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An Ghníomhaireacht um Chaomhnú Comhshaoil

vito

LIFE emerald

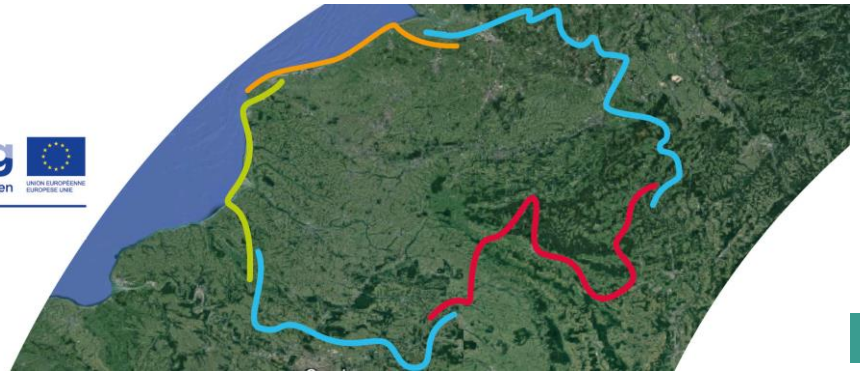
LIFE Emerald – Delivering Air Quality Forecasts & Mapping for Ireland

FAIRMODE Technical Meeting 2022,
Kjeller, Norway,
Wednesday 19th October 2022.

Dermot Burke, Air Specialist, National Ambient Air Quality Unit, EPA
Stijn Vranckx, Researcher, VITO

Summary

- EPA air quality monitoring overview
- LIFE Emerald & what it will deliver
- Application of FAIRMODE guidance on forecast model evaluation
  - Configuration of AQ Forecasting System in Ireland
  - Forecast model validation Belgium and Hauts-de-France
  - Validation of forecast bias correction techniques Belgium and Hauts-de-France



EPA air quality monitoring overview

Ambient Air Quality Monitoring in Ireland

- **The EPA is the Competent Authority for implementation**
  - **Manages the national ambient monitoring network**
  - **National Reference Laboratory (NRL) for air quality**
- **Pollutants monitored for;**
  - **NO2 / NOx, SO2, PM2.5 / PM10, Ozone**
  - **Benzene, CO, PAH, Metals – As, Ni, Pb, Cd, Hg**

EPA air quality monitoring overview

- **In 2017, the National Ambient Air Quality Monitoring Programme (NAAMP) was established and placed air quality monitoring on a statutory footing**
- **The NAAMP was a five year programme consisting of three main pillars:**
  1. **A greatly expanded national monitoring network in three tiers**
  2. **Modelling and forecasting capability**
  3. **Citizen science and citizen engagement initiatives**

EPA air quality monitoring overview

Ke

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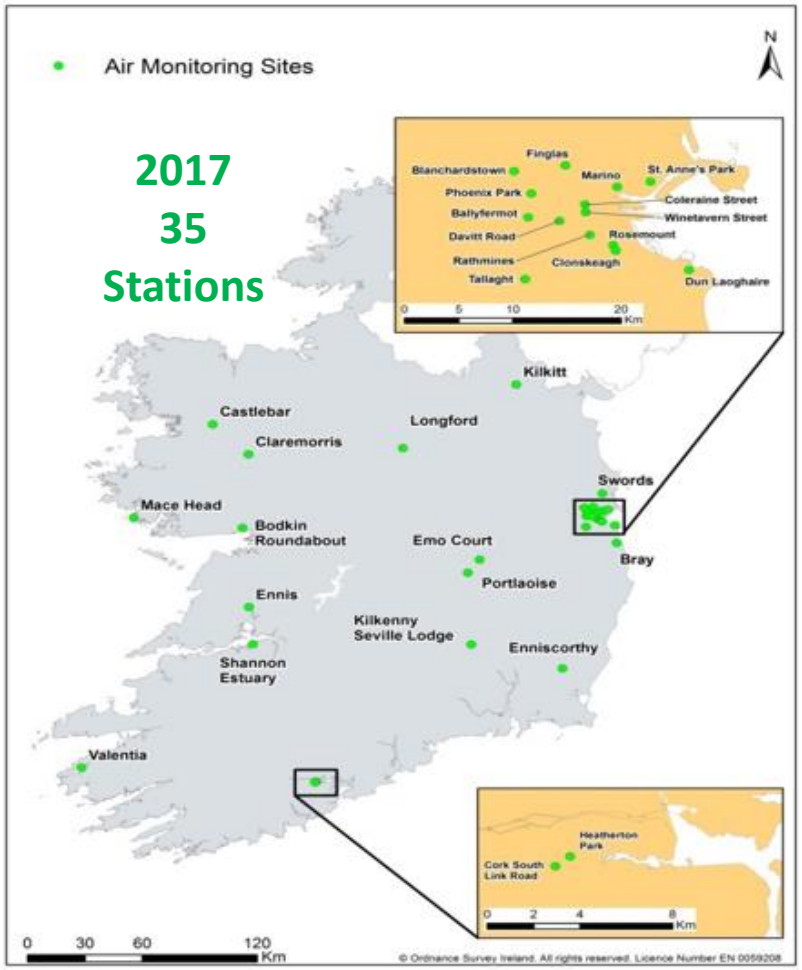
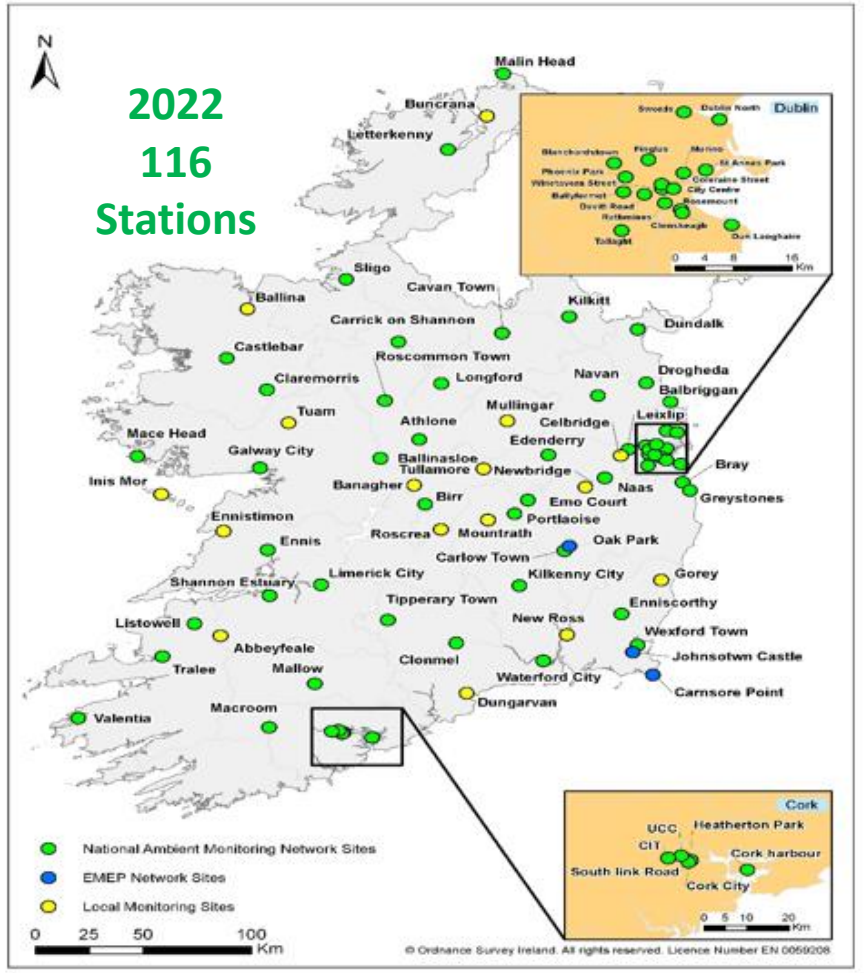




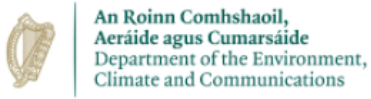
LIFE Emerald - Main Objective

The main objective is to strengthen air quality management in Ireland to ensure effective implementation of the EU Ambient Air Quality Directives

Project Details

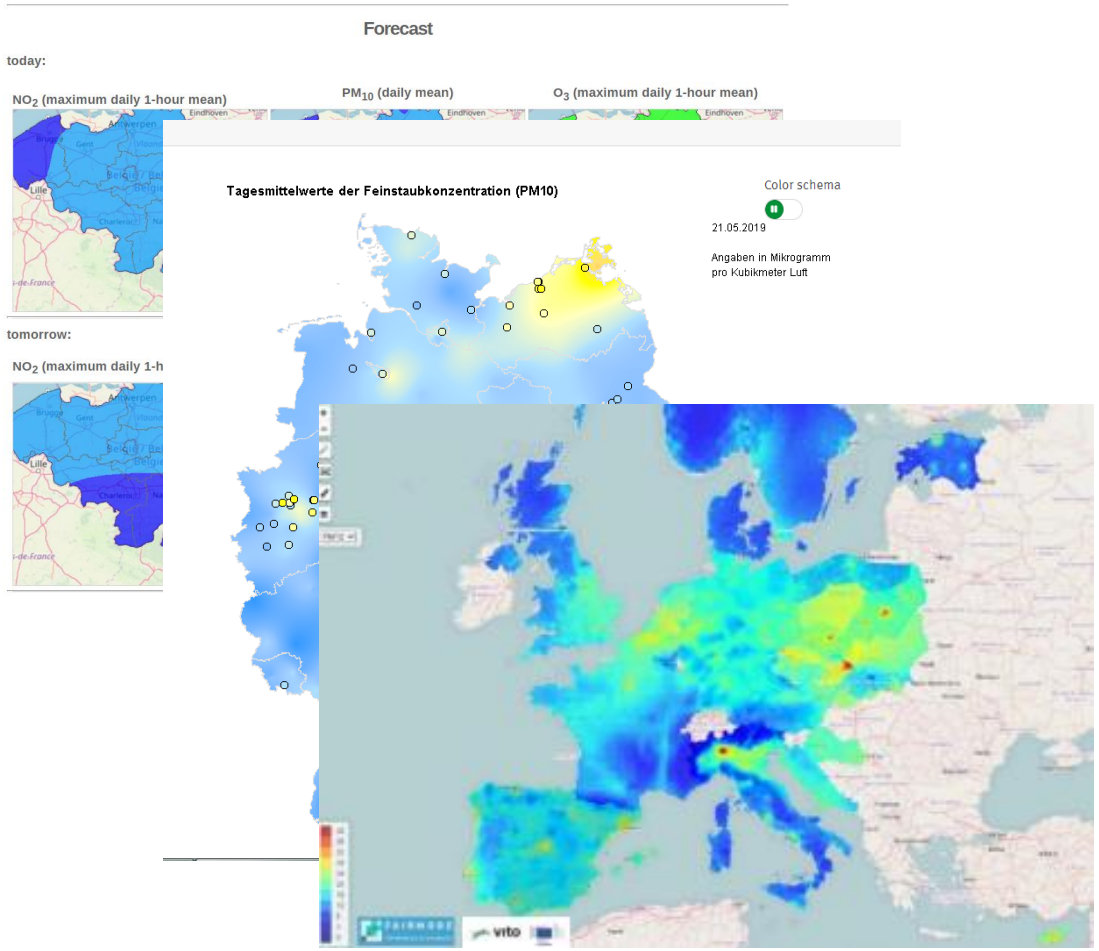
- **LIFE19 GIE/IE/001101- LIFE Emerald**
- **Emissions ModEling and FoRecasting of Air in IreLanD**
- **Start: 01/01/21 - End: 30/09/24**
- **Total: €1.6 million 52% of which is EC Co-funded**
- **Co-ordinating Beneficiary – EPA**
- **Associated Beneficiaries - ASI , DECC , HSE , UCC, VITO**

Project Stakeholders



What will LIFE EMERALD deliver?

- **Provide a lot of answers to queries on the future of modelling in Ireland**
- **3 day forecast for Ireland with high resolution in urban areas verified by DELTA forecasting tool**
- **Existing AQIH incorporated into Nowcast maps to provide more detailed information at a local level**
- **Production of annual historical maps both nationally and city level coupled with EU reporting mechanisms**



What will LIFE EMERALD deliver?

- **Spatial representativeness study for 1 – 2 new LIFE funded air monitoring stations in Dublin / Rural town**
- **Air quality management dashboards for planning purposes**
- **Measurement campaigns to validate modelling chain**
- **Outreach & dissemination to raise awareness**

DELTAPY DASHBOARD

Interreg France-Wallonie-Vlaanderen — UNION EUROPÉENNE / EUROPESE UNIE

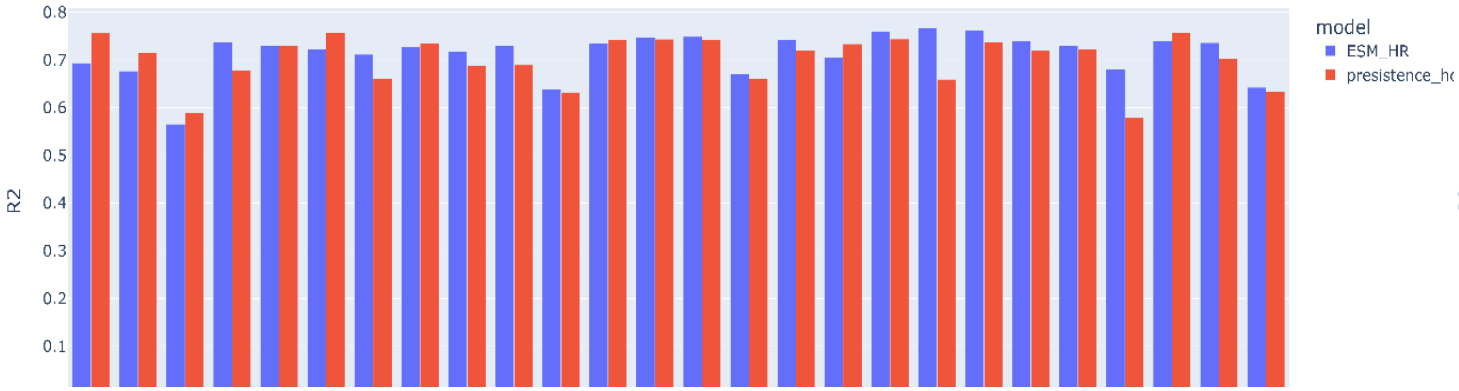
TransfAIR

Pollutant: PM10 | **model**: OVL, persistent_ircel | **FC_day**: 0 | **Aggregation**: da

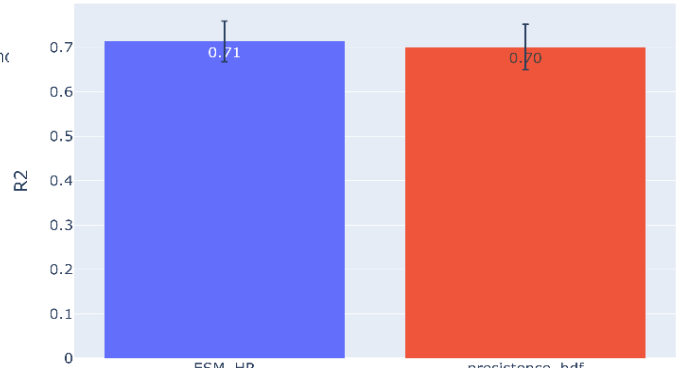
Score: R2 | **typologie**: all

100

Pol:PM10 Score:R2 agg:da day:0

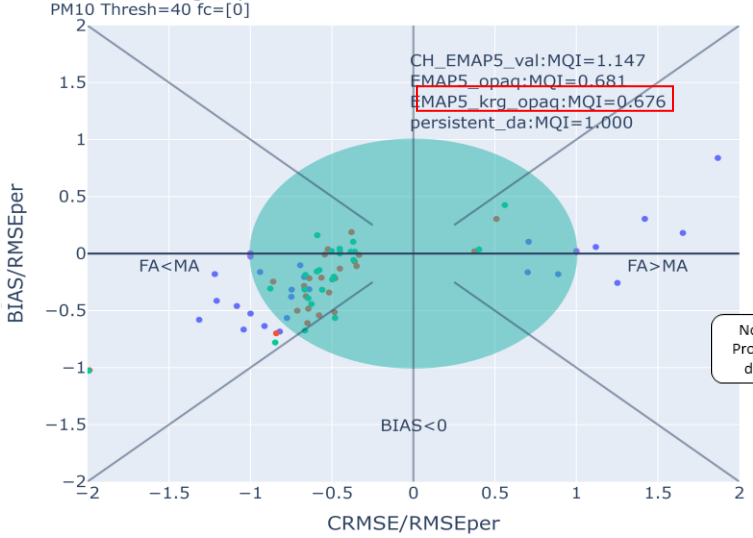


Pol:PM10 Score:R2 agg:da fc: [0] type:all



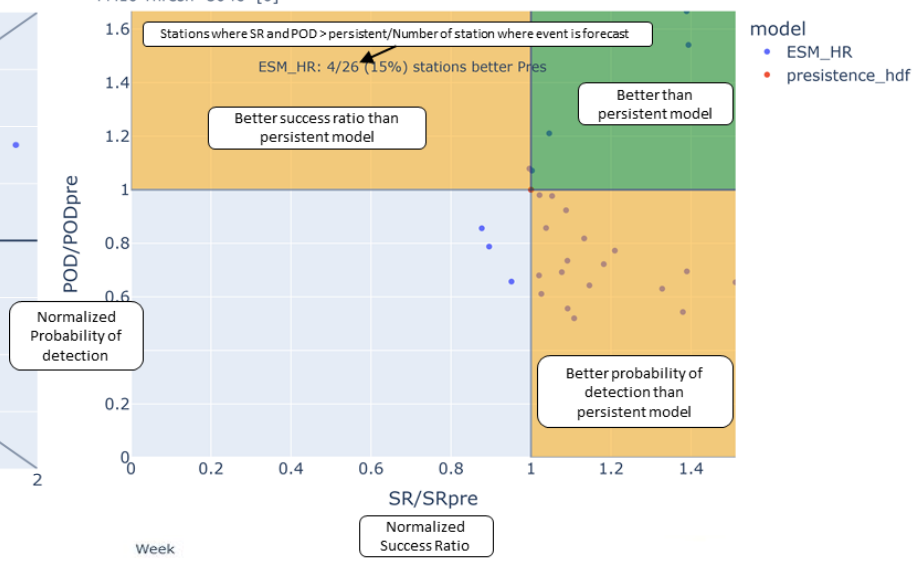
Forecast target plot

PM10 Thresh=40 fc=[0]



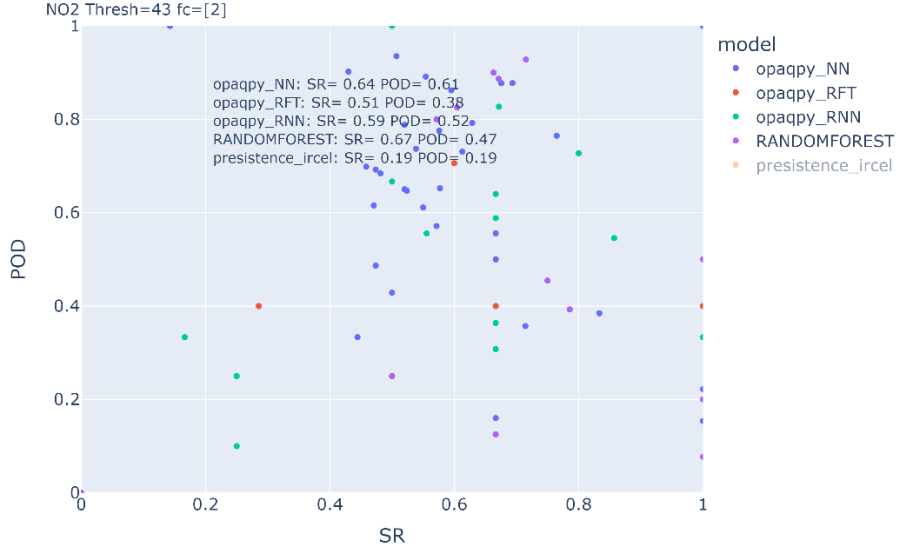
Cuvelier plot

PM10 Thresh=30 fc=[0]



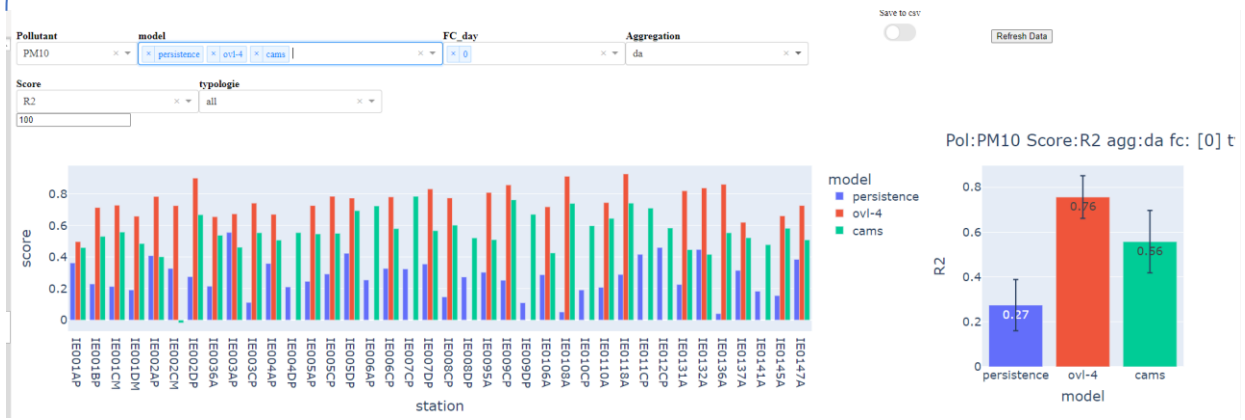
Forecast performance

NO2 Thresh=43 fc=[2]

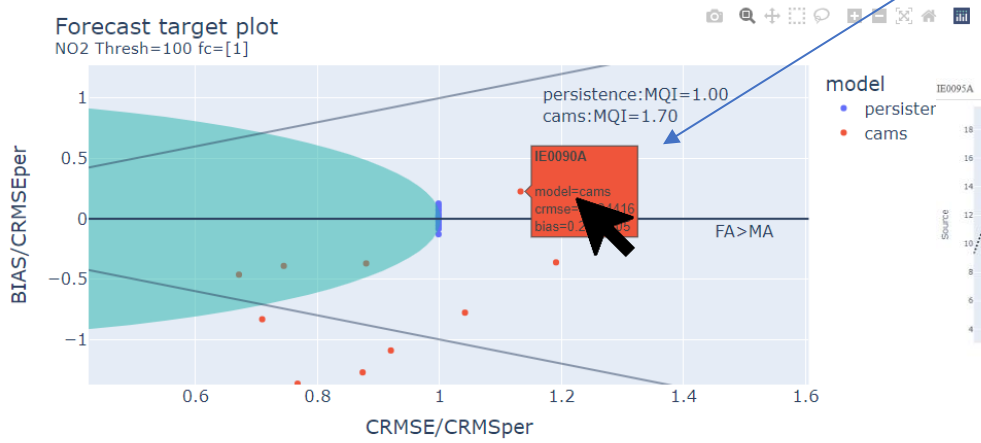


DELTAPY: dynamic features

Dynamic selection: pollutants; models, horizon; aggregation, flexible in data formats



Interactive plots (hovering zoom)



How to draw conclusions?

PM_{10} - MQI	Day0
opaqpy_nn	0.62
PREVAIR_AS	0.72
ESM_AS	0.73
OVL	0.79
Chimere_pp	0.82
ESM_BR	0.89
ESM_HR	0.96
CAMS	1.15
Chimere_raw	1.18
PREVAIR_BR	1.28
PREVAIR_HR	1.32

PM_{10} - MQI	Day1
ESM_AS	0.64
opaqpy_nn	0.64
PREVAIR_AS	0.65
Chimere_pp	0.67
ESM_BR	0.68
ESM_HR	0.75
CAMS	0.85
Chimere_raw	0.86
PREVAIR_BR	0.97
PREVAIR_HR	0.99
OVL	1.07

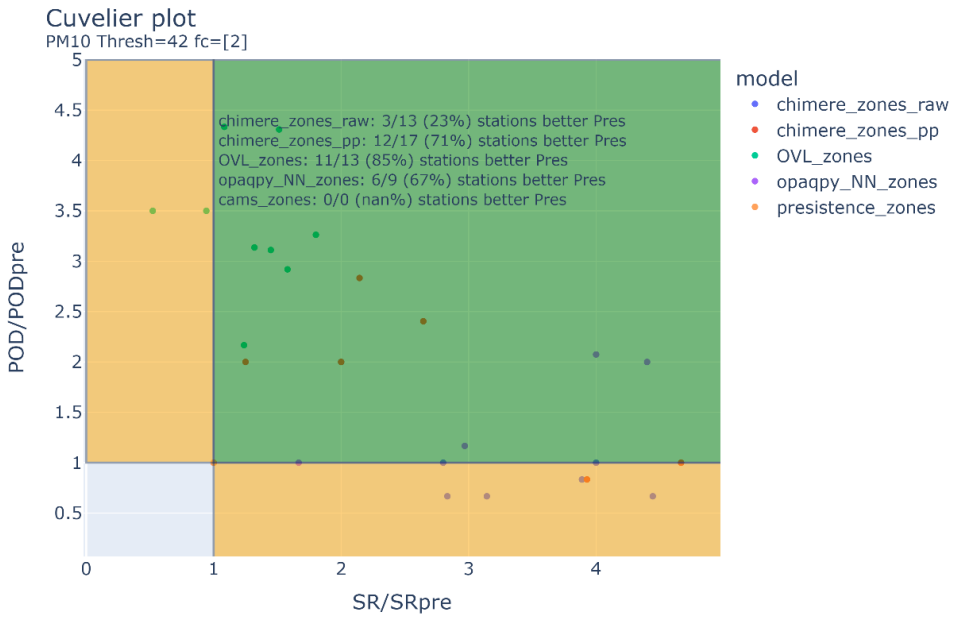
Figure 1: Models ranked by MQI for PM_{10}, Left- day0 right- day1.

PM_{10} - % better	Day0
opaqpy_nn	100%
OVL	77%
ESM_BR	46%
ESM_HR	42%
Chimere_pp	40%
ESM_AS	35%
PREVAIR_AS	23%
Chimere_raw	14%
PREVAIR_HR	0%
PREVAIR_BR	0%
CAMS	0%

PM_{10} - % better	Day1
OVL	92%
opaqpy_nn	90%
ESM_BR	65%
ESM_HR	62%
PREVAIR_AS	54%
Chimere_pp	36%
Chimere_raw	29%
ESM_AS	0%
PREVAIR_HR	0%
PREVAIR_BR	0%
CAMS	0%

Figure 1: PM_{10} Models ranked by percentage of stations outperforming the persistence model in terms of success ratio and probability of detection. Left- day0 right- day1

	Day0	Day1	Day2
Best Forecast model (MQI)	Opaqpy_nn	Opaqpy_nn	Opaqpy_nn
Best peak predictor (POD and SR)	OVL	OVL	OVL



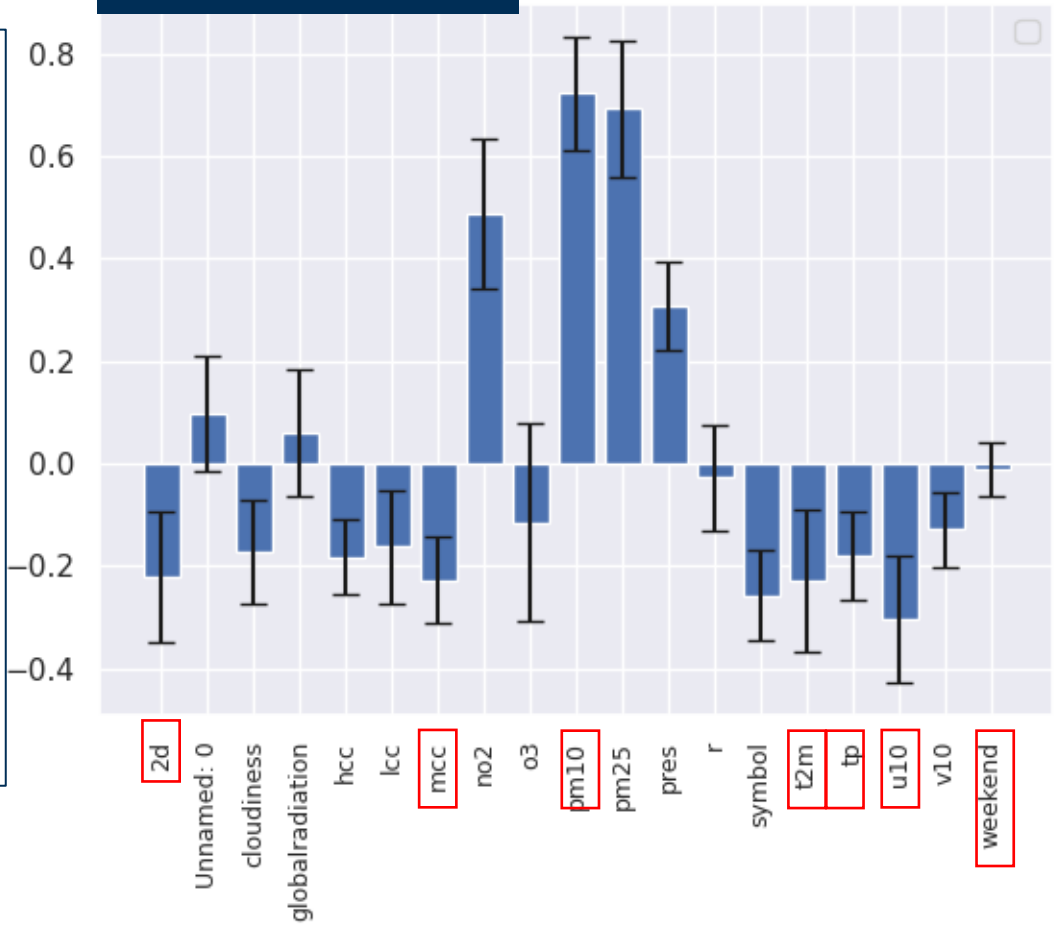
PM_{10} – Statistical forecast model config

Training Features

- **2d:** 2m dew point temperature [K]
- **cloudiness:**
- **globalradiation:** [W / m^2]
- **hcc:** high cloud cover [%]
- **lcc:** low cloud cover [%]
- **mcc:** medium cloud cover [%]
- **no2**: cams no2 [µg/m3]
- **o3:** cams o3 [µg/m3]
- **pm10:** cams pm10 [µg/m3]
- **pm25:** cams pm25 [µg/m3]
- **Pressure:** [Pa]
- **r:** relative humidity [%]
- **t2m:** 2m temperature [K]
- **tp:** total precipitation [m]
- **u10:** 10 metre U wind component [m/s]
- **v10:** 10 metre V wind component [m/s]
- **weekend:**obs in weekend [µg/m3]

Meteo variables from Met Éireann

Features Analysis



Models

1120: $obs_{8:-9}$,pm10, t2m, u10, v10, lcc, tp FFNN, OVL

1121: $obs_{8:-9}$, pm10 FFNN, OVL-1

1123: $obs_{8:-9}$, pm10, u10, v10 FFNN, OVL-3

1124: $obs_{8:-9}$, pm10, t2m FFNN, OVL-4

1125: $obs_{8:-9}$, t2m, u10, v10, lcc, tp FFNN, OVL-5

1126: $obs\_$(8:–9), pm10, t2m, tp, lcc, t2m, globalradiation, r, 2d, pressure FFNN, OVL-6

1127: $obs_{8:-9}$,pm10, t2m, u10, v10, mcc, tp FFNN, OVL-7

1130 : $obs_{8:-9}$,pm10 RNN, OVL-RNN

Data split

start_date_test: 2021-10-05

end_date_test: 2022-04-30

Start_date_training: 2021-10-05

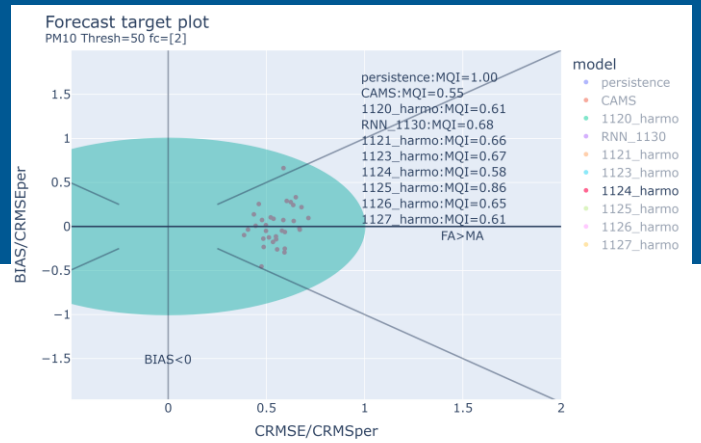
Start_end_training: 2022-04-30

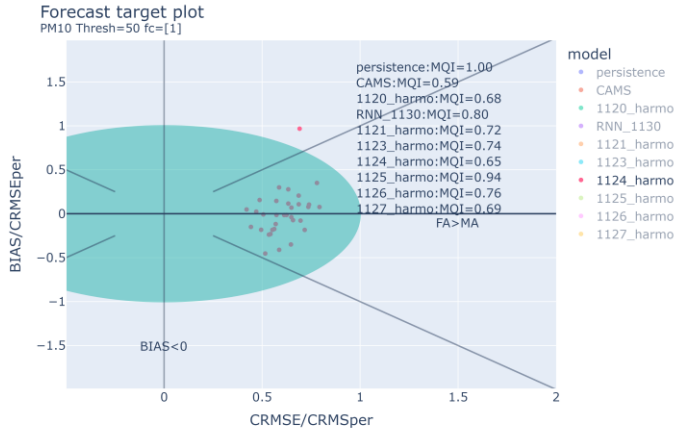
Start_date_validation: 2022-05-01

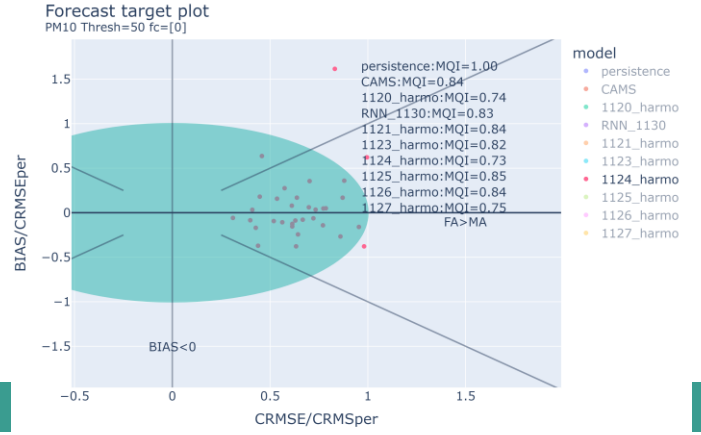
End_date_validation: 2022-06-30

PM_{10} model selection

models	R2			RMSE			BIAS			MQI		
	Day0	Day1	Day2	Day0	Day1	Day2	Day0	Day1	Day2	Day0	Day1	Day2
Pers.	0.56	0.28	0.18	4.29	5.79	6.60	0.06	0.43	0.05	1	1	1
CAMS	0.80	0.81	0.79	3.60	3.43	3.64	-0.98	-0.91	-0.97	0.84	0.59	0.55
OVL-1	0.83	0.69	0.67	3.16	3.96	4.10	0.52	0.51	0.61	0.74	0.68	0.61
OVL-2	0.90	0.61	0.79	3.58	4.19	4.41	1.19	2.44	2.48	0.84	0.72	0.66
OVL-3	0.89	0.80	0.79	3.48	4.33	4.51	2.48	2.39	2.19	0.82	0.74	0.67
OVL-4	0.85	0.79	0.70	3.10	3.80	3.92	2.19	0.04	0.3	0.73	0.65	0.58
OVL-5	0.78	0.73	0.16	3.62	5.43	5.66	0.80	1.75	1.49	0.85	0.94	0.86
OVL-6	0.79	0.26	0.64	3.62	4.43	4.39	1.49	0.51	0.25	0.84	0.76	0.65
OVL-7	0.83	0.65	0.67	3.20	4.01	4.11	0.25	0.88	0.61	0.75	0.78	0.61
OVL-RNN	0.80	0.61	0.62	3.37	4.50	4.57	0.58	1.16	1.19	0.83	0.80	0.68







ATMOSYS
Air Quality Modelling System

Forecast Maps - Map viewer

English

Near real time

Near real time maps

Animation

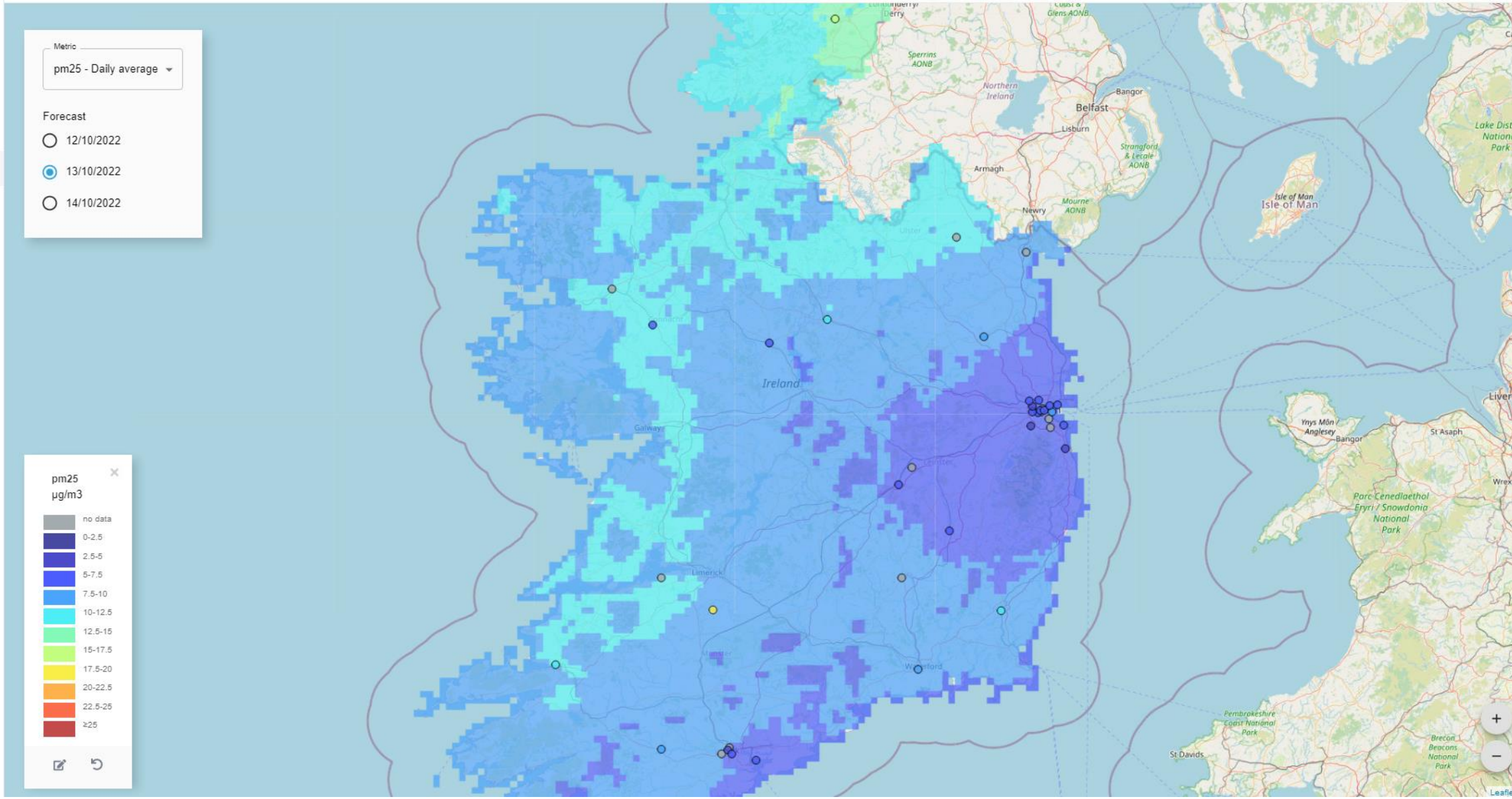
Air quality forecast

Forecast maps

Dashboard

Historic maps

Map viewer



ATMOSYS
Air Quality Modelling System

Forecast Dashboard - Validation

Near real time

Near real time maps

Animation

Air quality forecast

Forecast maps

Dashboard

Historic maps

Map viewer

Overview | Validation

Station: Clare Ennis Simms Lane - IE01...

Metric: pm10 - Daily average

Horizon: 0

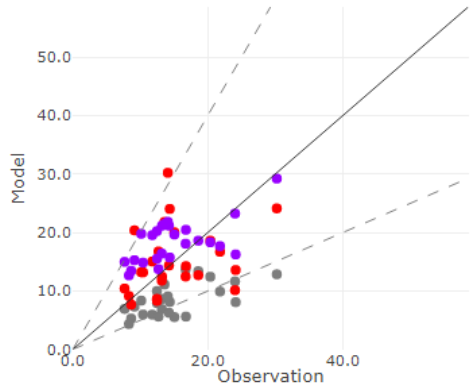
Start: 09/18/2022 to End: 10/12/2022

LOAD

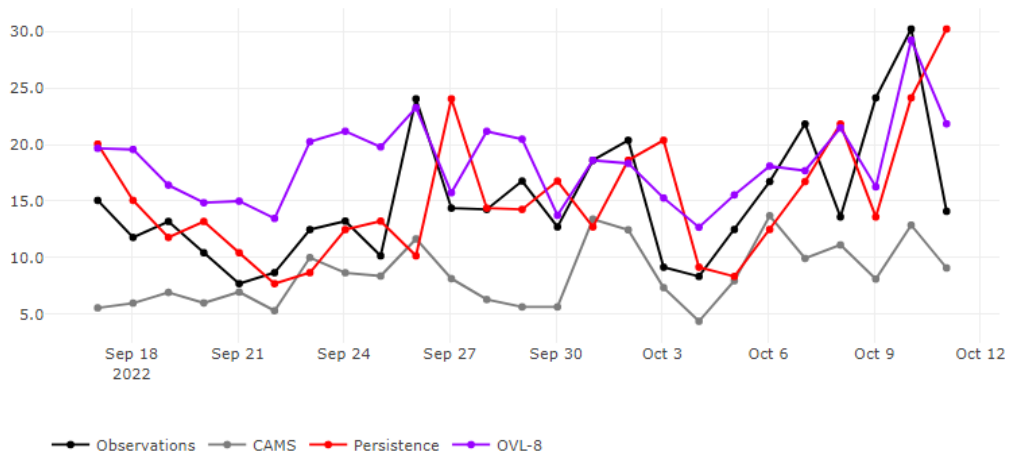
Statistics - IE0137A - Horizon 0 - pm10 - µg/m3

Model	RMSE	Bias	r²
CAMS	7.81	-6.52	0.4
Persistence	6.6	0.24	0.08
OVL	6.84	4.98	0.34
OVL-2	6.73	5.25	0.44
OVL-4	7.34	5.83	0.37
OVL-5	5.83	4.03	0.41
OVL-6	8.09	6.03	0.21
OVL-7	7.54	5.34	0.28
OVL-8	5.45	3.41	0.39
OVL-RNN	10.39	6.76	0.34

Scatter plot - IE0137A - Horizon 0 - pm10 - µg/m3



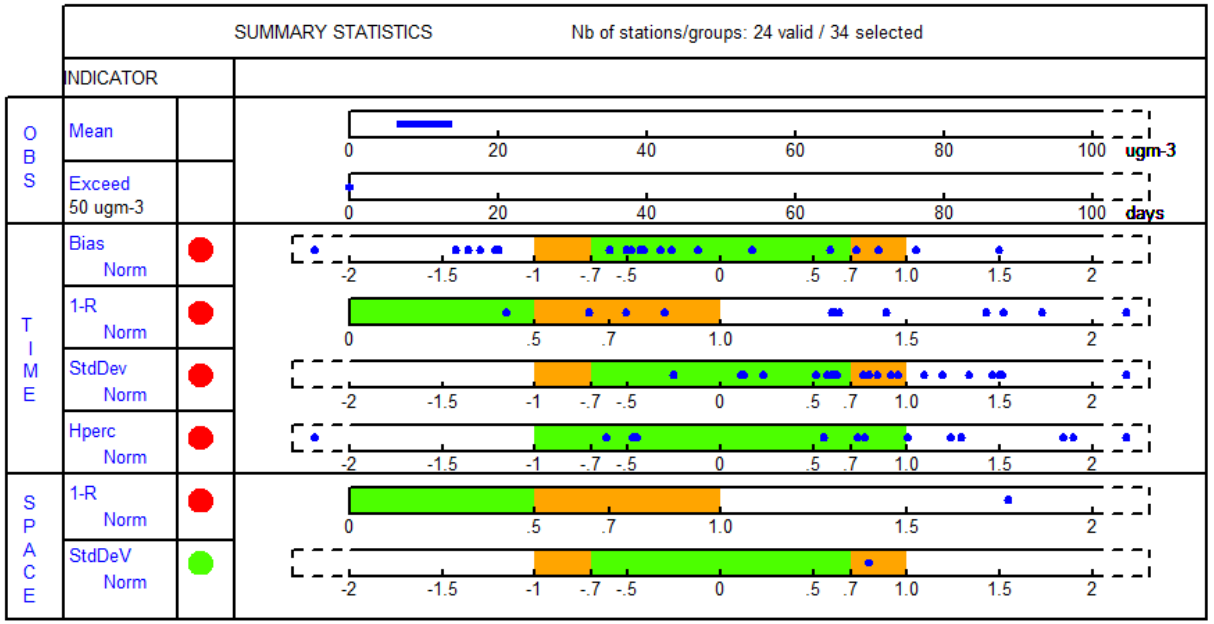
Daily average Concentration - IE0137A - Horizon 0 - pm10 - µg/m3



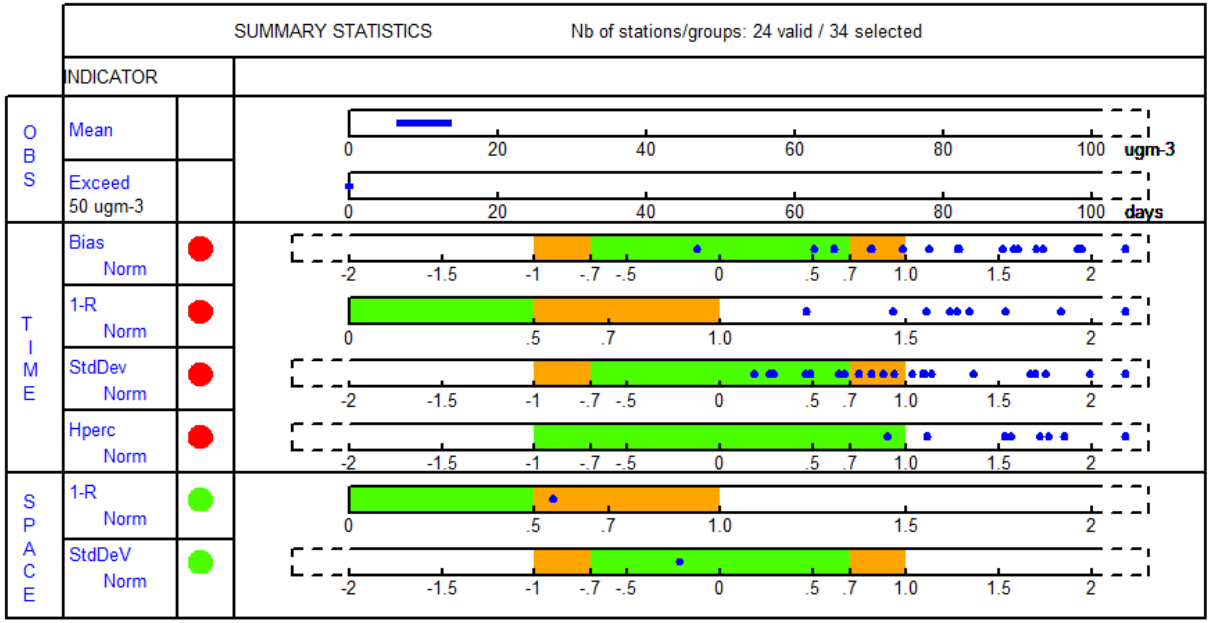
Model assessment: summary report plot

Delta tool v7.0, FAIRMODE 3.3

OPAQ

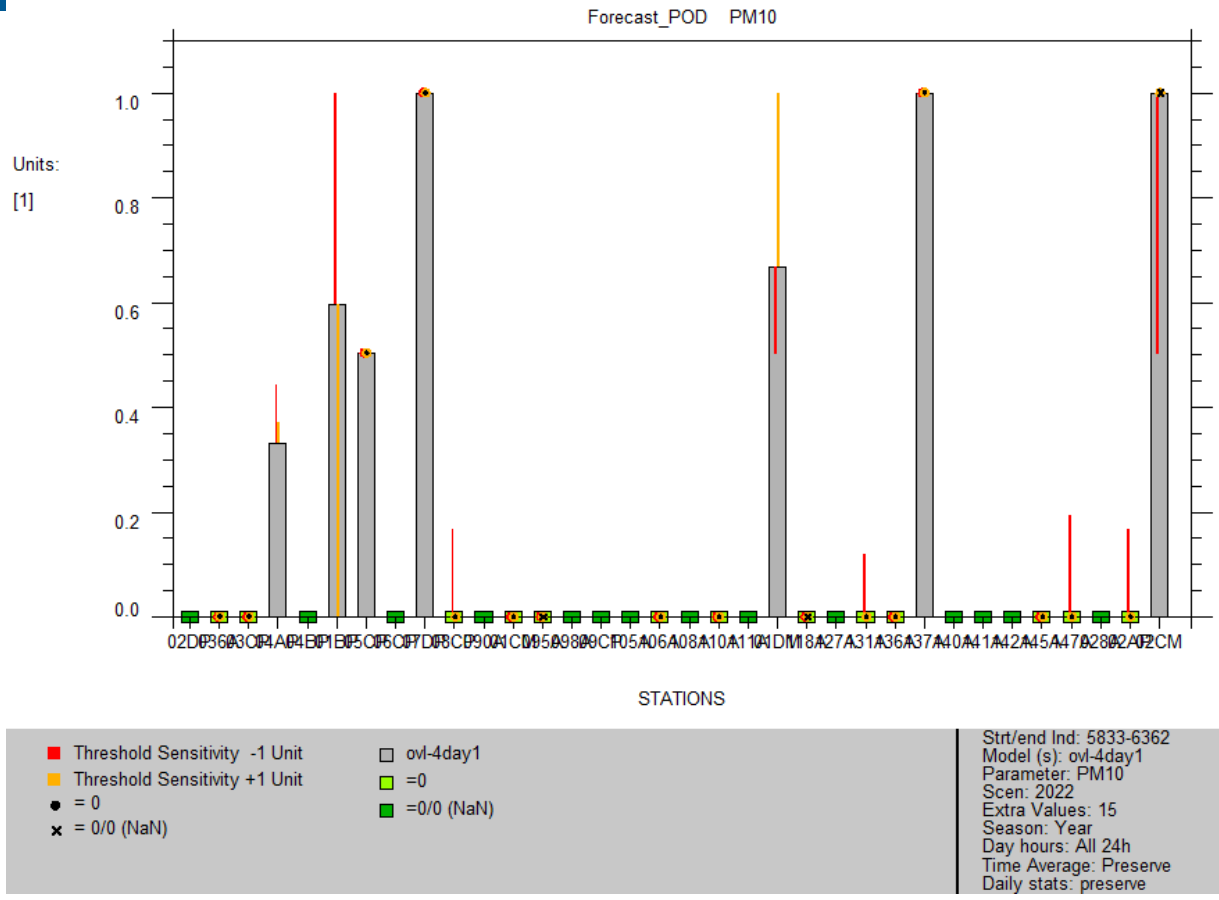


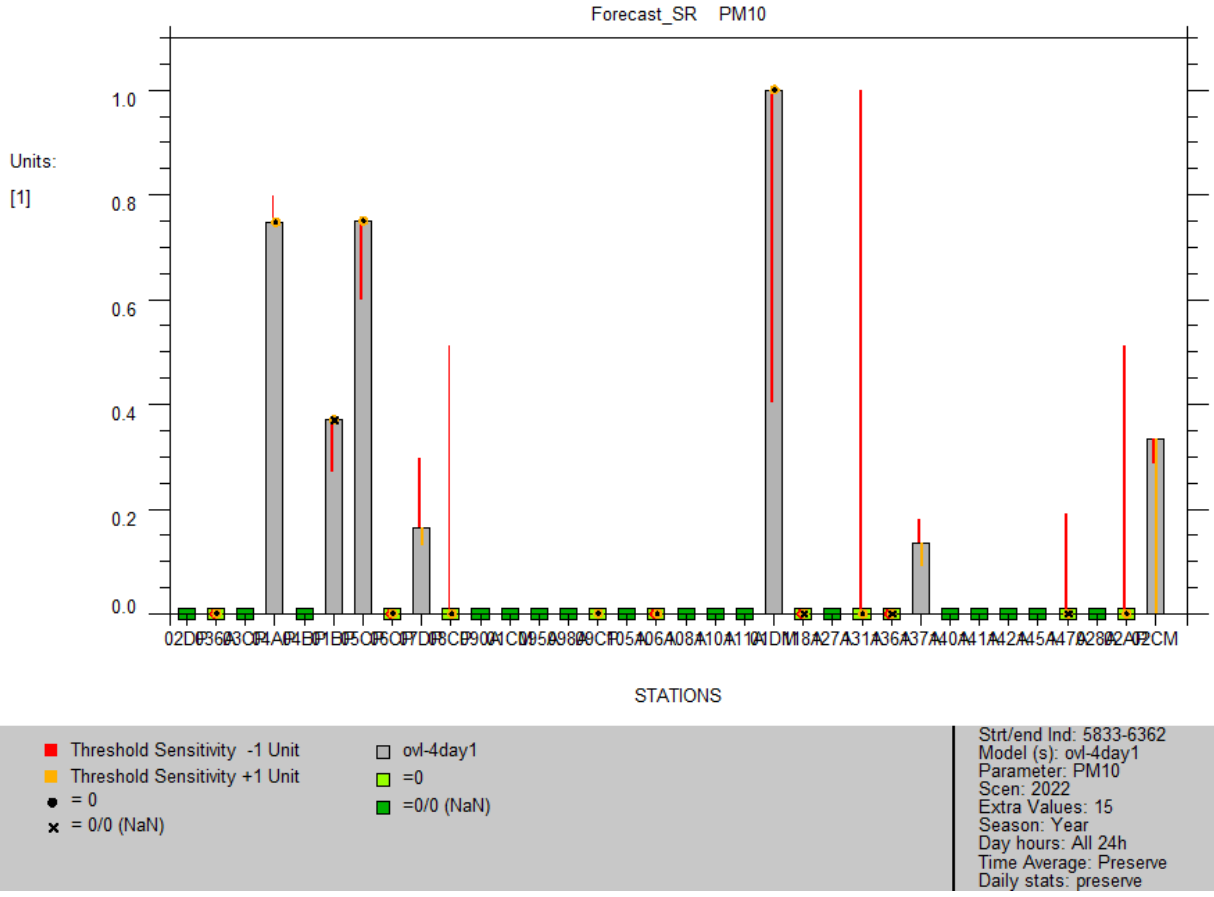
CAMS



N.B PM_{10} threshold set to 50 $\mu g/m^3$

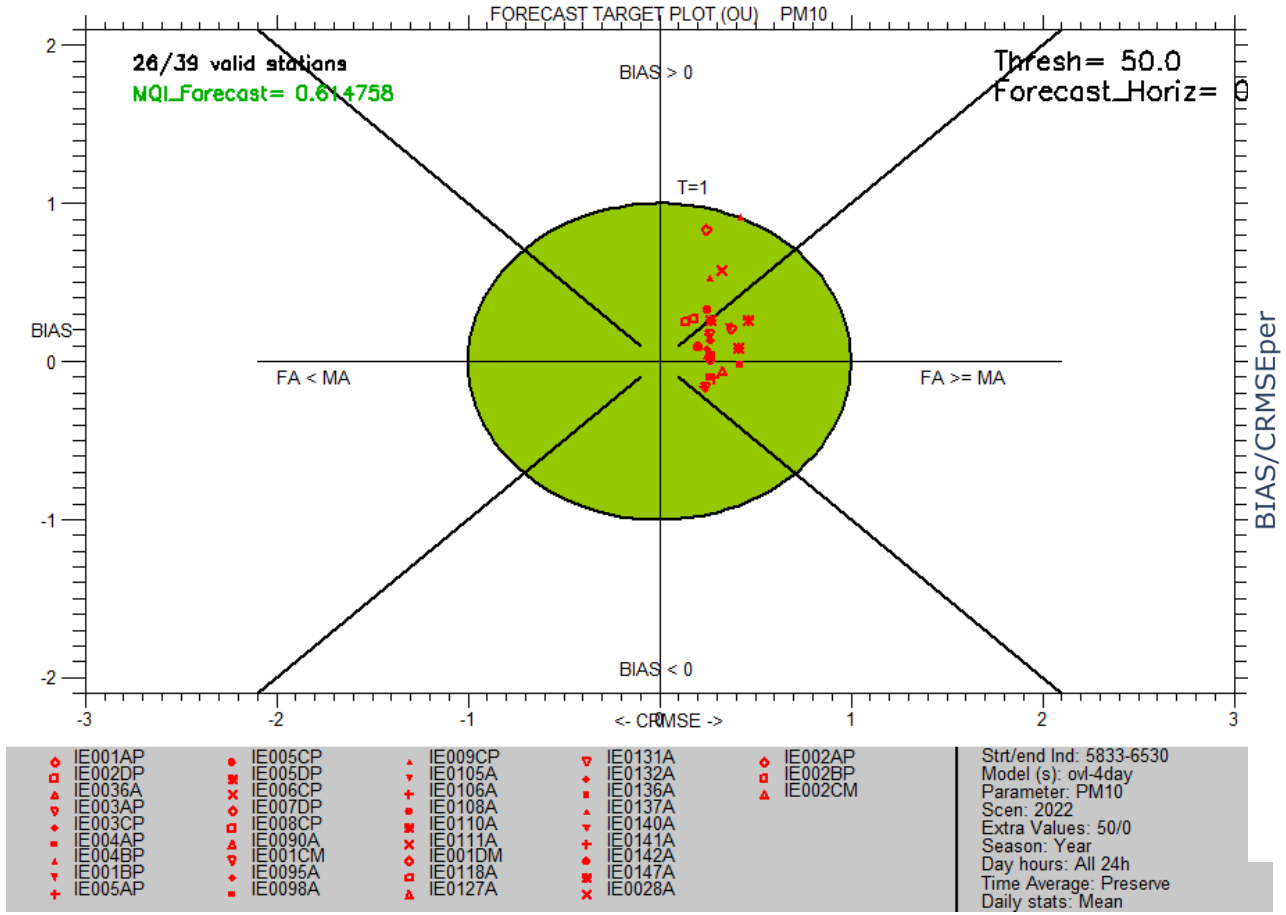
Forecast POD/SR plot

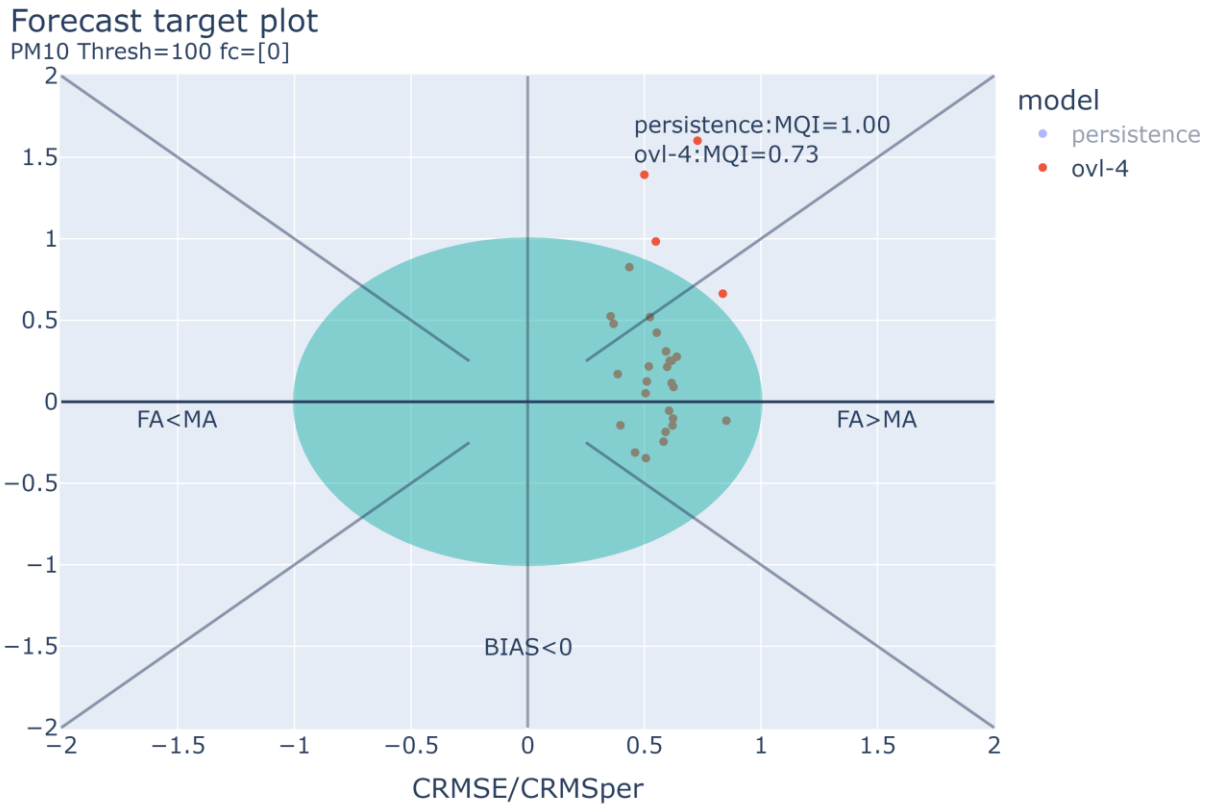




N.B PM_{10} threshold set to 15 $\mu g/m^3$

Target plot: DELTA TOOL <-> DELTAPY





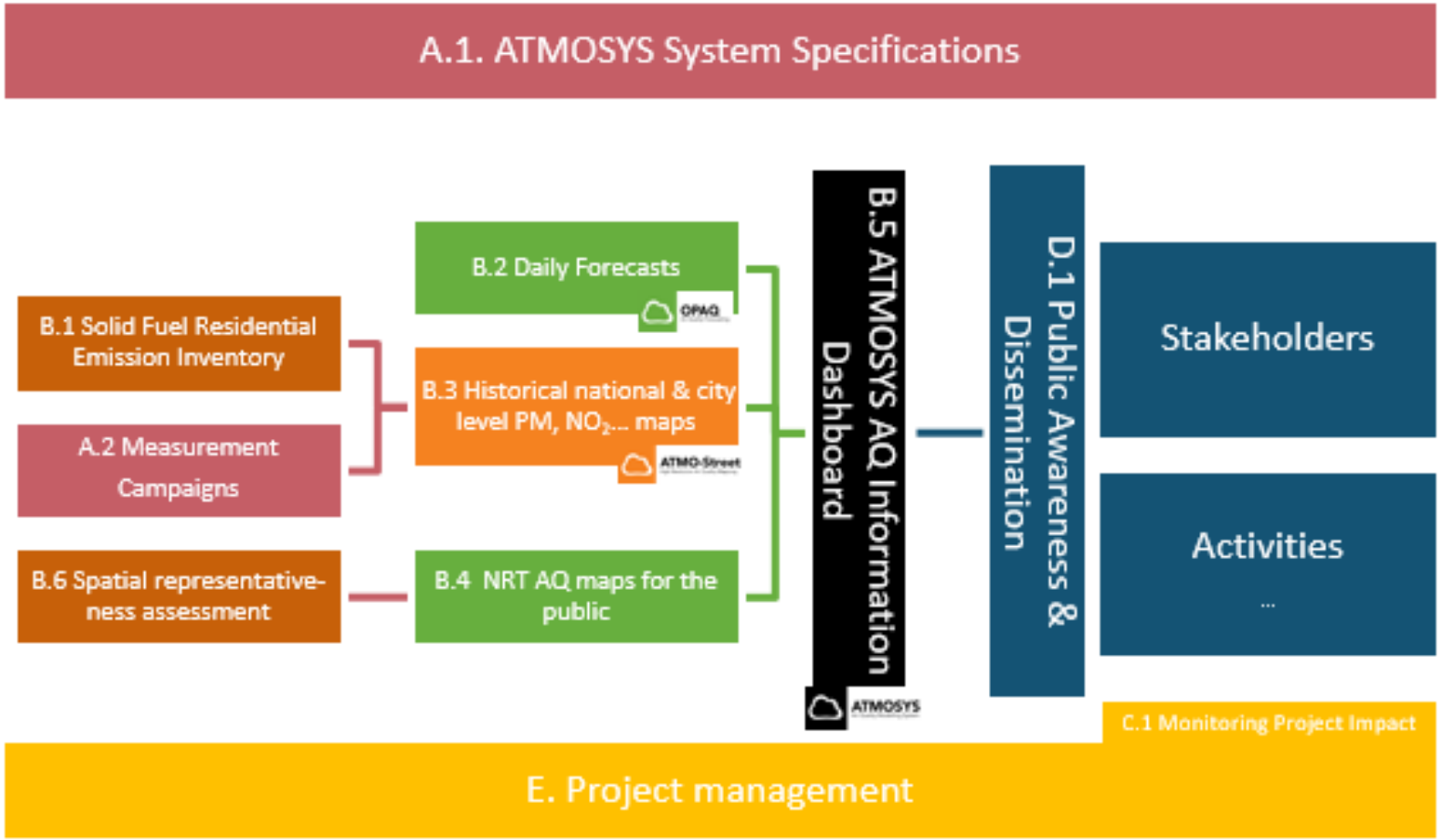
Questions

- Are the side outcomes (MPI diagram, POD & SR diagram on stations, summary report, Air Quality Index diagram) adequate to support the model evaluation, especially for experts?
- Does the current methodology look sufficiently complete? What (if any) important features are missing?
- Should the Air Quality index diagram be improved (with Multi-category Contingency Tables)?
- Can/should we plan an application of the methodology on European scale (e.g. on CAMS data)?

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

Questions?

The Overall Workflow



CT3 Future Activities

4 Questions

- Are the side outcomes (MPI diagram, POD & SR diagram on stations, summary report, Air Quality Index diagram) adequate to support the model evaluation, especially for experts?
- Does the current methodology look sufficiently complete? What (if any) important features are missing?
- Should the Air Quality index diagram be improved (with Multi-category Contingency Tables)?
- Can/should we plan an application of the methodology on European scale (e.g. on CAMS data)?

Thank You!!

JRC - Fair Mode

File Benchmark Mode Data selection Analysis Help

European Commission
Joint Research Centre
Institute for Environment and Sustainability

Data selection | Analysis | Execute

Run (Model/Scenario) Info

Models: ovl-4day*ovl-4day1*ovl-4day2*

Scenarios: 2022*

Runs: ovl-4day(2022)*ovl-4day1(2022)*ovl-4day2(2022)*

MOD without OBS

All available scenario(s)

Observation Info

single obs: IE002DP IE0036A IE003CP IE004AP

group obs: No group*

View Details

Elaboration/Parameter Info

Statistic: Forecast_Target Plot (OU) O3/NO2

Diagram: Target (Assess & Forecast)

Var(s): NO2*

EXTRA

Extra val#: 40#1

Goals,Criteria...

Stat: Max Time: preserve (none)

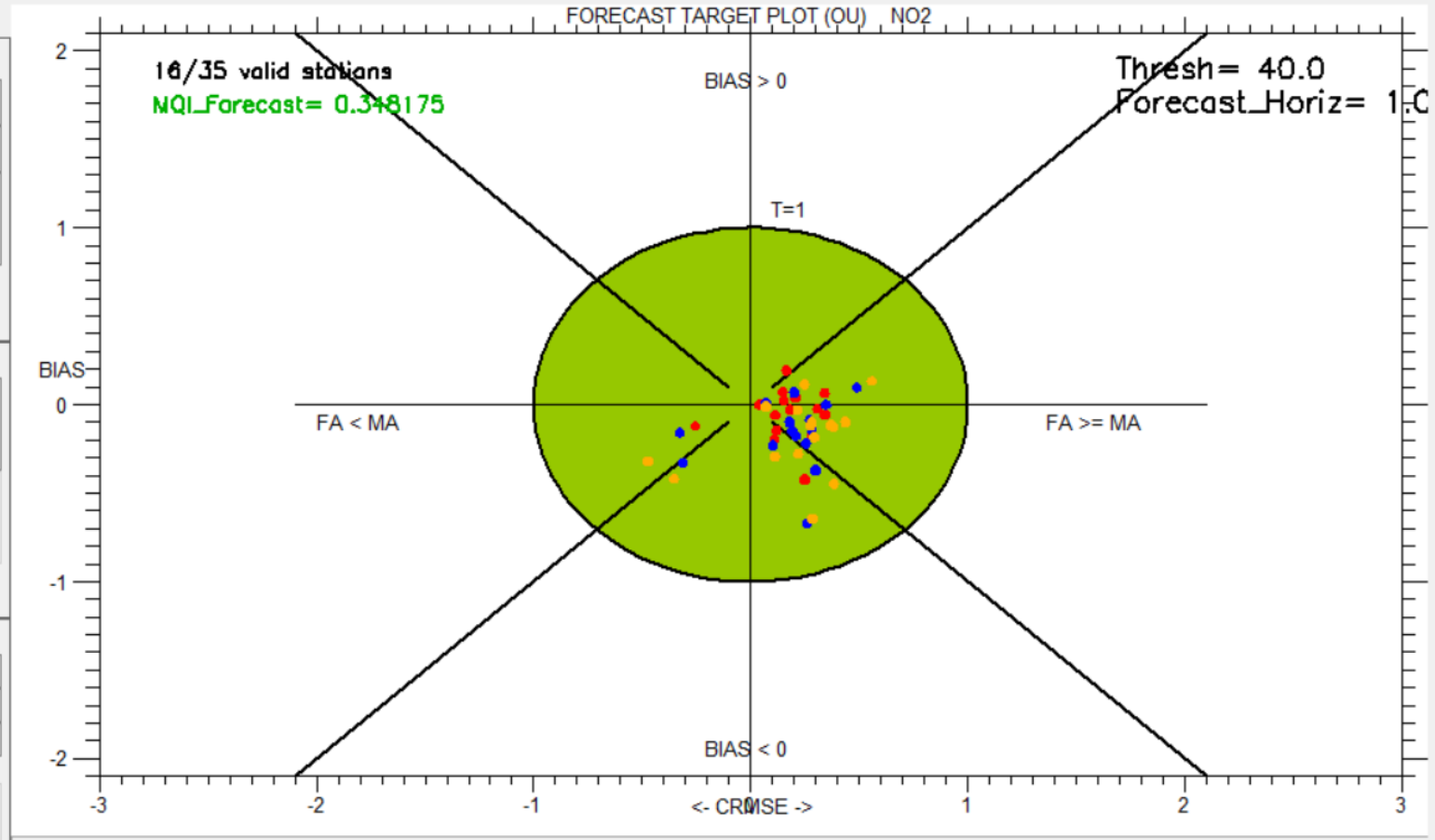
Date/Period Selection

Season: All

Hour type: All

Hour Day Month

0 1 9



---DeltaTool version 6.0---Info about plot data---

ovl-4day
ovl-4day1
ovl-4day2

Strt/end Ind: 5833-6552
Parameter: NO2
Scen: 2022
Extra Values: 40/1
Season: Year
Day hours: All 24h
Time Average: Preserve
Daily stats: Max

---Info input data => [startup_ovl.ini \\modeling\ovl \\monitoring\ovl]

Info on data points (click!)

ENG INTL 10:26 14/10/2022

JRC - Fair Mode

File Benchmark Mode Data selection Analysis Help

European Commission
Joint Research Centre
Institute for Environment and Sustainability

Data selection | Analysis | Execute

Run (Model/Scenario) Info

Models: ovl-4day1*

Scenarios: 2022*

Runs: ovl-4day1(2022)*

MOD without OBS

All available scenario(s)

Observation Info

single obs: IE002DP IE0036A IE003CP IE004AP

group obs: No group*

View Details

Elaboration/Parameter Info

Statistic: Forecast Summary P-Normalized O

Diagram: Summary Report & print (OU)

Var(s): PM10*

EXTRA

Extra val#: 10#1

Goals,Criteria...

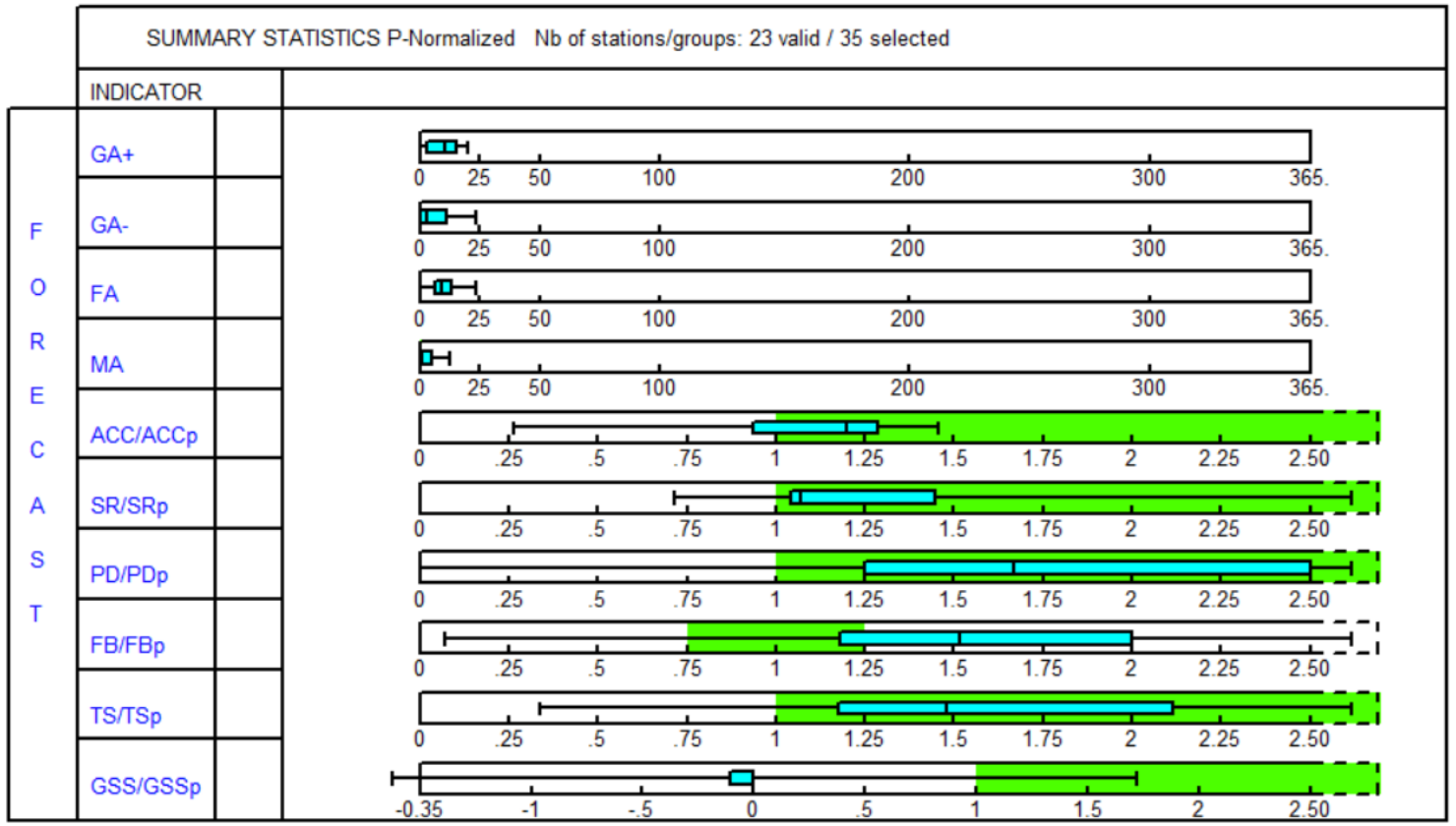
Stat: Preserve Time: preserve (none)

Date/Period Selection

Season: All

Hour type: All

	Hour	Day	Month
Date	0	1	9
	23	30	9



---DeltaTool version 6.0

---Info input data =>

Info on data points (click!)

Name

Value

ENG INTL 10:31 14/10/2022

JRC - Fair Mode

File Benchmark Mode Data selection Analysis Help

European Commission
Joint Research Centre
Institute for Environment and Sustainability

Data selection | Analysis | Execute

Run (Model/Scenario) Info

Models: camsday1*

Scenarios: 2022*

Runs: camsday1(2022)*

MOD without OBS

All available scenario(s)

Observation Info

single obs: IE002DP IE0036A IE003CP IE004AP

group obs: No group*

View Details

Elaboration/Parameter Info

Statistic: Assessment Summary O3/NO2/PM

Diagram: Summary Report & print (OU)

Var(s): PM10*

EXTRA

Extra val#: 10

Goals,Criteria...

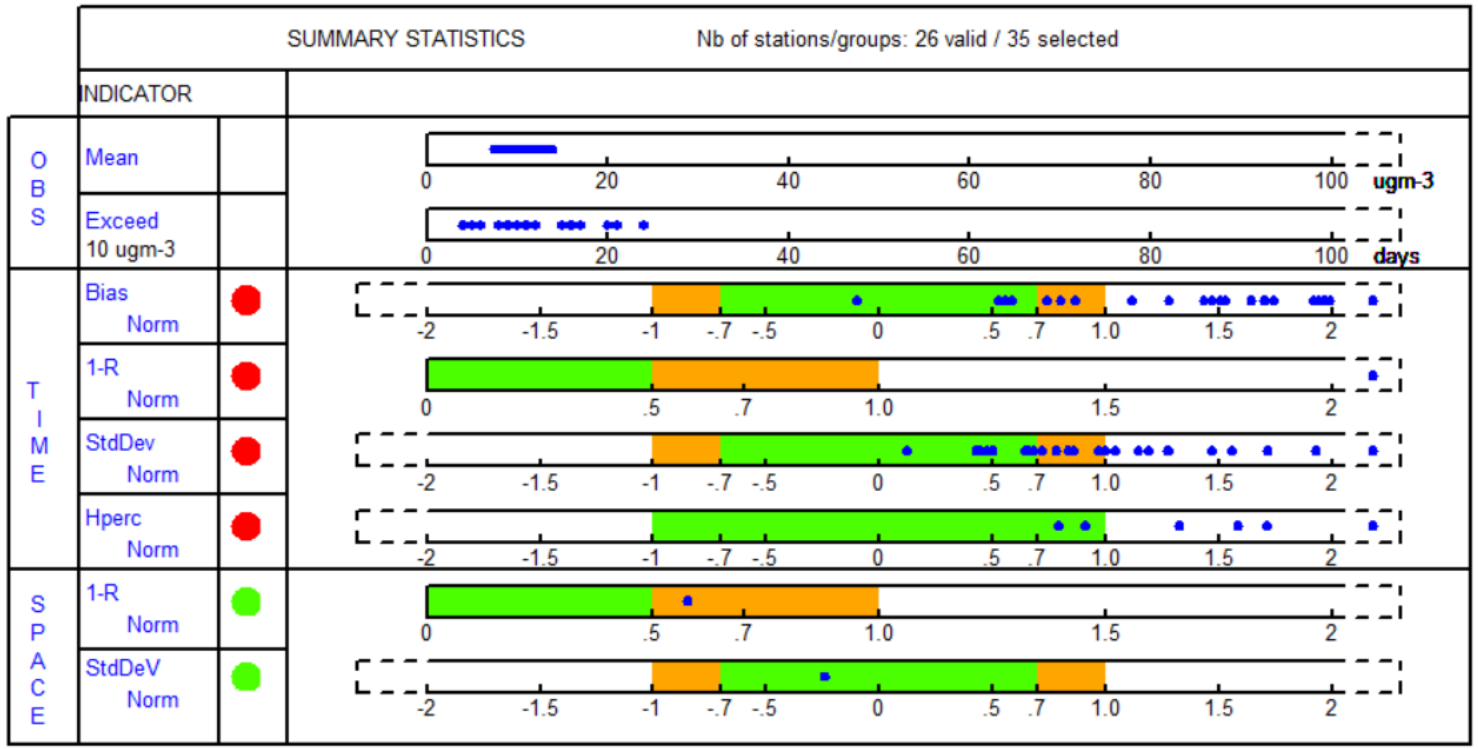
Stat: Mean Time: preserve (none)

Date/Period Selection

Season: All

Hour type: All

Date: Hour 0 Day 1 Month 9



---DeltaTool version 6.0---Info about plot data---

Performance Criteria satisfied

Performance Criteria satisfied; Error dominated by corresponding Indicator

TIME: >90% of stations fulfills the Performance Criteria

SPACE: Dot fulfills the Performance Criteria

TIME: <90% of stations fulfills the Performance Criteria

SPACE: Dot does not fulfill the Performance Criteria

---Info input data => [startup_ovl.ini \\modeling\ovl \\monitoring\ovl]

ENG INTL 10:49 14/10/2022

JRC - Fair Mode

File Benchmark Mode Data selection Analysis Help

European Commission
Joint Research Centre
Institute for Environment and Sustainability

Data selection | Analysis | Execute

Run (Model/Scenario) Info

Models: ov1-4day1*

Scenarios: 2022*

Runs: ov1-4day1(2022)*

MOD without OBS

All available scenario(s)

Observation Info

single obs: IE002DP IE0036A IE003CP IE004AP

group obs: No group*

View Details

Elaboration/Parameter Info

Statistic: Assessment Summary O3/NO2/PM

Diagram: Summary Report & print (OU)

Var(s): PM10*

EXTRA

Extra val#: 10

Goals,Criteria...

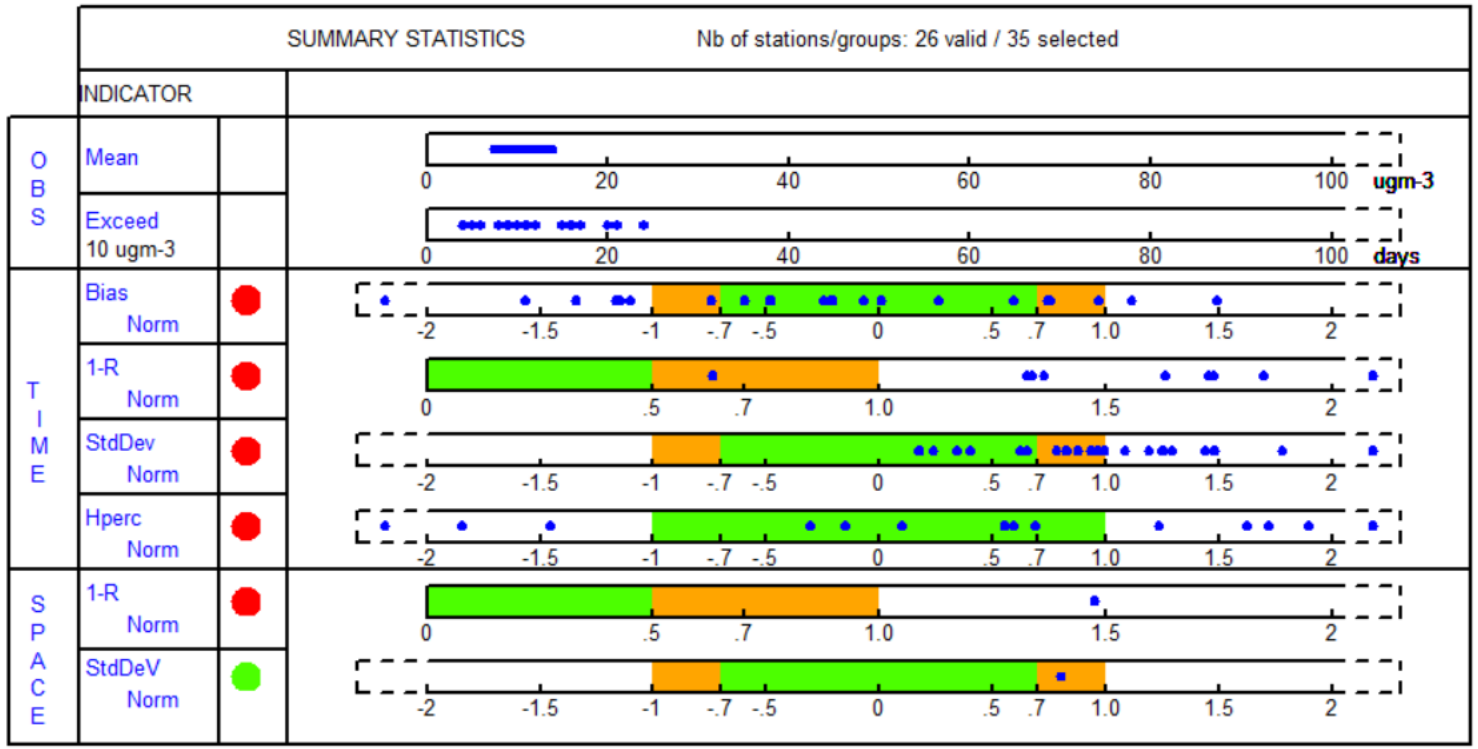
Stat: Mean Time: preserve (none)

Date/Period Selection

Season: All

Hour type: All

	Hour	Day	Month
Date	0	1	9
	23	30	9



---DeltaTool version 6.0---Info about plot data---

Performance Criteria satisfied

Performance Criteria satisfied; Error dominated by corresponding Indicator

TIME: >90% of stations fulfills the Performance Criteria

SPACE: Dot fulfills the Performance Criteria

TIME: <90% of stations fulfills the Performance Criteria

SPACE: Dot does not fulfill the Performance Criteria

Info on data points (click!)

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