Atmospheric Composition and Asian Monsoon (ACAM) – A coordinated modeling and analysis project: Part 1 – Aerosol simulated by global models

Wiki website: https://wiki.met.no/aerocom/phase3-experiments#atmospheric_composition_and_asian_monsoon_acam_analysis
Organizers: Xiaohua Pan, Jonathon Wright, Mian Chin
Contacts: Xiaohua Pan: xiaohua.pan@nasa.gov, Jonathon Wright: jswright@tsinghua.edu.cn

The current version is v10, updated on May 13, 2020 (changes/clarifications relative to the v9 are in red)

- *We periodically update the stauts and clarify the requirement according to the feedbacks from paricipants, so please exchange your idea with us and visit Wiki website above to obtain the latest version*

Motivation:

The Asian monsoon system is a major component in Earth's climate. Given rapid population and economic growth across the Asian monsoon region, serious concern has emerged that coupling between the monsoon system and surface emissions is having increasingly significant effects not only on regional air quality but also on global atmospheric composition. This proposed activity represents a coordinated modeling and analysis effort among the AeroCom, CCMI, and ACAM communities to study interactions between Asian air pollution and the monsoon system. In Part 1 of ACAM as stated in this docoment, we will only focus on aerosols simulated by global models. In Part 2, we may focus on trace gases by global models, and in Part 3 aerosols and trace gases by regional models.

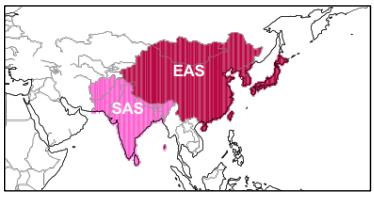
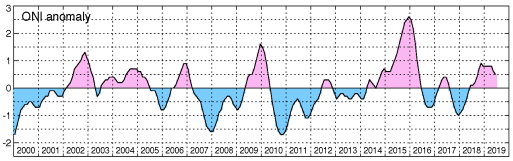
Objectives:

- Compare and evaluate model-simulated aerosol and related species in the Asian monsoon region with observations from remote sensing and recent ground-based and aircraft measurements
- Identify and examine pathways of trace gases and aerosols in the UTLS above the Asian monsoon with respect to the monsoon anticyclone, large-scale transport, and atmospheric chemistry
- Investigate interactions between Asian pollution and monsoon meteorology

Type of Simulations:

The following model experiments and outputs are proposed for ACAM. Note that these model experiments are the same as AeroCom Phase III UTLS Tier 2 experiments except for a shorter simulation period. Thus, modelers participating in the UTLS experiment with Tier 2 simulations do not need to repeat the model simulations, and the UTLS experiment results will be used for the ACAM analysis (and vice versa).

Model experiments:	
Simulation period:	2008-2017 (10 years)
Experiments:	
▪ BASE	Model simulation with all emissions
▪ FIR0	Same as BASE but without biomass burning emissions globally
▪ ANT0	Same as BASE but without anthropogenic emissions globally
▪ EAS0 (use region mask)	Same as BASE but without East Asian anthropogenic emissions
▪ SAS0 (use region mask)	Same as BASE but without South Asian anthropogenic emissions

Region mask:	https://tropo.gsfc.nasa.gov/gocart/products/xchange/aerocom/aerocom3/region_code/ file name = region-code_htap2_tier1_mod_0.5x0.5.nc (0.5 deg resolution)  

Emissions *(see AeroCom Phase III wiki for access to the emission files)**:***

Emission amount ▪ Anthropogenic: ▪ Biomass burning: ▪ Volcanic: ▪ Natural (dust, seasalt, biogenic):	 CMIP6 (sum of 8 sectors in CMIP6 anthropogic emission, i.e., 0: Agriculture; 1: Energy; 2: Industrial; 3: Transportation; 4: Residential, Commercial, Other; 5: Solvents production and application; 6: Waste; 7: International Shipping, and plus aviation emission) CMIP6 Carn dataset, SO_2 from eruptive and degassing volcanoes Model-calculated or specified
Emission height ▪ Anthropogenic: ▪ Biomass burning: ▪ Volcanic:	 Surface layer Boundary layer or the default height in your model Eruptive: top listed in Carn dataset. Degassing: crater to 1km above
Met. field	CTM or free run
Transport tracer:	CO with prescribed sources (will be provided) and 50-day lifetime (see description in "Tracer for transport" on AeroCom Phase III wiki page)
Wet/dry deposition tracer:	Pb-210 produced from Rn-222 decay (5.5-day lifetime) with removal (dry and wet deposition) processes prescribed as for sulfate (see description in "Tracer for removal" on the AeroCom Phase III wiki page)
Model Output:	See below; more information can be found in the file specification document on the AeroCom Phase III wiki page under the "UTLS" experiment heading

Model output:

Notes:

- Your AeroCom file name (one variable per file) should look like this:

aerocom3_⟨ModelName⟩_ACAM-⟨PerturbationName⟩_⟨VariableName⟩_⟨VerticalCoordinateType⟩_⟨Year⟩_monthly.nc

Examples:

2-D: aerocom3_GEOS-i33p2_ACAM-BASE_ps_Surface_2008_monthly.nc
3-D: aerocom3_GEOS-i33p2_ACAM-EAS0_rho_ModelLevel_2009_monthly.nc

Where the ⟨VariableName⟩ is in lower case, and the ⟨VerticalCoordinateType⟩ for each set of variables is varying and listed in the tables below (Mixed with Upper and lower cases).

- Please submit the essential variables listed below. These are "priority 1" variables listed in the AeroCom III Excel sheet. You can refer to AeroCom III-UTLS output specifications for detailed information and requirements there (the required diagnostic fields are listed under column "UTLS"). You are also encouraged to submit the "priority 2" variables if they are available.

a) 2-D fixed:

Variable	Variable name +	Variable Unit +
Surface altitude (relative to the sea level)	orog	m
area of each grid	areacella	m2
Land area fraction	sftlf	1

b) 2-D variables:

Variable	Variable name +	Variable Unit +	Temporal frequency		Evaluation Datasets
Met. fields	VerticalCoordinateType: Surface				
Surface air pressure	ps	Pa	Monthly		
Tropopause air pressure	ptp	Pa	Monthly		
Tropopause altitude	ztp	m	Monthly		
Tropopause air temperature	tatp	K	Monthly		
Sea surface temperature	tos	K	Monthly		
Near-surface air temperature	tas	K	Monthly		
Precipitation	pr	kg m-2 s-1	Monthly		
Atmospheric boundary layer thickness	bldep	m	Monthly		
Total cloud fraction	clt	1	Monthly		
Convective cloud area fraction	convclt	1	Monthly		
Radiation	VerticalCoordinateType: Surface				
TOA outgoing shortwave radiation	rsut	W m-2	Monthly		
TOA incident shortwave radiation	rsdt	W m-2	Monthly		
TOA outgoing clear-sky shortwave radiation	rsutcs	W m-2	Monthly		
TOA outgoing longwave radiation	rlut	W m-2	Monthly		
TOA outgoing clear-sky longwave radiation	rlutcs	W m-2	Monthly		
surface downwelling shortwave radiation	rsds	W m-2	Monthly		
surface upwelling shortwave radiation	rsus	W m-2	Monthly		
surface downwelling longwave radiation	rlds	W m-2	Monthly		
surface upwelling longwave radiation	rlus	W m-2	Monthly		
TOA outgoing shortwave radiation without aerosol radiative effect	rsutca	W m-2	Monthly		

TOA outgoing clear-sky shortwave radiation without aerosol radiative effect	rsutcsca	W m-2	Monthly		
TOA outgoing longwave radiation without aerosol radiative effect	rlutca	W m-2	Monthly		
Emission	VerticalCoordinateType: Surface				
Emission rate of black carbon aerosol mass	emibc	kg m-2 s-1	Monthly		
Primary emission rate of dry aerosol organic matter	emioa	kg m-2 s-1	Monthly		
Emission rate of anthropogenic organic matter	emiaoa	kg m-2 s-1	Monthly		
Chemical production of dry anthropogenic secondary organic matter	chepasoa	kg m-2 s-1	Monthly		
Total emission rate of SO2	emiso2	kg m-2 s-1	Monthly		
Total direct emission rate of SO4	emiso4	kg m-2 s-1	Monthly		
Total emission rate of DMS	emidms	kg m-2 s-1	Monthly		
Total emission rate of NH3	eminh3	kg m-2 s-1	Monthly		
Total emission rate of sea salt	emiss	kg m-2 s-1	Monthly		
Total emission rate of dust	emidust	kg m-2 s-1	Monthly		
Emission of artificial CO with 50-day lifetime	emco50	kg m-2 s-1	Monthly		
Emission of Rn-222 with 5.5 day lifetime	emrn	kg m-2 s-1	Monthly		
Deposition and concentration	VerticalCoordinationType: Surface				
Dry deposition rate of black carbon aerosol mass	drybc	kg m-2 s-1	Monthly		
Dry deposition rate of organic matter	dryoa	kg m-2 s-1	Monthly		
Dry deposition rate of SO2	dryso2	kg m-2 s-1	Monthly		
Dry deposition rate of SO4	dryso4	kg m-2 s-1	Monthly		
Dry deposition rate of NH3	drynh3	kg m-2 s-1	Monthly		
Dry deposition rate of NH4	drynh4	kg m-2 s-1	Monthly		
Dry deposition rate of sea salt	dryss	kg m-2 s-1	Monthly		
Dry deposition rate of dust	drydust	kg m-2 s-1	Monthly		
Wet deposition rate of black carbon aerosol mass	wetbc	kg m-2 s-1	Monthly		
Wet deposition rate of organic matter	wetoa	kg m-2 s-1	Monthly		
Wet deposition rate of SO2	wetso2	kg m-2 s-1	Monthly		
Wet deposition rate of SO4	wetso4	kg m-2 s-1	Monthly		
Wet deposition rate of NH3	wetnh3	kg m-2 s-1	Monthly		
Wet deposition rate of NH4	wetnh4	kg m-2 s-1	Monthly		
Wet deposition rate of sea salt	wetss	kg m-2 s-1	Monthly		
Wet deposition rate of dust	wetdust	kg m-2 s-1	Monthly		
Wet deposition rate of Pb-210	wetpb	kg m-2 s-1	Monthly		
Dry deposition rate of Pb-210	drypb	kg m-2 s-1	Monthly		
Surface concentration of BC	sconcbc [#]	kg m-3	Monthly		
Surface concentration of OA	sconcoa [#]	kg m-3	Monthly		

Surface concentration of SO4	sconcso4 #	kg m-3	Monthly		
Surface concentration of NO3	sconcno3	kg m-3	Monthly		
Surface concentration of fine mode NO3	sconcno325	kg m-3	Monthly		
Surface concentration of $PM_{2.5}$	sconcpm25 #	kg m-3	Monthly		
Load	VerticalCoordinateType: Column				
Column black carbon mass load	loadbc	kg m-2	Monthly		
Column organic aerosol mass load	loadoa	kg m-2	Monthly		
Column secondary organic aerosol mass load	loadsoa	kg m-2	Monthly		
Column dust mass load	loaddu	kg m-2	Monthly		
Column PM1 dust mass load	loadlt1d	kg m-2	Monthly		
Column sea-salt mass load	loadss	kg m-2	Monthly		
Column PM1 sea-salt mass load	loadlt1ss	kg m-2	Monthly		
Column PM2p5 sea-salt mass load	loadlt25ss	kg m-2	Monthly		
Column sulfate mass load	loadso4	kg m-2	Monthly		
Column methanesulfonic acid mass load	loadmsa	kg m-2	Monthly		
Column sulfur dioxide mass load	loadso2	kg m-2	Monthly		
Column dimethyl sulfide mass load	loaddms	kg m-2	Monthly		
Column nitrate mass load	loadno3	kg m-2	Monthly		
Column ammonium mass load	loadnh4	kg m-2	Monthly		
Column ammonia mass load	loadnh3	kg m-2	Monthly		
Column nitric acid mass load	loadhno3	kg m-2	Monthly		
Column Rn-222 mass load	loadrn	kg m-2	Monthly		
production of Pb-210 from Rn-222 decay	prodpb	kg m-2	Monthly		
Optical depth	VerticalCoordinateType: Column				
Cloud optical depth	dtau	1	Monthly		
ambient aerosol optical thickness at 550 nm	od550aer	1	Monthly		AERONET, MODIS, MISR
ambient aerosol optical thickness at 550 nm in clear sky	od550csaer	1	Monthly		AERONET, MODIS, MISR
sulfate aod@550nm	od550so4	1	Monthly		
black carbon aod@550nm	od550bc	1	Monthly		
Organic matter aod@550nm	od550oa	1	Monthly		
SOA aod@550nm	od550soa	1	Monthly		
Nitrate aod@550nm	od550no3	1	Monthly		
Sea salt aod@550nm	od550ss	1	Monthly		
Sea salt aod@550nm	od550ss	1	Monthly		
PM1 Sea salt aod@550nm	od550lt1ss	1	Monthly		
PM2p5 Sea salt aod@550nm	od550lt2p5ss	1	Monthly		
Dust aod@550nm	od550dust	1	Monthly		
PM1 dust aod@550nm	od550lt1du	1	Monthly		
PM2p5 dust aod@550nm	od550lt2p5du	1	Monthly		
ambient aerosol absorption optical thickness at 550 nm	abs550aer	1	Monthly		AERONET
ambient BC absorption optical thickness at 550 nm	abs550bc	1	Monthly		

ambient OC absorption optical thickness at 550 nm	abs550oc	1	Monthly		

c) 3-D variables (vertically in your model level):

Note:

- Output variables vertically in your model level (VerticalCoordinateType: ModelLevel), but make sure to provide layer height information, i.e., pfull (or phalf) or dh, one variable per file as an independent variable along with the information of longitude and latitude. Example of file name: aerocom3_GEOS-i33p2_ACAM-BASE_dh_ ModelLevel_2008_monthly.nc.

Variable	Variable name +	Variable Unit +	Temporal frequency $		Evaluation Datasets
Met. fields	VerticalCoordinateType: ModelLevel				
air pressure	pfull	Pa	Monthly		
air pressure at interfaces	phalf	Pa	Monthly		
air temperature	ta	k	Monthly		
Specific humidity	hus	kg kg-1	Monthly		
Relative humidity	rh	1	Monthly		
Eastward wind	ua	m s-1	Monthly		
Northward wind	va	m s-1	Monthly		
Upward air velocity	wa	m s-1	Monthly		
Vertical pressure velocity	omega	Pa s-1	Monthly		
Shortwave heating rate	tntrs	K s-1	Monthly		
Longwave heating rate	tntrl	K s-1	Monthly		
Air density	rho	kg m-3	Monthly		
Layer thickness	dh	m	Monthly		
Cloud area fraction	clt	1	Monthly		
Convective cloud area fraction	convclt	1	Monthly		
Mass fraction of cloud liquid water	clw	kg kg-1	Monthly		
Mass fraction of cloud ice	cli	kg kg-1	Monthly		
Extinction	VerticalCoordinateType: ModelLevel				
aerosol_extinction_at_550nm	ec550aer	m-1	Monthly		CALIOP, SAGEII, OSIRIS, OMPS LP
Elemental carbon extinction_at_550nm	ec550bc	m-1	Monthly		
Organic matter extinction_at_550nm	ec550oa	m-1	Monthly		
Sulfate extinction_at_550nm	ec550so4	m-1	Monthly		
NO3 extinction_at_550nm	ec550no3	m-1	Monthly		
Dust extinction_at_550nm	ec550dust	m-1	Monthly		
Sea salt extinction_at_550nm	ec550ss	m-1	Monthly		
Mixing ratio, production	VerticalCoordinateType: ModelLevel				
PM2.5 mass mixing ratio	mmrpm2p5	kg kg-1	Monthly		
PM10 mass mixing ratio	mmrpm10	kg kg-1	Monthly		
PM1 mass mixing ratio	mmrpm1	kg kg-1	Monthly		
CO mixing ratio	mmrco	mole mole-1	Monthly		MLS, StratoClim

Elemental carbon mass mixing ratio	mmrbc	kg kg-1	Monthly		
Organic matter mass mixing ratio	mmroa	kg kg-1	Monthly		
Secondary organic aerosol mass mixing ratio	mmrsoa	kg kg-1	Monthly		
Sulfate mass mixing ratio	mmrso4	kg kg-1	Monthly		
NO3 mass mixing ratio	mmrno3	kg kg-1	Monthly		
NH4 mass mixing ratio	mmrnh4	kg kg-1	Monthly		
Sea salt mass mixing ratio	mmrss	kg kg-1	Monthly		
dust mass mixing ratio	mmrdust	kg kg-1	Monthly		
SO2 mass mixing ratio	so2	mole mole-1	Monthly		MIPAS, MLS, OMO
DMS mass mixing ratio	dms	mole mole-1	Monthly		
Gas-phase production rate of SO4	chegpso4	kg m-2 s-1	Monthly		
Aqueous-phase production rate of SO4	cheaqpso4	kg m-2 s-1	Monthly		
Aerosol water mass mixing ratio	mmraerh2o	Kg kg-1	Monthly		
Artificial CO with 50-day lifetime	mmrco50	mole mole-1	Monthly		
Chemical decay of artificial CO with 50-day lifetime	dkco50	kg m-2 s-1	Monthly		
artificial CO with 50-day decay time produced by CH4 oxidation	co50pch4	kg m-2 s-1	Monthly		
Rn-222 mixing ratio	mmrrn	mole mole-1	Monthly		
Pb-210 mixing ratio	mmrpb	mole mole-1	Monthly		
chemical decay of Rn-222	dkrn	kg m-2 s-1	Monthly		

[+] Name required by AEROCOM III
[$] Model output resolution. In all situations, monthly outputs from January to December are required.
[#] variables not listed in the AeroCom III Excel sheet.

Observations:

Satellite:		
Column SO_2	OMI	2004 (later half) – present
UTLS SO_2 (with vertical information)	MIPAS MLS	2003 – 2012 2004 (later half) – present
UTLS CO	MLS	2004 (later half) – present
Stratospheric aerosol vertical profile	SAGE II OSIRIS SCIAMACHY GOMOS CALIOP OMPS LP	1998 – 2005 2001 – present 2003 – present 2003 – 2012 2006 (later half) – present 2012 – present
Aircraft observation:		

UT aerosol (S, C) concentration	CARIBIC	2004 – 2012
SO_2, sulfate vertical profiles	OMO	2015 (July-Aug)
Aerosol vertical profiles	StratoClim	2017(July-Aug)

Model output submission:

Please refer to Aerocom wiki page.

The location of experiments in AeroCom servers:

Main-directory: /metno/aerocom-users-database/AEROCOM-PHASE-III-2019/
e.g., $Main-directory/$ModelName_UTLS-FIR0

The status of participation:

Model Name	Contact	Email	BASE /HIST	FIR0	ANT0	VOL0	EAS0	SAS0
MIROC-SPRINTARS	TAKEMURA Toshihiko	toshi@riam.kyushu-u.ac.jp	Subm-itted	Subm-itted	Subm-itted	Subm-itted		
GEOS-i33p2	Huisheng Bian/Mian Chin	huisheng.bian-1@nasa.gov	Subm-itted	To do	To do	To do	To do	To do
	Kai Zhang	Kai.Zhang@pnnl.gov	maybe	maybe	maybe	maybe	maybe	maybe
	Kostas Tsigaridis	kostas.tsigaridis@columbia.edu	maybe	maybe	maybe	maybe	maybe	maybe
	Paul Ginoux	Paul.Ginoux@noaa.gov	maybe	maybe	maybe	maybe	maybe	maybe
CIESM-MAM7	Yiran Peng	pyiran@mail.tsinghua.edu.cn	maybe	maybe	maybe		maybe	maybe
GEOS-Chem	Tzung-May, Fu	fuzm@sustech.edu.cn	maybe	maybe	maybe		maybe	maybe

Considerations:

- The proposed activity is also in coordination with the CCMI subgroup on ACAM-related studies
- This is an opportunity to engage the extended international modeling and observation communities to study aerosol-chemistry-weather-climate interactions
- We now have plenty of remote sensing and in-situ observations over Asian monsoon regions for thorough model evaluations and uncertainty assessments

Timetable (tentative)

08.2020 – submit multi-model results to AeroCom server
09.2020 – circulate the first data analysis among co-authors
10.2020 – update the results at the annual AeroCom meeting
06.2021 – update the results at the biennual ACAM meeting
10.2021 – circulate the first draft among co-authors
06.2022 – submit the manuscript to the peer-reviewed journal