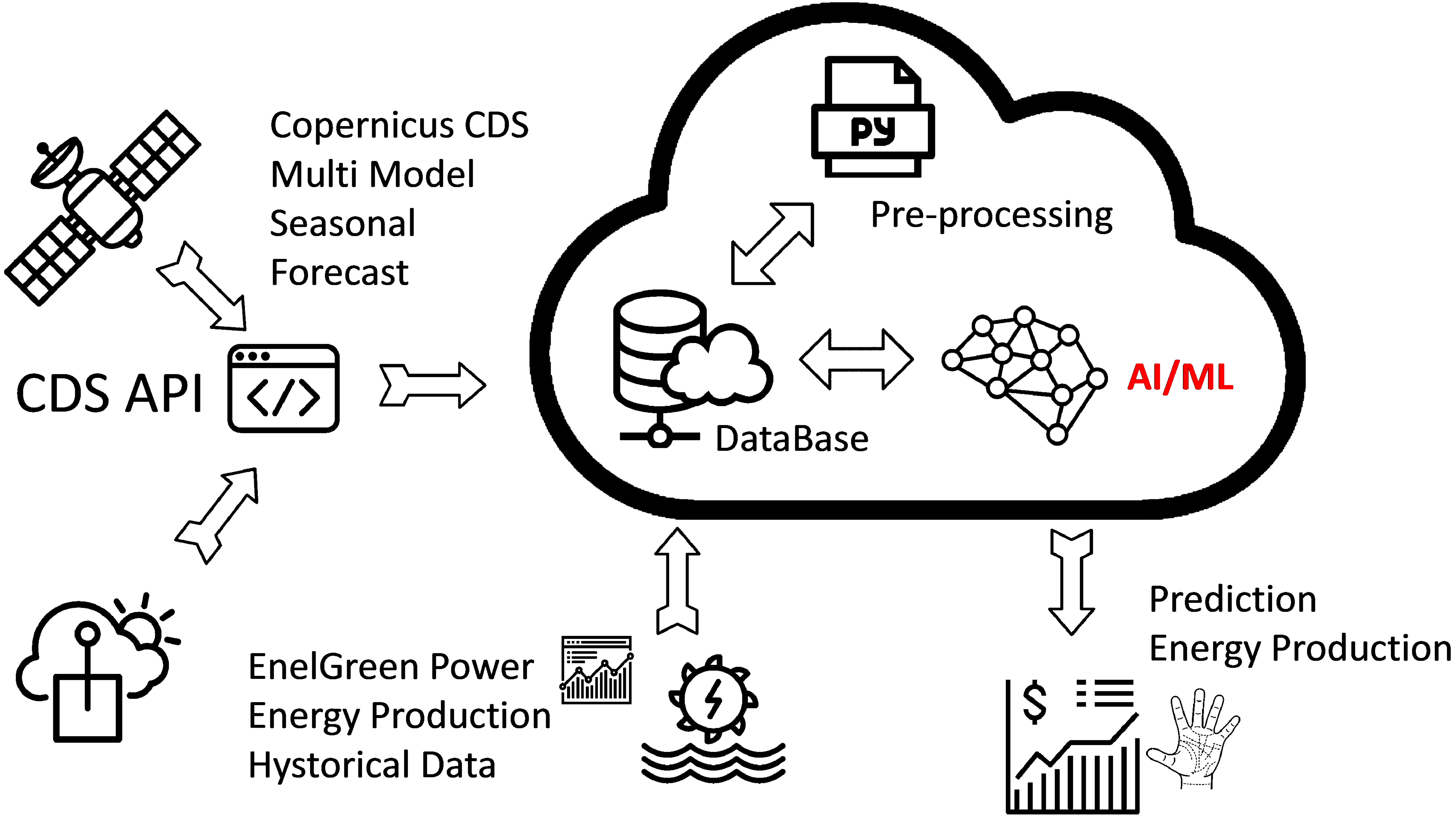
BENCHMARK: What you can setup with an excel spreadsheet - multiregression with same input features - EGP



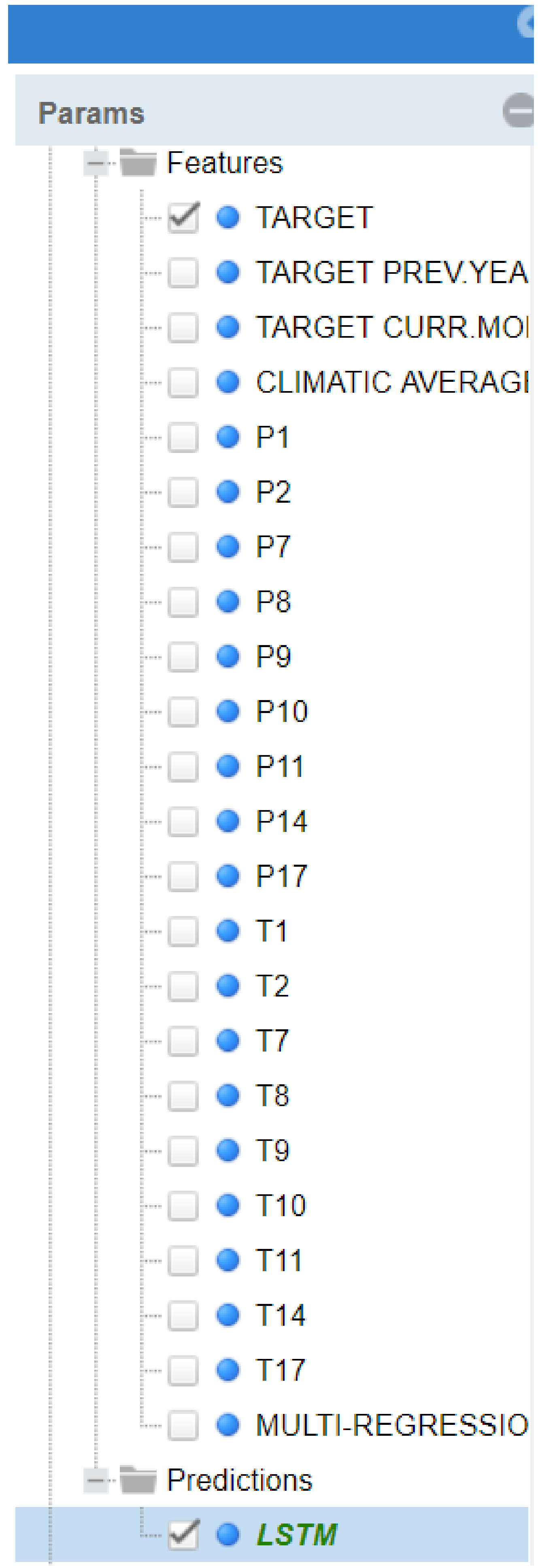
Best Model Results Vs Baselines- RMSE

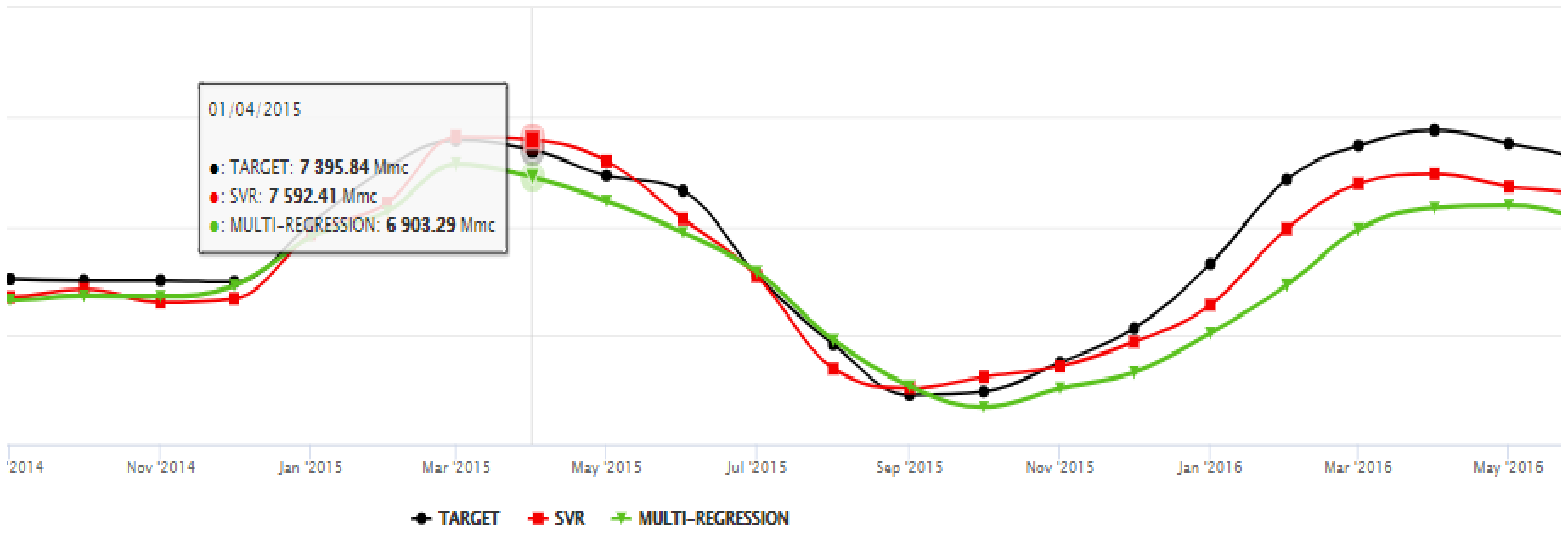
	BETANIA 6 Months RMSE (1E6 mc) Cum. Vol 6 Months	GUAVIO 3 Months RMSE (1E6 mc) Cum. Vol 3 Months
Deep Learning	**697**	**116**
SVR	819	116
Multi-regression	960	135
Climatic Average	1000	136

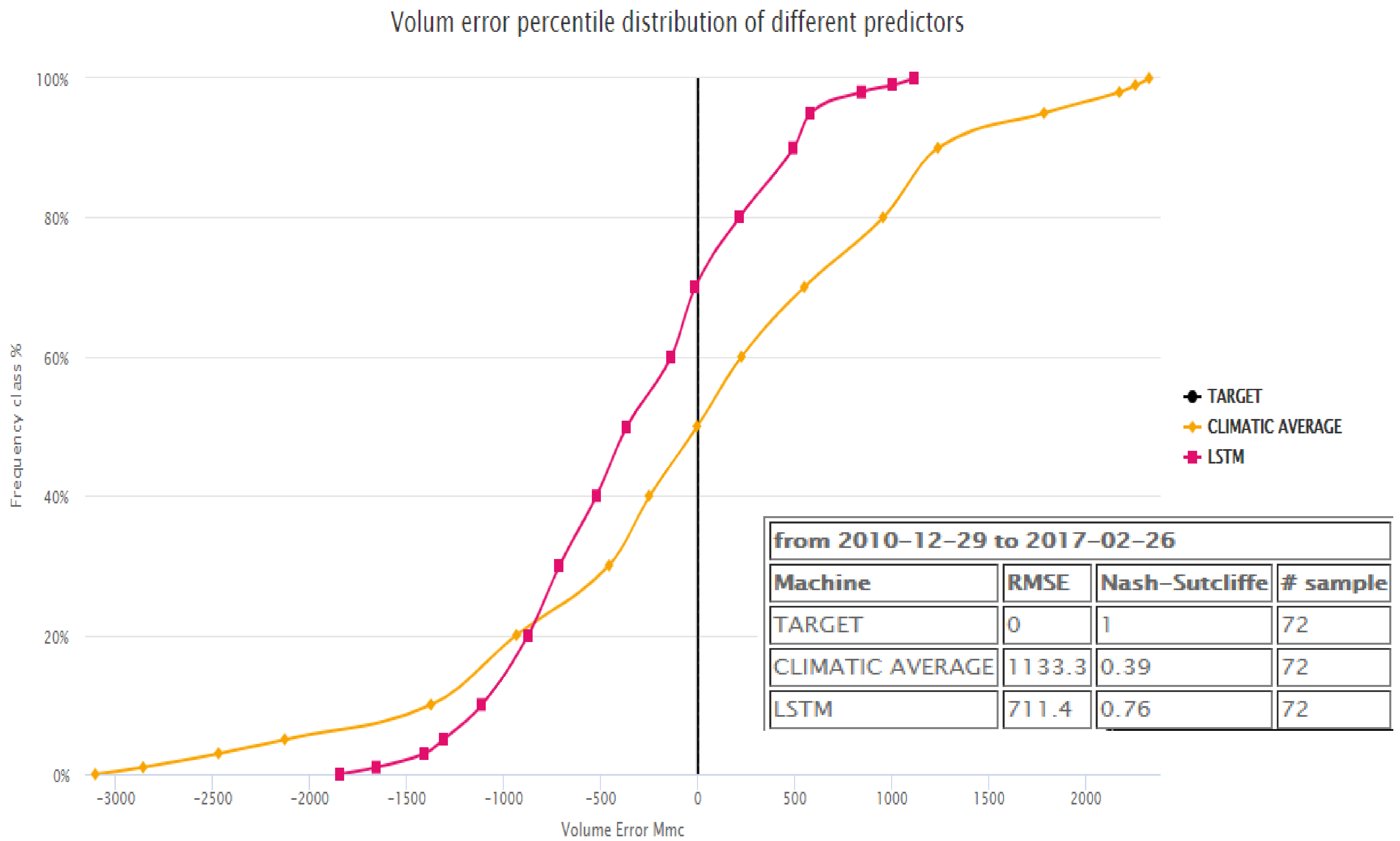
SCHT Operational Cloud-Web CS



SCHT Web Demo







from 2010-12-29 to 2017-02-26			
Machine	RMSE	Nash-Sutcliffe	# sample
TARGET	0	1	72
CLIMATIC AVERAGE	1133.3	0.39	72
LSTM	711.4	0.76	72

Conclusion- an added value example

- AI-based SCHT CS can improve seasonal forecast energy production
  - [+1,7%-+0,6%] on 2000GWh/year ≈ 0.5M$/year (*)
  - Better than multi-regression or Climatic Average
- SCHT SC is low time consuming and can be replicated in multiple sites
  - No needs of complex hydrological models
  - Purely “data” driven
- AI and CDS data can boost and democratize Climate Service development

	NO SEASONAL FORECAST	SCHT AI-based CS	PERFECT FORECAST
Years 2000-2016	100.0%	101.7%	103.1%
Years 2011-2016	106.0%	106.6%	108.3%

Simulation of expected benefits on annual producibility for budget adjustment twice a year, considering actual and perfect forecast , using hindcast data

(*) with *low* energy price oh 4 $c/Kwh

Thank you for your attention

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