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Geoscientific Model Development Discussions

Interactive comment on "An intercomparison of Large-Eddy Simulations of the Martian daytime convective boundary layer" *by* Tanguy Bertrand et al.

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The manuscript, "An intercomparison of large-eddy simulations of the martian daytime convective boundary layer" by Bertrand, Spiga, Rafkin, Colaitis, Forget and Millour aims to compare results from two independent large eddy simulation (LES) models, one operated by the Laboratoire Meteorologie Dynamique (LMD) and one by the Southwest Research Institute (SwRI). The intent is to identify areas in which LES models can be improved, based on differences in their output for similar conditions. Ultimately, this will yield a better product for entry, descent and landing (EDL) activities of future spacecraft. I think that this manuscript can positively advance our understanding of LES modeling, and its application to EDL, however in its present form, it suffers from

too many shortfalls to be acceptable without some substantive changes. The authors are on the right track, but disappointingly leave many areas of fruitful investigation unaddressed and incomplete. None of them are fatal to the manuscript, but they are not trivial to address, either. I believe if these particular issues are properly addressed, the manuscript will be greatly strengthened, and will serve as a go-to reference for the EDL modeling community.

High-level comments:

Pg. 2, line 21: You identify more than two extant LES models, the present ones, plus the MarsWRF LES and the OSU LES. As you note, the need to evaluate the differences predicted by distinct martian LES are many-fold. It would seem to me, then, that doing an intercomparison with only half of the available LES models makes this study somewhat incomplete. In particular, the LMD LES is based on the WRF framework, as is the MarsWRF LES, although they have been developed independently. That seems ripe for comparison. Were these other two groups approached to contribute to the intercomparison and, if not, why not? This, to me, is a significant weakness of the manuscript. It's less an intercomparison of Mars LES, and more a simple comparison of two Mars LES.

Section 5: I'm somewhat uncomfortable with this section in that you only perform sensitivity studies on one of the two models (the LMD model).Âă This, then, becomes less of a model intercomparison and more of a sensitivity study of a single model.Âă The two are quite different, and I would argue that the intercomparison study essentially ends in Section 4.Âă I would like to see similar sensitivity studies for the SwRI model to evaluate whether, for example, the greater resolved TKE, or vertical wind speeds are more sensitive to parameter changes in the SwRI model than in the LMD model.

Specific comments:

Pg. 5, line 24: Can you expand on the validity of this assumption? In mesoscale modeling, there are 10s of km between the top of the 'good' results from the model,

and the domain top. It seems that you're getting pretty close to the top of the domain when looking at the PBL, which comes in only a couple km below the model top. Are there issues with damping layers at the model top that might be affecting your results?

Figure 4: While you argue that the radiative forcing is about the same now after doing the radiative adjustment, the near-surface atmospheric temperatures are still vastly different–10 K in the nighttime and >20 K in the daytime based on this figure.Âă I can only imagine that is going to have a noticeable effect on the magnitude of turbulent activity at the smallest scales nearest to the surface.Âă I don't see any discussion or acknowledgement of this difference. Surely it has to be important!

Pg. 11, line 28: You discuss 'quantitative discrepancies' between the models as being responsible for some of the differences between LMD and SwRI, and then refer forward to Section 6. I think it needs to be stated here what these quantitative differences are for the reader to understand and interpret the results of this section.

Pg. 14, line 2: To be honest, I don't think you've done any investigation of the discrepancies between the two models to this point. You've identified what they are, but you haven't done any interpretation of what is causing those discrepancies, or provided any insight into how they might be resolved.

Pg. 16, line 21: This in an incomplete comparison–what were the model parameters in this 'other' LMD LES simulation?Âă It's peculiar to say that the current results are comparable to past results that you don't show, because I, as a reader, have no objective way to assess that statement.Âă What defines 'good agreement', for example?

Pg. 16, line 28: This is tied into the 'quantitative discrepancies' comment on Pg. 11, above. The difference in subgrid-scale diffusion scheme seems like a key difference that has gone unexplored.Âă You've already gone to the effort to match as many physical parameters of the two models as you can, so why not the subgrid-scale diffusion scheme?Âă It's somewhat of a cop-out to say that you see differences between the models, and then speculate on what might cause those differences (subgrid-scale dif-

fusion) without trying to actually determine if it is, indeed, a cause. I think this study is incomplete because of this.

Figure 5: Can you explain why there are far more points in the LMD curves than in the SwRI curves if both models have the same timestep?Âă Is it as simple as more frequent output in LMD vs. SwRI?Âă If so, why was that not coordinated?Âă The higher frequency output of LMD gives the impression it is 'noisier' than SwRI, and it should probably be reduced to the same output frequency for plotting, if this is a rigorous intercomparison.

Figures 10, 11, 12, 13, 16: Can you explain why in all of these figures, the SwRI LES output is truncated before the end of the time period under investigation? Also, in Figure 10, the LMD data is truncated at 17:00 as well. These figures need to be complete, or else an explanation given for their incompleteness. If it is due to something like a model crash, then this needs to be investigated and explained. I would not feel confident at all in model results that derived from a simulation that crashed. If it's just because the model was stopped because the interesting results had finished at a particular time, then this also needs to be explained and/or made consistent across all panels.

Typographical/minor issues:

Pg. 2, line 14: Change 'to resolve' to 'resolution of'

Pg. 2, line 25: Insert 'do' between 'only' and 'the'

Pg. 3, line 17: Change 'SouthWest' to 'Southwest'

Pg. 3, line 29: Change 'Section 2' to 'section 2' to remain consistent with other sections

Pg. 3, line 32: You jump from describing section 4 to section 6 without mentioning section 5

Pg. 4, line 13: Insert 'in' before 'which'

Pg. 4, line 15: Change ‘soil model’ to ‘soil models’

Pg. 4, line 20: Change ‘Turbulent Kinetic Energy’ to ‘turbulent kinetic energy’

Pg. 5, line 10: Insert ‘at’ between ‘aimed’ and ‘in’

Pg. 5, line 10: Change ‘to assess’ to ‘an assessment of’

Pg. 9, line 1: Insert ‘the’ after ‘above’

Pg. 9, line 2: Change ‘1D PBL’ to ‘1D, the PBL’

Pg. 9, line 17: You mention Ames here, but the reader has no context as to what that means.

Pg. 9, line 19: Change ‘of about’ to ‘by about’

Figure 3: You reference ‘top’ and ‘bottom’ but in this layout, it should be ‘left’ and ‘right’

Pg. 11, line 9: Here, you’ve jumped from Figure 5 to Figure 8, and then to Figure 9, then back to Figures 6 and 7. Figures should go in the order they are referenced. (So Figure 8 should become Figure 6, Figure 9 should become Figure 7, and Figures 6 and 7 should become the new Figures 8 and 9.

Pg. 11, line 17: Insert ‘a’ between ‘are’ and ‘typical’

Pg. 11, line 20: Change ‘predict maximum updrafts values’ to ‘predicts a maximum updraft value’

Figure 8: Is this for the models with no background wind or 15 m/s background wind?

Pg. 12, line 14: Change ‘to compare’ to ‘comparison of’

Pg. 12, line 21: Change ‘radio-occultations, which are’ to ‘radio occultations, which is’

Pg. 12, line 28: Change ‘condition’ to ‘conditions’

Pg. 14, line 1: Change ‘This enables to better understand’ to ‘This enables better

understanding of’

Pg. 14, line 7: Change ‘mixing coefficient’ to ‘mixing coefficients’

Pg. 14, line 9: Change ‘Same conclusions’ to ‘The same conclusions’

Pg. 15, line 25: Change ‘cause’ to ‘causes’

Pg. 16, line 16: Change ‘or’ to ‘and’

Pg. 16, line 32: Insert ‘the’ between ‘at’ and ‘grid’

Pg. 17, line 10: Change ‘is’ to ‘are’

Figure 10 caption: Change ‘09:00’ to ‘08:00’

Figure 5 goes from 09:00-17:00. Figure 10 goes from 08:00-17:00. Figure 11 goes from 07:00-19:00. Figures 12 and 13 go from 11:00-17:00. Figures 16-21 go from 08:00-17:00. Why not plot everything on the same temporal axis? Consistency makes the reader happy, and the manuscript easier to follow!

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