climate change initiative

→ AEROSOL NEWSLETTER

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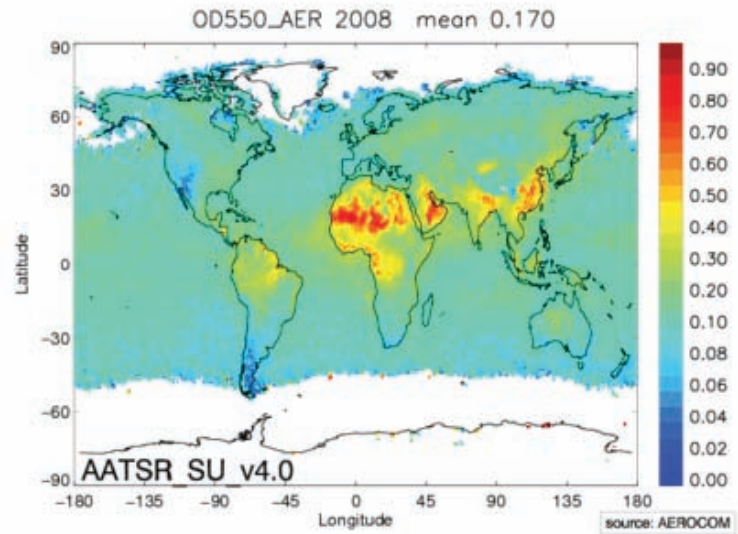
Living Planet Symposium Special



This image shows the annual mean Aerosol Optical Depth at 550 nm for 2008 calculated from one of the algorithms (Swansea University version 4.0) for the AATSR instrument on board ENVISAT (the images is perpared by AEROCOM).

In this issue:

Aerosol_cci approaches the end of Phase 1

The Aerosol_cci Phase 1 project (2010 – 2013) will have its final meeting on 29 and 30 October 2013 at ESA-ESRIN. In these three years the consortium went to intensive algorithm comparison, evaluations and dialogue between the involved expert groups in order to achieve a significant improvement of almost all contributing algorithms for European sensors. The Phase 1 work concludes with Production, Validation and User Evaluation of global annual data sets from multiple satellite instruments, plus a 17 year global time series for (A)ATSR.

Three cycles of algorithm development were conducted for nadir total column algorithms. First, algorithm experiments used one month of global data to compare different algorithm versions to understand the most critical issues. Secondly, four months of data in all seasons were compared between different algorithms (the round robin exercise). Finally, a complete annual cycle was produced and thoroughly validated. All steps have been published in peer reviewed papers (final validation under preparation). All steps have been published in peer reviewed papers (final validation under preparation).

In addition to nadir algorithms, dedicated algorithms for aerosol absorbing index and stratospheric extinction profiles were also improved and used for processing complete annual datasets.

The main achievement of this iterative algorithm work was that the three algorithms used for AATSR data have now achieved an accuracy similar to the NASA reference sensors MODIS and MISR over land. Over ocean, further work is still necessary (cloud contamiantion, surface parameterization). Another achievement is that different monthly mean maps from different algorithms/sensors generally agree better now than at the start of the project. However, statistical analysis shows that further work is needed for the MERIS and SYNAER algorithms. The POLDER algorithm over ocean already started with the highest accuracy.

Three years of intensive work led to "lessons learned" which will be used in coming years. It was proven that the critical mass of expertise assembled in the project and the open/critical dialogue, that included leading users of the data, led to significant algorithm improvements.

For the round robin exercise, a minimum data amount of four months of global data in all seasons was shown to be statistically significant (leading to similar conclusions as analysing complete annual datasets) – the necessary regional/seasonal analysis is then just feasable.

Evolving user requirements and improving algorithms can best be absorbed in a science-driven processing system with a minimum system engineering level. →

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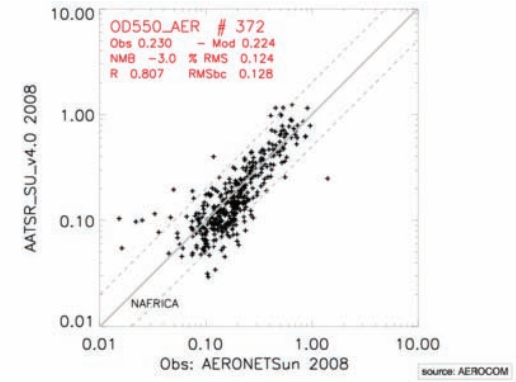
ECV products from Phase 1 are now available for download

As a major milestone of the Phase 1 global ECV datasets for 2008 (and 2000) have been produced with all mature algorithms in the project. All datasets are freely and openly available at the project ftp archive (use common account "cci" and password "cci")
http://www.icare.univ--ille1.fr/archive/index.php?dir=CCI-Aerosols



Above: The scatter plot shows one example of the comprehensive analysis made for Aerosol_cci datasets (here, Swansea v4.0). In addition to global analysis, regional analyses were also made to assess the quality for different aerosol regimes (here, dust-dominated Northern Africa/Mediterranean).

All datasets are provided in a common netCDF format using CF1.5 metadata conventions – as was agreed for all CCI in response to user needs.

Datasets as listed in the table below include various multi-spectral aerosol optical depth products, aerosol absorbing index products and stratospheric extinction profiles.

All datasets have been validated against AERONET ground-based sun photometer measurements and inter-compared to other satellite datasets (MODIS, MISR). All information on validation and inter-comparison results are available on the project website at:
http://www.esa-aerosol-cci.org

A user may ask why more than one aerosol product is provided. This reflects foremost the different information content of different instruments for aerosols. Furthermore, the typical under-determination of the underlying mathematical equations require the smart use of auxiliary information/a priori knowledge, which makes the use of different algorithms beneficial even for the same instrument.

Thus the range of differences between products from different algorithms/instruments contains additional information on the uncertainties of the products. All products carry validated estimates of pixel level uncertainties as valuable information for users (e.g. in data assimilation).

Product advantages/limitations

The detailed validation led to a clear understanding of strengths and weaknesses of each dataset; this is documented in condensed product sheets for easy use.

Very high accuracy already exists for POLDER over the ocean but was also achieved here for AATSR (all three algorithms!) over land. ATSR holds the potential for a 17 year dataset by comparing two instruments (ATSR-2 and AATSR), but has weaker coverage than MODIS.

Information on aerosol type / composition is part of the products, but has not yet been fully validated – only POLDER has full information content for a comprehensive observation of aerosol properties. Validation of aerosol optical depth also has inherent limitations (missing stations over ocean and Southern hemisphere, bias to cloud-free conditions).

The table (right) lists the aerosol ECV products available at the end of Phase 1 and specifies their parameters, sensors (and algorithms used) as well as temporal coverage. The upper part of the table lists the mature products, where a full year of data at least is available. The lower part lists experimental products and innovative algorithms under development during Phase 1.

Parameter	Sensor (Algorithms)	Coverage
AOD, Angstrom	ATSR-2 + AATSR (ADV, SU, ORAC)	2008 (2000), global (1995 – 2012)
AOD, Angstrom	MERIS (ALAMO)	2008, over ocean
AOD, Angstrom	PARASOL	2008, over ocean
Absorbing Aerosol Index	OMI (GOME, TOMS)	1978 – 2012, global
Stratospheric extinction	GOMOS	2008, global
AOD, Angstrom	MERIS (BAER, STD)	2008, global
AOD, aerosol type	SCIA/AATSR (SYNAER)	3/6/9/12 2008, global
AOD, Angstrom	AATSR/MERIS	3/6/9/12 2008, global
Stratospheric extinction	GOMOS/OSIRIS (merged)	2003, global
AOD, aerosol properties	Polder (multi-pixel algorithm)	Example scenes, land
Absorbing AOD (SSA)	AATSR	Examples, glint areas

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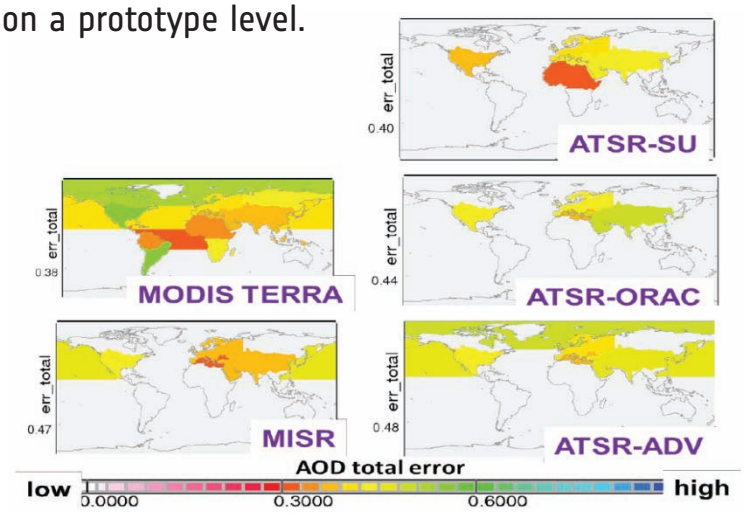
Aerosol_cci at the Living Planet Symposium

At ESA's Living Planet Symposium 2013 Aerosol_cci presents its main achievements in Phase 1 (2010 – 2013): In addition to qualifying algorithms for a full-fledged production of long-term ECV datasets, the three year project has worked out a concept for a science-driven "operational" system and demonstrated it on a prototype level.

Aerosol_cci went through the whole cycle of dataset analysis from user requirements, documentation and product specification over algorithm evaluation and improvements to prodcution of annual datasets and their detailed validation. In all these steps a flexible approach, that allowed the adoption of new and necessary tools, was required. For example, statistical evaluation of retrieved aerosol optical depth against AERONET ground measurements is also limited as discussed on page 2 of this newsletter. In order to ascertain that spatial and temporal gradients can be well reproduced with a satellite dataset, scoring tools as shown in the image on the right side are needed, which then allow better comparison to other satellite datasets.

Further tools to calculate and visualize difference maps between various satellite datasets, to deduce regional statistical comparisons, or to differentiate comparisons over land from those over ocean and coastal areas, or to filter for common points between different retrievals were developed and integrated. Such flexibility was also required on the side of the algorithms, where intensive comparisons led to testing many versions for different algorithms, which all needed to be included in the archive and distributed system of prototype processing chains.



Above: The maps shown here document, for different datasets (NASA MODIS and MISR versus Aerosol_cci three AATSR), the colour coded total error (increasing from red over yellow, green to blue) for different regions. It is clearly visible, that the AATSR dataset provides similar (or in some regions even slightly better) quality than the NASA datasets.

Joint meeting of Aerosol_cci with Cloud_cci

A joint meeting of the two CCI projects for aerosol and clouds was held at Bremen university on 6 June 2013. This meeting embarked on a detailed discussion of consistency between these two strongly linked variables and potential joint applications for studying aerosol impacts on clouds.

The Aerosol_cci and Cloud_cci teams at the joint meeting, 6 June 2013, Bremen, Germany.

Consistency between aerosol and cloud datasets is an important user requirement for studying indirect forcing. As a first assessment of consistency, cloud masks (for cloud property retrieval) and cloud clearing masks (for aerosol properties retrieval) were compared to identify gaps between both (mixed pixels, which require sophisticated future algorithms). This comparison also aimed to identify ambiguous pixels, where both aerosol and cloud properties are inconsistently derived. An initial analysis of the issues behind such inconsistencies was drafted and will be analysed further.

User requirements for ECV datsets to analyse aerosol–cloud interactions were also discussed at the joint meeting. For aerosol acting as condensation nuclei AOD is not the best possible proxy; separation into fine and coarse mode AOD is more suitable.

Joint histograms contain valuable information for such studies and should be prepared collaboratively by the two projects. It was also identified, that further interrelated datasets (e.g. on precipitation) should be acquired from other sources to facilitate additional analysis on the hydrological cycle.

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Aerosol_cci proposed tasks for Phase 2 (2014 - 2016)

In the week before the Living Planet Symposium Aerosol_cci has submitted its proposal for Phase 2. While the focus of the next three year will be shifted to producing full mission time series from all relevant European sensors, algorithm development will also be continued in order to better achieve the underlying GCOS requirements.

For Phase 2 it is proposed to produce a set of long-term datasets (ranging from 10 to 30 years) by evolving the decentralized prototype production system into a sustainable, distributed system.

Algorithm improvements will be sought on critical elements not fully solved during Phase 1 (cloud clearing, surface treatment for nadir-only algorithms, synergetic algorithms). New sensor capabilities will be brought in (thermal infrared IASI) and future time series extension will be started (Sentinel 3 and Sentiel 5-Precursor).

The gaps in validation will be addressed by using the best satellite dataset (POLDER with improved multi-pixel algorithm over land) for selected large regions as reference to optimize the other satellite algorithms with lower information content.

Parameter	Sensor (Algorithms)	Coverage (planned) - status
AOD, up to 4 wavelengths	ATSR-2 + AATSR (ADV, SU, ORAC)	1995 – 2012
	AATSR / MERIS	2003 - 2012
	PARASOL	1996, 1998, 2006 – 2015 (selected land regions)
	SYNAER	2003 - 2012
Dust AOD	IASI	2006 - 2015
Stratospheric extinction, AOD, size parameter	GOMOS	2003 - 2012
	SAGE-II, OSIRIS, GOMOS	1984 – 2012
Sentinel demo datasets	SLSTR AOD TROPOMI AAI	2015

Constituting AEROSAT

AEROSAT will be the International Satellite Aerosol Science Network. It has been initiated by Aerosol_cci based on experiences shared by other CCI teams, which showed that an international coordinated collaboration benefits all participating projects / space agencies

Goals of AEROSAT are:

- Exchange on evolving user requirements and discuss their consequences
- Inform on status and planning for satellite aerosol products.
- Agree on recommendations for priorities in algorithm developments
- Agree on standards for the products (e.g. error flags / uncertainties) and associated documentation to make utilization easier
- Organize collaboration on algorithm development

AEROSAT shall be an unfunded, open, independent, international network of aerosol remote sensing scientists (retrieval experts, validation experts, and experienced users of satellite data) focusing on best achievable quality aerosol satellite retrievals and guidance for their appropriate use. It shall not be restricted to any specific application area, but certainly cover climate long term records and air quality / near-real time products.

The (closed) constituting meeting of AEROSAT is organized in association with the tenth AEROCOM workshop on 27 September 2013.

AEROSAT aims at a close collaboration with related international aerosol initiatives AEROCOM (models), AEROCAST (forecasts) and AERONET (sun photometers) and defines its role to lead on all aspects of satellite retrievals.

AEROSAT shall organize annual open meetings in alternating locations (Europe, Americas, Asia). As far as appropriate AEROSAT meetings shall be associated with AEROCOM workshops.

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