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Comment on essd-2021-217

Anonymous Referee #1

Referee comment on "Development of East Asia Regional Reanalysis based on advanced hybrid gain data assimilation method and evaluation with E3DVAR, ERA-5, and ERA-Interim reanalysis" by Eun-Gyeong Yang et al., Earth Syst. Sci. Data Discuss., <https://doi.org/10.5194/essd-2021-217-RC1>, 2021

Comments on "Development of East Asia Regional Reanalysis based on advanced hybrid gain data assimilation method and evaluation with E3DVAR, ERA-5, and ERA-Interim reanalysis" by Yang et al.

The authors generated the East Asia Regional Reanalysis (EARR) using Weather Research and Forecasting (WRF, v3.7.1) during the ten-year period 2010-2019, based on the advanced hybrid gain data assimilation method (AdvHG). The new advanced hybrid gain (AdvHG) data assimilation method combining E3DVAR and ERA5 based on WRF model is newly proposed and investigated in this study. The manuscript verified the EARR for two-year period 2017-2018 by comparing EARR against ERA-Interim, ERA5 and observations.

I think a lot of work behind this manuscript is worth publishing. However, there are some details and the underlying physics processes were not well discussed.

The detailed comments are listed as below:

Major comments:

- It is not easy to understand the regional reanalysis method used in this paper. I'd suggest the authors use schematic diagram to clearly describe the regional reanalysis method. What does "forecast fields are integrated up to 36h" mean? Is reinitialization used? What does "6h forecast of ERA5 reanalysis based on WRF model" mean? Does it mean WRF simulations using ERA5 as LBC forcing? How many experiments are used in this manuscript? What experiments do "E3DVAR", "AdvHG", "WRF-ERA5" and "WRF-ERAIN" refer to respectively? These details should be more clarified.

- The newly advanced hybrid gain (AdvHG) data assimilation method uses 6h forecast ERA5 instead of deterministic analysis, and uses ERA5 instead of producing their own analysis fields from a variational DA method. The method is expected to save time and computing cost compared to traditional data assimilation framework. Why does the author use the 6h forecast of ERA5 reanalysis based on WRF instead of the deterministic analysis in AdvHG? Will the regional reanalysis be more accurate if using ERA5 deterministic analysis in AdvHG?

- EARR is developed during the ten-year period 2010-2019, while in the manuscript, the authors only verified the product for two-year period 2017-2018. Why is this two-year period instead of the entire ten-year period chosen to be verified? I would like to see how the EARR product performs compared to the other two ECMWF global reanalysis in a longer time period, and whether EARR is suitable for application in long-term climatology research. If so, the influence of this product will be greatly increased.

- The precipitation of AdvHG in winter (January) is the most accurate among other results, while E3DVAR (ERA5) performs better for weak (strong) thresholds in summer (July). The assimilation method tends to have positive effects on the simulated winter rainfall while brings limited improvement on summer rainfall. The possible underlying physics have not been well understood. Which physical process could be mostly possible affected leading to such positive effects?

- Figure 2, it is clear that E3DVAR has the lowest RMSE for up-level variables, so what are the advantages of AdvHG? Does ERA5 in Fig. 2 mean WRF results forcing by ERA5?

Minor comments:

- The meaning of variables in Eq. (3)-(6) should be clarified.