AEROSAT Goals (1)

- **Make satellite aerosol data *as useful as possible* to customers, especially climate modelers (e.g., AeroCom)**
- **Achieve open and active exchange of information**
  - retrievals and their strengths and limitations
  - match requirements of users to technical capabilities
  - benefit from the latest technological advances
  - standardization (data formats, data standards)
- **Forum for satellite aerosol retrieval experts**
  - learn from each other
  - initiate new developments
  - discuss harmonization

AEROSAT Goals (2)

- **Promote the use of satellite data**
  - as **complementary** to other sources of information
  - to better understand the role of aerosols on climate, climate change, air quality and atmospheric processes
- **Forum with satellite data users** (AEROCOM models, ICAP forecasts) and data providers (AERONET reference, space agencies)
  - listen to their needs and limitations
  - motivate new activities
  - Contribute to integration of all observations

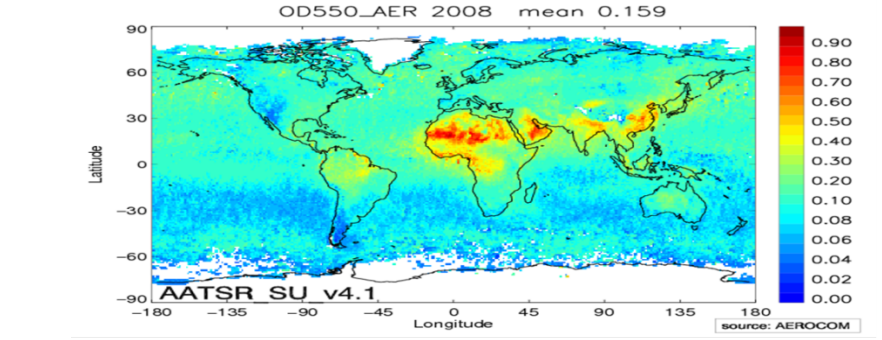
Goals of The Meeting

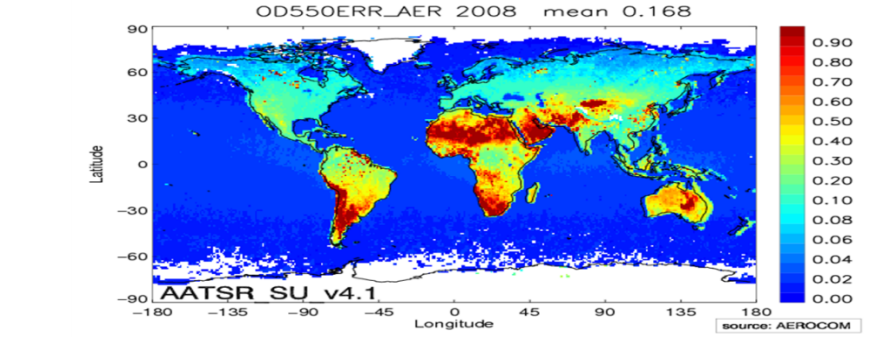
- Substantiate 5 prioritized working groups
  - Pixel-level uncertainties
  - Aerosol satellite product inter-comparisons
  - Aerosol typing
  - Satellite / In-situ / Ground-based / Model Inter-comparisons
  - Aerosol climate data records

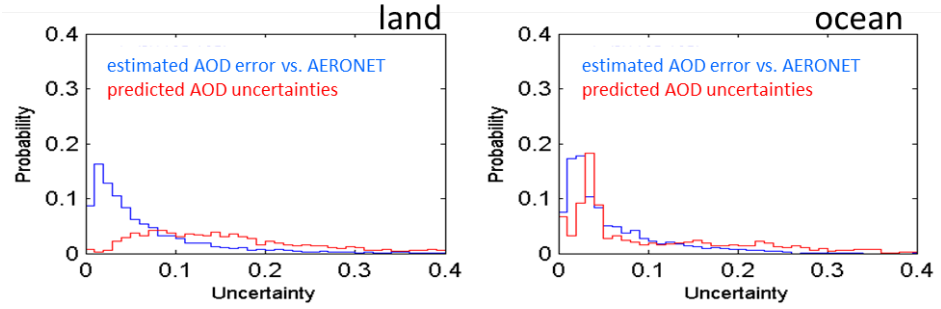
- Focus on discussion
- Only short introductory presentations / Seed questions

-> Refine current concepts / Develop new ideas

AOD Uncertainties (from CCI)







Retrieval Region Uncertainty
Main Points

- User request: pixel-level **one number** vs. **quality flags + diagnostics**
- Caution with **quantification** of uncertainties
- Long-term goal to provide „**error bars**“ for each retrieval
- Iterative process needed with **user involvement**
- Start with simple **AOD550_uncertainty** estimate
- Random, but must include also „**unknown biases**“

Inter-comparison ongoing table (land)

Publication	variables	method(s)	sensors															period	region(s)	reference(s)
			VIIRS	SeaWIFS	AVHRR	TOMS	MODIS	MISR	POLDER	AATSR	MERIS	SYNAER	OMI	AIRS	IASI	CALIOP	SEVIRI			
Kahn et al. (2011), JQSRT, 112:901–909. doi:10.1016/j.jqsrt.2009.11.003	AOD	L2 statistics					x	x										3 months 2006	Global	-
Liu, et al. (2014), JGR, 119, 3942–3962, doi: 10.1002/2013JD020360.	AOD	L2 statistics	x				x											2012/13	global	AERONET, MAN
Kinne, et al. (2003), JGR, 108, 4634, doi:10.1029/2001JD001253	AOD	Monthly means			x	x	x												global	AERONET, AEROCOM
Kittaka et al. (2011), AMT, 4, 131–141, doi:10.5194/amt-4-131-2011	AOD	Collocated pairs, 5 deg					x									x		2006-2008	global	-
Sayer, et al. (2012), AMT, 5, 1761, doi: 10.5194/amt-5-1761-2012	AOD	Lv3		x			x	x										Multi-year	global	AERONET
Redemann, et al. (2012), ACP 12, 3025-3043, doi:10.5194/ acp-12-3025-2012, 2012	AOD	L2					x									x		4M 2007 & 2009	Global CALIOP tracks	-
Carlson and Lacis (2013), JGR, 118, 8640–8648, doi:10.1002/jgrd.50686	AOD	PCA analysis		x			x	x										2002-2010	Global ocean	-
Kahn,et al. (2009), TGARS 47, 4095-4111, doi: 10.1109/TGRS. 2009.2023115	AOD, ANG	L2 statistics					x	x										2M of 2006	Global	-
Bréon,et al., (2011), RSE 115, 3102	AOD, ANG	L2 statistics					x		x		x					x	x	various,	global; sea/ land	AERONET
de Leeuw, et al., RSE (2014) doi: 10.1016/j.rse.2013.04.023	AOD, ANG	Lv2 / L3 L3 scoring				various algorithms for one sensor												4M of 2008	global;,	AERONET
Holzer-Popp, et al., AMT, 6, 1919 - 1957, (2013) doi:10.5194/ amt-6-1919-2013	AOD, ANG	L3 statistics algorithm experiment				various algorithms for one sensor												1M of 2008	Global; regions	AERONET
Kokhanovsky, et al. (2010), AMT, 3, 909-932, doi:10.5194/amt-3-909-2010	AOD, optical properties	Single cases				various algorithms for one sensor												Single cases	Single cases	Simulations

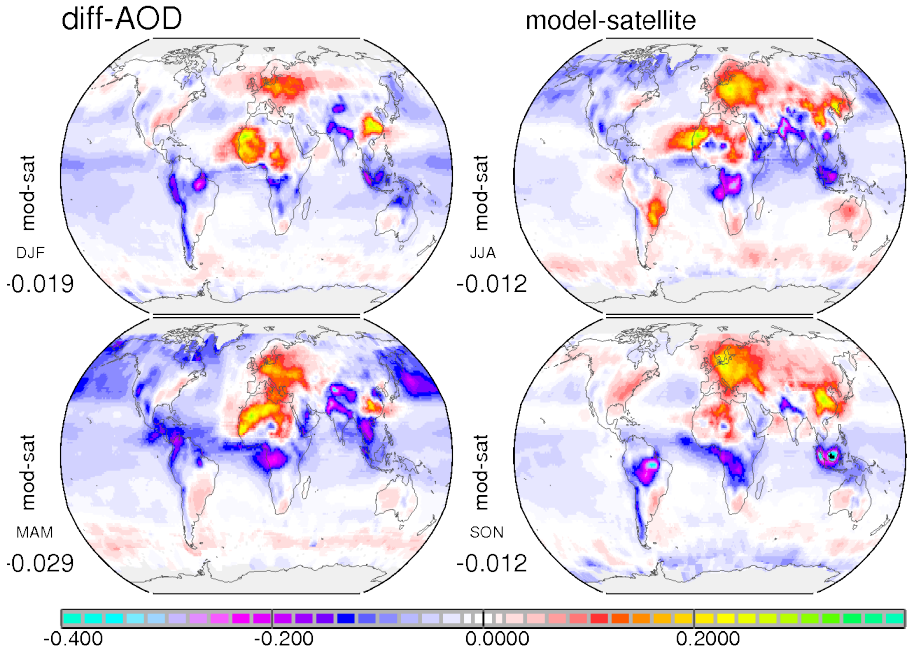
Inter-comparison Potential Gaps

- Aerosol **properties**: fine mode AOD / ANG, AAOD
- Frequency / capability of detecting **high AOD** episodes / spatial variability / plumes (DRAGON networks / DISCOVER-AQ)
- **PDFs** instead of mean aerosol state
- **Information content** / PCA analysis / simulated scenes based on CTM

- **Geostationary** (several SEVIRI algorithms; include Asian data)
- (regional) **trends and anomalies** (using same time windows, same background period)
- **Climatologies** of AOD (and aerosol properties)

Satellite Dataset Inter-comparison *Main Points*

- List of gaps / **possible studies**
- AEROSAT **experiments**
- Opportunity: **GEWEX Phase 2** / Aerosol_cci / Giovanni MAPS
- User support: dataset list, **FAQ / forum** / mailing list for inquiries

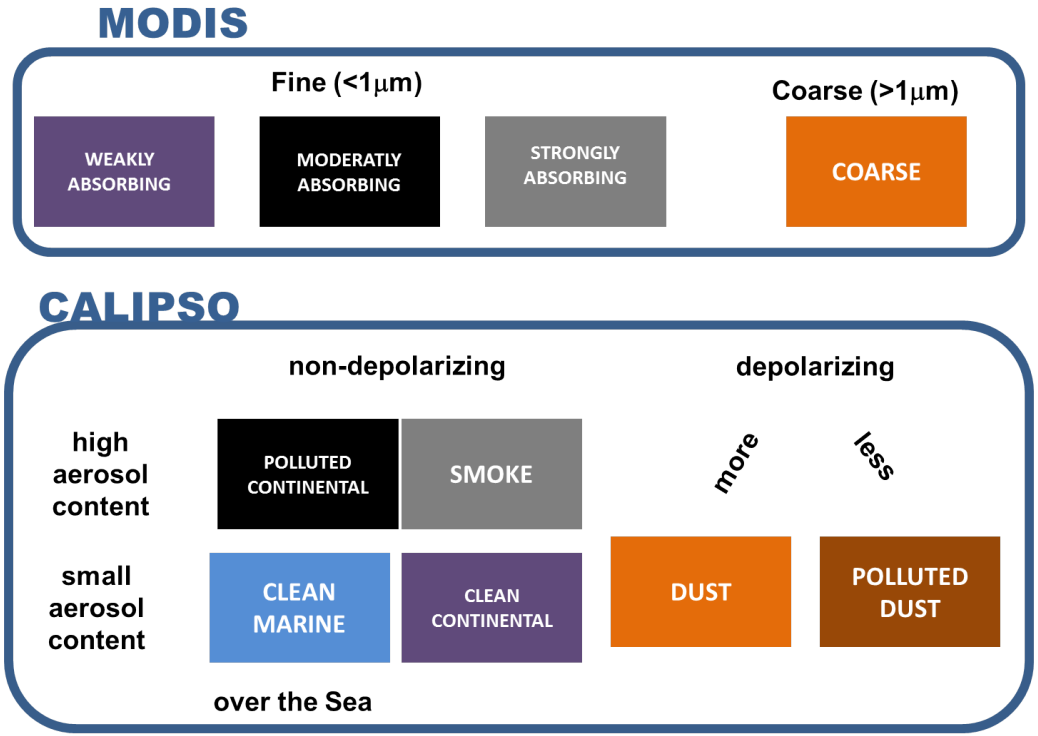


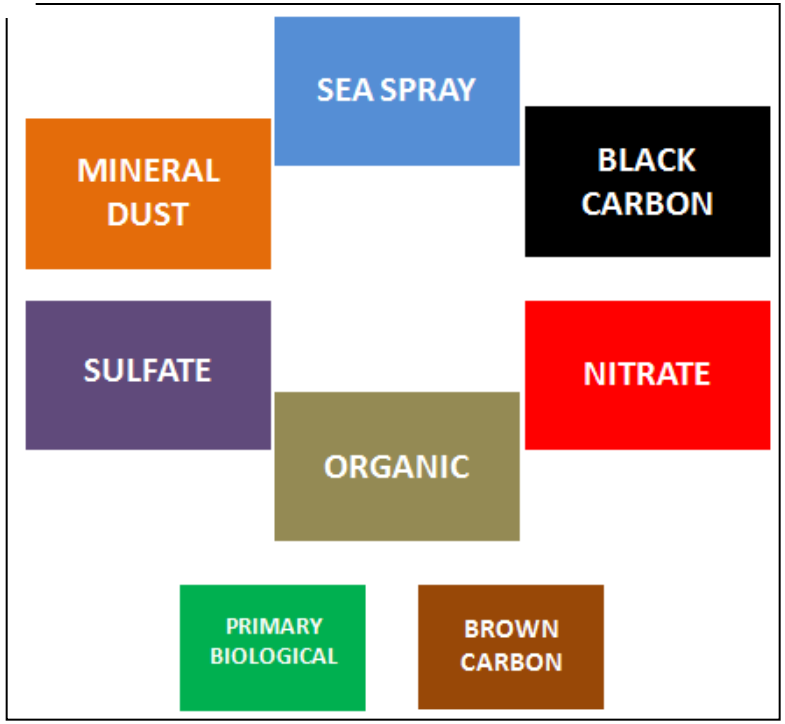
Sat composite
- AEROCOM
median difference

Aerosol type

- … is a **categorical** / qualitative variable
- … is **input** needed as a retrieval constraint (ill-posed) / affects AOD accuracy
  - … is estimated from sub-orbital data (sampling issues!) and/or model climatologies
- … can be **output** from retrievals to some extent (AERONET, satellite)
  - … varies with instrument and retrieval conditions
- Different instruments
  - … require different aerosol type definitions to obtain meaningful retrievals
  - … have different (limited) aerosol type information content
- Can we agree on overarching nomenclature / approach?

Different Concept Examples





IPCC 2013

Aerosol Typing
Main Points

- **Nomenclature**: AOD/AOT, components/particles – mixtures
- Overall **qualitative categorization** by size, absorption (including spectral dependance?), shape
- Some **similarity** among different approaches (e.g. MISR / SPRINTAS & Aerosol_cci)
- Should also report when AOD or aerosol type is unknown, and/or provide **pdfs of all mixtures that pass** the algorithm acceptance criteria
- A **review** of aerosol typing schemes will be made
- Might aim for a **Multi-sensor** merged „Level 4“ aerosol type product

Sat – Suborbital – Model Integration

Satellites

frequent, global *snapshots*; aerosol amount & aerosol type maps, plume & layer heights

Remote-sensing Analysis
- Retrieval Validation
- Assumption Refinement

Suborbital

targeted chemical & microphysical detail

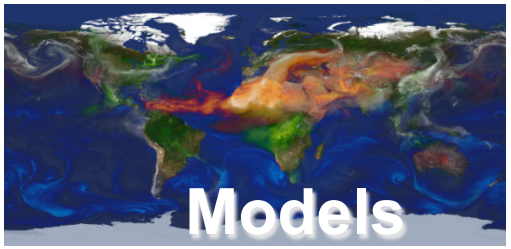
point-location time series

Regional Context

CURRENT STATE
- Initial Conditions
- Assimilation

Aerosol-type Constraints/ Predictions

Model Validation
- Parameterizations
- Climate Sensitivity
- Underlying mechanisms



space-time interpolation,

DARF & Anthropogenic Component

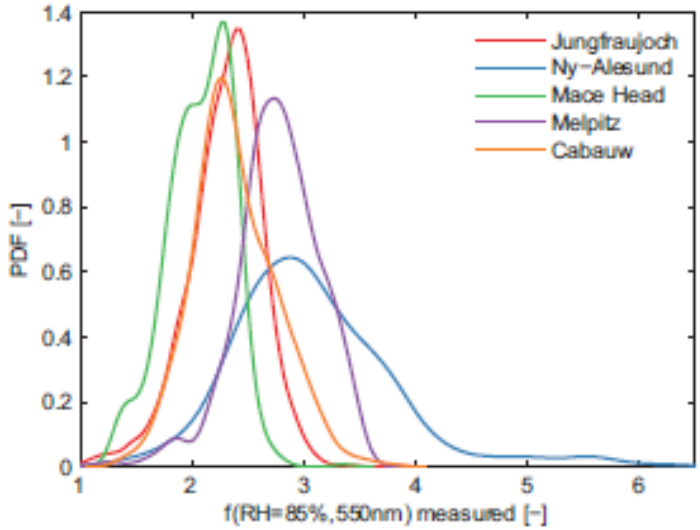
calculation and prediction

Adapted from: Kahn, Survy. Geophys. 2012

The value of Aerosol Measurement & Model Integration is Clear…

Sat – Suborbital - Model Integration *Main Points*

- Document experiences with hdf-**netCDF** converters (format can be an issue)
- Provide a **User Guide** & product list with linklist to relevant publications
- Initiate a group discussion of data **analysis tools** (GIOVANI/MAPSS, RAL, ICARE, WDC-RSAT, …) aimed at greater coordination
- User need for **Level 3 daily / Level 2-G** (multi-sensor merged) products



Pdfs of f(RH 85%) for 5 stations
-> 40% diversity

GCOS Aerosol Climate Data Record Requirements

Product A.10.1 Aerosol optical depth
Product A.10.2 Aerosol single scattering albedo
Product A.10.3 Aerosol layer height
Product A.10.4 Aerosol extinction profiles from the troposphere to at least 35km

Benefits

- Improved aerosol products, thereby leading to a reduction in uncertainty as to the quantitative role of aerosols in climate forcing identified by the IPCC;
- Improved products that are needed to validate and improve the capability of climate simulation models and reanalyses to represent aerosol effects.

Target Requirements

Variable/ Parameter	Horizontal Resolution	Vertical Resolution	Temporal Resolution	Accuracy	Stability
Aerosol optical depth	5-10km	N/A	4h	Max (0.03; 10%)	0.01
Single-scattering albedo	5-10km	N/A	4h	0.03	0.01
Aerosol-layer height	5-10km	N/A	4h	1km	0.5km
Aerosol-extinction coefficient profile	200-500km	<1km near tropopause, ~2km in middle stratosphere	weekly	10%	20 %

Potential CDR list
(draft illustration shown)

Satellite Instrument	Algo	Main Retrieved Quantities	Time Span	Provider	Access	Reference
NOAA-AVHRR	2-channel	AOD ocean	1981-2009	NOAA		
TOMS		AOD, AAI, SSA, AAOD	1979-2001			
SAGE		Strat. vert profiles				
SEAWIFS	DB/SOAR	AOD	1997-2008?	NASA		
TERRA-MISR	V22	AOD, ANG, aerosol type	2000-present	NASA		
AQUA-MODIS	C6	AOD, fine mode (ocean)	2002-present	NASA		
OMI	OMAERO	AAI, AOD		KNMI/NASA		
ERS-2 GOME, Envisat SCIAMACHY MetOp GOME-2, AURA OMI	AAI	Absorbing Aerosol Index	1995-2014	KNMI/TEMIS/ ESA		
ERS-2 ATSR-2, Envisat AATSR	SU v4.2 ADV 1.42 ORAC 2.1	AOD, mixing fractions, Angstrom	1995-2012	SU/ADV/ ORAC		
Envisat MERIS	ALAMO v2.2	AOD FMF, R_{eff}, altitude	2002-2012	HYGEOS/ ICARE		
Envisat GOMOS		Strat. extinction	2002-2012			
ODIN OSIRIS		Strat. extinction	2001-present			
MSG SEVIRI		AOD (15 min Europe, Africa, Atlantic)	2003-present			
CALIPSO CALIOP		extinction/backscatter, color ratio, depolarization ratio, AOD				
PARASOL Ocean	OC2	AOD, Angstrom, FMF/CMF, SSA	2005-2013	LOA/ICARE		
PARASOL Land	LS2	Fine mode AOD (865nm)	2005-2013	LOA/ICARE		

Climate Data Records
Main Points

- **GCOS requirements** table & process - need to identify
  realisticaly achievable goals
- Need to assess product **stability** (e.g., essential for trend analysis)
- **ob4MIPs** standards for documentation (input to CMIP-6)
- Complete **table of potential CDRs** (climate data records)

The AeroSat Web Site – **http://www.aero-sat.org**

AeroSat / AeroCom Discussion Session

→ At **Lunch Today**

Skyline Meeting Room

(you can bring your lunch)