



## **On the use of the saddle formulation in weakly-constrained 4D-Var**

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We discuss the practical use of the saddle variational formulation for the weakly-constrained 4D-VAR method in data assimilation. It is shown that the method, in its original form, may produce erratic results or diverge because of the inherent lack of monotonicity of the produced objective function values. Convergent, variationally coherent variants of the algorithm are then proposed whose practical performance is compared to that of other formulations (original saddle, state and forcing). This comparison is conducted on toy models by the mean of twin experiments. Because these variants essentially retain the parallelization advantages of the original proposal, they often - but not always - perform best, even for moderate numbers of computing processes.