# 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 Jacobeans
  - 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 asses 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?