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Interactive comment on "Changes in the simulation of instability indices over the Iberian Peninsula due to the use of 3DVAR data assimilation" *by* Santos J. González-Rojí et al.

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Reply by authors starts with the symbol ».

Dear authors,

I find this paper very interesting and well written. Nevertheless, from my point of view clarification about the vertical levels of ERA-Interim used as input to WRF is needed.

» Thanks for your kind words and we appreciate these insightful comments.

Authors write that they used 20 levels without providing further details. In González-Rojí et al, 2018 we find the information that levels range from 5 hPa to 1000 hPa. I

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conclude from this that authors work with data on pressure levels available from the ECMWF servers.

Counting the available pressure levels between 5 hPa and 1000 hPa from ECMWF, I find 34 levels. When data on model levels are used, 60 levels are available (terrain following and thus with different pressure levels at each grid point).

» Yes, we feed the WRF model with analyses of temperature, relative humidity, both wind components and geopotential at 20 pressure levels downloaded from the MARS repository. The exact pressure levels are: 5, 10, 20, 30, 50, 70, 100, 150, 200, 250, 300, 400, 500, 600, 700, 800, 850, 900, 925, 950, 1000 hPa.

» The data in the original model levels from ERA-Interim are represented in spherical harmonics, and we feed the inputs to WRF model in a regular longitude/latitude grid. The reason is that all the variables needed by WRF are obtained only in that regular grid. Only temperature is available in the original model levels from ERA-Interim (see Table 3 from Berrisford et al., 2011). Those are the reasons that we didn't follow the path suggested by Dr. Barfurs.

» Berrisford, P., Dee, D., Poli, P., Brugge, R., Fielding, K., Fuentes, M., Kallberg, P., Kobayashi, S., Uppala, S. and Simmons, A., 2011. The ERA-Interim archive, version 2.0. https://www.ecmwf.int/en/elibrary/8173-era-interim-archive

The calculation of CAPE and CIN is sensitive to the vertical of resolution of the data. If authors used pressure level data, information about the used levels and why they did not use all available pressure levels is needed. Furthermore, I would like to read why authors did not use model level data, since they provide much more information about the temperature and humidity profiles especially in regions with high topography.

If authors used model level data, I also would like to read information about the used levels and why not the full set of available levels have been used. From my point of

view some information provided by the assimilation could already be enclosed when using all available model levels.

» We know that both CAPE and CIN are sensitive to the number of vertical levels used in their calculation, but concerning ERA-Interim, we have not calculated the values of these indices. Neither in the original model data nor in the downloaded pressure levels. We have not used in our paper the CAPE values available in the forecast stream (not the analyses stream) of ERA-Interim (see Table 8 from Berrisford et al., 2011). Since the objectives of our paper do not include a comparison of WRF versus ERA-Interim, we do not see necessary to add this information.

» Regarding the indices calculated with the measured data from the radiosondes from Wyoming (aiRthermo in the manuscript), all the available pressure levels in the soundings were used for the calculation of TT, CAPE and CIN.

» In the case of both WRF simulations, the calculations were done using all the available eta model levels from our configuration. As stated in the manuscript, 51 vertical eta levels up to 2000 hPa (value at the top of the atmosphere) are available.

» All this information about the calculation of the indices with the pressure levels available for each option (aiRthermo and both WRF simulations) is already stated in the subsection 2.3.1. However, in the next version of the manuscript, all this information will be stated in a clearer way.

» Berrisford, P., Dee, D., Poli, P., Brugge, R., Fielding, K., Fuentes, M., Kallberg, P., Kobayashi, S., Uppala, S. and Simmons, A., 2011. The ERA-Interim archive, version 2.0. https://www.ecmwf.int/en/elibrary/8173-era-interim-archive

A minor issue: as far as I know, there is no quality control for the Wyoming radiosondes. Authors should provide information about their own QC routines. Waiving the high vertical resolution of Wyoming radiosondes (from my point of view not a good idea

when analyzing CAPE and CIN), IGRA quality controlled radiosondes could be used.

» The radiosondes from Wyoming University were already used for the validation of the precipitable water from our both experiments in González-Rojí et al. 2018, and none of the values were taken as erroneous. For the continuity of the study related with both simulations, we decided to use the same radiosondes for the calculation of the indices. Additionally, since the values of CAPE are very sensitive to methodological factors, such as the computation of the initial parcel or the vertical spacing in pressure levels, we have estimated CAPE and CIN from the values of temperature and relative humidity at pressure levels in IGRA soundings using the same methodology that we have used in our paper (see Section 2.3.1).

» In order to validate the CAPE, CIN and TT indices calculated by Wyoming University, they were compared with the ones calculated by IGRA as suggested by Dr. Barfurs. The comparison shows that the results are not sensitive to the selection of the dataset, (see enclosed Taylor diagrams). We expected these results, since the use of homogenous data is particularly important for long-term trends, and we are simply analyzing five years of data.

» Figure 1 shows by means of Taylor diagrams the comparison of previous results included in the paper against the TT index calculated from the IGRA soundings (all levels), which will be chosen as the reference. It is clearly seen that the closest points are always without almost no exception the green ones (values of TT reported by the Wyoming archive), and the yellow ones (those computed by our package aiRthermo from the pressure levels from Wyoming archives) with the only exception of Murcia. The next best determination of the TT index is achieved by the D experiment (WRF run including data assimilation, blue points) and, finally, the red points corresponding to the N simulation (WRF run without data assimilation) shows the worst agreement in all cases. This implies that the use of IGRA data as the reference instead of the Wyoming soundings does not change the conclusions of our study (even the exception for Murcia was observed in our previous results). It also shows that the error due to

homogeneity in such a short interval of time (five years) is very small (at least, in this observational record).

» Figure 2 shows a similar result for CAPE. The estimation of CAPE from Wyoming and the one estimated with aiRthermo using pressure levels from Wyoming soundings are always quite close to the value estimated from IGRA soundings (RMSE smaller than 20 J/kg in all cases). As in the case of TT, the main results of our paper are not affected by switching the reference dataset from Wyoming to IGRA: the D experiment shows better agreement with observed CAPE than the N experiment.

» Figure 3 shows the same result for CIN. The RMSE of CIN values computed from Wyoming soundings and IGRA soundings is also small (smaller than 20 J/kg). With the only exception of Gibraltar, in which N and D behave exactly the same (this was also observed in the paper), D always produces better results than the N simulation.

» Thus, we find that our results are robust to the selection of the observational dataset. However, the figures that we show here will be incorporated to the final version of the paper, since we feel this comment leads to a better paper.

» González-Rojí, S.J., Sáenz, J., Ibarra-Berastegi, G. and Díaz de Argandoña, J., 2018. Moisture balance over the Iberian Peninsula according to a regional climate model: The impact of 3DVAR data assimilation. Journal of Geophysical Research: Atmospheres , 123 (2), pp.708-729.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2020-53/hess-2020-53-AC1-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2020-53, 2020.

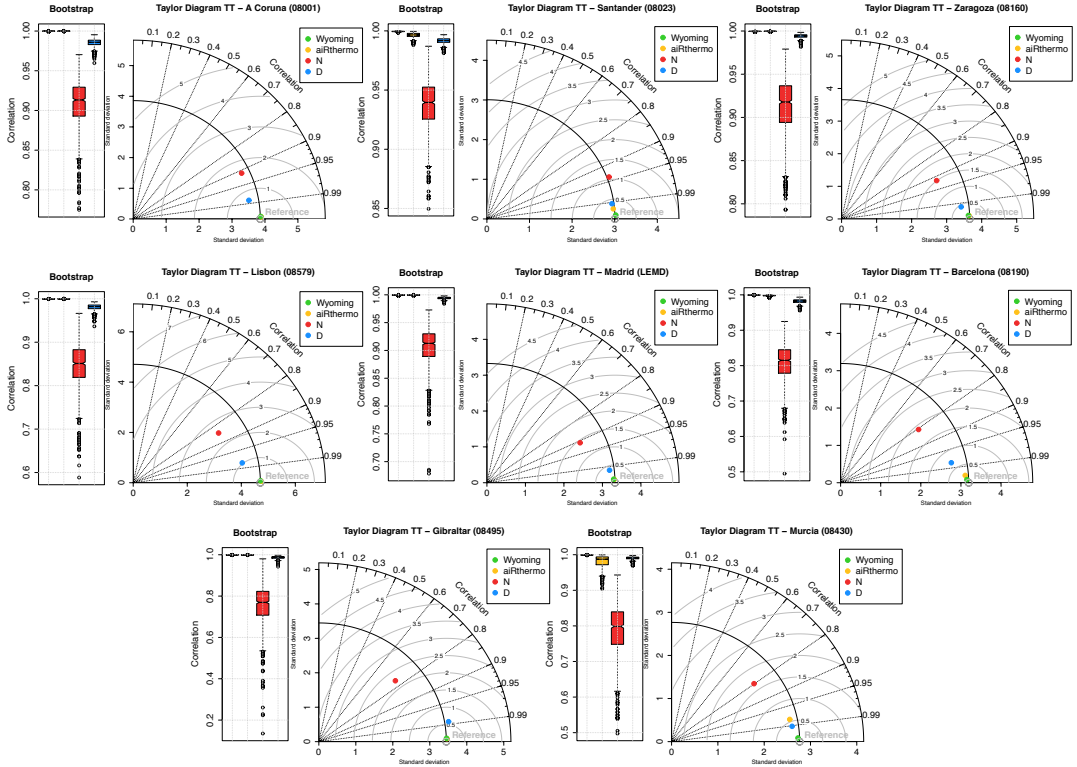

Fig. 1. Taylor diagrams of TT index if the values from IGRA are taken as reference.

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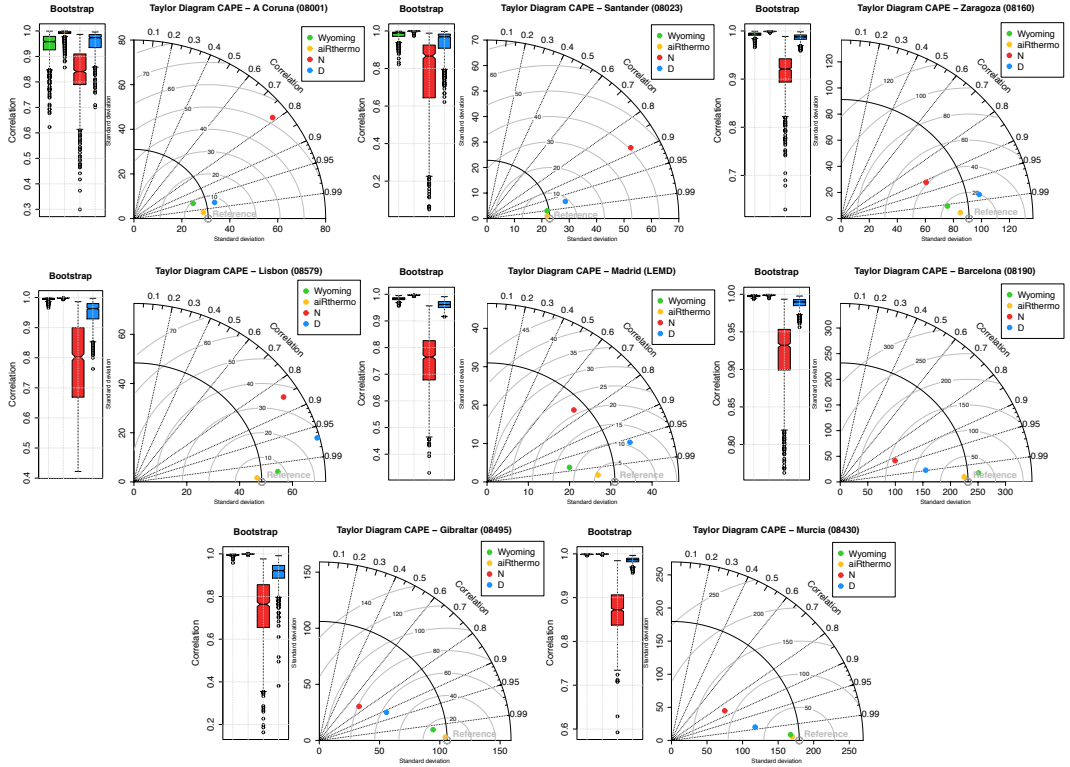

Fig. 2. Taylor diagrams of CAPE if the values from IGRA are taken as reference.

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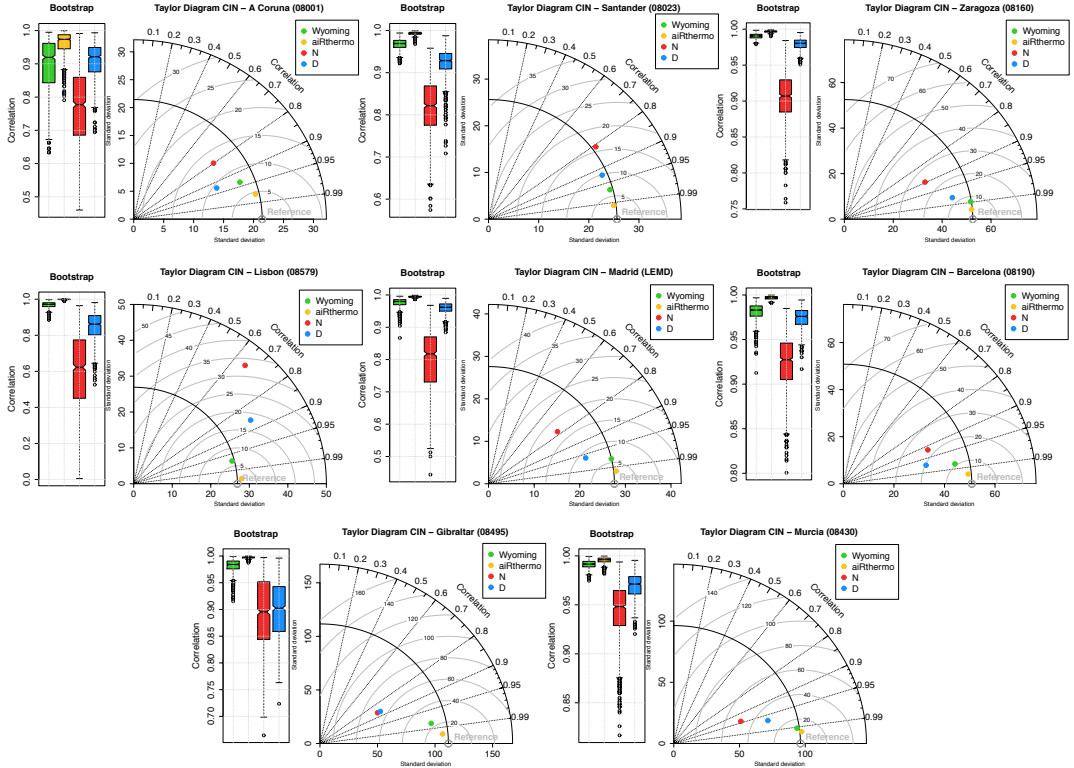

Fig. 3. Taylor diagrams of CIN if the values from IGRA are taken as reference.

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