Report of modifications

This is a report of the revisions in the PhD thesis 'Geological Storage of CO2: Sensitivity and Risk Analysis' to address the first review comments. In this report, we cover the issues and concerns mentioned in the first review comments. In addition to addressing the review comments, a detailed literature review is added to the introduction (Section 1.6.1) and paper I.

The received comments can be divided in four parts. We discuss each part by referring to the section in the dissertation that is revised.

1 The geological setup

Presentational defect on the SAIGUP static models

A detailed discussion on the SAIGUP modelling process is added in Sections 1.5.1 and 1.5.2. In addition, a paragraph is added to the end of Section 1.5 that is referring to examples of the SAIGUP realization data set and simulation models that are available online for download.

The native grid resolution is not stated, nor what degree of upscaling was required

Table 1.1 is added to provide the Grid specifications for fine and coarse scales in the SAIGUP modeling process.

Section 1.5.2 is expanded with a thorough discussion about the upscaling process. Figures 1.5 to 1.11 are added to support the discussion.

The SAIGUP model size is a cause of concern

The text in the beginning of Section 1.8.2 is re-written and the first three paragraphs now discuss the effect of size limitations in the SAIGUP models on the robustness of our study results, and lessons learned for the next generation of the research.

The size limitation is also discussed in the beginning of Section 1.10.2, i.e., 'Generic application of results'.

Only one injection well location or well completion is tested

This issue is discussed in the end of comment section for paper I in Section 2.2. There, we state our modelling choices, the limitations resulting from them, and the possible improvements that can be used in an extended study.

Location of the central leakage point might radically change the outputs

Similarly, a discussion in Section 2.2, comments on paper I, is given to address this issue.

2 The flow modeling

Theoretical basis for flow in porous media is given, but not used

The beginning of Section 1.6 is modified to explicitly mention that the set of discussed flow equations are used in the flow solver employed for the study. It is a convention in the Department of mathematics, University of Bergen, that any relevant equation used in the study should be mentioned in the report.

Hardly an adequate description on the used ECLIPSE model is given

Now, it is explicitly mentioned in Section 1.6 that ECLIPSE Black-Oil is used for the study. Section 1.6.2 is added that describes the ECLIPSE E100 models used in the study and provides the important parts of the ECLIPSE input files. This includes the physical models (PVT tables) used in the simulation.

The section on vertical averaging is irrelevant

This section is removed from the thesis, as it was not directly related to the main research are of the thesis.

3 Issues regarding papers and work conclusions

Papers I and II have low presentation quality

The first two papers are moved to appendix A. One more paper that was prepared during the PhD studies is added.

Generic application of the results

Section 1.10.2 is added to the thesis to cover the following issues:

- Model artifacts and generalization of the results: boundary and size of the model, number and location of the injection points, etc...
- Uncertainty assumptions in the stochastic modelling and the general work-flow of sensitivity analysis and uncertainty/risk assessment.

3.3 Contribution of the Candidate

A subsection added to the summary of each paper in Section 2.2 to clearly mention what the candidate contribution to each part of the work was.

4 Specific comments and issues

Sensitivity of reservoir pressure to the direction of progradation switches polarity at the end of the injection phase

A discussion is added to Paper I that describes the change in sensitivity sign before and after the injection. This discussion makes it clear how the results of sensitivity analysis should be used.

Plume and pressure evolution over time for a representative suite of models

A number of cases have been selected to visualize the heterogeneity impact on the flow behavior. The model cross sections and three dimensional plume evolutions are presented. In addition, pressure development in the system is shown and discussed. Moreover, new figures are added to paper I.

Meisam Ashraf,

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