Geoscientific
Model Development
Discussions

Open Access

Interactive comment on "divand-1.0: n-dimensional variational data analysis for ocean observations" *by* A. Barth et al.

A. Barth et al.

a.barth@ulg.ac.be

Received and published: 15 October 2013

Reply to Referee #2

We thank the reviewer of this constructive remarks and encouragement that our tool is likely to become a useful tool for many oceanographers.

Comments of the referee appear in bold while our reply is in normal typeface. The full citations of all reference used in the repy to the reviewers can be found in the revised manuscript.

This paper introduces a variational method that can be applied to an arbi-

trary high dimensional space to interpolate sparse data, and describes its implementation into the numerical tool 'divand'. The code is designed to work with oceanographic measurements, and it is likely to become a useful tool for many oceanographers, being freely-distributed and documented online (http://modb.oce.ulg.ac.be/mediawiki/index.php/Divand). I think the paper is interesting and deserves publication on GMD, though I suggest some minor changes could be made, especially considering that the number of potential users of the tool is not restricted to the specialists in variational methods, so that a few clarifications might be necessary.

There are some typos/grammar errors, requiring a more careful revision of the text (e.g. pag. 4010 Line 15: 'it increased' should be 'is increased'; pag.4011, line 4: 'a better [...] coverages': plural should not follow a singular indefinite article; pag. 4013 line 11: 'derive' should be 'the derivation of' followed by 'are introduced' . . . etc.)

I corrected the mentioned typos and carefully read the manuscript to correct typos and grammar error with the help of my fellow co-authors.

Introduction. This section presents a somehow generic (and sometimes a bit superficial) introduction to the data interpolation and assimilation problems. For example, the variational approach is much more effectively described in the abstract than in this section. Moreover, the differences between the proposed approach and the variational techniques used for data assimilation are only very superficially introduced (e.g. first paragraph of pag. 4012). Is this approach univariate or can it be extended to multivariate interpolation problems?

The introduction has been improved. In particular, the paragraph describing the relationship with variational assimilation has been added and it was clarified that the

presented approach is a univariate technique.

References on the application of OI techniques to ocean data do not seem particularly up-to-date (e.g. Roberts-Jones et al. 2012). Covariance models based on generalized distances have also been proposed (e.g. Nardelli 2012).

We thank the reviewer of these interesting references. The manuscript has been updated and for the publication of Nardelli (2012) the following was also included as it is particularly relevant to this paper:

Auxiliary variables can be used as additional dimensions in order to improve the realism of the covariance function. Buongiorno Nardelli (2012) used for instance temperature (based on satellite sea surface temperature) as an additional dimension to generate a sea-surface analysis of salinity using optimal interpolation. This innovative applications shows that dimensions are not necessarily restricted to space and time and that other related variables can be used to extend the notion of space and distance.

Lines 11-14. Direct linear interpolation is rarely an option also because the interpolant is not differentiable or smooth.

We agree with the reviewer and the manuscript was changed accordingly.

Section 2. Though this section provides a clear introduction to the variational inverse technique implemented in divand, and an exhaustive derivation of corresponding kernel, I suggest to add a reference describing kernel methods in general (or recall them in an appendix), so that it becomes immediate to see the way Eq. 5 defines the matrix B and how the kernel is effectively used in practice (pag. 4015 lines 4-15). Introducing the term Jc already in (1) seems logic and preferable.

We agree with the reviewer. A relationship between Eq. 5 (original manuscript) and the background error covariance is briefly explained and a citation to Gaspari and Cohn (1999) for the covariance inner product is given. We agree that it is indeed more complete to introduce the term Jc already in equation (1).

Section 2.1 Line 17-19, pag. 4017. Were there other possible choices for these coefficients? How can this assumption be interpreted in terms of physical properties?

At this stage the coefficients were chosen such that one can obtain an analytical solution of the covariance function. A discussion a posteriori, allows to interpret how sharp the covariance function should decrease at the origin by varying the parameter m (i.e. the highest order derivative).

Section 2.2 seems quite generic and is it not well linked to the way the additional constraints are presented in section 5 and 6.

Section 2.2 and the relevant parts of section 5 have been merged. However we left the particular expression for 2 or 3 dimensions of these constraints in section 6 since we believe that it is easier to discuss them with the example setup of section 6 and with the help of figures 6 and 7 (of the revised manuscript).

Section 5. Following previous comment on section 2.2, it would be nice to see (37) expressed in matrix form using the operators available within the tool.

We agree with the reviewer and section 5 has been expanded correspondingly.

Section 6. How is the "exhaustive search" cited in the first lines of section 6.1 carried out? What are the differences between this and the Nelder-Mead algo-

Interactive
Comment

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

rithm cited afterwards and, in case, why did the authors use different strategies in the two cases?

For the 2d-case without advection constrain, the only parameter were signal-to-noise ratio and correlation length. One can easily visualize this RMS (relative to the "true" solution) error in this case (Figure 4 of the revised manuscript) by varying these two parameters. The resulting RMS function gives a good illustration of the sensitivity of the solution with respect to these parameters. This exhaustive search is implemented by varying the signal-to-noise ratio between 1 and 30 (60 values equally distributed) and correlation length of 100 km to 3000 km (also 60 values equally distributed). 3600 analysis have then been carried out.

For all other cases, 3 or 4 parameters have to be optimized. The computational cost of an exhaustive search would be very high in this cases and it would be very difficult to visualize a function in 3 or 4 dimension. For this optimization a more efficient minimization strategy (Nelder-Mead algorithm) has been used which requires only a limited number of analyses.

Interactive comment on Geosci. Model Dev. Discuss., 6, 4009, 2013.