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Flow Based Coarsening of CO_2 Trapping for Long Term Migration

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Abstract—*Continuing estimation of the behaviour of CO_2 injected in trade quantities into sub surface reservoirs is usually performed by means of models including very partial geological aspect. The current study aims to partly estimate the validity of this assumption by selecting a chain of realistic geological features in addition to examine their impact as soon as modelling CO_2 sequestration. Injected CO_2 is mainly retained in structural along with stratigraphic traps at the top of the reservoir stage. We will consequently investigate how special top surface morphologies will influence the CO_2 storage capability. By this, a sequence of different top surfaces is shaped by combining different stratigraphic scenarios by means of different structural schemes. These models are produced stochastically to enumerate uncertainty. Assessment for actual trapping since a single point supply is planned in a simplified along with efficient approach by a spill point investigation and more accurately by a total flow simulation to facilitate assumes vertical equilibrium. Results from the two approaches are correlated for the fluid flow simulation technique; we examine the effects of grid resolution. The observations demonstrate that the morphology of the top seal is of great significance for the storage capacity and migration pattern and so as to the effects of upscaling is extremely structure dependent.*

Keywords*: Coarsening, Spill point, Morphology, Migration.*

1. INTRODUCTION

Carbon dioxide (CO_2) is a major greenhouse effective gas that contributes to Earth's global warming. Over the past two centuries, its concentration in the atmosphere has greatly increased, mainly because of the combustion of fossil fuels like coal, natural gas and oil for energy and transportation although certain industrial processes and land use changes also emit CO_2. Currently CO_2 can be stored by biologically, mineral trapping, deep ocean disposal and injection into geological formations. Activities such as burning of fossil fuels along with cement making have led to a significant increase in the CO_2 concentration in the atmosphere since the start of the industrial revolution [IPCC 2007]. CO_2 being a strong and long-lived Green House Gas (GHG), its increased concentrations in the atmosphere has led to increase in the global temperature [IPCC 2007]. Carbon Capture, Storage and Sequestration are presently viewed as an important strategy to reduce the concentration of CO_2 in the atmosphere. One way to conflict climate change is to prevent the release of CO_2 to the environment by storing it in natural underground reservoirs. This paper describes the concept and outlines some of the issues involved in estimating the trapping of CO_2 in geological formation [k. Srinivas Anish et al(2016)]. Sedimentary basins onshore geological formations surround an amount of saline reservoirs with huge amount of pore space potentially utilizable for CO_2 storage. The Norwegian Petroleum Directorate has proposed CO_2 Storage Atlas of geological formations [E. K. Halland et al(2012)] that survey large scale CO_2 storage for many number of reservoirs. In overall, twenty seven geological formations gathered into aquifiers whose qualities are assessed with CO_2 storage prospective [D. Lewis, M. Cloete et al(2008,2010)].The major purpose of reservoir simulation is to offer predictions of the migration of hydrocarbon phases along with water that will aid oil and gas industries build better decisions on how to establish and produce their assets. The difficulty of the work flow with the intention in lead to decision is still increasing and brings forward for consideration in reservoir characterization. Production expansion along by means of real time reservoir management is main task for continual demand for faster with additional advanced flow simulation tools .The traditional way is utilized for upgridding to create a new grid model by the way of reduced spatial resolution and upscaling to hold petro physical properties since the high resolution geological reason down to the current grid. A large number of various strategies have been industrialized to reduce the errors introduced in this model cut back process [M. A. Christie, L. J. Durlofsky, C. L. Farmer et al (2003)]. Upgridding as well as upscaling is usually a physical method and choosing the correct method and model resolution can be extremely problem dependent and very time overriding. The problem becomes extra complex changes are developed in the reservoir description to match observed dynamical data. Preferably, all modifications should be finished to the fine scale geological model.

2. EFFECT FOR MODEL DETERMINATION

The exactness of geological models used to present to substantial saline aquifiers will in most cases be faulty. Above all else, there is a general absence of precise information seismic surveys are not as thick with respect to petroleum reservoirs, center information from drilling are rare. In the CO_2 Storage Atlas [E. K. Halland et al(2011)], twenty one geological formations have been independently evaluated and gathered into saline aquifiers that can be considered possibility for CO_2 injecting. Utilizing data from the data sets, we could develop grid models and estimate trapping capacity for fourteen different sand volumes [H. M. Nilsen et al(2015)]. The atlas data sets cover extensive zones and are principally proposed for mapping. The separated grid models are along these lines similarly coarse, with common place parallel resolutions of 500 or 1000 m additionally, mistakes are likewise presented amid the data integration process while building the simulation grids [H.M.Nilsen et al(2015)].

3. METHODOLOGY

MRST-CO_2lab is a set of open source computational tools for designing large scale and long term migration of CO_2 in conductive reservoirs by combining thoughts from basin model, computational geometry, hydrology, and reservoir simulation. In this, we make use of the methods of MRST-CO_2lab to learn long term CO_2 storage on the extent of hundreds of megatonnes. We believe public data sets of aquifers commencing the CO_2 atlas as well as use of geometrical methods for determining structural traps, percolation type process for identifying possible spill paths along with vertical equilibrium models for efficient simulation of residual, structural and solubility trapping in a thousand year perspective. Particularly, we study how data resolution effects the estimation of storage capacity and talk about work flow for identifying fine injection sites and optimizing injection methodologies. We summarize the potential of structural trapping anticipated by the atlas model deviated importantly from two squat resolution models earlier developed for simulation purpose [G. Eigestad et al(2009)]. In this, we examine the effect of model resolution by rendering six grid realizations by means of raw data from the CO_2 Storage Atlas. The initial realization is the complete data set with 500 m sidelong resolution the next is coarsened by a factor two in each lateral way, the third by a feature three and so on. Every grid is quite coarse compared to characteristic simulation grids. All main traps appear inside the field and hence the estimation of trapping is not significantly effected by the computational algorithm determine traps against the perimeter which are assumed to be open.

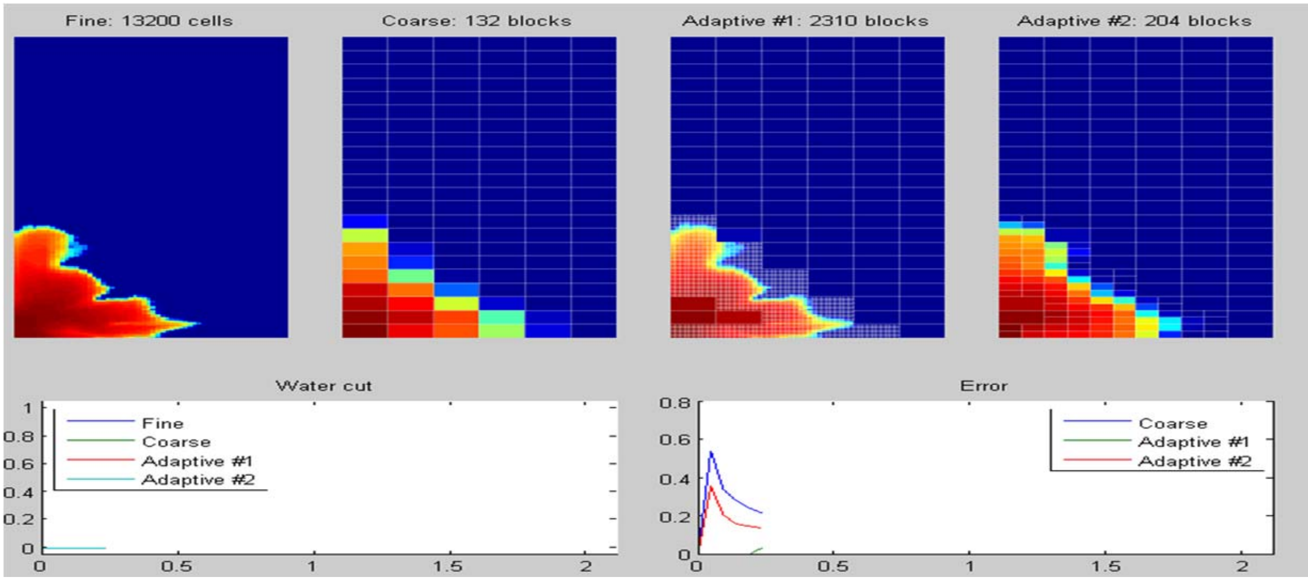
Table 1: Effect of grid resolution on structural trapping for the geological formation development.

Resolution [m]	# traps	Bulk volume [m3]	Avg. volume [m3]
500	722	2.61e+10	3.62e+07
1000	154	2.67e+10	1.73e+08
1500	73	2.75e+10	3.76e+08
2000	41	2.41e+10	5.88e+08
2500	26	2.35e+10	9.04e+08
3000	21	2.23e+10	1.06e+09

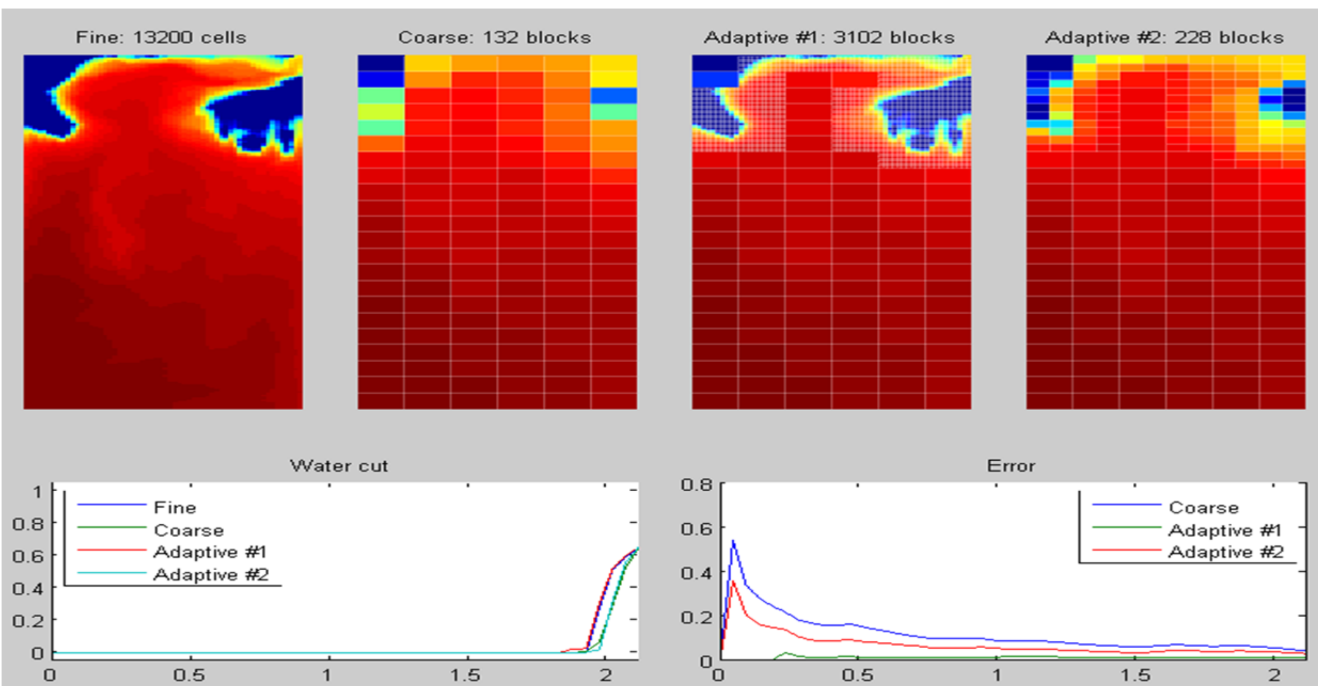
4. RESULTS

For translation by means of strong dislocation fronts, the majority of the projection error, which was briefly discussed in below simulation, is associated with inaccurate representation of the fluid front. Similarly, behind the displacement front the key is smooth with slowly unstable and can be acquired on a coarse grid. In the lack of capillary services on other side second order terms in the transport equation. The dislocation front is a discontinuity that needs high grid resolution to be precisely approximated. Motivated by means of these observations, we will demonstrate the simulation exactness can be significantly enhanced by dynamically accumulating local resolution near strong saturation fronts. Somewhat comparable ideas [Lee et al.(2009)] and[Zhou et al.(2009)] in their adaptive multistage finite volume method. Because all grids measured in this are obtained by coarsening a basic fine grid it is relatively straight forward to add local refinement by manipulating the panel vector by giving a local resolution to facilitate or may be less or equal to that of the fine grid.

4.1. Flow based coarsening for multi scale simulation of transport in porous media



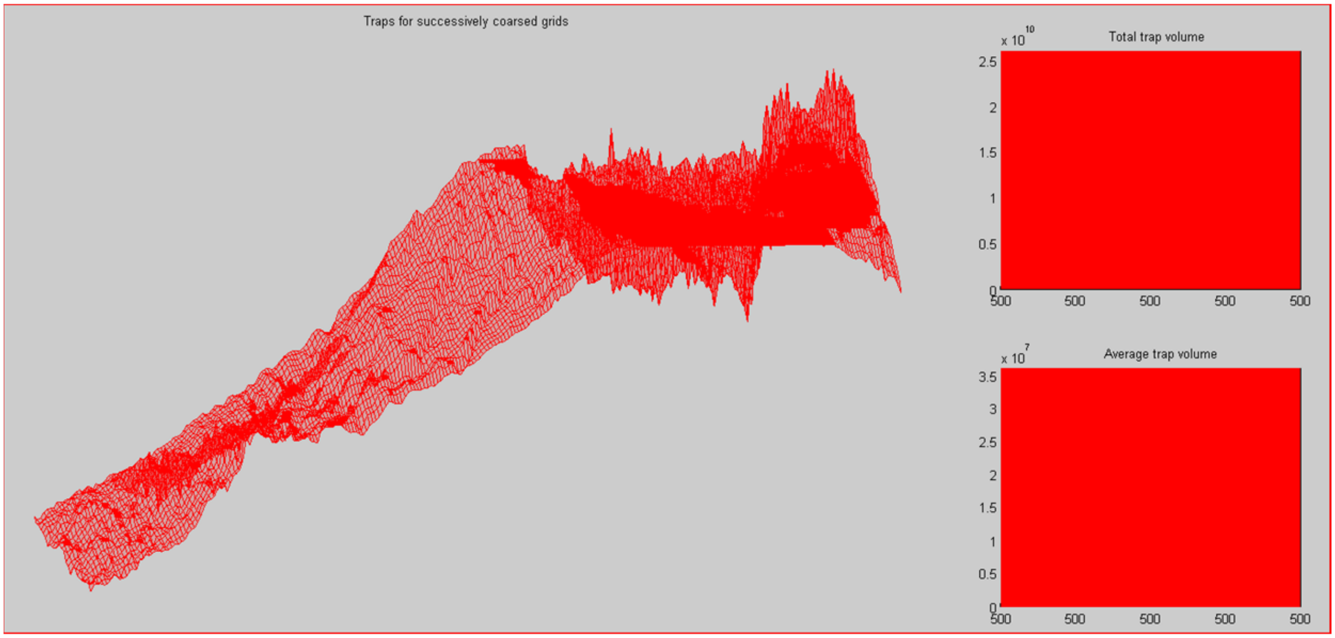
The above figure explains the water cut curve and error time function at the time of injection defined with graph(X-axis: Saturation error on coarse grid and Y-axis: Time).



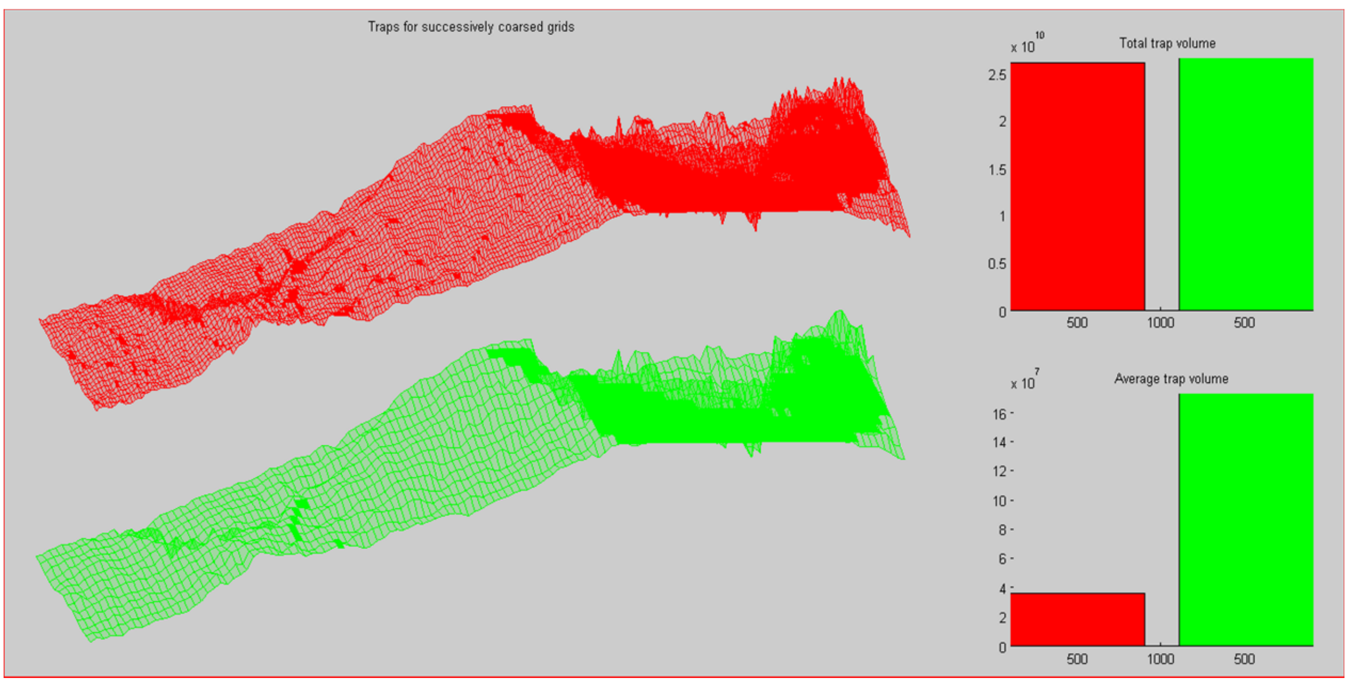
The above figure explains the water cut curve and error time function at the time of Migration defined with graph (X-axis: Saturation error on coarse grid and Y-axis: Time).

4.2. Effect of coarsening

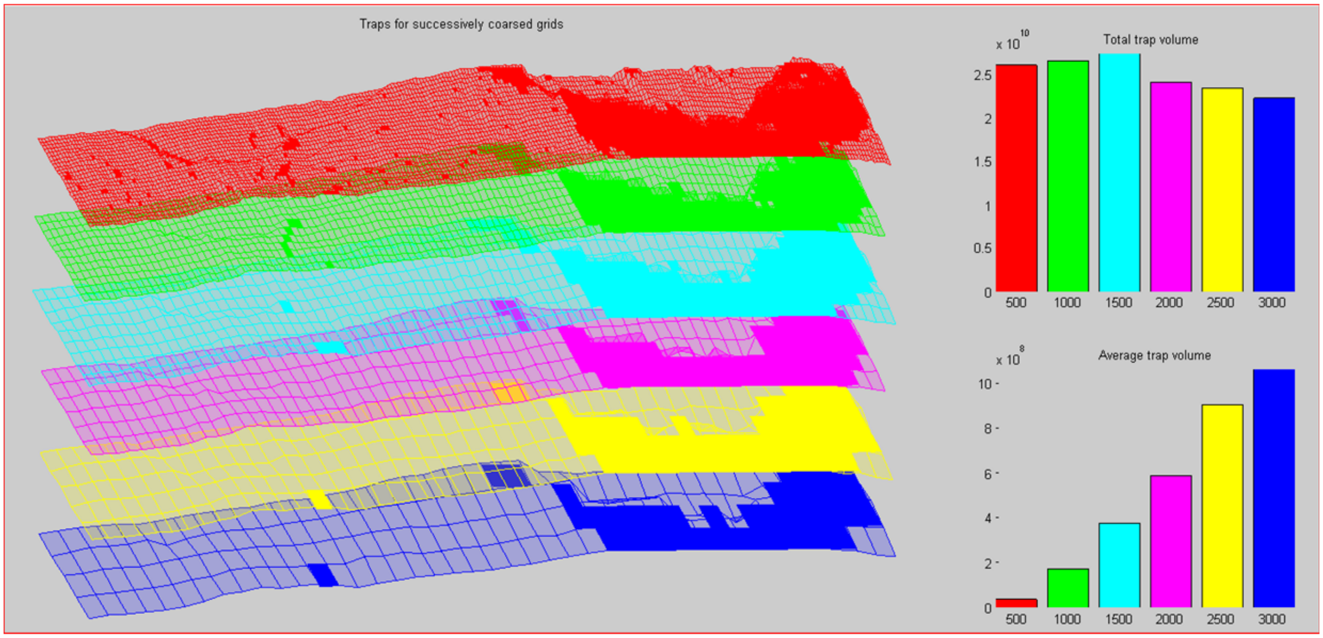
The common effect of coarsening is well considered for reservoir simulation, but the difficulty of CO_2 injection is special in that it has a light CO_2 phase trapped on top of a hydrocarbon phase.



The above figure explains the model of the aquifer commencing the CO2 Storage Atlas casing an area of 64.9 × 158.7 km2. The left plot represents the intensity map in meter for the model by means of full lateral resolution of 500 m. The plan to the right shows the top surface for the 50 × 50 km2 sub region noticeable in gray in the left plot for resolutions; Cells inside traps are obvious in solid color.



Models of reservoir from the CO2 Storage Atlas wrapping an area of 64.9 ×158.7 km2. The left plot shows the depth map in meter for the model with full lateral resolution of 1000 m. The plot to the right show the top surface for the 50 × 50 km2 sub region marked in gray in the left plot for two lateral resolutions.



The above figure shows the result of simulation of an aquifer from the CO2 Storage Atlas covering an region of 64.9 × 158.7 km2. The left plot exhibits the depth map in meter for the model among full lateral resolution of 3000 m. The plot to the right shows the top surface for the 50 × 50 km2 sub region noticeable in gray in the left plot for six different lateral resolutions and Cells that are inside traps are marked in solid color(X-axis: Average trap volume and Y-axis: Number of grids).

5. CONCLUSION

In this paper, we have shown that flow based coarsening is a adaptable method to establish efficient transport solvers with the aim of combination with multi scale flow solvers. In detail, we have initiated with a way proposed by [Aarnes et al(2007)] and exposed how the parts computed by this process can be enhanced by combining a preferred information regarding block geology. Trapping of CO_2 is well influenced by top surface morphology which contributes to structural trapping and adjournment of the plume migration. Thus, the information of the top surface morphology has a strong influence on the data of the trapped fluid. Though, the stretch of the plume is only reserved if the height of the plume is of the similar scale as the amplitude of the aid. A prudent relief may consequently retard the migration for low injection rates, but have small effect for high injection rates that create a thick plume intended for the specific parameters measured in this, structural and residual trapping are equally significant. In a upcoming paper [V. L. Hauge et al(2010)], we represent a wide ranging algorithmic framework for grid coarsening that include additional flow indicators based on petro physical parameters, vorticity, and time of flight and neighbourhood solutions that can be utilized to steer the amalgamation of cells into coarse blocks.

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