Though modern four-dimensional data assimilation schemes, such as the Kalman Filter, are both powerful and bec oming increasingly necessary, it is well known that they are all based, to some extent, on assumptions of linear dyn amics. Much research has thus focused on the feasibility of these assumptions, and ways to rectify them (e.g. by u sing ensemble statistics, instead of the linearized model dynamics, to derive covariances). The problem is further c omplicated, however, by dynamical balances, such as quasi- or semigeostrophic theory, which are themselves only approximations of the true dynamics. Traditionally, balances have been externally enforced after data insertion by reinitializing the analyzed fields. 4D schemes should not require this extra step, since they seek a dynamically co nsistent optimal estimate.

We investigate the representation of balance within different approximations to the nonlinear Kalman Filter, using very simple models of balanced dynamics. Basic experiments with different balance and assimilation parameters il lustrate the issues inherent in the problem of data assimilation for motion with multiple timescales, and some possi ble balance modifications to the assimilation scheme are discussed.