

Jet Propulsion Laboratory
California Institute of Technology

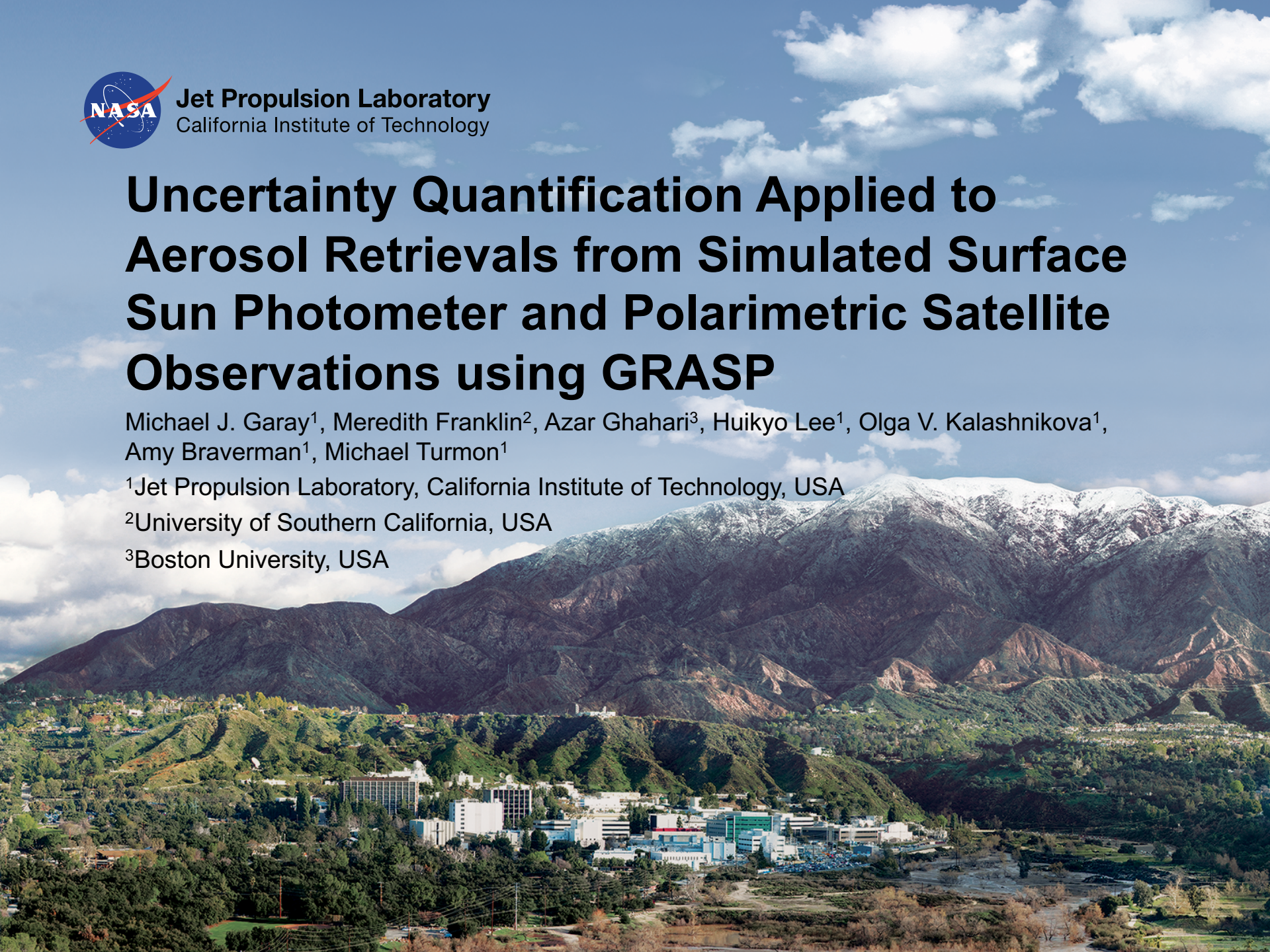
Uncertainty Quantification Applied to Aerosol Retrievals from Simulated Surface Sun Photometer and Polarimetric Satellite Observations using GRASP

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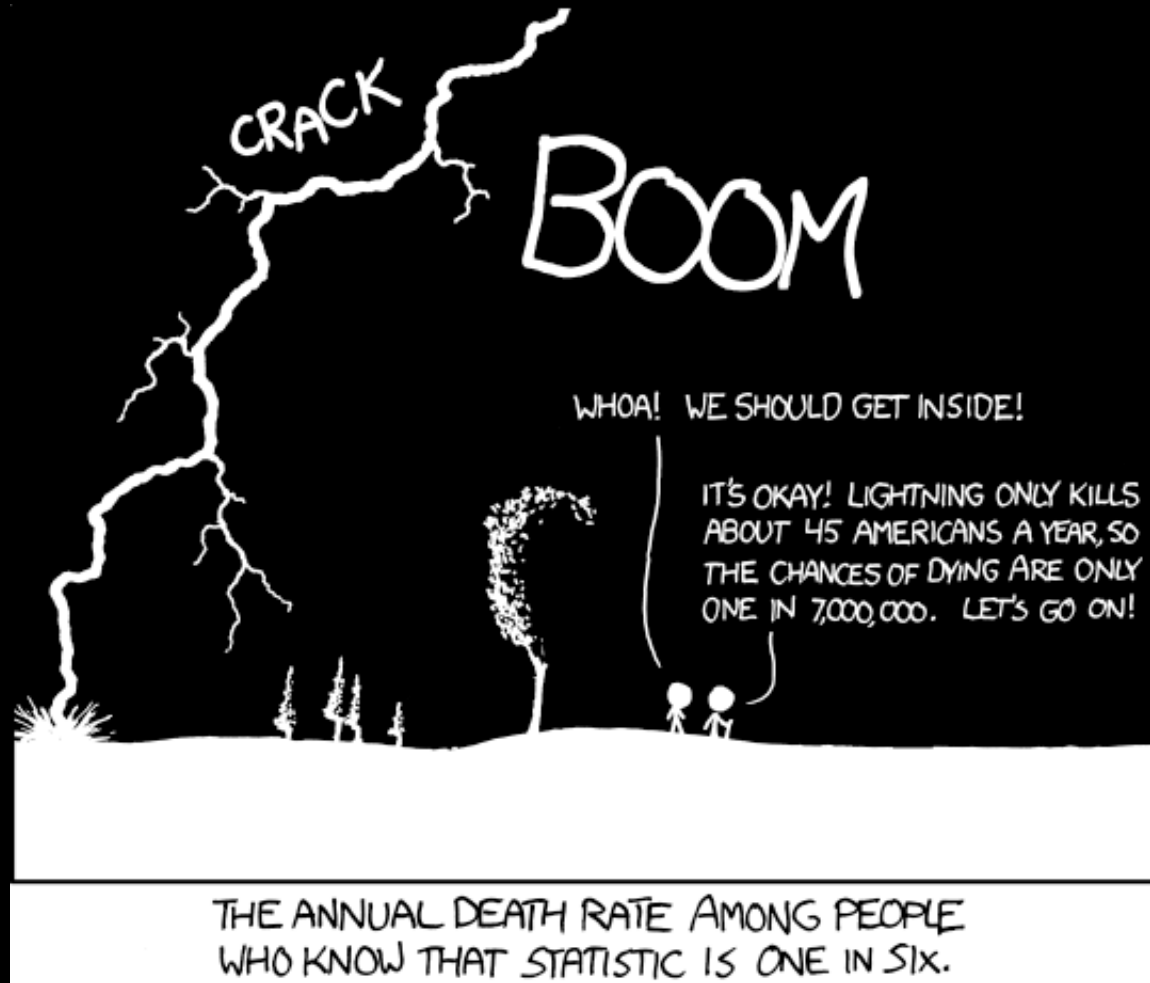


What is Uncertainty?

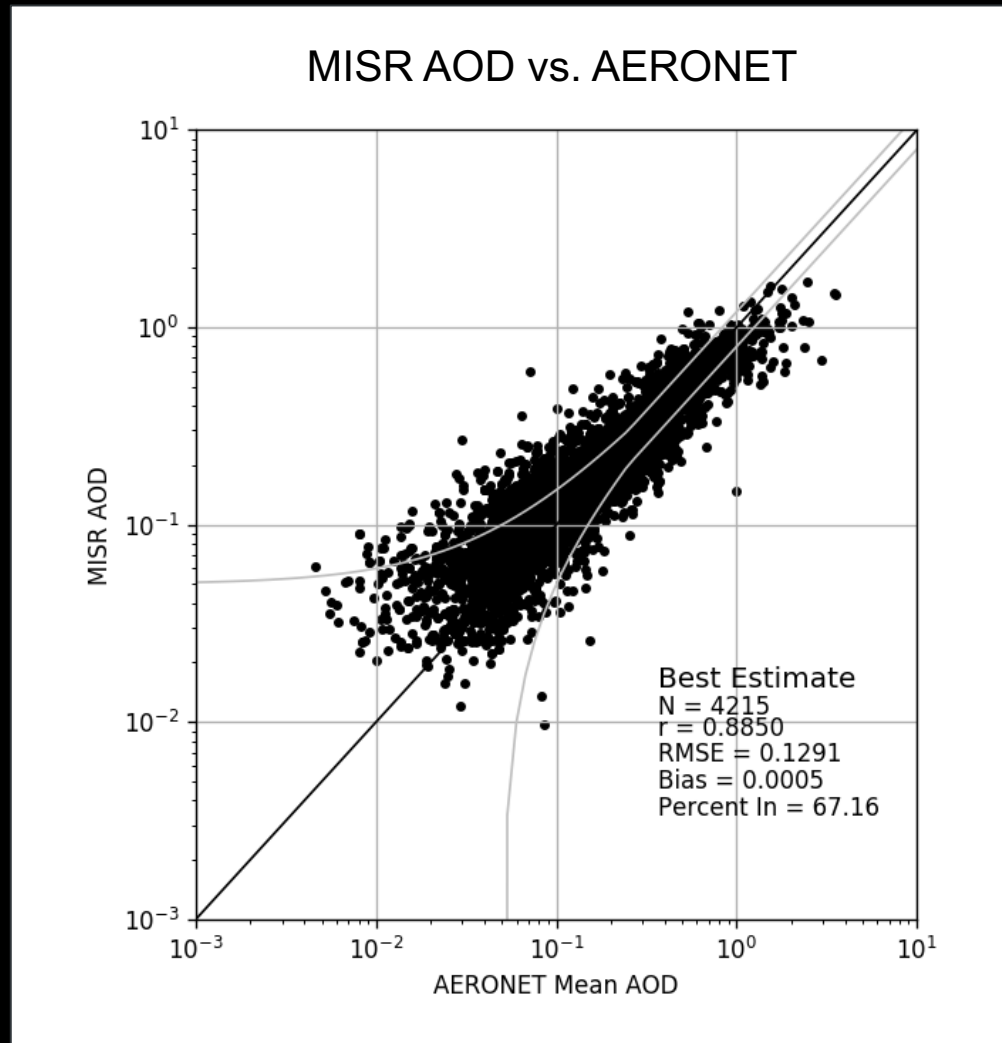
What is Uncertainty?

Uncertainty refers to epistemic situations involving imperfect or unknown information. It applies to predictions of future events, to physical measurements that are already made, or to the unknown. Uncertainty arises in partially observable and/or stochastic environments, as well as due to ignorance, indolence, or both.^[1] It arises in any number of fields, including insurance, philosophy, physics, statistics, economics, finance, psychology, sociology, engineering, metrology, meteorology, ecology and information science. (Wikipedia)

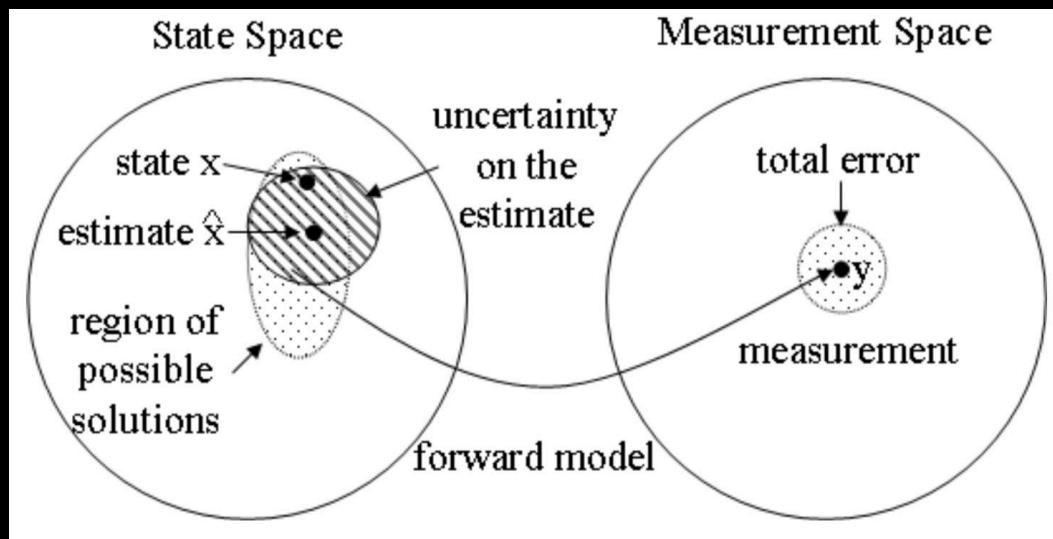
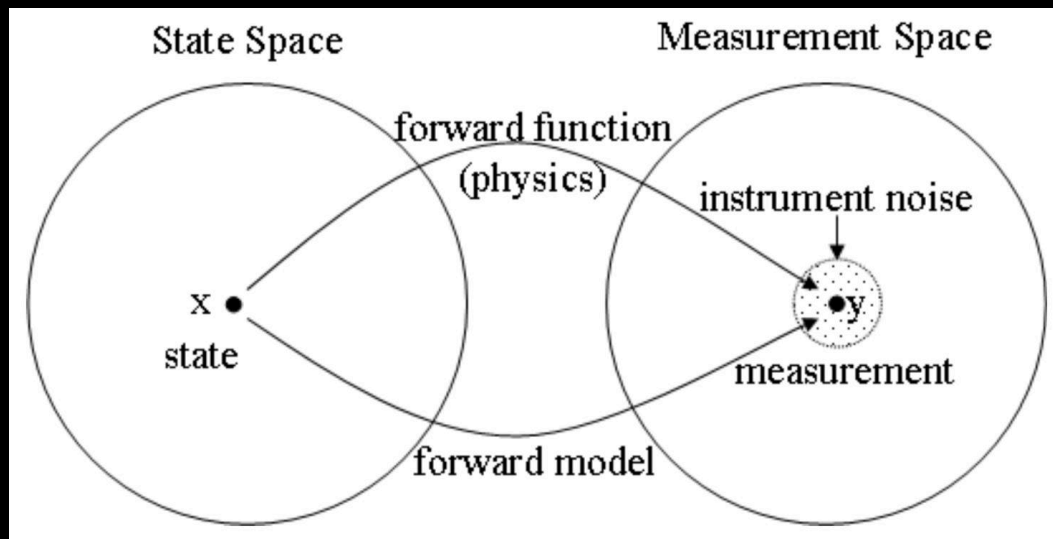
What is Uncertainty?



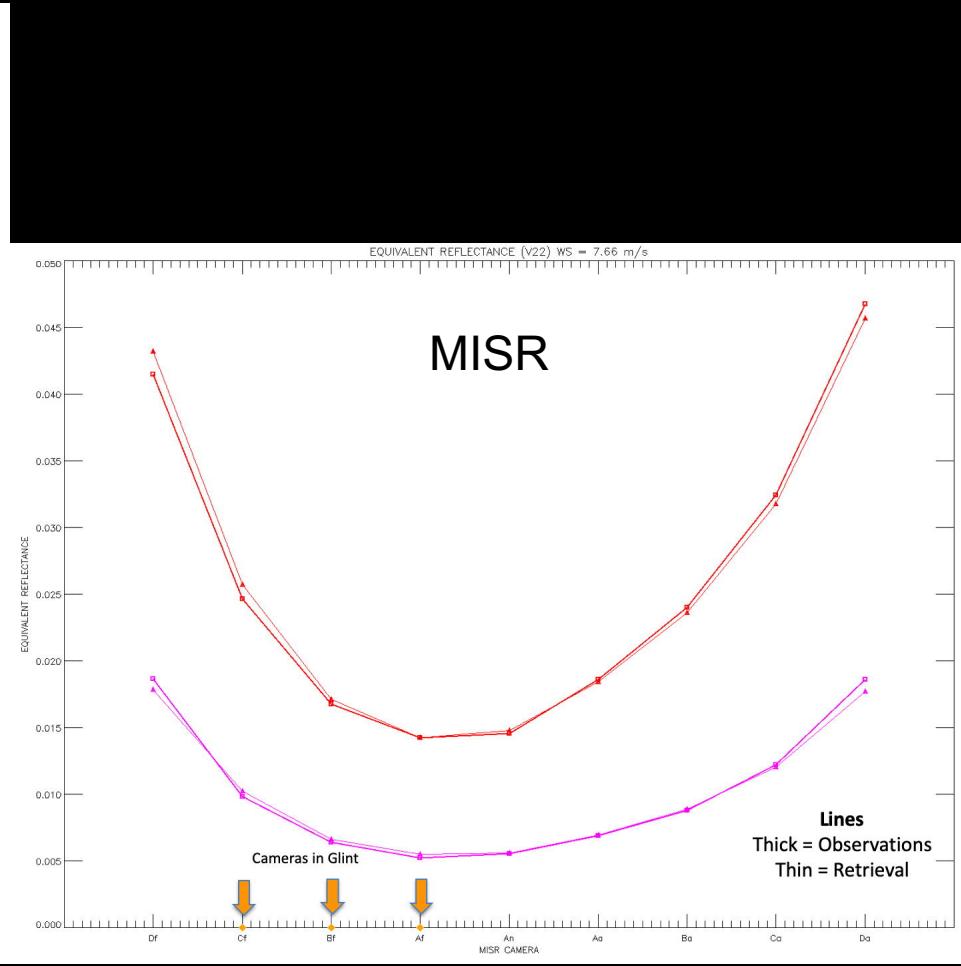
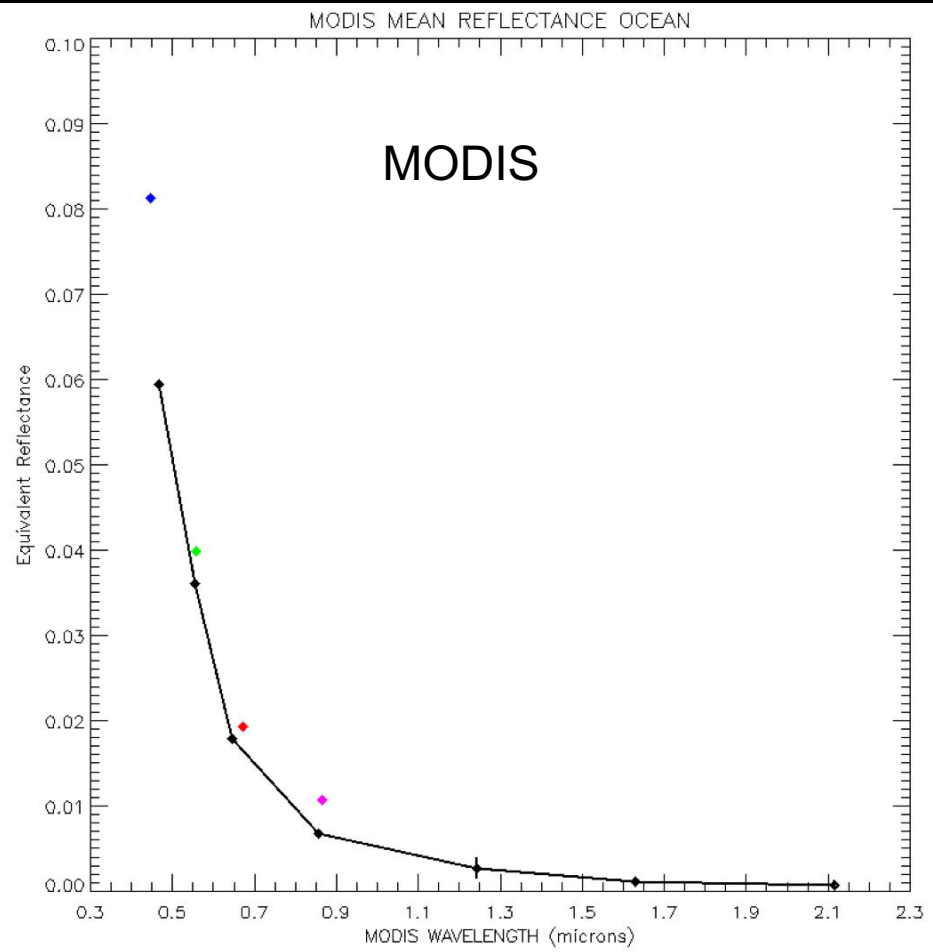
What is Uncertainty (Prognostic vs. Diagnostic)?



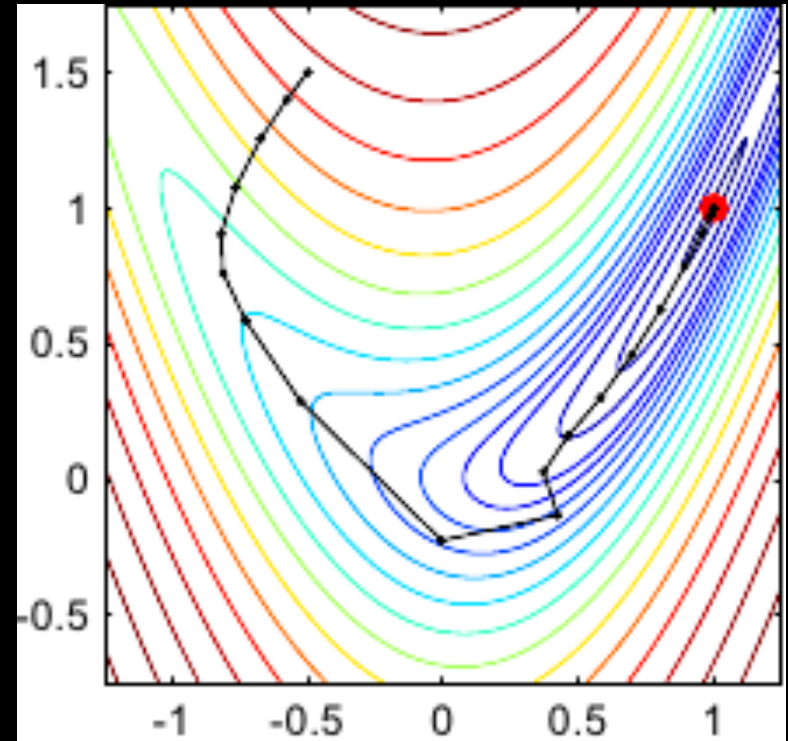
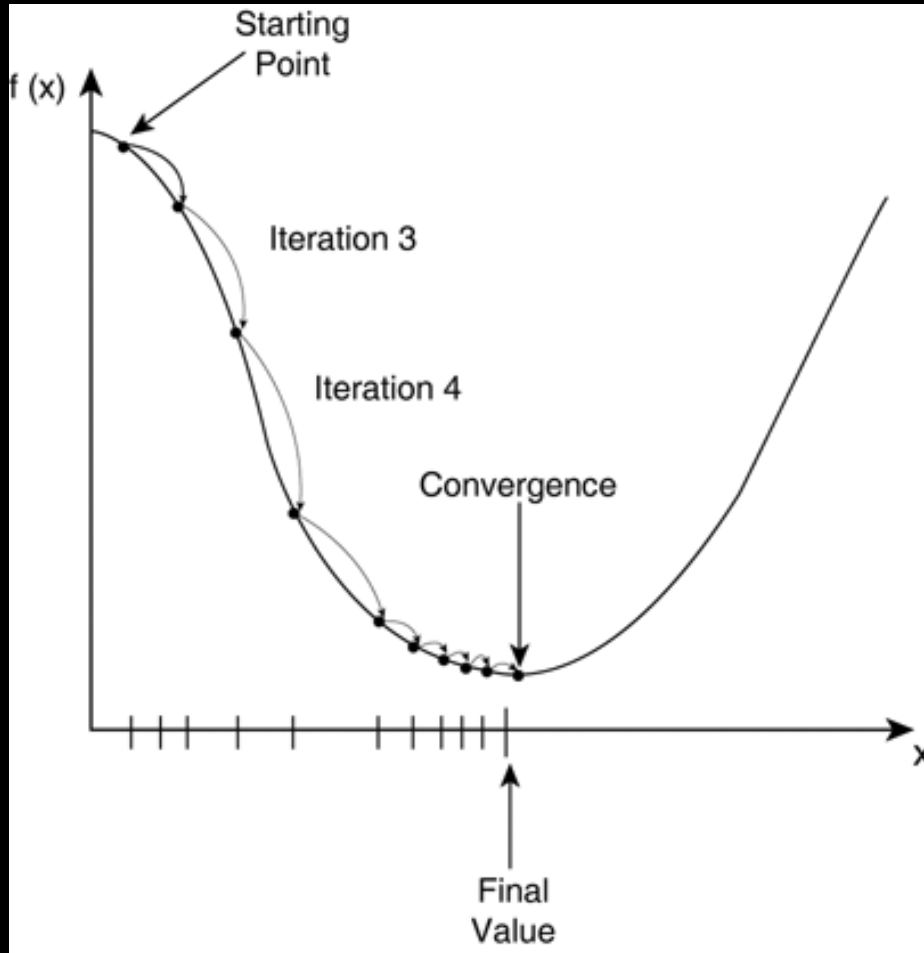
A Little Retrieval Theory



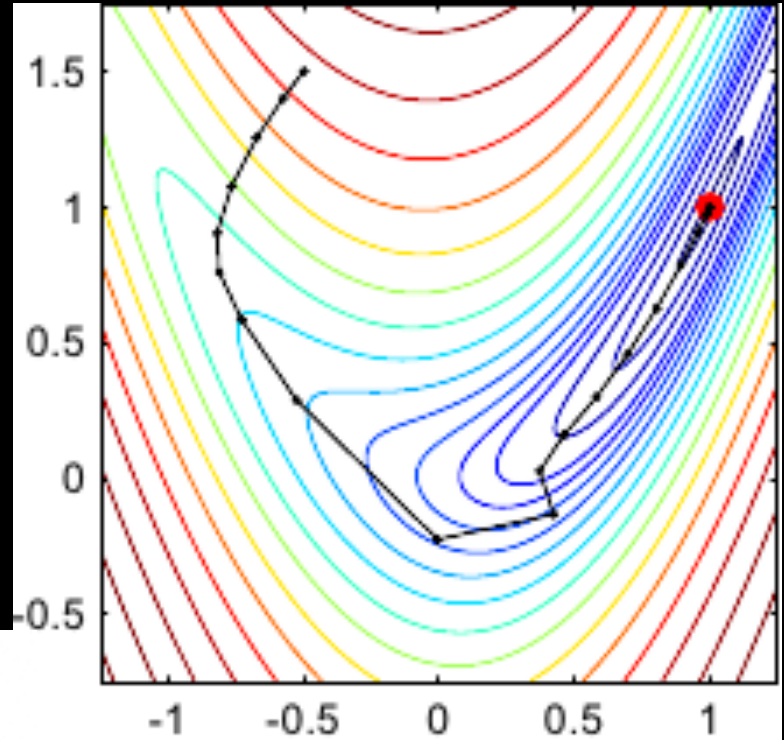
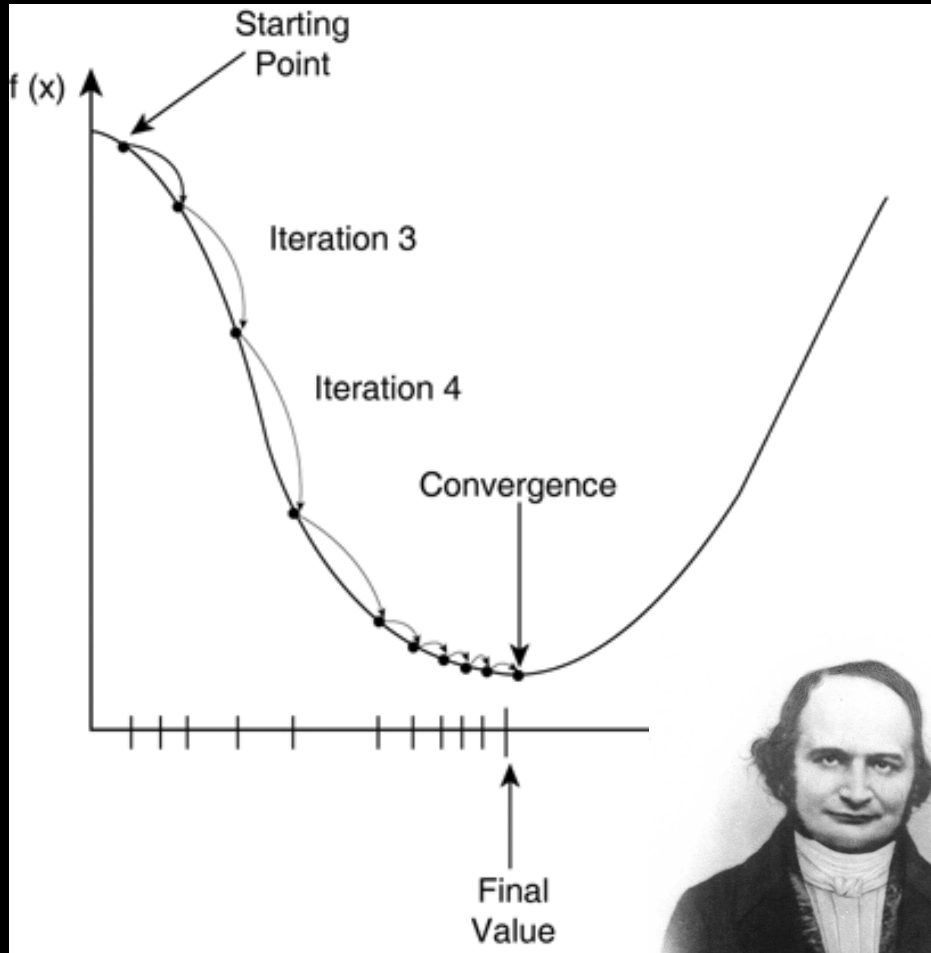
A Little Retrieval Theory (Cost Functions)



A Little Retrieval Theory (Finding a Solution)

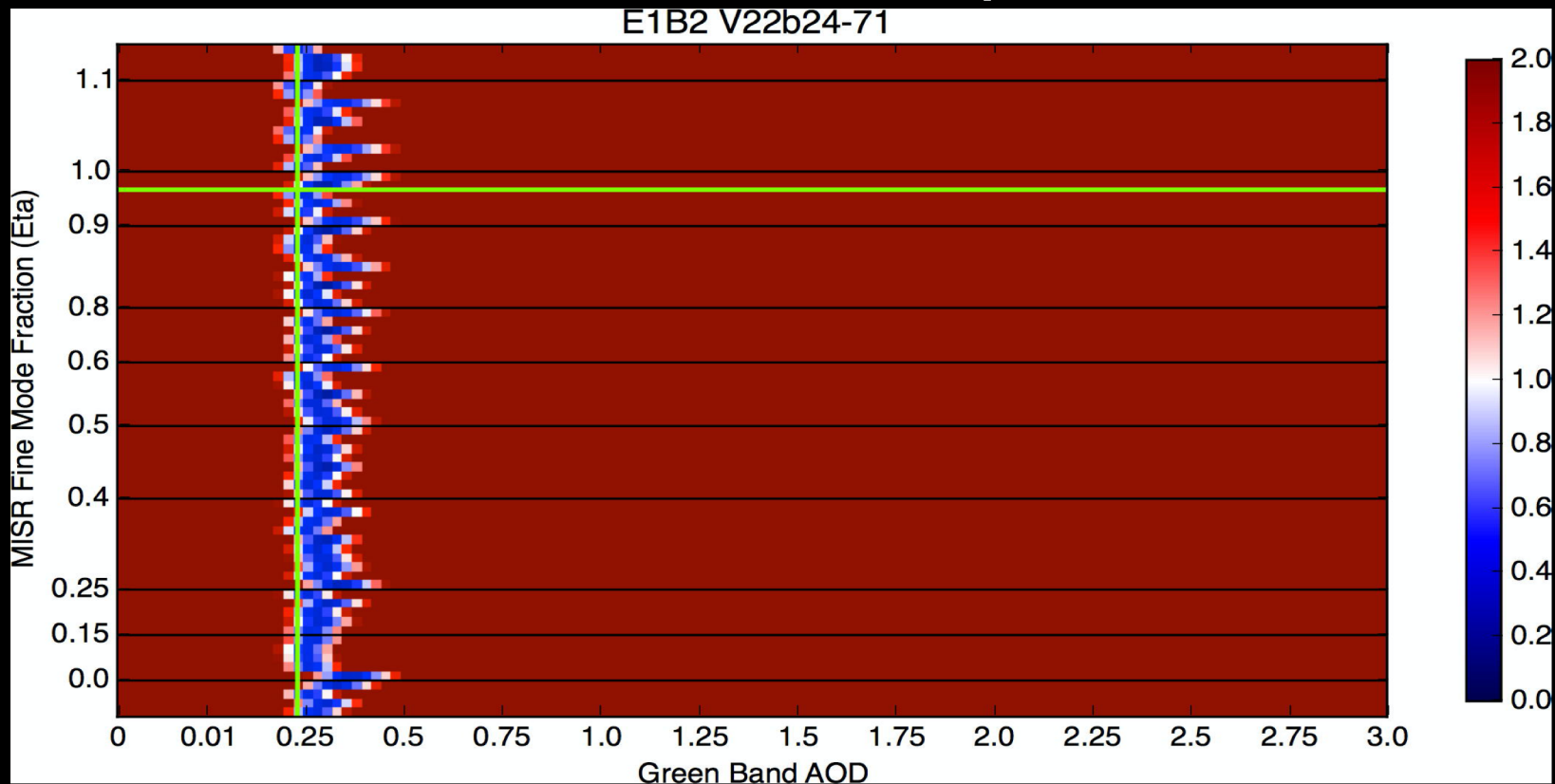


A Little Retrieval Theory (Finding a Solution)

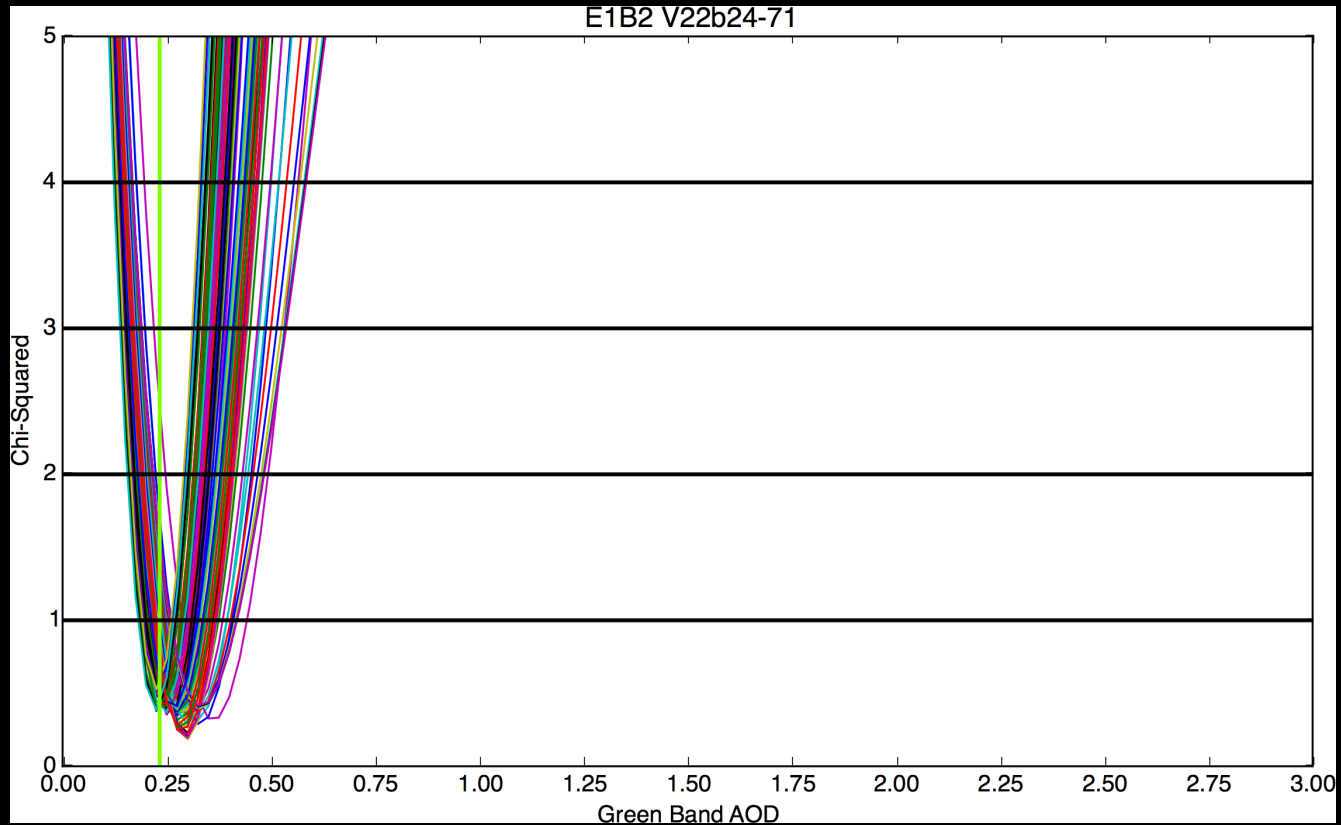


Carl Gustav Jacob Jacobi

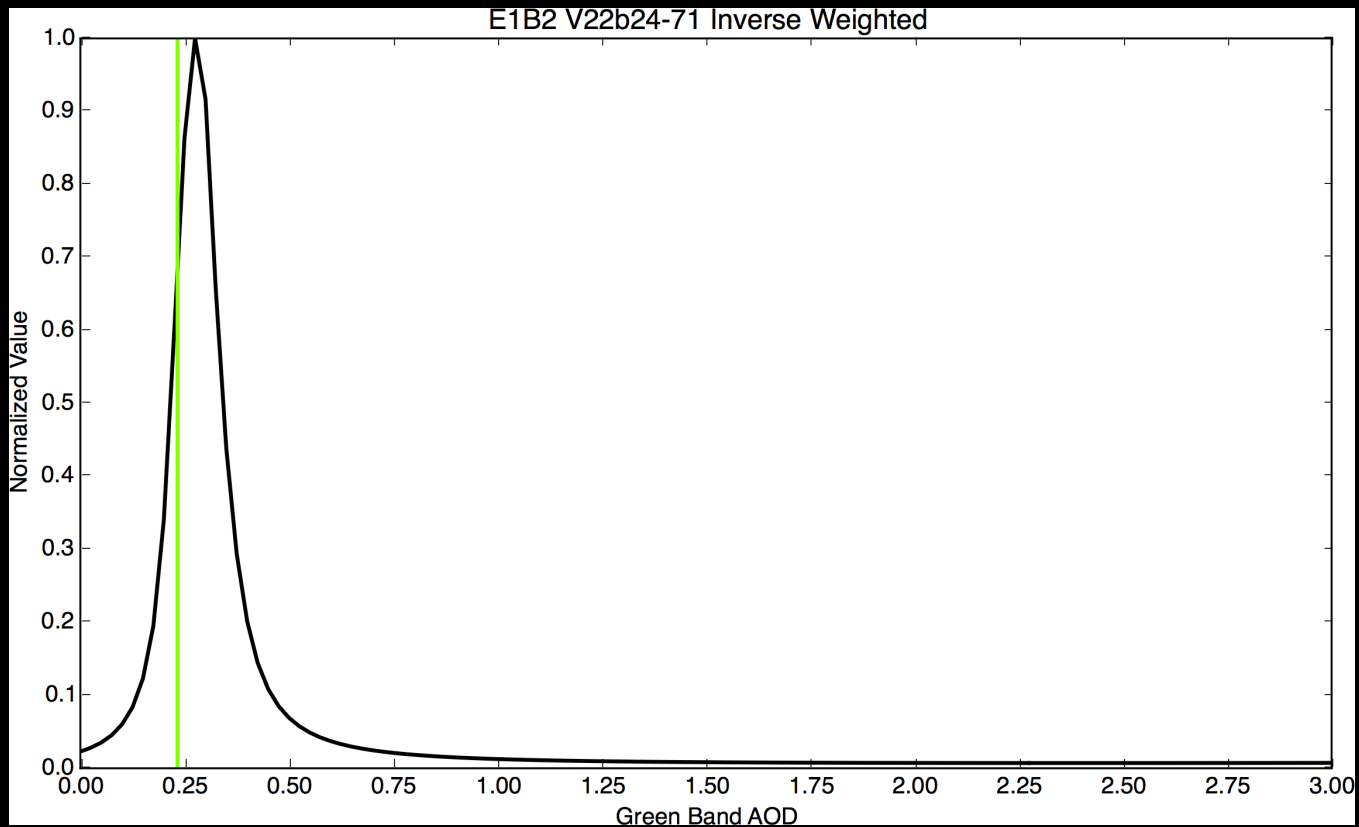
A MISR Example



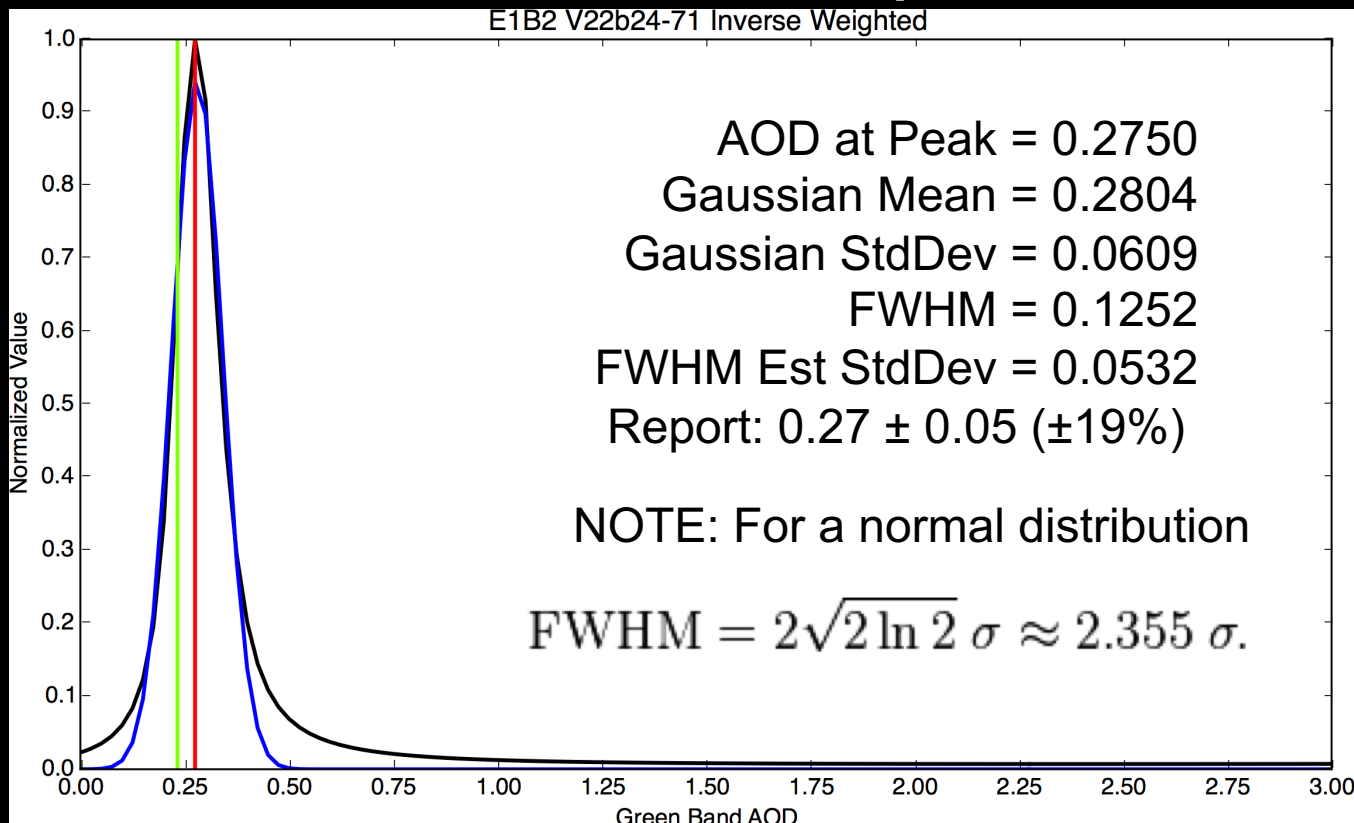
A MISR Example



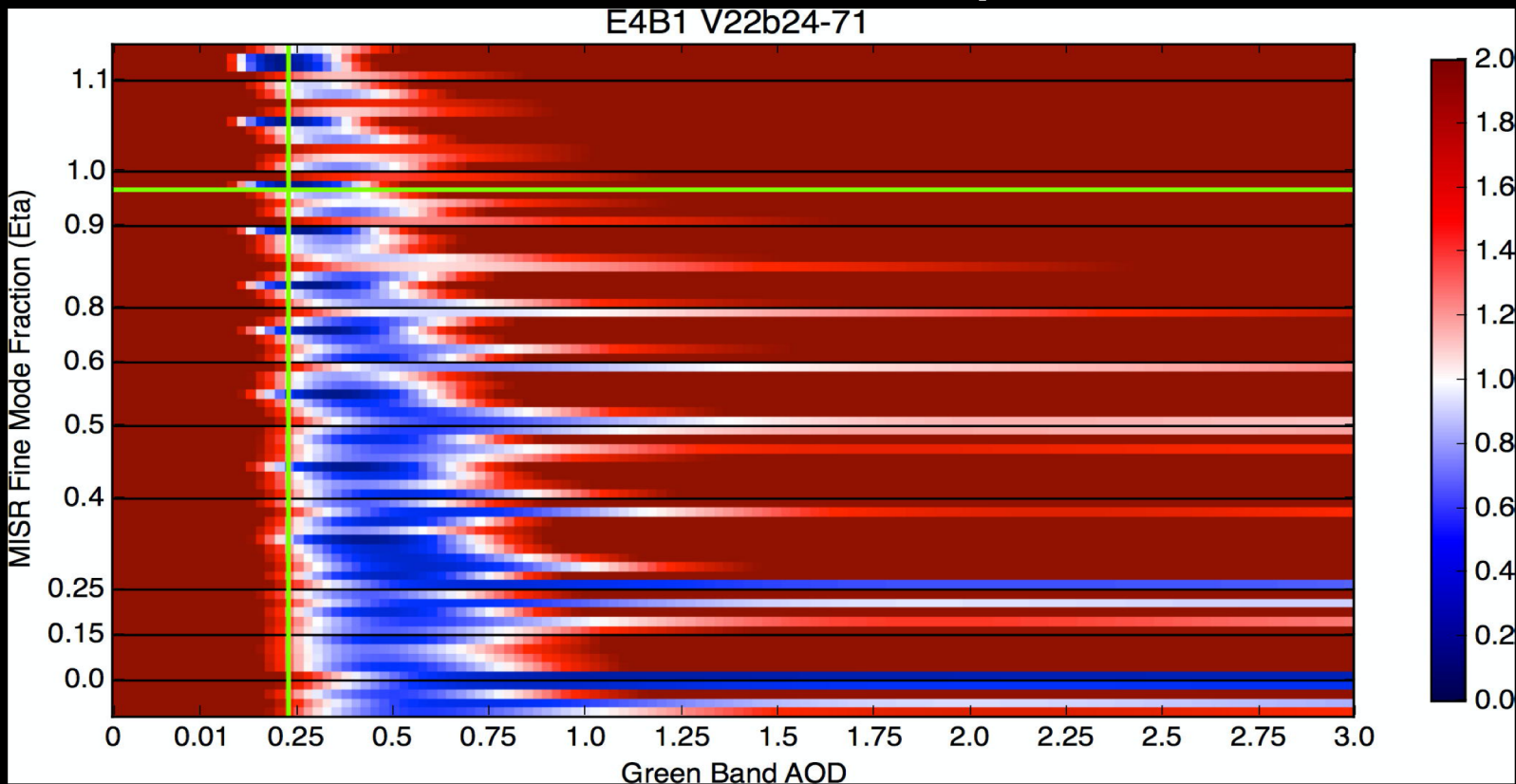
A MISR Example



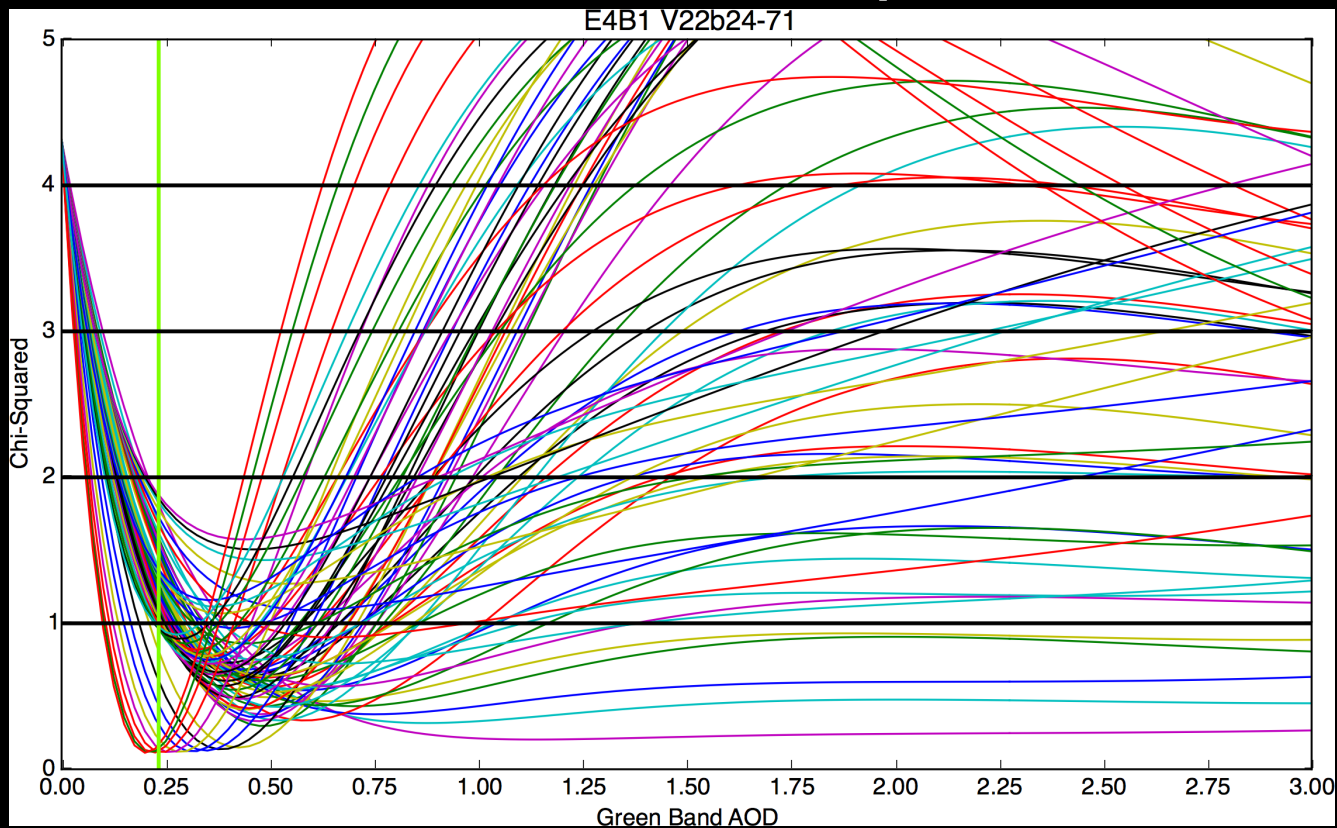
A MISR Example



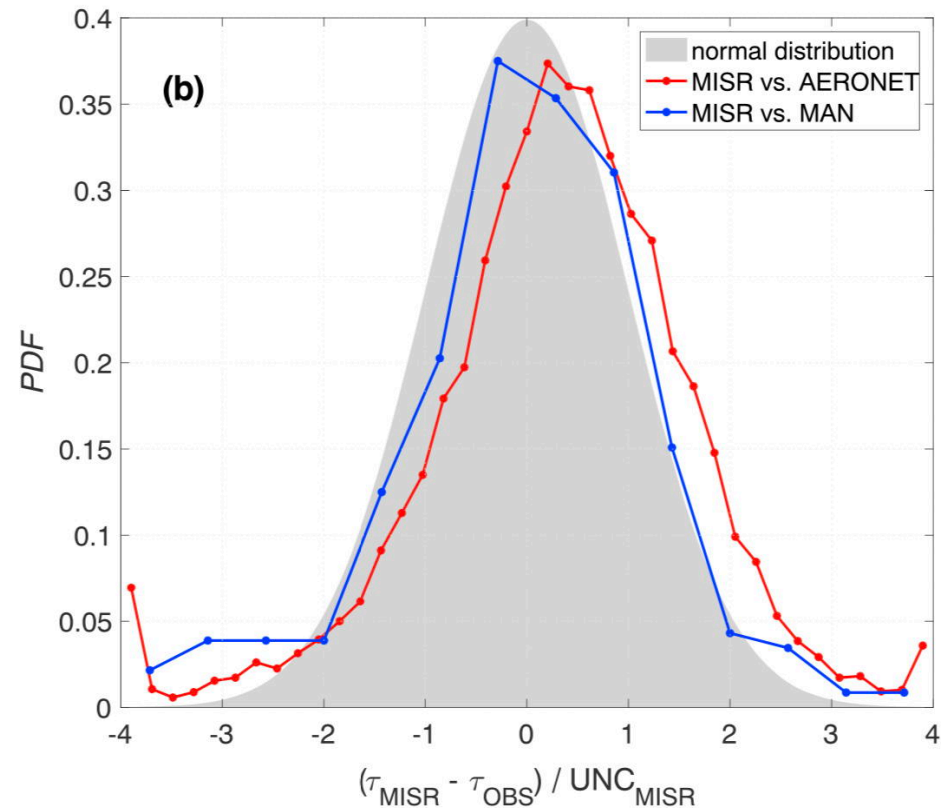
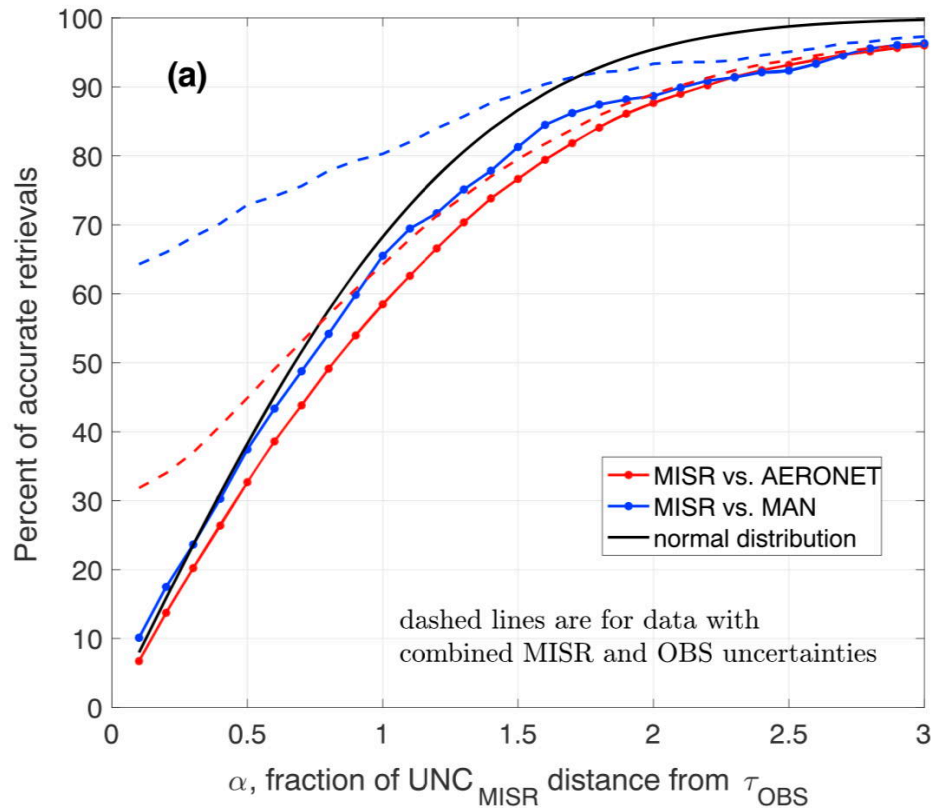
A MISR Example



A MISR Example

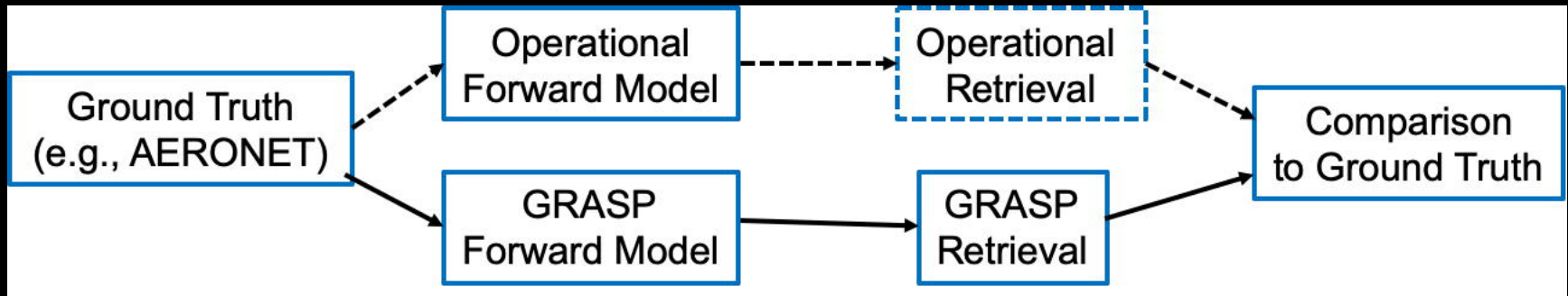


What is Uncertainty (Prognostic vs. Diagnostic)?

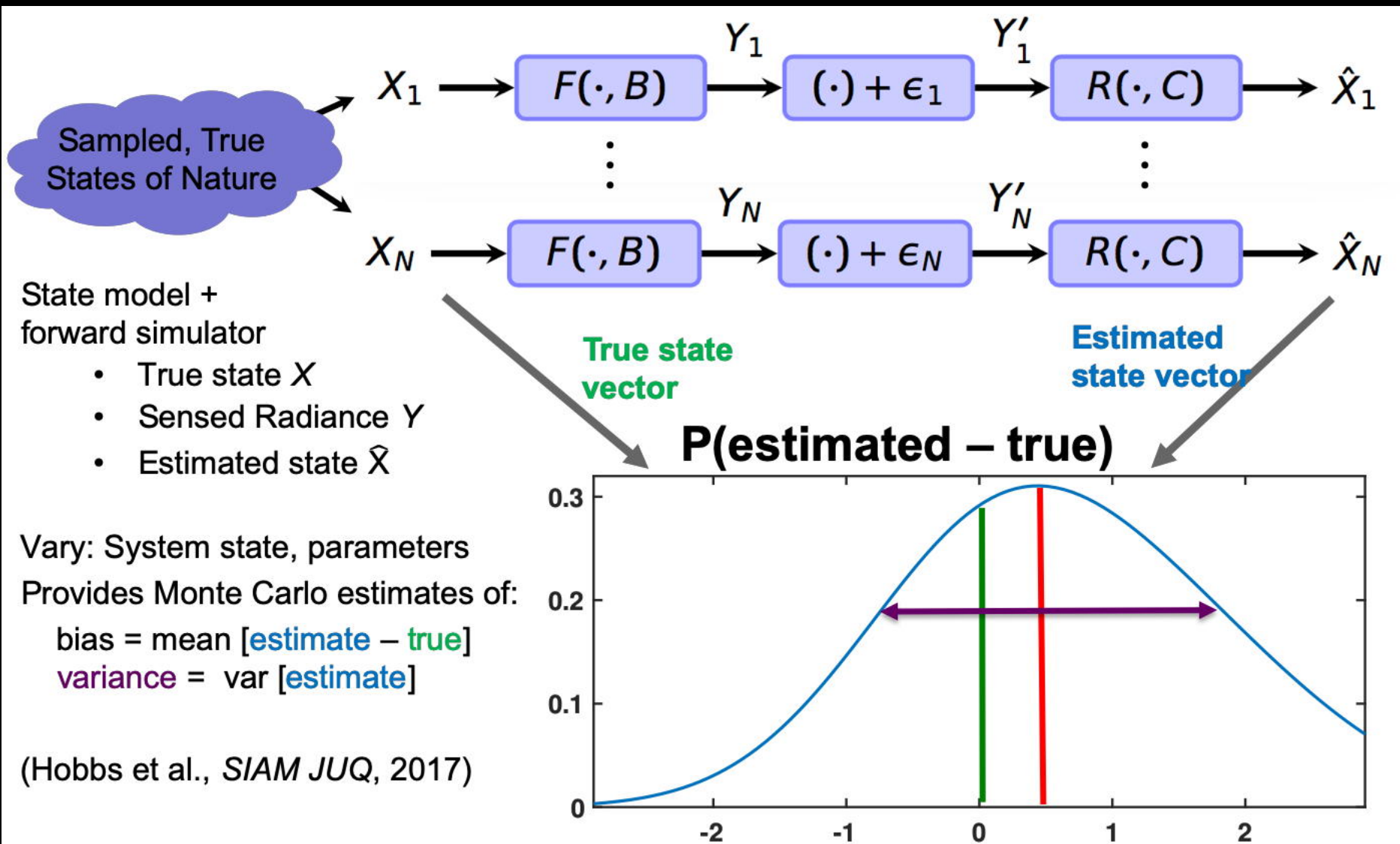


Witek et al. JGR (2019)

Observing System Uncertainty Experiment

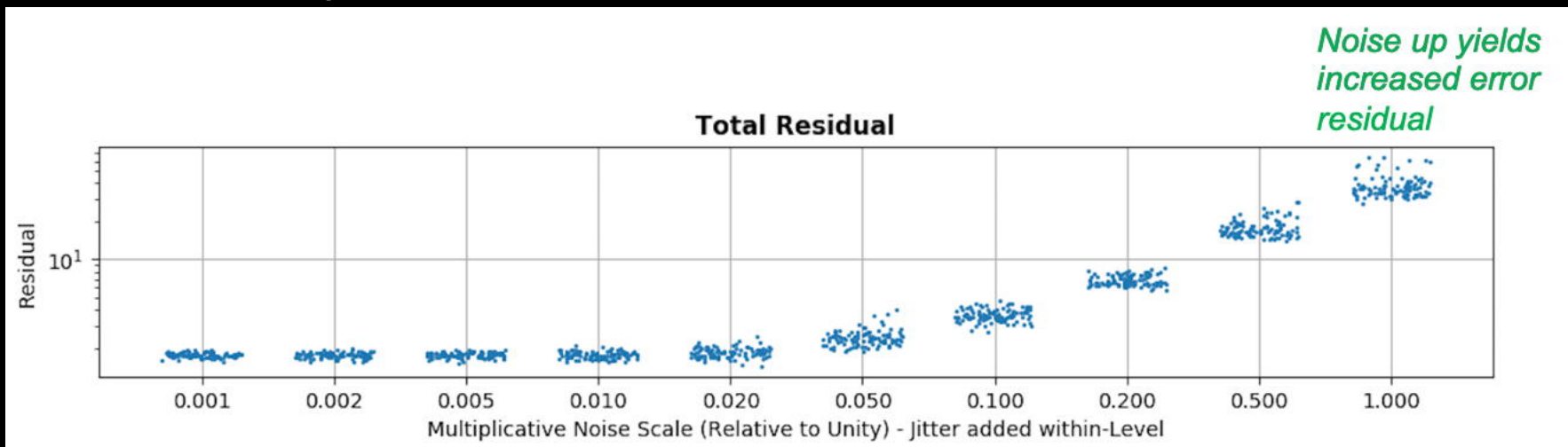


Observing System Uncertainty Experiment



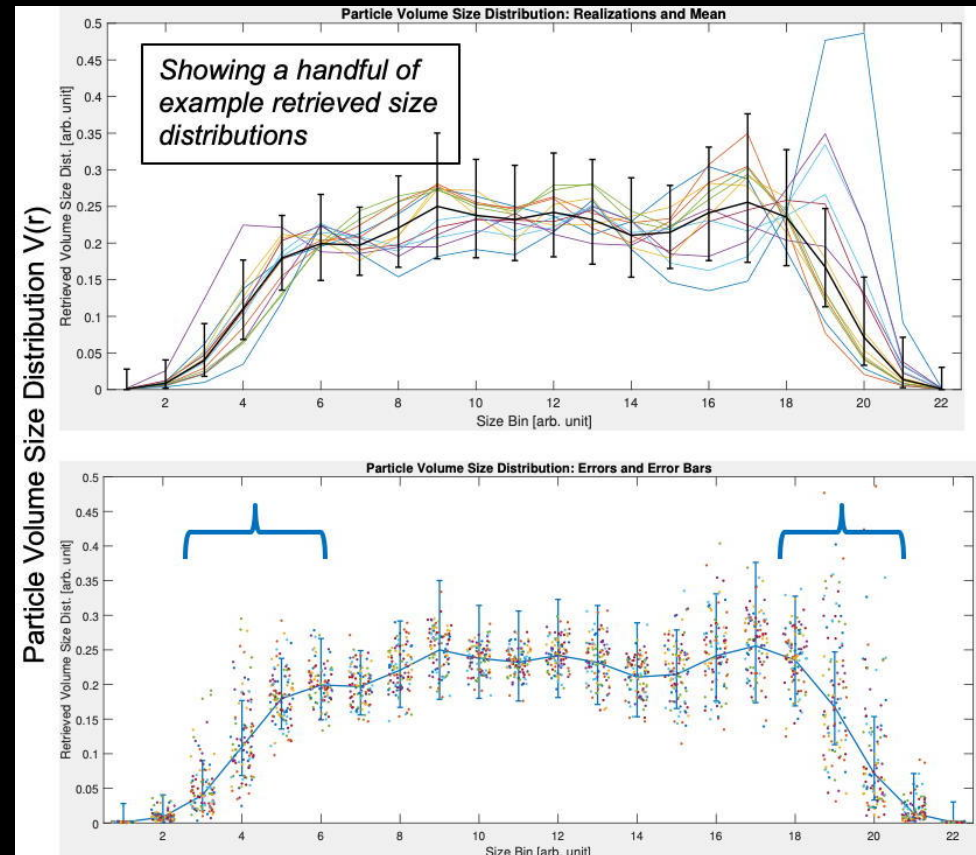
Observing System Uncertainty Experiment

- Initial runs using GRASP modeled conditions corresponding an AERONET site
- Retrieved parameters:
 - Particle size distribution $V(r)$ in 22 log-spaced size bins
 - Total AOD in 4 channels, $\lambda = 0.44, 0.67, 0.87, \text{ and } 1.02 \mu\text{m}$
- Below: Varying instrument noise as a sanity check of retrieval operation
 - 100 replicates at each noise level

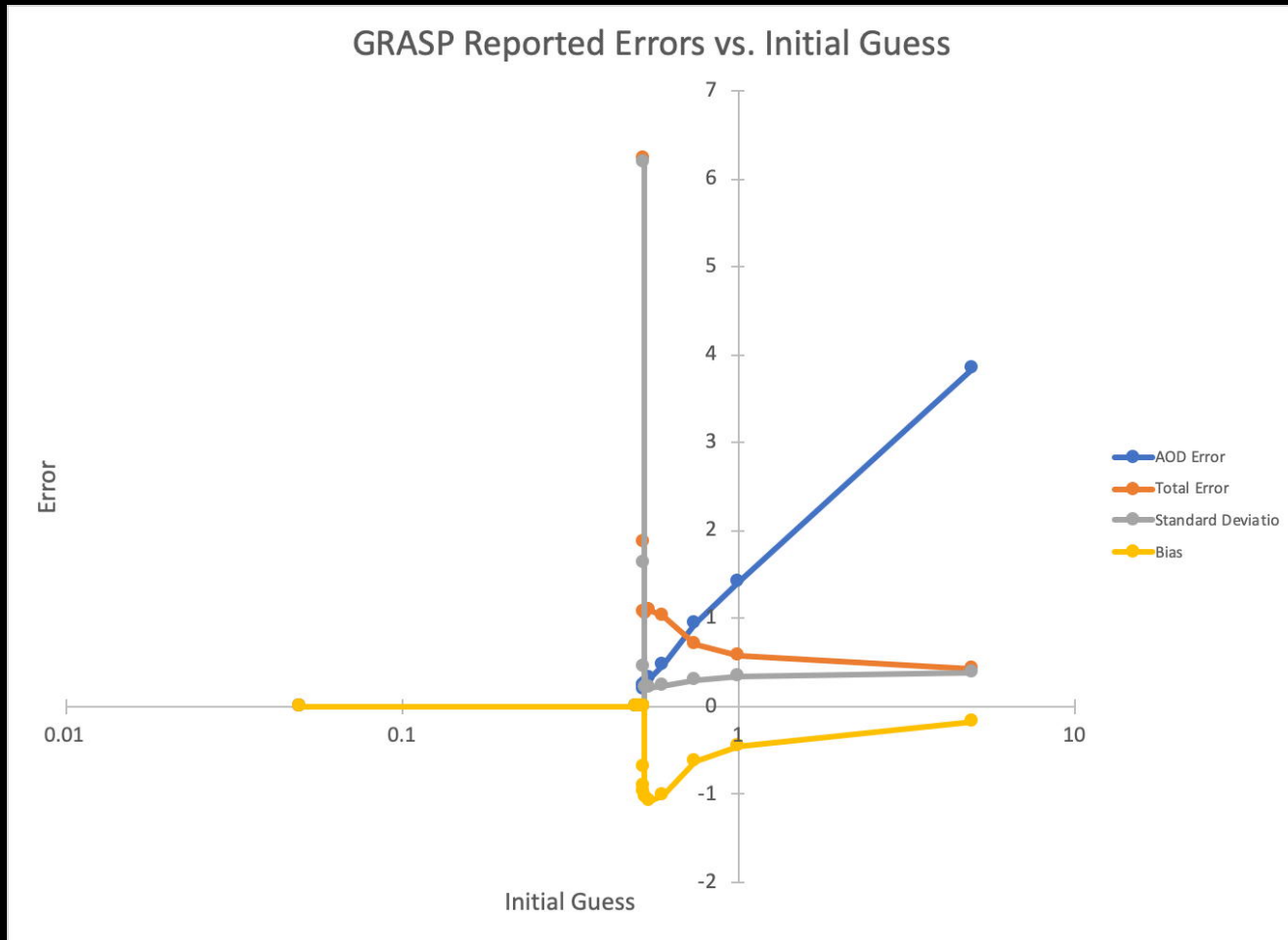


Observing System Uncertainty Experiment

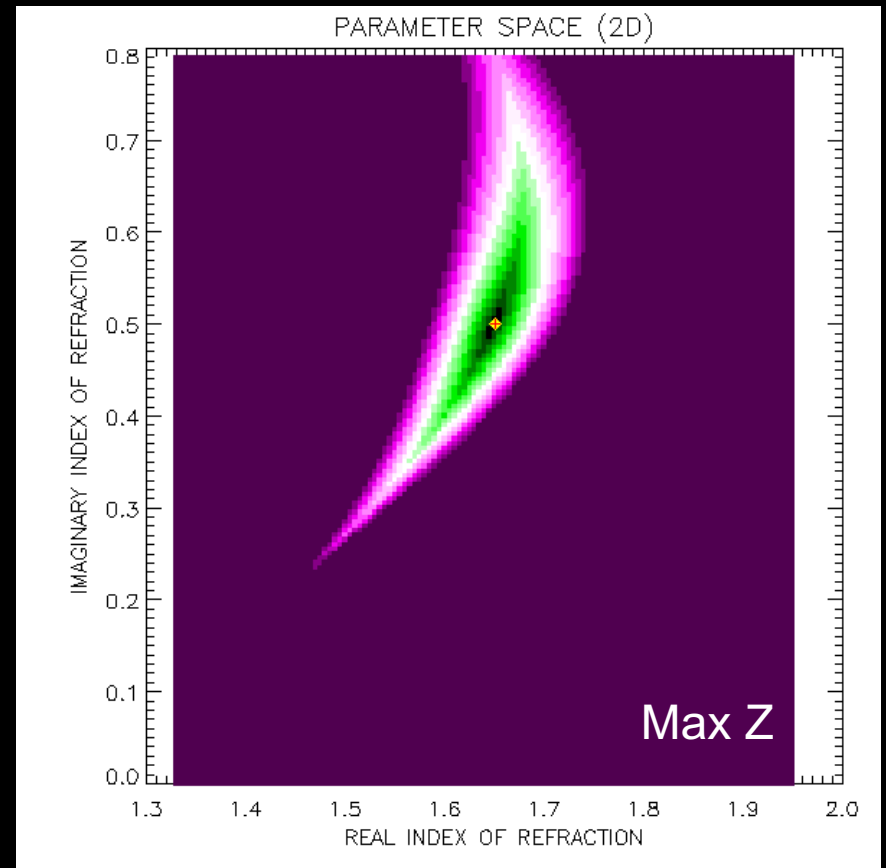
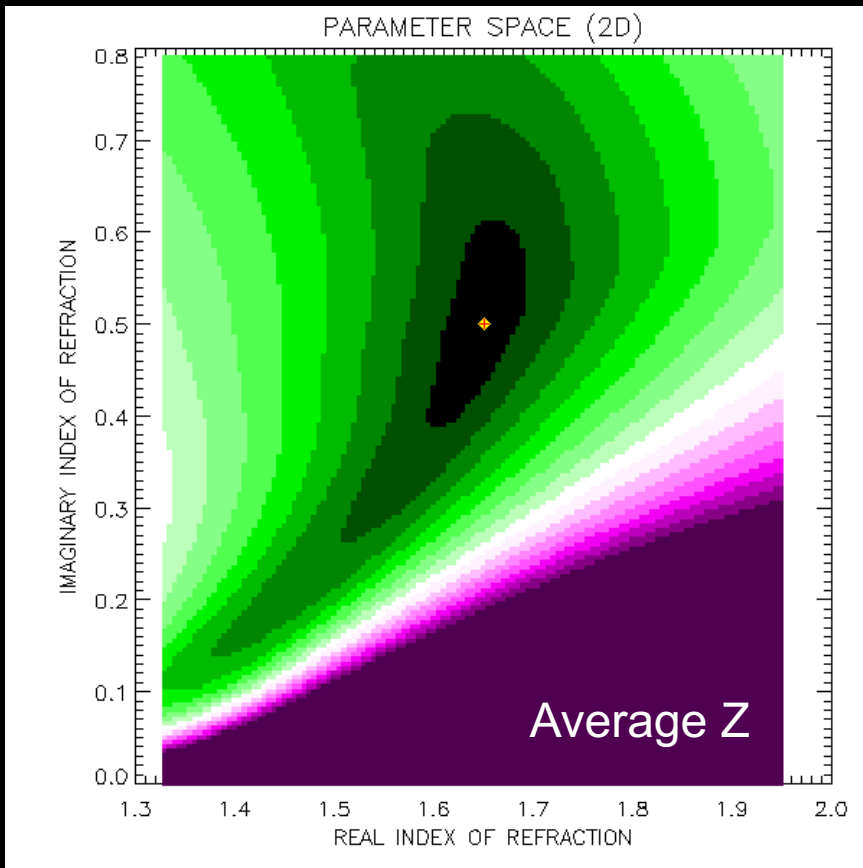
- Monte Carlo over instrument noise to verify GRASP error bar computation and method.
- Showing volume size distribution as a function of size (log-spaced bins)
- The mean is quite accurate
- Standard error is not accurate at low and high particle sizes
 - Rather tame AERONET forward model



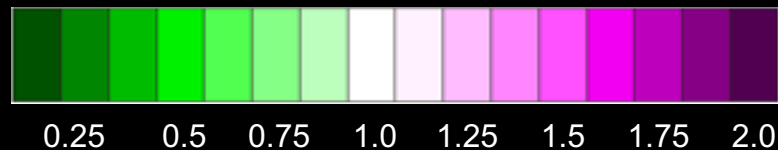
Observing System Uncertainty Experiment



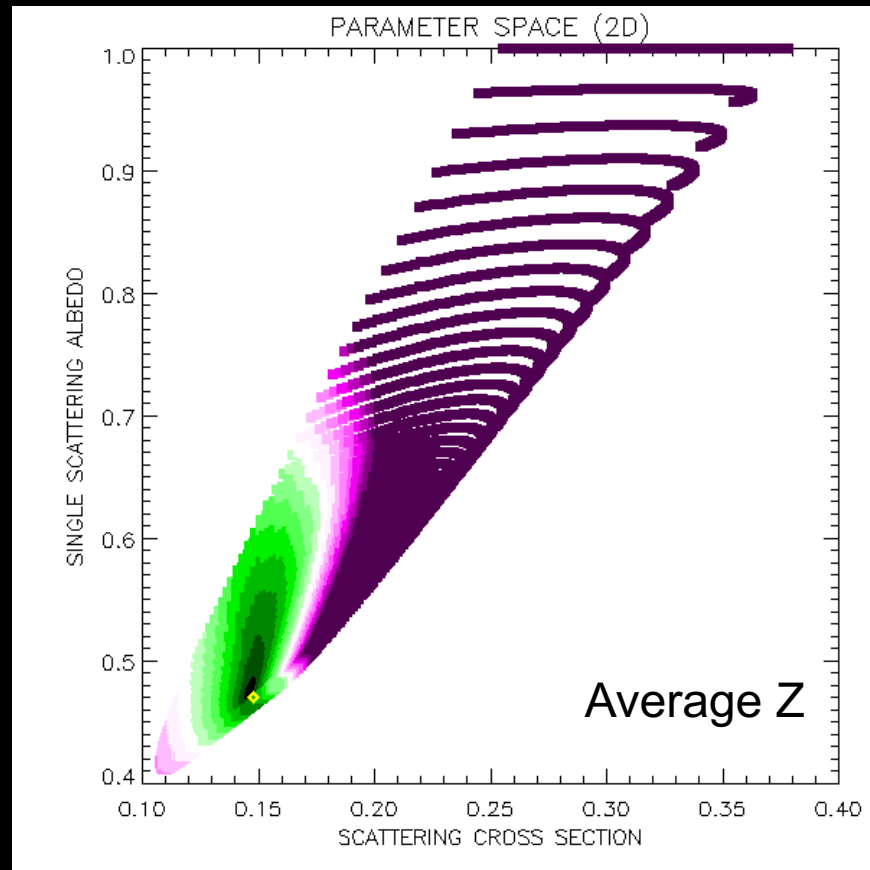
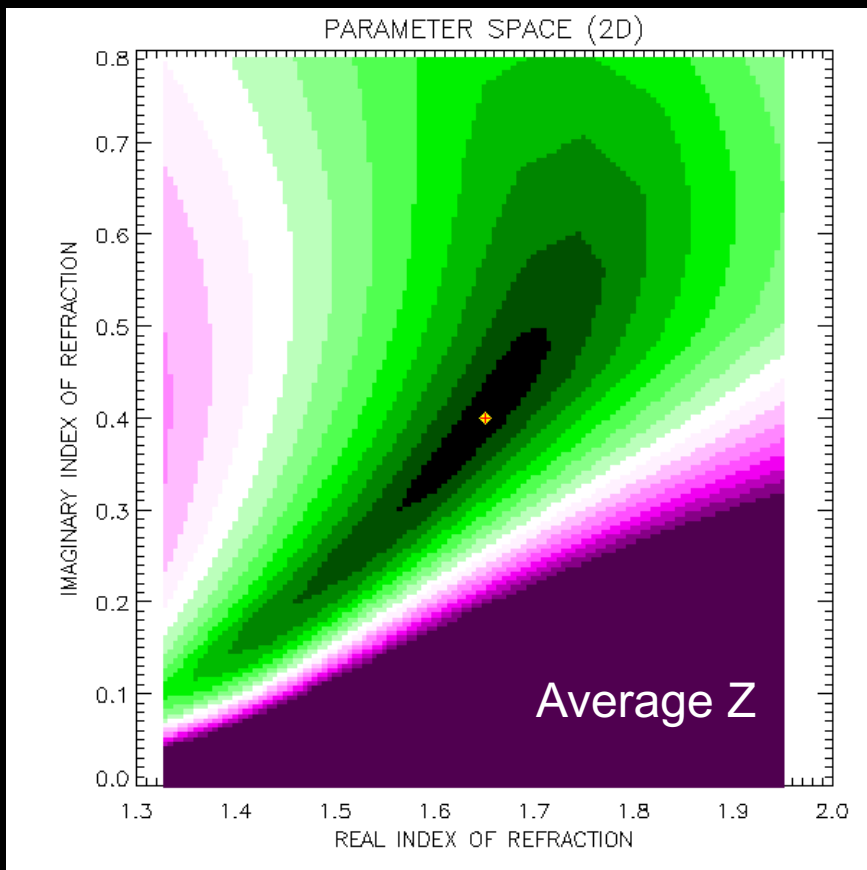
Some Explorations of Parameter Space



Z-Score



Some Explorations of Parameter Space

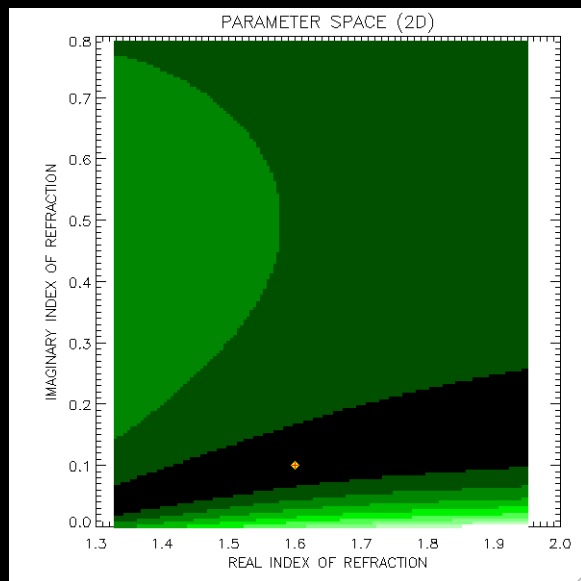


Z-Score

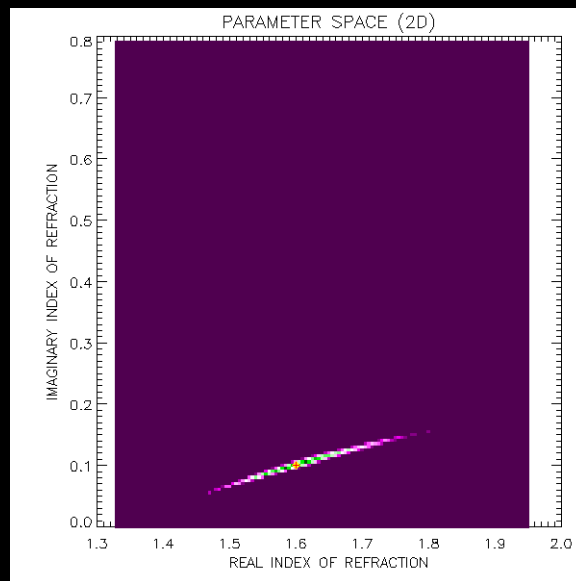


Some Explorations of Parameter Space

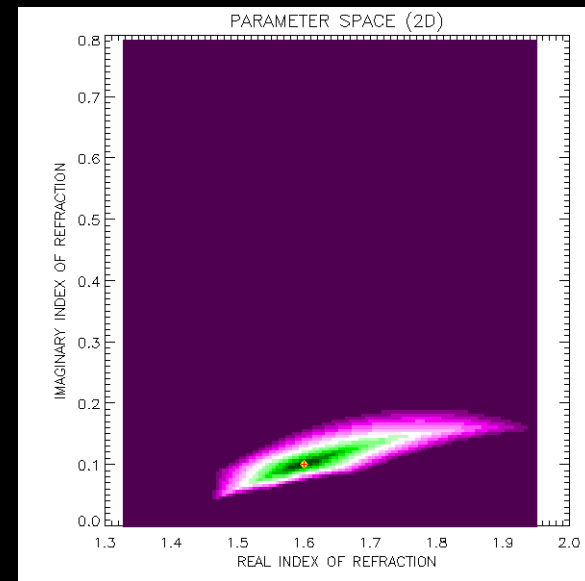
INTENSITY
ONLY



DoLP
ONLY



POLARIZATION
ONLY

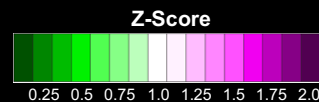


MAX_Z_SCORE_MSPI

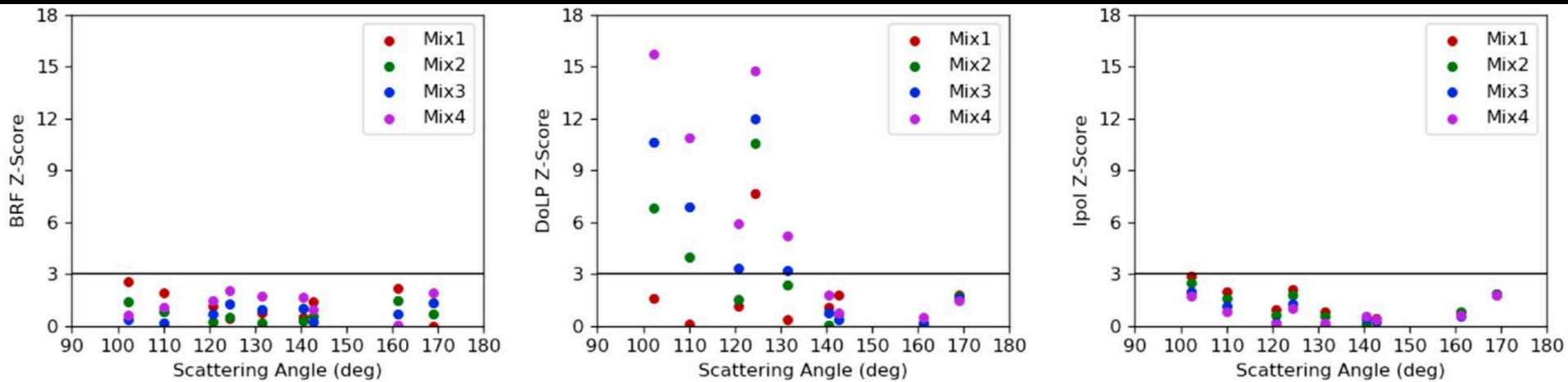
-----uncertainty-----

Intensity = 0.015

DOLP = 0.005



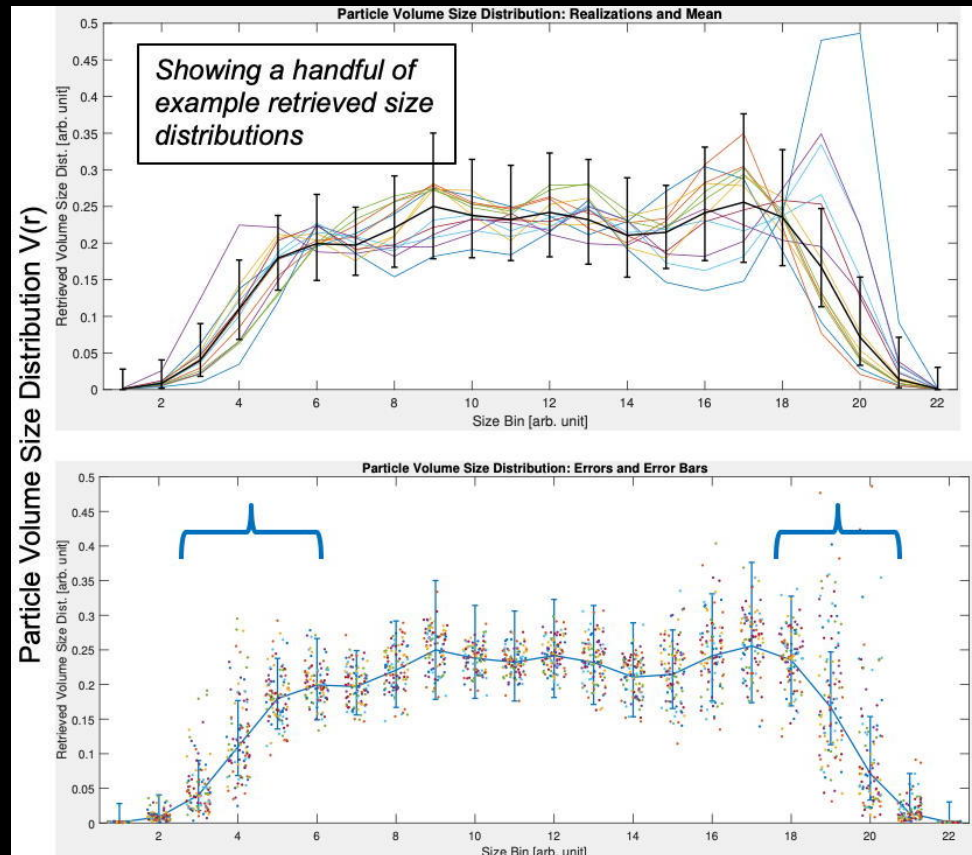
Some Explorations of Parameter Space

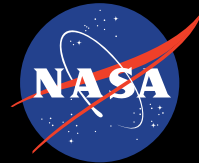


Kalashnikova et al. JGR (2018)

Observing System Uncertainty Experiment

- Monte Carlo over instrument noise to verify GRASP error bar computation and method.
- The mean is quite accurate
- Standard error is not accurate at low and high particle sizes
- Work in progress





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