

## ***Interactive comment on “Variational data assimilation with superparameterization” by I. Grooms and Y. Lee***

### **Anonymous Referee #1**

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### **Evaluation**

In this paper, Grooms and Lee set out to develop a new idealized superparameterization. Their model is constructed by modifying the two scale Lorenz-'96 model. The new framework includes a nonlinear interaction between large scale and small scale terms. Model small scale variables, the essence of the superparameterization, are related to realistic small scale variables statistically.

The framework for a 3DVAR data assimilation technique is constructed. The method is similar to a previously constructed approach, used with an ensemble technique. The new algorithm allows observations to be located away from the large scale grid points. In this SP model small scale variables contribute to the modeled observations. Covariances of small scale variables are interpolated to observation locations from the

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periodic small scale grid.

Grooms and Lee have constructed a coherent model that makes an excellent contribution towards understanding how to handle data assimilation with superparameterization models. The work is well presented and clearly described. Assumptions are fair for the model they have constructed and well stated and backed up. In my opinion the paper should be published subject to some minor considerations, outlined below.

### **General Comments**

- I have a hard time seeing the figure axis labels. At least in the version I received, the axis labels and numbers are very small and can't be read.
- I wonder if the title could be a bit misleading. Not to detract from the excellent work that you've done, but perhaps you would consider changing to e.g. "A framework for variational data assimilation with superparameterization" since you are not applying to a full NWP/climate SP model yet.
- I think you should consider changing the order of the sections so you introduce the model first and then describe the data assimilation, followed by the experiments. The way it reads now it goes from data assimilation to model and back to data assimilation. Reading your results I found myself having to flick back to the beginning having moved on to thinking about the model that you've developed.

### **Specific Comments**

- P516 L22: I wonder if you should just state at this point that it is periodic between large scale grid points. Although that quickly becomes clear it would save confusing a reader new to this topic.

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- P517 L6: You say mean of  $u'$  computed from SP variables but later say that it is zero?
- P517 L13: Could you comment on why you chose to interpolate the co-variances, rather than the small scale variable itself?
- P518 Ls20-21: Perhaps state here whether or not the periodic domain is centered on course grid points?
- P522 L16: can you state what the index  $i$  refers to here?
- P523 L44: Should  $Y_N$  in fact be  $N_Y$  or  $N_Y(N)$ ?
- P526 L15: This opening sentence is a bit wordy and could be shortened to just e.g. "In this section we describe data assimilation experiments in both regimes of the test model using the 3D-Var framework from Sect. 2.". Start a new paragraph after the opening sentence.

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Interactive comment on Nonlin. Processes Geophys. Discuss., 2, 513, 2015.