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Comparison between a vertical equilibrium model and a three-dimensional multiphase flow model for CO_2 sequestration in geologic formations

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The vertical equilibrium (VE) approach, assuming pore fluid pressure equilibrium in a vertical direction, becomes more popular within the CO_2 geosequestration research community due to its computational efficiency compared to three-dimensional multiphase flow models. However, the accuracy of this simplified pseudo 3-D numerical method has not fully verified for basin-scale geologic CO_2 storage applications. To address this problem, we have compared CO_2 plume migration in a homogeneous aquifer for benchmarking, calculated by both VE approach and 3-D model implemented by TOUGH2/ECO2N code. Then further comparison on injected fluid pressure and CO_2 transport was performed using a more complicated numerical grid having a realistic reservoir topology. Preliminary results show that the VE model is generally in good agreement with the 3-D model in terms of overpressure ratio, whose values are similar and reach $\sim$60% at the injection well installed in the reservoir with permeability of 4.0 x 10^{-14}m^2 and porosity of 15%. The migration distance of CO_2 plume estimated by both models also matched closely, showing $\sim$10 km dispersion along with flow path after 0.5 MtCO_2/year injection for 50 years. The results also suggest that the VE approach can be an efficient alternative method for CO_2 storage modeling, especially when reservoir formations have relatively small vertical heterogeneity.