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Interactive comment on "CEH-GEAR: 1 km resolution daily and monthly areal rainfall estimates for the UK for hydrological use" *by* V. D. J. Keller et al.

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The authors thank the referee #1 for his comments and constructive criticism, which will contribute to improve the paper.

Following are the authors' response to the referee #1 comments in order of appearance:

General comments

Choice of methodology: In many instances, the choice of method will have little influence on the result, but the natural neighbour method is considered to be one of the better methods of raingauge spatial interpolation in locations of uneven gauge distribution (British Standards Institute, 2011b). Also, daily grid production has not previously made use of data from monthly gauges in the way the authors have done for this dataset (monthly correction factor).

Methodology and the article

Title: The authors' affiliation is the Centre for Ecology and Hydrology (CEH), and as such, we have identified a clear need amongst hydrologists and hydrological modellers for a high resolution (1km) gridded rainfall dataset, which goes back in time as much as possible. The dataset was designed with this in mind, and for the hydrological community, and that is the reason why "for hydrological use" appears in the title. The dataset can, of course, be used for other purposes as well, and we would be delighted to see users from different fields. However, we wanted to specify the original aim of the dataset, because the needs in other fields of science might be different from the ones in hydrology. We could replace "for hydrological use" with "for hydrological and other applications" in the title.

(p.85-l.21) No, we did not use the same methodology as the Met Office used to create its 5 km grid. Our aim was not to replicate the Met Office's dataset at a finer resolution. We had already been producing monthly 1 km rainfall grids for many years at CEH using an earlier version of the GEAR methodology. We wanted to be consistent with the existing dataset, and extend it to daily data, and consolidate it under a DOI to make it citable.

Moreover, although we havenÎĎt formally tested it, we have a few reservations on the methodology used by the Met Office, and we believe that the methodolgy used to derive CEH-GEAR would overcome partly these limitations as we explain below.

The Met Office has used the IDW method, as described in Perry and Hollis (2005), with a normalisation by SAAR, to derive their monthly and daily rainfall grids. Our reservations about the use of IDW for interpolation of daily rainfall are firstly that it will tend to cause unwanted smoothing due to the high spatial variability of daily rainfall on showery days that will not be accounted for by the normalisation procedure. So you can imagine a point surrounded by gauges that have recorded zero rainfall - which would be allocated zero using the natural neighbours method - being allocated a non-zero value if more distant gauges at which it has rained are included in the averaging. The converse effect could happen for grid points within a localised storm.

Perry and Hollis (2005) section 4.3 shows they try to minimise this by using inverse-distance cubed weighting. However, sections 3.3 & 4.3 suggests they use all gauges within 50 km, increasing the radius if necessary as far as 75 km to achieve a minimum of 12 gauges. So the smoothing effect is bound to occur, but without testing it, we can't comment further.

Our second reservation is that it usually does not take the spatial distribution of gauges into account. Interestingly Perry and Hollis (2005) tested a density function (u in eqn. 2, section 3.3) which would have allowed for this (giving lower weight to gauges that were in a densely gauged locality), but they didn't use it because their tests showed it had little effect on the results (section 4.3). We would argue that there will be instances where not allowing for variable distribution will adversely affect the interpolation, for example a grid point lying midway between an urban area containing several gauges that have all recorded zero rain and a rural area containing a single gauge that has recorded high rainfall. Natural neighbour interpolation automatically compensates for this.

(88-7) The referee is right. After revisiting the original reference (Spackman, 1993), we realised that the contours were only derived for the printed maps. We will therefore remove this sentence in the revised paper.

(90) We do think that the categories follow a logical order, as we go from local to global fitting. But we do agree that some of the drawbacks of the 2nd category also apply to the 3rd one, so we will make that explicit in the revised version. We will also mention

splines and add a reference as suggested by referee #1.

(90-17) This sentence will be modified in order for IDW to be mentioned and discussed, as proposed by referee #1. The revised sentence will be: âĂźâĂź The British Standards Institute "Guide to the acquisition and management of meteorological precipitation data" (British Standards Institute, 2011b) recommends a set of such interpolation techniques, including the triangular planes method (Jones, 1983), the natural neighbour interpolation also called Voronoi interpolation (Gold, 1989; Ledoux and Gold, 2005; Sibson, 1981), and the Inverse Distance Weighting (IDW) method. The latter has been widely used for decades (Shepard, 1968) and is present in most GIS packages, but has the drawbacks of being adversely influenced by uneven spatial distribution of gauges, and giving too much weight to distant gauges, and therefore is sensitive to distant outliers. âĂžâĂž Note that the mention of Kriging in the sentence has been removed, and will be dealt with two comments below.

(90) Watson (1992) will be cited in the revised version and his book will be referenced for his comparison of interpolation functions for spatial data.

(90-21) A few lines will be added to explain Kriging. âĂźâĂź Another method suitable for interpolating raingauge observations is Kriging, which is a geostatistical method and uses the spatial correlation between gauge observations to determine how gauges should be weighted. The great advantage of kriging is that, together with the predicted values, it provides some measure of the uncertainty in the predictions. âĂžâĂž

(91-16) alpha will be changed to "p" in all formulas in the revised version (less ambiguous than "g", as "g" could also stand for gauge). However, we think that "i" is more appropriate than "r" for the raingauge location as "r" is already used for the rainfall value and could cause confusion.

(92) The value of the weight for each grid point could not be hard-code, as the raingauge network usually changes daily, necessitating the recalculation of the weights.

(92-17) The method does return the actual value of the input point. We did not correct for outliers other than rejecting unrealistically high rainfall readings during the quality control (QC) process described in section 4. The presence of undetected outliers during the QC process can cause local discontinuities in gradient near outliers.

(95-20) The normalisation step does compensate to a certain extent. However, the SAAR that has been used for the normalisation was also derived from a non-continuous network of raingauges, and has itself its uncertainty associated. Therefore, the compensation has its own limitation. Also, this is the sort of location that needs to be used to test the performance of the normalisation method.

The dataset Access has to comply with NERC (Natural Environment Research Council) policy, and within that framework, we have made the dataset as freely and openly available as possible. We consider this a minor limitation given the data is available free of charge for a wide range of uses, including many commercial applications.

Interactive comment on Earth Syst. Sci. Data Discuss., 8, 83, 2015.