



Atmosphere Monitoring

Trend analysis of long simulations aerosols/chemistry with IFS-COMPO cycle 49R1 in preparation for the next CAMS reanalysis

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AEROCOM 15/10/2024



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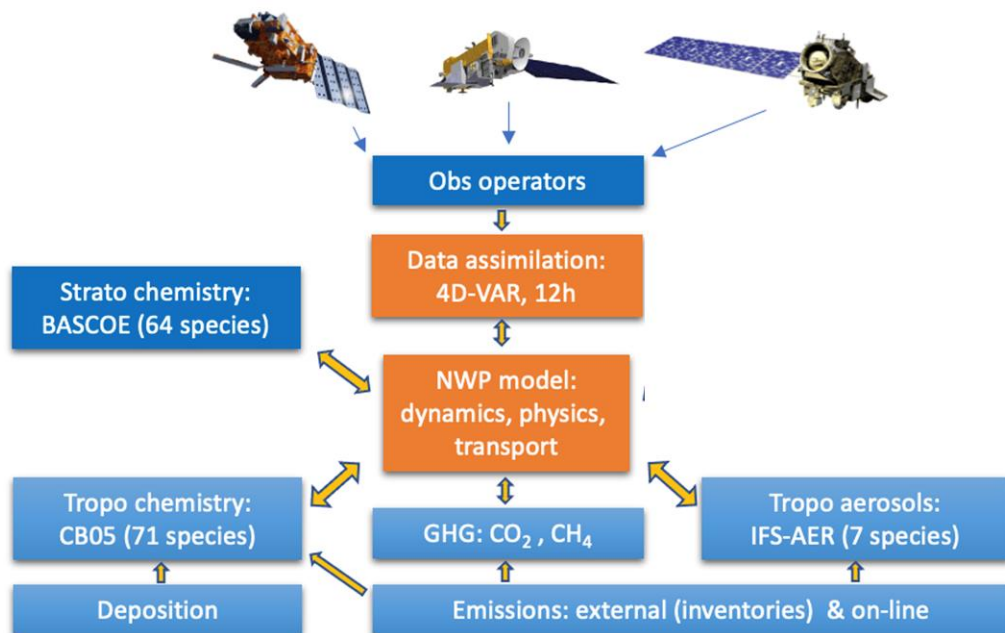
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- IFS : Integrated Forecasting System
- Used operationally for CAMS forecasts
- « Bulk-bin » approach :
 - 3 bins for SS and DU
 - Single tracer for other species
- Operational version since June 2023 : cycle 48R1
- Cycle 48R1 implements the BASCOE stratospheric chemistry
- Documentation at

<https://www.ecmwf.int/en/elibrary/81374-ifs-documentation-cy48r1-part-viii-atmospheric-composition>

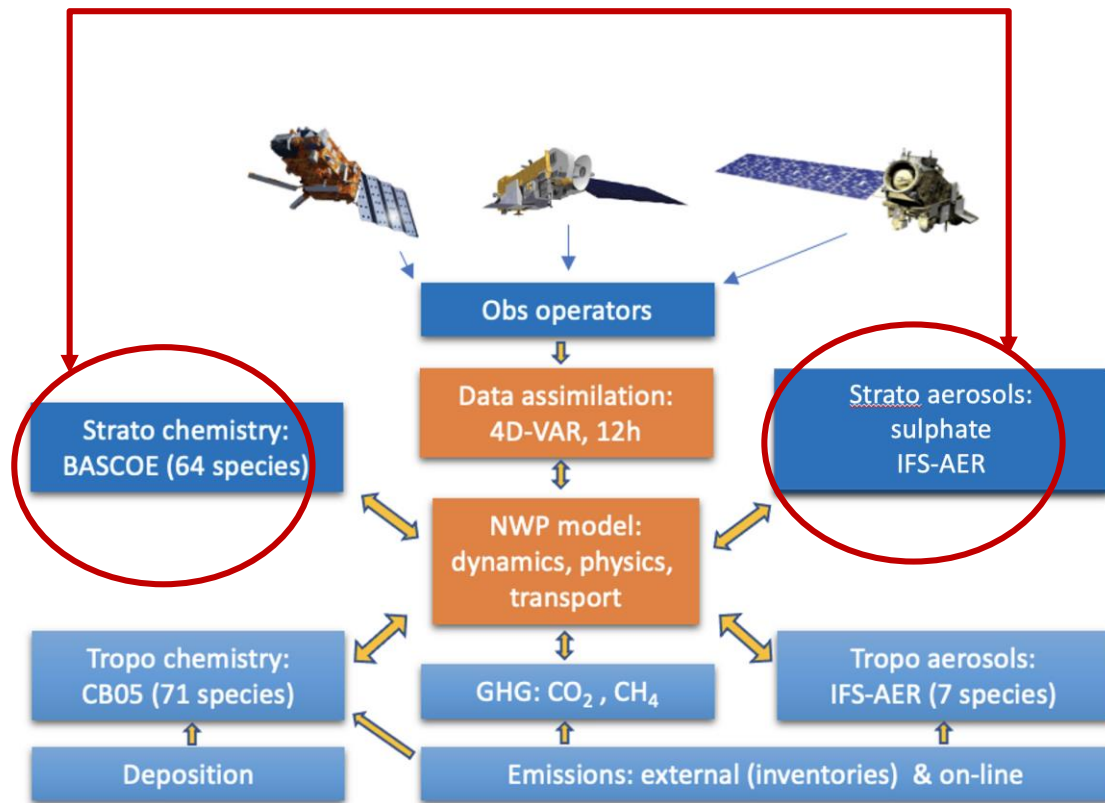




Atmospheric composition in IFS-COMPO

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- Cycle 49R1 is to be operationally implemented on 12/11/2024
- It implements a coupling of stratospheric aerosols and chemistry
- It also implements the use of EQSAM4Clim to represent HNO_3/NO_3 partitioning
- Cycle 49R2, based on CY49R1, will be used for next CAMS reanalysis
- Production of next CAMS reanalysis to start in early 2025



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Preparation of next reanalysis

Long simulations with cycle 49R1 IFS-COMPO without data assimilation have been carried out in order to prepare for next reanalysis. Objectives:

- Evaluate the skill of IFS-COMPO without assimilation, especially as compared to the CAMS reanalysis control run,
- Spot possible issues in the model/model configuration used for next reanalysis,
- Spot possible issues in the model inputs, particularly anthropogenic emissions which are provided by another group,
- Test different model configurations over long periods of time,
- Compare simulated and observed trends

Configuration of the runs:

- 1/1/2003 to 31/12/2020 (with two months spinup)
- Tropospheric and stratospheric chemistry/aerosols activated
- T_L255 (80km grid cell) with 137 levels
- Anthropogenic emissions from CAMS_GLOB_ANTv6.1 (derived from EDGAR)
- Cycling forecasts : aerosol/chemistry take their initial conditions from the previous forecast (no data assimilation), meteorological initial conditions are from an analysis





Some results

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AOD at 500nm versus AERONET

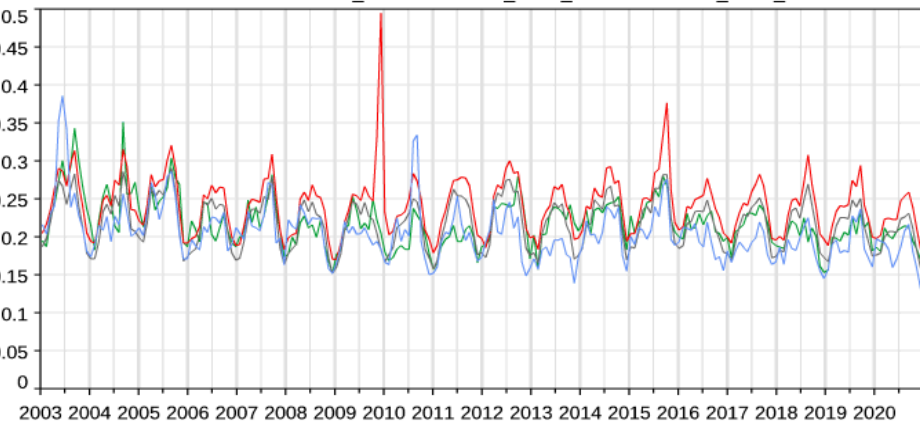
Experiment label	Comment
EAC4_CR	Control run for current reanalysis (EAC4)
EAC5_scout_v0	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched off
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on

Mean. Model against L2.0 Aeronet AOT at 500nm.

1114 Voronoi-weighted sites globally ($r_{max}=1276km$).

1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.11.

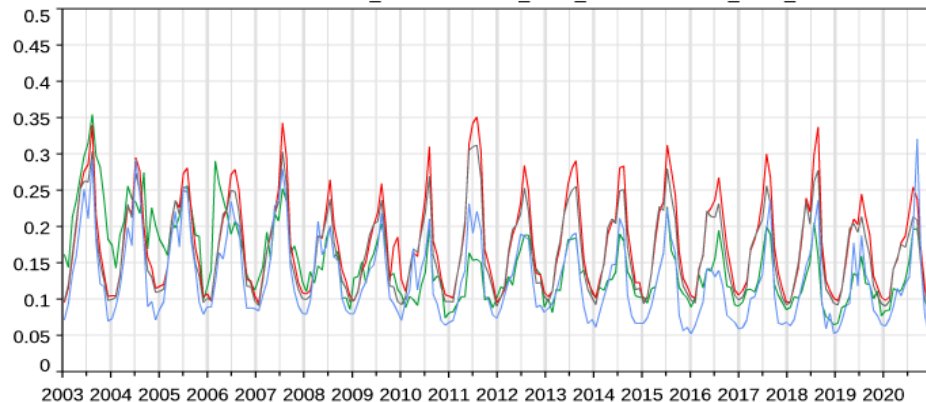
— Obs — eac4_cr — eac5_scout_v0 — eac5_scout_v1



Mean. Model against L2.0 Aeronet AOT at 500nm.

408 sites in N-America. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.11.

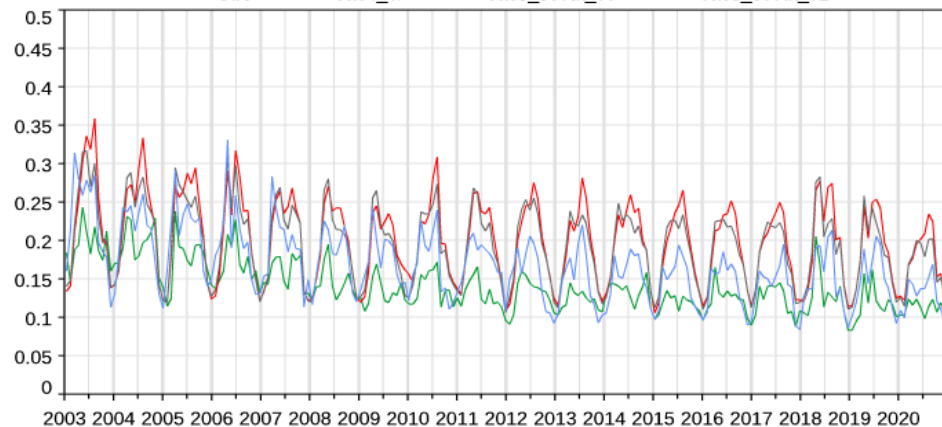
— Obs — eac4_cr — eac5_scout_v0 — eac5_scout_v1



Mean. Model against L2.0 Aeronet AOT at 500nm.

210 sites in Europe. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.11.

— Obs — eac4_cr — eac5_scout_v0 — eac5_scout_v1





Some results

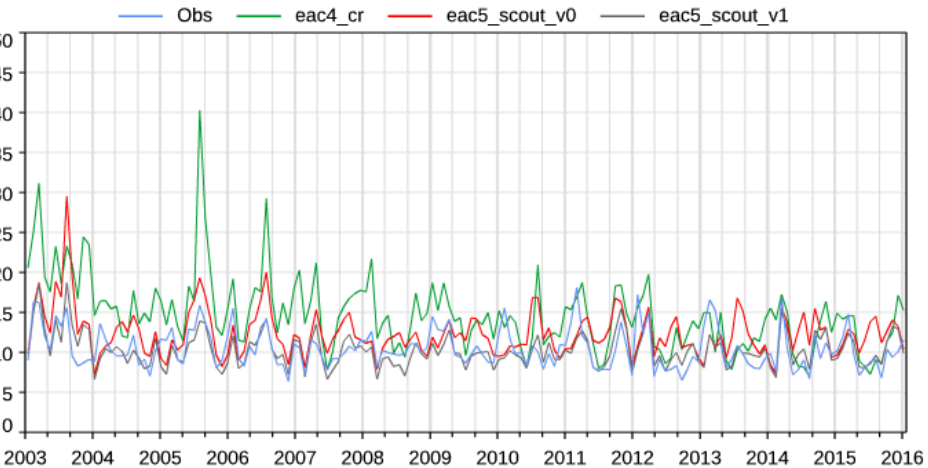
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PM2.5 versus obs in Europe, US, China

Experiment label	Comment
EAC4_CR	Control run for current reanalysis (EAC4)
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EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on

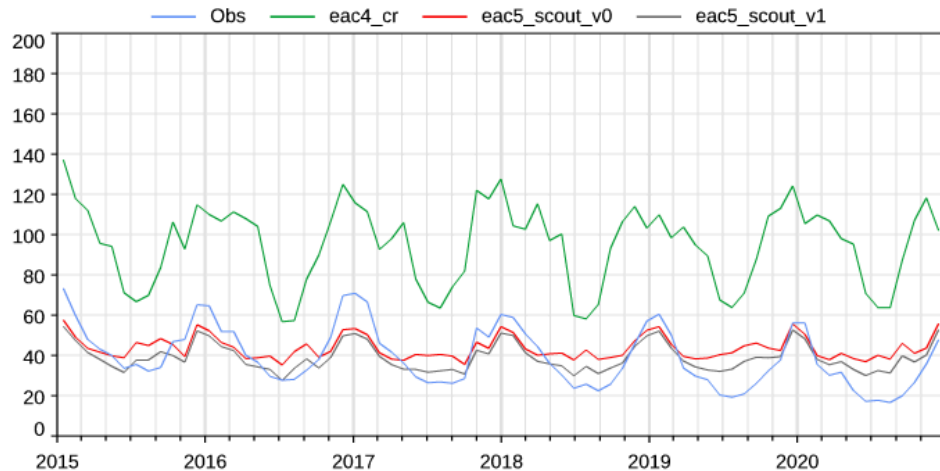
PM2.5 (ug/m3) Mean. Model versus AirBase.

75 sites in background rural. 1 Jan 2003 - 22 Jan 2016. 00Z, T+6 to 24. Ver0D 12.6.14.



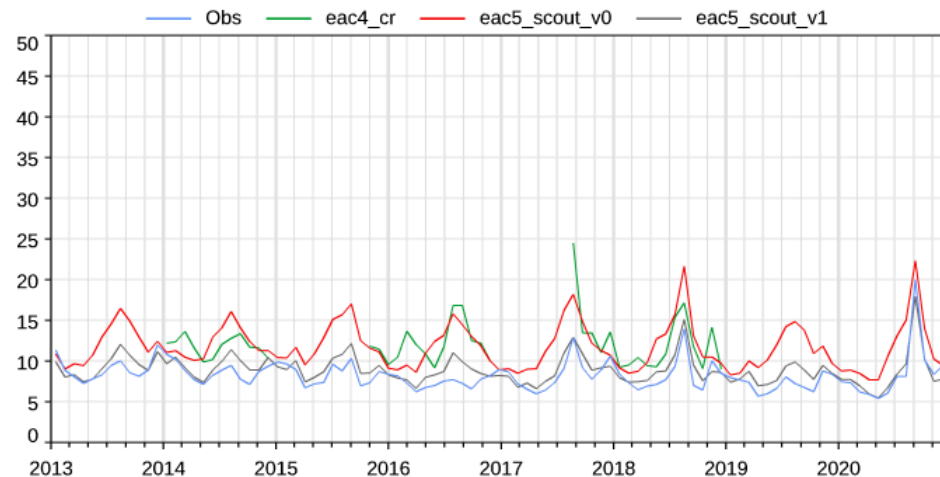
PM2.5 (ug/m3) Mean. Model versus China AQ.

161 sites in China rural. 1 Jan 2015 - 29 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.



PM2.5 (ug/m3) Mean. Model versus AirNow.

1014 sites in US. 1 Jan 2013 - 19 Dec 2020. 00Z, T+6 to 24. Ver0D 12.6.13.





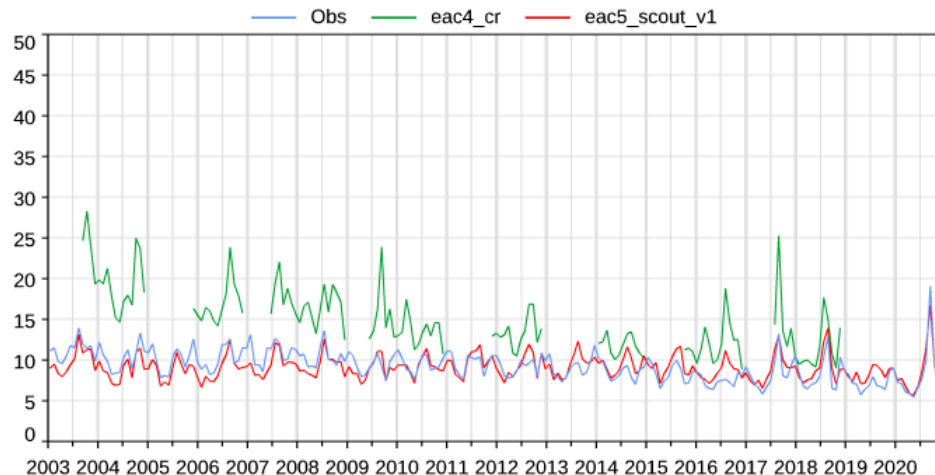
Some results

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PM2.5 versus obs in US

Experiment label	Comment
EAC5_scout_v0	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched off
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on

PM2.5 (ug/m3) Mean. Model versus AirNow.
1126 sites in US. 1 Jan 2003 - 26 Dec 2020. 00Z, T+6 to 24. Ver0D 12.6.11.





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Some results

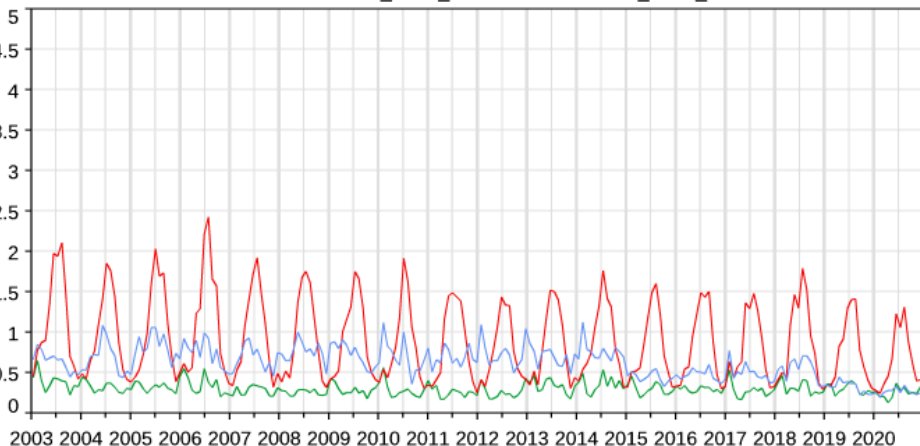
Surface concentration versus EBAS (Europe)

Experiment label	Comment
EAC5_scout_v0	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched off
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on

HNO₃_surf (ug/m³) Mean. Model versus EBAS.

41 sites in Europe. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.

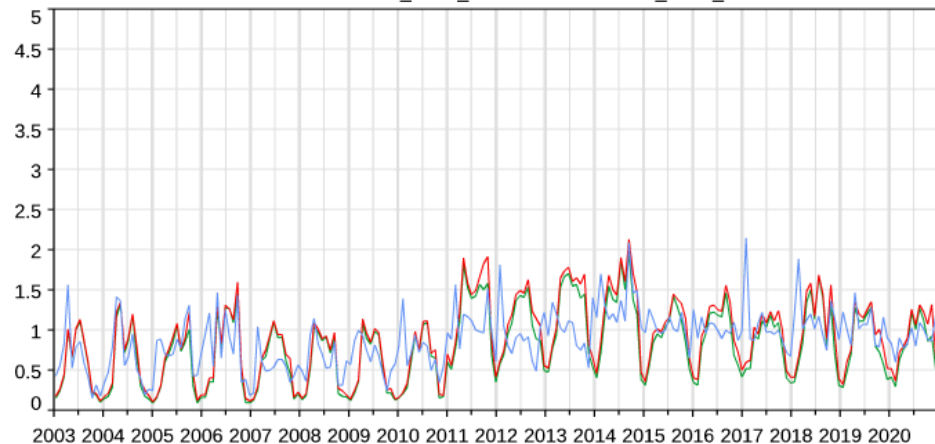
— Obs — eac5_scout_v0ebas — eac5_scout_v1ebas



SO₄_surf (ug/m³) Mean. Model versus EBAS.

28 sites in Europe background. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.

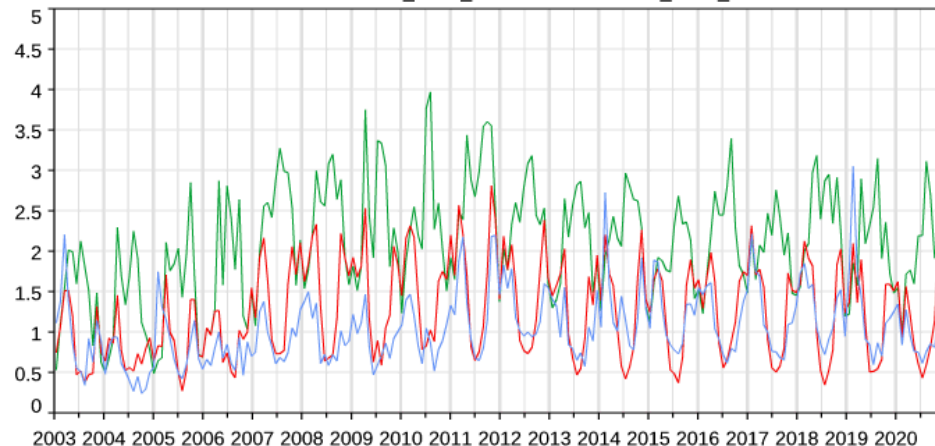
— Obs — eac5_scout_v0ebas — eac5_scout_v1ebas



NO₃_surf (ug/m³) Mean. Model versus EBAS.

25 sites in Europe background. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.

— Obs — eac5_scout_v0ebas — eac5_scout_v1ebas





Some results

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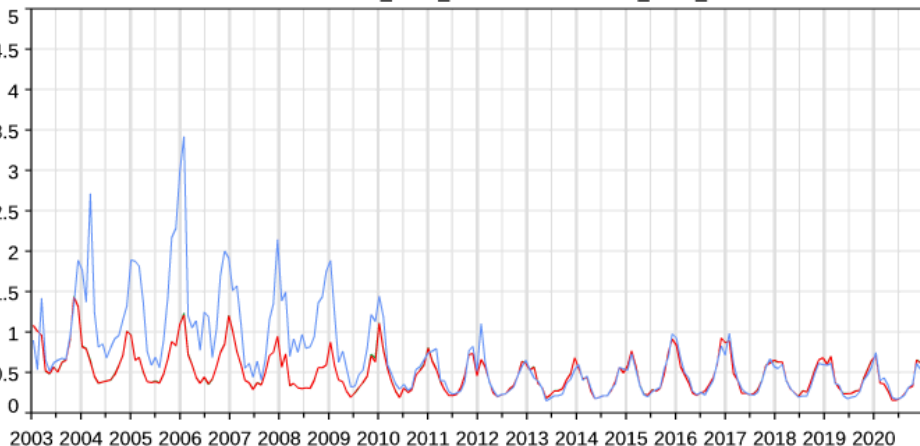
Surface concentration versus EBAS (Europe)

Experiment label	Comment
EAC5_scout_v0	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched off
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on

BC_surf (ug/m3) Mean. Model versus EBAS.

21 sites in Europe background. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.

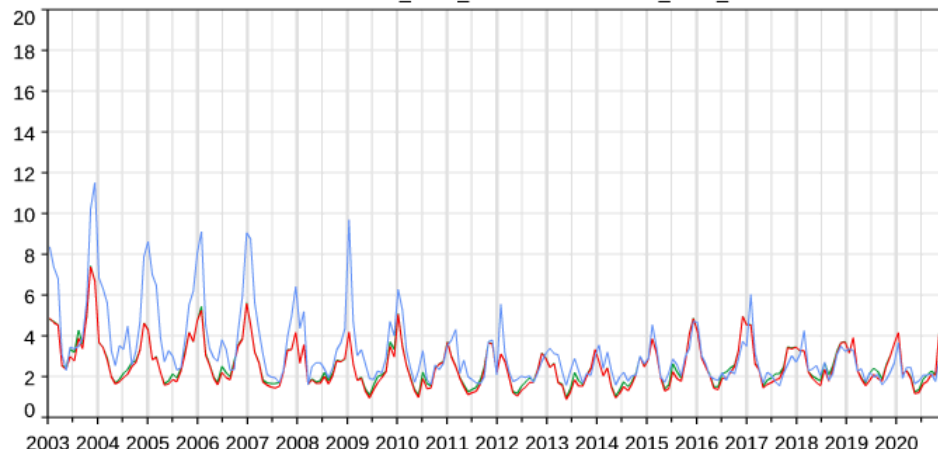
— Obs — eac5_scout_v0ebas — eac5_scout_v1ebas



OM_surf (ug/m3) Mean. Model versus EBAS.

21 sites in Europe background. 1 Jan 2003 - 26 Dec 2020. 00Z, T+3 to 24. Ver0D 12.6.12.

— Obs — eac5_scout_v0ebas — eac5_scout_v1ebas



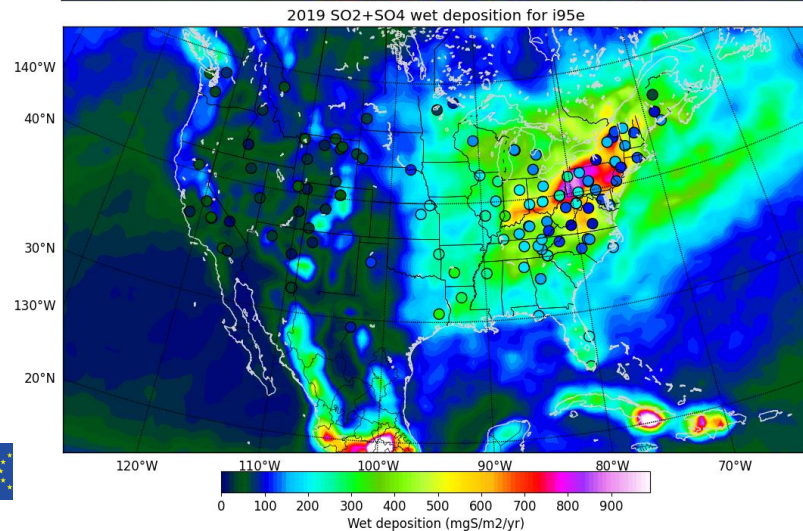
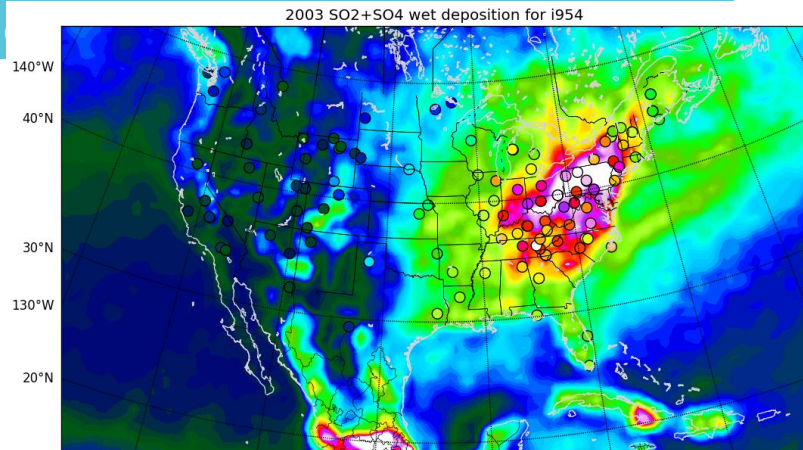
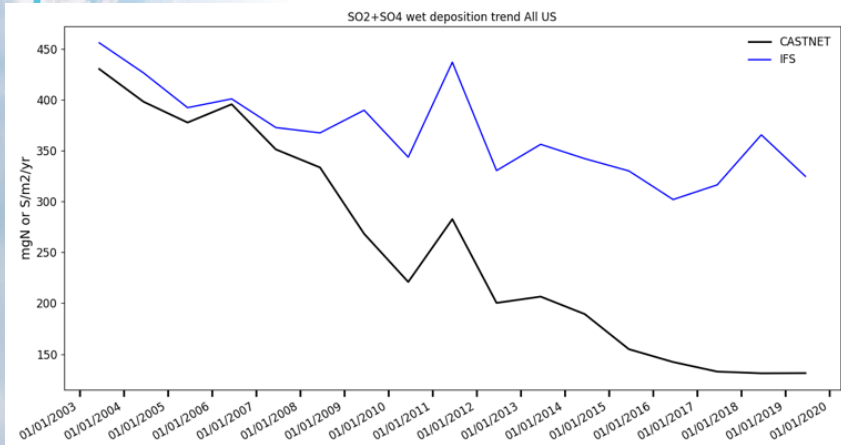


Wet deposition evaluation

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CASTNET wet deposition of SO₂+SO₄
Decreasing trend not well captured!

Experiment label	Comment
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on





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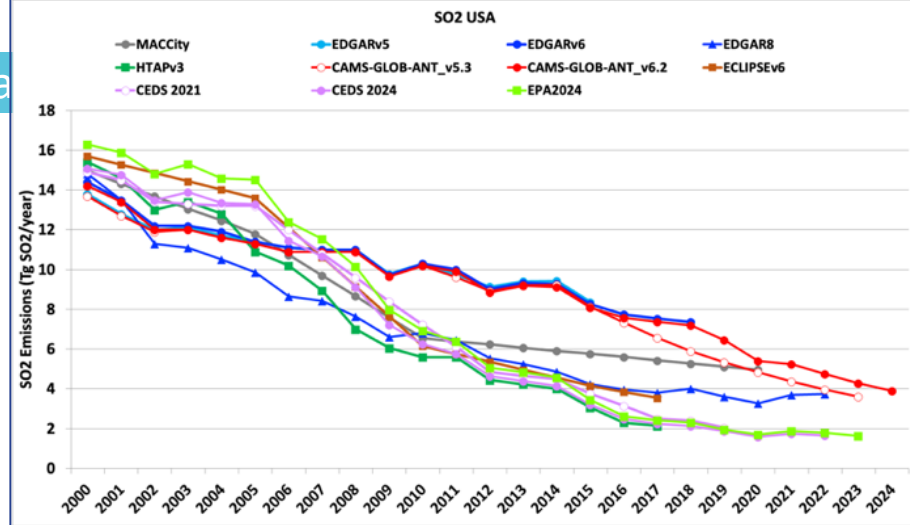
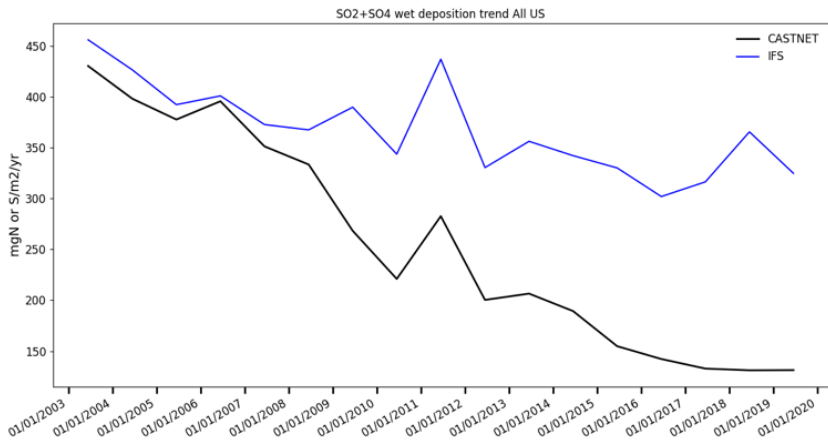
Wet deposition evaluation

CASTNET wet deposition of SO₂+SO₄

Decreasing trend not well captured!

=> Tests with scaled SO₂ emissions over US
to get closer to EPA2024 emissions

Experiment label	Comment
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on
EAC5_scout_v4	As EAC5_scout_v1 but with scaled anthropogenic emissions over US, China



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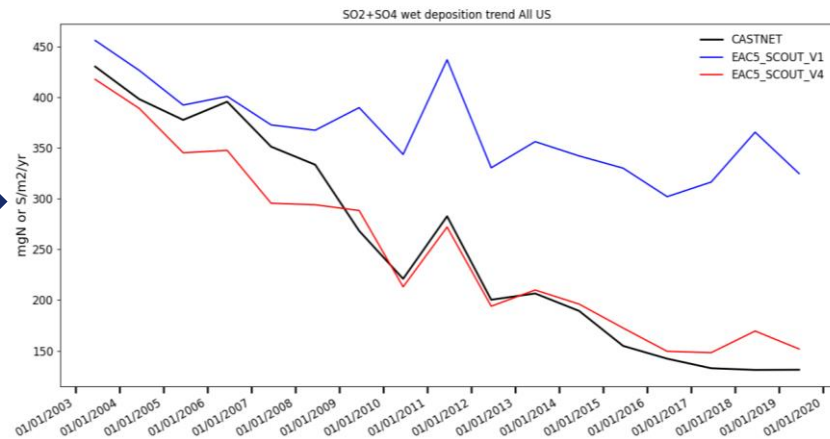
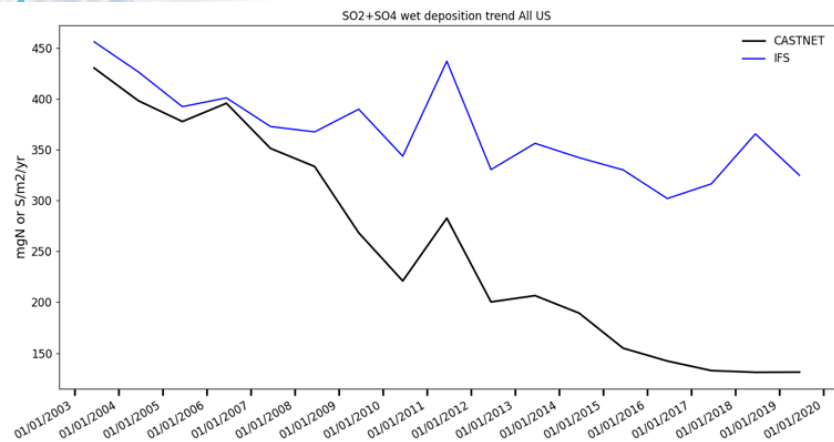
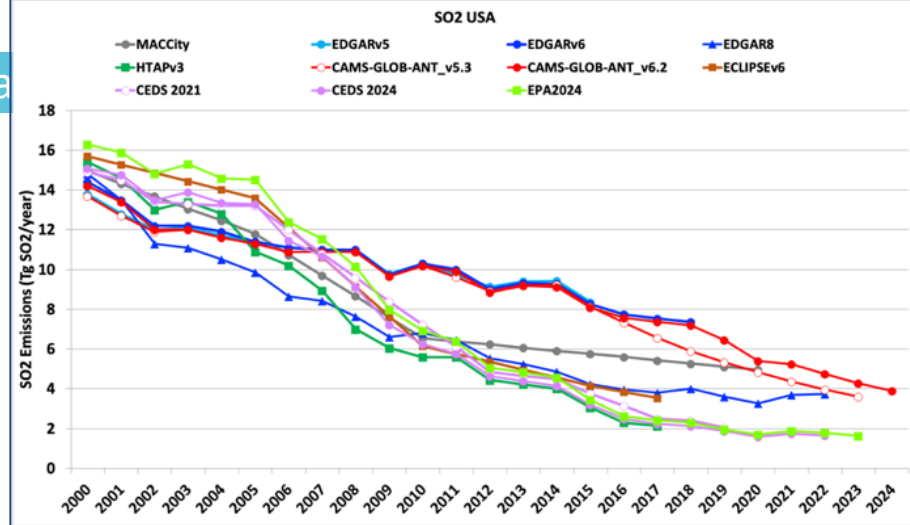
Wet deposition evaluation

CASTNET wet deposition of SO₂+SO₄

Decreasing trend not well captured!

=> Tests with scaled SO₂ emissions over US
to get closer to EPA2024 emissions

Experiment label	Comment
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on
EAC5_scout_v4	As EAC5_scout_v1 but with scaled SO ₂ /Nox anthropogenic emissions over US, China





Wet deposition evaluation over US

CASTNET wet deposition of SO₂+SO₄

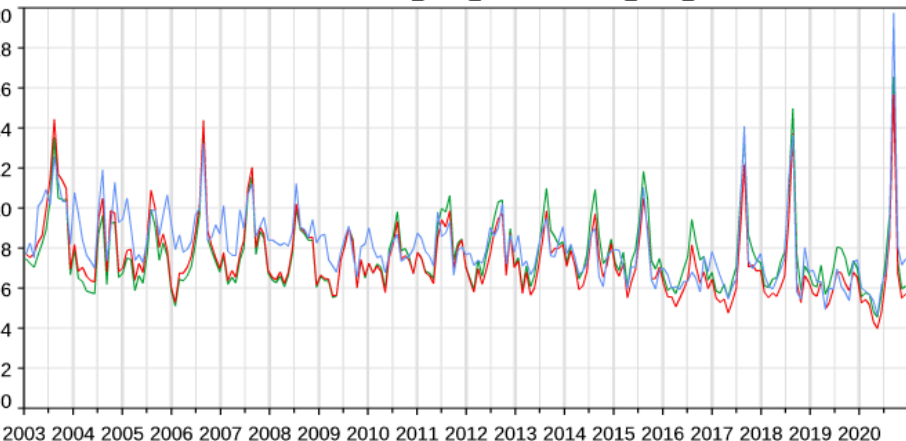
Decreasing trend not well captured!

- ⇒ Tests with scaled SO₂ emissions over US to get closer to EPA2024 emissions
- ⇒ Visible impact on simulated PM_{2.5}

Experiment label	Comment
EAC5_scout_v1	First scouting experiment based on pre-49r1 branch, EQSAM4Clim switched on
EAC5_scout_v4	As EAC5_scout_v1 but with scaled anthropogenic emissions over US, China

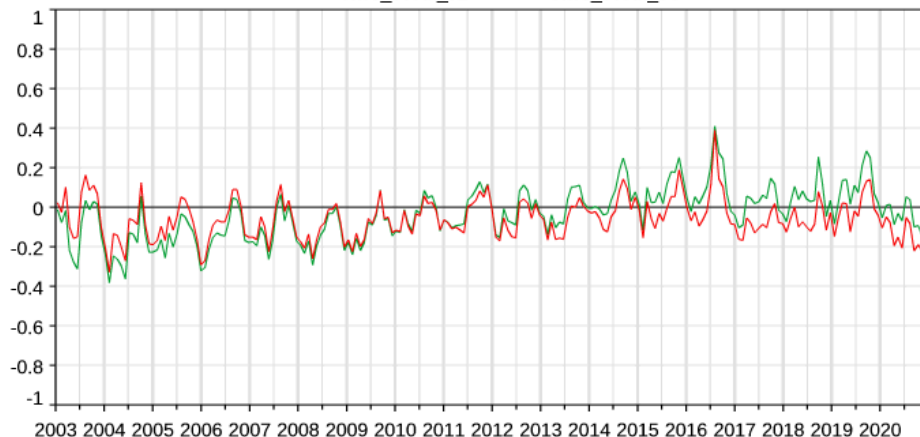
PM_{2.5} (ug/m³) Mean. Model versus AirNow.
207 sites in N-Am rural. 1 Jan 2003 - 26 Dec 2020. 00Z, T+6 to 24. Ver0D 12.6.17.

— Obs — eac5_scout_v1 — eac5_scout_v4



PM_{2.5} (ug/m³) Mod Norm Mean Bias. Model versus AirNow.
207 sites in N-Am rural. 1 Jan 2003 - 26 Dec 2020. 00Z, T+6 to 24. Ver0D 12.6.17.

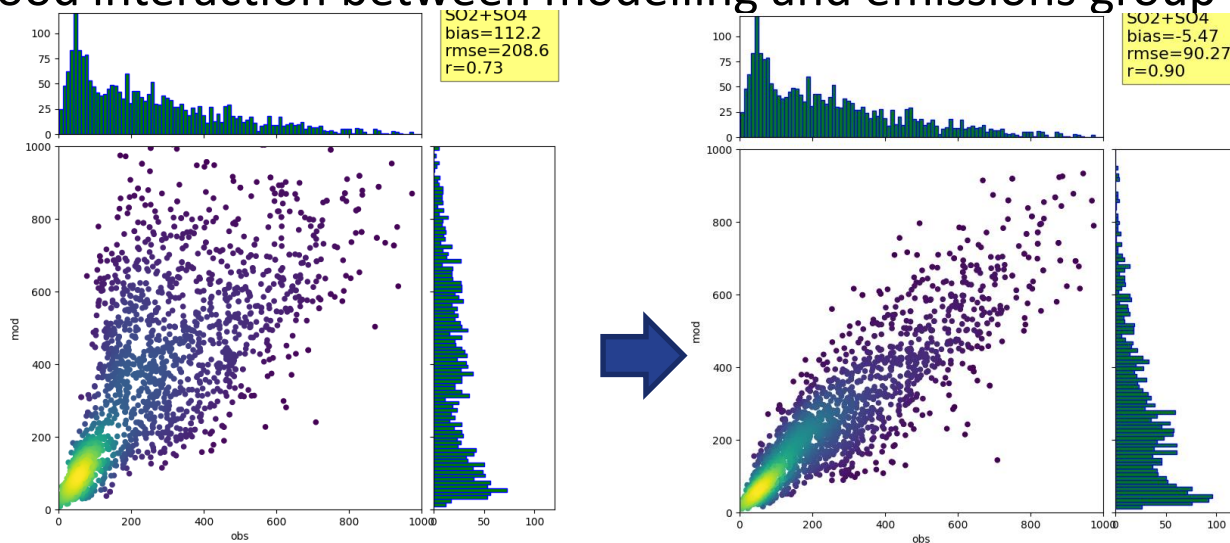
— eac5_scout_v1 — eac5_scout_v4





Conclusion

- We never spend too much time on emissions
- For species with short lifetime, and regions with dense observations, deposition can be used to evaluate emissions
- Good interaction between modelling and emissions group in CAMS



Simulated vs observed yearly SO₂+SO₄ wet deposition fluxes over all CASTNET stations, EAC5_scout_v1 (left) and EAC5_scout_v1 (right).