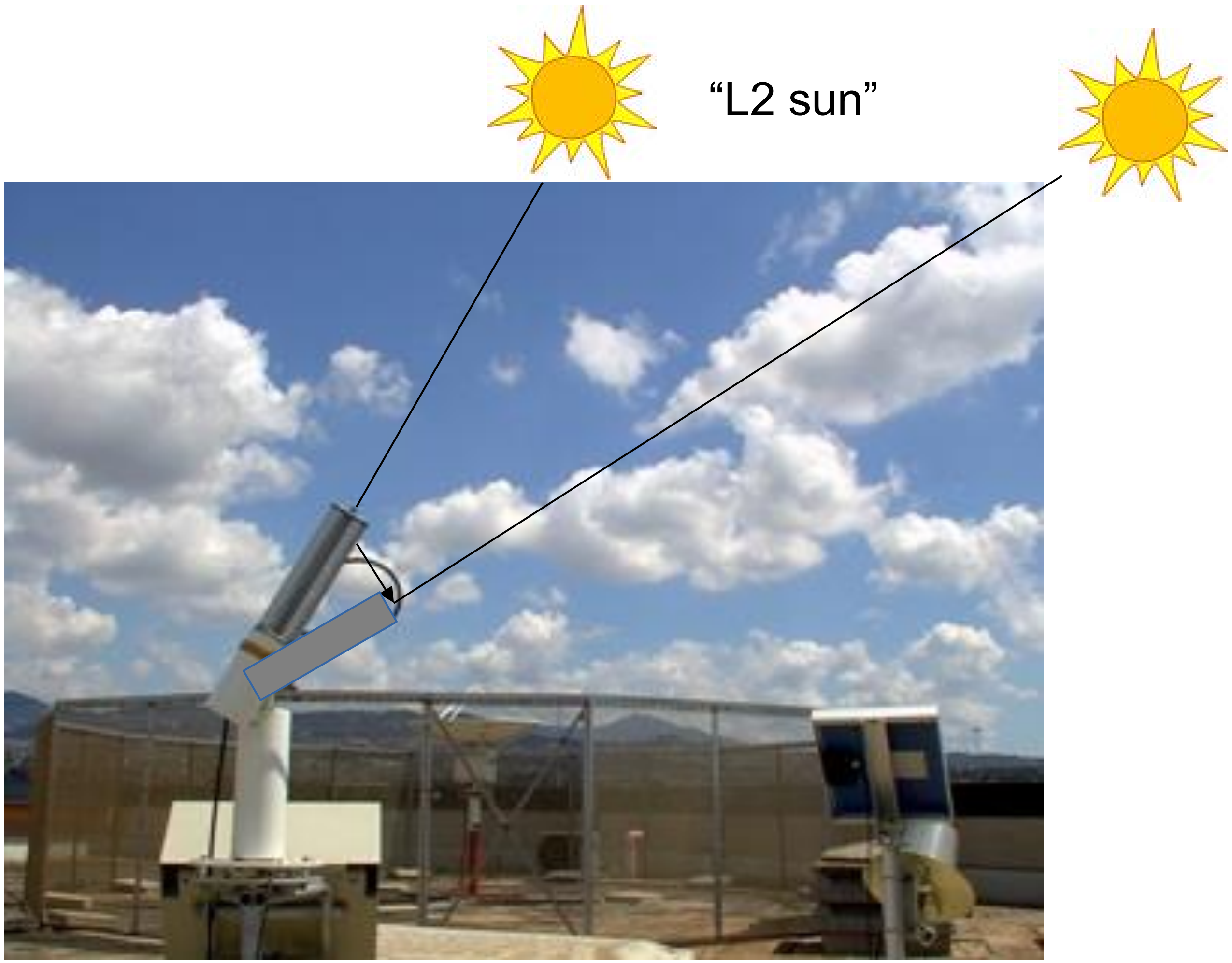
FINNISH METEOROLOGICAL INSTITUTE

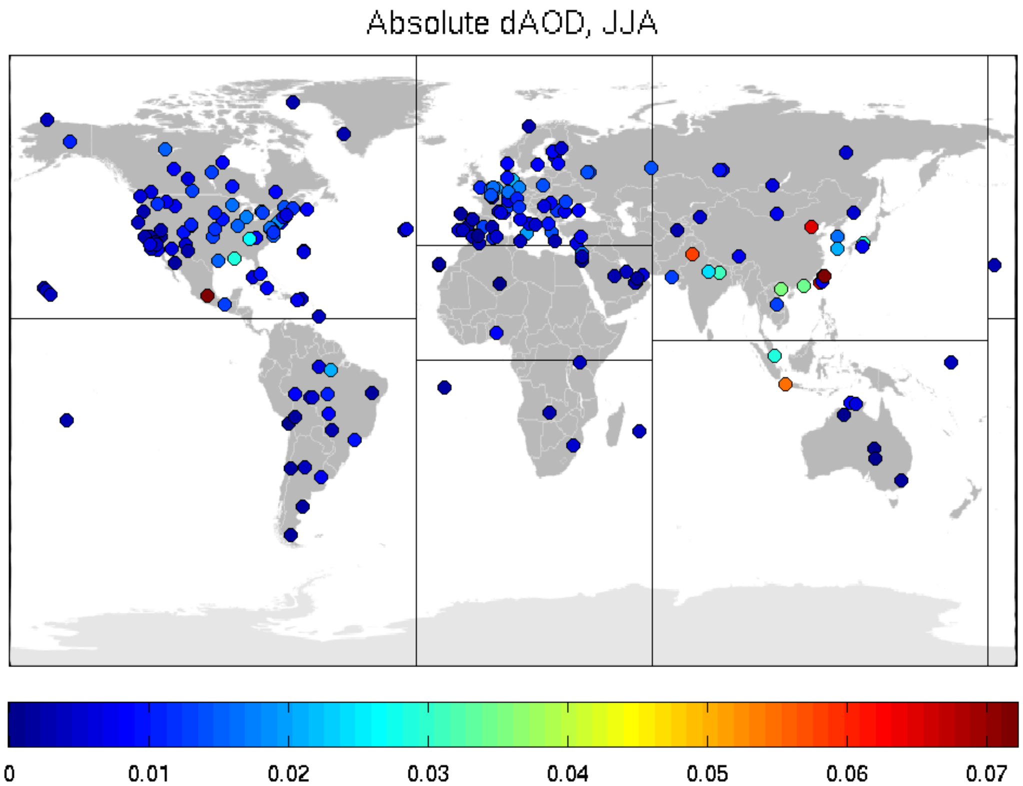
Assessment of cloud related fine mode AOD enhancements based on the AERONET SDA product

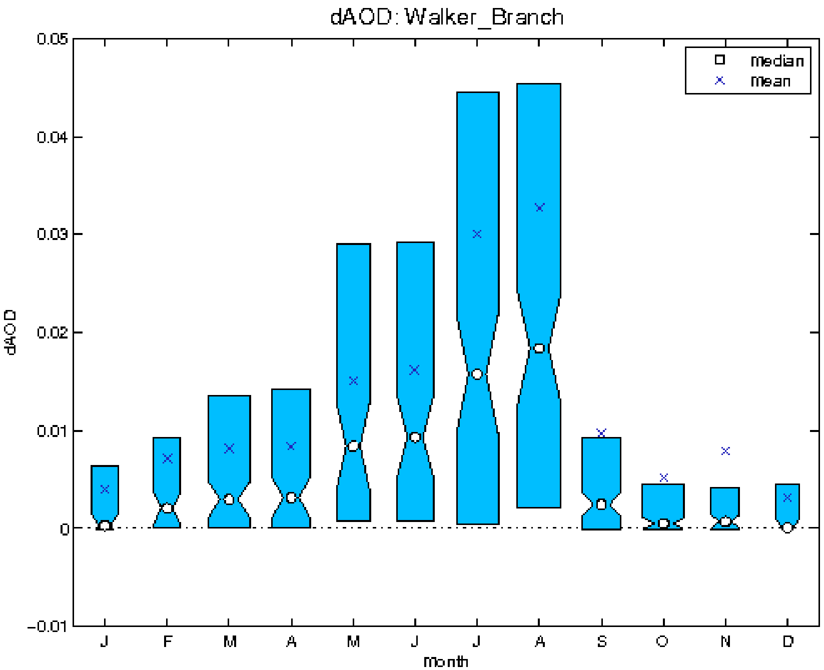
A. Arola, T F. Eck, H. Kokkola, T. Laaksoviita, A. V. Lindfors, M. Pitkänen and S. Romakkaniemi

"SDA effectively computes the fine mode AOD in mixed cloud-smoke observations". Should one then rather use L1 SDA than L2 to estimate the mean fine mode AOD?



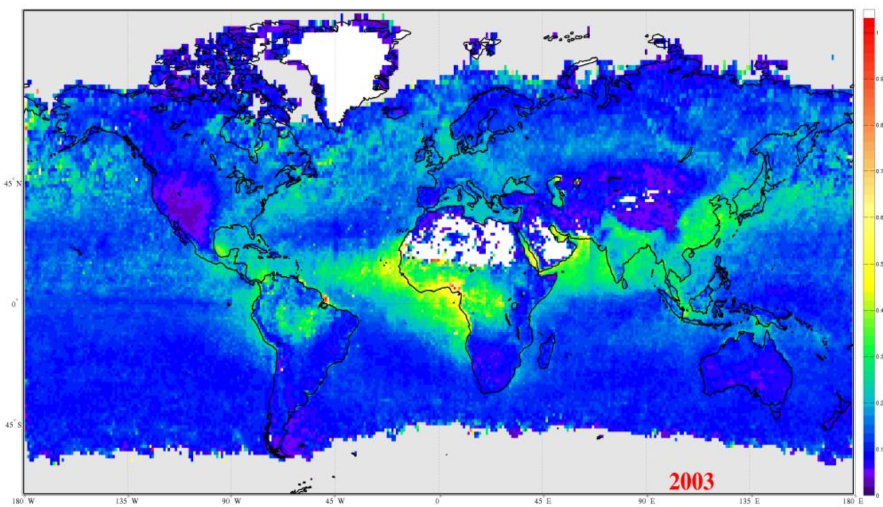
Difference in fine mode AOD between L1 and L2 AERONET data, sampled for the days when both L1 and L2 data were available.





G. De Leeuw, FMI

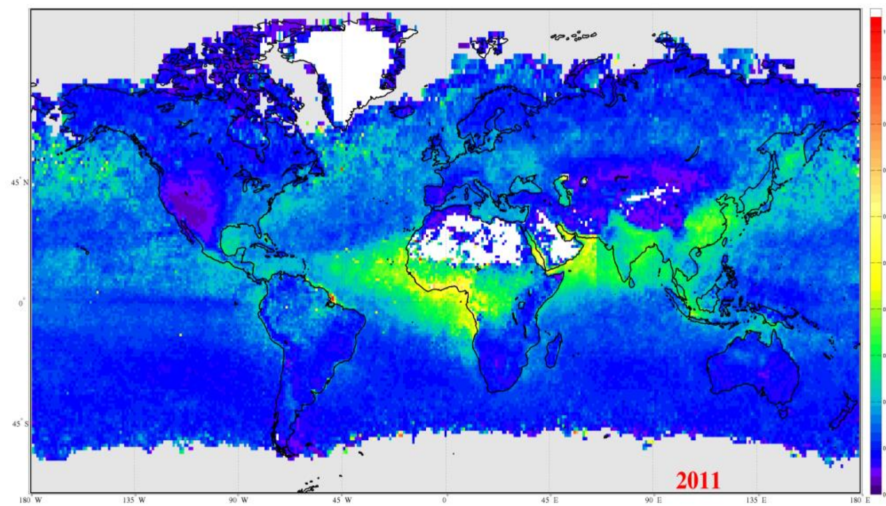
AATSR: 2003-2011



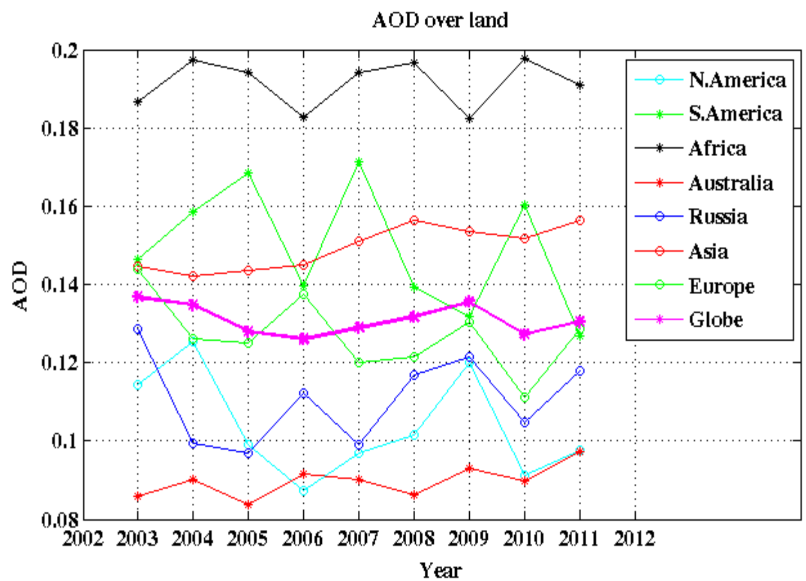
2004

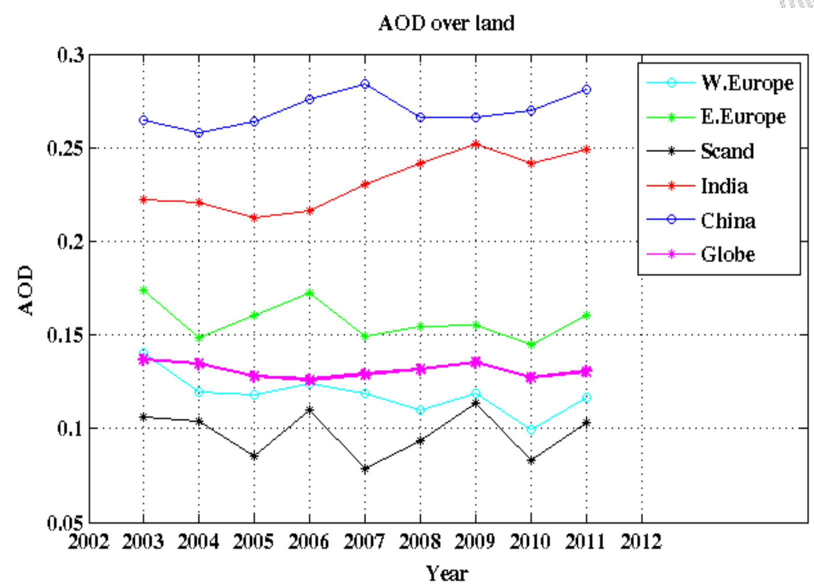
. . .

2010



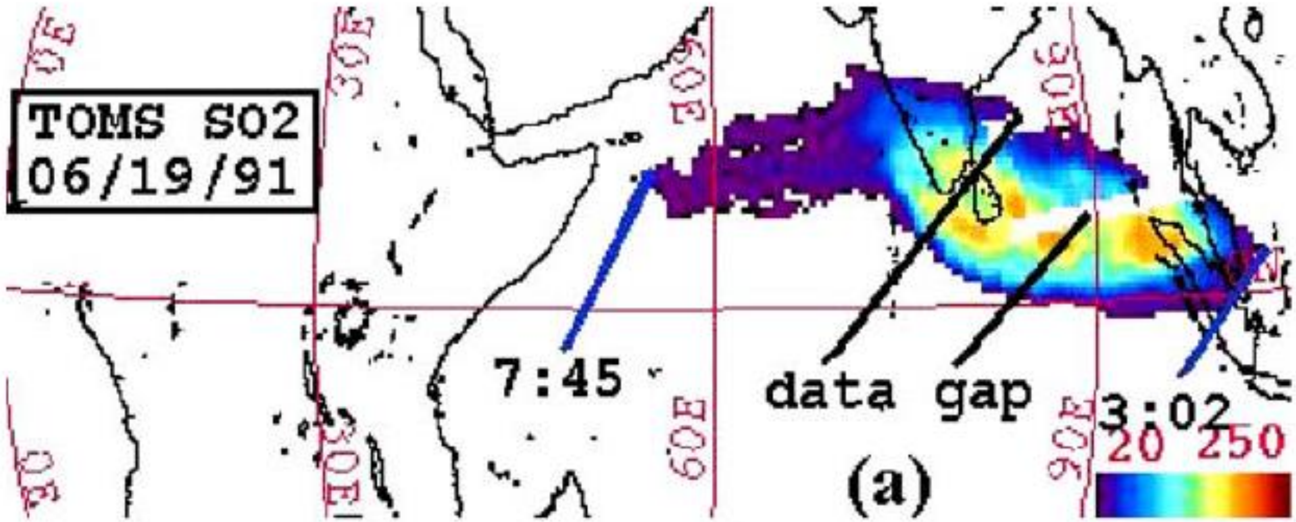
Continents < Time series > Regions





Aerosol microphysics simulations of the Mt. Pinatubo eruption with the UKCA composition-climate model

Sandip Dhomse, Graham Mann, Ken Carslaw, et al. (Univ. Leeds, U.K.)



Guo et al. (GGG, 2004.)

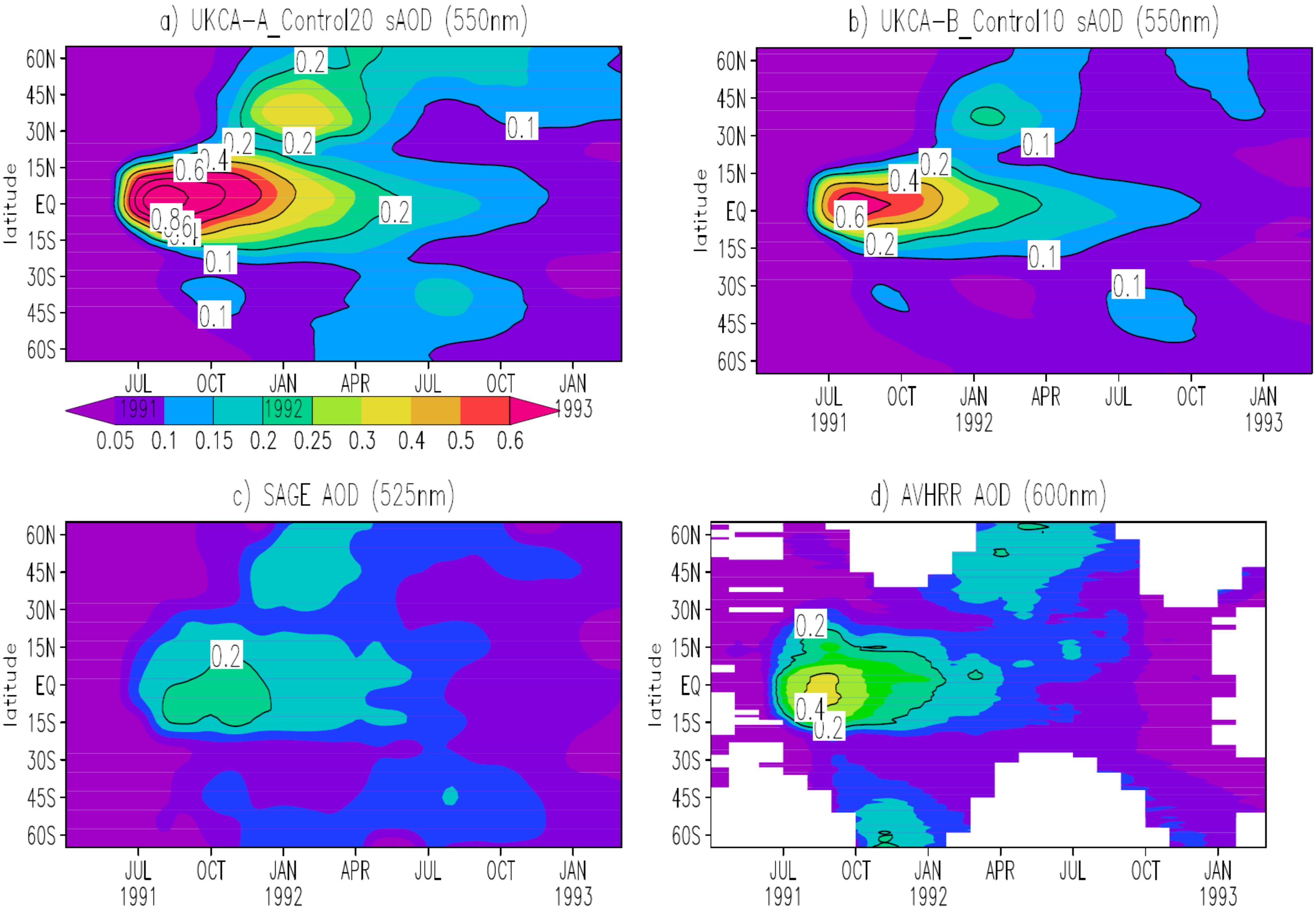
Satellite measurements indicate 14 to 23 Tg of SO_2 (7 to 11.5 TgS) was present in the tropical stratosphere shortly after the eruption.

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) this gives a range of 3.7-6.7 Tg of sulphur.

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. Dhomse et al. (ACP, 2014)

stratospheric aerosol optical properties

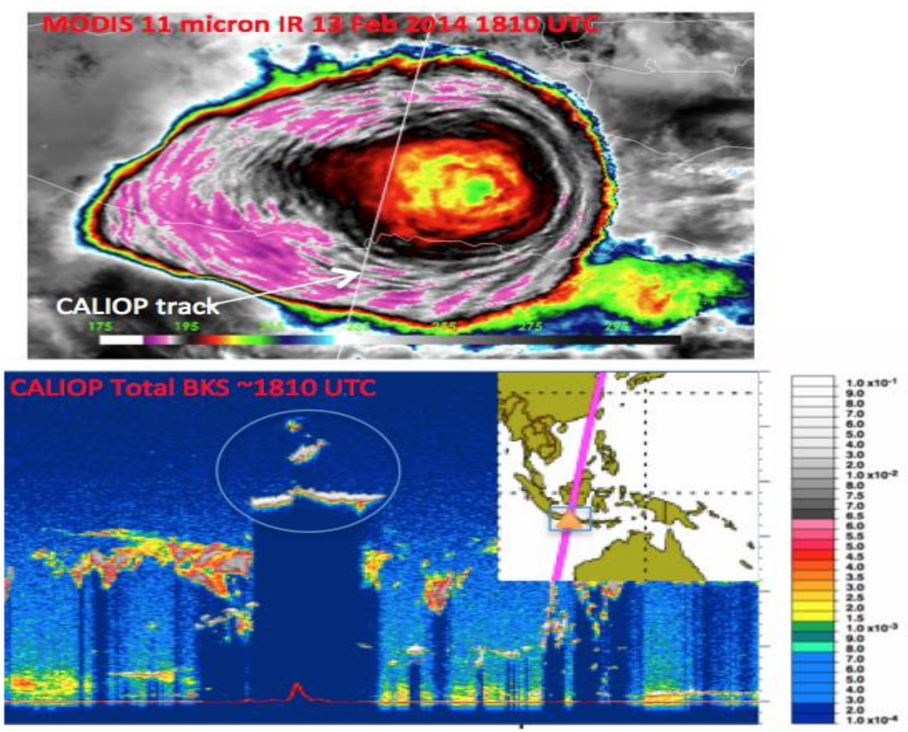


HadGEM-UKCA N48L60 CheS+GLOMAP. Dhomse et al. (ACP, 2014)

Klash, 2014: CALIPSO and in-situ balloon measurements of Mt. Kelud volcanic plume; persistence of ash in the lower stratosphere

T. Duncan Fairlie[2], Jean-Paul Vernier[1], Terry Deshler[3], Travis Knepp[1], Murali Natarajan[2], Katie Foster[3], Stan Smith[3], Kristopher Bedka[1], Chip Trepte[2], Larry Thomason[2], Frank Weinhold[4]

[[1]SSAI; [2]NASA LaRC; [3]U. Wyoming; [4]ETH, Zurich]



The eruption of Mt. Kelud : 14 Feb 2014:

MODIS(Aqua) Brightness Temperature (11 micron), and CALIPSO total attenuated backscatter curtain showing main volcanic plume ~18-19 km altitude, extending as high as 26 km.

KLASH deployment:

10-day balloon field experiment in Darwin (Australia) May, 2014.

Rapid Response, with critical support from NASA HQ (Considine, Kaye), CALIPSO (Trepte), SAGE (Thomason), Australian BOM (Atkinson), CASA.

Objectives: CALIPSO validation, ash confirmation, size, volatility, RF.

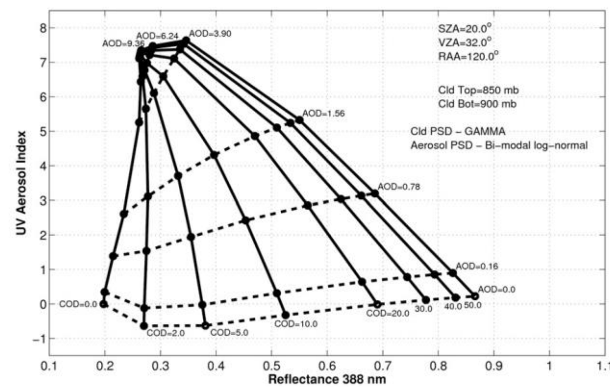
- Flew 4 dual backscatter (COBALD) sondes under medium balloons
- Flew combined optical particle counter (OPC) with COBALD under large balloon

Retrieval, Inter-comparison, and Validation of Above-cloud Aerosol Optical Depth from A-train Sensors

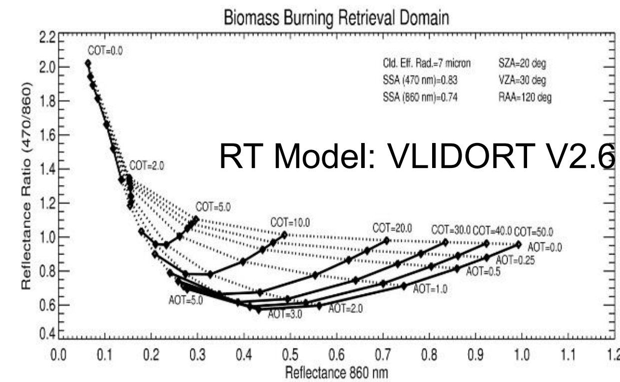
HIREN JETHVA, O. TORRES, P. K. BHARTIA, L. A. REMER, J. REDEMANN, S. E. DUNAGAN, J. LIVINGSTON, Y. SHINOZUKA, M. KACENELENBOGEN, M. SEGAL-ROSENHEIMER, ROB SPURR

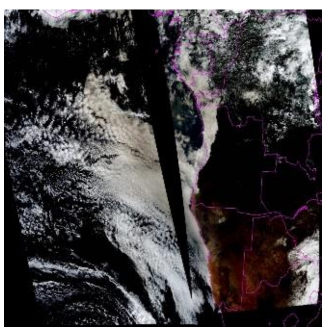
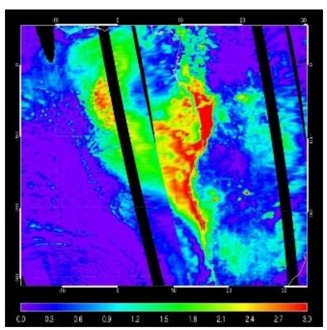
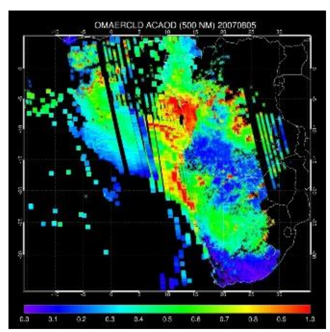
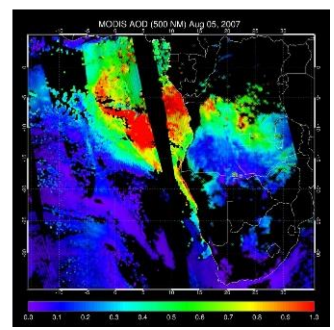
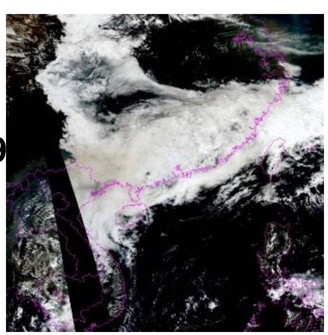
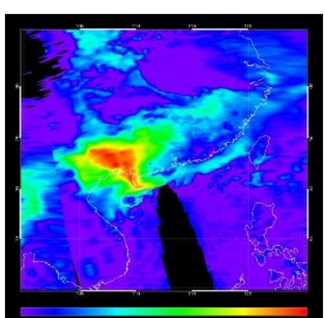
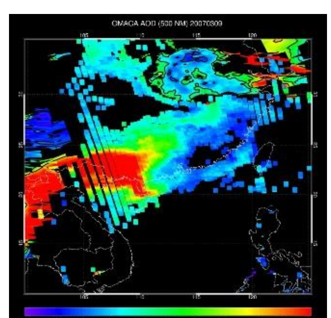
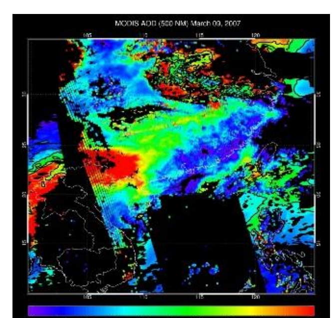
The presence of absorbing biomass burning and dust aerosols above clouds pose greater potentials of exerting positive radiative effects (warming) whose magnitude directly depends on the aerosol loading above cloud, optical properties of clouds and aerosols, and cloud fraction

Near-UV Retrieval Domain



VIS/SWIR Retrieval Domain



	Aqua/MODIS RGB	Aura/OMI UV Aerosol Index	OMI AOD	MODIS AOD
Aug 05 2007				
Mar 09 2007				

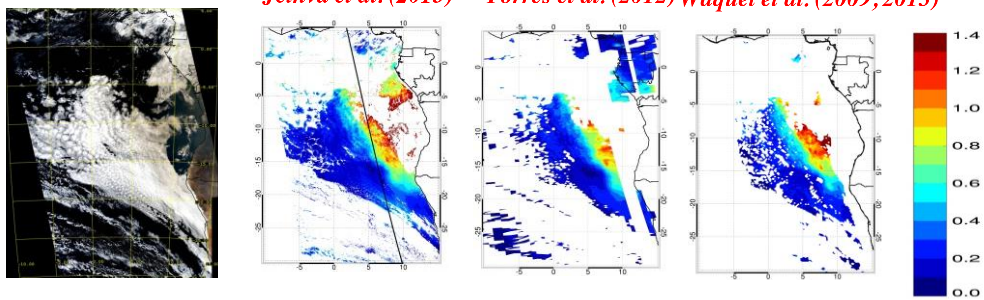
Input Parameters
TOA reflectance
OMI: 354 and 388 nm
MODIS: 470 and 660/860 nm (ocean/land)

A priori:
Aerosol Model (size distribution, real/imaginary part of refractive indices, aerosol vertical profile,
cloud droplet distribution (modified-Gamma),
Cloud top/bottom pressure

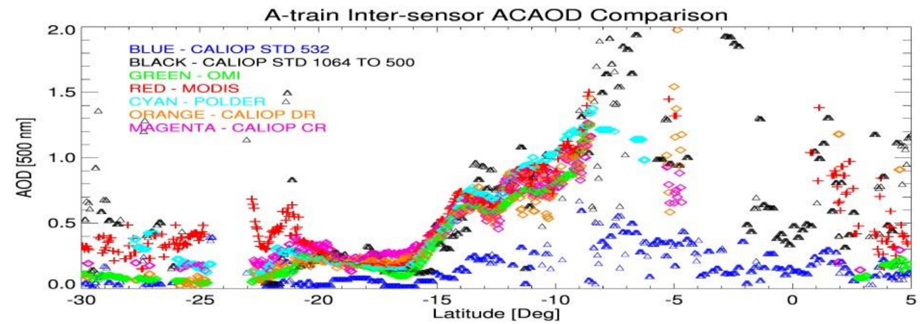
Output Parameters
Above-cloud AOD
(at 388 for OMI and at 660/860 nm for MODIS)
aerosol-corrected COD

A-train Inter-comparison of Above-cloud AOD

MODIS RGB | **MODIS ACAOD** *Jethva et al. (2013)* | **OMI** *Torres et al. (2012)* | **POLDER** *Waquet et al. (2009, 2013)*



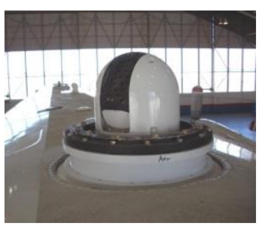
Aug 02, 2007

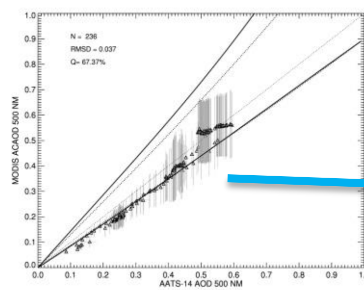


Validating Above-cloud AOD

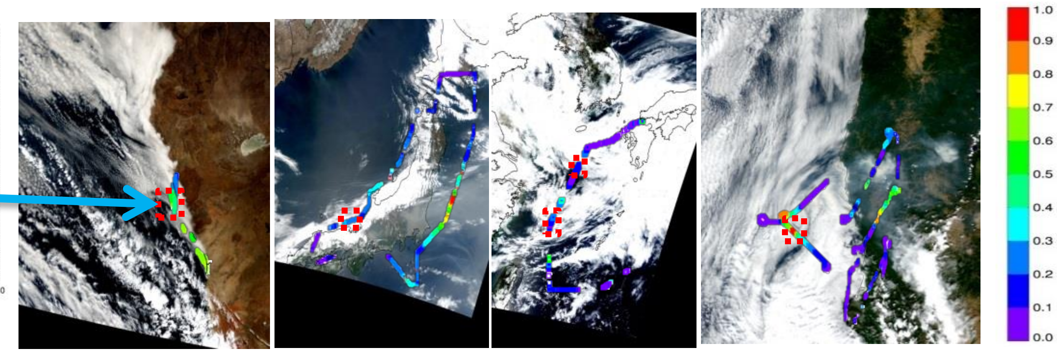
Ames Airborne Tracking Sunphotometer (AATS)
Spectrometer for Sky-Scanning, Sun-Tracking Atmospheric Research (4STAR)

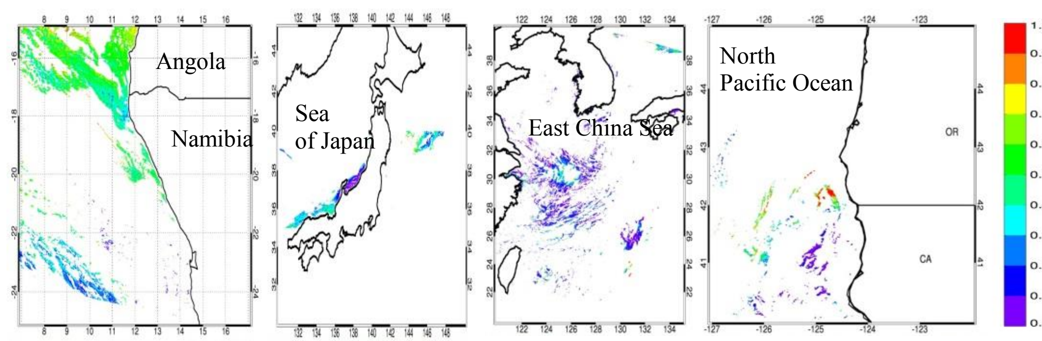
AATS-14 | 4STAR

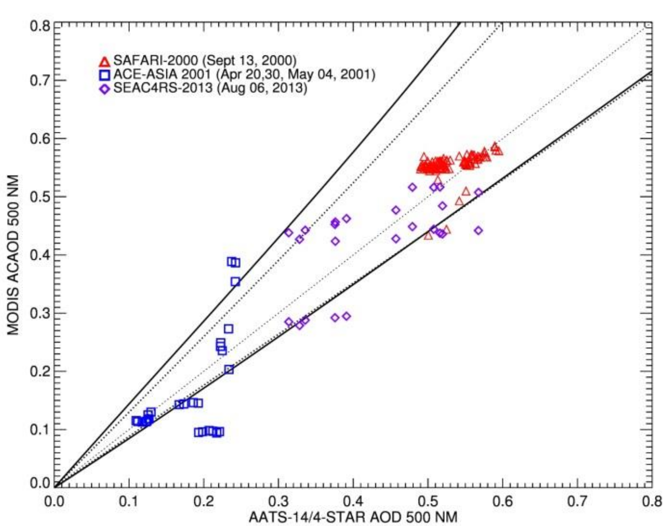




SAFARI-2000 | ACE-ASIA 2001 | SEAC4RS-2013





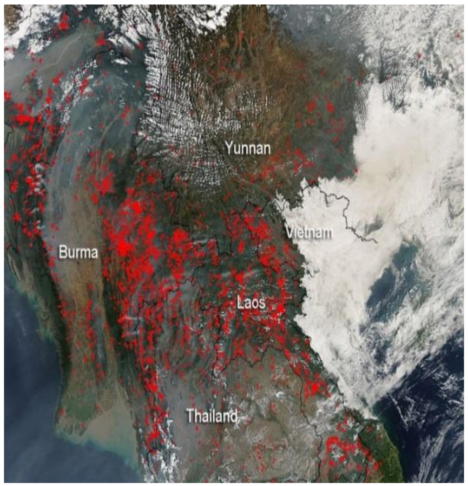


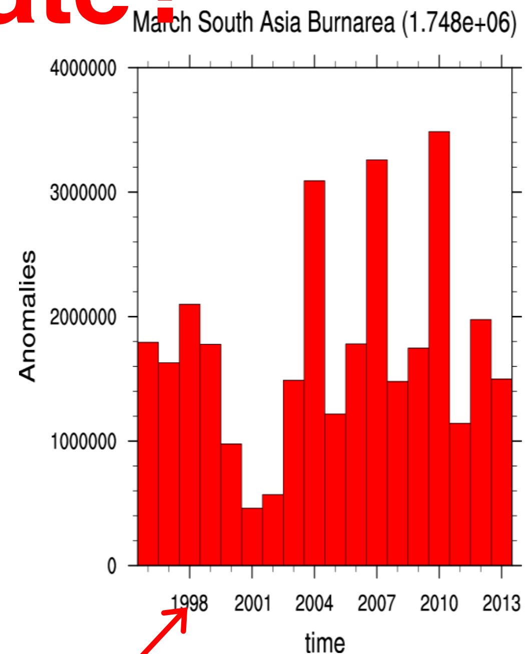
- Most satellite-airborne matchups falling within the predicted uncertainties in the above-cloud AOD retrieval (-10% to 50%)
- The co-retrieved COD was found to be either equivalent to the MODIS operational cloud product for lower AODs (ACE-ASIA) or higher by 30-35% for more absorbing aerosol event of SAFARI-2000

Impacts of Aerosol Induced by Wildfire over Indochina Peninsula on East Asian Climate

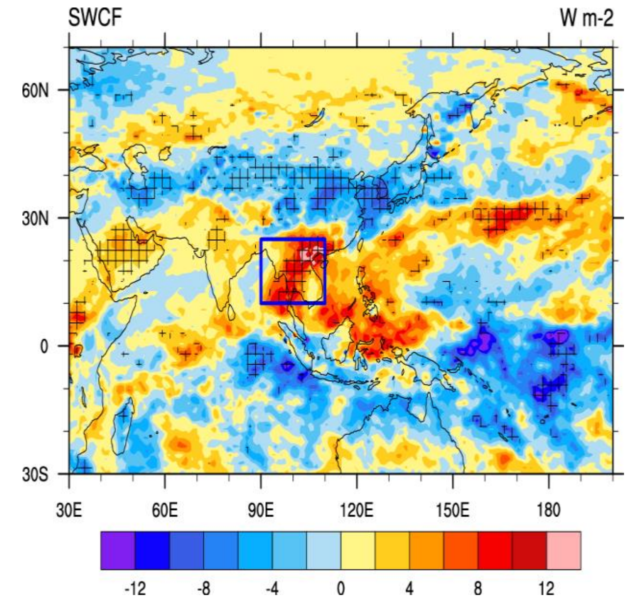
Yiquan Jiang[1], Xiaohong Liu[1]*, Yun Qian[2] and Kai Zhang[2]
1 Department of Atmospheric Science, University of Wyoming
2 Pacific Northwest National Laboratory, Richland, Washington, USA

How fire aerosols from Indochina affects climate?

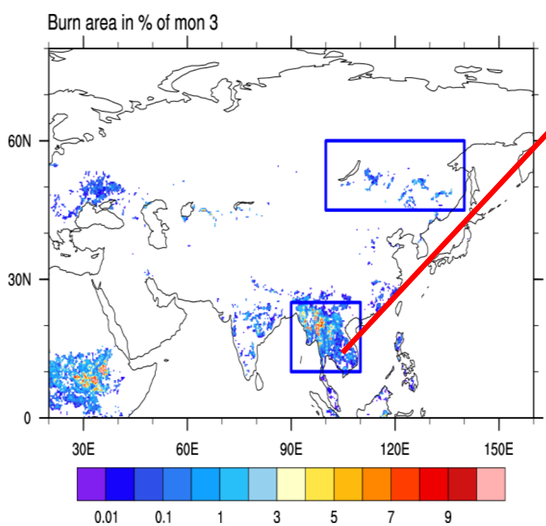




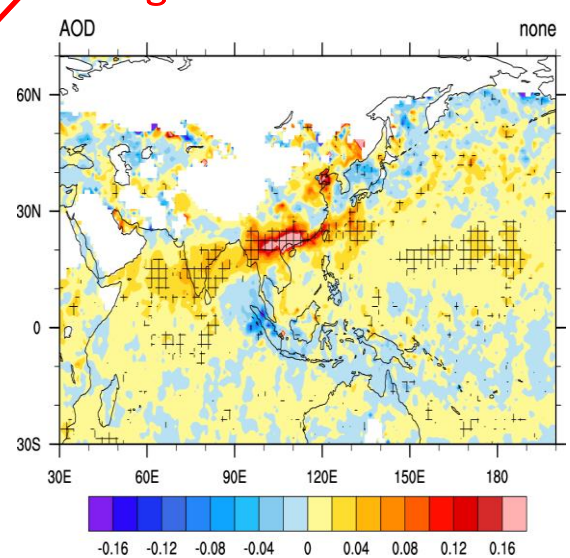
Regressed SWCF



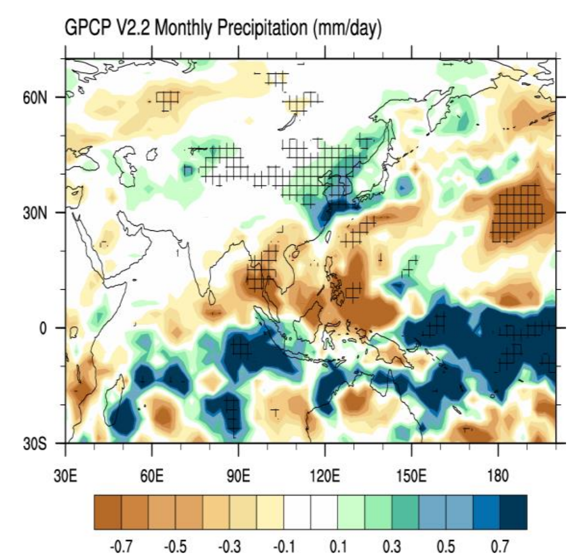
GFED Burn area of March



Regressed AOD



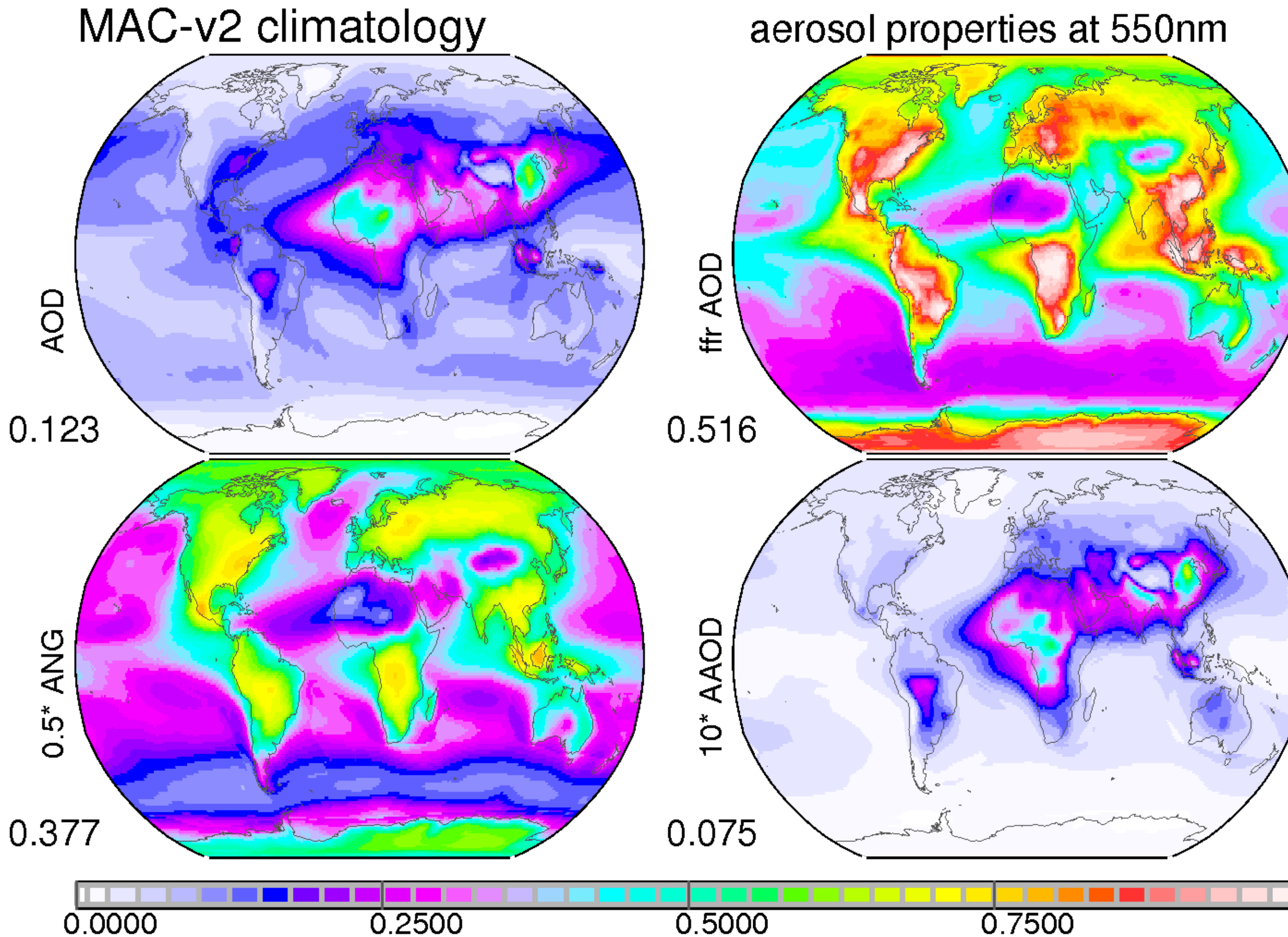
Regressed Precipitation



The MPI-M Aerosol Climatology

Stefan Kinne

AeroCom



annual global maps →

applications

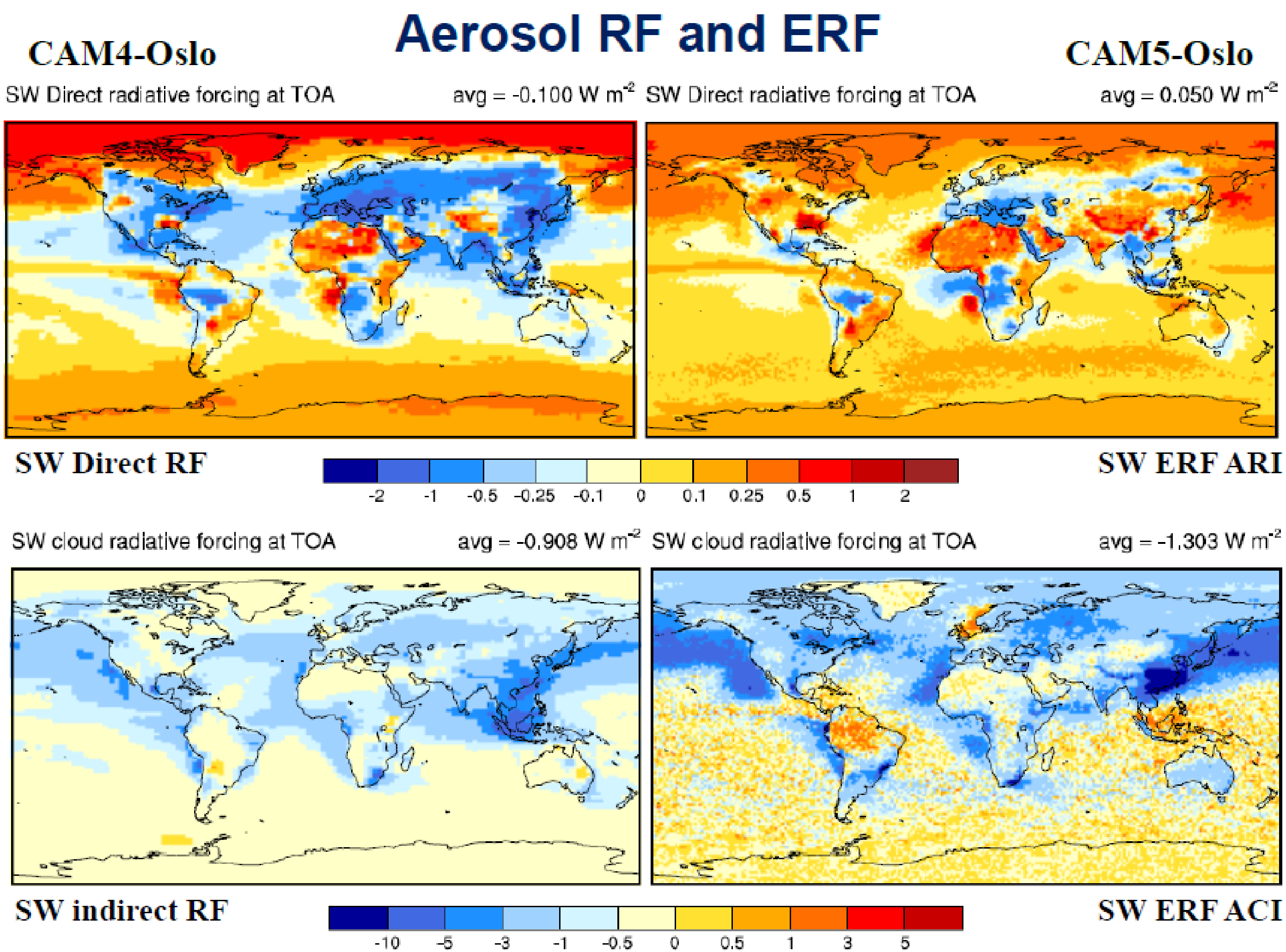
- a general reference
- shortcut, when opt/rad properties are needed
- with rad. transfer - a tool for sensitivity studies
- obs. connection helps identify model biases
- CCN estimates are a path to indirect effects

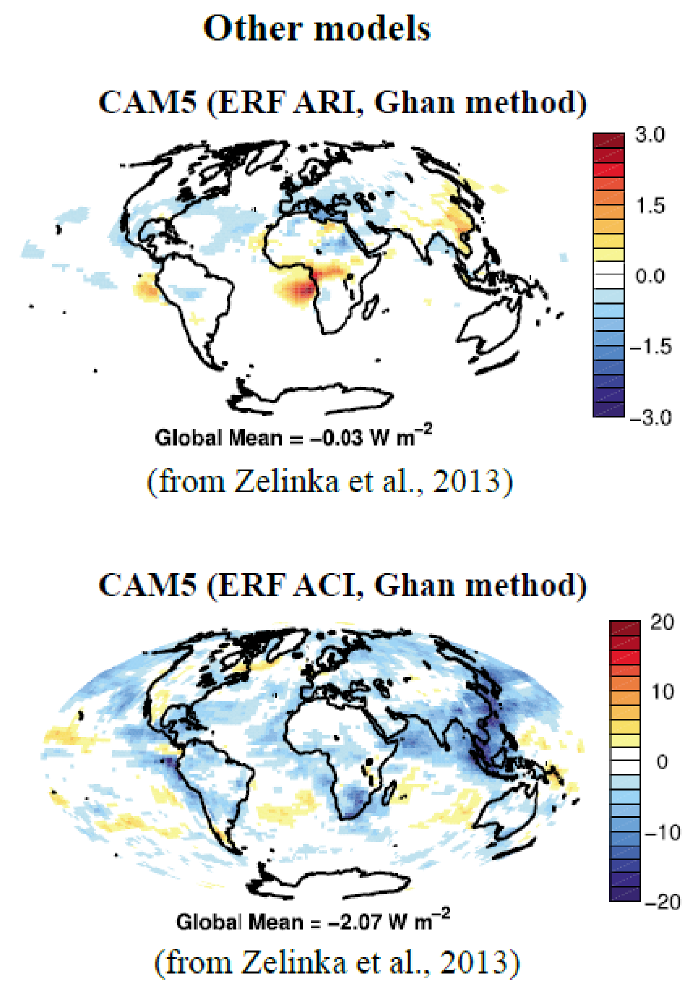
always think about simplifications, if they work

… not to get lost in complexity space

Preliminary estimates of Aerosol Effective Radiative Forcing in CAM5-Oslo

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





CAM5-Oslo is a version of CAM5 where schemes for aerosol chemistry, physics and interaction with clouds originally developed for CAM4-Oslo/NorESM1 will exist as options alongside with the modal aerosol modules (e.g. MAM3). Note: the aerosol coupling with ice nuclei is still as in CAM5 MAM3, and the treatment of wet-scavenging and aerosol activation is not yet consistent → only preliminary results!

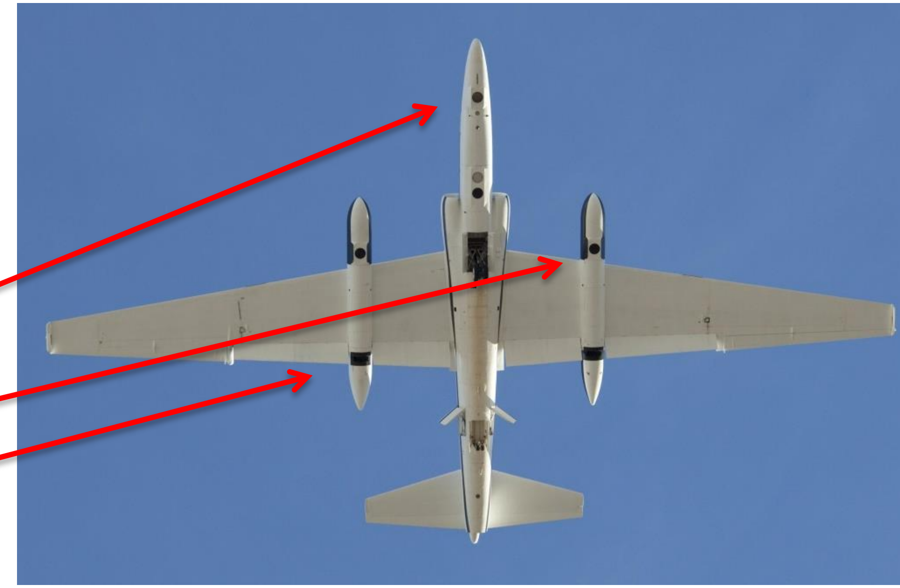
POlarimeter Definition EXperiment (PODEX) Level 1 comparisons

Kirk Knobelspiesse, Jens Redemann

NASA Ames Research Center

Airborne polarimeters relevant to NASA ACE, PACE missions:

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



PODEX goal: develop and inter-compare polarimeter aerosol / cloud retrievals

	Type	Approximate polarimetric accuracy @reflectance=0.2	# view angles	ER-2 Nadir ground resolution	355	380	410	445	470	550	555	660	670	766	865	870	935	960	1593	1880	2263	total # obs. per pixel
AirMSPI	Photoelastic modulation, imager	1%: Step & Stare mode; 0.5%: sweep mode	varies, 1 to 31	7m+9m smear	R	R		R	R+P		R	R+P			R+P		R					up to 420
PACS	Philips prisms + linear polarizers, imager	?	varies, max ~65	37m + smear?					R+P	R+P	R+P		R+P	R+P		R+P						up to 1170
RSP	Wollaston Prisms, not an imager	0.075%	~152	277m+277m smear			R+P		R+P		R+P		R+P		R+P			R+P	R+P	R+P	R+P	~4100

R = Reflectance; R+P = Reflectance+polarization

Level 1 intercomparisons (AirMSPI & RSP only, PACS data not available)

more details: earthscience.arc.nasa.gov/sgg/ACEPWG/

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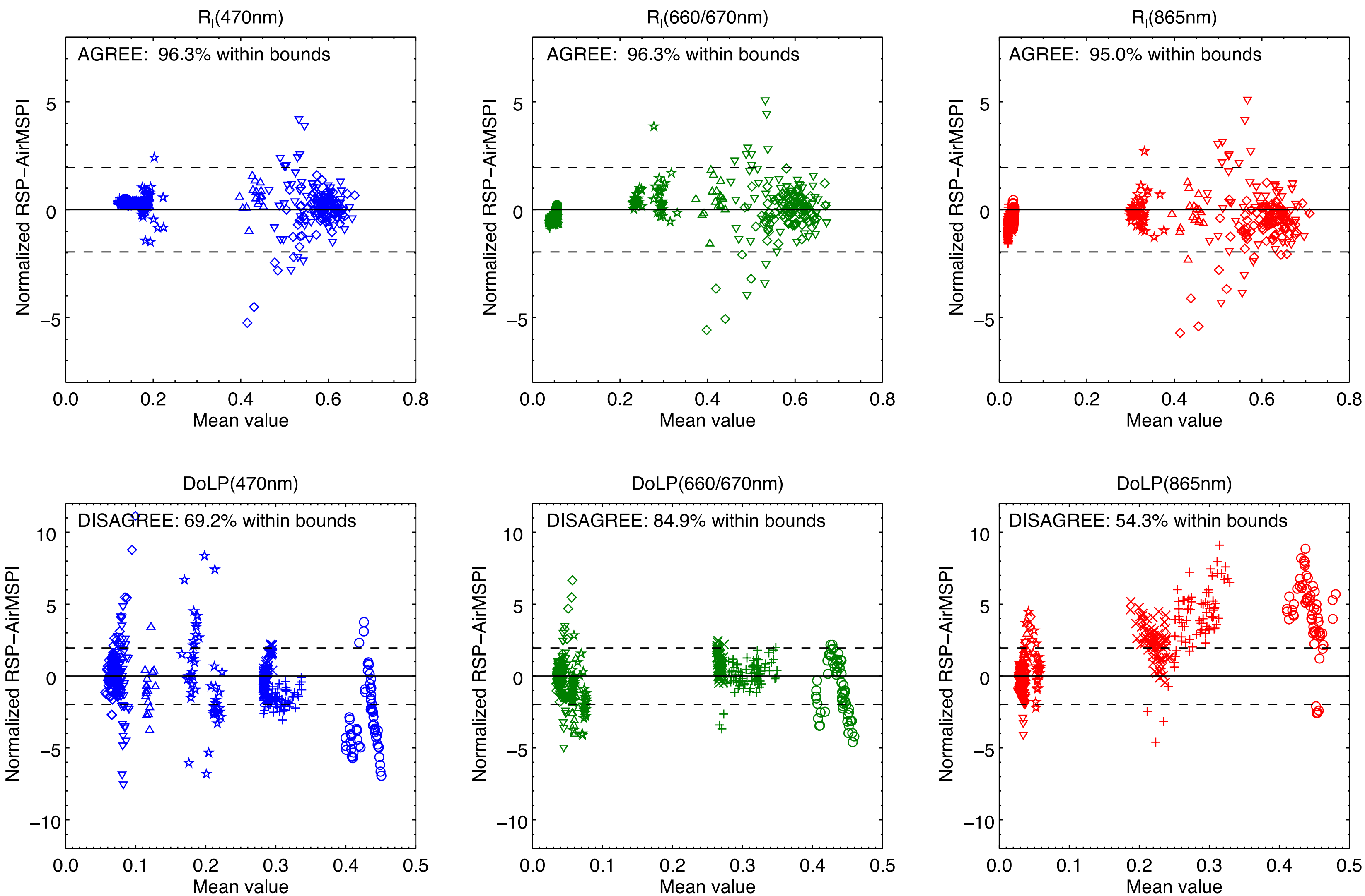
New!!

Comparison normalized by uncertainty



Reflectance compares well, but…

Degree of Linear Polarization (DoLP) differences are greater than uncertainty estimates

Evaluation of observed and modelled aerosol lifetimes

- using radioactive tracers of opportunity and an ensemble of 19 global models

N. I. Kristiansen[1], A. Stohl[1], T. Christoudias[2], D. Kunkel[3], B. Croft[4] , J. Pierce[4], R. Martin[4], T. Bergman[5], H. Kokkola[5], Y.H. Lee[6], D. Shindell[16], G. Pitari[7], G. Di Genova[7] ,H. Zhang[8], S. Zhao[8], O. A. Søvde[9], H. Wang[10], K. Zhang[10], X. Liu[11], N. Evangeliou[12], Y. Balanski[12], K. Tsigaridis[13], S. Bauer[13], H. Klein[14],S. Leadbetter[15] ,D. J. L., Olivié[14] ,M. Schulz[14]

NILU

Contact:
nik@nilu.no

1: NILU-Norwegian Institute for Air Research, Kjeller, Norway; 2: Cyprus Institute; 3: Institute for Atmospheric Physics, Johannes Gutenberg-University Mainz, Germany; 4: Department of Physics and Atmospheric Science Dalhousie University; 5: Finish Meteorological Institute; 6: NASA Goddard Institue for Space studies, New York; 7: University of L'Aquila, Italy; 8: Chinese academy of meteorological science; 9: Center for International Climate and Environmental Research – Oslo (CICERO), Oslo, Norway; 10: Pacific Northwest National Laboratory (PNNL), Richland, WA, USA; 11: University of Wyoming; 12: Laboratoire des Sciences du Climat et de l'Environnement, CEA-CNRS-UVSQ, Gif-sur-Yvette, France; 13: NASA Goddard Institute for Space Studies and Columbia Earth Institute, New York, NY, USA; 14: Norwegian meteorological institute; 15: Met Office, Exeter, UK; 16: Earth and Ocean Sciences, Nicholas School of the Environment, Duke University, Durham, NC 27708

Aim

Evaluate measured and modelled accumulation-mode aerosol lifetimes.

Measurements

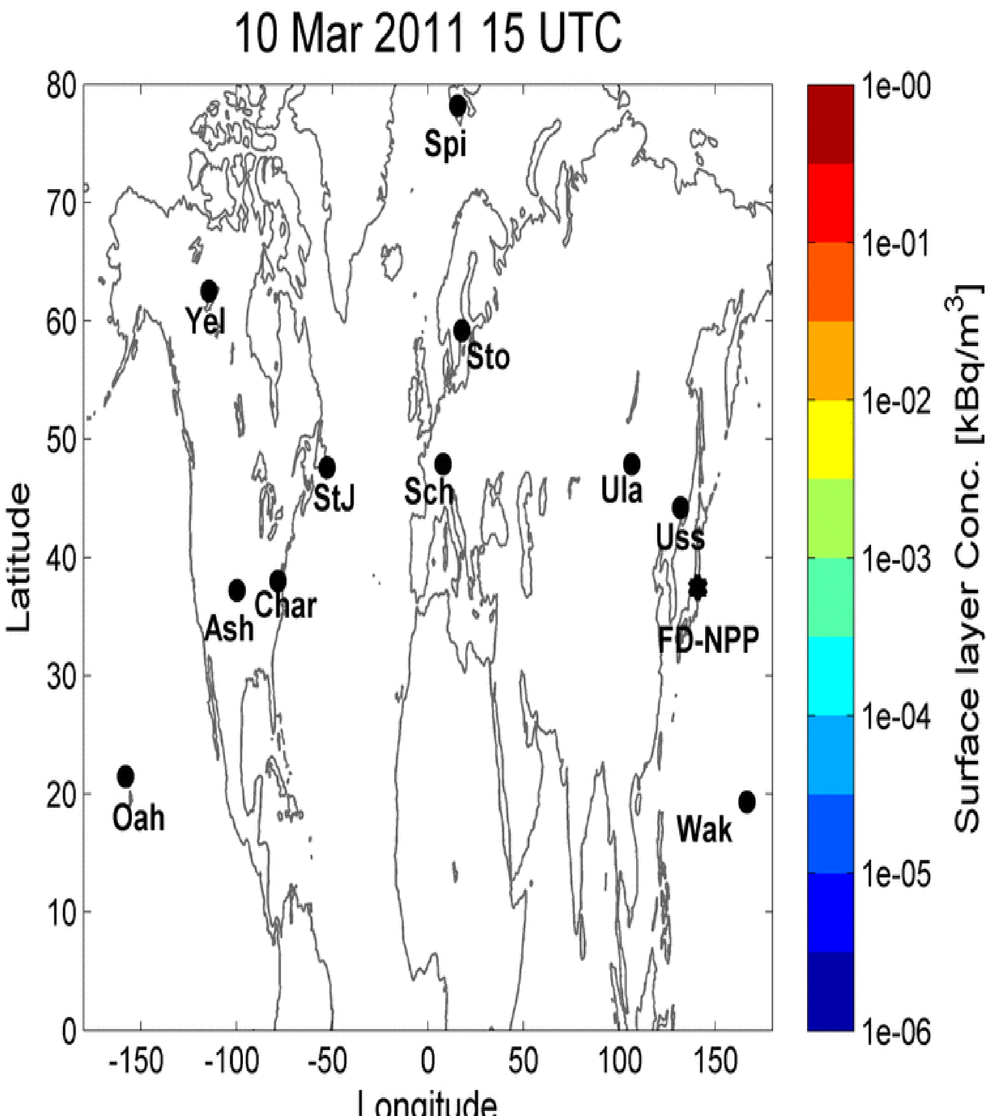
CTBTO station data of radioactive isotopes (aerosol-bound cesium, passive tracer xenon) released during the Fukushima accident of March 2011.

Models

19 global models simulated the transport of the radioactive isotopes using identical emissions.

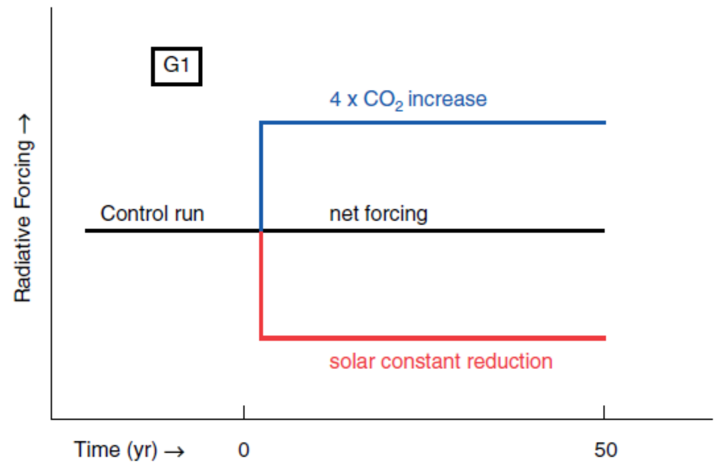
Key question

To what extent can the models reproduce the observed loss of aerosol mass with time?

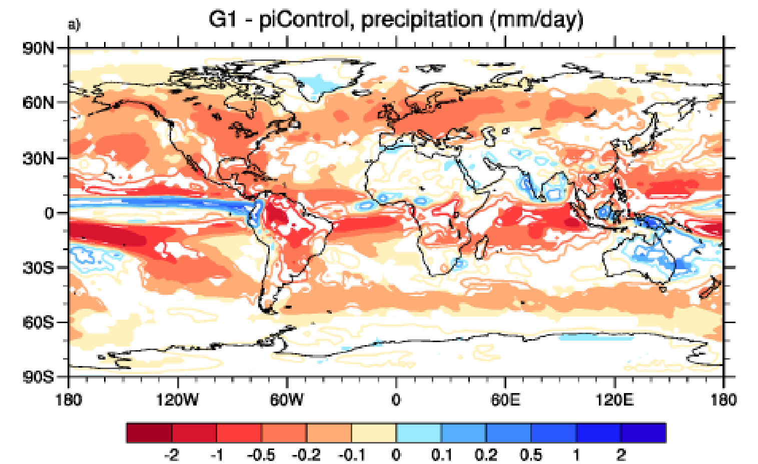


Climate Engineering and the Hydrological Cycle

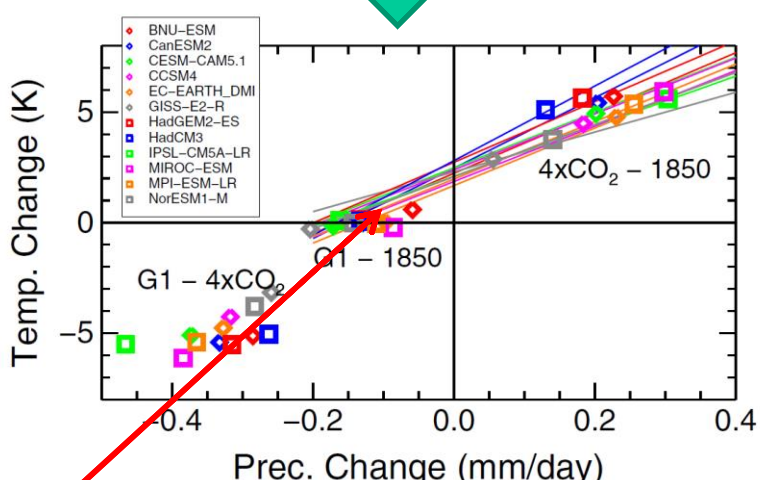
Jón Egill Kristjánsson (Univ. Oslo) Helene Muri (Univ. Oslo), Hauke Schmidt (MPI-M)



Kravitz et al. (2011: ASL)



Schmidt et al. (2012: ESD)



Tilmes et al. (2013: JGR)

A ~5% reduction in P for ΔT=0

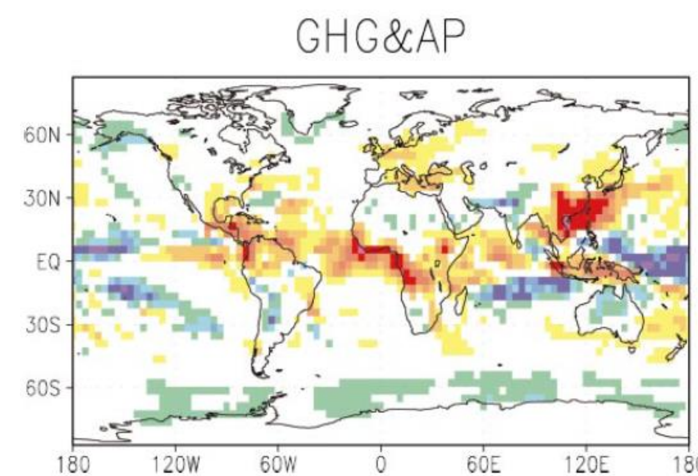
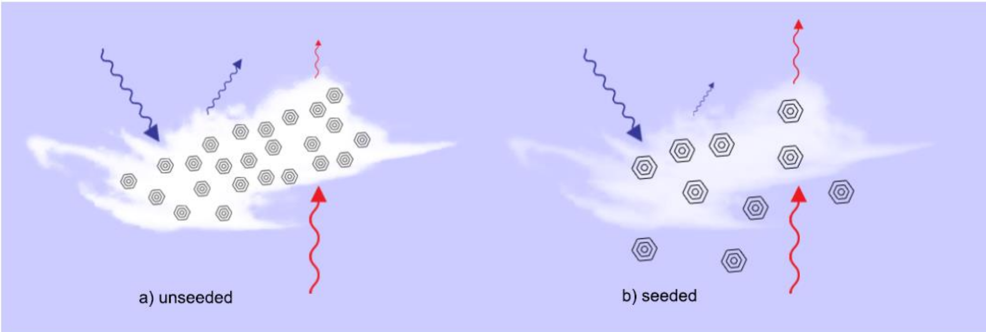


FIG. 5. Annual mean precipitation differences (mm day^{-1}) between PD and PI

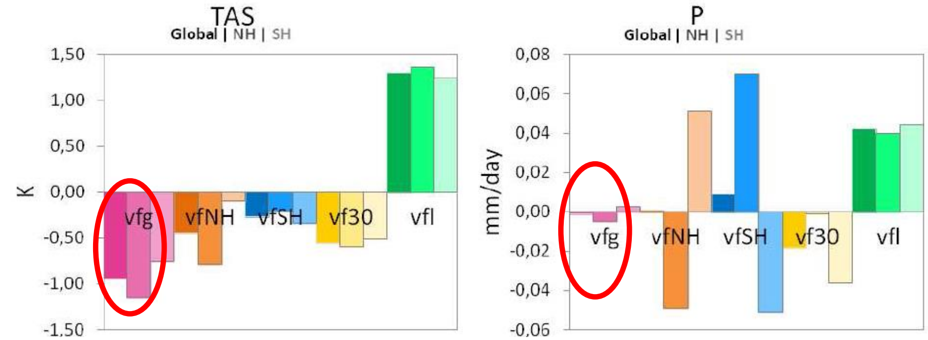
Feichter et al. (2004: J.Climate)

EXPEC

Cirrus Cloud Thinning



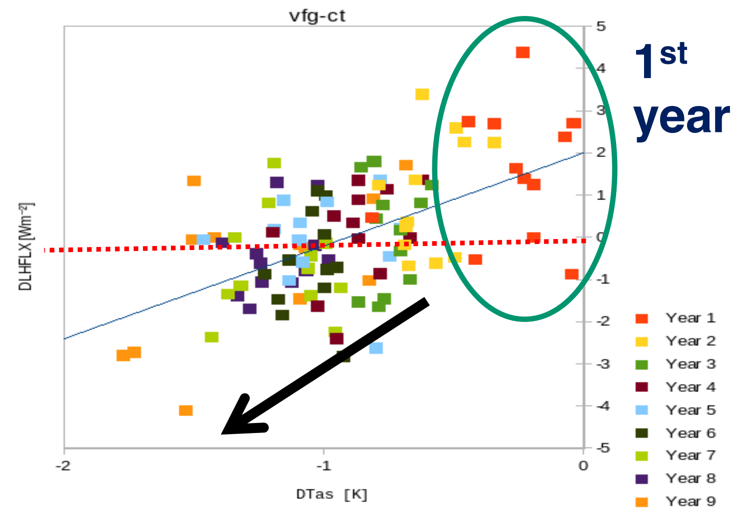
Storelvmo et al. (2013: GRL)



Muri et al. (2014: JGR)

- **CCT => Cooling, but no reduction in precipitation. Why?**

- **Fast feedbacks** dominated by the nature of the forcing: Enhanced Latent Heat Flux in 1st year
- **Cirrus Cloud Thinning cools the troposphere => Latent Heat Flux enhanced**



1st year

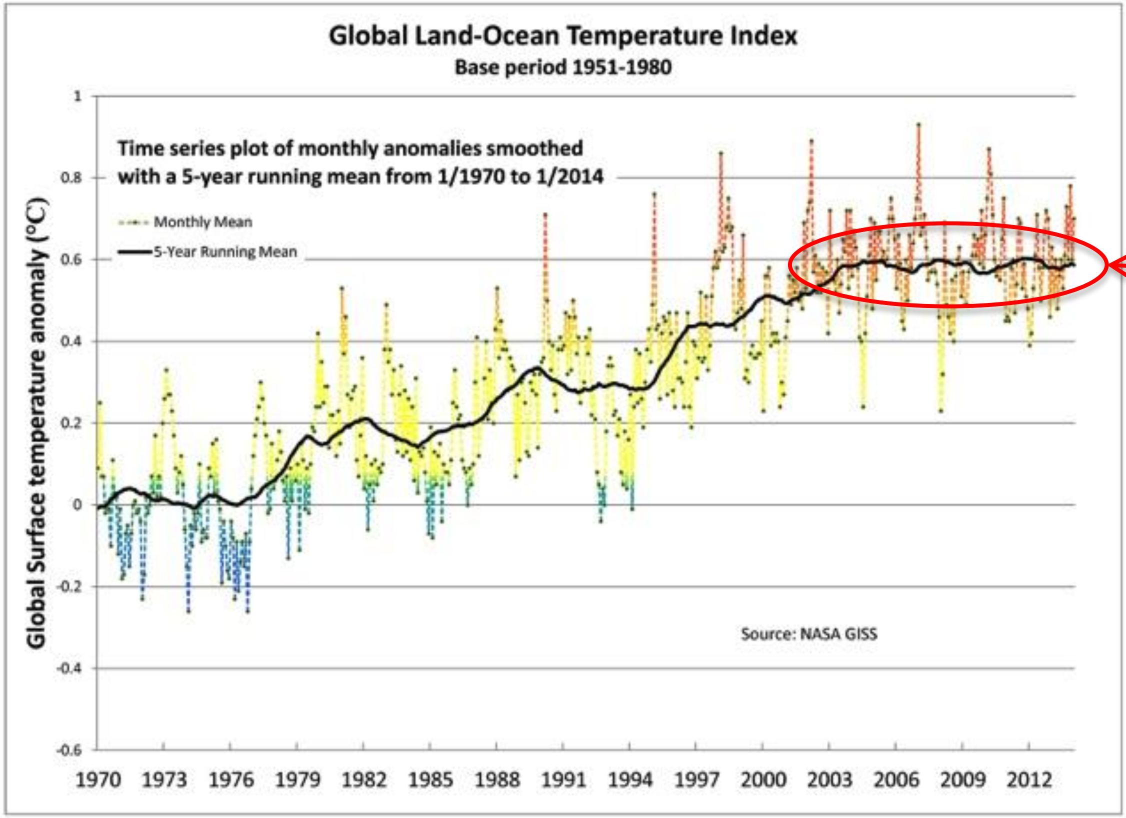
$$LH + SH = F^{\downarrow}_{SW+LW,surf} - F^{\uparrow}_{SW+LW,surf} - (F^{\downarrow}_{SW,TOA} - F^{\uparrow}_{SW+LW,TOA})$$

- Different CE techniques have very different influences on the hydrological cycle
- Cirrus Cloud Thinning: **Avoids suppression of the hydrological cycle**

EXPEC

Aerosol climate impact and its regional modulations in the 2000ies

Thomas Kühn, A.-I. Partanen, A. Laakso, Z. Lu, T. Bergman, S. Mikkonen, H. Kokkola, H. Korhonen, P. Räisänen, D. Streets, S. Romakkaniemi, A. Laaksonen

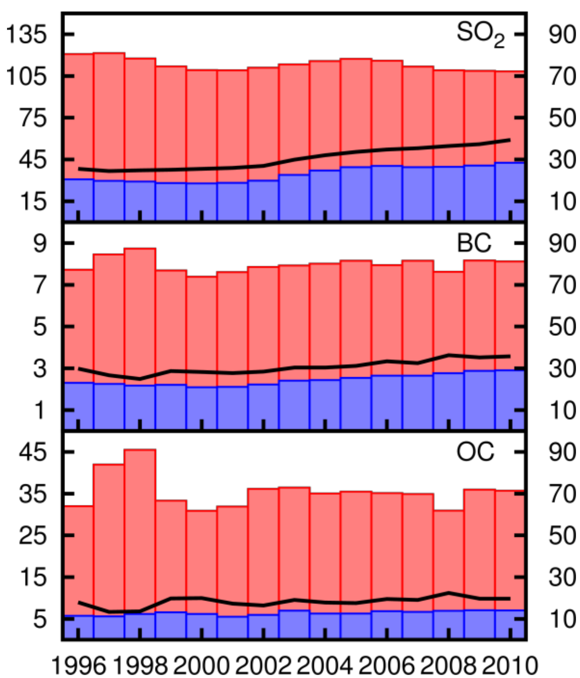


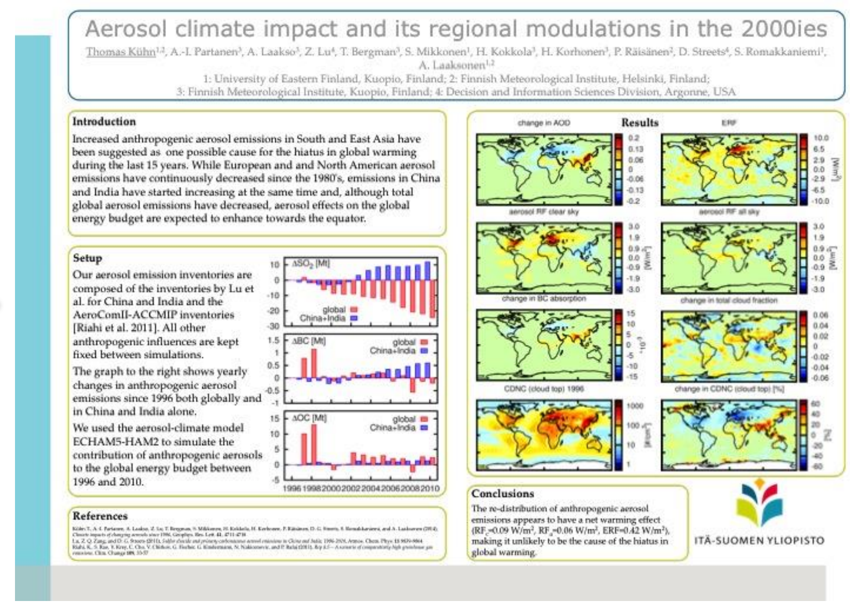
global warming "hiatus"

- ocean heat content
- solar variability
- ?asian aerosols?
- …

Aerosol climate impact and its regional modulations in the 2000ies

Thomas Kühn, A.-I. Partanen, A. Laakso, Z. Lu, T. Bergman, S. Mikkonen, H. Kokkola, H. Korhonen, P. Räisänen, D. Streets, S. Romakkaniemi, A. Laaksonen





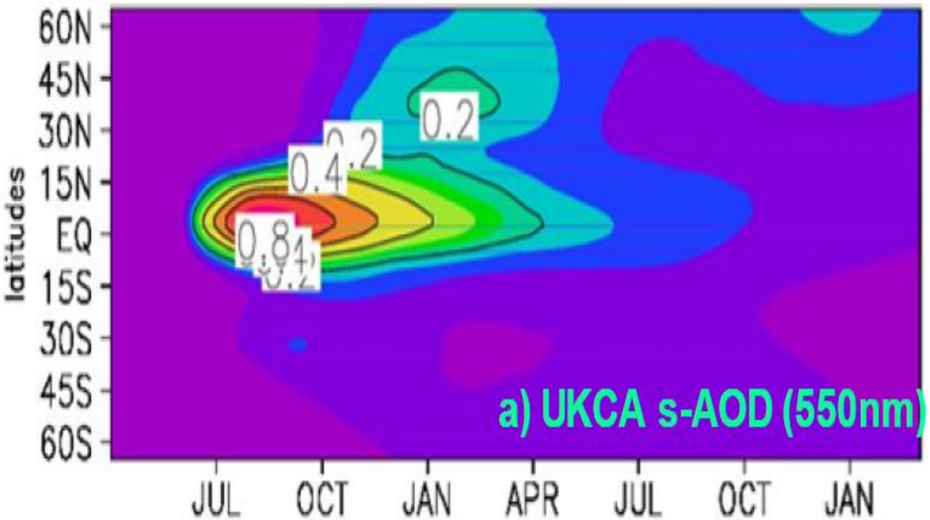
Planned co-ordinated experiments for the new SPARC initiative Stratospheric Sulphur and it's Role in Climate (SSiRC)

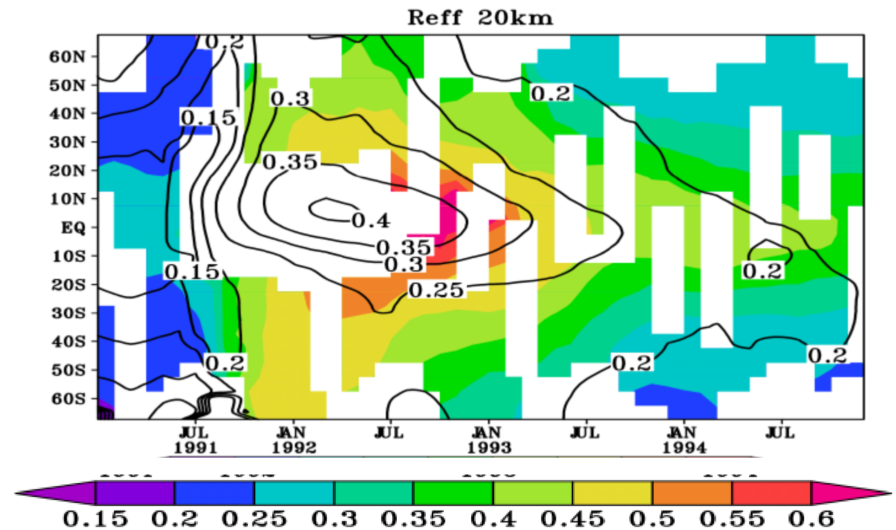
Claudia Timmreck, Graham Mann, Matt Toohey, Rene Hommel, Lindsay Lee, Valentina Aquila, Jason English, Mian Chin, Christoph Bruhl, Ryan Neely.

- New SPARC activity "Stratospheric Sulfur and its Role in Climate" (SSiRC) initiated to better understand changes in stratospheric aerosol and its precursor gaseous sulphur species
- One element of SSiRC is an intercomparison of A-GCMs which have interactive stratospheric aerosol modules
- Three co-ordinated experiments planned to intercompare background stratospheric aerosol, the perturbation through the Pinatubo period and the transient record between 1998 and 2013.
- Pinatubo experiment involves each model running perturbed physics ensemble with emulators used to quantify uncertainty in a range of key stratospheric aerosol properties and associated radiative forcings.

PinatubO Emulation in Multiple modelS (POEMS)
Quantify & attribute uncertainty via Gaussian emulation

Graham Mann, Ken Carslaw, Lindsay Lee , Sandip Dhomse et al. (Univ. Leeds, UK)





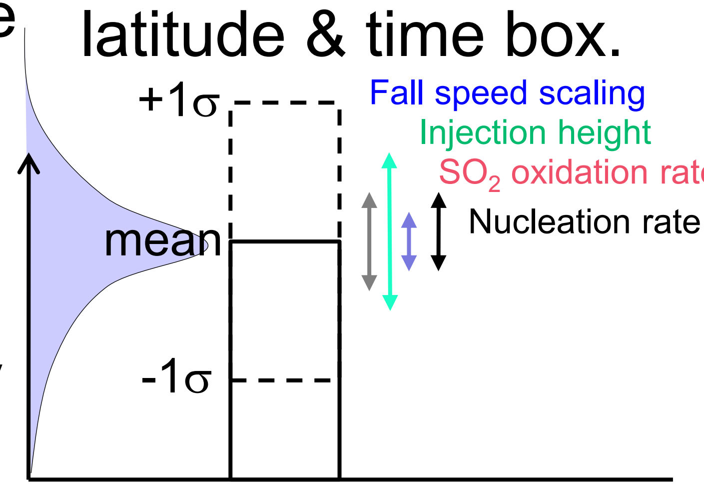
New statistical approach to quantify the magnitude & causes of uncertainty in Pinatubo radiative forcing predicted by stratospheric aerosol predicting GCMs

1. Perturbed Physics Ensemble of Pinatubo simulations with CCM

2 Use Gaussian emulators conditioned on CCM Pinatubo PPE.

3. Run full Monte Carlo of simulations with fast emulator for full variance-based sensitivity analysis.

Gives pdf for each latitude & time box.

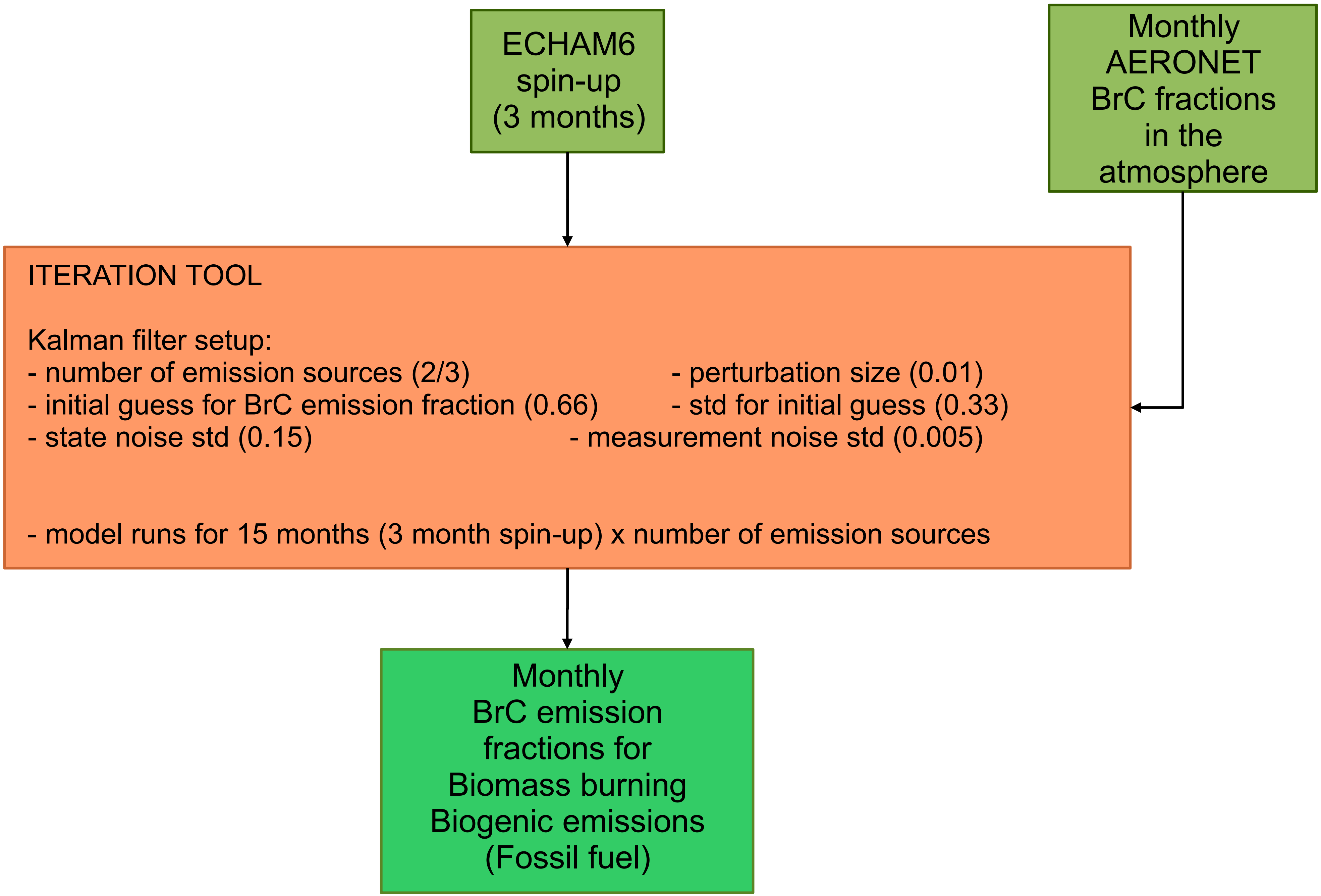


- title: "The aerosols in the CNRM global and regional climate models"
- synthesis: evaluation and use of a prognostic aerosol scheme, derived from the GEMS/MACC scheme of the ECMWF IFS
  - ✓ main primary aerosols and sulfate; 12 added prognostic fields
  - ✓ a number of adaptations, for instance new dust emission scheme and modulation of biomass burning emissions ($\times$ 2)

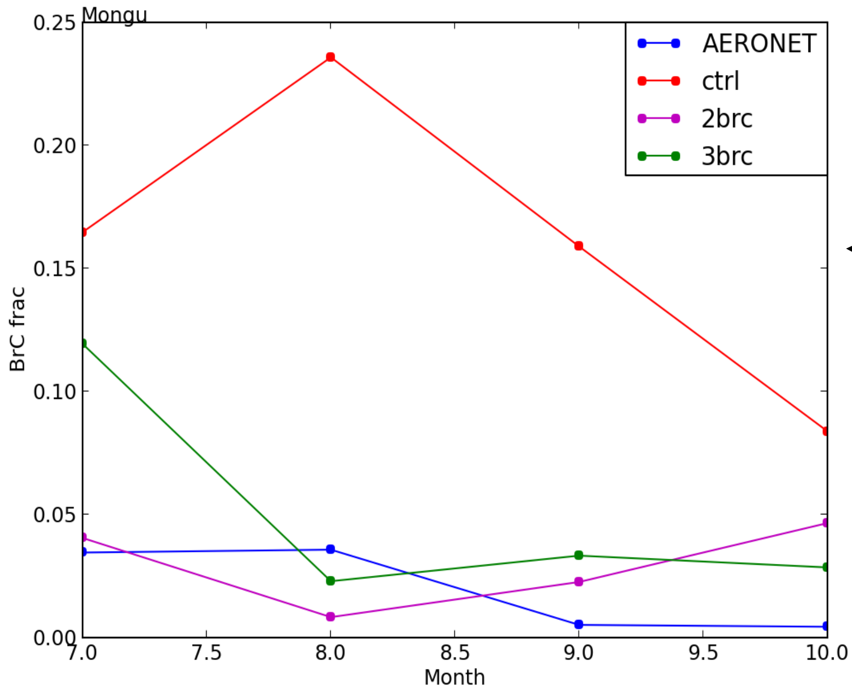
Simulations performed, evaluated and analysed

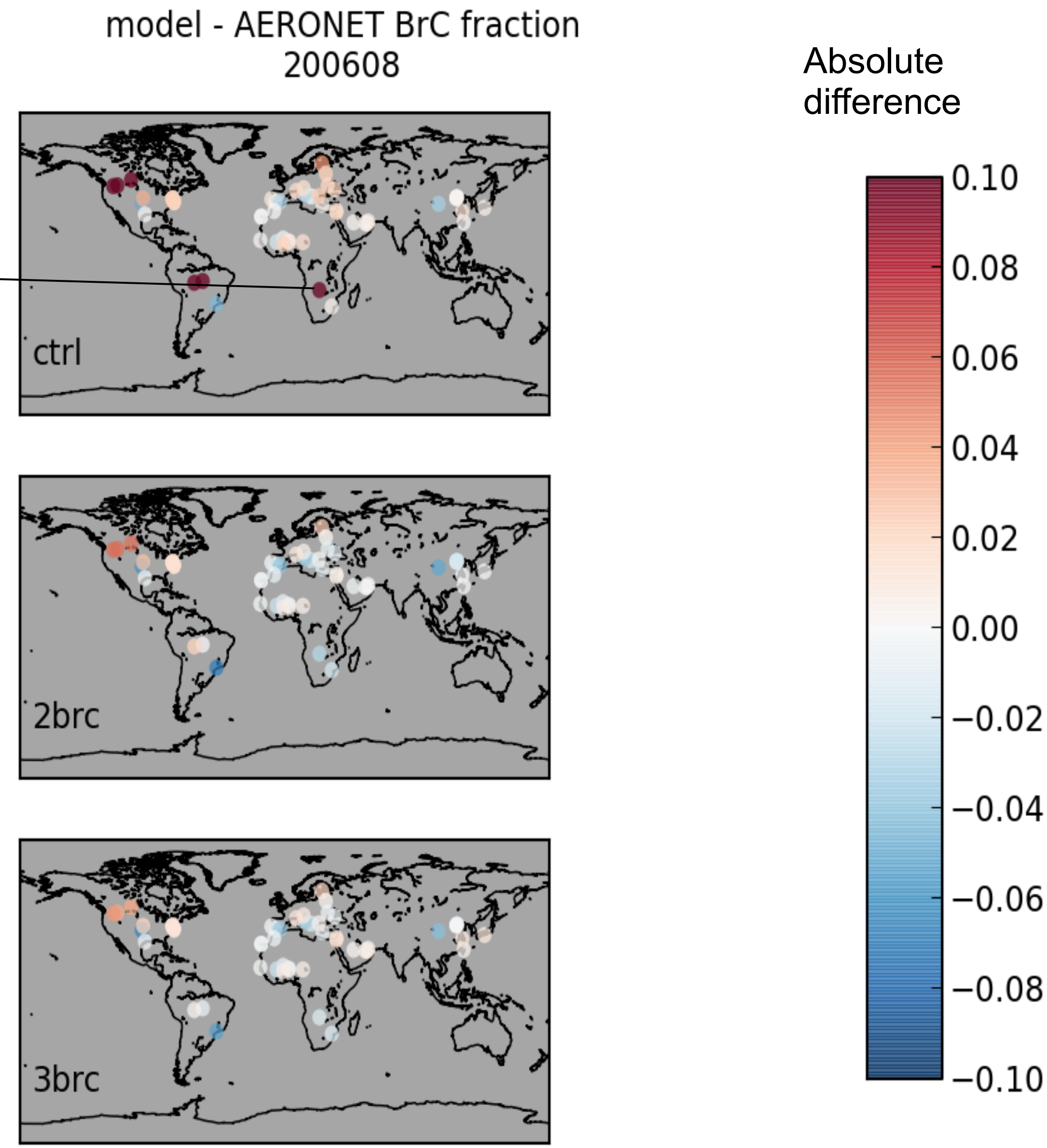
- ❒ with the global climate model
  - ✓ nudged and free, SST imposed, 1.4 deg (hor.), 2004, transient 1993-2012
  - ✓ AOD evaluation against satellite, MAC-v1 and AERONET monthly data
- ❒ with the regional climate model
  - ✓ coupled ocean/atmosphere, 50 km (hor.), summer 2012, transient 1980-2012
  - ✓ AOD evaluation against satellite, and AERONET monthly data over a large Mediterranean region
  - ✓ various analyses performed, e.g., analysis of the direct radiative forcing using prognostic aerosols and a climatology of these aerosols

How much brown carbon is emitted?



Preliminary results





BrC emission fractions

ctrl:	Fossil=0 Biomass=0.66 Biogenic=0.66
2brc:	Fossil=0 Biomass=optimized Biogenic=optimized
3brc:	Fossil=optimized Biomass=optimized Biogenic=optimized

Comparison of C5 & C6 MODIS dark target algorithm & validation

Munchak, Levy, Mattoo & Petrenko

- MODIS C5 aerosol products extensively used by modeling community, it is well understood and characterized.
- C6 recently available for MODIS-Aqua (L2 & L3), will soon be operational for MODIS-Terra
- This poster shows major changes to algorithm and details each change's effect on AOD

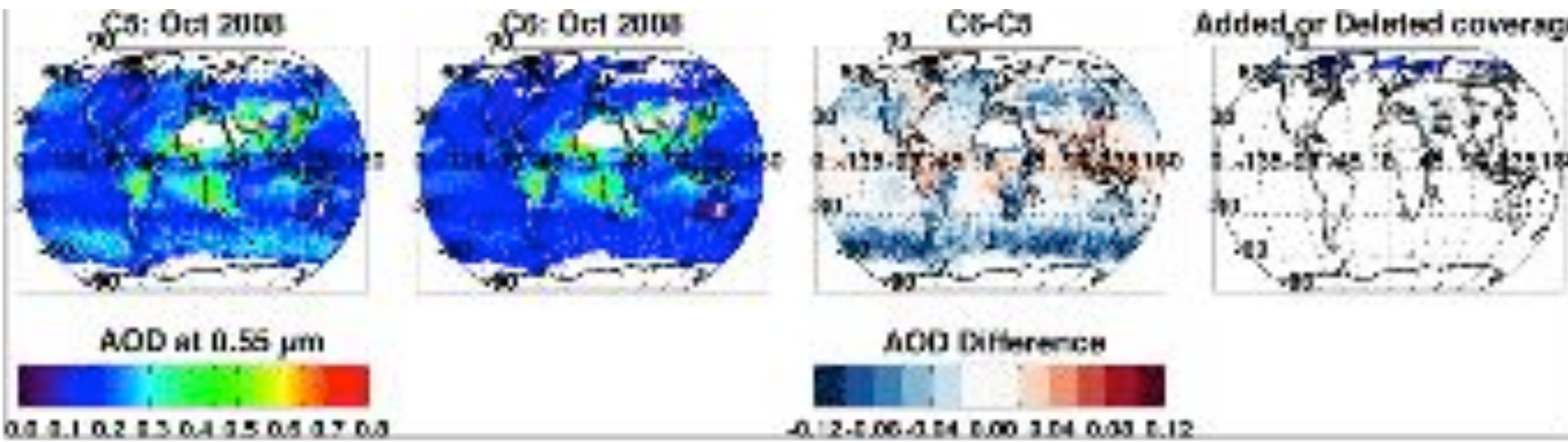
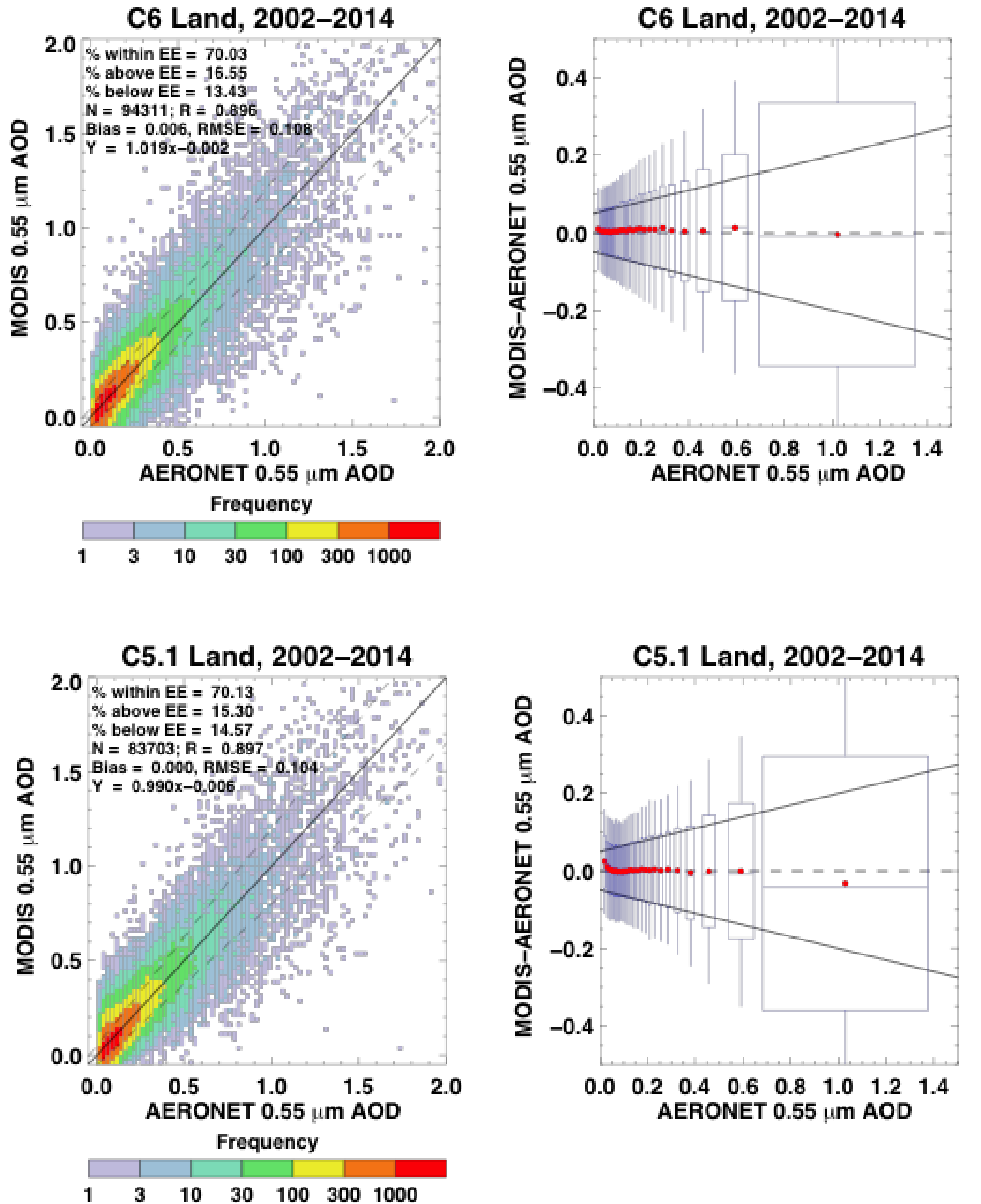


Figure from Levy et al., 2013

- Poster shows global validation with AERONET for both C5 & C6.

- Regional validation is shown for C6

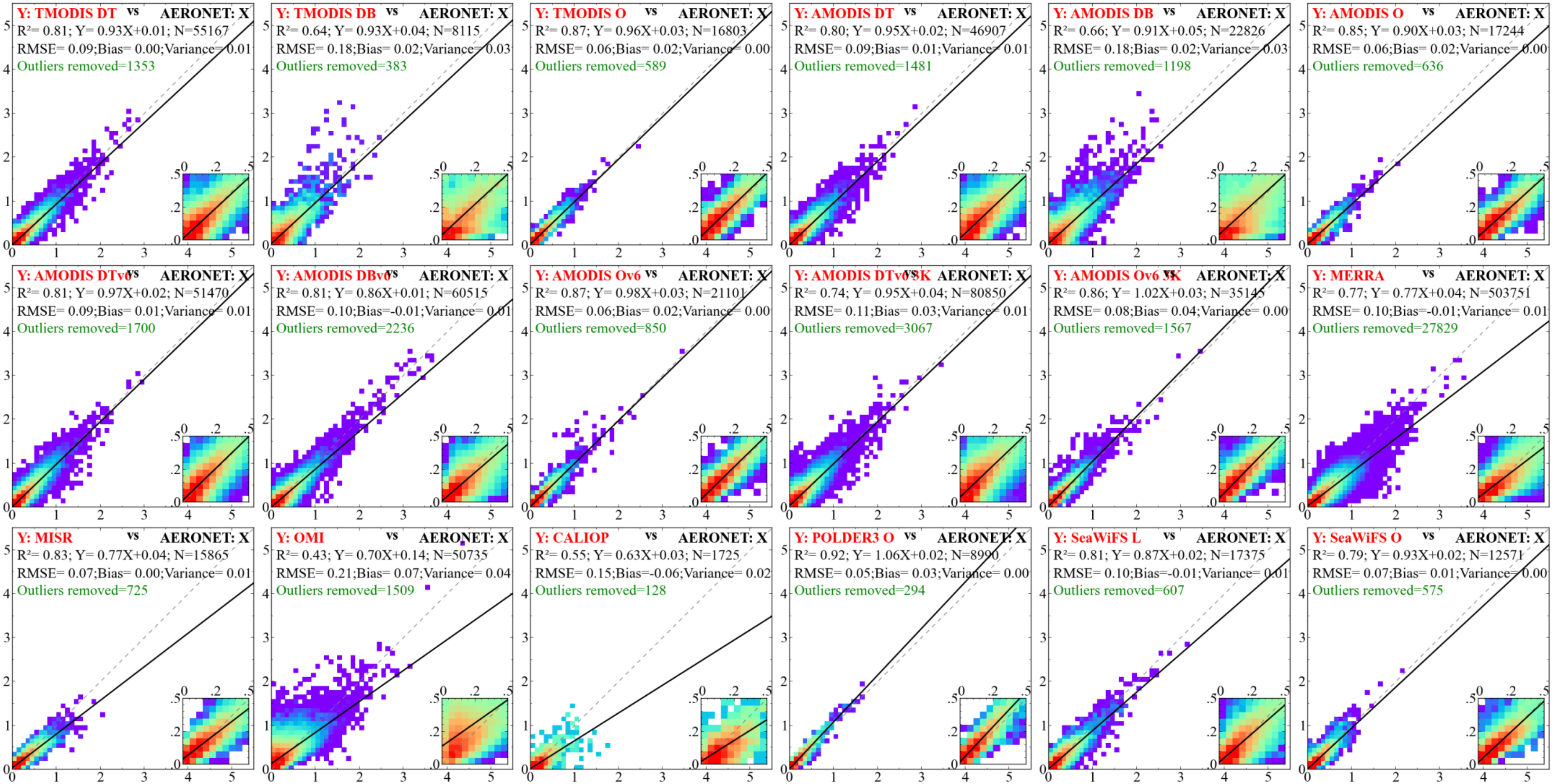
- Curious to hear from modelers about how MODIS is currently used, and what steps are needed to transition better from C5 to C6.



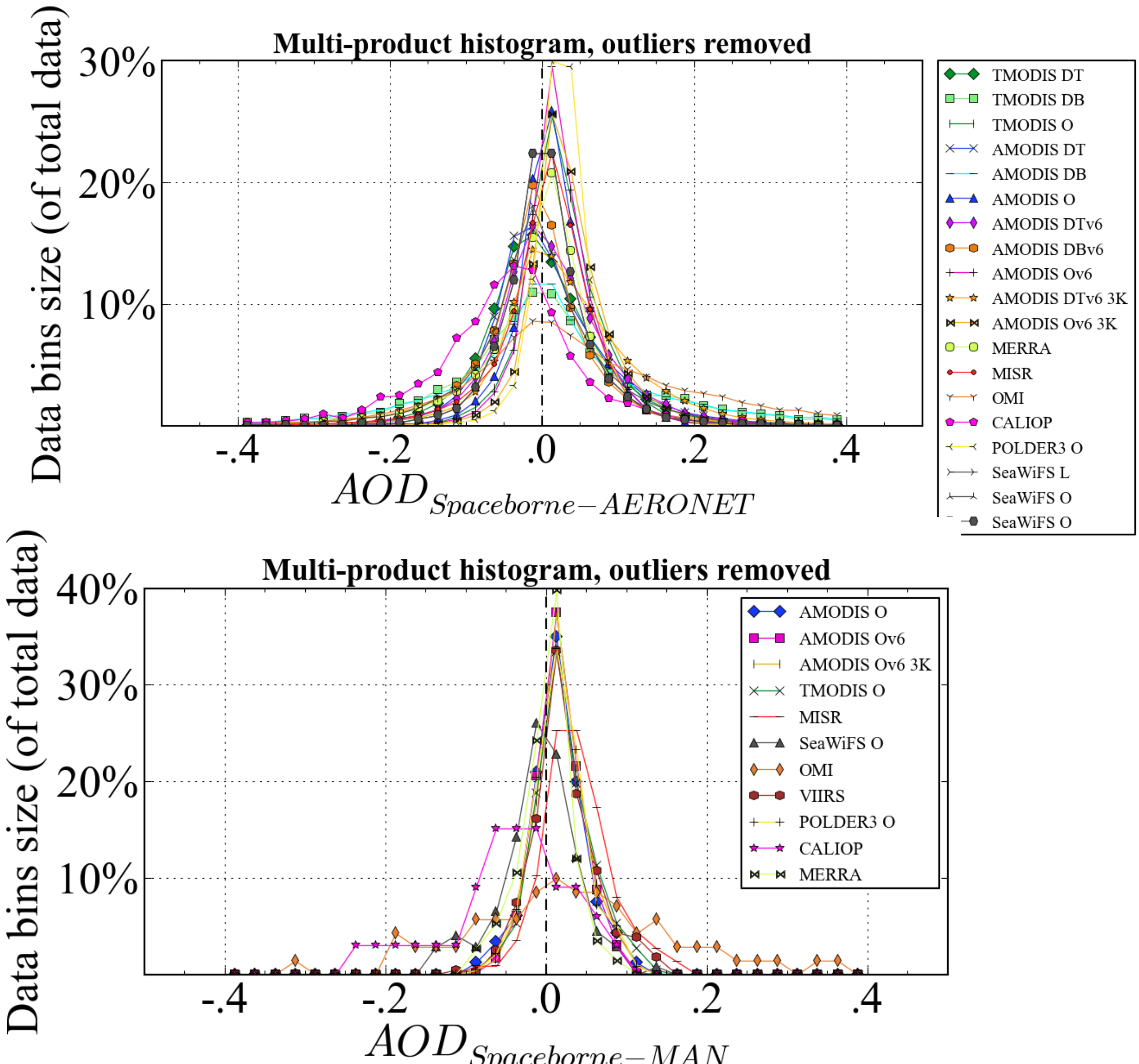
Joint Accuracy Assessment of Aerosol Retrievals from Multiple Satellite Sensors and GEOS-5 model

Maksym Petrenko, Alexander Smirnov, Charles Ichoku, Arlindo da Silva

NASA Goddard Space Flight Center, code 613, Greenbelt, MD 20771, USA.



Error Distri of Multiple Products Relative to AERONET and MAN

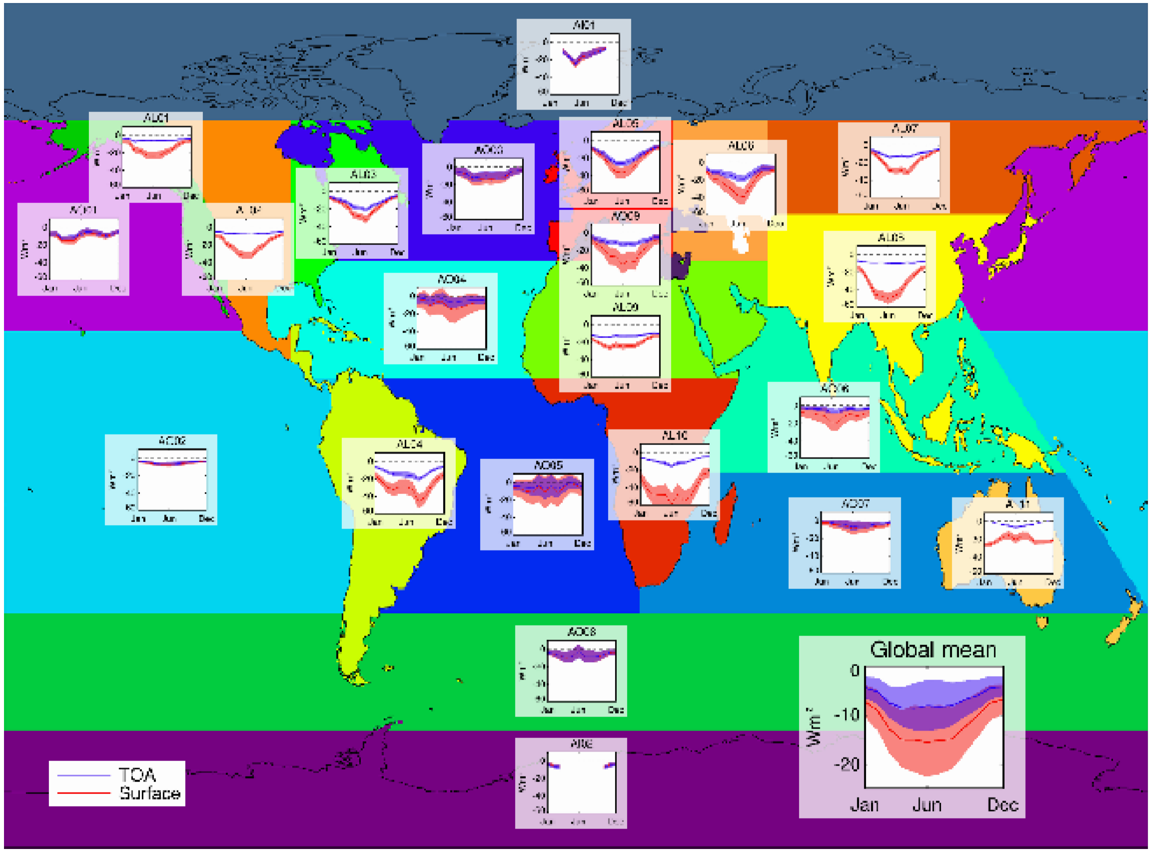


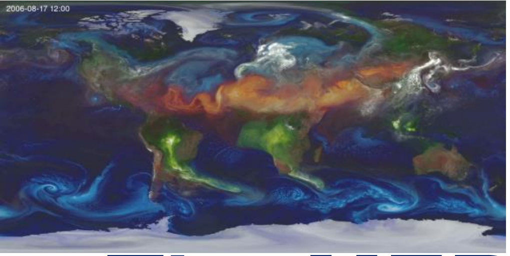
ORAC: The Optimal Retrieval of Aerosol and Cloud

- ORAC is a generalised optimal estimation scheme to retrieval cloud, aerosol, and surface properties from visible and/or infrared satellite imagers.
  - Currently supports (A)ATSR, AVHRR, MODIS, and SEVIRI
  - Additional sensors can be implemented as desired
- The algorithm has been used to produce various aerosol and cloud datasets
  - Work under way to harmonize these into a single retrieval code

ORAC: The Optimal Retrieval of Aerosol and Cloud

- Validation of aerosol and cloud products produced within the ESA Climate Change Initiative presented
- GlobAEROSOL product was used to estimate the aerosol direct effect over land and sea regions globally

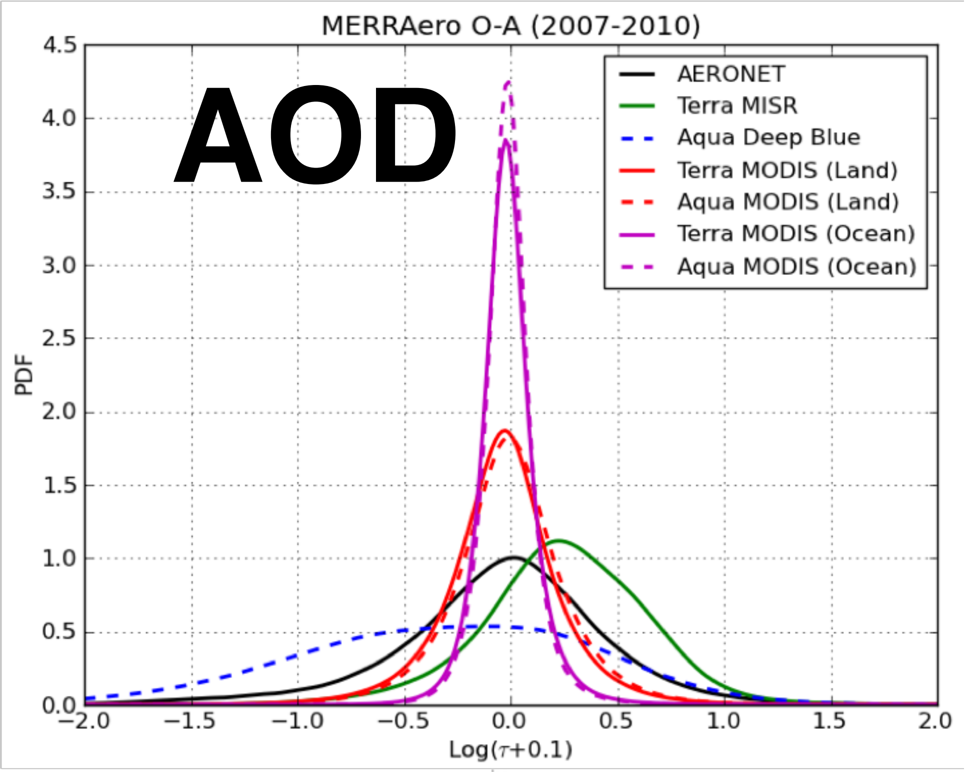


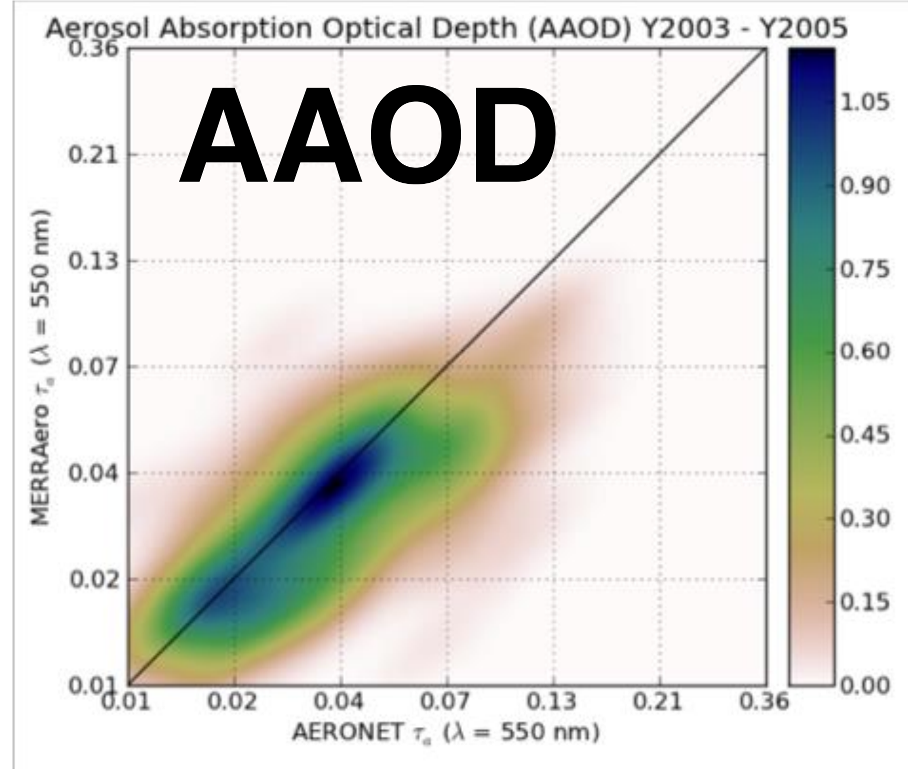


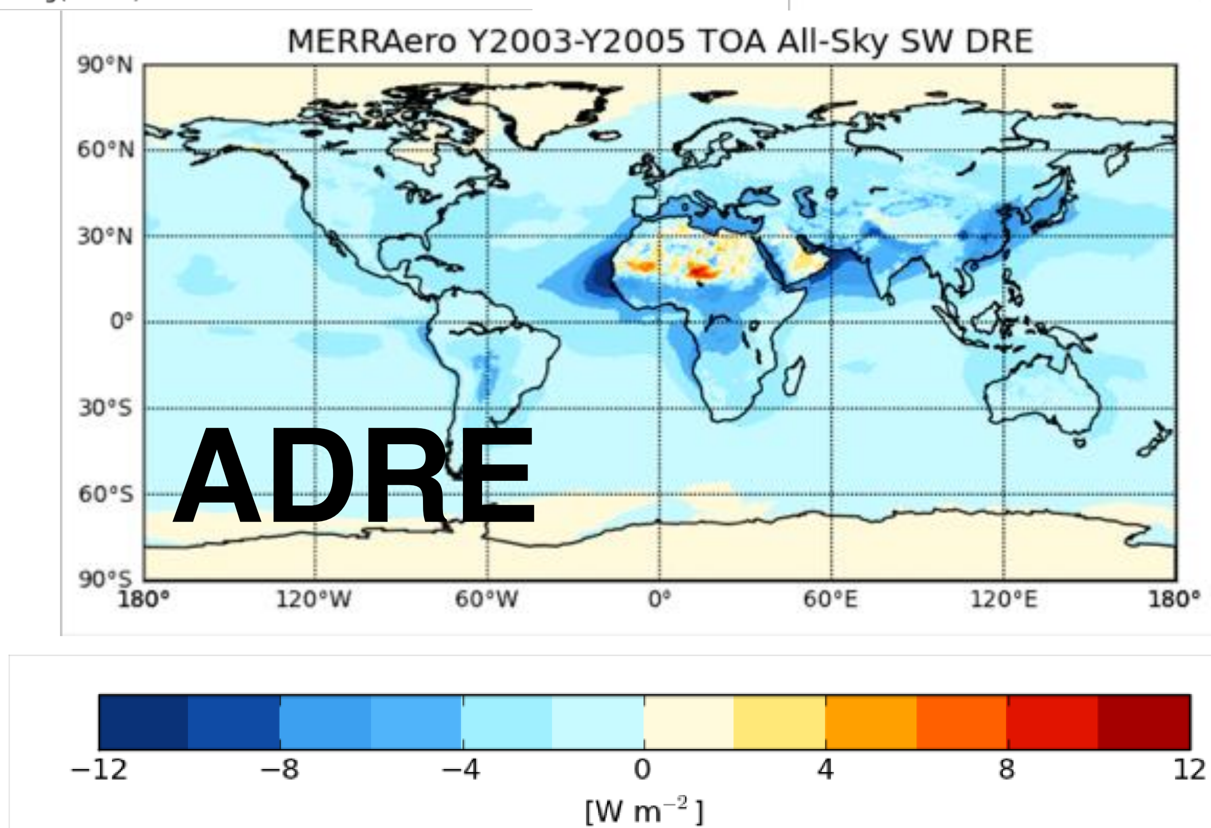
C. A. Randles, V. Buchard, P. R. Colarco, A. da Silva, A. Darmenov, E. Nowottnick, V. Aquila[2], and R. Govindaraju

The MERRAero Aerosol Reanalysis:
Evaluation and Climate Study Applications

Feature	Description
Model	GEOS-5 Earth Modeling System (w/ GOCART) Constrained by MERRA Meteorology (Replay) Land sees obs. precipitation (like MERRA*Land*) Driven by QFED daily Biomass Emissions
Aerosol Data Assimilation	Local Displacement Ensembles (LDE) MODIS reflectances AERONET Calibrated AOD's (550 nm Neural Net) Stringent cloud screening
Period	mid 2002-present (Aqua + Terra)
	2000-mid 2002 (Terra only)
Resolution	Horizontal: nominally 50 km Vertical: 72 layers, top ~85 km
Aerosol Species	Dust, sea-salt, sulfates, organic & black carbon


MERRAero O-A (2007-2010)
AOD
AERONET
Terra MISR
Aqua Deep Blue
Terra MODIS (Land)
Aqua MODIS (Land)
Terra MODIS (Ocean)
Aqua MODIS (Ocean)
PDF
Log(τ+0.1)


Aerosol Absorption Optical Depth (AAOD) Y2003 - Y2005
AAOD
MERRAero τa (λ = 550 nm)
AERONET τa (λ = 550 nm)

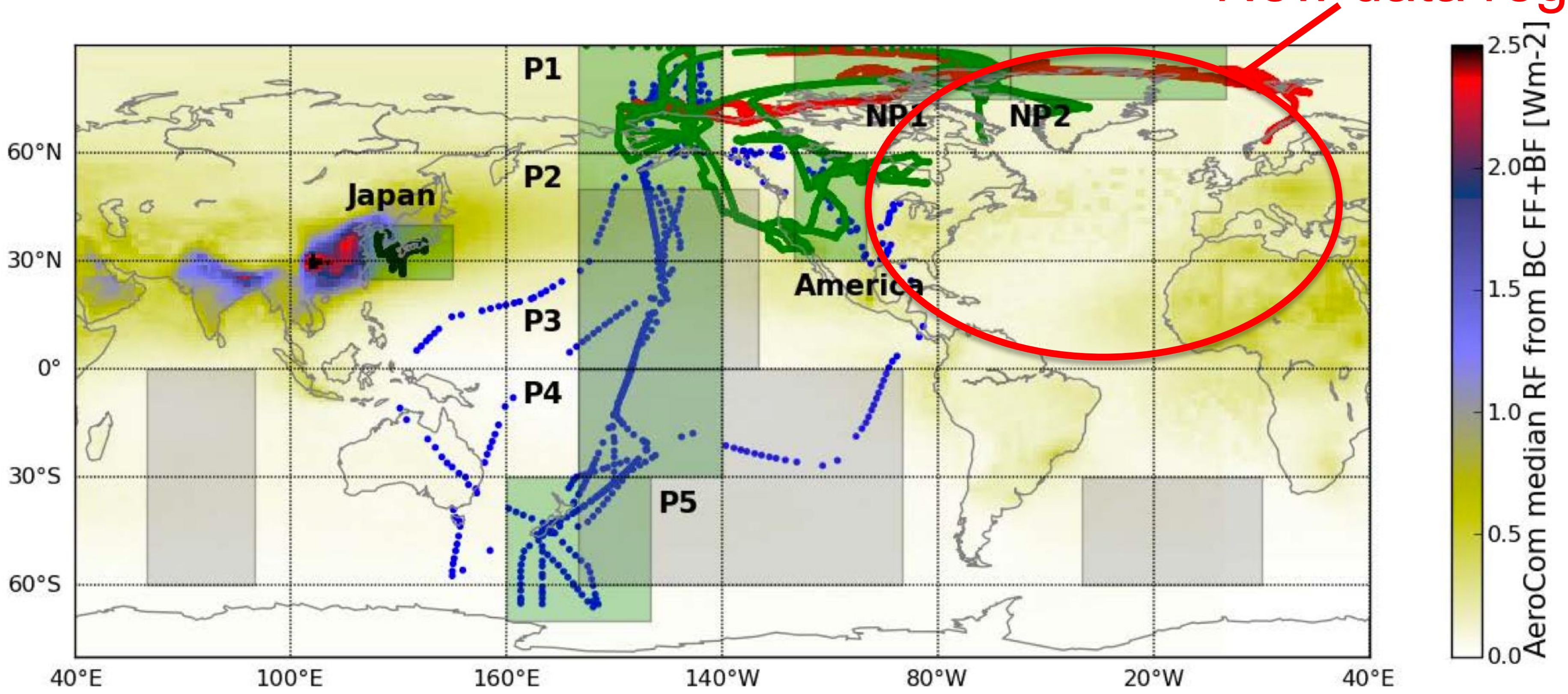

MERRAero Y2003-Y2005 TOA All-Sky SW DRE
ADRE
[W m⁻²]

AeroCom/BC Measurement Comparison

J. P. Schwarz and B. Weinzierl

Samset et al., 2014, Bond et al., 2013, and Koch et al., 2009, highlight the need for continued evaluation of BC MMR close to source regions (and at altitude), and in regions with strong dust influences.

New data region

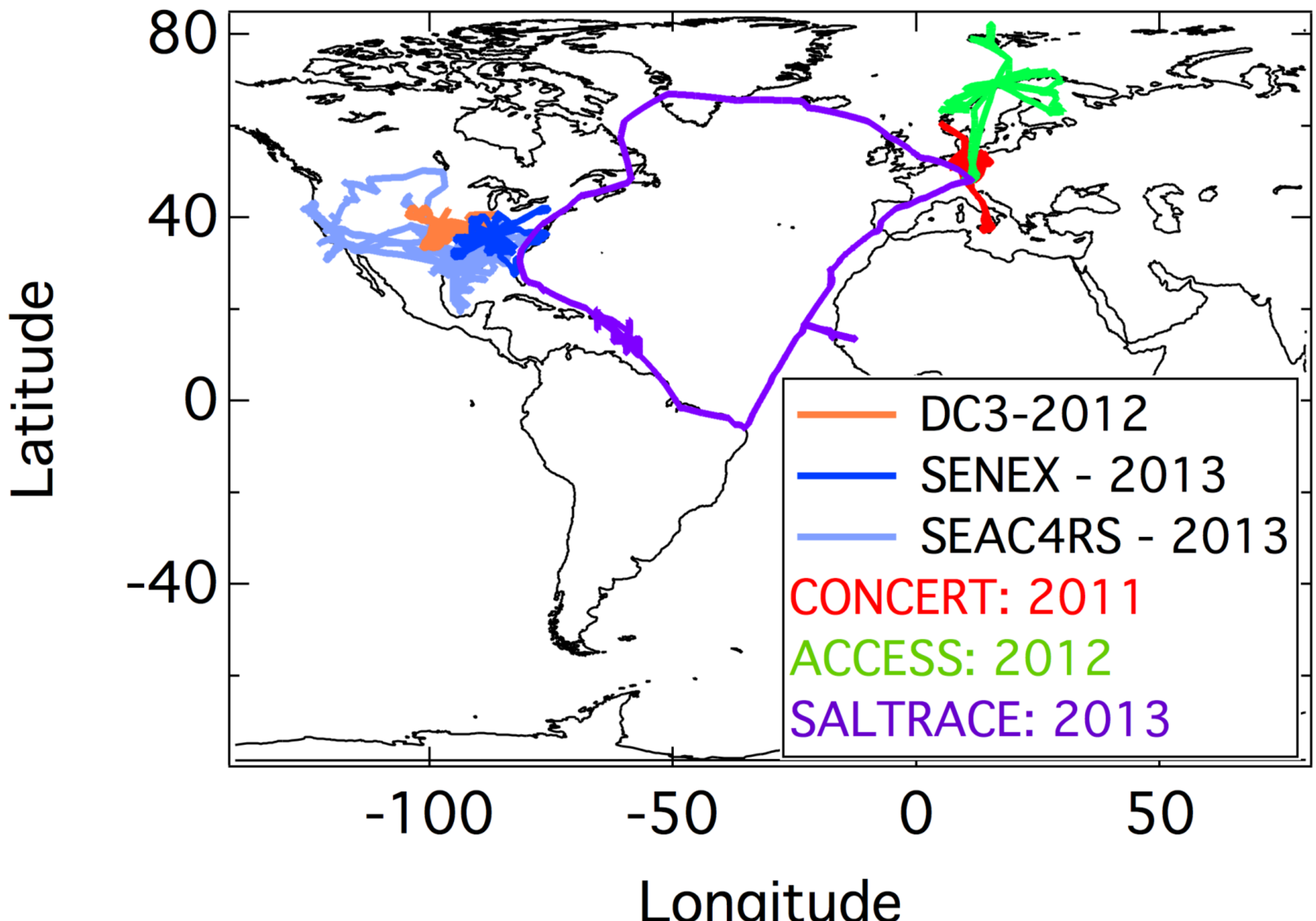


Samet et al.,ACPD, 2014

AeroCom/BC Measurement Comparison

J. P. Schwarz and B. Weinzierl

Multiple SP2 data sets obtained in DLR/NOAA/NASA Campaigns.



Estimating Anthropogenic Aerosol Indirect Effects Through Cirrus Clouds using CAM5.1 with Different Ice Nucleation Parameterizations

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

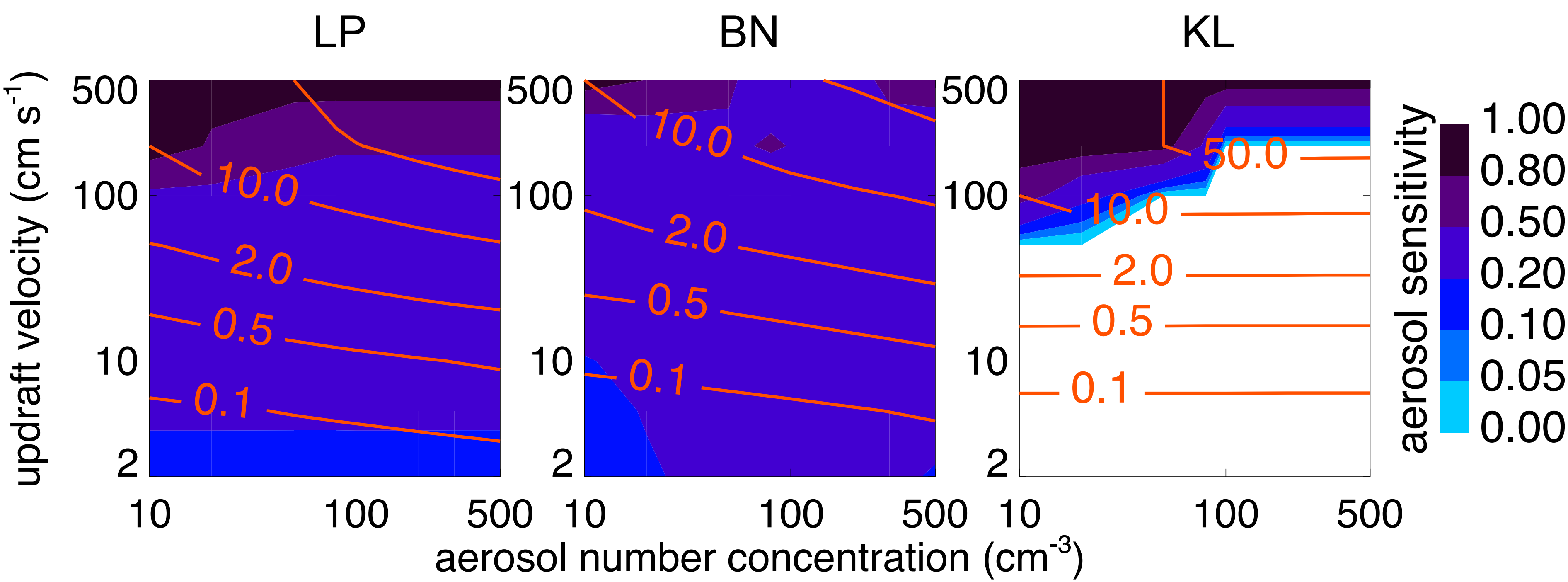
1. University of Wyoming
2. Pacific Northwest National Laboratory

Anthropogenic Aerosol Indirect Effects through cirrus clouds on climate.

Names	CF	LWCF	SWCF	IWP	LWP	CDNI	CDNC	PRECC	PRECL	PRECT
LP_{PD}	-27.84	25.86	-53.70	19.19	45.32	1.50	1.40	2.07	0.89	2.96
BN_{PD}	-27.81	25.46	-53.27	18.77	45.09	1.45	1.39	2.08	0.89	2.97
KL_{PD}	-28.15	25.06	-53.21	18.52	45.20	1.50	1.41	2.08	0.89	2.97
LP_{PI}	-27.97	25.50	-53.47	18.99	45.26	1.41	1.40	2.07	0.89	2.96
BN_{PI}	-27.91	25.13	-53.04	18.58	45.01	1.37	1.40	2.08	0.89	2.97
KL_{PI}	-28.02	25.01	-53.03	18.53	45.12	1.47	1.40	2.09	0.89	2.98
ΔLP	0.13	**0.36**	-0.23	0.20	0.06	**0.09**	0	0	0	0
ΔBN	0.10	**0.33**	-0.23	0.19	0.08	**0.08**	-0.01	0	0	0
ΔKL	-0.13	**0.05**	-0.18	-0.01	0.08	**0.03**	0.01	-0.01	0	0

Liu and Penner (2005) ;Barahona and Nenes (2009) ;Kärcher et al. (2006)

Aerosol Sensitivity Parameter (ηα) ηα=d(lnNi)/d(lnNa).

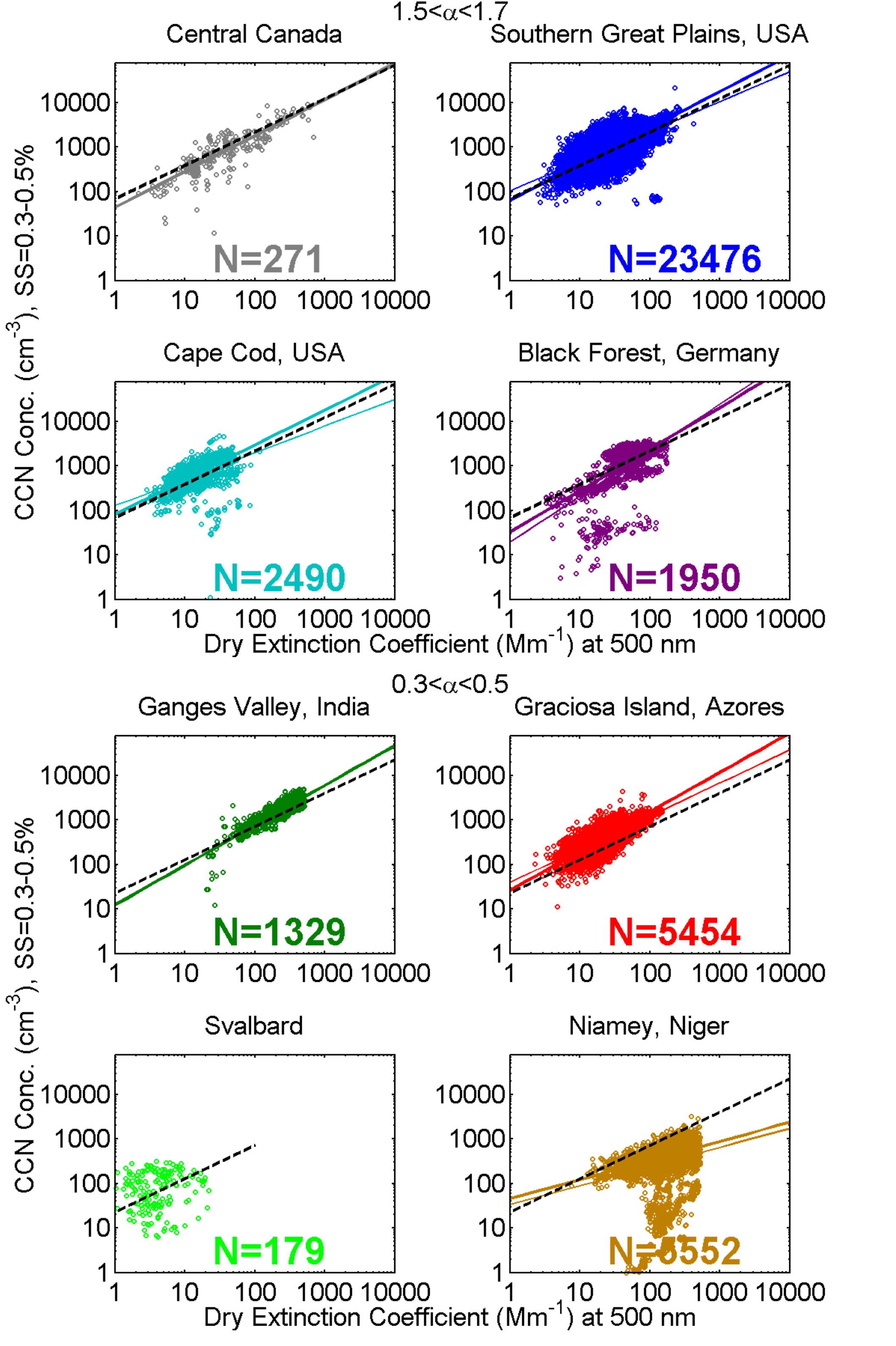


Ice crystals number concentration contoured as a function of vertical velocity and sulfate aerosol number concentration. Colors indicate the aerosol sensitivity parameter η_α. Results from pure homogeneous freezing experiments using ice nucleation parameterizations.

The relationship between CCN concentration and aerosol extinction

in situ observations for dried particles

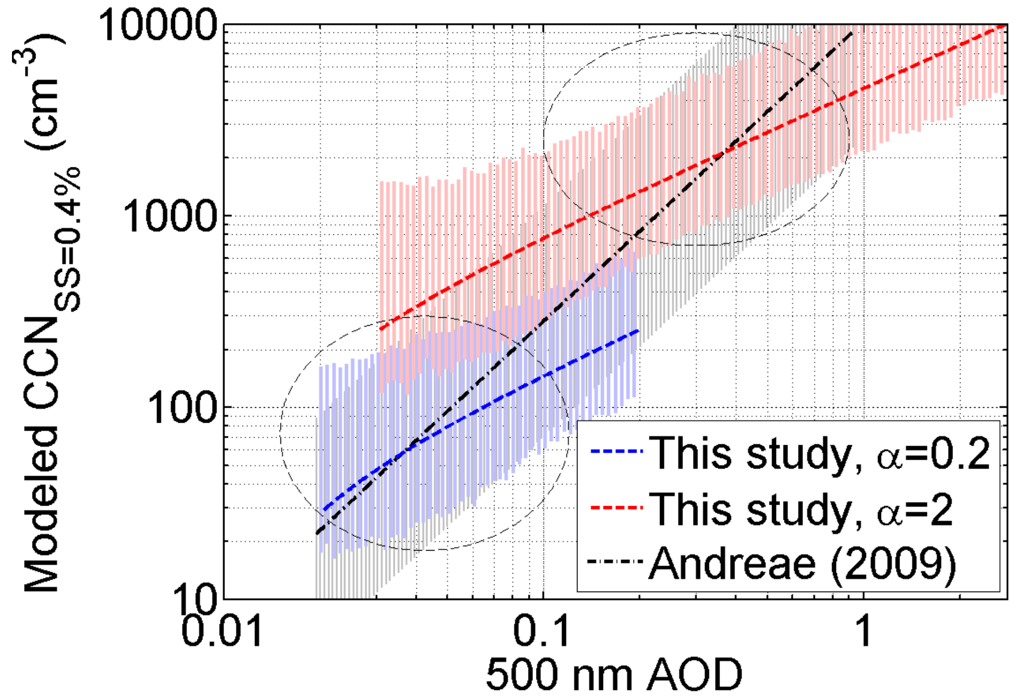
$CCN_{SS\sim0.4\%}(cm^{-3})=10^{0.4\alpha+1.2}\sigma^{0.75}$
σ: ext (Mm-1), α=Angstrom Exp.

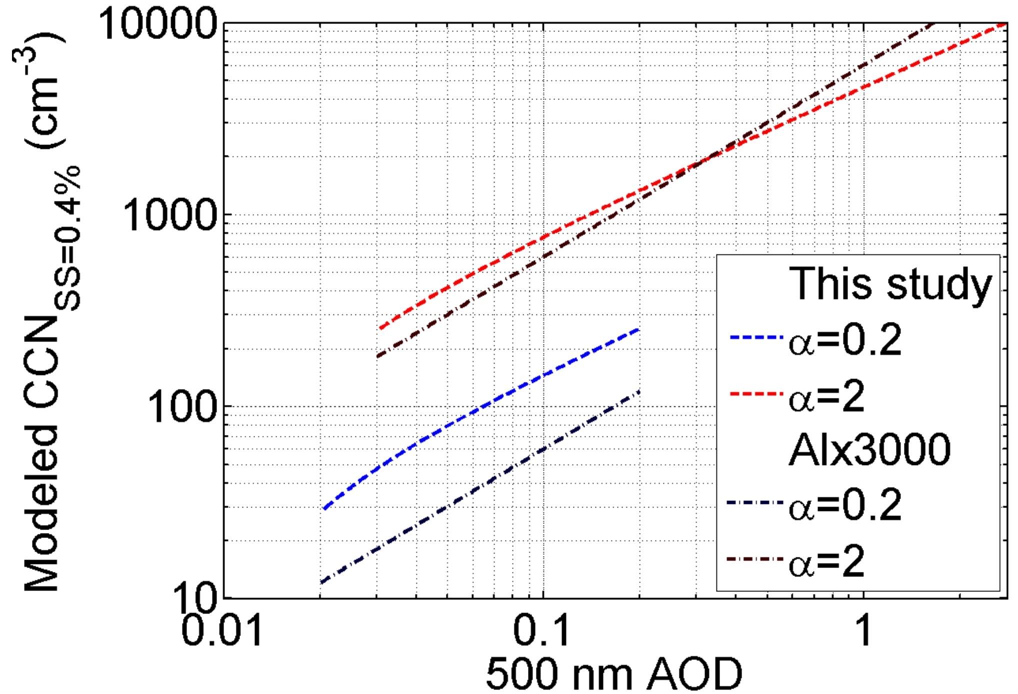


a et al.

The relationship between CCN concentration and aerosol extinction

implications on satellite-based CCN estimates



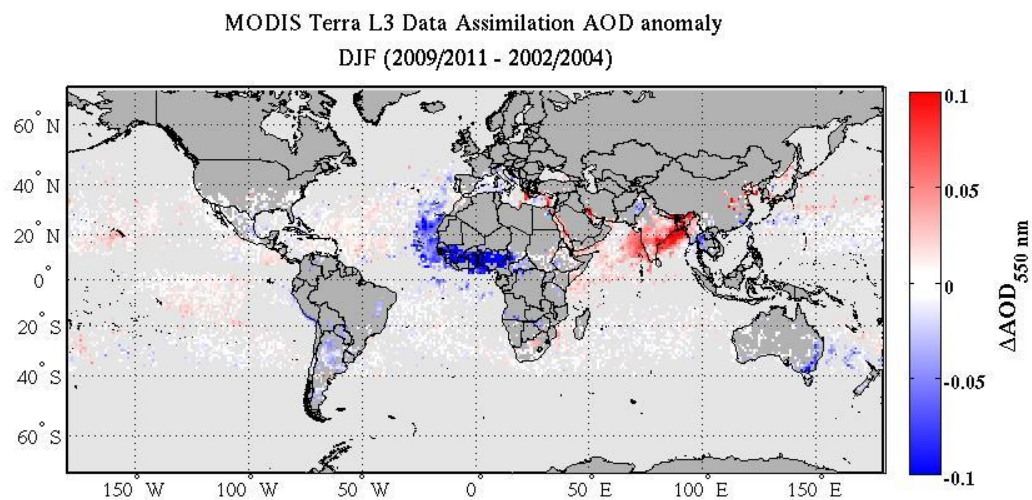


Shinozuka et al.

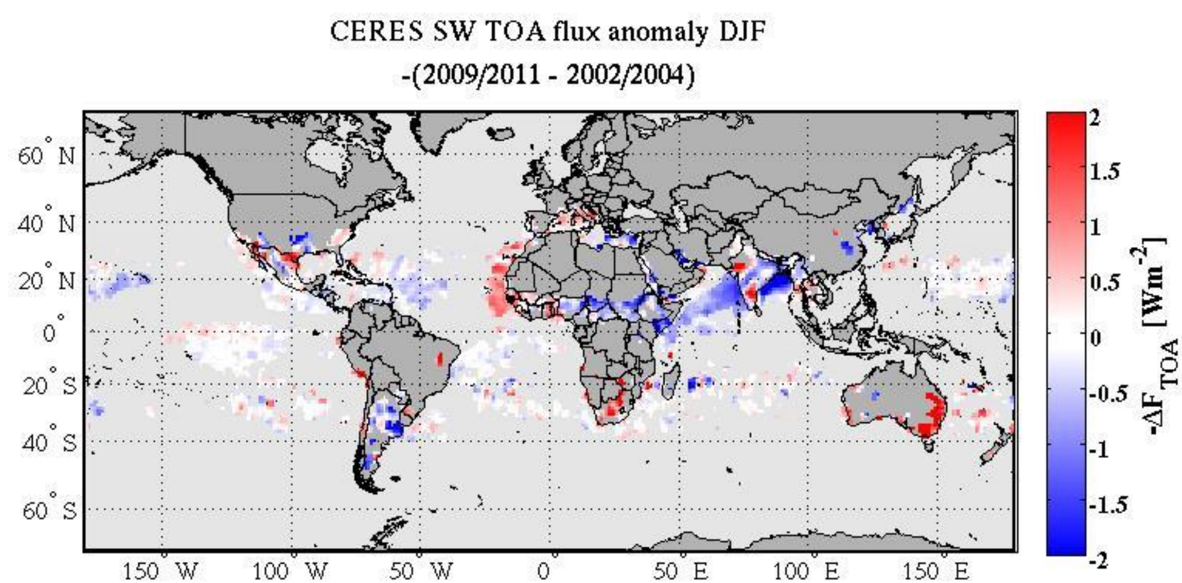
Sundström A.-M. et al.

DECADAL CHANGES IN CERES CLEAR-SKY SHORTWAVE TOA FLUXES: WHAT CAN WE SAY ABOUT AEROSOL CONTRIBUTION?

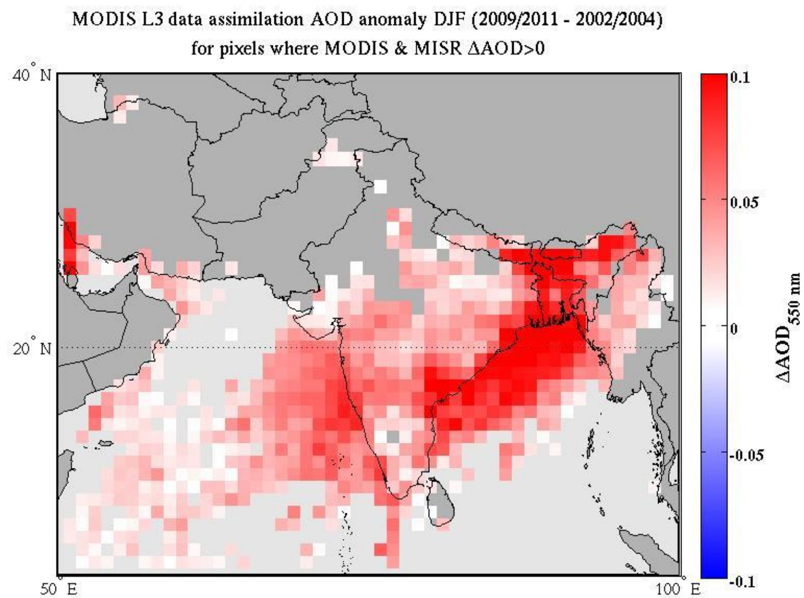
AOD anomaly winter (DJF) (2009/2011 2002/2004)



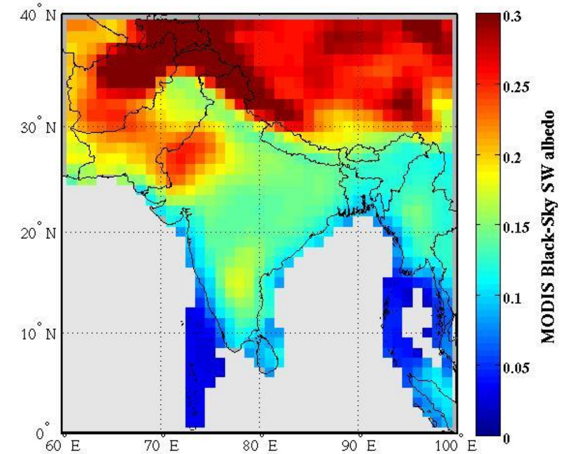
CERES clear-sky SW TOA flux anomaly winter (DJF) (2009/2011 2002/2004)



MODIS AOD anomaly



MODIS Black-Sky Albedo



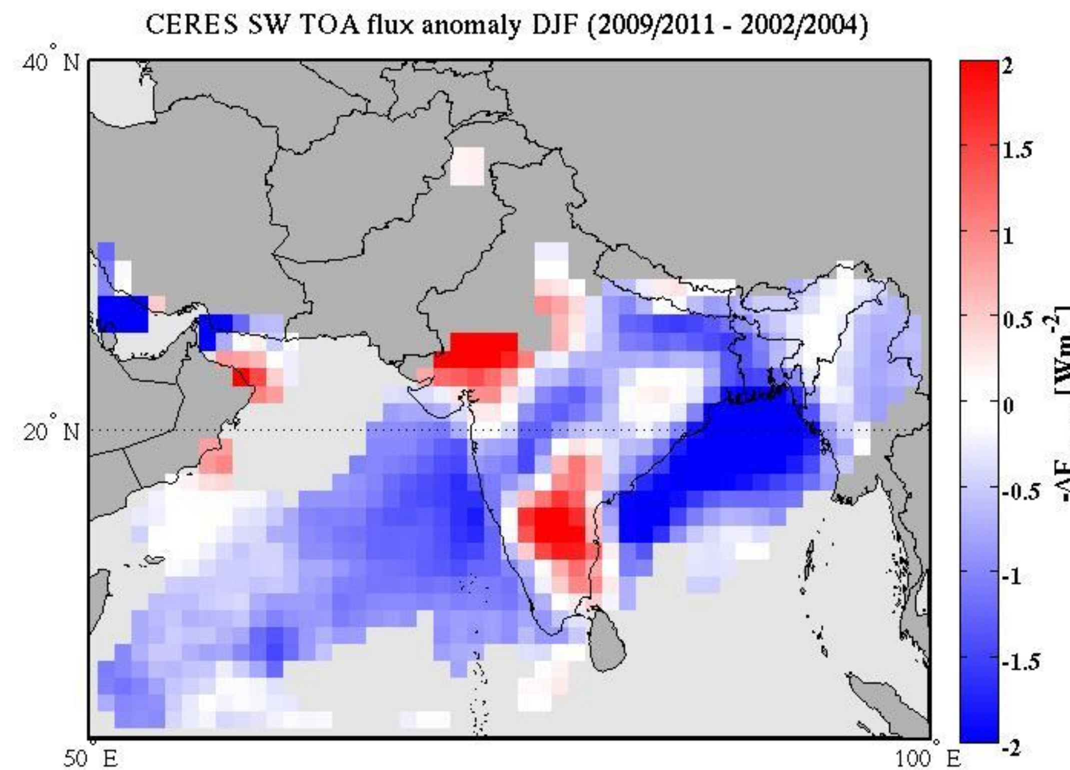
Simulations

"Dark" surface:
□ AOD=+0.05
□SW $Flux_{TOA}$ = 0.2…3 Wm^{-2}
(abs…. scatt. type)

Bright surface:
AOD=+0.05
□SW $Flux_{TOA}$ = 0.6…3 Wm^{-2}
(abs…. scatt. type)

+ precipitable water & surface anomalies

SW Clear-Sky TOA flux anomaly

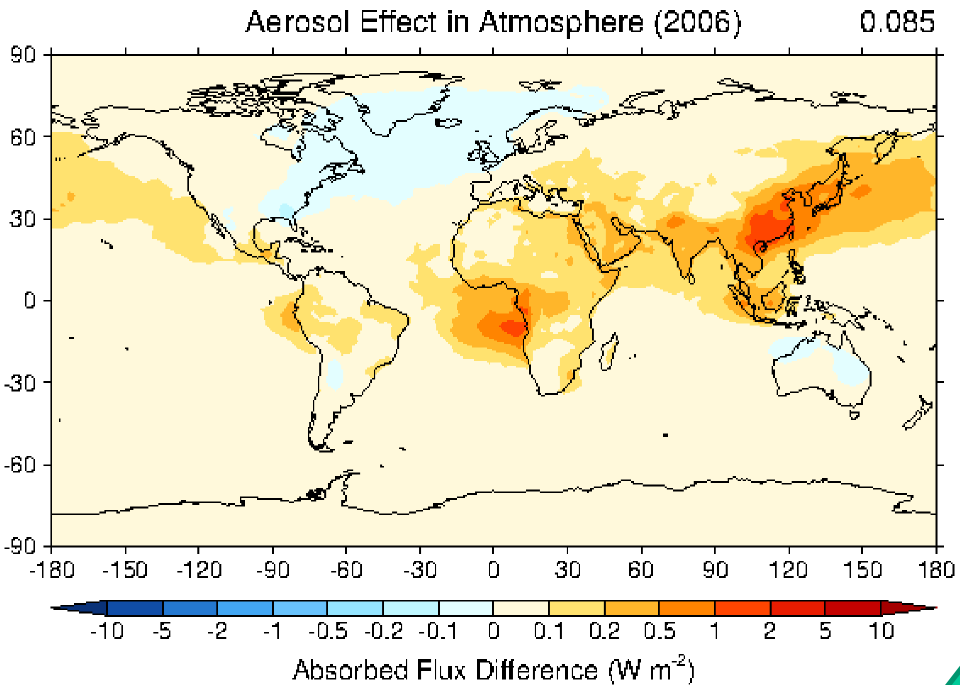


Clear-sky and all-sky direct radiative forcing estimates based on TM5 and a doubling-adding radiative transfer model using observed clouds

Michiel van Weele, Ana Ruiz-Garces, Twan van Noije, Jan-Willem Meijerink, Ping Wang, Piet Stammes
KNMI, The Netherlands

Reduce modelled uncertainties in direct aerosol effect/forcing = $(\Delta B)^2 * (\Delta M)^2 * (\Delta E)^2$

B = Burden — Determined by emissions and residence times
M = Mass extinction coefficient — Determined by load and water uptake
E = Radiative Efficiency — Determined by clouds, radiative transfer



Approach

(1) Chemical transport model TM5
Aerocom Phase 2 simulations

(2) Radiative transfer model DAK
Direct radiative effect / rad. forcing

(3) Observed clouds FRESCO/SCIAMACHY 2006

Results

(i) Cloud impact on atm. absorption
(ii) All sky radiative efficiency per AOD

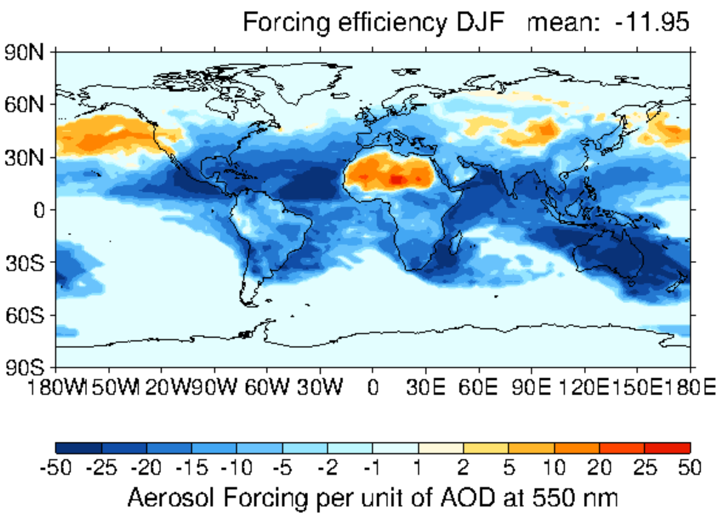
Positive (and slightly negative) effects of clouds on atm. absorption

Clear-sky and all-sky direct radiative forcing estimates based on TM5 and a doubling-adding radiative transfer model using observed clouds

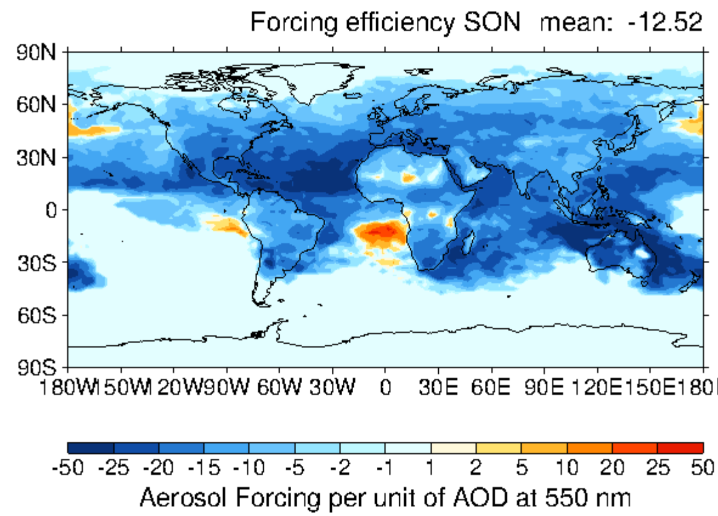
Michiel van Weele, Ana Ruiz-Garces, Twan van Noije, Jan-Willem Meijerink, Ping Wang, Piet Stammes

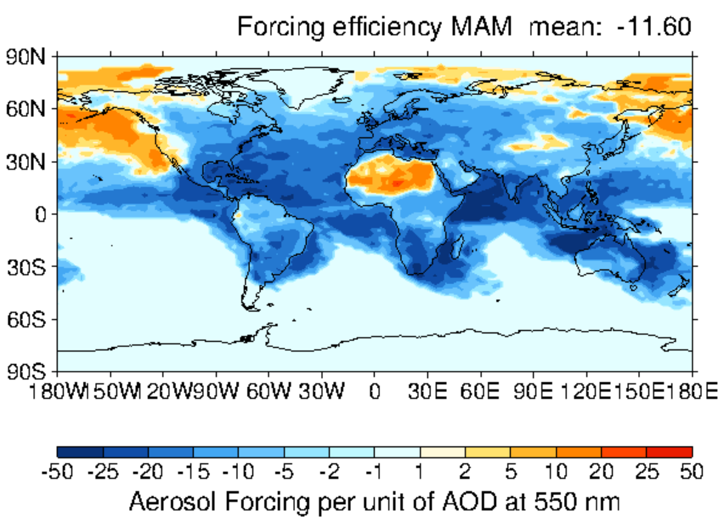
KNMI, The Netherlands

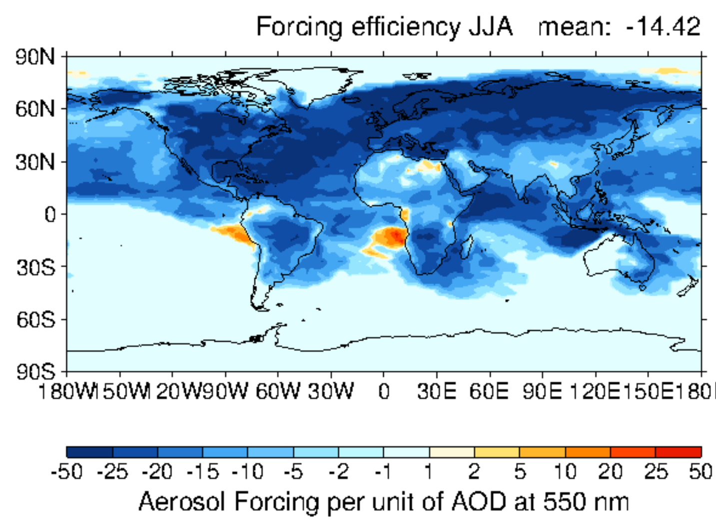
All sky aerosol forcing efficiency per season



Annual mean direct radiative forcing (at TOA):
$F \approx -12.6\,\tau$
Clear sky:
$F \approx -24.5\,\tau$

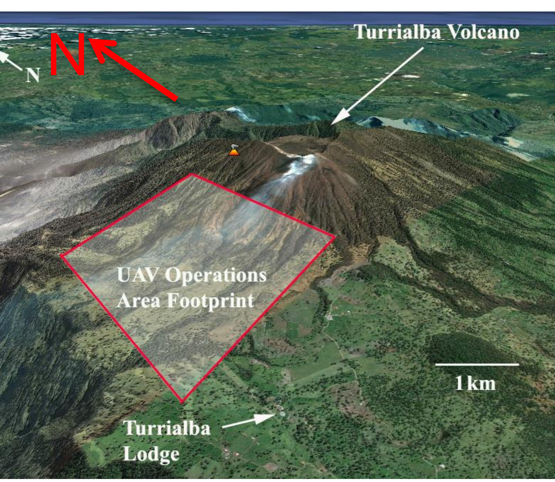


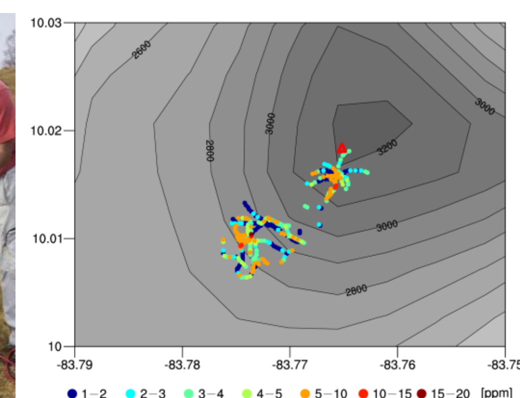




Top-down Estimates of SO_2 Degassing Volcano Emissions Using In Situ SO_2 Measurements and the WRF-STILT Model, a Case Study at the Turrialba Volcano, Costa Rica

Xin Xi[1] (xin.xi@nasa.gov), Matthew S. Johnson[1], Matthew Fladeland[1], David Pieri[2], Jorge Andres Diaz[3], Seongeun Jeong[4], Geoff Bland[5]
[1]NASA Ames Research Center; [2]NASA Jet Propulsion Laboratory. [3]University of Costa Rica, Costa Rica. [4]Environmental Energy Technologies Division, [4]Lawrence Berkeley National Laboratory [5]Wallops Flight Facility, NASA Goddard Space Flight Center





Through a case study at the Turrialba Volcano, Costa Rica (which is assigned an extraeruptive rate in AeroCom), our **research goals** are

1) to develop an inverse estimate of volcanic degassing rates by applying a high-resolution receptor-oriented analysis on in situ SO_2 measurements.
2) to examine the impact of top-down SO_2 emission fluxes on regional-scale atmospheric compositions.

Main findings:

WRF-STILT model is able to accurately connect measurement locations and the volcanic SO_2 source.

The top-down estimate of SO_2 degassing flux from the Turrialba Volcano is higher than the AEROCOM extraerupative (posteruptive) rate by a factor of 10^4 (100).

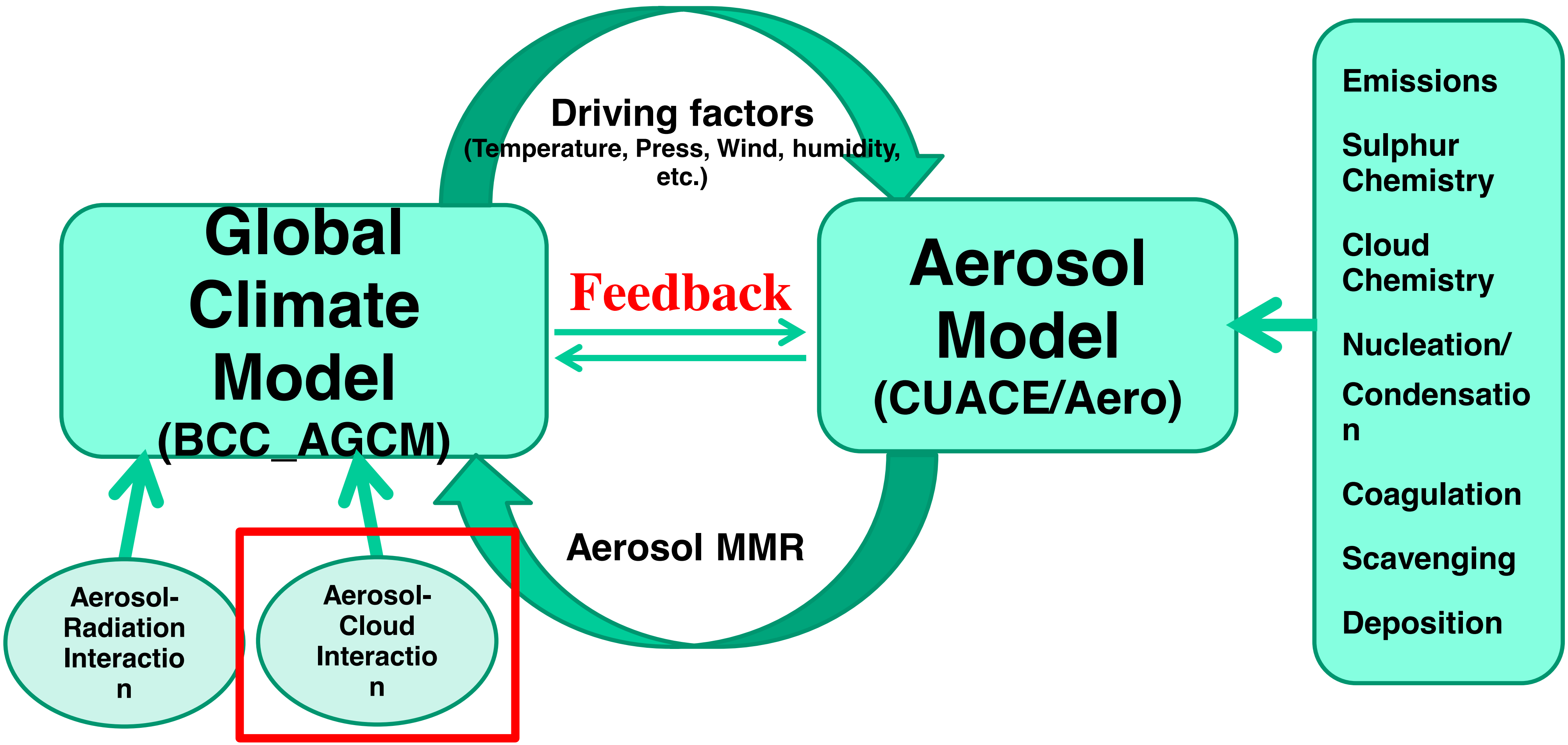
Sensitivity model tests using GEOS-Chem show the top-down SO_2 flux leads to large increases in the SO_2 and SO_4^{2-} concentrations near the source and in downwind regions, which implies that using the AEROCOM inventory underestimates the natural SO_2 contribution from the Turrialba Volcano.

Improvement of cloud microphysics in the aerosol-climate model BCC_AGCM2.0.1_CUACE/Aero, evaluation against observations, and updated aerosol indirect effect

Hua Zhang
(huazhang@cma.gov.cn)
National Climate Center,CMA, Beijing, China

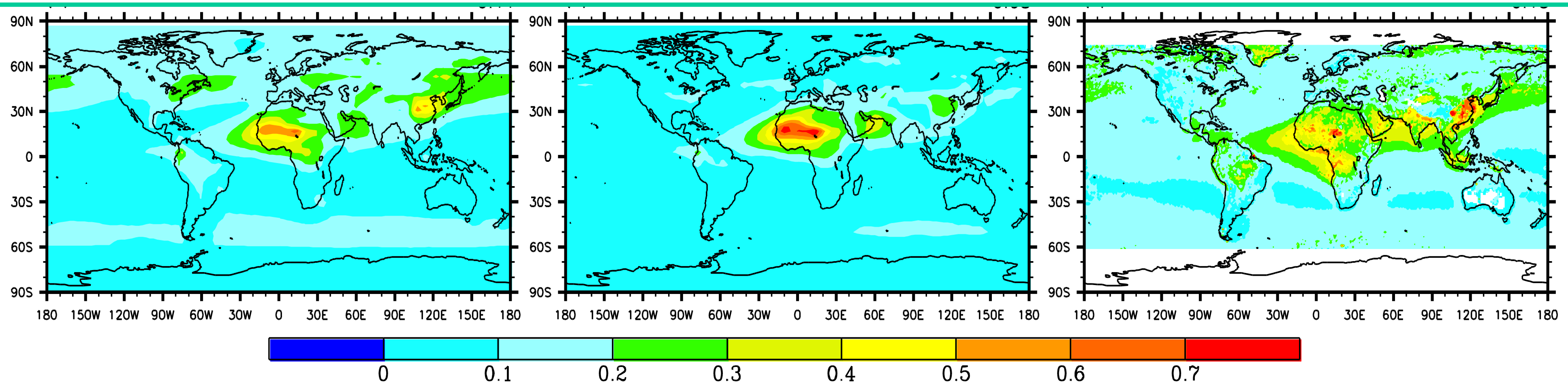
Zhili Wang and Peng Lu

Aerosol-Climate Model (BCC_AGCM2.0.1_CUACE/Aero）



We implemented two-moment cloud microphysical scheme 0f Morrison and Gettelman (2008) into this model instead of the original one-moment bulk cloud microphysical scheme , and evaluated the new model.

Global distributions of simulated and observed annual mean AOD at 550 nm. (a) New Model, (b) Old Model and (c) MODIS&MISR.

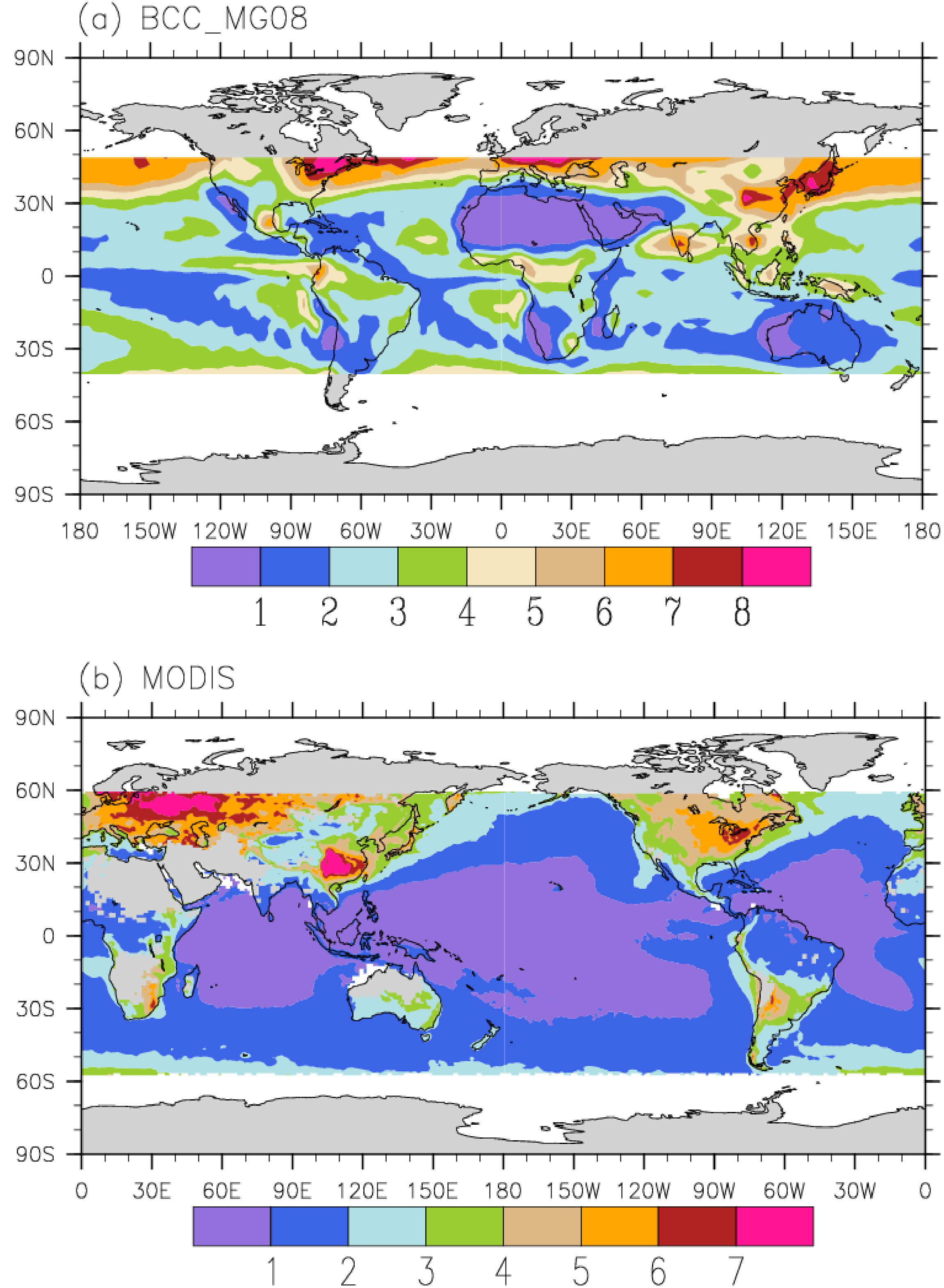


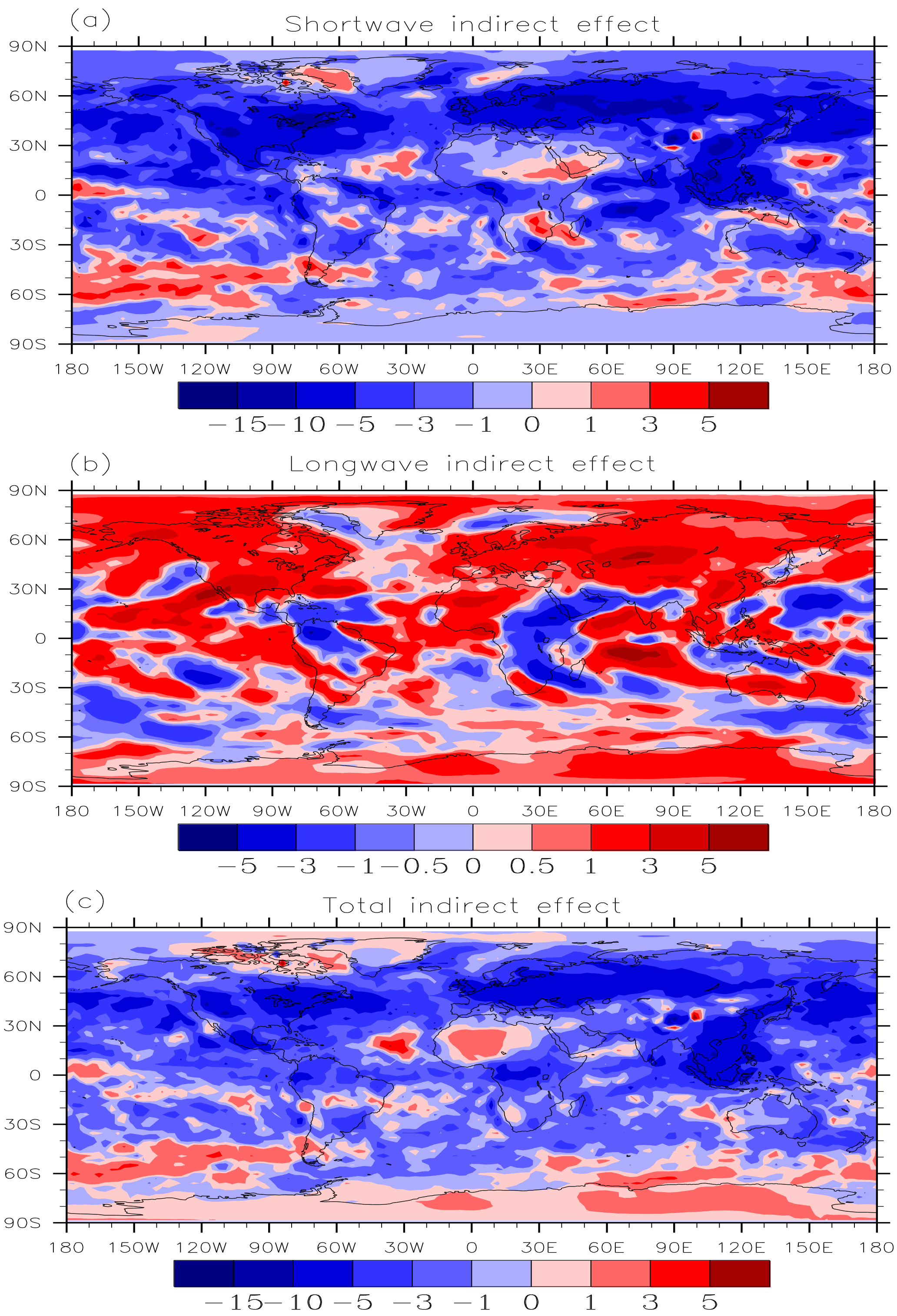
Global Budgets for Aerosols and Cloud Water (CW)[a]

	BCC_MG08				BCC_RK98			
	Source	Burden	Sink	Lifetime	Source	Burden	Sink	Lifetime
SU	70.2	0.97	20.2 (D), 52.9 (W)	5.0	–	0.69	16.7 (D), 55.4 (W)	3.6
BC	7.7	0.084	4.9 (D), 2.6 (W)	4.0	–	0.069	4.7 (D), 2.8 (W)	3.3
OC	66.1	0.79	39.1 (D), 26.6 (W)	4.4	–	0.68	38.0 (D), 27.3 (W)	3.8
DU	3846.4	20.7	3049.0 (D), 799.2 (W)	1.96	5535.6	21.3	4080.3 (D), 1459.1 (W)	1.4
SS	33320.3	7.2	31171.4 (D), 2154.7 (W)	0.079	34737.4	7.4	31688.5 (D), 3046.2(W)	0.078
CW	6.3×10^7	4.2×10^7	4.0×10^7	243.3	25.7×10^7	7.1×10^7	8.7×10^7	100.8

The cloud water lifetime in new model is significantly longer than that in old model, resulting in longer lifetimes and larger burdens of aerosols in new model.

Annual mean distributions of column cloud droplet number concentration (unit: 10^{10} m^{-2}). (a) Model, (b) MODIS.





Anthropogenic Aerosol Indirect effect.

Global mean value:

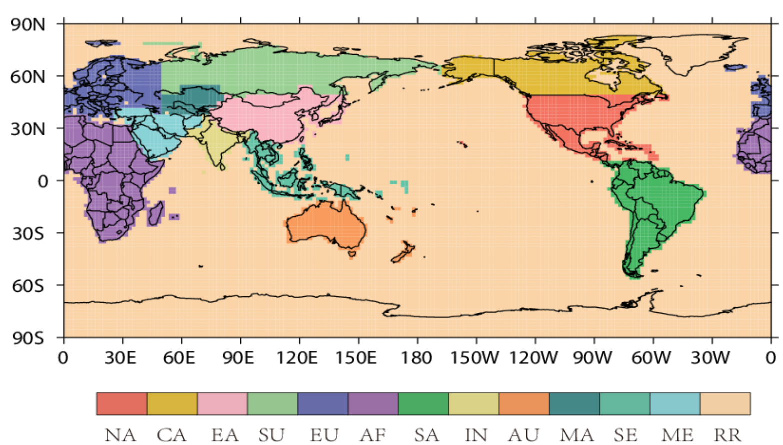
-1.9 Wm-2

Investigating the Vertical Distribution and Source Attribution of Black Carbon over the Pacific Ocean

Jiachen Zhang, Junfeng Liu, George A. Ban-Weiss, and Shu Tao

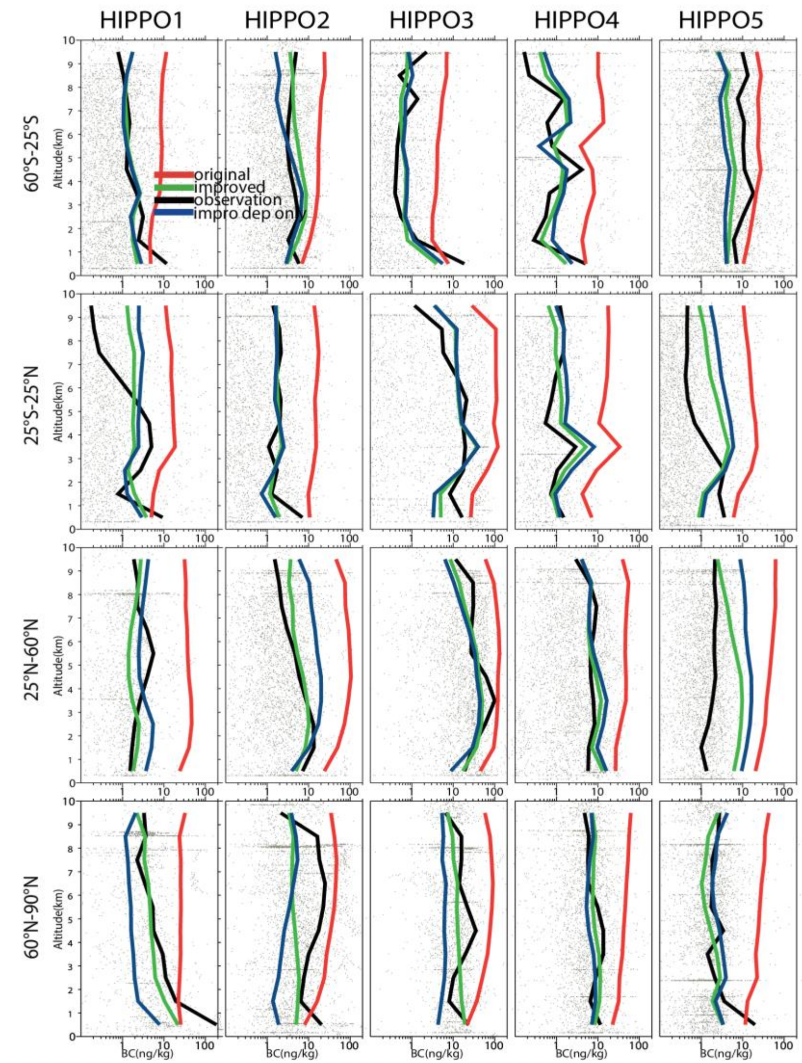
① Improve model's performance

- Implement physically-based dry& wet deposition schemes to MOZART-4
- Optimize aging rates according to different source regions



Thirteen defined source regions

		CA	SU	EU	MA	EA	ME	NA	SE	IN	AF	SA	AU	RR	Mean bias (Improved)	Mean bias (Original)
HIPPO1	Jan	200	120	60	120	4	48	60	4	4	4	60	4	4	3.4	26.4
HIPPO2	Nov	200	200	120	60	4	4	4	4	4	4	200	4	4	1.7	13.2
HIPPO3	Apr	200	200	200	200	24	60	4	24	38	48	4	4	200	1.4	6.6
HIPPO4	Jun	48	4	120	4	4	200	4	8	4	4	60	4	4	1.0	10.6
HIPPO5	Aug	60	4	12	4	4	4	4	4	4	60	4	27	4	2.2	18.7

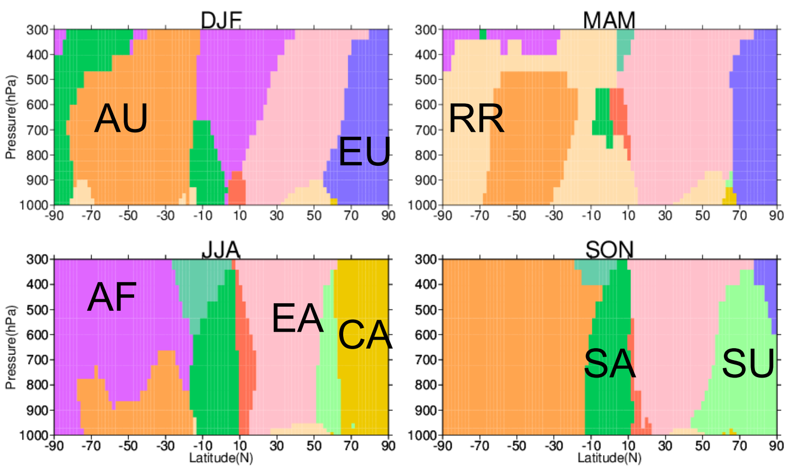


The vertical profiles of BC simulated by the improved model is closer to the HIPPO observations than the original model (Total biases on average are reduced by a factor of 5).

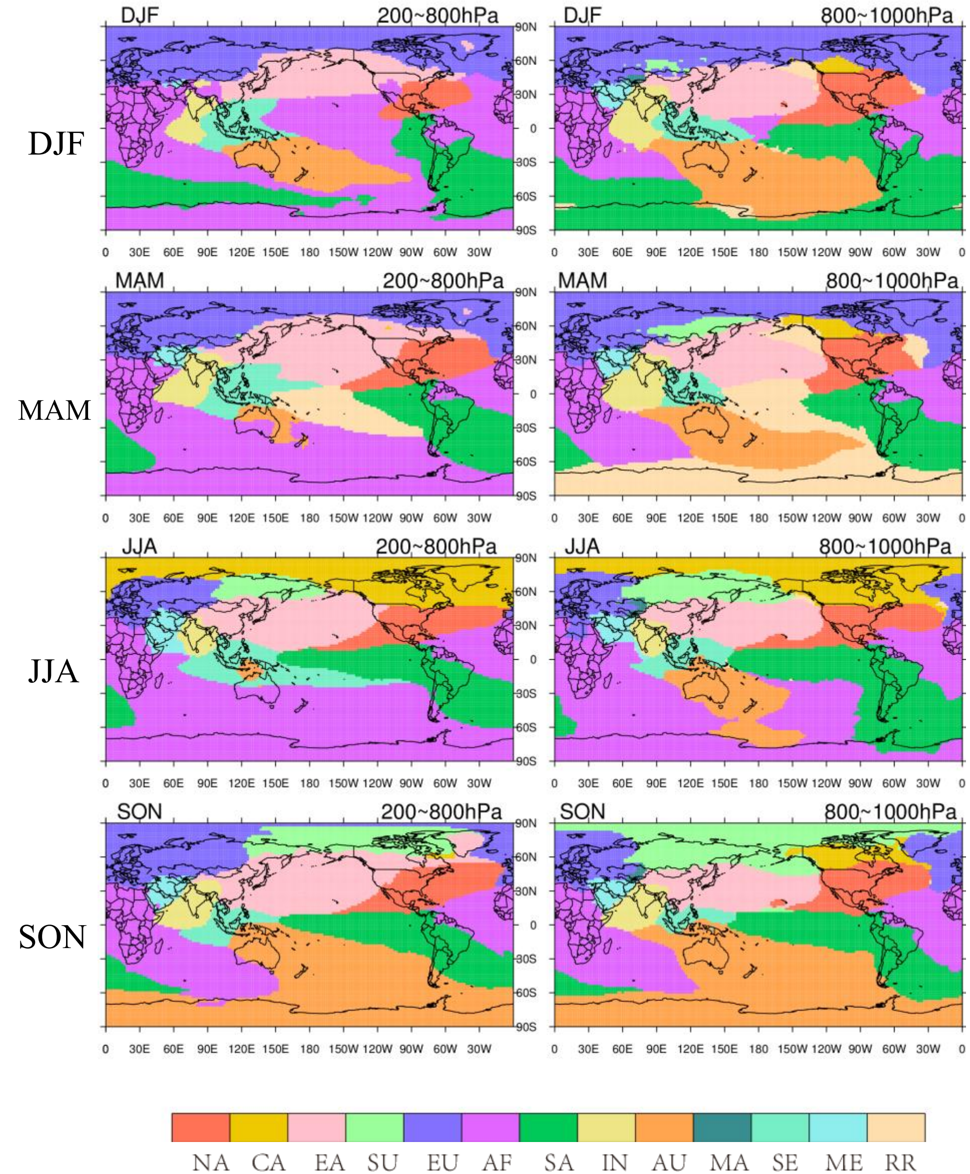
Vertical Distribution and Source Attribution of Black Carbon

② investigate regional contributions in different altitudes

The climate response of Black carbon (BC) depends on its altitude. [Ban-weiss et al., 2011; Samset et al, 2013]



The dominant regional contributors to zonal mean BC concentrations over the central Pacific (130ºW-150ºE)



The dominant regional contributors to BC burdens in the free troposphere (left column) and boundary layer (right column) in different seasons.

- BC in the boundary layer is dominated by local sources.
- BC in mid-upper troposphere over the Pacific ocean is influenced mostly by BC sources from ***East Asia, Africa, South America and Australia***.