

Interactive comment on “Comparative analyses of hydrological responses of two adjacent watersheds to climate variability and change scenarios using SWAT model” by Sangchul Lee et al.

Anonymous Referee #2

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Summary

This paper uses a SWAT model to assess how water and nitrate budgets could be impacted by changes in CO₂, temperature and precipitation, as well as GCM model runs, for two watersheds in the Chesapeake Bay Watershed. Compared to the selected baseline period of 2001-2014, streamflow and nitrate loads were predicted to increase substantially. Differences in predictions between the two watersheds were attributed to the fraction of cropland within each basin. Crop growth responses to climate change were also estimated and linked to the hydrologic and nitrogen cycles. An impressive

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amount of data were integrated from different sources, as well as a lot of analysis calibrating and running many different models (SWAT, USGS LOAD ESTimator, etc). The authors demonstrate their knowledge of the literature on the topic in the introduction and provide thoughtful implications of their results for managers trying to improve water quality in the future.

General comments

First, given that changes such as increase in CO₂, temperature and precipitation are likely to occur simultaneously, what is the rationale for assessing the effects separately? This seems particularly tricky given that often temperature and precipitation can have opposite impacts on streamflow and nitrate loads. More justification of this choice would be helpful, as well as some discussion on how separating these changes might impact the results of the paper. The GCMs do include multiple changes simultaneously, but because the change in precipitation and temperature in the GCM runs are different from those in the “sensitivity runs”, it is difficult to understand the impacts of the difference in changes versus the consideration of simultaneous changes in multiple factors. For example, it would be helpful to know if there is an increase in temperature that would cancel out simultaneous increases in precipitation?

Second, how general are these results—for different parts of the Chesapeake Bay Watershed and/or for different climate scenarios (or simultaneous changes in different CO₂ or weather factors)? In some ways, the paper might be seen as a case study. More explanation of why these two watersheds can allow us to draw broader conclusions beyond them could help to address this issue.

Third, including the statistical analyses is a nice idea, but it is important to ensure that the tests are appropriate. Do these samples meet the assumptions of the tests that were used (such as independence)?

Specific comments

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- Abstract: Perhaps mention the analysis of crop growth changes in the abstract?
- Might be good to include some discussion of:
 - How representative of historic climate was 2001-2014? Or, more specifically, the calibration years of 2001-2008? Was any cross validation done to assess the sensitivity of the selection of these groupings and time periods?
 - How were the two levels of increase in temperature and precipitation selected? From results in Najjar et al 2009?
 - Likely impact of using humidity, wind speed and solar radiation from the built in weather generator? Is this commonly done?
 - How much nitrate data was used and/or how often were the nitrate grab samples taken? Are there studies assessing the accuracy of using USGS LOAD ESTimator?
 - How was the 2-year warm-up period used in the SWAT modeling?
 - Good that a number of statistics were used to assess model performance. Since NSE in real space more heavily weights the larger flow values, how well were the low flows captured? (Estimating NSE of the natural logarithms of the streamflows can also be helpful for this.)
 - p 15 lines 316-318: I'm a little unclear on this method and what ensemble is referring to here Are you taking the average across the whole time period predicted? Or are there multiple simulated outputs per monthly, seasonal, annual time period? "The range of changes in simulated outputs was represented with the ensemble mean to show overall responses of watershed hydrological processes to climate change (Shrestha et al., 2012; Van Liew et al., 2012)." Also with regards to the 95 PPU's estimated – some more explanation of the sample of simulations used would be helpful.
 - P 17 line 352-354: specify what "good" or "very good" meant numerically or list some numbers from the table.

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- Figure 3: Do you know why there is such a difference between the two watersheds in terms of the 95 percent prediction uncertainty?
- Figure 4: perhaps connecting the ET with a line would help? It's a bit difficult to interpret
- P 18, Line 373: Since you are presenting p-values, do these predictions meet the assumptions of the statistical tests?
- Figure 5: Wouldn't CO2 and temperature likely both increase simultaneously? How would this effect plant growth?
- Figure 6: Since these are relative to the baseline, consider plotting pluses and minus relative to that value to better illustrate the changes? -P 21 Section 3.3 Lines 435-447: Did the GCM model runs include changes in CO2?
- P 22 lines 464-474: Should this section be sooner as it also impacts the results presented previously for the one-by-one simulations?

Technical corrections

- P2 line 23-24: Should the first line of the abstract perhaps read "be exacerbated by" rather than "exacerbate under"?
- P 4 line 64: The Chesapeake Bay is the largest estuary in North America and thus the US, not just within the mid-Atlantic region. Maybe this sentence could be restructured along the lines of: "Located in the Mid-Atlantic region, the Chesapeake Bay (CB) is the largest and most productive estuary in the United States (US)."
- P 6 lines 112-116: These two sentences seem to be saying the same thing as one another (and reference the same papers) – maybe cut one of the sentences?
- P 17 line 349: I would use the word "outside" or something similar rather than "beyond" which might imply higher than (when the reality is that predictions are lower).

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P 24 line 514 Section 4: I think this should read “Implications” with an “s” at the end?

P 26 line 560: typo: “five GCM data”

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