AERO-SAT International Satellite Aerosol Science Network

2nd AeroSAT workshop

September 27 – September 28, 2014
Steamboat Springs, CO
Sheraton

hosts: **Gannet Hallar** / **Ian McCubbin** / **John Ogren**
co-organizers: Thomas Holzer-Popp and Ralph Kahn

MAIN GOAL

The main goal of the meeting is to substantiate and invigorate these five AEROSAT working groups:

- **pixel level uncertainties**
- **aerosol satellite product inter-comparisons**
- **aerosol typing**
- **intercomparisons**
- **aerosol Climate Data Records**

On each of those five topics, dedicated working groups have been established and members will report on initial activities followed by open discussions. Draft concepts and plans of the five working groups are summarized at the end of this agenda.

Saturday, September 27, 2014 *AeroSAT*

8:00 – 9:00 **registration** for AeroSat (…at the **Skyline Meeting Room**)

9:00 **welcome**, introduction to AeroSAT T. Holzer-Popp, (DLR) and R. Kahn (NASA-GSFC)
short round table introduction of participants

9:30 TOP 1**: pixel level uncertainties** chair: A. Povey (Uni. Oxford)

GOALS

- discuss different error propagation approaches and methods for validating pixel level uncertainties
- discuss best practices for including pixel level uncertainties in satellite products

introduction and seed questions by the chair (5 min)
summary on aerosol-CCI uncertainty discussions (5 min) A. Povey (Uni. Oxford)
uncertainty estimation for CALIOP (5 min) D. Winker (NASA-LaRC)

10:30 *coffee break*

11:00 **discussions**

12:00 *lunch*

13:30 TOP 2: **aerosol satellite product inter-comparisons** chair: T. Holzer-Popp (DLR)

GOALS

- identify gaps in existing inter-comparisons
- identify available / necessary reference data
- define meaningful additional exercises (to seek funding)

introduction and seed questions by the chair (5 min)
Aerosol_cci: lessons and plans (5 min) T. Holzer-Popp (DLR)
GEWEX aerosol assessment (5 min) S. Kinne (MPI-M)

14:30 *coffee break*

15:00 **discussions**

List of existing satellite aerosol dataset inter-comparisons to be filled in prior to / at the meeting

publication	***variables***	***method(s)***	***sensors***	***period***	***region(s)***	***reference(s)***
G. de Leeuw et al., *Rem. Sens. Env.*, (2014) DOI: 10.1016/j.rse.2013.04.023	AOD Angstrom	Lv2 statistics L3 statistics L3 scoring	AATSR, MERIS, POLDER, SCIAMACHY/AATSR (MODIS, MISR)	4 months 2008	global	AERONET

15:45 *short break*

16:00 TOP 3: **aerosol typing** chair: T. Holzer-Popp (DLR)

GOALS

- discuss different aerosol typing schemes in passive / active aerosol satellite measurements and ground-based remote sensing measurements
- discuss information content of satellite measurements for aerosol type and include new innovative approaches (e.g. polarization, spectral dependencies, data combination)
- based on this review start discussing new / common approaches

introduction and seed questions by the chair (5 min)
simple aerosol typing in aerosol-CCI (5 min) T. Holzer-Popp (DLR)
aerosol typing with MISR data (5 min) R. Kahn (NASA-GSFC)
aerosol typing with CALIOP data (5 min) D. Winker (NASA-LaRC)

discussions

18:00 end of day

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Sunday, September 28, 2014

AeroSAT

8:30 review on actions/plans for **pixel level uncertainties** A. Povey (Uni. Oxford)

8:50 review on actions/plans for **product inter-comparisons** T. Holzer-Popp (DLR)

9:10 review on actions/plans for **aerosol typing** T. Holzer-Popp (DLR)

9:30 coffee break

10:00 TOP 4: **satellite-model-ground based intercomparison** chair: R. Kahn (NASA-GSFC)

GOALS

- suggest approaches to achieve widest benefit from comparing / integrating in situ data together with satellite data, ground-based remote sensing data and model results
- identify information content / thorough characterization and documentation of limitations for each (satellite and also ground-based) retrievals

introduction and seed questions by the chair (5 min)
lessons learned in Aerosol_cci (5 min) T. Holzer-Popp (DLR)
experiences using Giovanni (5 min) C. Ichoku (NASA-GSFC)

discussions

12:00 lunch

13:30 TOP 5: **aerosol Climate Data Records** (CDR) chair: S. Pinnock (ESA)

GOALS

- define consensus requirements to qualify as an aerosol CDR
- compile inventory of satellite aerosol data sets that could qualify as aerosol CDRs

introduction and seed questions by the chair (5 min)

discussions

list of available aerosol climate data records (CDRs) to be filled in prior to / at the meeting

satellite instrument	***algorithm***	***main retrieved quanitiies***	***time span***	***provider***	***access***	***reference***
ERS-2 ATSR-2, Envisat AATSR	SU v4.2	AOD (550nm, 659nm, 865nm, 1610nm), mixing fractions, Angstrom	1995-2012	U.Swansea Aerosol_CCI	www.esa-aerosol-cci.org	G. de Leeuw et al., *Rem. Sens. Env.*, (2014) DOI: 10.1016/j.rse.2013.04.023

15:00 *coffee break*

15:30 **summary**, concluding remarks R. Kahn (NASA-GSFC) and T. Holzer-Popp (DLR)

16:00 *end of the meeting*

16:00 optional visit of the Storm Peak Aerosol Lab (register via web: http://aerocom.zmaw.de)

18:30 ***reception*** *(together with AEROCOM – see AeroCom program)*

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AERO-SAT Working Group 1: External coordination

Objective

To coordinate active collaboration of the satellite aerosol community with other aerosol communities:

- Aerosol models (AEROCOM, ICAP).
- Aerosol measurements (AERONET, GALION, GAW).

Participants

- Thomas Holzer-Popp, DLR
- Ralph Kahn, NASA
- Members of AEROSAT steering committee

AEROSAT has been founded as open and unfunded network of satellite aerosol scientists during the 10th AEROCOM workshop on 27 September 2013 - AEROSAT will have its first fully open meeting on 27/28 September 2014 in coordination with the 2014 AEROCOM workshop. It is essential to understand that satellite datasets, various ground-based measurements (+ airborne campaign data) and model output are complementary to each other. Therefore, an active collaboration among these communities needs to be fostered. AEROSAT aims to assure such an exchange beyond the multiple bilateral collaborations that are already taking place.

To achieve this goal, the AEROSAT External Coordination working group will continuously pursue its activities and report at each annual AEROSAT meeting. Activities to be conducted include:

- Interact directly with the steering committees / leaders of AEROCOM, ICAP, AERONET, GALION, GAW (where possible through joint members of steering committees) to identify opportunities for promoting an integrated aerosol measurement system
- Identify and understand needs for satellite aerosol datasets from the range of aerosol communities
- Support organizing focused sessions in relevant international conferences on aerosol science; help organize the representation of the satellite aerosol community in the most important meetings of the other aerosol communities
- Work across the range of aerosol communities to promote open data exchange

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AERO-SAT Working Group 2: Climate Data Records

Objective

To identify and progress on issues related to climate data record (CDR) development that can usefully be addressed at international level, such as:

- Identify and promote internationally coordinated activities to strengthen the uptake of satellite aerosol CDRs by the climate research community.
- Identify best practice for CDR development, production, quality assessment and delivery.
- Propose standards for providing quality information in the products and metadata (e.g. common q/a flags on pixel level, common standards for useful documentation)
- Bring the aerosol CDR community together for regular exchange of information and to coordinate activities of common interest.

Participants

- Simon Pinnock, ESA, (contact: simon.pinnock@esa.int)
- Thomas Holzer-Popp, DLR
- Christina Hsu, NASA
- Gerrit de Leeuw, FMI & U. Helsinki
- Rob Levy, NASA
- Lothar Schueller, EUMETSAT
- Omar Torres, NASA

The CDR-WG is open to all aerosol CDR developers and users, and we aim to expand the list of participants to ensure representation of the main on-going aerosol-CDR activities.

Activities & Schedule

WG duration: Three years. At the end of this period the WG shall review its achievements in a final report and may recommend follow-on activities.

The initial work plan for Year 1 is:

- Define consensus requirements that data sets and their associated documentation should ideally meet to qualify as an aerosol CDR. The possibility to define a common CDR data format standard shall also be investigated, to promote interoperability of aerosol CDR products.
- Compile an inventory of satellite aerosol data sets that could qualify as aerosol CDRs, and record their status regarding the above requirements. The inventory shall be published on the web site together with a bibliography of related peer-reviewed publications.
- Organise a workshop to review the current status of aerosol CDR development and use. A major outcome of the workshop shall be the identification of priorities for aerosol CDR development.
- Explore the possibility to set up a virtual common portal for user-access to satellite aerosol CDRs.
- Design and promote a comprehensive and consistent aerosol CDR intercomparison and validation exercise, together with the AERO-SAT WG on Intercomparisons.

Priorities for later work are open to discussion.

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AERO-SAT Working Group 3: Inter-comparison

Objective

To coordinate complementary activities for inter-comparing satellite aerosol datasets:

- Identify gaps and opportunities for inter-comparisons of aerosol satellite data (among themselves and with model datasets), which can provide added value to the understanding and appropriate use of the satellite datasets
- Liaise closely with the AEROSAT WG on uncertainties to support the gap analysis
- Optimize communication to user communities on reasons for differences between satellite aerosol datasets and what we can learn on their overall uncertainties by inter-comparisons

Participants

- Thomas Holzer-Popp, DLR
- Ralph Kahn, NASA
- Jan Griesfeller, Michael Schulz, MetNo
- Stefan Kinne, MPI-Met
- Yong Xue, London Metropolitan University
- Gerrit de Leeuw, FMI and Helsinki University
- Dave Winker, NASA

Extensive validation has been done for most current satellite aerosol datasets, but for every new dataset collection (i.e. global and covering several years of data), a comprehensive validation (to ground reference measurements) and inter-comparison (to other satellite and model datasets) needs to be conducted to understand its strengths and limitations. A new dataset means either an incrementally new version of an existing dataset (upgraded algorithm, new algorithm) or a dataset from an entirely new instrument. Organizing this validation and inter-comparison is the foremost responsibility of the respective data provider, whereas conducting the validation can and probably should be performed by both the instrument team and independent validation experts or user teams.

When it comes to broader inter-comparisons of several datasets, AEROSAT can contribute by

- Identifying gaps in inter-comparisons (satellite datasets, reference datasets)
- Identifying necessary studies (inter-comparisons, algorithm experiments) based on the outcome of the AEROSAT uncertainties WG
- Agreeing on metrics and tools for such inter-comparisons
- Proposing additional validation / inter-comparison studies to fill identified gaps
- Identifying relevant algorithm experiments to study the impact of specific algorithm / module changes (e.g. common cloud masking)

Within ESA's Aerosol_cci project the use of the AEROCOM model evaluation tools and the "Kinne scoring" (evaluating spatial and temporal correlations) for daily gridded satellite datasets was chosen for model-user-oriented dataset validation in addition to direct level2 validation – in all cases AERONET was used as reference source. Limitations in coverage for spectral AOD of AERONET may be overcome by adding a quasi-reference using a "best" satellite dataset over ocean or in remote regions can be agreed upon. Limitations of AERONET particle type retrievals might be mitigated by field campaign data coincident with satellite observations, and by comparison with instruments that provide some constraints on particle type, such as POLDER and MISR.

The link to the GCOS requirements for accuracy is not always easy and it could be analysed in how far validation could be optimized to provide exactly the same quantities as used in the GCOS satellite supplement (e.g. combined absolute + relative accuracy threshold).

Activities & Schedule

WG duration: Three years. At the end of year 1 the WG shall review its gap analysis and will recommend concrete activities for years 2 and 3.

Year #1

- Gap analysis (WG members) & proposing additional inter-comparison studies (identify upcoming entirely new datasets, list existing comparisons)
- Identify funded planned activities which could be linked and interact with them to assure maximum possible complementarity
- Define appropriate metrices and tools focusing on response to GCOS
- Seek additional funding for open highest priority studies under the advice of AEROSAT

Year #2 + #3 (depend on results of year #1)

- Integrate results from complementary inter-comparisons and algorithm experiments responding to some of the identified gaps
- Conduct additional studies if funding is secured (link outcomes from existing projects or add new funded activities)
- Update the gap analysis based on available new results and datasets
- Based on the findings integrated / made contribute to updating GCOS requirements / proposed metrices.

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AERO-SAT Working Group 4: Pixel Level Uncertainties

Objective

To coordinate an exchange of work on pixel level and retrieval-region ("super –pixel") level uncertainties in satellite aerosol retrievals:

- discuss different error propagation approaches.
- discuss methods for validating pixel level uncertainties.
- identify best practices for including pixel level uncertainties in satellite products.
- discuss recommendations to users how these pixel level uncertainties shall be utilized.

Participants

- Thomas Holzer-Popp, DLR
- Adam Povey, Oxford University
- Gerrit de Leeuw, FMI & U. Helsinki
- Rob Levy, NASA
- Ralph Kahn, NASA
- Yong, Xue, London Metropolitan University
- Lucia Mona, IMAA

It is proposed for the second phase of ESA's Aerosol_cci project (2014-2016) to install a working group on pixel level uncertainties. This working group shall review the initial approaches for pixel level uncertainties which have been implemented in Aerosol_cci until 2013 and work towards a harmonization of this uncertainty output in different Aerosol_cci products. Activities will be initiated with a dedicated workshop in the first half of 2014.

Once approved, this project working group will be open to external participants and can thus become a nucleus of the AEROSAT WG on pixel level uncertainties. As a starting point activities on pixel level uncertainties within ESA (CCI project), NASA (MODIS, MISR teams) and GALION shall be inter-compared; further interested groups are invited to contribute to discussions.

Activities & Schedule

WG duration: Three years. At the end of this period the WG shall review its achievements in a final report and may recommend follow-on activities.

Year #1

- Review methodologies applied for calculating pixel level uncertainties including underlying errors which are propagated
- Discuss differences in the methods and learn from the approaches in other groups
- Interact with accredited meteorologists to improve quality and usability - as far as feasible - with the GUM (Guide for Uncertainties in Measurements) as a guide. (The GUM is not yet fully appropriate for satellite aerosol retrievals, consider proposing necessary additions)

Year #2

- Review methods for validating pixel level uncertainties and discuss how the results can be interpreted
- Review results of validating pixel level uncertainties define necessary improvements for the uncertainty calculation methods

Year #3

- Based on the discussions in the first 2 years identify best practices for including pixel level uncertainties in satellite products and discuss recommendations to users how these pixel level uncertainties shall be utilized.

AERO-SAT Working Group 5: Aerosol typing

Objective

Review methods to retrieve information on aerosol type from satellite and ground-based remote sensing

Participants

- Lucia Mona, CNR-IMAA (EARLINET/GALION)
- Gelsomina Pappalardo, CNR- IMAA (EARLINET/GALION)
- Ralph Kahn, NASA (MISR)
- Thomas Holzer-Popp, ESA
- Pieternel Levelt, KNMI

Aerosol typing is key information for aerosol measurements by satellite borne instruments in two respects. Depending on the specific measurement technique, aerosol typing is an input needed for the satellite retrieval and is output information from the algorithm.

Typically, aerosol retrievals from satellite measurements make *a priori* assumptions about aerosol type, usually based on external information. Due to the different information content of different types of instruments, the aerosol type assumptions in the algorithms need to be different. The accuracy of the derived aerosol products strongly depends on the reliability of these assumptions. Different algorithms typically adopt different assumption. A critical review of these assumptions is warranted, and harmonization of these procedures, though a challenging undertaking, could significantly reduce related uncertainties for making comparisons among the products, and possibly for the products themselves.

On the other hand, satellite measurements in the past years have provided valuable information about the global distribution of aerosol types, identifying, for example, the main source regions and typical transport paths. Climatological studies of aerosol loading at both regional and global scales typically rely on inferred aerosol type. The inhomogeneity among satellite aerosol typing schemes increases the difficulty in using multiple sensor dataset in a consistent way. Knowledge of the 4d distribution of the aerosol types at these scales is essential for understanding the impact of the different aerosol sources on climate, precipitation and air quality. This information is also needed to help plan the next-generation aerosol emissions policies at continental and global scales. The exchange of expertise and the communication among satellite (and ground-based) measurement communities about this topic is fundamental for improving long-term datasets consistency, and for reducing the uncertainties on aerosol types distribution.

First year Activities/Schedule:

Review of the existing aerosol typing schemes as adopted for aerosol satellite measurements.

Review of the aerosol typing from ground-based remote sensing measurements.