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Interactive comment on "Impacts of grazing on vegetation dynamics in a sediment transport complex model" *by* Phillipe Gauvin-Bourdon et al.

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We thank the referee for his valuable and constructive feedback on the manuscript. We will address the comments made by the referee and offer a response to each concern brought to our attention. Changes to be made to the manuscript in response to each comment will be explained here and will be added to the final version of the manuscript.

We thank the referee for his concern on the framing of the research and for the justification of our work on the integrated vegetation-grazing-sediment transport model. We recognize the need for a clarification of the context around our work and the justification of the research goal. The non-linearity of, and the capacity to, produce emergent pat-

terns from the interactions between the vegetation, sediment transport and grazing are one of the primary reasons we chose to use complex model in our research. Additional descriptions of the dynamics and interactions taking place between the vegetation, the sediment transport and the grazing was added in the introduction to help the reader understand the need for using a complex modeling approach such as ABM. To respond to comment 1 and 4 of the referee and to help better frame our research, the context section of the original manuscript will also be integrated in the introduction to help link the theory on the dynamics observed in arid environments and the application of those dynamics in models.

We acknowledge that the lack of connection between the model and any specific semi-arid environment may lead to confusion when interpreting the validity and applicability of the results. Unfortunately, due to the limited data from semi-arid regions on all of these variables over a similar duration, the evaluation of the model capacity and the tests presented could not be based on any specific location. The evaluation and testing of the model were done by comparing our ViSTA_GrAM results to other model results and data in the existing literature by collecting studies from different semi-arid environments. While the ViSTA_GrAM results are compared to results coming from various locations, most of the model simulations parametrization were inspired by the Kalahari environment and the literature used to support this project is also based on the Kalahari environment. We consider the Kalahari as the main reference environment for the simulations of the model, but also recognize that not all simulation variable ranges and subsequent results are representative of this exact semi-arid system. The simulations are not intended to represent a realist reproduction of a particular semi-arid environment daily evolution, but aims to represent the sensitivity of the model to different level of vegetation dynamics, rainfall regime, windspeed and stocking rate. As noted in the concluding statements, we recognize that the model has a large potential to be representative of a range of specific semi-arid environments with further work on vegetation response curves and inputs using meteorological data. In order to clarify the source of inspiration for each simulation, the method section was expended to better explain the simulation construction. We also made sure to further discuss the relevance of each simulation results compared to the reference environments of the literature support our work.

We want to thank the referee for recognizing the pertinence of the experiment presented and hope to help readers understand the methodology by clarifying the purpose and the context of the research in the introduction of the manuscript. The model ViSTA_GrAM was developed for the long term objective to help identify critical shifts in semi-arid environment stability and understand the dynamics that produce major changes of the environment. The MSc project on which this manuscript is based aimed more precisely to create a new approach to represent grazing in the already established ViSTA model (Mayaud et al., 2017). In order to integrate an agent-based model representing the grazer in the ViSTA model some modifications had to be made to the original code, particularly regarding the spatial resolution of the model. An upscaling of the grid from cell of 1 m to 5 m length meant that we could no longer only rely solely on the sensitivity testing presented in the original publication of the ViSTA model and therefore, additional tests were run to evaluate the applicability of the new model configuration. The new series of sensitivity tests exposed some limitations from the original model structure that were being highlighted by its upscaling (as described in appendix A). The realism of the simulations presented with the ViSTA_GrAM model is limited without corresponding data, but still allow for the execution of hypothetical scenarios and a generalization of the dynamics observed in semi-arid environment. The simulations presented in the proposed manuscript are closer to sensitivity tests than case studies, which explain their simplified approach and their use of a wider range of values to represent a specific semi-arid environment (e.g., Kalahari). Based on the range of simulations presented, we believe that the ViSTA_GrAM model has the capacity to improve the representation of the interaction between the vegetation, the sediment transport and the grazing over various spatial scales. By doing so this model

would be beneficial to decision makers and land manager, by providing a tool to more precisely evaluate and predict the response of semi-arid environments to adaptation strategies or climatic changes. One result of the sensitivity testing (shown in Appendix A) is the effect of the wind angle on the amount of sediment transport observed. Although outside the scope of this preliminary long-term application of the model, we propose that with simulations based on actual meteorological data, the ViSTA_GrAM model will be able to help explore threshold values inducing a change of state in semi-arid environments. In reflection of this, an improved explanation of the project context and a framing of the expectation for the model in its current state will be added to the introduction of the manuscript. Additional context and clarification on the interpretations that can be made from the results will also be added to the discussion and conclusions. With these changes, we hope to help highlight the fact that the model can be further improved with future work to realize the full potential of the model.

We finally want to address the concern of the referee about the description of the model simulations, which will describe in further detail here in response to their concerns and additionally highlight in the revised manuscript. The rainfall and grazing are presently integrated as a constant in the simulations (see Table 2 for simulation parameter definitions). The amount of rainfall available to the vegetation during the simulations is always determined as an annual equivalent. The distribution of the annual rainfall across each vegetation update iteration is than calculated as a ratio between the annual rainfall available and the number of vegetation updates in a year. The simulations are then conceptually distributing the rainfall on the grid in a homogeneous pattern (spatially and temporally) across the period of simulations (100 years in this case). The grazing temporal distribution on the grid is treated in a similar manner, but its spatial distribution is determined by the decision function of the grazing agents. As stated in the method section of the article, the grazers are not limited to a particular section of the grid at any time during the simulation, but the precise location that they will interact with, will be dependant on the vegetation and surface properties. The stocking strategy plan used in the simulation is similar to one of free ranging or continuous season-long ranging over a whole pasture. The decision to generalise and simplify the rainfall and grazing regimes was made because these simulations are considered as a sensitivity test or exploratory tests more than they are specific case studies. We understand though the need for clarification of the rainfall distribution in the simulations and additional context will be provided in the method section of the article with the description of the simulations.

We hope these additional explanations and the changes made to the original manuscript respond well to the concerns of the referee. We are open to further discussion about these changes with the referee and welcome additional comments.

We thank the referee for their valuable help in improving this manuscript.
Best wishes,
Phillipe Gauvin-Bourdon