

Ensemble Kalman Filter for Increased Oil Recovery

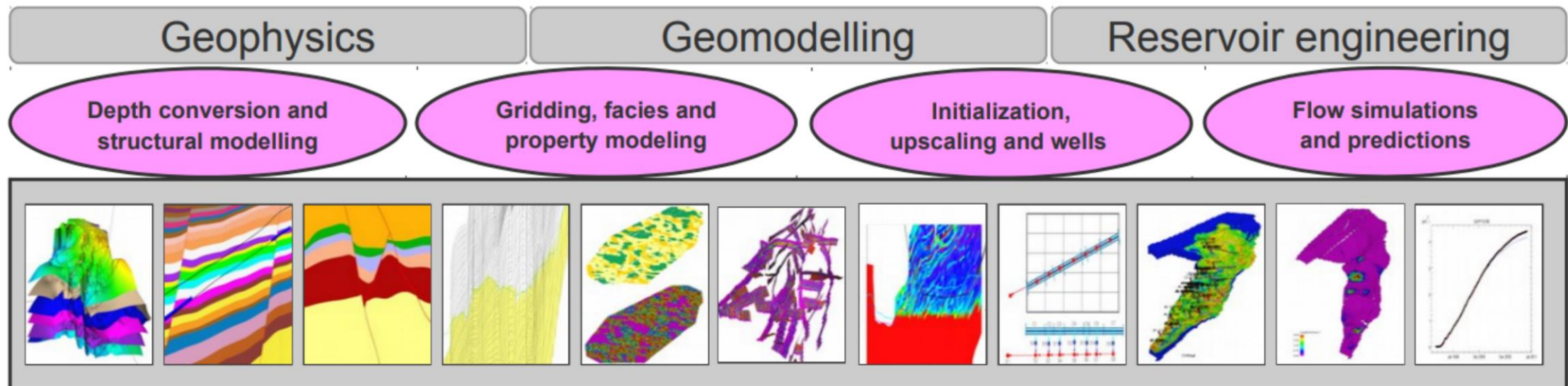
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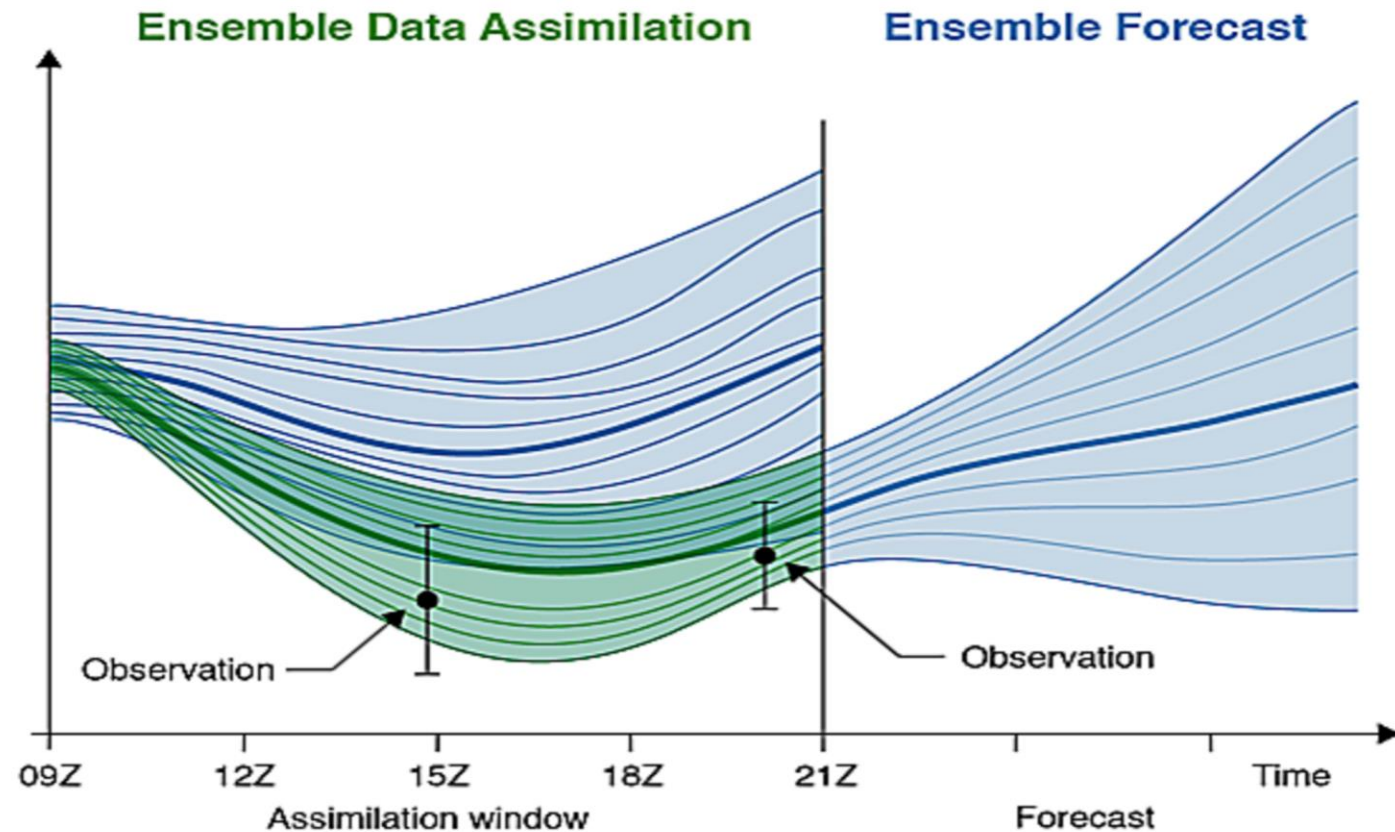
Better reservoir understanding leads to IOR

- We gather our knowledge about the reservoir in the reservoir model.
- We use the reservoir model to assess drainage strategies, well-placements, etc.
- It is very time consuming to build and maintain the reservoir models.

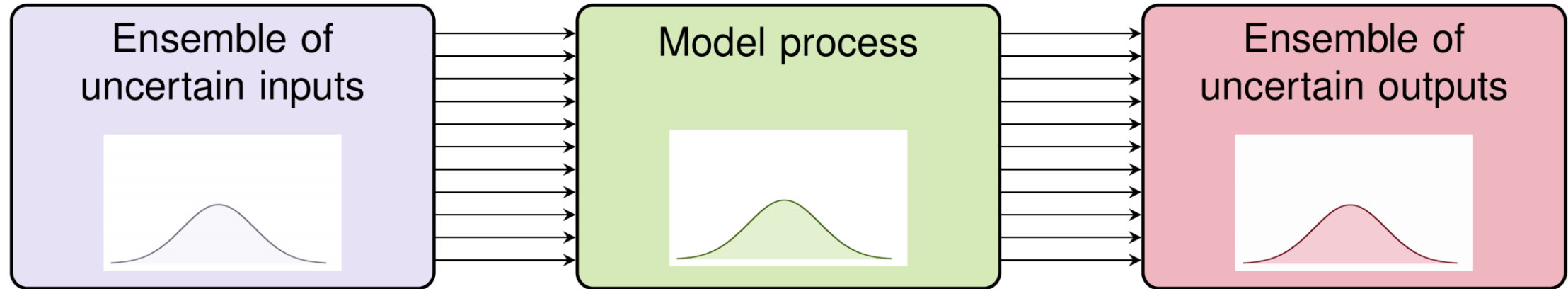


Ensemble Kalman Filters for weather prediction

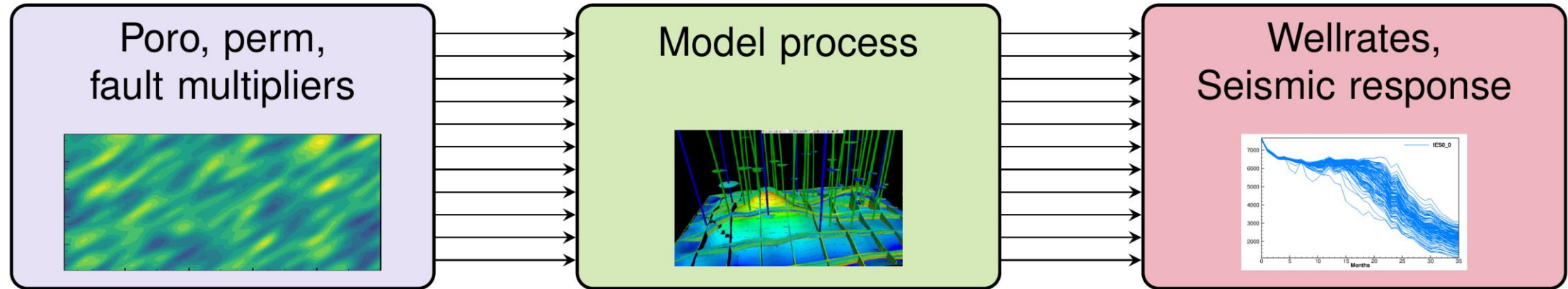
Weather-prediction centers use EnKF for uncertainty characterization and model updating



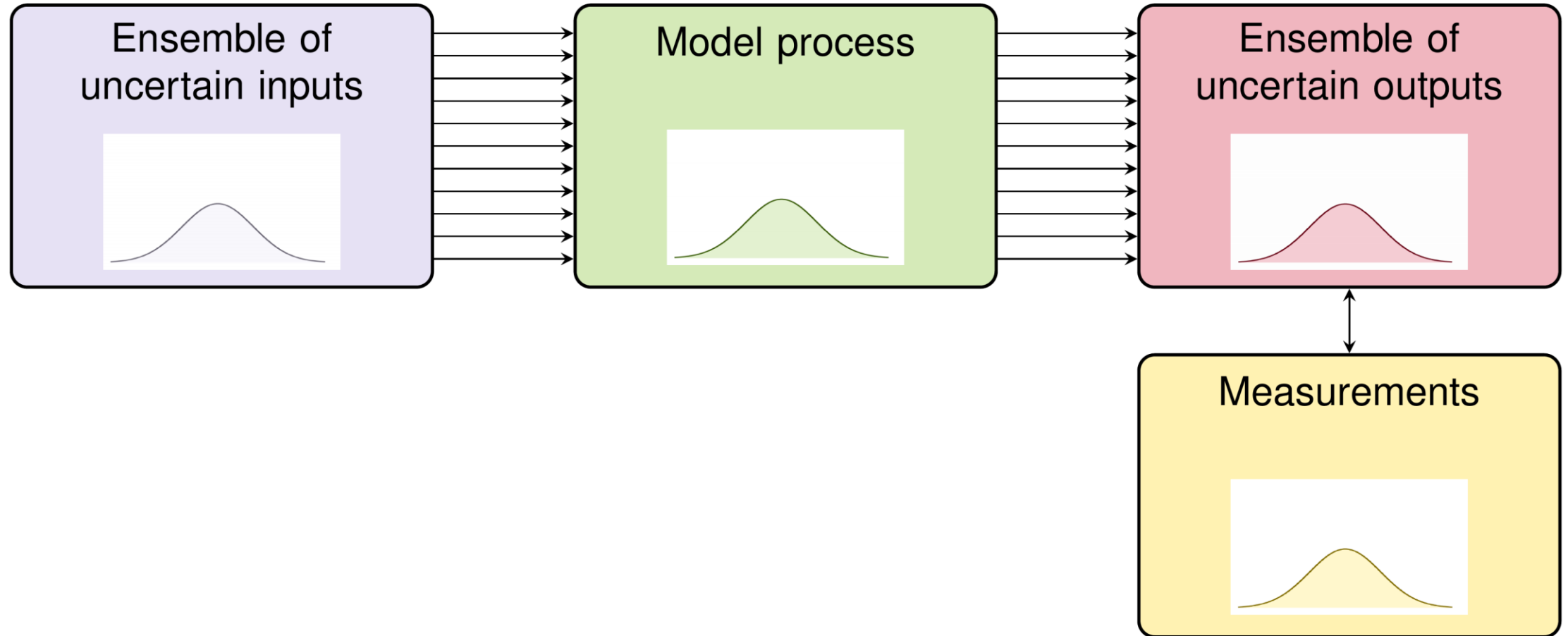
Ensemble-based uncertainty workflow



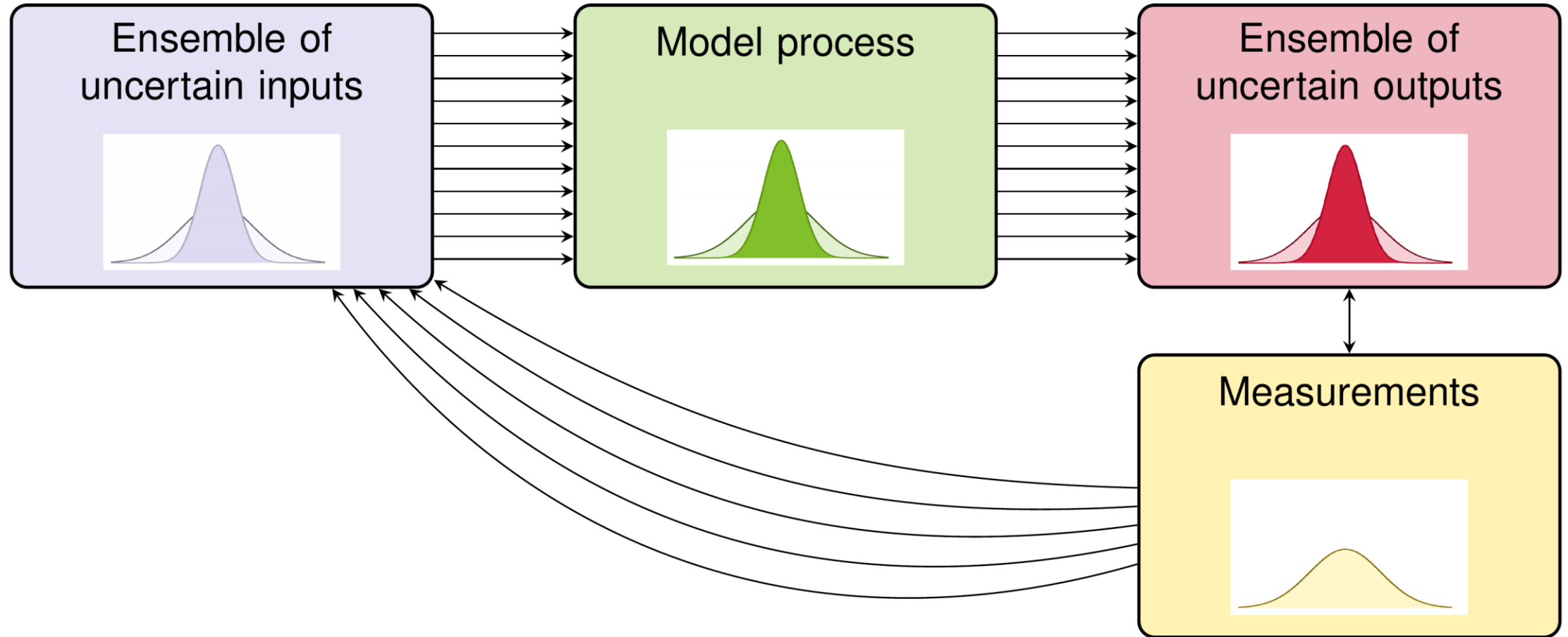
Ensemble-based reservoir-uncertainty workflow



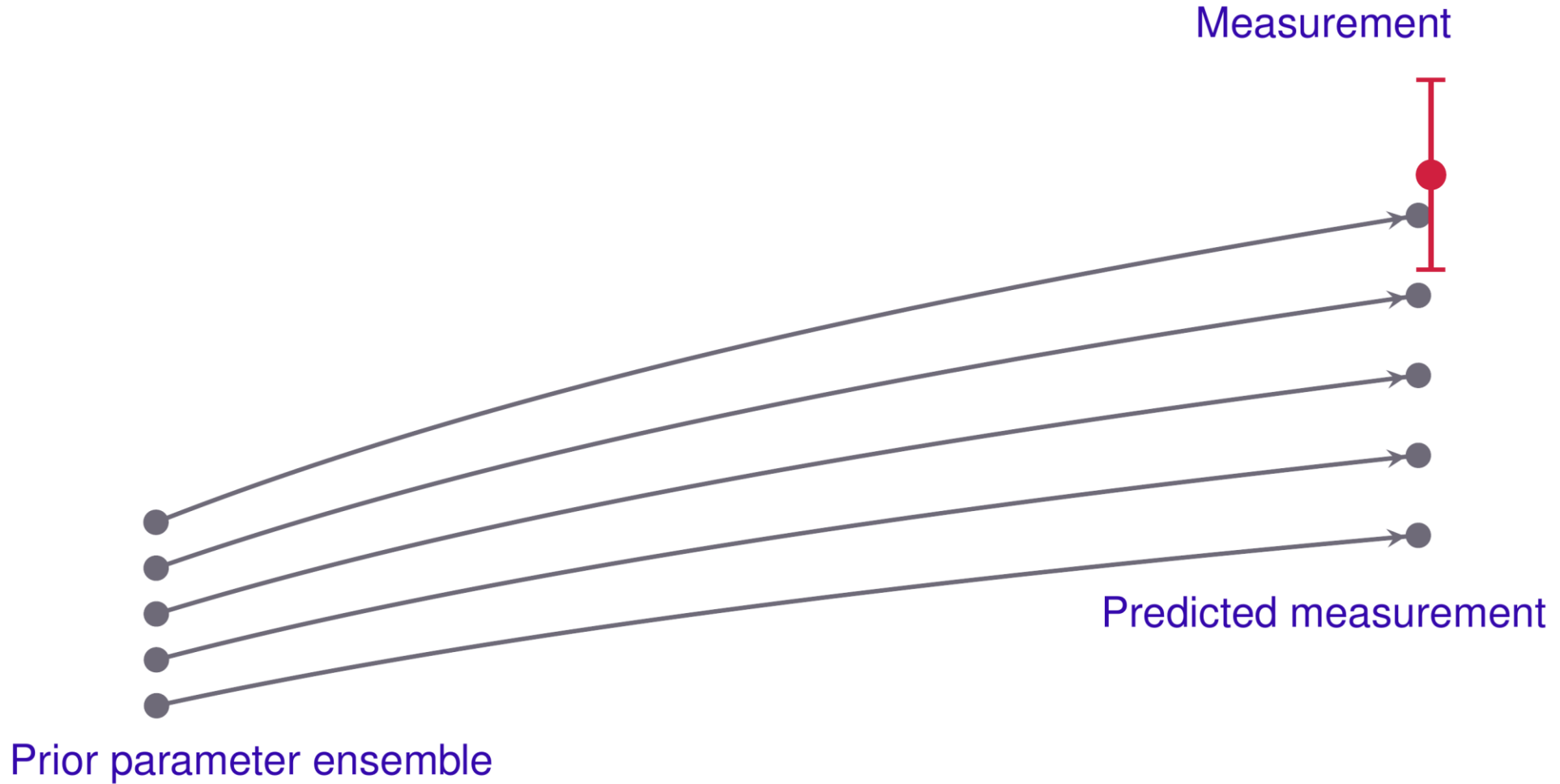
Conditioning on measurements



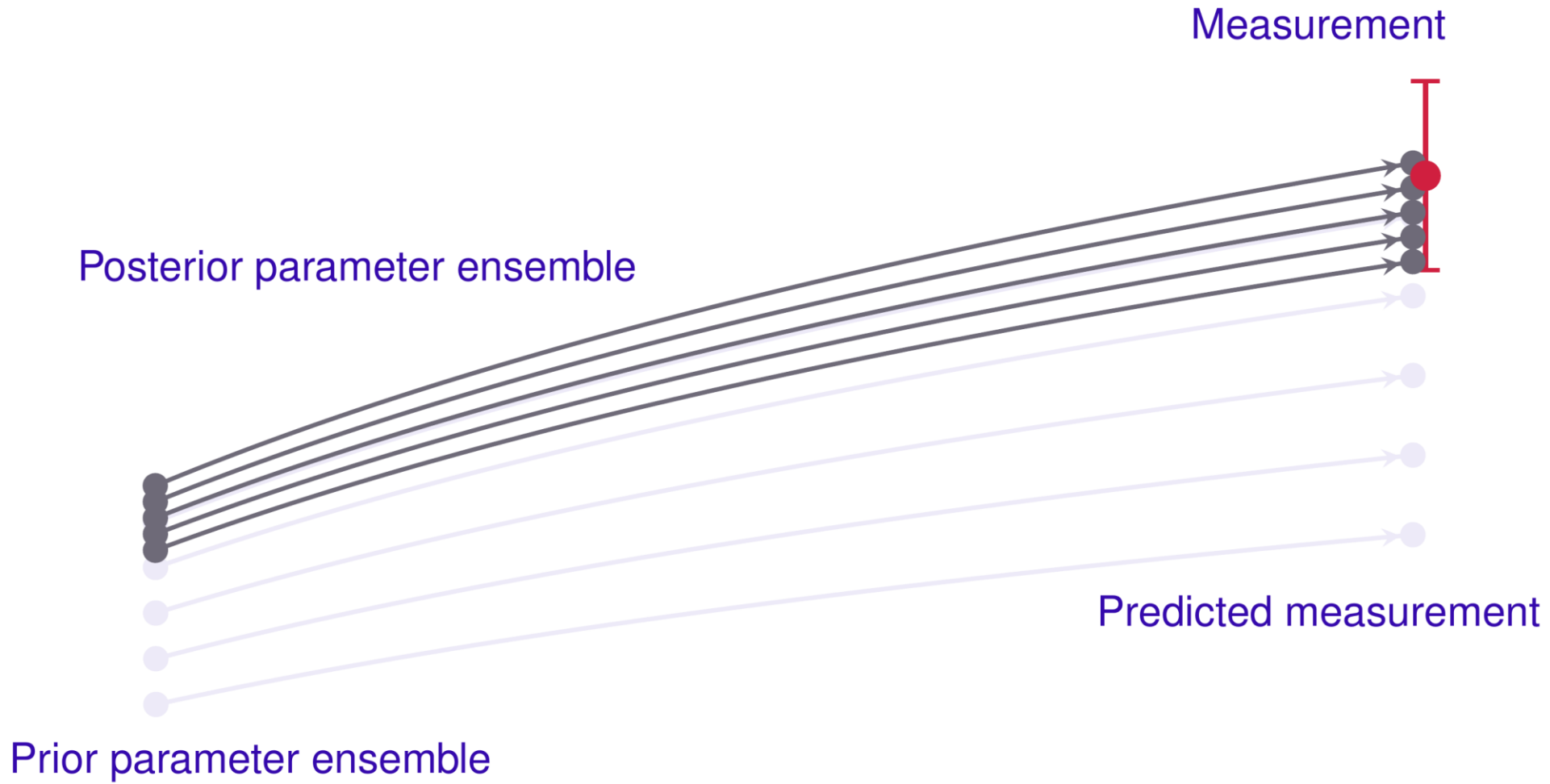
Posterior estimate



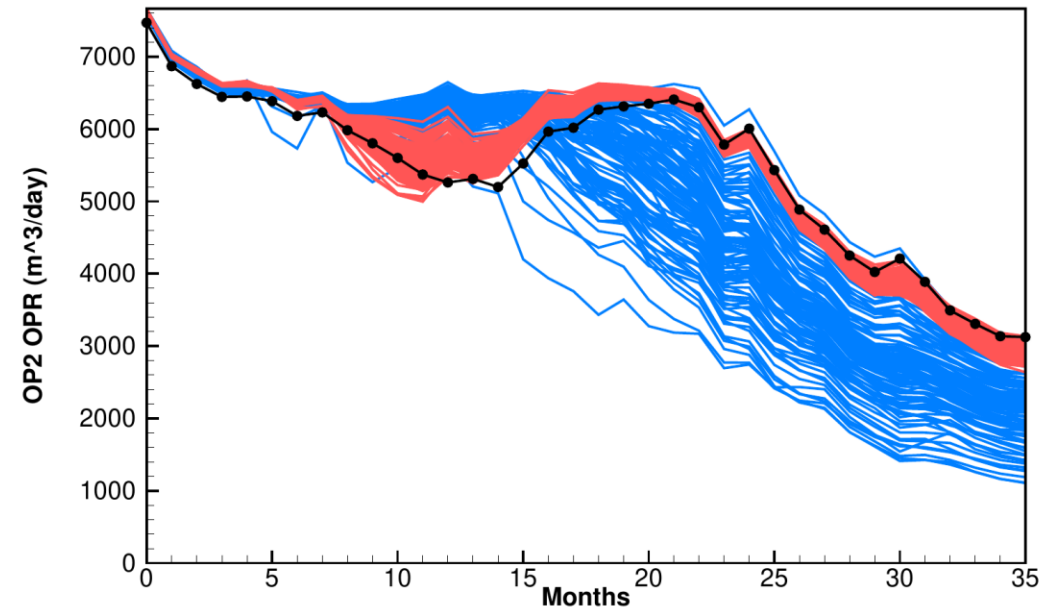
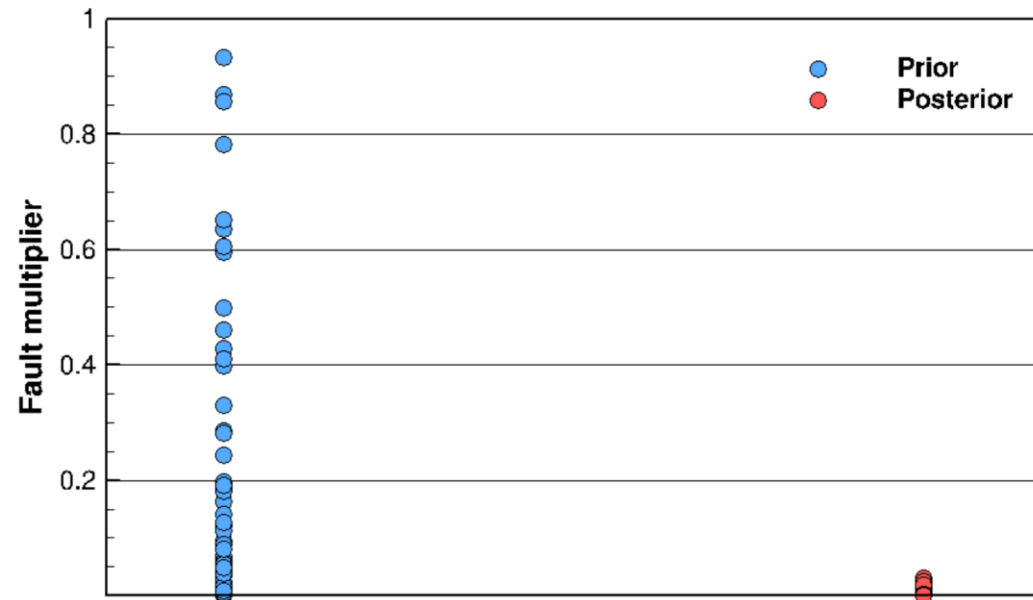
Prior ensemble and measurement



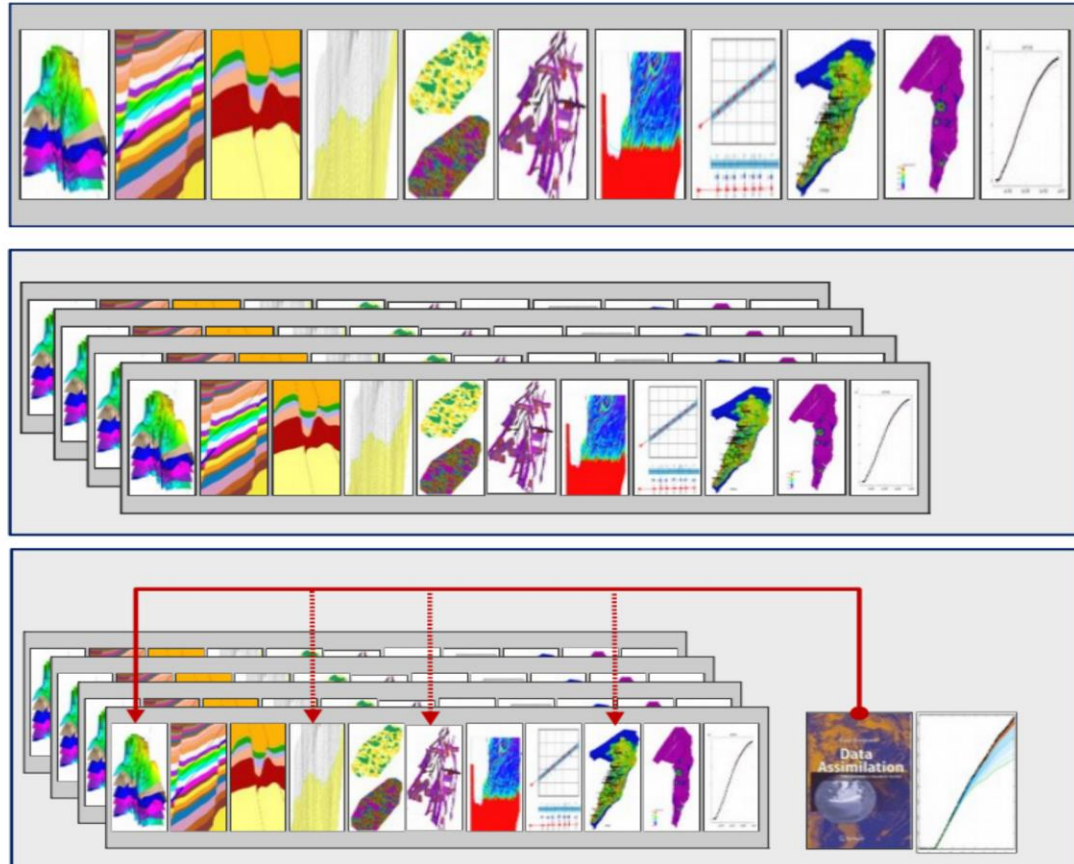
Regression update using ensemble correlations



Fault-multiplier update leads to data match



Fast Model Update (FMU)



Automated model-building process

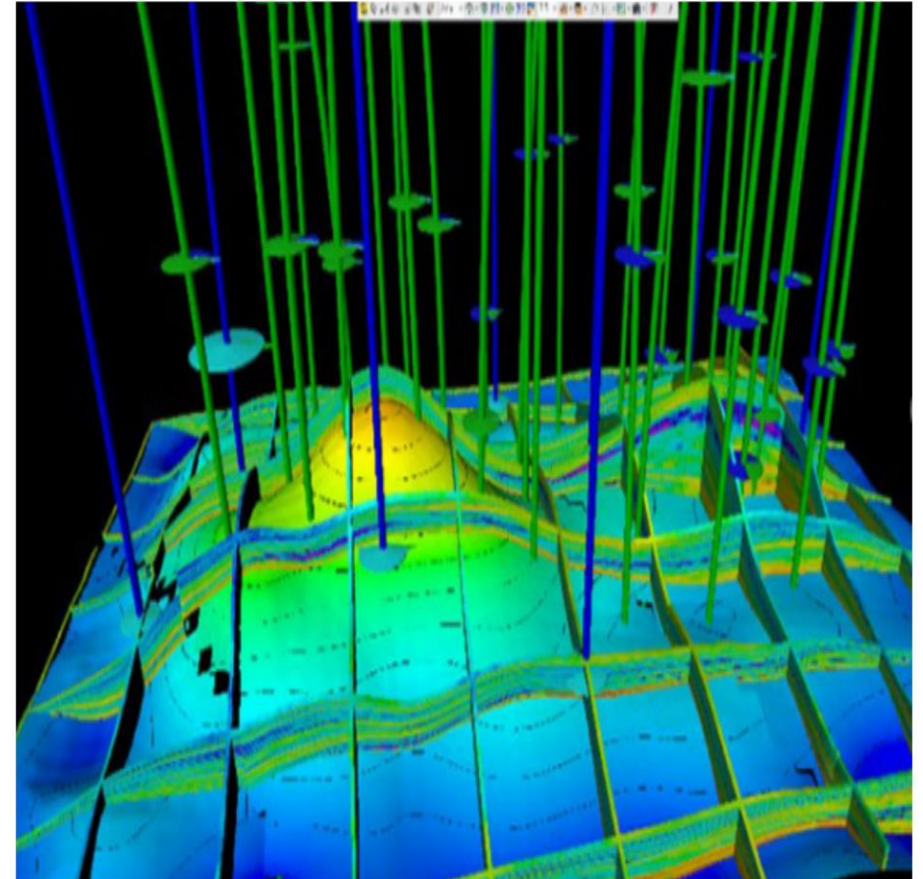
Representation of uncertainties

Flexible model updating

FMU technology broadly implemented in Equinor

- Implemented in 45+ fields.
- Standardized and automated.
- Used for all new projects.
- Reduced time for model updating.
- Improved understanding of uncertainty.
- Full data integration.
- Reduced risk and improved decision basis.

Improved models \Rightarrow Increased oil recovery



EnKF summary:

- Used in several petroleum companies.
- Widely used in very many research areas.
- Thousands of publications.
- Supports robust optimization methods.
- FMU and Ensemble Optimization key on Johan Sverdrup.

Current RCN project DIGIRES:
Ensemble methods for digital reservoirs.

