



# Discussions on the uncertainty in aerosol retrieval products

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# Recent discussions

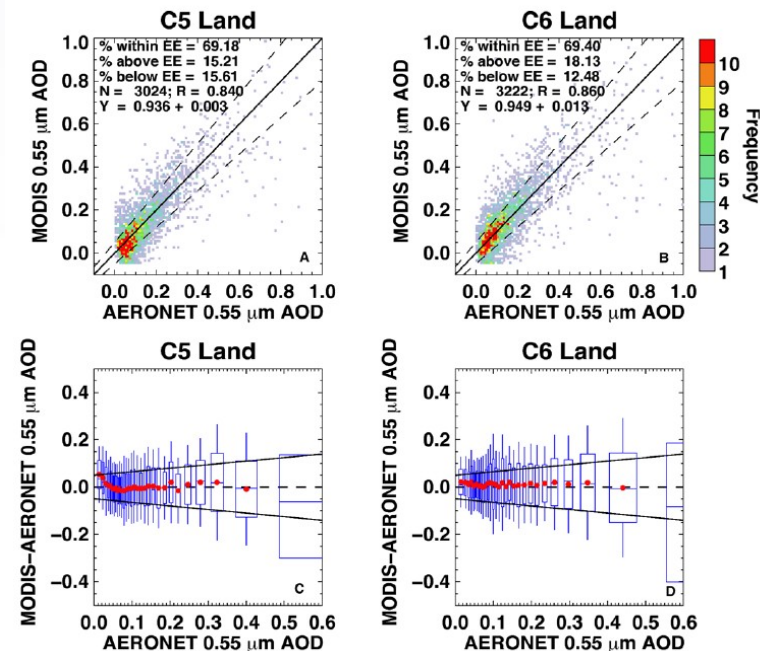


- In a workshop on Sep 4, Aerosol CCI discussed
  - How different algorithms estimate uncertainty;
  - Which sources of uncertainty in aerosol retrievals are least well constrained or understood;
  - How best to communicate uncertainty to users.
- A session of AeroSAT on Sep 27 was dedicated to pixel-level uncertainties
  - Input from Aerosol CCI and several NASA teams.
  - Discussed the merits of different approaches against the needs to users and practical limitations.

# Current techniques



- A wide range of methods are used to assess uncertainty in aerosol retrievals.
- “Expected error” envelopes are prevalent for aerosol optical depth (AOD)
  - AERONET sun-photometer observations are taken as the ‘true’ value.
  - An envelope which encloses 66% of the error is defined as a function of AOD.



# Current techniques



- A wide range of methods are used to assess uncertainty in aerosol retrievals.
- “Expected error” envelopes are prevalent for aerosol optical depth (AOD)
  - These have been stratified by aerosol type, surface conditions, etc. but these do not provide pixel-level assessments.
  - A disconnect exists between local and global sources of error which complicates the merging of different datasets.

# Current techniques



- A wide range of methods are used to assess uncertainty in aerosol retrievals.
- Aerosol CCI algorithms use Jacobians to propagate uncertainty
  - Only assesses known uncertainties;
    - Cloud contamination, aerosol model choice are known to introduce error but this cannot currently be quantified.
  - Not all errors will have a Gaussian distribution;
  - Neglects important spatial and temporal correlation of the error.

# Communication



- Users have varied, if compatible, needs.
- As the data volume increases, the desire for detailed information decrease
  - Decadal studies were reported to ignore even quality flags.
  - Process studies can make detailed use of auxiliary information.
  - Most users desired a single number characterising the uncertainty and perhaps a simple quality flag.

# Communication



- Users have varied, if compatible, needs.
- Data assimilation requires a quantitative estimate of uncertainty
  - If a user is informed of an uncertainty but not given an estimate of its magnitude, *they may arbitrarily invent one.*
  - Some groups (ECMWF, NRL) prefer to do their own bias correction.
- Though dissatisfying, it is not practically wrong to overestimate uncertainty.

# The future



- There are significant uncertainties in the uncertainty of aerosol retrievals. None the less, an estimate of uncertainty is required by users and for validation.
- Need to start with what can currently be achieved and iterate with users until we have usable uncertainty products.
  - Concentrate on how best to communicate where the algorithm is known to fail.
- Must improve reputation of remote sensing data among users. Providing validated pixel-level uncertainties and continuing the conversation about how to improve them should help.





Questions?

# Definitions



- Formal definitions taken from second collocation meeting
  - Error = “result of a measurement minus a true value of the measurand”.
  - Uncertainty = “characterizes the dispersion of the values that could reasonably be attributed to the measurand”.
- Fields names add “\_uncertainty” between variable name and wavelength
  - i.e. AOT550 => AOD\_uncertainty550

# Known issues



- AERONET provides an unusually extensive source of validation data for AOD
  - Uncertainties are significantly smaller than those in satellite retrievals and so it dominates validation activities;
  - Inhomogeneous spatial coverage can bias results;
  - Cloud clearing issues remain;
  - Additional data sources needed, especially over remote ocean.
- Virtually no validation of aerosol type available.