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Necessary conditions for algorithmic tuning of weather prediction models using OpenIFS as an example

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Algorithmic model tuning is a promising approach to yield the best possible performance of multiscale multi-phase atmospheric models once the model structure is fixed. We are curious about to what degree one can trust the algorithmic tuning process. We approach the problem by studying the convergence of this process in a semi-realistic case. Let us denote $\mathbf{M}(\mathbf{x_0};\boldsymbol{\theta}_\mathbf{d})$ as the default model, where $\mathbf{x_0}$ and $\boldsymbol{\theta}_\mathbf{d}$ are the initial state and default model parameter vectors, respectively. A necessary condition for an algorithmic tuning process to converge in a fully-realistic case is that the default model is recovered if the tuning process is initialised with perturbed model parameters $\boldsymbol{\theta}$ and the default model forecasts are used as pseudo-observations. In this paper we study the circumstances where this condition is valid by carrying out a large set of convergence tests using two different tuning methods and the OpenIFS model. These tests are interpreted as guidelines for algorithmic model tuning applications.

The results of this study can be used as recipe for maximising efficiency of algorithmic tuning. In the convergence tests, maximised efficiency was reached with using ensemble initial conditions, cost function that covers entire model domain, short forecast length and medium-sized ensembles.