Simulation-Based Uncertainty Quantification

- **Objective:** Develop statistical methods and analysis software to facilitate uncertainty quantification (UQ) for Level 2 atmospheric remote sensing data products produced by operational retrieval algorithms.
- Monte Carlo simulation of the observing system (Fig. 1) provides a general setting for UQ and investigation of sources of uncertainty on the retrieval error distribution.

Experiments require a realistic forward model (Fig. 2), which need not match a physical model incorporated in the retrieval.

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Statistical Tools

- Framework is based on a probabilistic representation of the input state vector \( \mathbf{X} \).
- Quantile transformation enforces physical constraints for individual state variables.
- Flexible multivariate model uses Gaussian mixture modeling (Fig. 3).
- Experiment is executed for a geophysical template, a specific set of atmospheric and observing conditions defined by region and season (Fig. 4).

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AIRS Implementation

- Simulation framework implemented for Atmospheric Infrared Sounder (AIRS) retrieval of temperature, humidity, and clouds.

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