SEEDS - Sentinel EO-based Emission and Deposition Service

Added value of SEEDS deposition products for daily forecasts

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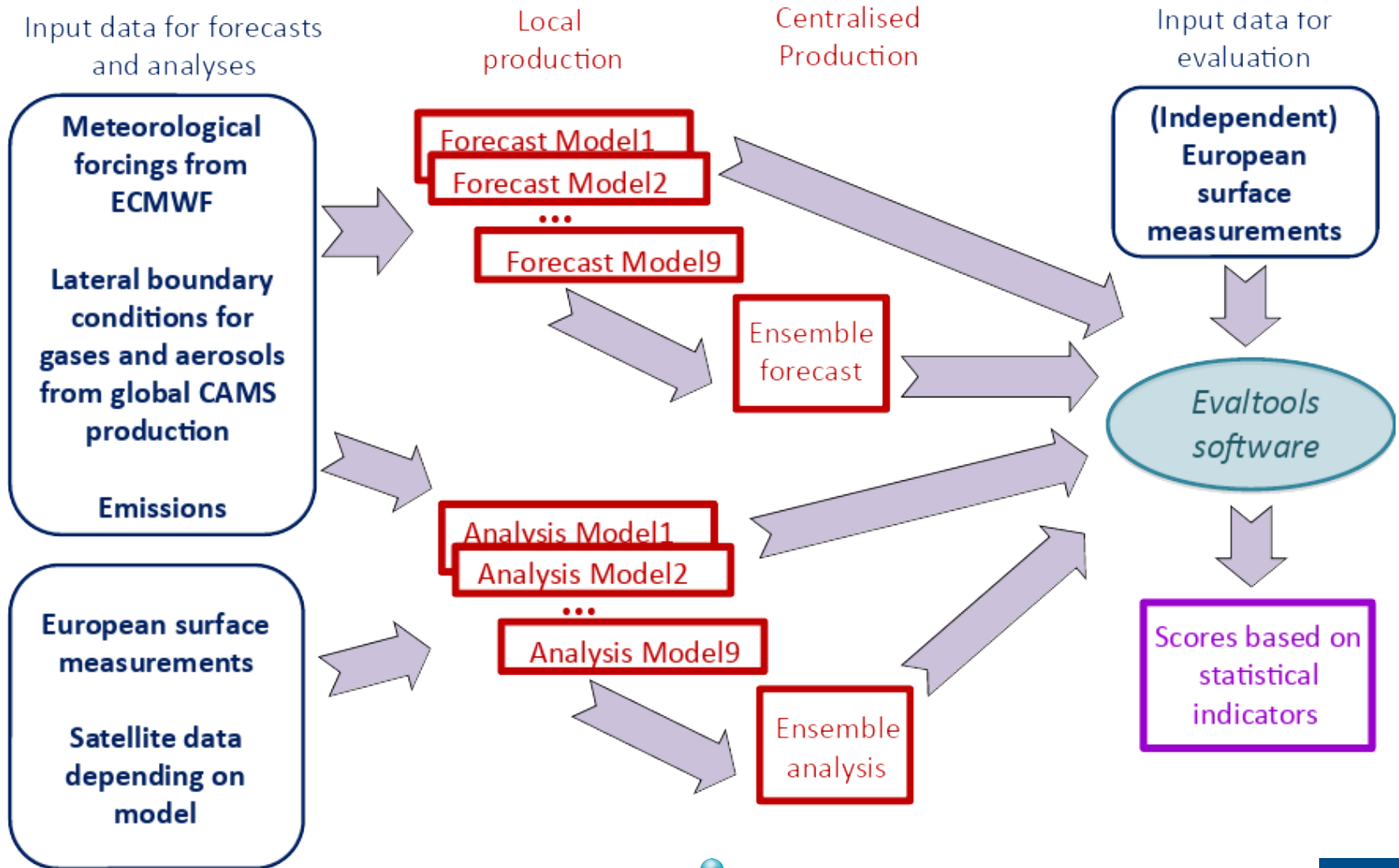CNRM - Météo-France/CNRM

General objective

- Assessment of the impact of the SEEDS products (WP1, WP2, WP3 and WP4) on the Copernicus Atmosphere Monitoring Service (CAMS) operational regional analyses and forecasts

- Test the SEEDS products as if they were delivered operationally

General design of the CAMS regional production

Configuration used to test products

Current MOCAGE setup for CAMS2-40 (U7) (<u>At project beginning</u>)

- Forecasts/analyses from ECMWF + forecasts/analyses chemical BC
- MOCAGE forecast initialized from an assimilation cycle (satellite obs)
- MOCAGE cycle mo11 used
- Regional Emissions from CAMS-REG-APv5.1 (2018) + MEGAN for Isoprene
- Global domain : Arpege 1x1° + CAMS-GLOB-ANT/CAMS-GLOB-BIO/CAMS-GLOB-OCE (2020)

Selected MOCAGE setup for SEEDS (U0)

- Forecasts/analyses from ECMWF + forecasts/analyses chemical BC
- MOCAGE forecast initialized from day before forecast
- MOCAGE cycle mo11 used (cycle mo07 in 2019)
- Regional Emissions from CAMS-REG-APv2.2 (2015) + MEGAN for Isoprene
- Global domain : Arpege 1x1° + MACCity (2016)/RCP60 (2016)/MEGAN-MACC (2010)

 - **MOCAGE o-suite in 2019** (except for source code)

BAU

Covid-19 LD

March 2019   Feb 2020   Aug 2020

General overview of simulations for deposition products

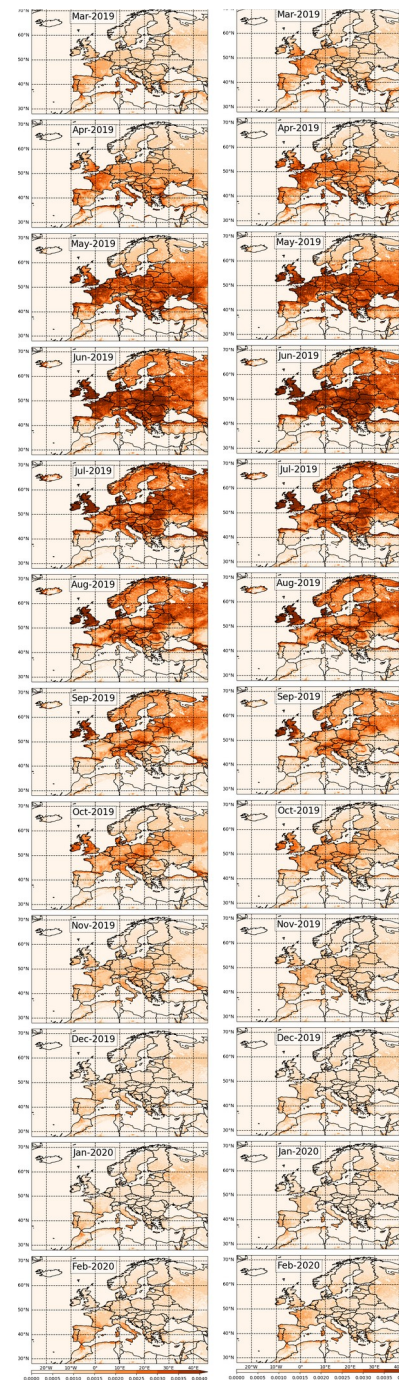| Product to test	MOCAGE simulation mode
Reference run	Analysis (24h)
	Forecast (96h)
Wesely deposition from SURFEX (Open-loop)	Analysis (24h)
Wesely deposition from SURFEX (EKF)	Analysis (24h)
EMEP deposition from SURFEX (Open-loop)	Analysis (24h)
	Forecast (96h)
EMEP deposition from SURFEX (EKF)	Analysis (24h)
	Forecast (96h)

Reference
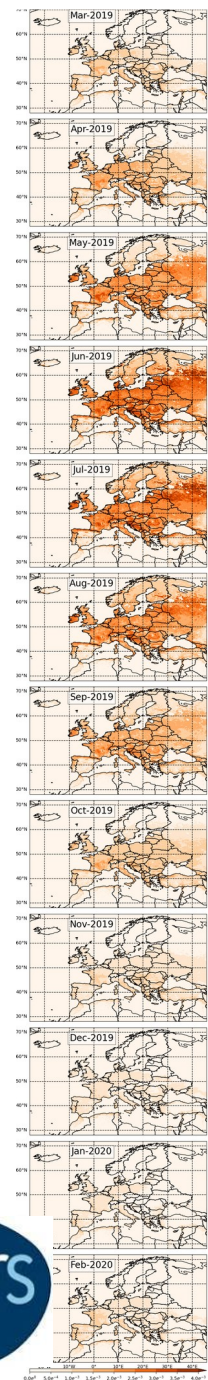
Wesely OL/EKF
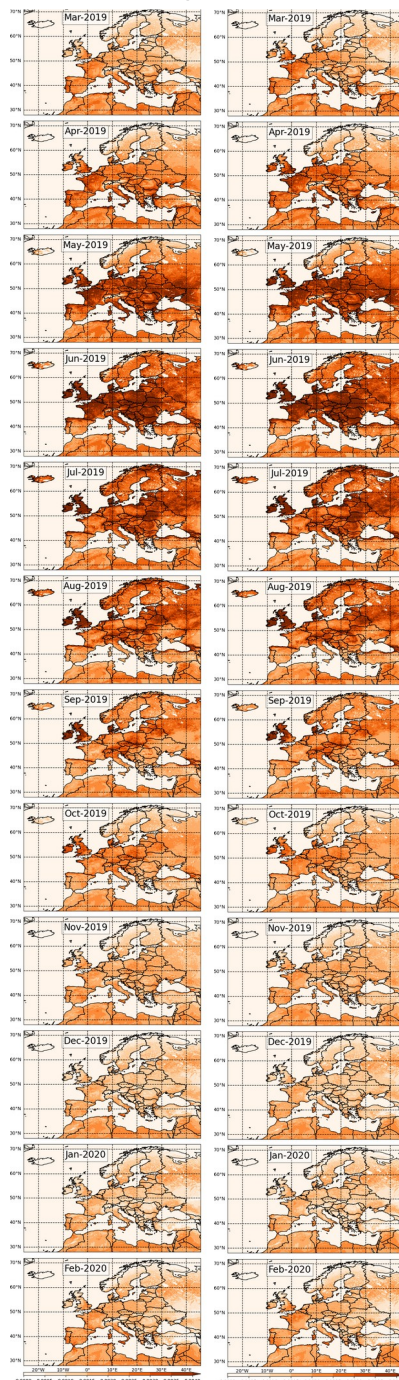
EMEP OL/EKF

NO$_2$

Results in Analysis chain - NO₂
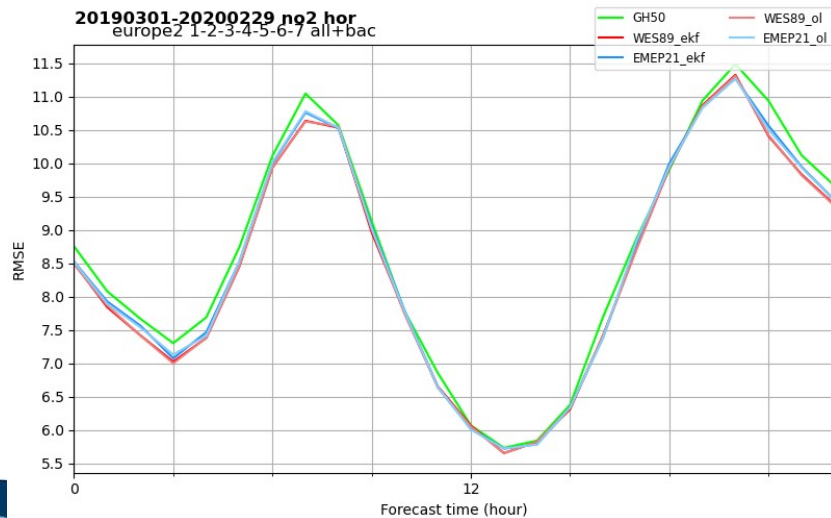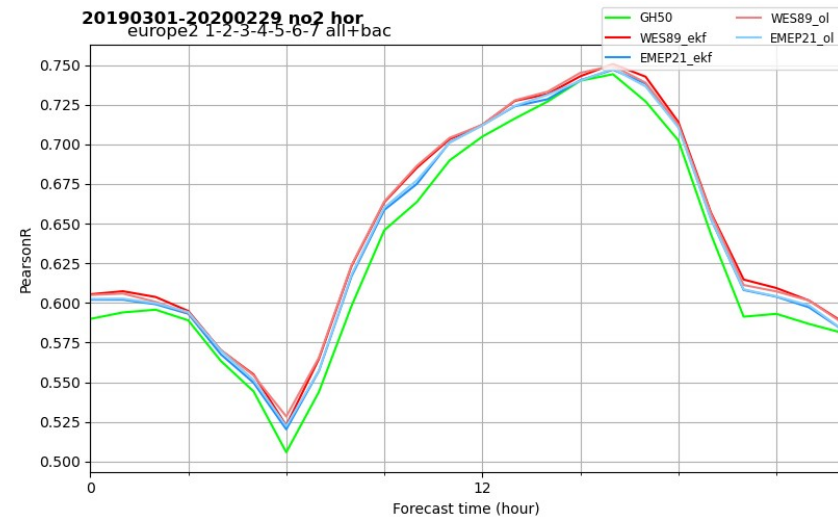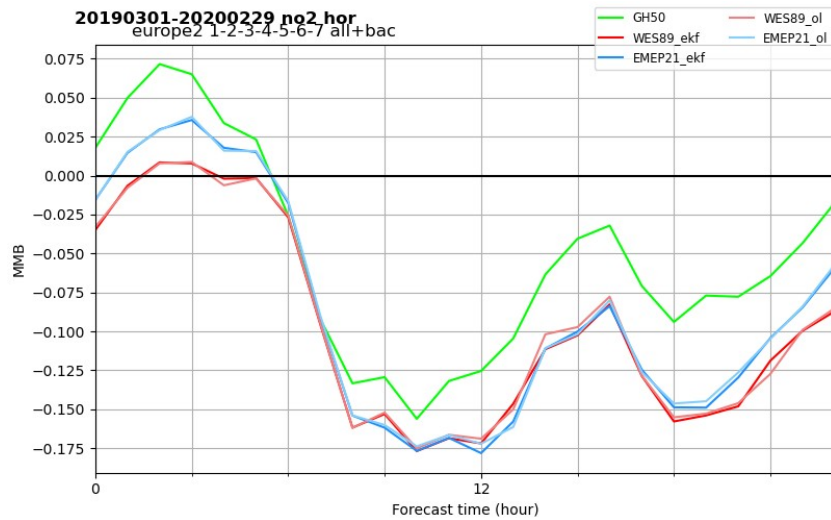
Results in Analysis chain - O₃

MMB

327 processed stations over 327
min: -0.18, avg: -0.0, max: 0.11

327 processed stations over 327
min: -0.16, avg: 0.0, max: 0.21

327 processed stations over 327
min: -0.17, avg: -0.0, max: 0.12

327 processed stations over 327
min: -0.15, avg: 0.0, max: 0.22

Wesely-OL - Ref

EMEP-OL - Ref

Wesely-EKF - Ref

EMEP-EKF - Ref

Correlation

327 processed stations over 327
min: -0.13, avg: -0.01, max: 0.07

327 processed stations over 327
min: -0.14, avg: -0.01, max: 0.06
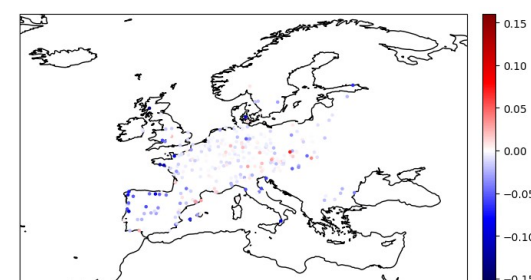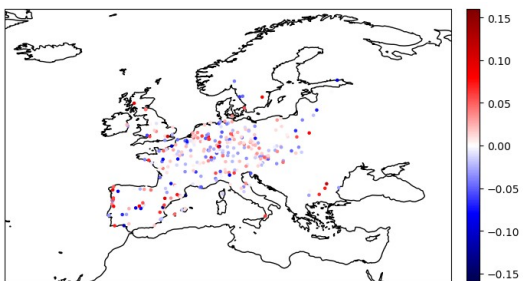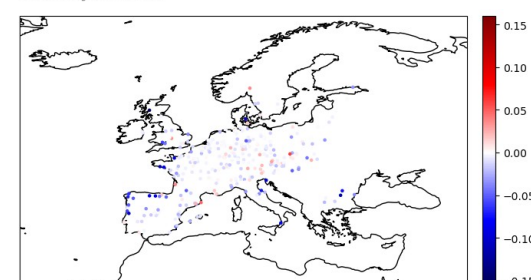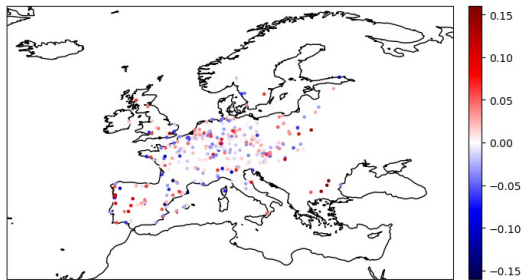
327 processed stations over 327
min: -0.14, avg: -0.01, max: 0.07

327 processed stations over 327
min: -0.15, avg: -0.01, max: 0.06

Results in Analysis chain

Success ratio :   EMEP > Wesely > Reference(Target of 1)

False alarm ratio :   EMEP < Wesely < Reference(Target of 0)

Bias score :   Reference > EMEP > Wesely(Target of 1)

threshold = 180.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GH50	0.99	0.71	0.6	0.43	0.4
WES89_ekf	0.99	0.59	0.67	0.39	0.33
EMEP21_ekf	0.99	0.55	0.7	0.39	0.3
WES89_ol	0.99	0.58	0.69	0.39	0.31
EMEP21_ol	0.99	0.54	0.7	0.37	0.3

threshold = 150.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GH50	0.96	0.7	0.73	0.51	0.27
WES89_ekf	0.96	0.62	0.76	0.47	0.24
EMEP21_ekf	0.96	0.61	0.77	0.47	0.23
WES89_ol	0.96	0.62	0.76	0.47	0.24
EMEP21_ol	0.96	0.6	0.78	0.47	0.22

=> SEEDS products:
- improve the quality of representation of more extreme ozone events
- degrade O_3 bias

Results in Analysis chain - PM10
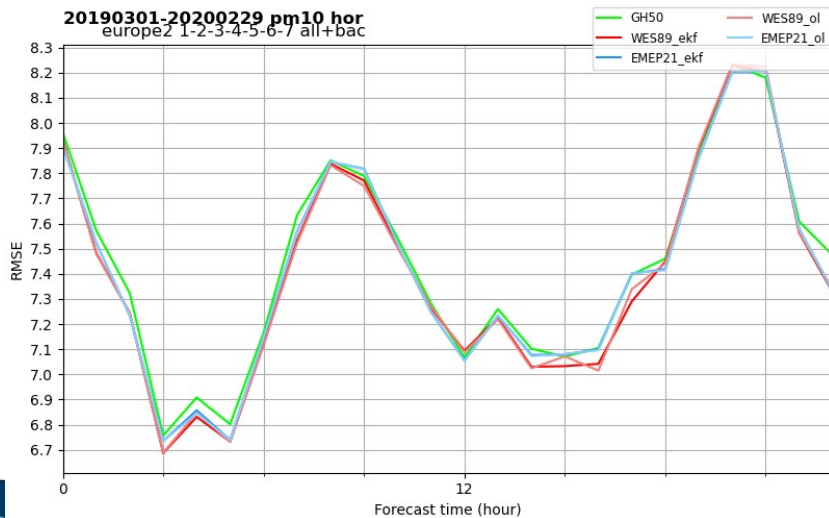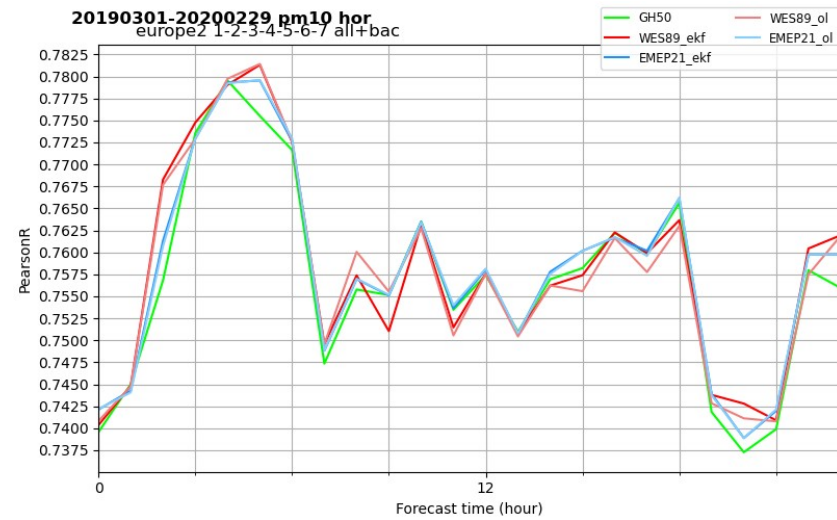
=> Impact due to SIA

Improved biais with WES89

Results in Forecast chain - NO₂

20190301-20191231 no2 hor
europe2 1-2-3-4-5-6-7 all+bac

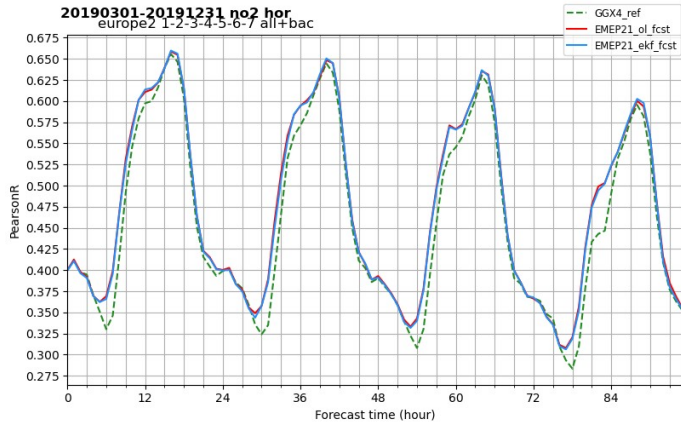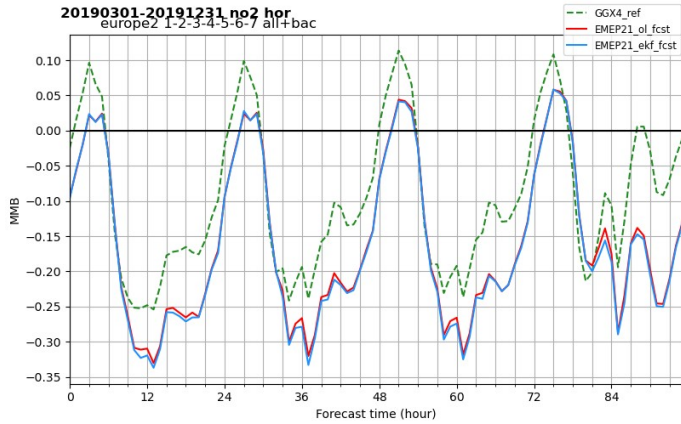Legend: GGX4_ref, EMEP21_ol_fcst, EMEP21_ekf_fcst

20190301-20191231 no2 hor
europe2 1-2-3-4-5-6-7 all+bac

Legend: GGX4_ref, EMEP21_ol_fcst, EMEP21_ekf_fcst

=> SEEDS products:
- slightly improve the quality of NO₂ predictions, during the 4 days of forecasting
- degrade bias

threshold = 50.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.85	0.66	0.36	0.24	0.64
EMEP21_ol_fcst	0.86	0.59	0.38	0.22	0.62
EMEP21_ekf_fcst	0.86	0.59	0.38	0.22	0.62

threshold = 30.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.7	0.55	0.69	0.38	0.31
EMEP21_ol_fcst	0.7	0.51	0.7	0.36	0.3
EMEP21_ekf_fcst	0.7	0.51	0.7	0.36	0.3

D0

⬇

D3

threshold = 50.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.85	0.76	0.35	0.26	0.65
EMEP21_ol_fcst	0.86	0.62	0.37	0.23	0.63
EMEP21_ekf_fcst	0.86	0.62	0.37	0.23	0.63

threshold = 30.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.7	0.59	0.67	0.4	0.33
EMEP21_ol_fcst	0.69	0.52	0.69	0.36	0.31
EMEP21_ekf_fcst	0.69	0.52	0.69	0.36	0.31

Results in Forecast chain - O₃

20190301-20191231 o3 hor
europe2 1-2-3-4-5-6-7 all+bac

20190301-20191231 o3 hor
europe2 1-2-3-4-5-6-7 all+bac
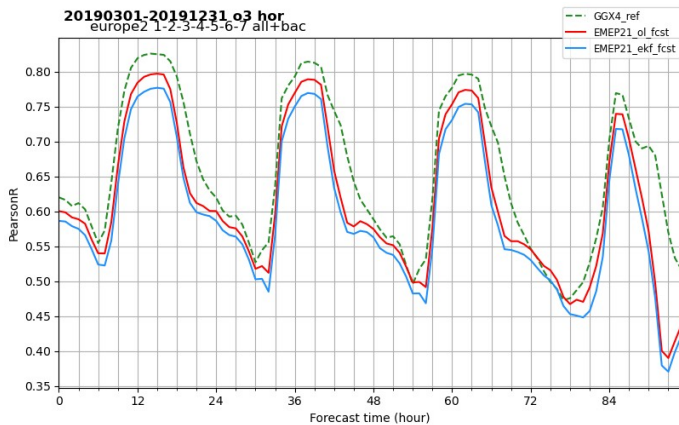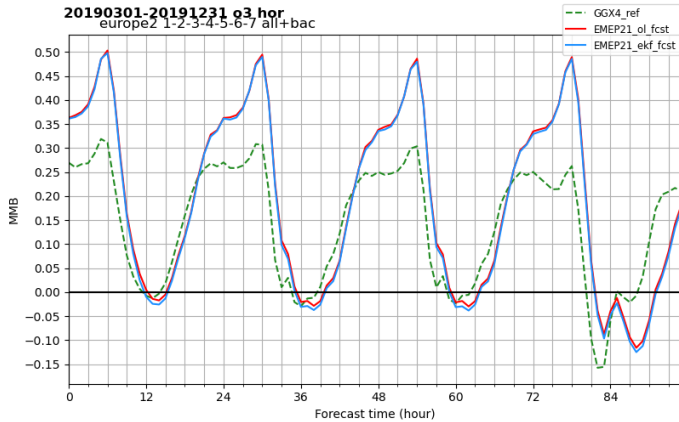
=> SEEDS products:
- degrade events detection
- degrade overall quality of the forecast
- degrade bias

threshold = 240.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	1	0.33	0.13	0.045	0.87
EMEP21_ol_fcst	1	0.3	0.13	0.04	0.87
EMEP21_ekf_fcst	1	0.33	0.12	0.04	0.88

threshold = 180.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.99	0.76	0.38	0.29	0.62
EMEP21_ol_fcst	0.99	0.57	0.39	0.22	0.61
EMEP21_ekf_fcst	0.99	0.61	0.38	0.24	0.62

D0

D3

threshold = 240.0

	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	1	0.95	0.048	0.045	0.95
EMEP21_ol_fcst	1	0.63	0.057	0.036	0.94
EMEP21_ekf_fcst	1	0.67	0.054	0.036	0.95

threshold = 180.0

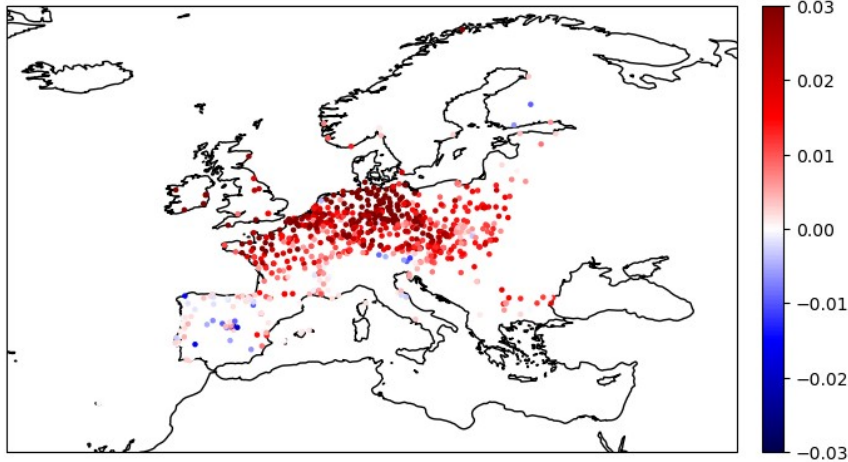|	accuracy	bias_score	success_ratio	hit_rate	false_alarm_ratio
GGX4_ref	0.99	1.8	0.22	0.38	0.78
EMEP21_ol_fcst	0.99	1.3	0.18	0.24	0.82
EMEP21_ekf_fcst	0.99	1.4	0.18	0.26	0.82

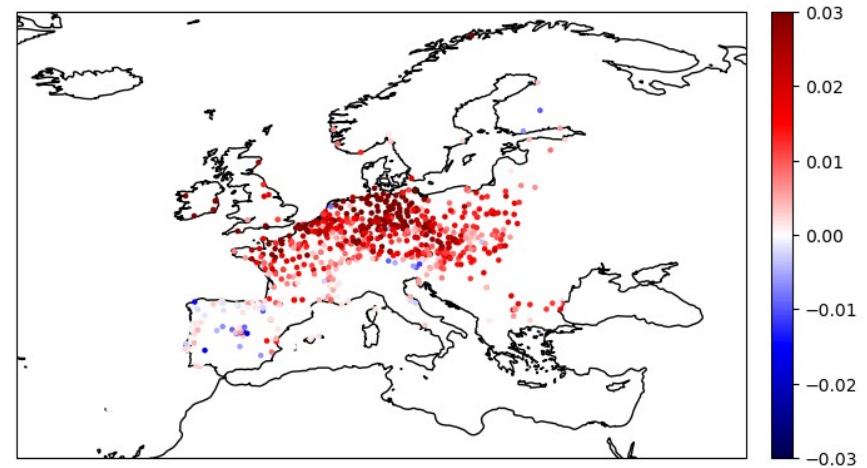# Results in Forecast chain
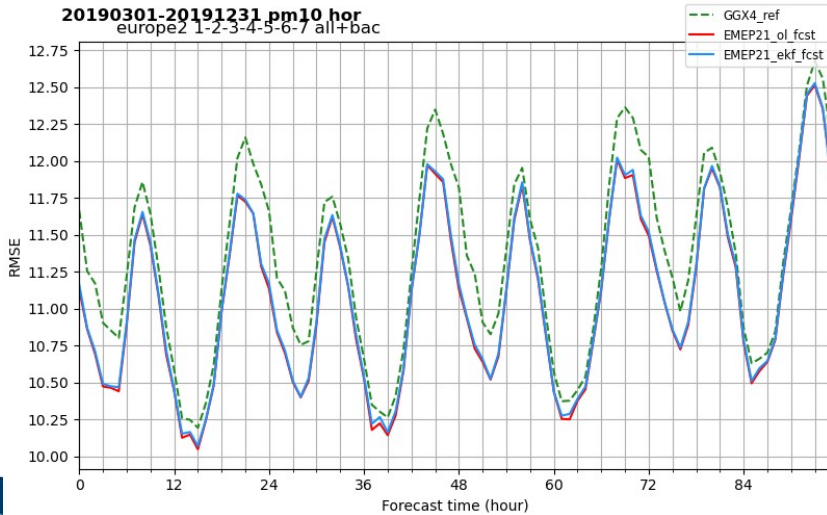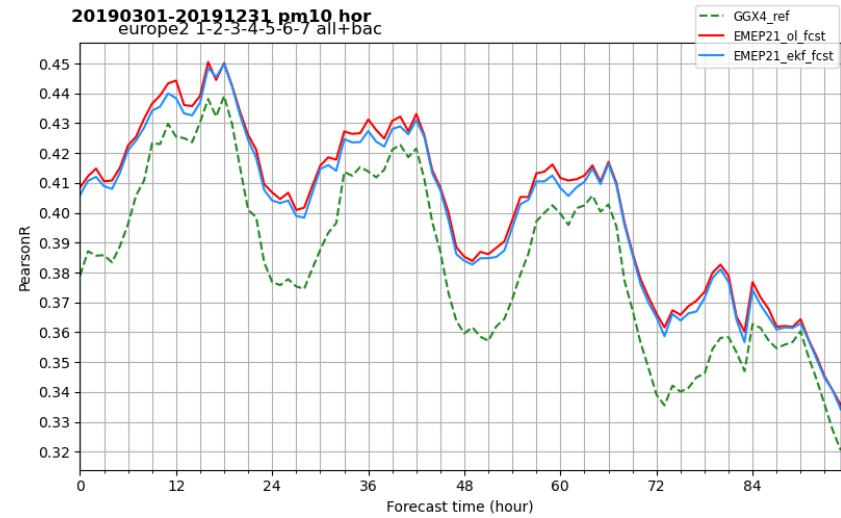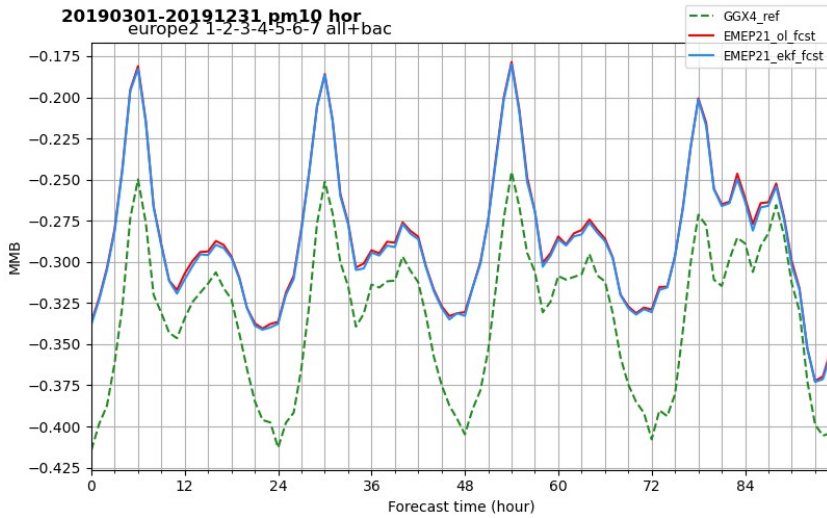
=> Nice improvement of PM10 forecasts !

Results in Forecast chain - PM10

Correlation

771 processed stations over 771
min: -0.03, avg: 0.02, max: 0.08

771 processed stations over 771
min: -0.03, avg: 0.01, max: 0.07

EMEP-OL - Ref

EMEP-EKF - Ref

=> Strange zonal variation...

Conclusion

Analyses

- No big improvement, but

  - interesting impact on ozone events

  - Reduction of PM10 bias

  - Difficulties to improve result in analyses

General

- Lots of work to analyze in depth all the simulations
- Same behavior between OL/EKF
- Impact visible on secondary pollutant
- All deposition velocities are changing

  - Not easy to determine the ways of the improvements/degradation

  - Lack of deposition velocities measurements to validate deposition schemes

    - Potential link with CAMS2_40 Task 4041 on deposition

  - Lack of concentration measurements

    - NH3, NMVOC, SIA, etc…

- Are these conclusions the same in other models? Need intercomparison

Forecasts

- Degradation of ozone scores :-(

  - But variable depending season

- Improvement of PM10 scores :-)

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