A New Observation Error Probability Model for Nonlinear Variational Quality Control and Applications within the NCEP Gridpoint Statistical Interpolation.

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Nonlinear variational quality control provides a methodology for treating observations within a variational data assimilation in a way that accounts for the fact that, in practice, their effective errors are distributed according to probability densities whose tails are significantly heavier than those of a Gaussian. In this way the rare but potentially damaging gross errors infecting typical atmospheric measurements can be recognized and down-weighted automatically within the iterative variational assimilation algorithm without recourse to a separate procedure. Unfortunately, an undesirable consequence of some of the simplest popular models of non-Gaussian error is an implied cost function characterized by multiple-minima. This means that it is easy for the assimilation to become effectively "locked" into false solutions close to the initial background state of the iterations that either accepts observations that should actually be severely down-weighted, or fails to attribute sufficient weight to valid observations at variance from a badly misleading background to permit these good data from adequately correcting the bad background. A new probability model for representing realistic measurement errors, which generalizes the "logistic" distribution, corrects the defective characteristics of traditional nonlinear quality control by ensuring that the negative-log-posterior distribution preserves the property of convexity possessed by the negative-log-prior, and is therefore free of multiple minima. We report on parallel tests of the new quality control procedure within the operational gridpoint statistical interpolation scheme at NCEP, and address the problem of estimating the parameters of the new probability model from the diagnostics of the assimilation that are available to us.