Response to anonymous referee #1

The paper presents and documents a global daily precipitation dataset at a 1 degree resolution. The dataset is compiled from several data sources. In the paper, discussions on the method to grid daily precipitation and the density of the network, including the consequences this has for the precipitation estimates on the grid, are included. In addition to REGEN, a dataset based only on the long-running stations is presented which will be temporally more homogeneous than the dataset based on all station data.
The study is a very welcome contribution to the field where for daily precipitation now many national and several regional datasets exist, but (up to now) not a global dataset based on in-situ measurements. The study is well written and clear and as far as I can judge, no problems in the analysis are there. However, the study could do with a more expansive and in-depth comparison against existing (regional) observational datasets - the current comparisons are too ad-hoc and uninformative.

My advise to the editor is to accept the paper with minor adjustments.

We thank the reviewer for their thoughtful and thoroughly researched comments and agree with the major criticism about the lack of a more in-depth comparision with regional datasets.

We have responded (in red) to each reviewer comment below. Page and line numbers refer to the original unmodified text.

More Serious Concerns

1. Metadata is often a problem (lacking, erroneous etc.). The day shift discussed in sect. 2.3 - a very necessary thing to do - is in the face of poor metadata an action which might be problematic. The give an example, according to the Appendix, the data from the Netherlands are shifted one day backward in time. This is appropriate for the manual rain gauges but not for the 30+ automatic weather stations which measure precip between 0-0 UTC. It could be that only the rain gauges are in the GPCC dataset - but the reader can't tell.

Checking with other NMHSs in Europe, I could confirm the necessity to shift the date, except for Hungary (there is a question to the Hungarian NMHS out now).

There is another confusing part of this date-adjustment. Are you aiming to get 24-hour values coinciding with a day defined by local time or by UTC? The reason for asking is that for Indonesia, my understanding is that measurements are from 7 - 7 local time, which is (nearly) O - O UTC.

The correlations with CPC (figure 11d) are low in some areas - could it be that an erroneous timeshift or a missed time shift could be related to the low correlation? I guess you have tried to shift the whole dataset back and forth and looked for areas on the globe with increases in correlation?

We agree with the reviewer about the problems associated with poor metadata and the day shift discussed in the text. We are aware of automated weather stations that measure precipitation over a different 24h window to the country they are in. In the text we have identified a similar issue with 10% of American stations which were also automatic weather stations (P7 L33). We will expand the note on this issue as follows:

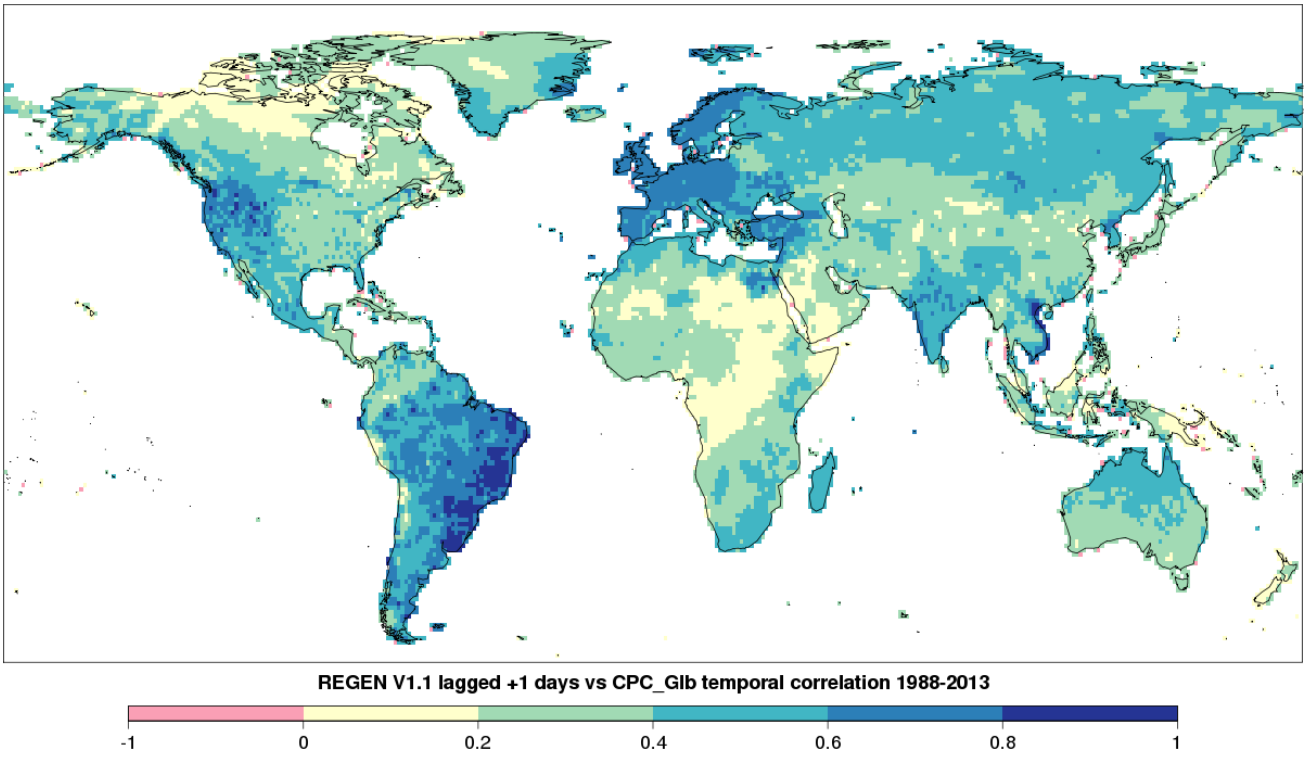
"Note that some countries maintain a mix of manually monitored and automated weather stations which may represent precipitation over differing 24h windows that may not be suitable for being

shifted identically. For example, around 10% of observations in the US and around 30 stations in the Netherlands are midnight observations, i.e. observations over the 24h period from midnight to midnight UTC which are assigned to the day on which the observing period ends. Although these observations have not been manually adjusted in this version of REGEN, they will be taken care of in the next iteration. Globally more countries may exist whose gauge observations may represent a mix of reporting times (due to the use of automatic weather stations for example), however, without proper metadata about these reporting times it is not possible for us to adjust their timestamp accordingly."

Regarding the hungarian data, it in fact has not been shifted by us. The inclusion of "Hungary" in the list of shifted stations in the appendix was an error. It will thus be removed from the list. We thank the reviewer for bringing this to our attention.

Dates are not adjusted to match 0-0 UTC time but rather to match the local 0700h-0700h local time to preserve the diurnal aspect of precipitation.

It is possible that correlations between REGEN and CPC are lower because of this shifting. Based on the correlation between REGEN V1.1 All Stations shifted +1 days and CPC (shown below) we see that the correlations are higher in and around the countries where data was shifted a day back (eg. Vietnam, Brazil, Uruguay, Peru, Suriname, Netherlands, Norway, Ukraine and Turkey). Lower correlations are observed in all other regions.



The above figure will be added to the supplementary materials (Figure S1) and the following note will be added to the text on P12 L26.

"Correlations between REGEN and CPC may be lower in parts where the underlying stations were shifted a day backward (see Appendix). Indeed, based on correlations between REGEN lagged +1 days and CPC (Fig. S1), the correlations are higher compared to figure 11d in and around the countries where data was shifted a day back (eg. Vietnam, Brazil, Uruguay, Peru, Suriname, Netherlands, Norway, Ukraine and Turkey). Correlations do not change compared to figure 11d in all regions where REGEN raw station data are not shifted."

2. The comparison against regional dataset of daily precipitation (sect. 3.2) is too ad-hoc. In your article, you claim (rightly so) that national and regional datasets are based on a more extensive dataset. I would like to add that especially national datasets have a far greater detail in the understanding of the metadata. This means that a meaningful comparison can be made between national/regional datasets and the REGEN dataset. This should go beyond simply picking one event of a few days, averaging precip over a region and plot a few timeseries.

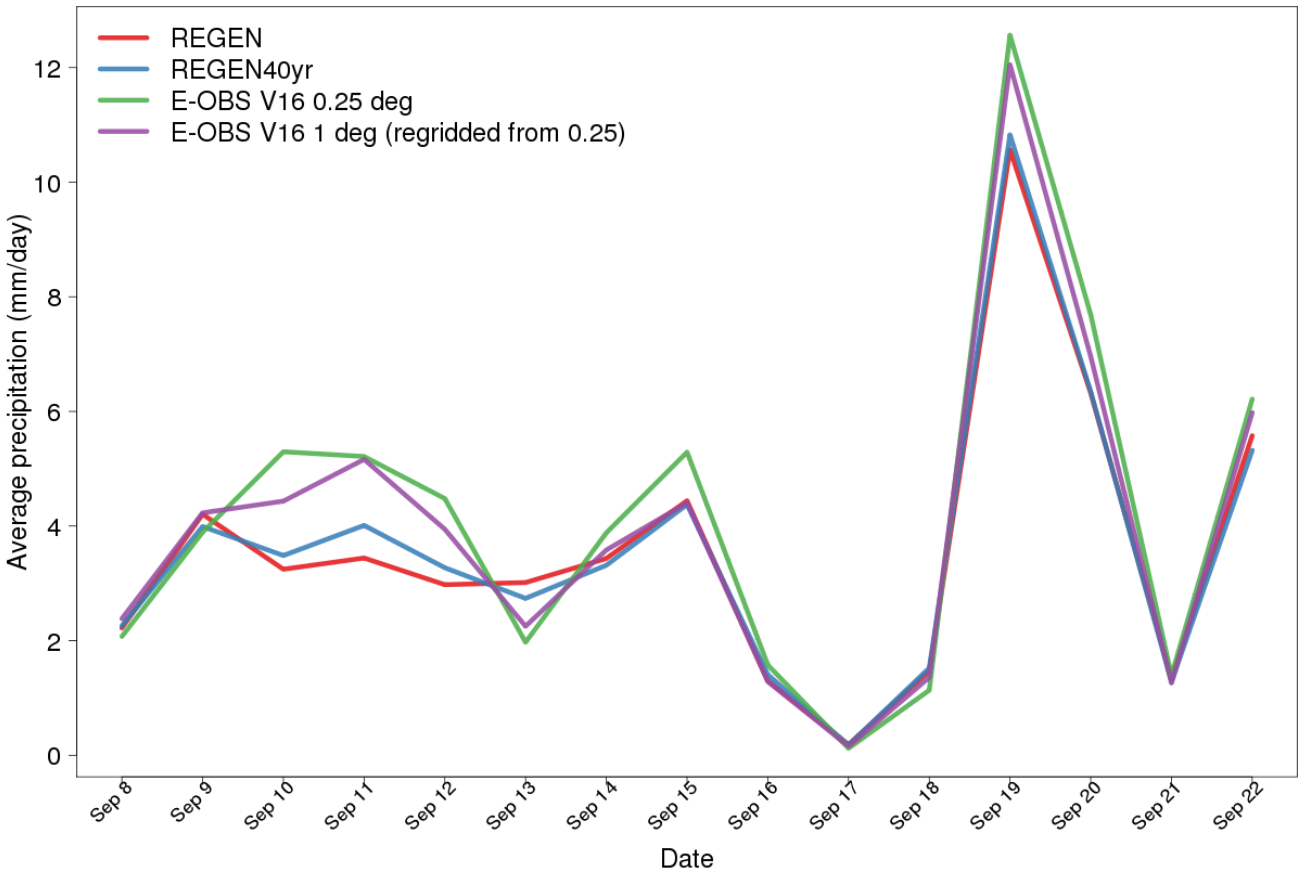
Please add a more expansive comparison with regional datasets like Aphrodite etc. Other datasets might be interesting to use as well, like the SA-OBS for Southeast Asia (van den Besselaar et al. 2017. doi:10.1175/JCLI-D-16-0575.1). Comparison you could make easily are the standard deviation of the daily difference, perhaps stratified over different periods, but other comparison metrics are equally useful. Given the particular focus on precipitation extremes by the international community - and of some of the authors of the paper - a dedicated focus of representation of extremes (beyond one example) is required.

I was taken by surprise when reading about the the "Great flood of 1968" in Southeast England and France. The article referred to (Jackson, 1977) never mentions France. Below are a few pictures from the E-OBSv19.0e for 14-16 September 1968 and the area you use to compare REGEN with the regional dataset is somewhat large compared to the area affected by this event.

We are currently in the process of adding a new figure that compares the mean and standard deviation of difference between REGEN and the regional datasets in the main text. These include those datasets already mentioned in the paper (CPC CONUS, E-Obs, Aphrodite, AWAP) as well as the SA-Obs dataset highlighted by the reviewer. The statistics can be aggregated over individual years and shown as a timeseries over the overlapping time period. In addition to the above figure we will also include maps of temporal correlations of local (grid-cell) timeseries between the regional datasets and REGEN to show a comparision of temporal variability between the dataset pairs. Finally, as suggested by anonymous referee #2, we will also include a table comparing number of stations between the regional datasets, REGEN and REGEN40YR now. This table is shown below.

Regional Dataset Name	Regional Dataset Stations	All REGEN v1.1 stations	Long term (40yr) REGEN v1.1 stations
APHRODITE	Daily max of 8000+	8551	1539
SA-Obs v1.0	7956	2527	64
E-Obs	17,468	28,338	11,261
CPC CONUS	~28,500	42,229	3940
AWAP	Daily max of ~7500	12,993	1424

We will modify figure 7a so only UK is included in the spatial averaging and any mention of France can be removed. The updated figure is shown below.



Other issues the authors may want to look into

1. page 2, line 16: here is is claimed that radar provides 'highly accurate' estimates of precipitation. It is my understanding that radar can underestimate extreme precipitation by as much as 40% (e.g. https://journals.ametsoc.org/doi/10.1175/2009BAMS2747.1)

The sentence will be replaced with the following:
"Radar estimates provide high spatial and temporal resolution estimates of rainfall over local regions, however these estimates can be inaccurate compared to rain gauges (Krajewski et al. 2010 Villarini and Krajewsky 2010 and McKee and Bins 2015), and very few national networks of radar observations exist.".

2. the referencing to figures is a bit curious: The first 3 are referenced chronologically, but then on page 7, you refer to fig. 4b, the next reference (line 31) is to fig. 7b page 9 10 have refs to fig 5 and page 11 has a reference to fig 7.

Besides the reference to Figure 7b all other references are in order of figure appearance (see locations below). Figure 7b is referenced earlier as it helps to demonstrate the time-shifting of data. We leave it to the editor to clarify whether chronological figure referencing is strictly necessary, or whether referencing the Figure 7 once a little earlier is acceptable to improve readability.
Fig 4a,b: P6 L12, P7 L5
Fig 5a-f: P9 L26-27, P10 L10
Fig 6: P10 L25

3. page 8, lines 4-7. Relocated stations often keep the WMO id and if the relocation is to a site in the vicinity, then your criterion labels the old and new station as the same. This may not be a problem for precipitation, but perhaps it is good to inform the reader about this.

The following note will be added to the text on P8 L8:
"Also note that WMO station IDs do not change after a station is relocated to a site in the vicinity which can result in two stations in different locations merged together according to our criteria."

4. page 11, line 10. There is no 1.0 degree version of the E-OBS. I guess you regridded the E-OBS data to the REGEN grid to arrive at the 1 degree resolution?

The 1 deg version of E-Obs was created by regridding the 0.25 deg product using second order conservative remapping from CDO (cdo remapcon2). P10 L7 will be updated as follows to reflect this.
"There is good agreement between the daily timeseries from REGEN, REGEN40YR and both 0.25 degree and 1 degree (*regridded from 0.25 degree version using CDO remapcon2)* versions of E-Obs Version 16".
The figure label will also be updated (see figure above).

5. page 14, line 19-20. Here you make the point that there is an ordering in the number of stations used by national, regional and global datasets. The point is very valid, but the example provided is misleading. Herrera used 2756 stations, the E-OBS uses 210 station in Spain (incl. Catalonia) and for the whole of Europe, 15962 series are used. Hardly 'roughly the same number' as claimed.

The sentence is false. We meant to say that the Spanish Meteorological Agency (AEMET) maintains roughly the same number of stations as those used in the entirety of Europe by E-Obs. The text (P14 L13) will be modified to reflect this as follows:
"For example, the Spanish Meteorological Agency (AEMET) itself manages roughly over 9000 stations (Hererra et. al. 2012) which is almost the same number of stations as those used by E-Obs for the entirety of Europe (around 12,000 gauges at its maximum)."

Very minor issues

page 3, line 4, It is the Climatic Research Unit (not Climate)
"Climate" will be changed to "Climatic"

page 7, line 4, typo in procedures
"prodcedures" will be changed to "procedures"

page 9, line 20, perhaps an odd formulation?
The sentence will be modified as follows:
"Kriging error. This is not an absolute error but rather…"

references, many citations have the http address twice in the citation, e.g. Jack- son (1977).
The repeated links will be removed from the following citations:

Yamamoto 2000, Xie et al 2007, Tian, Y. and Peters-Lidard 2010, Smith et al 2010, Schneider et al 2014, Schamm et al 2015, Peterson et al 1997, Perry and Hollis 2005, Osborne and Hulme 1998, Jackson 1977, Isotta et al 2013, Hofstra et al 2008, Herrera et al 2012, Harris et al 2014, Groisman et al 2005, Funk et al 2015, Frei et al 1998, Donat et al 2013b, Chen et al 2008, Bytheway and Kummerow 2013, Ashouri et al 2014, Allen and Ingram 2002, Alexander et al 2006, and Adler et al 2003.

Appendix A. you apparently made an effort to make an alphabetical list - but didn't quite succeed. There are duplicates in the list too - like Indonesia.
The countries will be re-ordered in alphabetical order. Also repeat entries of Georgia and Indonesia will be removed and "Guam" will be removed from this list as it is a US territory.

caption fig. 5: fig. c d show what?
The figure caption will be modified as follows:
"Figure 5. Kriging error (KE) (figures 5a and 5b), Coefficient of variation (CoV) (figures 5c and 5d) defined by…"