Overall Comments:

Overall, this is a well-written manuscript describing 4 new ways to account for irrigation that could be used by managers and modelers alike. This type of work is much needed, as the human element/drivers of new LSM physics remain a challenge in how to account for them and prescribe them accurately. This is also a novel dataset put to good use. The schemes use sound assumptions and represent an array of complexities. The paper is a worthwhile contribution, but becomes a bit thin in the results section and a few of the major limitations are glossed over and require further discussion. As a result, I recommend major revisions in order to help the manuscript become more impactful and useful for irrigation-related studies. In addition, I strongly recommend that, if possible, the results/analysis be extended to time series and sub-annual breakdowns of irrigation water vs. precipitation (and variability) for each of these schemes. Much of the utility for managers and more so for modelers will be on the diurnal and sub-seasonal scales, in which they need to obtain the water balance, soil moisture, and fluxes correct in order to couple to the atmosphere and represent the precipitation connection more accurately (i.e coupling). Also missing is the broader applicability of these schemes outside of this unique, well-instrumented and reported-on field/domain. Other locations with less decision-making data points or coarser precipitation will no doubt find greater challenges.

Thank you for the thoughtful comments. We will do our best to address your main concerns.

Specific Comments:

L24: What is difference between a conservative and water savings routine? Sounds similar if you do not know the terminology. This is explained better in the paper itself, but maybe a word or two in the abstract could help better clarify what is meant by each.

Thank you for the suggestion. We will update the abstract to be more consistent with the manuscript.

L29: Is the actual transition of information and decision making part of this paper? Or is it suggested that it would be valuable in the future for managers? If the latter (which according to the paper itself there is no transition or decision making taking place (yet!), then please clarify this here to suggest it may be useful in the future (not that it already has been useful).

Agreed, we will update to make more explicit that it could be useful in the future.

L52: might want to mention that the impact of SM on these is really modulated by the flux contribution to the atmosphere (SHF, LHF, or evap fraction, or just ET). So getting the SM-Flux relationship correct is critical, and i.e irrigation is essential as a component of that.

Indeed, the presence of irrigation doesn't necessarily impact the flux rates – we will update to include the SM-Flux relationship.

L58: Which are the 'both' here? L59: Is there a predictive nature to irrigation decisionmaking? Do Calendars vs. Consultants vs. Probe percentages change over time due to other factors

(technology, financial, drought, etc.)? Are consultant-based decisions consistent (is the advice consistent) over time?

Both the risk-aversion side of decision making and from biophysical requirements. Gibson, 2015 identified that the majority of irrigated fields were irrigated approximately 50mm more that crop water demand.

Gibson, J.P., Estimation of Deep Drainage Differences between Till and No-Till Irrigated Agriculture. Master's Thesis, 2015.

L99: Not clear what is meant by 'irrigation triggering regimes'? Earlier (abstract) they were referred to as 'routines' that could be incorporated into LSMs. Regimes suggest something different?

We will update to keep routine consistent throughout the manuscript.

L122: What is the native resolution of SSURGO relative to the study area and field scale?

Greater than field scale but still does well for in- field observations.

L125: Same for SPNRD.

Data is on the field scale, total volume pumped for irrigated area.

Section 2.2: Based on the descriptions of these, are this ranging from the most simple to most complex (in order)?

Yes, simplest to most complex. We will clarify.

For H, would it be possible that the minimal yield loss could be set so high as to represent larger irrigation than in CM?

Not possible within the constraints of irrigation depths and frequency (3 days for the lateral to move 360 degrees). The CM is triggered with no constraint on irrigation frequency.

L168: 'amount of water'

Will update to target total of irrigation plus in-season rainfall.

L179: Has this approach been used in the past? There are no references, and based on interviews and expert knowledge. How did you come up with 6.5 exactly? If the ultimate goal is to have this in an LSM, I can envision that it might be very sensitive to this 6.5 number and thus overly simplistic. Are there any other knobs to turn?

The SPNRD recommends a total amount of P+I of 650 mm within the growing season. In other areas this could be informed by growing season ET totals. The irrigation season is approximately 100 days long based on typical irrigation patterns. So 650mm/100 days is 6.5 mm/day in the absence of rainfall to meet this demand. The work of Sharma and Irmak 2012 quantify net irrigation requirement around NE.

Sharma, V. and Irmak, S.: Mapping spatially interpolated precipitation, reference evapotranspiration, actual crop evapotranspiration, and net irrigation requirements in Nebraska: Part II Actual evapotranspiration and net irrigation requirements, Trans. ASABE (American Soc. Agric. Biol. Eng., 55(3), 923–936, doi:10.13031/2013.41524, 2012.

L185: This sounds reasonable as first order approximations for extreme rainfall. What about the low-intermediate rainfall conditions and the speed of drainage? Should the delay estimates be constant regardless of the soil type (conductivity), land cover, and precipitation rate?

Low rainfall rates (<6.5 mm/day) will not lead to a delay in irrigation application and this is consistent with discussions with producers in the area. Significant drainage is not expected within the growing season due to ET demand. Highly conductivity soils would require a shorter delay, however maize is not typically produced in such soils. Land cover will change but these algorithms are specific to maize.

L243: What is meant by seasonal dynamic?

Will update to daily time series.

L280: All assumptions embedded in these approaches have been explained and seem reasonable. The proof is in the pudding, of course, and the results will bear that out. However, it might be useful to summarize what the input requirements and the assumed/tunable parameters are for each approach as well, if they are to be used in LSMs. An example here is the date ranges that are used. 6.5 is another as is -500cm, and the depths of the soil pressure.

Yes, a summary table will be added to explain how these parameters would need to be update based off different management practices.

L284: Where are they located with respect to the study site and the fields? Should some kind of interpolation (or average) be used as well?

The average of the 7 gauges was used.

L293: Mean ETc?

Will update to the range between the highest and lowest rainfall totals.

L294: Totals of what?

Will update to precipitation totals.

L297: This is critical. The 4 schemes rely on P as the most important input (right?). Forcing for LSMs comes from satellite and gauge-based datasets, likely much coarser (e.g. .125-deg) than the <1km field scale. How will this be addressed? How can we capture the irrigation variability without knowing that of Precip?

Indeed, P is the most important input in both the routines and in the field. Decision making occurs from both radar estimations and in-field gauge readings. On shorter timescales (day to weekly), rainfall variability tends to be large. However, on the monthly to seasonal scale, variability tends to decrease. This is in part why we have focused on seasonal totals.

L325: I think a lot more could be said - this is the critical result/figure from this paper. There is a lot of error bar info on there and other aspects that could be discussed. The low bias stands out and is significant.

Yes, the low bias motivates the recommendation of 50-75 mm reduction in irrigation application. The fact that irrigation application is in excess of crop water demand is in line with Gibson, 2015.

L328: 'Regimes' again.

Will update to routine.

L338: See earlier comment. This is a major limitation to all of these approaches and modeling irrigation at this scale.

See comment above (L325).

L356: What does this imply about the assumed yield-irrigated amount relationship? That they underestimate and still didn't impact yield is even more surprising. There must be a lot of leeway (i.e. overwatering?).

This is the motivation and focus of the ongoing cost-share program funded by Coca-Cola within the study area. This will be the focus of Gibson's PhD looking at corporate supply chain sustainability and scientifically sound water savings numbers. More to come over the next few years.

L373: You are saying that, based on these models, you can get away with much less water and still produce the same yield, correct? Isn't that something that should have been quantified in the past (or known by the farmers)? Or is this still largely unknown?
How certain are we that the models are correct and that the yield will still be met?

See comment above.

L384: Supports the need for a bit further analysis/figures looking into the time series of the results.

We will investigate this.

L392: This was alluded to in an earlier comment: How can we know that prior decision making holds in the future or during other conditions not in the recent historical record?

We can only hypothesize about future conditions, continued monitoring of irrigation application will be important with the continued trend of irrigation technology adoption.

L404: Why? Is it because soil types here are so are similar, with slowly varying properties?

Measurement of the soil properties is currently in progress. This was a surprising result indeed!

L433: How about a controlled experiment/field to test sensitivity and realism of these schemes and resultant quantities? Is that reasonable in the future?

Integration of these considerations within a producer's operation may be feasible and is indeed the focus of current work. However, the suggestion of a producer strictly following these mechanistic routines and abandoning their own "know-how" is unlikely to be well received other than at research and extension centers with more control. Producers are unlikely to make decisions that will affect their economics. Perhaps a program where we compensate the producer for yield losses could be implemented in the future.

L443: Any predictive capabilities?

We will investigate this.

Section 4: This discussion section was welcome - lot of areas that need study but this is a good start.

L453: 'may be useful'?

Will update.

Section 5: The conclusions are a bit thin, and perhaps should focus on some of the limiting factors and broader/future applicability (precip forcing, decision making, soil properties).

Thank you for the suggestion.

Fig. 1: Hard to tell exactly where these fields are as this box points to a point on the corner of CO and NE.

Fig. 1: Might be interesting to overlay a 1km model grid on these to see what we are dealing with when trying to resolve individual fields.

Agreed, will take a look and see if this helps.

Fig. 2 (Caption): Is this from STATSGO or from individual field samples?

SSURGO data downloaded from web soil survey and parsed via the NRCS toolkit.

Fig. 3 (Caption): Inferring that heavier precip is more localized?

Thank you for the suggestion.

Fig. 4 (Caption): depths across all sites?

Thank you for the suggestion.

Fig. 5: Hard to see the error bars (busy plot already) - are they important or can they be conveyed in a sentence or two (general trends of increasing w/irrigation amount?).

Agreed, will surmise in text.

Fig. 5: They are all underestimating the reported totals, though the slopes are consistent mostly weighted by the very high anchor points (600mm). Very mixed bag at lower values (300mm).

Thank you for the suggestion.

Fig. 6 (Caption): Is this P+I from observations, or output from the schemes?

From observation, will update.

Fig. 7: What is going on in 2008?

We will investigate this.

I'm a big disappointed in the analysis/figures. Would have been nice to see some time series of how these schemes are all working over time and in response to precip and precip variability.

To this end, it will be important for LSMs to get the seasonal and sub-seasonal cycle right (including the exact timing of irrigation) if they are to be used for coupled modeling and initialization. So the long-term or annual totals do not tell the whole story.

We will investigate this but are somewhat limited by the data only being at annual totals. We are working on a followup paper using energy use as a proxy to estimate subdaily irrigation rates in the area.