



CAMAERA

ASSIMILATION OF LIDAR/CEILOMETER DATA

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and the ECMWF CAMS team



PROGRAMME OF
THE EUROPEAN UNION



IMPLEMENTED BY



1





MONTH 1-18

OBJECTIVES

- Assimilation of E-profile lidar/ceilometer into IFS
- Evaluation of IFS with lidar/ceilometer assimilation only

TOPICS

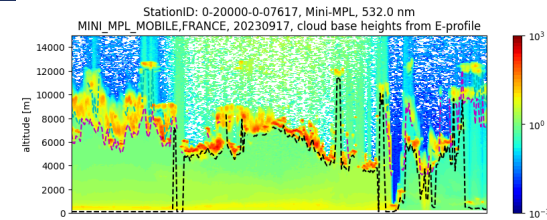
- How to treat cloud signals?
- How to represent dust asphericity?
- Consistency of vertically resolved information with AOD



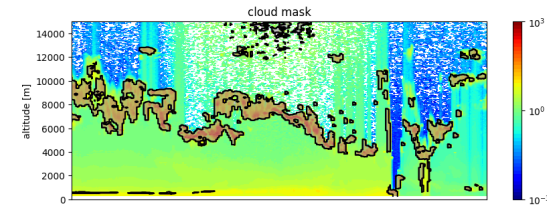


MASKING UNWANTED DATA (METEO-FRANCE)

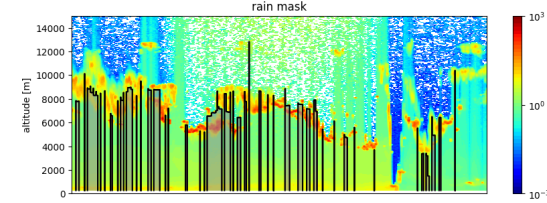
Cloud base heights (E-profile)



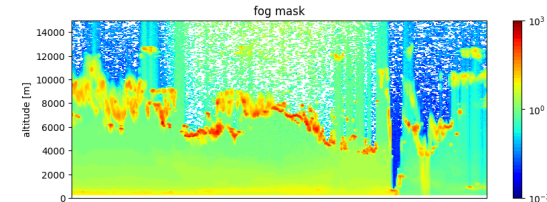
Cloud mask



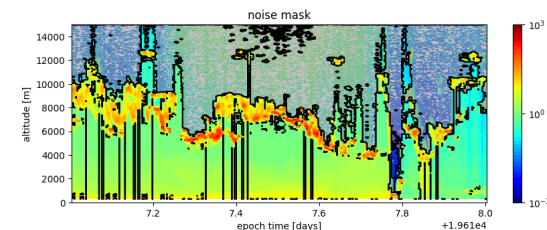
Precipitation mask



Fog mask



Noise mask



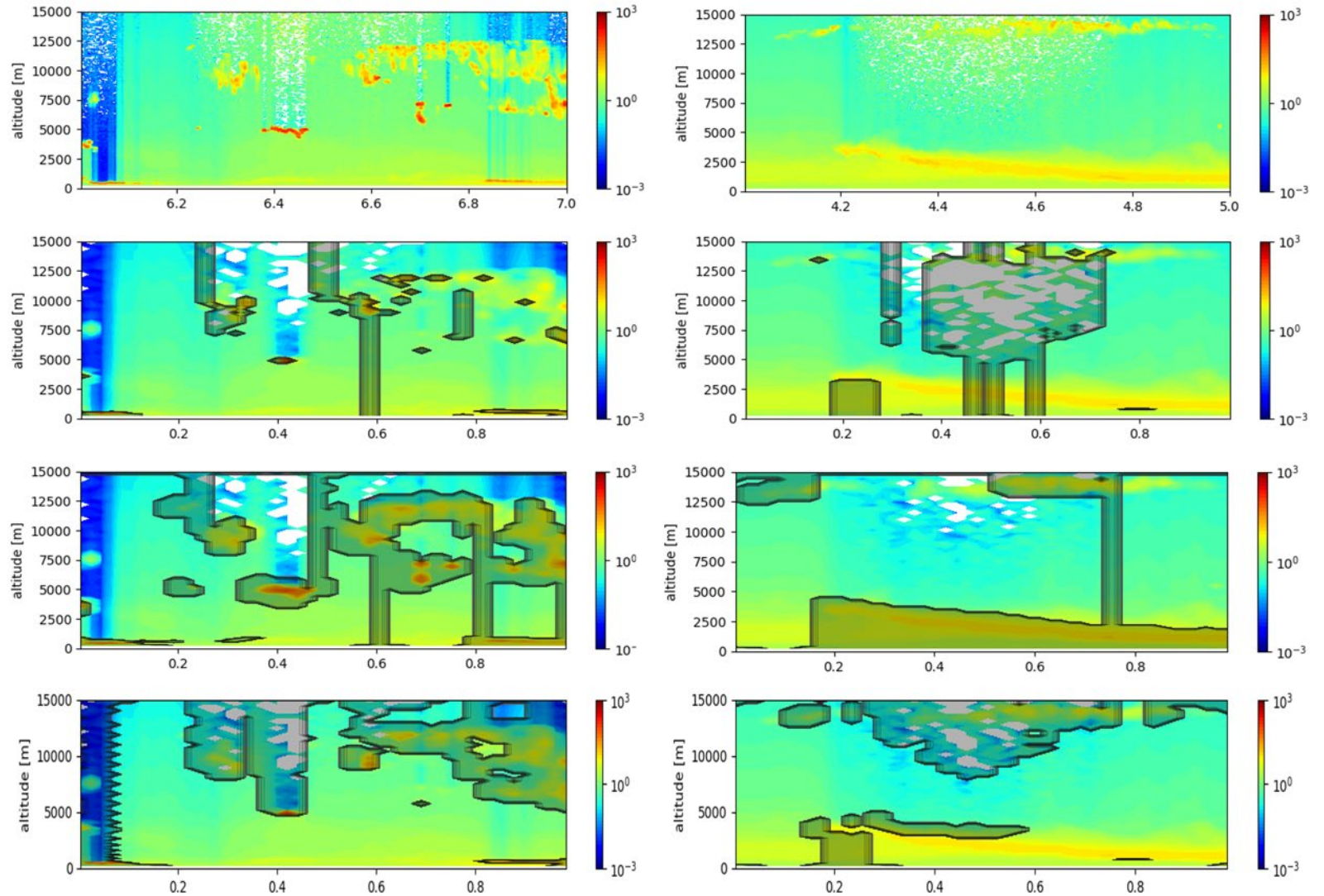


RESOLUTION REDUCTION BY AVERAGING

(avg) * (noise) * (fog) * (prec) * (cloud)

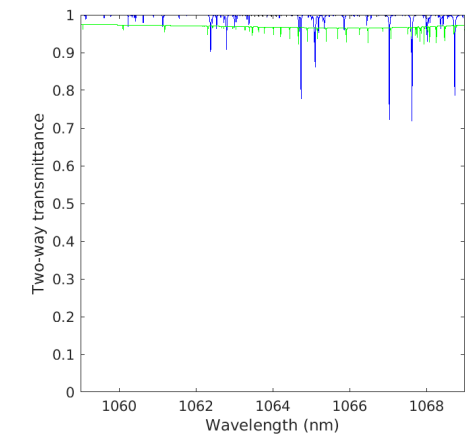
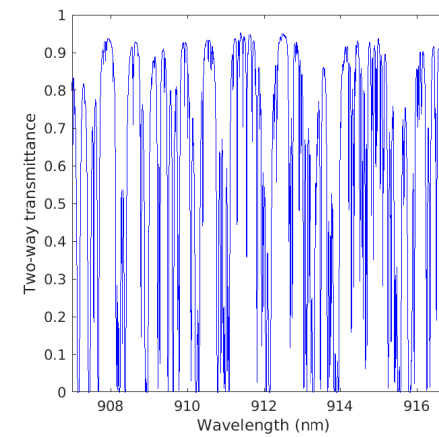
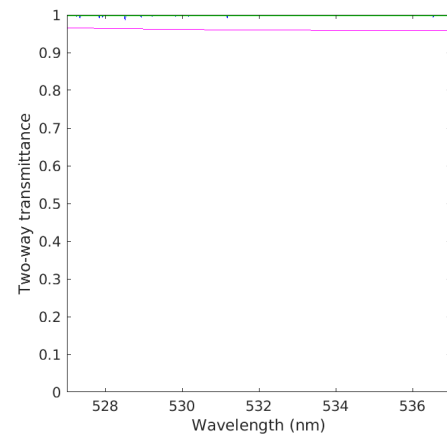
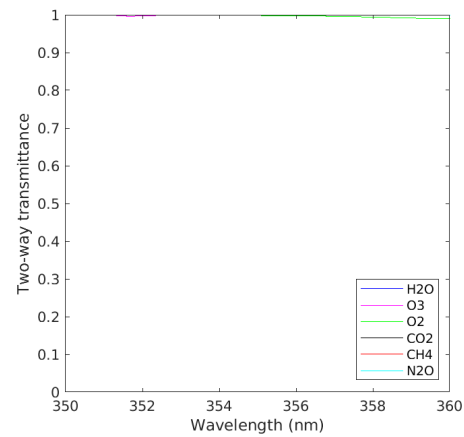
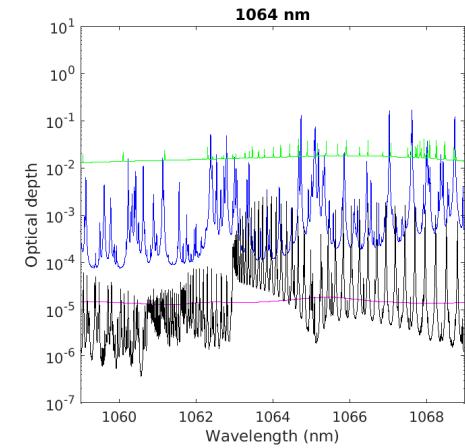
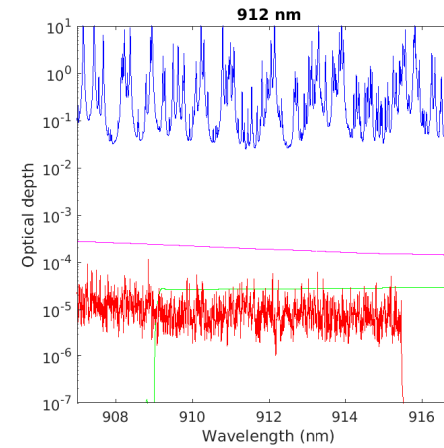
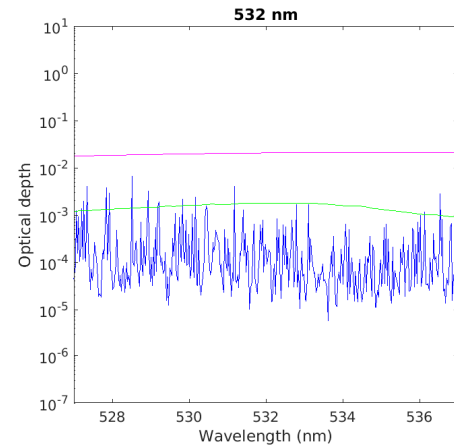
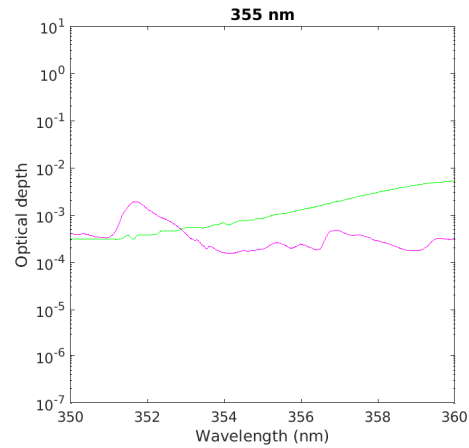
(noise) * (fog) * (prec) * (cloud) * (avg)

(noise) * (avg) * (fog) * (prec) * (cloud)





OBSERVATION OPERATOR AT 910 NM





OBSERVATION OPERATOR AT 910 NM

Main absorber: water vapour

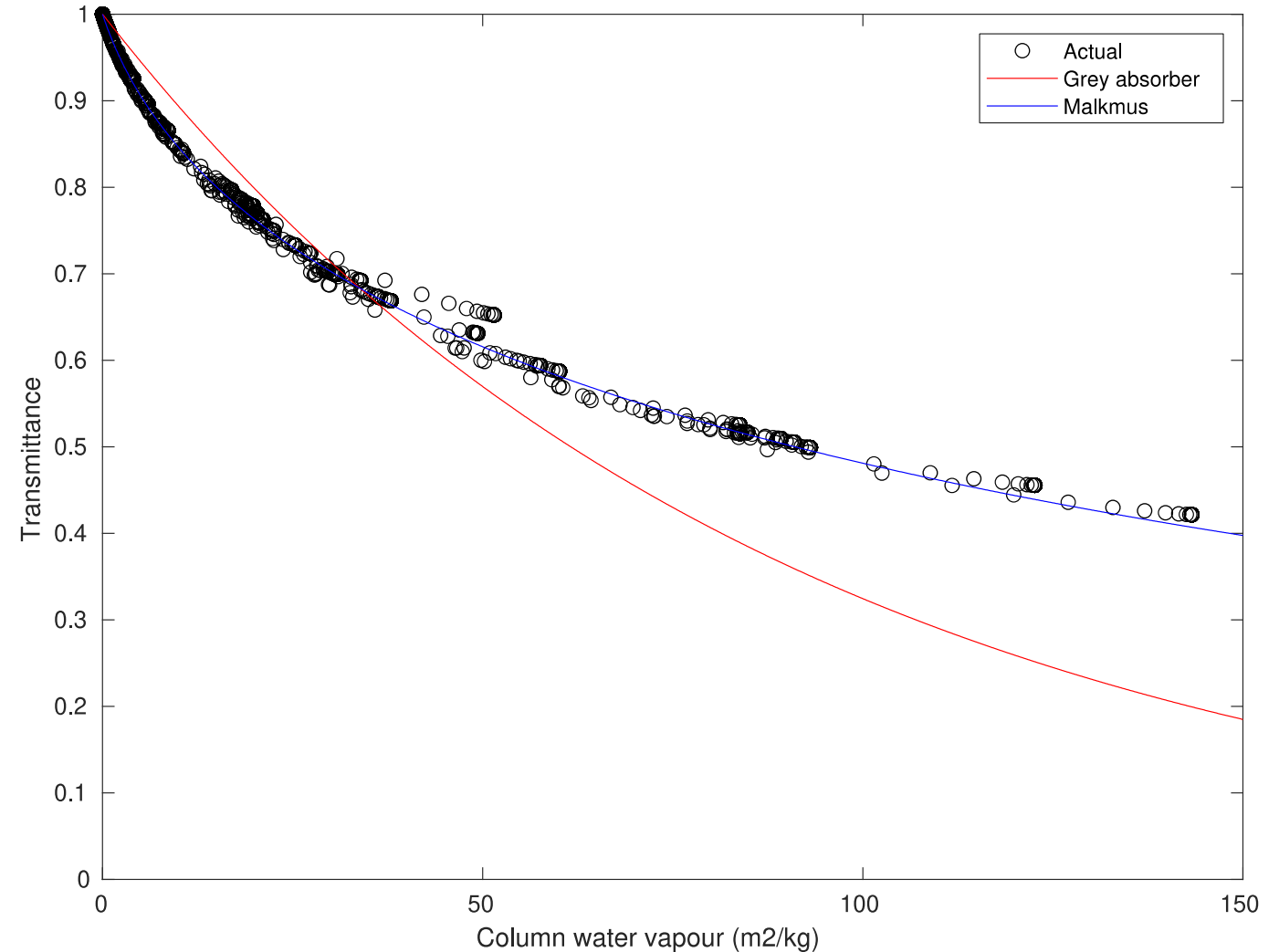
model:

$$\tau_{\text{eff}} = 2C [\text{sqrt}(1 + X K_0/C) - 1]$$

X: column water vapour

$C = 0.034$

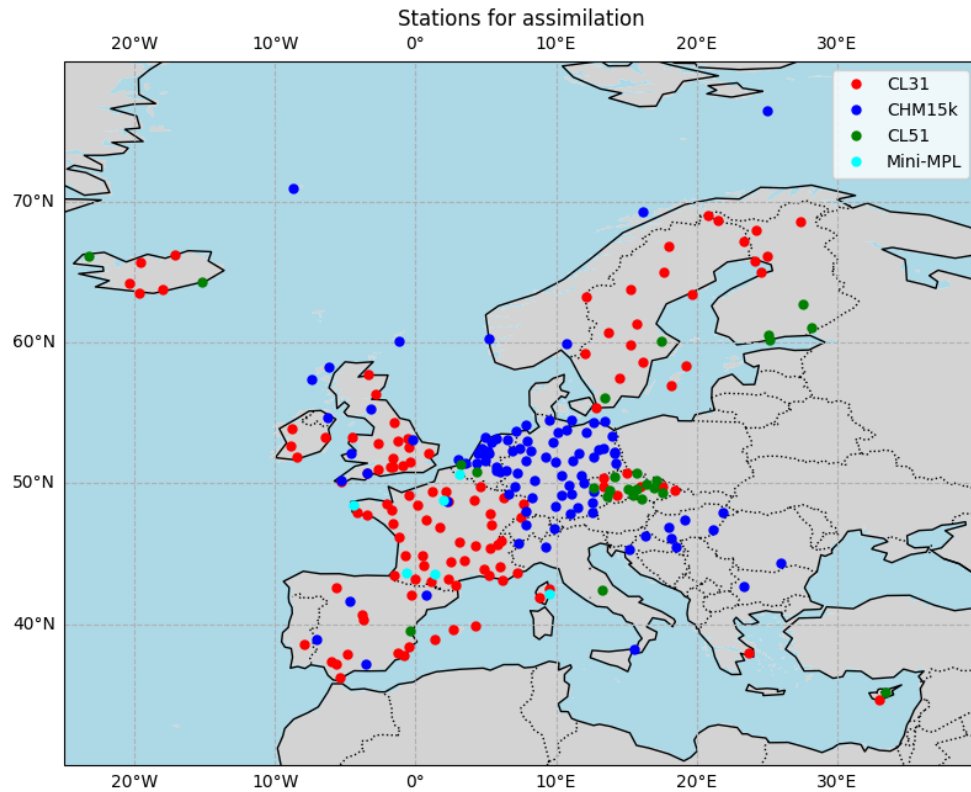
$K_0 = 0.013509 \text{ m}^2/\text{kg}$



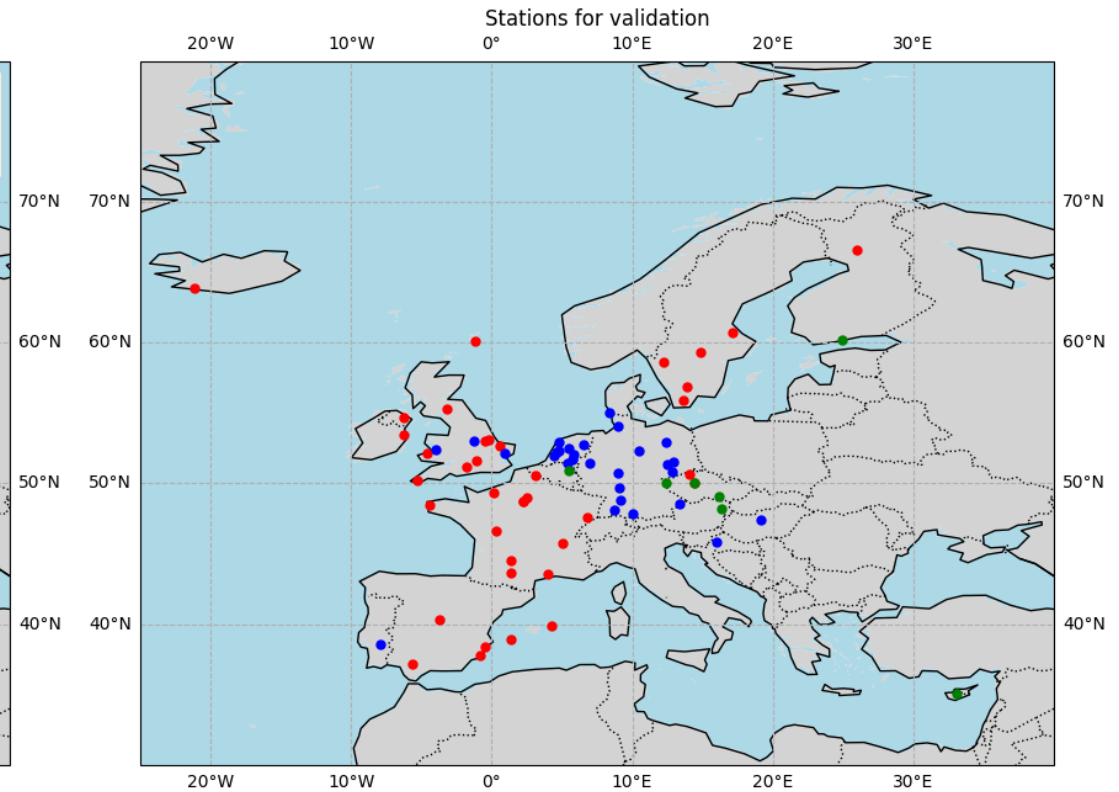


E-PROFILE STATION NETWORK

assimilated

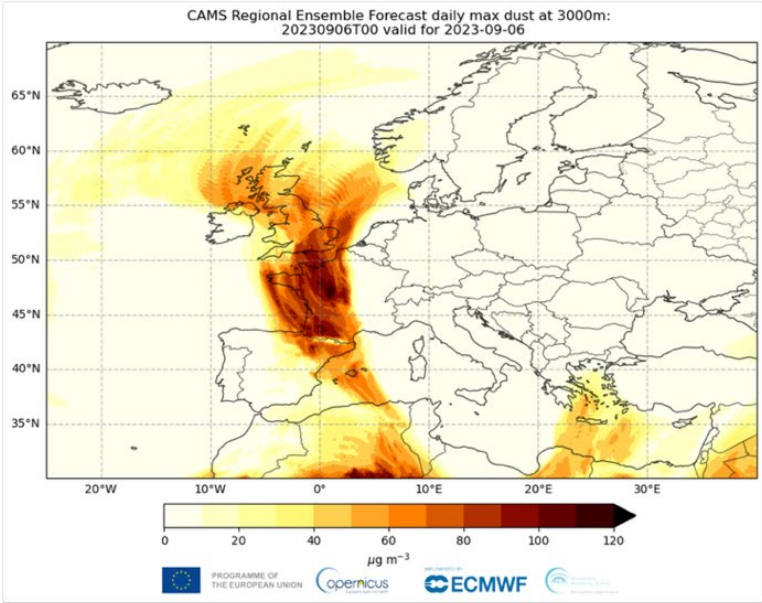


withheld



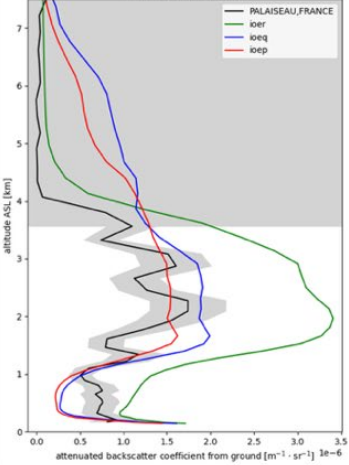


SAHARA DUST STORM, SEPTEMBER 2023

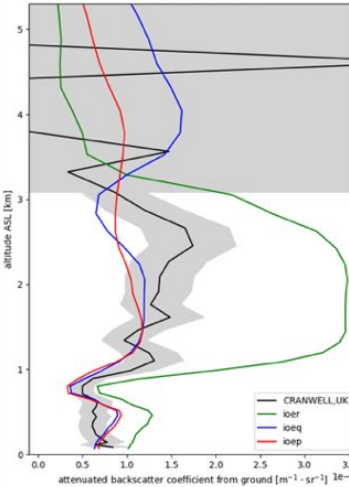


Std wavelets

StationID: 0-250-1001-07151 Instrument: CHM15k $\lambda = 1064.0 \text{ nm}$
date: 20230906 time: 3

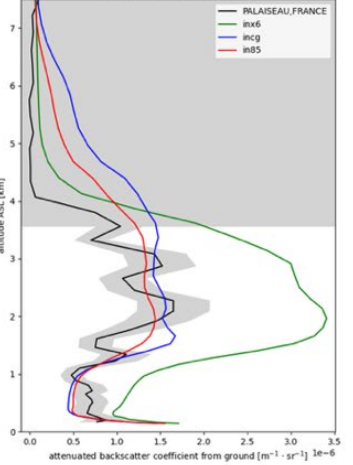


StationID: 0-20000-0-03379 Instrument: CL31 $\lambda = 910.0 \text{ nm}$
date: 20230906 time: 15

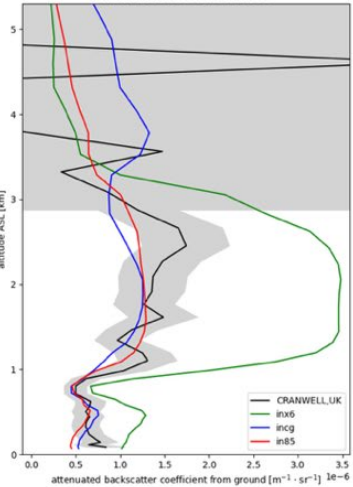


Wavelets with zero vertical correlations

StationID: 0-250-1001-07151 Instrument: CHM15k $\lambda = 1064.0 \text{ nm}$
date: 20230906 time: 30000



StationID: 0-20000-0-03379 Instrument: CL31 $\lambda = 910.0 \text{ nm}$
date: 20230906 time: 150000

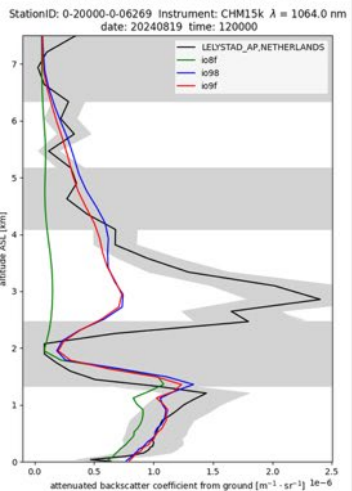
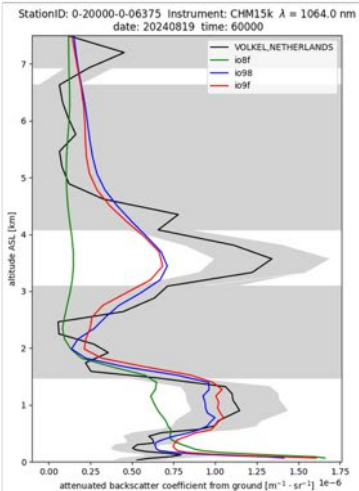
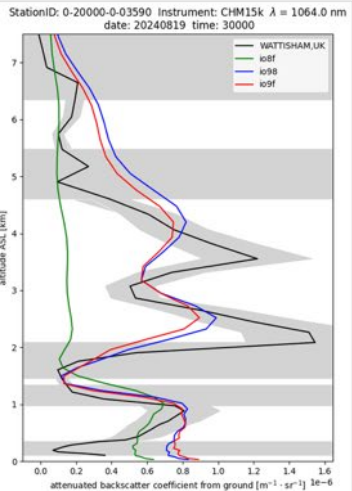
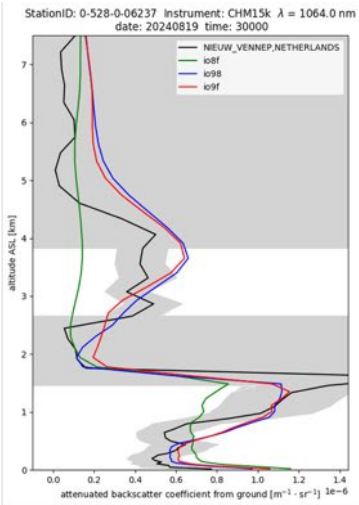
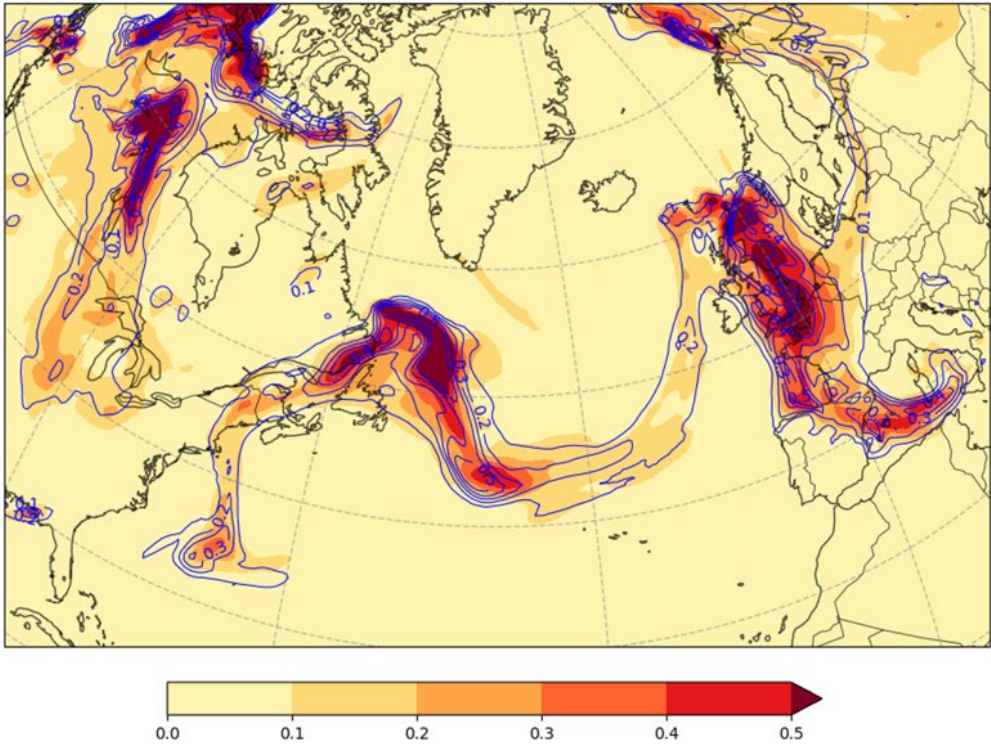


obs
ctrl
AN spheres
AN spheroids



CANADIAN WILDFIRES, AUGUST 2024

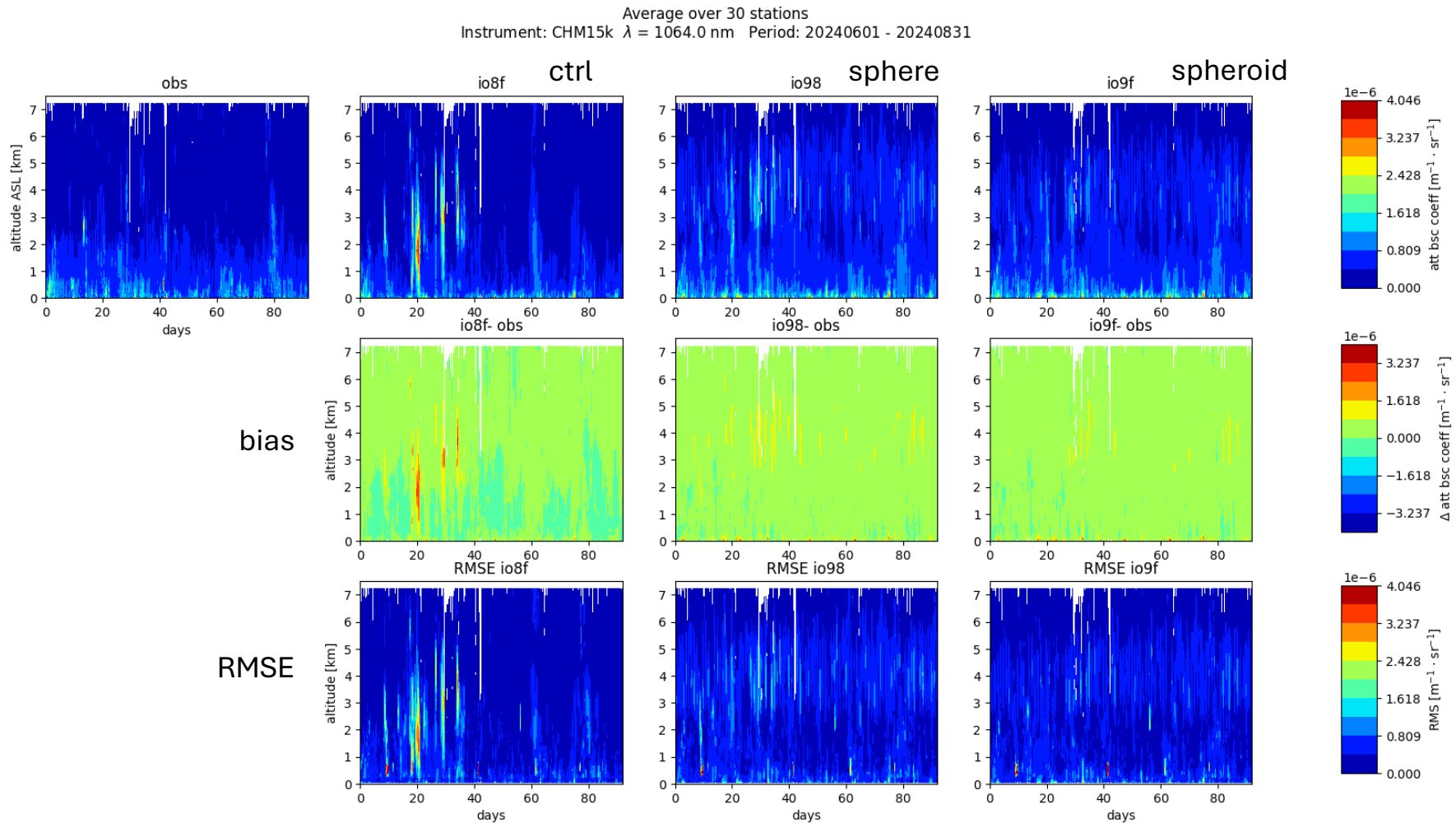
CAMS Forecast vs. Analysis Organic Matter Aerosol Optical Depth At 550Nm
Initialized 20240818T12 (contours), valid for 20240819T12 (shading)



obs
ctrl
AN spheres
AN spheroids



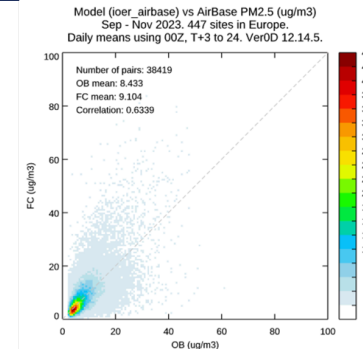
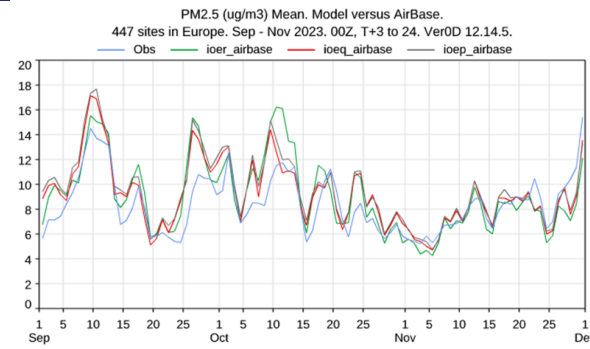
ATTENUATED BACKSCATT COEFF, JJA 2024



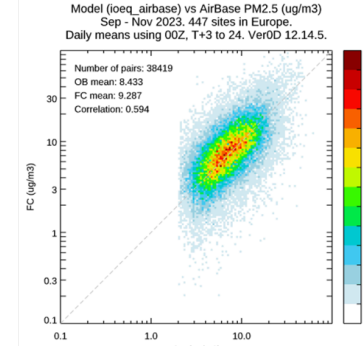
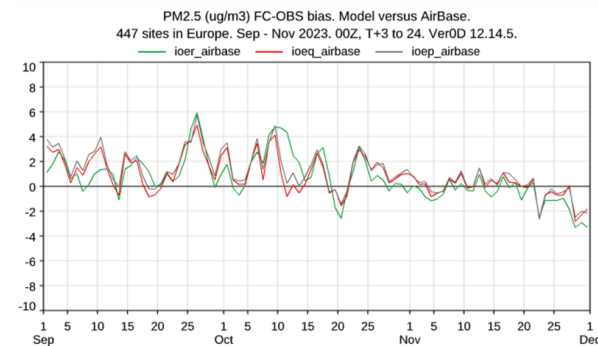


PM2.5, SON 2023, STANDARD WAVELETS

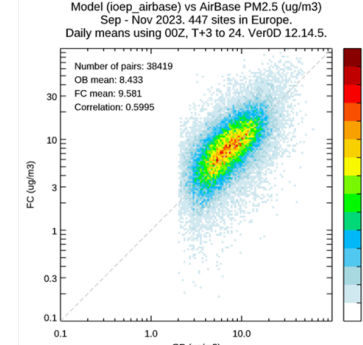
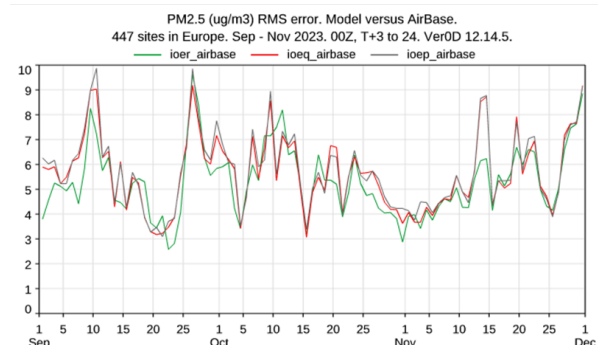
obs
ctrl
spheres
spheroids



ctrl



spheres



spheroids

bias

RMSE

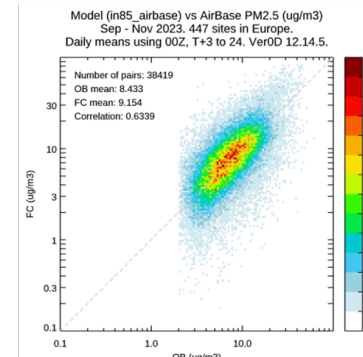
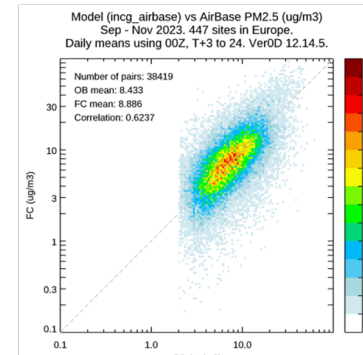
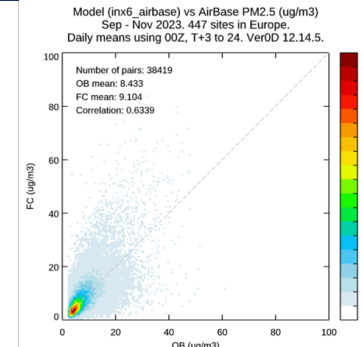
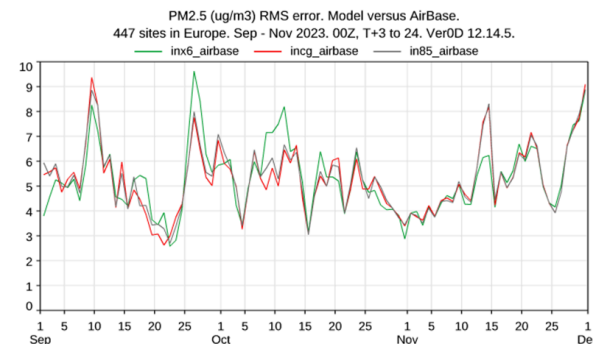
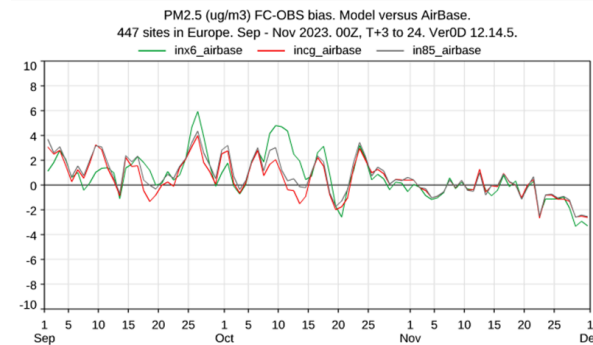
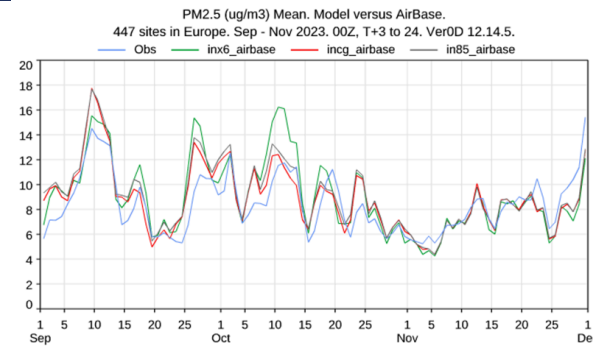


PM2.5, SON 2023, ARTIFICIAL WAVELETS

obs
ctrl
spheres
spheroids

bias

RMSE



ctrl

spheres

spheroids



TIME- AND STATION-AVERAGED METRICS

Period & wavelets		AOD 870			PM2.5			PM10		
	exp ID	bias	rmse	corr	bias	rmse	corr	bias	rmse	corr
SON 2023 standard	ioer (ctrl)	-0.004	0.016	0.72	0.67	1.88	0.63	-3.1	4.31	0.59
	ioeq (sphr)	0.017	0.025	0.51	0.86	1.73	0.59	-4.2	4.71	0.55
	ioep (sphrd)	0.026	0.031	0.59	1.15	1.95	0.60	-3.5	3.97	0.57
JJA 2024 standard	io8f (ctrl)	-0.006	0.019	0.81	0.08	1.09	0.48	-3.9	5.12	0.52
	io98 (sphr)	0.040	0.050	0.50	1.70	2.11	0.43	-3.3	3.80	0.47
	io9f (sphrd)	0.051	0.061	0.59	2.15	2.49	0.45	-2.2	3.01	0.51
SON 2023 artificial	inx6 (ctrl)	-0.004	0.016	0.72	0.67	1.88	0.63	-3.1	4.31	0.59
	incg (sphr)	0.001	0.017	0.64	0.46	1.51	0.62	-4.5	4.92	0.58
	in85 (sphrd)	0.009	0.018	0.69	0.72	1.67	0.63	-3.7	4.17	0.60



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JJA 2024 standard	io8f (ctrl)	-0.006	0.019	0.81	0.08	1.09	0.48	-3.9	5.12	0.52
	io98 (sphr)	0.040	0.050	0.50	1.70	2.11	0.43	-3.3	3.80	0.47
	io9f (sphrd)	0.051	0.061	0.59	2.15	2.49	0.45	-2.2	3.01	0.51
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	io98 (sphr)	0.040	0.050	0.50	1.70	2.11	0.43	-3.3	3.80	0.47
	io9f (sphrd)	0.051	0.061	0.59	2.15	2.49	0.45	-2.2	3.01	0.51
SON 2023 artificial	inx6 (ctrl)	-0.004	0.016	0.72	0.67	1.88	0.63	-3.1	4.31	0.59
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	io98 (sphr)	0.040	0.050	0.50	1.70	2.11	0.43	-3.3	3.80	0.47
	io9f (sphrd)	0.051	0.061	0.59	2.15	2.49	0.45	-2.2	3.01	0.51
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TOPICS

- Vertical correlations
- Optics model for dust aerosols
- Masking of unwanted data points
- Observation errors
- PM2.5 / PM10 partitioning
- Aerosol mixing state



TOPICS (RANKED)

1. Vertical correlations
2. Optics model for dust aerosols
3. Masking of unwanted data points
4. Observation errors
5. PM_{2.5} / PM₁₀ partitioning
6. Aerosol mixing state



MONTH 19-36

Analysis experiments started with *full CAMS setup* for

- 2 seasons
- 2 sets of wavelets
- 2 dust-optics model
- 2 masks