

AEOLUS Aerosol Assimilation in the DISC (A3D)

ATMOS 2021

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With the support of Melanie Ades, Zak Kipling, Tomas Kral, Gabor Radnoti, Roberto Ribas and many others

Objectives



Why do we want to assimilate lidar backscatter profile in COMPO-IFS?

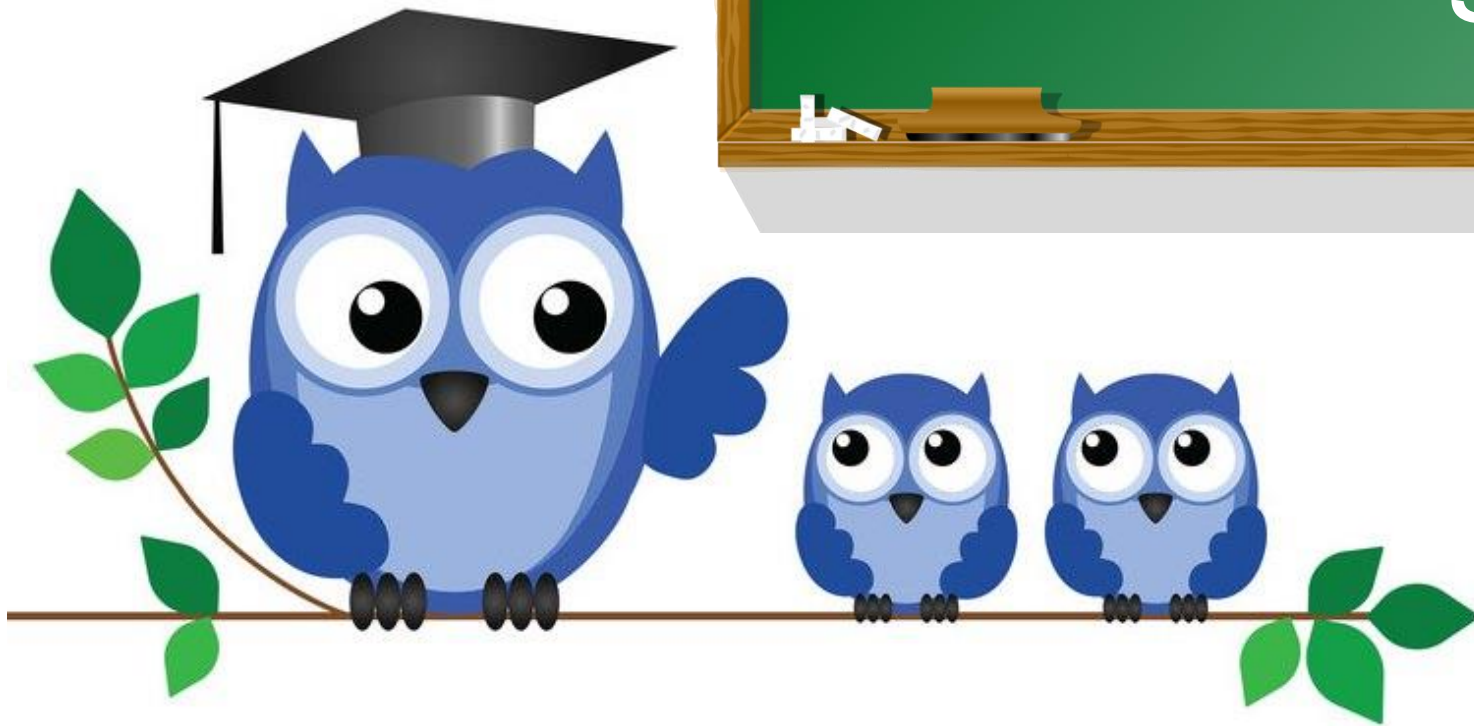
COMPO-IFS is doing a good job already having a strong model for aerosol and a beneficial assimilation of AOD coming from MODIS (AQUA and TERRA) and PMAp.

The problem is the AOD is an column integrated data, no vertical distribution information is available.

Attributing the plume to an altitude can have a detrimental effect.

The backscatter profile is providing a key information that can only have positive effect in the system assimilation.

First step: Monitoring



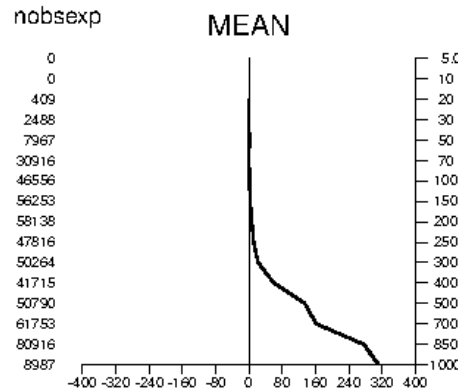
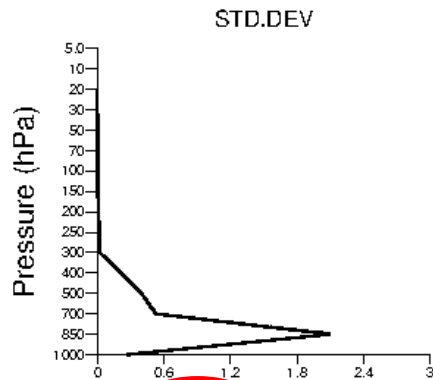
Importance to monitor the instrument

- The benefits to monitor an instrument are:
 - Observe any deviation of the instrument
 - Validate the quality of data
 - Notice any degradation
 - Recognise any artefacts introduced by the algorithm
 -

Monitoring of AEOLUS L2A for October 2019 and April 2020

2019100100-2019103112(12)
 TEST AODL [] Globe
 all AODL TEST

----- Analysis departure (o-a) (hhg)
 ——— Background departure (o-b) (hhg)

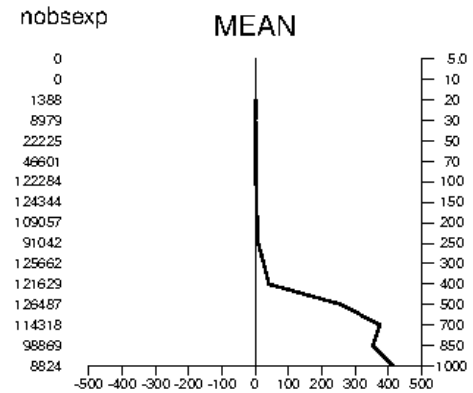
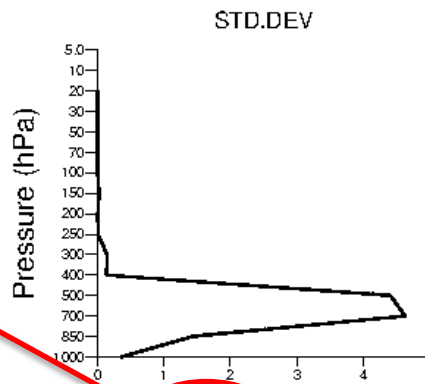


x 10000

The standard deviation is out of range

2020040100-2020043012(12)
 TEST AODL [] Globe
 all AODL TEST

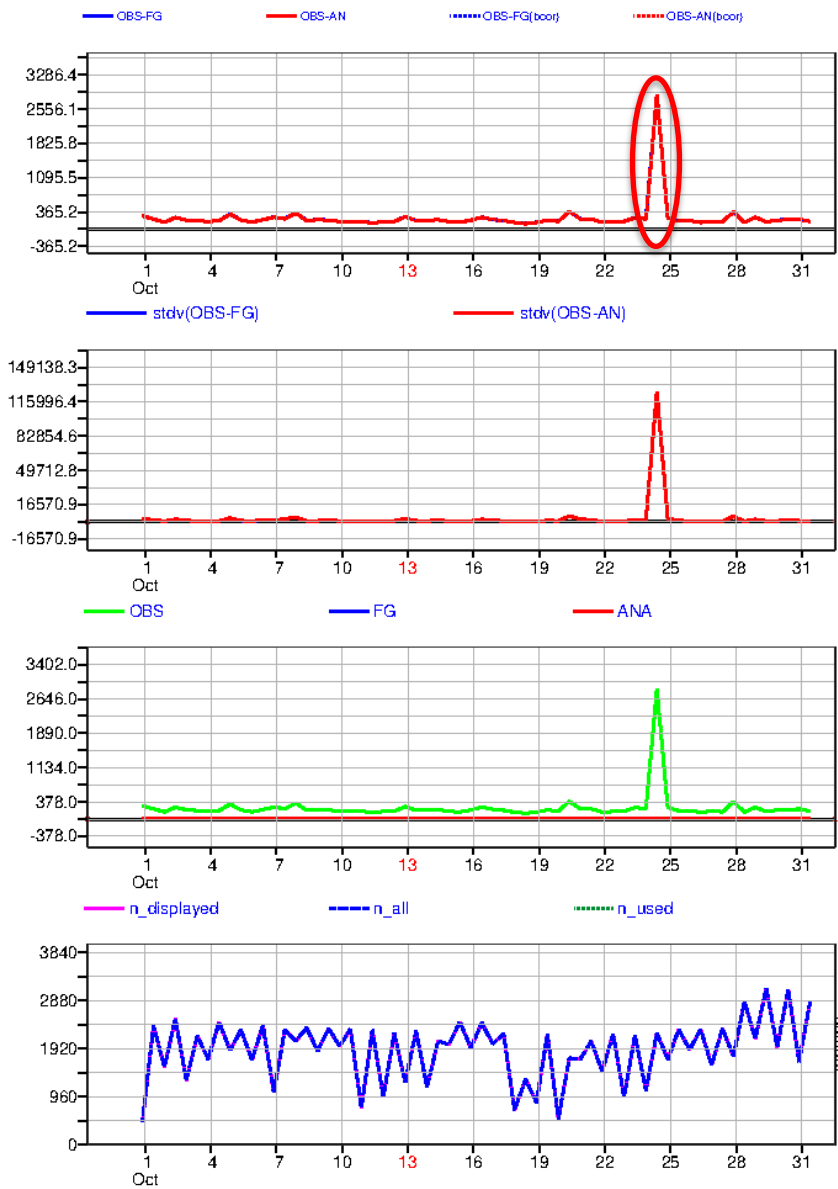
----- Analysis departure (o-a) (hh2c)
 ——— Background departure (o-b) (hh2c)



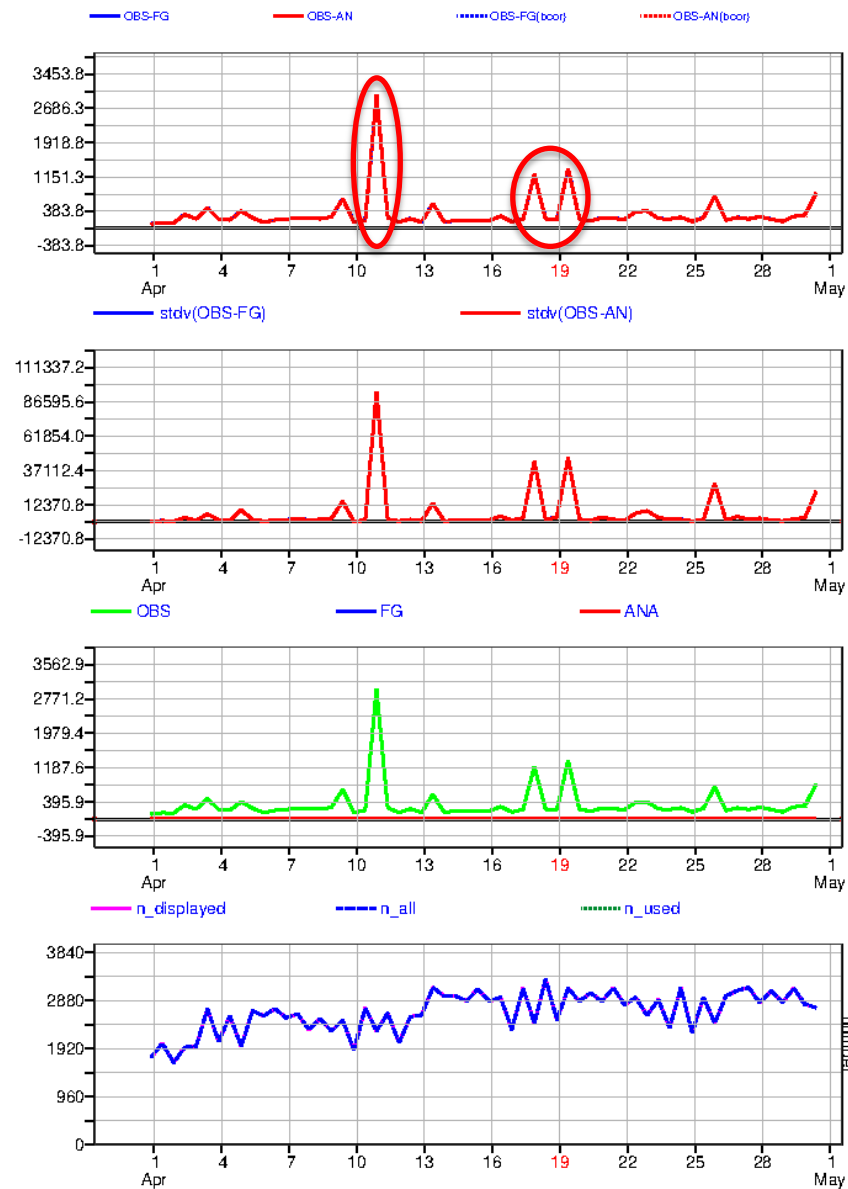
x 10000

When looking at the first result comparing the observations with the first guess departure, it is clear that some artefact are left in the observations. It can be observed in both periods.

AEOLUS LIDAR MONITORING
 LEVEL =700.00 - 1013.25 HPA, ALL DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HHGL



AEOLUS LIDAR MONITORING
 LEVEL =700.00 - 1013.25 HPA, ALL DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HH2C



Monitoring of AEOLUS L2A

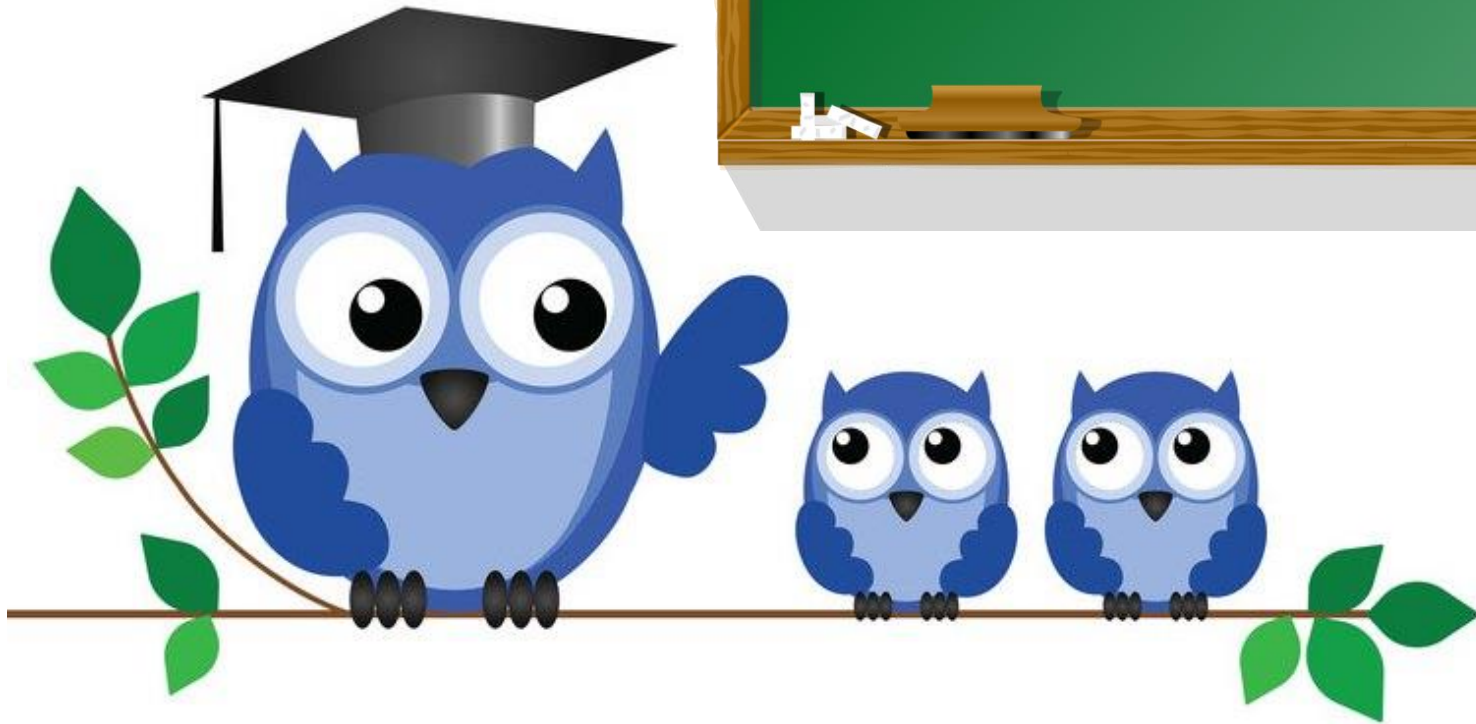


The monitoring shows:

- Some artefacts are present for some days for AEOLUS.
- No link can be done with the AEOLUS time line status

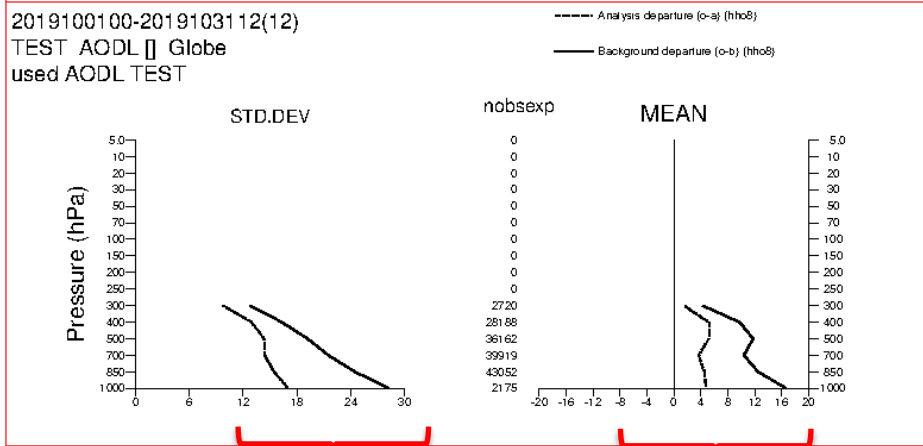
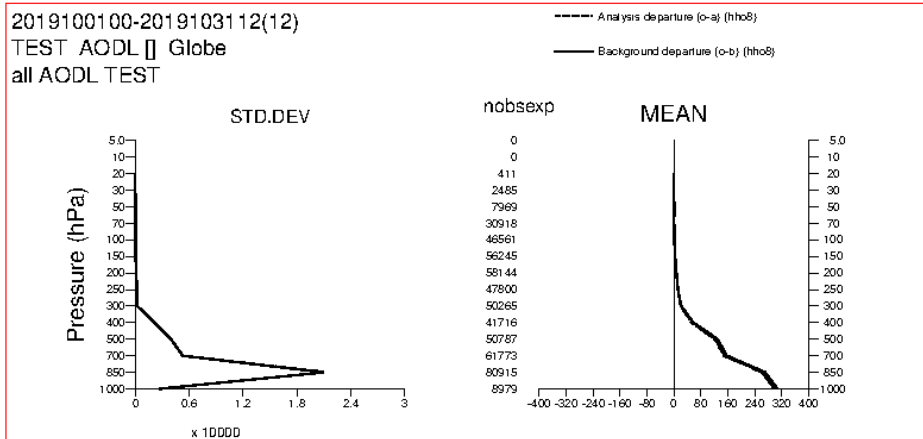
Will the assimilation be able to remove these artefacts?

Second step: Assimilation

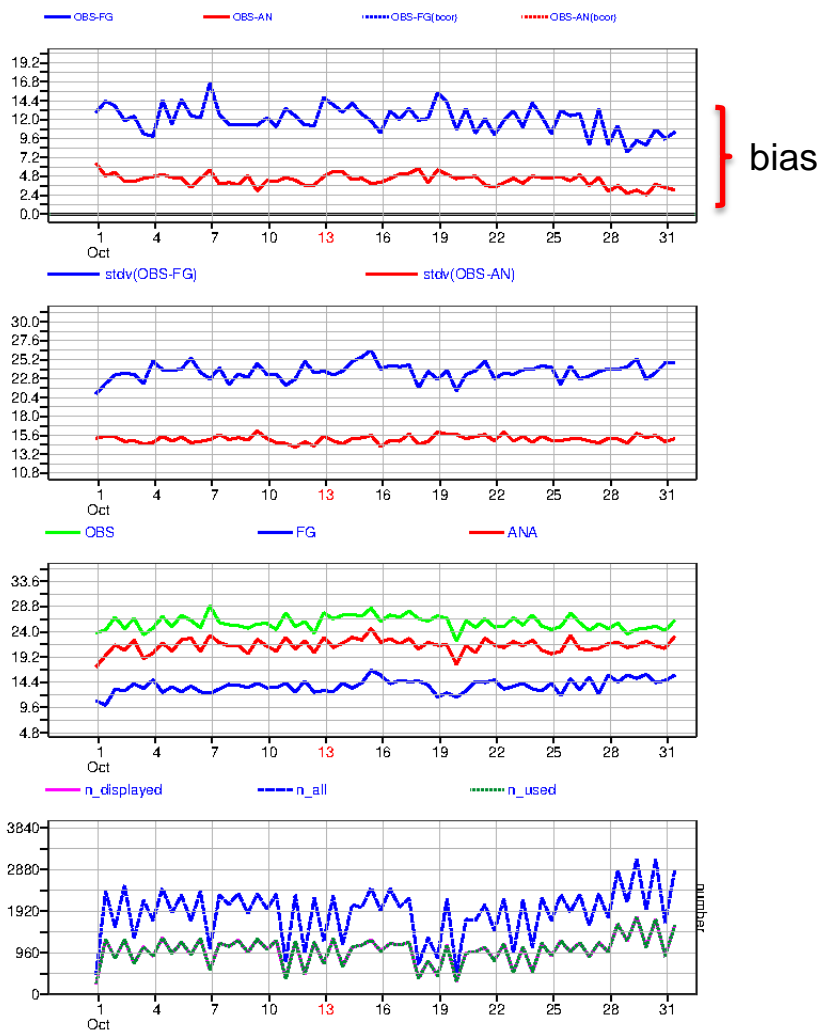


Assimilation of AEOLUS L2A for October 2019

AODL FROM OZONE
 LEVEL = 700.00 - 1013.25 HPA, USED DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HH08

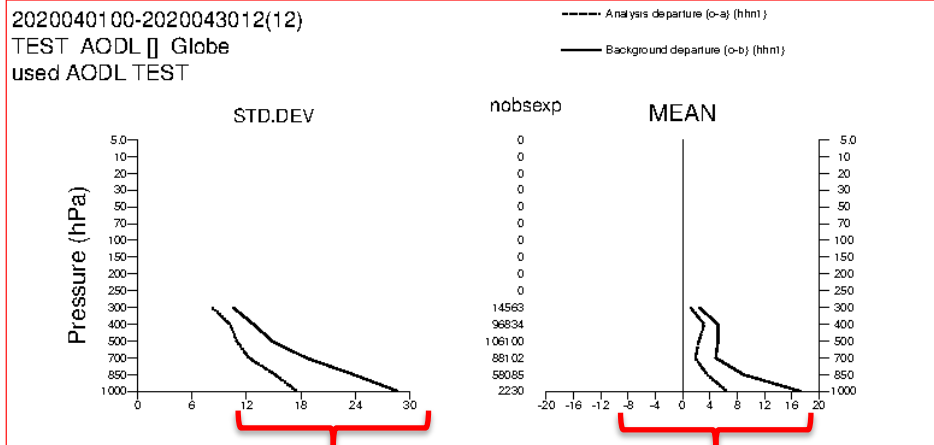
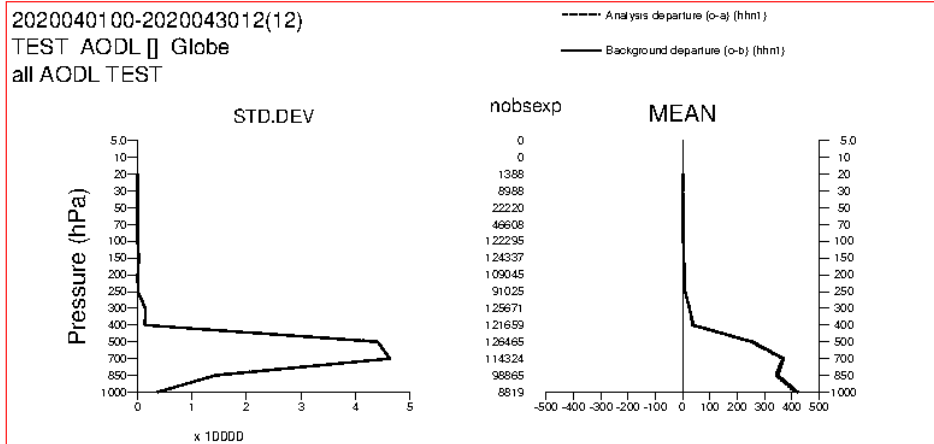


Large reduction of the range of data

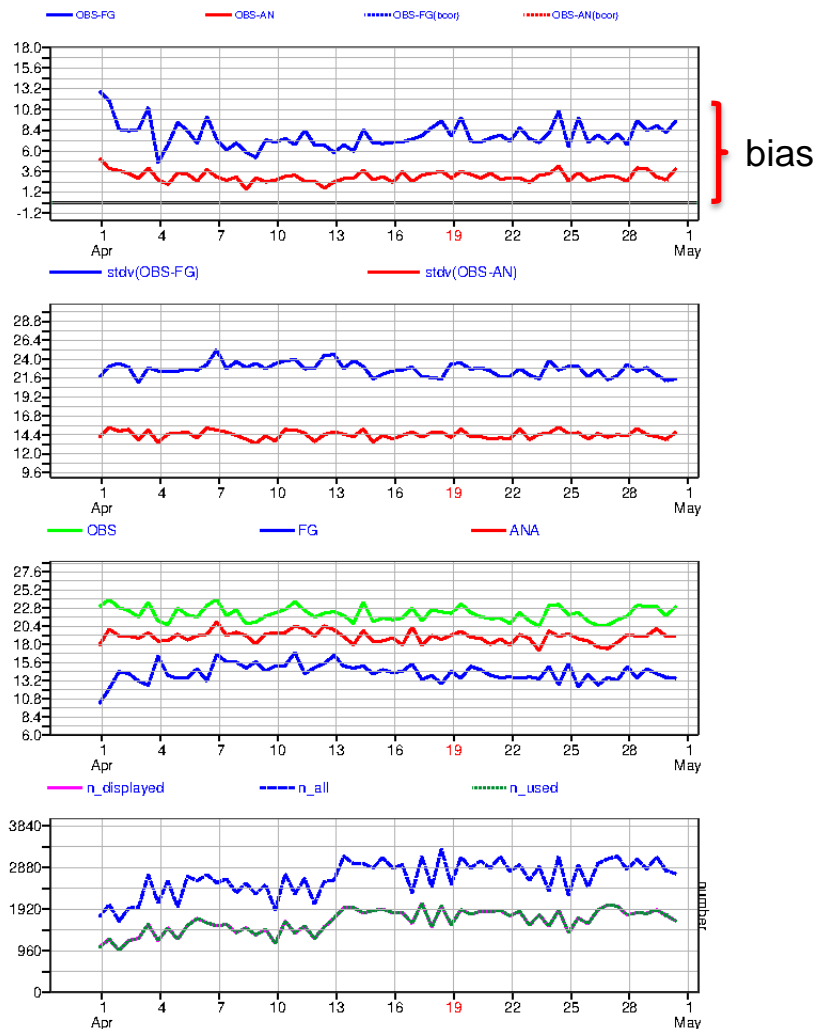


Assimilation of AEOLUS L2A for April 2020

AEOLUS LIDAR ASSIMILATION
 LEVEL = 700.00 - 1013.25 HPA, USED DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HHN1



Large reduction of the range of data



Assimilation results

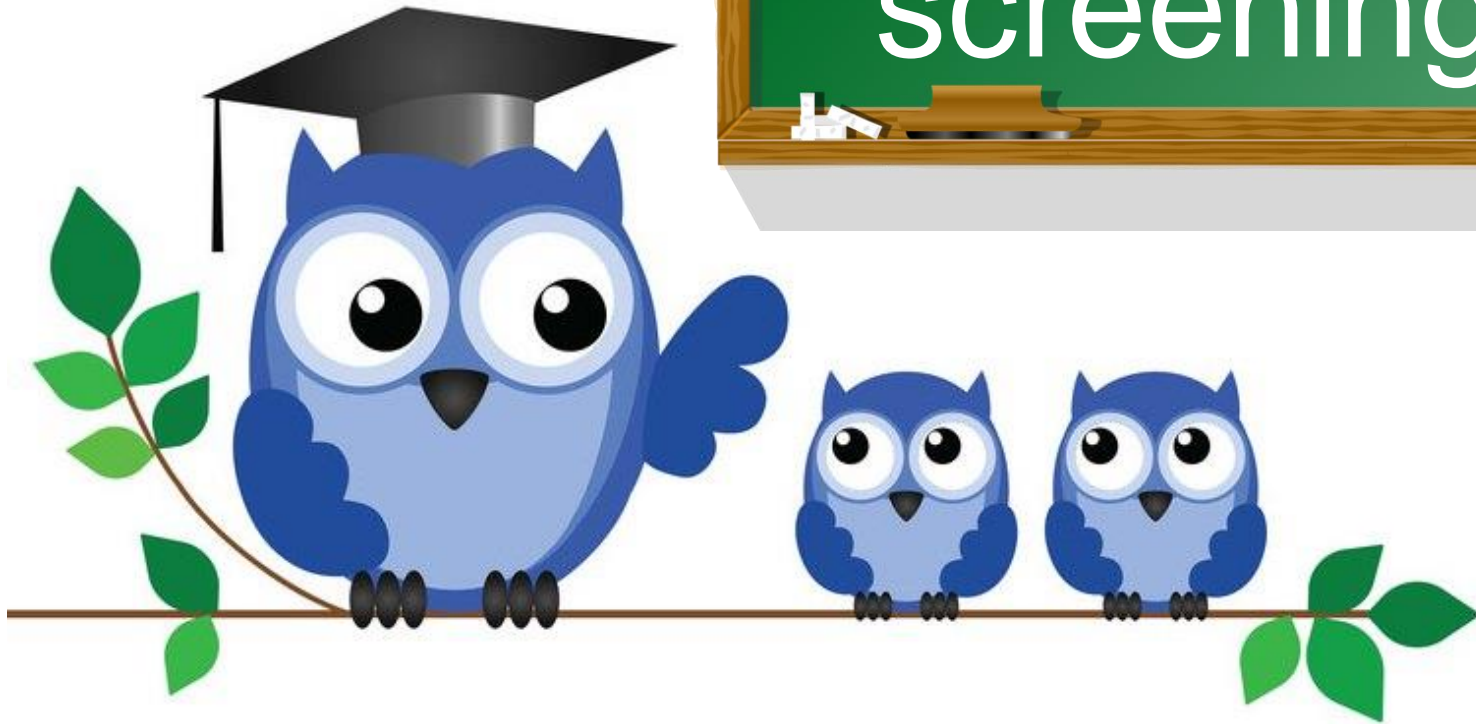


The assimilation shows:

- Elimination of major artefact for AEOLUS L2A
- Decrease of 50% of data for AEOLUS L2A
- Decrease of the bias between the observation and the model but still a bias left after assimilation.
- Positive impact of the assimilation as it is bringing the model closer to the observation

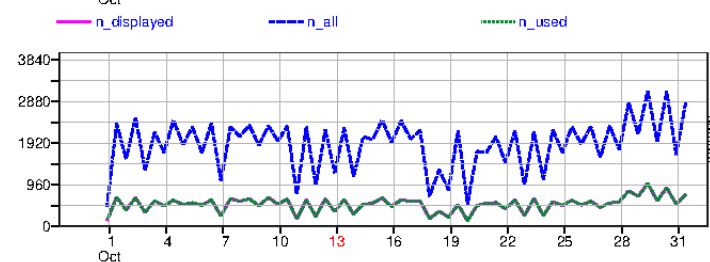
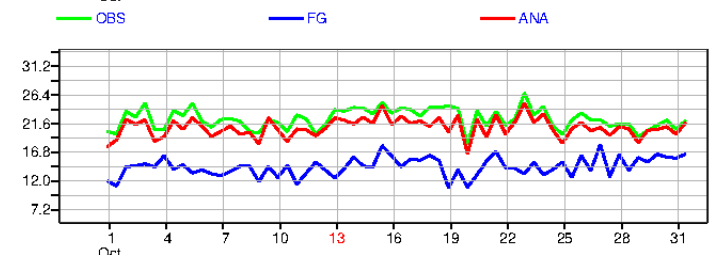
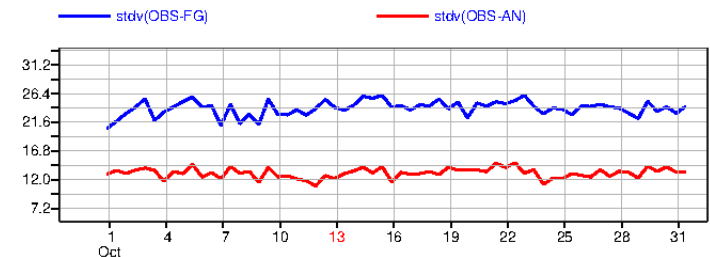
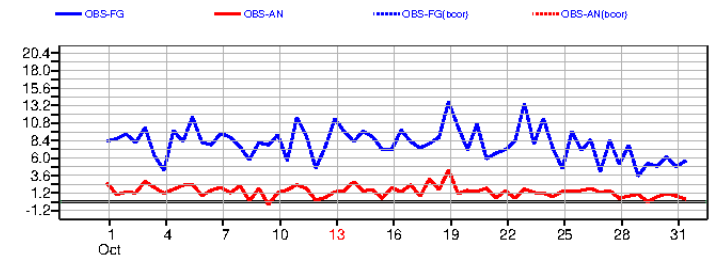
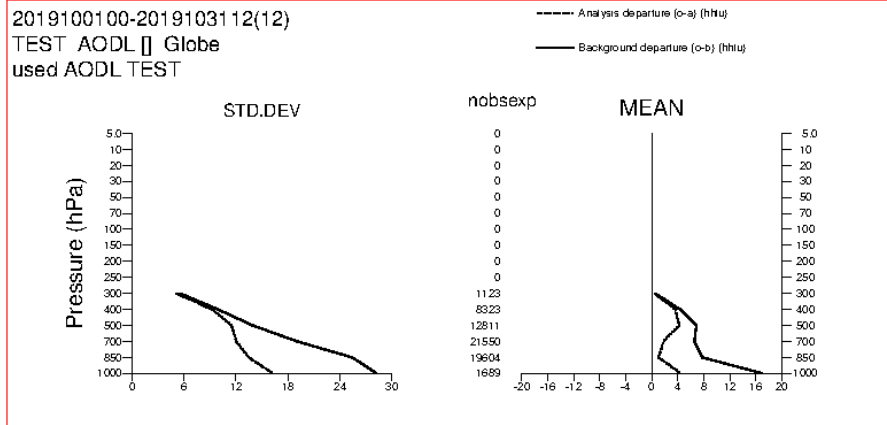
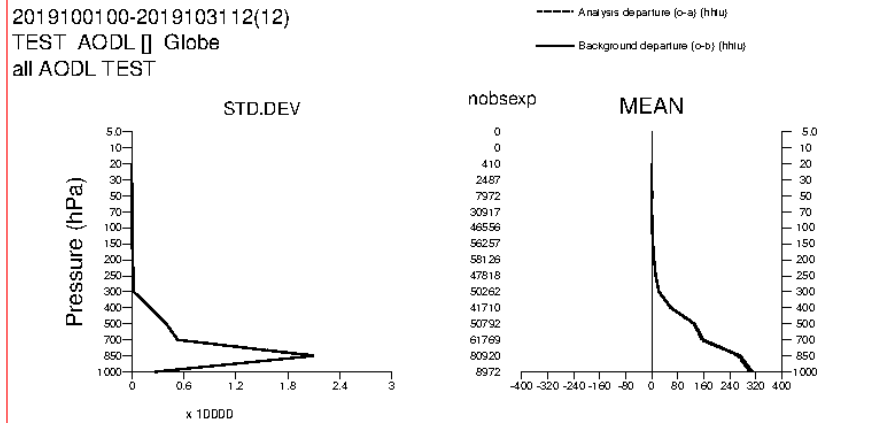
Will a cloud screening based on the model be able to remove the residual bias for AEOLUS L2A?

Third step: Cloud screening



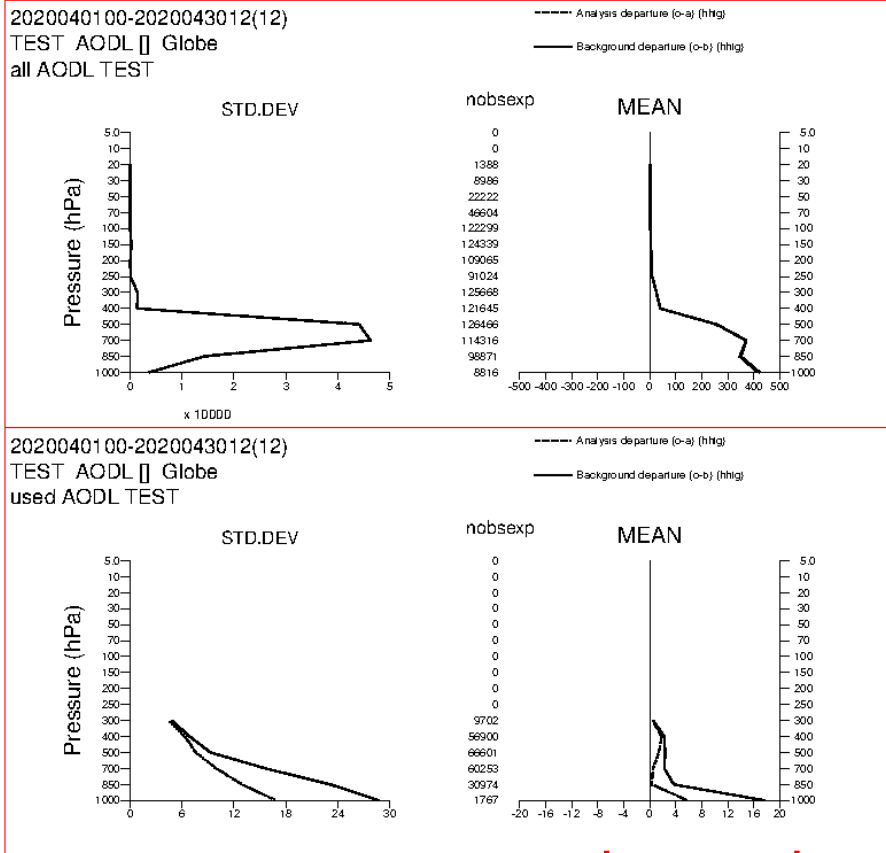
Assimilation with cloud screening for October 2019

AEOLUS LIDAR ASSIMILATION WITH CLOUD SCREENING
 LEVEL = 700.00 - 1013.25 HPA, USED DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HHLU

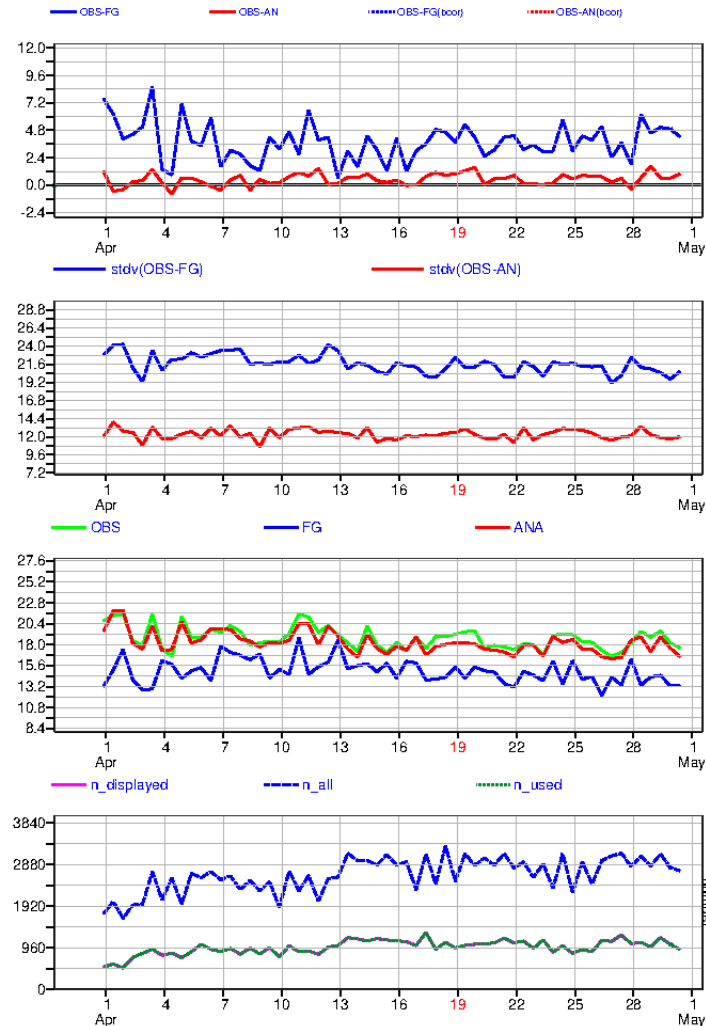


Assimilation with cloud screening for April 2020

AEOLUS LIDAR ASSIMILATION WITH CLOUD SCREENING
 LEVEL = 700.00 - 1013.25 HPA, USED DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 180.0, lon_e= 180.0, lat_s= -90.0, lat_n= 90.0 (over All_surfaces)
 EXP = HHLG



The assimilation is reaching the no bias



Bias reduction

Assimilation with cloud screening results



The cloud screening shows:

- Elimination of the residual bias
- Decrease of 75% of data
- Positive impact of the assimilation as it is bringing the model even closer to the observation

Will the comparison with independent data be improved by the backscatter profile assimilation?

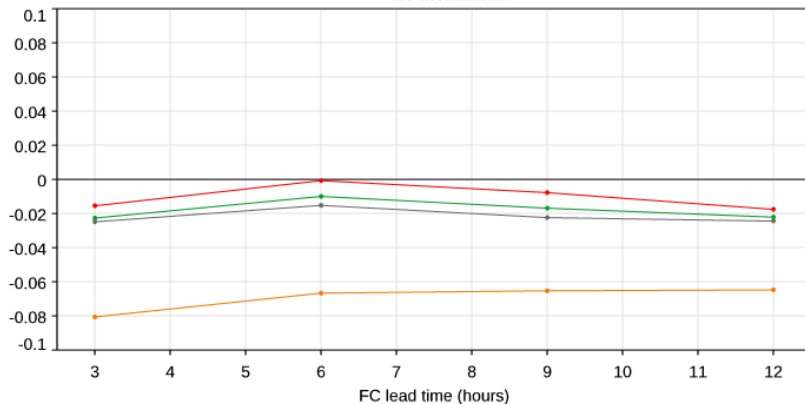
Forth step: Comparison with AERONET



October 2019 AEOLUS

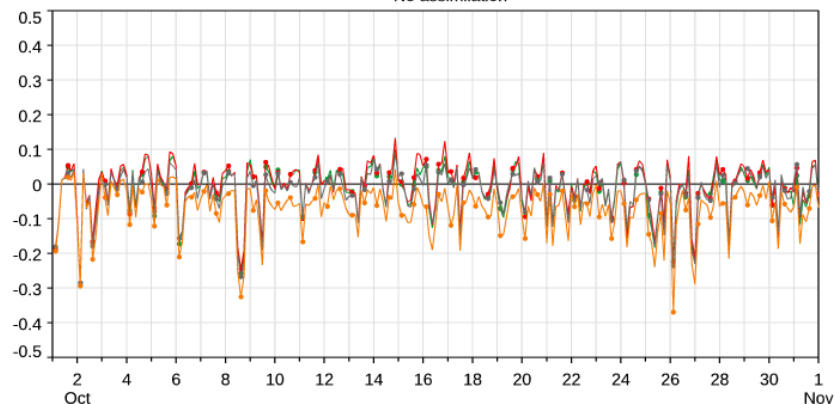
FC-OBS bias. Model against L1.5 Aeronet AOT at 500nm.
337 Voronoi-weighted sites globally ($r_{max}=1276km$).
1-31 Oct 2019. FC start hrs=00,12Z.

— AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD
— No assimilation



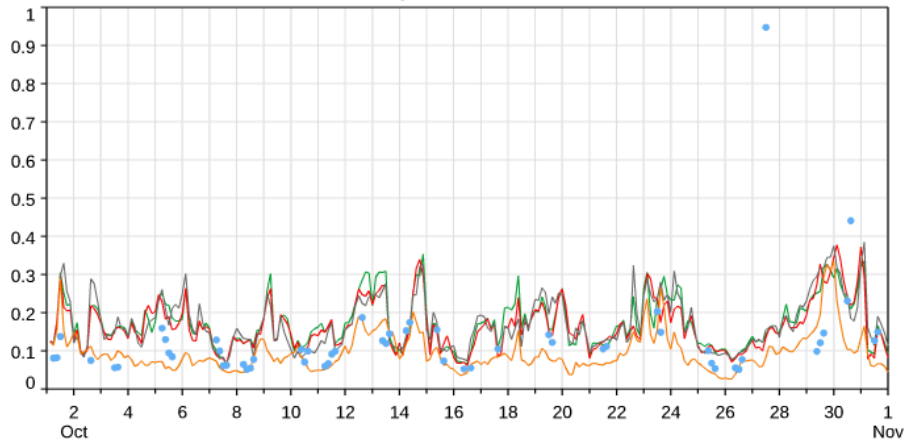
FC-OBS bias. Model against L1.5 Aeronet AOT at 500nm.
337 Voronoi-weighted sites globally ($r_{max}=1276km$).
1-31 Oct 2019. FC start hrs=00,12Z. T+3 to T+12.

— AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD
— No assimilation



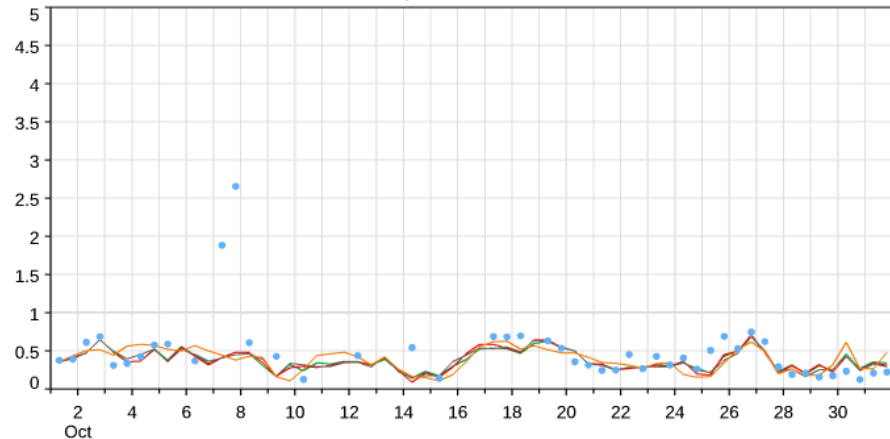
Comparison of hllu, hho8, hhgl & hhgk and L1.5 Aeronet AOT at 500nm over
Toulouse_MF (43.57°N, 1.37°E). Model: 00 & 12UT, 1-31 Oct 2019, T+3 to T+12.

● L1.5 Aeronet — AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD — No assimilation



Comparison of hllu, hho8, hhgl & hhgk and L1.5 Aeronet AOT at 500nm over
Dakar (14.39°N, 16.96°W). Model: 00 & 12UT, 1-31 Oct 2019, T+3 to T+12. 12hr means.

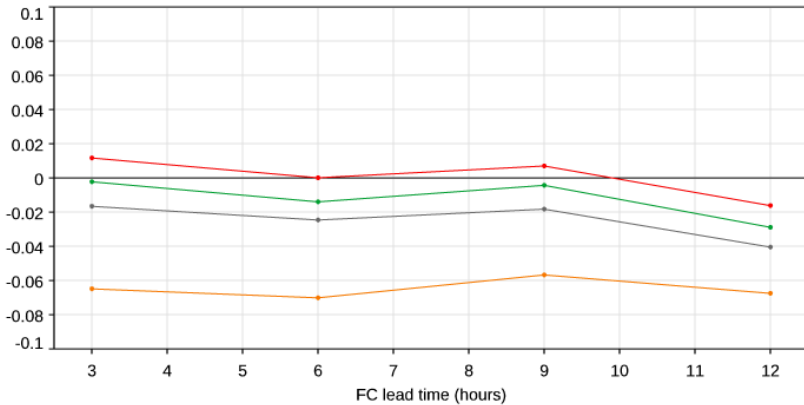
● L1.5 Aeronet — AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD — No assimilation



April 2020 AEOLUS

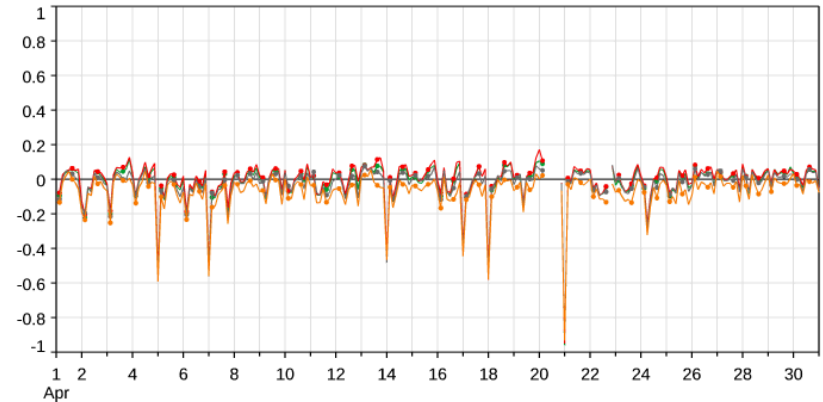
FC-OBS bias. Model against L1.5 Aeronet AOT at 500nm.
321 Voronoi-weighted sites globally ($r_{max}=1276km$).
1-30 Apr 2020. FC start hrs=00,12Z.

— AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD
— No assimilation



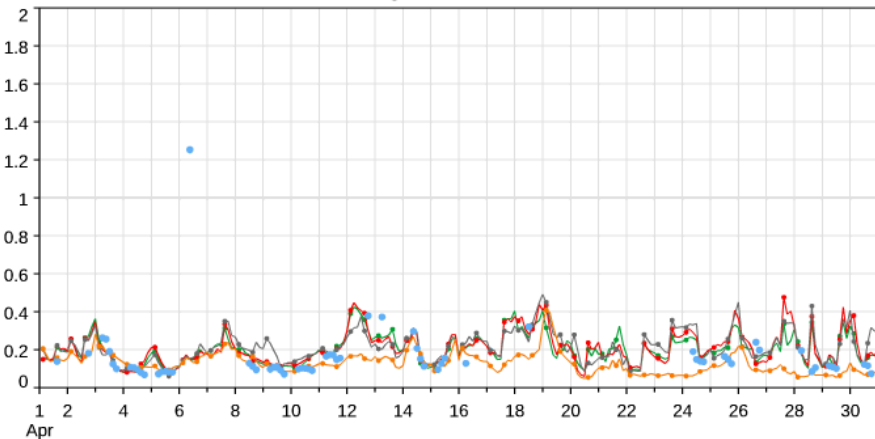
FC-OBS bias. Model against L1.5 Aeronet AOT at 500nm.
321 Voronoi-weighted sites globally ($r_{max}=1276km$).
1-30 Apr 2020. FC start hrs=00,12Z. T+3 to 12.

— AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD
— No assimilation



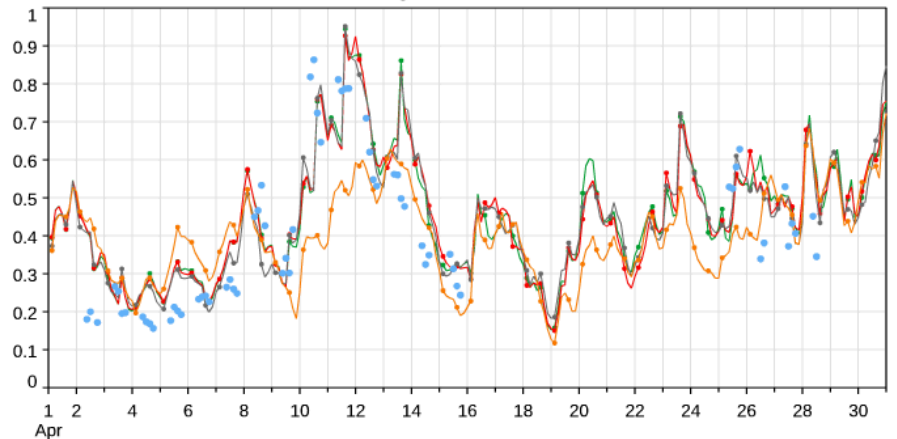
Comparison of hhlgl, hhn1, hh2c & hh2d and L1.5 Aeronet AOT at 500nm over
Toulouse_MF (43.57°N, 1.37°E). Model: 00 & 12UT, 1-30 Apr 2020, T+3 to T+12.

● L1.5 Aeronet — AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD — No assimilation



Comparison of hhlgl, hhn1, hh2c & hh2d and L1.5 Aeronet AOT at 500nm over
Dakar_Belair (14.70°N, 17.43°W). Model: 00 & 12UT, 1-30 Apr 2020, T+3 to T+12.

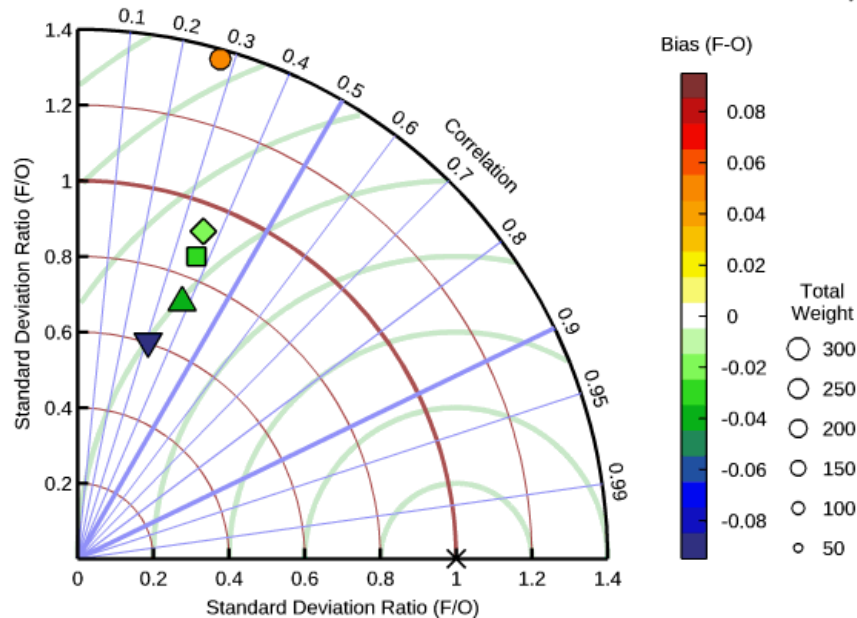
● L1.5 Aeronet — AEOLUS with cld screening + AOD — AEOLUS + AOD — AOD — No assimilation



Taylor diagrams AEOLUS

Model 12hr mean against L1.5 Aeronet AOT at 500nm.
 Used 321 sites globally. Voronoi-weighted with $r_{\max}=1276\text{km}$.
 1-30 Apr 2020. 00/12Z FCs from T+3 to T+12.

○ AEOLUS with cld screening □ AEOLUS with cld screening + AOD ◇ AEOLUS + AOD △ AOD ▽ No assimilation



The best results are given by the assimilation of AOD and AEOLUS. The assimilation of AEOLUS only shows a positive bias

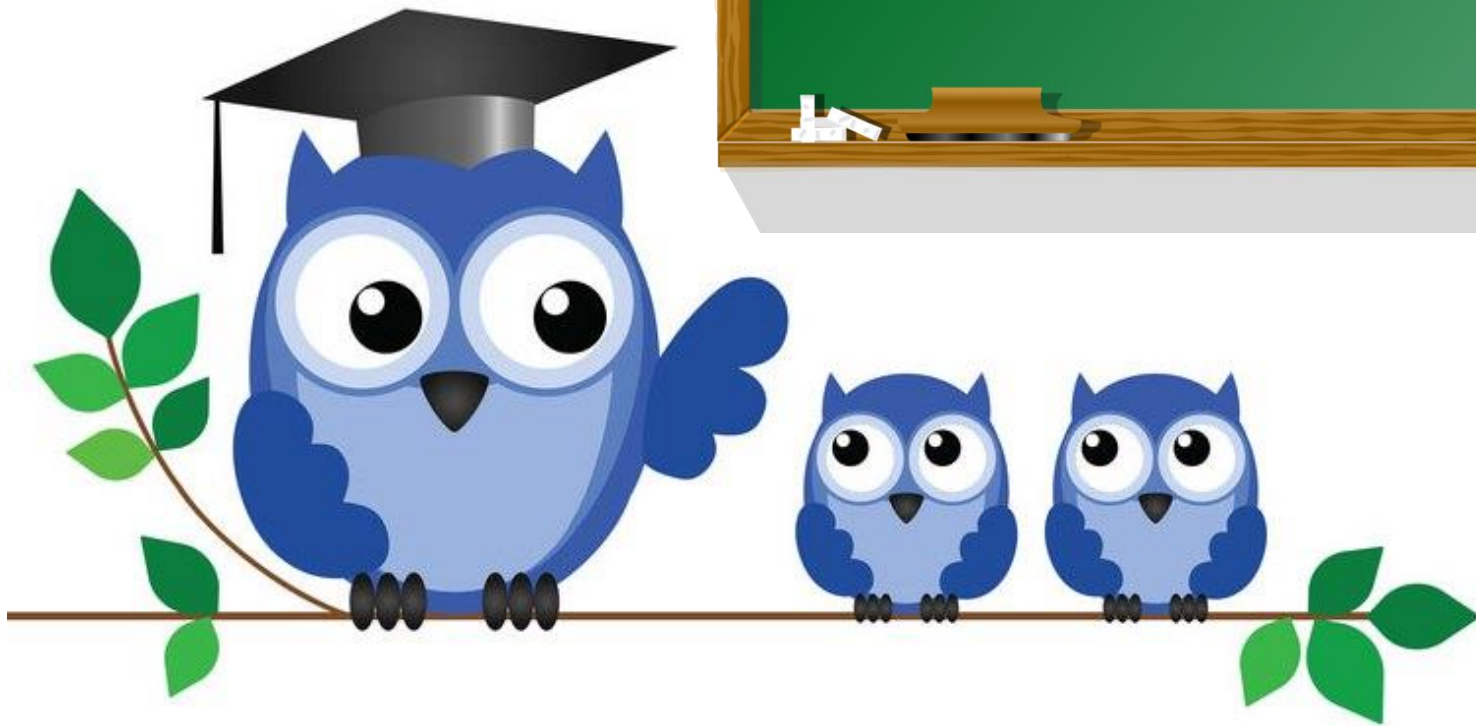
Assimilation with cloud screening results



The comparison with AERONET shows that the assimilation of AEOLUS on top of the AOD is improving the AOD estimate by the model.

The improvement done by the cloud screening on the observation assimilation is not perceptible here.

Conclusion



Conclusion



During the first part of the project, Aeolus L2A data have been used to demonstrate the positive impact that the assimilation of aerosol backscatter can have on COMPOIFS.

The impact and necessity of monitoring has also been demonstrated.

A cloud screening based on the model using internal or AUX files can improve the quality of data.

AEOLUS was not dedicated to aerosol but the scientific teams have managed to extract a product of good quality from the data.