Geosci. Model Dev. Discuss., 7, C26–C28, 2014
www.geosci-model-dev-discuss.net/7/C26/2014/

Geoscientific Model Development Discussions

Interactive comment on "Limiting the parameter space in the Carbon Cycle Data Assimilation System (CCDAS)" *by* S. Kemp et al.

Anonymous Referee #1

Received and published: 23 February 2014

In this paper, the authors attempt to deal with the problem of solutions to variational problems that are not physical. This is a common occurrence in using variational techniques that ultimately rely on the minimisation of a cost function when complex, non-linear models (such as the studied CCDAS) are involved. This is an important topic, of practical interest to many groups using 4DVAR techniques, and this analysis is welcomed.

There are some missing points. For example, if one assumes a Gaussian prior that extends into negative values when these make no physical sense, and a negative assumption is provided by the scheme, we need to interpret this as a consistent solution (consistent with the model as it stands, and with the prior description). I think that instead of looking at the MAP value of a particular parameter, we need to address the

whole distribution, and maybe decide that if the prior has a very large amount of weight in the non-physical space, it should be narrowed or modified.

The authors pursue some parameter space limitation strategies. The first one is the addition of an extra "penalty constraint". This approach has problems, as it basically changes the prior term to something different. The resulting cost function is also dependent on a number of parameters (D_{18}, μ_{18} in the paper, Eq. 10). These choices have implications (you are solving a different problem after all), which the authors do not address (despite the fact that the method didn't work!)

The authors do not address why the optimiser boundary experiments fail to converge. It would be interesting to know the reasons behind their results, as it's the most logical way for users to impose constraints (for example, how does the bounded space relate to the prior pdf?)

The transformations are useful, but their form (the double bounded transformation) is not included! This is a major oversight! Please include the transformations you used in the paper (was it a simple linear transformation, or a more complicate transformation? We don't know). Additionally, why not calculate the uncertainties in transformed space and transform back e.g. the 5-95% CI? This should hopefully result in uncertainties that are now bounded, and thus more realistic.

Finally, Section 2.2 should be shortened, as most details are of little relevance to this study. Figure 2 is unnecessary. Figs 6 is superficially discussed, and Fig 7 should be better presented: as it is, it looks like an optometrists test! Finally, a table with the prior extents would be useful (see comments above) to compare the boundaries of the parameter to the true extent of the prior.

I think the paper can be in general shortened, and more discussion on the merits (or rather, demerits) of the different approaches should be provided, along the lines mentioned above.