AEROSAT Perspectives
On Collaboration with Modelling

Thomas Popp / DLR
Ralph Kahn / NASA-GSFC

AEROSAT Goals (1)

- **Work with modelers to make satellite aerosol data as useful as possible for climate modeling (e.g., AeroCom)**
- **Achieve open and active exchange of information**
  - Retrievals and their strengths and limitations
  - Match requirements of users to technical capabilities with data
  - Share the latest technological advances
  - Work toward inter-operability (data formats, data standards)
- **Forum for satellite aerosol retrieval experts**
  - Learn from each other, collaborate as appropriate
  - 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 in climate, climate change, air quality, and atmospheric processes
- **Forum includes satellite data users** (AEROCOM / CCMI models, ICAP forecasts) **and data providers** (AERONET reference, space agencies)
  - Listen to each others' needs and limitations
  - Discuss what is possible; Motivate new activities
  - Contribute to integration of satellite & suborbital observations
- AEROSAT is an unfunded network (like AEROCOM)

AeroSat in the First 3 Years

- **Joint Sessions with AEROCOM**
  - Needs of modelers ←→ Possibilities & limitations of data producers
  - Common understanding of definitions

- **Internal Retrieval Expert Discussions**
  - Principles, *consistent definitions*, strengths / limitations
  - Constraining *aerosol type* with satellite data
  - Deriving *pixel-level uncertainties*
  - Producing *long-term* satellite data records
  - Satellite capabilities / limitations for *air quality applications*

- **Summary (draft) outcomes**
  - Intensified dialogue (among retrieval experts & with modelers)
  - List of long-term datasets
  - List of inter-comparison studies
  - Inventory of aerosol-type products & definitions
  - Review of validation metrics (linear regression; confidence intervals, etc.)

Long-term Data Record Table 2015

AEROSAT Working Group on Climate Data Records

List of candidate aerosol CDRs currently available:

Satellite Instrument	*Algo*	*Main Retrieved Quantities*	*Time Span*	*Provider*	*Access*	*Reference*
NOAA-AVHRR	2-channel	AOD (ocean)	1981-2009	NOAA	NOAA CLASS	Heidinger et al., 2014: The Pathfinder Atmospheres–Extended AVHRR Climate Dataset. Bull. Amer. Meteor. Soc., 95, 909–922.
TOMS	near-UV	AOD, AAI	1979-2005[1]	NASA	ozoneaq.gsfc.nasa.gov	O. Torres, P. K. Bhartia, J. R. Herman, A. Sinyuk, Paul Ginoux, and Brent Holben, 2002: A Long-Term Record of Aerosol Optical Depth from TOMS Observations and Comparison to AERONET Measurements. *J. Atmos. Sci.*, **59**, 398–413.
SAGE	ver 7.0 (SAGE II) ver 4.0 (SAGE III)	Aerosol extinction coefficient profiles from cloud top to 40 km at 4 wavelengths in the UV-vis-NIR	1984-2005[2]	NASA LaRC eosweb.larc.nasa.gov	sage.nasa.gov	R. P. Damadeo, R. P., J. M. Zawodny, L. W. Thomason, and N. Iyer, SAGE Version 7.0 Algorithm: Application to SAGE II, Atmos. Meas. Tech., 6, 3539-3561, 2013 www.atmos-meas-tech.net/6/3539/2013/, doi:10.5194/amt-6-3539-2013 Thomason, L. W., James R. Moore, Michael C. Pitts, Joseph M. Zawodny, and Er-Woon Chiou, An Evaluation of the SAGE III Version 4 Aerosol Extinction Coefficient and Water Vapor Data Products, Atmos. Chem. Phys., 10, 2159-2173, 2010 www.atmos-chem-phys.net/10/2159/2010/

[1] TOMS data after 2001 should not be used for trend analysis. TOMS instruments were flown on the following satellites: Nimbus-7 (Nov 1978 - May 1993), Meteor-3 (Aug 1991 - Dec 1994), Earth Probe (July 1996 - Dec 2005), and ADEOS (Sep 1996 - June 1997)

[2] SAGE II (Oct 1984-Aug 2005), SAGE III-Meteor-3M (Feb 2002-Dec 2005). Older data sets from SAM II (1975-1978) and SAGE I (1979-1981) also exist.

Table collected from AEROSAT Participants

This is 1 of 6 pages

… Table needs updating

Aerosol Product Inter-Comparison Table (land) 2014

Publication	variables	method(s)	sensors: VIIRS	SeaWIFS	AVHRR	TOMS	MODIS	MISR	POLDER	AATSR	MERIS	SYNAER	OMI	AIRS	IASI	CALIOP	SEVIRI	period	region(s)	reference(s)
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					x	x	x	x various algorithms for one sensor	x	x						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					x	x	x	x various algorithms for one sensor	x	x						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					x	x	x	x various algorithms for one sensor	x							Single cases	Single cases	Simulations

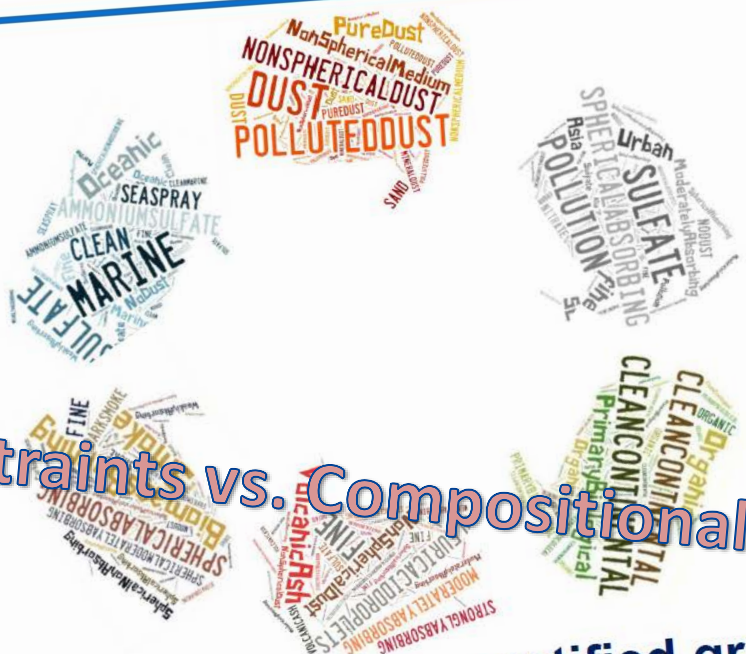
Table collected from AEROSAT Participants

2nd table over ocean

… Tables need updating

Overview of typing procedure

The nomenclature is very heterogeneous among different platforms.

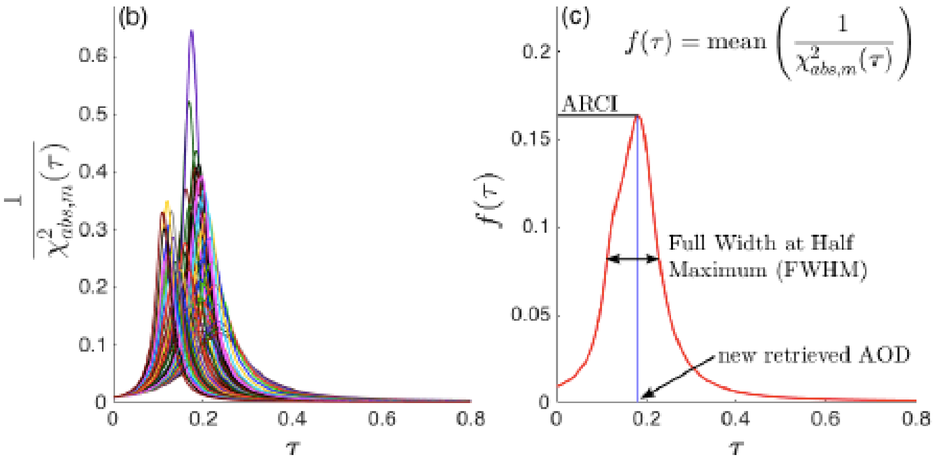


Optical Constraints vs. Compositional Inferences

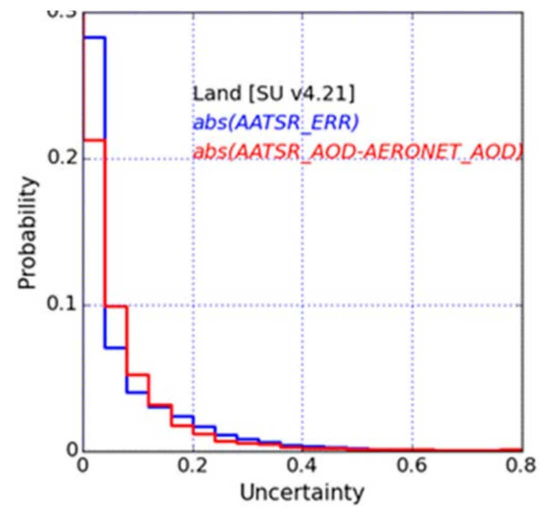
6 main classes could be identified grouping the different nomenclatures.

Useful validation metrics

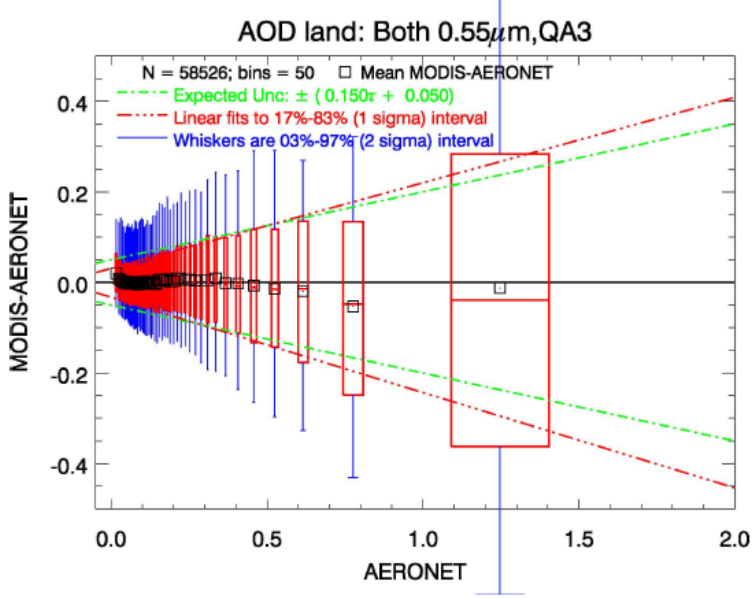
Inverse goodness-of-fit metric



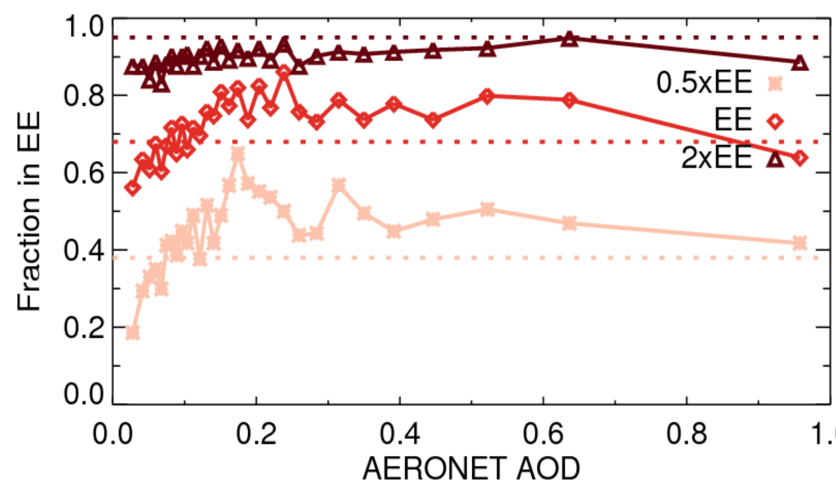
Compliance with uncertainty estimates



Error statistics as function of AOD



Fraction of pixels within error envelope



Modified from: Andrew Sayer, AEROSAT 2016 Beijing

AeroSat 2017

- **Continue *Presentation & Discussion* of Strengths & Limitations**
  - How to document added-value and guide product usage
  - AERONET new version
  - GRASP multi-sensor algorithm
  - SAT – MOD optics inter-comparison
  - Variables beyond AOD (ANG, Aerosol Type)
  - Validation of pixel-level uncertainties
  - …

- **Discuss new element: Possible AeroSat Experiments**
  - Study sensitivities / spread of results
  - Investigate approaches to ***constraining and/or validating models***
  - Investigate ways to ***add value to satellite products*** using models
  - Study scientific questions

- **Possibilities for contributing to aerosol-cloud interaction studies**

Perspectives on Collaboration with Modelers

- **Support model-satellite consistency**
  - Discuss + publish ***definition similarities & differences*** (Mod + Sat)
  - Provide ***aerosol typing information*** in a useful form
    -- Includes application of ***optical vs. compositional types***
  - Provide ***uncertainty characterization*** in a useful form

- **Guide the use of satellite datasets**
  - Provide a ***critical assessment*** of strengths and limitations
  - Provide harmonized ***quality statements***
  - Create ***data-record ensembles*** –> report spread / confidence

- **Experiments**
  - Involve modelling to tie evaluations to critical variables
  - Develop smart ways to integrate complementary information content