A global sensitivity methodology to guide risk assessment for CO2 geological storage in deep saline aquifers

Jeremy Rohmer

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Jeremy Rohmer

aBRGM, “Natural Hazards and Safety of CO2 Storage” Division, Orléans, FRANCE

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**European Directive 2009/31/EC on the geological storage of carbon dioxide states:**

- Annex I, Step 3.2: Sensitivity characterisation
- Multiple simulations shall be undertaken to identify the sensitivity of the assessment to uncertainties associated with key parameters. The simulations shall be based on altering parameters in the static geological earth model(s), and changing rate functions and assumptions in the dynamic simulation model. The sensitivity assessment shall be taken into account in the risk assessment.

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**Methods**

**Numerical models for risk assessment:**

- Multiple input parameters
- High non-linearities
- High computer time cost

**Response surface method:**

- g* = "real" computing-intensive model
- g = meta-model or surrogate "simpler" model to mimic g* ("regression model")

**Recursion partitioning:**

- Evaluation of g is faster

**Step 1:** Mapping and training data

- Between the input and output domain
- Limited number of samples
- Work fairly well with modest number of inputs

**Step 2:** Response surface construction

- Goal: keep only the most important parameters in the surrogate model
- Objective: build a 1d recursive partitioning model

**Step 3:** Importance measure

- Coefficient of determination $R^2 = \frac{\sum (y_i - \bar{y})^2}{\sum (y_i - \bar{y})^2}$
- Importance order

**Adapted from Bouc et al., 2009**

**References**

- **Classification and regression trees** (Chapman and Hall, New York), 1984.
- **Large-scale impact of CO2 storage in deep saline aquifers: a sensitivity study on the pressure response in the injection zone** (J. Giot, D., Le Nindre, Y.M., Criaud, A., Fouillac, C., Brach, M., 1994).
- **Determining safety criteria for CO2 geological storage** (ISAG, 2008).
- **Large-scale impact of CO2 storage in deep saline aquifers: a sensitivity study on the pressure response in the injection zone** (J. Giot, D., Le Nindre, Y.M., Criaud, A., Fouillac, C., Brach, M., 1994).

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