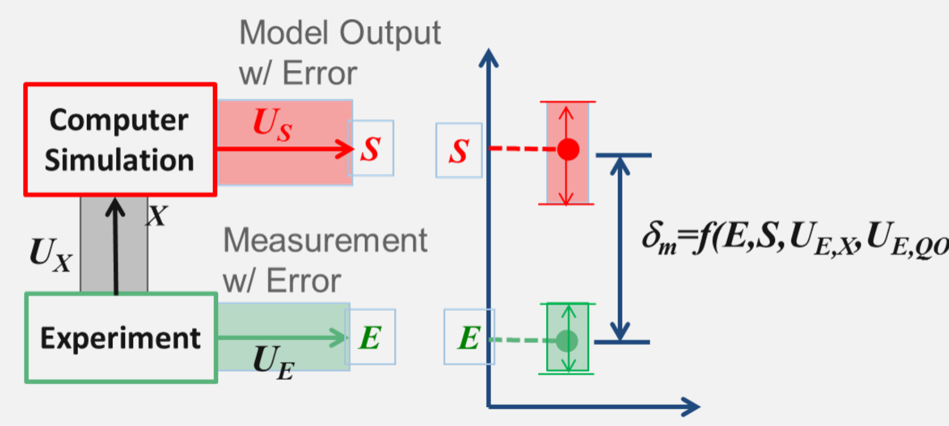
WE START WITH YES.

VALIDATION AND UNCERTAINTY PROJECT: ANL UPDATE TO SSPC 140



RALPH T. MUEHLEISEN
Principal Building Scientist

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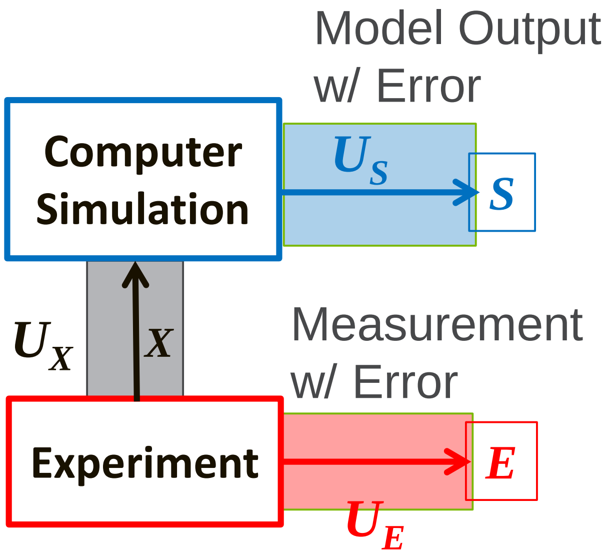
OUTLINE

- Update on uncertainty metrics
- Background / Goals
- Simple Static Metric
- Complex (asymmetric distribution) Metric
- Dynamic Metric
- Modeling Plans

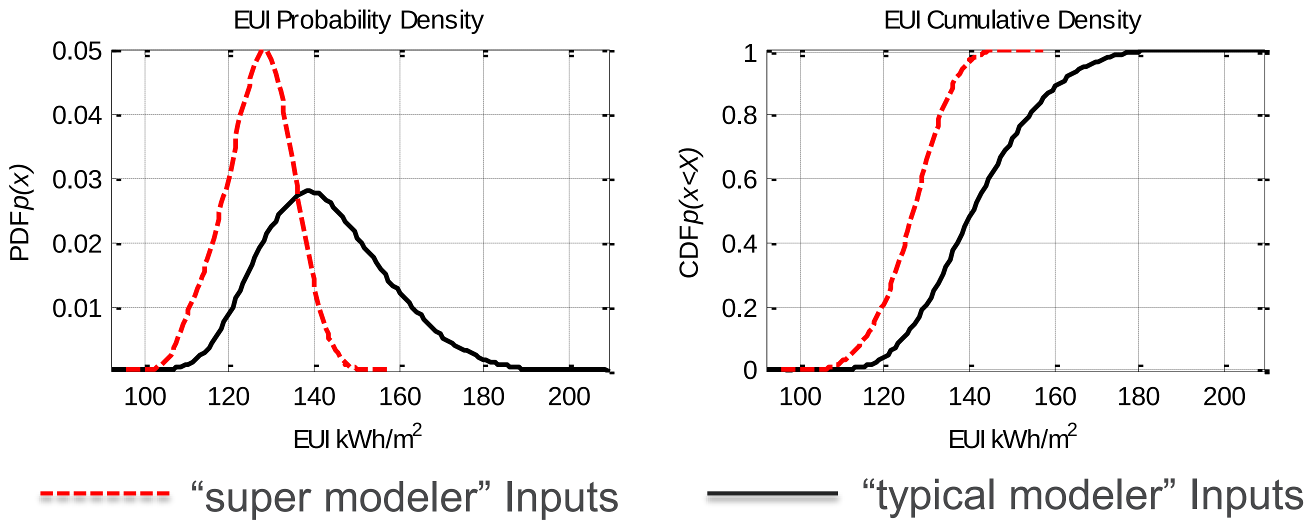
UNCERTAINTY ANALYSIS GOALS

1. Characterize the uncertainty in the experiments – both the direct measurements and the other quantities inferred from direct measurements
2. Characterize the values and the uncertainty in model inputs given detailed description of the experiments and facilities
3. Develop a standard method for propagation of uncertainty (e.g. sampling method, number of runs) to estimate simulation output and uncertainty



UNCERTAINTY ANALYSIS GOALS

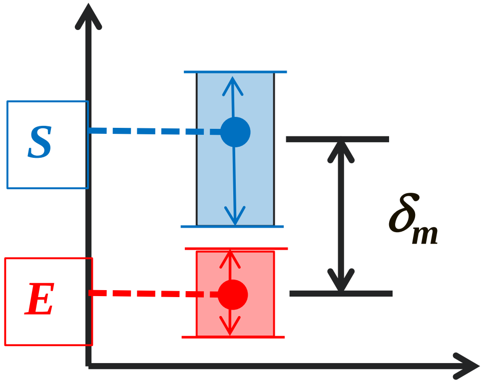
4. Determine Uncertainty Bounds for Inputs to estimate uncertainty a “typical” modeler should expect when trying to model the experimental setup.
   – i.e. when one does not have an instrumented building, other measurement lab equipment, but only a set of drawings

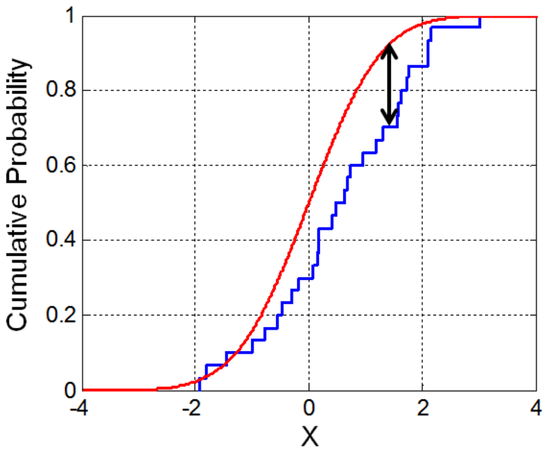


UNCERTAINTY ANALYSIS GOALS

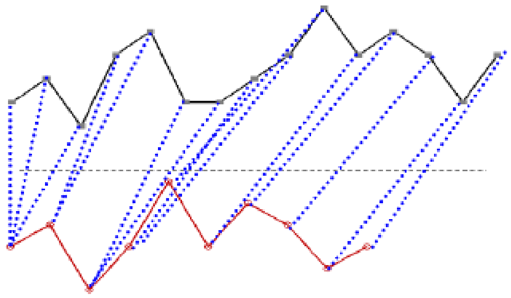
5. Develop discrepancy metrics for comparing experiment to simulations when there is uncertainty in both

Static / Steady State data





Dynamic data



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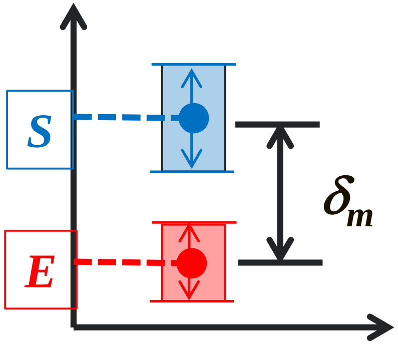
SIMPLE STATIC DISCREPANCY METRICS

- For well behaved distributions (symmetric and well described by mean, $\bar{x}$, and standard deviation, σ) we can use the Uncertainty Ratio (Manz 2007)

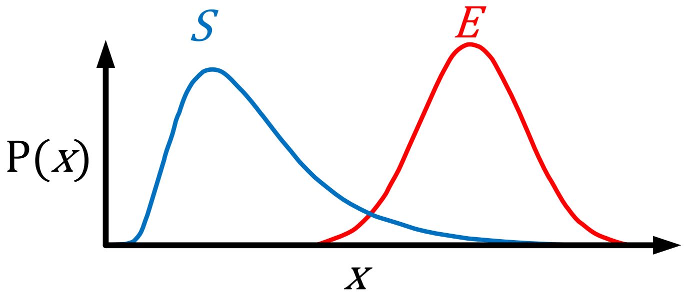
$$UR = \frac{\delta_m}{\sigma_S + \sigma_E}$$



- To do: Determine values of UR that are acceptable
  – Is it UR < 1.0? 1.2?

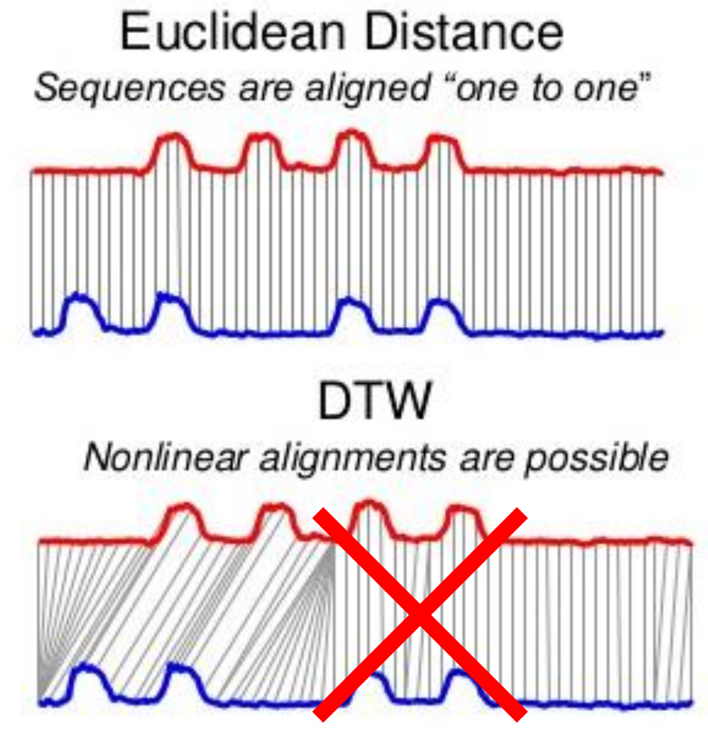
COMPLEX STATIC DISCREPANCY METRIC

- For non-symmetric distributions (these will usually come from the simulation) long tails mean that the distribution is not well described by a mean and deviation so UR is not a good metric.
- We are evaluating other statistical distance metrics including
  - **Bhattacharyya distance (Bhattacharyya 1943)**
  - **Energy Distance (Szekely 2013)**
- Metrics we have decided against are
  - ~~Komolgorov-Smirnov statistics~~
  - ~~f-divergence (Ali 1966)~~
  - ~~Jensen-Shannon divergence (Endres 2003)~~



DYNAMIC DISCREPANCY METRIC

- We need a measure of the “distance” between the two along with similarity of features that can account for a fixed time delay between simulation having to do with properly defining a clock “zero”
  - Dynamic time warping is neither necessary nor desired because a simulation needs to properly capture the temporal physics of the problem (e.g. the temporal variations should in simulation should be the same as reality)
- So, Euclidian distance of a time “aligned” signal can work.
  - Need to select a probabilistic Euclidian distance metric, perhaps energy distance again.



INDEPENDENT MODEL DEVELOPMENT

- Argonne is developing independent models of Flexlab and FRP from facility descriptions in EnergyPlus and possibly other engines.

  (Already did this for the first Flexlab setup but will redo for the updated one)

  – The modelers will NOT see the existing, calibrated models
  – I will act as a go-between on giving information to try to keep the info given to the modelers as generic and modeling engine agnostic as possible.

- We will use both sets of models for doing some sensitivity analysis

- I have got a volunteer from the Cyclone Energy Group (Irena Susorova) who would like to generate IES models for me to use in the comparison

SENSITIVITY ANALYSIS

- Sensitivity analysis to find biggest contributors to uncertainty
- Need help from TAG and 140 committee to select a few model outputs to use for this sensitivity
- Yearly integrated heating and cooling energy?
- Yearly peak heating and cooling load?
- What else?

FOR FY17:

- Redevelop model for modified Flexlab setup, recompute uncertainty and sensitivity given actual setup and experimental configuration
  - We need to do this before we can assess whether or not

- Develop independent model for ORNL FRP setup, develop set of model/measurement uncertainties, perform sensitivity and simulation uncertainty estimation

- Select a complex static measurement and dynamic measurement metric

WE START WITH YES.
AND END WITH THANK YOU.

DO YOU HAVE ANY BIG QUESTIONS?