Aerosol Observations

Obs4MIPs – CMIP6 Planning Meeting,
Washington DC, 30/04/2014

Thomas Holzer-Popp, DLR

DLR

Obs4MIPs data requirements

- be based on a parent observations dataset that:
    - history of **peer reviewed publications**
    - **version controlled**
    - resides in a **long term archive**

- **time period long enough** to be of use for model comparison (5 years)

- match a **model variable** in the CMIP5 protocol

- be converted to the **obs4MIPs format**
    - no additional processing beyond editing, binning, averaging, interpolation
    - netCDF, CF convention, gridded

- **estimate of the uncertainty** of the dataset values (quality flags are insufficient)

- be accompanied by a **technical note** using obs4MIPs technical note template.

DLR

Obs4MIPs data requirements

- be based on a parent observations dataset that:
    - history of **peer reviewed publications** √
    - **version controlled** √
    - resides in a **long term archive** √

- **time period long enough** to be of use for model comparison (5 years)

- match a **model variable** in the CMIP5 protocol

- be converted to the **obs4MIPs format** √
    - no additional processing beyond editing, binning, averaging, interpolation
    - netCDF, CF convention, gridded

- **estimate of the uncertainty** of the dataset values (quality flags are insufficient)

- be accompanied by a **technical note** using obs4MIPs technical note template.

DLR

Relevant aerosol variables in CMIP5 protocol

- Ambient **Aerosol Optical Thickness** at 550 nm od550aer
- Ambient **Aerosol Optical Thickness** at 870 nm od870aer
- Ambient **Aerosol Extinction** at 550 nm (stratosphere only) ec550aer
- Ambient **Fine Aerosol Optical Thickness** at 550 nm od550lt1aer
- Ambient **Aerosol Absorption Optical Thickness** at 550 nm abs550aer
- Load of **Dust** (column mass) loaddust

Sources of information (1)

Satellite:	Terra (NASA)
Instrument(s):	Multi-angle Imaging SpectroRadiometer (MISR)
Instrument/algorithm PI:	David J. Diner, Jet Propulsion Laboratory
Contact details:	David.J.Diner[at]jpl.nasa.gov, Ralph.Kahn[at]nasa.gov
Parameter(s):	Aerosol optical depth, 3-to-5 size bins (small, medium, large), fraction AOD non-spherical, and a qualitative constraint on SSA (absorbing/non-absorbing)
Aerosol algorithm:	Different for DarkWater and Heterogeneous Land Surfaces
Cloud screening:	RCCM (radiometric)/SDCM (stereo)/ASCM (angular- spectral)/angular smoothness/angular correlation methods
Aerosol model:	Bimodal and trimodal mixtures of spherical absorbing and non-absorbing particles, plus non-spherical dust models
Retrieval assumptions:	Negligible ocean water-leaving radiance at 672, 866 nm; spectral invariance of land surface angular reflectance factor; limited selection of aerosol components and mixtures
Retrieval limitations:	Not applicable over Case 2 waters, homogeneous snow/ice, cloud
Spatial, temporal coverage:	□80□ latitude, dayside, late February 2000 to present Spatial, temporal resolution: 17.6 km / 380 km / 16 day orbit repeat period; every 9 days at equator, 2 days near poles
Spatial, temporal resolution:	OMI - 13x24 km□ / 14-orbits per day / Daily Global Coverage TOMS - 50x50 km2 / 14-orbits per day / Daily Global Coverage
Operations status:	Operational / experimental
Validation status:	Validated against ground-based and aircraft sunphotometers
Quality control:	Goodness of fit thresholding
last algorithm version:	Version 22 (12/2007)
last validation:	12/2007; ongoing

Algorithm description Product format description

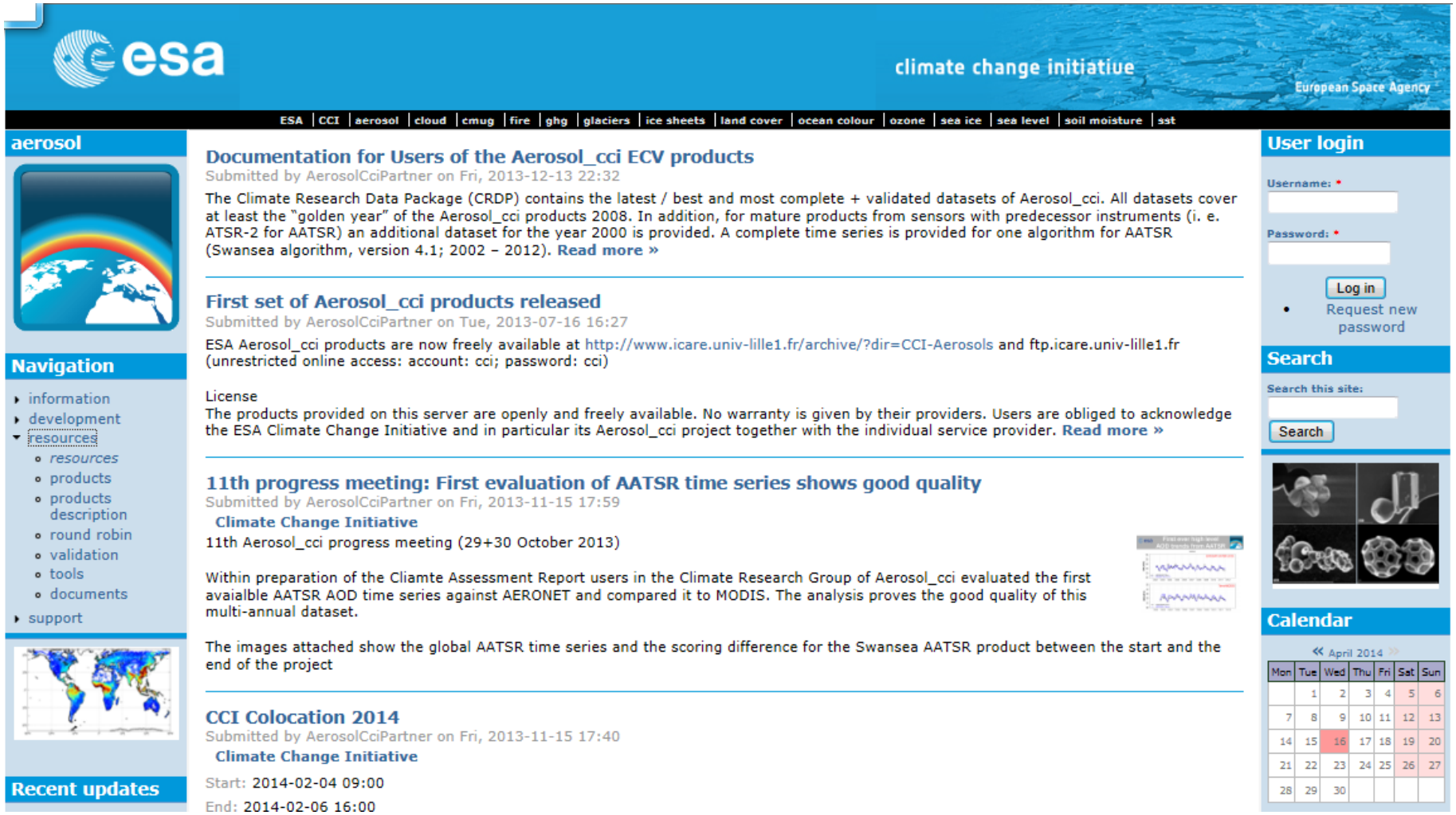
Version explanation Validation summary

Publications

Product data access
Image / quicklook data access

DLR

Sources of information (2)

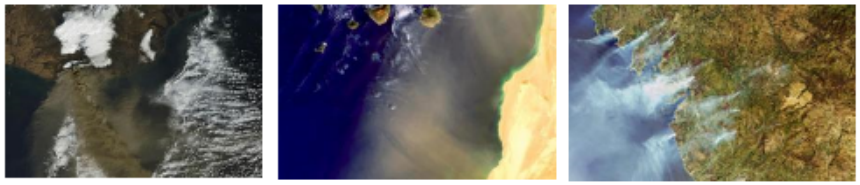


http://www.esa-aerosol-cci.org/

DLR

Sources of information (3)

AERO-SAT International Satellite Aerosol Science Network



Information on the occurrence and properties of atmospheric aerosol is of crucial importance for climate and atmospheric research, numerical weather prediction, air quality monitoring and natural hazards. Satellite retrieval of aerosol properties, together with ground-based in-situ and remote sensing, and atmospheric models, are the essential tools used to provide aerosol information.

The **International Satellite Aerosol Science Network (a.k.a. AERO-SAT)** is an initiative to help strengthen collaboration between different research groups around the world working on satellite aerosol retrieval. The AERO-SAT constituting meeting took place in Hamburg (Germany), on 27 September 2013, in association with the 10th annual AeroCom meeting. The terms of reference, contact points and network participants are provided in the pages below.

AERO-SAT is an unfunded activity intended to be of mutual benefit to the scientific work of the network participants.

Objectives

To:

- Advance satellite aerosol retrieval research and product development by providing a mechanism to promote and facilitate international scientific collaboration.
- Federate the satellite aerosol community to provide a more powerful collective voice towards the ecosystem of international projects, funding agencies and space agencies
- Coordinate scientific activities of mutual benefit (e.g. intercomparisons, common definitions, common tools, common formats, etc.)
- Stimulate communication and coordination between producers of satellite information on aerosol properties and the global user community.
- Identify best practice in retrieval development
- Promote the long term continuity of satellite aerosol data set production
- Encourage the open exchange of satellite, model and in-situ aerosol data streams, and harmonized access for users
- Help users to understand the strengths and weaknesses of different satellite aerosol products by promoting activities to intercompare data sets

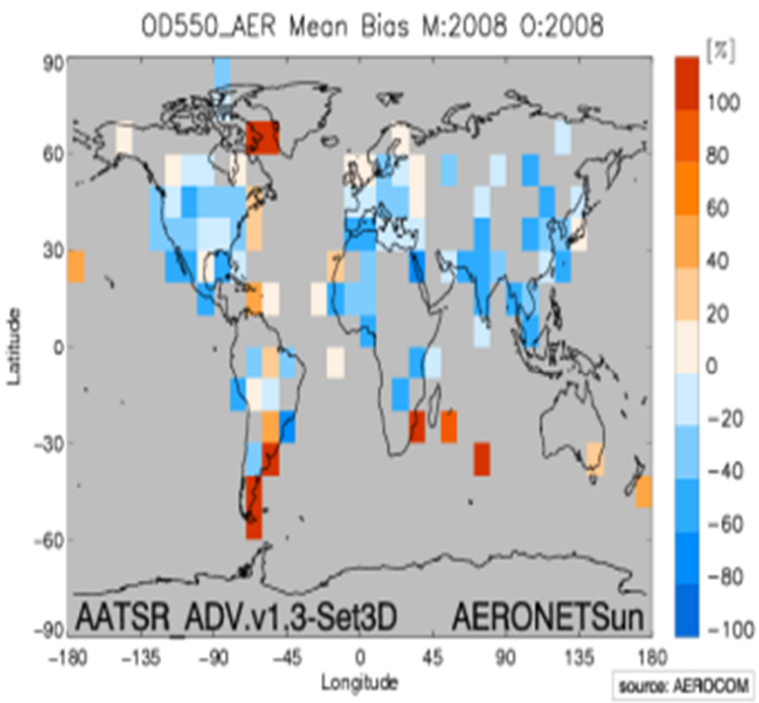
Next Meeting

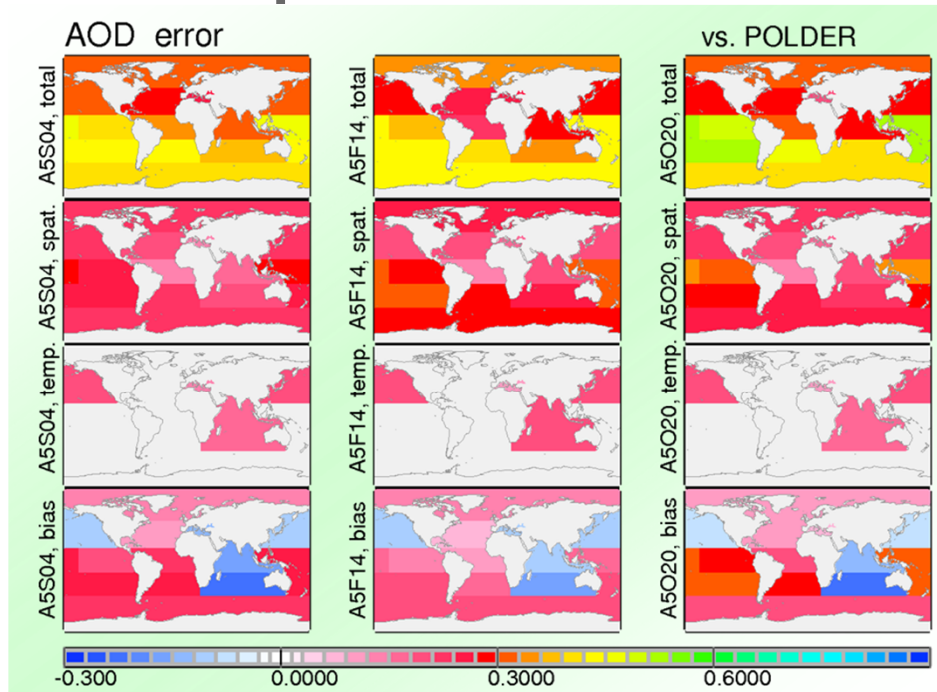
We plan to hold the next AERO-SAT meeting on 27-28 September 2014 in Steamboat, Colorado, USA, as part of the 11th AeroCom meeting (note that 27-28 September is a weekend).

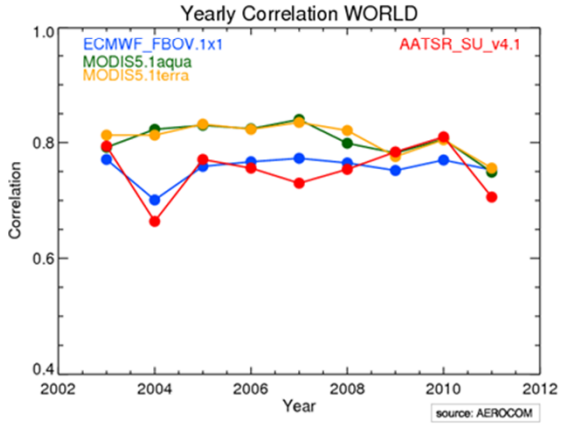
http://aero-sat.org/

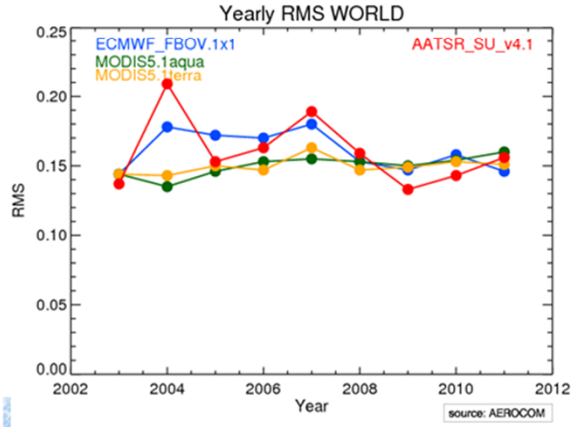
DLR

Validation / inter-comparison





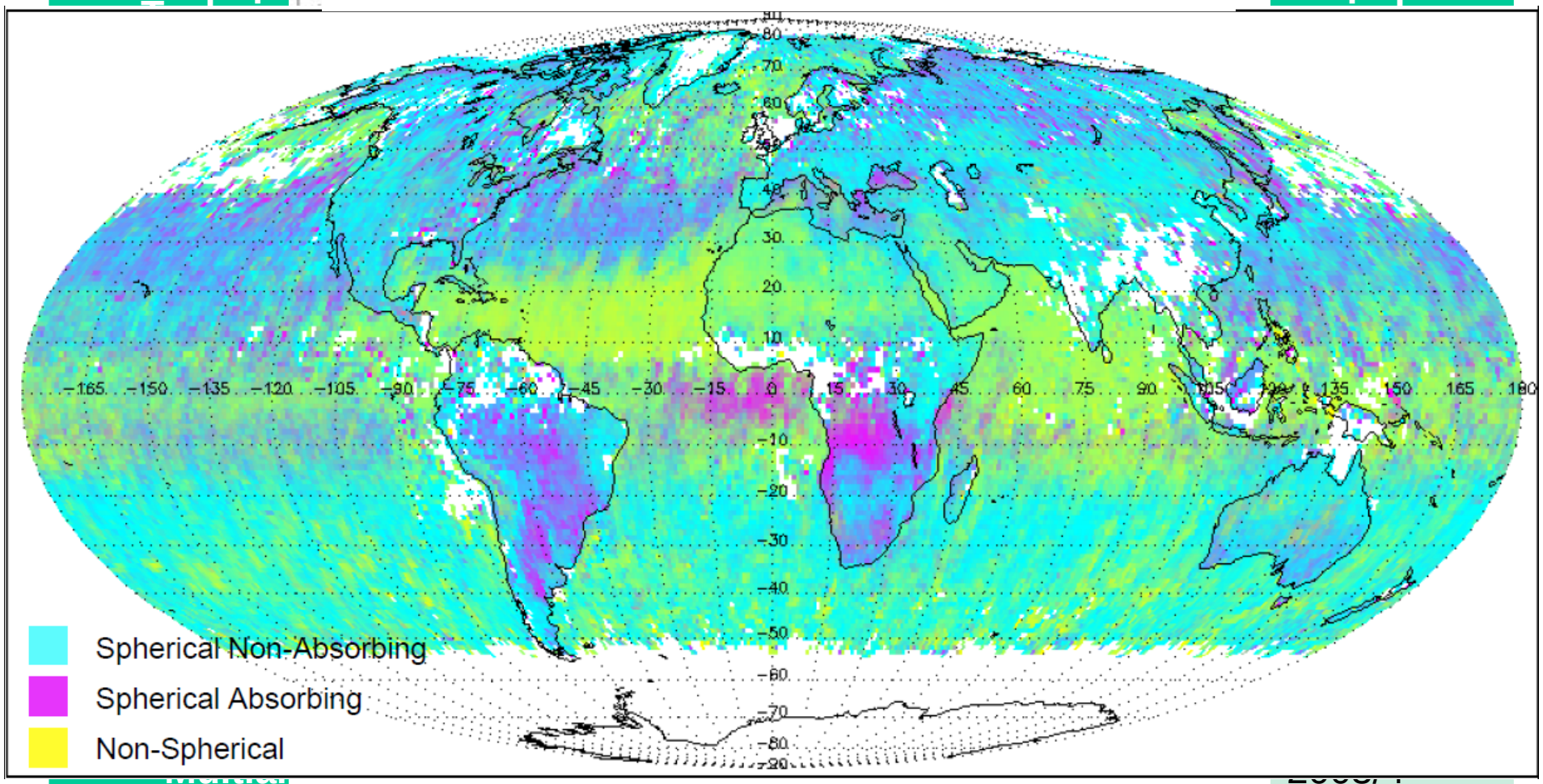




DLR

Retrieval techniques and aerosol variables (1)

MISR



Multispe

POLDE

AOD at 550 nm

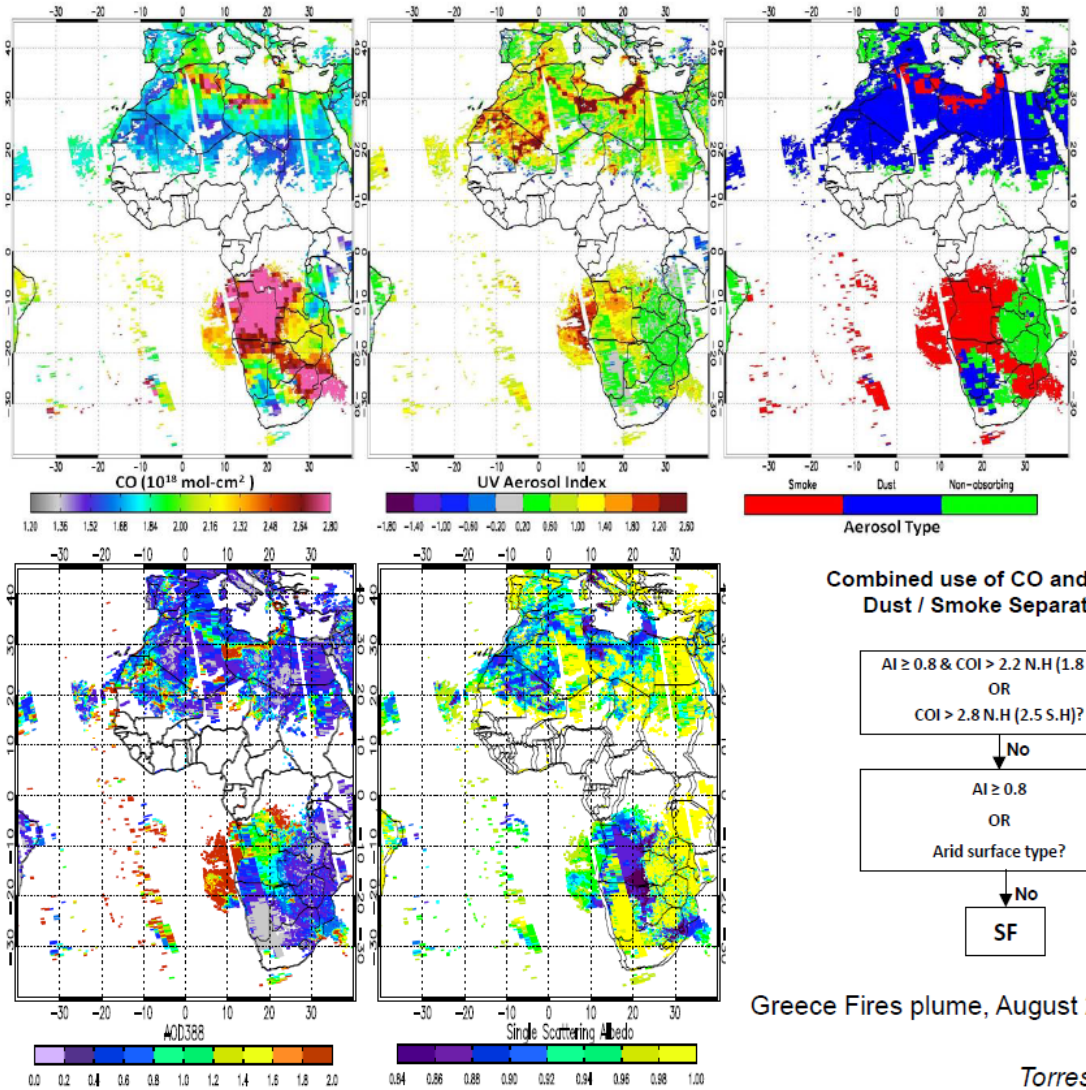
-0.05 0.05 0.15 0.25 0.35 0.45 0.55 0.65 0.75

005 – 2013

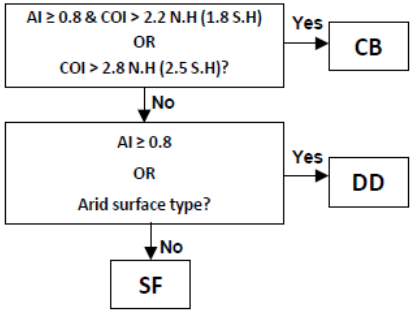
Retrieval techniques and aerosol variables (2)

Tech	eriod
UV 2-b TOMS / GOM GOM	978 -
Therma AIR	003 -
Daily ac SEVIR (FY2	NRT)
L C	006 -

Aerosol Type Determination



Combined use of CO and AI for Dust / Smoke Separation



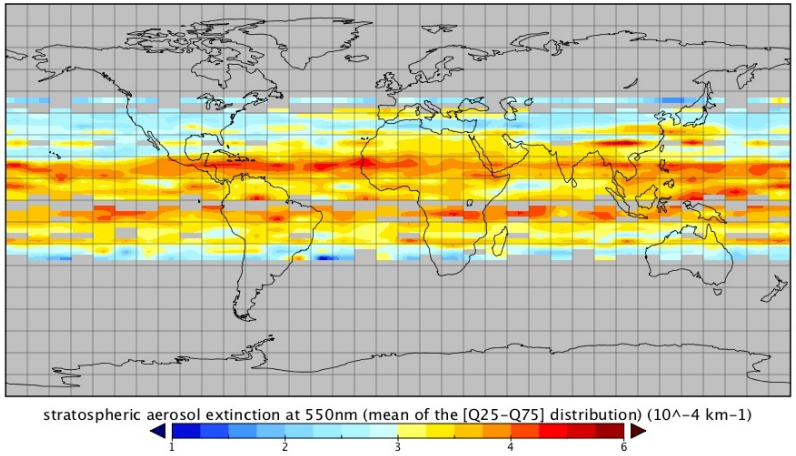
Greece Fires plume, August 27, 2007

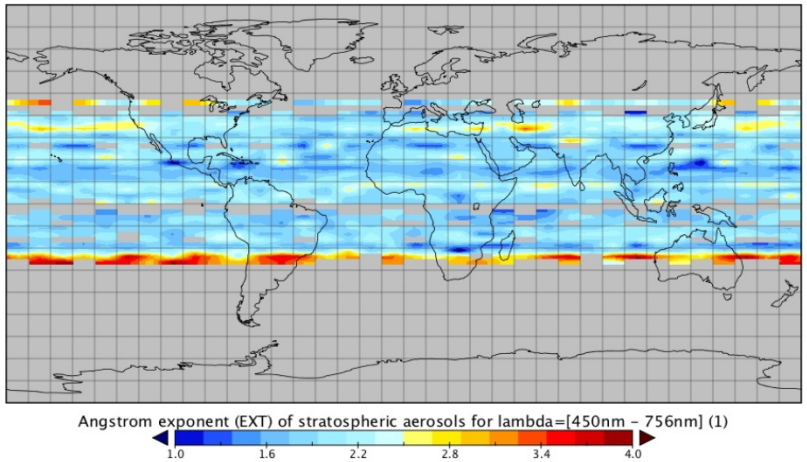
Torres et al, AMTD, 2013

DLR

Retrieval techniques and aerosol variables

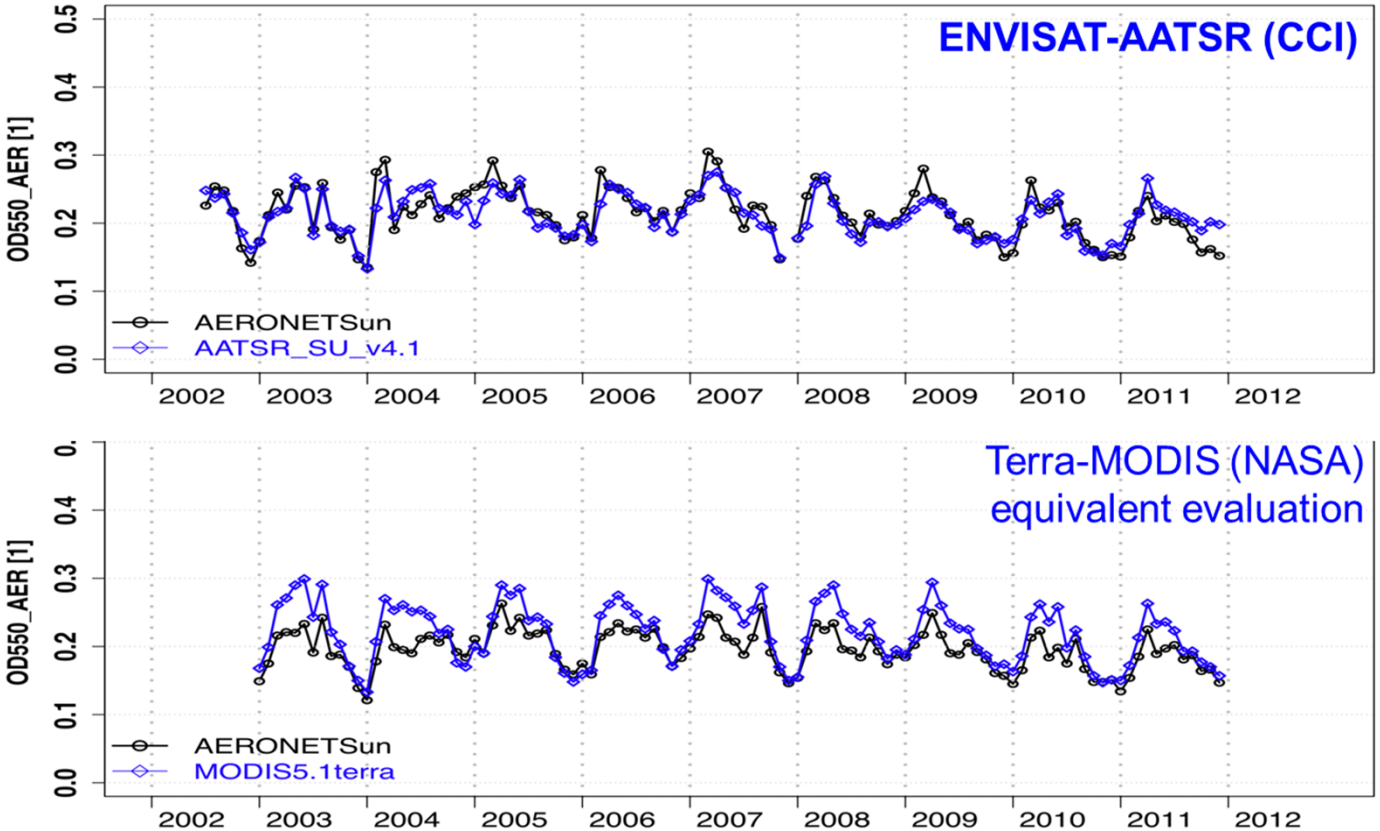
Technique(s)	product	resolution	period
Limb solar occultation **SAM, SAGE, OSIRIS**			1975 -
Star occultation **GOMOS**			2003 - 2012





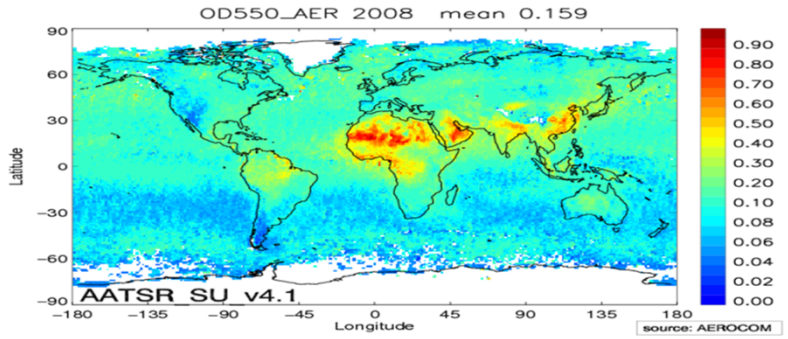
DLR

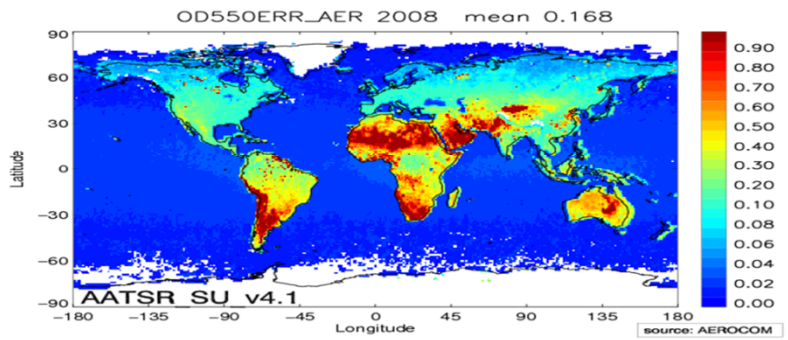
ESA / NASA complementary AOD time series

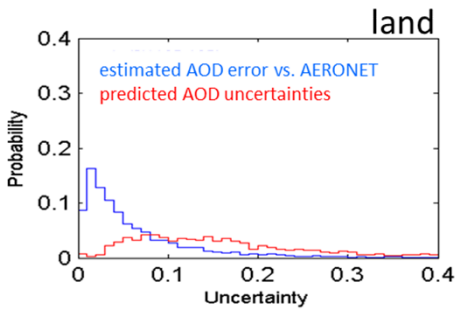


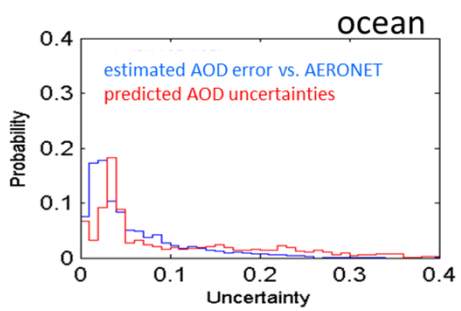
DLR

AOD uncertainties



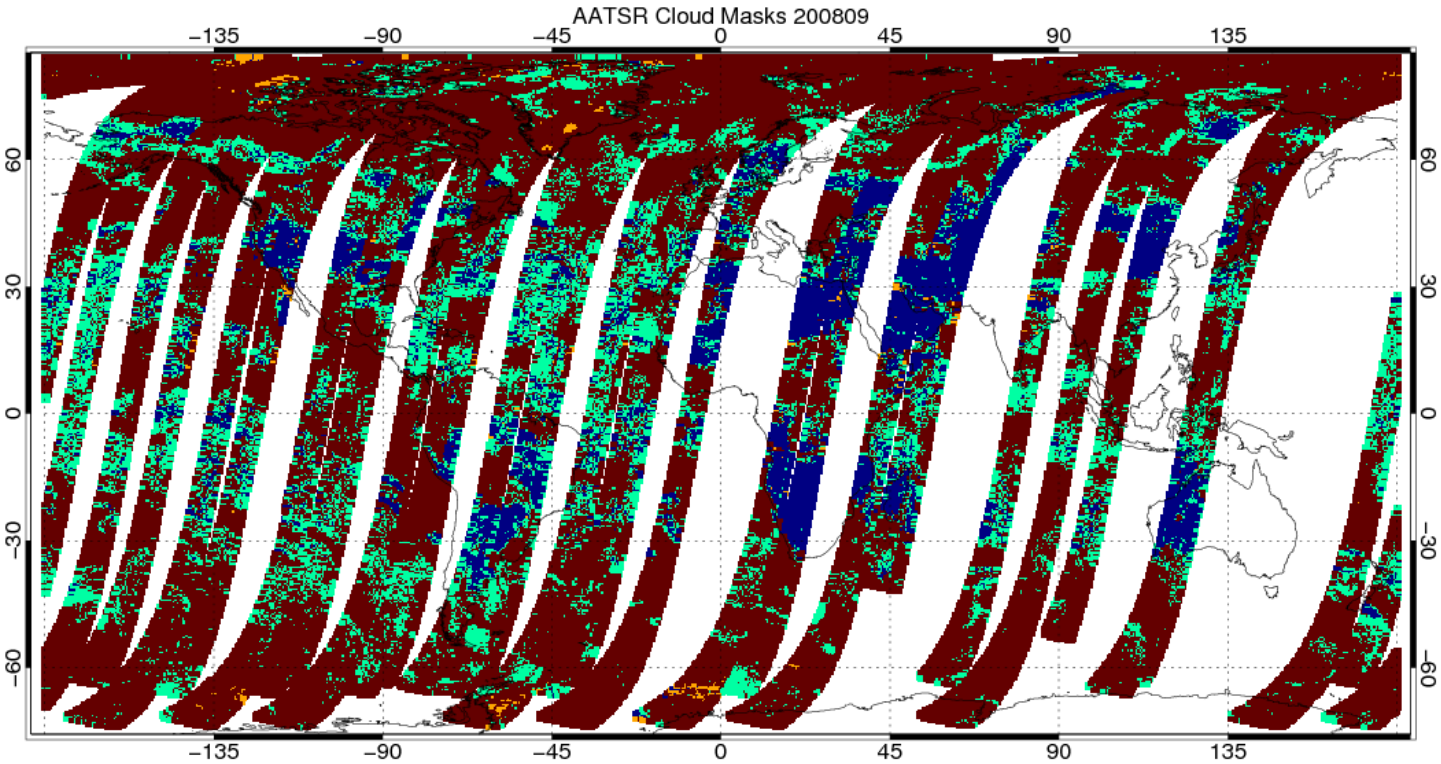






DLR

Cloud mask consistency



APOLLO / Cloud_cci

13.1%	21.6%	0.3%	64.9%
No Cloud / No Cloud	Cloud / No Cloud	No Cloud / Cloud	Cloud / Cloud

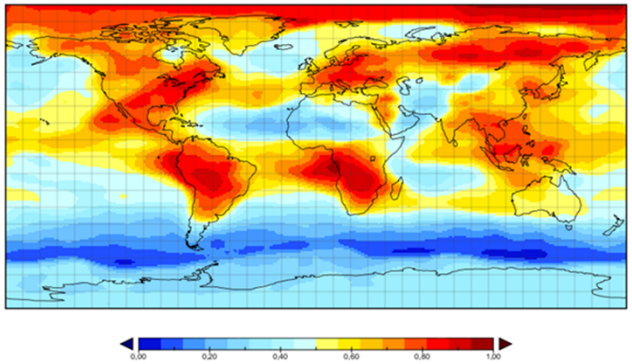
DLR

Experimental Aerosol_cci datasets in progress

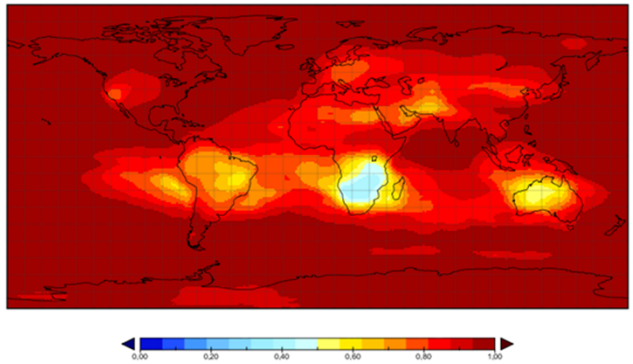
AOD, Ångström	**MERIS (land)**	2008, global
AOD, **aerosol type**	SCIAMACHY/AATSR (SYNAER)	3/6/9/12 2008, global
AOD, Ångström	**AATSR/MERIS**	3/6/9/12 2008, global
Stratospheric extinction profiles	GOMOS/OSIRIS (**merged**)	2003, global
AOD, **aerosol properties**	POLDER (GRASP algorithm)	Example scenes, **land**
Absorbing AOD (SSA)	AATSR (glint)	Examples, **glint areas**

Mixing aerosol components (AEROCOM – AERONET climatology)

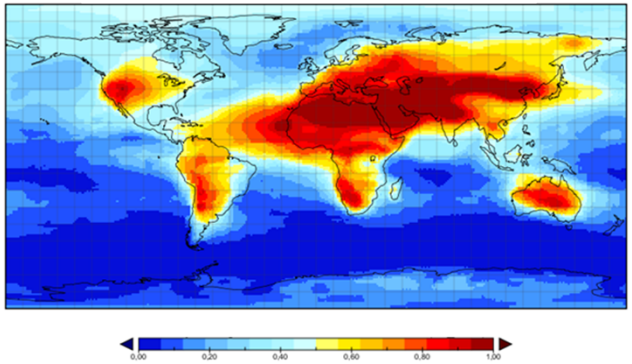
Fine mode fraction



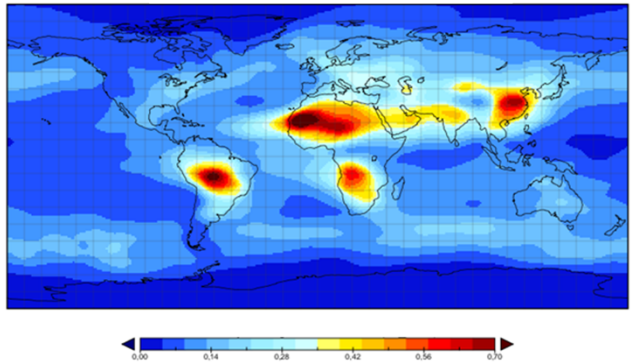
Fraction of the less absorbing component in the fine mode



Fraction of dust in the coarse mode



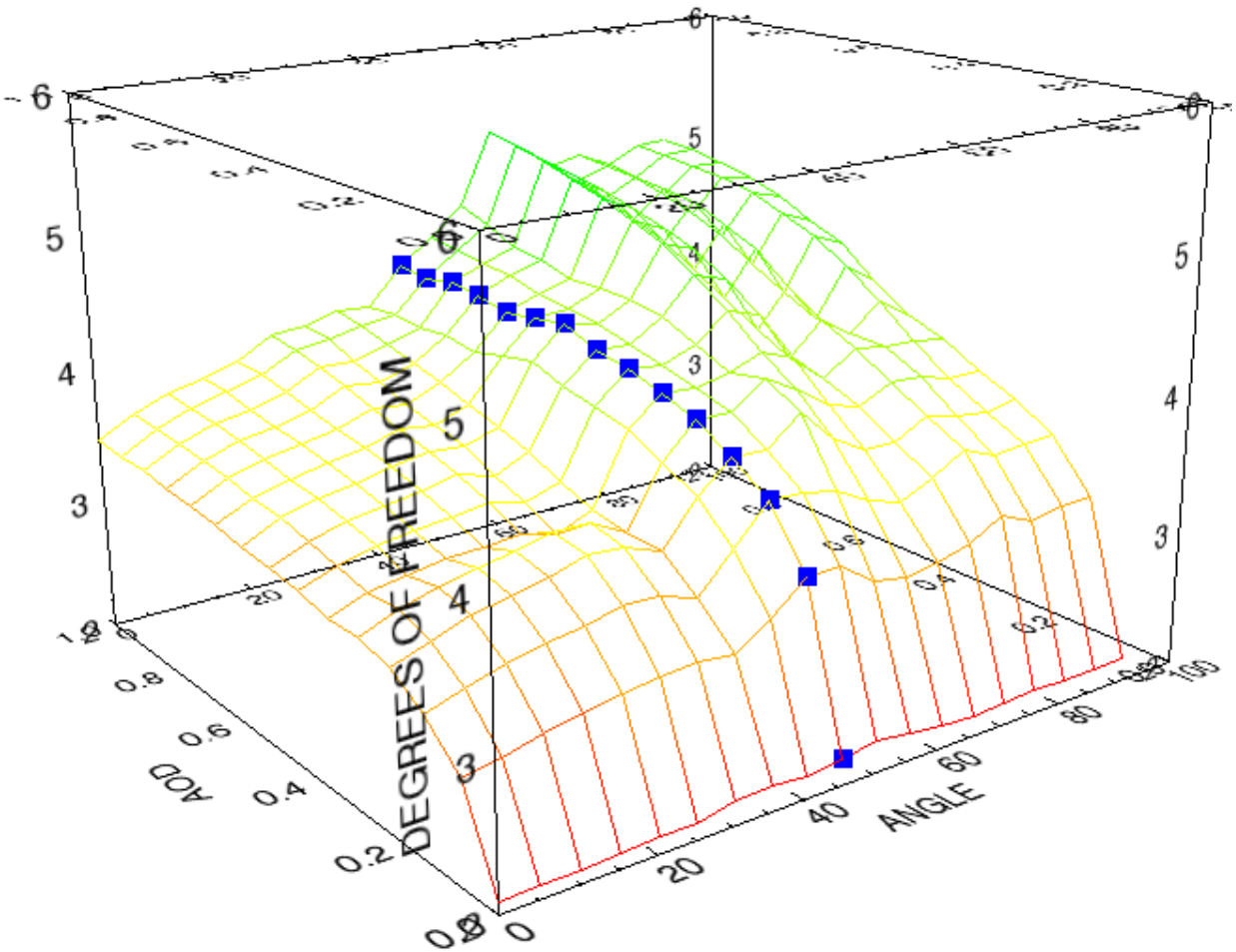
AOD550 (not used as a priori)



DLR

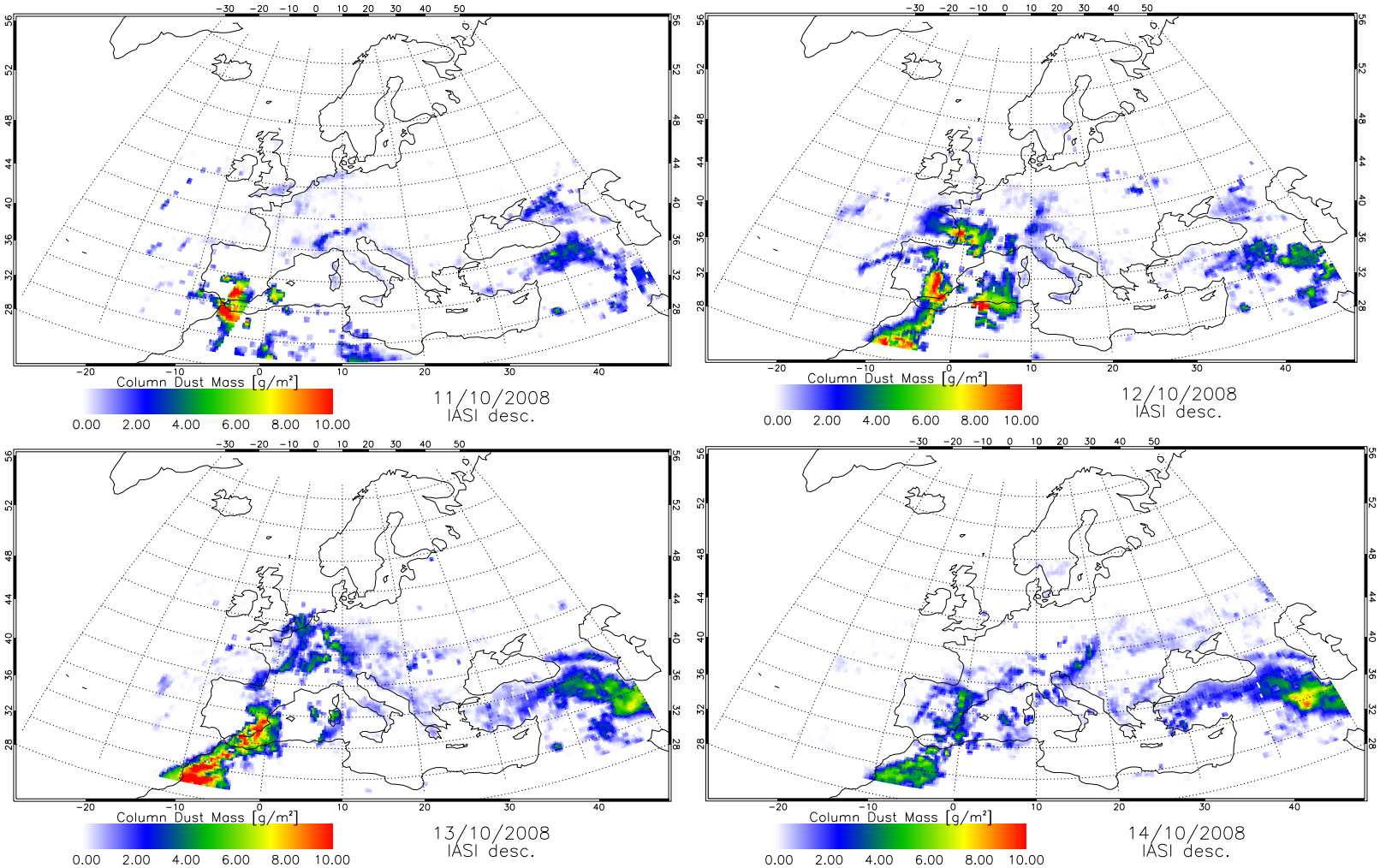
Information content for **aerosol composition** (SYNAER)

Aerosol retrieval from SCIAMACHY + AATSR (ENVISAT)



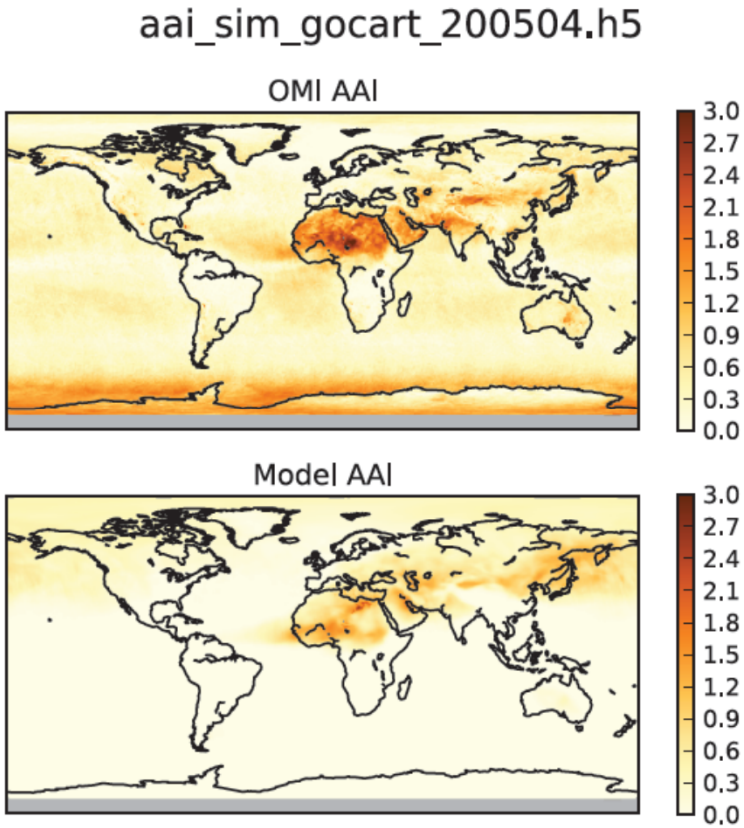
IASI (TIR sensor): mineral dust load

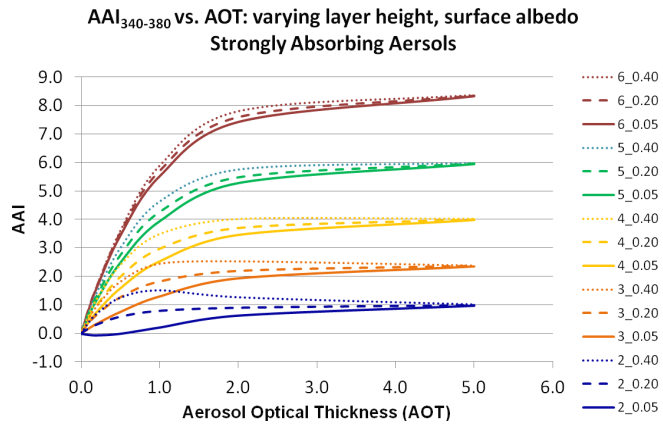
Mineral Dust mass load in October 2008

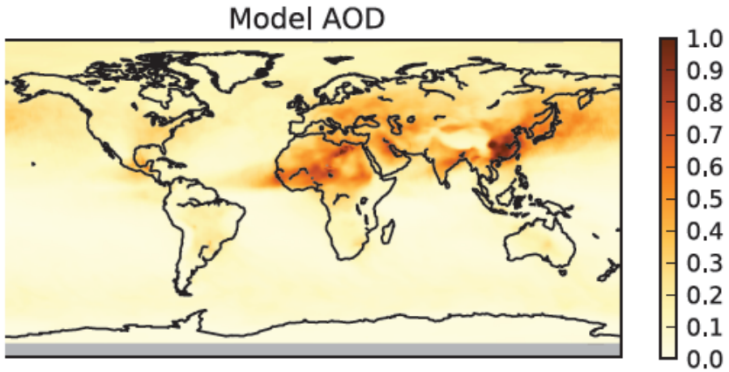


DLR

Absorbing aerosol index (AAI) simulator

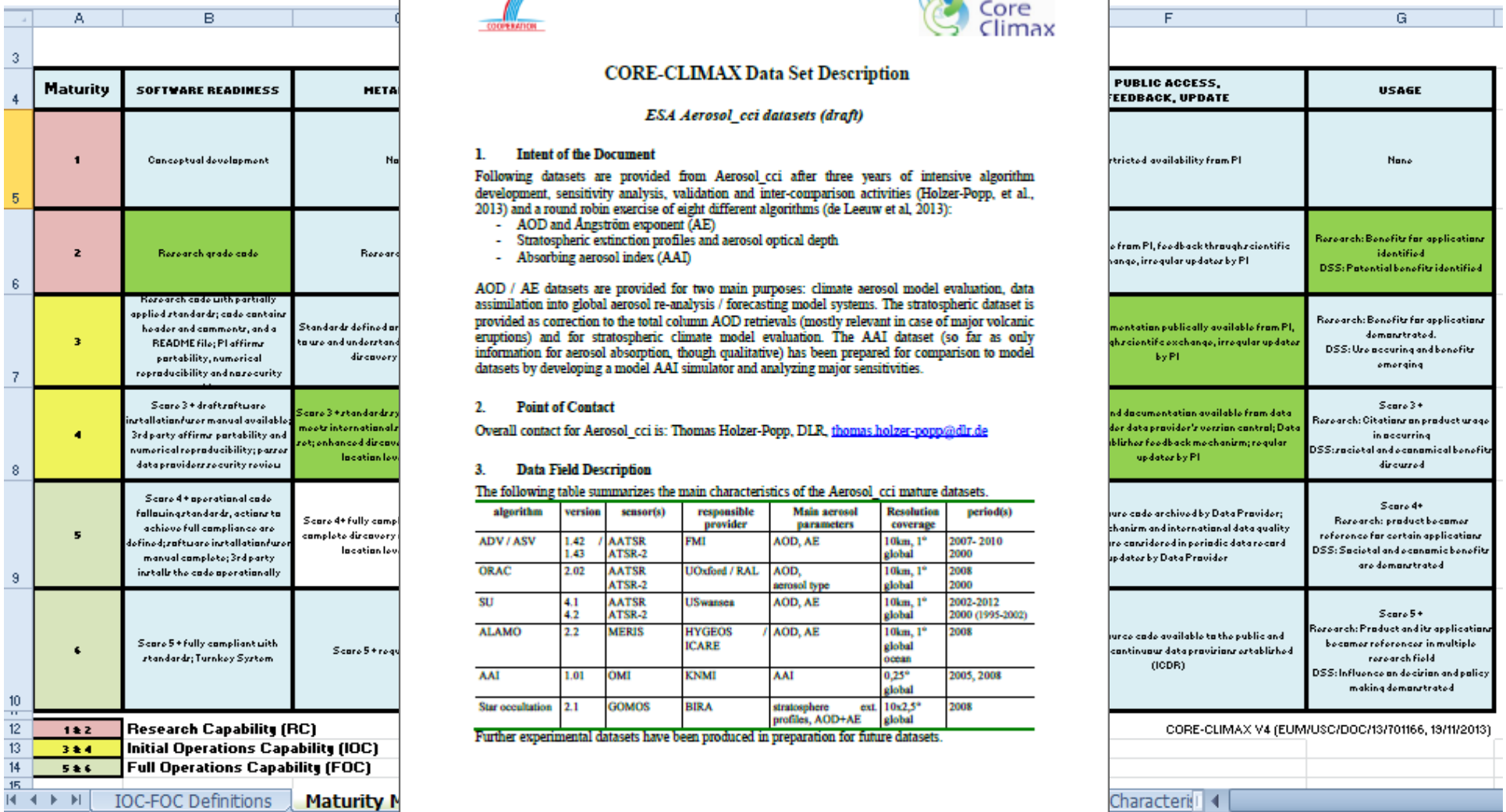






DLR

Core- … s index“)



Maturity	SOFTWARE READINESS	META…	PUBLIC ACCESS, FEEDBACK, UPDATE	USAGE
1	Conceptual development	No…	…tricted availability from PI	None
2	Research grade code	Researc…	…e from PI, feedback through scientific …hange, irregular updates by PI	Research: Benefits for applications identified DSS: Potential benefits identified
3	Research code with partially applied standards; code contains header and comments, and a README file; PI affirms portability, numerical reproducibility and no security …	Standards defined or to use and understand discovery	…mentation publically available from PI, …gh scientific exchange, irregular updates by PI	Research: Benefits for applications demonstrated. DSS: Use occuring and benefits emerging
4	Score 3 + draft software installation/user manual available; 3rd party affirms portability and numerical reproducibility; passes data providers security review	Score 3 + standards sy… meets international s… set; enhanced discov… location lev…	…nd documentation available from data …der data provider's version control; Data …blishes feedback mechanism; regular updates by PI	Score 3 + Research: Citations on product usage in occurring DSS: societal and economical benefits discussed
5	Score 4 + operational code following standards, actions to achieve full compliance are defined; software installation/user manual complete; 3rd party installs the code operationally	Score 4+ fully comp… complete discovery … location lev…	…ure code archived by Data Provider; …chanism and international data quality …re considered in periodic data record …updates by Data Provider	Score 4+ Research: product becomes reference for certain applications DSS: Societal and economic benefits are demonstrated
6	Score 5 + fully compliant with standards; Turnkey System	Score 5 + requ…	…urce code available to the public and continuous data provisions established (ICDR)	Score 5 + Research: Product and its applications becomes references in multiple research field DSS: Influence on decision and policy making demonstrated

1 & 2	Research Capability (RC)
3 & 4	Initial Operations Capability (IOC)
5 & 6	Full Operations Capability (FOC)

CORE-CLIMAX V4 (EUM/USC/DOC/13/701166, 19/11/2013)

IOC-FOC Definitions | Maturity M… | Characteri…

CORE-CLIMAX Data Set Description

ESA Aerosol_cci datasets (draft)

1. Intent of the Document

Following datasets are provided from Aerosol_cci after three years of intensive algorithm development, sensitivity analysis, validation and inter-comparison activities (Holzer-Popp, et al., 2013) and a round robin exercise of eight different algorithms (de Leeuw et al, 2013):

- AOD and Ångström exponent (AE)
- Stratospheric extinction profiles and aerosol optical depth
- Absorbing aerosol index (AAI)

AOD / AE datasets are provided for two main purposes: climate aerosol model evaluation, data assimilation into global aerosol re-analysis / forecasting model systems. The stratospheric dataset is provided as correction to the total column AOD retrievals (mostly relevant in case of major volcanic eruptions) and for stratospheric climate model evaluation. The AAI dataset (so far as only information for aerosol absorption, though qualitative) has been prepared for comparison to model datasets by developing a model AAI simulator and analyzing major sensitivities.

2. Point of Contact

Overall contact for Aerosol_cci is: Thomas Holzer-Popp, DLR, thomas.holzer-popp@dlr.de

3. Data Field Description

The following table summarizes the main characteristics of the Aerosol_cci mature datasets.

algorithm	version	sensor(s)	responsible provider	Main aerosol parameters	Resolution coverage	period(s)
ADV / ASV	1.42 / 1.43	AATSR ATSR-2	FMI	AOD, AE	10km, 1° global	2007- 2010 2000
ORAC	2.02	AATSR ATSR-2	UOxford / RAL	AOD, aerosol type	10km, 1° global	2008 2000
SU	4.1 4.2	AATSR ATSR-2	USwansea	AOD, AE	10km, 1° global	2002-2012 2000 (1995-2002)
ALAMO	2.2	MERIS	HYGEOS / ICARE	AOD, AE	10km, 1° global ocean	2008
AAI	1.01	OMI	KNMI	AAI	0,25° global	2005, 2008
Star occultation	2.1	GOMOS	BIRA	stratosphere ext. profiles, AOD+AE	10x2,5° global	2008

Further experimental datasets have been produced in preparation for future datasets.

Conclusions (1)

- Available satellite aerosol datasets
    - **AOD** (multi-spectral) is key variable
    - Resolution at best **hourly / daily – 10 km (3 km)**
    - Period back to **1995 (1978)**
    - **Additional qualitative information** is available
        - AAI, Ångström coefficient, mixing fractions
        - Need validation
    - **Pixel uncertainties are emerging**
    - More work ongoing on additional aerosol properties (fine mode AOD, SSA)
    - **Limitations for validation** exist (oceans, Southern hemisphere, properties)
    - **International coordination**

DLR

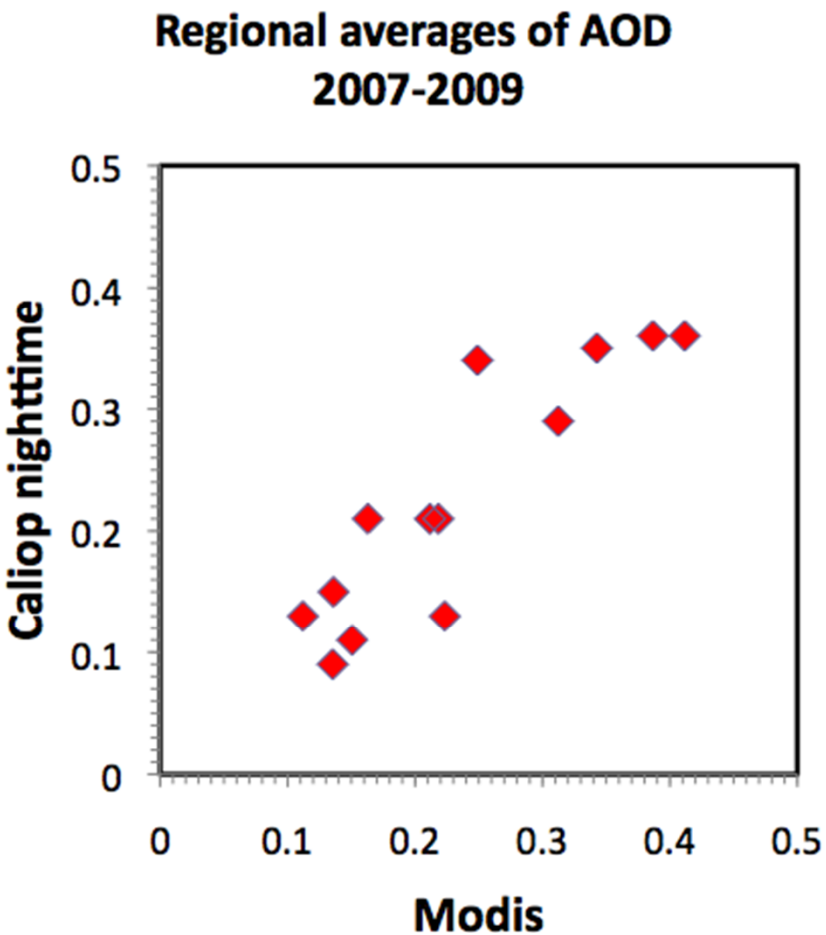
Conclusions

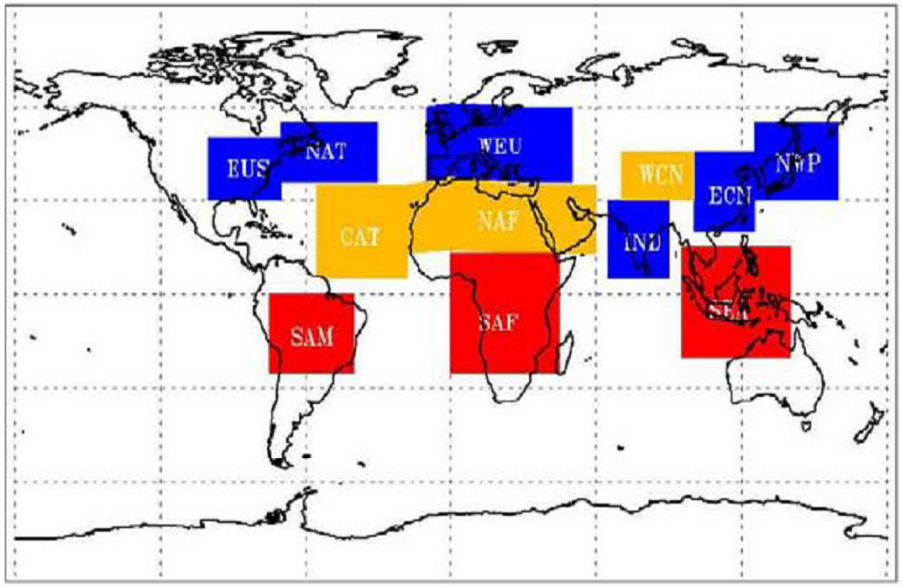
- **Aerosol_cci (Phase 2)** will
  - Produce European full mission time series (2016/2017)
  - Consolidate uncertainties, consistency
  - Assess potential for aerosol typing (e.g. UV-VIS-TIR)
  - Conduct round robins for absorption, layer height

- **General CCI feedback**
  - Modelers should use uncertainties / not only variance of several datasets
  - Documentation should exactly specify spatial grid (avoiding shifts)
  - Land cover / probability masks become available

DLR

GCOS / Aerosol_cci requirements





DLR