Turbulence closures and data assimilation methodologies have a range of similar technical difficulties that must be overcome, of which the most prominent is inhomogeneity or large scale flow dependence but also includes how to represent higher order non-Gaussian terms. The calculation of the error covariance of fields described by an evolving nonlinear system requires the solution of an infinite hierarchy of moment equations; this problem is formally identical to the closure problem that arises in statistical approaches to turbulence. Typically both variational and Kalman filter methods are unable to accurately account for cumulants of third order and higher, although these cumulants are often required to ensure that regime transitions in nonlinear models are accurately tracked. We describe the development of an accurate yet computationally tractable statistical dynamical Kalman filter theory for strongly nonlinear geophysical flows[1]. Prognostic equations based on renormalized perturbation theory are developed for evolving mean fields, covariances and higher order non-Gaussian terms. Comparisons are made with ensemble averaged direct numerical simulations during large scale atmospheric mid-latitude blocking transitions[2].