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Interactive comment on "Multi-scale optimal interpolation: application to DINEOF analysis spiced with a local optimal interpolation" *by* J.-M. Beckers et al.

Anonymous Referee #2

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General comments:

With great pleasure I read this long-awaited paper on combing the two important techniques of generating gapless spatial information from sparse remote sensing data: Optimal Interpolation (OI) and Empirical Orthogonal Function (EOF) fitting. I am impressed with the complex theoretical framework presented to put DINEOF into an overarching OI framework, allowing taking overall error estimates into account which are theoretically not part of the DINEOF approach. The different approximation methods of handling the combination of OI and DINEOF are well treated, showing the merits of the theoretical framework. This work definitely deserves publication OS. However, I have some recommendations on the way the results are communicated to ensure

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proper uptake in the relevant communities. My main suggestion is to simplify and/or shorten the paper, to allow readers without too much mathematical background or time or to grasp the essentials of the paper too, yet at the same time being complete for readers with solid mathematical background and sufficient time. I have a couple of suggestions for that.

Specific comments:

First, I suggest simplifying naming conventions by renaming them, or actually simplifying them. The number of available methods treated is a bit too much to illustrate the essential message of the paper: to combine OI and DINEOF in a theoretically solid manner. There are too many permutations due to the number iterations (0,2,10 vs. 20) x process order (1 vs. 2) x theoretical approximations (K1, K01, DINEOFOI vs. DINEOF + K2). The result is dazzling to a reader new to this matter. For instance, the cases in Table 5 (0 and 10 it) do not match the ones in Table 4 (0, 2 and 20 it). Also the meaning of subscripts varies (in K1, the 1 refers to a process while in K01, the 1 refers to a gain matrix formulation) forcing the reader to go back to previous sections all the time. Perhaps it would be an idea to add one extra table with the relevant equations that match the labels in Table 5, and add textual labels in addition to only operators with indices.

Second, I tend to suggest removing treating the order of process 1 and 2 from the paper. First, mathematically these methods are identical anyway ("Similar relationships hold for K2 (as we can just interchange indices 1 and 2)." line 21 page 899). Secondly, in your conclusions you suggest to use 1 for the signal with the highest signal-to-noise ratio, which would be an obvious choice anyway. This complex paper might be greatly simplified by stating this as an assumption upfront, and moving all material to support this assumption to appendix or even supplementary material (keep it for reader with enough time).

Third, your conclusions, and uptake of your DINEOFOI, might benefit from a recap

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discussing the different approaches to combine EOF and OI in general terms, without using codified information such as P1a and P2b in the conclusion, thereby making reading the conclusions possible without reading the body of the paper first. The conclusions might also benefit from focusing more specific on the novel idea of combining DINEOF and OI and its benefits, instead of an abstract description of combing two "combinations of analysis tools". The same applies to the abstract, where DINEOF and OI are currently mentioned as a mere examples, instead of as the main finding. Is the theoretical framework the main message, and DINEOF-OI a mere example (as it is currently written), or is DINEOF-OI the main message, and the theoretical framework a mere justification (what I suggest)? The latter would allow the last paragraph of the discussion to suggest using the theoretical framework also for cases beyond DINEOF-OI.

Fourth, the theoretical framework plus the examples represent an enormous amount of information which makes this paper very time consuming to ingest. A suggestion to show the merits of this work would be to re-use suitable test examples from previous OI and DINEOF publications from your group, and show how the new DINEOFOI variants improves these tests. This would reduce the amount of new material in this paper, allowing readers to focus on the DINEOF-OI combination as new material. Plus it would also provide good evidence that the new method is indeed better than simply DINEOF or OI alone as in previous papers, with the OI addition to DINEOF superior in representing fine scales than pure EOF modes.

Technical corrections:

* Shouldn't (DIN)EOf be (DIN)EOF? (small f, e.g. page 897) * Is subscript i is missing for second Σ (Eq. 1)?

Interactive comment on Ocean Sci. Discuss., 11, 895, 2014.