Validating uncertainty estimates

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So your retrieval has an uncertainty estimate…

- How do we know if the uncertainty estim[illegible]useful or realistic?

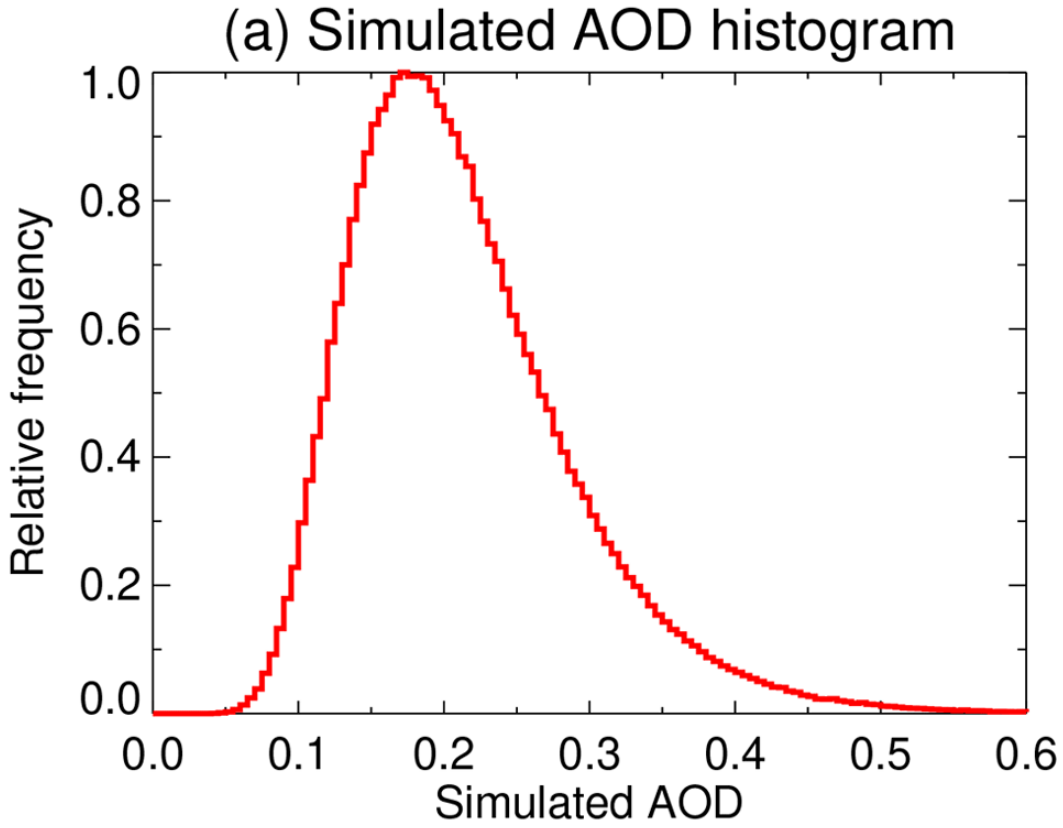
Reminder: uncertainty and error are different

- Uncertainty is an *expected level of dispersion*
  - Typically one standard deviation (1σ, ~68% of the time as good as X)
- Error is an observed quantity
  - A *draw from the distribution* of possible errors given the uncertainty level

You *expect* 3.5
You *get* 1, 2, 3, 4, 5, or 6

Uncertainty distributions and error distributions

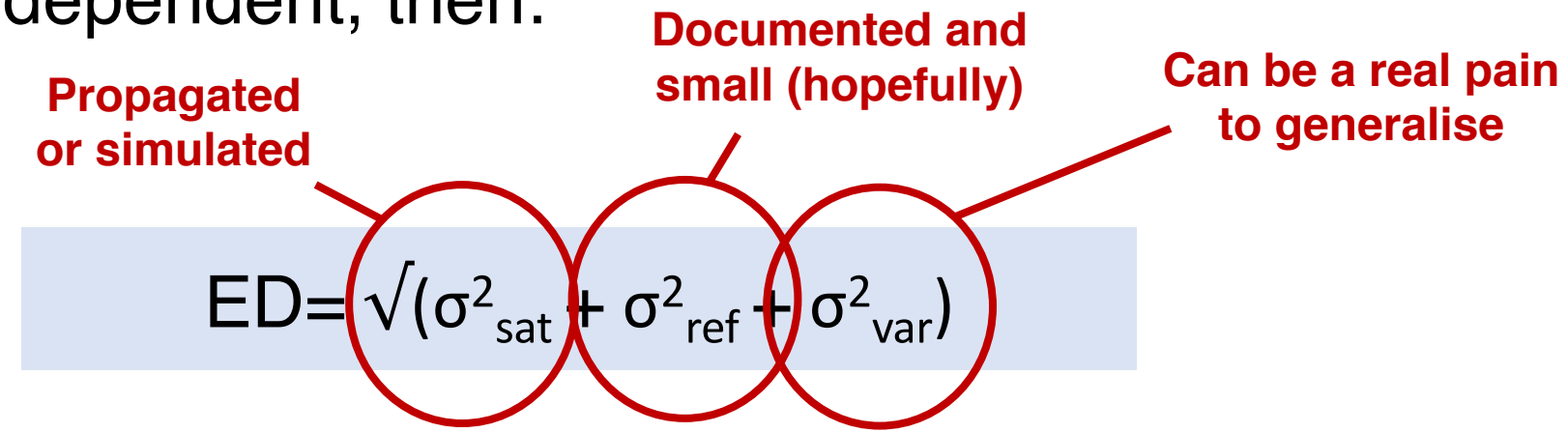
- Suppose AOD uncertainty is ±(0.05+15%). Then:



Sayer *et al.*, AMT (2020)

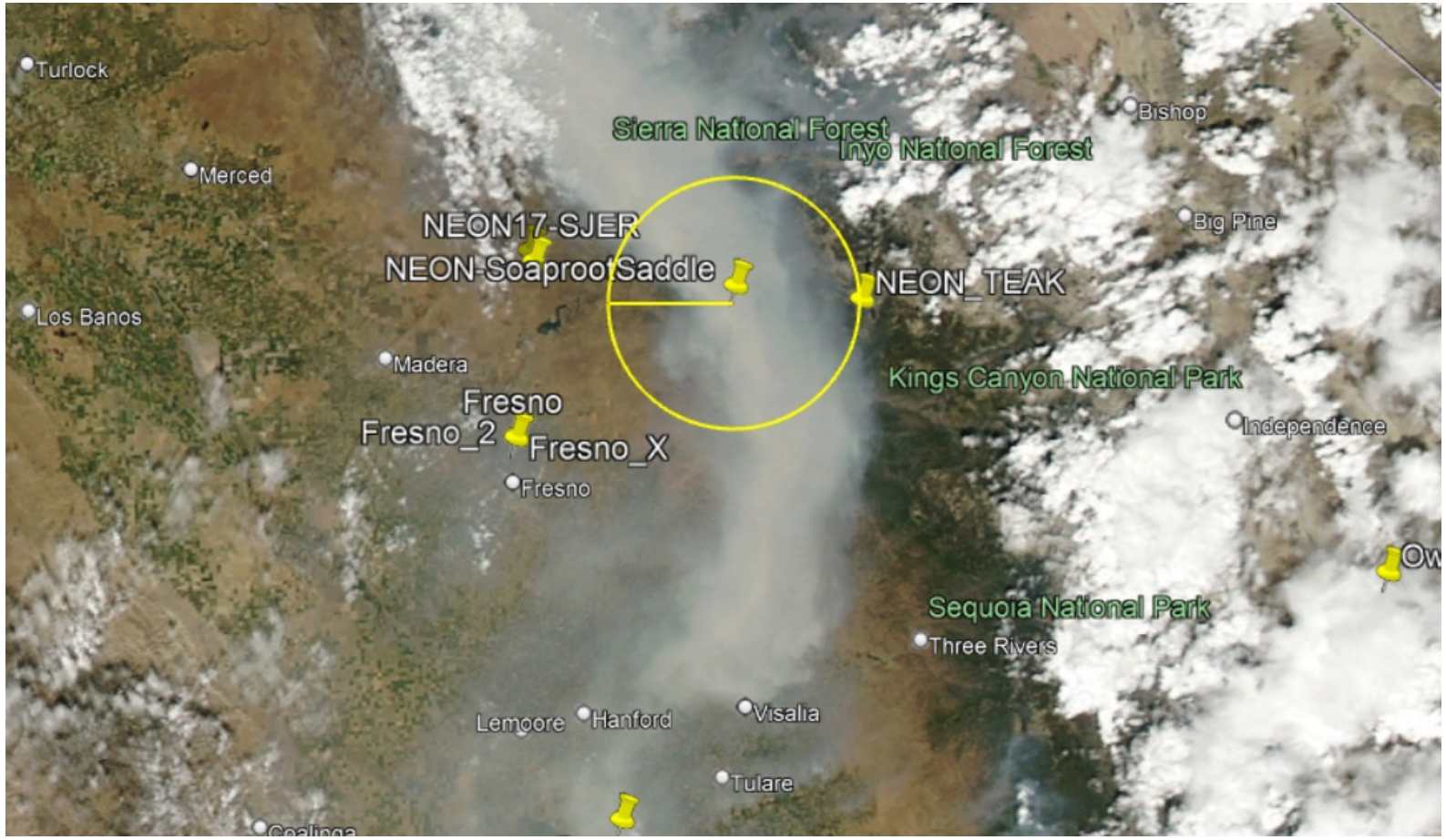
Solution: compare distributions of observed errors to expected discrepancy (ED)

- Observed error = (truth – retrieval)
- Expected discrepancy contains contributions from:
  - Retrieval uncertainty σ_{sat}
  - Reference uncertainty σ_{ref}
  - Spatiotemporal variability inherent in the comparison σ_{var}
- If assumed independent, then:



Spatial and temporal variations can both be important

- Look at *spatial statistics* of satellite data in the area, *temporal statistics* of the ground data
- *Generalise* based on a model
- Use *robust statistics* (e.g., median not mean)
- *Shrink* area aggregated or comparison window



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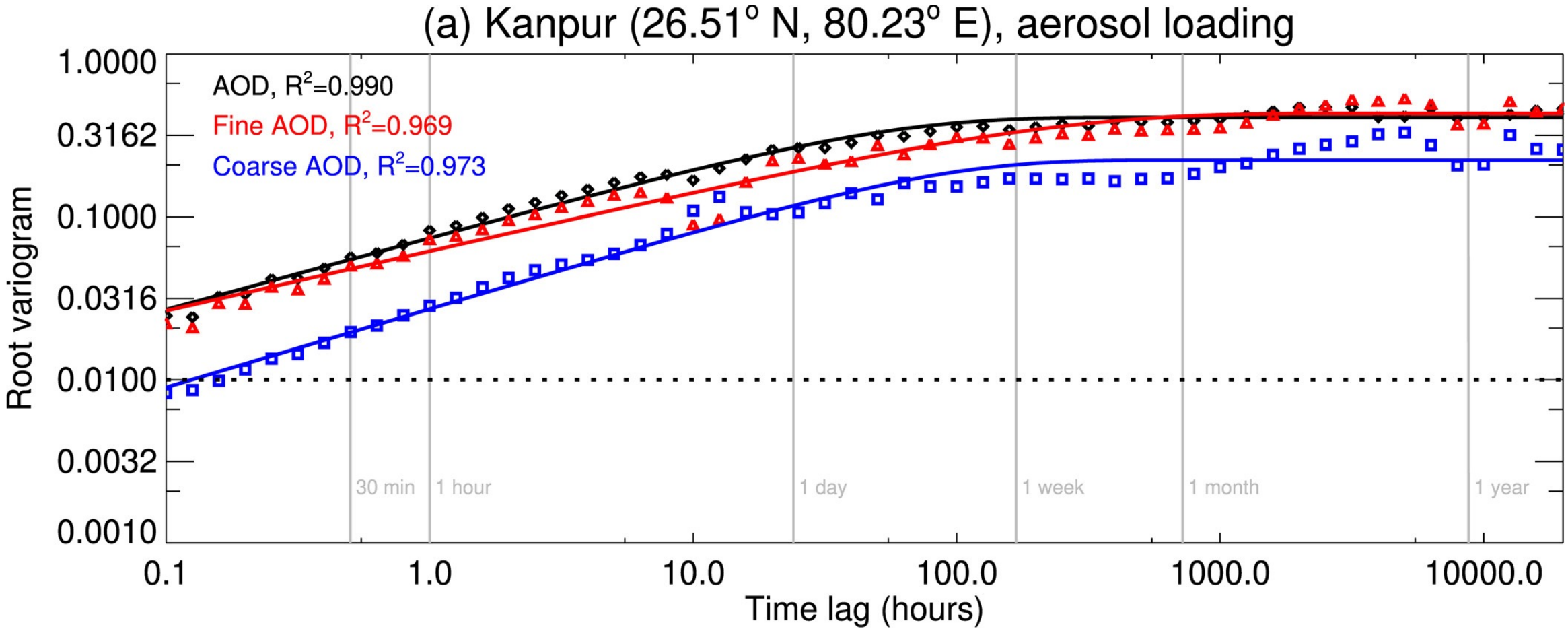
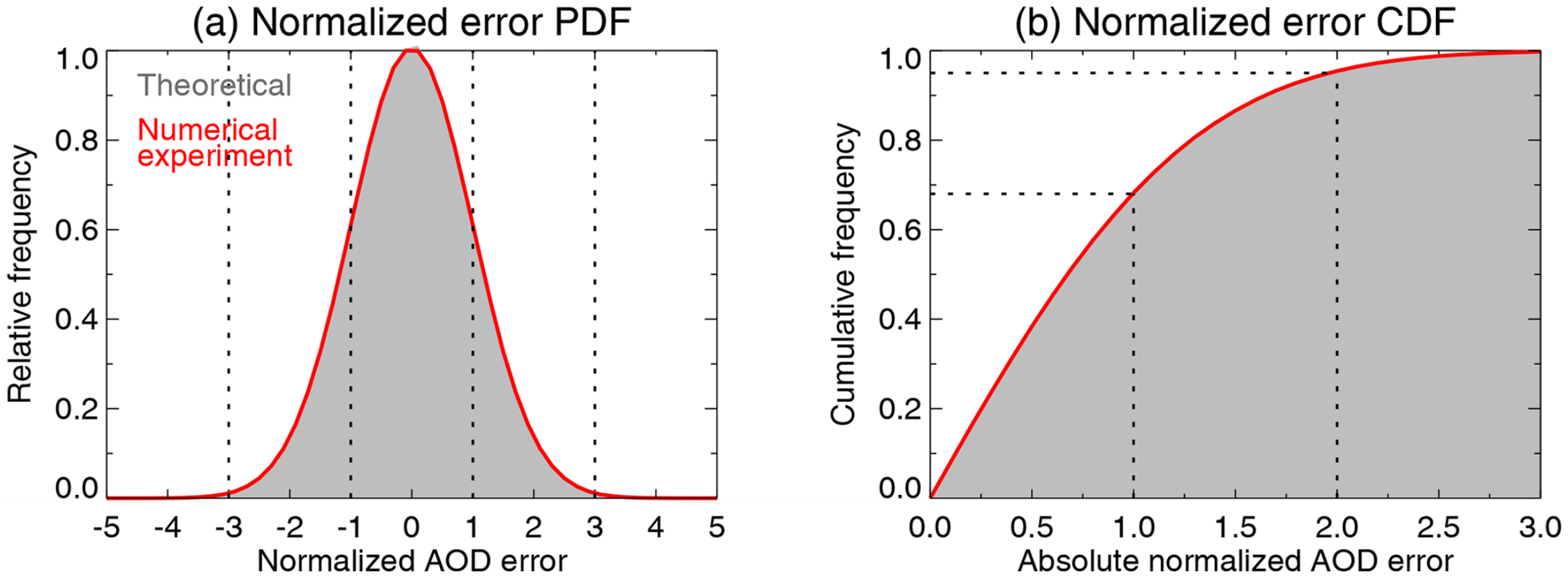


Sayer, ESS (2020)

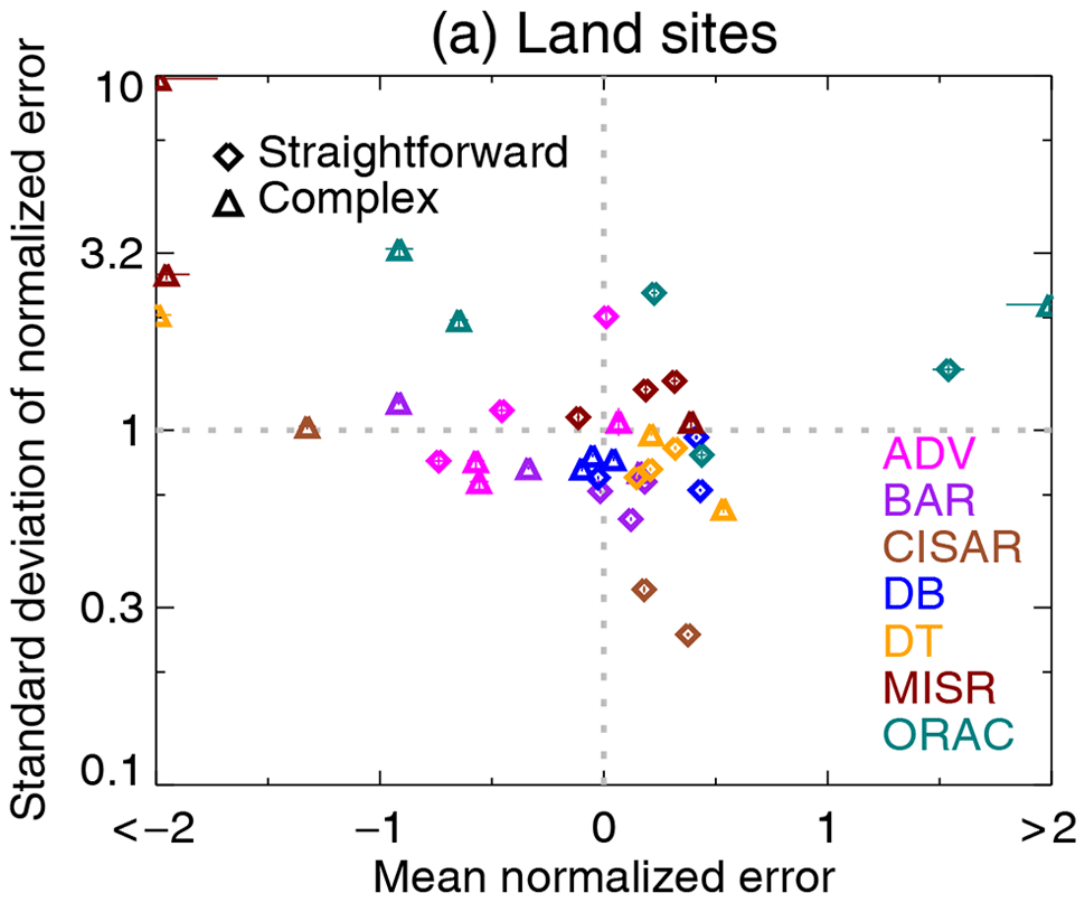
Look at distributions of normalised error

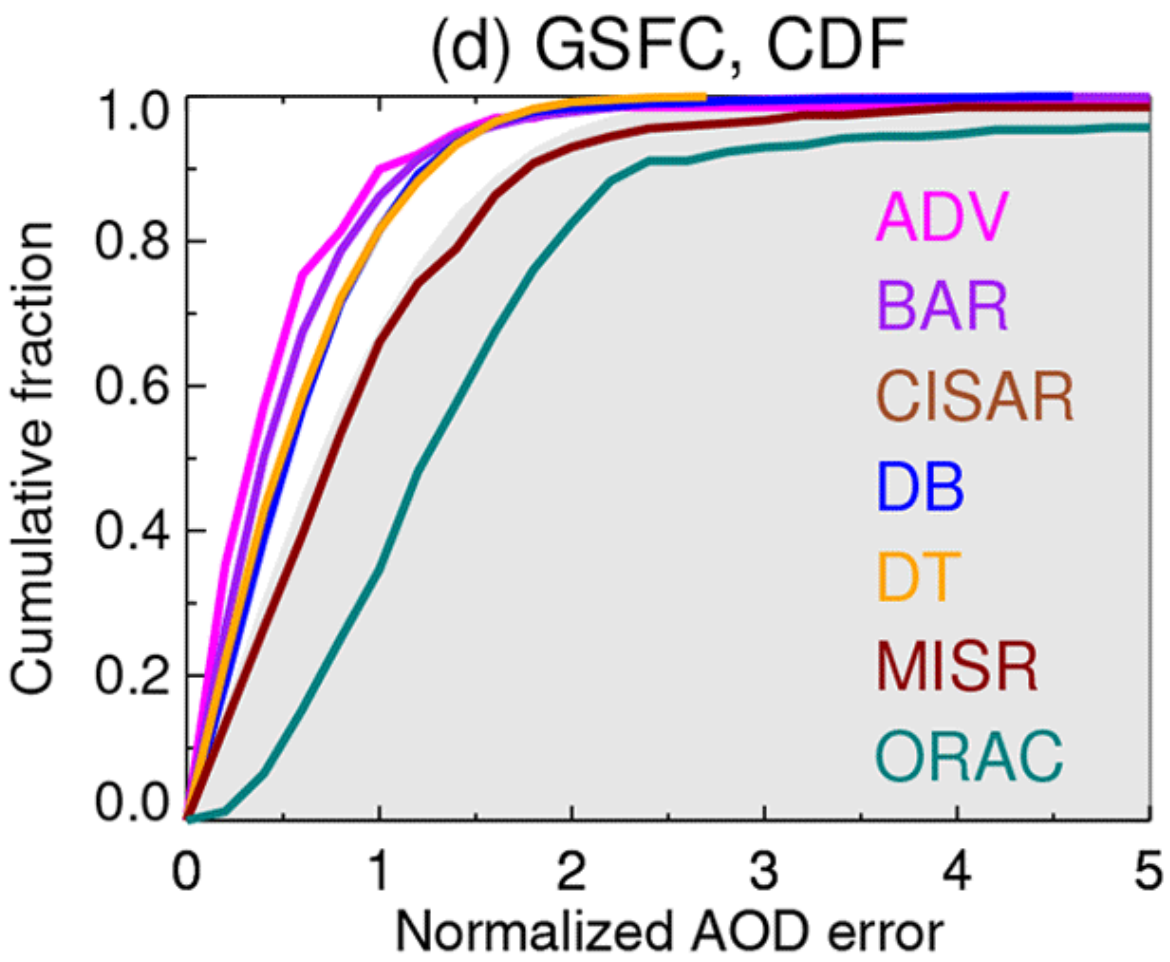


- Normalise as error/ED
- If unbiased and appropriate magnitude, distributions should follow N(0,1)

Sayer *et al.*, AMT (2020)

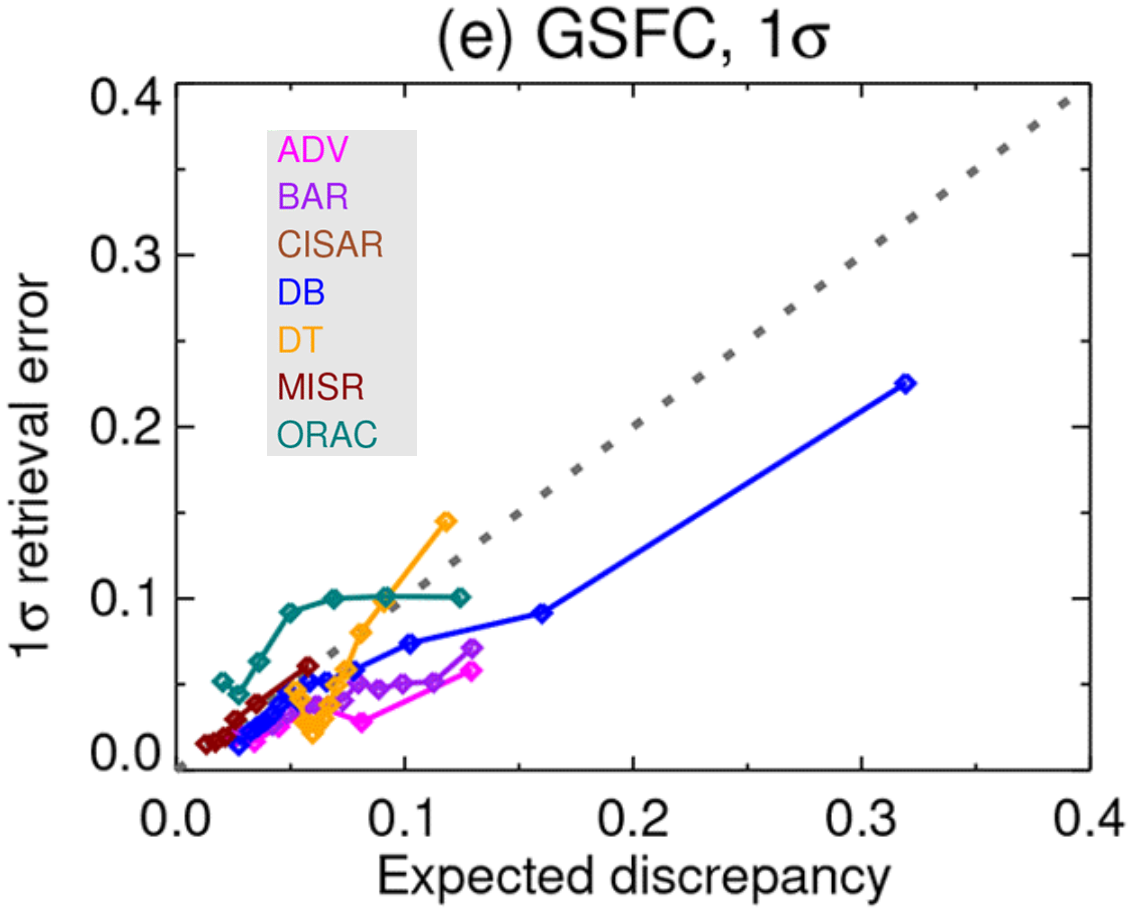
Examples on real aerosol data



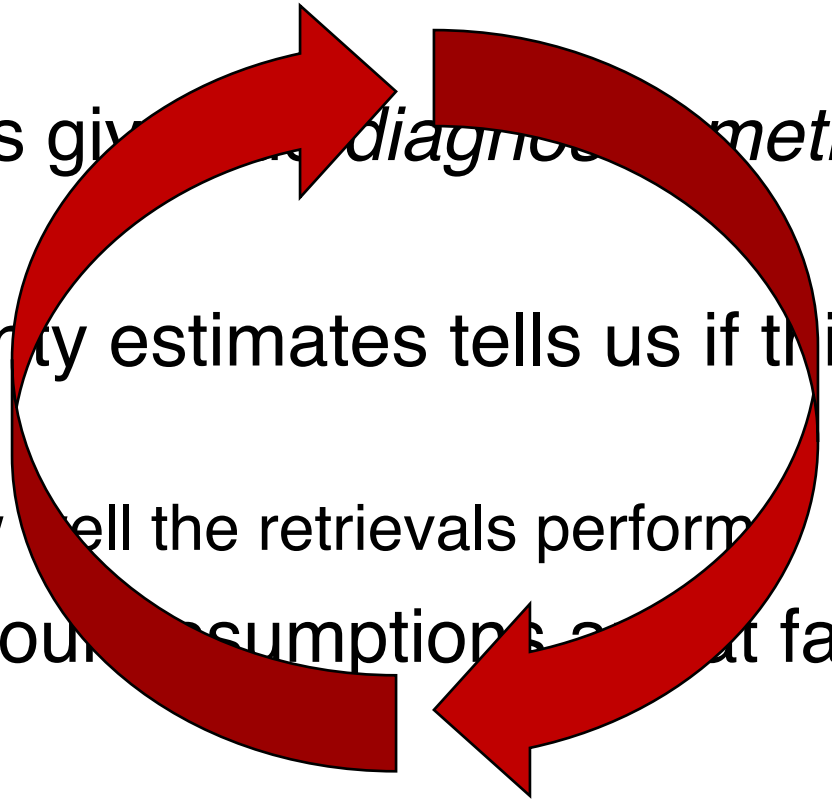


Can we tell low-uncertainty situations from high ones?

- Stratify by ED
- Look at 1σ point (68th percentile) of absolute error
  - Additional percentiles can tell you more about *how Gaussian* the error distribution is for a given ED
- Similar to *forecast calibration*, *skill scores*, etc



Closing the loop



- Validating retrievals gi[illegible] *diagnostic metrics of quality* to report uncertainty
- Validating uncertainty estimates tells us if things are *working as we expect*
  - Regardless of how well the retrievals perform
- Figure out where your assumptions are at fault, then *refine* them!

References and resources

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