Whats AeroCom

a global modeling community effort
with support by data groups

AeroCom

- Evaluate and compare global aerosol models
- Improve these models
- Derive useful products

Coordination: Michael Schulz, Mian Chin, Stefan Kinne, Christiane Textor

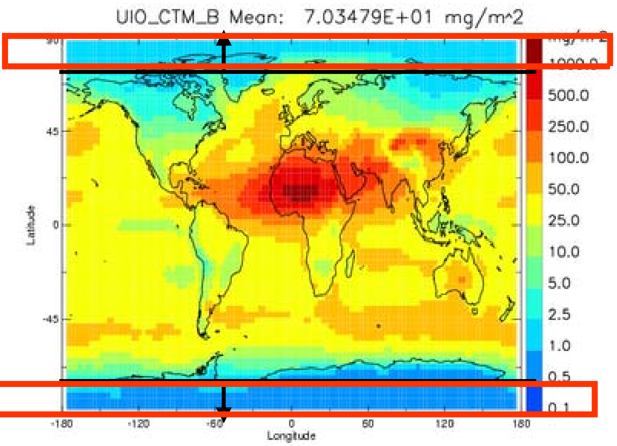
MODELS MODELERS: ARQM-GCM/CAM **ARQM Meteorological Service Canda, Toronto, Canada: S. Gong, P. Huang** CAM **NCAR, Boulder,USA, N. Mahowald** DLR-ECHAM-MADE **Institut für Physik der Atmosphäre, DLR, Oberpfaffenhofen, Germany: J. Hendricks, A. Lauer** GISS **Columbia University, GISS, New York, USA: D. Koch, S. Bauer** GOCART **Goddard Space Flight Center, Greenbelt; Goddard Earth Sciences and Technology Center, University of Maryland Baltimore County, USA: T. Diehl, M.Chin** KYU-SPRINTARS **Kyushu University, Fukuoka, Japan: T. Takemura** LSCE-LMDzT-INCA **Laboratoire des Science du Climat et de l'Enivonnement, Gif-sur-Yvette, France: M. Schulz, Y.Balkanski, C. Textor, S. Generoso, S. Guibert, D. Hauglustaine** LOA-LMDzT **Laboratoire d'Optique Atmosphérique, Université des Sciences et Technologies de Lille, CNRS, Villeneuve d'Ascq, France: O. Boucher, S. Reddy** MATCH**, NCAR, Boulder, Colorado, USA: D. Fillmore, P. Rasch, B. Collins** MPI_HAM-ECHAM5-HAM**, Max-Planck-Institut für Meteorologie, Hamburg, Germany: P. Stier , J. Feichter, E.Vignati, J.Wilson, S.Kloster, M.Schulz** MOZGN **NOAA, Geophysical Fluid Dynamics Laboratory, Princeton, New Jersey, USA: L. Horrowitz, P. Ginoux, X. Tie, J.F. Lamarque** PNNL-MIRAGE **Battelle, Pacific Northwest National Laboratory, Richland, USA: S. Ghan, R. Easter** TM5 **Institute for Marine and Atmospheric Research Utrecht (IMAU) Utrecht University, The Netherlands: M. Krol, EC, Joint Research Centre, Institute for Environment and Sustainability, Climate Change Unit, Italy: F.Dentener** UIO_CTM2**, University of Oslo, Department of Geophysics, Oslo, Norway: G. Myhre T. Berntsen,T. Berglen, A. Grini,** UIO_GCM-CCM-Oslo**, University of Oslo, Department of Geophysics, Oslo, Norway: T. Iversen, Ø. Seland, J.E.Kristjansson, A. Kirkevåg,** ULAQ-CCM**, Universita degli Studi L'Aquila, Italy: G. Pitari, V. Montanaro , E. Mancini** UMI-IMPACT/DAO**, University of Michigan, Ann Arbor, MI, USA: J. Penner, X. Liu**

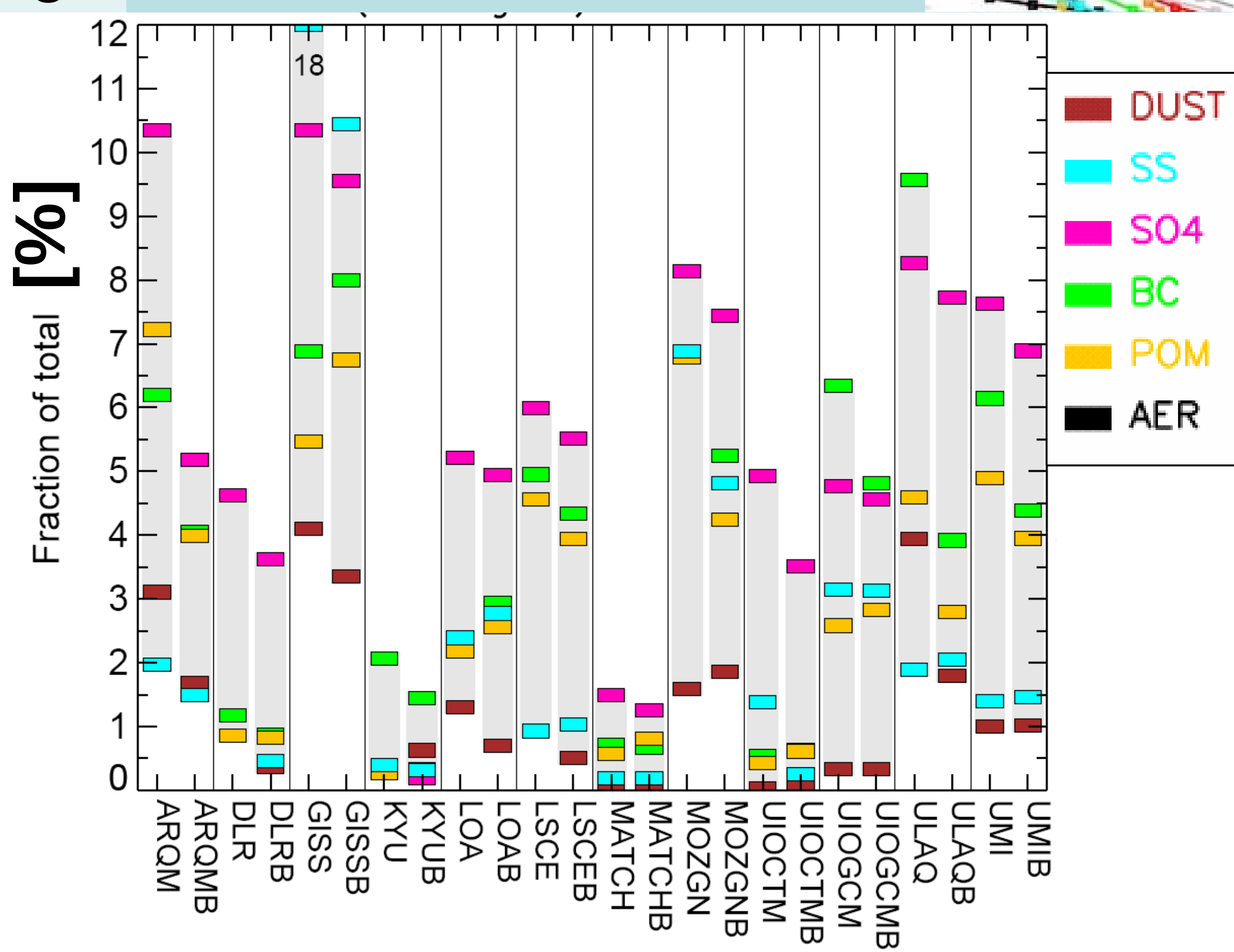
Currently direct support from EU-EUCAARI – EU-GEOMON – EU-GEMS

Mass fraction of Aerosol components Arriving in polar regions north of 80°

AeroCom

load





… is model specific

Textor et al. 2006

Outline talk

- Standard Diagnostics
- AeroCom data server and web interface
- Indirect Aerosol Effect Experiment
- Prescribed Forcing Experiment & Absorption Diagnostics
- Dust Benchmark
- Supersite Diagnostics => Size, Composition, Hygroscopicity
- Vertical distribution Lidar & CALIOP
- AEROCOM C and Hindcast experiment
- Next AeroCom workshop

AeroCom Standard Diagnostics

See excel table and CMOR tables via AeroCom Website

AeroCom

Dust and Sea salt	Organic Aerosol	Nitrate	Sulphur	Hygroscoppicity	Aerosol Size	Direct radiative forcing	Indirect Radiative effect	PRIORITY	Dimension- re 2 2 2 3 3 2 0	Aer ject varia e harm with HTA UNI ne		Var sho reg sev ut files HTA	TO BE INSERTED AS ATTRIBUTE "Standard Name" in netCDF file
d = d o = p = a x = c								essential???	H D M y D a ntaneous	**outp ble nam**	(CF)	**out nam**	**CF "Standard**
x	d	x	x	x	x	d	x		2D-D	od550_pom	1 (i.e., dim-less)	aerosolaod	particulate_organic_matter_aerosol_ambient_optical_depth_at_550_nm
d	x	x	x	d	x	d	x		2D-D	od550_ss	1 (i.e., dim-less)	aerosolaod	seasalt_aerosol_ambient_optical_depth_at_550_nm
d	x	x	x	x	x	d	x		2D-D	od550_du	1 (i.e., dim-less)	aerosolaod	dust_aerosol_ambient_optical_depth_at_550_nm
x	x	x	x	d	x	d	x		2D-D	od550_aerh2o	1 (i.e., dim-less)	aerosolaod	aerosol_water_aerosol_ambient_optical_depth_at_550_nm
x	x	x	x	x	o	o	x	!!!	2D-D	od550_aer	1 (i.e., dim-less)	aerosolaod	aerosol_optical_depth_at_550_nm
x	x	x	x	x	o	o	x	!!!	2D-D	od550lt1_aer	1 (i.e., dim-less)	aerosolaod	fine_mode_aerosol_optical_depth_at_550_nm
x	x	x	x	x	o	o	o	!!!	2D-D	ang4487_aer	1 (i.e., dim-less)	aerosolaod	aerosol_angstrom_exponent
x	x	x	o	x	x	[illegible]	x	!!!	3D-M	vmr_so2	mole mole-1	tracerm	mole_fraction_of_sulfur_dioxide_in_air
x	x	x	o	x	x	[illegible]	x		3D-M	vmr_dms	mole mole-1	tracerm	mole_fraction_of_dimethyl_sulfide_in_air_as_dimethyl_sulfide
x	x	x	o	x	x	x	x	!!!	3D-M	mmr_so4	kg kg-1	aerosolm	mass_fraction_of_sulfate_as_sulfate_dry_aerosol_in_air
x	o	x	x	x	x	x	[illegible]	[illegible]	[illegible]	[illegible]	kg-1	aerosolm	mass_fraction_of_particulate_organic_matter_as_particulate_organic_matter_dry_aerosol_in_air
x	o	x	x	x	x	x	[illegible]	[illegible]	[illegible]	[illegible]	kg-1	aerosolm	mass_fraction_of_secondary_organic_matter_as_secondary_organic_matter_dry_aerosol_in_air
x	x	x	d	x	x	x	[illegible]	[illegible]	[illegible]	[illegible]	m-2 s-1	aerosolm	aqueous_phase_production_of_sulphate
x	x	x	d	x	x	x	x	!!!	3D-M	chegp_so4	kg m-2 s-1	aerosolm	gas_phase_production_of_sulphate
x	d	x	x	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	kg m-2 s-1	aerosolm	tendency_of_atmosphere_mass_content_of_secondary_organic_matter_dry_aerosol_due_to_net_pr
x	x	x	d	x	x	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	kg m-2 s-1	depm	tendency_of_atmosphere_mass_content_of_sulfur_dioxide_due_to_wet_deposition
x	x	x	o	x	x	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	kg m-2 s-1	depm	tendency_of_atmosphere_mass_content_of_sulfate_dry_aerosol_due_to_wet_deposition
x	x	x	o	x	x	x	x	!!!	3D-M	evap_so4	kg m-2 s-1	depm	tendency_of_atmosphere_mass_content_of_sulfate_dry_aerosol_due_to_cloud_evaporation
x	o	x	x	x	[illegible]	x	x	!!!	3D-M	wet_pom	kg m-2 s-1	depm	tendency_of_atmosphere_mass_content_of_particulate_organic_matter_dry_aerosols_due_to_wet_c

AEROSOL PROBLEM

RESOLUTION

VARIABLE NAME

UNIT

OUTPUT FILE

CF Convention Standard Name netcDF Attribute!!

OBSERVABLE

DIAGNOSTIC

DISPENSABLE FOR PROBLEM

http://nansen.ipsl.jussieu.fr/AEROCOM/protocol.html

New components of diagnostics

AeroCom

Build on earlier AeroCom and HTAP protocol
Almost CF compliant - CMOR tables for writing netCDF output available

Completed forcing diagnostics (surface albedo, indirect…)

3D monthly wet removal of aerosol tracers, 3D Secondary aerosol formation

Supersite ALL tracer output

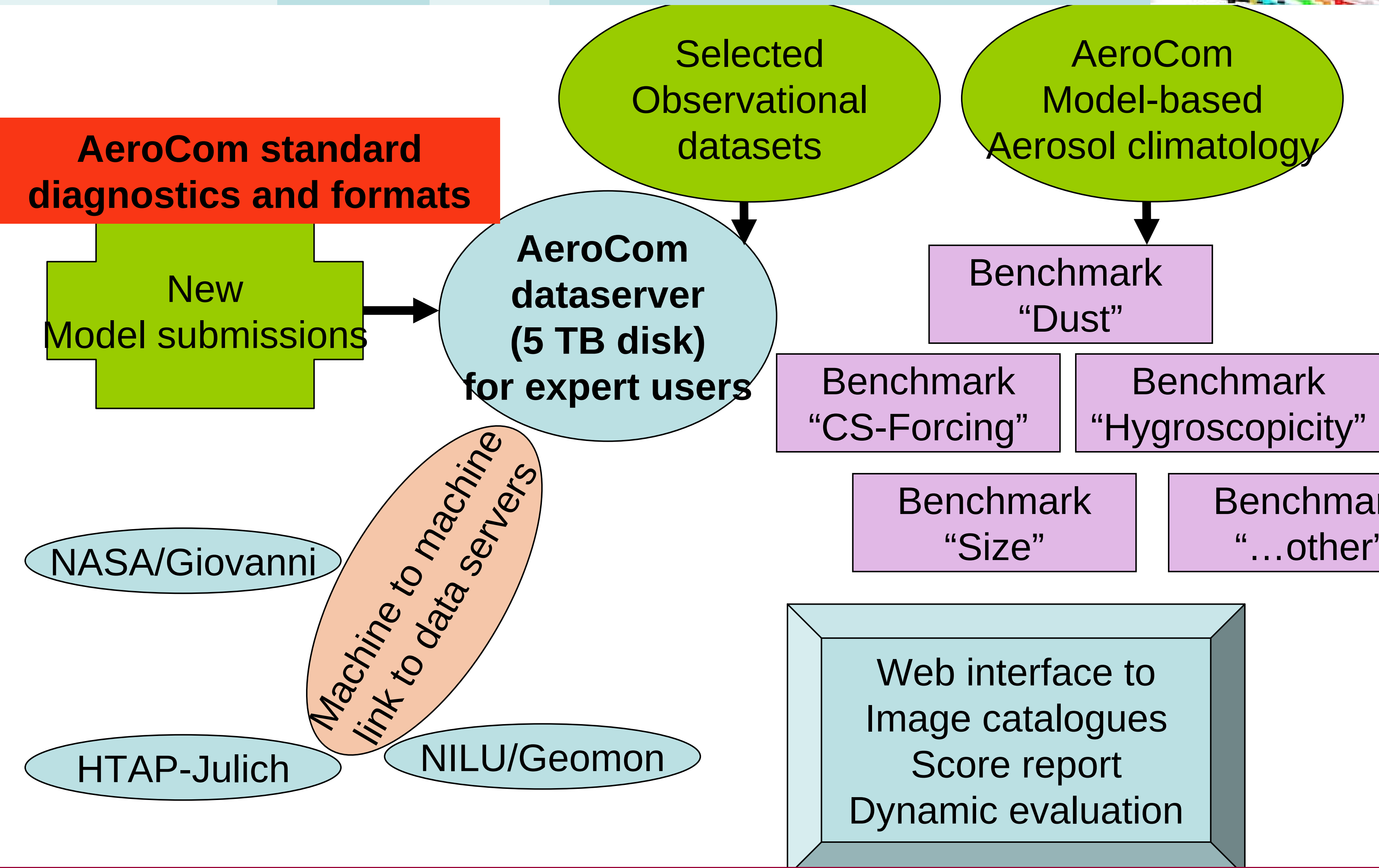
3D daily extinction for CALIOP comparison

Additional diagnostics for secondary organics, nitrate, biomass burning aerosol

Problem split to limit implementation work eventually

AeroCom platform

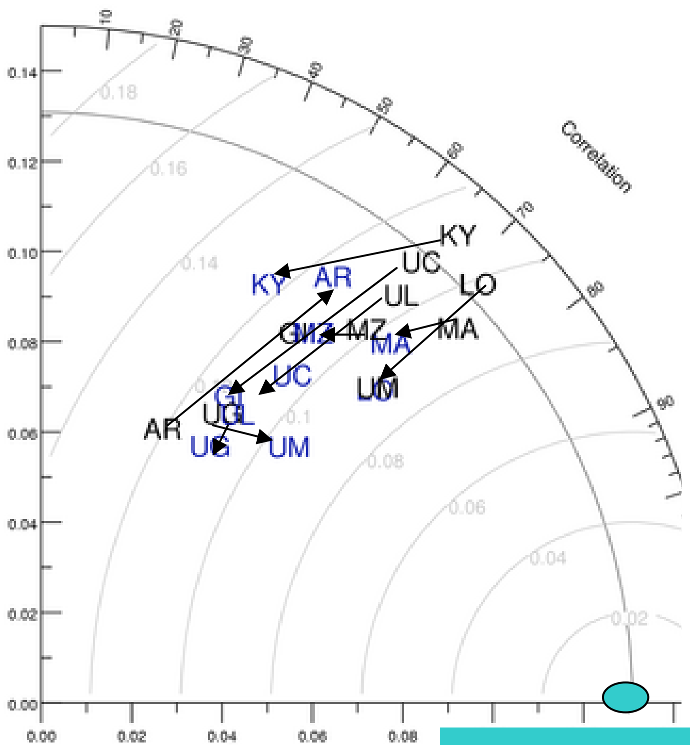
AeroCom

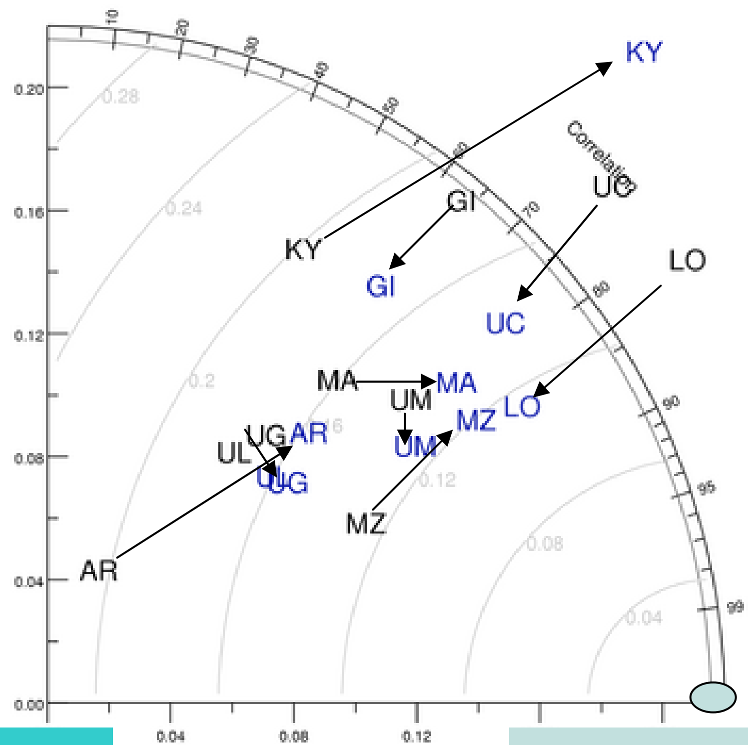


http://nansen.ipsl.jussieu.fr/AEROCOM/data.html

How can we monitor model progress??

AeroCom





MODIS 2000

AERONET 2000

AR: ARQM_9999
AR: ARQM_B_9999
GI: GISS_2000
GI: GISS_B_2000
KY: KYU_2000
KY: KYU_B_2000
LO: LOA_2000
LO: LOA_B_2000
MA: MATCH_2000
MA: MATCH_B_200
MZ: MOZGN_2000
MZ: MOZGN_B_200
UC: UIO_CTM_2000
UC: UIO_CTM_B_2
UG: UIO_GCM_999
UG: UIO_GCM_B_9
UL: ULAQ_9999
UL: ULAQ_B_9999
UM: UMI_2000
UM: UMI_B_2000

AEROCOM A

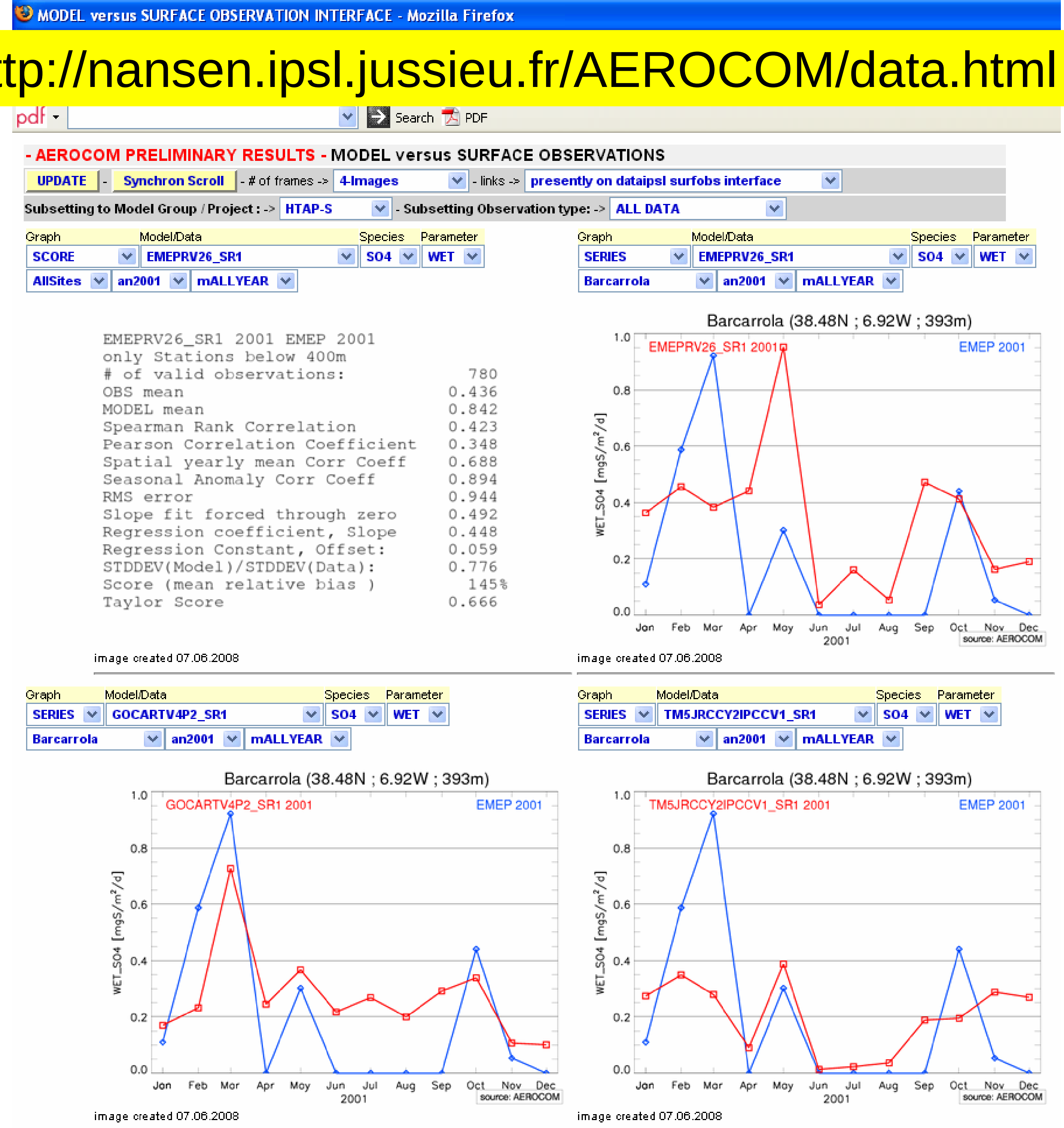
AEROCOM B (models with identical emissions)

Functionality of any benchmark test tools

- Centered around an aerosol property
- Intended for model development progress monitoring
- Reading CMOR formatted or AeroCom similar model output
- Reading standard obs dataset
- ‘error’ insensitive (data gaps, variable names, axis …)
- Multiple filters and weighting
  (sea/land, regions, station-subsets, thresholds, data quality)
- Reference imbedded (AeroCom median, Data-climatology)
- Multiple plots and statistics and scores
- Published
- Available as bundled tool
- Activated “near-automatic” on AeroCom server

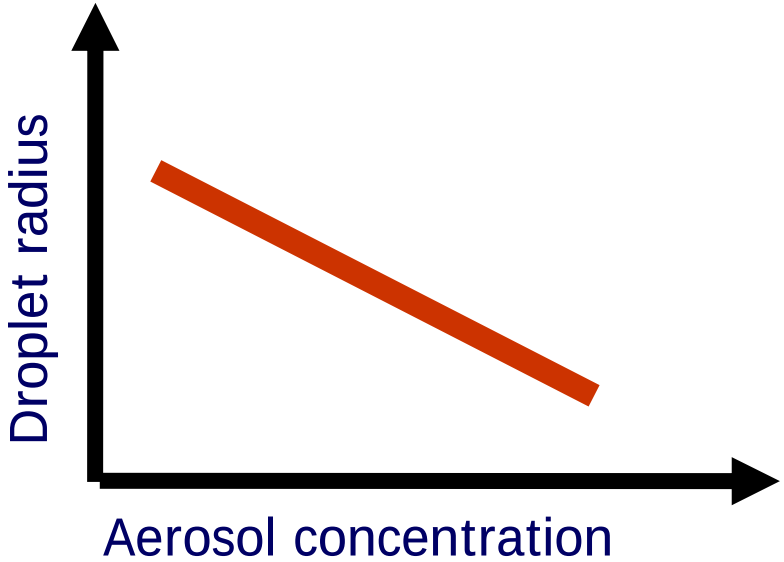
AeroCom SURFOBS web interface

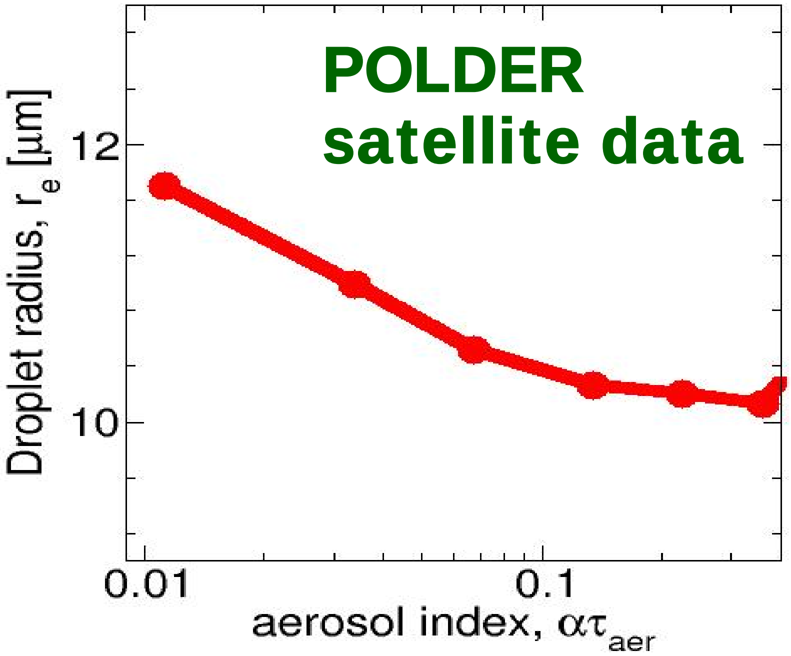
http://nansen.ipsl.jussieu.fr/AEROCOM/data.html



Statistical relationships for the evaluation of the aerosol indirect effect

AeroCom





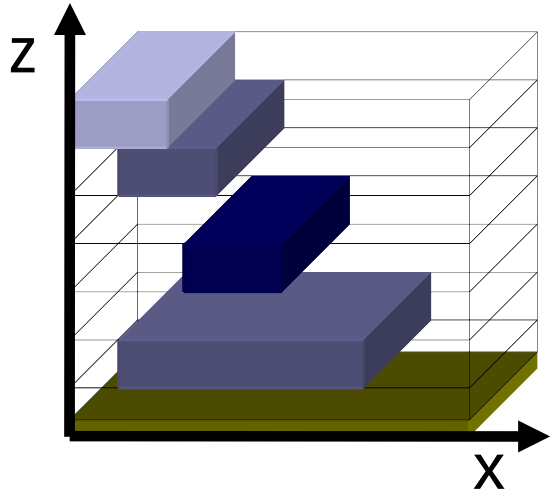
- robust
- relative changes only
- valid in changing climate

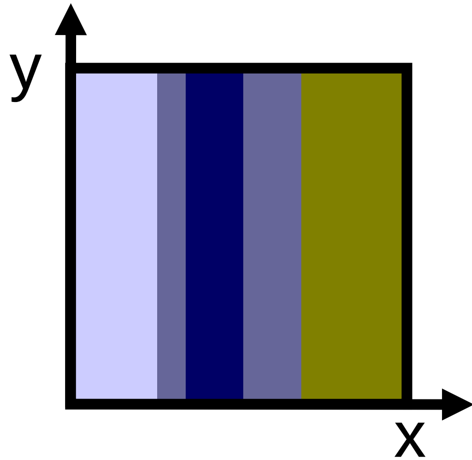
Bréon et al., Science 2002; *Quaas, Boucher, Bréon*, J. Geophys. Res. 2004

MODIS-Simulator / available for participants

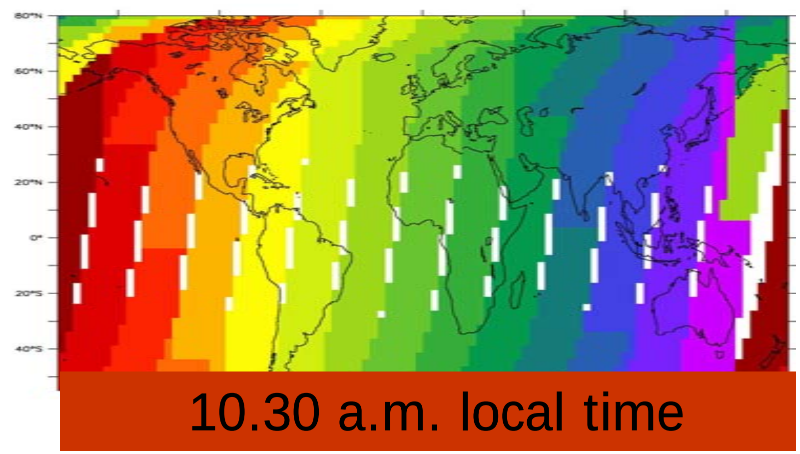
AeroCom

- sample cloud top quantities





- sample overpass time

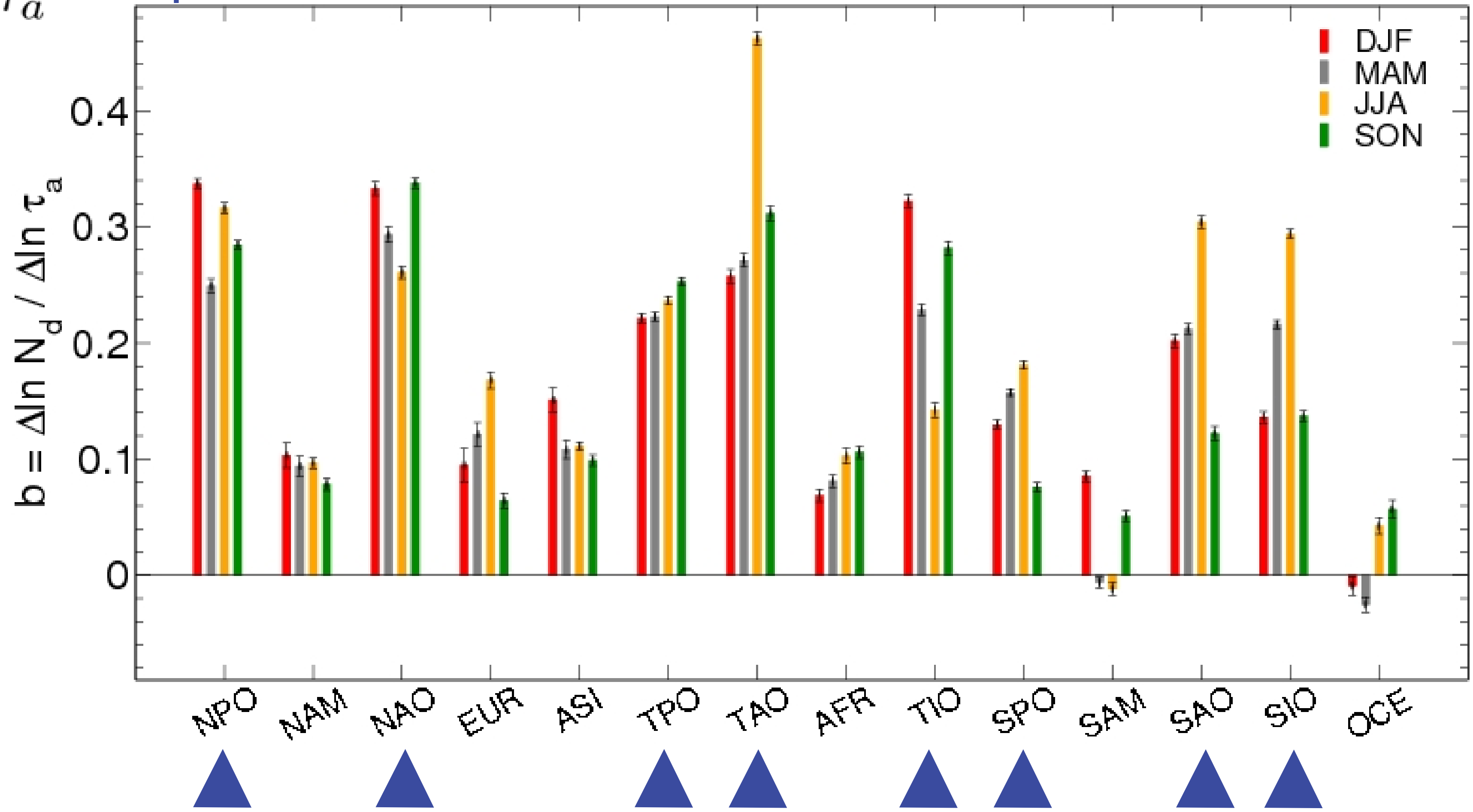


- use same assumptions

Regionally-resolved aerosol indirect effect

$$\frac{d \ln N_d}{d \ln \tau_a}$$

Maritime clouds more susceptible to aerosol perturbations??



Quaas, Boucher, Bellouin, Kinne, J. Geophys. Res., 2008

Indirect effect intercomparison and evaluation

model	forcing*	status	institution
GFDL GCM	$-2.1\ Wm^{-2}$	submitted	GFDL Princeton
GISS	$-0.6\ Wm^{-2}$	submitted	LBL Stanford
SPRINTARS	$-1.0\ Wm^{-2}$	submitted	Univ Kyushu
CCM	$-1.9\ Wm^{-2}$	submitted	Univ Michigan
CCM		running	NCAR Boulder
ECHAM5		running	ETH Zürich
HadGEM		running	Met Office Exeter
CCM-Oslo		in prep	Univ Oslo
EC-Earth		in prep	ETH Zürich
ECHAM5		in prep	Univ Oxford
GMI		in prep	Georgia Tech
LMDZ-INCA		in prep	LSCE Gif s/ Yvette

* all aerosol effects

for more information, see
http://wiki.esipfed.org/index.php/Indirect_forcing

Decomposing reasons for forcing diversity

AeroCom

Precursor emissions (SO_2, NOx, VOC)

chemical production, condensation

Primary aerosol emissions (BC, POM, dust, sea salt)

↓ Residence times
Transport, dispersion, wet and dry deposition

Aerosol Loads

↓ Optical properties
Mass extinction/absorption coefficient

Aerosol Optical Depth

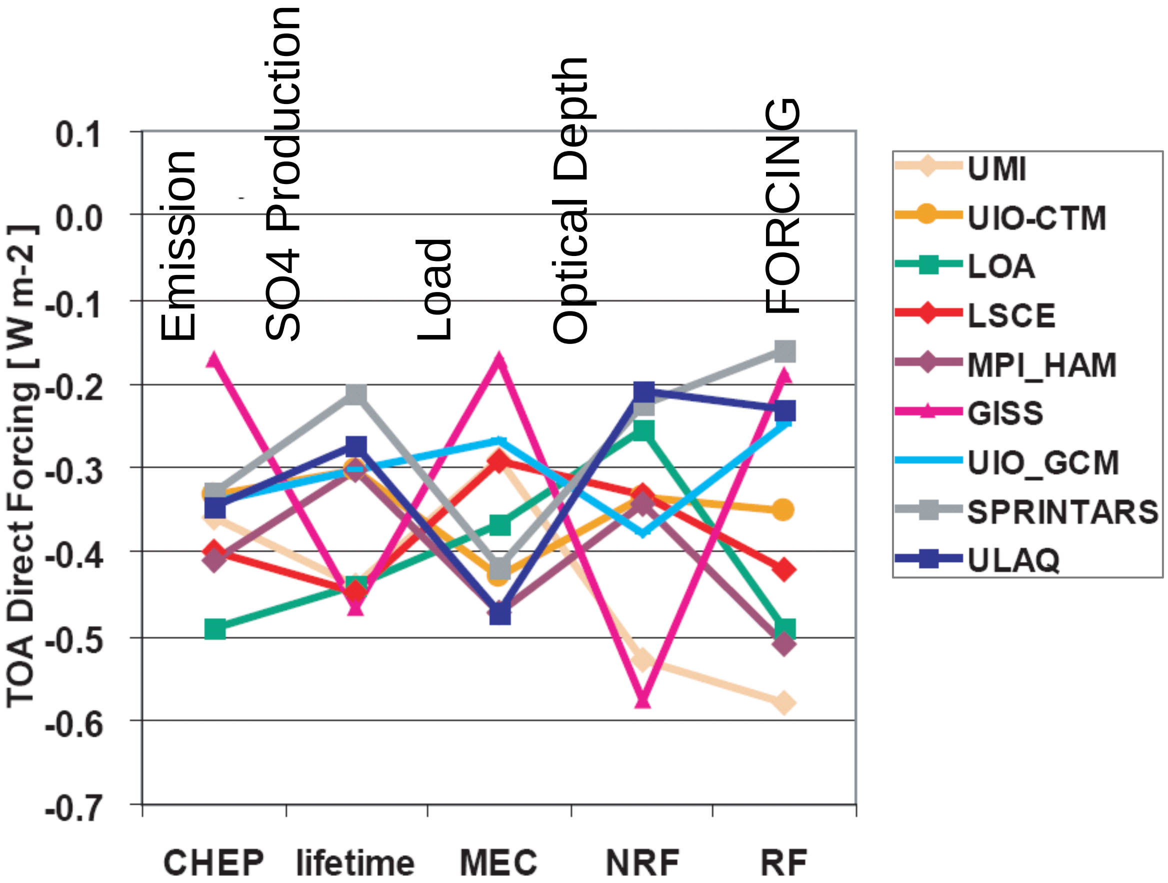
↓ Forcing efficiency per unit optical depth
Single scattering albedo
Hemispheric Backscatter
Vertical Distribution of aerosol
Cloud and aerosol position

Direct radiative forcing

↕ Interdependence of processes ??

Chain reaction from Emission to Forcing

AeroCom

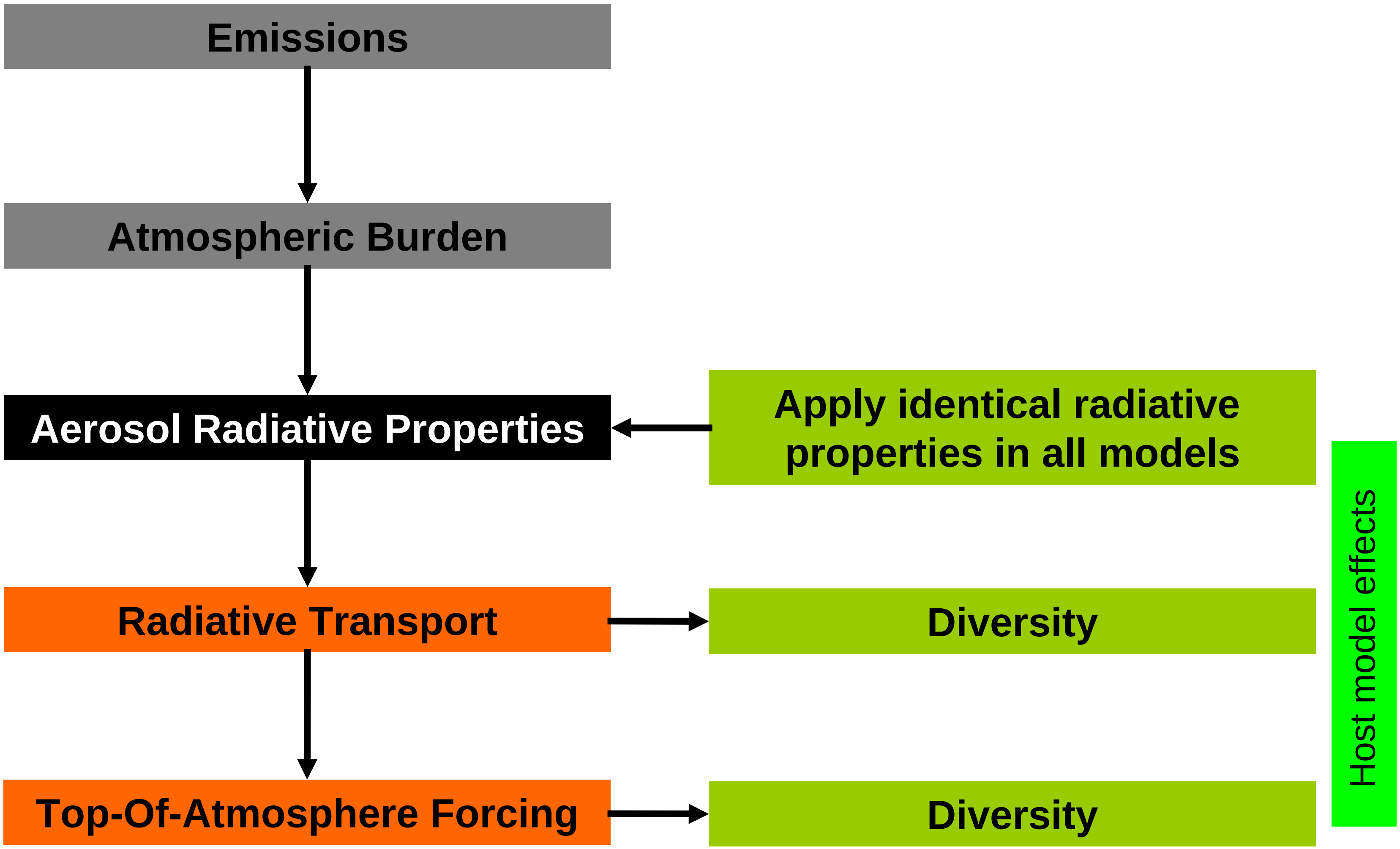


Sulfate

Schulz et al. 2006

Prescribed Forcing & Absorption

AeroCom Prescribed : Facilitate inter-comparability through fixing 3D aerosol radiative properties



Prescribed Forcing & Absorption

AeroCom

Prescribe aerosol radiative properties identically in all models / satellite models:

- Extinction, Single Scattering Albedo, Assymetry Factor:

  - 3D distributions

  - 24 SW wavelengths

  - offline mapping tools to model resolution and radiation bands

INPUT about to be distributed…

2000 meteorology

OUTPUT: standard AeroCom forcing diagnostics

Coordination Philip Stier / Oxford

Oxford Physics

More information and discussion

http://wiki.esipfed.org/index.php/AeroCom_Prescribed

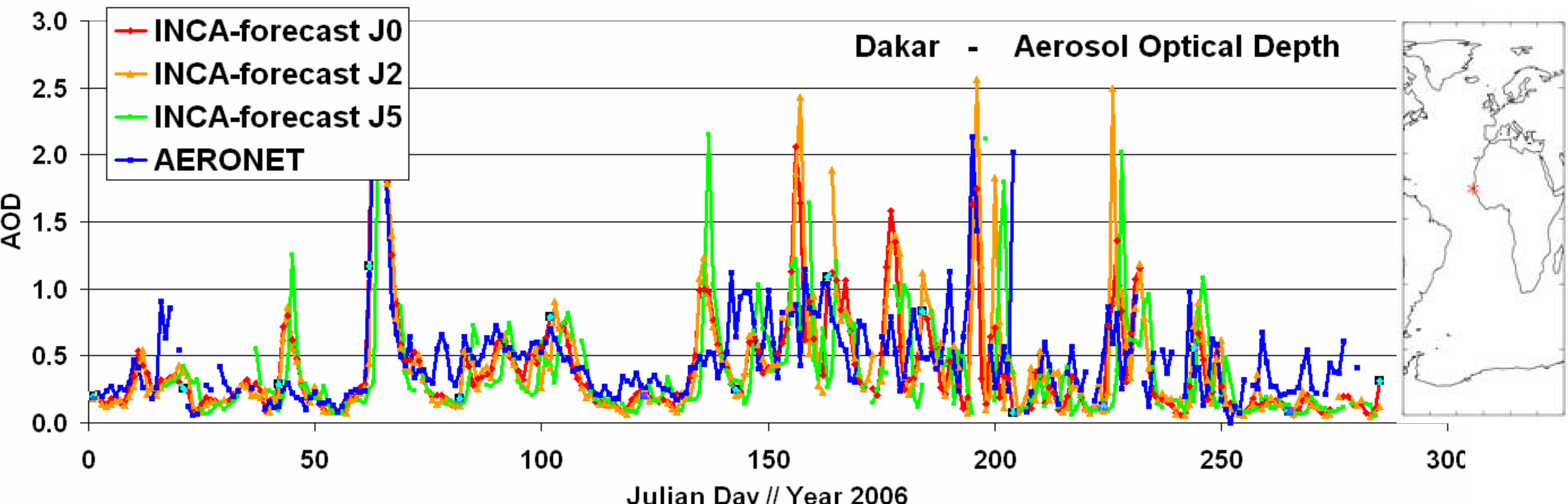
Dust Benchmark

AeroCom

Data available:
Aeronet dusty sites, Modis, MISR, POLDER // AOD, fine & coarse fraction
TOMS/OMI // absorption
AEROCE // dust deposition and concentration
IMPROVE & EMEP // Ca deposition and concentration
WMO // Visibility

Application: WMO sand and dust storm forecasting system

Contact: Nicolas Huneeus / LSCE



Supersite Diagnostics
Size Composition Hygroscopicity

AeroCom

« Aerosol representation in models is complicated »
=> Lets keep this in the diagnostics

Suggested Output
at 50 aerosol GAW & EUSAAR aerosol supersites:

HOURLY
Surface concentration of ALL aerosol tracers (masses, numbers)
Aerosol water
Total hygroscopic growth factor at 90% RH
Dry and wet aerosol extinction and absorption
Model RH and Temperature
Gases SO_2, NO_x, HNO_3, NH_3

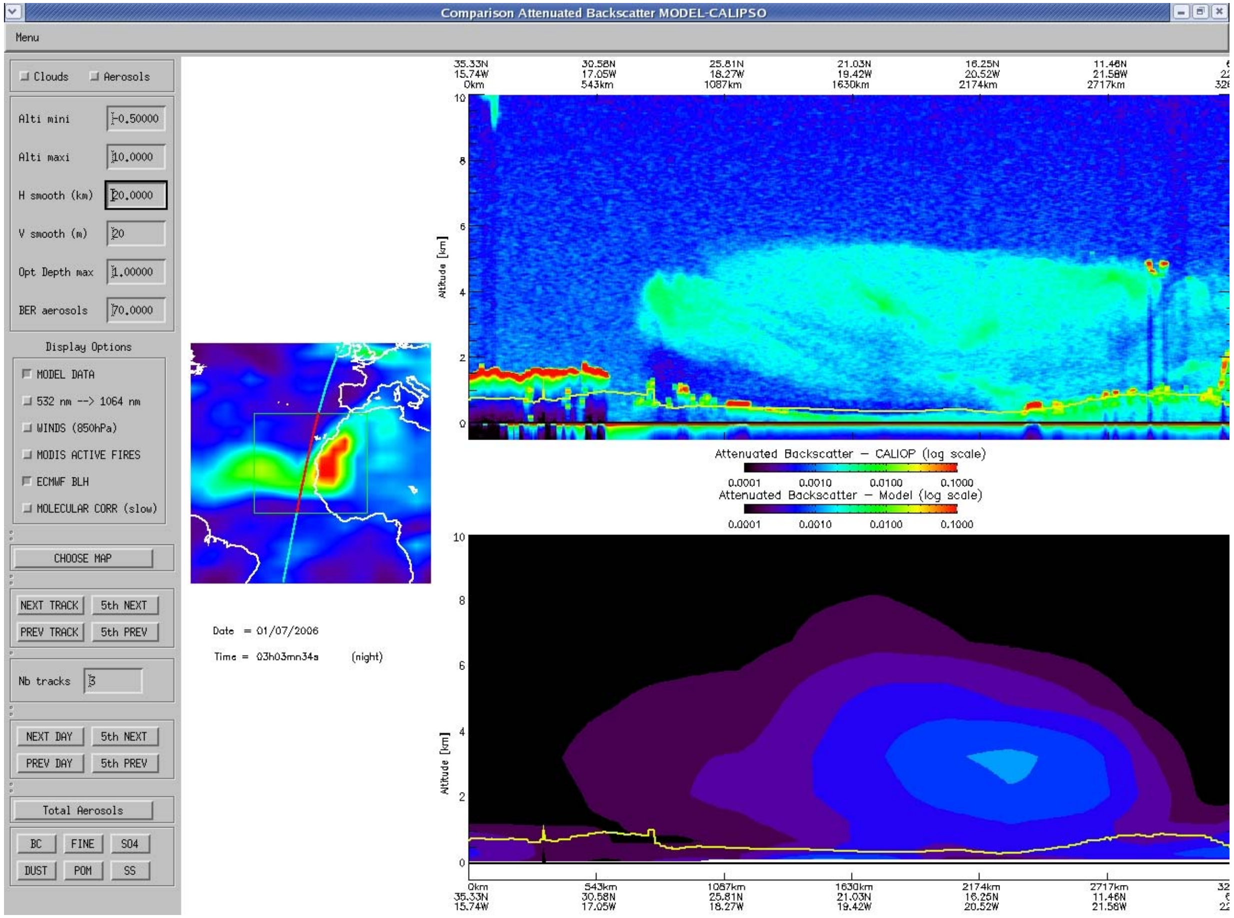
People interested in analysis: Graham Mann, Univ Leeds; Julian Wilson Ispra ++

Vertical Distribution
CALIOP and Lidar data comparison

Caliop-Model
Comparison idl tool
Available on AeroCom Server
Based on 3D daily extinction
Contact: Michael Schulz

Lidar comparison
Under discussion with
EARLINET & ARMS
& GALION

Column dedicated output
AOD => Forcing
Hourly at 10 sites?



AEROCOM C and HINDCAST

AEROCOM C (=Champaigne)

Bottle of Champaigne offered if you beat with a model output submitted to AeroCom
In ALL benchmark tests the AeroCom A median model

AeroCom ACC Hindcast

See Mian Chins talk

NEXT AeroCom workshop

AeroCom

Reykjavik, Iceland
8-10 October
Host: Iceland Met Office and
University of Oslo Jon Egill Kristjannson

Contact:
michael.schulz@cea.fr
Stefan.kinne@zmaw.de

Recall of subjects of work

AeroCom

- Standard Diagnostics
- AeroCom data server and web interface
- Indirect Aerosol Effect Experiment
- Prescribed Forcing Experiment & Absorption Diagnostics
- Dust Benchmark
- Supersite Diagnostics => Size, Composition, Hygroscopicity
- Vertical distribution Lidar & CALIOP
- AEROCOM C and Hindcast experiment
- Next AeroCom workshop