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Interactive comment on “Appraising the capability of a land biosphere model as a tool in modelling land surface interactions: results from its validation at selected European ecosystems” by M. R. North et al.

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Received and published: 19 June 2015

REPLIES TO REVIEWERS COMMENTS

We thank the reviewers for providing their comments to our manuscript. Their feedback comments have been very useful in further improving the manuscript. Responses to the comments are provided in detail below. We are happy to provide more details or incorporate any further suggestion in any aspect of our work, where it might be required.

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REVIEWER 2:

This manuscript uses observational data from a number of point locations to evaluate the performance of a land surface model SimSphere.

R2C1: The authors claim that this study is "an in-depth validation" of the model, but I find it a very restrictive validation. The periods of comparison between the model and the observations have been restricted to day-time, with clear skies, during the growing season and with "atmospherically stable conditions". Furthermore, although a number of sites with varying land cover have been studied, these sites are all within Europe. So there is little assessment of the model across a range of climates (e.g., semi-arid, tropical, ...). ANSWER: We thank the review for his thoughts on this matter. Several measures were implemented in this study to evaluate the models' representation over alike conditions (i.e. in the growing season, year 2011, atmospherically stable conditions, cloud free etc.). This was done deliberately as because we wanted to analyse the model's performance in alike conditions to understand the model's representation in different ecosystem types. We indeed share the same view with the reviewer that this study is by no means a 'comprehensive' validation of the model (which we also state in various places of the manuscript, e.g. conclusions) and we have now further changed in the manuscript any claim that may have existed previously relevant to this. We have also decided to address this matter by adding in the manuscript results presented here that are the first steps towards an in – depth validation and future research can be examining the model performance over a range of years, and environmental conditions (i.e. cloud cover, different seasons etc.), this is highlighted within the 'future research' in the concluding remarks section. Yet, it should be noted that, to our knowledge, this is indeed the first so detailed validation of the SimSphere model and this is the main point we ensured it is maintained in our manuscript.

R2C2: The authors have selected individual days from the observational datasets based upon energy balance closure of those days. However, energy balance closure is inappropriate on such timescales. The energy stored in the soil leads to both

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a strong diurnal cycle and a strong seasonal cycle. Hence energy balance closure can only be assessed on multi-year periods. If only one year of data is available, then assessing energy balance on this length of dataset would be acceptable, but not ideal. Timescales less than a year do not capture the seasonal cycle of the soil energy store and are hence inappropriate. Furthermore, such an assessment can only be made for observational datasets without long periods of missing data that could bias the closure calculations. For the stated aims of the manuscript (an in-depth validation of the model), simulations should be undertaken for all periods (day-time, night-time, clear skies, cloudy skies, precipitation, all seasons, etc.) with valid observational data. ANSWER: “Timescales less than a year do not capture the seasonal cycle of the soil energy store and are hence inappropriate” We appreciate the reviewers concern expressed in the comment above. This initial comment related to the timescales above would be valid if no attempt were made to measure soil energy storage since it would indeed be necessary to wait for flows to move completely in and out of the soil to fully capture them with above ground sensors. However, the G term in the energy balance equations include an estimation of soil surface heat flux for each given averaging interval, generally one half hour. This is calculated by adding empirically measured heat flux (from buried soil heat flux plates) at a given depth to the energy stored in the soil layer above this depth; this calculation takes account of the specific heat capacity of both the mineral soil and changes in the moisture (measured) it contains (soil air is typically ignored) and the change in temperature during the averaging interval. These measurements are usually taken every second and averaged over the half hour which captures any energy moving into or out of the soil at these small time steps, thus any diurnal or seasonal patterns in soil energy storage should be irrelevant since flows and storage are captured at much smaller timescales anyway. In regards to the other part of the reviewer comment related to “. . . such an assessment can only be made for observational datasets without long periods of missing data that could bias the closure calculations”, we would like to underline here that only days of complete measured data were included in the EBC estimations, days with gapped data were rejected. Further-

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more, in regards to the other comment of the reviewer related to: “For the stated aims of the manuscript (an in-depth validation of the model), simulations should be undertaken for all periods (day-time, night-time, clear skies, cloudy skies, precipitation, all seasons, etc.) with valid observational data.” we also agree that this is of course a valid criticism although though unfortunately unavoidable since reliable validation data under all conditions would be unavailable. Eddy Covariance data (LE and H components) used as observational validation data are subject to strict assumptions such as sufficient turbulent mixing, appropriate atmospheric thermal structure etc. Particularly for open path sensors scattering of infra-red signals by water droplets precludes measurements during precipitation events being retained for example and nighttime data are often plagued by insufficient mixing due to low friction velocities. Strict quality control typically rejects data collected under unfavourable conditions resulting in no data being available for model validation during these times. Continuous long term Eddy Covariance datasets that extend across these conditions do so only by being themselves modelled (gapfilled) from higher quality measurements. It is these higher quality measurements that have been used in the validations in this paper with short term assessments of energy balance closure being used to determine the suitability of these validation days. It is only by using these data that uncertainties in the observation data can be minimised and validations can be judged. Finally, in overall, many of the previously validation exercises on SimSphere which we have cited in our manuscript herein (but also in other similar studies to ours implemented to other models) have used “selected” days only to validate the model performance (e.g. days of stable atmospheric condition, non-convective conditions etc) and our practice here is in line to those studies as well and we do believe it is only fair to the model to validate it under conditions which it is able to simulate or take into consideration as otherwise cannot be expecting the model to replicate a reality which hasn’t been taken into consideration into its architectural design in the first place.

Specific Comments:

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R2C3: p. 223 L10-14: In the introduction, the authors state that studies comparing models with in-situ data have been scarce and incomprehensive. However, the authors seem to be unaware of the community activities following the PILPS experiments that have been evaluating models over a range of sites, land cover types and climates, since the 1990s. Indeed, the latest PILPS experiment has even considered the urban environment (which is mentioned within the manuscript). ANSWER: This sentence (p 223 L10-14) directly relates to SimSphere's previous validation, not to SVAT model validation's in general; the sentence has now been changed to better reflect this in the revised manuscript.

R2C4: p. 229 - 230. There is no mention of how the soil temperature and soil moisture have been initialised for the simulations. It is well known that soil moisture can take multiple years to spin-up and incorrect soil moisture can have significant impacts on the sensible and latent heat fluxes. As such, the initialisation methodology needs to be described. ANSWER: This mistake has been rectified, and the paper now reflects where / how soil moisture and temperature values are initialised. We thank the reviewer for pointing this out to us.

R2C5: p. 227 L 8: Data is plural, so "data was" should be replaced with "data were". ANSWER: We thank the reviewer for his comment; this has now been changed and the manuscript has been checked thoroughly.

R2C6: p. 227 L 9: Data is plural, so "data was" should be replaced with "data were". ANSWER: We thank the reviewer; this has now been changed and the manuscript has been checked thoroughly.

R2C7: p. 228 L 1: Text references the "above equation" whereas the equation is actually below this statement. Use the equation number rather than its position relative to text. ANSWER: We thank the reviewer for highlighting this mistake, it has now been changed in the revised manuscript.

R2C8: p. 228 L 12, 13 and equation on 16: The terms "G" and "S" are used in the

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equations without being defined. ANSWER: These terms have now been described in the revised manuscript.

Interactive comment on Earth Syst. Dynam. Discuss., 6, 217, 2015.

ESDD

6, C391–C396, 2015

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