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## Inferring the instability of a dynamical system from the skill of data assimilation exercises

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Data assimilation (DA) aims at optimally merging observational data and model outputs to create a coherent statistical and dynamical picture of the system under investigation. Indeed, DA aims at minimizing the effect of observational and model error and at distilling the correct ingredients of its dynamics. DA is of critical importance for the analysis of systems featuring sensitive dependence on the initial conditions, as chaos wins over any finitely accurate knowledge of the state of the system, even in absence of model error. Clearly, the skill of DA is guided by the properties of dynamical system under investigation, as merging optimally observational data and model outputs is harder when strong instabilities are present. In this paper we reverse the usual angle on the problem and show that it is indeed possible to use the skill of DA to infer some basic properties of the tangent space of the system, which may be hard to compute in very high-dimensional systems. Here, we focus our attention on the first Lyapunov exponent and the Kolmogorov–Sinai entropy and perform numerical experiments on the Vissio–Lucarini 2020 model, a recently proposed generalization of the Lorenz 1996 model that is able to describe in a simple yet meaningful way the interplay between dynamical and thermodynamical variables.