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Applications of a 3D basin and basement temperature modelling tool

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A new flexible modelling suite has been developed to estimate subsurface temperatures from site- to regional-scale, up to the depth of the lithosphere-asthenosphere boundary (LAB). A typical structure for regional models has four layers, consisting of sediments, upper crust, lower crust and lithospheric mantle. Temperature-dependent thermal properties, including radiogenic heat production and temperature- and pressure-dependent bulk thermal conductivity, can be assigned on the base of broad-scale lithological variation or made into a more refined model based on observations from wells. The temperature-dependent thermal properties are corrected with a 1-D steady-state temperature approximation, assuming only vertical heat flow. Using these corrected thermal properties, the 3-D thermal field is calculated with a conjugate-gradient method, assuming fixed temperatures or heat flow at the surface and at the base of the model. It is straightforward to add or remove layers and to adjust initial properties and boundary conditions in order to tailor the model to the data available and the user's needs. Further improvements of the thermal model, aiming at consistency between temperatures and heat flow observations and tectonic model predictions, are obtained by applying data assimilation. An ensemble smoother with multiple data assimilation approach (ES-MDA) is used to fit the temperature or heat flow data and improve prior estimates of thermal properties and the thermal field. The generated probability density functions (PDF's) for properties and temperatures allow for further uncertainty assessments, vital for de-risking prospects on site-scale models, and a great tool to improve volumetric resource estimates based on regional-scale thermal models.