

Geosci. Model Dev. Discuss., author comment AC4
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Reply on RC1

Ivette H. Banos et al.

Author comment on "Assessment of the data assimilation framework for the Rapid Refresh Forecast System v0.1 and impacts on forecasts of a convective storm case study" by
Ivette H. Banos et al., Geosci. Model Dev. Discuss.,
<https://doi.org/10.5194/gmd-2021-289-AC4>, 2022

General comments:

The paper is overall well structured, clearly described, and provides a succinct evaluation of a single use case used for tuning some parameters of RRFS. My one critical comment here is that the title may be a bit misleading, and should be modified if possible (something along the lines of '*... on forecasts of a convective storm case study*'. As it stands, readers are at first likely expecting a larger, more comprehensive, data assimilation evaluation paper consisting of multiple case studies and deeper analyses. To be clear, this single case study paper is useful, but the correct expectation should be set with the title.

We thank the reviewer for the comments and suggestions. Our responses are noted below. Changes to the document are highlighted in magenta.

The title was modified to "Assessment of the data assimilation framework for the Rapid Refresh Forecast System v0.1 and impacts on forecasts of a convective storm case study"

Specific comments:

- **GSI is capable of hybrid 4DEnVar. Is there a reason this flavor of DA was not included in the comparisons?**

The Rapid Refresh Forecast System (RRFS) is intended for hybrid 3DEnVar data assimilation following the currently operational Rapid Refresh (RAP) configuration. As in RAP, hourly updated cycles are configured in order to leverage available data with higher frequency such as surface observations. Testing and development of a hybrid 4DEnVar system is a worthwhile pursuit, but due to limited resources it is beyond the scope of this article describing the v0.1 capability.

- **For those not familiar with how rapid refresh systems are typically cycled, why is it necessary to perform a periodic cold start even though hourly DA is performed?**

Rapid refresh systems are usually configured for regional domains in which a reduced amount of data is used compared to global domains. Benjamin et al. (2016) pointed out

the importance of a partial cycling technique to update large scale conditions such as the longwave representation. This is of greater importance in regional domains with coverage over oceans such as in RAP and thus in RRFS, where cycles with a warm start from a parallel partial cycle (currently only cold start in RRFS v0.1) are used in order to improve the drift from the global scale. A sentence was added to account for the reviewer's comment.

Lines 241-243: "Periodic updates of the large scale atmospheric conditions are needed in regional modeling systems in order to account for corrections made by global observations over land and ocean and to avoid model drift from those conditions (Benjamin et al., 2016)."

- **You mention the great importance of tuning localization parameters but only vertical localization is tuned, why is it assumed that the default horizontal localization does not need tuning?**

We agree with the reviewer. RRFS v1 will use a convective-scale ensemble and therefore the horizontal localization also needs to be tuned in order to assess if the default localization is good enough or if a different value leads to better results. In this study using RRFS v0.1, we use global ensemble members and seek to establish a measure of sensitivity to such parameters to inform further development. For convective systems the vertical representation is very important for storm initialization. Due to limited resources and time, and taking into account that a 3 km grid spacing is used in the experiments, similar to the High Resolution Rapid Refresh (HRRR) horizontal resolution, we decided to only present results of tuning the vertical localization. Testing and evaluating the horizontal localization in RRFS is underway in a separate work. A sentence was added to address the reviewer's comment.

Lines 312-313: "A separate study is underway in which the optimal horizontal localization for RRFS is also investigated and therefore it is not examined here."

Technical corrections:

- **At first I was confused by the different version numbers RRFSv1a/RRFSv0.1, perhaps it would be useful to clarify early on that these are the physics suite / cycling system**

In order to avoid confusion between these acronyms, RRFSv1a was changed to RRFS_PHYv1a and is more clearly written that RRFS v0.1 is the prototype RRFS used in this study. Lines 67, 111, 152-153, 594 were modified to account for these changes.

Line 66-67: "...a suite based on GFS version 16 physical parameterizations and a prototype of the RRFS physics suite (henceforth called RRFS_PHYv1a)."

Line 105: " For the purpose of this paper, the prototype RRFS used is called RRFS v0.1"

- **64 - define what the "convective gray zone" is for readers who might not be unfamiliar**

Line 65 was modified in order to provide a more straightforward argument of what was investigated in Harrold et al. (2021):

Line 65: "Harrold et al. (2021) investigated how the SRW represents convection and associated precipitation for varied model grid spacing in two physics suites..."

- **92 - "as good" -> "as well"**

As suggested, the correction was made in line 94.

Line 94: "...it is imperative that the data assimilation component behave **as well as or better than** the current operational state-of-the-art"

References:

Benjamin, S. G., Weygandt, S. S., Brown, J. M., Hu, M., Alexander, C. R., Smirnova, T. G., Olson, J. B., James, E. P., Dowell, D. C., Grell, G. A., et al.: A North American hourly assimilation and model forecast cycle: The Rapid Refresh, *Monthly Weather Review*, 144, 1669–1694, <https://journals.ametsoc.org/view/journals/mwre/144/4/mwr-d-15-0242.1.xml>, 2016

Harrold, M., Hertneky, T., Kalina, E., Newman, K., Ketefian, G., Grell, E. D., Lybarger, N. D., and Nelson, B.: Investigating the Scalability of Convective and Microphysics Parameterizations in the Unified Forecast System Short-Range Weather (UFS-SRW) Application, in: 101st American Meteorological Society Annual Meeting, AMS, 2021