Session 1 –
Pixel level uncertainties in aerosol retrievals

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Definitions

• A measurand is a “particular quantity subject to measurement”.

• The error of a measurement is the “result of a measurement minus a true value of the measurand”.

• The uncertainty of a measurement “is a parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand”.
Definitions

● Random error = “result of a measurement minus the mean that would result from an infinite number of measurements of the same measurand carried out under repeatable conditions”.

● Systematic error = “mean that would result from an infinite number of measurements of the same measurand carried out under repeatable conditions minus the true value of the measurand”.

– It is important that products contain estimates of both random and systematic uncertainties.
L2 error calculation

- The primary Aerosol CCI algorithms propagate measurement and surface model uncertainty through their algorithm using Jacobians
  - Optimal estimation techniques do so as part of the retrieval calculation
  - Others perform calculation after retrieval
- “Expected error” envelopes can be produced from sensitivity studies and validation against AERONET
  - Does not comment on quality of a single pixel
  - Provides analogue for GCOS requirements
Group question 1

By what metric do you assess uncertainty in your algorithm?

What techniques are used to propagate uncertainty through your retrieval?
Negligible sources of error

- Trace gases
- Vertical profile of aerosol
  - Except where gradients of composition present
- Radiative transfer
- LUT interpolation
- Surface wind speed
  - Where used
Product validation

• Comparison against AERONET
  – Even considering representivity error, the uncertainty was felt to be smaller than satellite retrieval errors.
  – Inhomogeneous spatial coverage limits the range of circumstances in which AERONET can be applied.
    – The remote ocean was felt in need of attention.
    – MAN provide sparse alternative measurements, though the variation of these with surface winds should be explored.
    – New products from POLDER could be used to provide validation, though these will be of comparable accuracy to our retrievals.

• Supplemented with comparison against ground-stations
Poorly characterised errors

- Aerosol model choice
  - Monte Carlo techniques
  - Retrieval cost analysis
  - Likely highly non-linear

- Cloud filtering
  - Radiative transfer shows that clouds can affect an area of up to 5km
  - Filtering frequently removes thick aerosol plumes
Group question 2

How do you validate uncertainties in your product?

What are the limitations of that process?
Group question 3

Producers: What do you feel users don't appreciate about your uncertainty estimates?

Users: What do you most want to learn from uncertainty estimates?
Further considerations

• Are errors normally distributed? (Is a standard deviation useful? Would interquartile range, etc be helpful?)

• What is the difference between uncertainty estimation and quality flagging?

• Is it possible to exploit the spatial correlation of errors in independent retrievals?