Hyvää päivää = Good afternoon

TWO PROPOSED AEROCOM MODEL EXPERIMENTS/ANALYSIS: UTLS AND ACRI

- MOTIVATION
- CURRENT SITUATION OF MODELING STUDIES
- PROPOSED EXPERIMENTS/ANALYSIS

UTLS –

AEROSOLS IN THE UPPER TROPOSPHERE: NATURAL AND ANTHROPOGENIC SOURCES, MONSOON TRANSPORT, AND DECADAL TRENDS

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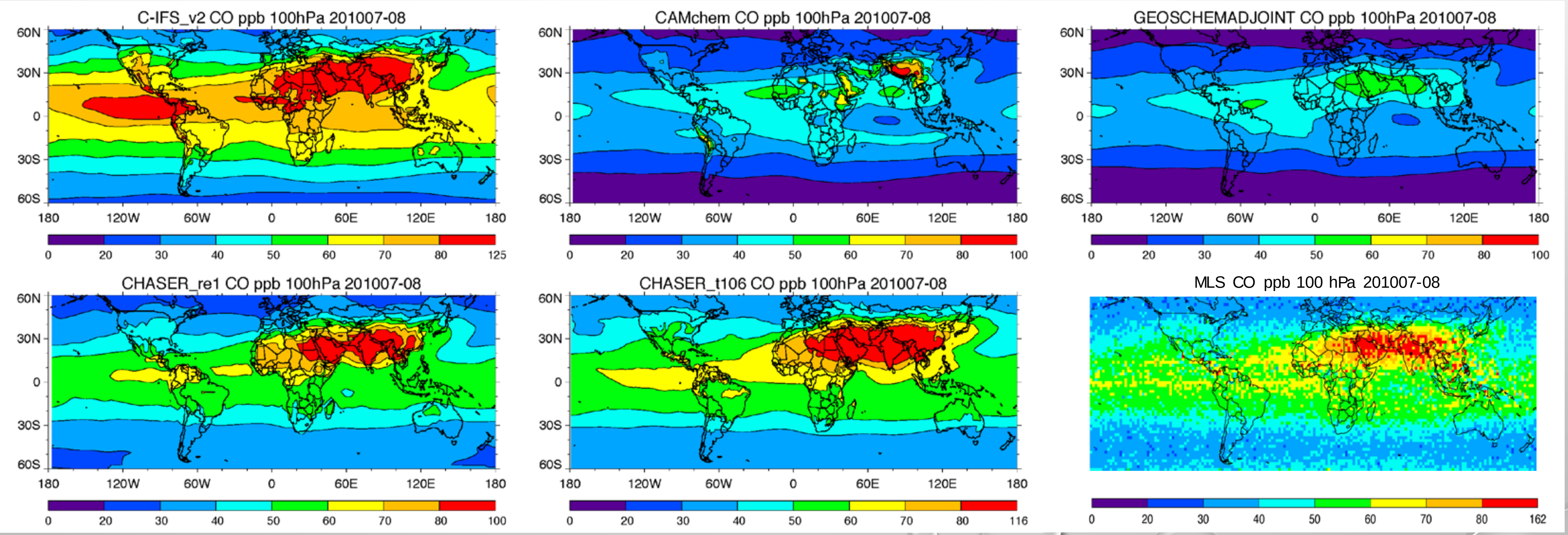
MOTIVATION

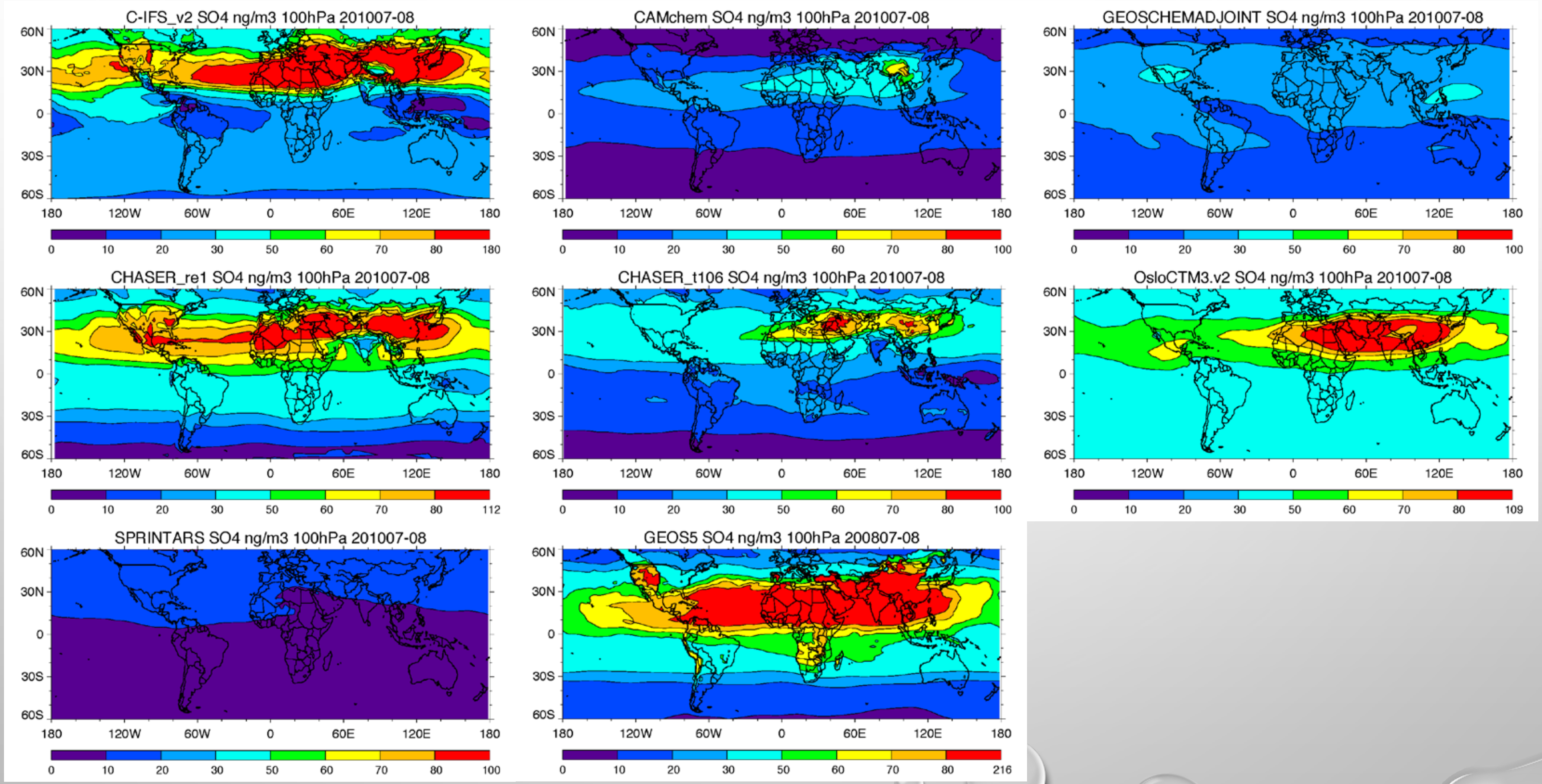
- UTLS is a climate sensitive region
- Aerosols in UTLS affect radiative balance, ice cloud formation, and chemistry
- Aerosols in UTLS are from anthropogenic sources transported by deep convections especially during the summer monsoon season, from volcanic eruptions, and sometimes pyrocovective fires and even occasionally dust storms
- Models show very large differences in this region – much more diverse than the diversity in column AOD or surface concentrations shown in previous AeroCom studies. Although previous AeroCom comparisons of vertical profiles (e.g., BC from ARCTAS and HIPPO) have shown large differences in the free troposphere, there is a need for coordinated model experiment focusing on the UTLS

CURRENT MODEL BEHAVIOR

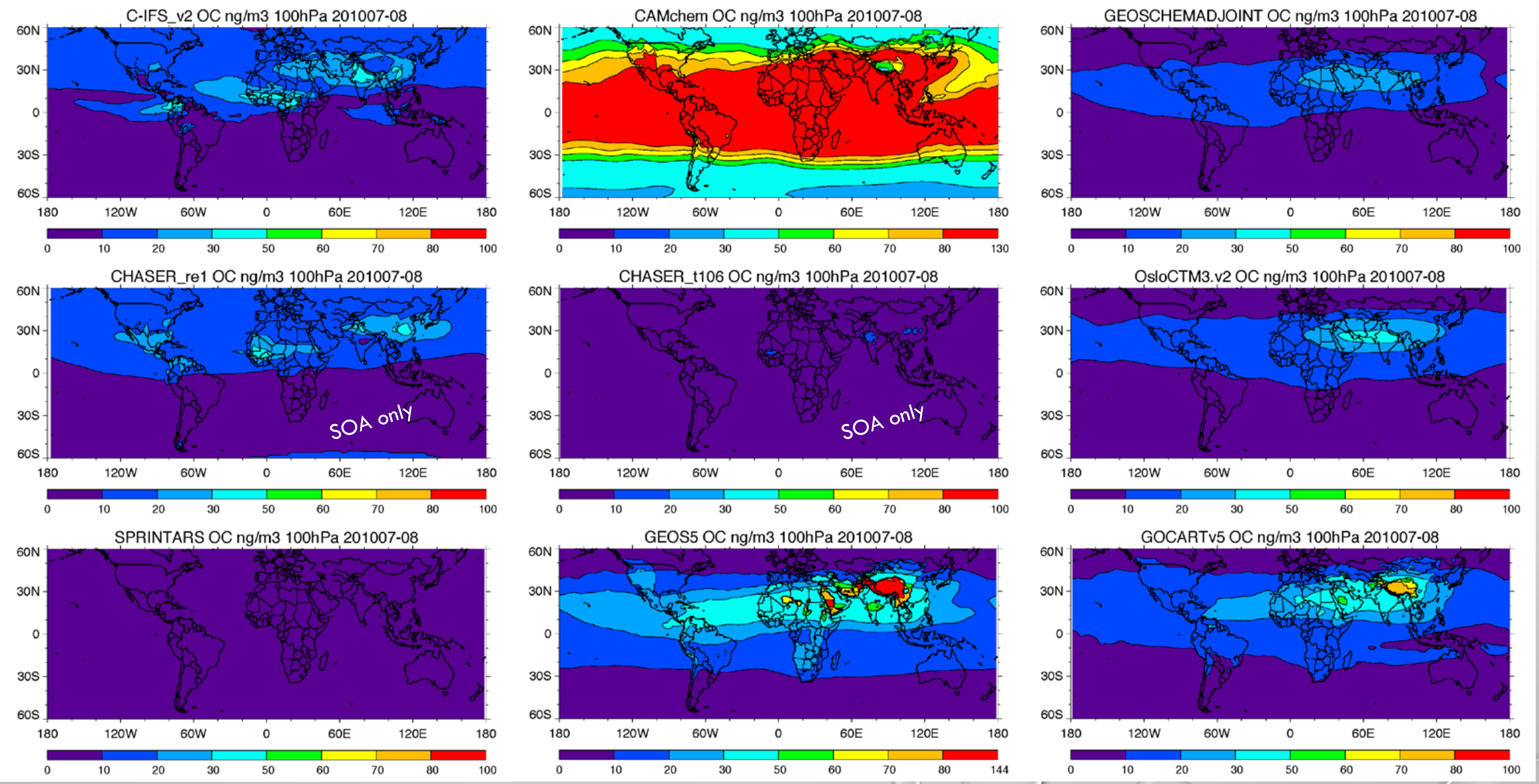
MODEL DIVERSITY – EXAMPLES OF CO AT 100 HPA



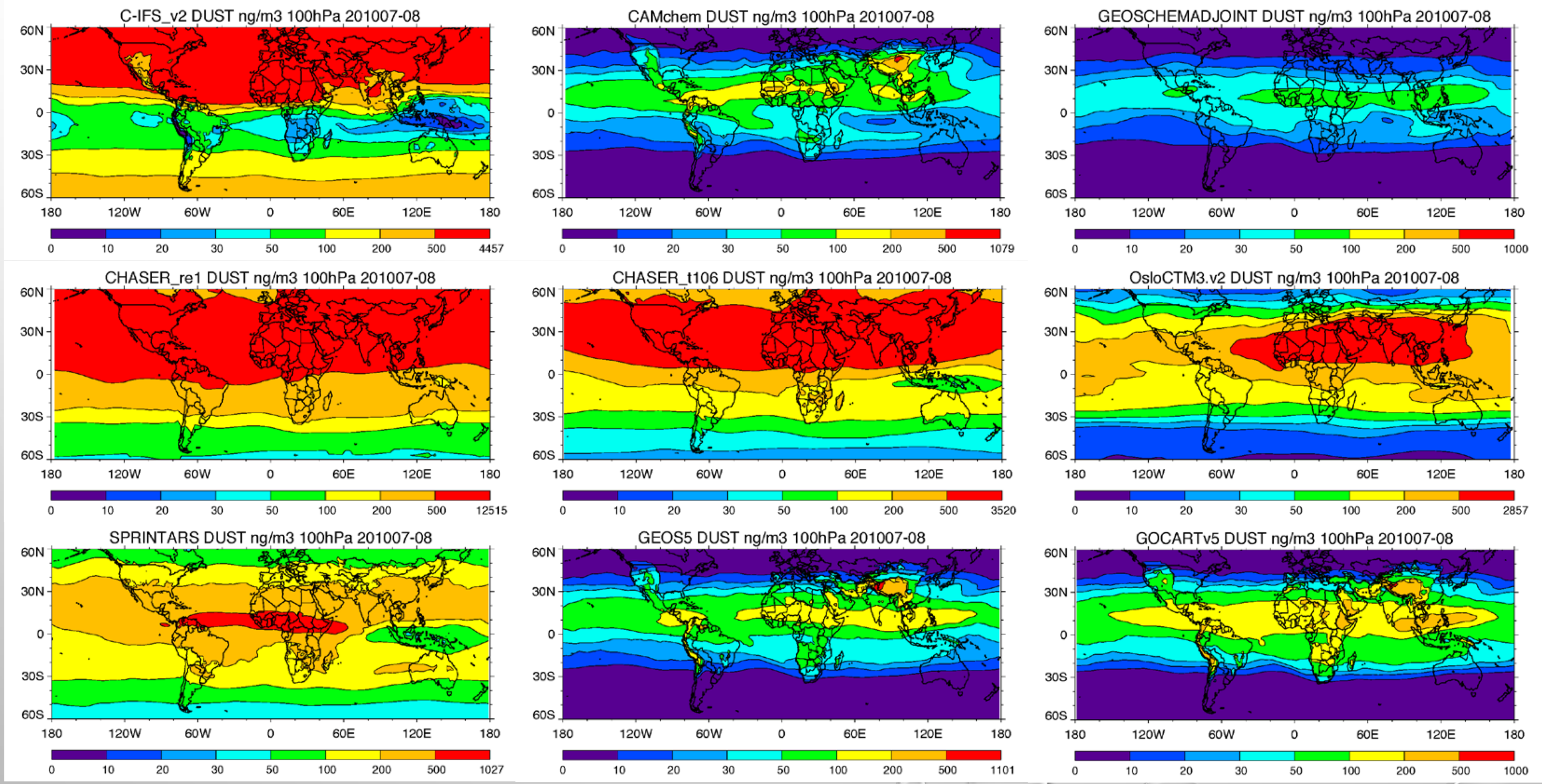
MODEL DIVERSITY – EXAMPLES OF SULFATE AT 100 HPA

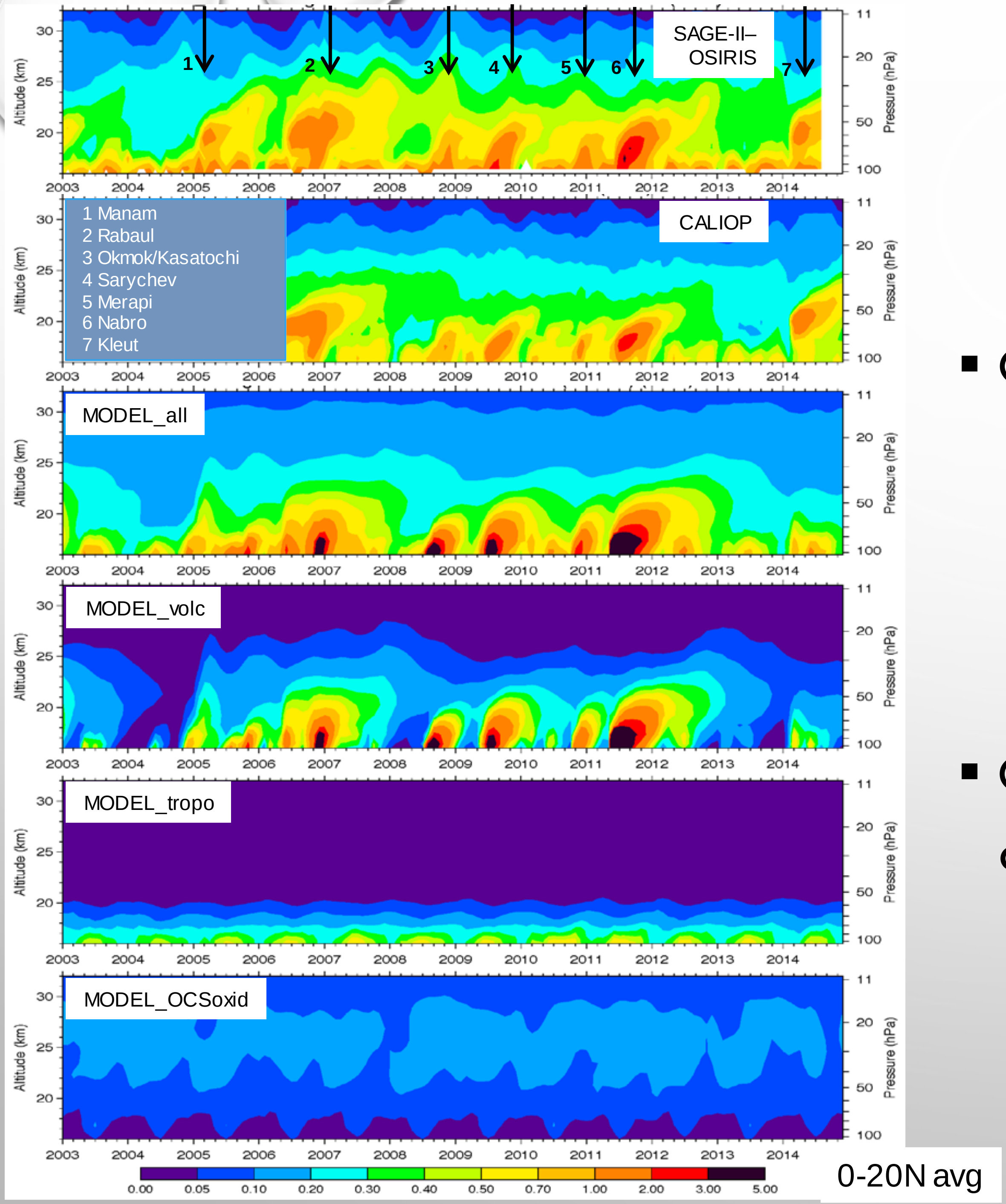


MODEL DIVERSITY – EXAMPLES OF OC AT 100 HPA



MODEL DIVERSITY – EXAMPLES OF DUST AT 100 HPA





VOLCANIC VS. ANTHROPOGENIC VS. OTHER SOURCES

- GEOS-5 simulation, 2003-2014
  - Anthropogenic: EDGAR 4.1(?)
  - Volcanic: Carn et al., 2015, 2016 (?)
  - Biomass burning: FEER (Ichoku and Ellison, 2014)
  - OCS: fixed surface concentrations at 500 ppt
- Comparisons with satellite data from OSIRIS and CALIOP (shown in left 0-20N average)

PROPOSED AEROCOM UTLS EXPERIMENT/ANALYSIS

- Objectives:
  - Compare and evaluate the model simulated aerosol and precursors in the UTLS regions
  - Examine the pathways of aerosols in the UTLS region (e.g., roles of convective transport, chemistry, and direct injection)
  - Assess the contributions of anthropogenic and volcanic emissions to the decadal variations of UTLS aerosols
  - Coordinate with other community model experiments/analysis (Stratospheric Sulfur and its Role in Climate or SSiRC, Atmospheric Chemistry and Asian Monsoon or ACAM)

MODEL SIMULATIONS

Years:	2002-2014 (desired: 1998-2017)
Emission amount: Anthropogenic Volcanic Biomass burning Dust, sea salt, biogenic	 CMIP6 OMI-based (Carn et al., 2015, 2016) GFEDv4 or FEER (Ichoku and Ellison, 2014) Model calculated
Emission height: Anthropogenic Biomass burning Volcanic Other (dust, sea salt, biogenic)	 Surface layer Boundary layer OMI-based estimate (Carn et al., 2015, 2017) Model-calculated
Model simulations: BASE VOL0 FIR0 ANT0	 Base simulation with all sources Simulation without volcanic emissions Simulation without biomass burning emissions Simulation without anthropogenic emissions
Transport tracer:	CO with prescribed sources (will be provided) and a 50-day decay time
Wet scavenging tracer:	Pb210 (or soluble CO?)
Model output:	File specification will be provided

See poster by Chin et al. for more information

AVAILABLE DATA

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

Aircraft:		
UT aerosol (S, C) concentration	CARIBIC	2004 – present
SO_2, sulfate, and aerosol extinction vertical profiles	ICARTT INTEX-B ARCTAS VIRGAS POSIDON StratoClim HIPPO Atom	2003 – 2012 2004 (later half) – present 2008 2016 2016 2017 2009 – 2011 (5 phases) 2016 – 2018 (4 phases)

AGU CHAPMAN CONFERENCE:

STRATOSPHERIC AEROSOLS IN THE POST-PINATUBO ERA

PUERTO DE LA CRUZ, TENERIFE, SPAIN, 18-23 MARCH 2018

Abstract deadline:

8 November 2017 !!!

http://chapman.agu.org/stratospheric-aerosol/

ACRI:

AEROSOL-CLOUD-RADIATION INTERACTIONS AND THEIR EFFECTS ON SURFACE RADIATION TRENDS

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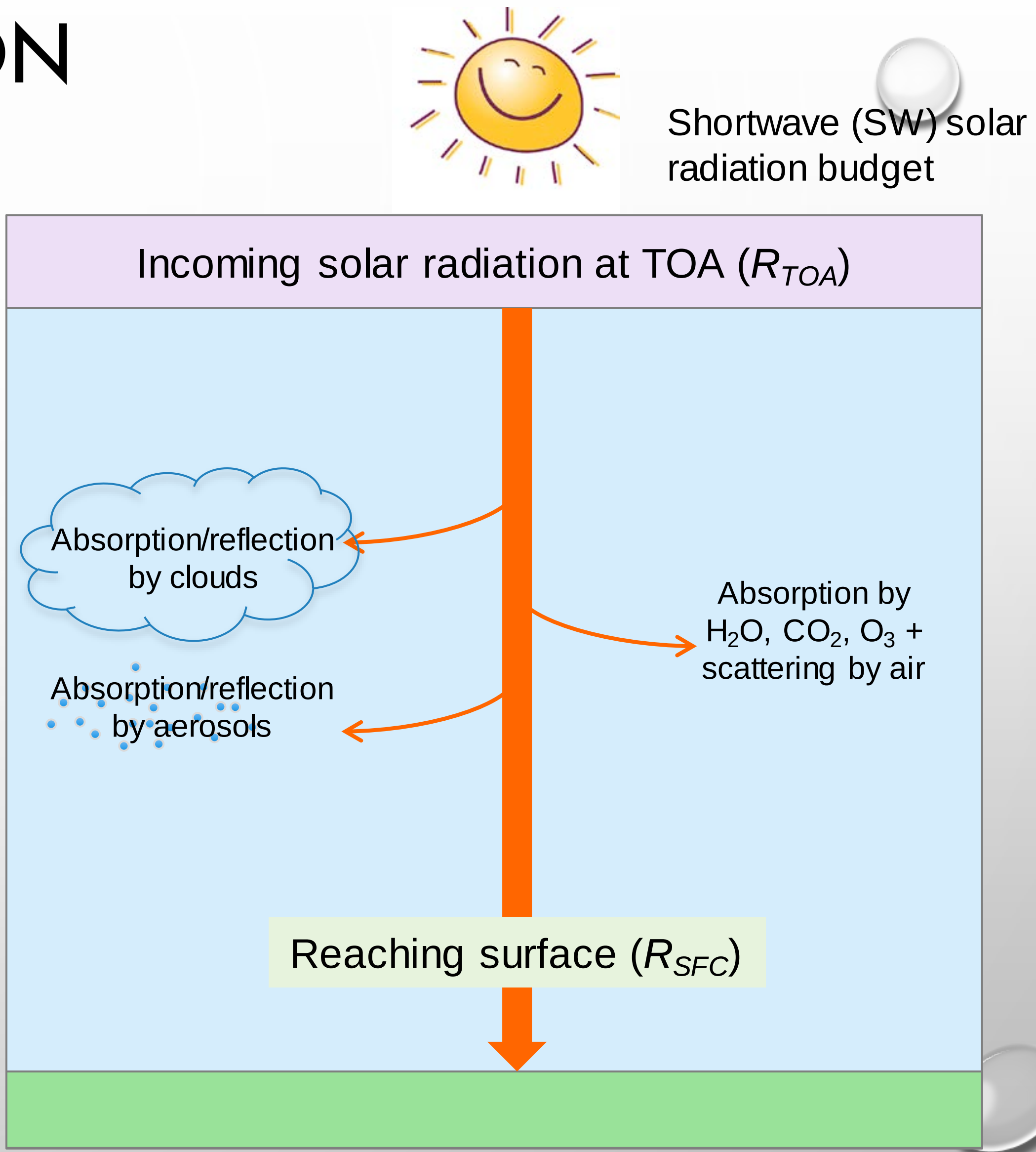
*ETH, SWITZERLAND

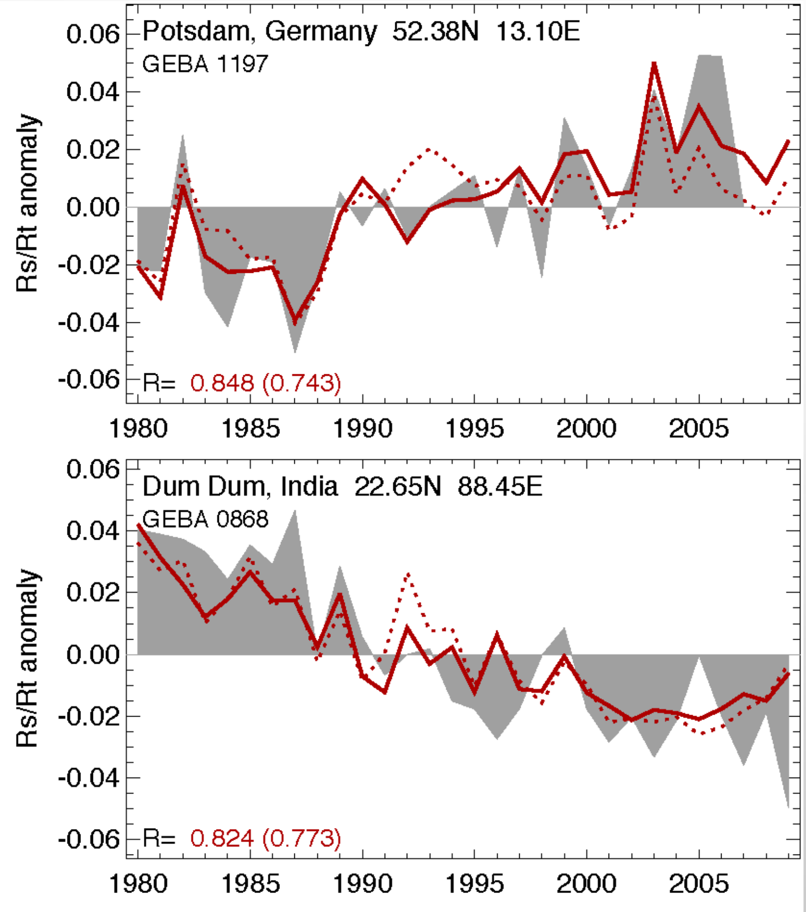
MOTIVATION

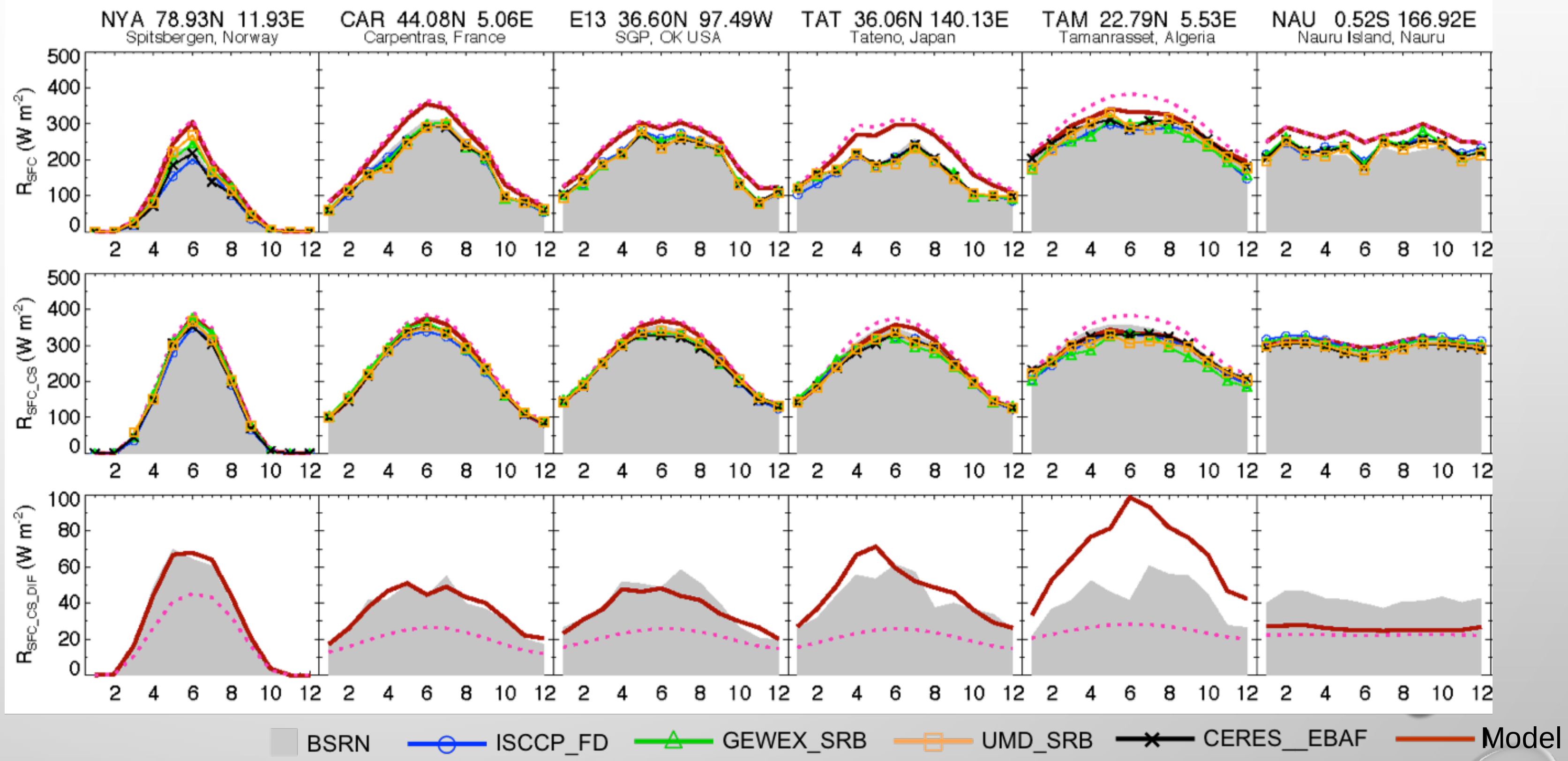
- Globally, about 53-55% of the incoming solar radiation reaches the Earth's surface, the rest being reflected or absorbed by the atmosphere
- Long-term surface observations have shown decrease or increase trends of solar radiation reaching the surface (R_{SFC}), aka "dimming" or "brightening", in difference regions
- Several previous studies have suggested that the R_{SFS} trends are determined by the changes of anthropogenic aerosols in those regions
- Is aerosol responsible for the R_{SFC} change? If yes, how? If no, then who is and why?



CURRENT MODEL STUDY

EXAMPLE: GOCART MODEL ANALYSIS





- Aerosol direct radiative effects show small effects on the change of R_{SFC} in all sky condition
- Aerosol effect can only be detected with diffuse radiation in cloud-free sky

AEROSOL-CLOUD-RADIATION INTERACTION

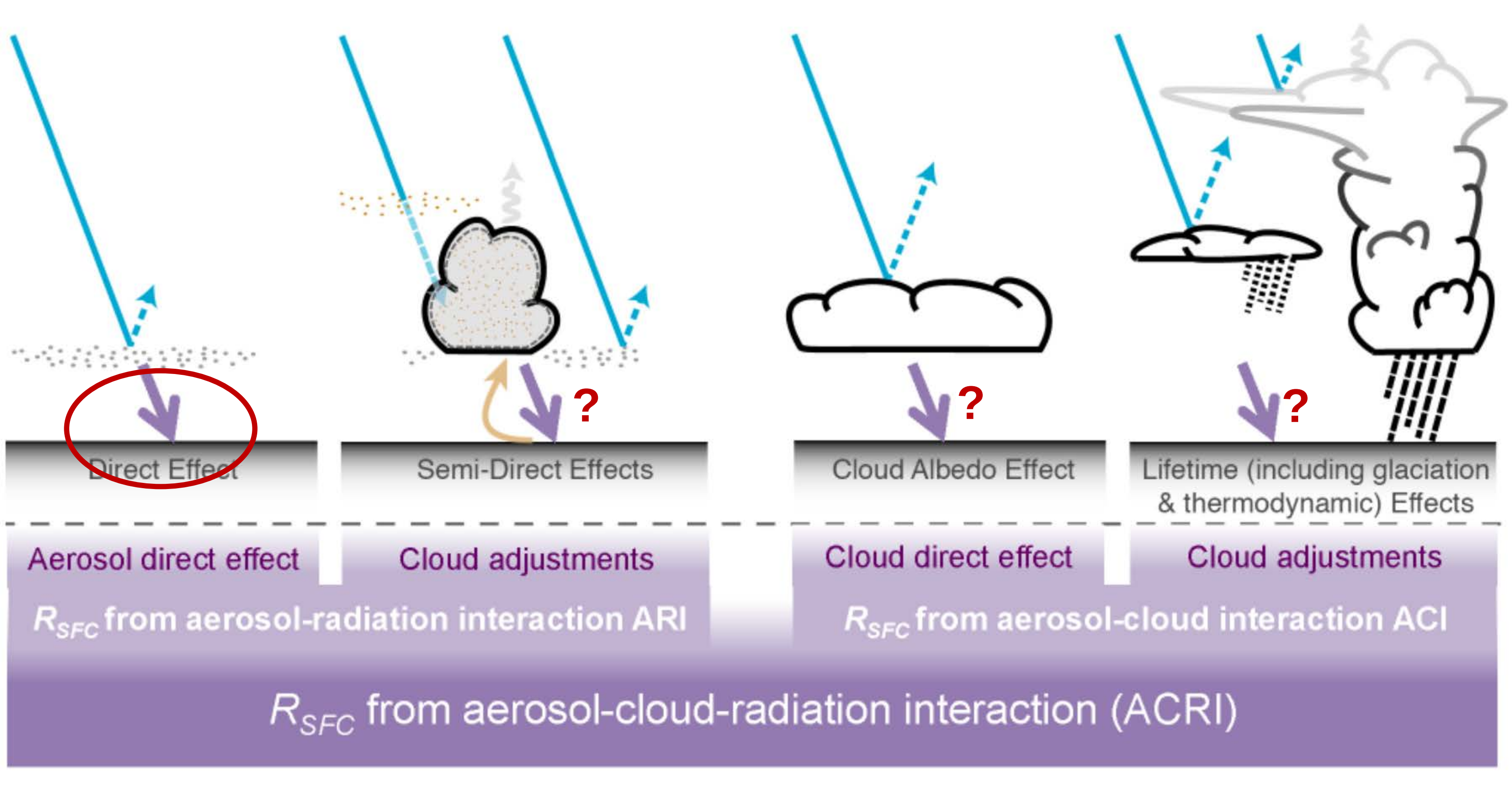
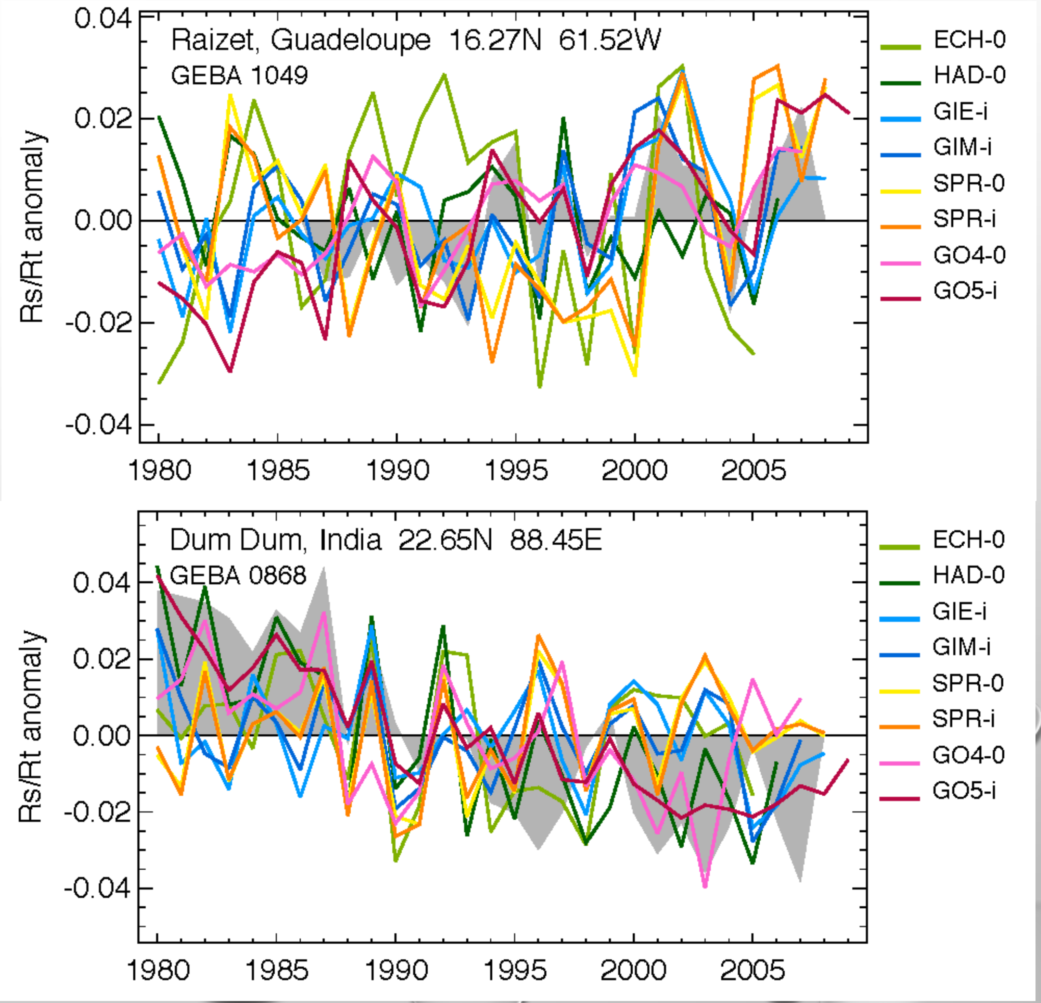


Figure adapted from Boucher et al., 2013 with modifications

PREVIOUS AEROCOM MODELS RELATED TO R_{SFC} TRENDS

- All sky R_{SFC} shows that models are not consistent with trends – problem of aerosol or clouds?
- Only a few model provided cloud-free sky R_{SFC} (with different definition/conditions of "cloud-free"), and even fewer (3) provided diffuse radiation
- It is time to tackle this important issue as a community with a better design of model experiment

Comparison of model simulated R_{SFC} with GEBA, all sky



PROPOSED AEROCOM ACRI EXPERIMENT/ANALYSIS

- Objectives:
  - To assess the effect of climate change/climate variability on multidecadal trends in cloud cover and aerosol levels;
  - To estimate the role of aerosols on multidecadal variations in cloud cover through ACRI under different aerosol and cloud regimes; and
  - To identify the roles of aerosols, clouds, and climate variability on SW downwelling radiation at the surface in recent decades

AGCM MODEL SIMULATIONS

Years:	1985-2015
Emission amount: Anthropogenic Volcanic Biomass burning Dust, sea salt, biogenic	 CMIP6 TOMS+OMI-based (1985-2015) Carn et al., 2015, 2016) Retro (1985-1996) & GFEDv4 (1997-2015) Model calculated
Emission height: Anthropogenic Biomass burning Volcanic	 Surface layer Boundary layer TOMS+OMI-based estimate (Carn et al., 2015, 2016)
Model simulations: BASE FIXSST FIXAER FIXARI FIXACI	 Simulation time-varying all sources and SST, coupled ACRI Same as BASE but with 1985 SST for all years Same as BASE but with aerosol concentrations at 1985 Same as BASE but with 1985 aerosol for ARI part Same as BASE but with 1985 aerosol for ACI part
Model output:	File specification will be provided

See poster by Chin et al. for more information

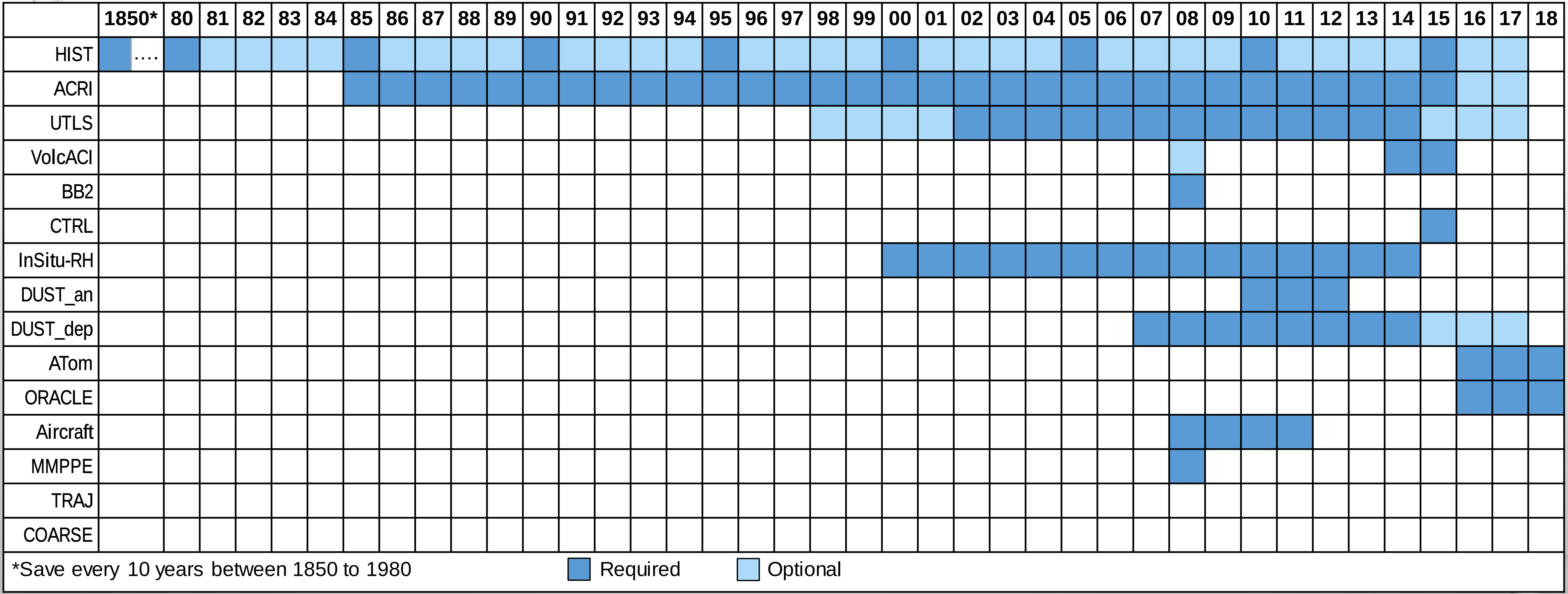
AVAILABLE DATA FOR MODEL EVALUATION

Location of long-term sites	**GEBA**	**BSRN**
# long-term sites	323 sites with data record > 20 years	26 sites with data record > 10 years (1992-)
Variables used in this study	Monthly average total *rsds* under all sky condition	Monthly average total, direct, diffuse under all sky and cloud-free conditions
Info website	http://www.geba.ethz.ch/	http://bsrn.awi.de/

Satellite-based	**ISCCP-FD**	**GEWEX-SRB**	**UMD-SRB**	**CERES-EBAF**
Time period*	1983 – 2009	1983 – 2007	1983 – 2014	2000 – 2015
Relevant product	Total and cloud-free *(rsds, rsdscs)*	Total and cloud-free *(rsds, rsdscs)*	Total and cloud-free *(rsds, rsdscs[&])*	Total and cloud-free *(rsds, rsdscs)*
Spatial resolution	2.5° × 2.5°	1° × 1°	1° × 1°	1° × 1°
Cloud fields used	ISCCP-D1	ISCCP-D1	ISCCP-DX	CALIPSO, CloudSat, CERES, MODIS (CCCM)
Aerosol fields used	Trop: GISS model climatology. Strat: SAGEII climatology	AeroCom climatology with variability from ECHAM model	LUT built with information from MODIS, AERONET, and other sources	AERONET/MODIS validation-based estimates
Reference	Zhang et al., 2004	Zhang et al., 2013	Ma and Pinker, 2012	Kato et al., 2013

COORDINATION OF AEROCOM MODEL EXPERIMENTS/ANALYSIS:

CURRENTLY PROPOSED AEROCOM MODEL EXPERIMENTS AT-A-GLANCE



HIST – historic (Gunnar), ACRI, UTLS (Mian), VolcACI – volcanic ACI (Florent), BB2 – BB phase 2 (Maria/Mariya), CTRL – controlled experiment (Michael), InSitu-RH – in site hygroscopicity experiment (Betsy/Paul Z), DUST_an – anthropogenic dust (Paul G), DUST_dep – dust deposition (Hongbin), ATom (Huisheng), ORACLE (Sarah D?), Aircraft (Duncan Watson-Parris), MMPPE – perturbation (Lindsay), TRAJ – trajectory (David Patridge), COARSE – COARSEMAP (Natalie)