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Abstract. The description of intra-granular fission gas behaviour is a fundamental part of any model for the prediction of fission gas release and swelling in nuclear fuel. In this work we present a model describing the evolution of intra-granular fission gas bubbles in terms of bubble number density and average size, coupled to gas release to grain boundaries. The model considers the fundamental processes of single gas atom diffusion, gas bubble nucleation, re-solution and gas atom trapping at bubbles. The model is derived from a detailed cluster dynamics formulation, yet it consists of only three differential equations in its final form; hence, it can be efficiently applied in engineering fuel performance codes while retaining a physical basis. We discuss improvements relative to previous single-size models for intra-granular bubble evolution. We validate the model against experimental data, both in terms of bubble number density and average bubble radius. Lastly, we perform an uncertainty and sensitivity analysis by propagating the uncertainties in the parameters to model results.

Keywords. Fission gas behaviour, intra-granular behaviour, oxide fuel, gaseous swelling, fuel performance codes.