AOKI

Validation plan of GCOM-C1/SGLI Satellite Aerosol Optical Properties retrievals form Ground-based and Ship-borne Sky Radiometer

Kazuma Aoki

University of Toyama, Japan

Sky radiometer system
(Aoki and Fujiyoshi, 2003)

3. Example of Ground-based observation at several Japan sites.

We started the long-term monitoring of aerosol optical properties by using a sky radiometer since 1990's. The sky radiometer is an automatic instrument that takes observations only in daytime under the clear sky condition without cloud. Observation of direct and diffuse solar intensity of interval was made every ten or five minutes by once (direct measurement every one minute). Ship-borne type, GPS provides the position with longitude and latitude and heading direction of the vessel, and azimuth and elevation angle of sun. Horizon sensor provides rolling and pitching angles. We used seven wavelengths (0.315, 0.4, 0.5, 0.675, 0.87. 0.94, 1.02 μm). The two wavelengths (0.315 and 0.94 μm) can be used to estimate total ozone amount and precipitable water. There were used to analysis direct solar irradiance and diffuse solar radiance at fifth wavelength (0.4, 0.5, 0.675, 0.87, 1.02 μm) by aerosol channel. The aerosol optical characteristics were computed using the SKYRAD.pack version 4.2 developed by Nakajima et al. (1996).

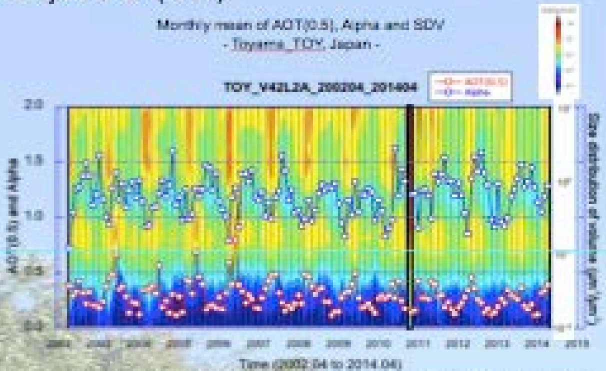


Fig. 4 Aerosol optical thickness at 0.5 μm, Ångström exponent and volume size distribution averaged monthly for the period from April 2002 to April 2014 in Toyama.

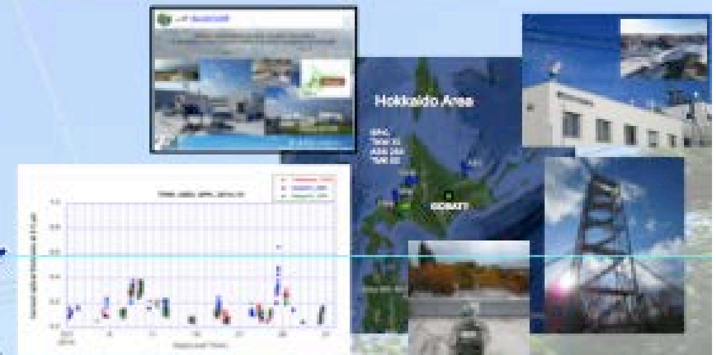


Fig.5 Aerosol optical thickness at 0.5 μm at October 2014 in Takikawa, Abashiri, and Sapporo/Hokkaido.

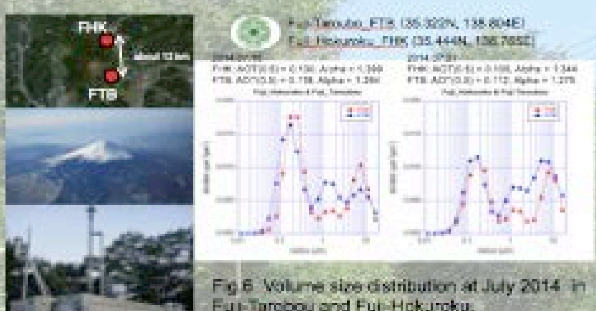


Fig.6 Volume size distribution at July 2014 in Fuji-Tarobou and Fuji-Hokuroku.

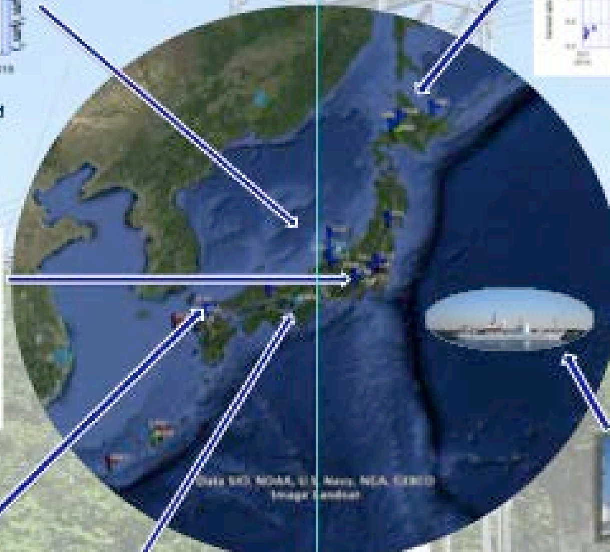


Fig.3 Sky radiometer network in Japan
(http://skyrad.sci.u-toyama.ac.jp)

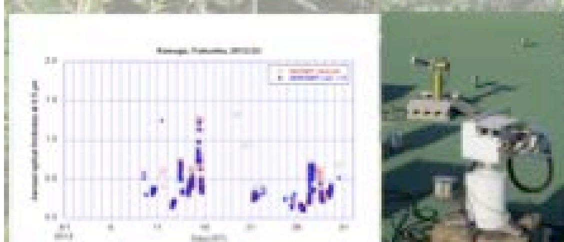


Fig.7 Comparison AOT (0.5) between AERONET and SKYNET at Kasuga/Fukuoka, March, 2012.

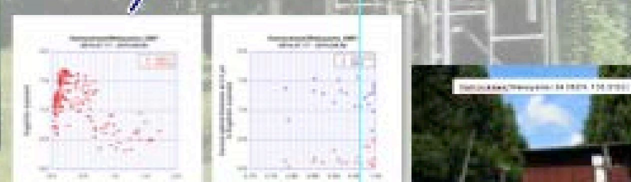


Fig.8 Relationship between Aerosol optical thickness at 0.5 μm, Ångström

4. Maritime Aerosol

Maritime Aerosol optical properties measurements were made in MR10-02 to MR14-06 cruise onboard the R/V Mirai, JAMSTEC. This cruise area included a Japan to Tropical ocean. Figure 9 shows the relationship of aerosol optical thickness at 0.5 μm (Ångström exponent) to Latitude (N) between 120E to 180E. Near the coast area, AOT and Alpha is high value and variability. Especially, near the Japan coast.

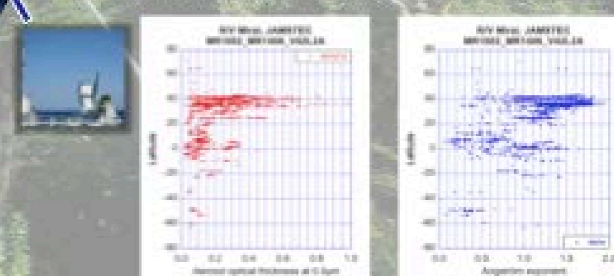


Fig.9 Relationship of aerosol optical thickness at 0.5 μm (Ångström exponent) to Latitude (N) between 120E to 180E during MR10-02 to MR14-06 cruise on board R/V Mirai, JAMSTEC.

Acknowledgments. This study used data collected during the R/V Mirai cruise, JAMSTEC. This work was supported by JAXA (GCOM-C1) and JSPS.

References
Aoki, K., and Fujiyoshi (2003), Sky radiometer measurements of aerosol optical

BALKANSKI

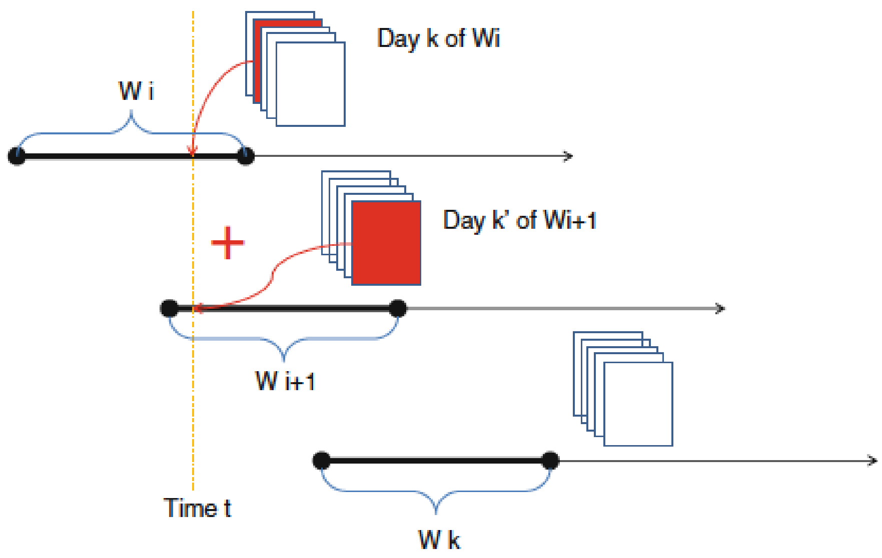
Simulation of the Laki volcano in 1783 based upon analogs of winds; analysis using historical data of reported fog and deaths

Y. Balkanski, L. Menut, S. Jourdain, E. Garnier, C. Eschstruth, M. Vrac, R. Vautard, P. Yiou

od (*Yiou et al.; 2013, 2014*)

- Reconstruction of the period 1781 to 1785 taking the closest 5-day period analog from the ERAI (from 1979 to 2013) with a resolution of 1.125°x1.125°

- Fields of 20 analogues consist of moving windows of 5 days with shifted increments of 2 days



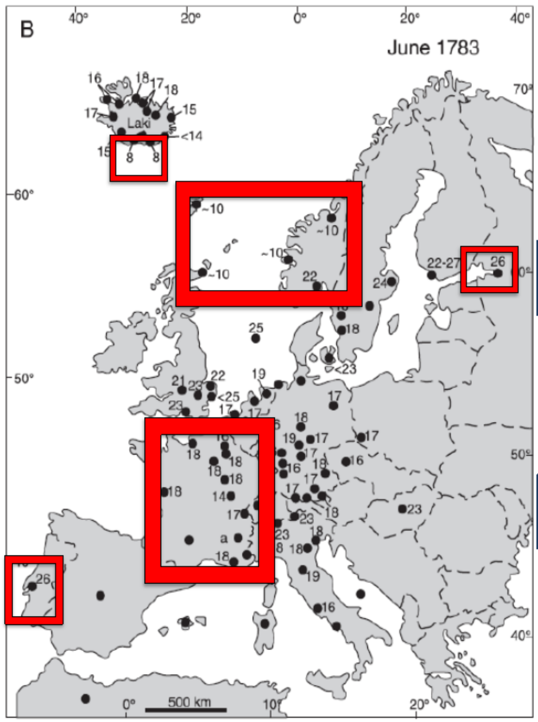
Historical archive of fogs and of additional deaths following the eruption

Day in June when the first manifestation of the Laki volcanoe was reported over Europe

June 8th: South of Iceland

June 10th: Coast of Norway

June 26th: Lisbon,Portugal



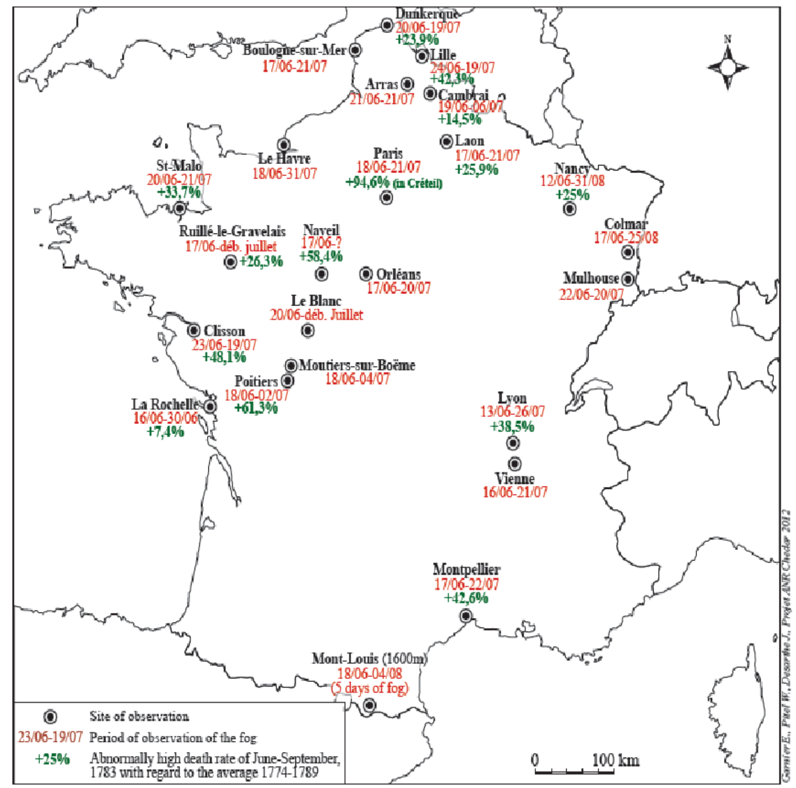
June 26th: St Petersburg

June 17, 18th: France, Italy

Thondarson and Self, 2003

Abnormal death rate (in green) from June to Sept. 1783 when compared with the average of 1774 to 1789

Atmospheric and sanitary effects of the volcano Laki in France (summer 1783)



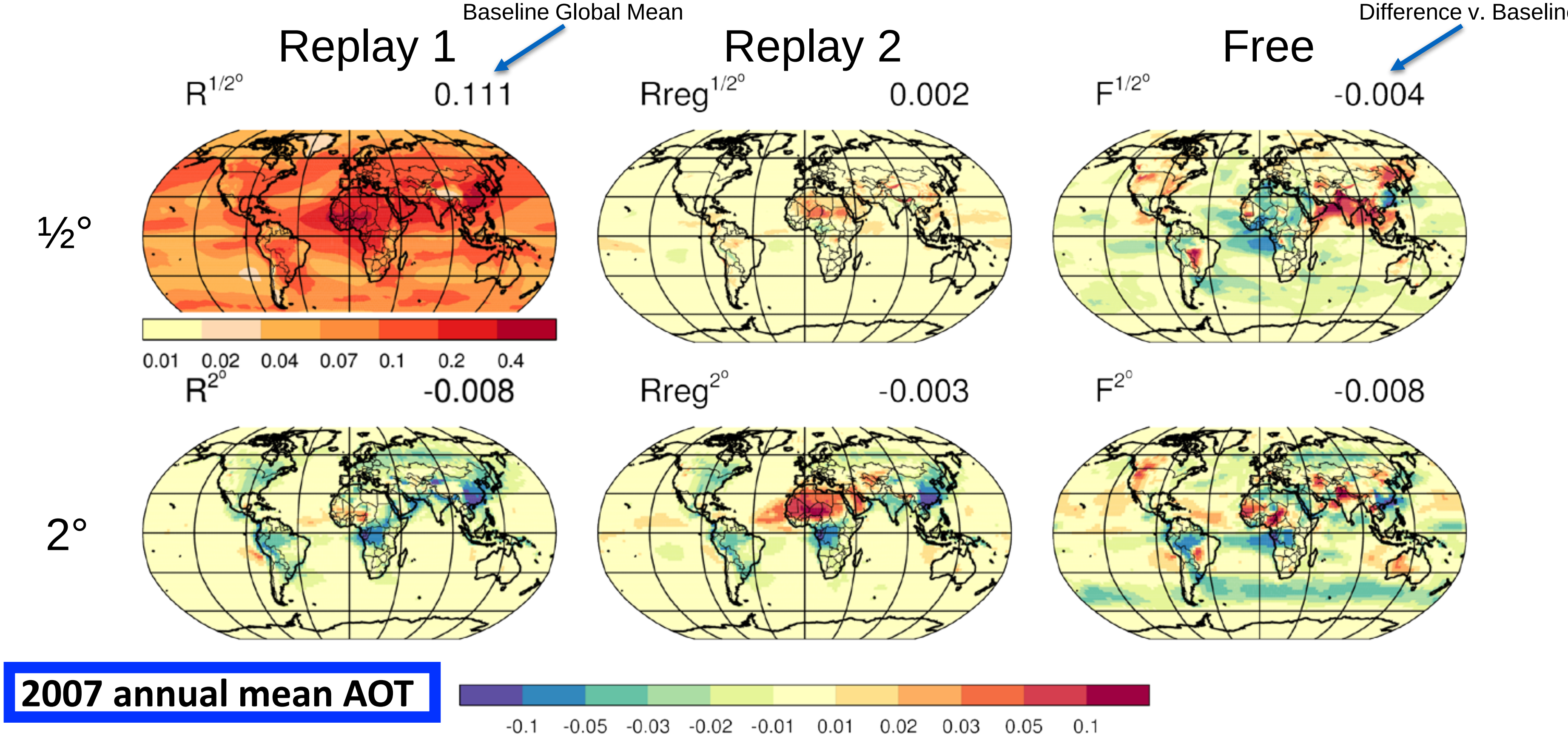
Climate and Health Data Rescue and Modeling (CHEDAR) project

COLARCO

Diversity of Aerosol Simulations in the NASA GEOS-5 Model

Impacts of Meteorology and Spatial Resolution (i.e., my own private AeroCom)

Peter Colarco, NASA GSFC



GEOS-5 model with GOCART aerosols can be run in numerous configurations

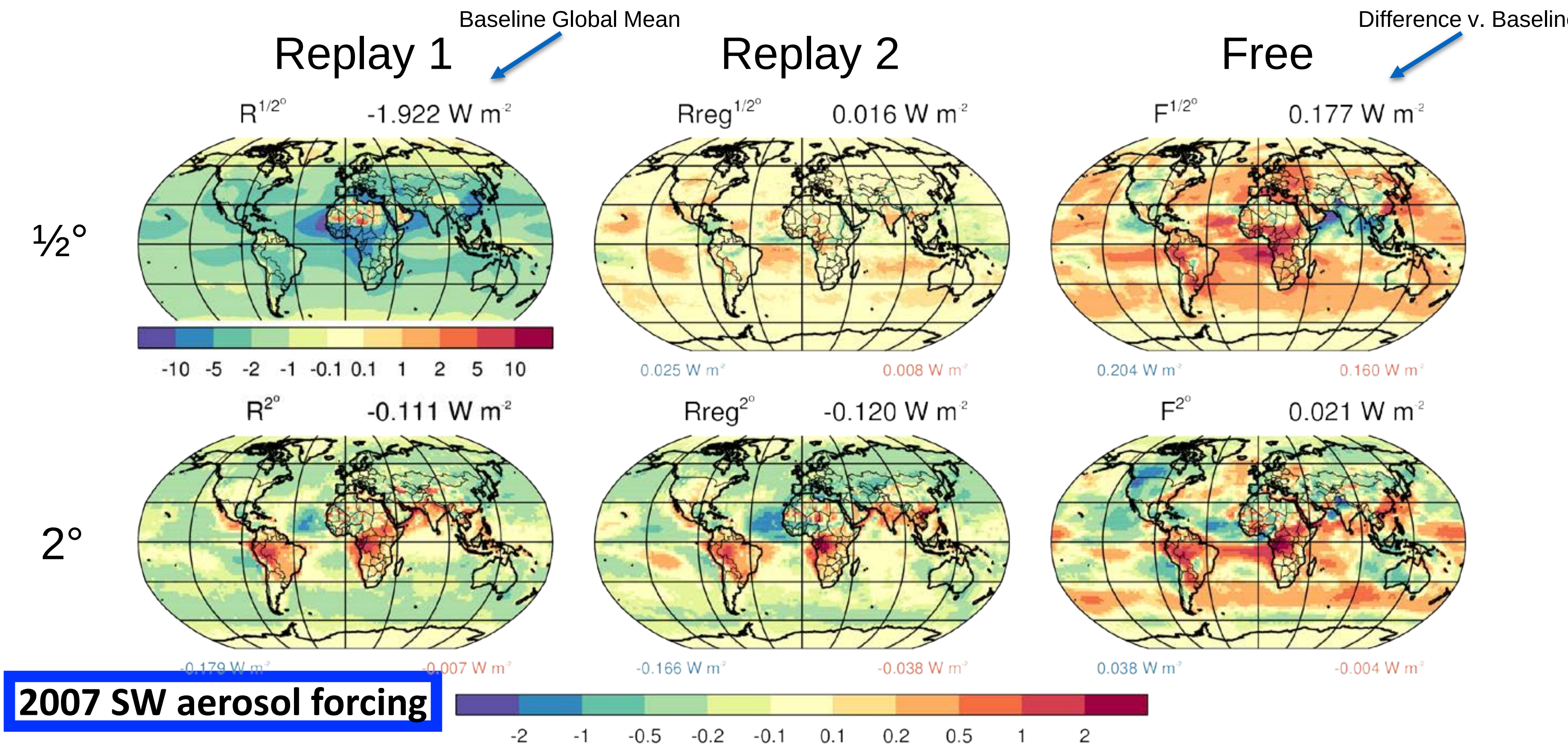
- different spatial resolutions, time steps, replay meteorology vs. free-running, etc.

Simulations with same emissions result in global AOT differences < 10%, but regional variability

Diversity of Aerosol Simulations in the NASA GEOS-5 Model

Impacts of Meteorology and Spatial Resolution (i.e., y own private AeroCom)

Peter Colarco, NASA GSFC



GEOS-5 model with GOCART aerosols can be run in numerous configurations

- different spatial resolutions, time steps, replay meteorology vs. free-running, etc.

with same emissions: global AOT differences < 10%, but regional variability

diff in cloud and aerosol distributions: differences in aerosol forcing ~0.3 W m^{-2}

How sensitive are our models to configuration choices?

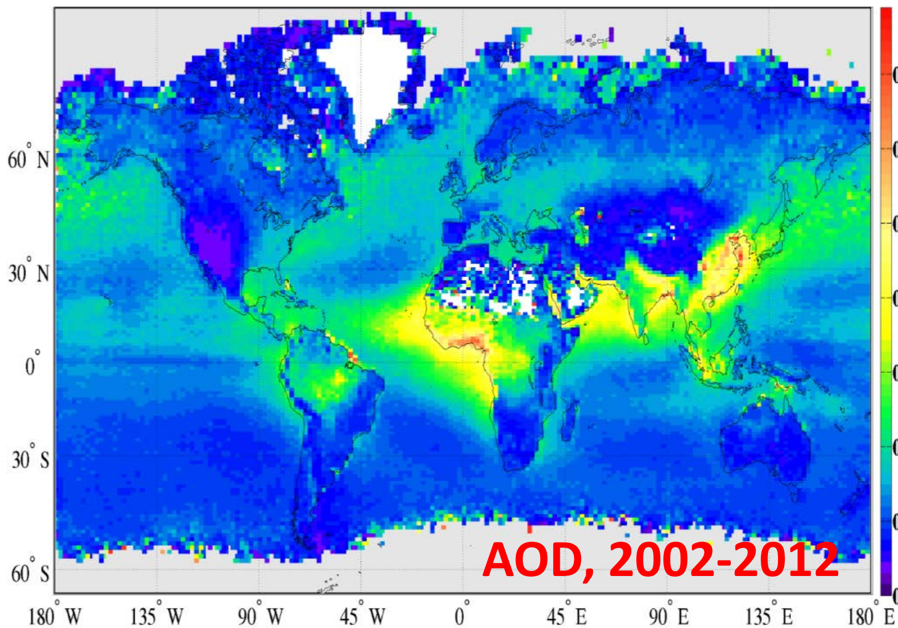
DE LEEUW

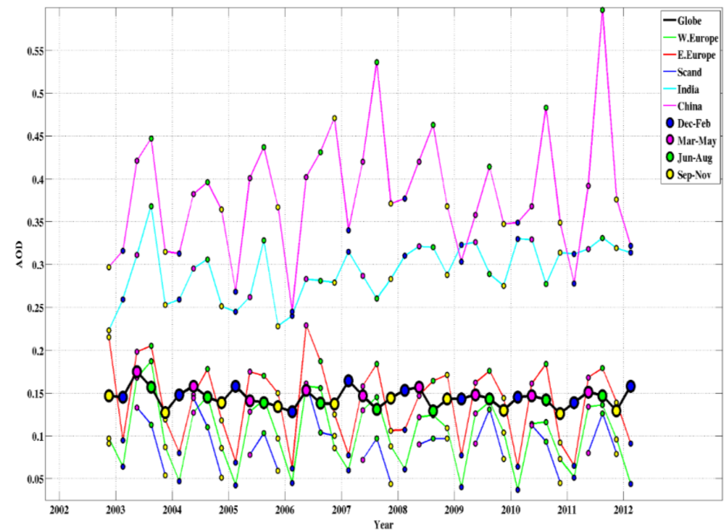
Retrieval of Aerosol and Cloud Properties from ATSR using ADV/ASV

[1]Finnish Meteorological Institute
[2] University of Helsinki
[3] EUMETSAT

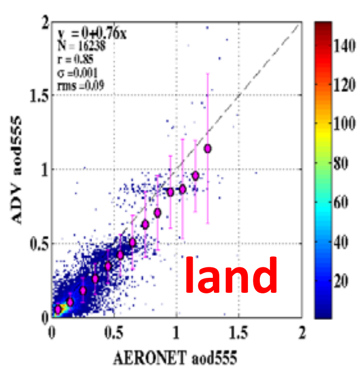
Gerrit de Leeuw[1,2] Larisa Sogacheva[1], Pekka Kolmonen[1],
Timo H. Virtanen[1], Giulia Saponaro[1] and Alexander Kokhanovsky[3]

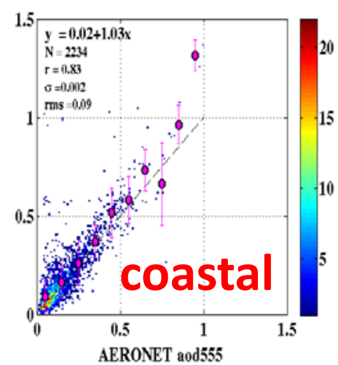
AEROSOLS

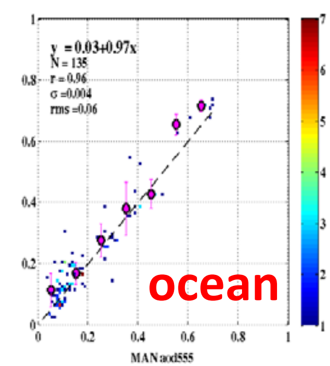




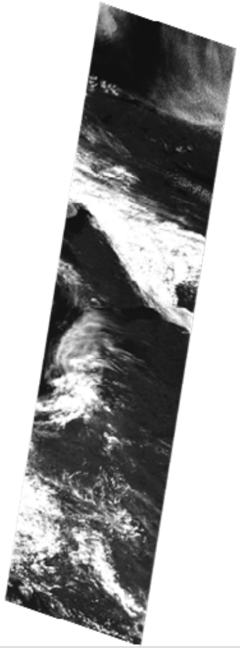
Validation:

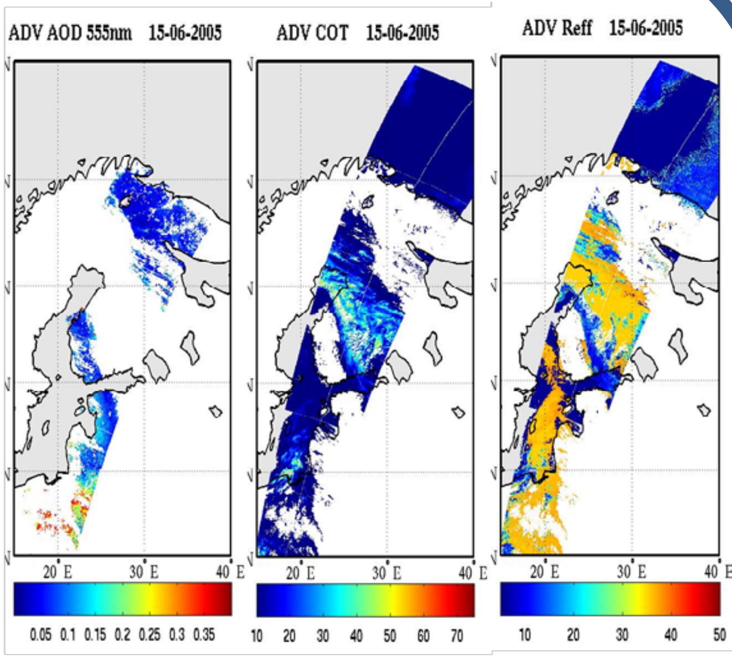


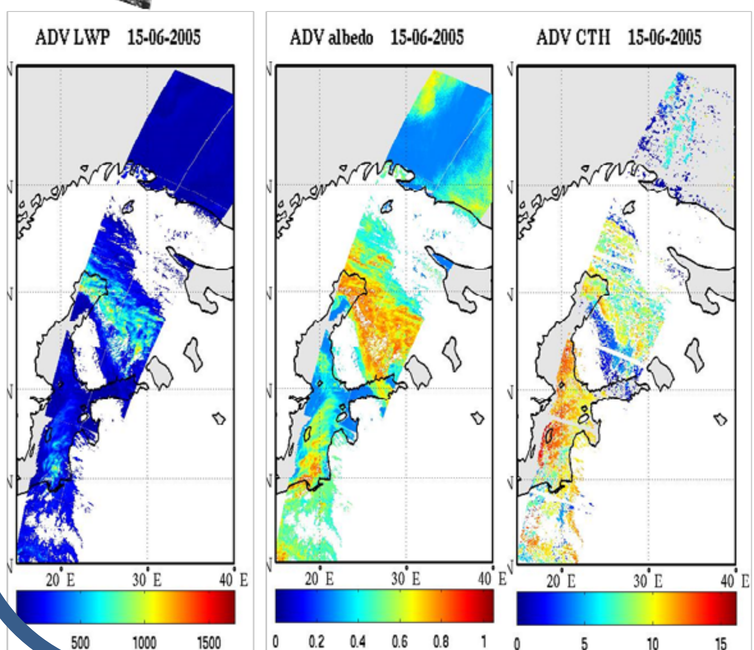




CLOUDS

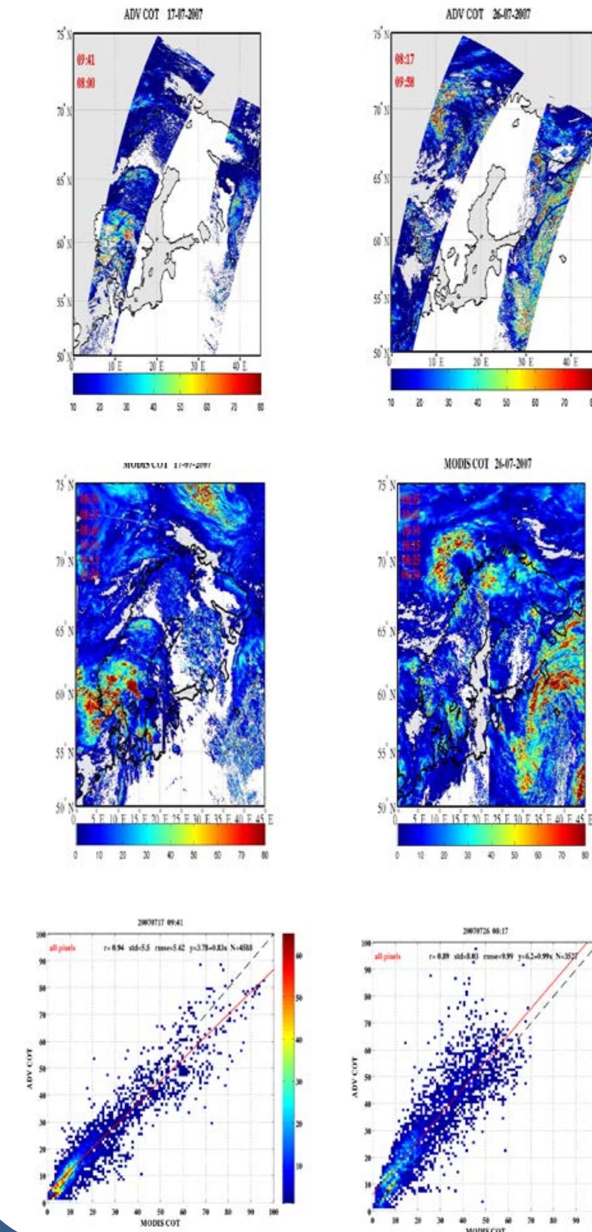






ADV

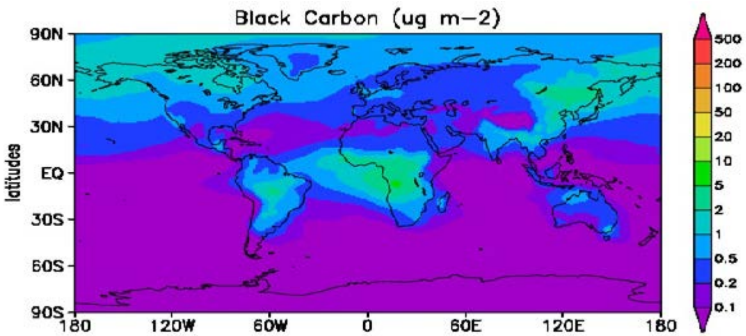
comp with MODIS



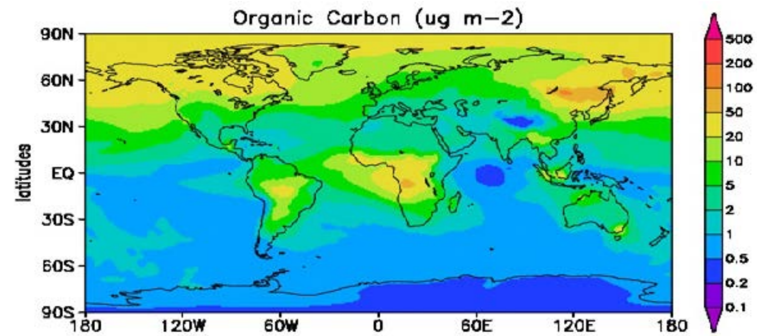
DHOMSE

IFS-GLOMAP

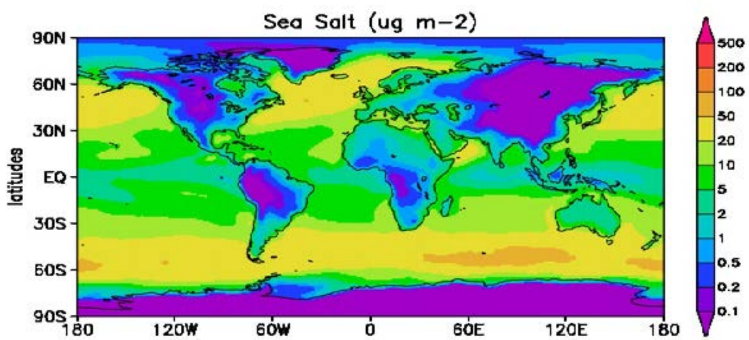
Sandip Dhomse, Graham Mann et al.,
(University of Leeds)



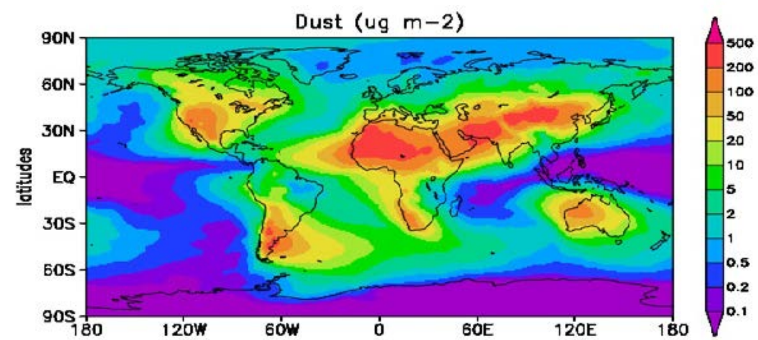
BC



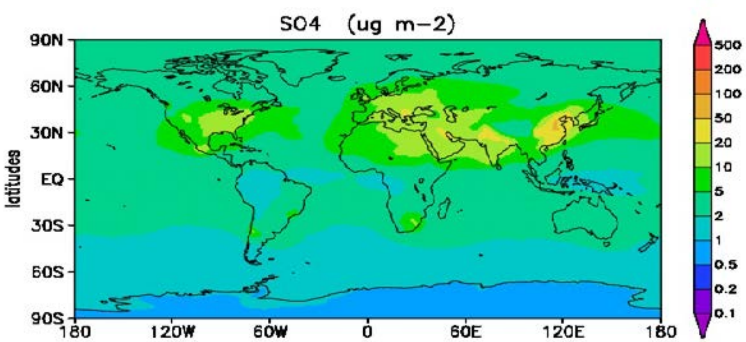
OC



SS



DU

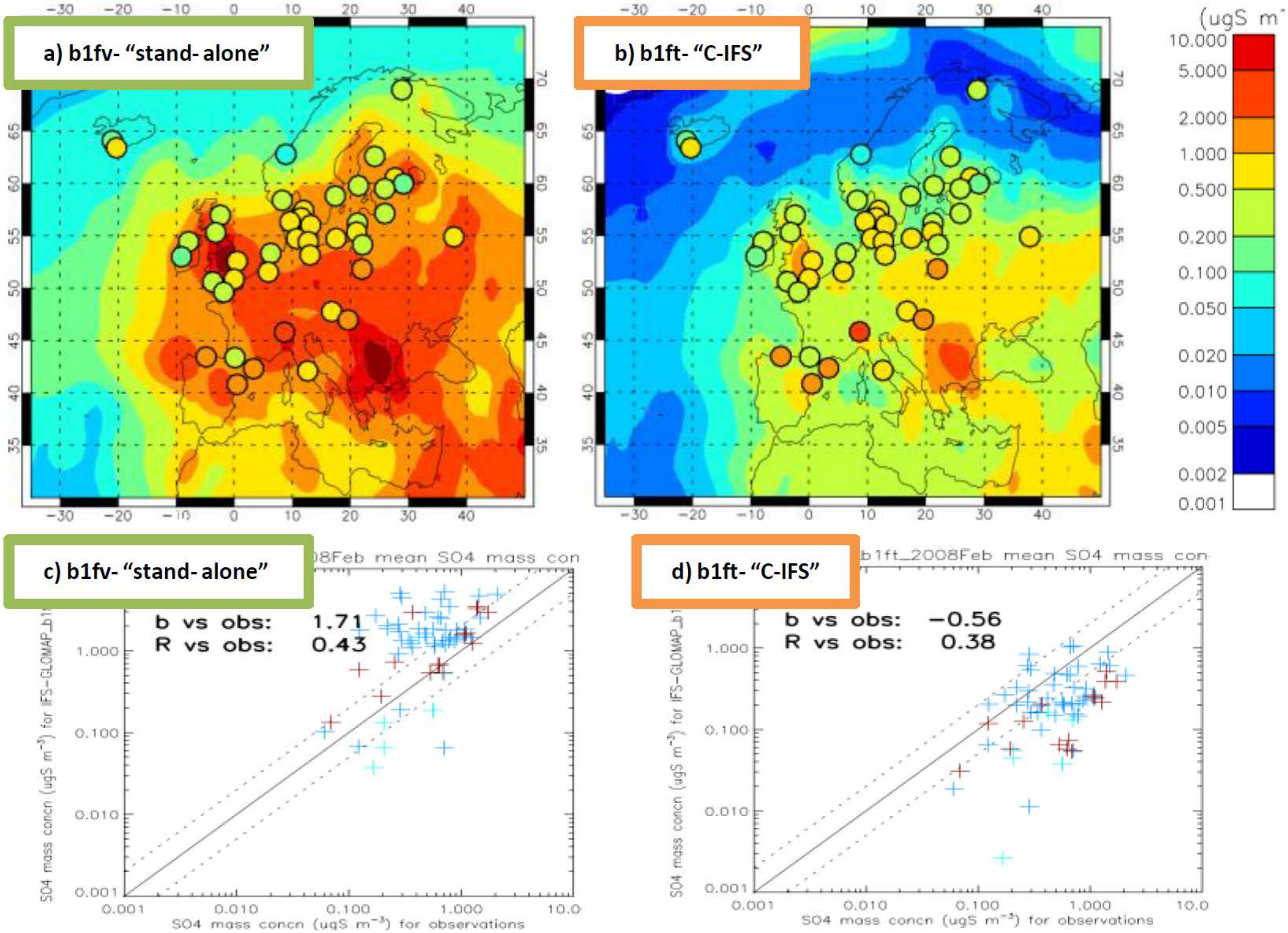


SU

GlobalBurden in various simulations

Experiment	SO4 (Tg S)	BC (Tg C)	POM (Tg C)	NaCl (Tg)	Dust (Tg)
Reference (2003)	0.58	0.15	1.41	5.97	11.7
No-DMS (2003)	0.54	0.21	2.65	6.05	13.5
Reference (2008)	0.70	0.13	1.47	5.92	13.7
C-IFS (2008)	0.11	0.11	1.80	5.93	22.76

Improved representation of SO4 aerosol in C-IFS-GLOMAP



DUBOVIK

GRASP: Generalized Retrieval of Aerosol and Surface Properties

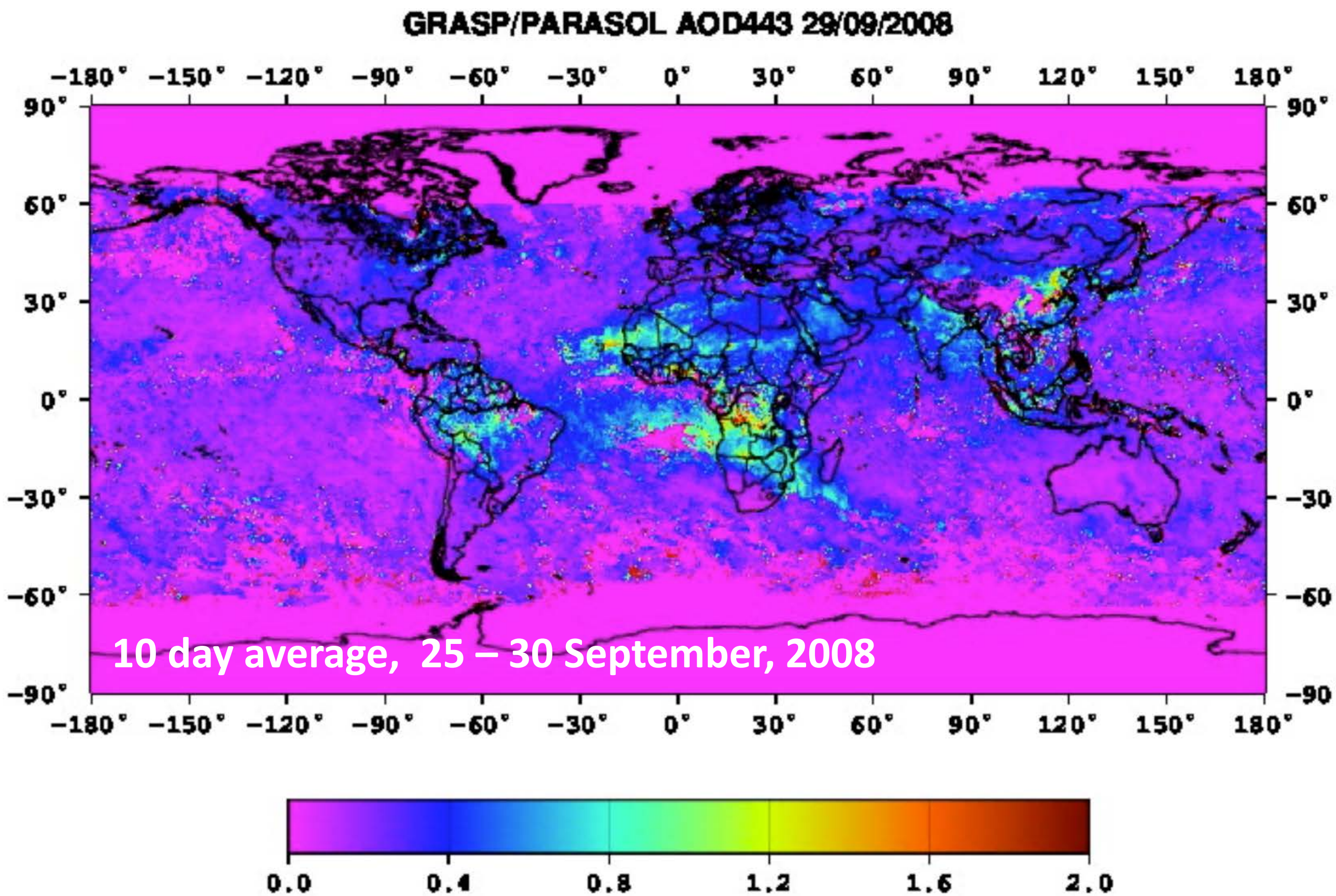
Dubovik et al. 2011, 2014

Open Source

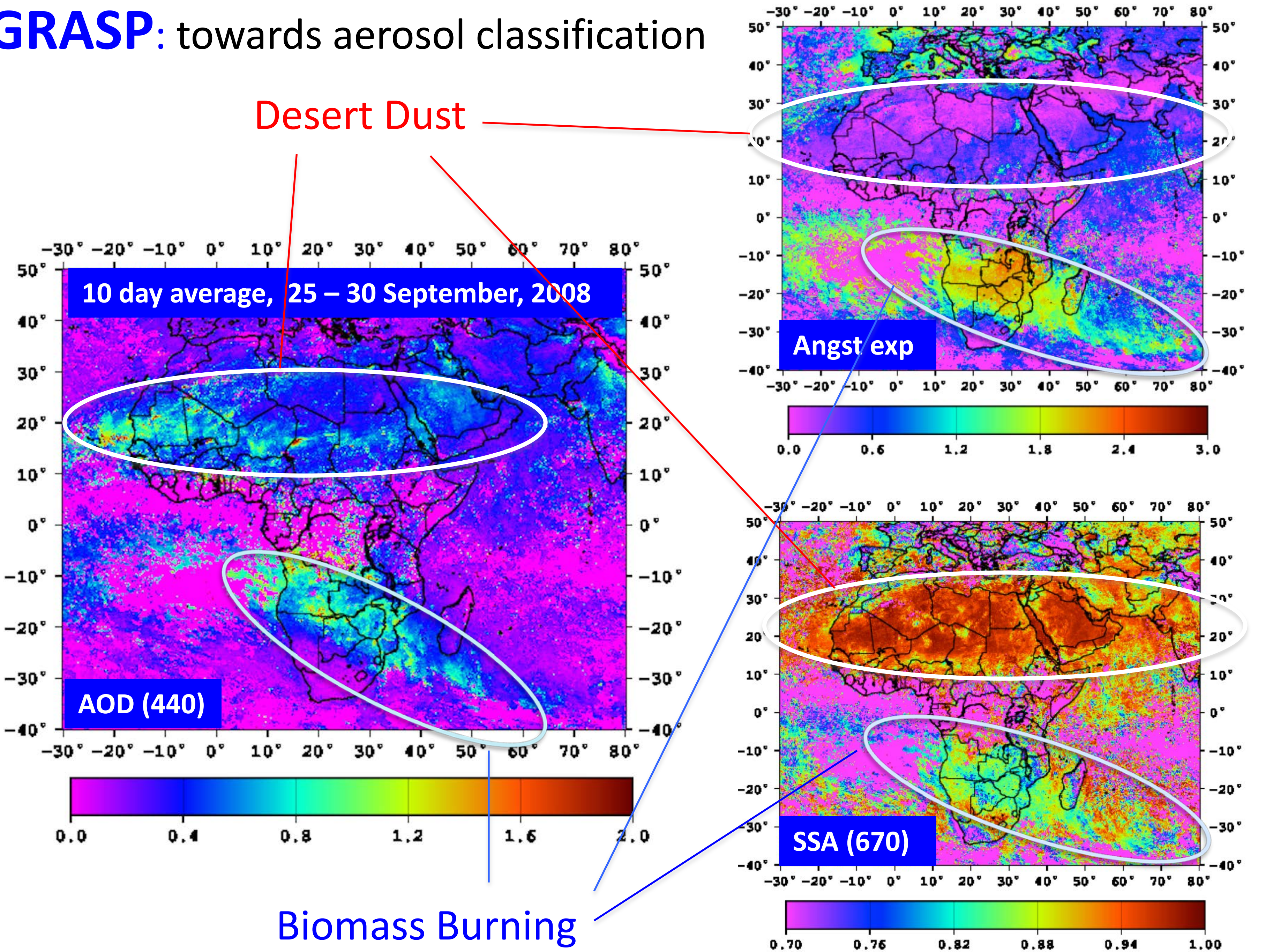
NO ASSUMPTIONS on aerosol and surface **All calculation on the fly**

Retrieved parameters: Surface reflectance, aerosol: AOD, SSA, aerosol height, size information, refractive index, aerosol type, etc.

Expected practical advantages: accurate even over bright surfaces, even for high AOD, and for extended set of parameters



GRASP: towards aerosol classification



FIEBIG

Confronting AeroCom Models with Particle Size Distribution Data from Surface In Situ Stations, Episode 2 (AeroCom project INSITU PNSD)

Markus Fiebig, Stephen Platt
Norwegian Institute for Air Research
Michael Schulz
Norwegian Meteorological Institute
Graham Mann
School of Earth and Environment, University of Leeds

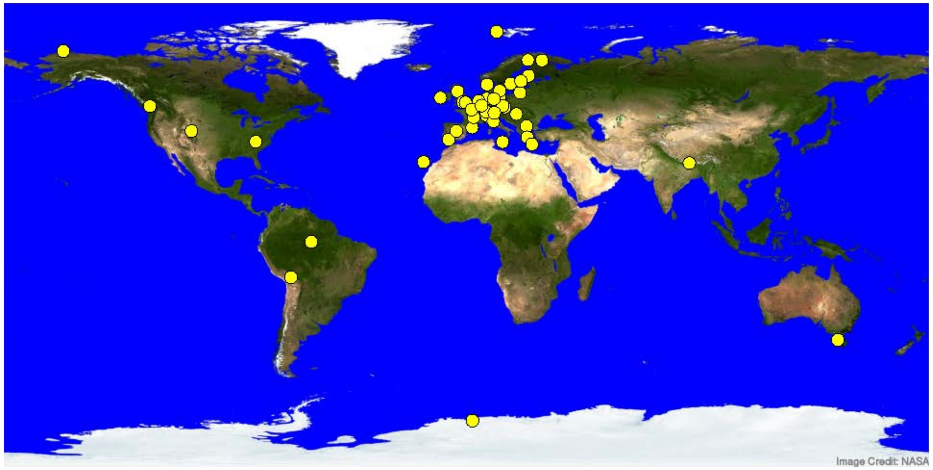
Motivation

- Particle size distribution probably most fundamental aerosol property relevant for any interaction of particles, e.g. direct and indirect climate effects.
- Surface in situ particle number size distribution (PNSD) data are of high accuracy, meterologically traceable – comparison, will improve models.
- Continue /update Graham Mann's work during phase II.

Objectives

- Update PNSD comparison to AeroCom Phase III
- Compare not only sectional particle concentration, also particle size (modal median particle diameter).
- Extend comparison from fine (D_p < 1 µm) to coarse size range (D_p < 1 µm) by using proxies (scattering Ångström coefficient, particle mass size distribution)
- Compare model-by-model to find reasons for agreement and disagreement.

Scope



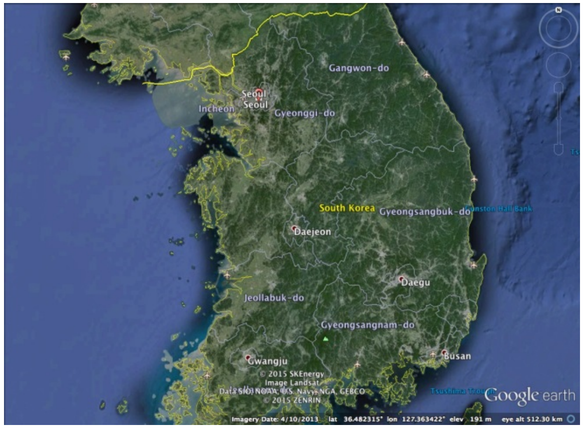
- 49 stations with fine-range PNSD
- 23 stations measuring spectral scattering coefficient in addition.
- 15 stations measuring PM2.5 / PM10 mass conc. in addition.

Become Involved!

- Request for targeted model output (PNSD and particle mass size distribution at surface and station location).
- See post on aerocom mailing list, aerocom Wiki, or poster for more information.

GARAY

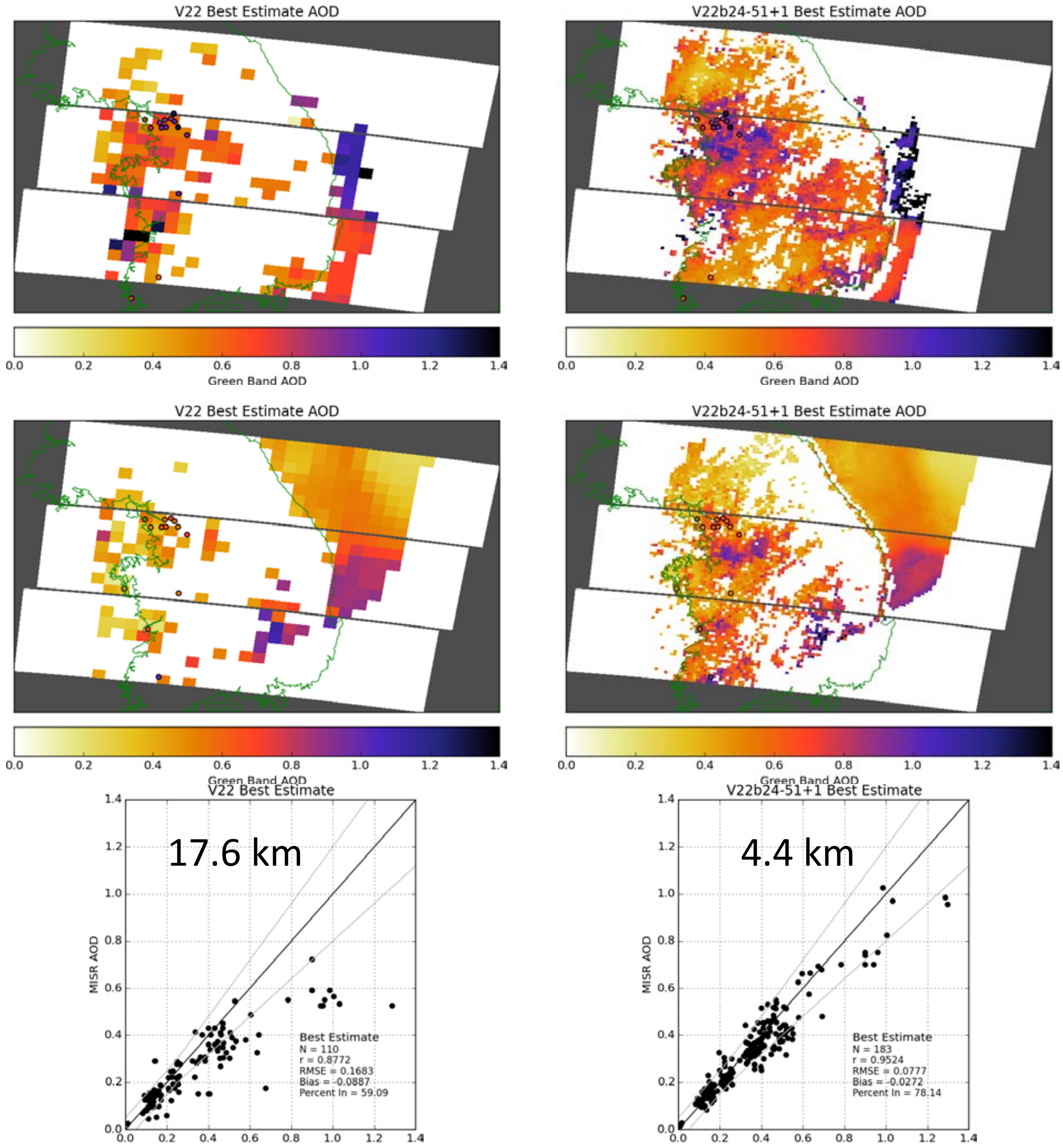
MISR High-Resolution Retrievals Over Korea from AERONET-DRAGON Asia 2012



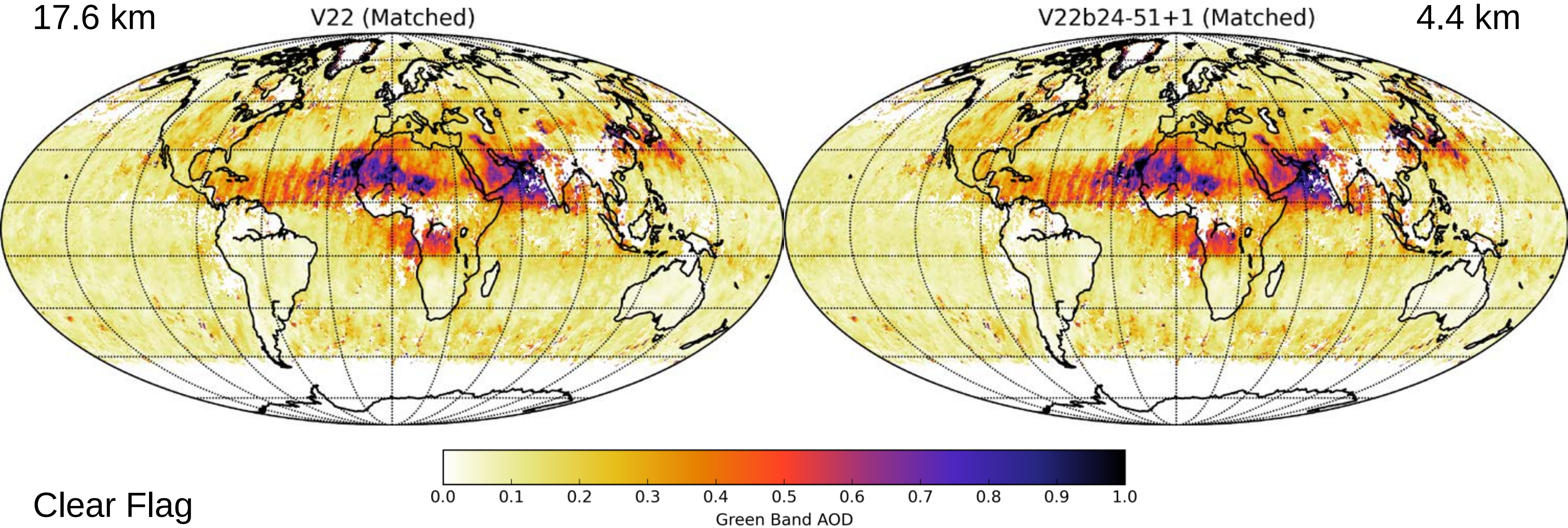
MISR 4.4 km Operational Retrieval

(COMING SOON!)

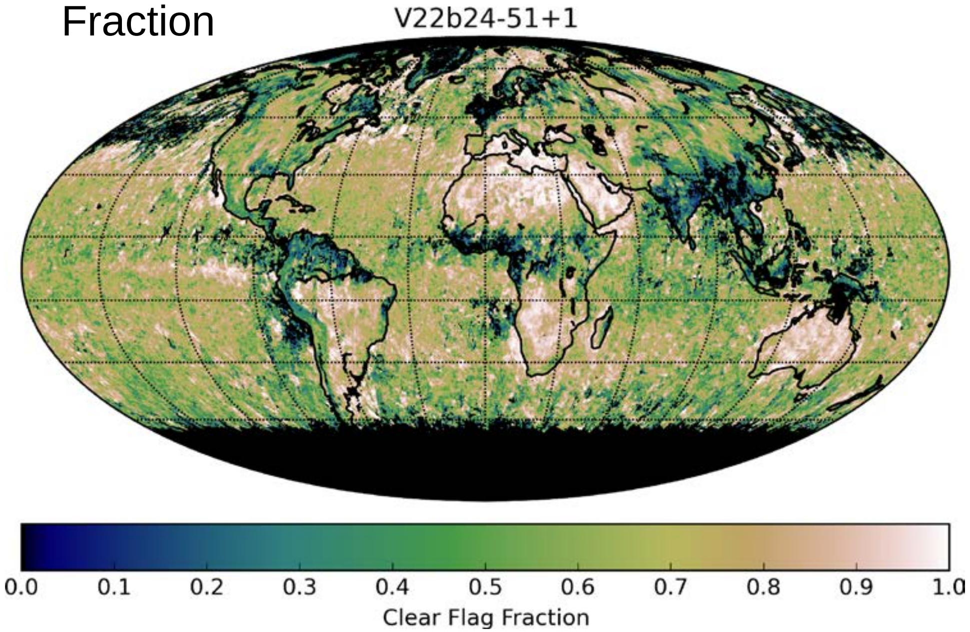
- 4.4 km algorithm nearly identical to 17.6 km (Version 22) algorithm you know and love!
- 4.4 km retrievals reported over both land and water!
- Improved spatial coverage, better agreement with AERONET AODs, better able to resolve spatial gradients in AOD!



Global Maps (July 2007)



Clear Flag Fraction



MISR 4.4 km Operational Retrieval

(NOW WITH ADDITIONAL FIELDS!)

- Latitude/longitude/time for each retrieval!
- Easier to understand content!
- Retrieval quality assessment for every retrieval!
- New fields to help diagnose performance!

GHAN

Constraining Cloud-Aerosol Interactions in Climate Models

Steven Ghan, Pacific Northwest National Laboratory
Minghuai Wang, Nanjing University

$$\Delta R = R \frac{d\ln R}{d\ln \tau_c} \boxed{\frac{d\ln \tau_c}{d\ln N_d}} \frac{d\ln N_d}{d\ln CCN} \frac{d\ln CCN}{d\ln E} \Delta \ln E$$

Ignore cloud fraction change

R: "clean-sky" shortwave cloud forcing (Ghan, ACP, 2013)
ΔR: ERFaci
$|_\chi$: cloud optical depth N_d: cloud droplet number
CCN: CCN at 1 km (0.1% supersaturation)
E: anthropogenic emission
L: liquid water path r_e: droplet effective radius

$$\frac{d\ln \tau_c}{d\ln N_d} = \frac{\partial \ln \tau_c}{\partial \ln r_e} \frac{d\ln r_e}{d\ln N_d} + \frac{\partial \ln \tau_c}{\partial \ln L} \frac{d\ln L}{d\ln N_d}$$

$$\simeq -\frac{d\ln r_e}{d\ln N_d} + \frac{d\ln L}{d\ln N_d}$$

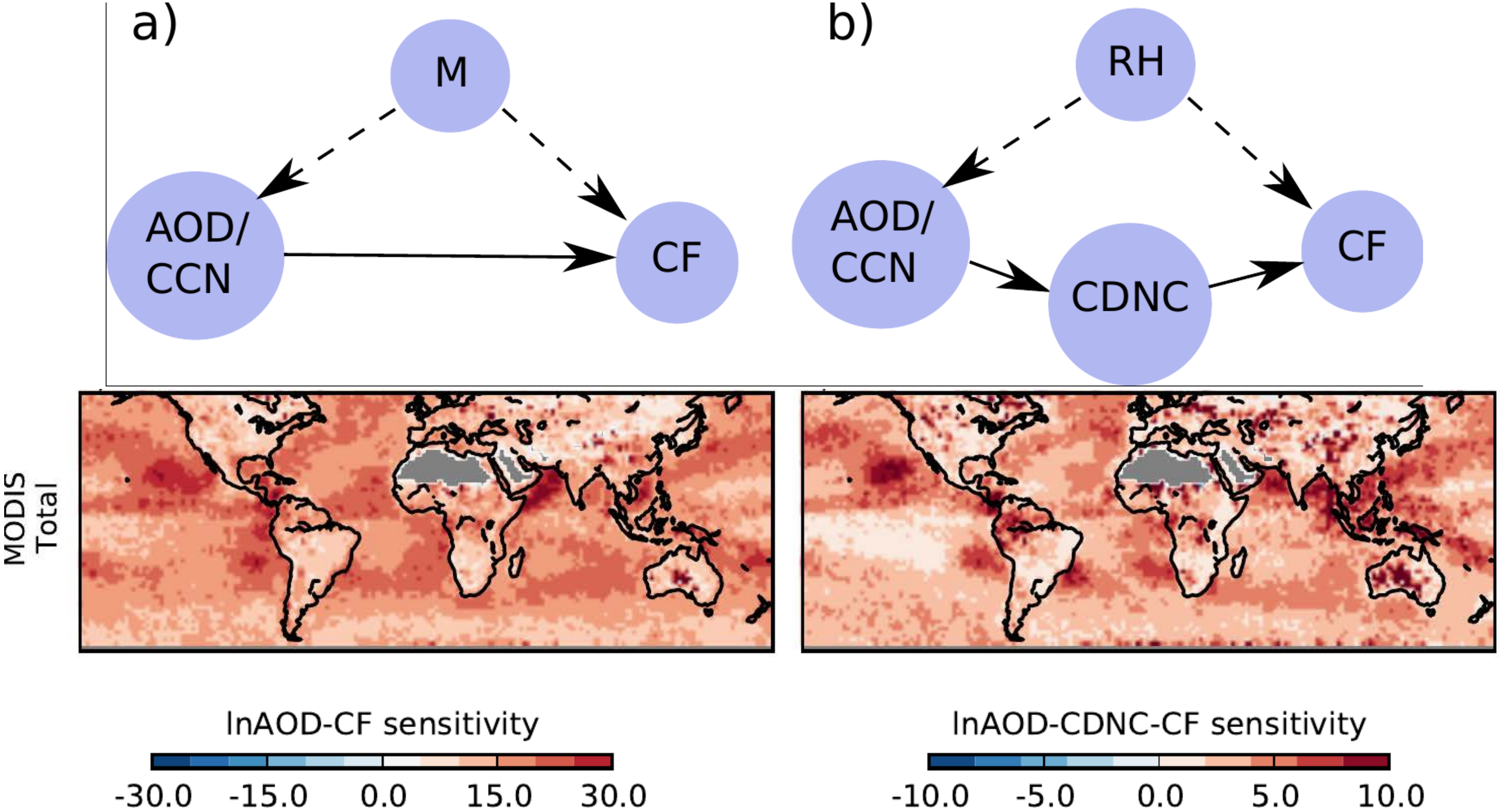
$$\tau_c \propto \frac{L}{r_e}$$

albedo effect lifetime effect

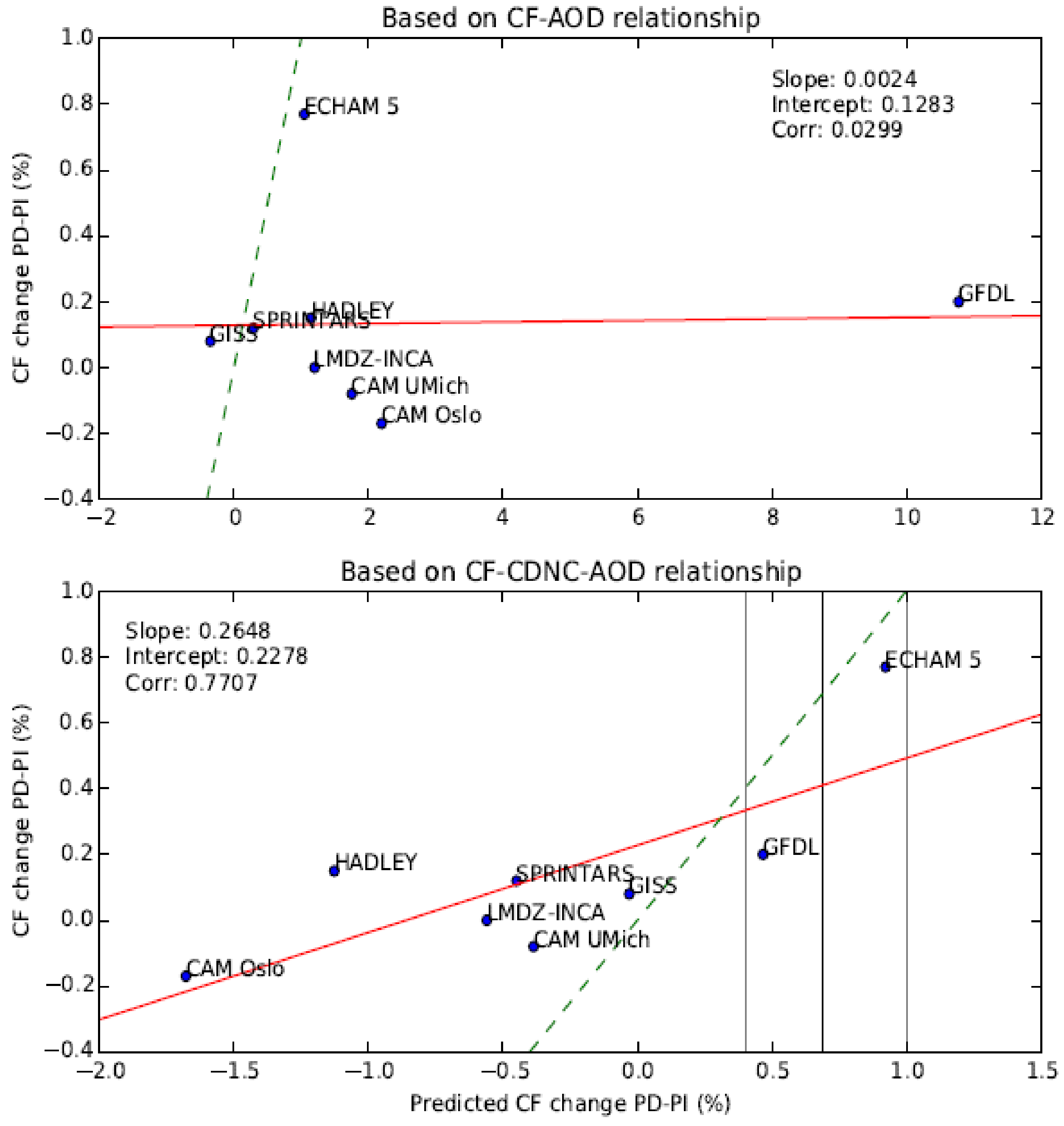
GRYSPEERDT

AOD and CF in observations and global models

Edward Gryspeerdt



what about AeroCom models?



GRZEGORSKI

EUMETSAT Meteorological Satellite Conference, Toulouse, 24/09/2015

RETRIEVAL OF AEROSOL OPTICAL PROPERTIES OVER LAND AND OCEAN USING PMAP

EUMETSAT

Michael Grzegorski, Andriy Holdak, Gabriele Poli, Rüdiger Lang, Rosemary Munro

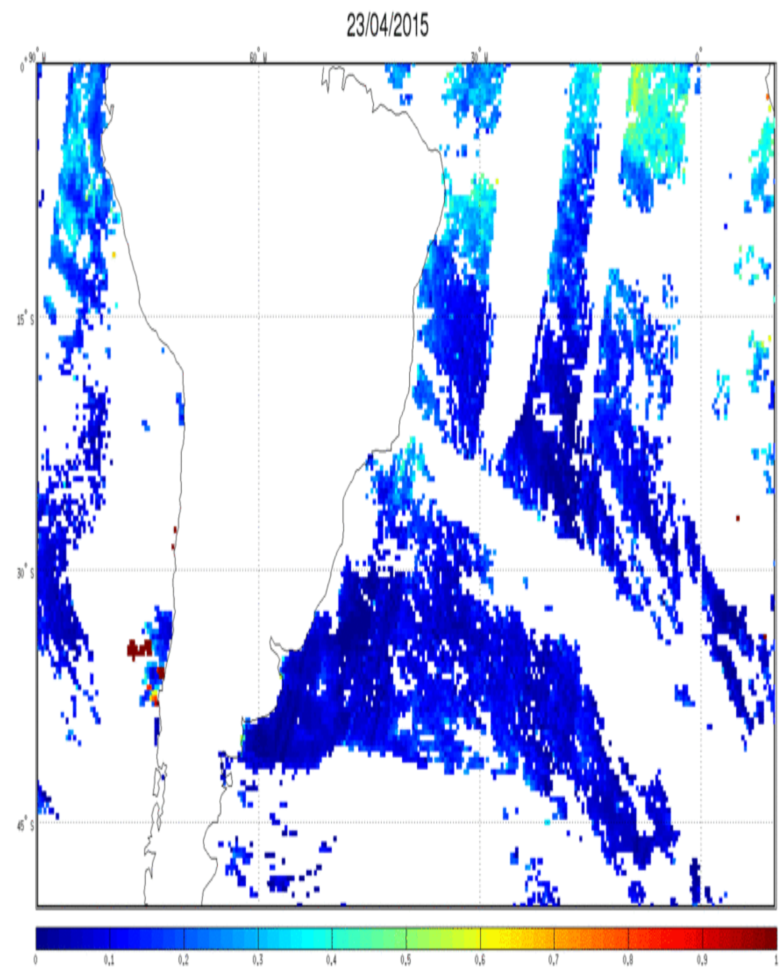
Retrieval of aerosol optical properties over land and ocean using PMAp I

- PMAp: Polar Multi-sensor Aerosol product

  - AOD over ocean, aerosol type classification (volcanic ash)
  - Delivered as a GOME product (PMD resolution)
  - Fully operational product quality status since October 14th 2014
  - major update at January 20th 2015
  - Distributed by EUMETCast in netcdf4

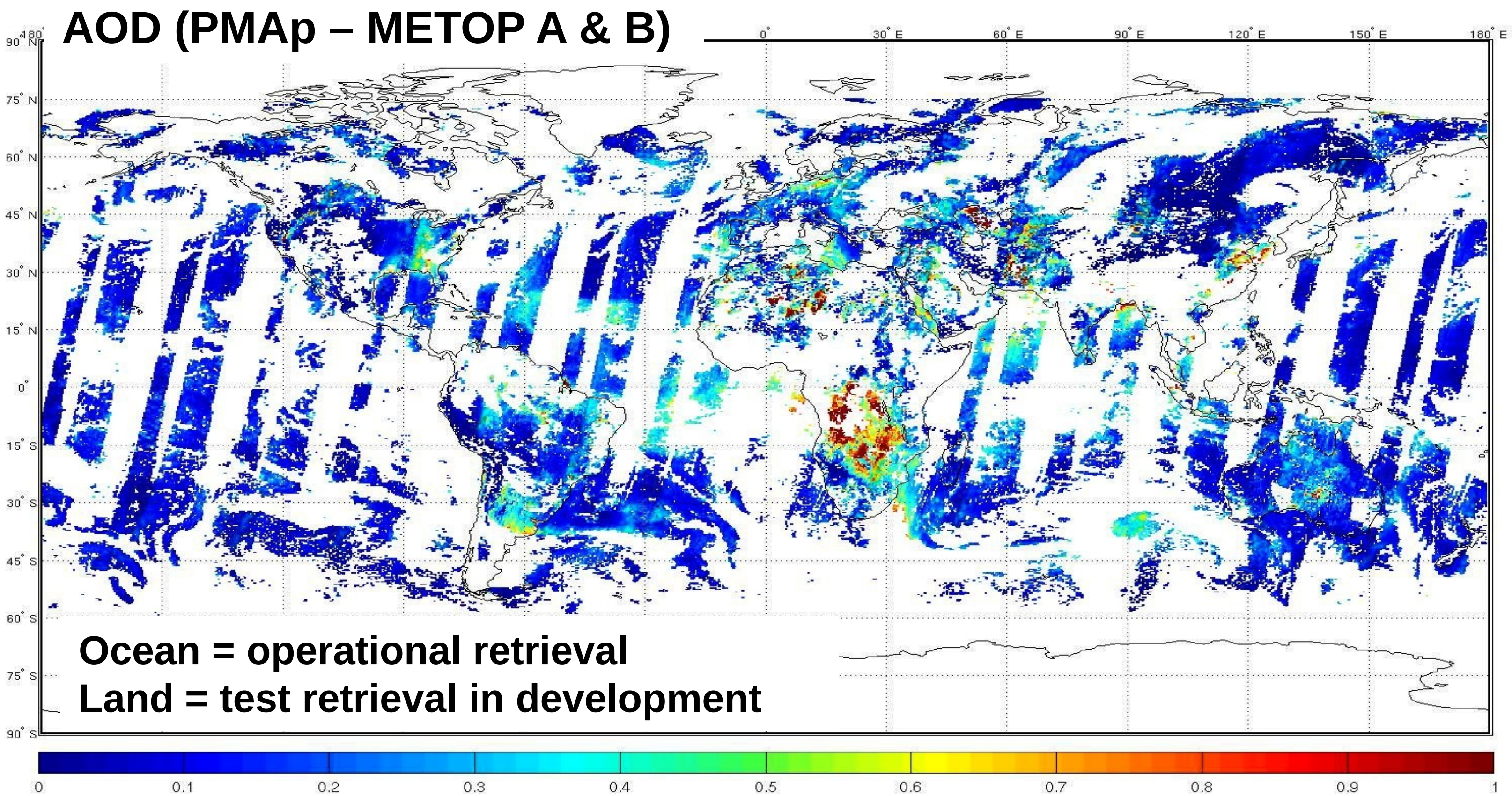
Video:

Volcanic ash eruption April 2015



Retrieval of aerosol optical properties over land and ocean using PMAp II

- Q1/2016: *Implementation of PMAp Release 2 including retrieval over land on the core ground segment (expected)*

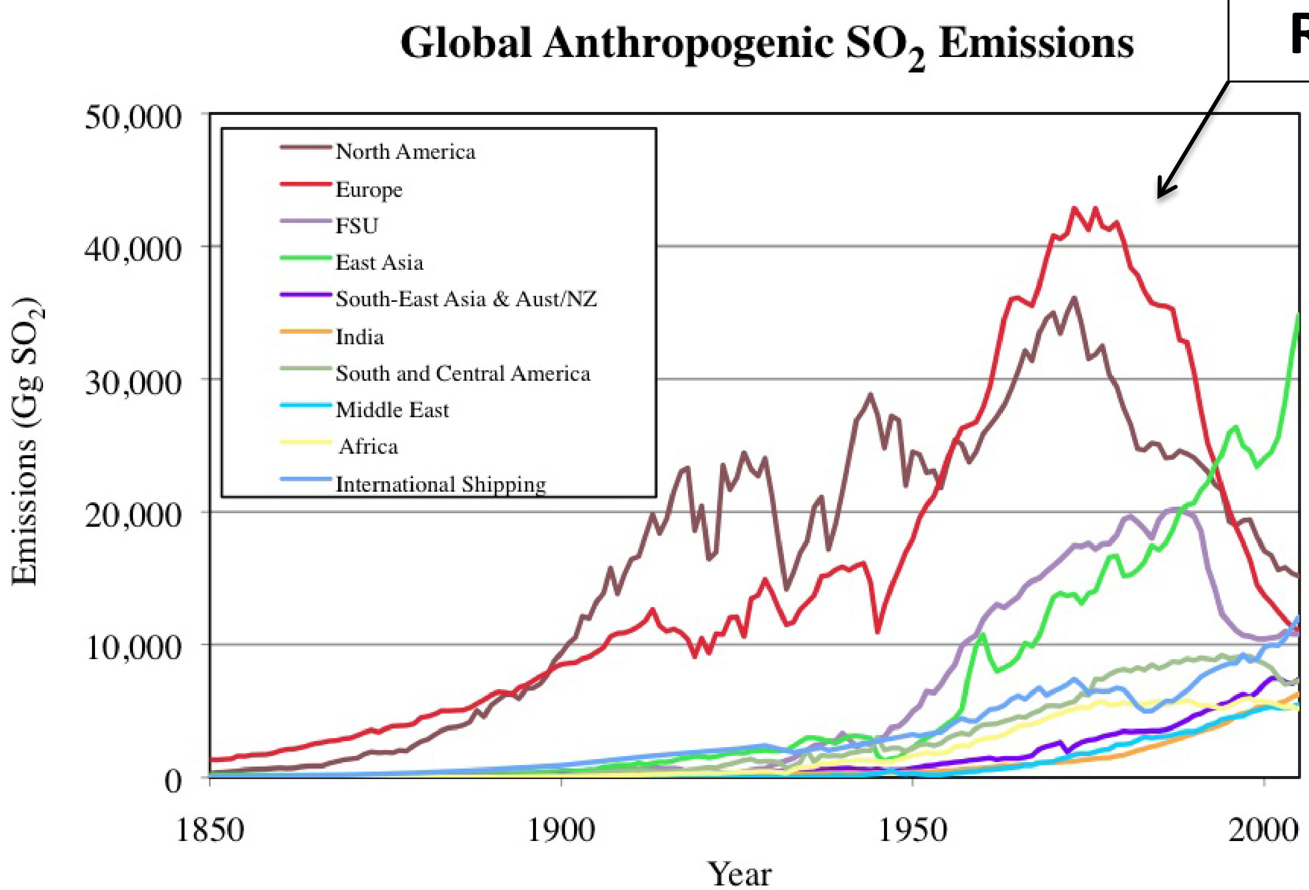


HANSSON

How does European aerosol emissions affect the Arctic climate?

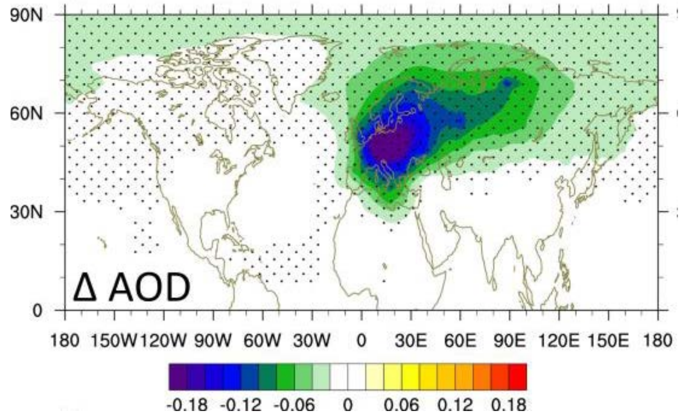
Acosta Navarro, J. C.& Varma, V, Riipinen, I., Seland, Ø., Kirkevåg, A., Struthers, H., Iversen, T., Hansson, H.-C., Ekman, A. M. L.

European Air Quality Regulation started

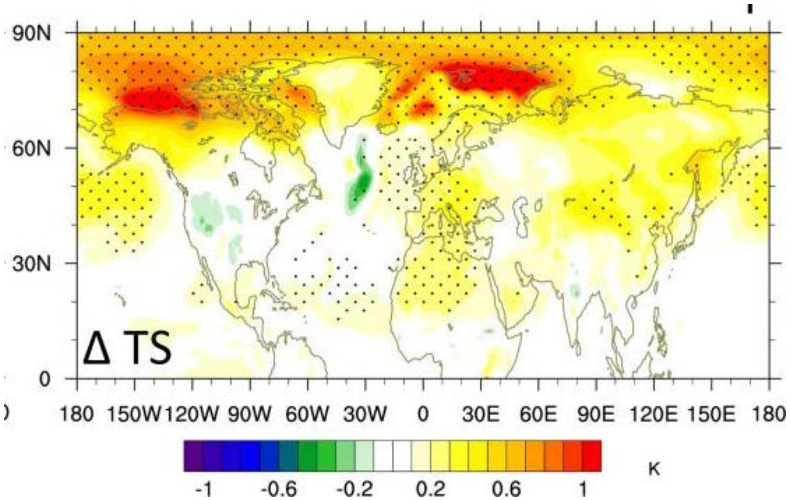


Smith et al. (2011)

NorESM says



The changes in AOD, CDNC and TOA show clearly main forcing is over Europe!
BUT temperature effect in the Arctic!!!!



Why is the effect in the Arctic when the forcing is in Europe?

JOHNSON

Holuhraun eruption 2014
The tropospheric equivalent of Pinatubo

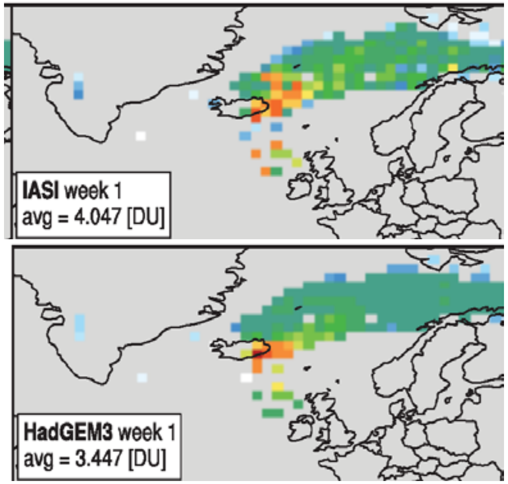
Jim Haywood[1,2], Andy Jones[1], Florent Malavelle[2], ...

Nicolas Bellouin[3], Olivier Boucher[4], Sophie Bauduin[5], Ken Carslaw[5], Lieven Clarisse[6], Hugh Coe[7], Mohit Dalvi[1] Sandip Dhomse[5], Andrew Gettelmann[8], Dan Grosvenor[9], Margaret Hartley[6], Ben Johnson[1], Colin Johnson[1], Jeff Knight[1], Jon-Egill Kristiansen[10], Graham Mann[5], Fiona O'Connor[1], Steve Platnick[11], Jens Redemann[12], Anja Schmidt[5] Graeme Stephens[13]

[1]Met Office Hadley Centre, UK. [2]University of Exeter, UK. [3]University of Reading, UK. [4]LMD, Jussieu, France. [5]University of Leeds. UK [6]ULB, Belgium. [7]University of Manchester, UK. [8]NCAR, Boulder, USA. [9]University of Leeds, UK. [10]CICERO, Norway. [11]NASA GSFC, USA. [12]NASA Ames, USA. [13]JPL, USA

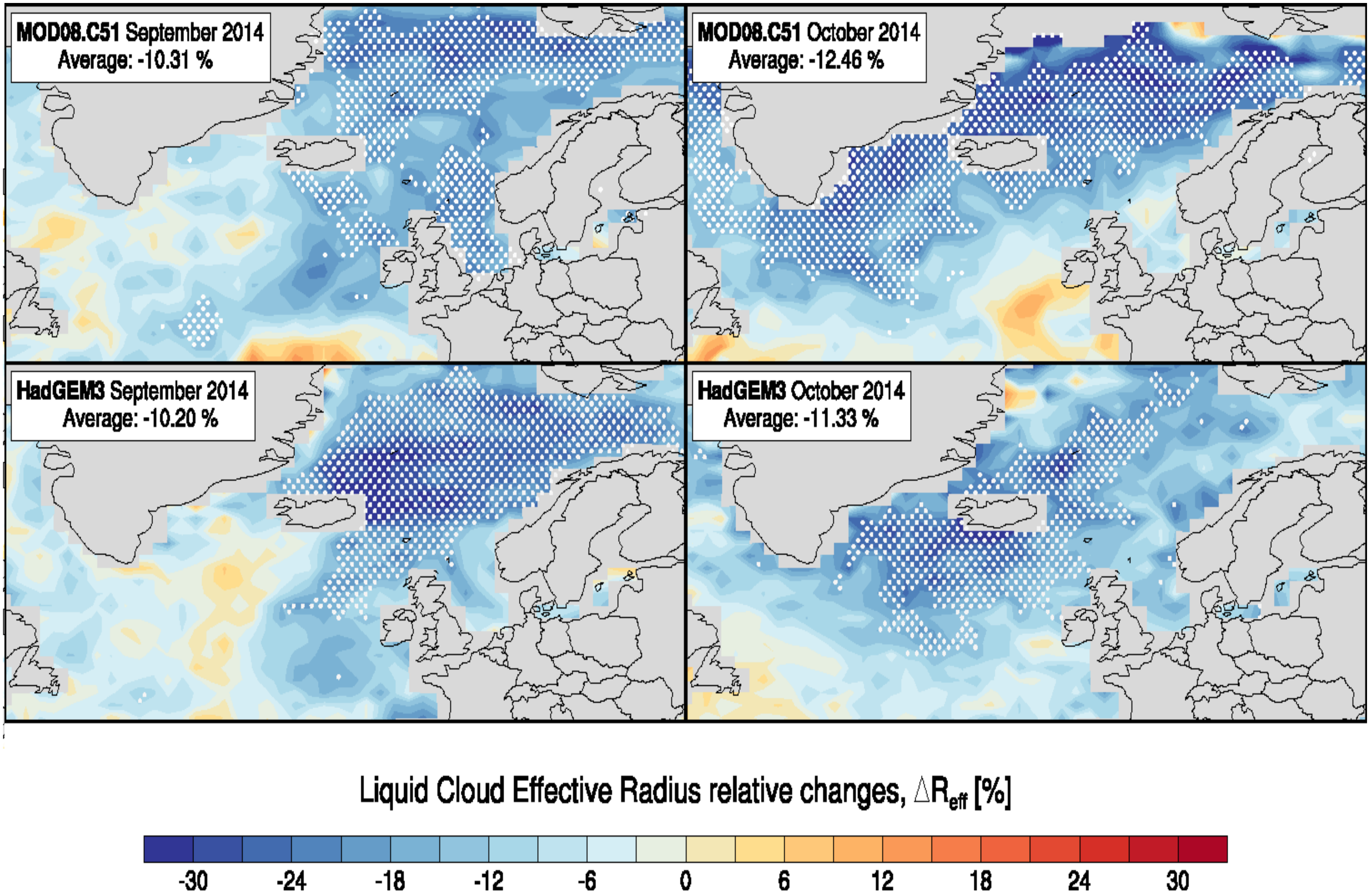
Holuhraun 19 Sept 2014
Gro B.M. Pedersen, University of Iceland, Reykjavik.

Aerosol plume 11 Sept 2014
MODIS visible image, NASA



SO2 column 1-7 Sept 2014
IASI retrieval and HadGEM3 simulation

impact on cloud effective radius



KINNE

MAC climatology

- **MAC** = **M**ax-Planck **A**erosol **C**limatology

    merging AERONET/MAN on AEROCOM ensemble backgrd

  - AOD

    .12

  - AAOD

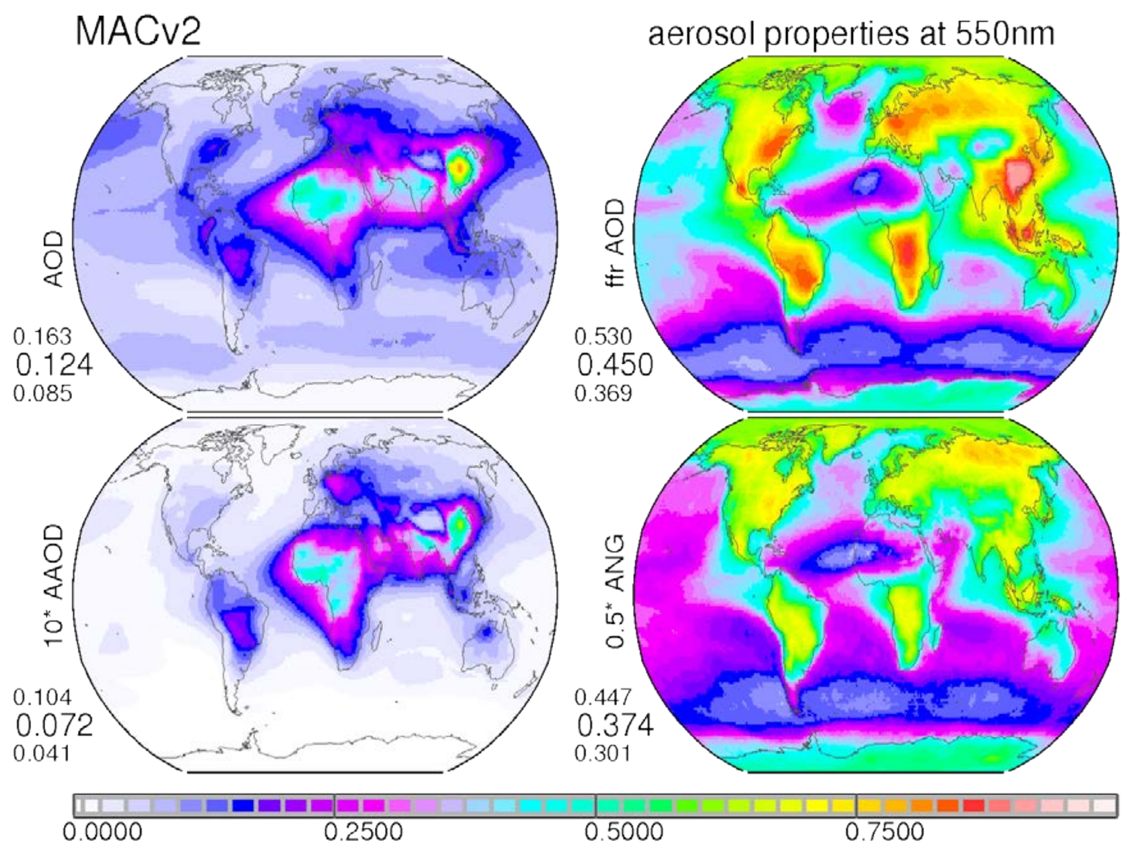
    .007

  - FMF,AOD

    .45

  - Ang

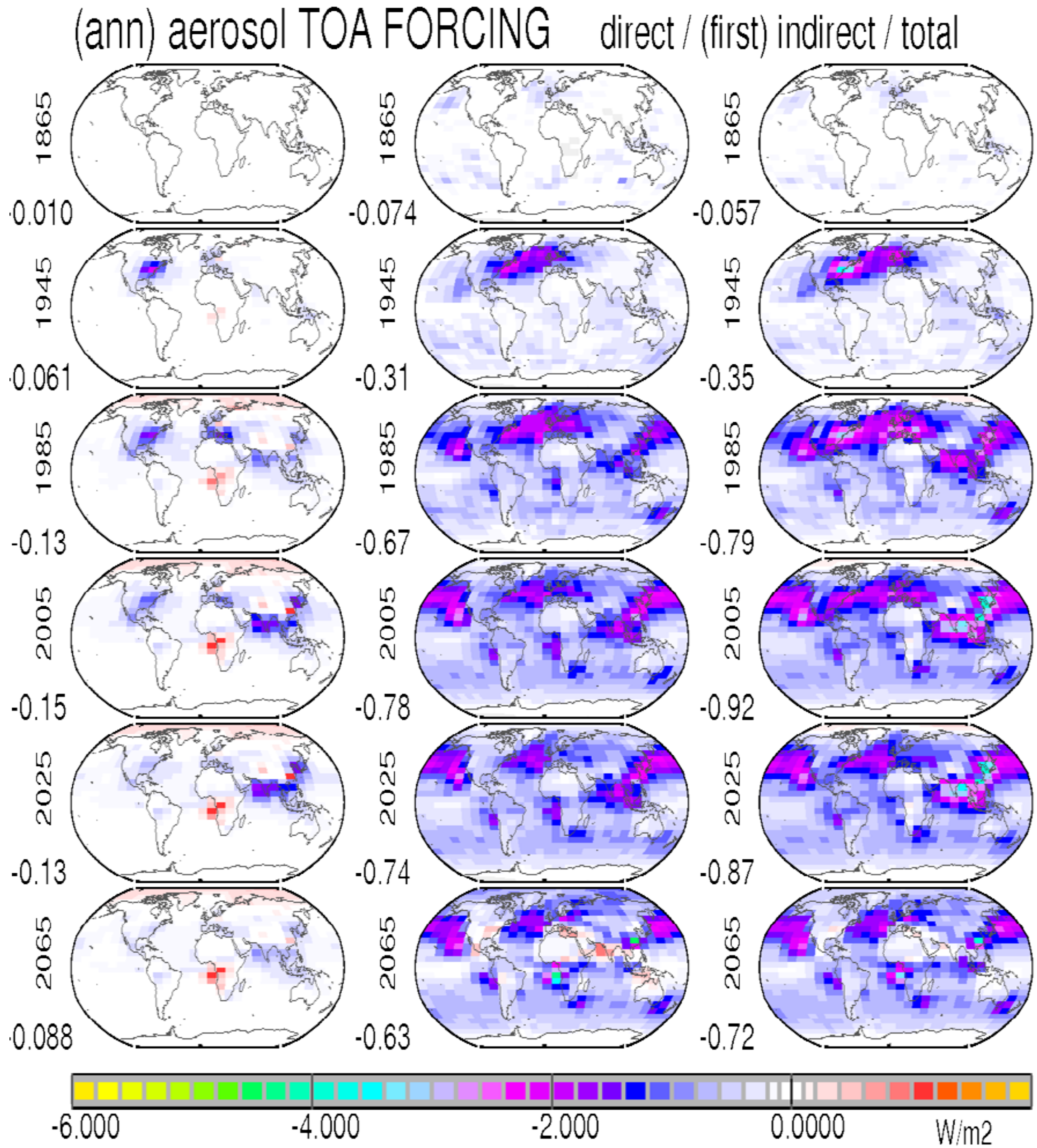
    .75



direct indirect total

MAC
rad. forcing
(climate impact)
application

- focus on forcing patterns
  - … as a function of time



KIPLING

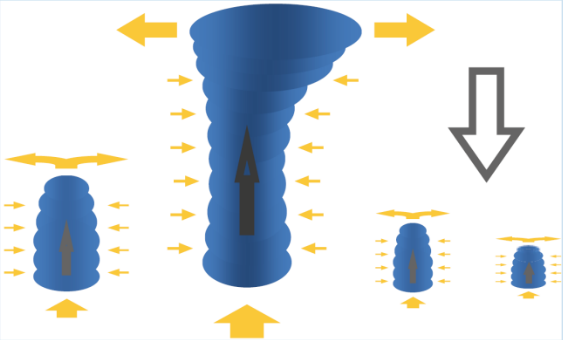
Quantifying global aerosol effects on convection using the Convective Cloud Field Model (CCFM)

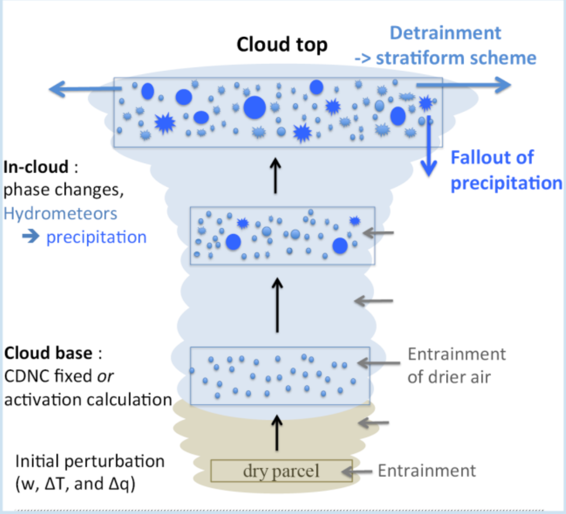
Zak Kipling, Laurent Labbouz, Philip Stier and Till Wagner

Atmospheric, Oceanic and Planetary Physics, Department of Physics, University of Oxford. Contact: zak.kipling@physics.ox.ac.uk

European Research Council
Established by the European Commission

Convective Cloud Field Model

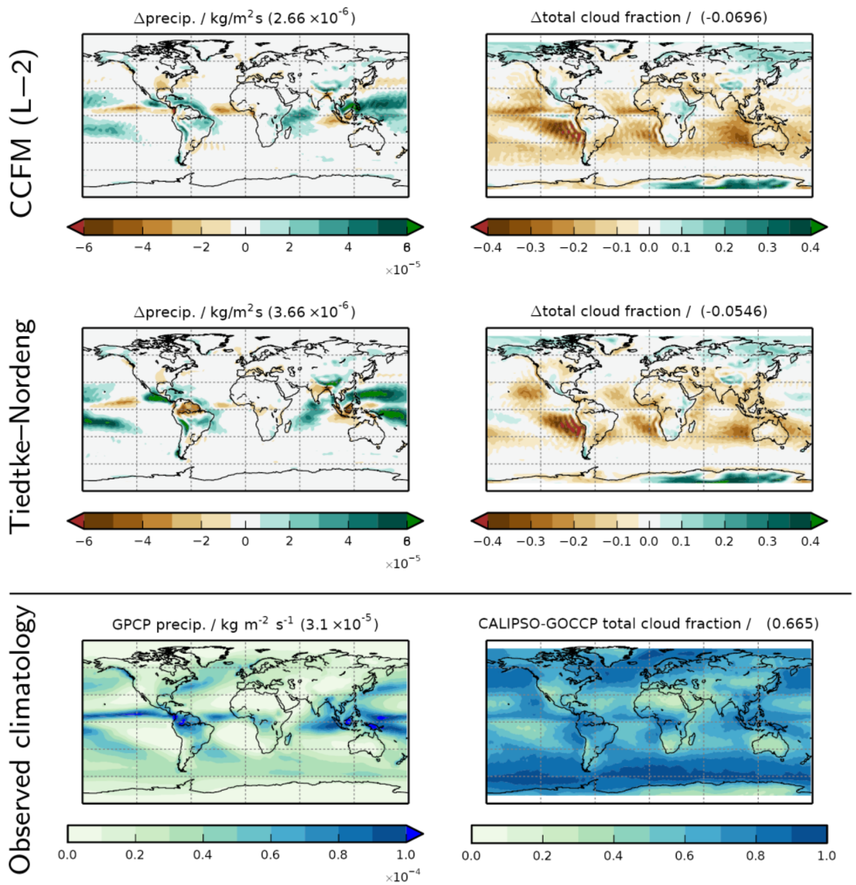




Baseline evaluation

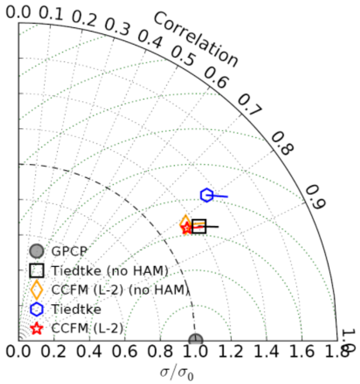
Precipitation vs GPCP

Cloud cover vs CALIPSO-GOCCP

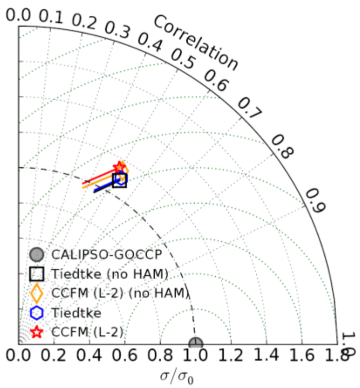


Monthly Taylor diagrams

Precipitation



Cloud cover



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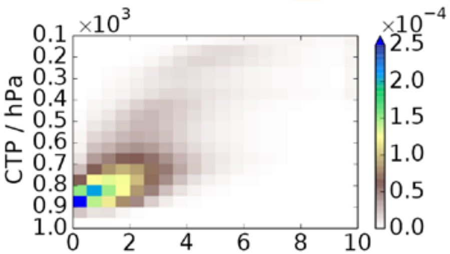
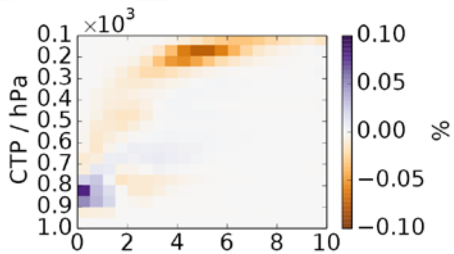
University of Oxford

European Research Council
Established by the European Commission

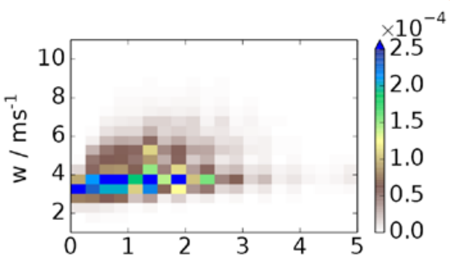
Detrainment to resolved scale/stratiform cloud scheme



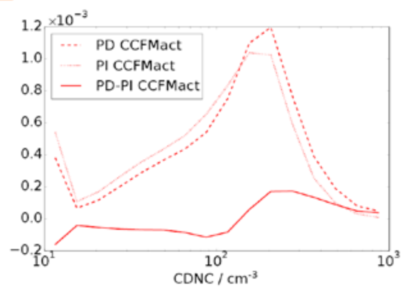
Cloud-top distribution (PD)



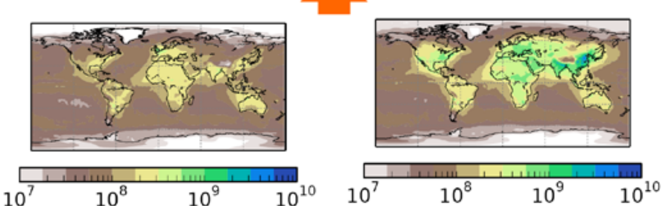
(PD−PI as % of total)



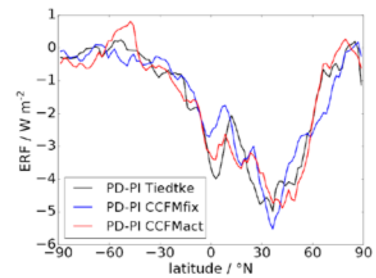
Cloud-base updraught dist.

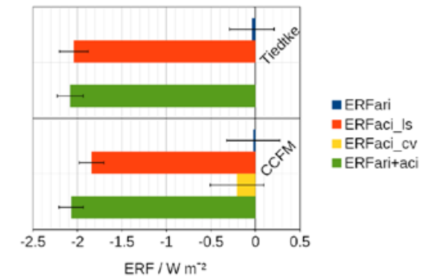


Cloud-base CDNC dist.

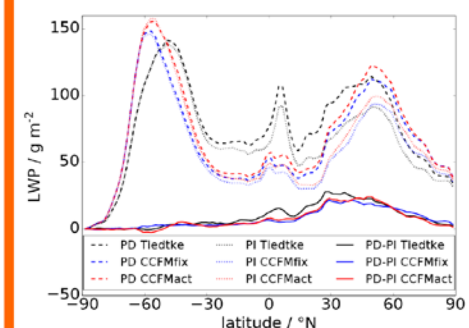


Surface CCN concentrations / m⁻³

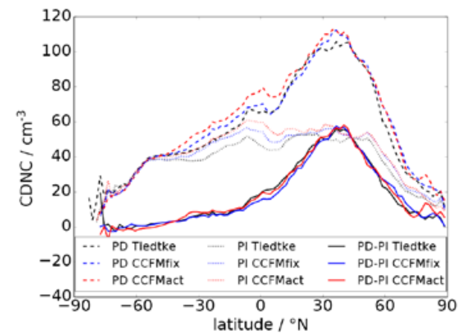




Effective radiative forcing at TOA



Liquid water path



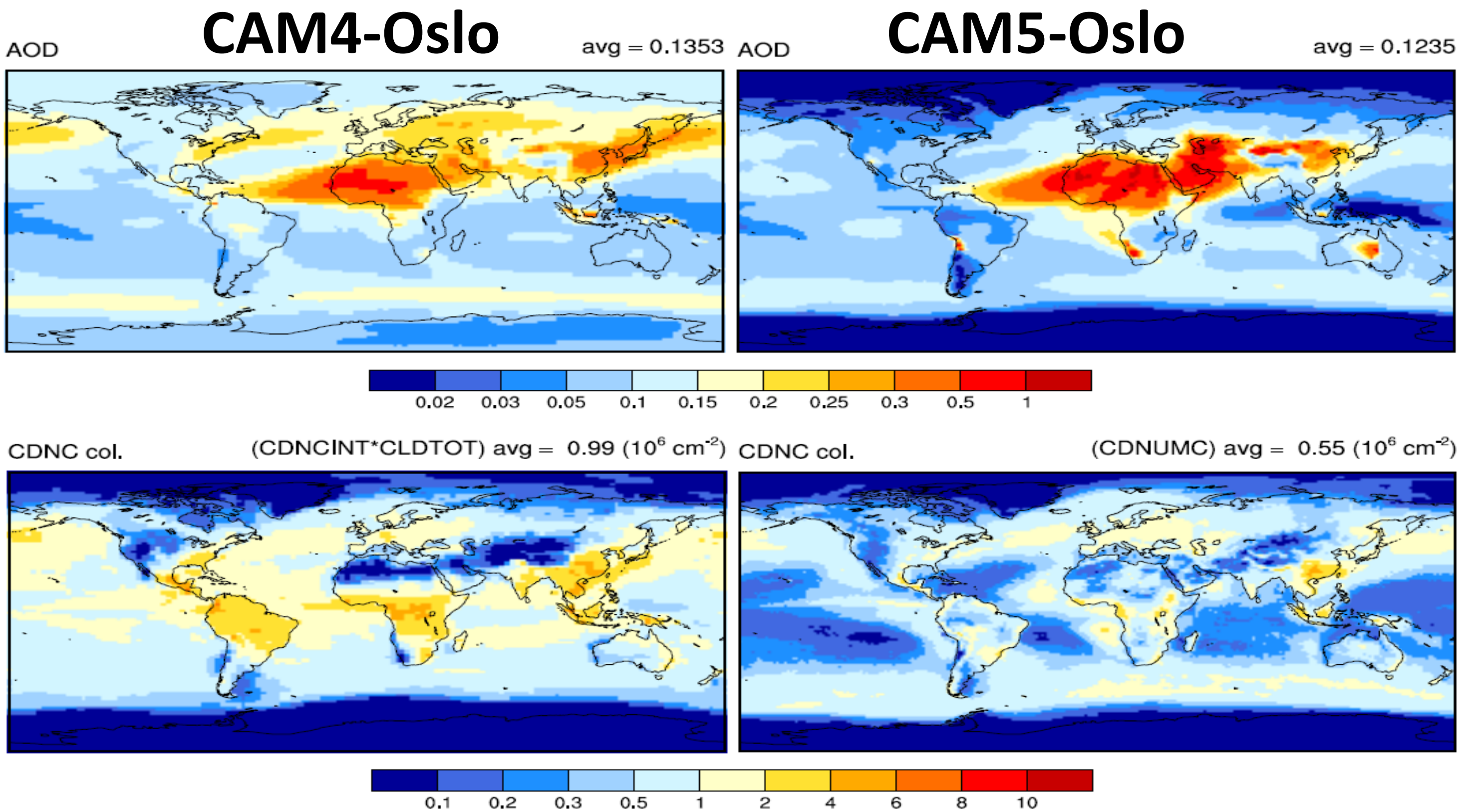
Cloud-top CDNC

▲ The aerosol–convection forcing pathway ▲

KIRKEVAG

Preliminary estimates of Aerosol Effective Radiative Forcing in CAM5-Oslo/NorESM2

A. Kirkevåg, K. Alterskjær, A. Grini, T. Iversen, D. Olivié, M. Schulz, and Ø. Seland



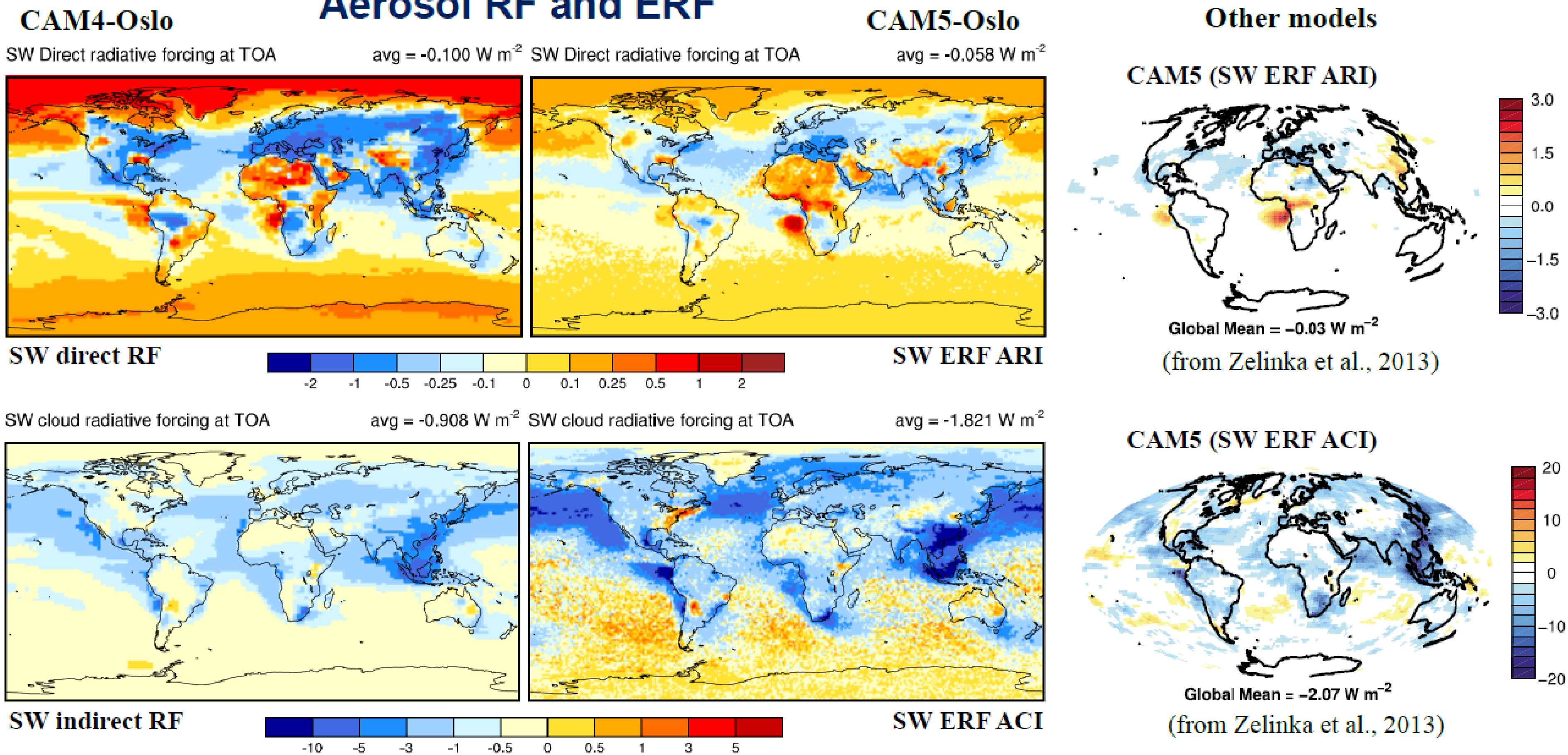
AOD at 550 nm

CDNC (cm^{-2})

CAM5-Oslo is a version of CAM5 where schemes for aerosol chemistry, physics and interaction with clouds originally developed for CAM4-Oslo/NorESM1 exist alongside the modal aerosol modules of CAM5 (e.g. MAM7). Present basis is CAM5.3, but will be updated as new CAM5 versions are released.

Sea-salt emissions has been updated and SOA and explicit nucleation is new since CAM4-Oslo. Work on b.b POM, interactive DMS and marine biog. POM etc. not final → only preliminary results

Aerosol RF and ERF



SW Effective RF (ERF) may be split (according to Ghan, 2013) into

- a direct forcing term: **Direct RF = Δ(F – Fclean)** **(SW ARI)**
- a term for indirect and semi-direct effects:
  Cloud RF = Δ(Fclean – Fclear-sky,clean) **(SW ACI)**
- a residual term: **Surface albedo RF = ΔFclear-sky,clean**

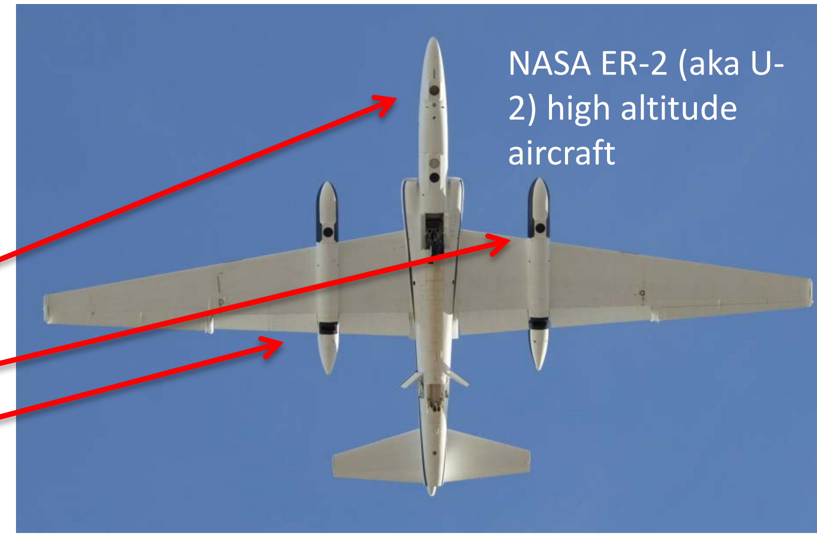
KNOBELSPIESSE

Progress of the NASA Aerosol/Cloud/Ecosystems (ACE) Mission Polarimeter Working Group instrument inter-comparison

Kirk Knobelspiesse, Qian Tan, Jens Redemann
NASA Ames Research Center

Airborne polarimeters relevant to NASA ACE, PACE missions:

- AirMSPI, NASA/JPL
- PACS, UMBC
- RSP, NASA GISS



overall mission goal: develop / inter-compare polarimeter aerosol / cloud retrievals

Our (subset) goal: confirm level 1 (geolocated radiance/polarization) agree within uncertainties

	Method	Imager?	Approximate polarimetric accuracy @reflectance=0.2	# view angles	Nadir ground resolution for ER-2 altitude	Channel center wavelength (nm) 355	380	410	445	470	550	555	660	670	766	865	870	935	960	1593	1880	2263	total # obs. per pixel
AirMSPI	Photoelastic modulation	Yes	1%: Step & Stare; 0.5%: sweep; 0.25%: averaged to RSP resolution	1 to 31	7m footprint, 9m along track 'smear'	▨	▨		▨	■ 1		▨	■ 2			■ 3		▨					up to 420
PACS	Philips prisms + linear polarizers	Yes	uncharacterized	Up to ~65	37m footprint, smear?					■	■	■		■	■		■						up to 1170
RSP	Wollaston Prisms	No	0.075%	~152	277m footprint, 277m along track 'smear'			■		■ 1		■		■ 2		■ 3			■	■	■	■	~4100

▨ indicates no polarization sensitivty

1,2,3 indicates polarimetric comparison channels

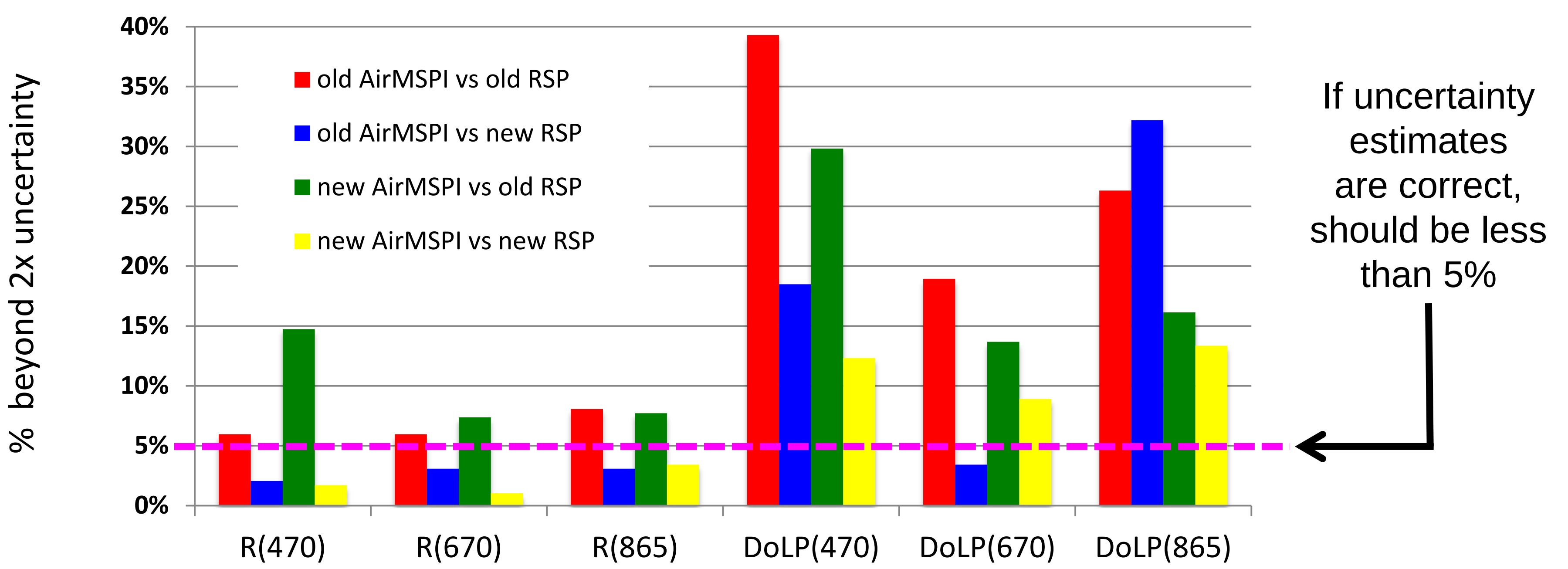
Level 1 instrument pixel to pixel intercomparison

- Only available for AirMSPI, RSP in 3 channels (470, 660/670, 865nm)
- Level 1 = calibrated, geolocated observables (Reflectance, R, Degree of Linear Polarization, DoLP)
- Previous results: Reflectances OK, Polarimetric comparisons larger than measurement uncertainty
- New RSP data has improvements to geolocation – available in version 2 data
- New AirMSPI data has improvements to calibration – but not yet publically available
- New comparison is better than before, but polarimetric biases are still too large
- Upcoming work: more scenes (currently pixel N~280), investigate view angle differences

below: percentage of AirMSPI/RSP biases larger than 2x the joint uncertainty

For realistic uncertainty estimates, this should be less than 5%

Main message: polarimeters agree better than before, problems/work remains



KOKKOLA

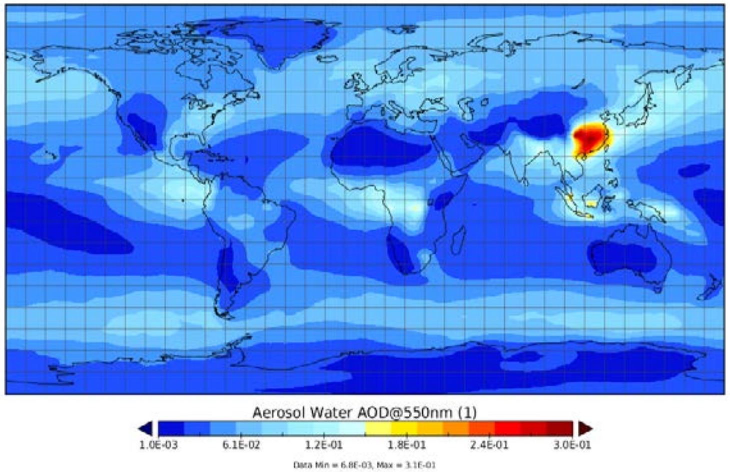
Contribution of water to modeled aerosol direct effect

H. Kokkola, T. Laaksoviita, A. Kirkevåg, T. Kühn, S. Romakkaniemi, A. Arola

- **Aerosol optical depth is the most used parameters in model evaluation**
- **The contribution of water to AOD differs significantly between models**

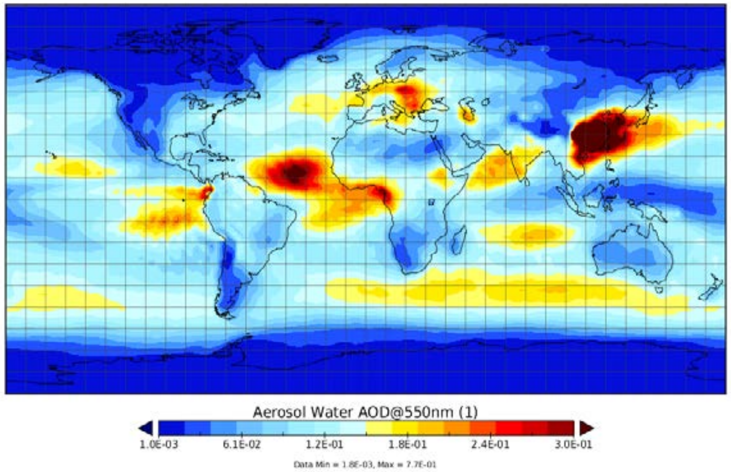
GOCART

0.113 Total AOD
0.049 Water AOD



ECHAM-HAMMOZ

0.115 Total AOD
0.076 Water AOD



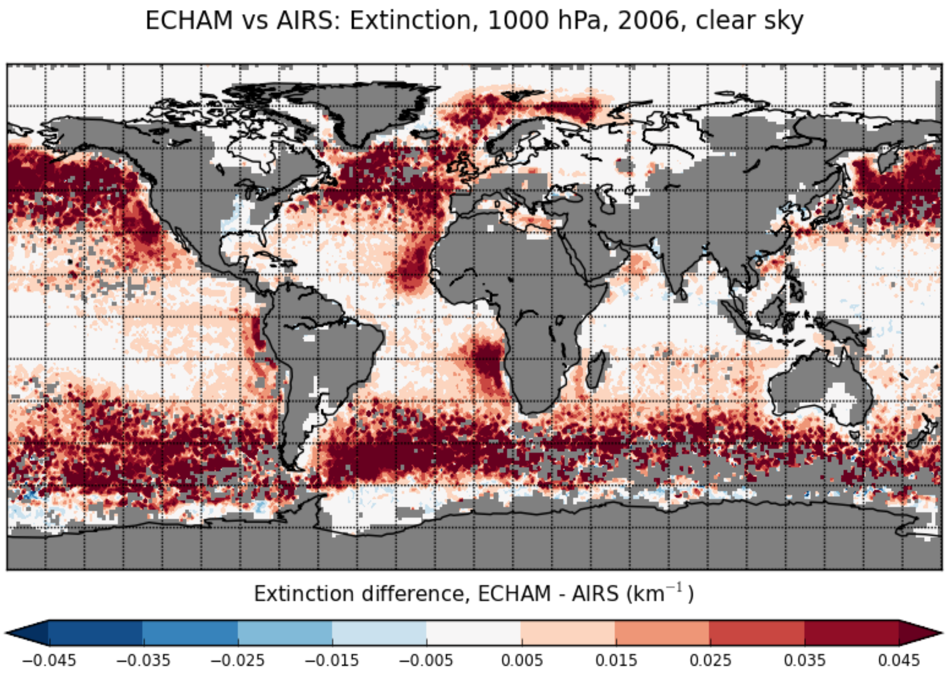
=> significantly different dry aerosol => different aerosol 1st indirect effect

Contribution of water to modeled aerosol direct effect

H. Kokkola, T. Laaksoviita, A. Kirkevåg, T. Kühn, S. Romakkaniemi, A. Arola

- In this study, we investigate **how much uncertainty comes from modelled**
  - **relative humidity**
  - **aerosol number size distributio**
  - **aerosol comp / hygroscopicity**

- **comparison** between
  - **models**
  - **satellite** date (AIRS)
  - **reanalysis** data (NCEP-DOE)



KORHONEN

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

REgional Climate Impacts of anthropogenic Aerosols (RECIA)

Hannele Korhonen, Finnish Meteorological Institute

overall objective: improve the understanding on how the regional climates respond to changes in anthropogenic aerosol emissions locally and via teleconnections

approach: Unified aerosol and CCN climatologies; model experiments from highly idealized to more realistic

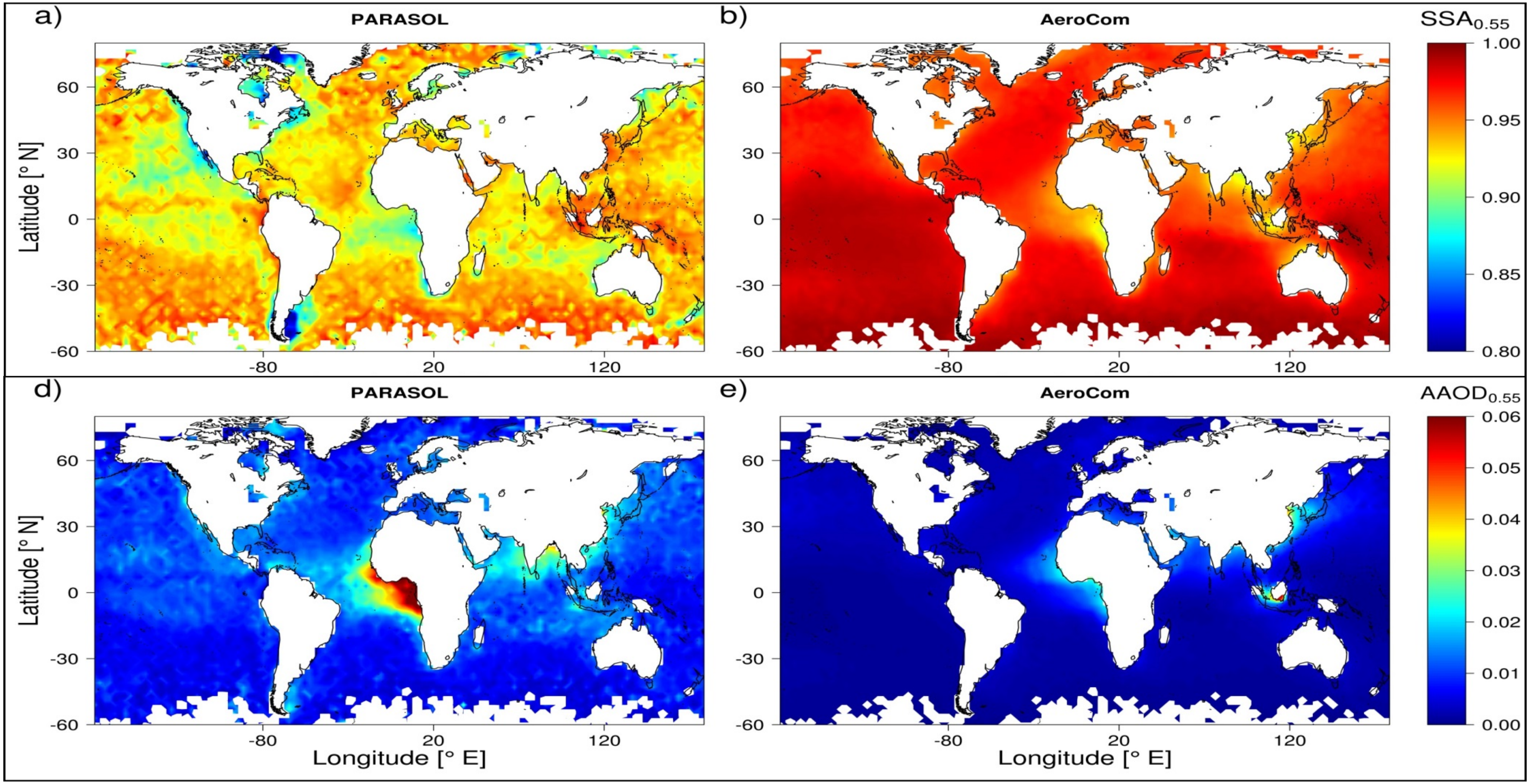
currently 3 models: MPI-ESM, EC-Earth, NorESM

We welcome other modelling groups to participate!

LACAGNIA

Aerosol Absorption over the global ocean: comparing PARASOL retrievals with AeroCom models estimates

Carlo Lacagnina and Otto P. Hasekamp et al.



PARASOL provides new information about aerosol absorption over ocean

Spatial distribution of SSA simulated by AeroCom models is rather uniform and higher, compared to PARASOL

LEE

School of Earth and Environment

UNIVERSITY OF LEEDS

PinatubO Emulation in Multiple Models (POEMs): planned co-ordinated experiments for the SPARC Stratospheric Sulphur and it's Role in Climate initiative (SSiRC)

Lindsay Lee

l.a.lee@leeds.ac.uk

Graham Mann, K. S. Carslaw, M. Toohey, V. Aquila, C. Timmreck, J. M. English, R. R. Neely III

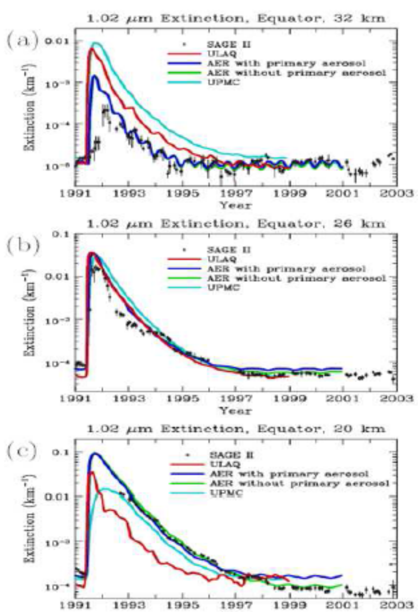
NATURAL ENVIRONMENT RESEARCH COUNCIL

The Leverhulme Trust

Inter-model diversity exists

Larger inter-model differences in predicted extinction, both peak magnitude and decay timescale. Several factors may be important here:

- differences in the way the models inject the SO2 (injection height-range, latitude-spread)
- treatment of the chemical conversion of SO2 to H2SO4 may affect aerosol evolution
- evolution of the aerosol size distribution following growth processes and sedimentation
- different stratospheric circulation and strat-trop exchange



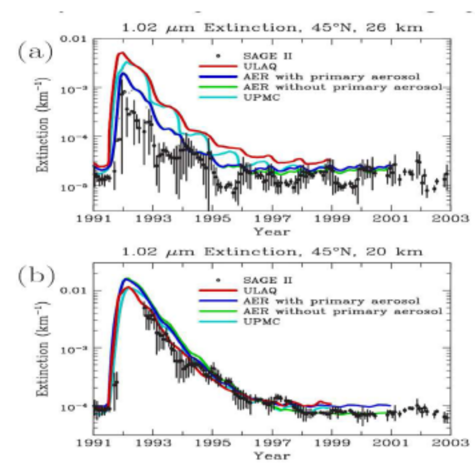


FIGURE 4: The intermodel diversity for a range of simulated outputs

MMPPE Proposal

Experts have chosen 8 uncertain parameters to be perturbed (3 eruption, 5 model processes) to understand the uncertainty in the chosen model outputs and their diversity across models:

- Mass of SO_2 emitted
- Injection height-range
- Injection latitude-spread
- Sedimentation velocity scaling
- Oxidation of SO_2 to H_2SO_4
- Nucleation rate scaling
- Sub-grid particle formation
- Coagulation rate scaling

The uncertain parameters were chosen based on the need to better understand the aerosol optical depth (AOD) and effective radiative forcing (r_{eff}) response to the Pinatubo eruption.

When model capability does not allow perturbation of all 8 parameters a subset will be designed to allow comparability across models.

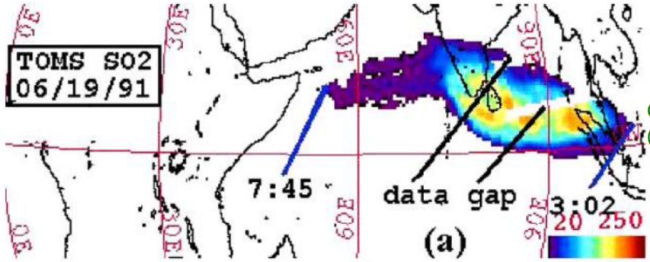
We will investigate how each output responds to the uncertain parameters and how this compares across models.

MANN (1)

Whole-atmosphere aerosol microphysics simulations of the Mt. Pinatubo eruption: Part 2: Quantifying the direct and indirect (dynamical) radiative forcings

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
UNIVERSITY OF LEEDS
G. W. Mann (NCAS-Climate, Univ. Leeds, U.K.), S.S. Dhomse, K. S. Carslaw, M. P. Chipperfield, L. A. Lee (Univ. Leeds, U.K.), K. M. Emmerson (CSIRO, Aspendale. Australia)
L. Abraham, P. Telford, J. A. Pyle (Univ. Cambridge, U.K.), P. Braesicke (KIT, Karlsruhe, Germany), N. Bellouin (Univ. Reading, U.K.), M. Dalvi, C. E. Johnson (Met Office, Exeter, U.K.)

3. The 1991 Mount Pinatubo eruption



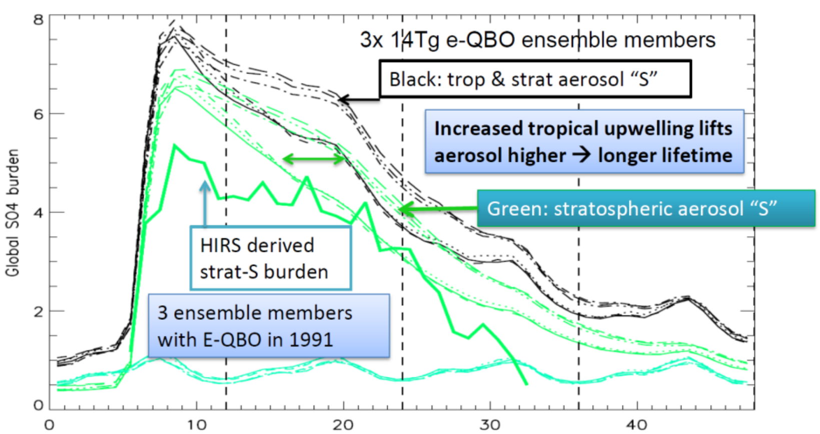
Guo et al. (GGG, 2004.)

Satellite measurements indicate 14 to 23 Tg of SO_2 (7 to 11.5 TgS) was present in the tropical stratosphere shortly after the eruption.

The stratospheric aerosol loading peaked several months later in the range 19-26 Tg (Lambert et al., 1993). Assuming 59 to 77% sulphuric acid (Grainger et al., 1993) gives a range of 3.7 to 6.7 TgS.

Investigate the eruption's impact on the stratospheric aerosol in UKCA with runs which inject 10 & 20 Tg of SO_2 into the tropical stratosphere

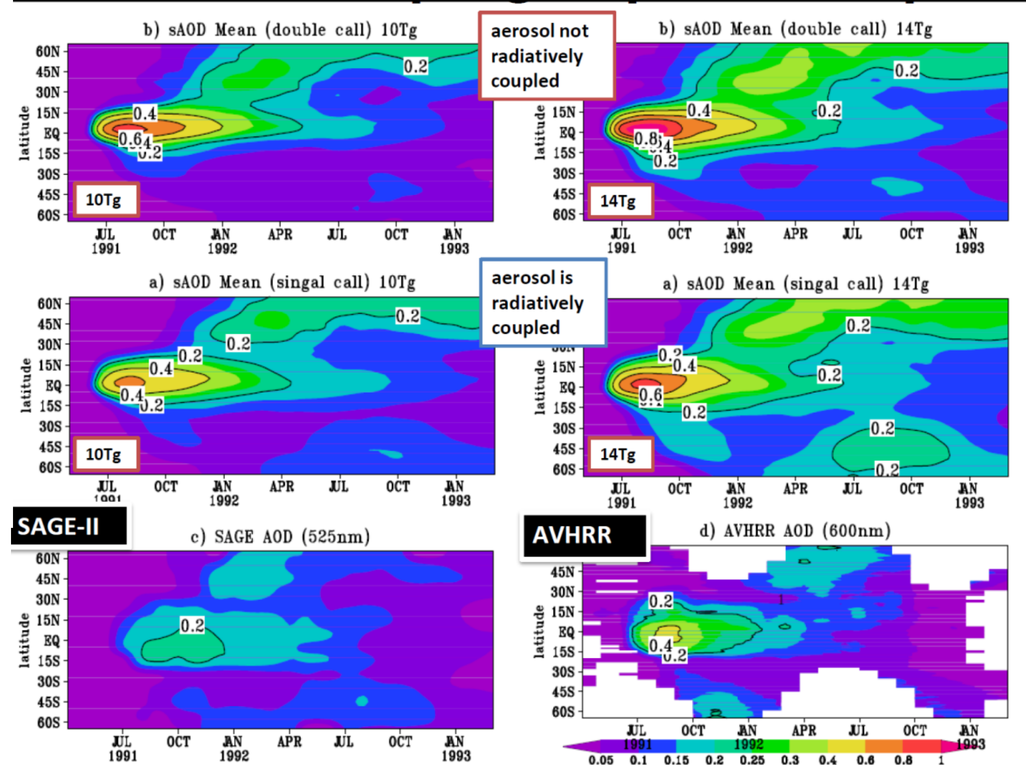
HadGEM-UKCA N48L60 CheS+GLOMAP.



Stratospheric aerosol sulphur burden in UM-UKCA (thin green) vs HIRS (thick green)
v7.3 CheS+GLOMAP N48L60

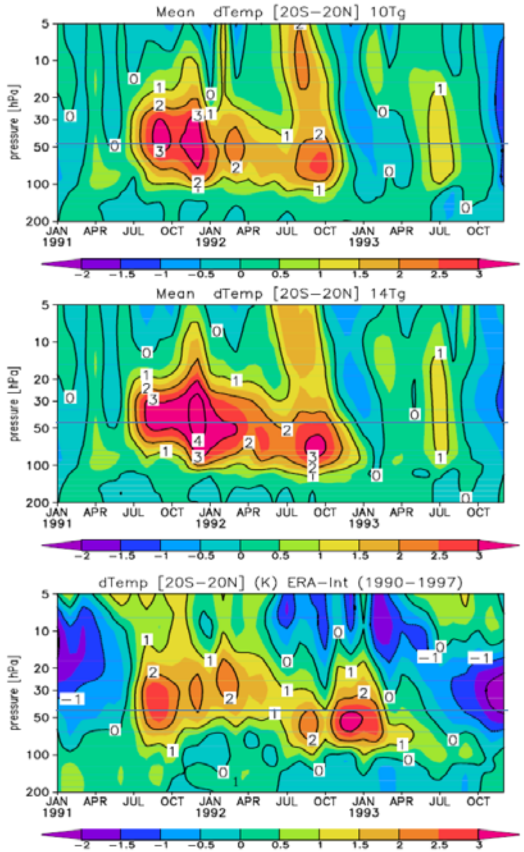
Mann et al., in preparation

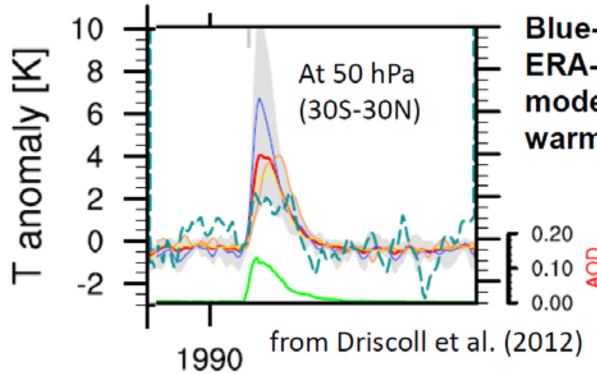
9. Radiative coupling: impact on dispersion



v7.3 CheS+GLOMAP N48L60: sAOD evolution vs SAGE-II sAOD & AVHRR anomaly

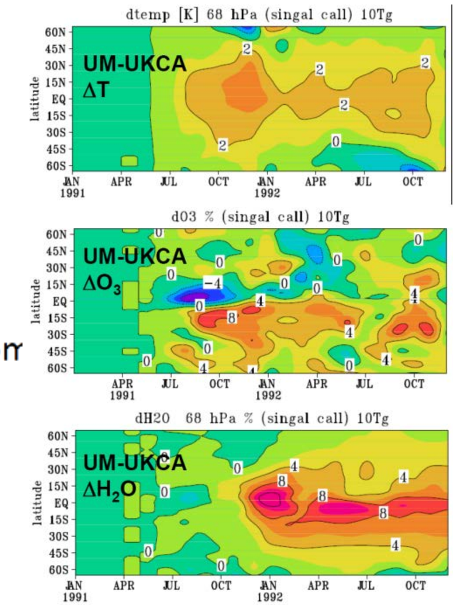
11. Radiative heating vs ERA-interim T-anomaly





from Driscoll et al. (2012)

Blue-dashed-line is ERA-interim, with model-imposed warming too strong



CMIP5 models with prescribed volcanic forcings over-predict strat-warming.

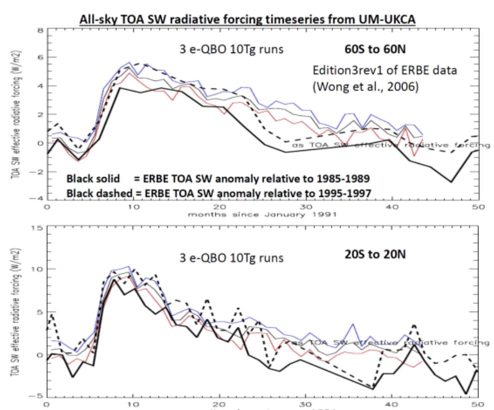
Partly due to models not having cooling effect from easterly QBO phase. But also prescribed volcanic forcings may not capture coarse mode aerosol and models missing cooling from dynamical reduction in stratospheric ozone.

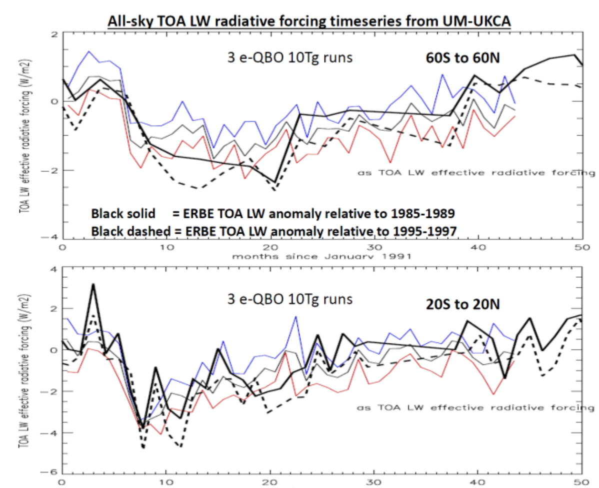
With 10 Tg injection, UM-UKCA captures stratospheric warming with 14 Tg too high.

v7.3 CheS+GLOMAP N48L60

10Tg simulatons match shape of ERBE anomaly

SW forcing





LW forcing

MANN (2)

The SSiRC Historical Eruption SO2 Emissions Assessment (HErSEA): intercomparison for interactive stratospheric aerosol models

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

UNIVERSITY OF LEEDS

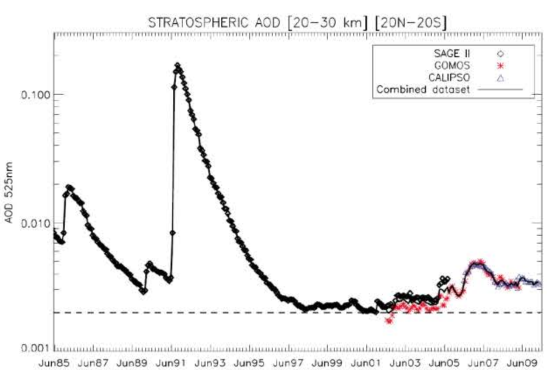
Graham Mann, Sandip Dhomse (Univ. Leeds, U.K.), Jianxiong Sheng (Harvard Univ., U.S.A.), Mike Mills (NCAR, U.S.A.)

4. SSiRC model intercomparison to assess and evaluate global models with interactive stratospheric aerosol schemes

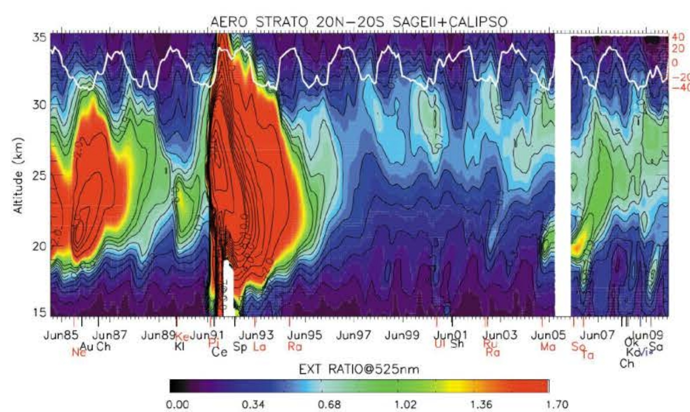
Name	Focus	Boundary Conditions (SST, GHG, ODS etc.)	Anthropogenic & Biomass Emissions	Ensemble size	Years per member	Total years	Knowledge gap to be addressed
Background **(BG)**	Stratospheric sulphur budget (quiescent)	Time-slice year-2000 monthly-varying	Year-2000 emissions (Granier et al, 2011)	1	10	10	Chemistry, aerosol and dynamical processes affecting quiescent stratospheric aerosol conditions.
Transient Aerosol Record **(MiTAR)**	Evaluate strat-aerosol properties 1998-2011	Transient 1998-2011 monthly-varying	1998-2011 emissions (Granier et al, 2011)	Up to 3 (volc SO_2)	14	14 to 42	Understand drivers and mechanisms for observed stratospheric aerosol increase since 2000
Historical Eruption SO_2 Emissions Assessment **(HErSEA)**	Perturbation to strat-aerosol for min/max SO_2 for Pinatubo, El Chichon & Agung	Transient for each historical eruption period (1991-1995, 1982-1986, 1963-1967)	Time-varying from Granier et al., 2011) or RETRO for 1960s (Schultz et al., 2008)	6 for each (ctrl, mid & hi/lo, deep/ shallow	5	270	Assess how injected SO_2 for historical eruptions perturbs stratospheric aerosol properties and radiative forcings in different complexity global strat-aerosol models
Pinatubo Emulation in Multiple Models **(PoEMS)**	Perturbed parameter ensemble of runs to quantify uncertainty in each model'ssimulated radiative forcings	Transient for Pinatubo-perturbed period (1991-1995)	1991-1995 emissions (Granier et al, 2011)	Vary 3/5/7 of 8 parameters with 7 values / parameter 21, 35 or 49.	5	105, 175 or 245 (3, 5 or 7)	Quantify sensitivity of simulated Pinatubo ERF to uncertainties in injection parameters (SO_2 amount, injection height and latitude-spread) and to uncertainties in model processes (e.g. coagulation-rate-scaling, sedimentation-rate-scaling, SO_2-oxidation-rate-scaling).

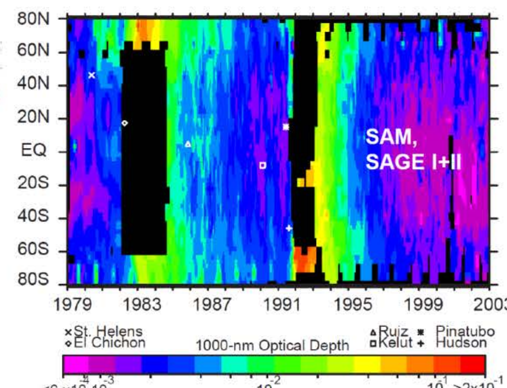
- Paper will be submitted to Geoscientific Model Development (Timmreck et al., 2015) describing the rationale, observations and experimental specifications for the co-ordinated intercomparison. Timeline for the experiments --- models to begin submit BG, MITAR & HErSEA later in 2015 & 16. PoEMS in 2016/7.

6. Satellite record since 1980s: stratospheric AOD and extinction profile



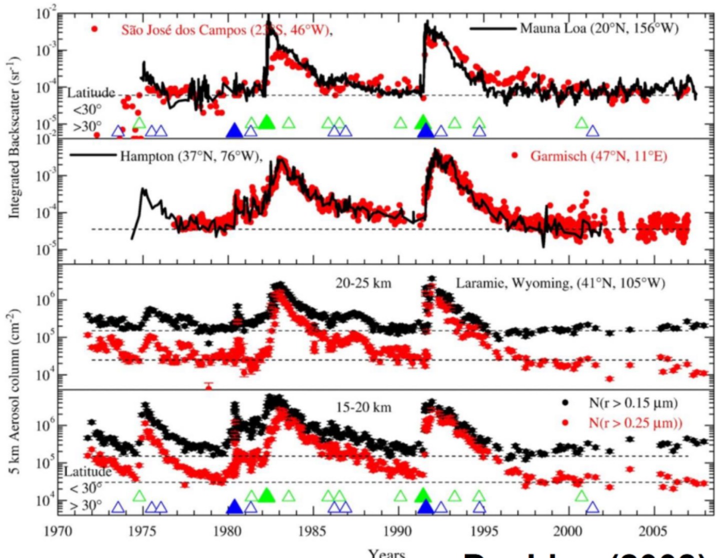
Vernier et al. (2011)



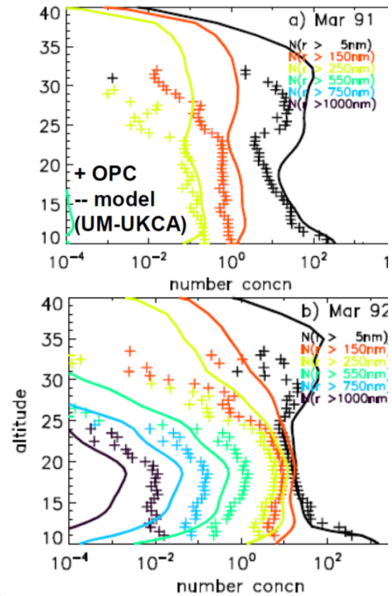


Hamill & Brogniez (2006)

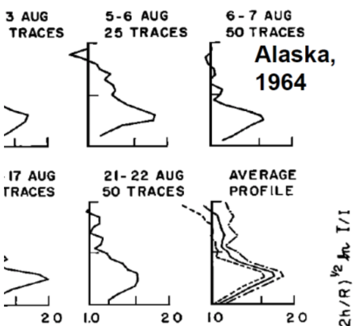
7. Balloon-borne optical particle counter record of size-resolved particle concentratior



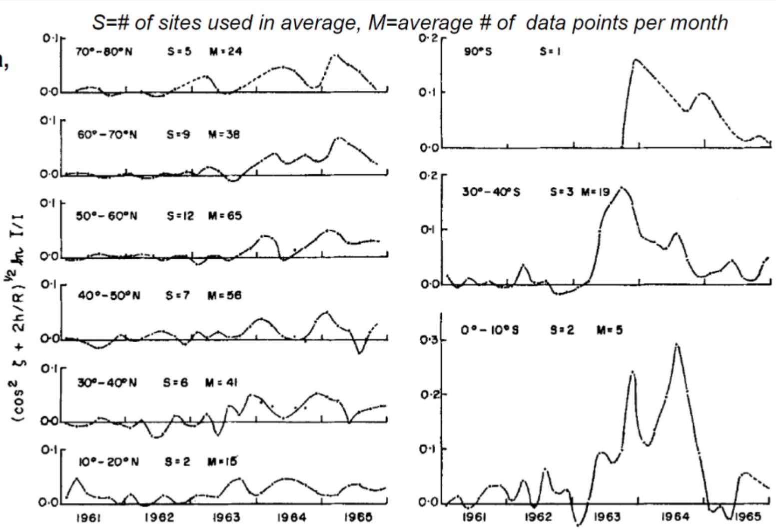
Deshler. (2008)



8. Ground-based lidar & radiation measuremen

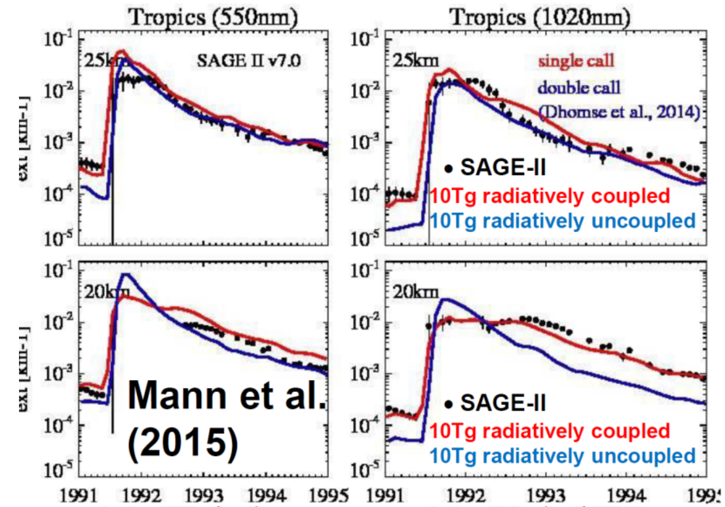


Grams & Fiocco (1967)

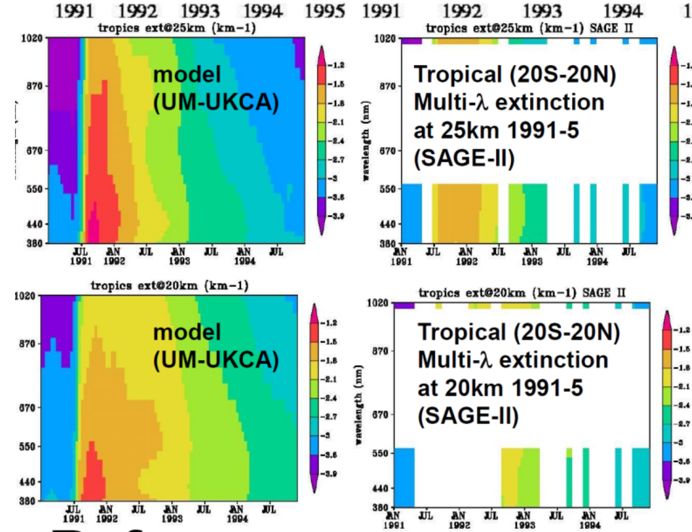


Dyer and Hicks (1968)

9. Potential for improved volcanic forcings by constraining new models with observations.



Mann et al. (2015)

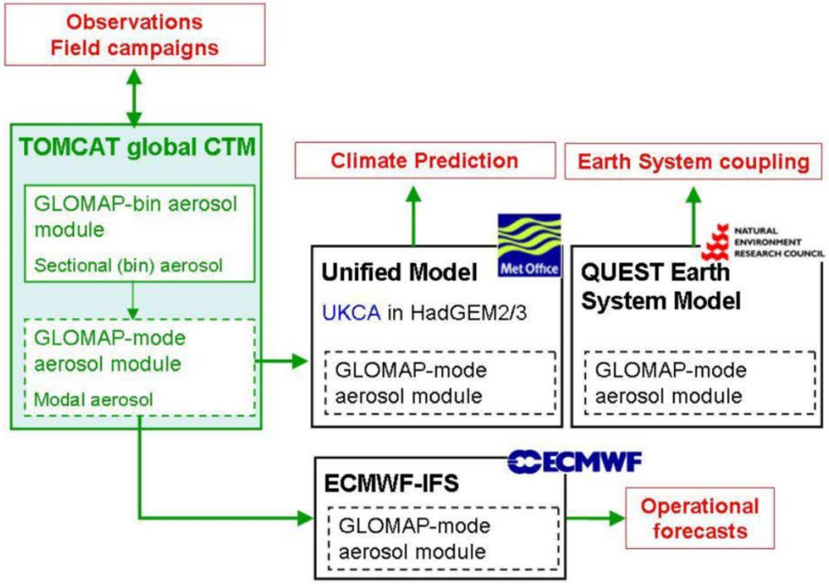


MANN (3)

Evaluation of tropospheric aerosol properties simulated by HadGEM-UKCA & TOMCAT-GLOMAPmode

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
UNIVERSITY OF LEEDS

Graham Mann, Jo Browse, Nicolas Bellouin, Colin Johnson, Mohit Dalvi, Luke Abraham, Ken Carslaw, Philip Stier, J. Rae, D. V. Spracklen, P. Telford, J. A. Pyle, F. O' Connor, G. Carver, K. J. Pringle, M. T. Woodhouse, Z. Kipling, R. West



6. AeroCom CTM & UKCA runs

Compare GLOMAP-mode simulated aerosol in HadGEM-UKCA against established TOMCAT-GLOMAP framework and observations.

TOMCAToffox T42L31 with 6-hrly monthly-mean oxidant fields (TOMCAT)
--- GLOMAP-mode v6 with revised modal settings as Mann et al . (2012)
--- AOD & forcings can be alculated offline based on monthly fields.
--- use AEROCOM phase 1 emissions (Dentener et al., 2006)

UKCA_NRTropIsop : N96L63 v7.3 HadGEM3-A-r2.0 TropIsop w FAST-J
--- GLOMAP-mode v6 with revised modal settings as Mann et al . (2012)
--- diagnose AOD & aerosol direct & indirect radiative effects online every radiation timestep using double-call to radiation scheme (RADAERv2)
--- use AEROCOM phase 2 emissions (Diehl et al., 2012)

UKCA_BEStdTrop : N96L38 v7.3 HadGEM3-A-prelim StdTrop w 2D-phot
--- GLOMAP-mode v5 with original modal settings as Mann et al . (2010)
--- diagnose AOD & aerosol direct & indirect radiative effects online every radiation timestep using double-call to radiation scheme (RADAERv1)
--- use AEROCOM phase 2 emissions (Diehl et al., 2012)

Simulates aerosol lifecycle resolving new particle formation and growth to climate-relevant sizes.

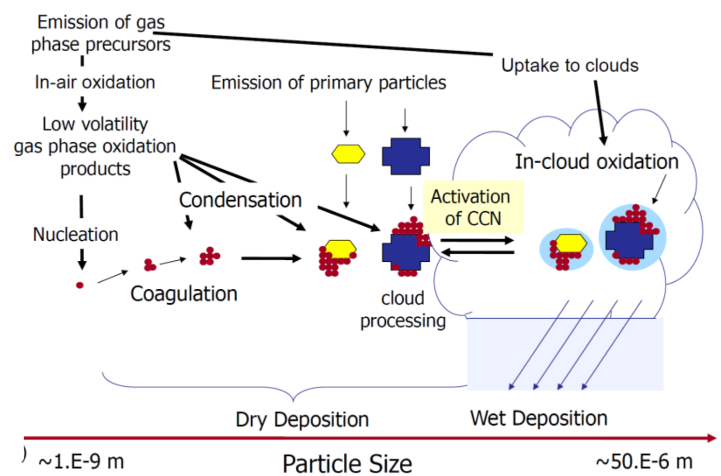
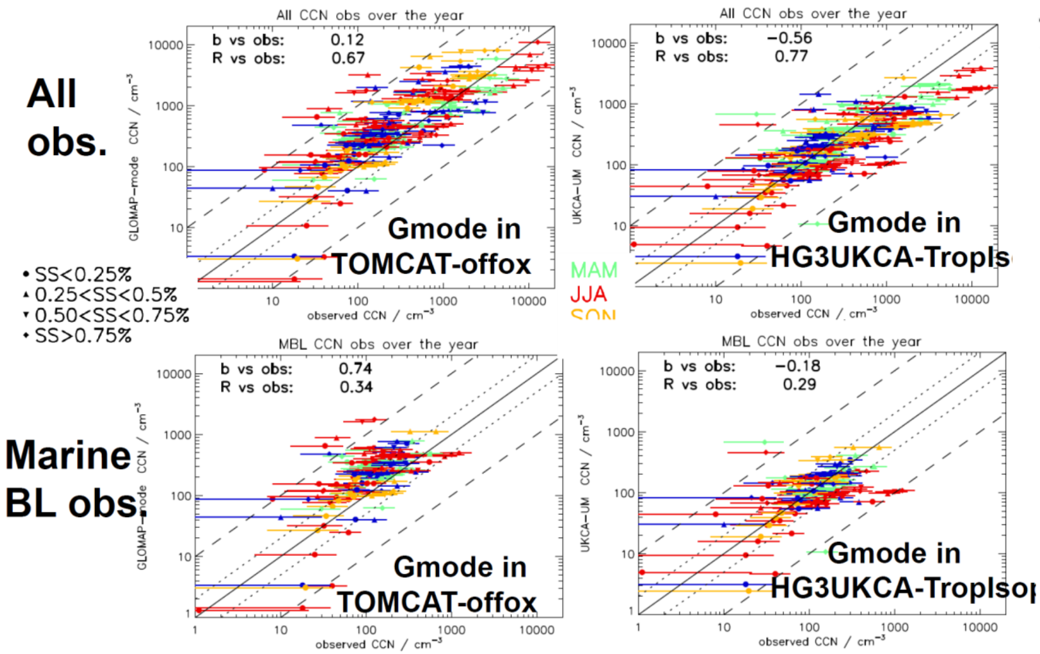
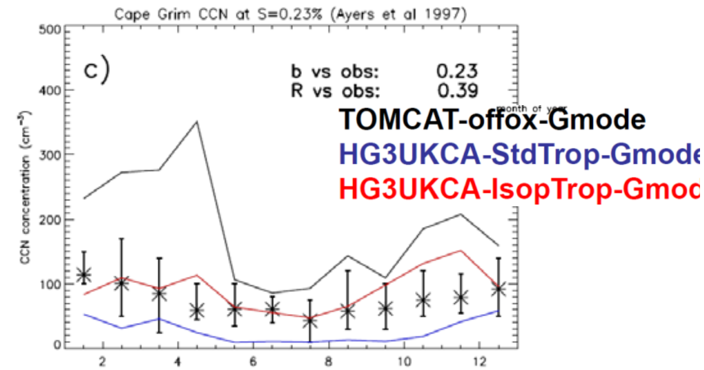
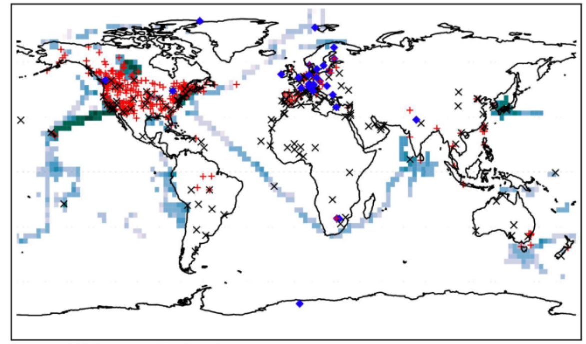


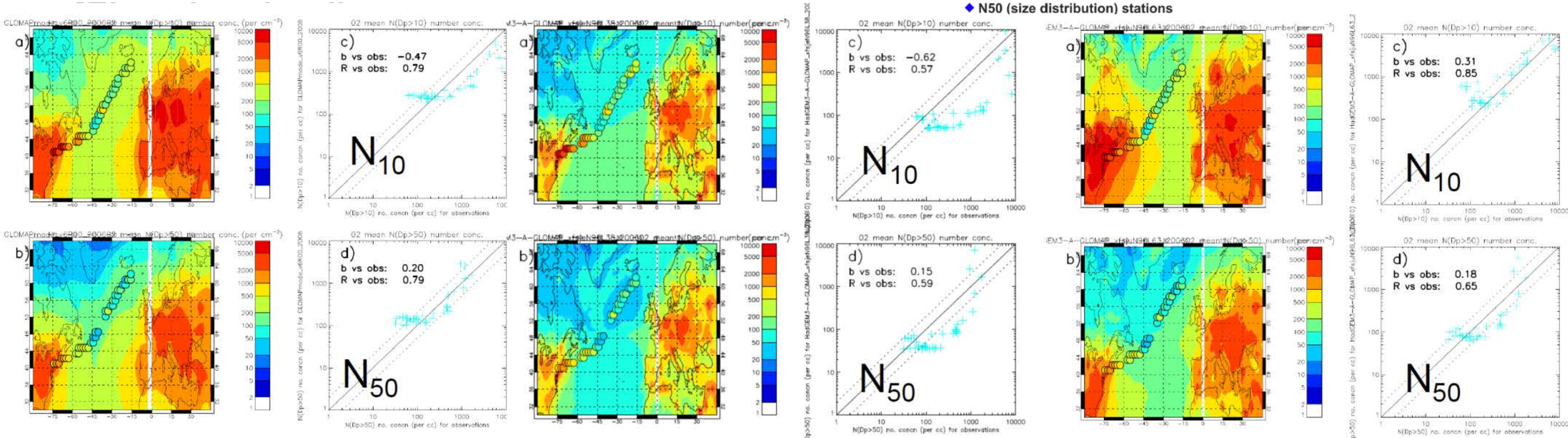
Fig. 8 : CCN vs compilation of observations (surf)







× AERONET sites (BC load)
+ PM2.5 stations
◆ N50 (size distribution) stations



Gmode in TOMCAT-offox   Gmode in v7.3 HG3UKCA-StdTrop   Gmode in v7.3 HG3UKCA-TropIsop

MARSHALL

Eruption source parameters controlling the climatic effects of volcanism

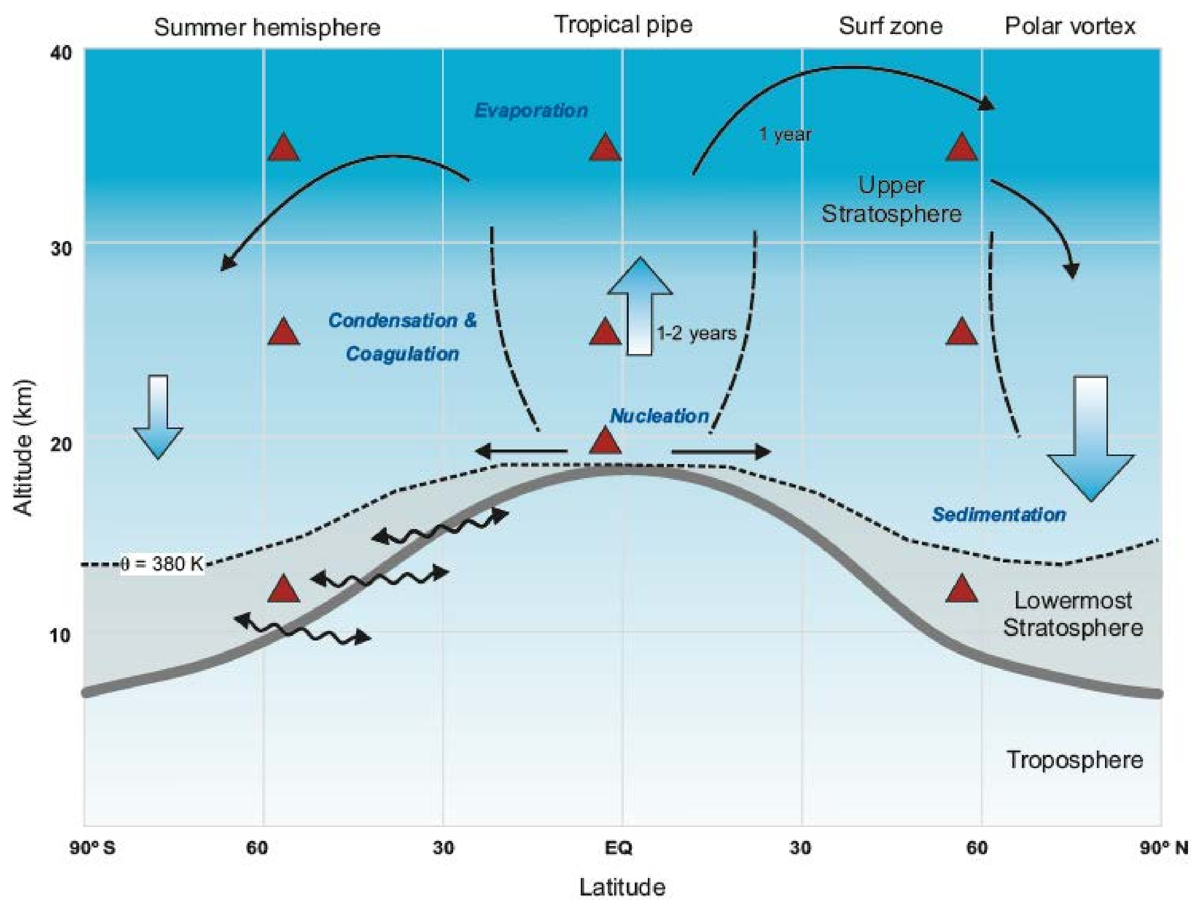
E-mail: eelrm@leeds.ac.uk

UNIVERSITY OF LEEDS

Parameter space

- Amount of SO_2 injected
- Injection altitude
- Location
- Season

Series of modelling experiments based on regions in the atmosphere where there are different **dynamical** and **chemical** regimes



= eruption height and latitude

SO_2 injections of 10,20,40,80,160,320 Tg

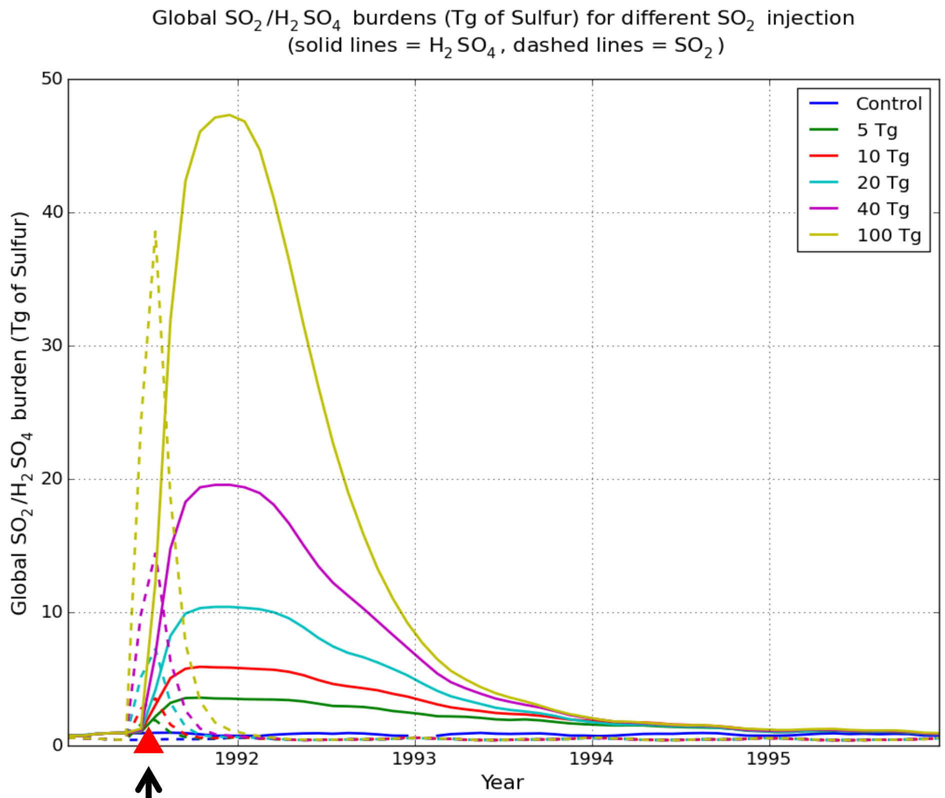
Lauren Marshall[1], Anja Schmidt[1], Graham W. Mann[1,2], Kenneth S. Carslaw[1], Jim Haywood[3,4], Andy Jones[3]
1. School of Earth and Environment, University of Leeds, UK 2. National Centre for Atmospheric Science, University of Leeds, UK 3. Earth System and Mitigation Science, Met Office Hadley Centre, Exeter, UK 4. College of Engineering, Maths and Physical Science, University of Exeter, UK

E-mail: eelrm@leeds.ac.uk

Eruption source parameters controlling the climatic effects of volcanism

UNIVERSITY OF LEEDS

Non-linear responses as we increase injection magnitude



15th June 1991

'Pinatubo-like' eruption, except different SO_2 injection.

15 °N
One day eruption
Plume 19-29 km
Easterly QBO

Lauren Marshall[1], Anja Schmidt[1], Graham W. Mann[1,2], Kenneth S. Carslaw[1], Jim Haywood[3,4], Andy Jones[3]
1. School of Earth and Environment, University of Leeds, UK 2. National Centre for Atmospheric Science, University of Leeds, UK 3. Earth System and Mitigation Science, Met Office Hadley Centre, Exeter, UK 4. College of Engineering, Maths and Physical Science, University of Exeter, UK

MICHIBATA

Evaluation of microphysical conversion processes for warm rain in the MIROC-SPRINTARS with satellite observations

Takuro Michibata and Toshihiko Takemura: Kyushu University, Japan

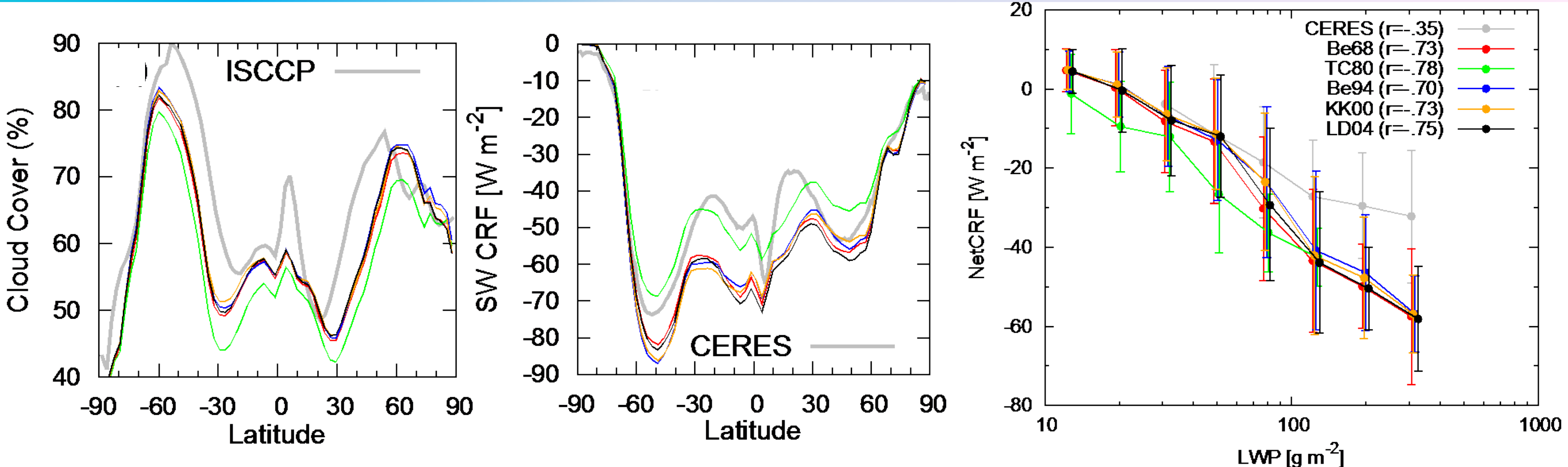
Content

1. ***Process Rates (Autoconversion, Accretion)***
2. ***Cloud Vertical Structure, SW/LW Radiation***
3. ***Conclusion and Future Work (PROG-RAIN in MIROC)***

List of autoconversion schemes examined in this study

Schemes	Autoconversion rate ($\mathrm{kg\,m^{-3}\,s^{-1}}$)	Models
Berry [1968]	$\dfrac{3.5\times10^{-2}\,L_c^2}{0.12+1.0\times10^{-12}\,\dfrac{N_c}{L_c}}$	MIROC5; NICAM-SPRINTARS
Tripoli and Cotton [1980]	$\dfrac{0.104\,g\,E_{cr}}{\mu\,\rho_w^{1/3}}\,L_c^{7/3}\,N_c^{-1/3}\,H(q_c-q_{crit})$	HadGEM2; GFDL CM3
Beheng [1994]	$6.0\times10^{28}\,n^{-1.7}\,(L_c\times10^{-3})^{4.7}\,(N_c\times10^{-6})^{-3.3}$	ECHAM5
Khairoutdinov and Kogan [2000]	$1350\,L_c^{2.47}\,(N_c\times10^{-6})^{-1.79}\,\rho_a^{-1.47}$	ECHAM5-HAM; PNNL MMF
Liu and Daum [2004]	$\left(\dfrac{3}{4\pi\rho_w}\right)^2\,\kappa_2\,\beta_6^6\,L_c^3\,N_c^{-1}\,H(R_6-R_{6c})$	CSIRO Mark3

Model Potential Uncertainty



Berry (1968) *Tripoli+Cotton (1980)* *Beheng (1994)* *Khairoutdinov+Kogan (2000)* *Liu+Daum (2004)*

■ [Brief Summary]

1. The Acc/Aut ratio is sensitive depending on the schemes.
2. There are critical biases in the vertical cloud macrophysical structure.
   – too few too blight low-cloud problem in MIROC as well
3. SWCRF is overestimated due to smaller cloud droplet radius in low-cloud.

■ [Future Work]

Need more fundamental improvements in addition to microphysical processes
→ PROG-RAIN scheme with drizzle in MIROC (ongoing)

Acknowledgements: This study was supported by the Environment Research and Technology Development Fund (S-12-3) of the Ministry of the Environment, Japan.

MICHOU

TACTIC1: an aerosol climatology for CNRM-CM CMIP6 simulations

- This poster presents TACTIC1 (Tropospheric Aerosols for ClimaTe In CNRM-CM) aerosol climatology for use in CMIP6 type simulations of the AOGCM CNRM climate model CNRM-CM6
-
- The motivation for this work was the growing number of AOGCM/ESM with either interactive or semi-interactive aerosols
-
- Version 1 of the prognostic aerosol module included in CNRM-CM modified to correct some drawbacks, a 1850-2019 simulation performed with prognostic aerosols, and a monthly climatology of the AOD of 5 aerosol types, TACTIC1, derived from this simulation

➡ modifications of the aerosol scheme, specificities of the 1850-2019 simulation, characteristics of the TACTIC1 AOD climatology, and first results from simulations with interactive versus semi-interactive aerosols

Interest in discussing

- The choice of sea salt parameterization / indirect effect parameterization
- Some characteristics/drawbacks of the aerosol emissions we used / future aerosols emissions
- Possible use of our TACTIC simulation outputs in the aerosol forcing field project for CMIP6
- Interactive versus semi-interactive aerosols in climate simulations
- ……

MIELONEN

Does Increasing Temperature Increase Carbonaceous Aerosol Direct Radiative Effect (over Boreal Forests)?

- **Tero Mielonen et al.**

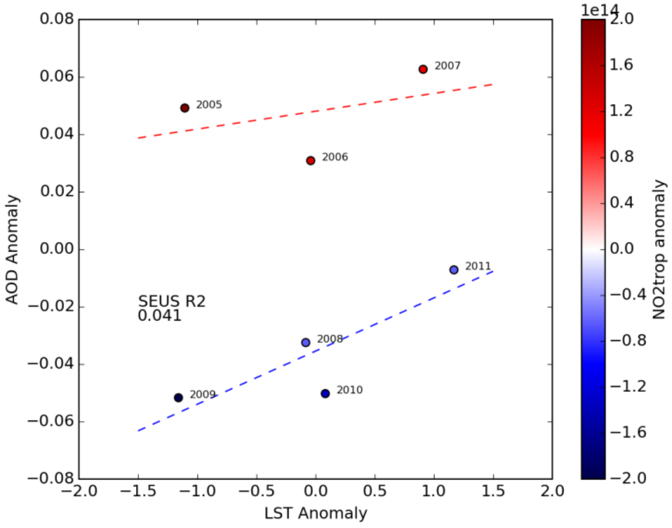
- estimate the effect of increasing temperatures on the aerosol direct radiative effect

- investigate the causes of the positive correlation between AOD and LST using remote sensing data (AATSR) and a climate model ECHAM-HAMMOZ
    - over the Southeastern US
    - over boreal regions

-estimate the significance of the negative feedback caused by a warming-induced increase in the aerosol direct radiative effect

First results:

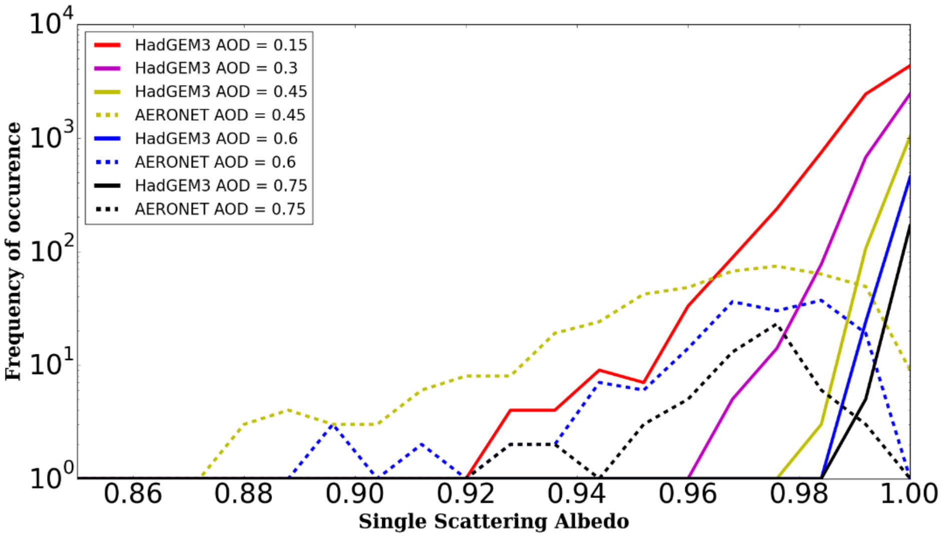
AATSR products show a clear AOD-LST dependency over SE US

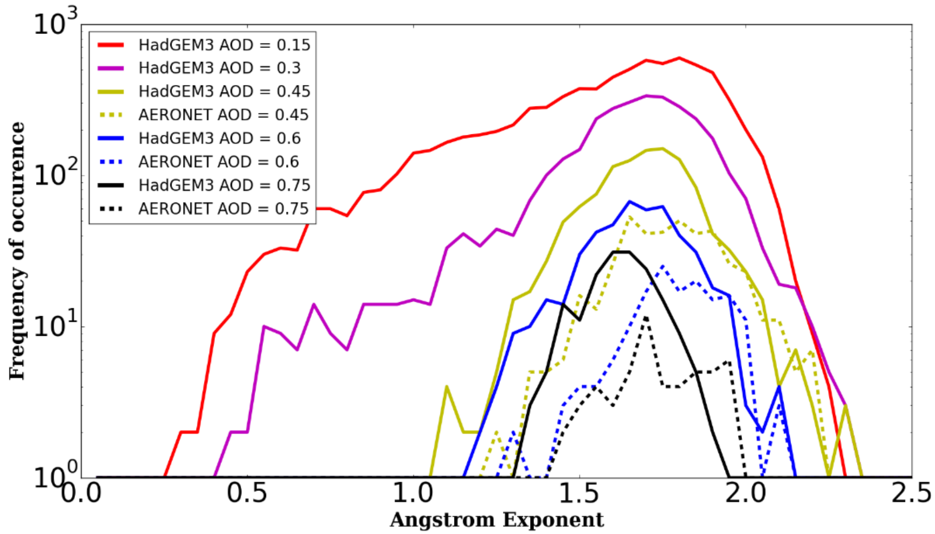


MOLLARD

Constraining aerosol optical properties in HadGEM3-UKCA using AERONET

James Mollard, Nicolas Bellouin, Ellie Highwood, Ben Johnson

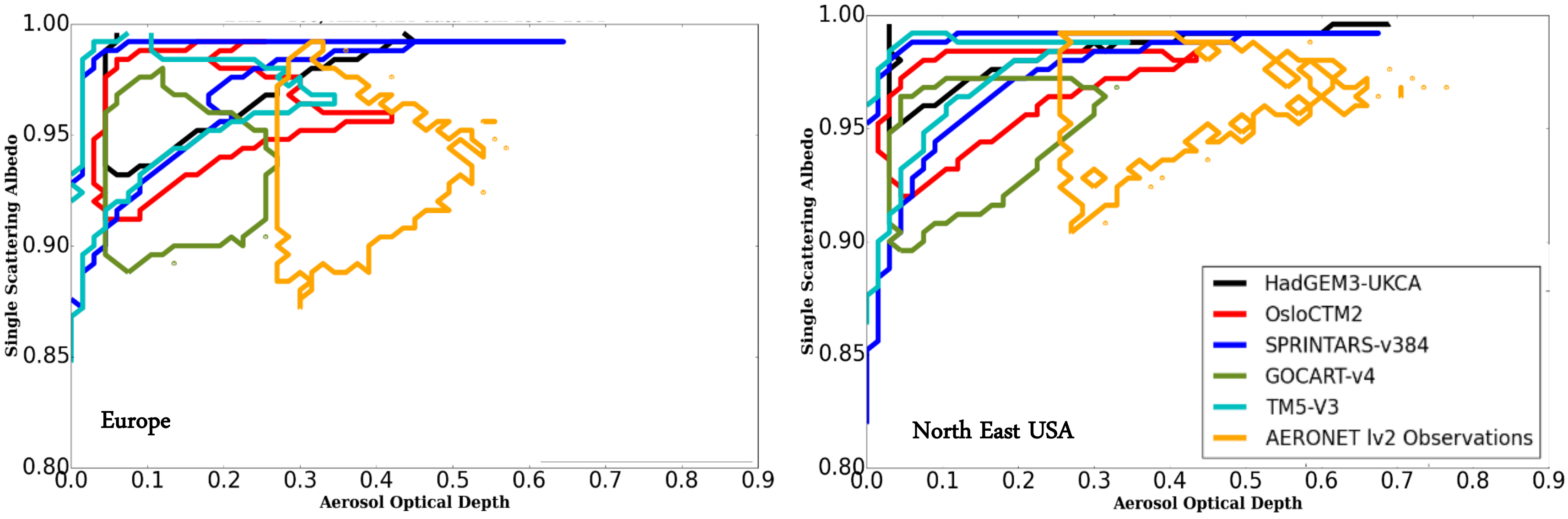




- The variability of SSA and Angstrom Exponent decrease as AOD increases

Constraining aerosol optical properties in HadGEM3-UKCA using AERONET

- Compare models with AERONET in SSA/AOD and SSA/AE space



- From analysing AEROCOM differences, we use it as a method to evaluate a sensitivity study on carbonaceous aerosol refractive indices.

MORGENSTERN

National Science Challenges

THE DEEP SOUTH

Te Kōmata o Te Tonga

Improving the Modelling of Clouds & Aerosols in the Southern Ocean Region

O. Morgenstern[1], A. McDonald[2], M. Harvey[3], R. Davies[4]

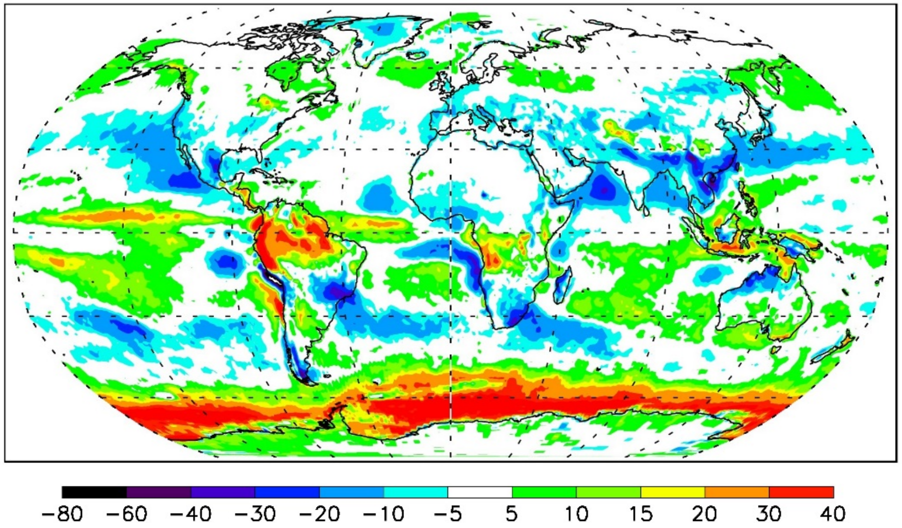
[1]NIWA, Lauder, New Zealand

[2]U. Canterbury, Christchurch, New Zealand

[3]NIWA, Wellington, New Zealand

[4]U. Auckland, New Zealand

Cloud biases are a first-order problem in modelling Southern-Hemisphere climate.



Cloud-radiative forcing bias in DJF (W/m²) in the NIWA-UKCA chemistry-climate model, relative to a satellite climatology (CERES-EBAF).

National Science Challenges | THE DEEP SOUTH | Te Kōmata o Te Tonga

The Clouds & Aerosols project

- Part of the Deep South National Science Challenge
- Focusses on improving the modelling of clouds in the Southern Ocean region
- Likely this will involve improved modelling of natural aerosols
- Target: Deliver an improved cloud/aerosol scheme, produce improved climate simulations

MULCAHY

Towards UKESM1:

Implementation and evaluation of the GLOMAP-Mode aerosol scheme

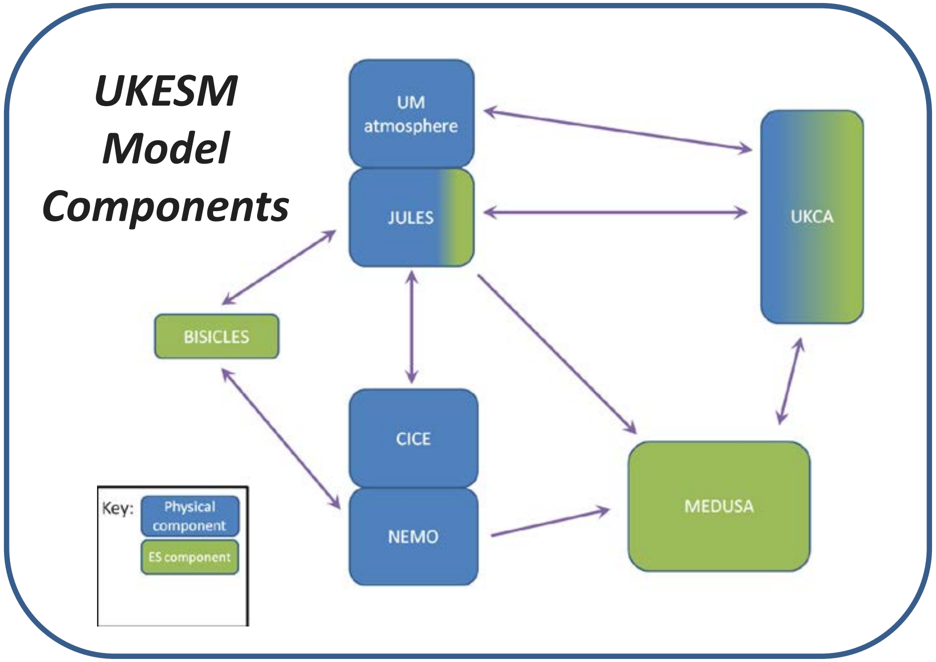
P. Mulcahy[1], J. Browse[3] C. Johnson[1], B. Johnson[1], G.W. Mann[2,3], A. Jones[1], A. Sellar[1], M. Dalvi[1], K.S. Carslaw[3], C. Jones[1,2]

[1] Met Office Hadley Centre, Exeter, Devon, UK

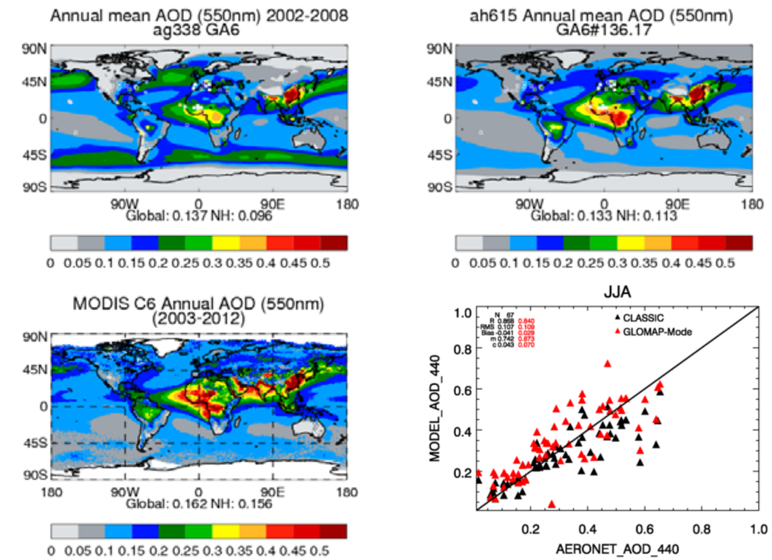
[2] National Centre for Atmospheric Science, University of Leeds, Leeds, UK

[3] Institute for Climate and Atmospheric Science, School of Earth and Environment, University of Leeds, Leeds, UK

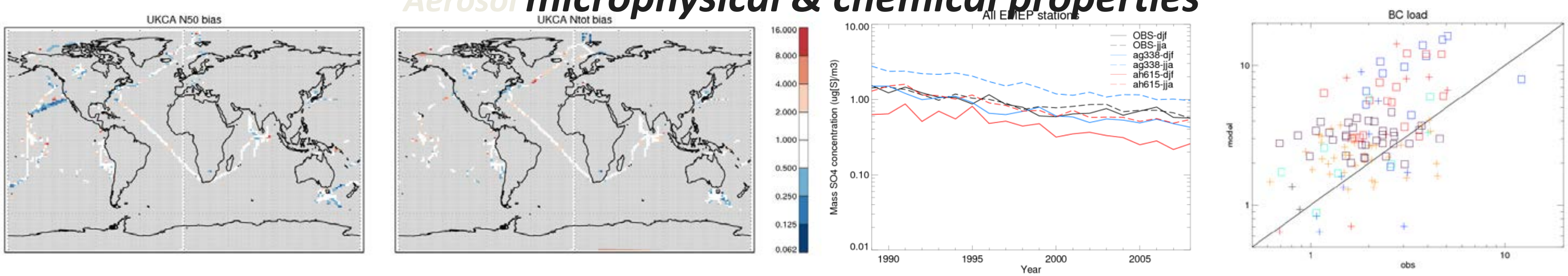
Evaluation of aerosol simulation in UKESM



Aerosol optical properties



Aerosol microphysical & chemical properties



NABAT

Evaluation of the CNRM-CM aerosol scheme in the regional climate model CNRM-RCSM

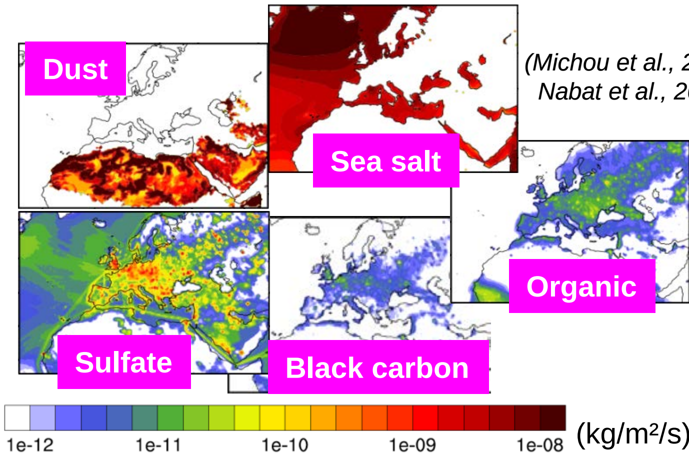
P. Nabat [1], M.Michou [1], S.Somot [1], M. Mallet [2], L.Watson [1] and D.Saint-Martin [1]

[1] Météo-France / CNRM-GAME [2] Laboratoire d'Aérologie

- The global (CNRM-CM) and regional (CNRM-RCSM) climate models of CNRM share the same numerical code

=> taking benefit of the finer resolution in CNRM-RCSM, an evaluation of the aerosol scheme is performed with CNRM-RCSM

Prognostic aerosol scheme



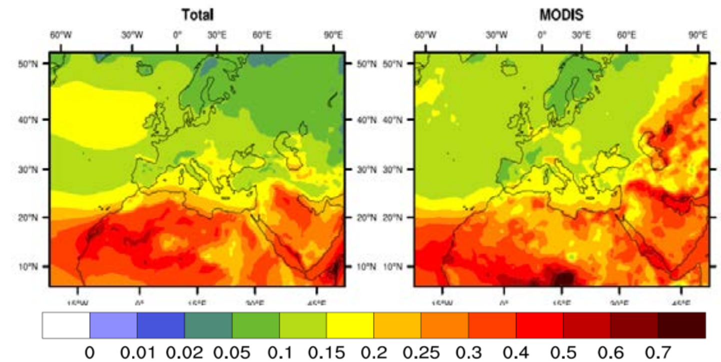
(Michou et al., 2015 ; Nabat et al., 2015)

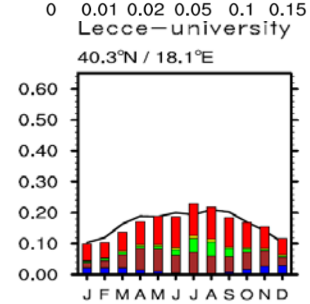
Emissions

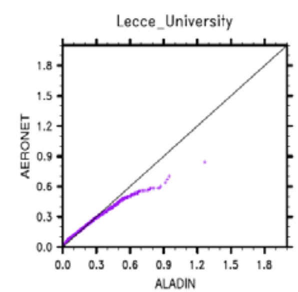
- Adapted from the GEMS/MACC scheme *(Morcrette et al., 2009)*
- 5 aerosol types :
Dynamic emissions for dust/sea-salt
ACCMIP inventaries for sulfate / BC / organic matter
- Simplified scheme to keep a low numerical cost (multi-annual climate simulations)

Evaluation

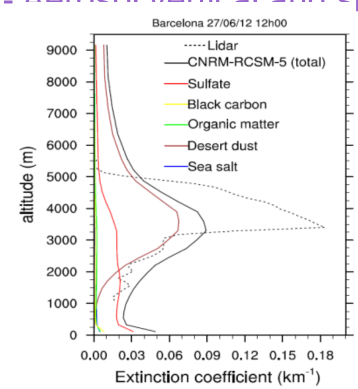
- AOD (against satellite data and AERONET data)

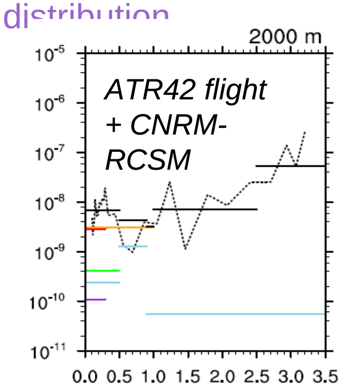




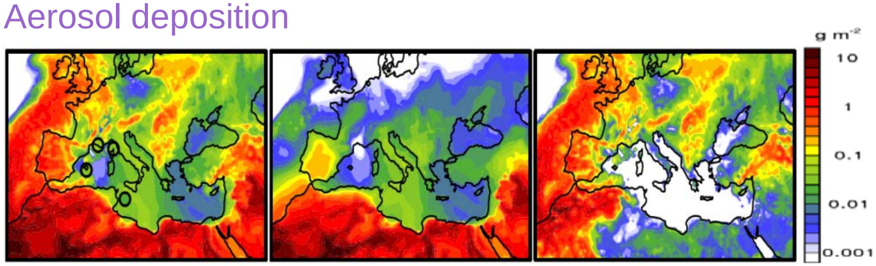


- Aerosol vertical and size distribution





- Aerosol deposition



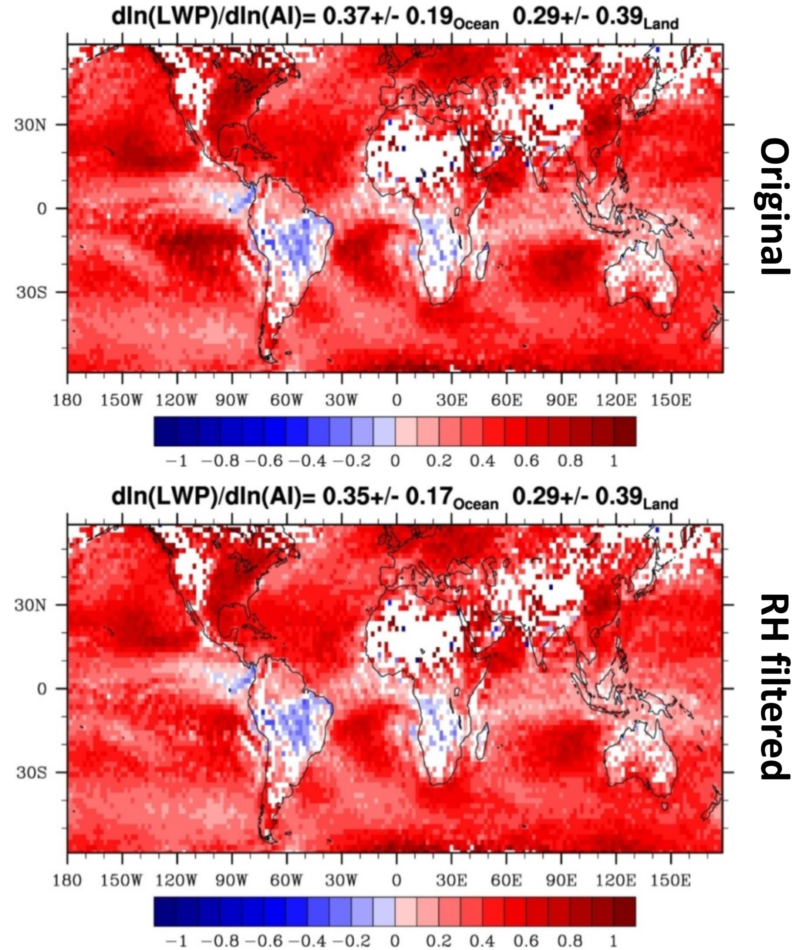
Total / Dry / Wet deposition in CNRM-RCSM (21-28 June

NEUBAUER

Aerosol-cloud interactions in ECHAM6-HAM2 and the (A)ATSR dataset

D. Neubauer[1], U. Lohmann[1], M. Christensen[2], C. Poulsen[2]
[1]ETH Zurich, [2]RAL Space

- **Statistical relations** to infer aerosol-cloud interactions
- Level 2 **Aerosol CCI** and **Cloud CCI** data
- Analysis done on **1°x1°** or 1.9°x1.9° spatial scale
- Impact of **relative humidity**



ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

RAL Space

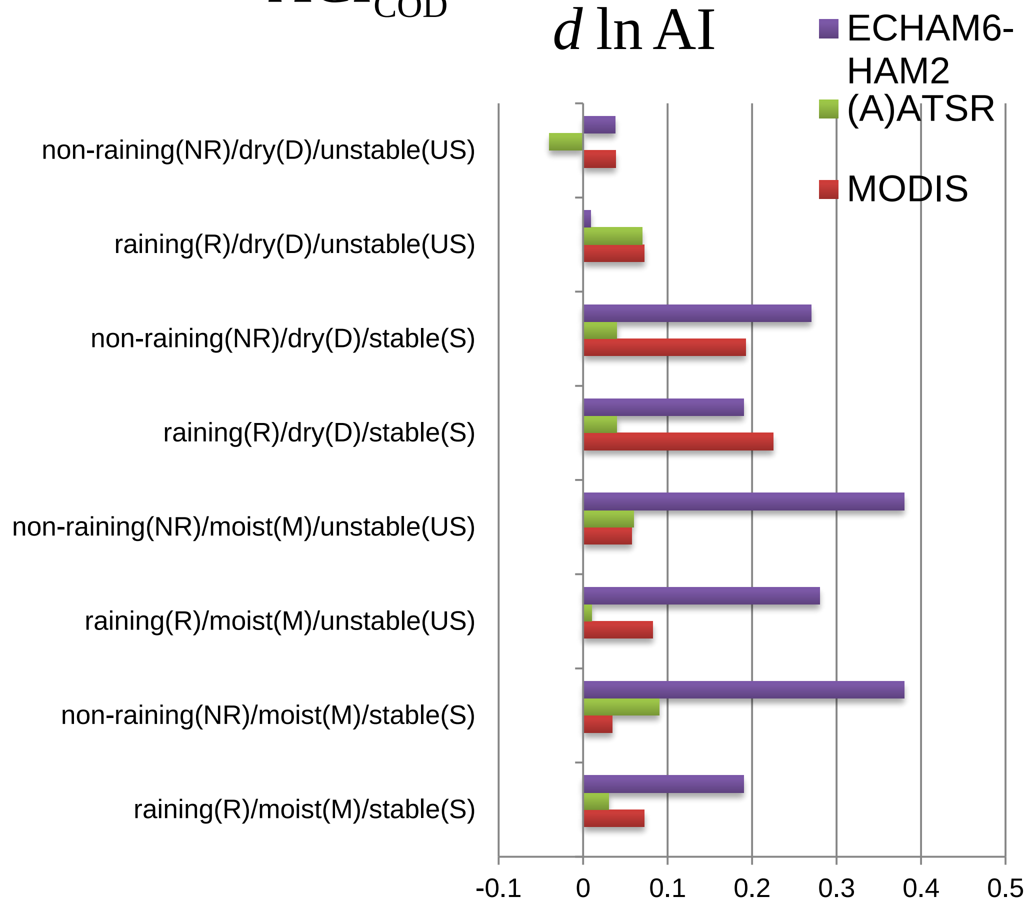
aerosol cci

Aerosol-cloud interactions in ECHAM6-HAM2 and the (A)ATSR dataset

D. Neubauer[1], U. Lohmann[1], M. Christensen[2], C. Poulsen[2]
[1]ETH Zurich, [2]RAL Space

$$\mathrm{ACI_{COD}} = \frac{d \ln \mathrm{COD}}{d \ln \mathrm{AI}}$$

- **Model / satellite data comparison**
- **Environmental regime composites:**
  - **precipitation state**
  - **free tropospheric rel. humidity (RH_{FT})**
  - **lower tropospheric stability (LTS)**
- **Radiative forcing estimate**



OLIVIE

SLCP emission reduction : how to simultaneously improve air-quality and limit climate change?

D. Olivié, L.H. Baker, R. Cherian, W. Collins, Ø. Hodnebrog, G. Myhre, J. Quaas, M. Schulz, R.B. Skeie, and A. Stohl

Motivation

1) Difficulties in reducing LLGHGs emissions

2) Impact of some short-lived species both on climate and air-quality

Experiment with 4 AOGCMs for 2005-2050 period

1) Reference emission scenario (Current legislation)

2) Optimization scenario : new air-quality measures only implemented if they have a cooling effect according to GTP20 emission metric.

ECLIPSE project

Evaluating the Climate and Air Quality Impacts of Short-lived Pollutants

Results + sensitivity analysis

See the poster ...

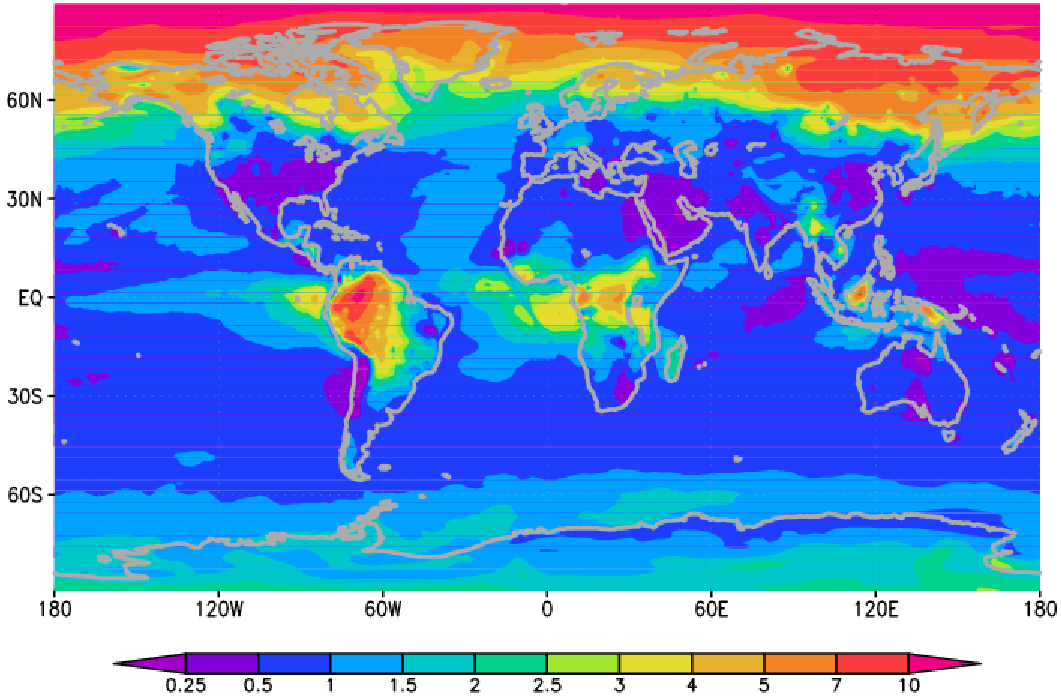
OSHIMA

Impact of black carbon aging on its spatial distribution and radiative effect using a MRI global aerosol model

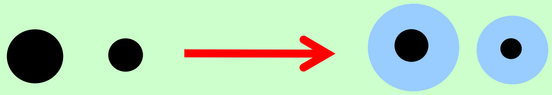
Naga Oshima

Meteorological Research Institute, Japan Meteorological Agency, Japan.

τ_{BC} below 800hPa (days)



Hydrophobic BC Hydrophilic BC



τ_{BC} (BC aging timescale)

[*Oshima and Koike, 2013, GMD*]

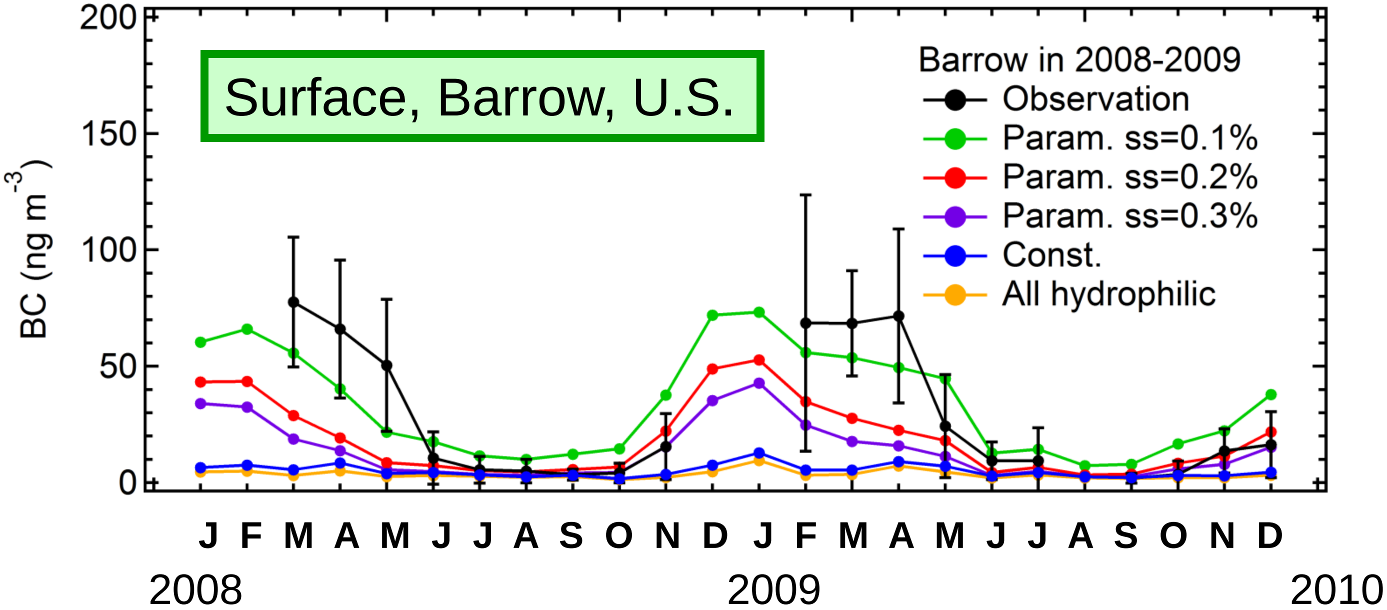
Apply our new parameterization of BC aging to a MRI global model. Spatial and temporal variations of τ_{BC}, not constant (24-36 hours).

East Asia : τ_{BC} < 1 day
Arctic : τ_{BC} = 1 week

BC

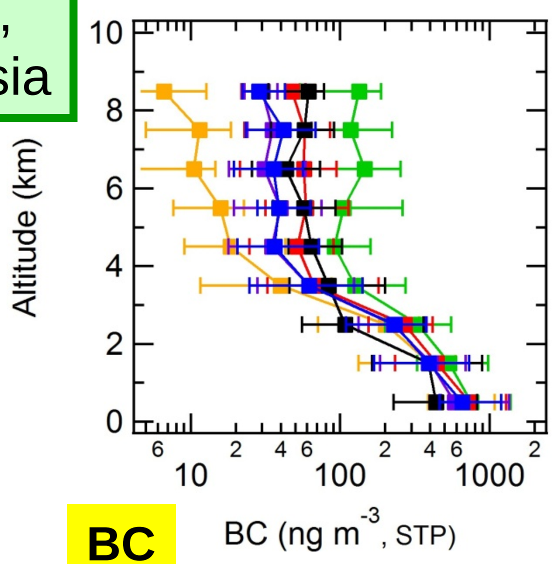
Spatial Distribution of BC

Surface, Barrow, U.S.



Use of the parameterization improves the seasonal variations of BC over the Arctic.

Aircraft, East Asia



BC

0. **Observation**
1. **Run 1: Param. Slower (base*1/4)**
2. **Run 2: Param. Baseline**
3. **Run 3: Param. Faster (base *2.2)**
4. **Run 4: Const. (τ_{BC} = 1.2 days)**
5. **Run 5. All hydrophilic BC**

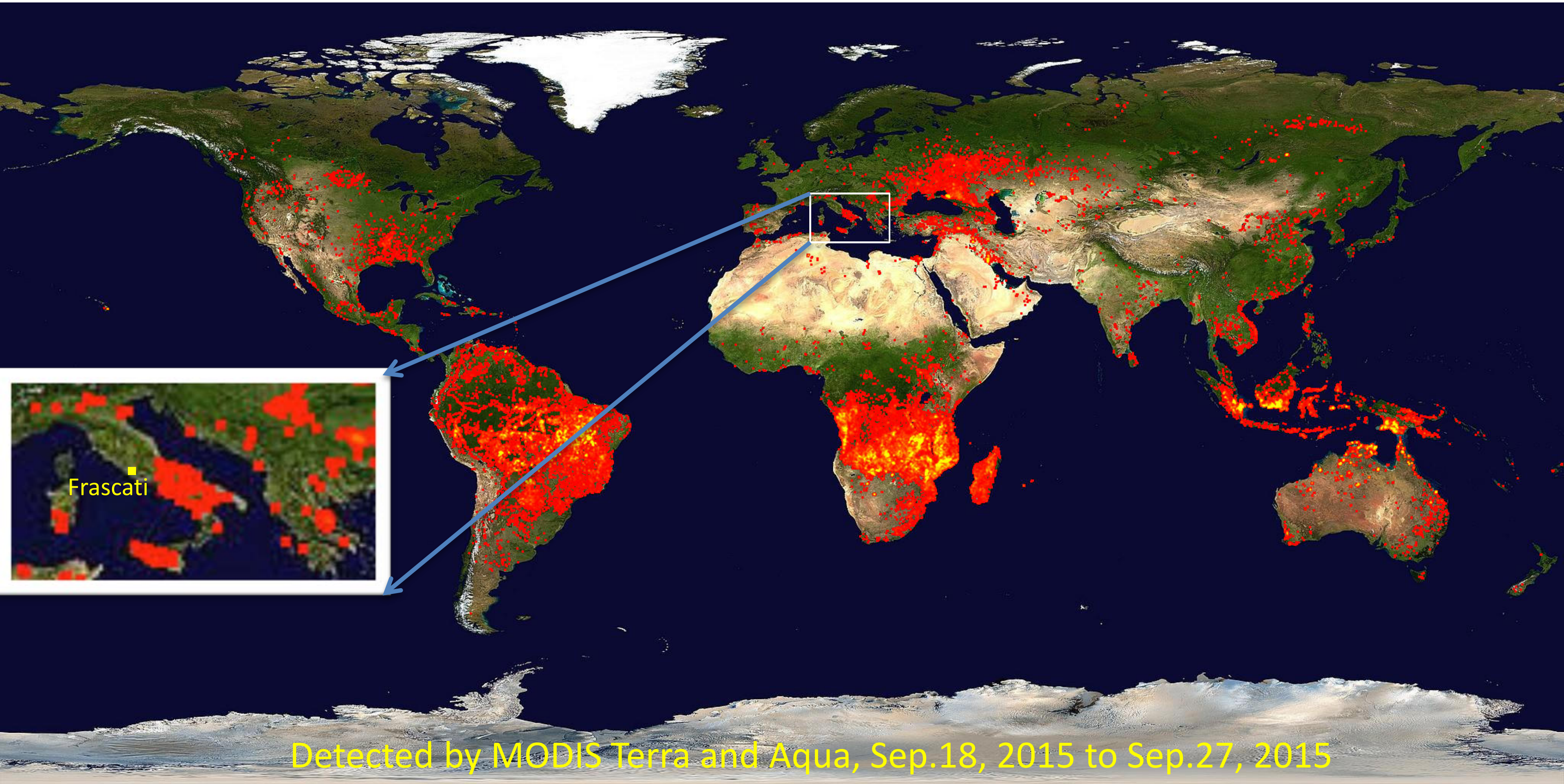
We also estimate direct radiative forcing by BC.

PAN

Comparison of GFED3, QFED2 and FEER1 Biomass Burning Emissions Datasets in a Global Model

Xiaohua Pan [*,1,2], Charles Ichoku [2], Huisheng Bian [3,2], Mian Chin [2], Luke Ellison [4,2], Arlindo da Silva [2], Anton Darmenov [2]
[*]xiaohua.pan@nasa.gov ; [1]UMD ESSIC; [2] NASA Goddard Space Flight Center; [3] UMBC JCET; [4] SSAI

Global Fire Map



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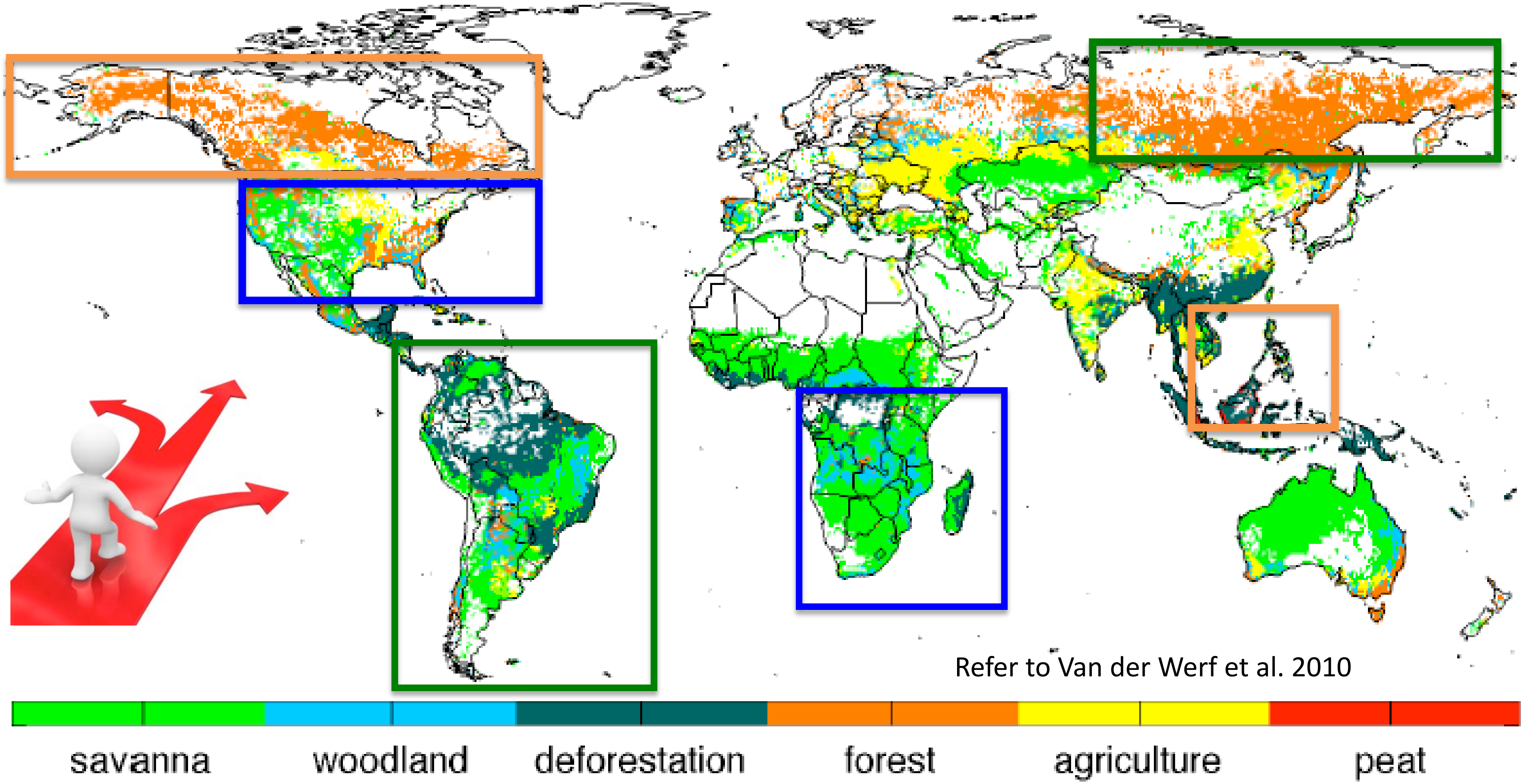
Xiaohua Pan [*,1,2], Charles Ichoku [2], Huisheng Bian [3,2], Mian Chin [2], Luke Ellison [4,2], Arlindo da Silva [2], Anton Darmenov [2]
[*]xiaohua.pan@nasa.gov ; [1]UMD ESSIC; [2] NASA Goddard Space Flight Center; [3] UMBC JCET; [4] SSAI

Dominant fire type



PEARCE

Nitrate Aerosol: Implications for European Air Quality and Climate

Hannah Pearce University of Leeds

Graham Mann, Steve Arnold, Fiona O'Connor, Steve Rumbold, Francois Benduhn and Kirsty Pringle

Motivation

- Observed dominant contribution of nitrate aerosol to European PM.
- Projected increase in relative importance of nitrate aerosol
- Recent model development (new 'hybrid' dissolution scheme in UKCA)

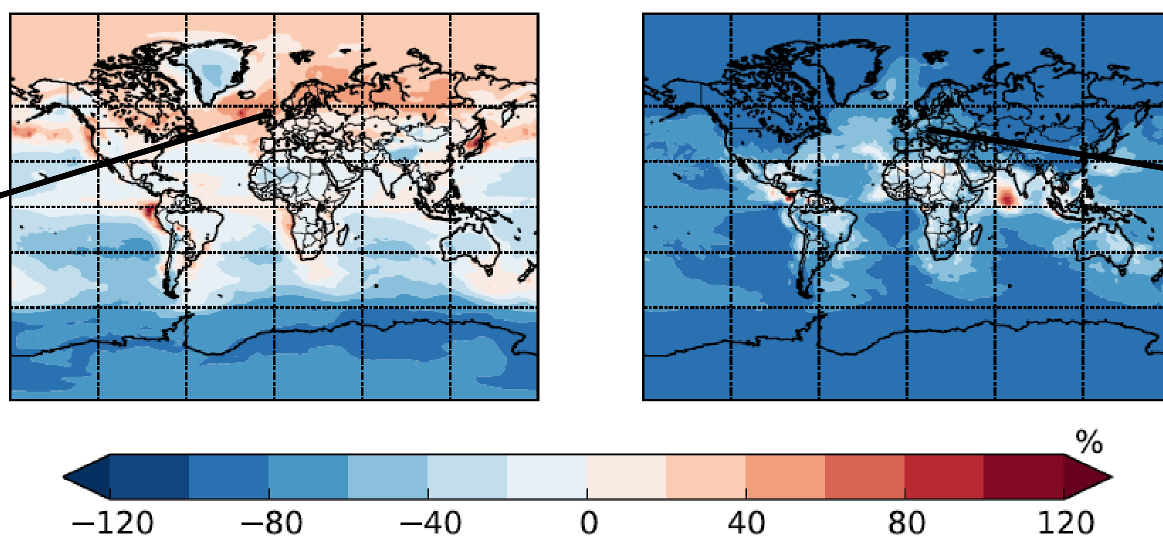
% change in nitrate aerosol surface conc.

Fine mode nitrate aerosol

Coarse mode nitrate aerosol

N. + W. Europe

↑ 20-60%



N. Europe

↓ 60-100%

W. + Central Europe

↓ 40-80%

Nitrate Aerosol: Implications for European Air Quality and Climate

Hannah Pearce University of Leeds

Graham Mann, Steve Arnold, Fiona O'Connor, Steve Rumbold, Francois Benduhn and Kirsty Pringle

Ongoing Work

To continue model-observation comparison

EUCAARI Project

(European Integrated Project on Aerosol Cloud Climate and Air Quality Interactions)

Future Work

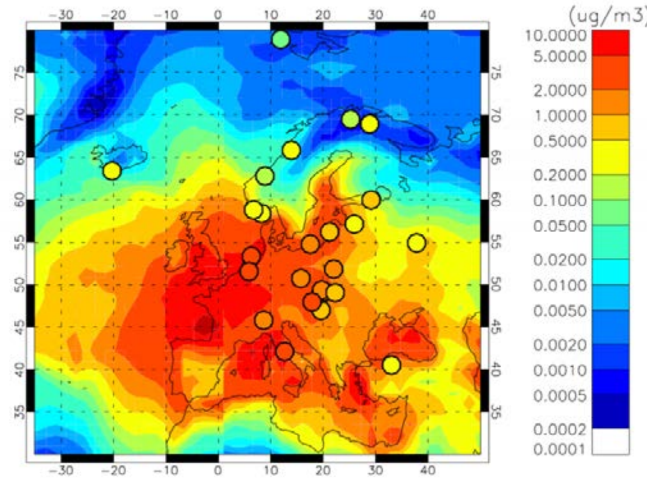
?

Focus on changing role of nitrate in influencing particulate matter exceedances and aerosol radiative forcings

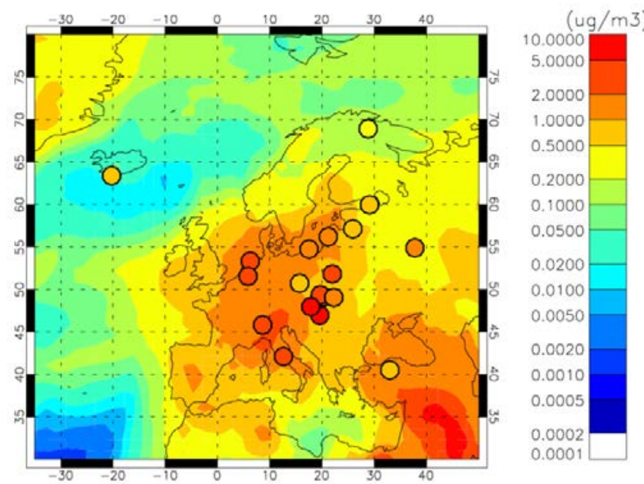
- **Post-1980 (Air Quality era)**
- **Future**

EMEP nitrate aerosol

June



December



PLATT

Aerosol measurements at Birkenes, Norway

S. M. Platt[1], K.E. Yttri[1], M. Fiebig[1], W. Aas[1]

[1]Department of atmosphere and climate, Norwegian Institute for Air Research (NILU), 2007 Kjeller, Norway

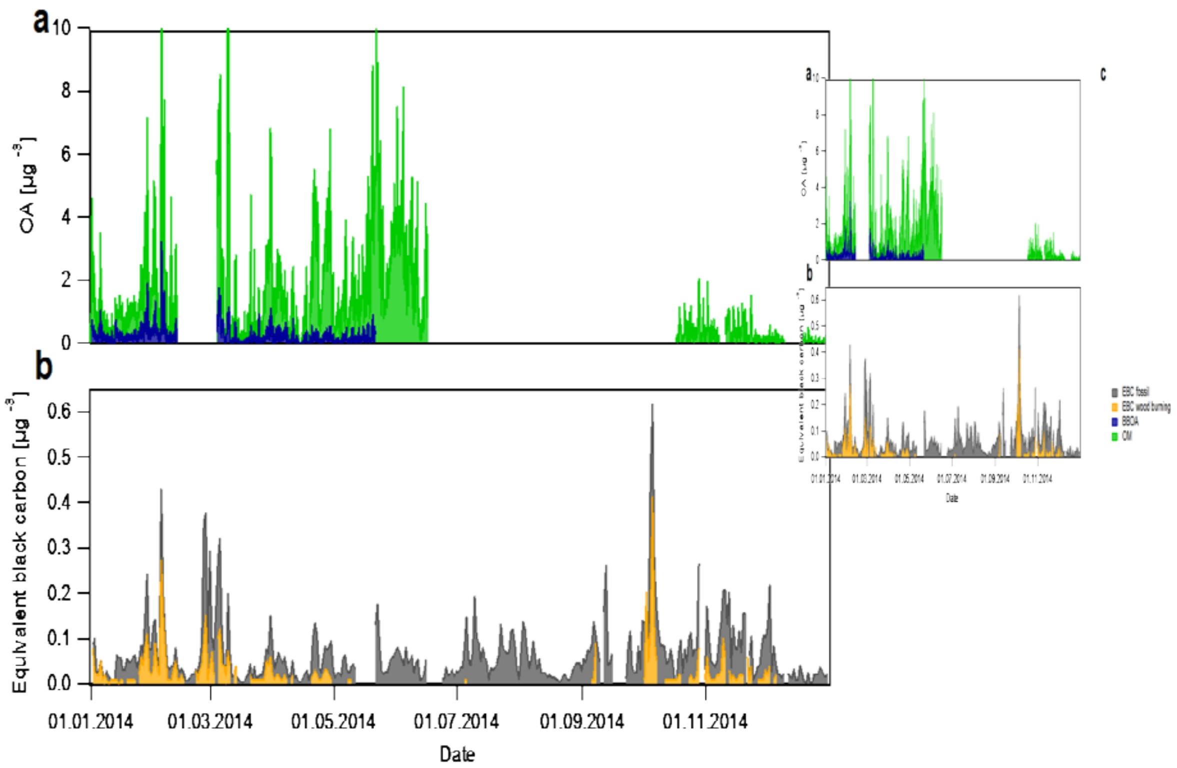
- Birkenes is a rural background site in southern Norway
- The Birkenes Observatory is situated downwind of major anthropogenic emission regions in Europe, and is thus well suited to monitor the outflow of air pollution from continental Europe
- Here we present an overview of aerosol measurements and preliminary ME2 source apportionment at Birkenes

NILU

Preliminary results

We present an overview of many of the newer measurements being performed at Birkenes including from:

- Aerosol composition from an aerosol chemical speciation monitor (ACSM) and ME2 analysis (see e.g. right)
- Size distribution measurements (see also the poster from Markus Fiebig)
- Quantification of PM10
- Measurement of equivalent black carbon, determination of fossil and wood burning fractions
- Aerosol composition from offline filters

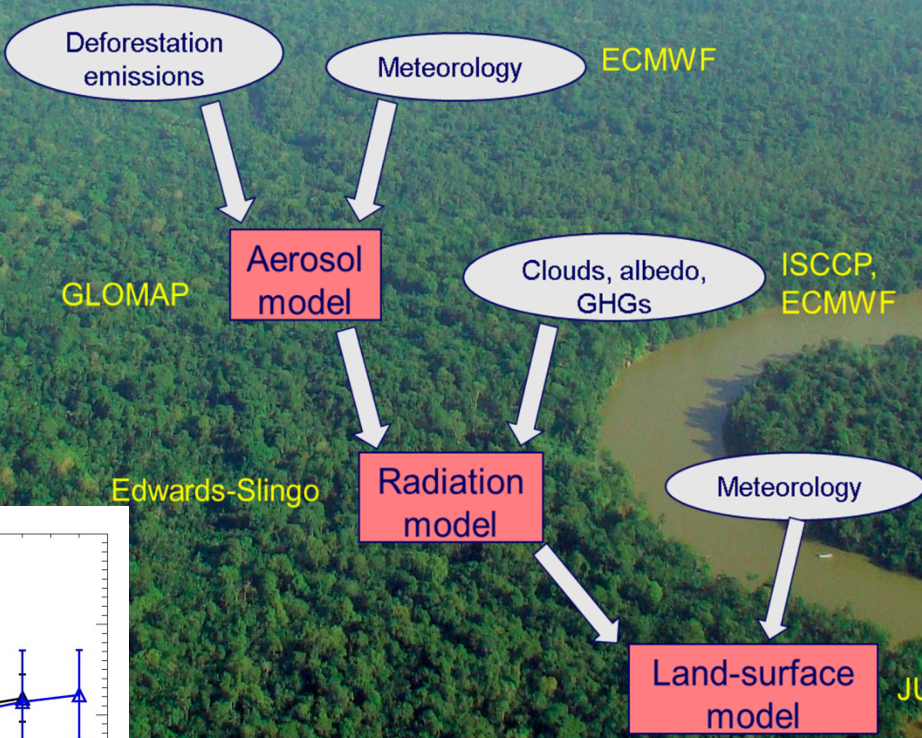


NILU

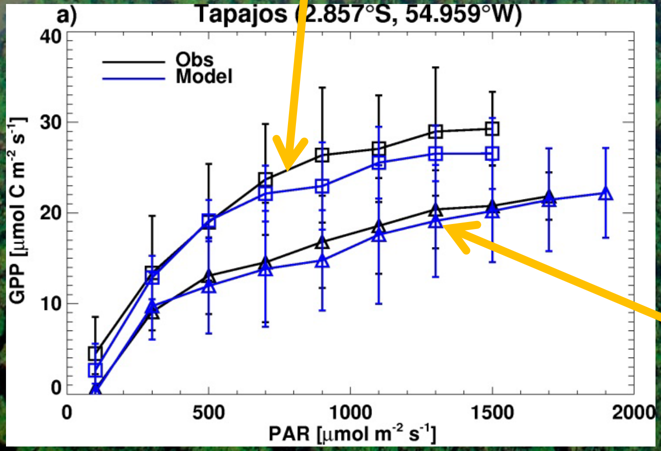
RAP

Impact of biomass burning aerosol on Amazon plant productivity through changes to diffuse radiation

Alex Rap



diffuse radiation regime

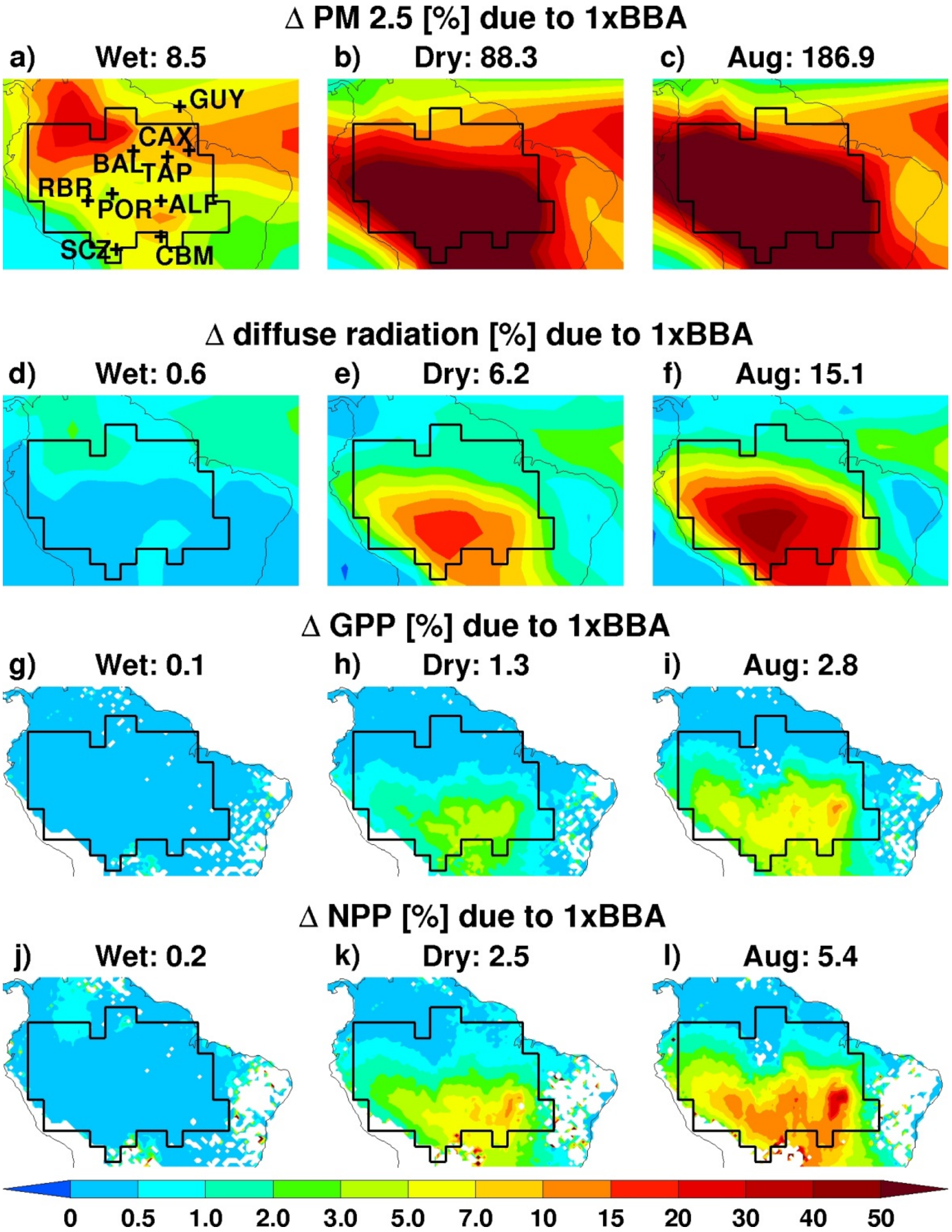


direct radiation regime

Photosynthesis is more efficient under diffuse light

UNIVERSITY OF LEEDS

Results

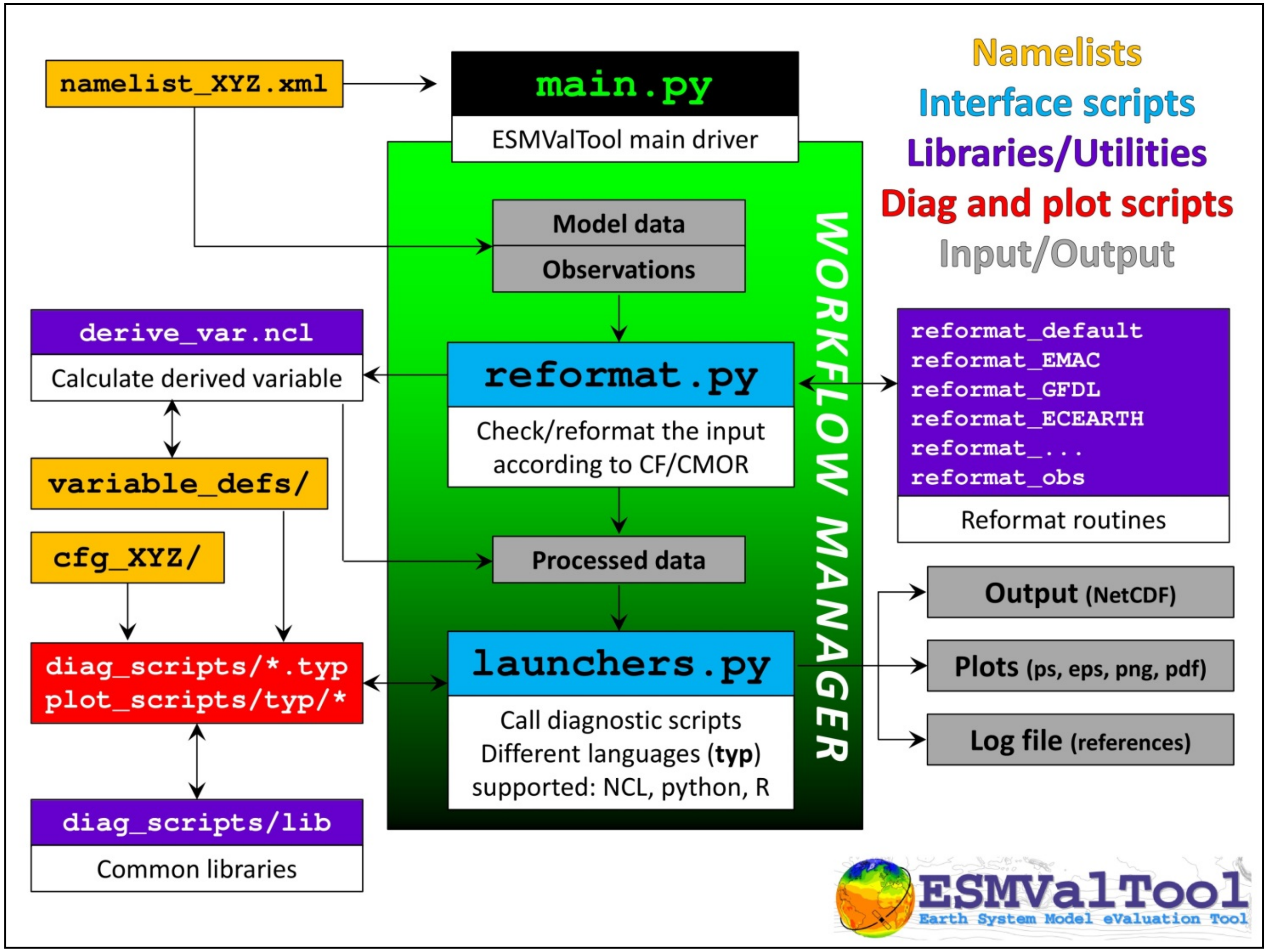


- Amazon-basin Net Primary Productivity (NPP) enhancement due to diffuse radiation fertilisation from biomass burning estimated at 78–156 Tg C a^{-1}
- Remaining forests respond to changes in diffuse radiation by absorbing additional carbon
    - this offset 33–65% of the original carbon emission from fires
    - represents 8–16% of the observed carbon sink across mature Amazonian forests
- Fertilization from diffuse radiation mitigates a substantial fraction (40–50%) of the observed moisture-generated decline in NPP in drought years

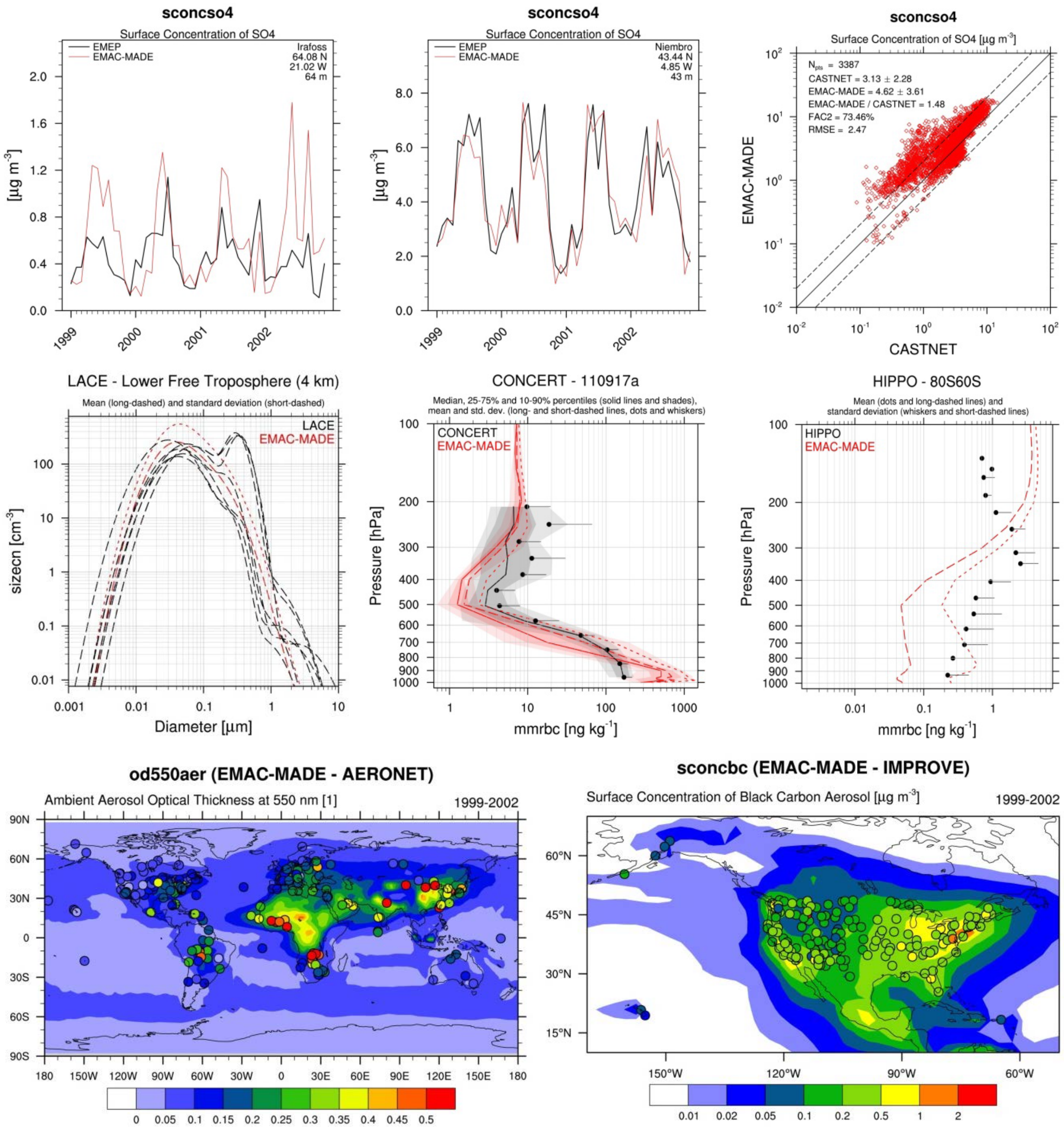
RIGHI

Aerosol evaluation with the Earth System Model eValuation Tool (ESMValTool)

M. Righi, V. Eyring, J. Hendricks, J. C. Kaiser, and A. Lauer
DLR – Institut für Physik der Atmosphäre, Oberpfaffenhofen (Germany)



- ✓ Wide scope
- ✓ Well-established approach
- ✓ Standardized model evaluation
- ✓ Quantitative evaluation
- ✓ Integration in modelling workflows
- ✓ High flexibility
- ✓ Multi-language support
- ✓ Open package
- ✓ CF/CMOR compliant
- ✓ Growing development team



Station networks: IMPROVE, CASTNET, EANET, EMEP, AERONET

Aircraft campaigns: ACCESS, CIRRUS, CONCERT, CR-AVE, DC3, HIPPO, INCA, SALTRACE, TC4, Texas

Satellite data: MISR, MODIS, ESA-CCI

RUMBOLD

National Centre for Atmospheric Science (NCAS), University of Reading
UKESM Core Team, Met Office Hadley Centre

University of Reading
National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
Met Office Hadley Centre
UNIVERSITY OF LEEDS

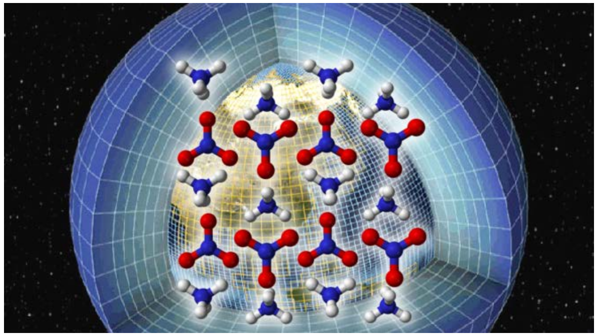
Ammonium nitrate aerosol in UKESM1

Steve Rumbold[1,2,3,*] | Graham Mann[1,4] | Hannah Pearce[4] | Francois Benduhn[4,5] | Kirsty Pringle[4] | Colin Johnson[3] | Fiona O'Connor[3]
Ken Carslaw[4] | Dave Topping[6] | Gordon McFiggans[6] | Claudia Steadman[7] | Mohit Dalvi[3] | Nicolas Bellouin[2]

1. National Centre for Atmospheric Science | 2. University of Reading | 3. Met Office Hadley Centre | 4. University of Leeds
5. Institute for Advanced Sustainability Studies, Potsdam | 6. University of Manchester | 7. University of Edinburgh
* Contact: steven.rumbold@metoffice.gov.uk; s.t.rumbold@reading.ac.uk

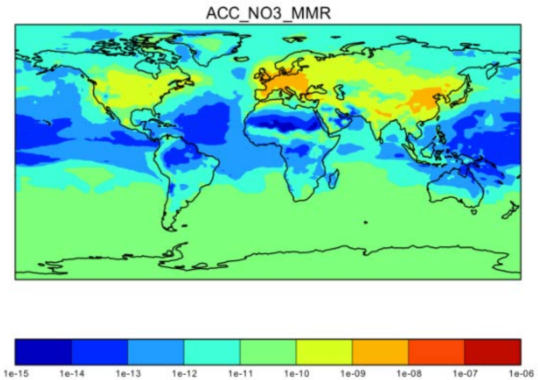
Introduction

Ammonium nitrate aerosol is of increasing importance in climate simulations both in terms of radiative forcing and air quality. A modal ammonium nitrate aerosol scheme is being incorporated into the UK Earth System model version 1 (UKESM1) .



- *Topics covered...*

- Importance of nitrate aerosol
- Nitrate extension to standard GLOMAP
- Incorporating code in UKESM
- Strategy for nitrate radiative coupling
- Code speed and optimisation



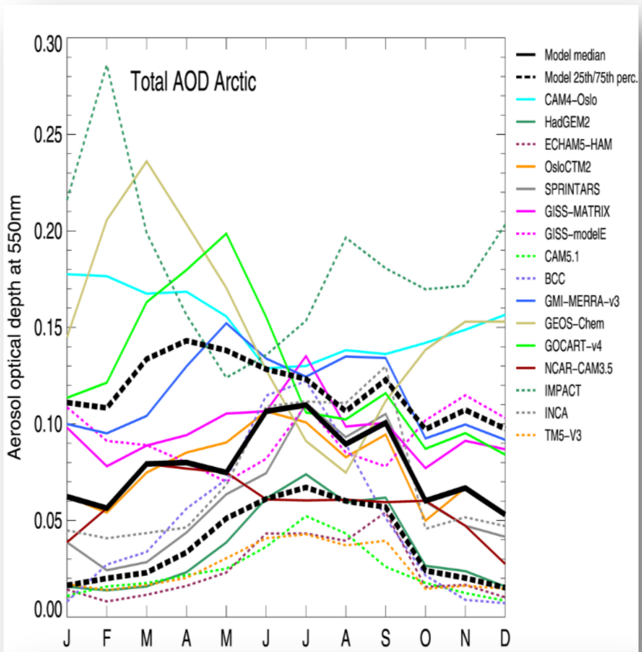
- Current surface mmr results

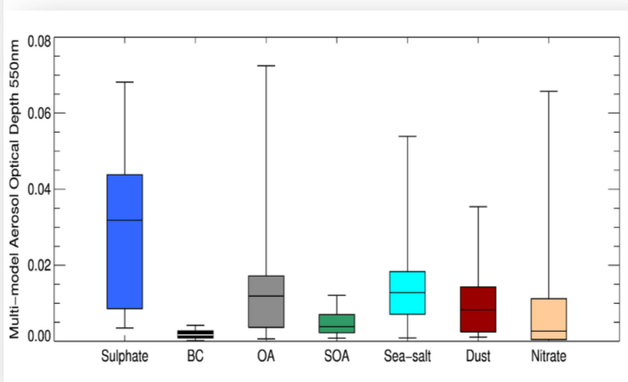
SAND

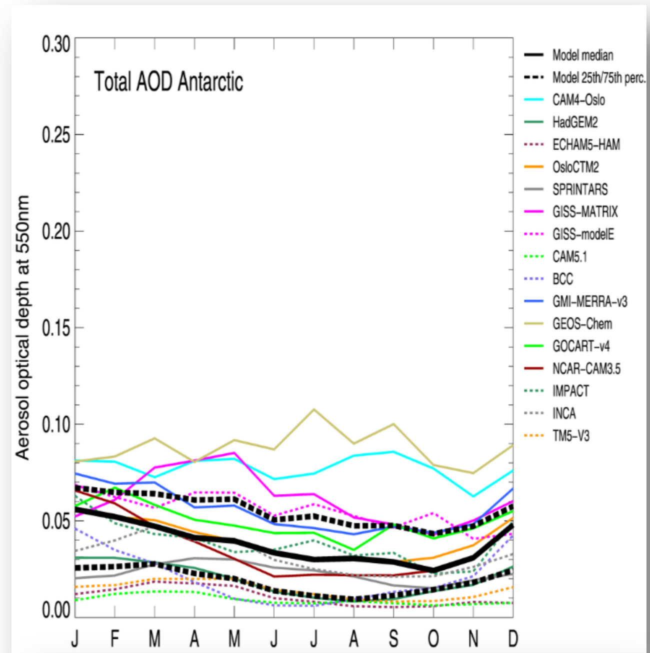
Aerosols at the Poles

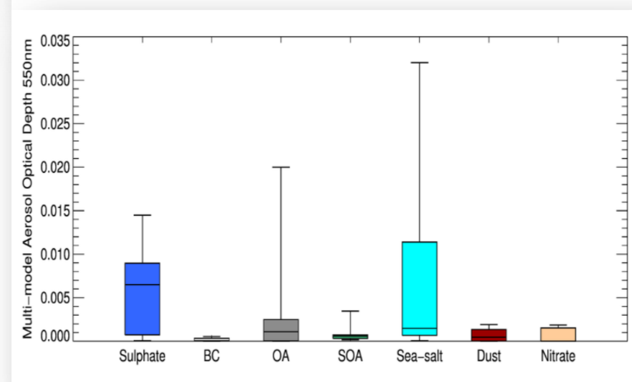
Maria Sand[a,b] and Bjørn H. Samset[a]

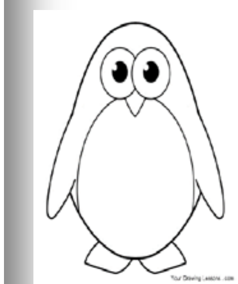
[a] Center for International Climate and Environmental Research – Oslo (CICERO), Norway, [b] NASA Goddard Institute for Space





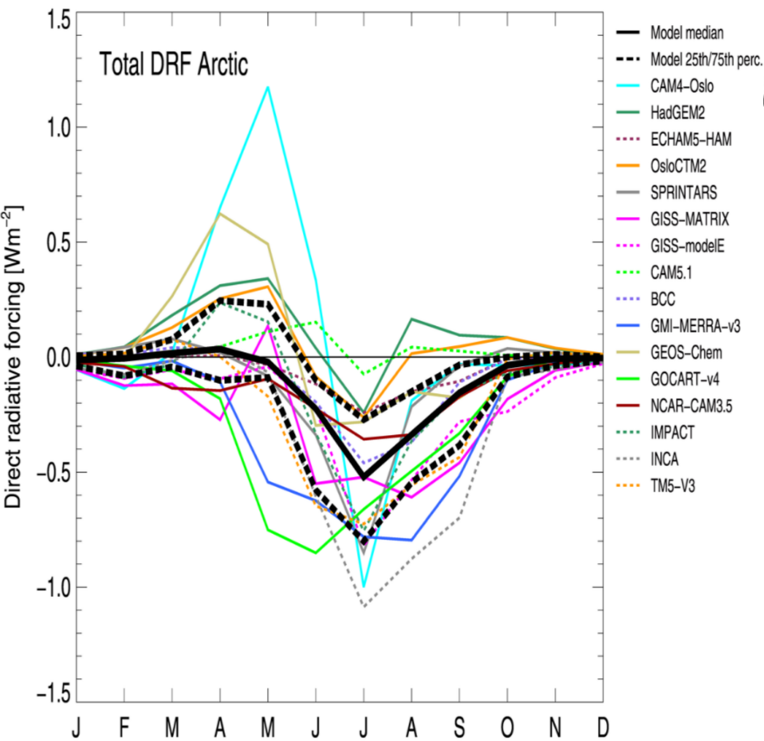


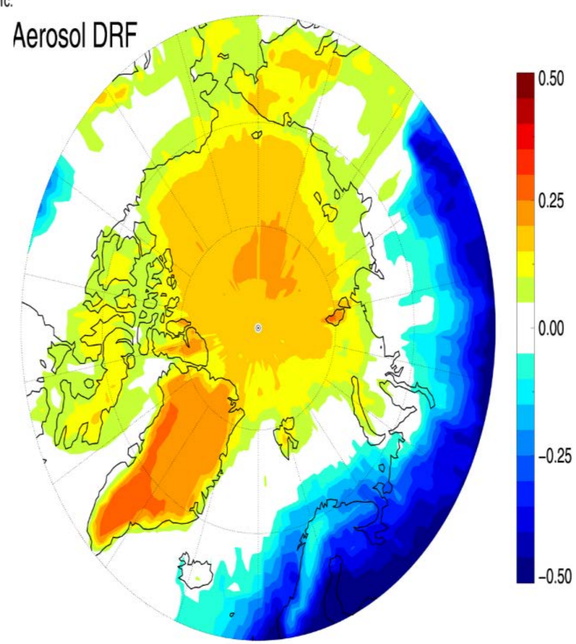


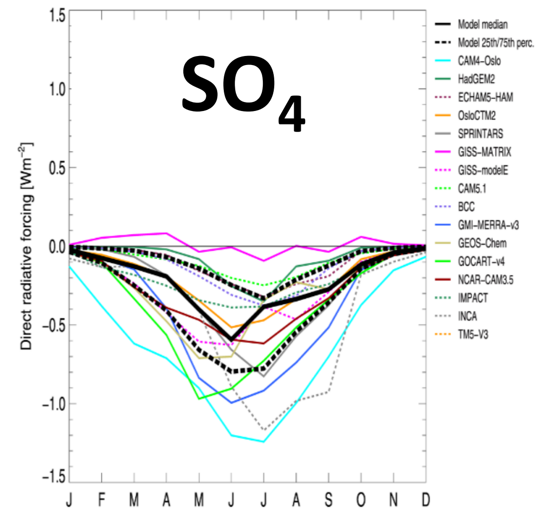


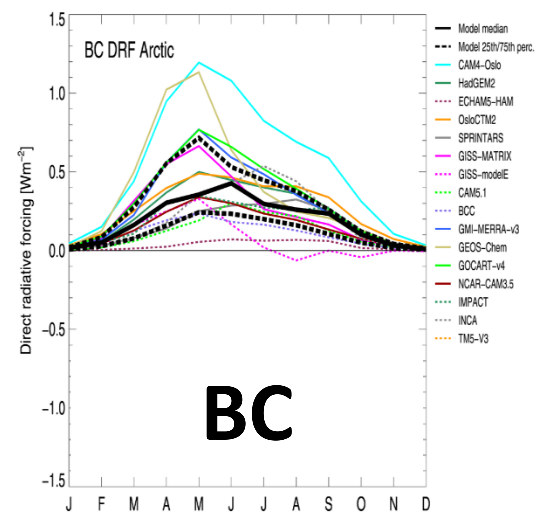
Arctic direct radiative forcing

TOTAL







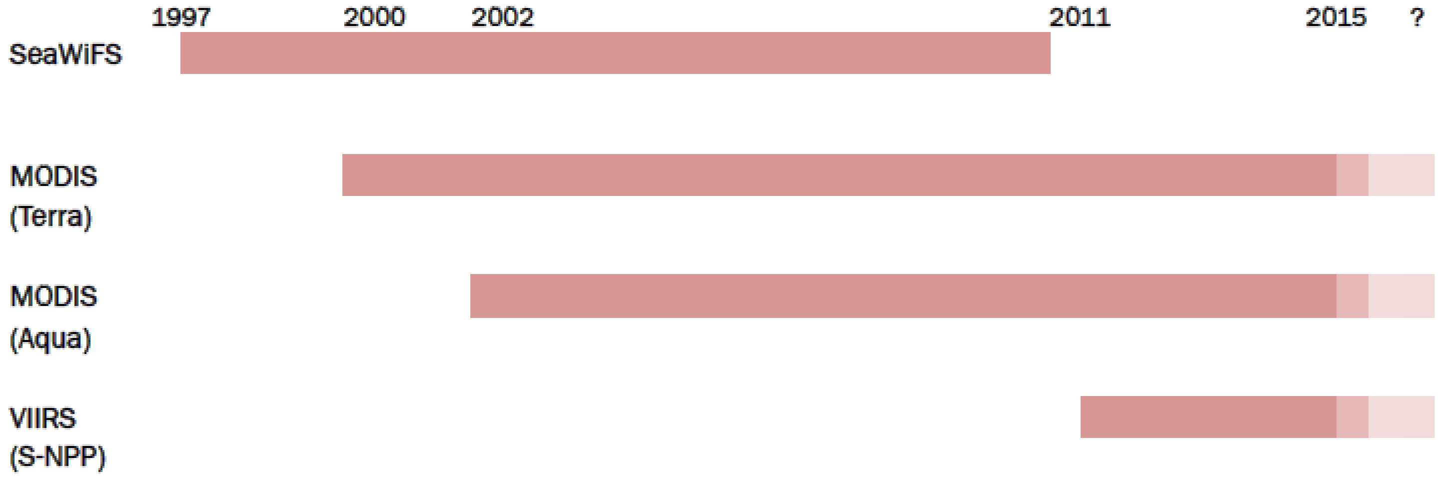


SAYER

The multi-sensor Deep Blue aerosol project: recent updates

A. M. Sayer[1,2], N. C. Hsu[1], C. Bettenhausen[1,3], J. Lee[1,4]

1: NASA Goddard Space Flight Center, Greenbelt, MD, USA 2:Goddard Earth Sciences Technology And Research (GESTAR), Universities Space Research Association, Columbia, MD, USA
3: Science Systems & Applications, Inc. Lanham, MD, USA 4: Earth System Science Interdisciplinary Center (ESSIC), University of Maryland, College Park, MD, USA



Main topics: MODIS Terra stability, VIIRS data release

deepblue.gsfc.nasa.gov

SCHUTGENS (1)

Will a perfect model agree with perfect observations?

N.A.J. Schutgens

E. Gryspeerdt

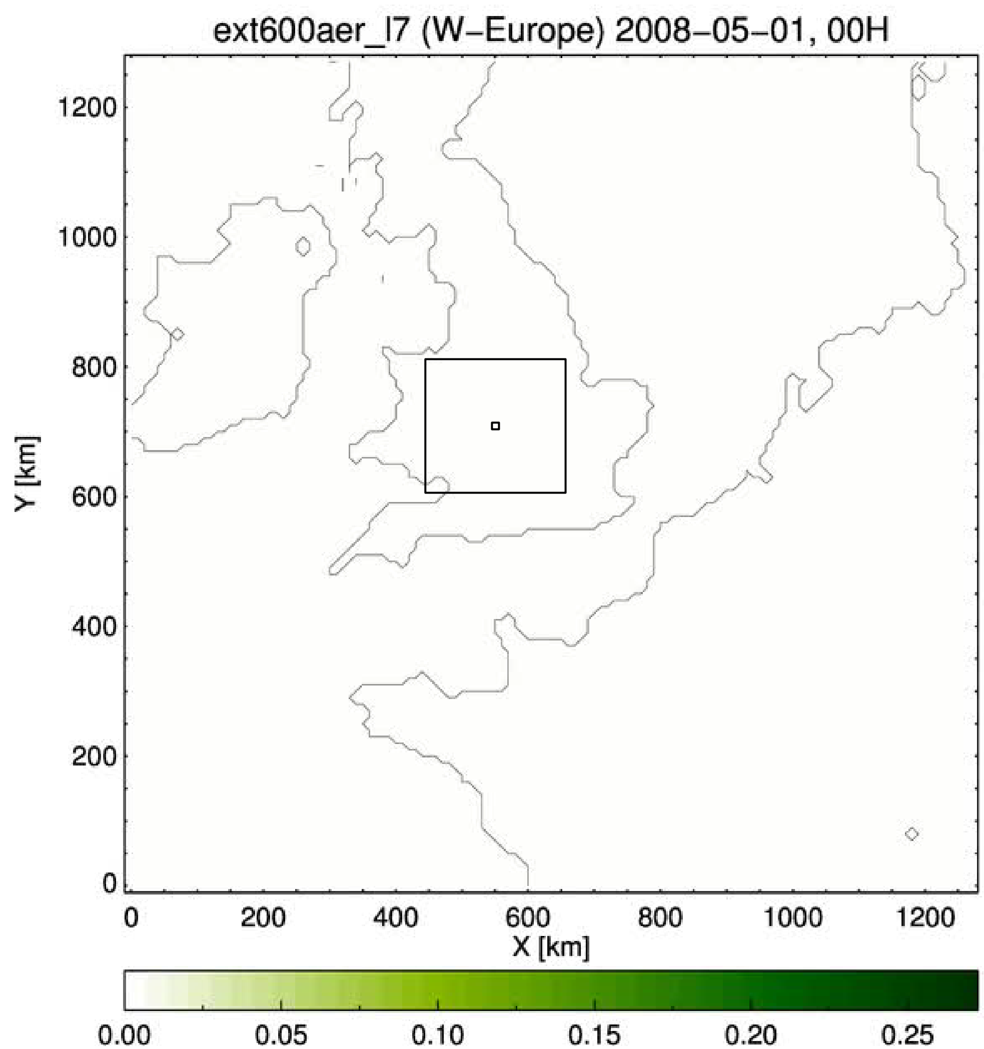
S. Tsyro

D. Goto

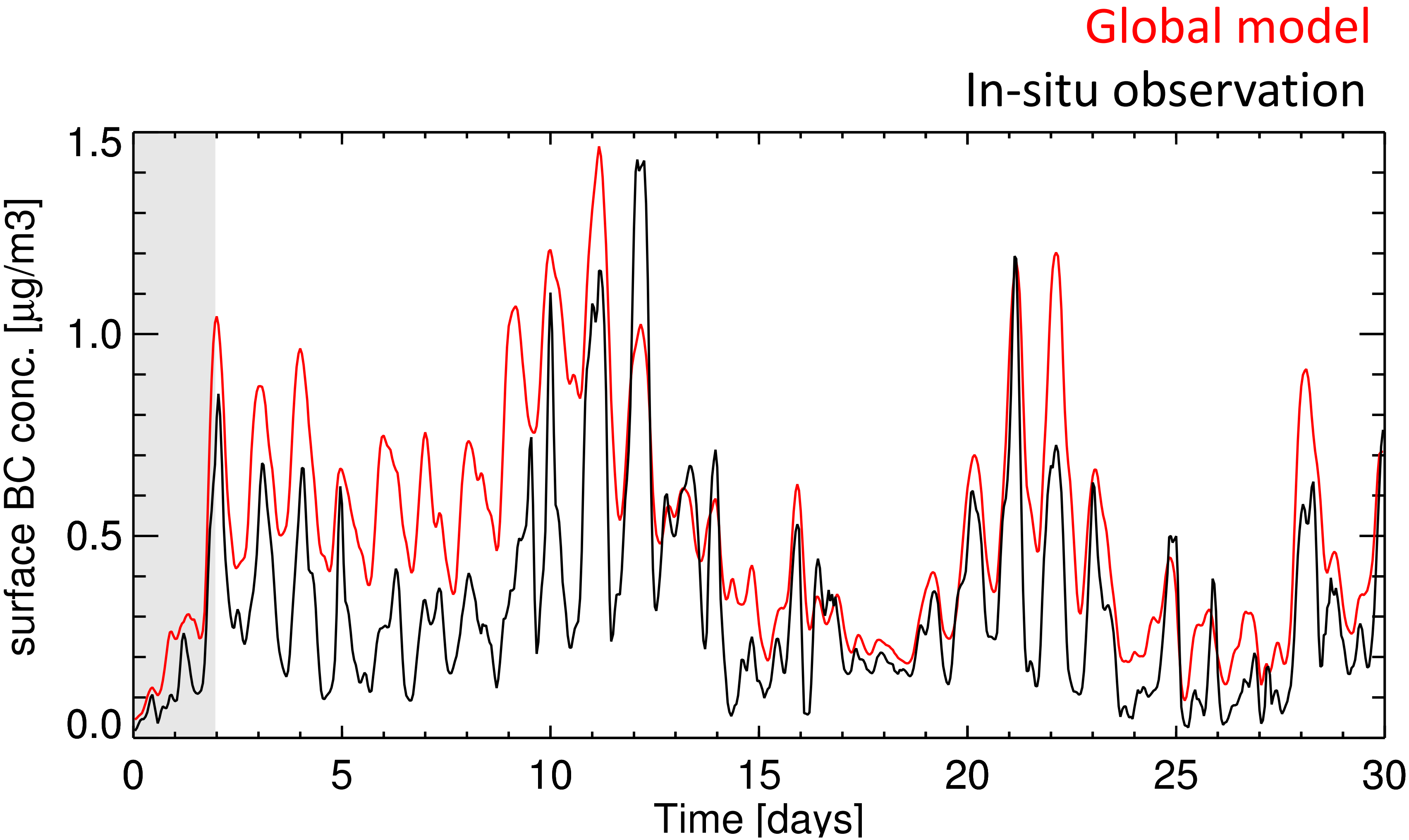
M. Schulz

D. Partridge

P. Stier

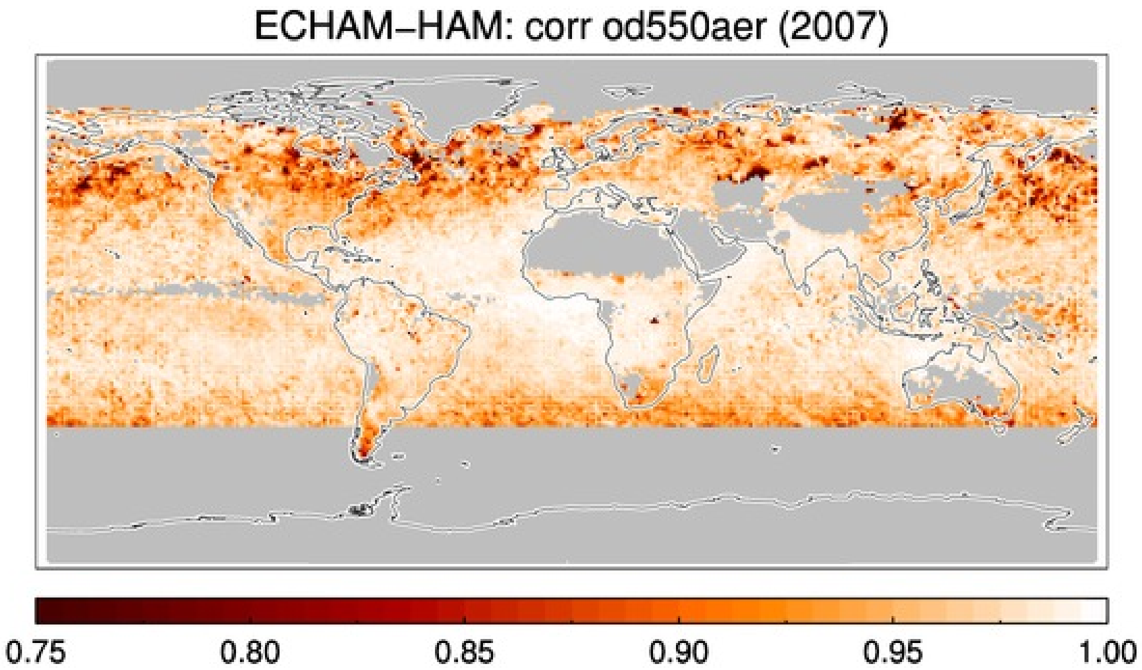


Aerosol extinction at an altitude of ~ 2km

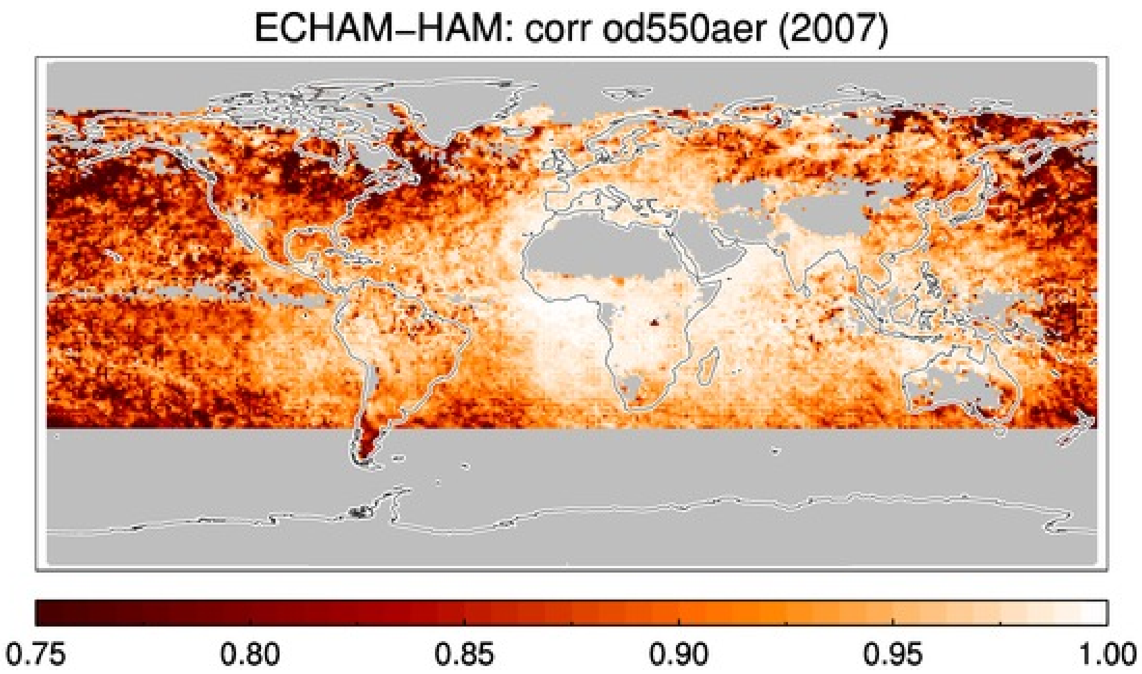


Global model
In-situ observation
surface BC conc. [µg/m3]
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
Time [days]

A day is defined as the 24 hours surrounding a MODIS overpass



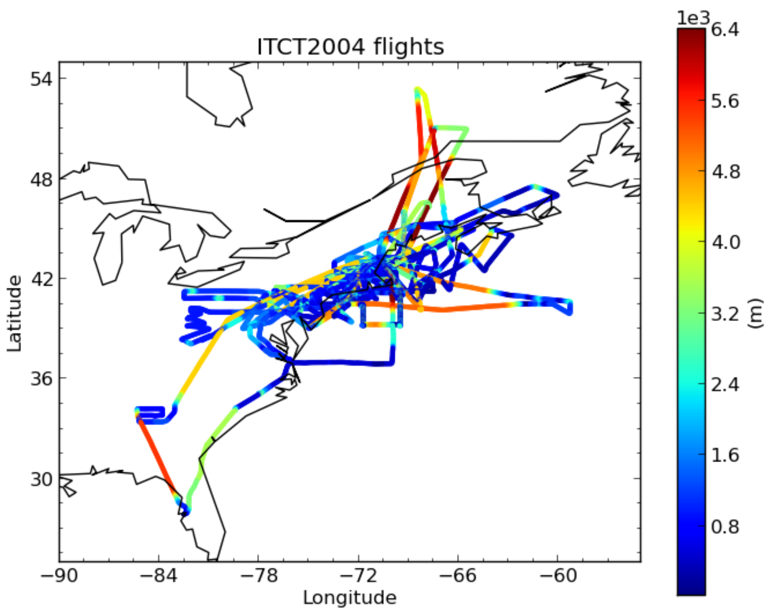
A day is defined by UTC

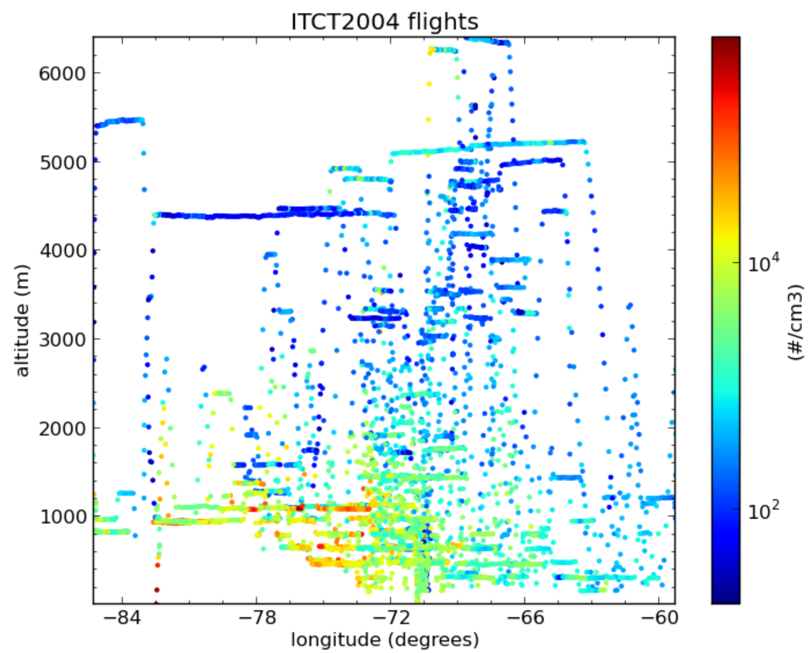


SCHUTGENS (2)

Community Intercomparison Suite

N.A.J. Schutgens, D. Watson-Parris, Z. Kipling, P. Kershaw, P. Stier

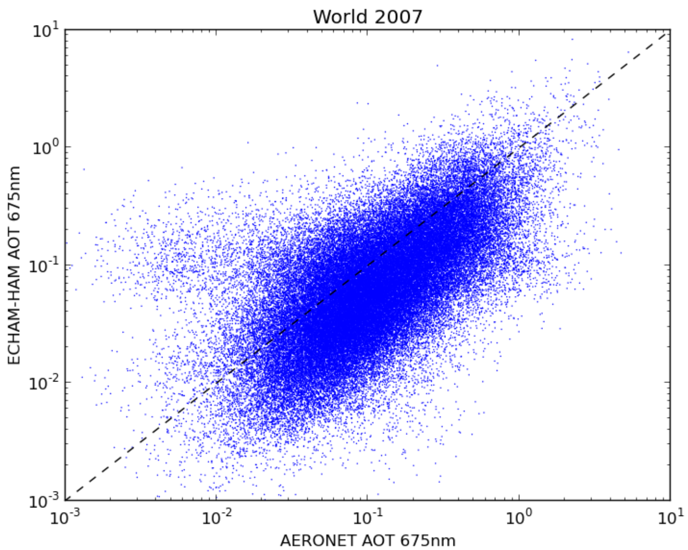


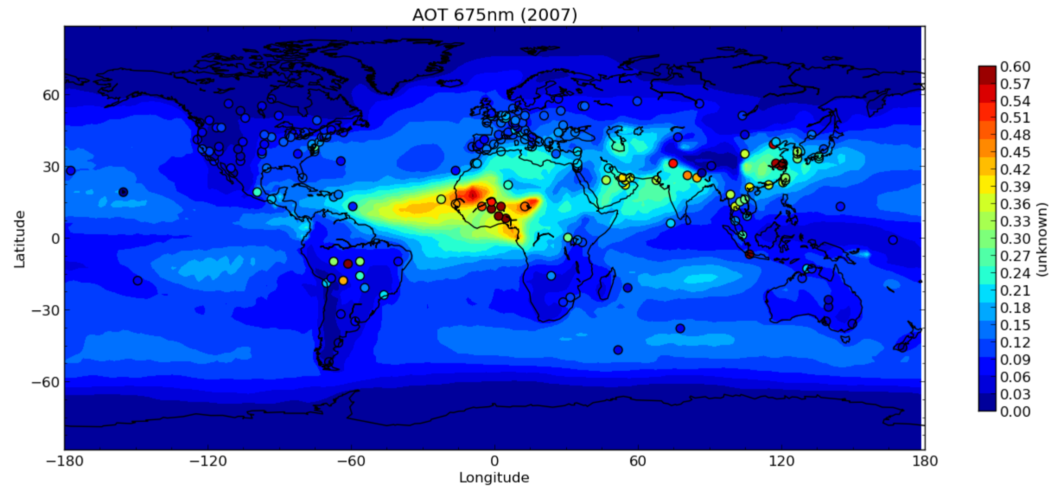


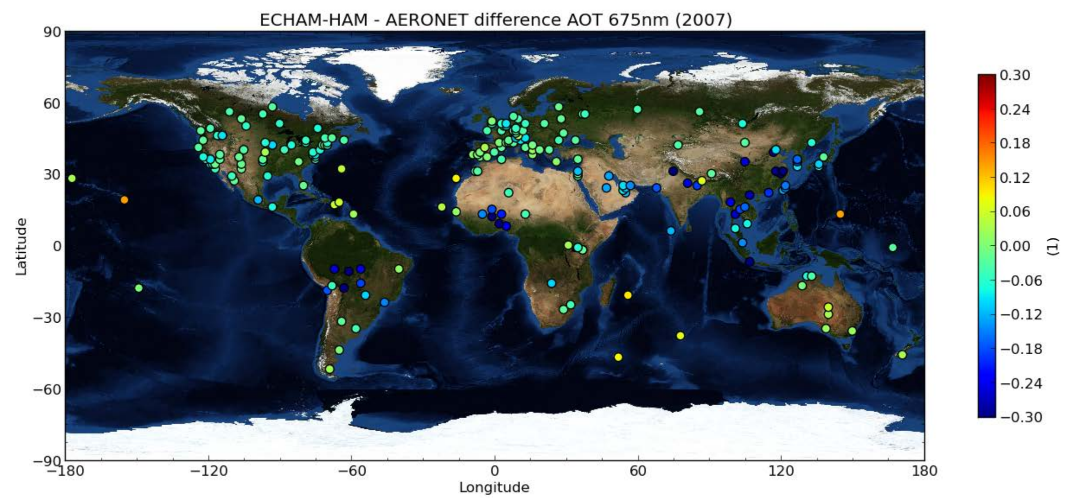
A simple tool to
colocate, visualise and analyse your datasets
www.cistools.net

Evaluation of ECHAM-HAM with AERONET AOT

ECHAM-HAM	1 year of 3-hourly global AOT output (2007)	NetCDF
AERONET	all available native AERONET Direct Sun lvl2 data	ASCII





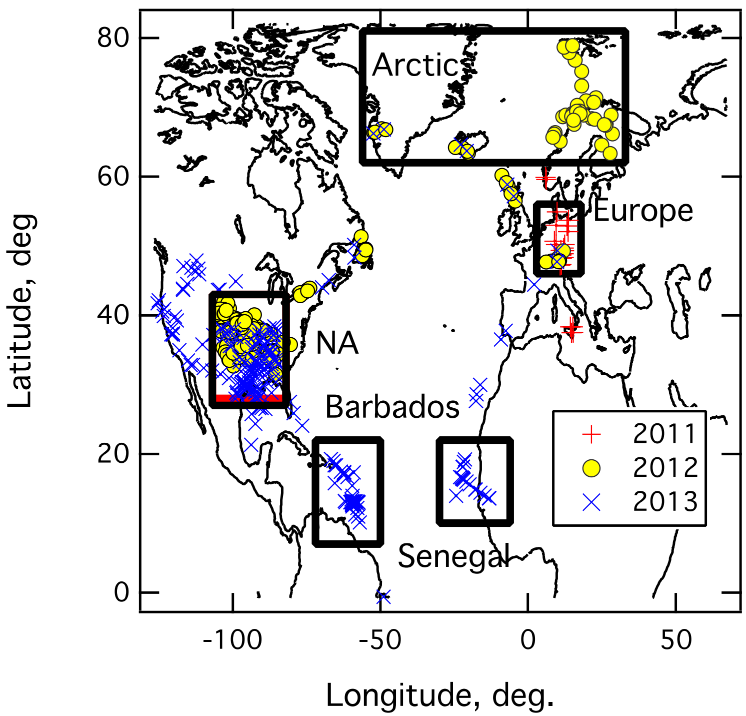


Mean AERONET: 0.18
Mean ECHAM-HAM: 0.12
Correlation: 0.62
Slope: 0.46

SCHIWARZ

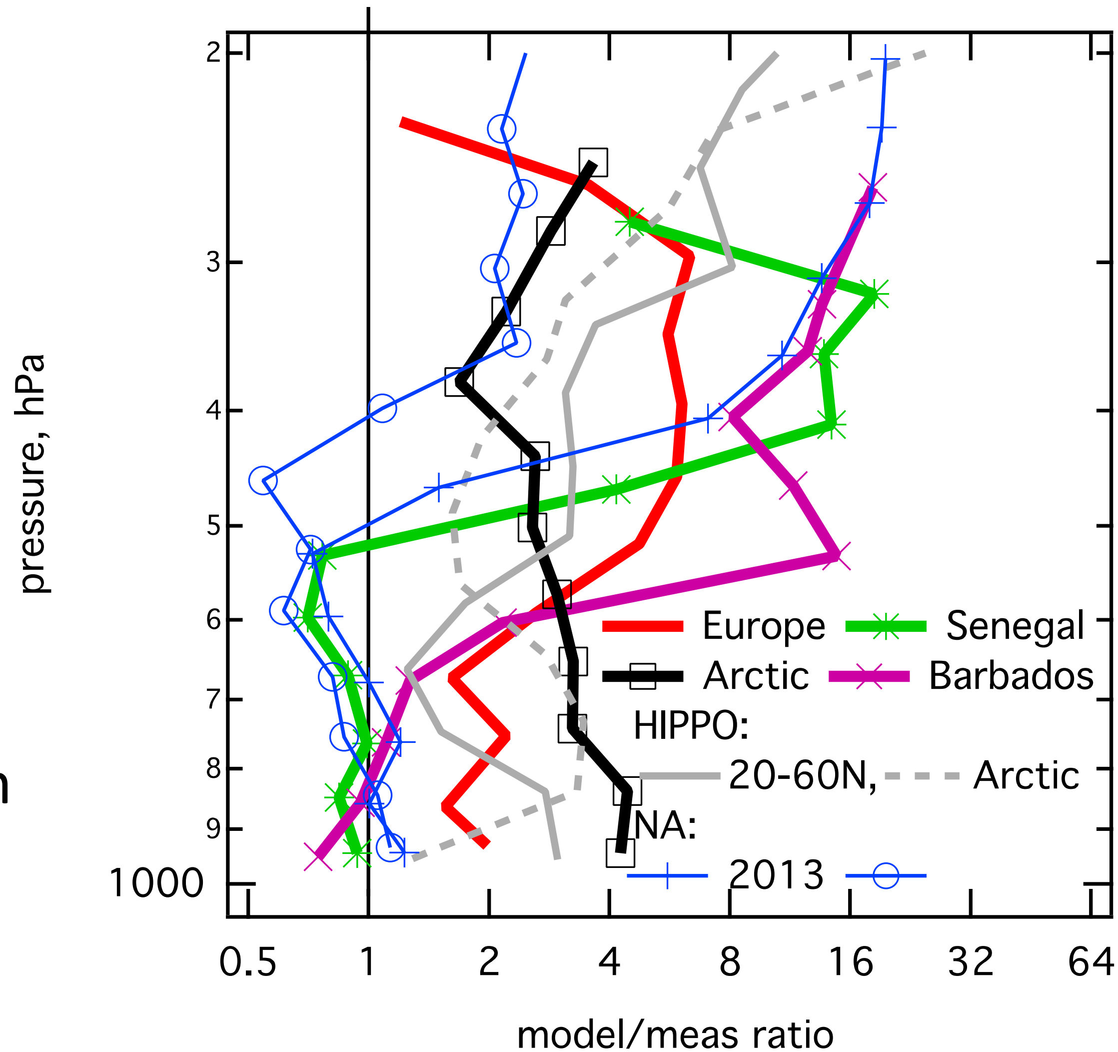
BC Vertical Profiles and AeroCom - A Romance

J. P. Schwarz, B. Weinzierl, B. Samset



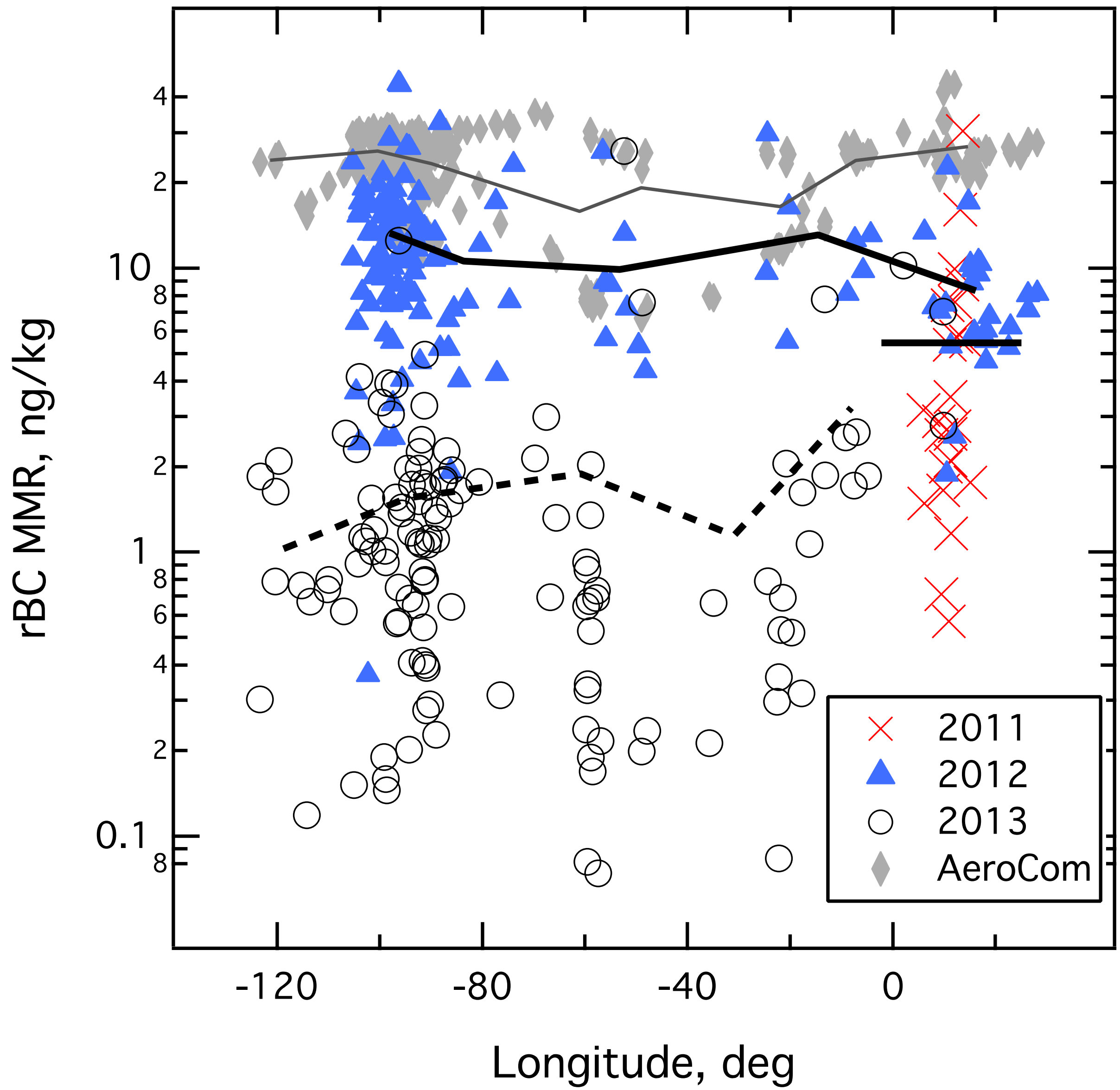
- Three years of data
- Up to 200 hPa
- Compared to AeroCom ala HIPPO approach

AeroCom Phase II compared to SP2



UT BC MMR vs Longitude

- Very effective longitudinal mixing
- Order of magnitude difference observed on global scales between two periods
- AeroCom UT bias largely longitude independent.



SHI

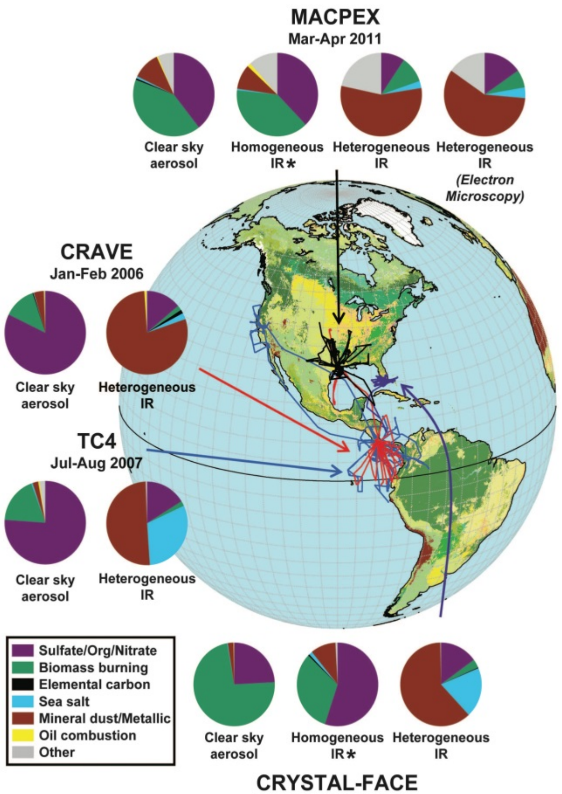
AeroCom 2015, Frascati Italy

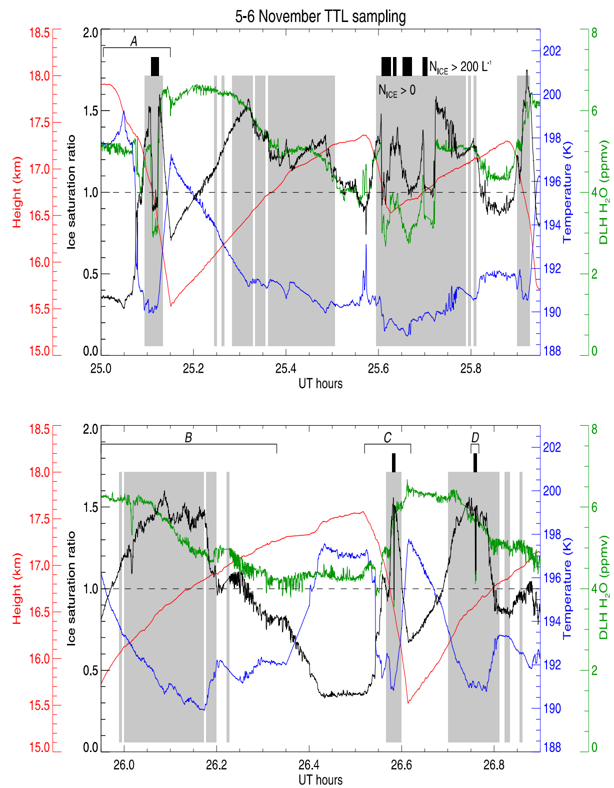
Effect of Cloud-Scale Vertical Velocity on the Contribution of Homogeneous Nucleation to Cirrus Cloud Formation and Climate Forcing

Xiangjun Shi[1,2], Xiaohong Liu[1]

Univercity of Wyoming, Atmospheric Seciece Department
Hebei Meteorological bureau, Climate Center

Which is the dominant mechanism for cirrus cloud formation? homogeneous or heterogeneous freezing





Cziczo et al. 2013 Science

residual ice composition
heterogeneous freezing

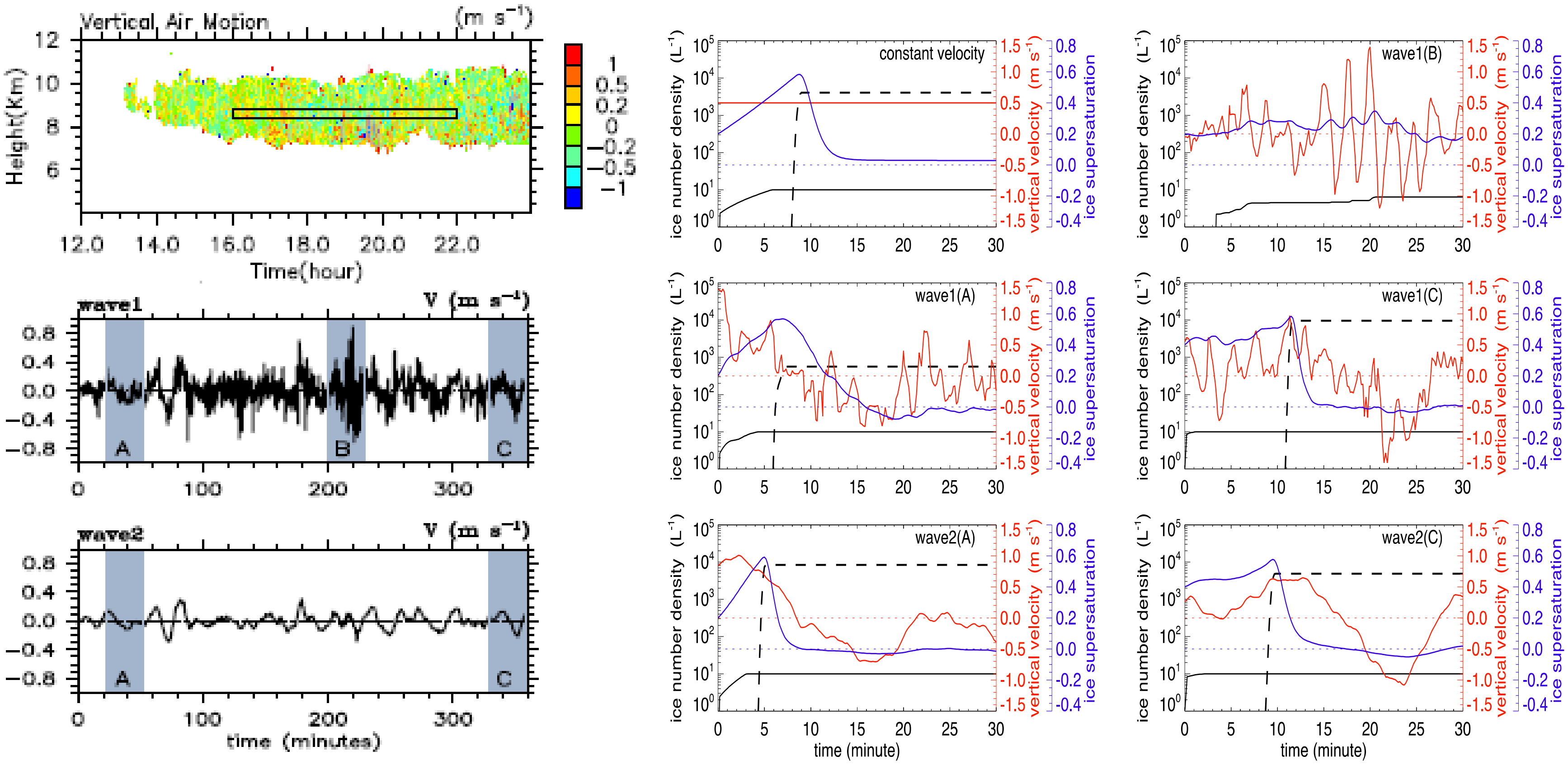
Jensen et al., 2013 PANS

ice number density
heterogeneous freezing

Shi et al., 2015 ACP

Climate Model results
homogeneous freezing

The vertical velocity during ice nucleation process



General circulation models : ice nucleation parameterizations are derived from a rising air parcel. Updraft velocity is is assumed to be constant.

Actually: Cloud parcel model shows vertical fluctuations play an important role in cirrus formation.

SHIM

Climate Effects of Aerosol-Cloud Interaction over East Asia

Sungbo Shim, Yoo-Rim Jung, Kyung-On Boo, Younghwa Byun and ChunHo Cho
Korea Meteorological Administration, National Institute of Meteorological Research, Jeju, Republic of Korea

INTRODUCTION

❖ East Asia is densely populated region over 60 percentile of the world`s population and economically rapid development accompanies heaviest aerosol-burden as well, exceeding the emission levels of Western Europe and Eastern United States.

❖ Unlike the long-live GHGs, which are distributed uniformly over the globe, aerosols show different lifetime and regionally different distribution of concentration [Ramanathan et al., 2001]. The Physical properties and chemical composition of aerosol differ considerably form region to region.

❖ Many studies have investigated the climate effects of aerosol over East Asia from a GCM or RCM [Zhang et al., 2012; Guo et al., 2013; Jiang et al., 2013]. In spite of a variety of preceding studies, the uncertainty of quantitative estimation of radiative forcing from aerosol-cloud interaction processes. Therefore, aerosol-cloud interaction and its effect of on the climate system are investigated in this studies.

EXPERIMENTS DESIGN

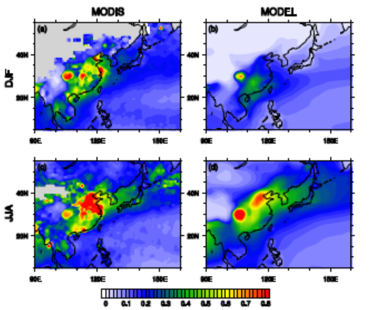
❖ The simulations were conducted with the coupled ocean-atmosphere model developed by UK Met office, referred to as HadGEM2-AO. It has been run from the year of 1860 until 2005.

❖ We perform some simulations to understand effect of anthropogenic forcing on climate change during the 20th century over East Asia.

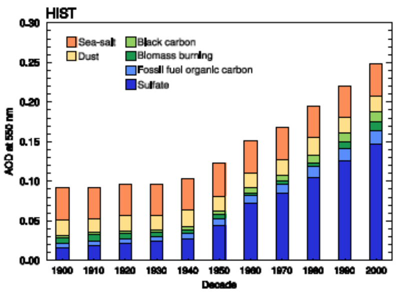
❖ Singe forcing experiments of aerosol and GHGs are compared with historical simulation considered total forcings.

EXP.	Description
CONT	No forcing EXP, fixed pre-industrial (1860 year) condition
HIST	Total forcing (GHGs, Aerosol, Natural, Land use change)
AERO	Aerosol-only forcing, other forcings are given as fixed values
GHGS	Greenhouse gas-only forcing, other forcings are given as fixed value

AEROSOL-SUNLIGHT INTERACTION



[Spatial distribution of total AOD at 550 nm observed by the MODIS satellite instruments from 2000 to 2005 year, and simulated by HadGEM2-AO climate model]

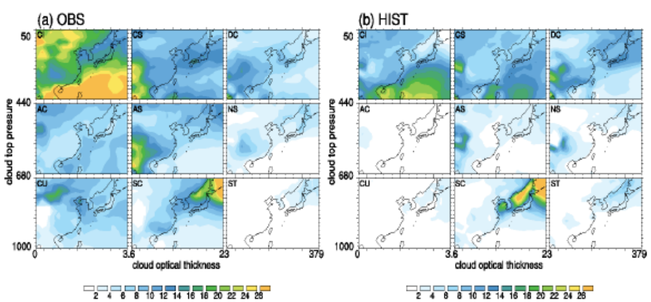


[Changes in decadal mean AOD at 550 nm of six aerosols over East Asia for total forcing (HIST) experiment]

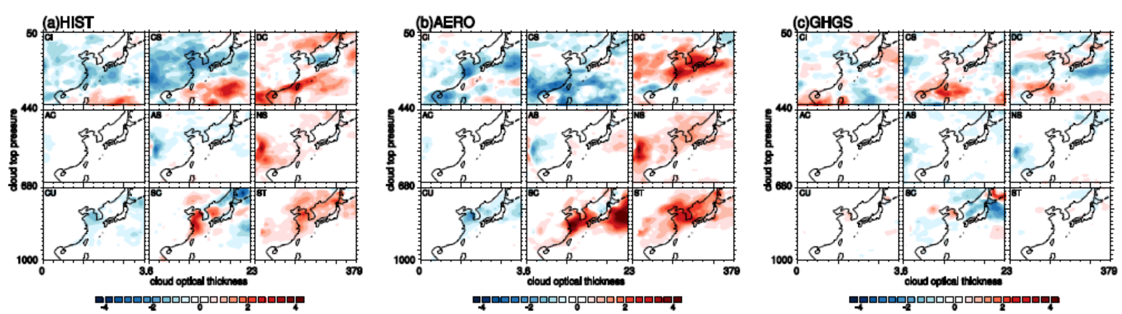
❖ To evaluate the model performance of the aerosol direct effect over East Asia, aerosol optical depth(AOD) at 550nm retrieved by MODIS satellite was compared to the results simulated by the HadGEM2-AO climate model. Simulated AOD are similar to the observed in spatial distribution and seasonal difference. In both observation and simulation, the value of AOD is higher in summer (JJA) than in winter (DJF). It is mentioned in Ju and Han [2011] that radiative forcing was strongest among the four seasons in summer (JJA). In DJF, simulated AOD is lower than the observed. This underestimation is consistent with Bellouin et al [2011] shown that HadGEM2 has the tendency of simulating the sulfate aerosol number concentration low in winter at the high latitude of northern hemisphere.

❖ Aerosol emissions over East Asia increase rapidly in the second half of the 20th century. In the early 20th century, total AOD is mostly attributed to natural particles such as sea-salt. Later, the increase of AOD due to anthropogenic aerosol such as sulfate was substantial as a result of the industrialization. As previous studies have interest on the sulfate effect as the main component of anthropogenic aerosols [Jiang et al 2013, Liu et al 2009], consistent result are confirmed.

AEROSOL-CLOUD INTERACTION



[Spatial distribution of climatological JJA mean of (a) observed and (b) simulated cloud fraction (unit: %) for each cloud type from the ISCCP cloud classification for years of 1984-2005]



[JJA mean change (1980-2000 minus 1900-1920) in distributions of cloud types (units: %) based on the ISCCP classification method for (a) HIST, (b) AERO, and (c) GHG experiment]

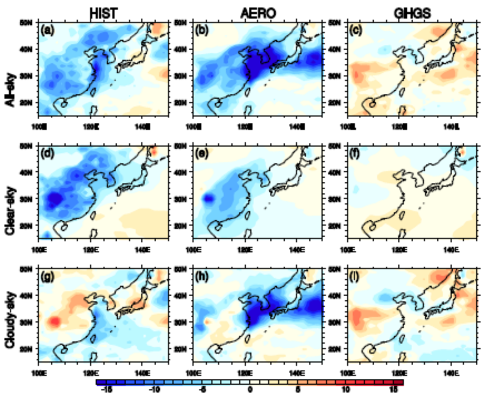
❖ To find out the performance of climate model, clouds were classified to 9 cloud types in accordance with optical depth and top altitude based on the ISCCP cloud classification. According to the observation data, Cirrus (CI) and Stratocumulus (SC) are main cloud types in summer of East Asia. Tang and Chen (2006) also showed the ISCCP cloud type frequently observed in summer of the East Asian monsoon area is SC.

❖ In the late 20th century, cloud optical depth was thickened by aerosol forcing, main cloud type (SC, ST) increases in East Asia. Duan and Wu [2006] and Warren et al [2007] reported the observed trend of increasing low-level cloud in the late 20th century in East Asia. On the other hand, GHGs forcing experiment could not find distinct change in spatial distribution for each cloud type.

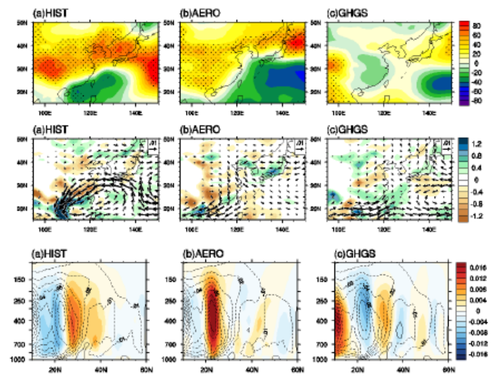
Climate Effects of Aerosol-Cloud Interaction over East Asia

Sungbo Shim, Yoo-Rim Jung, Kyung-On Boo, Younghwa Byun and ChunHo Cho
Korea Meteorological Administration, National Institute of Meteorological Research, Jeju, Republic of Korea

AEROSOL EFFECT ON RADIATIVE FORCING



[Simulated climatological JJA mean change (1980-2000 minus 1900-1920) in distribution of the net radiative flux at the TOA]



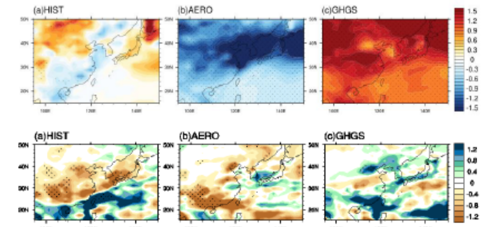
[JJA mean changes (1980-2000 minus 1900-1920) in distribution of MSLP(Pa, upper), 850 hPa moisture flux(10^{-8} kgm^{-1}s^{-1}) and moisture flux convergence(kgm^{-2}s^{-1}, middle), and vertical wind (Pa s^{-1}, bottom)]

❖ In AERO, the indirect radiative effect is estimated to -2.4 Wm^{-2} due to aerosol-cloud interaction process, larger than -1.5 Wm^{-2} for direct radiative effect. CRF effect of aerosol occupies 62% of the total aerosol effect in JJA. In the late 20th century, negative radiative flux at the top of atmosphere (all-sky) is shown over China, extending eastward, which is coincident with the spatial pattern of the summer (JJA) total AOD increased largely in HIST. Likewise, negative change in the net radiative flux at the top of the atmosphere under clear-sky condition is exhibited over land by the direct aerosol forcing. Under cloudy-sky condition, positive radiative effect appeared exceptionally in southeast china, the Korean Peninsula, and Japan. This can be explained by the feedback phenomenon that change of the atmospheric circulation and monsoon precipitation by aerosol and GHGs forcing.

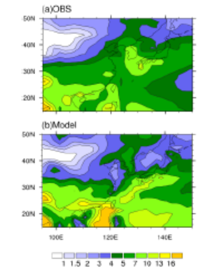
❖ The aerosol forcing changes thermal structure of atmosphere and affects circulation and transportation of vapor. The East Asian summer monsoon system is generally governed by the atmospheric pressure difference between the high pressure in the South China Sea, Northwest Pacific and the low pressure in the East Asian continent [Ding, 1994]. The surface pressure increased substantially over land due to surface cooling, whereas surface pressure in the South China Sea was decreased, thus leading to the weakening of the land-sea gradient of surface pressure. These caused the weakening of the moisture transport as well as the weakening of the ascending motion, and consequently the East Asian summer monsoon precipitation is weakened in the late 20th century.

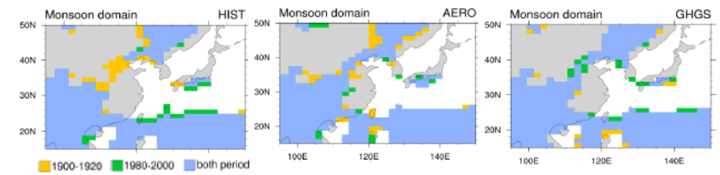
units: % (land only)	HIST	AERO	GHGS
Monsoon Area	-2.0 (-6.8)	-1.6 (-3.5)	1.3 (-2.2)
Monsoon total precipitation	2.4 (-12.5)	-7.0 (-9.6)	6.1 (1.6)
Monsoon precipitation intensity	4.5 (-6.2)	-5.4 (-6.3)	4.7 (3.9)

IMPACT ON EAST ASIAN SUMMER MONSOON



[JJA mean changes (1980-2000 minus 1900-1920) in distribution of surface air temperature (K) and total precipitation (mm/day). The stippling shows changes statistically significant at 95% level]





[Simulated monsoon domain over East Asia based on the method suggested by Wang et al [2011]. Yellow (Green) shading shows monsoon domain in the early (late) 20th century. Blue shading shows monsoon domain in both periods]

❖ The distribution of aerosol-induced precipitation changes was consistent with the results reported by Liu et al [2009] which investigated the direct radiative forcing effect of sulfate on precipitation changes of the East Asian summer monsoon area. Main properties of monsoon system such as the monsoon area, monsoon total precipitation, and monsoon intensity were investigated for the same period.

❖ Based on the method suggested by Wang et al [2011], the region where the annual range of precipitation exceeds 2.5 mm/day was defined as monsoon area, and the Nov. to Mar. average precipitation. Following Hsu et al [2013], the monsoon total precipitation is defined as the mean of summer rainfall in the monsoon area, and the monsoon intensity is defined to measure the monsoon precipitation amount per unit area.

❖ Decreasing of monsoon area was clearly shown over land in China, indicating precipitation band in the summer monsoon area could not shift north and stay in the south of China in the late 20th century. Changes in monsoon area accompany changes in total precipitation amount and precipitation intensity. As monsoon area was reduced in AERO, total precipitation amount decreases with weak intensity. The opposite pattern in GHGS.

This research has been supported by project NIMR-2012-B-2 of the National Institute of Meteorological Research in Korea Meteorological Administration.

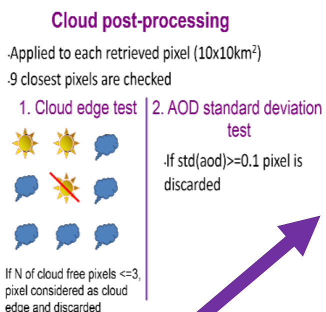
SOGACHEVA

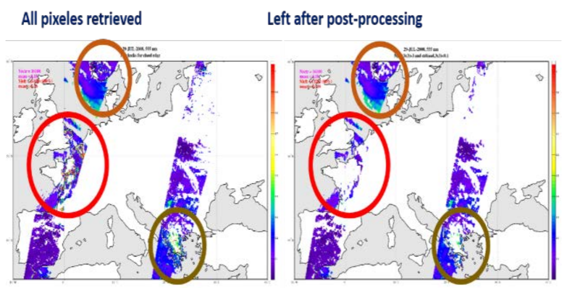
Cloud post-processing for ADV/ASV AATSR aerosol retrieval: reg. aspects

[1]Finnish Meteorological Institute
[2] University of Helsinki
Larisa.Sogacheva@fmi.fi

Larisa Sogacheva[1], Pekka Kolmonen[1], Timo H. Virtanen[1], Edith Rodriguez[1], Giulia Saponaro[1], Anu-Maija Sundström[2], Gerrit de Leeuw[1,2]

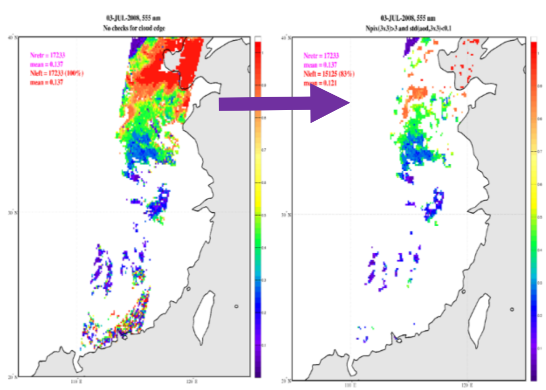
"Old" method





- in **low AOD** loading conditions the method works well

- in **high AOD** loading conditions too many "good" pixels are discarded

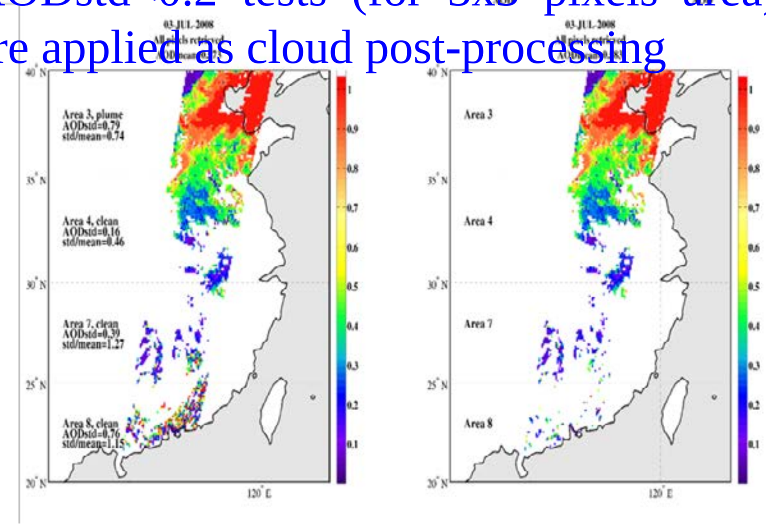


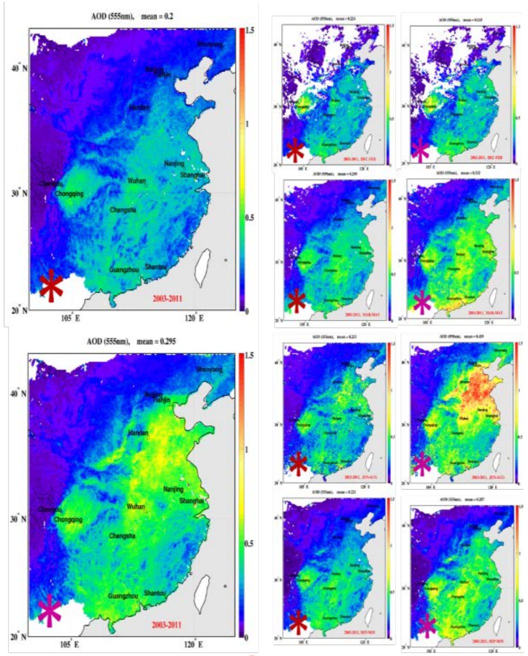
"New" method

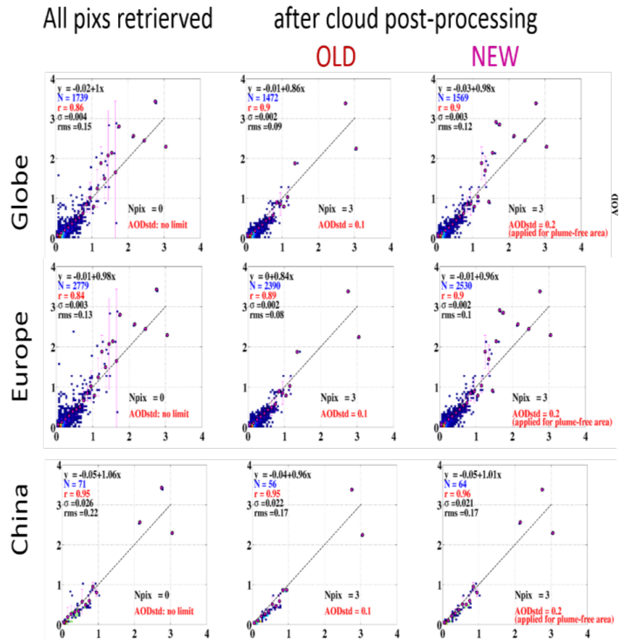
For high AOD areas a "plume" detection algorithm has been developed. "Plume" is detected if in a 5°x5° area the number of pixels with AOD =[0 0.6] is below 40%

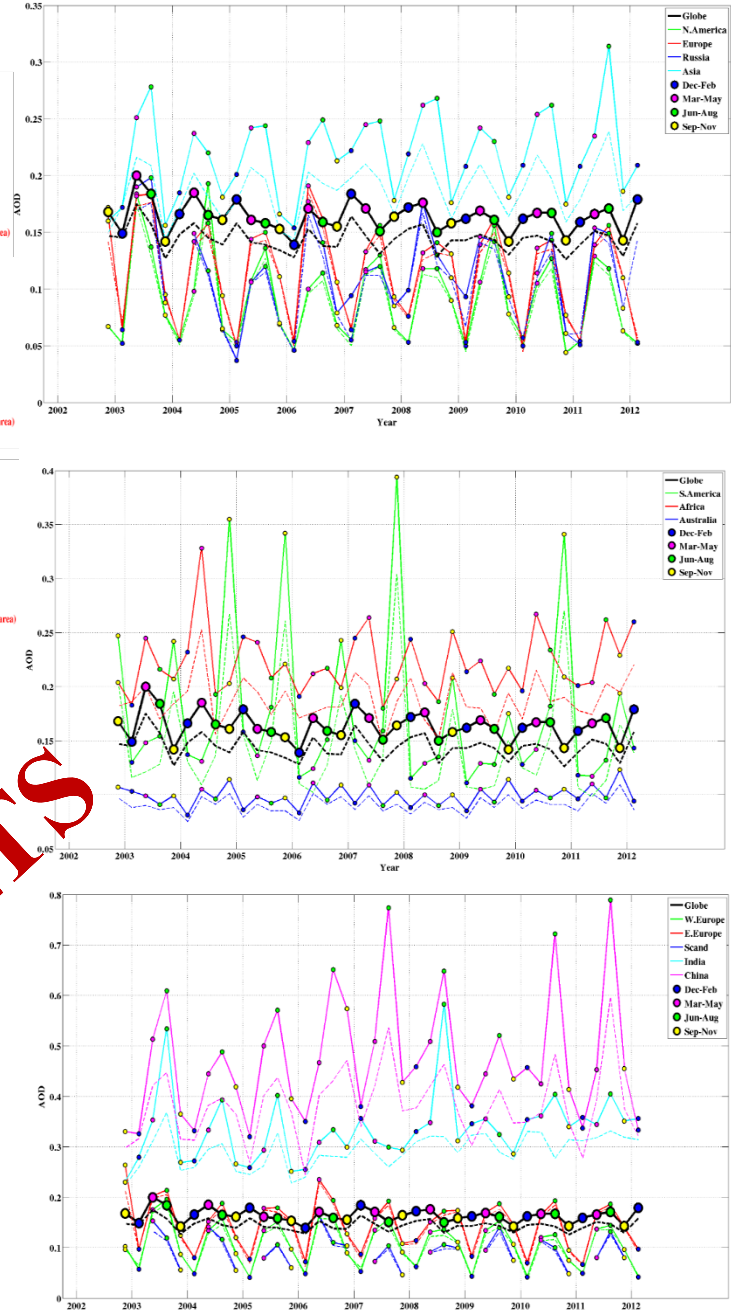
If a plume is detected, only Nlim=3 (for 3x3 pixels area) test is applied

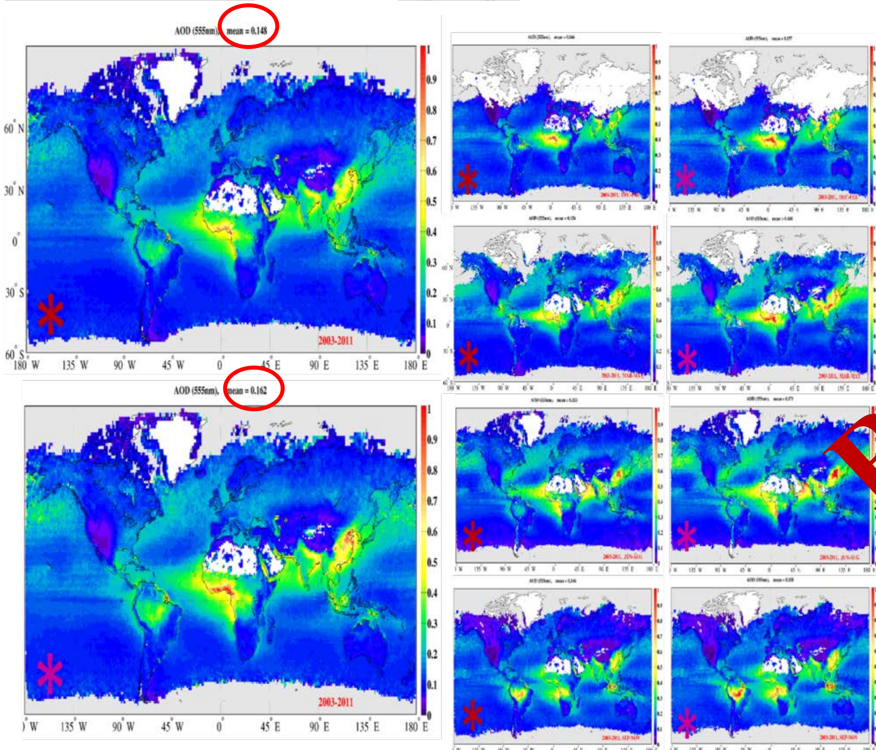
For non-plume areas, both Nlim=3 and AODstd<0.2 tests (for 3x3 pixels area) are applied as cloud post-processing




AOD (555nm), mean = 0.2
AOD (555nm), mean = 0.295
2003-2011
105° E
120° E


All pixs retrierved
after cloud post-processing
OLD
NEW
Globe
Europe
China
y = -0.02+1x
N = 1739
r = 0.86
σ =0.004
rms =0.15
Npix = 0
AODstd: no limit
y = -0.01+0.86x
N = 1472
r = 0.9
σ =0.002
rms =0.09
Npix = 3
AODstd = 0.1
y = -0.03+0.98x
N = 1569
r = 0.9
σ =0.003
rms =0.12
Npix = 3
AODstd = 0.2
(applied for plume-free area)
y = -0.01+0.98x
N = 2779
r = 0.84
σ =0.003
rms =0.13
y = 0+0.84x
N = 2390
r = 0.89
σ =0.002
rms =0.08
y = -0.01+0.96x
N = 2530
r = 0.9
σ =0.002
rms =0.1
y = -0.05+1.06x
N = 71
r = 0.95
σ =0.026
rms =0.22
y = -0.04+0.96x
N = 56
r = 0.95
σ =0.022
rms =0.17
y = -0.05+1.01x
N = 64
r = 0.96
σ =0.021
rms =0.17

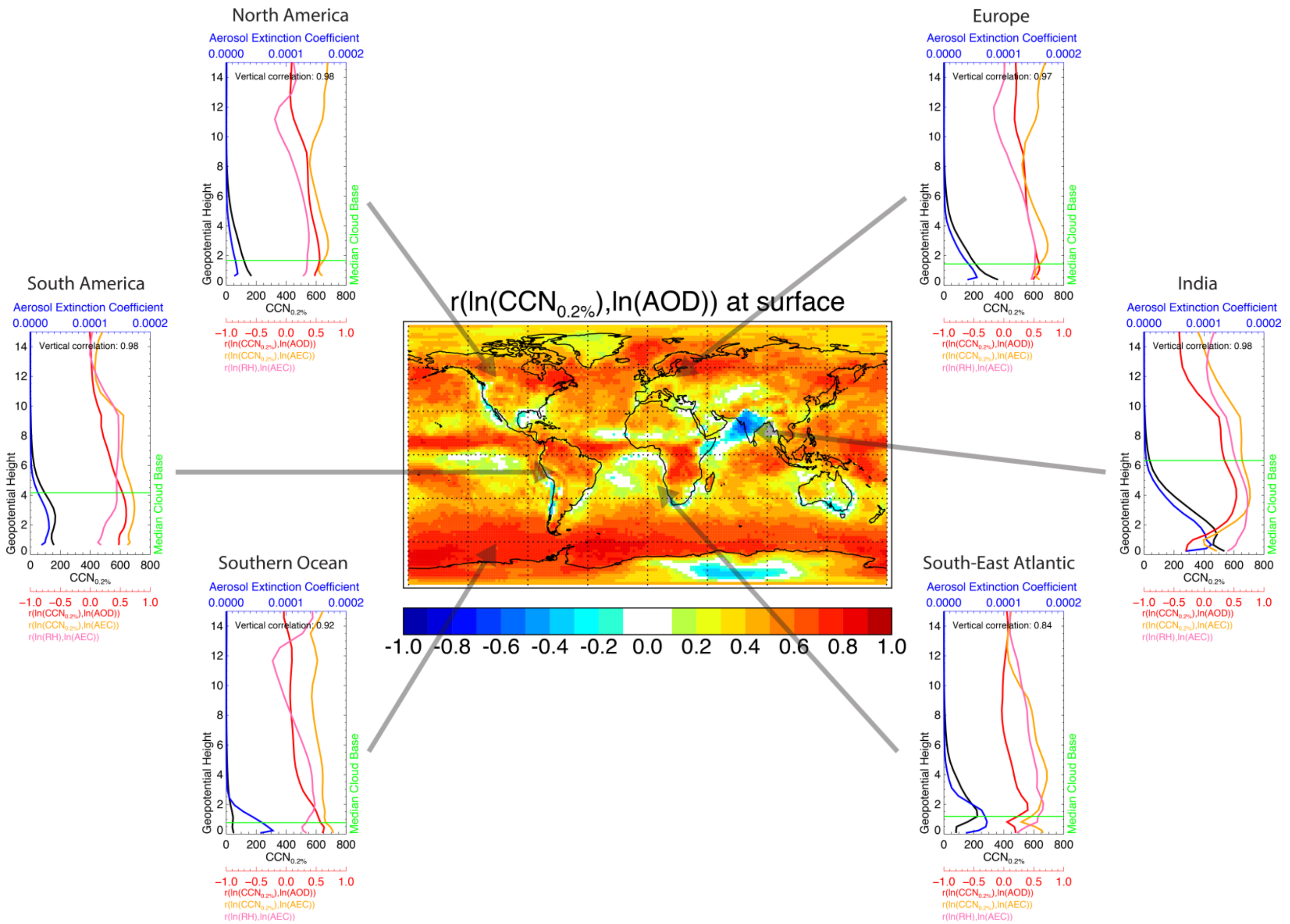

AOD
Year
Globe
N.America
Europe
Russia
Asia
S.America
Africa
Australia
W.Europe
E.Europe
Scand
India
China
Dec-Feb
Mar-May
Jun-Aug
Sep-Nov


AOD (555nm), mean = 0.148
AOD (555nm), mean = 0.162
2003-2011
60° N
30° N
0°
30° S
60° S
180° W
135° W
90° W
45° W
0
45° E
90° E
135° E
180° E

RESULTS

STIER

Suitability of AOD as proxy for CCN



Climate Processes Group

Philip Stier

TAKEMURA

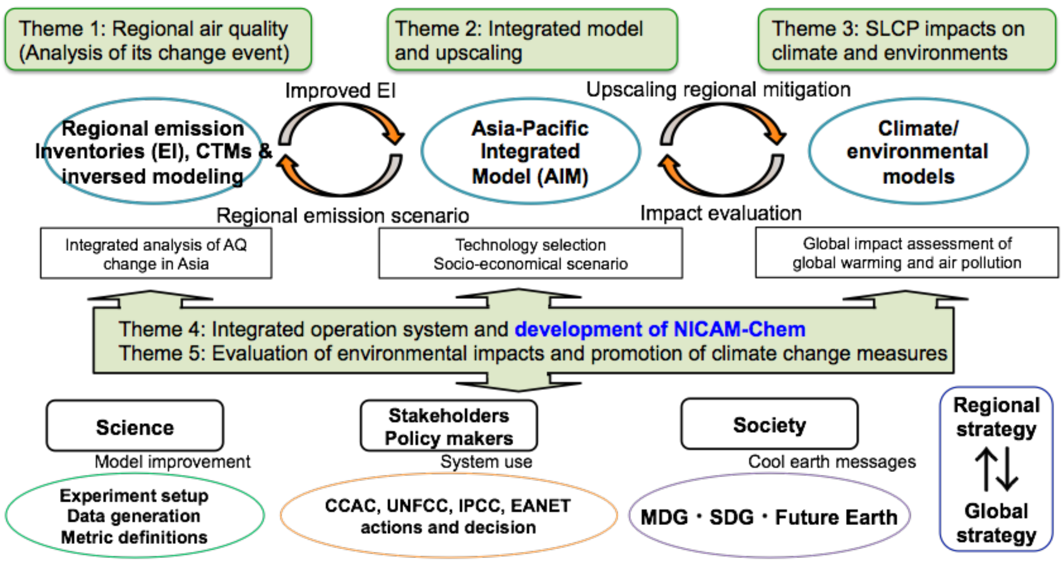
Integrated assessment on effects of short-lived climate pollutants (SLCPs) in Asia

Toshihiko Takemura
Research Institute for Applied Mechanics, Kyushu University, Japan
Kengo Sudo, Kayo Ueda, Yuji Masutomi, Shingo Watanabe, Makiko Nakata, Hiroshi G. Takahashi, Daisuke Goto, Teruyuki Nakajima

Japanese research project on SLCPs

Active evaluation of SLCP impacts and seeking the optimal pathway

- Ministry of the Environment of Japan's S-12 Project
- FY2014–2018
- PI: Teruyuki Nakajima (JAXA)



Objectives of Theme 3 of the Japanese research project

PI: Toshihiko Takemura

Quantitative assessment of effects of SLCPs on climate, hydrological cycle, health, and agriculture with climate-air quality coupled models.

➡Contribution to scientific bases for suitable reductions of SLCPs/WMGHGs.

[Sub-themes 1 & 2]
Assessment of effects of SLCPs on climate with climate-aerosol-chemistry models (SPRINTARS/CHASER)

⬌

[Sub-themes 5 & 6]
Assessment of changes in hydrological cycles by SLCPs with climate models

➡

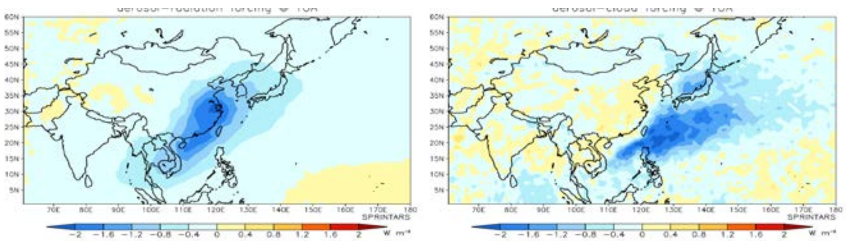
[Sub-themes 3 & 4]
Assessment of impacts on health and agriculture by SLCPs

S-12-3 Phase I

MIROC$_{ATM}$-SPRINTARS: T213/T106 L56, w/ & w/o nudging

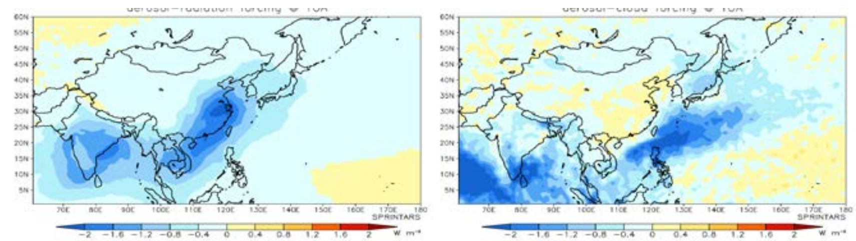
(2010STD – 1980CHN)/2010STD

aerosol-radiation aerosol-cloud



(2010STD – 1980ASIA)/2010STD

aerosol-radiation aerosol-cloud



S-12-3 Phase II

MIROC$_{ATM–OCN}$-SPRINTARS

Emission scenarios from 1950 to 2050 based on SSPs and new REAS

Acknowledgements

- Developers of both SPRINTARS and MIROC.
- Supercomputer system of the National Institute for Environmental Studies, Japan.
- Environ Research and Techn Developm Fund (S-12-3) of the Ministry of the Environ Japan.
- JSPS KAKENHI Grant Number 15H01728 and 15K12190.

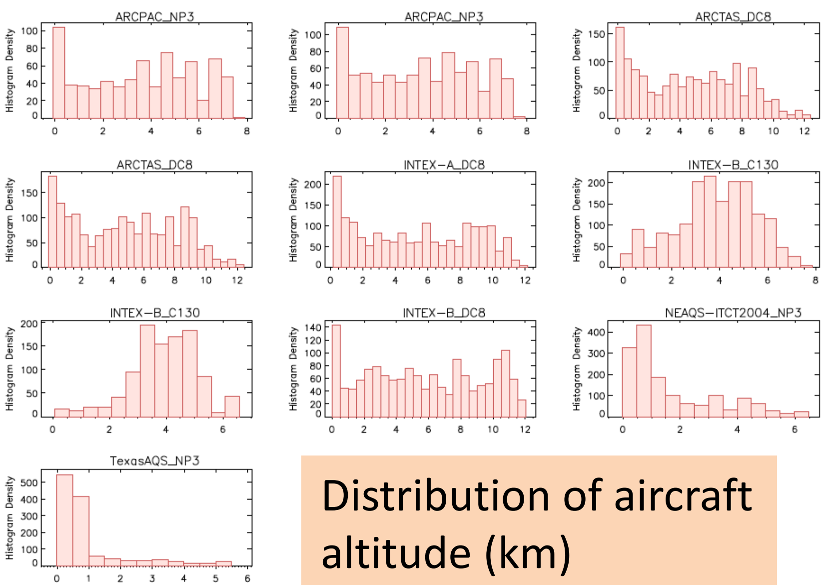
TAN

Evaluation of SO_2 vertical distributions

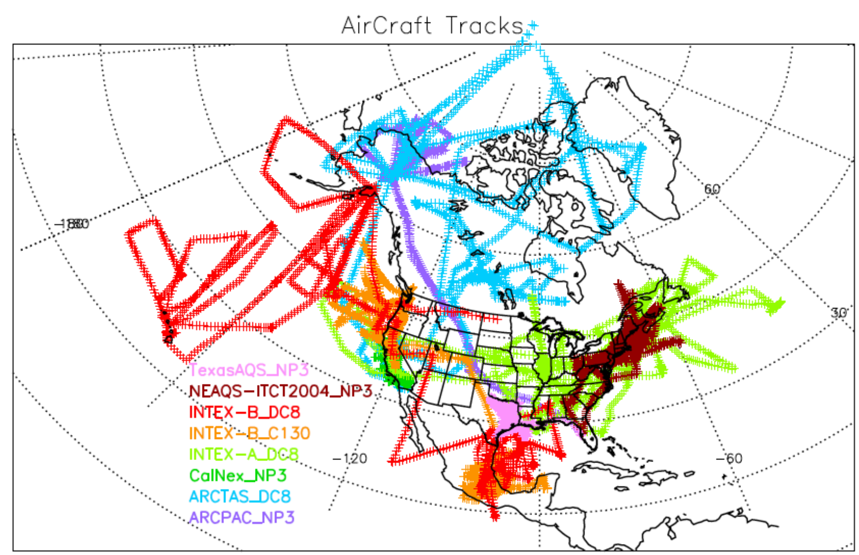
Q. Tan, M. Chin, H. Bian, V. Aquila, G. Chen, A. Benson

SO2, an important aerosol precursor shows significant variations temporally and spatially. 10 sets SO_2 measurement from 8 aircraft campaigns are compared to GOCART/GMAO-GEOS-5 simulations.

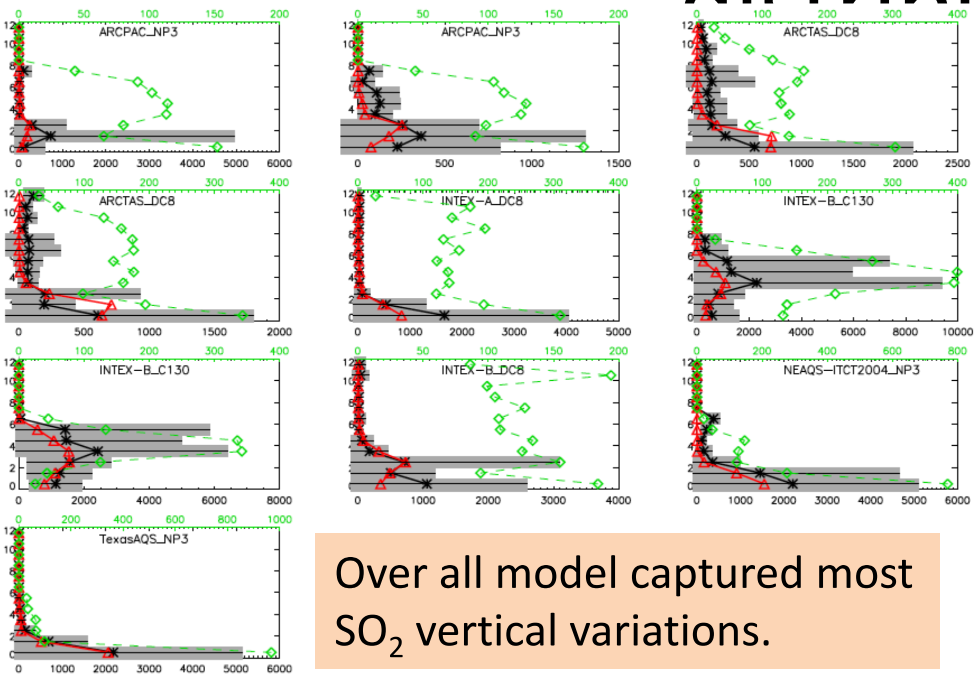
Campaign	AirCraft	Time	SO_2 Instrument	Season
ARCPAC	NP3	Mar-Apr, 2008	NOAA	Spring
ARCTAS	DC8	Mar-Apr Jun-Jul, 2008	CIMS (CIT/GATech)	Spring/Summer
CalNex	NP3	May-Jun, 2010	NOAA	Early Summer
INTEX-A	DC8	Jul-Aug, 2004	CIMS (GATech)	Summer
INTEX-B	C130	Mar-May, 2006	CIMS (CIT) /NOAA	Spring
INTEX-B	DC8	Mar-May, 2006	CIMS (GATech)	Spring
NEAQS-ITCT2004	NP3	Jul-Aug, 2004	NOAA	Summer
Texas AQS	NPS	Sep-Oct, 2006	NOAA	Autumn

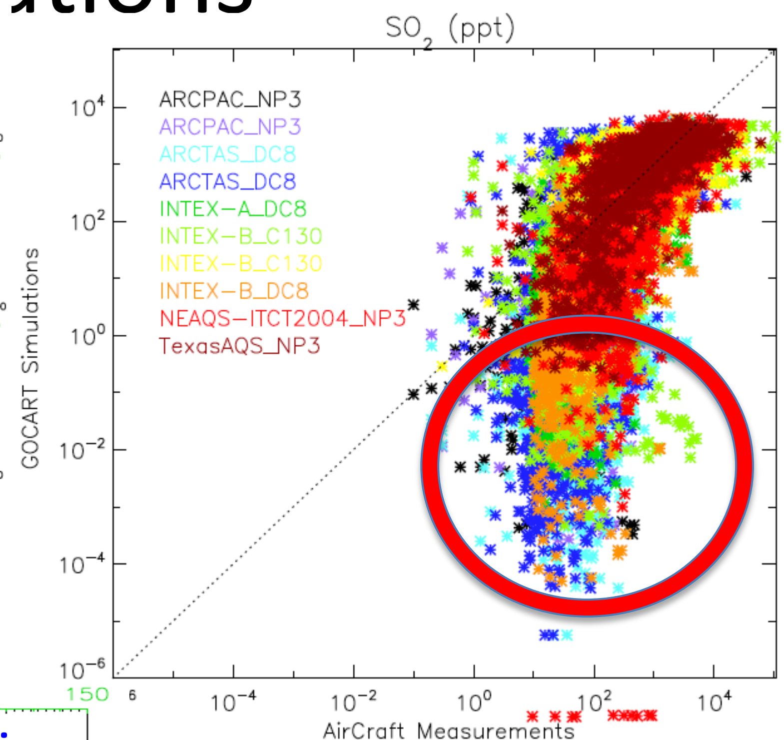


Distribution of aircraft altitude (km)

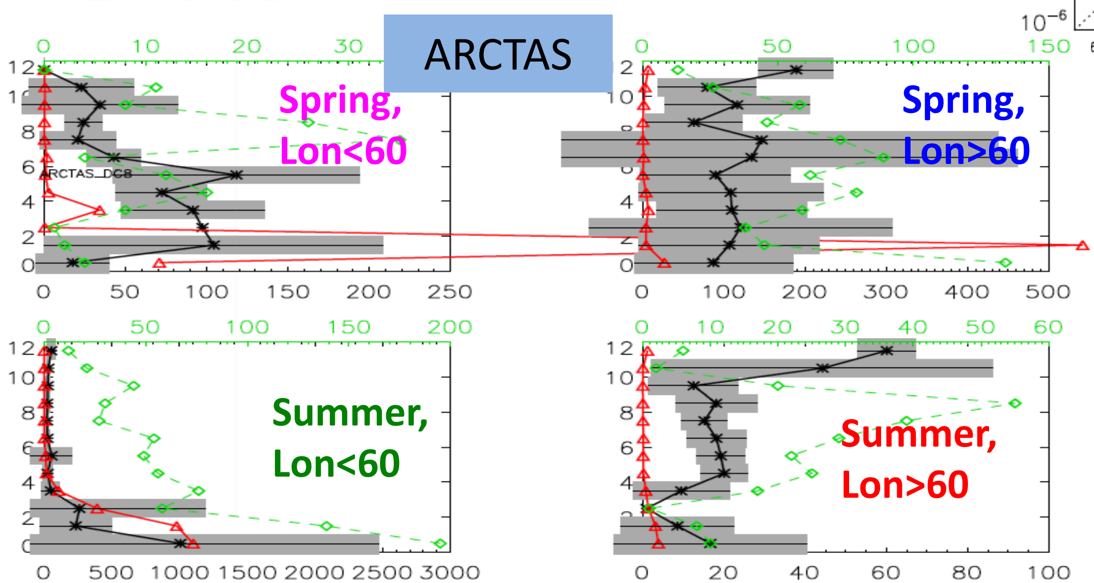


Evaluation of modeled SO_2 vertical distributions





Over all model captured most SO_2 vertical variations.



Low $[SO_2]$: instrument detection limit vs small numerical value in model.

Model underestimated SO_2 in high latitude in spring time.

TORRES

Improved OMI Record of 388 and 500 nm Single Scattering Albedo

Omar Torres, Hiren Jethva, Changwoo Ahn
NASA-GSFC, GESTAR/USRA, SSAI

Main Algorithm Upgrades:

-Introduce non-spherical particle desert dust aerosol model.

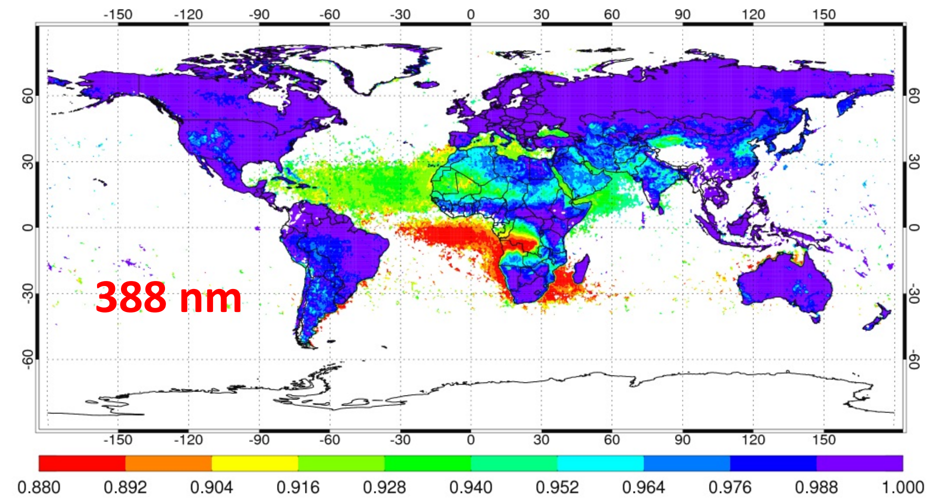
-Upgrade surface reflectance climatology

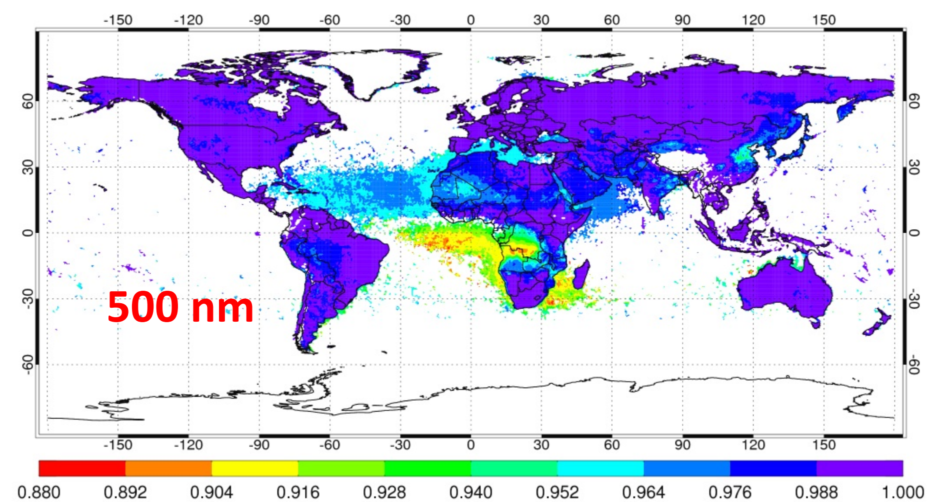
-Revisit UV-VIS spectral dependence of aerosol absorption:

Carbonaceous aerosols:
Kirchstetter et al [JGR, 2004]

Desert dust aerosols
Syniuk et al [JGR, 2003]
Dubobik et al [JAS, 2002]

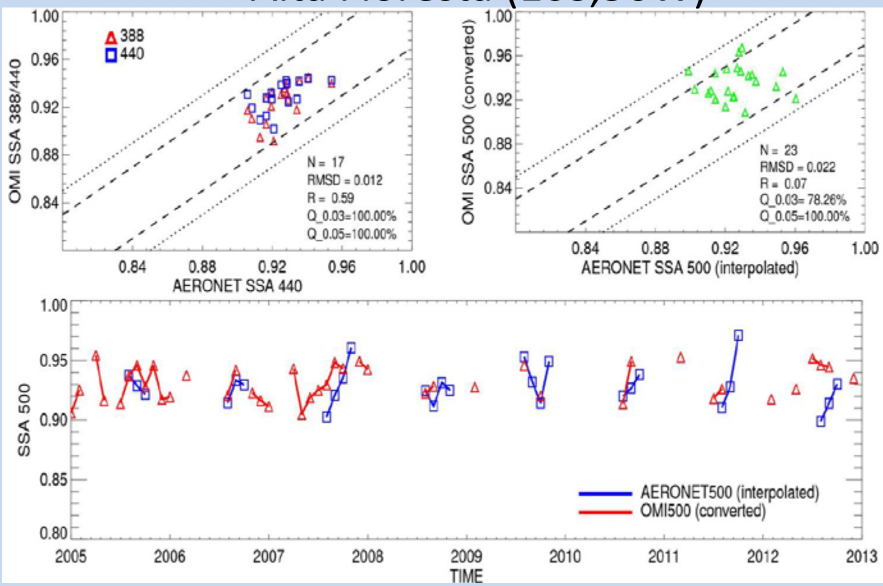
8-year SSA Summer Climatology



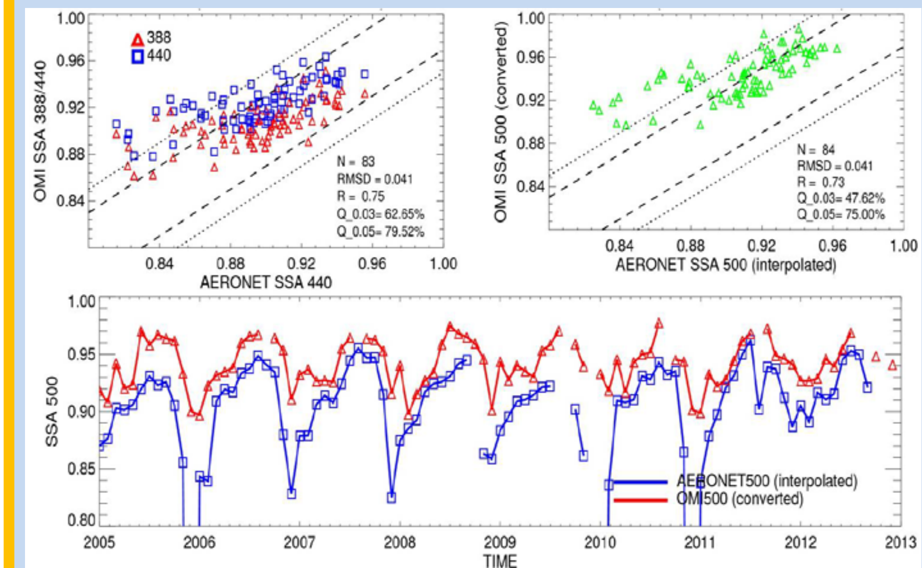


OMI-AERONET SSA COMPARISON

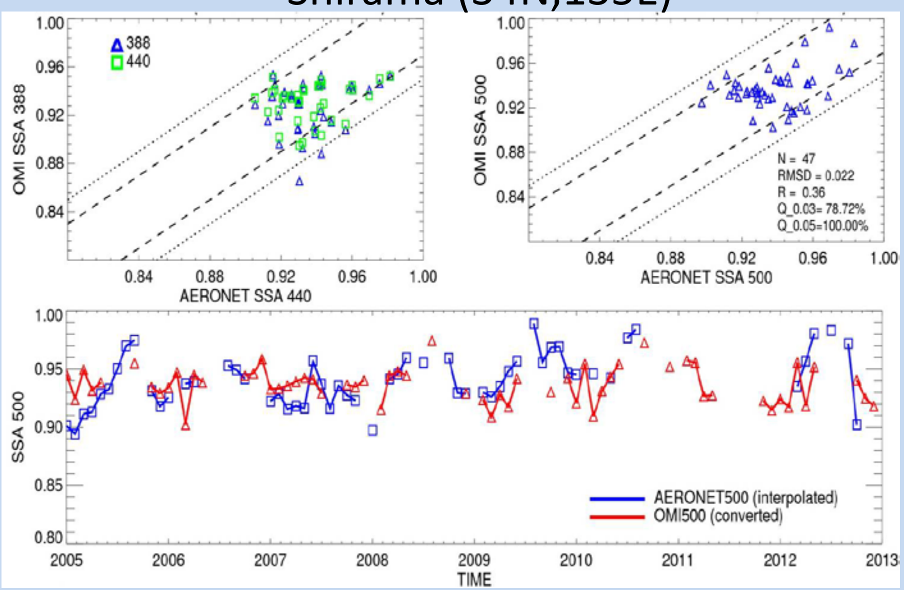
Alta Floresta (10S,56W)



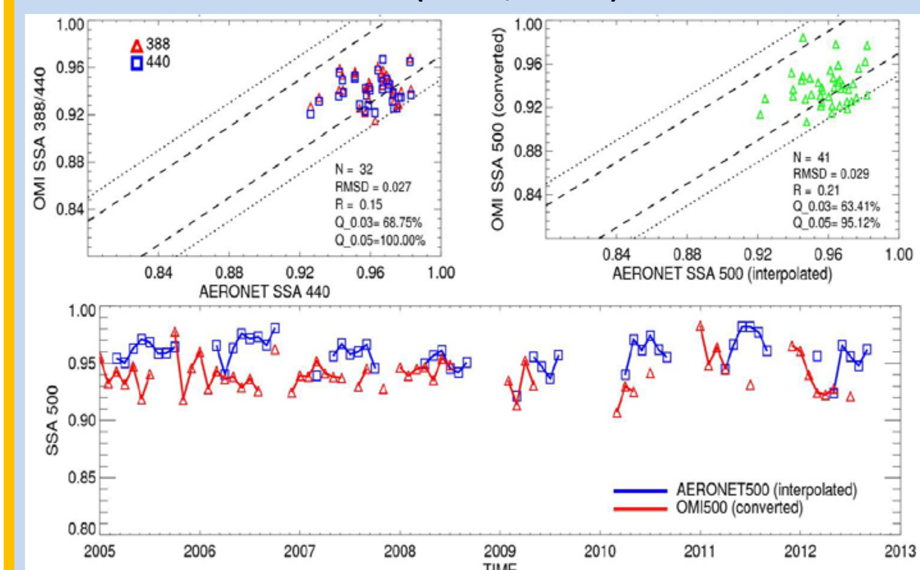
Dakar (14N,17W)



Shirama (34N,135E)



GSFC (39N,77W)



TSIGARIDIS

Columbia University
in the City of New York

Organic aerosol volatility parameterizations and their impact on atmospheric composition and climate

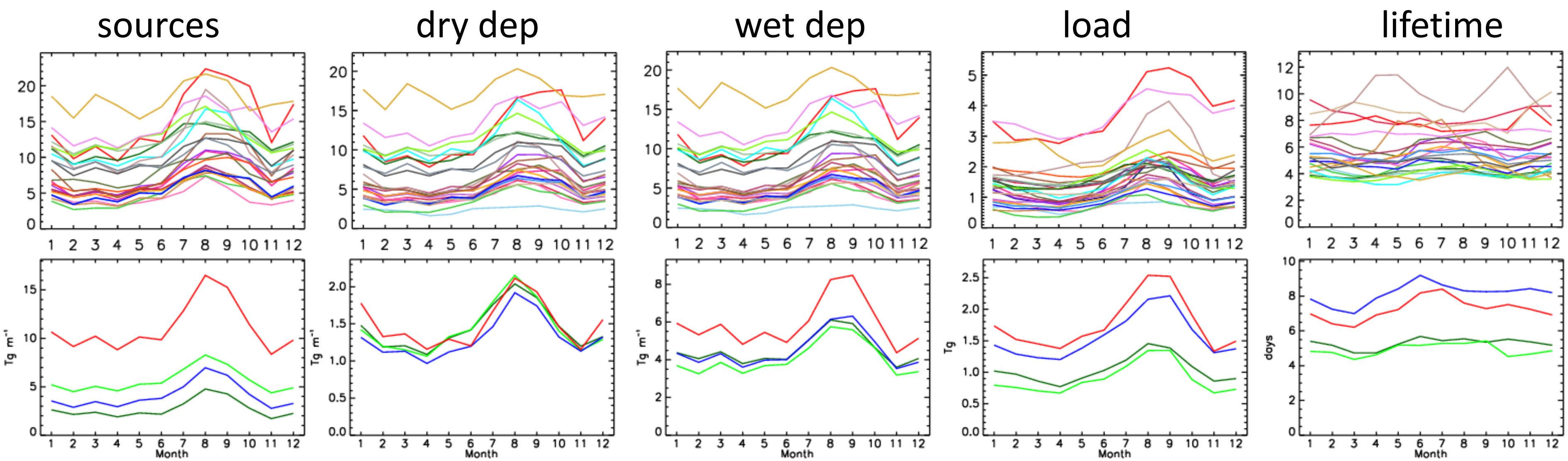
Kostas Tsigaridis
kostas.tsigaridis@columbia.edu

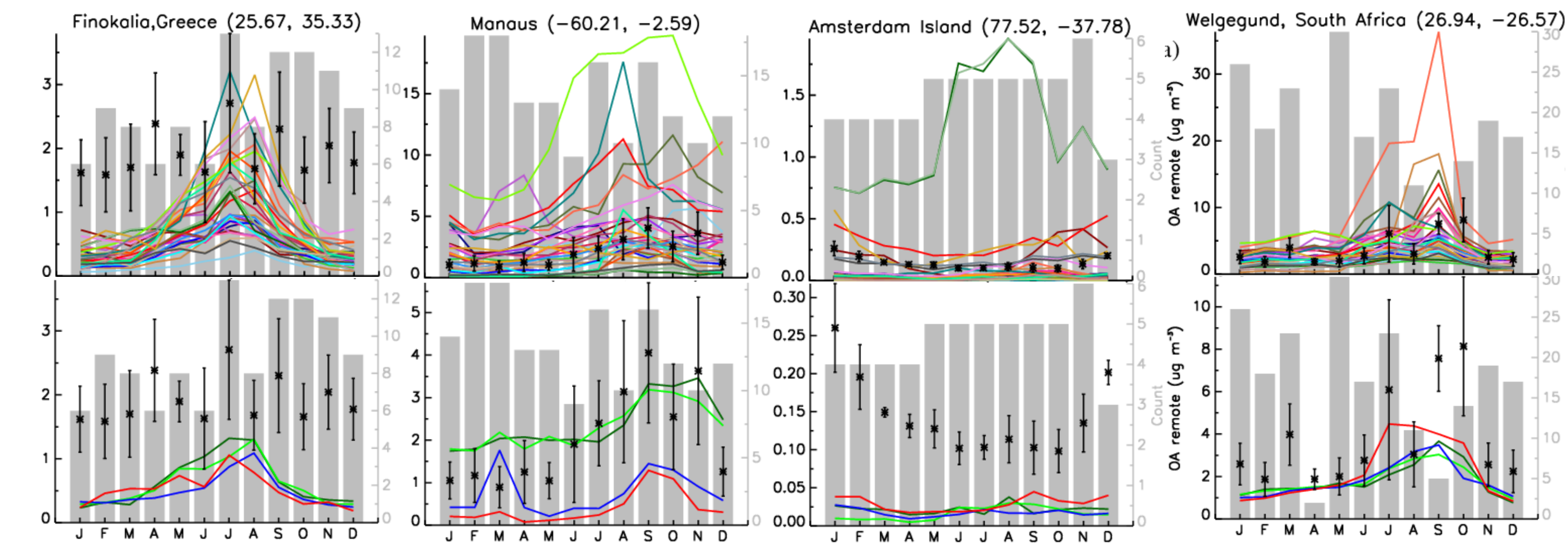
	Volatility		Emissions		Chemistry	
	Primary	Secondary	Primary	Secondary	Primary	Secondary
noSOA	Non-volatile	Non-volatile	BB+Anthro	0.15*(Terp)	Aging	Aged
SOA	Non-volatile	Semi-volatile	BB+Anthro	Terp+Isop	Aging	Oxidation
VBS	Semi-volatile	Semi-volatile	2.5*(BB+Anthro)	Terp+Isop	Oxidation	Oxidation

	Aerosol parameterization
OMA	One-moment aerosols (bulk)
MATRIX	Aerosol microphysics

Dentener et al., 2006

To take into account the intermediate volatility organic compounds (IVOCs); Shrivastava et al., 2008.

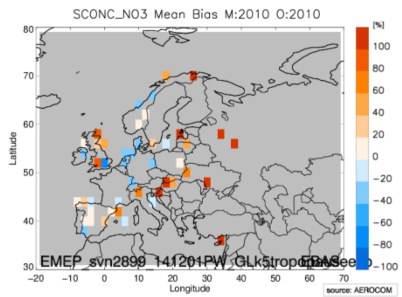

sources
dry dep
wet dep
load
lifetime
Tg m⁻¹
Tg
days
Month


Finokalia,Greece (25.67, 35.33)
Manaus (−60.21, −2.59)
Amsterdam Island (77.52, −37.78)
Welgegund, South Africa (26.94, −26.57)
OA remote (ug m⁻³)
Count
J F M A M J J A S O N D

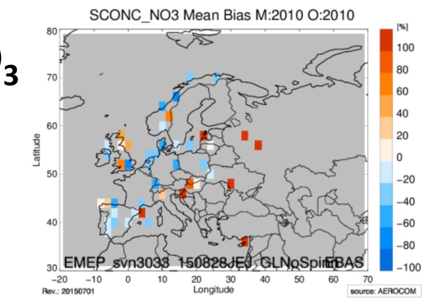
Example 1: Evaluation of NO3

NH_4NO_3 - thermodynamic equlibrium MARS

OLD: HNO_3 ->coarse NO_3 with const. reaction rates for Rh</Rh>90%

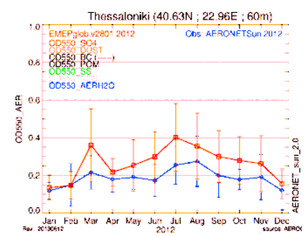


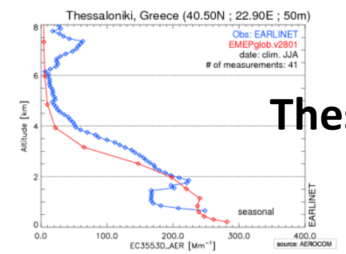
NEW: HNO_3 ->coarse NO_3 condens. on sea salt (γ=0.01) & dust (γ=0.02); aerosol surf. = f(Rh)



Example 2: Evaluation of mineral dust

Background dust: AOD vs. AERONET and extinction profiles vs. EARLINET climatology



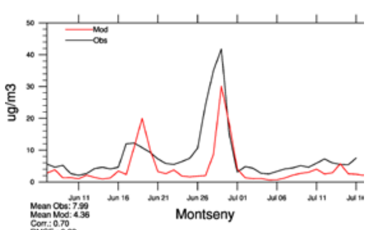


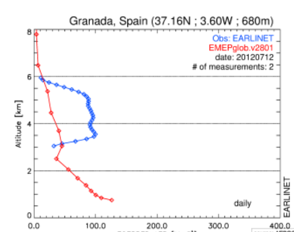
Thessaloniki

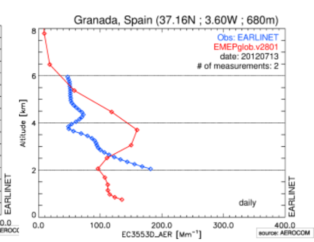
Dust episodes and sources:

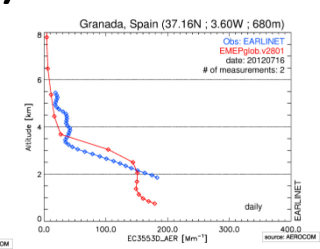
intensive measurement period June-July 2012 & Jan-Feb 2013

Surface concentrations (EMEP) and extinction profules (EARLINET)









Example 3: Effect of finer resolution

Some interim results for PM and AOD

Norwegian Meteorological Institute

TSYRO

Aerosols in the EMEP/MSC-W model

Experiments and evaluation using integrated observations

Svetlana Tsyro, Michael Schulz and Jan Griesfeller

MODEL

- Ref: Simpson et al., ACP (2012); Open source http://emep.int
- Regional (on 50 km – 7km -> 0.1x0.1°) / Global (1x1° ; 0.5x0.5°)
- Meteorology: 3h off-line from ECMWF-IFS / Chemistry: 130 species, 160 reactions
- Aerosols: SO_4, NO_3, NH_4, EC, OA (POA+BSOA+ASOA), sea salt, min.dust
  Bulk mass: fine and coarse size fractions
- AOD and extinction profiles at multiple wavel lenghts
- Research version with MAFOR aerosol dynamics (16 sections: 1nm - 10μm)

Observations

Air concentrations: EMEP monitoring and intensive periods, Airbase

AOD: AERONET, (satellite)

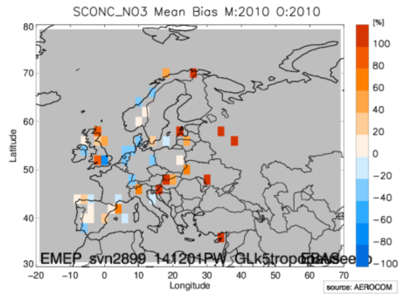
Extinction profiles: Earlinet, (CALIOP)

Norwegian Meteorological Institute

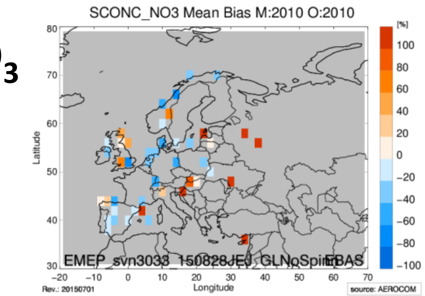
Example 1: Evaluation of NO3

NH_4NO_3 - thermodynamic equlibrium MARS

OLD: HNO_3 ->coarse NO_3 with const. reaction rates for Rh</Rh>90%

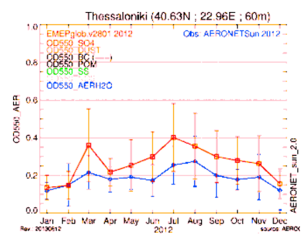


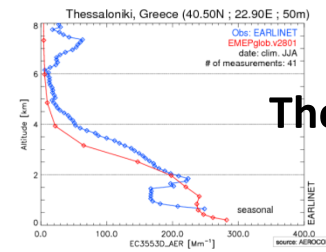
NEW: HNO_3 ->coarse NO_3 condens. on sea salt (γ=0.01) & dust (γ=0.02); aerosol surf. = f(Rh)



Example 2: Evaluation of mineral dust

<u>Background dust</u>: AOD vs. AERONET and extinction profiles vs. EARLINET climatology



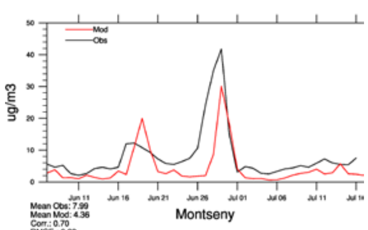


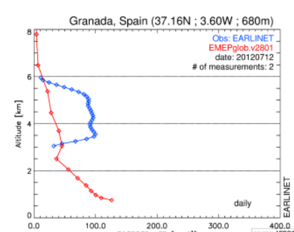
Thessaloniki

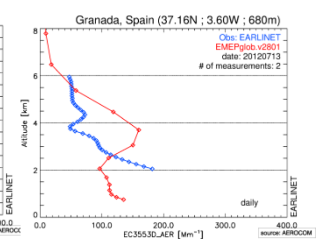
<u>Dust episodes and sources:</u>

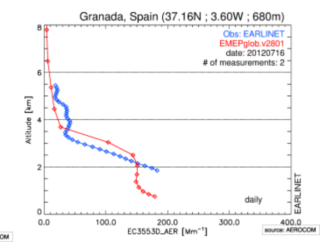
intensive measurement period June-July 2012 & Jan-Feb 2013

Surface concentrations (EMEP) and extinction profules (EARLINET)









Example 3: Effect of finer resolution

Some interim results for PM and AOD

Norwegian Meteorological Institute

TWOHEY

MPI-M and (IPCC 6) RF-MIP

Max-Planck for Met and IPCC Radiative forcing exercises

- the single plume concept SP
  - prescribe aerosol optical properties as function of local sources in x,y (horiz), z (vertical) and t (time)
- tropospheric anthropogenic
  - fit ant AOD with ca 10 sources (associate SSA, ASY, Ang)
  - translate ant AOD-fields in drop size reductions for low clouds
    - Stephanie.Fiedler@mpimet.mpg.de (at this meeting, Wed talk)
- stratospheric volcanic
  - fit AOD / reff distr. as function of eruption strength/location
    - Matt.Twohey@mpimet.mpg.de (this summary, no poster)

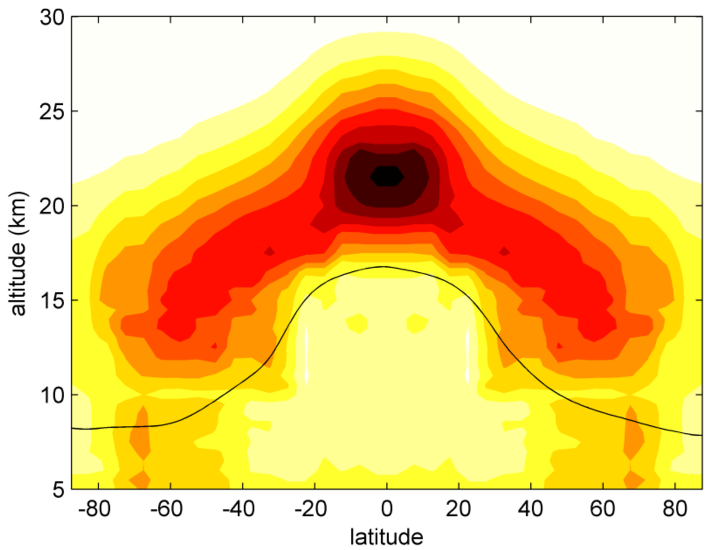
stratospheric volcanic aerosol

- approach: describe by 3 zonal mean "plumes"

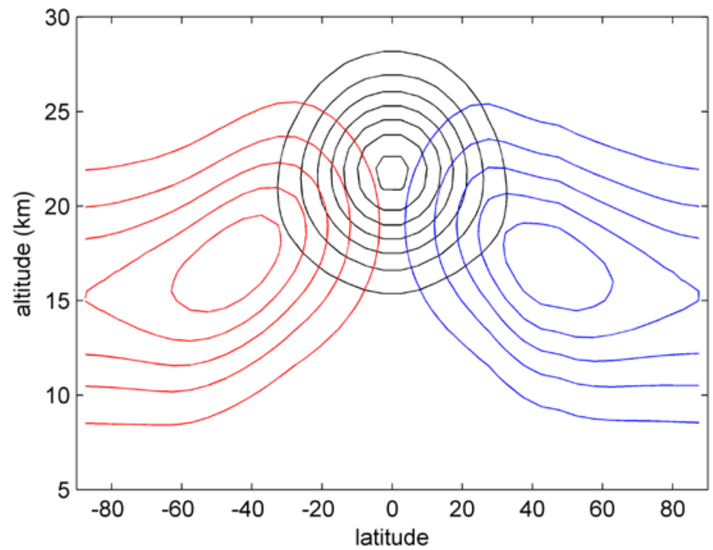
$$EXT(t,\varphi,z) = \sum_{i=1}^{3} M_i(t) * \widehat{H}_i(\varphi[x,y]) * \widehat{V}_i(z)$$

tempoal | horizontal | vertical

Satellite observations, Pinatubo, 4-year mean

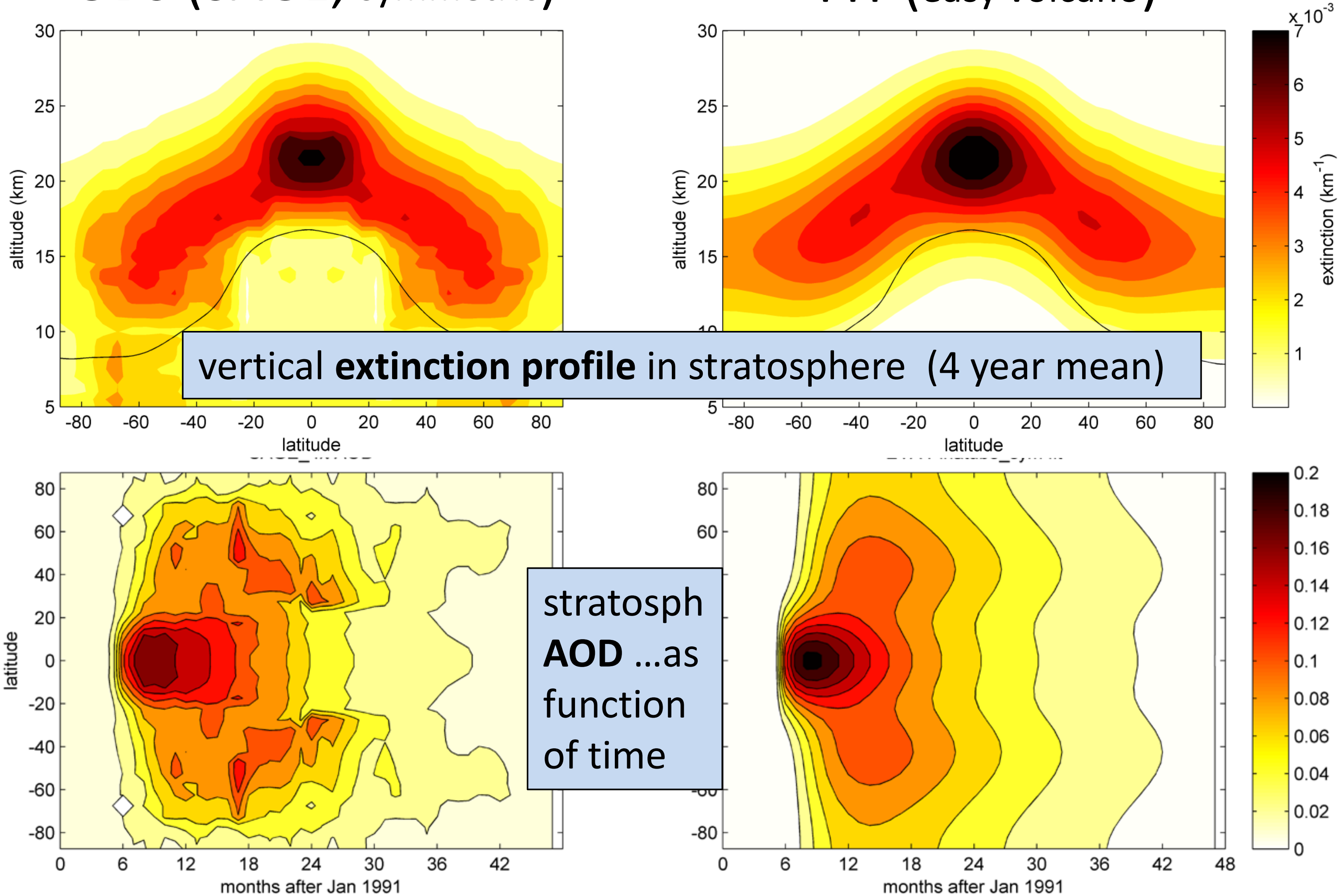


Gaussian shape functions



Mt. Pinatubo **example**

OBS (SAGE, symmetric) FIT (easy volcano)



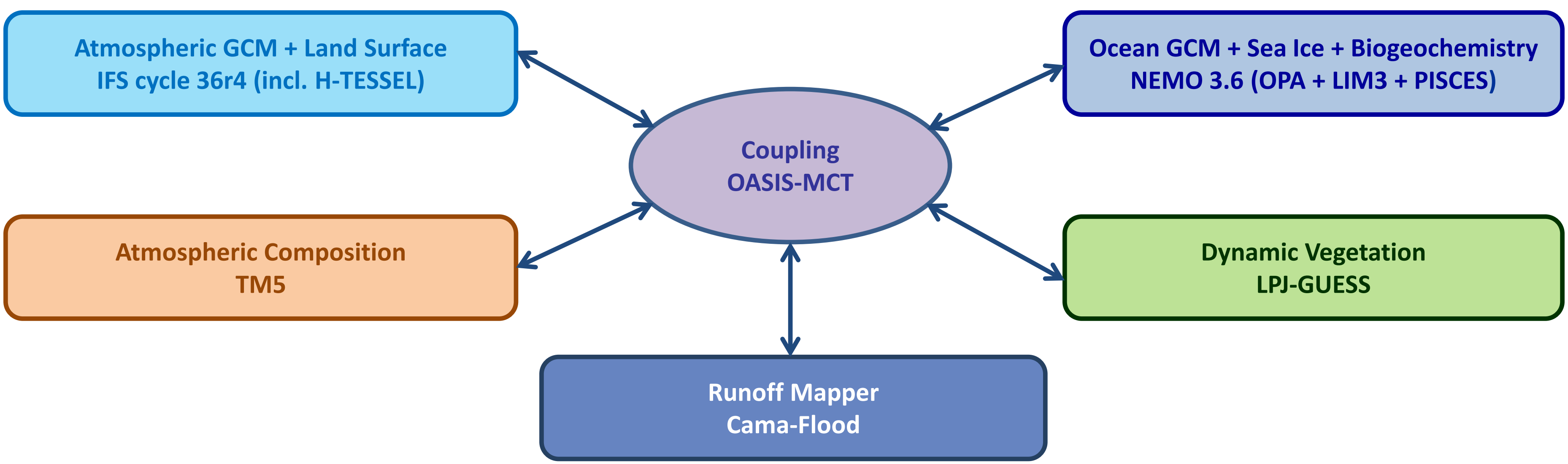
vertical **extinction profile** in stratosphere (4 year mean)

stratosph **AOD** …as function of time

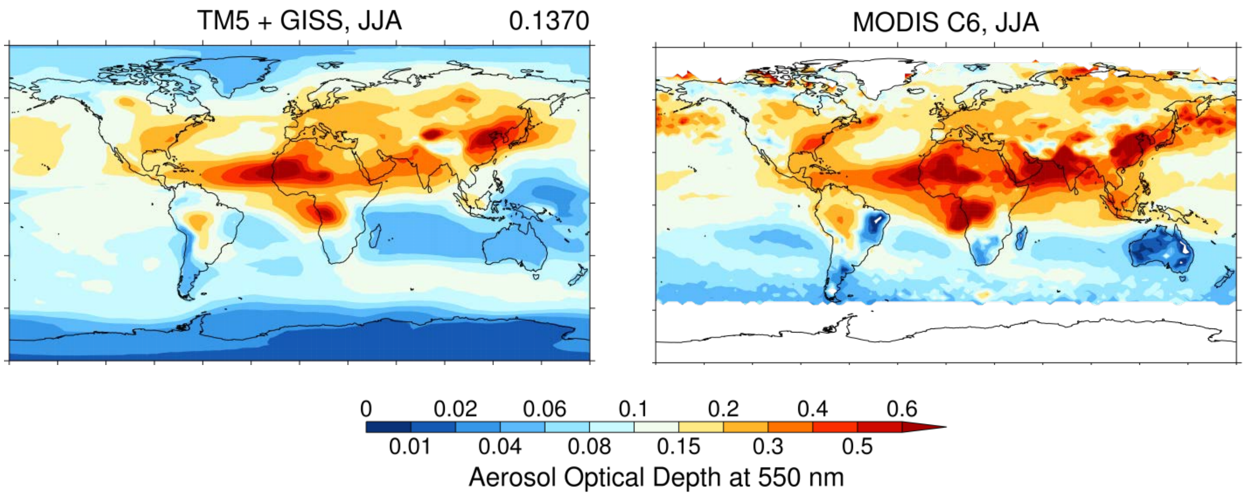
Van NOIJE

Aerosol Modelling with EC-Earth

Twan van Noije, Philippe Le Sager, and EC-Earth Partners

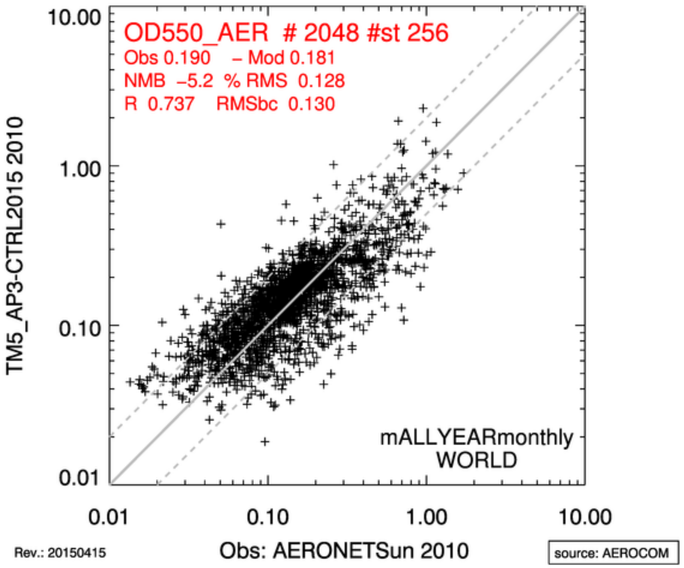


TM5 vs. MODIS Collection 6 (2006)



Royal Netherlands Meteorological Institute

TM5 vs. AERONET (2010)



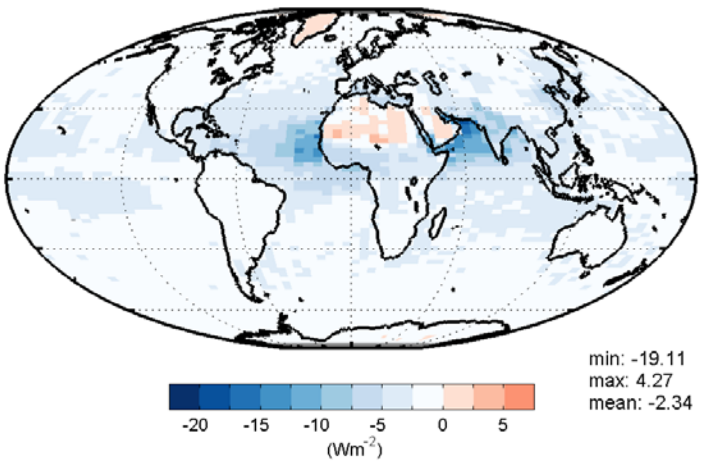
Winker

How well can we estimate the aerosol direct radiative effect?

#61

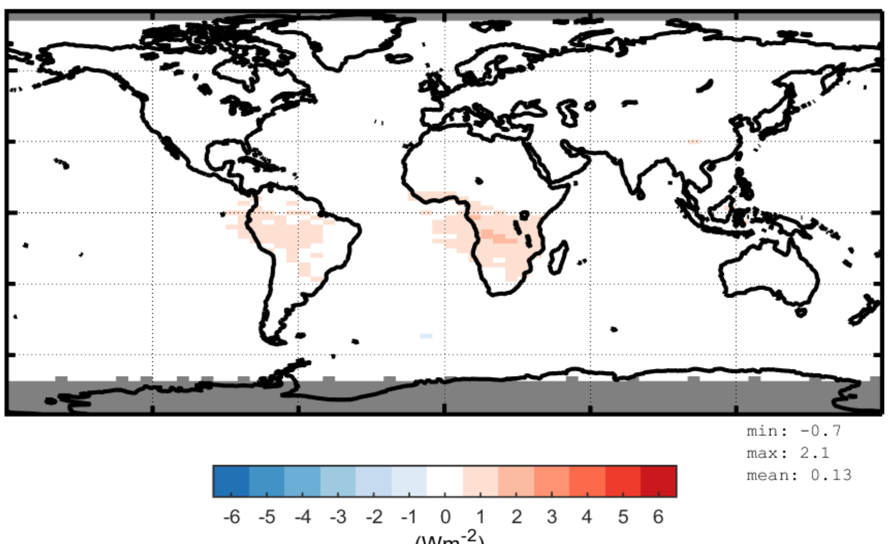
Dave Winker, Seiji Kato, Fred Rose
NASA Langley Res. Ctr.

All-Sky Aerosol SW DRE



	Ocean Clear-Sky	Global Clear-Sky	Global Cloudy-Sky	All-Sky
C3M	**-3.94**	**-3.30**	**-1.93**	**-2.34**
Oikawa et al. (2013)	-4.24	-3.79		
Matus & L'Ecuyer (2015)	-2.6	-2.6		-1.9
Loeb & Smith (2005)	-5.46 -3.8	MODIS NOAA		
Yu et al. (2006)	-5.5			

Impact on TOA DRE of adjusting smoke SSA to SAFARI



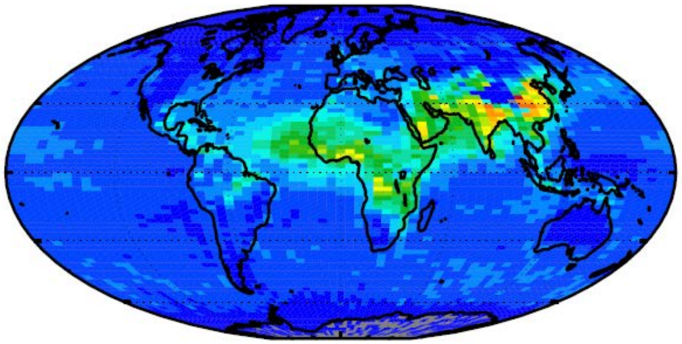
Merged CALIOP and A-train data used to:

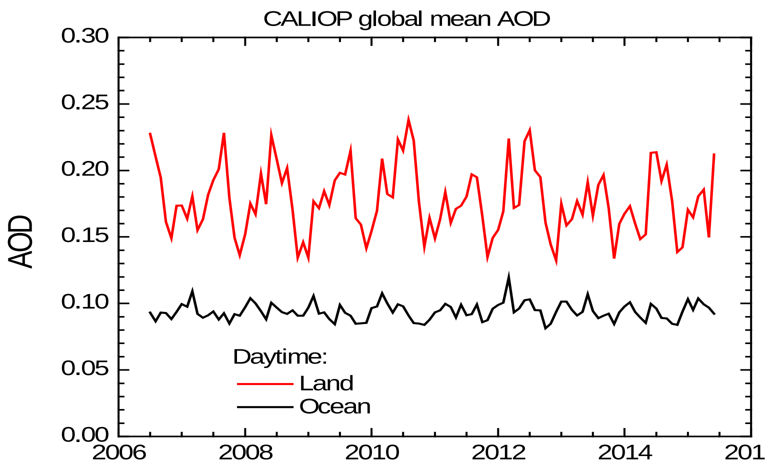
- **estimate clear-sky/all-sky aerosol DRE from observations**
- **estimate impacts of uncertainties in aerosol absorption and OD**

New CALIPSO Level 3 aerosol product to be released October 14

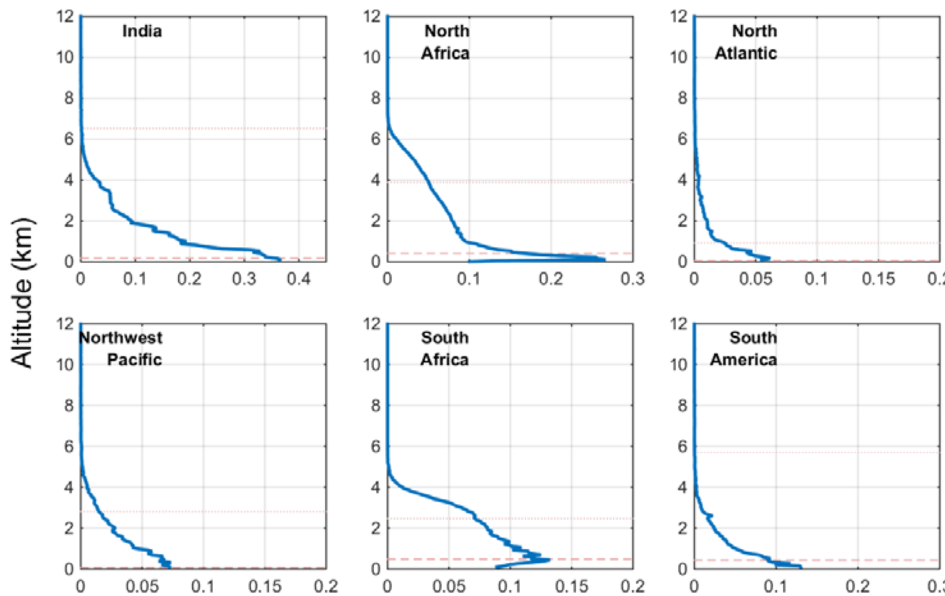
- Replaces β-version, many improvements
- Now report clear-sky, above-cloud, and all-sky extinction
- Now includes extinction profiles for
  - Total aerosol
  - Smoke, Dust, Polluted Dust

Cloud-free, Daytime





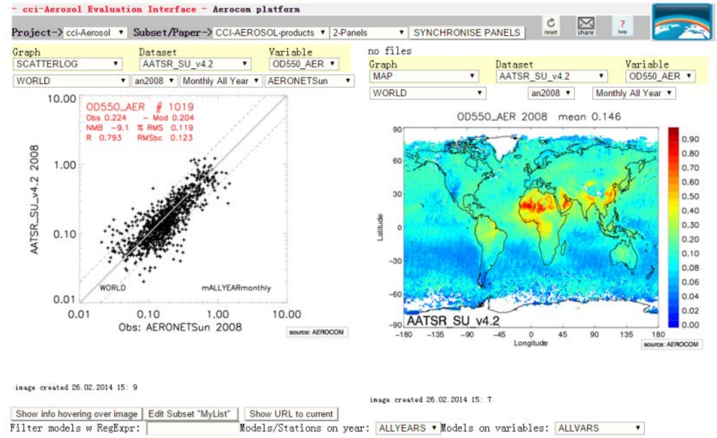
Regional monthly all-sky profiles



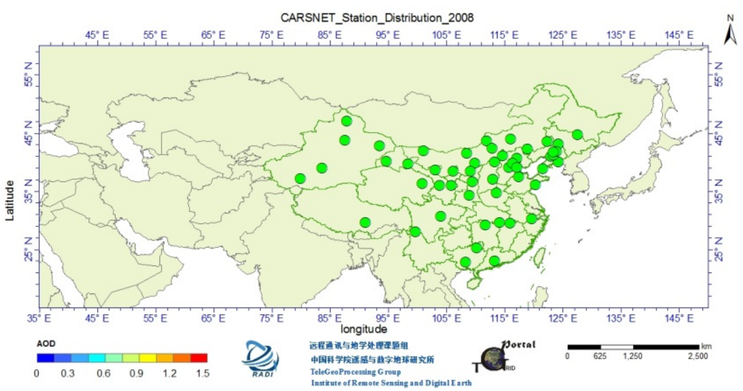
XUE

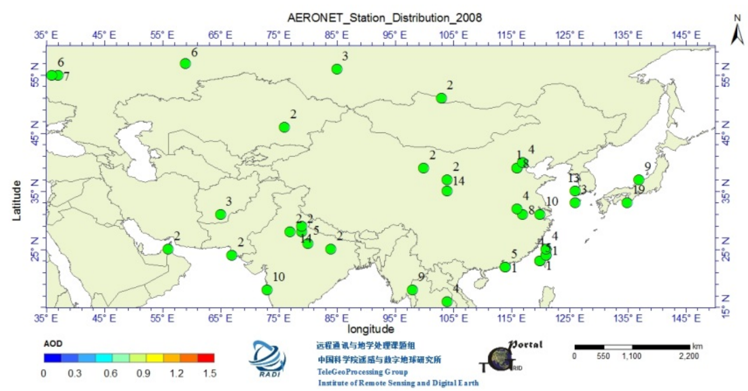
AOD Datasets

- http://www.icare.univ-lille1.fr/drupal/archive/?dir=CCI-Aerosols
  - AATSR ADV.V1.42
  - AATSR ORAC.V2.02
  - AATSR SU.V4.2



2008





Ground measurements – AERONET and CARSNET

- Yong Xue, et al.
- Email: y.xue@londonmet.ac.uk

Comparisons of three AATSR AOD products for mainland China in 2008

		N	MSA	MAA	MBE	MAE	RMSE	RMB	CC
AATSR SU	AERONET	200	0.343	0.347	0.004	0.089	0.12	0.990	0.855
	CARSNET	129	0.254	0.345	0.091	0.102	0.117	0.737	0.880
	AERO&CARS	329	0.308	0.346	0.038	0.094	0.124	0.891	0.849
AATSR ADV	AERONET	201	0.250	0.312	0.062	0.090	0.1	0.803	0.878
	CARSNET	115	0.191	0.343	0.152	0.158	0.13	0.556	0.784
	AERO&CARS	316	0.229	0.323	0.095	0.115	0.121	0.707	0.824
AATSR ORAC	AERONET	323	0.378	0.338	-0.041	0.146	0.25	1.120	0.568
	CARSNET	350	0.337	0.363	0.026	0.201	0.334	1.076	0.647
	AERO&CARS	673	0.357	0.351	-0.007	0.175	0.247	1.018	0.603

ZHANG

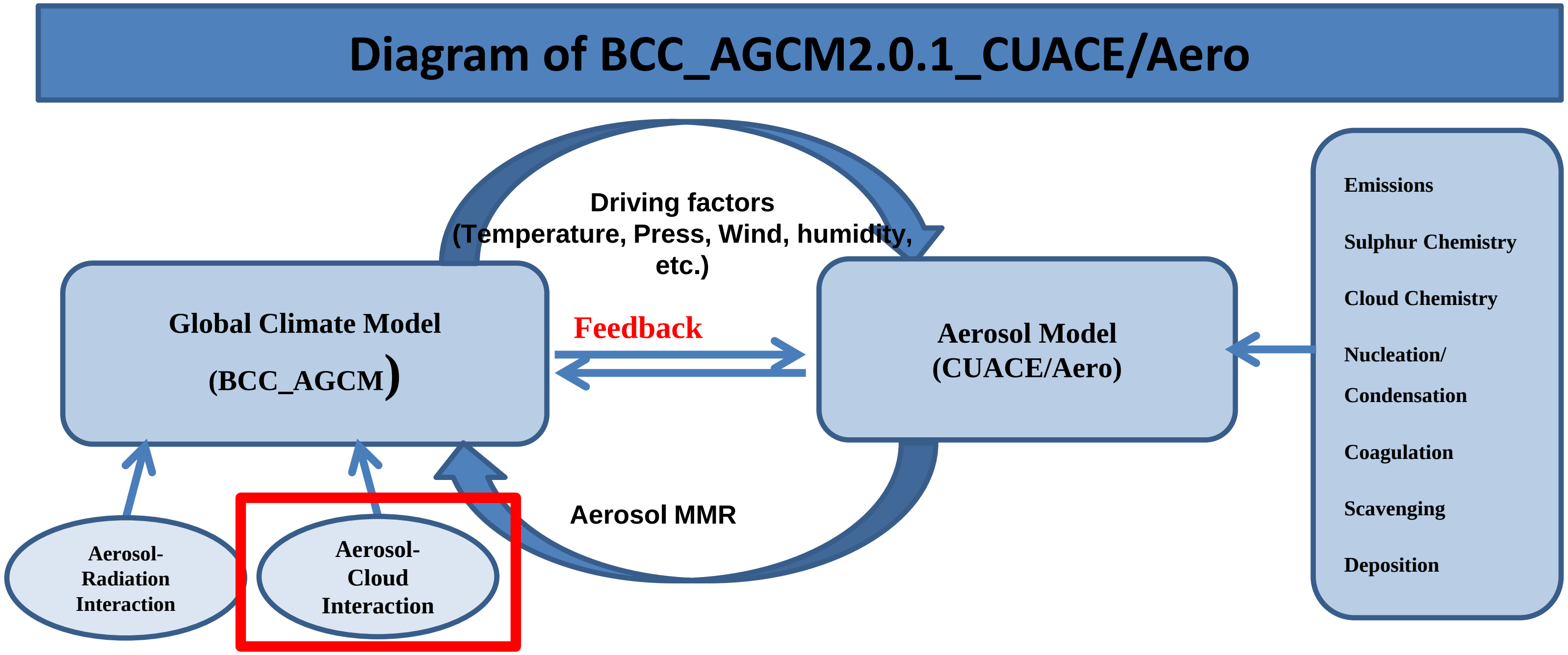
The updated effective radiative forcing of major anthropogenic aerosols and their effects on global climate at present and in the future

Hua Zhang[1], Shuyun Zhao[1], Zhili Wang[2] , Xiaoye Zhang[2], and Lianchun Song[1]

1.Laboratory for Climate Studies, National Climate Center, China Meteorological Administration, Beijing, China;
2. Chinese Academy of Meteorological Sciences, Beijing, China

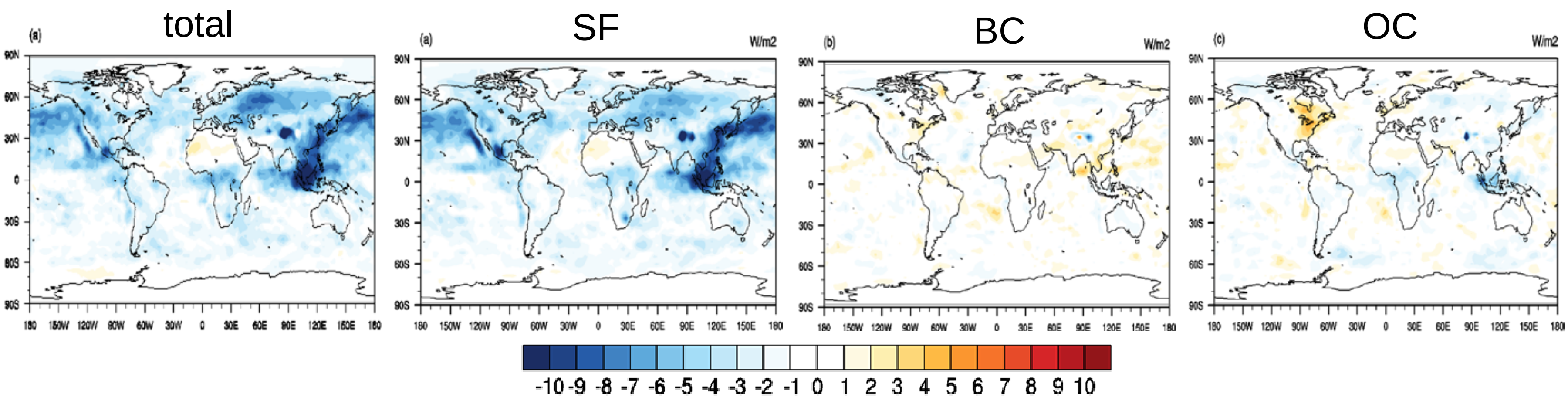
Why and how we do this work?

1. Effective radiative forcing (ERF) was newly defined by IPCC AR5, because fast adjustments in the troposphere and on land should be distinguished with climate responses and added onto forcing in the application of predicting long-term climate, especially for short-lived factors, e.g. aerosols.
2. Though the climatic effects of aerosols were studied in many specific regions, it is still valuable to study this problem from a global perspective.

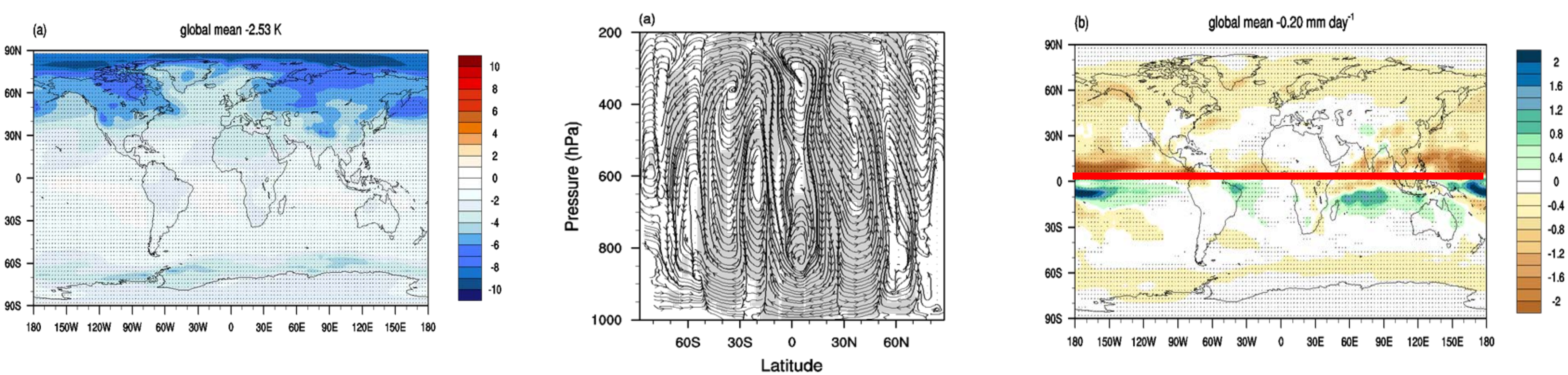


A two-moment cloud microphysical scheme developed by Morrison and Gettelman (2008) has been incorporated into BCC_AGCM2.0.1_CUACE/Aero instead of the one-moment bulk cloud microphysical scheme used in the original model by Wang et al. (2014).

The effective radiative forcing of major anthropogenic aerosols (SF, BC, and OC)



For anthropogenic aerosol the **total ERF is -2.49 W m^{-2}**, with **ERFari -0.30 W m^{-2}** and **ERFaci -2.19 W m^{-2}**. ,(S U ERF is -2.37 W m^{-2}, BC Erf is 0.12 W m^{-2}, and OC ERF -0.31 W m^{-2}.)



The upper four figures show the 1850-2010 ERF of total anthropogenic aerosols, SF, BC, and OC. The lower three figures briefly show how anthropogenic aerosols influence tropical precipitation through affecting mid and high latitude temperature and meridional cell.

Please see my poster for detail information.