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Earth System Dynamics Discussions

Interactive comment on "Carbon farming in hot, dry coastal areas: an option for climate change mitigation" *by* K. Becker et al.

Anonymous Referee #2

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I appreciate the opportunity to review *Carbon farming in hot, dry coastal areas; an option for climate change mitigation*. The manuscript addresses a GeoEngineering-type research topic that certainly deserves more research and careful consideration in the future. Thankfully, the authors were also open about the necessary assumptions required to obtain these results (*e.g.* species selection and biomass accumulation rates, site selection, modifications to the regional model). Overall, in this manuscript I encountered a well-written and intriguing research study that, with a few modifications, clarifications, and additions, definitely deserves publication.

1 Topics that need to be addressed

- Long-term storage - It appears that you are presenting *Carbon Farming* as a means to avoid the long-term storage complexities related to carbon capture and storage (CCS) (p.1223 line 10-13). Yet although it was not discussed here, *Carbon Farming* would also require a long-term storage mechanism. The *Jatropha curcas* biomass accumulation rate appears to have been derived from some 32 month-old samples and some 12-year old samples, then extrapolated to a 20 year-old representative. Without being shown these curves, the connection between future rates of CO_2 bio-accumulation and the necessity and rate storage remains ill-addressed — they should not be. By including the curve or fit-equation, not only is the study more reproducible, but it would further highlight the rates of growth and fruit/litter production that could be expected.

- Site selection - I like the fact that you are proposing the use of only degraded land for *Carbon Farming*. Your extrapolation of small-scale experiments to the larger 10^9 hectare scale suggests that the previous utilization of these land areas (such as failed agricultural lands that were overly irrigated?) does not inhibit the cultivation of *Jatropha curcas* at these locations. Is this truly the case?

- Salt build-up - Could you please address how long these *Carbon Farming* regions could be cultivated/irrigated before the salt concentrations of the fertilizers (referred to as the fertilizer's salt index) added to the reverse-osmosis desalinated water have reached soil concentrations that prevent further cultivation in this area?

- Relating to CO_2 emissions - Comparing a development scale of $0.73 \cdot 10^9$ to offset the 2 ppm increase is good in context, but also assumes indefinite storage of the plant (and all fruit and litter? — this is unclear in the text). I appreciate putting your simulations in context but there appear to be some shortcomings in

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solidly making this conclusion.

- Burn or not burn - Several parts in the text make it unclear if the intermediate results assume the fruit and leaf litter is being burned as the desalination power source or if this material is being accumulated and stored indefinitely. This should be clarified.

- Fig. 5 - This plot leaves me wondering why the simulated Oman plantation only influences the PBLH within the plantation region while the simulation for the Sonora plantation extends about half the plantation length-scale further. Using a similar scale between these 2 plots may partially clarify this confusion, yet the spatial and quantity differences in precipitation (Fig. 6 - which also uses different scales) seem largely unrelated in comparison to the simple schematic of Figure 1.

2 Minor requests for clarification

- Table 1 - I interpret the table's original intent (p.1226) was to illustrate the land area potentially available for *Carbon Farming*. Instead, I find a lot of other information that isn't directly applicable and is rather confusing. For example, instead of seeing the surface area of Saudi Arabia, I would prefer to know the coastal spatial extent of potential regions where *Carbon Farming* could be implemented. My recommendation would be to either clarify why Table 1 is included, modify it, or remove it entirely.

- "Positive-negative" types of phrasing - I would prefer that you closely read the manuscript to identify phrasing such as, *"These effects can reduce the amount of water for irrigation and* ***improve*** *the local climate"* p.1227 and *"...would have fewer potential negative impacts on the environment"* p.1242. Assuming I was

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deploying concentrated solar power in this area or refining a method for decentralized carbon capture and storage, I may have a contrasting opinion to your own as to what positive or negative suggests. The scientific validity of the study is already strong enough without adding these adjectives.

- Summer - Instances like *"Overall, summer precipitation increased,"* and *"...deep convection during summer time"* occur throughout the manuscript, yet it is unclear if summer indicates June-July-August or is another time period.

- PBLH increase - Noting a mean increase of 250m over the plantations would be more informative if you could additionally specify the percent change this represents.

- Self-stability - Given that you have WRF simulations of the 2 regions, you could quantify the soil moisture increase related to the changes in precipitation, in that way giving insight as to when self-stability might be reached. My assumption is that the diurnal timing of the precipitation has a large influence here (*e.g.* afternoon precipitation on a 40C sand surface vs. evening precipitation on a 25C sand surface) but the similarities and differences between these 2 regions would be quite informative and the answer is already in your model output file.

- Fig. 2 - The information density of including these 5 pictures in this configuration seems quite limiting. If you could instead eliminate one, a 4 panel view of the photographs would convey much more information to the reader.

- Precipitation effects - You quantify the 11mm and 30mm precipitation increases in Oman and the Sonora for the summer? Given that you ran the simulations for all of 2007, are the only changes to the precipitation occurring in the summer (see also 'summer' confusion above) or are other changes to the precipitation also occurring but to a lesser quantity?

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