Geoscientific
Model Development
Discussions

# *Interactive comment on* "The Land Variational Ensemble Data Assimilation fRamework: LaVEnDAR" *by* Ewan Pinnington et al.

**Anonymous Referee #1**

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This is a short, neat paper describing the initial application of a 4DEnVar technique to the JULES land surface model. Results first from a twin experiment and then a test at an agricultural site are presented and seem to show considerable promise for this technique to estimate model parameters in these circumstances. It is well written, presenting the ideas clearly and concisely with very few grammatical/spelling errors and is well within the scope of GMD.

The authors articulate well the needs for such an approach – developing and maintaining an adjoint for rapidly evolving land surface models is an almost impossible task. Being model agnostic is likely to make this a potentially useful tool to many modeling groups. Their assertion that an additional benefit of the approach is that it identifies "true" parameters that are defined as being static in time seems tenuous and superflu-

ous, not least as they also suggest in the preceding paragraph that land model parameters can, and might be expected to, change over time. This is a distraction, and it is in the nature of land surface models that so called "parameters" are not equivalent to physical constants more common in fluid dynamics models.

It is beyond this reviewer's skill set to verify the validity of all the equations in sections 3.2.1 and 3.2.2, but with my level of understanding they seem to be complete. However, given the role of this paper in introducing the new framework it would be very good to have a small amount of addition information as to how the system is actually implemented. This is most important addition this manuscript requires to increase is benefit to the community.

In addition to this, overall the manuscript would benefit from clarifications about the following points, listed in general order of appearance.

Page 9 Line 12 What does "2% Gaussian noise" mean? 1 standard deviation = 2% of value at time of sampling. And presumably this is also used for the observation error variance?

P10L2 Why do you use different variances for the parameter perturbations in the twin v. real experiment? Would it not have been more informative to use the same (ie higher) value for the twin?

P10L3 The justification for arbitrarily assigning observation errors is insufficient. How do these compare to actual estimates from field studies. In particular, using a percentage value for the fluxes is a poor choice – absolute errors don't scale well with flux magnitude. Again, using different/unknown values for the twin experiment relative to the real data is not helpful when making comparisons between the two.

P10L17 The authors comment multiple times on the error introduced/reduced around due variability in harvesting dates. That in itself may be a distraction, but nevertheless if it important the model description needs to include details as to how its calculated.

P10L20 Similarly, how is harvestable material calculated? This is particularly important to know as later there is an apparent discrepancy between good harvestable material estimates, but poor leaf C and stem C estimates.

P11L3 The parameter priors don't seem to be very normally distributed, but they should be? Mu in particular is seems weighted around the true value?

P15L7 "only capturing 5 of the 11 observations" What is meant by this? It seems like all but one observation lie within +- 1 SD in the prior case, although that is wide and poorly constrained. What metric is being used?

P15L15 If LAI agrees with observations, but leaf C does not, this implies SLA is incorrect, but this is one of the parameters being optimized, or at least a coefficient controlling it? What is the suggestion of this for the model?

P20L2 How will the correlations in the prior error covariance matrix be determined/estimated?

P20L4 To what extent is this ensemble collapse a function of (over optimistic) observation error?

P20L28 Again, how is harvestable material calculated? It would appear they might be compensatory biases given harvestable material estimates seem better than either leaf C or stem C

P21L4 A brief discussion of the steps required to extend this framework to models running on spatial grid regionally/globally in addition to a need for localization would be very beneficial, including any potential limitations.

P21L9 Can you elaborate on how you intend to use this framework in a cycling system? Over what sort of timescales would you run the model before restarting. Won't this result in variation in the "true parameters"?

P21L20 This sentence is unclear and need editing.

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