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Variational data assimilation in continuous time - questions and insights

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We revisit a class of variational data assimilation approaches which could be considered as variants of weakly constrained 4DVAR. These algorithms find trajectories by minimising some sort of error or misfit, integrated over space and time. In the atmospheric physics community, variational data assimilation is almost always formulated in discrete time. In this talk, I will demonstrate that a formulation in continuous time gives interesting additional insights and might have a number of advantages, despite the fact that some additional mathematical machinery is required (especially if the dynamics or observations contain stochastic components). After discussing the general formulation, we will focus on selected aspects of the continuous time setting. We will consider how the terminal point of the trajectory updates as new observations come in; we will see that thus every variational approach gives rise to a filtering algorithm with *linear* error feedback (in discrete time, this is only approximately true). Further, we will look at how the continuous time problem would be approached numerically, and why it might allow for longer assimilation windows than in discrete time. Finally, we discuss issues concerning the interpretation of the WC-4DVAR error functional in continuous time, and how these bear on the discrete time setting.