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Conformity assessment for seismic monitoring and reservoir simulation at the Ketzin pilot site – how much conformity can be reached?

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The EU CCS Directive defines three high-level criteria which have to be fulfilled by a site operator in the post closure phase of a storage site before liability can be transferred to the public after site closure. One of these high-level requirements is "Demonstrating conformity between observed and simulated plume behaviour". The observed plume behaviour is derived from geophysical and/or geochemical monitoring. Repeated 3D seismic observations have proven to provide the most comprehensive image of a CO_2 plume in various projects such as Sleipner, Weyburn, or Ketzin. The simulated plume behaviour is derived from reservoir simulation using a model calibrated with monitoring results. Plume observations using any monitoring method are always affected by limited resolution and detection ability, and reservoir simulations will only be able to provide an approximated representation of the occurring reservoir processes. Therefore, full conformity between observed and simulated plume behaviour is difficult to achieve, if it is at all. It is therefore of crucial importance for each storage site to understand to what degree conformity can be achieved under realistic conditions, comprising noise affected monitoring data and reservoir models based on geological uncertainties. We applied performance criteria (plume footprint area, lateral migration distance, plume volume, and similarity index) for a comparison between monitoring results (4D seismic measurements) and reservoir simulations, considering a range of seismic amplitude values as noise threshold and a range of minimum thickness of the simulated CO_2 plume. Relating the performance criteria to the noise and thickness threshold values allows assessing the quality of conformance between simulated and observed behaviour of a CO_2 plume. The Ketzin site is provided with a comprehensive monitoring data set and a history-matched reservoir model. Considering the relatively high noise level, which is inherent for land geophysical monitoring data, a reasonable conformance between the observed and simulated plume behaviour is demonstrated. However, it is also shown that maximum conformance which can be achieved between monitoring data and simulations is affected by limited resolution related to the small quantities of stored carbon dioxide. Applying the same approach to a larger scale storage complex is a viable method for demonstrating conformance within acceptable borders.