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Nonlinear Processes in Geophysics
Discussions
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Interactive comment on "Non-Gaussian data assimilation of satellite-based Leaf Area Index observations with an individual-based dynamic global vegetation model" *by* H. Arakida et al.

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General comments:

1. This paper applies a particle filter data assimilation scheme to assimilate MODIS Leaf Area Index (LAI) data into an explicit individual-plants dynamical global vegetation model. Results indicate that the scheme reduces the uncertainty of the LAI analyses as compared to random initialization. Furthermore, the technique appears to successfully estimate the model parameters that control separately LAI for the forest and for the grass types, out of whole LAI observations.

2. The content of the paper is relevant for Earth Systems and non-linear modeling. It

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addresses one important aspect to increase models realism through the use of information contained in fine time-scale observed data.

3. The problem addressed in this study is challenging considering the nonlinearities in the dynamics of the vegetation, the multitude of interactive physical and biogeochemical processes taking place at the local and regional scales, and the fact that not all state variables are observed or retrieved by satellite.

4. The study is well executed to proof the concept with all the needed elements (calibrated model, quality controlled data, an optimized data assimilation scheme) and reduced (only a few geographical points) scope to make it successful.

Specific comments and questions:

1. While the description is succinct and easy to follow, it needs to make explicit major assumptions made and the problems one may encounter if they were to be relaxed.

2. Below is a list of questions that arose while reading the manuscript: 2.1: What modifications to the original vegetation model were made to adapt it to the DA scheme? Were these only the changes in parameter values we see in the appendix? 2.2: Are the field observations in the Siberia Yakutsk Larch forest site independent or were they included to create the climate forcing data 2001-2007 in the vegetation model? 2.3: Was the 2004-2007 period of MODIS 4-days frequency data continuous on the study site? Were there missing data? How does the missing data was handled? 2.4: Was the 8000 particles generated decided by computer capacity, or any other criteria? 2.5: Simulated observations (in the OSSE) versus real observations: How do they compare? Were the real observations also normally distributed? Were standard deviations of real observations about 10% as in the OSSE experiment? 2.6: Did you follow any particular rule to determine the perturbation size of Pmax and Dor? In the study you allow larger amplitude perturbations for forest than for grass types. The amplitude of Dor is relatively very small. 2.7: The manuscript indicates that perturbations of parameters are applied only to duplicated particles. Since the particle DA scheme eliminates

particles far away from observations (Fig. 1), that would mean that the range of the distribution of all the particles decreases after several cycles at least compared to the initial (uniform) distribution. Is this correct? Still, you do not report any issue with collapsing of the DA scheme when observations are outside the range of the distribution of particles. Can you please, elaborate more on this issue? 2.8: The NODA and the TEST experiments; Figure 3. How the 8000 particles are inserted at the initial conditions? Is this done every 4 days with a uniform distribution each time? The TEST experiment appears to reduce a big systematic error that appear during the growing months. Traditional DA schemes apply a bias-correction strategy of the First Guess prior to performing the analysis. Does this mean that particle DA also removes systematic errors? 2.9: TEST experiment; Figure 3a (forecast+grass). Please, explain the problem at the end of the fall months (circled in blue in the attached figure). Can this be attributed to neglecting observations when LAI<0.5 ? Will this be removed if observations are added there? 2.10: It is obscure to me how come the individual LAI of Forest and Grass are accurately estimated out of the whole LAI. Even when the whole LAI estimation is incorrect as in the periods in the blue circle in the attached figure. What mechanism or statistical assumption within the DA process makes the partitioning of LAI correct? Is this pure chance? 2.10: In the Real-World Experiment; there is no detail on the perturbation strategy, so I suppose it is the same as in the OSSE experiment. 2.11: The observation error standard deviation in the real case needs more explanation. What is the truth from which the error is estimated? Is this the in situ observation? Is this error an input in the DA scheme?

Technical corrections

Page 1. Abstract. ".. newly developed" should be ".. developed". You repeated that later on in the text.

Page 1. Abstract. ".., assuming the satellite-based LAI." This is an incomplete statement. You repeated this statement problem in the introduction, page 2, row 11. Maybe you meant to say "using" instead of "assuming".

Page 2. row 8. “straightforward” may be replaced by “numerically straightforward”. In this context, it is not simple to go from local to global because spatial covariances become relevant.

Page 2. (last) row 31. “phase space stays the same” may be “phase space dimension stays the same”

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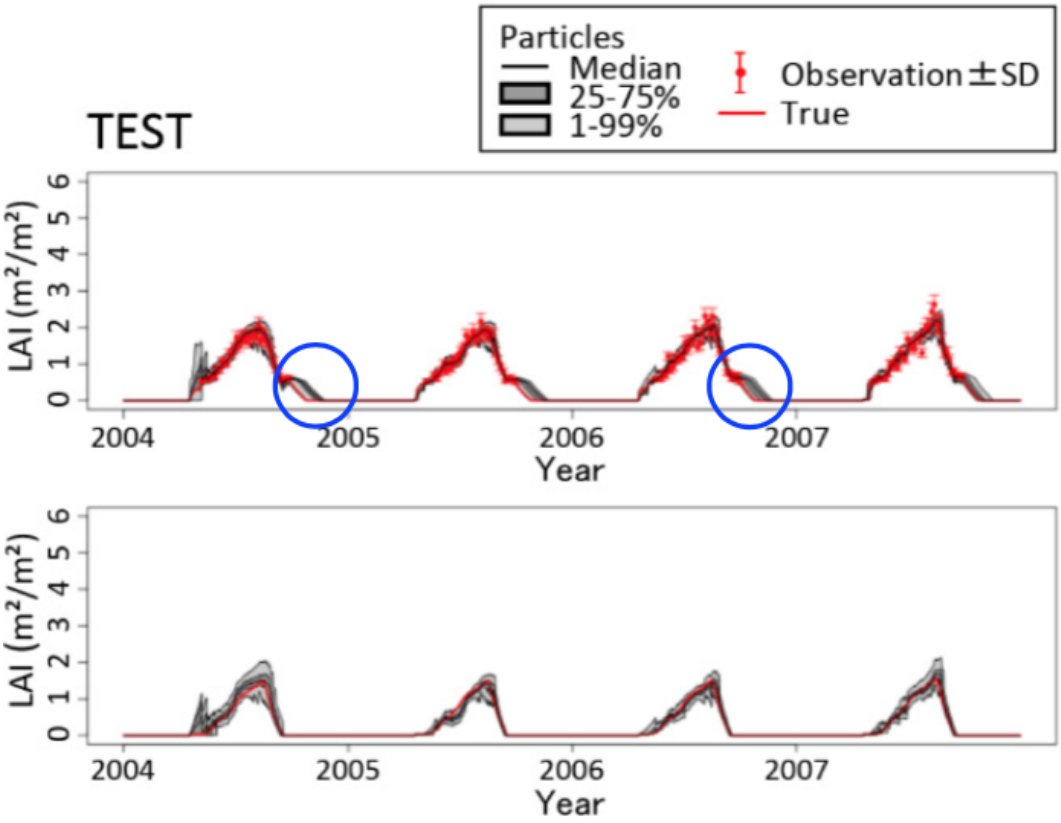

Fig. 1. Problem described in my comments are circled in blue

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