SKB Task Force GWFTS: Pragmatic Validation Using Predictive Modeling Exercises

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1. SKB Task Force GWFTS

- The international **SKB Task Force on Modeling of Groundwater Flow and Transport of Solutes (TF GWFTS)** was established **1992** to support and interpret field experiments (www.skb.se/taskforce).
- Further objectives: To develop, test and improve tools for conceptual understanding and simulating groundwater flow and transport of solutes in fractured rocks.
- Work is organized in **collaborative modeling tasks**.

- The participating organizations in TF GWFTS:
  BMWi (Germany), **DOE** (USA), **NUMO** (Japan), **NWMO** (Canada), **KAERI** (Korea), **Posiva** (Finland), **SKB** (Sweden) and **SURAO** (Czech Republic)
- The Modeling Teams are:
  BMWi: **GRS**; DOE: **LANL**; NUMO: **JAEA**; NWMO: **Uni. of Waterloo**; KAERI: **KAERI**; Posiva: **VTT**; SKB: **Amphos21, SU**; SURAO: **PROGEO, TUL**

2. Task 10 – Pragmatic Validation

Task 10 focuses on **pragmatic validation*** of **hydrogeological** and **transport** models with **discrete features**. Of importance for Task 10 are:

- Pragmatic validation consistent with the IAEA definition of "**fit for purpose**" validation considering limited available data.
- Use of **multiple** conceptual and numerical **models** to quantify **uncertainties/sensitivities**.
- **Confidence building** considering model conditioning, calibration and rejection.
- Sensitivity and uncertainty assessment of **key parameters**.
- **Progressive validation** as additional data are collected.
- Robust **model audit** to identify and evaluate assumptions and limitations.
- **Prediction-outcome (P/O)** exercises to evaluate whether a model is an **adequate representation** of the real system.

*) Finsterle S, Lanyon B. Pragmatic Validation of Numerical Models Used for the Assessment of Radioactive Waste Repositories: A Perspective. Energies 2022, 15, 3585. doi: 10.3390/en15103585
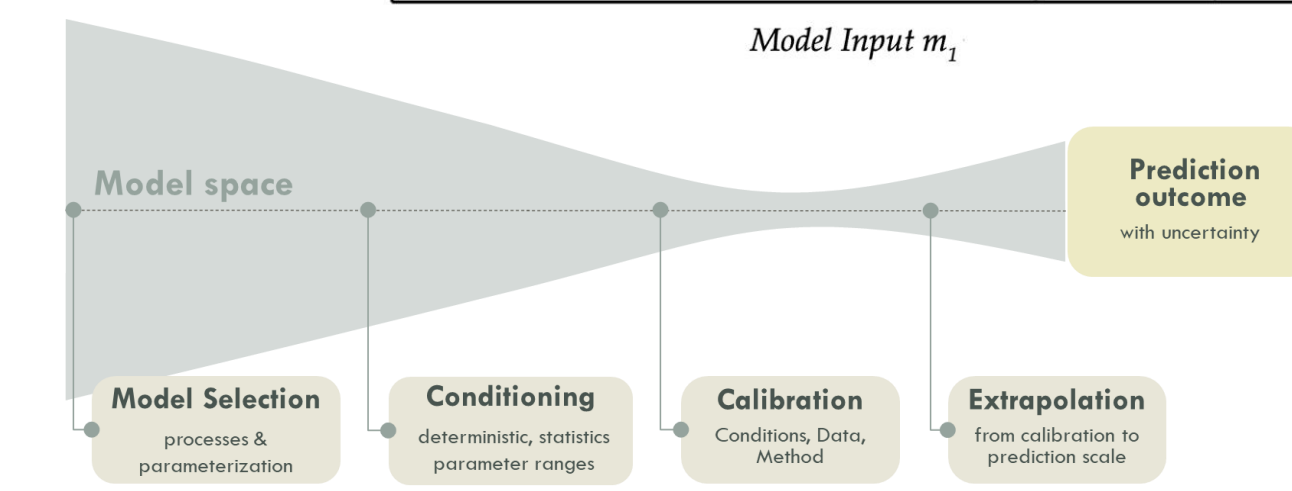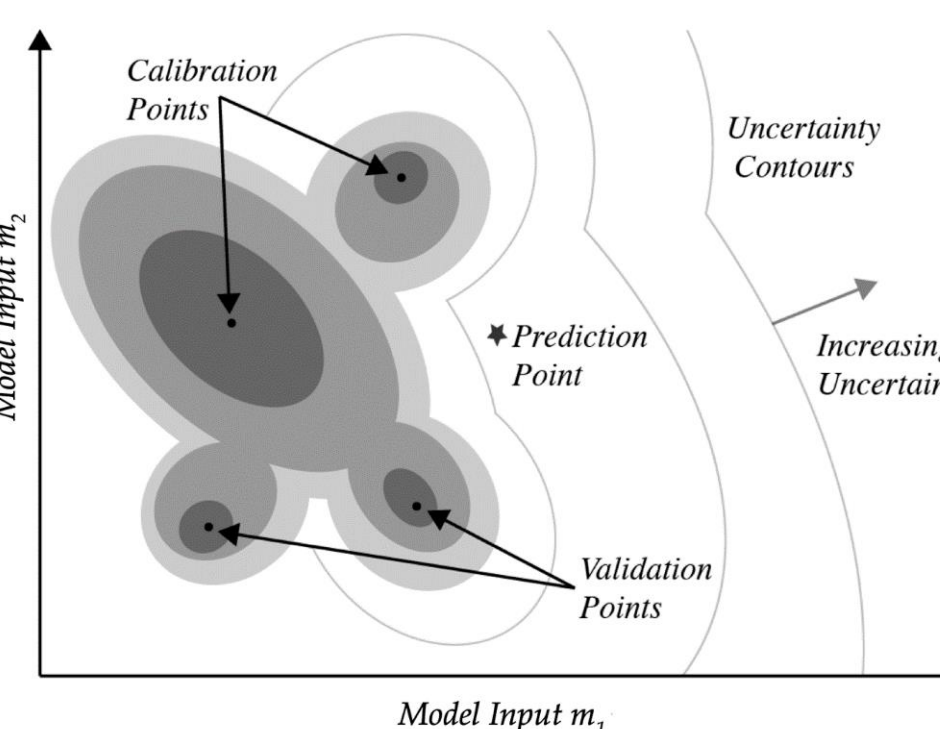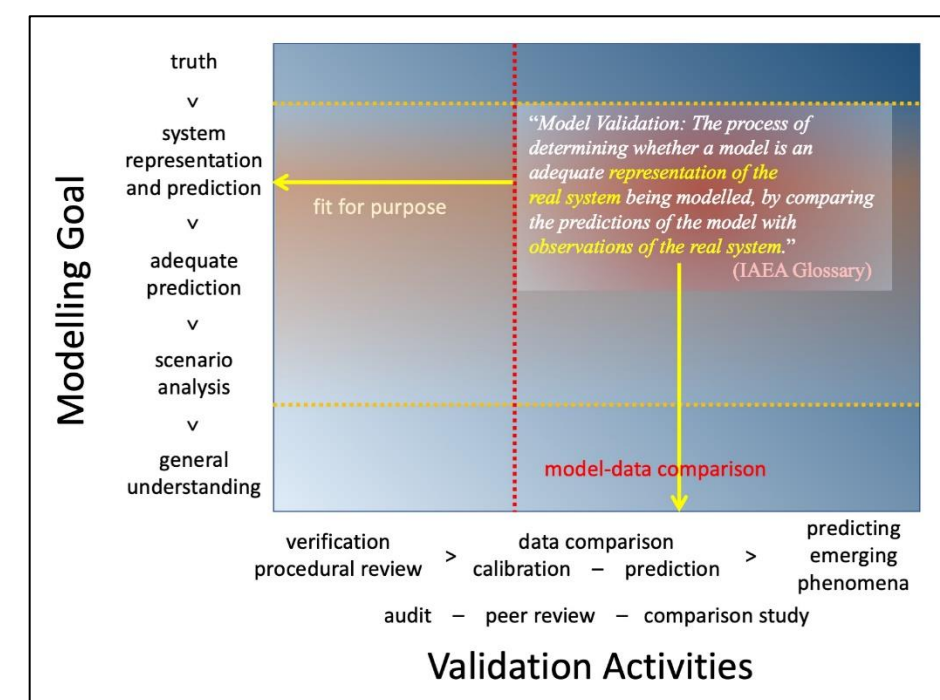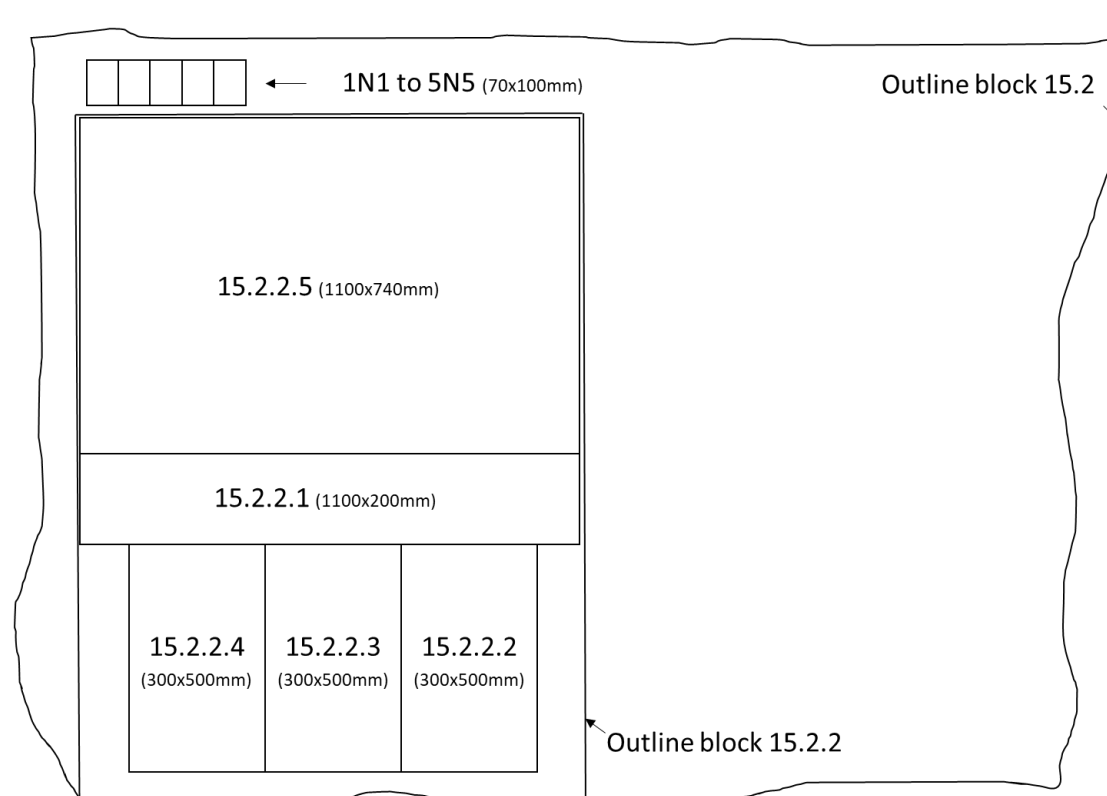
3. Task 10.2.1 – An ongoing P/O exercise

Data from rock blocks from the Flivik quarry in Sweden

The objectives of the Task 10.2 exercises are to:
- Develop **concepts and models** for flow and transport at the single fracture scale.
- Consider importance of **hydro-mechanical coupling** on flow and transport.
- Develop modelling approaches for **prediction** of:
  - **Flow and transport** in single fractures.
  - **Upscaled** fracture properties from **borehole to deposition hole scale**.
- Build starting points for pragmatic validation; Task 10.2.1 is a **prediction-outcome exercise**.

Fracture roughness
- **Predictions** of the **fracture roughness** distributions on the 1 m scale
- Calculate fracture roughness **Performance Measures** (PMs)
- Determine the **uncertainty range**
- **Compare** the results with acceptance criteria, i.e., expected spread of PMs

Fracture aperture
- **Predictions** of the **aperture** distribution
- Calculate fracture aperture **PMs**
- Determine the **uncertainty range**
- **Compare** the results with the expected spread of PMs

4. Task 10.2.2 – Another ongoing P/O exercise

The main objectives of this subtask are:
- **Prediction** and **validation** of the **upscaled** fracture geometry from **borehole sized fracture geometry** and/or **fracture trace geometry**.
- **Prediction** and **validation** of **flow** along a fracture at different normal stresses.
- Support the **development** and **demonstration of pragmatic validation workflow** at the single fracture scale

In brief, the modelers are expected to:
- **Predict aperture distributions** at normal stresses of 0, 1 and 4 MPa and predict the **flow** in two orthogonal directions for these three normal stresses.
- Calculate the **flow rates** at normal stresses of 10, 20, 30 and 40 MPa in the 2-4 direction.
- Explore aspects to be tackled in subsequent subtasks (e.g., transport, or flow and transport on **deposition hole, block and tunnel scales**).
- Address the other items of the **Pragmatic Validation Workflow**.