Session 1:
Pixel-level uncertainties

Summary

Communicating with users

- Users have a wide range of requirements
  - Case studies desire a quality flag to filter the data but the attention paid seems to decrease as the data volume used increases
  - Whether such a flag should be determined from the uncertainty or from external factors (surface properties, etc) remains an open question

Communicating with users

- Users have a wide range of requirements
  - Many desire a single number quantifying the uncertainty in a retrieval
  - Data assimiliation requires that and a correction for the bias
    - Such groups generally perform the bias correction themselves
    - If an estimate of the bias is provided, it will likely be simply subtracted from the product
  - If a user is informed that there is an uncertainty but it isn't quantified, they will likely simply invent one

What is already being done

- Aerosol_cci groups primarily using Jacobeans
  - Optimal estimation methods can propagate errors throughout the algorithm to capture final uncertainty.
- MODIS using Jacobeans + AOD derived from standard deviation of aerosol model types [experimental]
- Deep Blue is based on retrieved AOD and viewing geometry
- Swansea does aerosol model uncertainty via Monte Carlo distributions of many different types and surfaces then see the observed spread.
- CALIOP has a mature uncertainty technique based on propagating errors through the lidar ratio. Detailed in publication. Every pixel, every layer, every product has an associated uncertainty.

Use of Expected Error envelopes

- Deep Blue has both per pixel uncertainty & EE envelopes
- MISR provides a global EE, but also stratifies by aerosol type, looks at situations with cloud, etc. and examines how that EE envelope changes.
- OMI develops EE envelope based on sensitivity tests and comparing with AERONET.
- The problem with EE envelopes is that there is a disconnect between local and global uncertainty.

Currently outstanding issues

- Pixel level uncertainty sidesteps spatial/temporal correlations in error.
  - For example, if you average data over large time or spatial areas, does that increase or decrease error?
- Current methods only address the ‘known unknowns’. How can the ‘unknown unknowns’ be addressed?
- Jacobian techniques assume errors are Gaussian; this is not true for some error terms.
  - Should distributions be investigated?
- Need standardized ways of reporting (if not calculating) uncertainty so that satellites can be properly intercompared.
- How can uncertainty in Level 3 be best characterized?

Potential future work

- Investigate and seek out any/all new sources of validation data
- Investigate what problems are caused by not providing a pixel-level uncertainty
- Investigate what problems are caused by reporting an uncertainty that is known to be insufficient (or contain very rough estimates)
- Investigate the distribution of errors in aerosol retrieval
  - Is a single number representative of that?