A particle method strategy to estimate subsidence induced by a high-dimensional disc-strain model for reservoir compaction.

Samantha Kim[1], Femke Vossepoel[1], Ramon F. Hanssen[2], Marius Wouters[3], Rob Govers[3], and Esther Stouthamer[3]

[1]Department of Geoscience and Engineering, Delft University of Technology, Delft, The Netherlands
[2]Department of Geoscience and Remote Sensing, Delft University of Technology, Delft, The Netherlands
[3]Department of Geosciences, Utrecht University, Utrecht, The Netherlands

January 13, 2020

Abstract

This work is part of the "Subsidence" DeepNL project which aims to identify subsurface drivers of subsidence above the Groningen (the Netherlands) gas field and to forecast future subsidence. The hydrocarbon extraction in Groningen induces a pressure reduction in the gas reservoir which triggers compaction and land subsidence. This deep-subsurface process is modeled by a disc-shaped reservoir model, which is a superposition of individual nuclei of strain based on the Geertsma's approach. We estimate the surface deformation and the strength of the disc strain using a particle method.
We apply the method to one single nucleus of strain at 3 km depth and extend to a disc-shape geometry. Synthetic experiments with a single nucleus of strain and with discs of varying sizes, 2.2 km to 13.3 km diameter, at 3 km depth are performed to assess the performance of the method for an increasing degree of complexity. Sequential Importance Resampling prevents the sample degeneracy when the number of nuclei increases. Adding a jitter noise in the resampling step avoids an impoverishment of the ensemble values. The results indicate that the method estimates the surface deformation and the strength for a large number of sources and for a relatively small effective ensemble size. In further investigations, localization can provide an additional means to deal with increasing dimensions and a relatively small ensemble size.