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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Validation of a new SAFRAN-based gridded precipitation product for Spain and comparisons to Spain02 and ERA-Interim" *by* P. Quintana-Seguí et al.

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We thank the reviewer for the time spent reviewing this article and by raising two main issues, which, when addressed, will improve the quality of the manuscript.

Hereafter we will use italics to cite the referee's text and we will use regular type for our own answers.

Summary: The paper presents a validation of a precipitation dataset for Spain meant potentially for hydrological and climatological simulations. The new generated dataset spanning more than four decades it is primarily of regional interest. Gridded precipitation data are important for hydro-climatological applications and its evaluation has to

be appropriate.

The paper is well structured, the results are clearly presented but the methodology used for verification (Section 3.6) is not sufficiently described. As such, it gives the impression that it is suitable for continuous variables rather than for precipitation. To avoid misleading results for precipitation, the verification should be carried out such as the precipitation datasets used for verification, including rain gauge measurements, to represent the same spatial scales. I recommend publication once the authors have clarified these aspects and responded to the comments below.

The two main issues raised by the referee are:

1. The methodology is not sufficiently described.
2. The verification should be carried out such as the precipitation datasets used for verification, including rain gauge measurements, represent the same spatial scales.

Concerning these issues:

1. We agree that we can improve the quality of the methodology section (section 3.6).
2. We think that we must improve the discussion on the sampling errors in both the methodology section and in the discussion, but we do not think we have to change the methodology.

Hereafter we respond in detail to all the questions raised by the reviewer.

Specific comments:

In order to improve the clarity of the paper, the authors might consider either to expand the acronyms before their first usage (as they have already done it in the first line of the Abstract) or to add an Appendix in which to list all the acronyms in the paper.

We agree and we can apply any of the solutions proposed.

Section 1 Page 2, Line 15: Typo: e.g. -> to be removed.

We do not consider this a typo, as we added it consciously. But we can remove it if the editor deems it necessary.

Page 3, Line 33. ERA-Interim precipitation data come from pure low-resolution forecasts and this should be pointed out in the paper.

We can clarify this in the text.

Section 2. Page 4, Line 14: After Koppen classification a reference is missing and should be introduced.

Yes. The best reference would be Peel et al. (2007), which is the classification used in AEMET (2011), which we already cite.

Peel, M. C., Finlayson, B. L., & Mcmahon, T. A. (2007). Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences*, *11*, 1633–1644.

Section 3.1 Page 5, Line 2: Ritter and Geleyn (1992) developed a scheme for the parametrization of the radiative transfer in numerical weather prediction models. It should be better explained that SAFRAN uses this scheme to produce forecast fields for downward visible and infrared radiation.

This can be done. However, following the recommendations of Reviewer 1, we might remove emphasis on the other variables of SAFRAN, different from precipitation.

Page 5, Line 8: How the climatically homogeneous zones are defined, particularly in

areas where no rain gauge measurements are available as in the northeastern Spain (Fig.1b).

Climatological zones are an important part of the SAFRAN approach. They should be areas of about 1000 km2 with weak horizontal gradients of the different variables, even though in practice, it is impossible to create zones that perfectly fulfil these requirements. The availability, or not, of stations is not considered when designing the zones. In the case there are no stations in the zone, SAFRAN will use information from stations in neighbouring zones. For variables other than precipitation, the first guess is, of course, also used.

When we decided to implement SAFRAN in NE Spain we started our tests using river basin limits and AEMET's meteorological alert zones (Quintana-Seguí et al. 2016a). Although the difference was small, better results were obtained when using meteorological warning zones.

When we decided to expand SAFRAN to the whole of mainland Spain and the Balearic islands, we found that, in some regions, the meteorological alert zones of AEMET were too big; thus, we decided to subdivide them. We manually modified these large zones with the aid of a map of river basins and our own expert knowledge. In some areas it was very easy to define limits, just using basin boundaries; however in others, such as flat regions where there are no obvious discontinuities in the values of meteorological variables, the divisions were somewhat arbitrary. Note that, in this particular case, this is not a problem since the horizontal gradients are weak.

To sum up, the method used to define the map of zones shown in Figure 1, combined our own expert knowledge on the local climate, meteorological alert zones, river basin boundaries and the knowledge acquired in our previous study showing that the sensitivity to the limits of the zones is low.

We can include a description of the process in the manuscript.

Page 5, Line 10: 'The zones have several vertical levels, spaced ... '. How many vertical levels are? Do all zones have the same number of vertical levels?

There is the ground level (at whatever altitude it is) and then levels at 300, 600, ... m. Of course, only the levels higher than the relief are considered. Similarly, the upper level depends on the relief of the zone. As many levels as necessary are included in order to surpass the altitude of the highest point of the zone.

Page 5, Line 11: 'These values are subsequently horizontally interpolated to a regular grid ...' Does it mean that each zone has its own regular grid? What is the value of the grid-mesh? In addition, how many grid points on a horizontal plane contains a zone? How many analysis points has SAFRAN across Spain? How the analysis horizontal points are defined or chosen?

We can clarify the description of the interpolation to the grid in the article, even though this is explained in Quintana-Seguí et al (2008, 2016a). We can add the grid points on Figure 1 and, maybe, a map of the gridded precipitation. This would further clarify this point.

There is a single regular grid. It is a 5 km resolution grid in a Lambert Conformal Conic projection that covers all the Iberian Peninsula and the Balearic Islands. All the land grid points belong to a zone. So, once the analysis is performed for each zone, we have a value of precipitation for each altitude level (one value at the ground, another at 300 m., another at 600 m., and so on). Then we find the value of precipitation for each grid point. Each grid point has an altitude. The precipitation of that grid point will be the linear interpolation of the precipitation of the two closest levels. This way, we go from a value of precipitation for each zone and level, to a value of precipitation for each grid point.

Page 5, Line 15: 'Afterwards, the data are time interpolated to the hourly scale using different methods for each variable...'. It should be described how accumulated daily precipitation is hourly disaggregated, particularly over the mountains when liquid and

solid precipitation may occur during the same day.

We did not explain this in this article because the article focuses on daily precipitation and, thus, hourly interpolation, which is explained in previous papers, does not affect at all the results.

Page 5, Line 16: '... SAFRAN uses as much data as possible ...'. How the observation quality control is performed in SAFRAN? For each grid point how many nearby observations are allowed to be used?

SAFRAN does a quality control of the observations. This is an iterative procedure based on the comparison between observed and analyzed quantities at the observation location (Quintana-Seguí et al. 2008).

Page 5, Line 24: '... for which no first guess is used.' Optimal Interpolation do need a first guess, therefore if no first guess is used for precipitation analysis, what type of interpolation for rain gauge measurements employs SAFRAN? Please describe the precipitation analysis scheme used in SAFRAN.

Our writing is indeed confusing. The first guess used by SAFRAN is a field of zero precipitation. This gives better results than using, for example, the precipitation fields of ERA-Interim.

Section 3.2 Page 6, Line 3: Which is the Spain02 AA-3D grid mesh value used?

The resolution of Spain02 AA-3D considered was 0.11°.

Section 3.4 Page 6, Line 13: '... which start in September ... '. Also, it should be mentioned when the hydrological year ends?

We can mention this. In hour context, hydrological years start on the 1st of September and end on the 31st of August.

Section 3.6 As I have already mentioned in the summary, this section should better describe the methodology used for verification. Unlike gauge measurements which

are point observations, model precipitation represents the area of the model grid box, that is about 79 km times 79 km for ERA-Interim but not mentioned for SAFRAN. Comparisons between precipitation observation and the nearest grid point might provide misleading results.

We agree with the referee that the local or areal representativeness of the different datasets is an important problem for most verification studies. However, in our opinion all analyses in this study are independent of this problem for two main reasons:

- On the one hand, the article is focused on the intercomparison of the products (SAFRAN and Spain02) using a common dataset, with observations as reference. In this sense, all the conclusions are obtained based on the relative differences between the validation scores obtained for both datasets.
- On the other hand, most of the validation has been performed using spatial averages, which makes negligible the effect of the spatial representativeness.

The case of ERA-Interim is slightly different because of its coarser resolution. Nevertheless, we decided to include it in the study as a reference because it is often used to force high resolution (~5 km) LSMs or hydrological models when high resolution data is not available (this happens in data poor countries, where there are no alternatives). In this case it is interesting to show the difference in performance, including both modelling errors and sampling errors.

Finally, SAFRAN and Spain02 are interpolated products that ingest observations and, thus, it is necessary to validate them using the same kind of data they ingest, as all previous studies validating these products do.

We propose to further discuss this important and interesting issue in the "Datasets and Methods" section of the manuscript, which is not well developed in the current version of the manuscript. We should also introduce some references to this problem in the

discussion section. We do not think it is necessary to, for example, upscale SAFRAN or Spain02 to ERA-Interim's resolution, as this is out of the scope of this study.

Section 5. Page 10, Line 4 The term 'skill scores' to compare SAFRAN and Spain02 seems unsuitable as throughout the paper no skill scores have been shown. I suggest to use only 'scores' without reference to the skill, both in Conclusions and in the Abstract (page 1, Line 12).

We can change "skill score" to "score".

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