4th AeroSAT workshop

September 22 – 24, 2016, Beijing, China

Minutes

Agenda

Posters

All presentation slides are available at http://www.aero-sat.org/aero-sat-meeting-4.html

Minutes

SESSION 9 AeroCom-AeroSAT interactions
chair: ***Larisa Sogacheva***

Following topics were raised as highly important for interaction between modeling and retrieval experts:

- assumed optical properties (satellite + model) – look-up-tables or additional data layers
- are more components needed in models to match satellites – how many? emissions (aerosol composition) or optics-determined (size, shape, absorption)?
- closure studies using model-simulated radiances in satellite retrievals
- using common / clearly defined terminology is important (e.g., aerosol “type”)
- assimilation of all datasets – how / what to keep for independent validation
- how use satellite aerosol+cloud data for processes in modeling

SESSION 10 **interactions – concepts, applications and needs**
chair / rapporteur: ***Mian Chin / Linlu Mei***

Use of uncertainties in models

- Testable hypothesis: A model is valid (against an observation) if it is ***not statistically different from the observation*** - this is easy to assess as long as we know the statistics of the models and observations
- Comparison needs to ***consider sampling and statistics*** of model and observations
- ***Uncertainty*** can be ***quantitative*** (envelope error, pixel-level uncertainty) and ***qualitative*** (flags)
- Largely ***under-estimated uncertainties*** are not helpful
- Need to define suitable ***parameters for the comparisons*** (AOD maybe too uncertain, to test process understanding)
- We need to work on ***quantifying level 3 uncertainties*** due to retrievals and due to sampling
- Matching ***model grid points in space and time to satellite retrievals*** should be used to reduce the sampling error in satellite-model inter-comparisons
- ***Distribution histograms*** (in a grid cell) of retrieved values can provide more information than averages
- Difficult contribution to ***uncertainties by cloud masking*** (possible ways forward: probabilistic, qualitative)
- Observation simulation experiments (***OSSEs***) can be useful to estimate uncertainties

Use of aerosol types in models

- How ***quantitative does satellite aerosol type*** need to be to be useful for modeling?
- How can the ***categorical satellite information*** be used to constrain models?
- Dust considered as most reliable aerosol type information over land; ***constraining absorption*** is needed (and needs improvement)
- Aerosol type information is ***difficult to quantify*** from satellite
- Passive satellite instruments provide ***column-effective, ambient values***, categorical aerosol types
- Satellite strength: ***spatial distribution patterns***
- Retrievals from ***different independent observations*** can provide additional information.
- Aerosol ***type definitions are different*** between models and observations, and among observations
- ***Sensitivity studies*** for different aerosol types are useful for both observations and models
- ***Translation of different assumptions*** to the same language to avoid any wrong comparison for different parameters
- ***Aircraft observations*** can be introduced to be the linkage between observations and model
- ***Ranges / PDFs of satellite retrieved parameters*** for each aerosol type should be provided to modelers
- Documentation and communication of quantitative ***optical properties of aerosol type definitions*** (wiki page) is needed (both retrievals and models)
- Joint ***model + satellite twining teams*** should analyse case studies, e.g. of the A-train to define consistent matching of aerosol types

How support aerosol-cloud studies (ACPC)?

- How can we qualify the ***relationship between AOD and CCN***
- We need creative ***ideas how to use satellite data*** at their limits for aerosol-cloud studies
- Satellite retrieval limitations: ***collocation between aerosol and cloud, particle size required*** to analyse interaction, aerosol type definitions
- Use ***low and high spatial resolution*** (e.g. Landsat) to analyze case studies
- Better use of ***geostationary*** satellites
- Coordinated ***in-situ and airborne measurements*** for aerosol and cloud
- Exploit known aerosol sources in ***homogeneous conditions for closure studies*** (e.g. ship tracks, volcanoes)

Needs for data assimilation to standardize algorithm qualification

- How can we support retrieval preparation for data assimilation (***uncertainty characterization***, ***bias correction***, …)?
- How can we separate ***systematic and random uncertainties***?
- What can be done for ***values which cannot be validated*** (no reference)
- Assimilate all data and do prediction / ***forecast to check assimilation***

How can we support CMIP6 [AERCHEMMIP/RFMIP/VOLMIP]?

- Critical questions were raised towards ***CMIP / obs4MIPs approach*** (***too simplified***, monthly means ***to coarse***, possibly ***unconsolidated datasets***, lack of detailed ***process understanding***)
- It was acknowledged that CMIP works for a ***different user community***, which needs condensed information
- Possible way out: Guiding users to ***utilize uncertainty*** provided with the satellite datasets
- Model simulation experiments need a ***reasonable initialization*** (not a perfect) by observations

SESSION 11 Uncertainties in satellite retrievals
chair / rapporteur: ***Gerrit de Leeuw / Rob Levy***

This session discussed uncertainties, and that we can ***derive uncertainties in two main ways***. The first is by ***comparing to a ground truth*** (e.g. AERONET sunphotomer) data, the second is by ***deriving internal estimates*** (e.g. pixel-level uncertainties) based on the algorithms themselves. The first topic was introduced generally by Andy Sayer, and the second by Thomas Popp. A third talk, given by Qi Zhang, used the differences between MODIS Collection 5 and 6 data to illustrate uncertainty in trends.

Let's start with Andy's talk. This talk was a very nice criticism of the kind of statistics most of us use describe algorithm/product performance, namely ***linear least square (LLSQ) regression to compare with "ground truth"*** (AERONET). He graciously noted that his "goal was not to name or shame", but only to point out that we can still ***learn how to do things correctly***. Most importantly, the problem with LLSQ is that ***AOD is not normally distributed***, but rather close to lognormal. This means that the there are some quirks in any results. For example, since AOD is right skewed (a few very high values), the ***mean_AOD is almost always larger than EXP(mean_logAOD***). ***Other assumptions*** of a normal (Gaussian) distribution are also not true in the case of AOD. Since there are no negative AOD, ***bias at zero must be positive***. In fact, even for a nice lognormal distribution with millions of points, LLSQ on the true data (e.g. AOD) leads to a positive offset and slope < 1.0.

The other key problem with comparing satellite and ground data are that there are both ***temporal and spatial autocorrelations***. This means that ***errors are correlated to a given "context***". Scatterplots at different AERONET sites show very different characteristics.

If not simply LLSQ regressions, then ***what to do***? Some ideas were to include ***uncertainty in x-axis***, put more emphasis on "***compliance with uncertainty estimates***" and to ***evaluate biases as a function of the retrieval space*** (satellite retrieved AOD) in addition to standard evaluation as a function of ground truth (AERONET observed AOD). Other considerations included dealing with sticky issues such as ***"defining" the population*** and deciding whether one statistic can tell all. Also, whether we should be ***assigning uncertainty to regression statistics*** (e.g. is it a statistically significant conclusion to decide that product #1 with R=0.8 is better than #2 with R=0.73?).

Finally, Andy discussed a few other big issues. One example was that validation does not tell us about the ***events we miss*** (e.g. retrievals of extreme events in Indonesia). Others include how to deal with assigning ***uncertainty to a level 3 product***, and how to we deal with ***AERONET variability and uncertainty***.

Instead of moving on to Thomas's talk (as scheduled), there was organic flow into a discussion about ***deriving validation-based uncertainties***. I have information about who suggested what (when I knew who they were), but don't share here. ***Do log/log plots "hide" data***, even if they may be more appropriate for doing comparisons? Is there an advantage for, in addition of comparison with AERONET using AERONET AOD as X-axis, for ***using satellite AOD as X-axis? Yes, because this provides the information for a model or assimilation study***. How do we demonstrate conditions when things don't work at all (no chance of a "good" regression). Other audience members gave concrete suggestions for new or improved statistics, including ***bootstrapping***, mathematical ***transformation of distributions***, and doing ***regressions multiple times*** (repeatedly excluding pieces of the dataset). Finally, there were some thoughts about ***leveraging other CCI teams*** (having same problems) and should we invest in an AeroSAT statistician?

Just before coffee break, we segued into the ***pixel uncertainties*** and Thomas's talk. Thomas showed how ***error propagation (partial derivatives) can lead to large uncertainty***, and ***maybe larger than as actually demonstrated by comparison to ground truth***. Can one actually "validate" the uncertainties (***uncertainty versus error = difference from truth***). Is it sufficient to show that these two variables have similar PDFs?
A main reason for developing pixel uncertainties is to provide ***information for data assimilation***. Thomas showed, and there was a spirited discussion, about slides from European data assimilation. The slide showed that ***model PDF looks more like AERONET when a satellite dataset with constant error estimate is assimilated***. The improvement is even larger if there is a ***good estimate of pixel level uncertainty***. However, it was repeatedly stressed that all of this ***assumes that a single value of AERONET is good enough*** to validate, and that we shouldn't put "too" much value in data assimilation.

If we want the best estimate from satellite products, Thomas pointed out ***strength in diversity***. For AATSR, there is strength in the ensemble, as no one algorithm (out of the three) is best under all circumstances. One could calculate medians and use uncertainties from individual algorithms. When it comes to ***Level 3 products***, he provided some guidelines, including

- Account for ***mean uncertainty*** (confidence in used pixels)
- ***Standard deviation*** (natural variability)
- ***Propagated uncertainty*** (independent random)
- Sum of last two (dominant sources of error)

Although error-propagation and pixel level uncertainties report some information, there are some sources of error that we cannot (yet) describe. For now, we ***must use "flags" and quality assurance***/documentation in place of:

- Uncertainty of "***cloud" (or other) masks***
- Validation ***where no reference data exist*** (cloud edges, coastal water, etc.)
- Separation into ***systematic vs. random***
- ***Propagation to gridded*** datasets
- Treatment of ***uncertainty terms with different correlations***
- ***Assumptions of uniformity*** in the observations over time.
- Unknown

Qi Zhang then discussed v*ariation and trends of MODIS C5 & C6 products errors* in Northern China. All errors increased as function of time, but had seasonal cycle. She concluded that

- ***Ground-based AOD showed slight negative trend***, MODIS doesn't catch these characteristics.
- ***Merge of DTDB is better*** than either alone (ensemble)

Questions:

- Could trends be different because of ***different aerosol types over time***?
- How does processing of CSHNET site compare with processing of AERONET site?

General discussions

How can we relate the discussions?

- Problems of ***AOD sampling over time***. What about the increasing/decreasing trends?
- Problems with ***ground based data. Stability of calibrations*** as well?
- How do we get back to the bigger picture? How do we know that a new dataset is better than before?
- How do we determine ***statistics of trends***?
- ***Independent trend analyses need to be consistent*** (e.g. same periods, same metrics)
- An analysis with a clear (= ***obvious) result creates higher confidence*** (though not always justified)
- How do we decide ***which algorithm/product to use***?
- There are a lot of papers that discuss statistical "power" from social scientists. How do we decide that a dataset is statistically different than before?
- What are the ***requirements on assessing uncertainty***? Different for climate and air quality?
- We need several ***INDEPENDENT datasets to look for trends***.
- ***Assumption of independent data*** is often not valid: e.g. MODIS C6 and C5 (same sensor) or MODIS-TERRA and AQUA (same retrieval), MODIS/MISR (seeing the same world at the same time).
- Critical point, we are all validating with AERONET
- Conclusion: We ***need a review / synthesis paper about validation and uncertainties*** – Andy Sayer is asked to kindly lead on it, with AEROSAT support

SESSION 12 air quality and aerosol
chair / rapporteur: ***Ralph Kahn / Jan Griesfeller***

Seed questions

1. Obtaining the ***near surface AOD-component***
2. ***Speciation*** - constraining the aerosol type
3. ***Spatial resolution*** - especially in urban areas
4. ***Temporal resolution*** - often big diurnal variations
5. Based on all those 4 issues: ***AOD - PM2.5 conversion***

<u>"The NOAA VIIRS aerosol products and air quality applications" given by Lorraine Remer</u>

Main conclusion:

- Air quality from space is not just about getting PM 2.5 correct but also about
- Spatial resolution
- Temporal resolution
- ***Spatial coverage***

<u>"From climate to air quality: Polarimetric characterization of speciated airborne particulate matter" given by O. Kalashnikova</u>

Main conclusions:

- ***Quantitative determination of PM*** distributions, trends, sources and types is ***necessary*** for measuring and predicting exposure and toxicity
- Advanced ***polarimetric*** remote sensing technologies improve aerosol retrieval sensitivity to particle type
- ***MAIA*** major advance will be to ***partition PM2.5 by particle species*** (sulfate, nitrate, organic carbon, black carbon, dust) over selected target areas
- A reliable ***conversion of column AOD and fractional AOD to PM2.5 species*** is achievable through combined WRF-Chem/AirMSPI retrievals

Comments / **clarifications**:

- ***PM2.5*** comes ***from model***, but is constrained by observations
- ***Species separations*** made ***by model*** only
- ***Vertical distribution*** made ***by model*** only
- New; ***No data or publication yet***
- Species will be part of MAIA product, but the quality is unknown for now

Discussion

- There's not much information on the aerosol species using an ***AOD measurement within 0.2 - 0.5 micron*** range. But it might be possible to ***use models to constrain***
- AOD - PM2.5 correlation is small when transported aerosol is present
- AOD -> PM2.5 conversion is ***not linear***
- Question: Why are there no ***PM10*** measurements from satellites?
  Answer: no long enough wavelength is measured. Next generation satellites should have that; politics cares about PM2.5 only, but if PM10 capability can be demonstrated this might evolve; But PM10 has lower health impact
- The ***SPARTAN nephelometer*** is able to constrain the ***H * S factor***. 15 stations so far

Where **H: boundary layer height**; ***S: specific extinction efficiency*** that contains all the optical information about aerosol 'type'

- Horizontal resolution from satellites is poor; There will be ***no 100m product of PM2.5*** from satellite
- Satellite data ***cloud masks too much*** to qualify PM2.5
- Suggestion to use ***coarse resolution satellites to constrain fine resolution models*** (done in the European Copernicus CAMS project).
  There are sites that have high resolution ground based observations to test models (e.g. Beijing)
- MISR / MAIA have only a ***revisiting time of ~ one week***; it might be possible to use statistical models to get around that
- There's ***no diurnal cycle from most satellites***; A discussion on diurnal cycle of H * S followed
- Some attendees found it strange to even use satellites for local problems. They saw it as aiming for the wrong problem
- ***Different applications have different needs*** (e.g. long-term epidemiology studies, daily air quality forecasting)
- The ***capability to identify mineral dust*** from satellite data was pointed out

SESSION 13 aerosol typing
chair / rapporteur: ***Thomas Popp / Olga Kalashnikova***

The main discussion was centered on:

1. ***How to consolidate different reference aerosol typing*** data from different satellite sensors
2. How to incorporate official ***aerosol property definitions*** to qualitatively compare reported aerosol types for future use by Chemistry Transport Models

Main discussion points

- need to ***define and possibly constrain aerosol types*** reported by measurements and to evaluate ***quantitative uncertainty*** in the reported aerosol types
- taking into account ***different instrument sensitivity*** to particle type and to the retrieval conditions
- capture in documentation ***how uncertainties in retrieved optical properties are defined*** by different instruments and then assess how uncertainties might propagate
- models and satellite retrievals have different look-up tables - as a first step, we need at least ***compare different look-up tables***
- ***model assimilations of observations*** (radiances, not retrieved quantities) could solve the issues. However, this just puts the burden of interpreting the radiances in terms of geophysical quantities on the model rather than a retrieval algorithm. It is also challenging and in the end leads to similar issues as already treated in years of retrieval development
- an ***inventory of aerosol type quantitative definitions and case studies*** were suggested
- inventory: Lucia Mona has implemented a relational database, where quantitative aerosol type definitions (optical property ranges) need to be added; also limiting conditions need to be added (e.g. low AOD threshold, surface brightness, …)
- regarding ***collocated case studies*** the concern was raised that they would need high effort; ***dust episodes*** could be first candidates with strong signal
- ***collaboration between modeler + retrieval*** is needed, e.g. recent JPL effort to compare aerosol type patterns between MISR and several transport models: Lee, H., Kalashnikova, O. V., Suzuki, K., Braverman, A., Garay, M. J., and Kahn, R. A.: Climatology of the aerosol optical depth by components from the Multi-angle Imaging SpectroRadiometer (MISR) and chemistry transport models, Atmos. Chem. Phys., 16, 6627-6640, doi:10.5194/acp-16-6627-2016, 2016.

AEROSAT acknowledges the fact that ***different satellite sensors have different information content***, and proceeds with comparing definitions to reduce the confusion for the end user. That includes:

- ***Providing a description*** and documentation of currently produced aerosol types.
- Investigating if ***case studies*** might be helpful to understand satellite capabilities (keeping in mind that the purpose of case studies might become confusing and it would require a large effort. In addition, very small number of case studies might be disputed if results will be unfavorable to certain satellite teams)

SESSION 14 long satellite records

chair / rapporteur: ***Thomas Popp / Gareth Thomas***

Thomas Popp, introduction

- ***GCOS Climate Monitoring System*** provides guidelines to what we should be aiming for
- Seed Questions:
  - How much do we need to do to ***reach climate quality***?
  - How best to ***characterise biases***?
  - How to produce ***consistent CDRs*** from different sources?
  - ***How many different CDRs*** do we want/need?
  - How can we ***validate stability*** with changing ground truth?
  - How do we ***validate early data*** (1980s)?

Rob Levy – Creating long (and wide) term aerosol data record from satellite remote sensing

- ***List of 10+ years satellite aerosol datasets*** from the USA.
- ***GCOS requirements*** – AOD 0.03/10% accuracy and 0.01/decade stability
  - However, regional records are important as well
- ***Consistency***: Stability of a single instrument; consistency of similar instruments, successor instruments, separate instruments.
  - ***Calibration*** drift is a tricky problem. Need decadal stability of ~ 1% in radiance for 0.01 in AOD.
  - ***Any changes of orbit*** (overpass time etc.) can have a big impact. Terra moved orbit early in mission.
- ***Similar – "sister" – instruments***: e.g., MODIS Aqua and Terra:
  - In C5 Terra has a drift compared with Aqua over land, and an offset over ocean. Much better in C6, but not 100% consistent and offset is still there (0.02 in AOD). Could be real!
    - To check, produced L3U type files and matched with model – do model and data show the same differences. No they don't – models do not show a big difference between morning and afternoon overpasses.
    - Revisiting calibration: i.e. it's tricky.
  - Deep Blue has already made additional calibration corrections and got at least half the difference in Aqua/Terra AOD as seen in Dark Target.
- ***Similar but different instruments***: eg. MODIS vs VIIRS
  - Differences in channel ***wavelength band-passes*** become important: Gas absorptions and Rayleigh scattering.
  - NASA Dark Target still gives a ~20% offset between MODIS and VIIRS
  - Dataset where VIIRS and MODIS have very closely collocated measurements: can use these measurements to create a VIIRS (or MODIS) calibration correction (Sayer et al. 2016.).
  - Eg. 2: AVHRR. Using many instruments with different orbits, orbital drifts and poor calibration (and potentially differing channels) becomes *very* tricky.
    - People have still tried (Zhao et al)

- ***Stability of ground truth***.
    - AERONET shows that AOD is log-normal: so should our observations.
    - ***Missing big events***: peat fires have up to AOD > 5: AERONET v2 tops out at about 2! V3 puts a lot of this stuff back (Eck et al. 2016). These events can have a big effect on forcing and trends.
- Metrics in addition to AOD? ***Angstrom***, ***size parameters***, "***types***"?
- How should data be ***gridded***: monthly L3, daily, seasonal?
- Consistent, or at least known, ***assumptions between products*** (retrievability)
- More questions:
    - Should we use a ***simple common algorithm*** (single channel?) which is consistent between many instruments? Or…
    - Should we try and exploit the strengths of each instrument to come up with the ***best product for each sensor***?
    - Should we rely on ***data assimilation to deal with merging*** many data sets into a consistent product, or work on our own data-ensemble?

Questions and discussion:
Does a ***change in cloud cover affect trends?***

- Yes, difference between Aqua and Terra could partly be cloud cover as well.

MODIS/VIIRS can make 'daily mean' because they measure twice (whereas most products only measure once a day).
Can we ***check how close we are to GCOS***: good first step.
CCI have done this by ***comparing errors to the requirements*** (fraction of pixels within required accuracy)
GCOS isn't stationary and we can feed-back (a review of the GCOS requirements is happening now)
AVHRR has too many problems to be trusted:
need to ***look at supporting data with long-term data records*** (ground based radiometers etc. – not just instruments designed for aerosol measurements) to see if they can shed light on weather AVHRR observed trends are consistent.
AVHRR has big ***sampling problems***. One way to minimise the issues introduced by this is to ***look at anomalies*** rather than overall trends: they are more significant.
Comparing instruments and trends from them, we need to take cloud cover into account.

<u>Huikyo Lee (JPL) – Is AOD averaged over the last 16 years stable? (from MISR)</u>
WMO requires 30 years of continuous data for a CDR… we don't have this.

- Has been shown that the ***length of AOD record strongly affects climatologic mean*** (and trends)
    - How long does the data record need to be before the mean becomes stable?
- Using MISR L3 joint aerosol. 5x5 degree 8-dimensional histograms of aerosol
- Have created climatological and monthly statistics of AOD for 8 aerosol "types" (Lee et al. 2016).
- Looked at the ***stability of the multi-year mean AOD*** due to temporal sub-sampling:
    - To do this he sub-sampled the full data set, and looked at variation as the sampling was increased:
        - ***Globally, mean is pretty stable***: ***std-dev. decreases rapidly with longer temporal coverage.***
        - He has calculated how many years need to be sampled ***to get a 5% stability in AOD for each 5-degree bin*** separately. ***Varies strongly with region: can be as low as 2 years, or at least 15/16*** (i.e. whole data record… implying it could be longer)

        - When looking at ***AOD for each type, the length of data required for stability gets much***
        - ***longer*** – it is ***lowest over source regions*** (eg. Sahara for dust)
    - Breaking this down ***by season, the stability doesn't show much dependence***, either for total AOD or type-specific AOD
    - Comparison with ***AEROCOM models: only have a 5 year overlap***, so need to reduce the stability requirement to 10% (still only works for East China and Atlantic Dust region ONLY when looking at type-specific AOD records)
        - Compare seasonal climatological AOD and non-absorbing AOD on a seasonal basis
        - ***All models show an offset***
        - Over ***China, most don't show the same seasonal cycle and "over-estimate" AODs***. (MISR could well be wrong here due cloud flagging and bias….)
        - Over ***dust region, models show good seasonal cycle but severely under-estimate AOD***
- http://rcmes.jpl.nasa.gov for data and documentation

Questions and discussion:
How long does the data need to be for trends?

A: ***16 years probably isn't enough***.

Meteorology probably plays a big role in determining the trend. Eg. West Africa has a very predictable seasonal cycle, so somewhat lower time period needed.
The WMO definition of 30 years for a CDR is because we are talking ***multi-decadal trends***, rather than stability limitations.

Larisa Sogacheva – How different approaches affect the AOD from the same instrument (ATSR)
Overview over GCOS requirements and Aerosol_cci data (including future: SLSTR, IASI, 3MI)
Overview of the Aerosol_cci cycle: see slides or Popp et al 2016.
The three (A)***ATSR algorithms show differences in AOD and other parameters***: idea is to figure out what is causing these differences. ***Table of the differences and similarities*** between algorithms.
Cloud masking:

- Comparison between 3 algorithms
- Try using ***common cloud mask*** (Apollo)
- Compare with Cloud CCI
- Compare with manual classified truth
- Participate in GlobTemperature comparison (more manual classification)

Looking at global annual and seasonal and monthly maps and global average AOD. Differences and similarities in values, quality and quantity. All for 2007.
Zoom in on Africa, Atlantic and South America – Again looking at yearly, seasonal and month differences…. Can start to really see differences due to cloud masking in biomass regions. Big differences in number of pixels retrieved as well.
Also have ***regional comparisons with MODIS on a monthly basis*** (dust, desert, Africa BB, ocean+dust, ocean-clean, S. America BB). Some consistency, some differences… nothing consistent!
Have also looked at AOD validation parsed by aerosol source
Has extracted a bunch of cases where retrievals have problems to look closely at L2:

- ORAC (v3) tends to throw away biomass and pollution
- Others loose dust over ocean
- Different products have different cloud screening problems in different situations!

Questions and Discussion:
Differences are dominated by cloud masking, but now we need to look at common points.
Why does ORAC loose the biomass
Missing in standard mask; I put dust back in, but didn't catch all biomass.
standard mask is designed for SST (and LST retrieval)
Bremen cloud comparison: ORAC often had most (and best) coverage, so we've been seeing worst case scenarios.

General discussion

Analysis of length of time required for a stable climatology is interesting – so ***highly stable regions can be used as a validation source for early (AVHRR) data***, by comparing climatologies?
We ***could do the same with models*** - would the answer be different?
Basically AOD is more consistent in some areas… also could use an absolute AOD threshold rather than percentage.
There is information here: ***looking at consistency between absolute and relative thresholds could be informative***
Periodic events (like wild fires) have a big impact
Lin Lu has looked at something similar in validating trends with AERONET. 5-7 years seemed to be a minimum data record required.
There is a risk of not having periodic events in your 16 – 17 year window, e.g. the 1997 El Nino, which is in the ACCI record, but not MODIS/MISR.
Required spatial and temporal scales depend on application and what the data can provide
Huikyo Lee plans further analysis extending to MODIS, AERONET, AEROCOM etc…
It is noted that ***this analysis does not provide any insight into change*** – Stefan Kinne's climatology has some change/trends built in
These ***climatologies*** are very useful for ***looking at and for anomalies***, but it is important that data provides information about ***the assumptions*** behind it so we can check consistency
This is an example where one could ***use the satellite data to define regions to constrain the model***. i.e. where are we most confident in the satellite products - Dust is a strong case for such analysis.
Climatology assumes a stationary field - this sort of work can perhaps reveal (using the stability measurements) where there are changes
We ***need many datasets***, to gain confidence in the trends/climatologies
Discussion about many strong independent algorithms vs. rather simple common lowest-denominator algorithm
Instrument-specific algorithms make best use of complementary information content of each sensor
common open source algorithms for multiple instruments are available (e.g. ORAC / GRASP)
simplest algorithms across all instruments (e.g. two channel) could lead to consistent datasets
Discussion about adding extra data layers into the products files
People – particularly in developing countries – struggle to actually download the data because it is too big!
Could ***provide AUX files*** (LUTS etc) to solve the file growth problem, but this is difficult in the NASA operational framework for instance.
Diurnal sampling -> lead to time biased long term records – ***use modeling and geostationary*** satellites for studies
To strengthen credibility a multi instrument/product ensemble could help to really show the agreement/diversity in products; we have seen that ***multi-model median is better than any one model. This suggests that this could work with satellites as well***
evaluation of long-term data needs to be done on a regional, focused way - more validation data is needed to have confidence in derived products globally

SESSION 15 summary and wrap-up
chair / rapporteur: ***Ralph Kahn / Sophie Vandenbussche***

Thomas Popp:
• This year AEROSAT had ***more than 100 participants*** (first day, then ~70).
• New participants from ***developing countries joined*** and contributed actively.
• Bringing ***modelling and retrievals together***: ensembles can provide common ground
• We need to ***document and communicate assumptions*** and underlying aerosol properties / their ranges or PDFs in the retrievals and models

We have discussed:

- **Satellite – model inter-comparison**
- **Uncertainties**, including limitations of linear regression
- **Air quality**
- **Aerosol types**
- **Long-term records**

Intended topic for next year (suggested in 2015, but not possible this year): ***AERONET new version + uncertainties***

Ralph Kahn:
Action items
Experiments: ***biomass burning experiment*** between satellite and AEROCOM (individual twins)
Uncertainties: Paper rationalising how uncertainties and error assessment should be done, ***lead A. Sayer***
Air quality (new topic): No action items… need to think over this for future
Aerosol typing: contribute to inventory of retrieval / model assumptions, rationalising nomenclature, ***lead L. Mona***
Long term data records: test two-file system (basic results, and detailed auxiliary assumptions included); this activity will link strongly with the uncertainty activities.

Stefan Kinne: Would like to ***add aerosol absorption*** as a topic for the next meeting

Closing the session, all thank the local hosts (Zhaohui Lin, Xiaohong Liu, Wencheng (Diane) Chen & CAS-TWAS).

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Program

Thursday, September 22, 2016

*chair: **Larisa Sogacheva***

08:30 - 10:30	**SESSION 9**	**AeroCom AeroSAT interactions**
08:30 - 08:50	**M. J. Choi**	Current status of GOCI Yonsei aerosol retrieval and other geostationary satellite retrievals using MI, Himawari-8, and GEMS over East Asia
08:50 - 09:10	**Nick Schutgens**	*Remote sensing evaluation of AEROCOM models*
09:10 - 09:30	**Stefan Kinne**	*The MAC aerosol climatology*
09:30 - 09:50	**Gerrit de Leeuw**	*Aerosol over China / multiple satellite instruments (MarcoPolo)*
09:50 - 10:10	**R. Kahn / T. Popp**	*Outcome of last year AEROSAT meeting*
10:10 – 10:30	*discussion*	*initial thoughts on "burning needs for collaboration"*
10:30 - 11:00	coffee-break	

*chair: **Stefan Kinne***

11:00 - 12:00	**AeroSAT poster introduction**	
12:00 - 13:30	lunch	

*chair / rapporteur**: Mian Chin / Linlu Mei***

13:30 - 18:00	**SESSION 10**	**interactions – concepts, applications and needs**
13:30 - 13:35	**session introduction + seed questions by chair**	
13.35 - 13:50	**Andrew Gettelman**	*use of uncertainties in models*
13.50 - 14.30	***discussion***	*how to use uncertainties in satellite datasets*
14:30 - 14.45	**Mian Chin**	*use of aerosol types in models*
14:45 - 15.30	***discussion***	*how to use aerosol type information in satellite datasets*
15:30 - 16:00	coffee-break	
16:00 - 16:15	**Xiaoyan Ma**	*Evaluations of seasonal / spatial global AOD variations in GEOS-Chem-APM based on multiple-platform observations*
16:15 - 16:30	**Po-Lun Ma**	*Satellite simulators reconcile modeled and observed aerosol effects on clouds*
16:30 - 16:35	**Ralph Kahn**	*how support aerosol-cloud studies (ACPC) ?*
16.35 - 17.00	***discussion***	
17:00 - 17:05	**Thomas Popp**	*needs for data assimilation to standardize algorithm qualification*
17.05 - 17.30	***discussion***	
17:30 - 17:35	**Michael Schulz**	*how can we support CMIP6 [AERCHEMMIP/RFMIP/VOLMIP] ? **(Skype)***
17.35 - 18.00	***discussion***	
19:00 – 22:00	**common dinner**	

Friday, September 23, 2016

chair / rapporteur: ***Gerrit de Leeuw / Rob Levy***

09:00 - 12:00 SESSION 11 uncertainties in satellite retrievals

09:00 - 09:05 session introduction by chair

09:05 - 09:20 Andy Sayer *(Miss-) use of linear regression for validation / alternative methods*
09:20 - 09:35 Thomas Popp *ESA Aerosol_cci progress on pixel-level uncertainties*
09:35 - 09:50 Qi Zhang *Variation and trends of MODIS C5 & C6 products errors …*

09:50 - 10:30 ***discussions*** (1)
uncertainties as function of different scales

10:30 - 11:00 coffee-break

11:00 - 12:00 ***discussions*** (2)
use of linear regression and alternatives

12:00 - 13:30 lunch

chair / rapporteur: ***Ralph Kahn / Jan Griesfeller***

13:30 - 15:30 SESSION 12 air quality and aerosol

13:30 - 13:35 session introduction + seed questions by chair

13:35 - 13:50 Lorraine Remer *The NOAA VIIRS aerosol products and air quality applications*
13:50 - 14:05 O. Kalashnikova *From Climate to Air Quality: Polarimetric Characterization of Speciated Airborne Particulate Matter*

14:05 - 15:30 ***discussions***
where do we stand with the AOD to PM conversion ?
how can satellite information be useful for air quality applications

15:30 - 16:00 coffee-break

chair / rapporteur: ***Thomas Popp / Olga Kalashnikova***

16.00 - 18:00 SESSION 13 aerosol typing

16:00 - 16:05 session introduction + seed questions by chair

16:05 - 16:20 Lucia Mona *Update of aerosol type inventory* ***(via Skype)***

16:20 - 18:00 ***discussions***
connecting retrieved optical properties with interpretive composition
assessing retrieved aerosol-type uncertainty

Saturday, September 24, 2016

chair / rapporteur: ***Thomas Popp / Gareth Thomas***

09:00 - 12:00 SESSION 14 long satellite records

09:00 - 09:05 **session introduction + seed questions by chair**

09:05 - 09:20 **Robert Levy** *Creating aerosol optical depth climate records from US-based satellite remote sensing*

09:20 - 09:35 **Huikyo Lee** *Is climatological aerosol optical depth averaged over the last 16 years stable?*

09:35 - 09:50 **L. Sogacheva** *How the different retrieval approaches effect the aerosol optical depth retrieved from the (A)ATSR*
(+ brief overview of other European datasets)

09:50 - 10:30 ***discussions*** (1)
ideas for deriving historical AOD

10:30 - 11:00 coffee-break

11:00 - 12:00 ***discussions*** (2)
what needs to be done to achieve consistent CDR quality

chair / rapporteur: ***Ralph Kahn / Sophie Vandenbussche***

12:30 - 13:00 SESSION 15 summary and wrap-up

T. Popp, R. Kahn *AeroSAT 2016 preliminary summary*

13:00 - 15:00 lunch with **poster viewing**

AeroSAT posters ***poster introductions on Thursday morning***

P-2-01 *Antti Arola*
Retrieval of aerosol optical depth from surface solar radiation measurements using machine learning algorithms, non-linear regression and a radiative transfer-based look-up table

P-2-02 *Heming Bai*
Prediction of ground-level PM2.5 concentrations from 3km resolution MODIS AOD over southern Jiangsu

P-2-03 *Yahui Che*
Inter-comparison of three AATSR Level 2 (L2) AOD products over China

P-2-04 *Thomas Fairlie*
Characterizing the Asian Tropopause Aerosol Layer using balloon measurements, satellite observations, and a chemical transport model

P-2-05 *Cheng Fan*
An Atmospheric Correction Algorithm for FY3/MERSI data over land in China

P-2-06 *Michael Garay*
Improvements to the MISR Operational Aerosol Product Including Cloud Screening, Uncertainty, and Microphysical Properties

P-2-07 *Paul Ginoux*
Dust emission derived from satellite based surface extinction

P-2-08 *Kang Hu*
Climatology (2002–2014) of aerosol products derived from MODIS, MISR and OMI sensors over the Yangtze River Delta

P-2-09 *Christina Hsu*
Retrieving Aerosol Plume height information by synergetic use of VIRS OMPS and CALIOP Observations

P-2-10 *Guang Jie*
Aerosol Optical Depth Retrieval in Xinjiang Region Using Indian National Satellite (INSAT 3D) Data

P-2-11 *Aoki Kazuma*
Temporal and spatial variability of Aerosol optical properties retrieval from sky radiometer observation in Japan sites.

P-2-12 *Carlo Lacagnina*
Aerosol Single Scattering Albedo: comparing PARASOL, OMI and MISR retrievals

P-2-13 *Antti Lipponen*
Pixel level uncertainty estimates for AOD using Bayesian Dark Target algorithm

P-2-14 *Ying Li*
Monitoring World Atmosphere Aerosol and Siberia Wildfire in 2012 using Satellite and Model Datasets

P-2-15 *Hongqing Liu*
NOAA VIIRS Dark Target-Bright Surface Aerosol Optical Depth Algorithm

P-2-16 *She Lu*
Joint retrieval of aerosol optical depth and surface reflectance over land using geostationary satellite data

P-2-17 *Shana Mattoo*
Aerosol absorption retrievals from the PACE broad spectrum Ocean Color Instrument (OCI)

P-2-18 *Linlu Mei*
Aerosol retrieval over Polar Region

P-2-19 *Ali Akbar Noroozi*
Identify areas with dust storm potential of physiographic and climatic characteristics

P-2-20 *Muhammad Imran Shahzad*
Analyses of Extreme Air Pollution Events over Lahore using Satellite and Ground Based Remote Sensing

P-2-21 *Krishna Kumar Shukla*
Identification of the cloud base height over the central Himalayan region: Intercomparison of Ceilometer and Doppler Lidar

P-2-22 *Gareth Thomas*
The Optimal Retrieval of Aerosol and Cloud (ORAC) algorithm: Introduction, overview and status

P-2-23 *Si-Chee Tsay*
7-SEAS/BASELInE: Satellite-surface perspective of air quality and aerosol-cloud effects on the environment

P-2-24 *Sophie Vandenbussche*
IASI dust within the ESA aerosols CCI: four different scientific approaches, their intercomparison and comparison with external data

P-2-25 *Sophie Vandenbussche*
Exploitation of almost 10 years of 3D dust distribution from IASI with the MAPIR algorithm for studying desert dust sources in Asia.

P-2-26 *Yanqing Xie*
Image fusion of MODIS AOD products based on the maximum likelihood estimate method