Data uncertainty: what is it, where does it come from, and why should we care?

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Data uncertainty

What is it?

*Data uncertainty is the ignorance that remains about the true value of a geophysical quantity of interest (QOI) after seeing the data.*
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Where does it come from?

Data uncertainty arises because there is not a known, one-to-one correspondence between the observation and the quantity of interest.
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Where does it come from?

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Why should we care?

*Because scientific conclusions drawn or decisions made as if that correspondence did exist may result in costs that are related to the magnitude of the error (the difference between the data and the true value of the QOI).*
Why is probability a good way to measure data uncertainty?

- Probability is coherent (internally consistent).
  - important for propagating through processing flows
  - permits universal comparisons

- Probability is intuitive (interpretation as long-run relative frequency).
  - communication by analogy with games (and betting)

- Probability is mathematically precise (it’s branch of mathematics).
  - the basis for hypothesis testing (scientific method)
  - the basis for decision theory
Questions? Contact Amy.Braverman@jpl.nasa.gov.

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Panel Discussion
Observing system

True state $X$ → $\mathcal{F}(\cdot, B)$ → Noisy radiance $\mathcal{Y}$ → Instrument observation $\mathcal{Y} + \epsilon$ → Retrieval observation $Y$ → $\hat{X}$

$\mathcal{F}$ = nature’s true forward function; $B =$ other true quantities.

$F =$ forward model used in retrieval; $B =$ other retrieval quantities.

$\epsilon =$ instrument measurement error.
Data uncertainty

True state $X$ forward function $\mathcal{F}(\cdot, B)$ noiseless radiance $Y$ instrument observation $Y + \epsilon$ retrieval $R(\cdot, F, B, \ldots)$ state estimate $\hat{X}$

$P(X, \hat{X})$