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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Assimilation of wind data from airborne Doppler cloud-profiling radar in a kilometre-scale NWP system" *by* Mary Borderies et al.

Anonymous Referee #1

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Review comments on "Assimilation of wind data from airborne Doppler cloud-profiling radar in a kilometre-scale NWP system" by Borderies et al.

The authors assimilated wind profile data observed by an airborne Doppler radar, and then examined their impacts on wind field and rainfall forecasts using a kilometer-scale DA. Positive impacts were seen both in the wind field and rainfall forecasts of the case study. Especially they found slightly better result in the 3-h assimilation window experiment. On the other hand, a statistical study showed mostly neutral skills between the 1-h, 2-h, and 3-h assimilation windows, even in comparison with the control experiment (no data assimilation). The 1-h assimilation window experiment was very slightly hope-

ful in rainfall forecast. I recommend the authors to improve the manuscript and conduct some additional investigations before publication.

[Major comments]

1. The authors conducted two verification of a case study and a statistical examination. The case study showed that the RASTA assimilation improved wind and rainfall fields, and the 3-h assimilation looked best. On the other hand, the statistical examination for the entire domain in Figure 1 illustrated that the RASTA assimilation mostly had no impact even on the wind field, and only the 1-h assimilation has some skill in rainfall forecasts. Since the RASTA data is limited in cloud region, the assimilation impact is also limited in time and space. I suggest that the statistical examination is re-conducted over a limited area, for instance, the Figure 2 area, or convective-system-related area, or RASTA-related area, since the inconsistent results between the case study and the statistical examination makes the readers confused.

2. I agree that Figure 6 implies a spin-up problem in forecast. For the reason of the spin-up, I doubt that the observational error of RASTA use in the present study would be smaller than appropriate value because it is the same with that of radiosondes. The error should be larger since RASTA includes much more sources of errors than radiosondes include.

3. I suggest that Figure 5, and explanations for Figures 4 and 5 will be modified. The increment in Fig. 5A is reflected the flight path of all observations, thus, all data points assimilated in this 3-h window should be presented in Fig. 5A. Moreover, the 1-h, 2-h, and 3-h assimilation window experiments include the observation until 0630, 0700, and 0730 UTC, respectively (L10 P7). I think that this different time limitations create the difference between panels in Figure 4 unlike the authors explanation on overpasses (L6-17 P8). Please exam and discuss this point of view.

4. It is amazing for me that RASTA_3h in Figure 4 improved the wind filed even at the end of the assimilation window because the experiment did not employ FGAT. Since

the RASTA data only exist in cloud area, 3 hours seems too long to assimilate the data appropriately. I understand that this is the motivation of the authors to conduct three experiments. If they use FGAT, the 3-h experiment may significantly improve the result. I recommend the authors to conduct the FGAT experiment additionally if possible.

5. The authors used the median value of observations in a grid box (L16 P5) for thinning. If observational data distribute followed the Gaussian PDF and their number are large enough, the median and the mean values are the same. Usually "super observations" are made by the "mean" method in order to reduce representativeness errors and avoid noises. Therefore, the authors should explain why they adopt the "median" method instead of the mean.

6. English needs to be proofread by professional native speaker(s) with scientific background.

[Minor comments]

L23 P1: "To fill the gap in clear air condition" I suggest the authors to refer the following articles, because wind observations in clear air can be also provided by Doppler lidars (air-born and ground-based), and clear air echoes (insects) by Doppler radars.

[Ground-based lidar] Kawabata, T., H. Iwai, H. Seko, Y. Shoji, K. Saito, S. Ishii, and K. Mizutani, 2014: Cloud-Resolving 4D-Var Assimilation of Doppler Wind Lidar Data on a Meso-Gamma-Scale Convective System. Mon. Wea. Rev., 142, 4484–4498, doi: 10.1175/MWR-D-13-00362.1. [Air-born lidar] Weissmann, M., R. H. Langland, C. Cardinali, P. M. Pauley, and S. Rahm, 2012: Influence of airborne Doppler wind lidar profiles near Typhoon Sinlaku on ECMWF and NOGAPS forecasts. Quart. J. Roy. Meteor. Soc., 138, 118–130, doi:10.1002/qj.896. [Clear air echoes] Kawabata, T., H. Seko, K. Saito, T. Kuroda, K. Tamiya, T. Tsuyuki, Y. Honda, and Y. Wakazuki, 2007: An assimilation and forecasting experiment of the Nerima heavy rainfall with a cloud-resolving nonhydrostatic 4-dimensional variational data assimilation system. J. Meteor. Soc. Japan, 85, 255–276, doi:10.2151/jmsj.85.255.

L19 P2: "has never been investigated" I did not understand what thing has never been investigated in the following "vertical profiles from Doppler W-band radar". "vertical profiles from Doppler radar"? "W-band radar"? "vertical profiles" by W-band radar? ("horizontal" winds have been done)? Please clarify.

L30 P2: "first" This is the same with the above. What is the first?

L8 P3: "HyMeX-SOP1" What is this? Spell out it and add explanation.

L28 P3: "six Cassegrain antennas" How do these six antennas observe three directions above and below the aircraft? Add explanation and, if possible, a schematic figure.

L30 P3: "unambiguous distance" "unambiguous velocity" What are these? Observational range and available observations? But, in Figure 4, we see larger observations than 7.8 m/s.

L22 P4: "2.5 km x 2.5 km" Modify it to 2.5 x 2.5 km" and add the number of horizontal grids or the horizontal size of the domain.

L25 P4: "specially designed" What is the special in this study? Please clarify.

L7 P5: "GPS" Spell out it. GPS stands for Global Positioning System operated by U.S.A.. I guess the authors use other navigation satellite systems like Galileo and GLONASS. In this case, GPS should be replaced by "GNSS" (Global Navigation Satellite System).

L17-19 P5: "When the aircraft – removed from the interpolation." It is hard to understand the situation and removed data. Did the authors remove the data only outside the grid box or the whole profile of the data? It should be better to show a schematic figure of the aircraft with the six radar antennas, and wind profiles in and out the grid boxes.

L29 P6 and L10 P10 I suggest that the title of Section 5 and 6 as well as the examinations are named as "the case study" and "the statistical study" instead of IOP7a and

HyMeX SOP1, respectively.

L30, L31, L34 P9: “the maximum rainfall” Please show the exact maximum values in each experiment, not approximated values.

L31-31 P10: “small number” From Figure 8, the numbers of observations are several thousands. These are not “small”.

Figure 1 Add the explanation on the red box.

Figure 3 It is helpful for the readers if the authors add the information on flight level in this figure, for instance, by changing the size of circles as height, or by replacing the circles with triangles or rectangular or cross-marks as height.

Figure 4 Add (a), (b), (c) and etc. or figure titles to each panel to refer it easier.

Figure 7 Add the maximum rainfall amount values to each panel.

Figure 8 I suggest that Figure 8 will be illustrated by the difference between CTRL and others, not each profile, in addition to the examination on the limited area (see the major comment).

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