First results from the ongoing AeroCom 2019 control experiment: evaluation of present day modelled aerosol optical properties using ground and space based observations from AERONET, EBAS, MODIS, MISR and AATSR

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Acknowledgement: *AeroCom, AERONET, NILU/EBAS, NOAA, CAMS, cci-Aerosol, AeroCom*

Norwegian Meteorological Institute

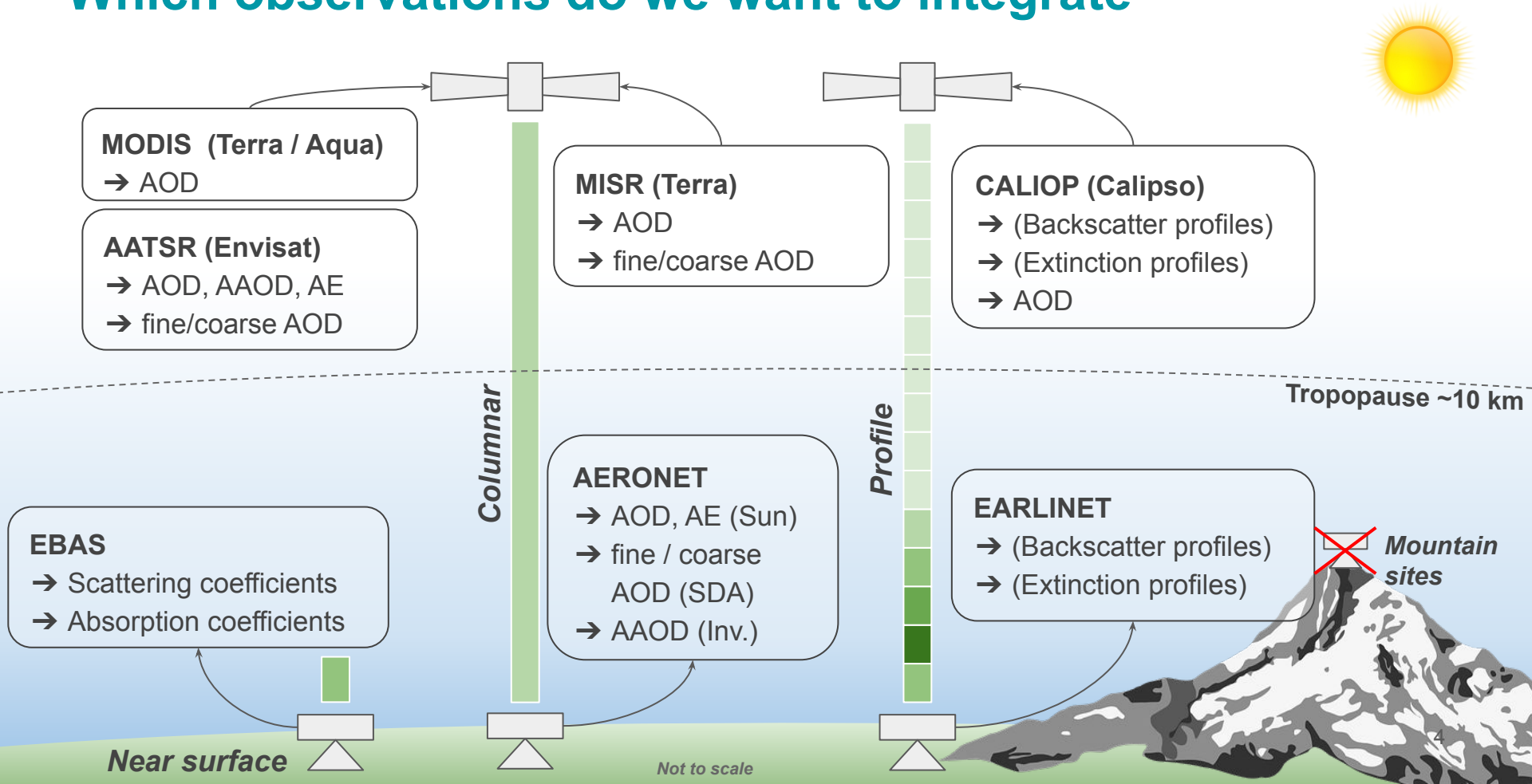
Outline

- Motivation
- Overview models and observations
- Satellites vs. AERONET
- Model evaluation (preliminary)
  - Emissions and burdens
  - Optical properties evaluation

Motivation and background

- IPCC: large uncertainty in aerosol attributed effective radiative forcing (ERF)
- Aerosol optical properties are closely linked with ERF ari
- New model data for AeroCom / CMIP6 need evaluation in 2019 (IPCC deadline)
- Model development needs fast feedback
- Combine different observations with different advantages / disadvantages, e.g.
  - Satellites: better spatial coverage but time sampling restricted to local overpass time
  - Ground based: usually more continuous time sampling, but lower spatial coverage
- AeroCom 2019 CTRL experiment
  - SST: prescribed
  - Meteorology: nudged with 2010
  - Emissions: CMIP6 **2010** and 1850

Which observations do we want to integrate



Observation datasets used

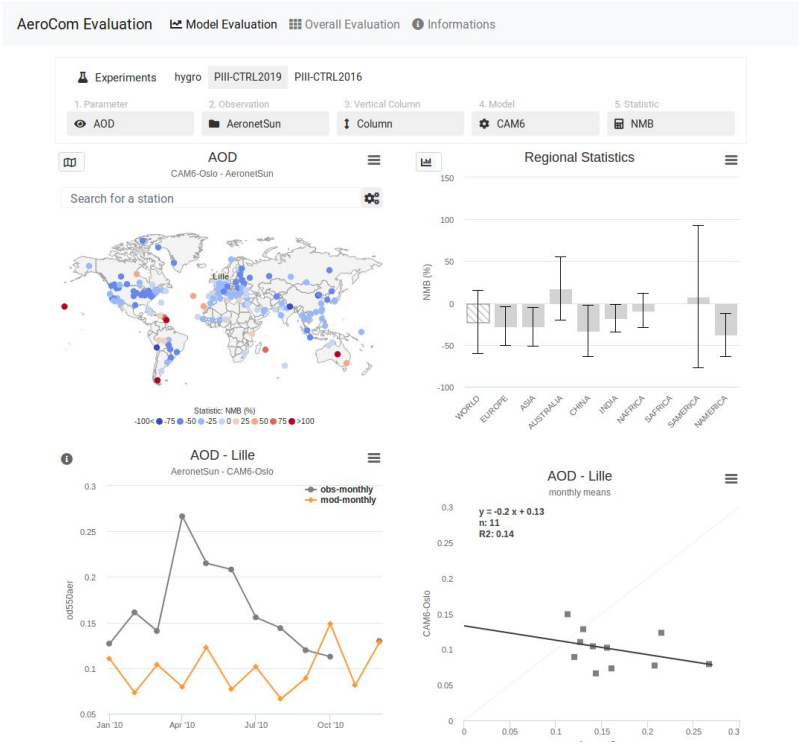
Name	Lev	Variables	Freq.	Vertical	Updated
EBAS	3	scatc550dryaer, ac550aer	Mostly hourly	Near surface	01.07.2019
AERONET V3 (Sun, SDA, Inversion)	3	od550aer, od550lt1aer, od550gt1aer, abs550aer, ang4487aer	Daily	Column	06.06.2019
AATSR-SU V4.3	3	od550aer, od550lt1aer, od550gt1aer, abs550aer, ang4487aer	Daily	Column	Variable (09/2016 - 01/2018)
MODIS V6 (aqua / terra)	3	od550aer	Daily	Column	16.09.2015
MISR V3.2	3	od550aer, od550lt1aer, od550gt1aer	Monthly	Column	14.11.2018

Models used

Abbr.	AeroCom ID	Comment
ECHAM-HAM2.3	ECHAM6.3-HAM2.3-met2010_AP3-CTRL	
GEOS	GEOS-i33p2-met2010_AP3-CTRL	
EC-Earth	EC-Earth3-AerChem_AP3-CTRL2019	
TM5	TM5_AP3-CTRL2019	
SPRINTARS-MIROC	MIROC-SPRINTARS_AP3-CTRL	
CAM6-Oslo	CAM6-Oslo_NHIST_f19_tn14_20190710_2010	Historical run (no met. nudging)
GFDL-AM4-met2010	GFDL-AM4-met2010_AP3-CTRL	
GFDL-AM4-fSST	GFDL-AM4-fSST_AP3-CTRL	PD obs. SST, no met. nudging
OsloCTM3	OsloCTM3v1.01-met2010_AP3-CTRL	
ECMWF-REAN	ECMWF_CAMS_REAN	CAMS reanalysis dataset
CAM5-ATRAS	CAM5-ATRAS_AP3-CTRL	

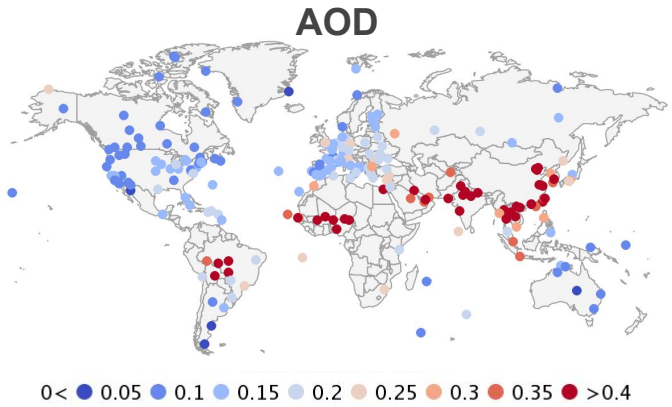
Methods & new data quicklook interface

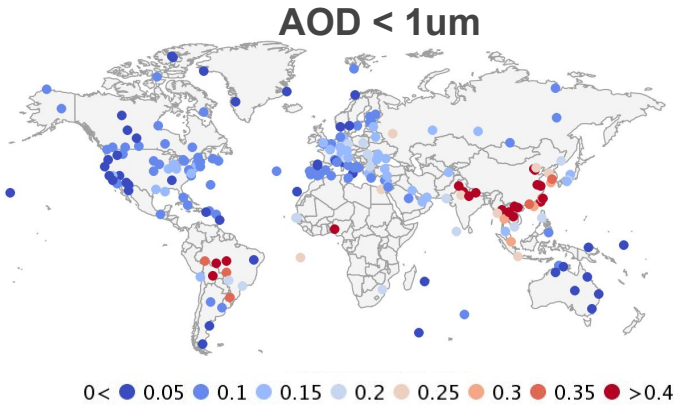
- Data processing with pyaerocom: https://pyaerocom.met.no/
- Mountain sites excluded (i.e. alt. > 1000 m a.s.l.)
- AOD>1um used where available, else computed from dust and sea-salt AOD
- AE computed from AOD@440 & 870 nm
- Dry scattering computed from dry extinction and absorption, where available
- Hierarchical time resampling of observations (e.g. daily to monthly: at least 7 data points)
- No time colocation for daily model data
- Satellite colocation: model and satellite data regridded to 5x5
- Interactive previews of the results available at: https://aerocom-evaluation.met.no

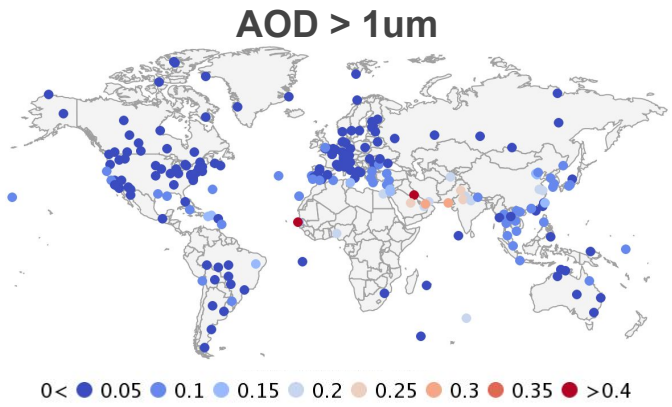


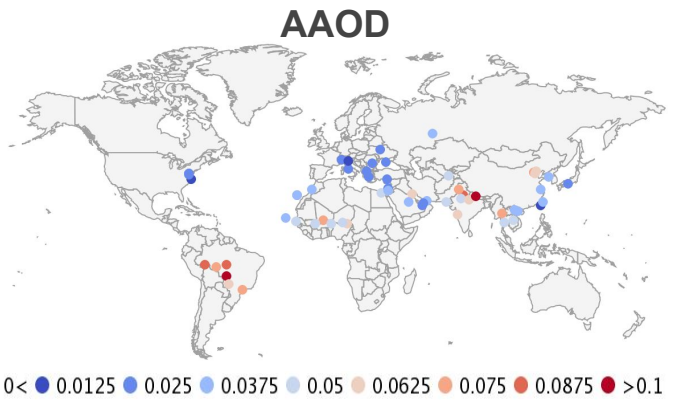
New AeroCom evaluation interface

AERONET AOD's (2010 yearly averages)

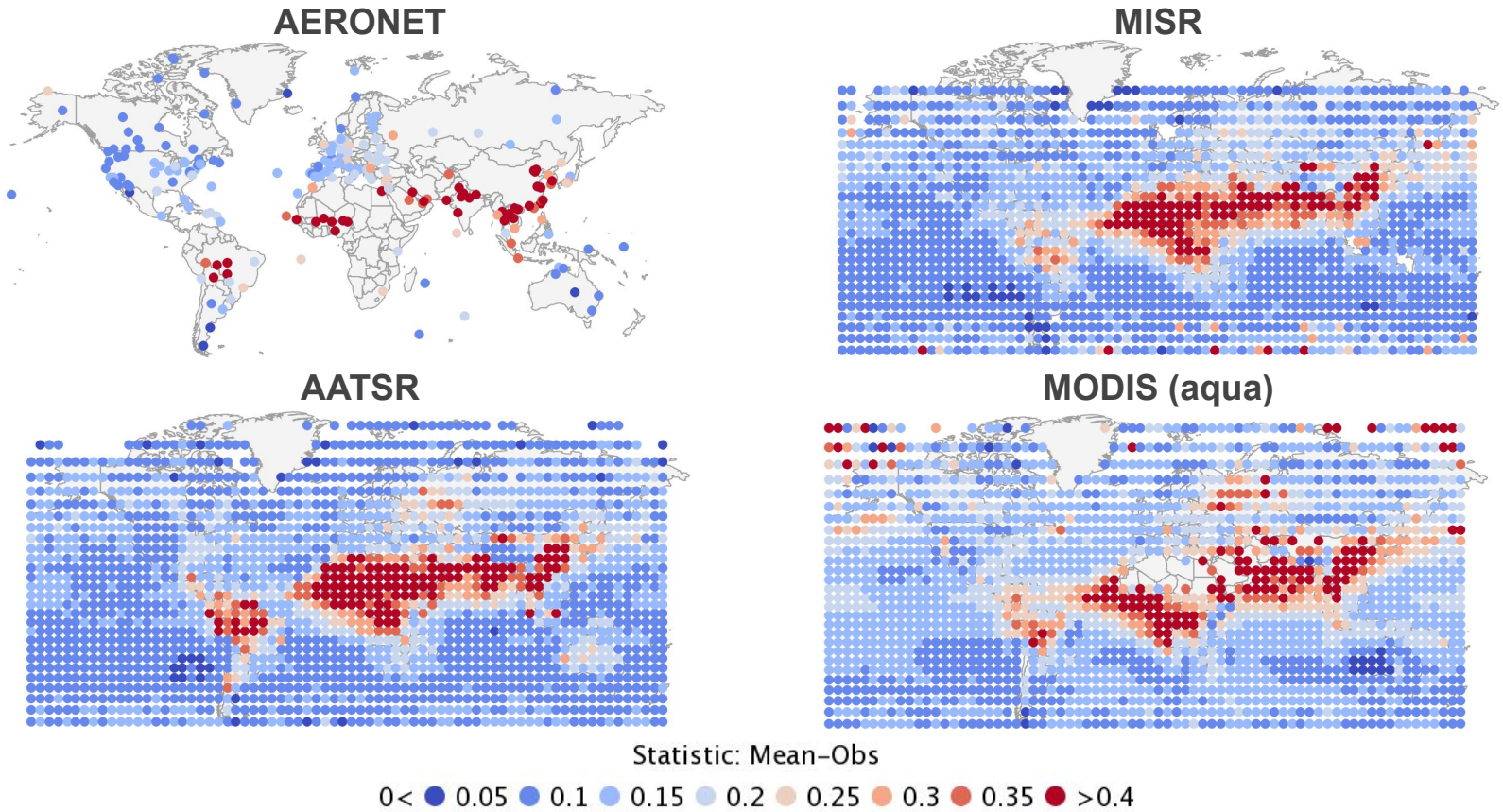






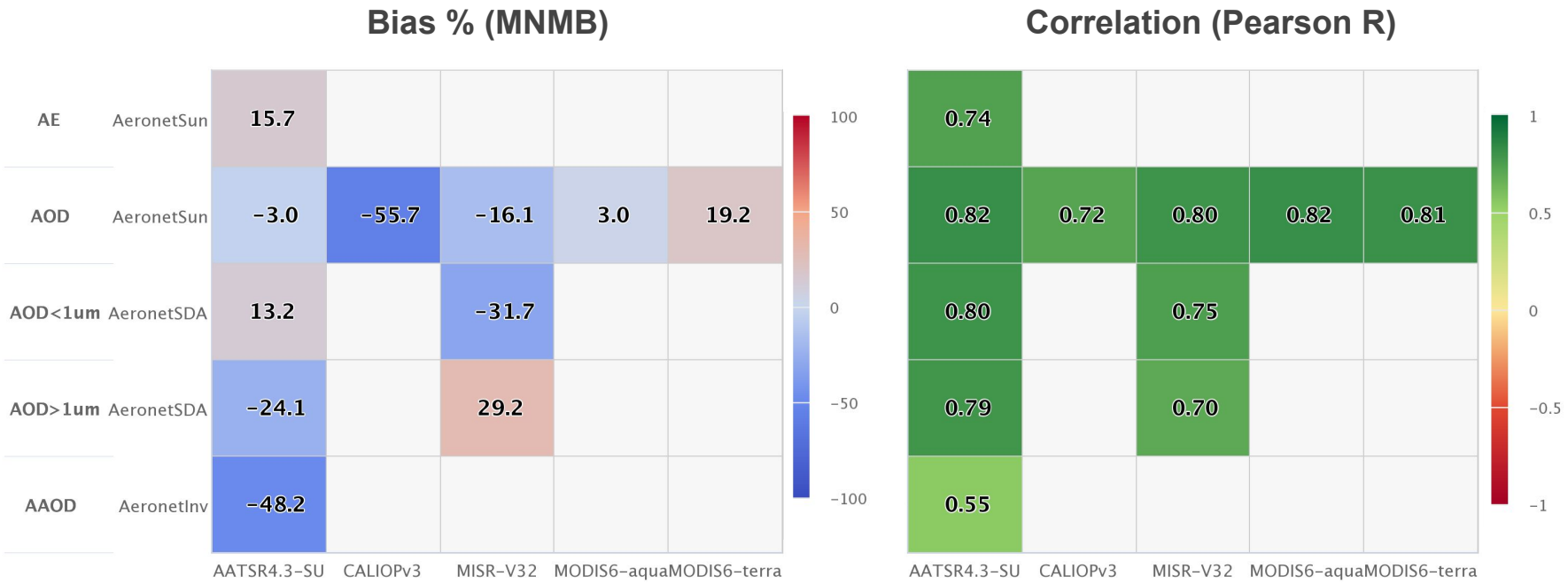


Satellites vs. AERONET (global AOD)



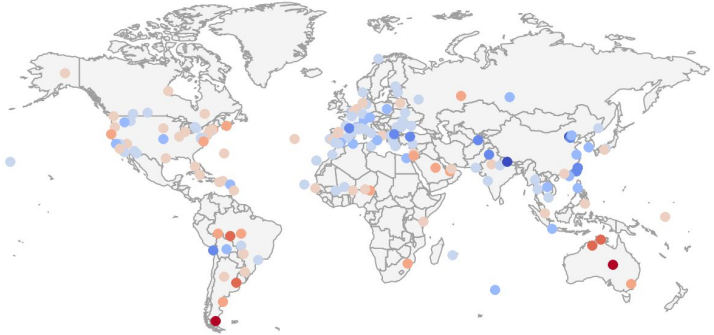
Satellites vs. AERONET

$$MNMB = \frac{2}{N}\sum_{i}^{N}\frac{m_i - o_i}{m_i + o_i}\ \epsilon\{-2, 2\}$$ (MNMB: Modified normalised mean bias)

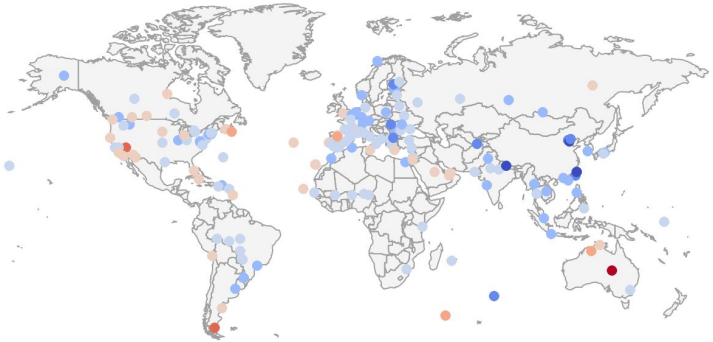


Satellites vs. AERONET (AOD's)

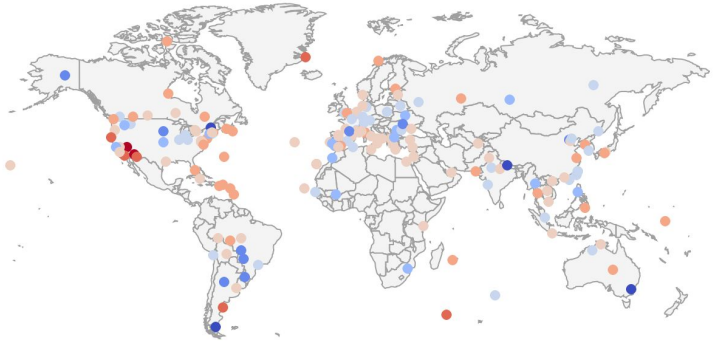
AATSR MNMB (-3.0 %)



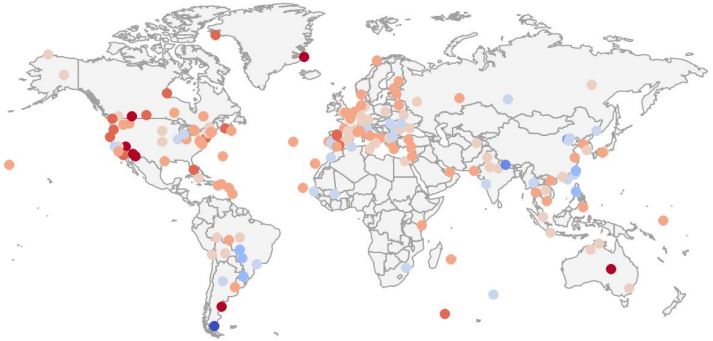
MISR MNMB (-16.1 %)



MODIS Aqua MNMB (+3.0 %)



MODIS Terra MNMB (+19.2 %)

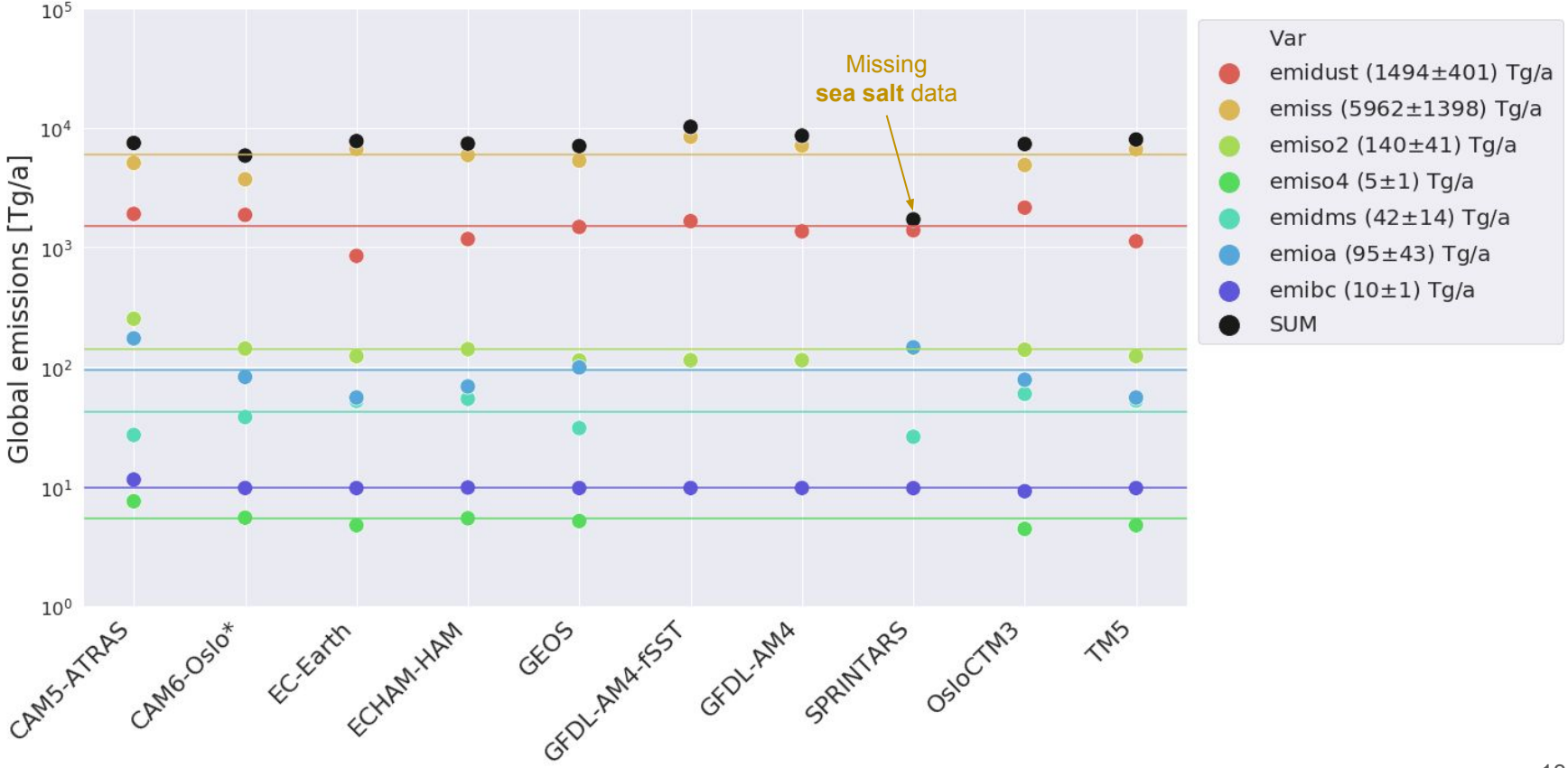


Statistic: MNMB (%)

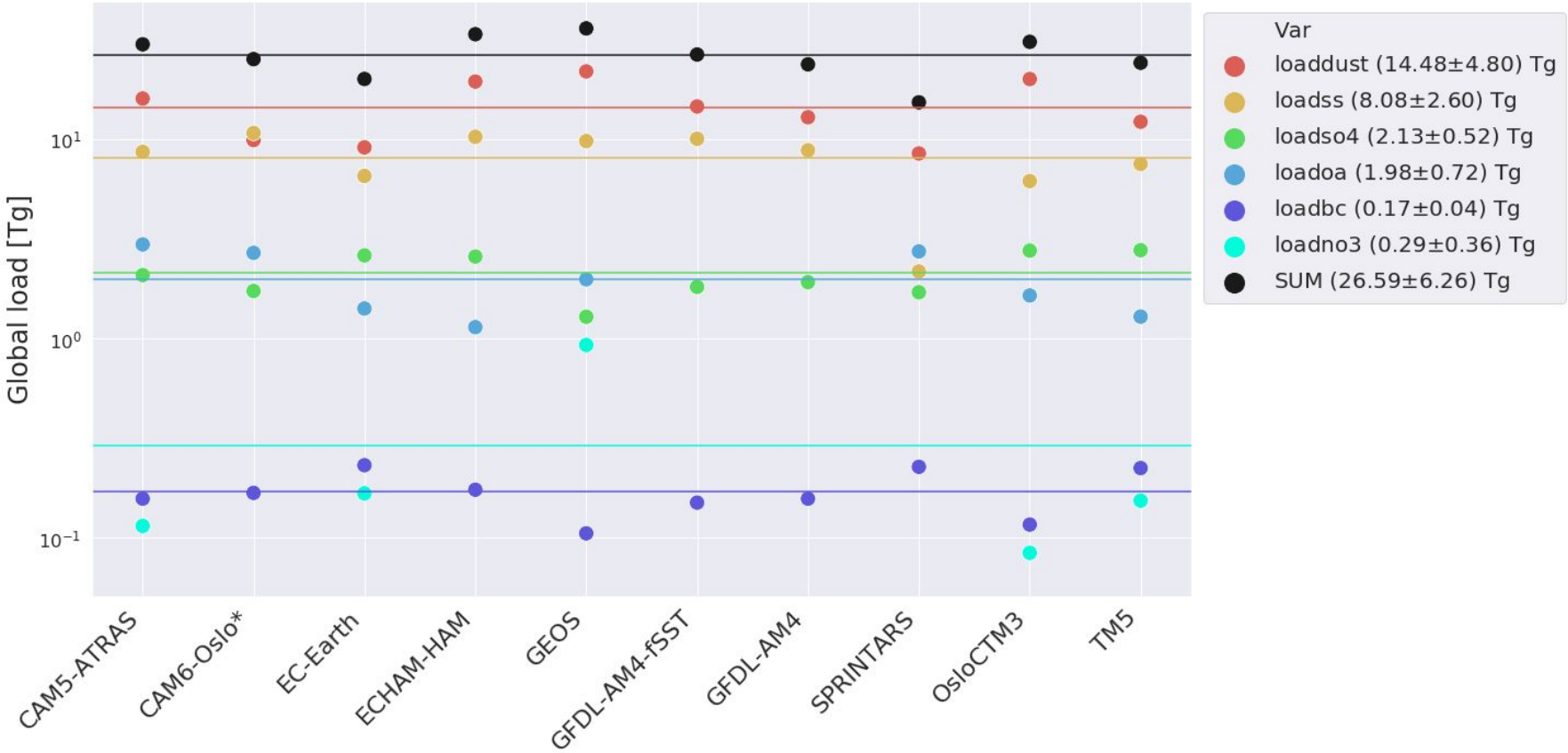
−100< −75 −50 −25 0 25 50 75 >100

Model evaluation

Global emissions



Global burden



Synthesis analysis of optical properties in AeroCom models

or

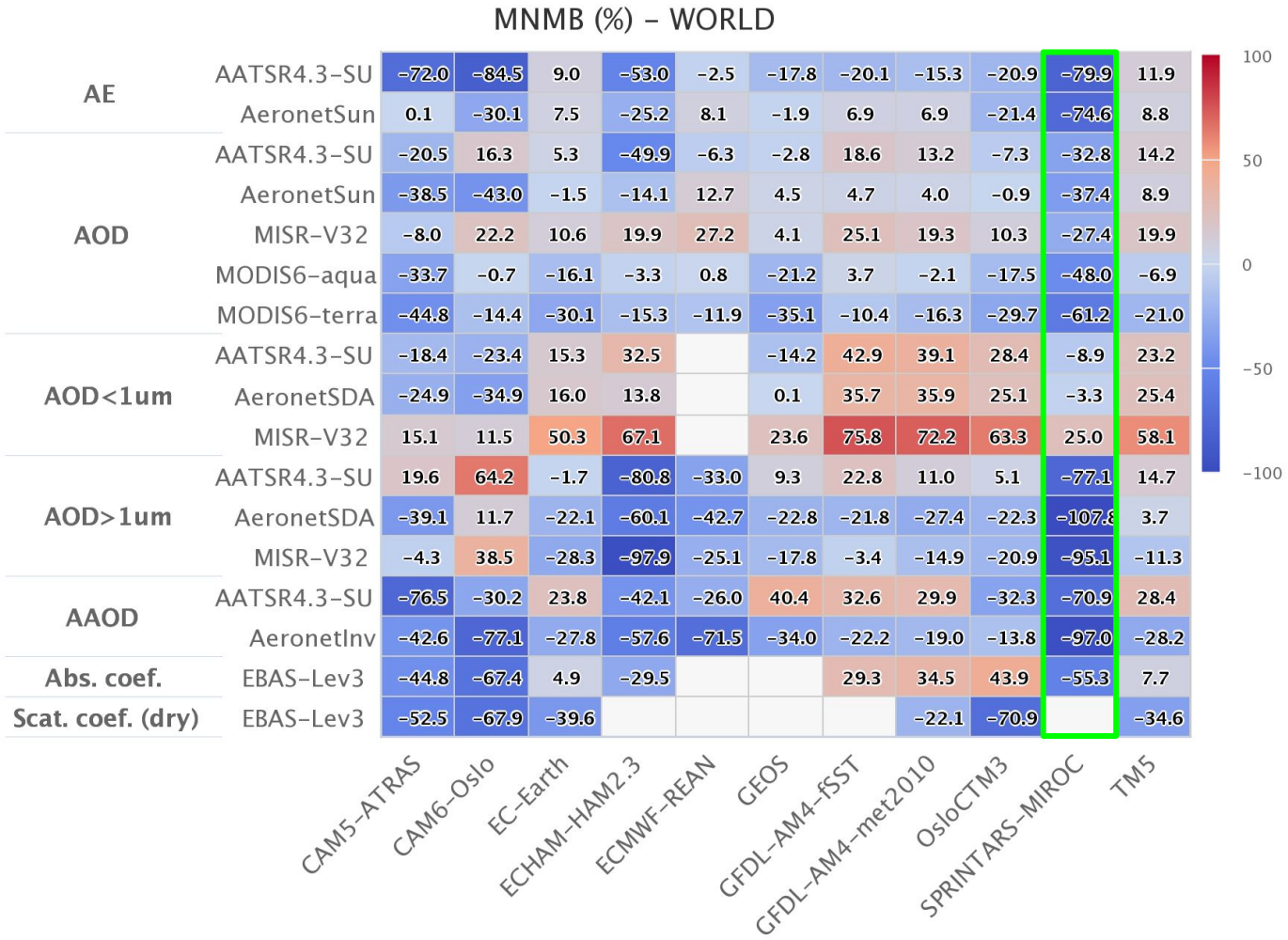
Where to look?

Bias % (MNMB)

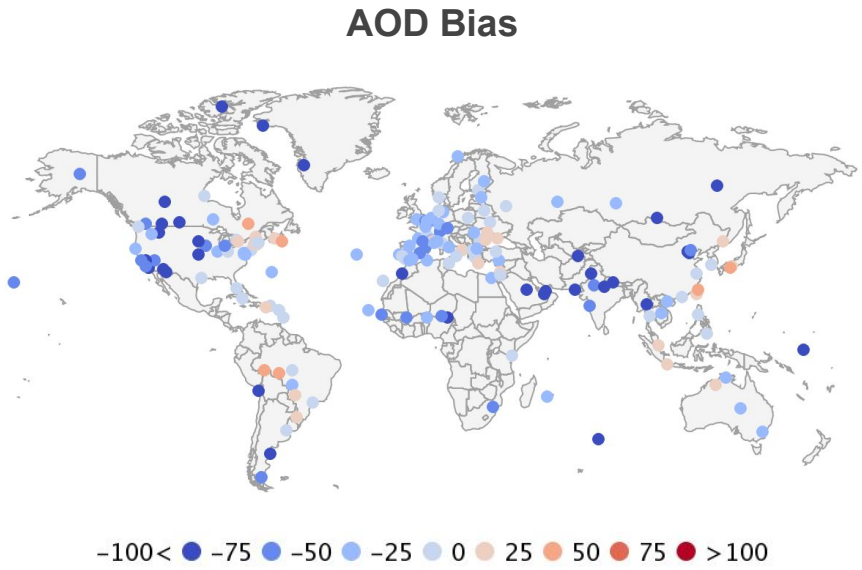
		CAM5-ATRAS	CAM6-Oslo	EC-Earth	ECHAM-HAM2.3	ECMWF-REAN	GEOS	GFDL-AM4-fSST	GFDL-AM4-met2010	OsloCTM3	SPRINTARS-MIROC	TM5
AE	AATSR4.3-SU	-72.0	-84.5	9.0	-53.0	-2.5	-17.8	-20.1	-15.3	-20.9	-79.9	11.9
	AeronetSun	0.1	-30.1	7.5	-25.2	8.1	-1.9	6.9	6.9	-21.4	-74.6	8.8
AOD	AATSR4.3-SU	-20.5	16.3	5.3	-49.9	-6.3	-2.8	18.6	13.2	-7.3	-32.8	14.2
	AeronetSun	-38.5	-43.0	-1.5	-14.1	12.7	4.5	4.7	4.0	-0.9	-37.4	8.9
	MISR-V32	-8.0	22.2	10.6	19.9	27.2	4.1	25.1	19.3	10.3	-27.4	19.9
	MODIS6-aqua	-33.7	-0.7	-16.1	-3.3	0.8	-21.2	3.7	-2.1	-17.5	-48.0	-6.9
	MODIS6-terra	-44.8	-14.4	-30.1	-15.3	-11.9	-35.1	-10.4	-16.3	-29.7	-61.2	-21.0
AOD<1um	AATSR4.3-SU	-18.4	-23.4	15.3	32.5		-14.2	42.9	39.1	28.4	-8.9	23.2
	AeronetSDA	-24.9	-34.9	16.0	13.8		0.1	35.7	35.9	25.1	-3.3	25.4
	MISR-V32	15.1	11.5	50.3	67.1		23.6	75.8	72.2	63.3	25.0	58.1
AOD>1um	AATSR4.3-SU	19.6	64.2	-1.7	-80.8	-33.0	9.3	22.8	11.0	5.1	-77.1	14.7
	AeronetSDA	-39.1	11.7	-22.1	-60.1	-42.7	-22.8	-21.8	-27.4	-22.3	-107.8	3.7
	MISR-V32	-4.3	38.5	-28.3	-97.9	-25.1	-17.8	-3.4	-14.9	-20.9	-95.1	-11.3
AAOD	AATSR4.3-SU	-76.5	-30.2	23.8	-42.1	-26.0	40.4	32.6	29.9	-32.3	-70.9	28.4
	AeronetInv	-42.6	-77.1	-27.8	-57.6	-71.5	-34.0	-22.2	-19.0	-13.8	-97.0	-28.2
Abs. coef.	EBAS-Lev3	-44.8	-67.4	4.9	-29.5			29.3	34.5	43.9	-55.3	7.7
Scat. coef. (dry)	EBAS-Lev3	-52.5	-67.9	-39.6					-22.1	-70.9		-34.6

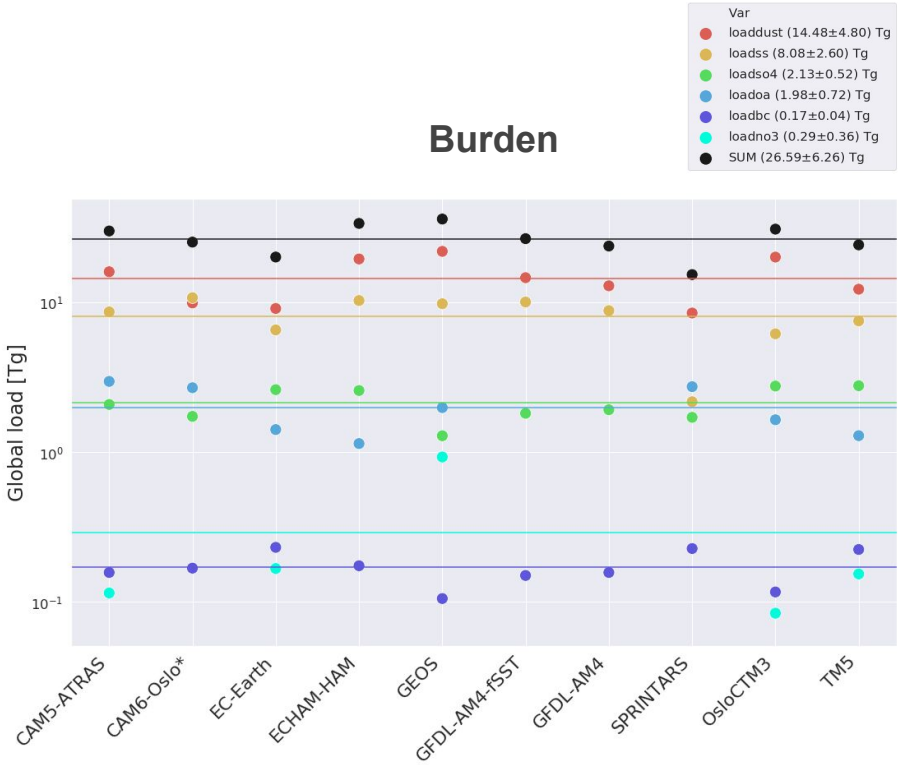
Correlation (Pearson R)

		CAM5-ATRAS	CAM6-Oslo	EC-Earth	ECHAM-HAM2.3	ECMWF-REAN	GEOS	GFDL-AM4-fSST	GFDL-AM4-met2010	OsloCTM3	SPRINTARS-MIROC	TM5
AE	AATSR4.3-SU	0.75	0.75	0.73	0.76	0.79	0.67	0.75	0.75	0.72	0.58	0.73
	AeronetSun	0.65	0.53	0.69	0.53	0.76	0.75	0.54	0.52	0.68	0.23	0.69
AOD	AATSR4.3-SU	0.70	0.50	0.68	0.61	0.84	0.76	0.68	0.70	0.83	0.48	0.68
	AeronetSun	0.76	0.66	0.82	0.61	0.90	0.83	0.78	0.79	0.80	0.61	0.79
	MISR-V32	0.49	0.41	0.58	0.38	0.67	0.63	0.57	0.59	0.62	0.41	0.59
	MODIS6-aqua	0.54	0.36	0.59	0.40	0.77	0.59	0.54	0.58	0.64	0.43	0.58
	MODIS6-terra	0.54	0.35	0.58	0.39	0.76	0.58	0.53	0.56	0.63	0.42	0.57
AOD<1um	AATSR4.3-SU	0.63	0.64	0.76	0.48		0.73	0.71	0.74	0.69	0.56	0.73
	AeronetSDA	0.75	0.69	0.82	0.55		0.79	0.72	0.74	0.75	0.60	0.79
	MISR-V32	0.58	0.58	0.67	0.41		0.65	0.63	0.66	0.67	0.48	0.67
AOD>1um	AATSR4.3-SU	0.48	0.18	0.50	0.57	0.88	0.77	0.62	0.66	0.77	0.53	0.56
	AeronetSDA	0.63	0.38	0.60	0.44	0.85	0.78	0.71	0.77	0.77	0.50	0.59
	MISR-V32	0.31	0.17	0.45	0.43	0.52	0.55	0.45	0.48	0.53	0.38	0.47
AAOD	AATSR4.3-SU	0.75	0.75	0.75	0.75	0.36	0.70	0.78	0.78	0.81	0.69	0.77
	AeronetInv	0.43	0.44	0.56	0.51	0.51	0.36	0.44	0.43	0.48	0.43	0.56
Abs. coef.	EBAS-Lev3	0.44	0.37	0.53	0.69			0.46	0.45	0.62	0.46	0.57
Scat. coef. (dry)	EBAS-Lev3	0.51	0.41	0.80					0.50	0.78		0.73


MNMB (%) – WORLD
AE
AATSR4.3-SU -72.0 -84.5 9.0 -53.0 -2.5 -17.8 -20.1 -15.3 -20.9 -79.9 11.9
AeronetSun 0.1 -30.1 7.5 -25.2 8.1 -1.9 6.9 6.9 -21.4 -74.6 8.8
AOD
AATSR4.3-SU -20.5 16.3 5.3 -49.9 -6.3 -2.8 18.6 13.2 -7.3 -32.8 14.2
AeronetSun -38.5 -43.0 -1.5 -14.1 12.7 4.5 4.7 4.0 -0.9 -37.4 8.9
MISR-V32 -8.0 22.2 10.6 19.9 27.2 4.1 25.1 19.3 10.3 -27.4 19.9
MODIS6-aqua -33.7 -0.7 -16.1 -3.3 0.8 -21.2 3.7 -2.1 -17.5 -48.0 -6.9
MODIS6-terra -44.8 -14.4 -30.1 -15.3 -11.9 -35.1 -10.4 -16.3 -29.7 -61.2 -21.0
AOD<1um
AATSR4.3-SU -18.4 -23.4 15.3 32.5 -14.2 42.9 39.1 28.4 -8.9 23.2
AeronetSDA -24.9 -34.9 16.0 13.8 0.1 35.7 35.9 25.1 -3.3 25.4
MISR-V32 15.1 11.5 50.3 67.1 23.6 75.8 72.2 63.3 25.0 58.1
AOD>1um
AATSR4.3-SU 19.6 64.2 -1.7 -80.8 -33.0 9.3 22.8 11.0 5.1 -77.1 14.7
AeronetSDA -39.1 11.7 -22.1 -60.1 -42.7 -22.8 -21.8 -27.4 -22.3 -107.8 3.7
MISR-V32 -4.3 38.5 -28.3 -97.9 -25.1 -17.8 -3.4 -14.9 -20.9 -95.1 -11.3
AAOD
AATSR4.3-SU -76.5 -30.2 23.8 -42.1 -26.0 40.4 32.6 29.9 -32.3 -70.9 28.4
AeronetInv -42.6 -77.1 -27.8 -57.6 -71.5 -34.0 -22.2 -19.0 -13.8 -97.0 -28.2
Abs. coef.
EBAS-Lev3 -44.8 -67.4 4.9 -29.5 29.3 34.5 43.9 -55.3 7.7
Scat. coef. (dry)
EBAS-Lev3 -52.5 -67.9 -39.6 -22.1 -70.9 -34.6
CAM5-ATRAS
CAM6-Oslo
EC-Earth
ECHAM-HAM2.3
ECMWF-REAN
GEOS
GFDL-AM4-fSST
GFDL-AM4-met2010
OsloCTM3
SPRINTARS-MIROC
TM5
100
50
0
-50
-100

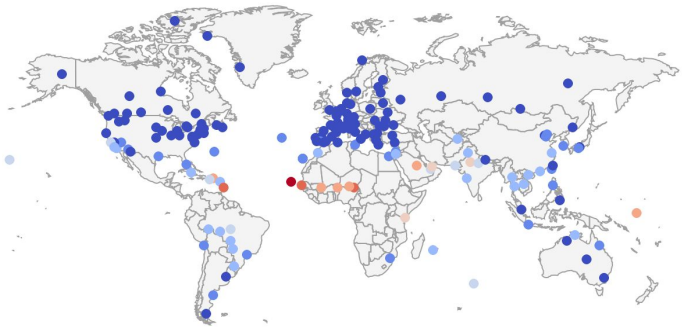
Low SPRINTARS emissions / burdens



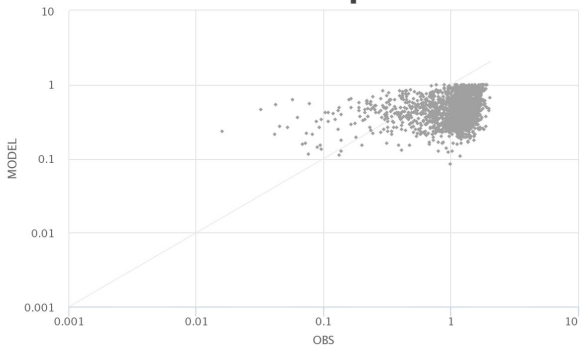


SPRINTARS AE vs fine / coarse AOD

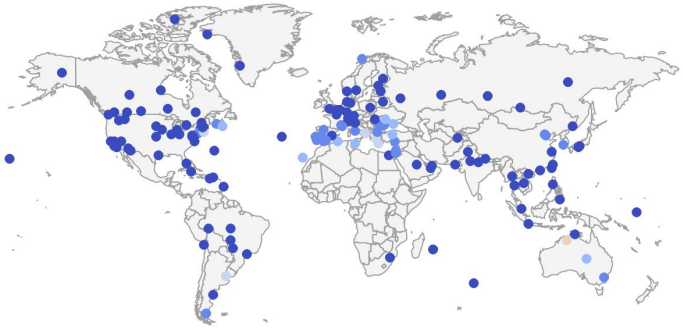
Bias AE (<0 ⇒ bigger particles)



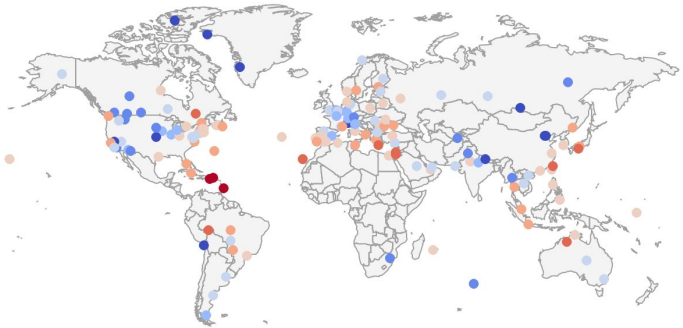
AE scatterplot



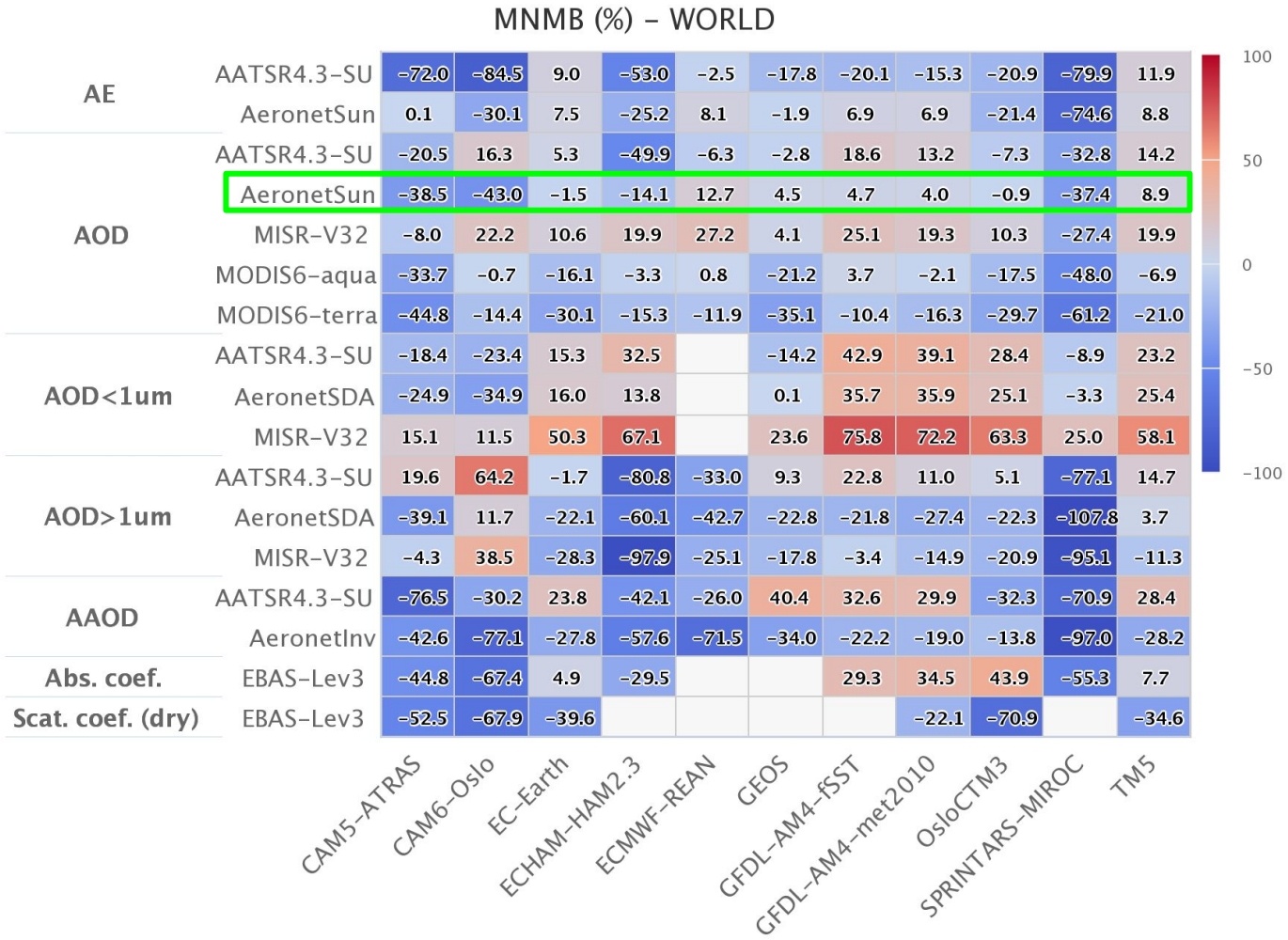
Bias AOD > 1um



Bias AOD < 1um



−100< −75 −50 −25 0 25 50 75 >100


MNMB (%) – WORLD
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AOD<1um
AATSR4.3-SU -18.4 -23.4 15.3 32.5 -14.2 42.9 39.1 28.4 -8.9 23.2
AeronetSDA -24.9 -34.9 16.0 13.8 0.1 35.7 35.9 25.1 -3.3 25.4
MISR-V32 15.1 11.5 50.3 67.1 23.6 75.8 72.2 63.3 25.0 58.1
AOD>1um
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AAOD
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Scat. coef. (dry)
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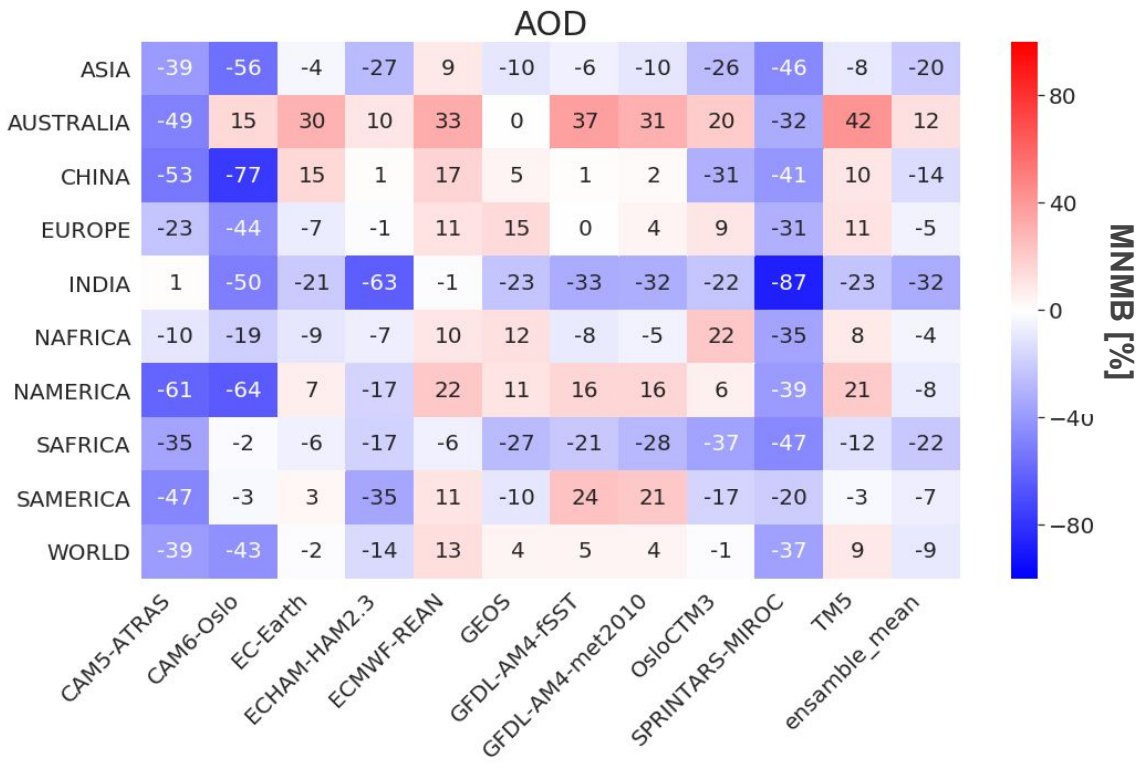
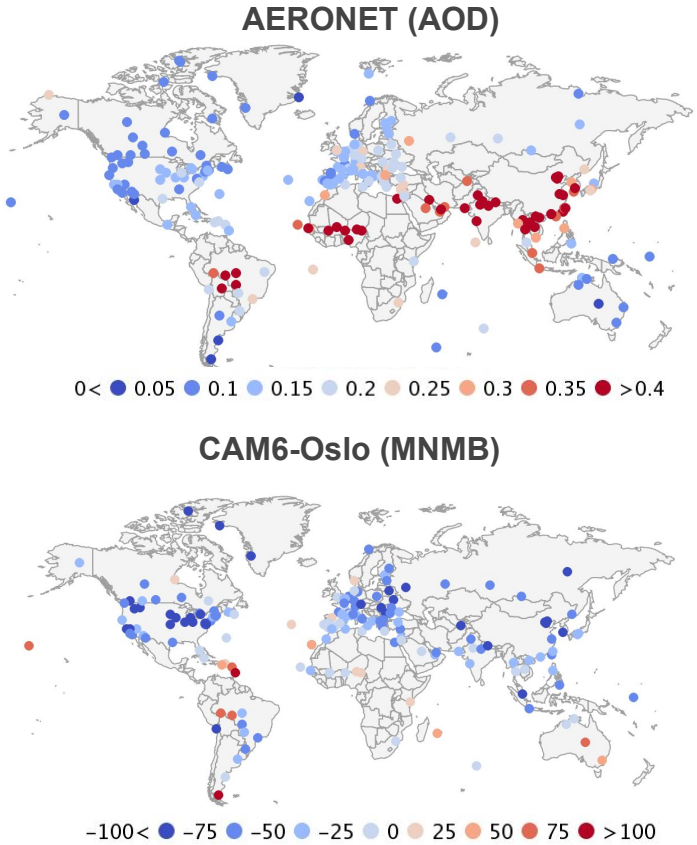
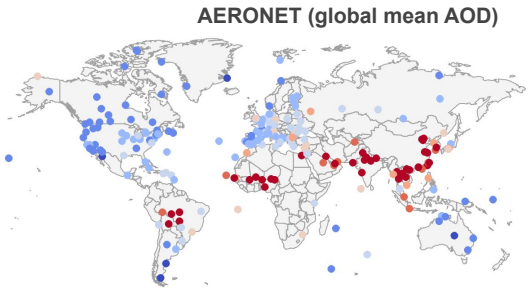
CAM5-ATRAS
CAM6-Oslo
EC-Earth
ECHAM-HAM2.3
ECMWF-REAN
GEOS
GFDL-AM4-fSST
GFDL-AM4-met2010
OsloCTM3
SPRINTARS-MIROC
TM5
100
50
0
-50
-100

Regional bias: models vs. AERONET





Regional bias: models vs. AERONET

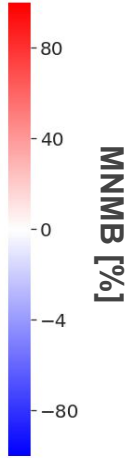


AOD

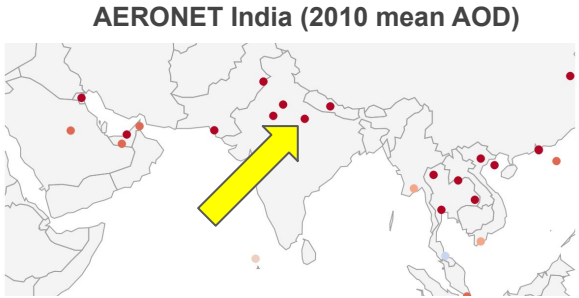
	CAM5-ATRAS	CAM6-Oslo	EC-Earth	ECHAM-HAM2.3	ECMWF-REAN	GEOS	GFDL-AM4-fSST	GFDL-AM4-met2010	OsloCTM3	SPRINTARS-MIROC	TM5	ensamble_mean
ASIA	-39	-56	-4	-27	9	-10	-6	-10	-26	-46	-8	-20
AUSTRALIA	-49	15	30	10	33	0	37	31	20	-32	42	12
CHINA	-53	-77	15	1	17	5	1	2	-31	-41	10	-14
EUROPE	-23	-44	-7	-1	11	15	0	4	9	-31	11	-5
INDIA	1	-50	-21	-63	-1	-23	-33	-32	-22	-87	-23	-32
NAFRICA	-10	-19	-9	-7	10	12	-8	-5	22	-35	8	-4
NAMERICA	-61	-64	7	-17	22	11	16	16	6	-39	21	-8
SAFRICA	-35	-2	-6	-17	-6	-27	-21	-28	-37	-47	-12	-22
SAMERICA	-47	-3	3	-35	11	-10	24	21	-17	-20	-3	-7
WORLD	-39	-43	-2	-14	13	4	5	4	-1	-37	9	-9

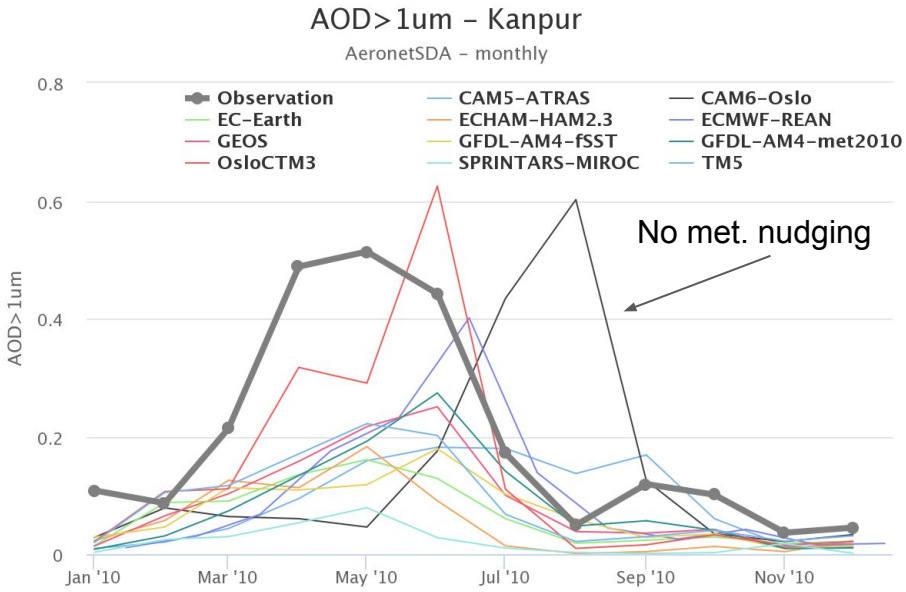
AOD>1um

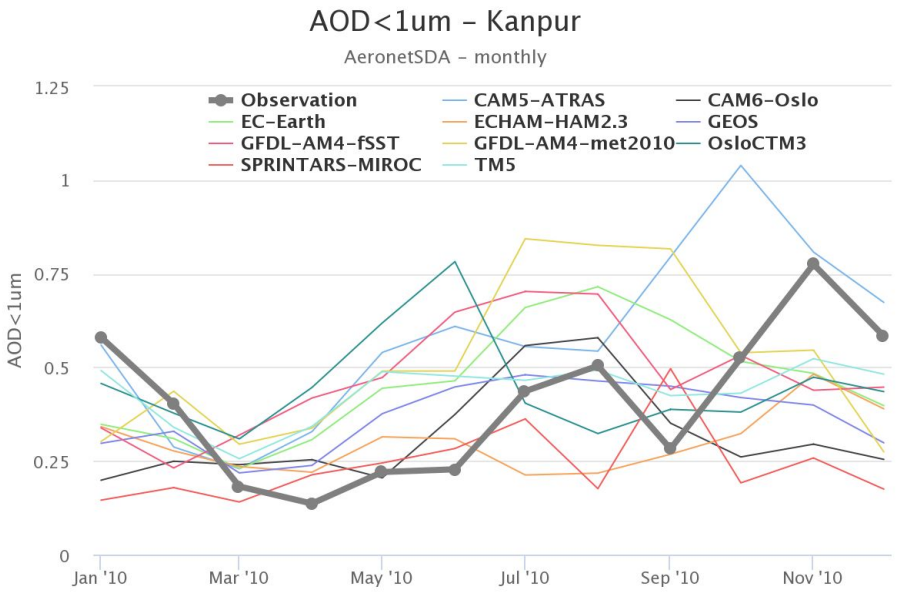
	CAM5-ATRAS	CAM6-Oslo	EC-Earth	ECHAM-HAM2.3	ECMWF-REAN	GEOS	GFDL-AM4-fSST	GFDL-AM4-met2010	OsloCTM3	SPRINTARS-MIROC	TM5	ensamble_mean
ASIA	-73	-13	-26	-88	-51	-38	-35	-58	-43	-130	-12	-52
AUSTRALIA	6	68	-6	-63	12	5	16	4	5	-69	20	-0
CHINA	-62	19	23	-67	-35	-31	-18	-41	-44	-104	39	-29
EUROPE	-17	27	-13	-15	-14	21	-6	5	17	-79	19	-5
INDIA	-81	-65	-85	-118	-76	-68	-77	-78	-46	-144	-63	-82
NAFRICA	-5	-22	-21	-4	-6	29	-11	3	37	-59	9	-4
NAMERICA	-56	5	-16	-73	-65	-54	-38	-47	-43	-131	17	-45
SAFRICA	46	69	-78	-126	-93	-30	-33	-34	-56	-86	-62	-44
SAMERICA	-31	6	-57	-99	-71	-65	-12	-23	-64	-114	-56	-53
WORLD	-39	12	-22	-60	-43	-23	-22	-27	-22	-108	4	-32

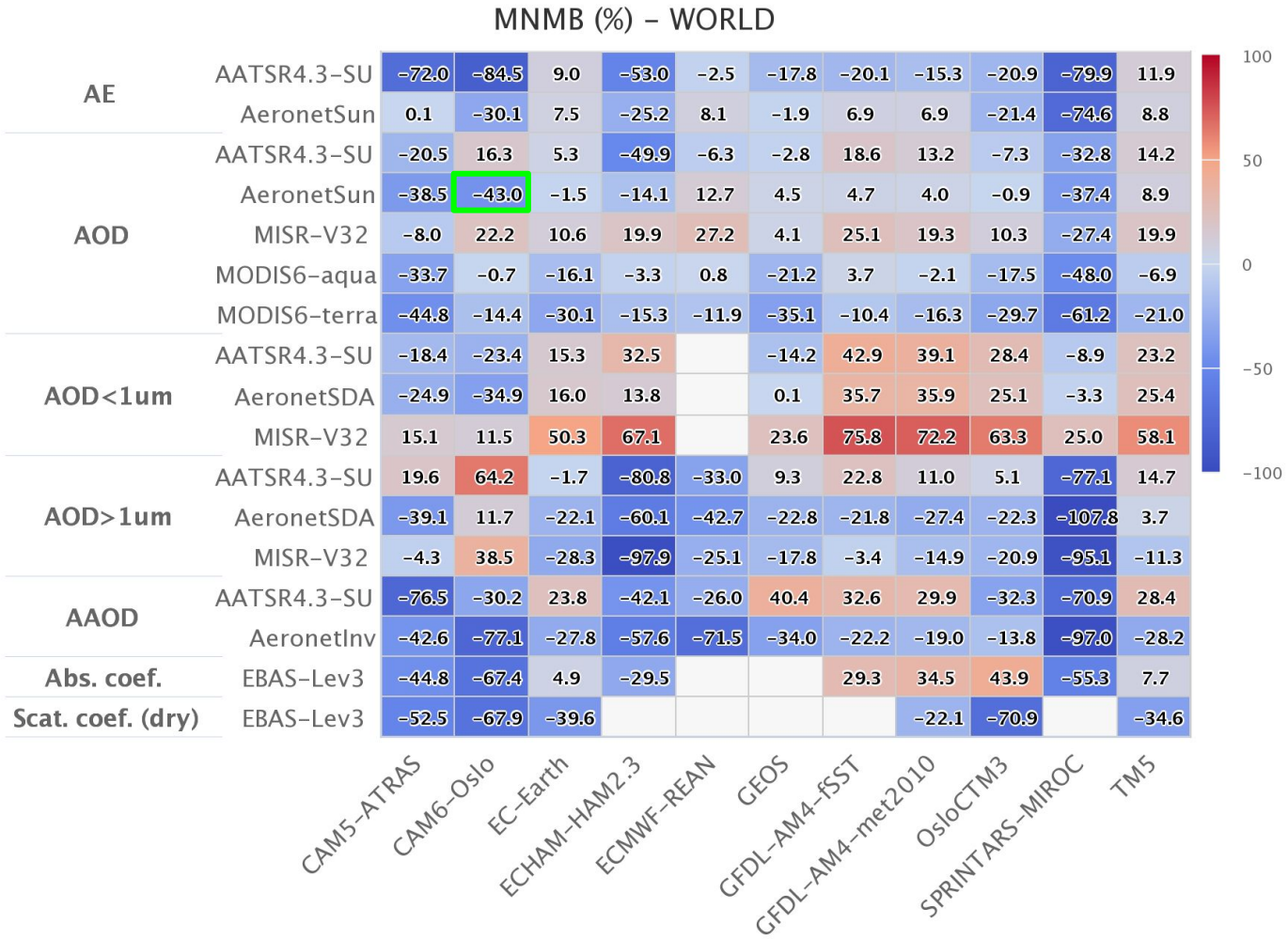


Regional bias: models vs. AERONET

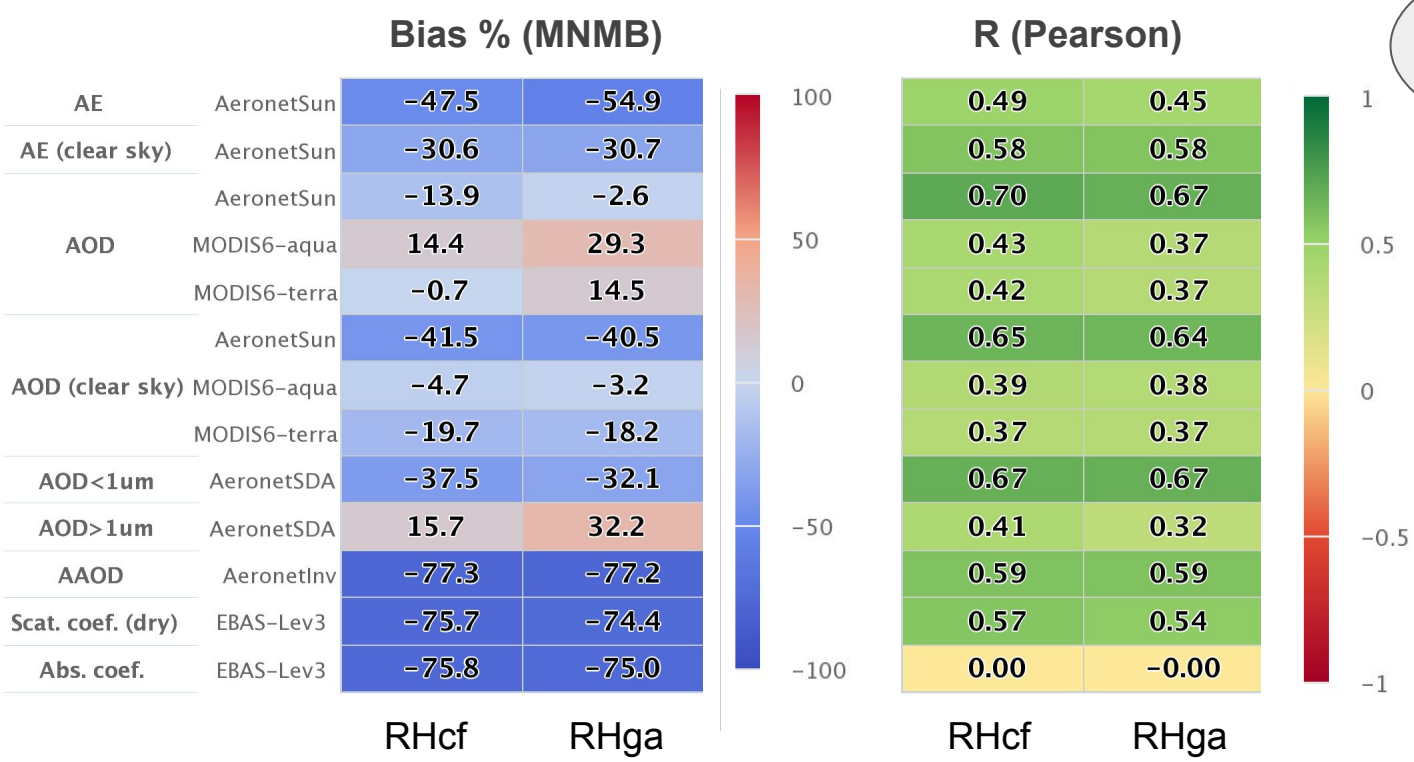




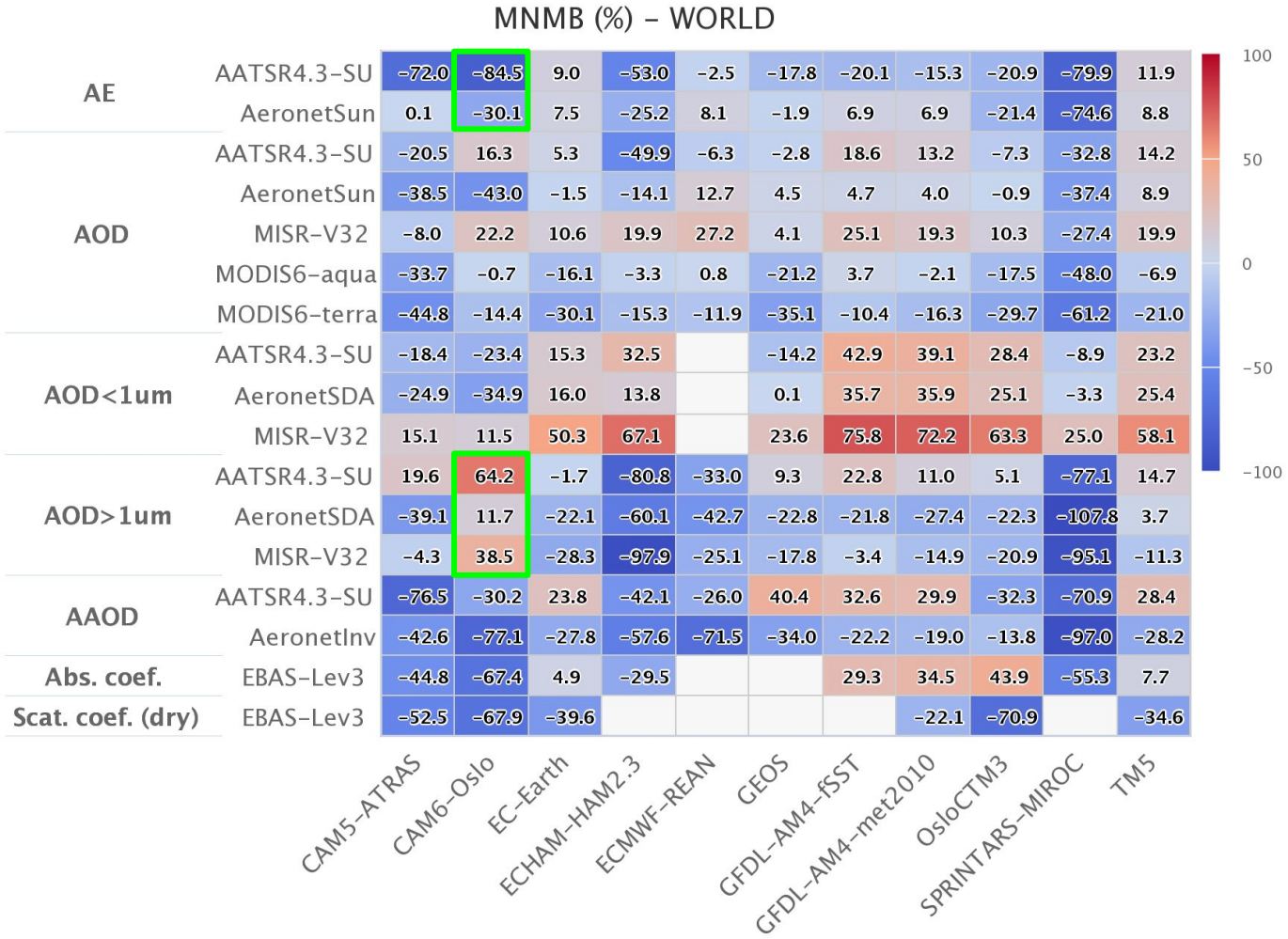



MNMB (%) – WORLD
AE
AATSR4.3-SU -72.0 -84.5 9.0 -53.0 -2.5 -17.8 -20.1 -15.3 -20.9 -79.9 11.9
AeronetSun 0.1 -30.1 7.5 -25.2 8.1 -1.9 6.9 6.9 -21.4 -74.6 8.8
AOD
AATSR4.3-SU -20.5 16.3 5.3 -49.9 -6.3 -2.8 18.6 13.2 -7.3 -32.8 14.2
AeronetSun -38.5 -43.0 -1.5 -14.1 12.7 4.5 4.7 4.0 -0.9 -37.4 8.9
MISR-V32 -8.0 22.2 10.6 19.9 27.2 4.1 25.1 19.3 10.3 -27.4 19.9
MODIS6-aqua -33.7 -0.7 -16.1 -3.3 0.8 -21.2 3.7 -2.1 -17.5 -48.0 -6.9
MODIS6-terra -44.8 -14.4 -30.1 -15.3 -11.9 -35.1 -10.4 -16.3 -29.7 -61.2 -21.0
AOD<1um
AATSR4.3-SU -18.4 -23.4 15.3 32.5 -14.2 42.9 39.1 28.4 -8.9 23.2
AeronetSDA -24.9 -34.9 16.0 13.8 0.1 35.7 35.9 25.1 -3.3 25.4
MISR-V32 15.1 11.5 50.3 67.1 23.6 75.8 72.2 63.3 25.0 58.1
AOD>1um
AATSR4.3-SU 19.6 64.2 -1.7 -80.8 -33.0 9.3 22.8 11.0 5.1 -77.1 14.7
AeronetSDA -39.1 11.7 -22.1 -60.1 -42.7 -22.8 -21.8 -27.4 -22.3 -107.8 3.7
MISR-V32 -4.3 38.5 -28.3 -97.9 -25.1 -17.8 -3.4 -14.9 -20.9 -95.1 -11.3
AAOD
AATSR4.3-SU -76.5 -30.2 23.8 -42.1 -26.0 40.4 32.6 29.9 -32.3 -70.9 28.4
AeronetInv -42.6 -77.1 -27.8 -57.6 -71.5 -34.0 -22.2 -19.0 -13.8 -97.0 -28.2
Abs. coef.
EBAS-Lev3 -44.8 -67.4 4.9 -29.5 29.3 34.5 43.9 -55.3 7.7
Scat. coef. (dry)
EBAS-Lev3 -52.5 -67.9 -39.6 -22.1 -70.9 -34.6
CAM5-ATRAS
CAM6-Oslo
EC-Earth
ECHAM-HAM2.3
ECMWF-REAN
GEOS
GFDL-AM4-fSST
GFDL-AM4-met2010
OsloCTM3
SPRINTARS-MIROC
TM5
100
50
0
-50
-100

CAM6-Oslo: Clear-sky vs. all-sky optical properties



See poster Kirkevåg et al.


MNMB (%) – WORLD
AE
AATSR4.3-SU -72.0 -84.5 9.0 -53.0 -2.5 -17.8 -20.1 -15.3 -20.9 -79.9 11.9
AeronetSun 0.1 -30.1 7.5 -25.2 8.1 -1.9 6.9 6.9 -21.4 -74.6 8.8
AOD
AATSR4.3-SU -20.5 16.3 5.3 -49.9 -6.3 -2.8 18.6 13.2 -7.3 -32.8 14.2
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MODIS6-aqua -33.7 -0.7 -16.1 -3.3 0.8 -21.2 3.7 -2.1 -17.5 -48.0 -6.9
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AATSR4.3-SU -18.4 -23.4 15.3 32.5 -14.2 42.9 39.1 28.4 -8.9 23.2
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MISR-V32 15.1 11.5 50.3 67.1 23.6 75.8 72.2 63.3 25.0 58.1
AOD>1um
AATSR4.3-SU 19.6 64.2 -1.7 -80.8 -33.0 9.3 22.8 11.0 5.1 -77.1 14.7
AeronetSDA -39.1 11.7 -22.1 -60.1 -42.7 -22.8 -21.8 -27.4 -22.3 -107.8 3.7
MISR-V32 -4.3 38.5 -28.3 -97.9 -25.1 -17.8 -3.4 -14.9 -20.9 -95.1 -11.3
AAOD
AATSR4.3-SU -76.5 -30.2 23.8 -42.1 -26.0 40.4 32.6 29.9 -32.3 -70.9 28.4
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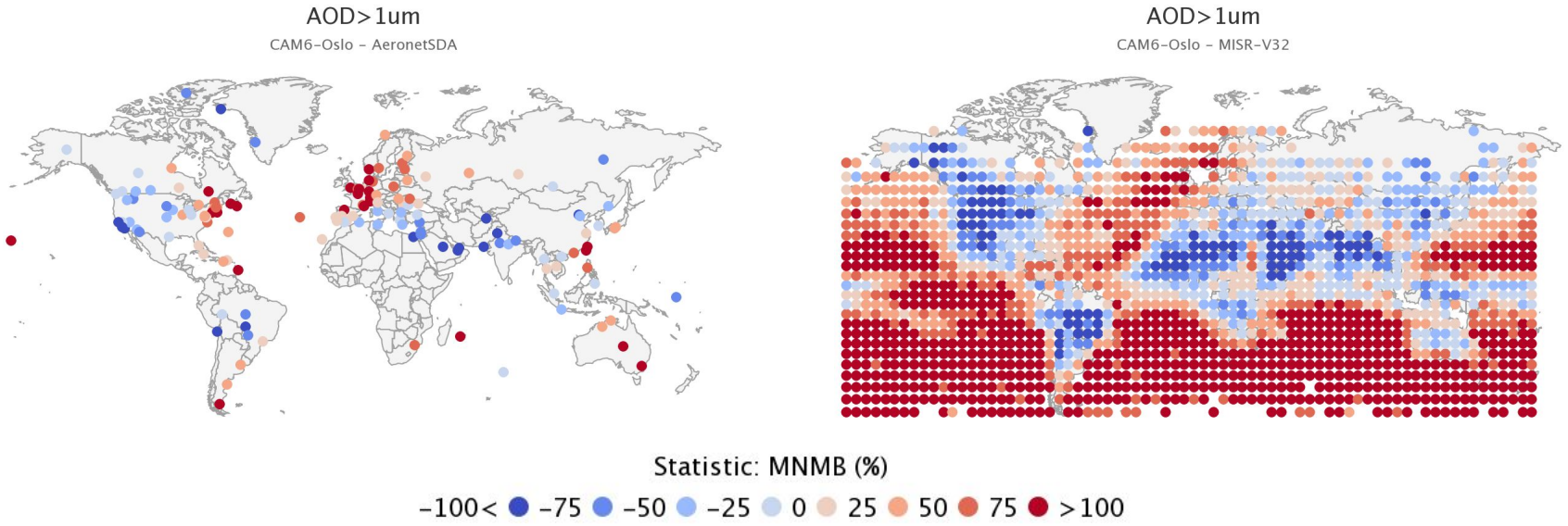
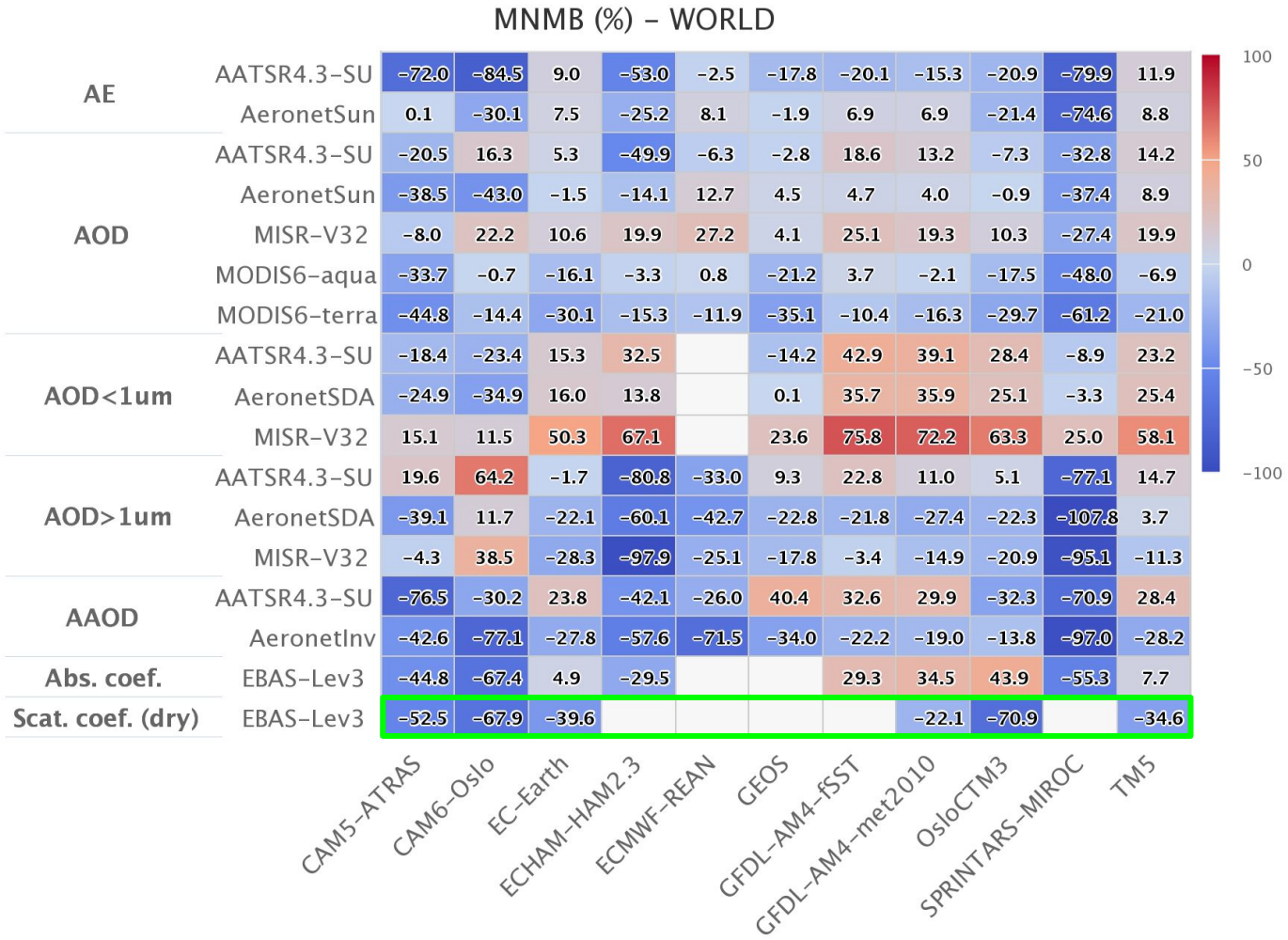
ECMWF-REAN
GEOS
GFDL-AM4-fSST
GFDL-AM4-met2010
OsloCTM3
SPRINTARS-MIROC
TM5
100
50
0
-50
-100

CAM6-Oslo: too much sea-salt




MNMB (%) – WORLD
AE
AATSR4.3-SU -72.0 -84.5 9.0 -53.0 -2.5 -17.8 -20.1 -15.3 -20.9 -79.9 11.9
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AOD<1um
AATSR4.3-SU -18.4 -23.4 15.3 32.5 -14.2 42.9 39.1 28.4 -8.9 23.2
AeronetSDA -24.9 -34.9 16.0 13.8 0.1 35.7 35.9 25.1 -3.3 25.4
MISR-V32 15.1 11.5 50.3 67.1 23.6 75.8 72.2 63.3 25.0 58.1
AOD>1um
AATSR4.3-SU 19.6 64.2 -1.7 -80.8 -33.0 9.3 22.8 11.0 5.1 -77.1 14.7
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AAOD
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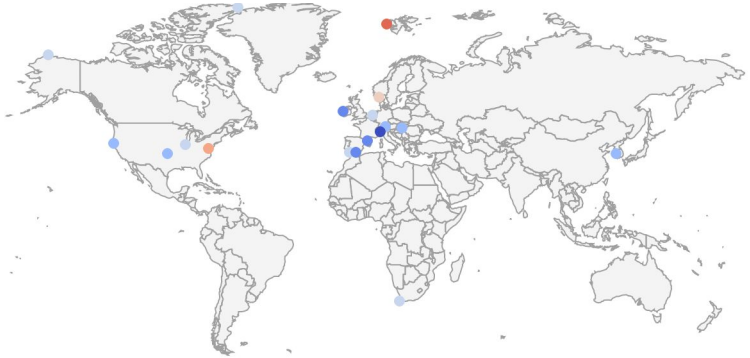
ECMWF-REAN
GEOS
GFDL-AM4-fSST
GFDL-AM4-met2010
OsloCTM3
SPRINTARS-MIROC
TM5
100
50
0
-50
-100

Underestimated dry surface scattering

Bias GFDL



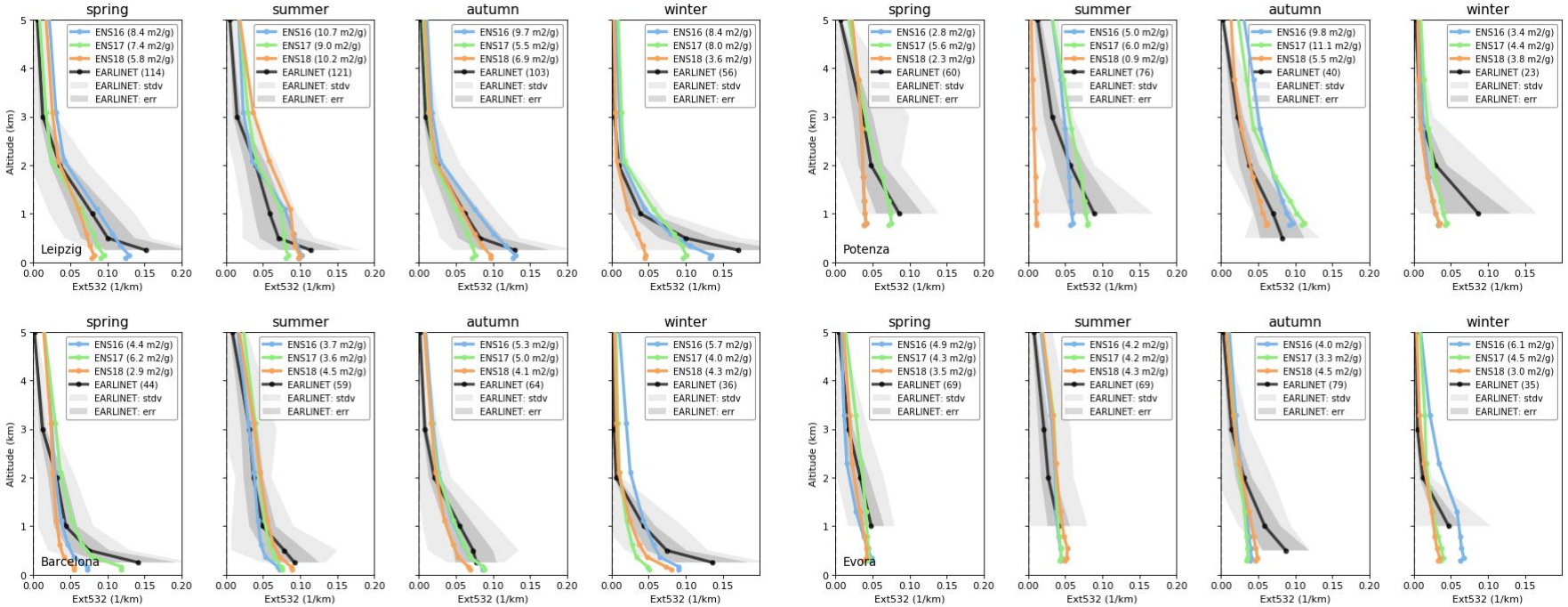
Bias OsloCTM

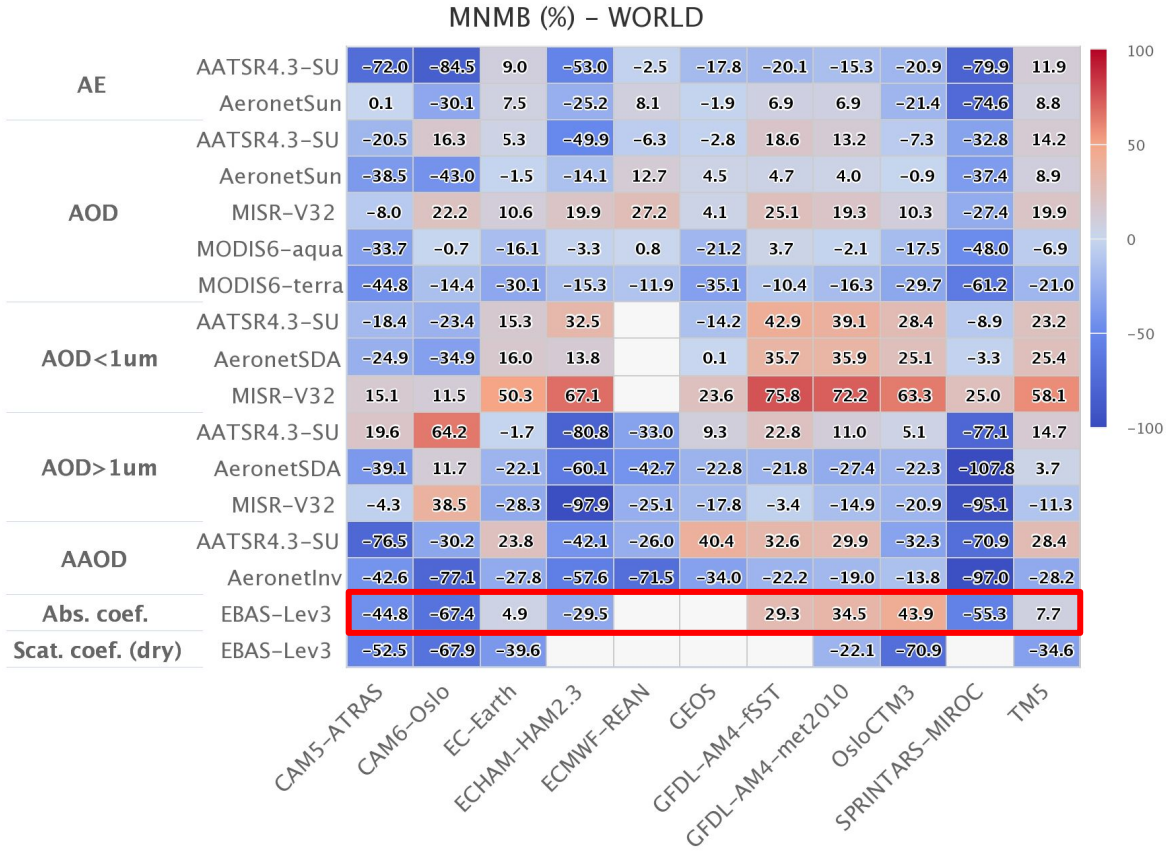
Bias EC-Earth

Bias TM5

Underestimated surface scattering

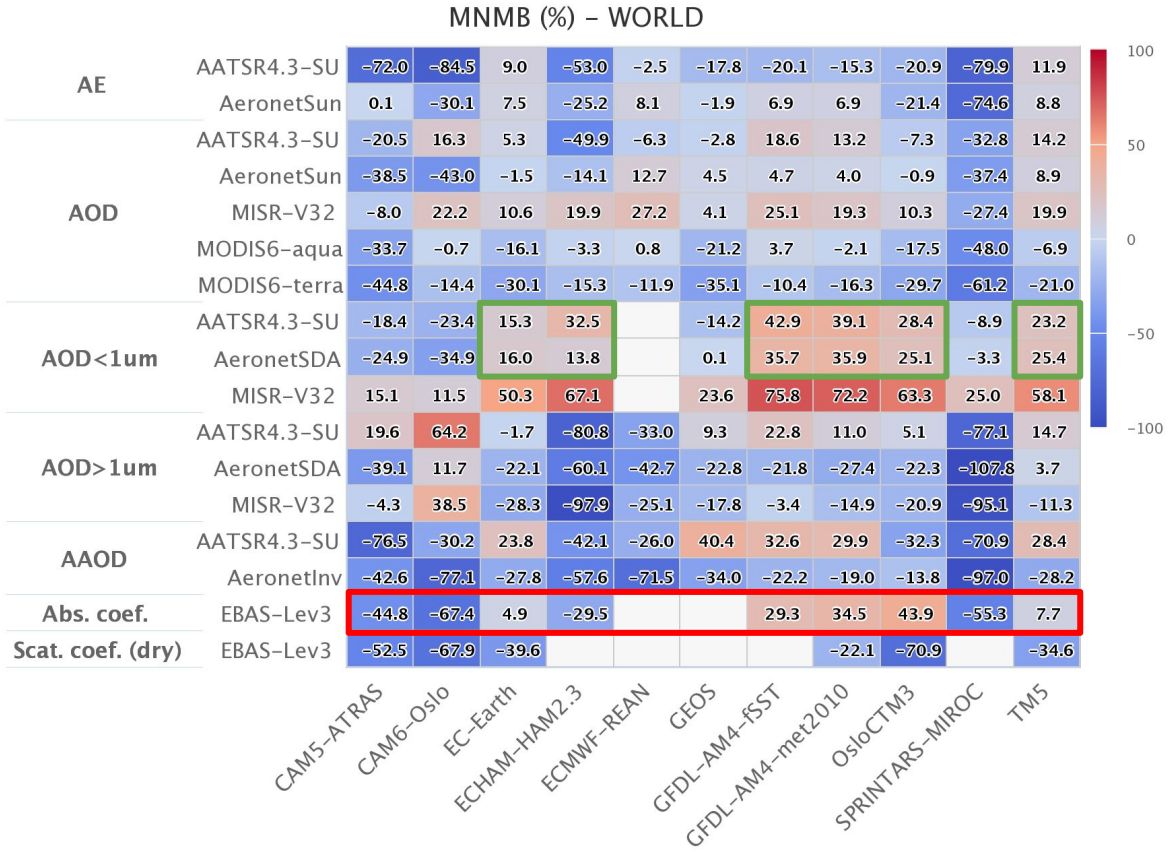
CAMS regional ensemble models vs EARLINET stations





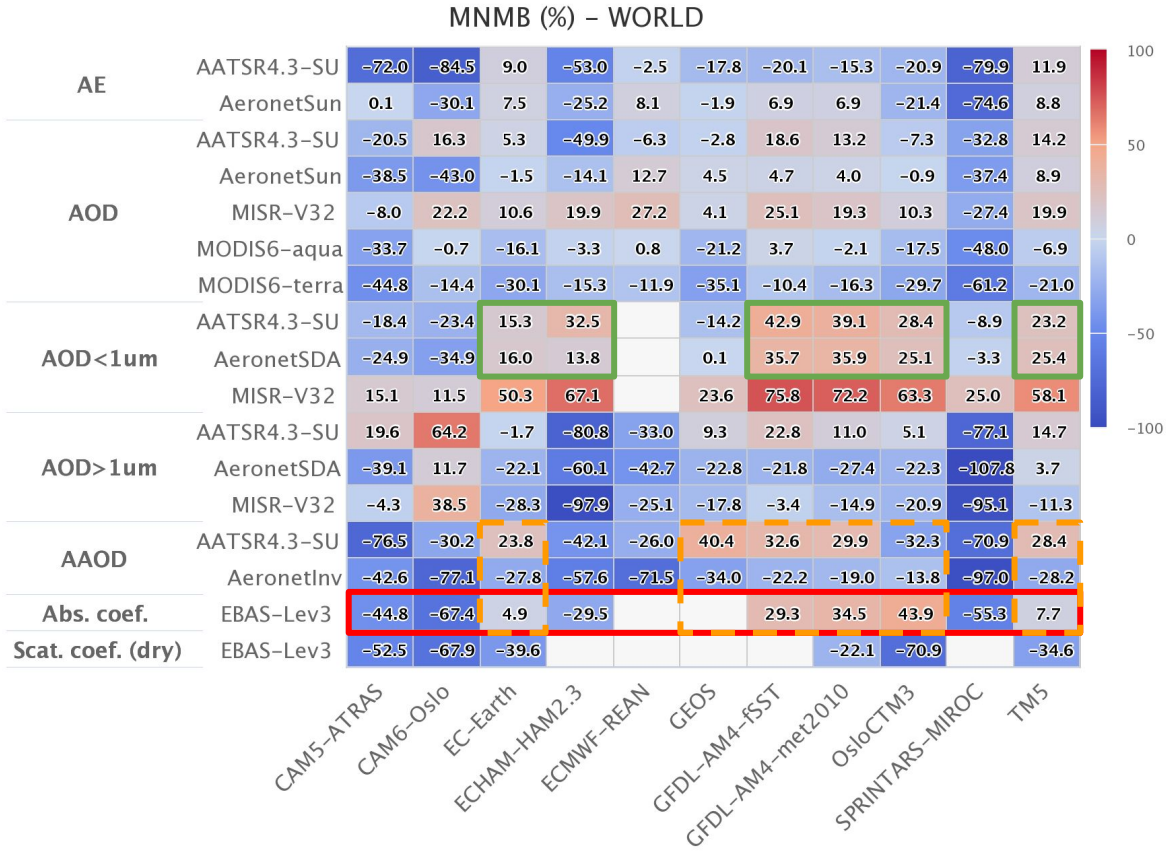
Some further points:

- **High diversity in surface absorption**



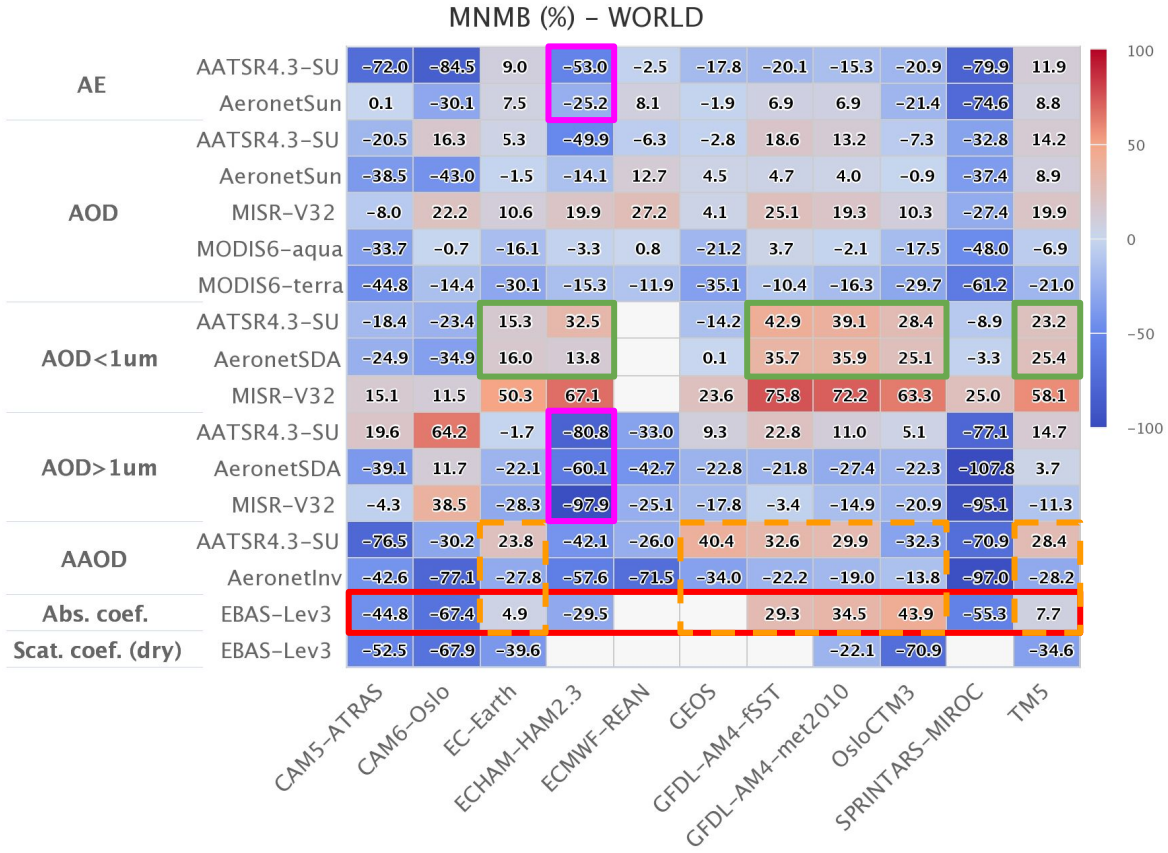
Some further points:

- **High diversity in surface absorption**
- **Overestimated fine mode in several models**



Some further points:

- **High diversity in surface absorption**
- **Overestimated fine mode in several models**
- **Different signs in absorption signals**



Some further points:

- High diversity in surface absorption
- Overestimated fine mode in several models
- Different signs in absorption signals
- ECHAM: too little dust, but AE bias suggests larger particles

Summary and conclusions

- Analysis of modelled optical properties against multiple ground and space based observations (interactively visible at https://aerocom-evaluation.met.no/)
- Global scale, yearly average statistics for 2010 emissions and meteorology
- Satellites vs. AERONET:
  - MODIS terra AODs overestimated (cf. e.g. Wei et al., 2019)
  - MISR fine mode AOD underestimated vs. AERONET (-30%), coarse mode overestimated (+ 30%)
- AOD underestimated in CAM6-Oslo, CAM5-ATRAS and SPRINTARS (~ -40 %)
  - SPRINTARS: low overall emissions and burden
  - CAM6-Oslo: possibly due to missing of e.g. nitrate, agricultural dust, anthropogenic SOA
- Satellites “see” the ocean (e.g. sea-salt bias CAM6-Oslo visible in AOD’s and AE)
- Contradictory results in some models (e.g. AE vs. fine/coarse AOD ECHAM, SPRINTARS)
- India has too little coarse particles (dust transport?)
- Surface scattering underestimated in all models (further work required)
  - check profile extinction data
  - check dry assumptions, i.e. RH=0 vs. RH<40%).
- High diversity in surface absorption (@EBAS stations): -68% (CAM6-Oslo) - +44% (OsloCTM3)

Outlook / Discussion

- Evaluate modelled surface concentrations of OA, SS, SO4, (NO3) and BC vs. EBAS
- Investigate lifetimes of individual species
- Investigate diversity of modelled AOD's from individual species
- Incorporate CALIOP and EARLINET observations to investigate vertical distributions
- Evaluate AeroCom mean / median ensemble model
- How to account for spatial and temporal representativeness of measurements?
  - e.g. regional averages, station classification (rural, urban, marine, …), land / sea filtering
  - Spatial / temporal gap filling methods?
- Next steps in web interface:
  - Evaluation of vertical profiles, regional and seasonal heatmaps for individual variables…
- Discussion data processing: improve processing workflow from upload of model data to automised processing / preview in new interface