Table S1. List of AERONET sites used in this study for evaluation of the aerosol reanalysis products for 2011-2019. Geolocation and additional site information of these sites can be found from https://aeronet.gsfc.nasa.gov/cgi-bin/draw_map_display_aod_v3.

ATHENS-NOA	CEILAP-RG	Ersa	IMAA_Potenza	Lecce_University	NASA_LaRC	Rimrock	Toravere
AgiaMarina_Xyliatou	CLUJ_UBB	Evora	IMPROVE-MammothCave	Leipzig	NEON_CVALLA	Rio_Branco	Toronto
Alta_Floresta	CUIABA-MIRANDA	FZJ-JOYCE	IMS-METU-ERDEMLI	Lille	NEON_Harvard	Rome_Tor_Vergata	Toulouse_MF
Anmyon	CUT-TEPAK	Fort_McMurray	Iasi_LOASL	Lulin	NEON_MOAB	SANTA_CRUZ_UTEPSA	Trelew
Appalachian_State	Cabo_da_Roca	Fresno_2	Ilorin	MCO-Hanimaadhoo	NEON_ONAQ	SEDE_BOKER	Tucson
Arica	Cairo_EMA_2	Frioul	Ispra	MD_Science_Center	NEON_OSBS	SERC	UCSB
Ascension_Island	CalTech	Fukuoka	Issyk-Kul	Madrid	NEON_RMNP	SP_Bayboro	UMBC
Aubiere_LAMP	Camaguey	GSFC	Izana	Mainz	NEON_TALL	Saada	USC_SEAPRISM
BONDVILLE	Canberra	Gandhi_College	Jabiru	Manila_Observatory	OHP_OBSERVATOIRE	Sandia_NM_PSEL	USGS_Flagstaff_ROLO
BSRN_BAO_Boulder	Capo_Verde	Gangneung_WNU	Jaipur	Masdar_Institute	Osaka	Santa_Cruz_Tenerife	USM_Penang
Banizoumbou	Carpentras	Georgia_Tech	Ji_Parana_SE	Mauna_Loa	Palaiseau	Santa_Monica_Colg	U_of_Wisconsin_SSEC
Barcelona	Cart_Site	Gloria	KAUST_Campus	Medenine-IRA	Palangkaraya	Saturn_Island	Ubon_Ratchathani
Beijing	Chen-Kung_Univ	Gobabeb	Kanpur	Messina	Palencia	Seoul_SNU	Univ_of_Houston
Beijing-CAMS	Chiang_Mai_Met_Sta	Goldstone	Karachi	Mexico_City	Palma_de_Mallorca	Sevilleta	Univ_of_Lethbridge
Belsk	Chiba_University	Granada	Key_Biscayne	Mezaira	Paris	Silpakorn_Univ	Univ_of_Nevada-Reno
Ben_Salem	Coruna	Guadeloup	Key_Biscayne2	Minsk	Petrolina_SONDA	Singapore	Ussuriysk
Billerica	Dakar	Gwangju_GIST	Kyiv	Missoula	Pickle_Lake	Sioux_Falls	Valladolid
Birdsville	Dalanzadgad	Halifax	LISCO	Modena	Pokhara	St_Louis_University	Venise
Bozeman	Davos	Harvard_Forest	La_Laguna	Moldova	Pontianak	TABLE_MOUNTAIN_CA	Wallops
Brussels	Dhaka_University	Helsinki	La_Parguera	Mongu_Inn	Pretoria_CSIR-DPSS	Tabernas_PSA-DLR	WaveCIS_Site_CSI_6
Burjassot	Dushanbe	HohenpeissenbergDWD	La_Paz	Monterey	QOMS_CAS	Table_Mountain	White_Sands_HELSTF
CARTEL	EPA-Res_Triangle_Pk	Huancayo-IGP	Lahore	Montsec	REUNION_ST_DENIS	Tallahassee	XiangHe
CCNY	Egbert	Huelva	Lake_Argyle	Moscow_MSU_MO	Ragged_Point	Tamanrasset_INM	Yonsei_University
CEILAP-BA	Eilat	IASBS	Lake_Lefroy	Munich_University	Railroad_Valley	Thessaloniki	Zaragoza
CEILAP-Neuquen	El_Farafra	IER_Cinzana	Lampedusa	Murcia	Red_Mountain_Pass	Thompson_Farm	Zinder_Airport

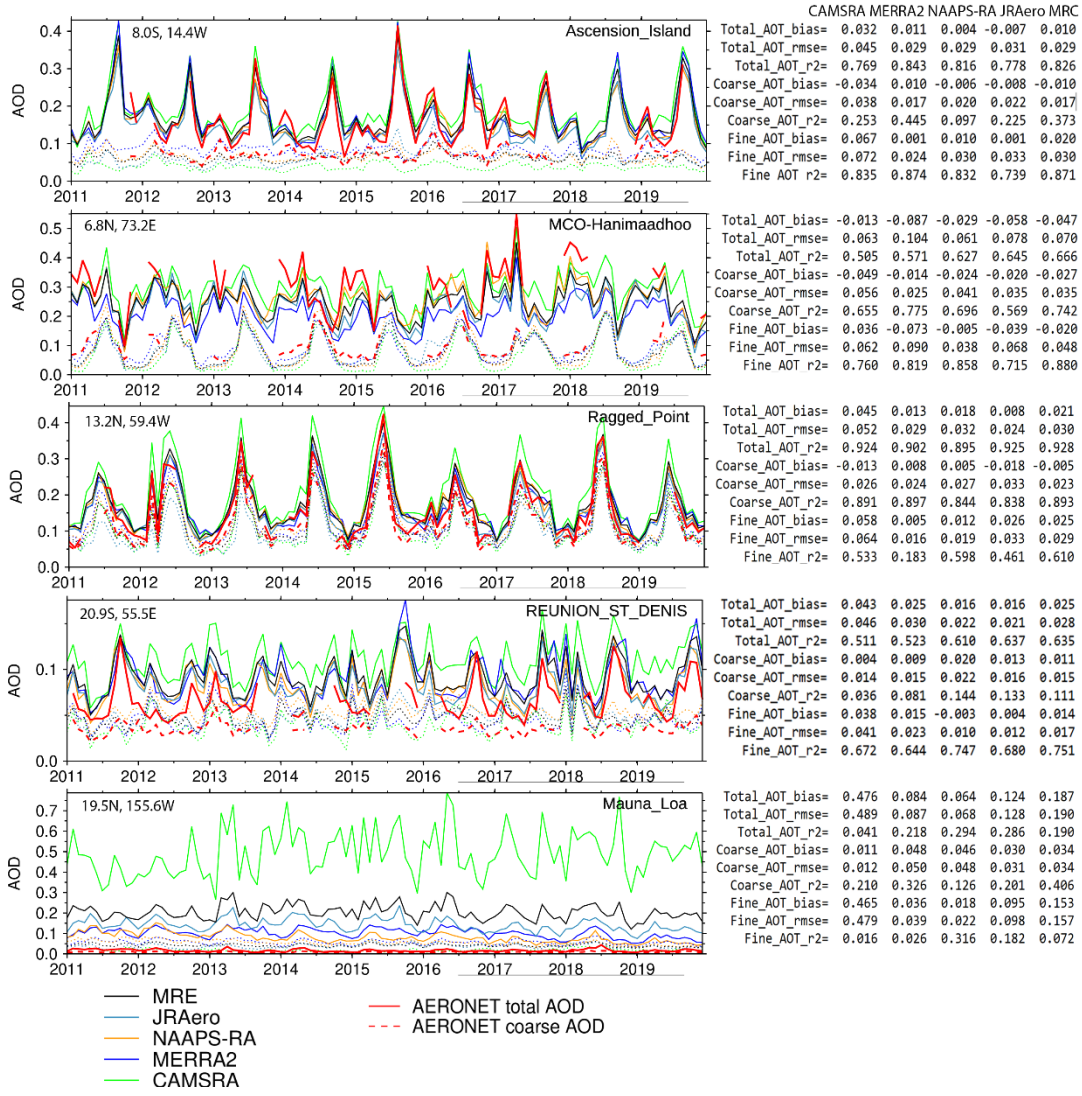


Figure S1. Time series of monthly total and CM AODs at 550nm from the four aerosol reanalyses, the MRC and AERONET at remote marine sites. Modal AOD RMSE, bias and r^2 of each reanalysis validated with AERONET data is shown on the text column on the right.

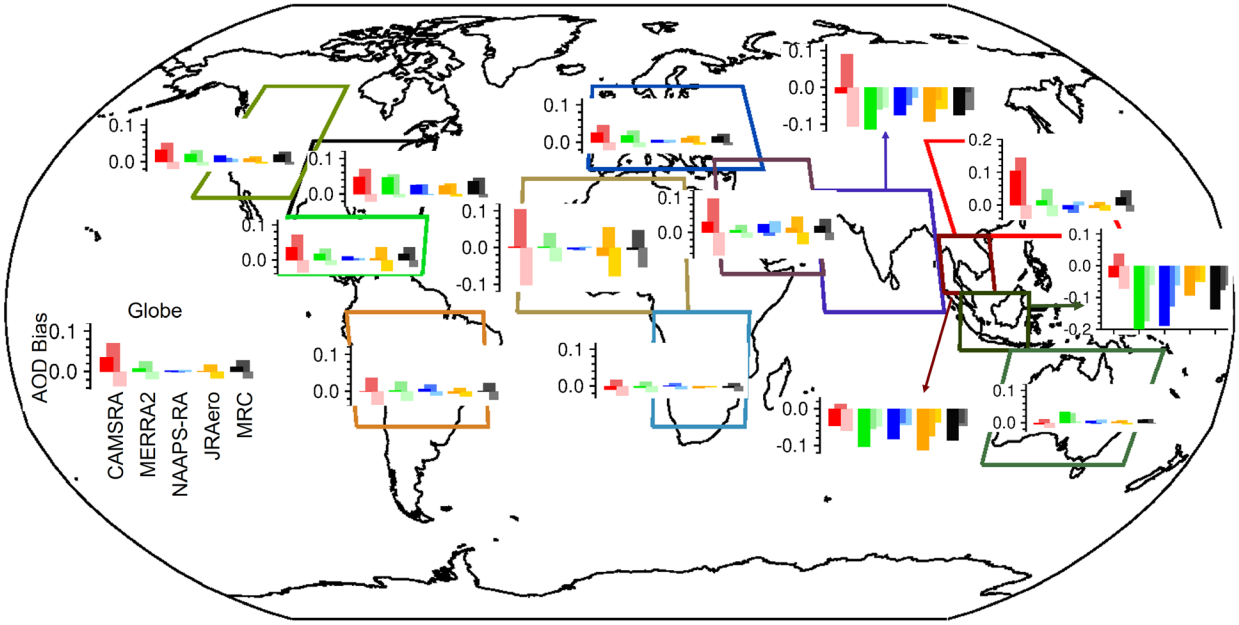


Figure S2. Regional total, FM, and CM AOD biases for the four reanalyses and the MRC compared with AERONET data. Each grouped bars in the same color system present total, FM, and CM AOD biases from left to right (also dark to light). This figure is similar to Fig. 5, except that FM and CM AOD are calculated with considering FM and CM components of dust and sea salt aerosols, while dust and sea salt are considered as CM in Fig. 5.

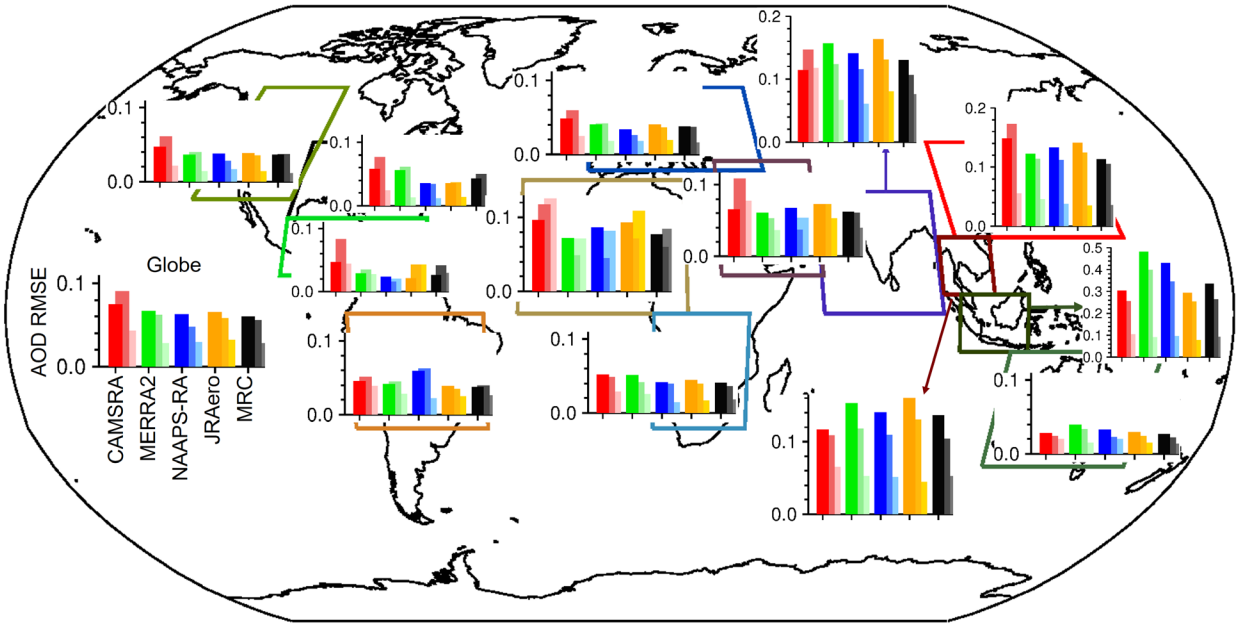


Figure S3. Same as Fig. S2, except for AOD RMSE.

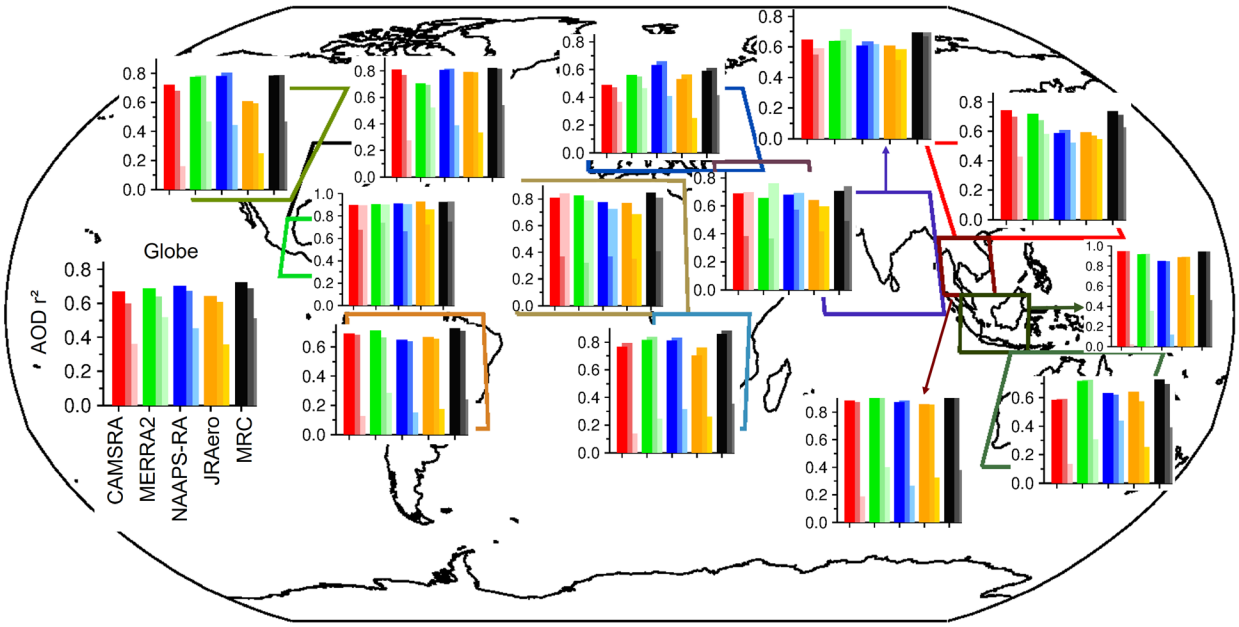
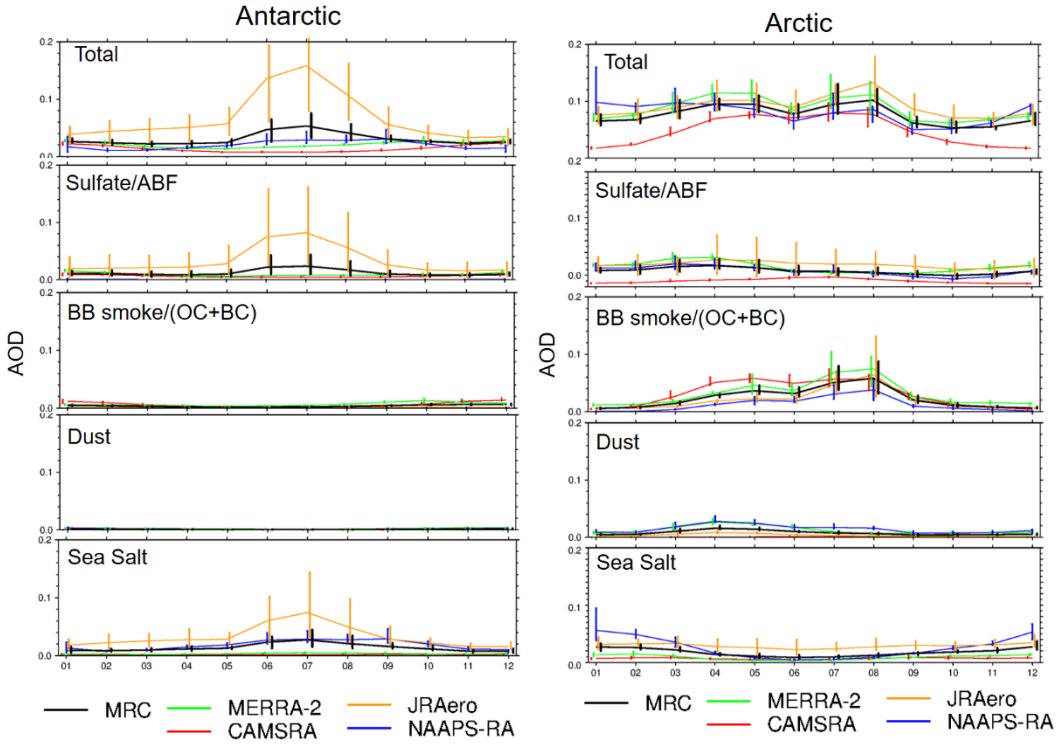
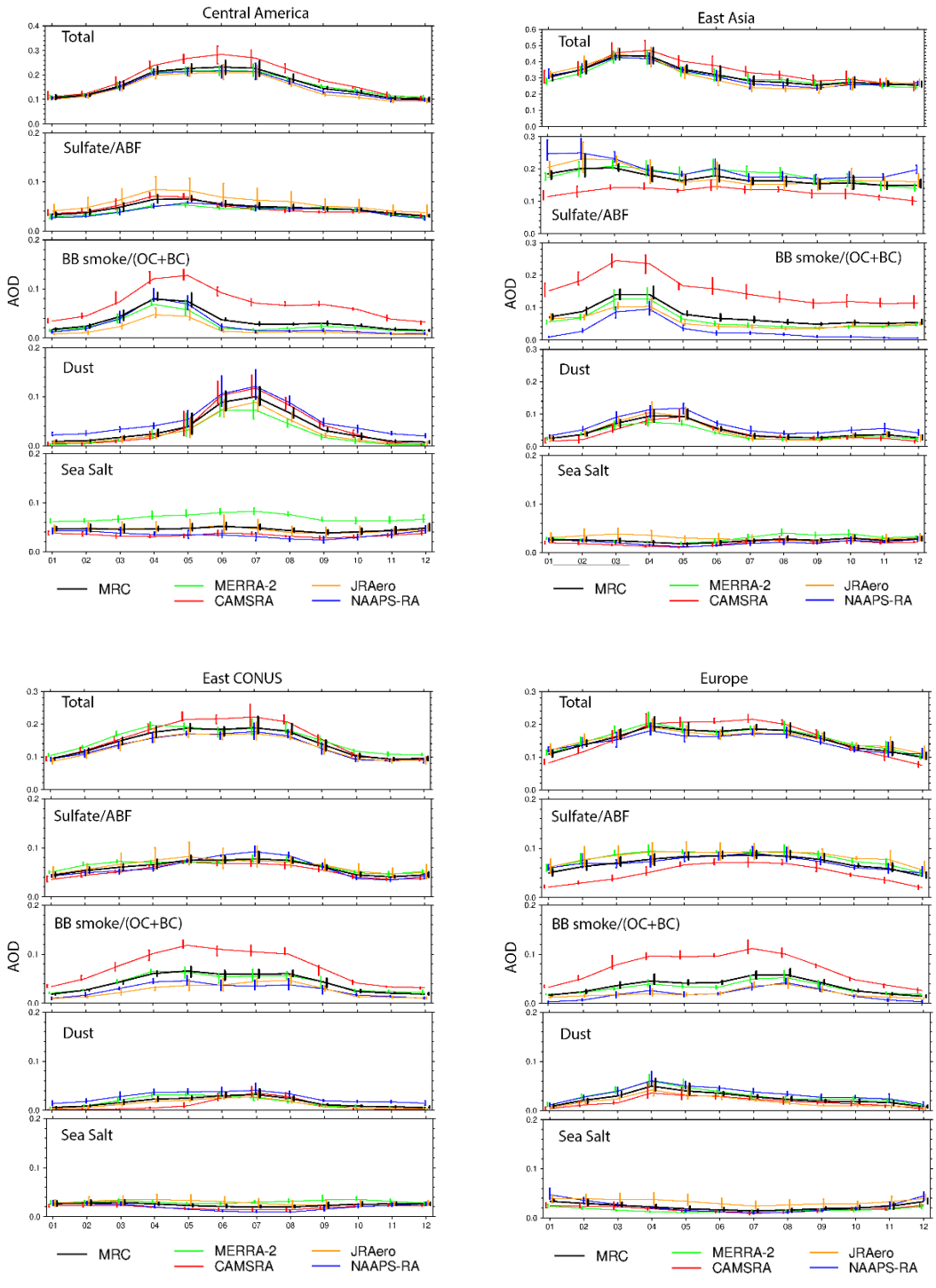
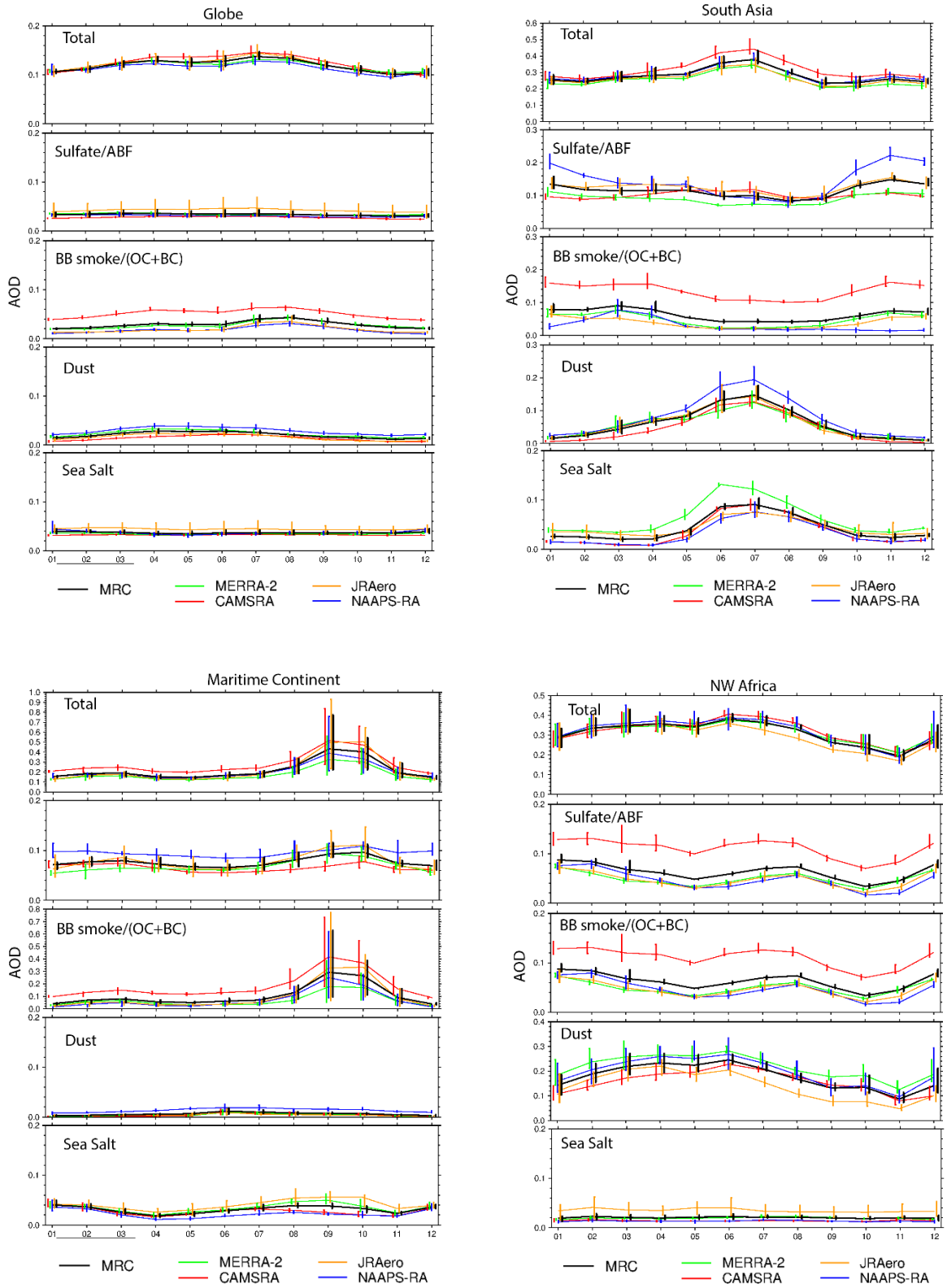
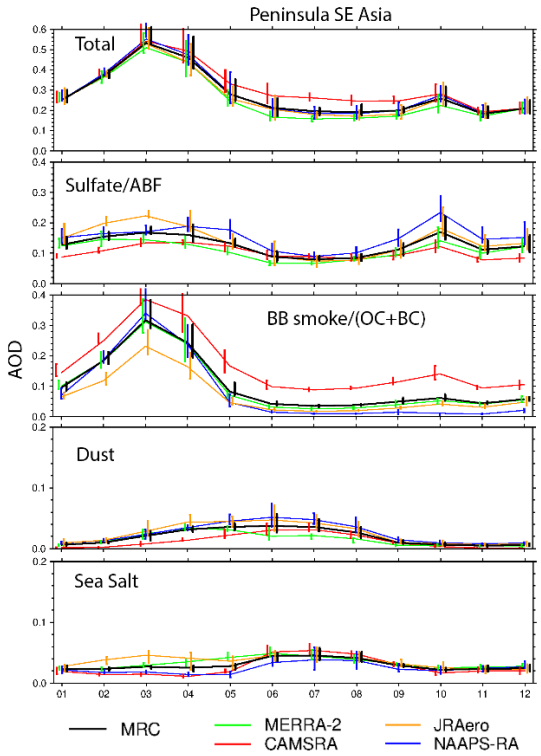


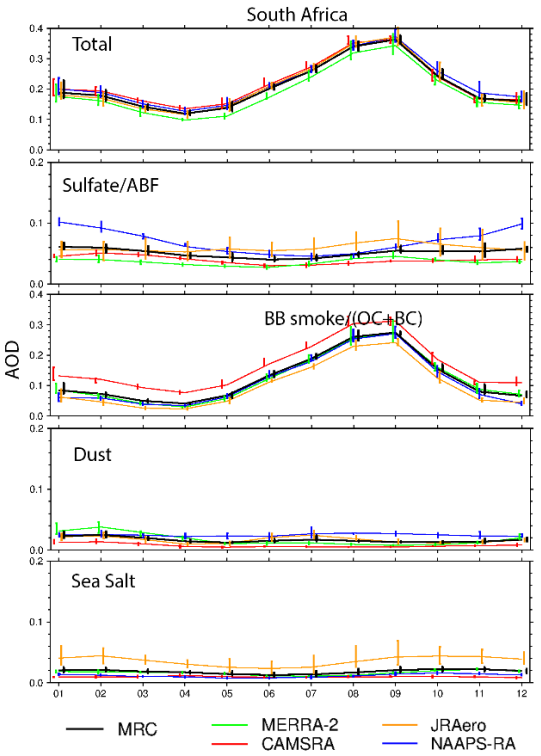
Figure S4. Same as Fig. S2, except for AOD coefficient of determination (r^2).

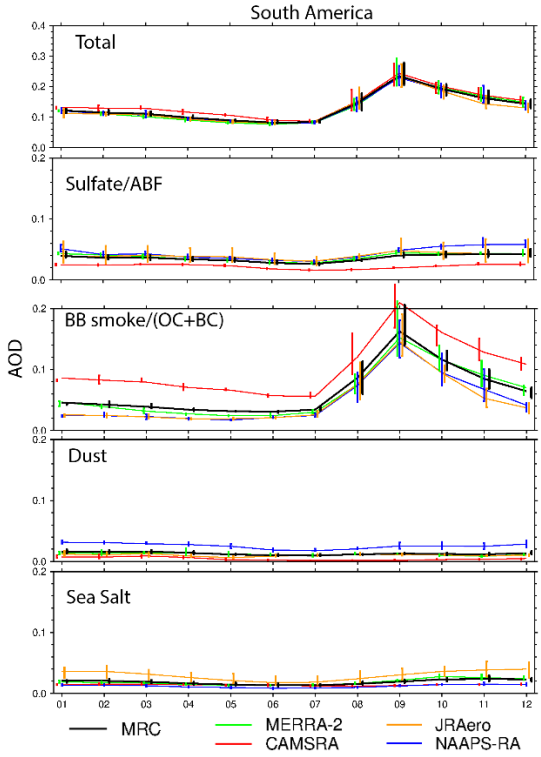


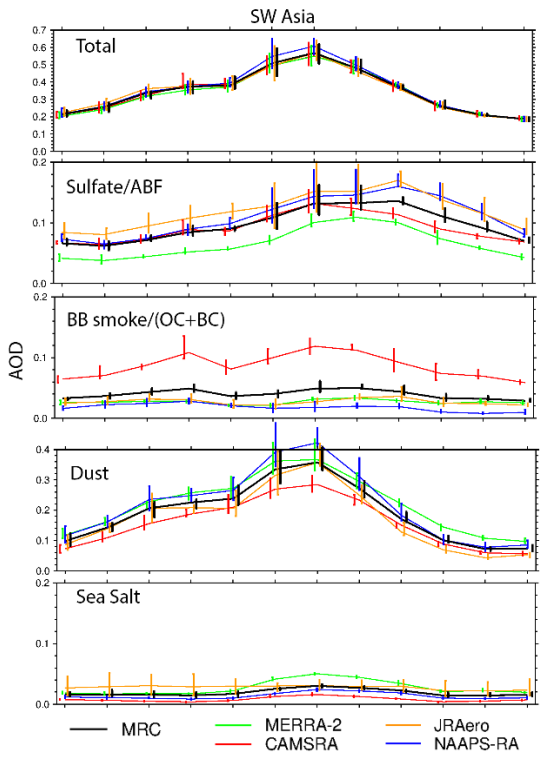

Central America
East Asia
East CONUS
Europe
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA


Globe
South Asia
Maritime Continent
NW Africa
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA


Peninsula SE Asia
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
01 02 03 04 05 06 07 08 09 10 11 12
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA


South Africa
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
01 02 03 04 05 06 07 08 09 10 11 12
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA


South America
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
01 02 03 04 05 06 07 08 09 10 11 12
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA


SW Asia
Total
Sulfate/ABF
BB smoke/(OC+BC)
Dust
Sea Salt
AOD
MRC
MERRA-2
CAMSRA
JRAero
NAAPS-RA

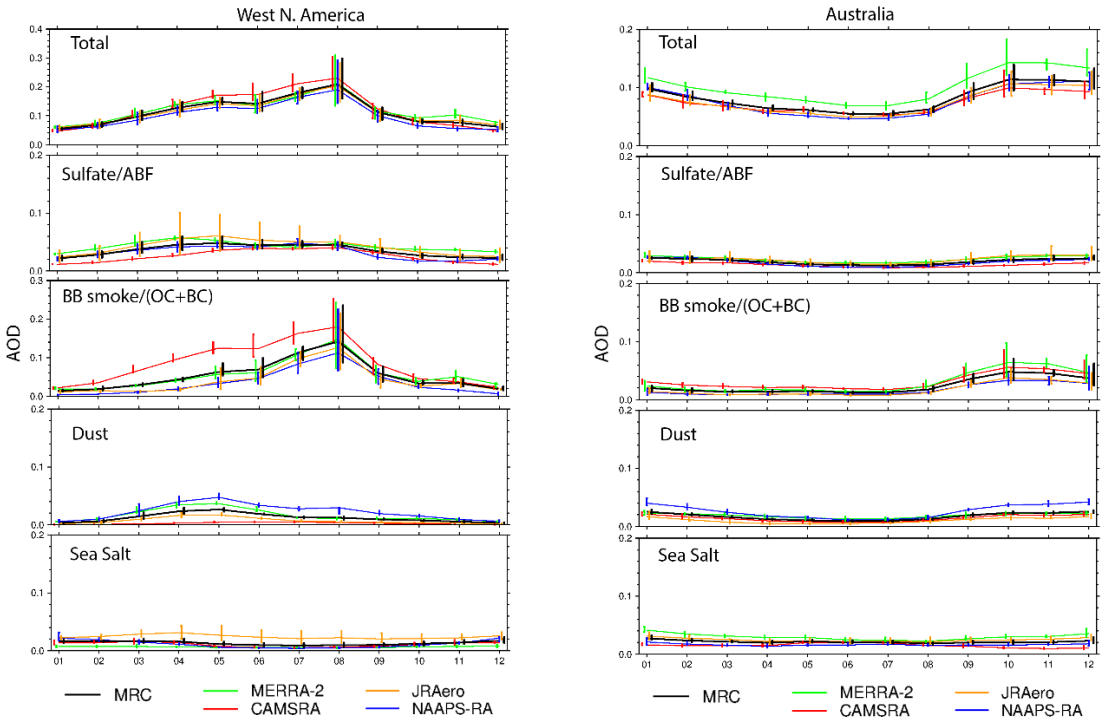


Figure S5. Climatological seasonal cycle of regional mean total and speciated AODs for the 16 regions from the four RAs and the MRC. Bars represent the interquartile range of monthly-mean AOD for 2011-2019.