

Interactive comment on “A new moisture tagging capability in the Weather Research and Forecasting Model: formulation, validation and application to the 2014 Great Lake-effect snowstorm” by Damián Insua-Costa and Gonzalo Miguez-Macho

Anonymous Referee #3

Received and published: 30 October 2017

In this paper, the authors develop an online moisture tracking scheme within the WRF model, and validate the performance of the model against observations of an extreme winter precipitation event in the Great Lakes region of the United States. I recommend publication pending minor revisions (see below).

GENERAL COMMENTS

In general this is a very good paper, with an excellent background on the range of mois-

C1

ture tracking options available including Lagrangian and Eulerian tracking schemes, as well as a detailed explanation of the model, data sources, and the novel contributions of this team. The moisture tagging approach that is implemented within WRF is somewhat outside of my academic background, but in general appears sound. The validation of the approach against an observed extreme event is particularly interesting and it is a sign of how far the science has come in recent years, especially in realistically representing surface and atmosphere coupling during extremes. I have only a few minor comments:

1. First in the introduction, the authors briefly discuss offline Eulerian tracking schemes, and it is suggested that the vertical integration is a significant shortcoming of these approaches. I think that if the authors are going to cite the Goessling and Reick (2013) paper (which is critical of the single column version of the WAM-2layers, as described in Keys et al. 2012), the authors should also cite how this issue has been addressed using a two-layer, model-level version of the Eulerian tracking scheme, which performs favorably relative to regional climate model comparisons. One of the other reviewers already highlights this, by pointing the authors to van der Ent et al. (2013) “Should we use a simple or complex model for moisture recycling and atmospheric moisture tracking?” <https://doi.org/10.5194/hess-17-4869-2013>

Other work that has used the two-layer, model-level tracking scheme includes van der Ent et al. (2014) which couples the WAM-2layers to a land-surface hydrology model, Keys et al. (2014) which examines whether the WAM-2layers can be used with multiple datasets, and Duerinck et al. (2016) which examines soil moisture coupling in Illinois. I am by no means suggesting the authors cite this list of other papers, but rather am illustrating that much work has been done to address the single column assumption, and now in using the improved version.

I do recommend the authors consider adding a sentence or two more at Page 2, Line 17 to more accurately represent the current state of Eulerian tracking generally (and that as a ‘class’ of tracking schemes some Eulerian models have addressed the valid

C2

criticism associated with the single model level integration).

2. The authors make a point in the final sentence of the abstract by writing "...resulting in the highest socio-economic impacts." Since this is the final sentence in their abstract I think the authors ought to either:

a) explore this a bit more, clarifying what those socio-economic impacts actually were (in specific terms) during the snowstorm event, which populations were affected, and maybe even the adequacy of alerts and warnings ahead of the snowstorm.

b) eliminate any reference to that aspect of the paper.

I think that the authors have done such an amazing job with the rest of this work that it seems a little bit like they are doing themselves and the reader a disservice by mentioning socio-economic impacts so blithely (aside from the mention at Page 15, 1st paragraph of section 4). I think it is the norm in this field to feel obligated to say something about socio-economic impacts since you have to justify why this science matters. At this point, if the justification is 'socio-economic impacts' then I'm not convinced that this science helps with anything. I think it could, such as through improved monitoring of lake temperatures, regional humidity, etc. and coupling such monitoring insights with emergency management and weather monitoring stations. Perhaps this was already done during the snowstorm. But I think that the authors ought to dig a bit deeper here, if they want to justify the paper as such.

MINOR CORRECTIONS (Page = P, Line = L)

P1 L21 Change 'especial' to 'special'.

P3 L2 Check formatting for the citation.

P5 L7 The last clause of this sentence is confusing; consider revising for clarity.

P11 L11 Change '2104' to '2014'.

P11 L21 Change 'precipitations' to 'precipitation'

C3

P15 L11 Good overview of the snowstorm event, but this is not adequate for justifying this work. Consider adding more substantive context for using this storm as a justification for the approach (perhaps in the summary section, or wherever is appropriate).

P16 L5 Cite the source of the "Snowvember" reference.

P16 L17 Change 'Eire' to 'Erie'.

REFERENCES

Duerinck, H. M., van der Ent, R. J., van de Giesen, N. C., Schoups, G., Babovic, V., & Yeh, P. J. F. (2016). Observed Soil Moisture–Precipitation Feedback in Illinois: A Systematic Analysis over Different Scales. *Journal of Hydrometeorology*, 17(6), 1645-1660.

Gößling, H., & Reick, C. H. (2013). On the "well-mixed" assumption and numerical 2-D tracing of atmospheric moisture. *Atmospheric Chemistry and Physics*, 13, 5567-5585.

Keys, P. W., Barnes, E. A., van der Ent, R. J., & Gordon, L. J. (2014). Variability of moisture recycling using a precipitationshed framework. *Hydrology and Earth System Sciences*, 18(10), 3937.

Keys, P. W., Van der Ent, R. J., Gordon, L. J., Hoff, H., Nikoli, R., & Savenije, H. H. G. (2012). Analyzing precipitationsheds to understand the vulnerability of rainfall dependent regions. *Biogeosciences*, 9(2), 733-746.

Van der Ent, R. J., Tuinenburg, O. A., Knoche, H. R., Savenije, H. H. G., & Kunstmann, H. (2013). Should we use a simple or complex model for moisture recycling and atmospheric moisture tracking?. *Hydrology and Earth System Sciences Discussions*, 10 (5), 2013.

Van der Ent, R. J., Wang-Erlandsson, L., Keys, P. W., & Savenije, H. H. G. (2014). Contrasting roles of interception and transpiration in the hydrological cycle-part 2: Moisture recycling. *Earth System Dynamics*, 5(2), 471.

C4

