

## HESS Review – Response

We would like to thank all referees and the editor for taking the time to assess our responses and for the helpful comments and suggestions. Below, we provide the response for each.

### Referee 1

The authors present a work to use hexagonal cells for investigation of global irrigation expansion in comparison to that derived from using lat-lon based grid cells. This work is interesting for me. The authors find that the use of hexagonal cells can achieve a better prediction performance while being compared to the use of lat-lon grid cells based on the random forest method. My major concerns are why and how the hexagonal cells can work better than the lat-lon grid cells.

1. Line 115: Besides the ‘1’ for fully irrigated and ‘0’ for none irrigated, how about the cells partially irrigated?

**Reply:** The variable is the irrigation fraction, so all values between 0 and 1 are possible. We rephrased the sentence to make it less ambiguous.

2. Figure 2: Why the resolution 9 (d) looks similar to the lon-lat (a)? Since the resolution 9 has a resolution finer than resolution 7 and 8, what I expected is that it will lead to a better performance than (a) and (b). Besides, the statistical performances can be displayed in the sub-figures.

**Reply:** We describe this in section ”Grid choice”. Actually, the more aggregated the values are (larger grid cells) the better the prediction performance is. The resolution 9 grid on average has a similar grid cell size than the lat-lon grid, while the resolution 8 grid has a comparable total amount of cells. According to Figure 2, the predictions from the lat-lon grid and the resolution 9 grid perform similar with regards to a visual inspection of the scatter plot. Table 2, however, shows that the resolution 9 grid is still superior to the lat-lon grid, when analyzing the detailed statistics.

3. Line 27: Since the authors claimed the unique of northernmost regions, it will be interesting to find the difference of prediction in such areas based on the hexagonal and lat-lon cells. For example, can we find the differences between the high-latitude areas while being compared to that in the low-latitude areas, as the two regions have different geographic distortions while being mapped at grid cells.

**Reply:** Please see also our reply to comment 4 below. With a uniform lat-lon grid, the cells in areas near the equator are too large compared to those in Europe. This leads to an unnatural number of samples in these grid cells, and the effect is amplified by the grid.

4. Section 4.2: The analysis is necessary, but I am more interested on the role of hexagonal cells in interpretation. Will the lat-lon grid cells lead to different explanations? The

more deeper discussions on this point, i.e., why and how the hexagonal cells can work better than the lat-lon grid cells, can help us better understanding the topic of this study.

**Reply:** We are not sure how to address this comment. Section 4.2 specifically compares the relative importance and partial dependencies between the lat-lon grid and the hexagonal grid. Since the grid cells are more uniform in shape, size, and area compared to a traditional lat-lon grid (with the exception of a very small number of cells), it is expected that this grid will perform better. This uniformity enhances the interpretability of the overall results and their significance for individual grid cells. The role of neighbouring cells becomes more pronounced, as the definition of a neighbour is now much clearer—each neighbour shares an equal-length border with the considered cell, which is not the case in the lat-lon grid.

### **Referee 2 (Shijie Jiang):**

1. I appreciate the authors' comprehensive response to my previous concerns, which have been successfully addressed. I have only one minor editorial comment before the manuscript can be accepted: The bar plot colors in Figure 4 are too similar, making it difficult to distinguish between the bars. I recommend adjusting the colors to improve readability.

**Reply:** We will do that, thank you!