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Comment on essd-2021-303

Anonymous Referee #3

Referee comment on "HOTRUNZ: an open-access 1□km resolution monthly 1910–2019 time series of interpolated temperature and rainfall grids with associated uncertainty for New Zealand" by Thomas R. Etherington et al., Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2021-303-RC3, 2022

GENERAL COMMENTS:

The data set is novel. However, the methods, materials, and output uncertainties are not described in sufficient and clear detail, and the interpolation of monthly mean meteorological data has occurred without any consideration of key geographical aspects (elevation and proximity to the coast). This severely compromises the utility of the data. The data set is accessible via the given identifier. The data (presumably numbers that people can use in calculations) are provided in Tag Image File Format (*.tif files), which have long been used primarily for images. No guidance is given on how to access or extract numerical values from these, which also limits the dataset's utility.

Of particular concern to me are
• the interpolation of meteorological data in mountainous regions without regards to changes in elevation between observations,
• the lack of precision with language in statistical settings (e.g. "reliable", "uncertainty") and/or specific meteorological meaning (e.g. "dynamical"),
• the re-use of published figures without explicit attribution.

MAJOR COMMENTS:

1) WEATHER & CLIMATOLOGY DATA (lines 61-3): What do you mean by "reliable" and how did you decide the data were reliable? What is "sub-kilometre spatial precision", and how was the precision of the data determined? Did you use all the data you obtained? If not, what was your decision process and the results? For the monthly mean air temperatures, how were those calculated and was the calculation the same across stations and time? (i.e. was it an average of hourly data, an average of max and min data, or something else?)

2) WEATHER & CLIMATOLOGY DATA (lines 63-67, Figure 1): There should be latitude, longitude, and some sort of km scale on all these maps. More information about the "mountainous interiors" is needed, specifically the horizontal and vertical variability. A single, high-resolution, easily read map for the entirety of New Zealand would be a fine addition; the greyscale underlays in Fig. 1 seems to show hills as well as mountains throughout the country.

3) WEATHER & CLIMATOLOGY DATA (lines 68-69): "Reprojected and aggregated to 1-km^2 grid cell resolution" needs more explanation. Also, how did you ensure that these data were never duplicating the NIWA data? Or did you use these as the climatology for your "climatologically aided interpolation"? If so, that's unclear when reading this; you should clarify here that the climatological data will be used in the calculation of anomalies as part of the interpolation process.

4) INTERPOLATION WITH UNCERTAINTY (lines 72-79): What are the advantages and disadvantages to climatologically aided interpolation? Why not just interpolate the data, rather than calculating anomalies and interpolating them? It seems to me that the calculation of anomalies might add its own (possibly spatial) error potential.

5) INTERPOLATION WITH UNCERTAINTY (lines 83-5): What do you mean that natural neighbour interpolation will "retain the original data values in the interpolated grid"?

6) INTERPOLATION WITH UNCERTAINTY (lines 91-102): This paragraph serves to highlight my confusion about how you are using the word "grid" and "cell". As a meteorologist who has worked with numerical models of the atmosphere and their output, when I read about data being on a "grid" I think of a mesh of evenly spaced points in (x,y) or (x,y,z) space, where typically x=east-west distance, y=north-south distance, z=vertical distance, and â□□x=â□□y. I'm unfamiliar with the notion of cells, but would guess that they are perhaps the contents of a grid box.

How do you "define a grid of cells"? What is a "data cell"? What is a "grid cell"?

Also, what areas are "harder to interpolate accurately", and why?

7) INTERPOLATION WITH UNCERTAINTY (Figure 2): Figures 2a, 2b, and 2c appear to be identical to Etherington (2020) Figures 1c, 1e, and 1f, respectively. Figure 2d appears to be identical to Etherington (2020) Figure 2c. Figures 2e and 2f appear to be Figures 3a and 3b from Etherington (2020), with the annotations on the 8 small squares removed from the former and the color scale changed in the latter. However, there is no citation or acknowledgement of the re-use and (in some cases) adaptation. While Etherington (2020)

8) INTERPOLATION WITH UNCERTAINTY (lines 91-102): The manuscript touts the horizontal resolution of the new data set, but says almost nothing concrete about space in the creation of the data set. What is the range of distances over which interpolation occurs? How does it vary across New Zealand and across time? What are the impacts? And most importantly: What about elevation and distance from the ocean? Elevation has *major* impacts on precipitation and temperatures; nearness to the coast, even in the absence of any elevation changes, has major impacts on temperatures. Yet the interpolation scheme appears to ignore geography. This is especially astounding for 2 reasons: the NZEnvDS (McCarthy et al. 2021) contains a wide range of geographical information that would affect the weather measurements, including distance to coast and various terrain data, and the repeatedly referenced Willmott and Matsuura () compares a planar temperature interpolation with a digital elevation model (DEM) assisted interpolation.

Do geographical factors ever constrain your interpolation? If so, how? If not, why, and from a meteorological rather than a statistical point of view what are the implications?

9) INTERPOLATION WITH UNCERTAINTY (lines 104-113): The analysis of this section is trivial, and boils down to saying that the maps show horizontal differences in both values and uncertainty, and they change in time. "Clear differences" are not necessarily correct; neither are calculated gridpoint values of uncertainty, and their "dramatic changes". Why do you interpret "dynamic uncertainty" (by which you seem to mean "changing uncertainty" rather than "uncertainty connected with meteorological dynamics") as being due to sparse data rather than meteorological incompatability of data collected in highly variable terrain? What do you mean by, and do you have any evidence of, the "spatial variability of individual monthly weather patterns"? (Weather tends to operate on timescales of minutes to a few days; see https://glossary.ametsoc.org/wiki/Weather.)

10) INTERPOLATION WITH UNCERTAINTY (overall): There is no discussion of the uncertainties of the source data, and it is not clear whether the "uncertainty" provided in the gridded data represents purely computational error (i.e. is attributable only to the interpolation) or includes measurement error. This needs to be explicitly discussed in the paper and clearly identified in the data set.

11) INTERPOLATION VALIDATION (lines 121-125): What other interpretations are there for the consistency of the New-Zealand-average MAE for all weather variables over time, and why do you reject them? Given the changes in measurement techniques over time, and the extreme difficulty of measuring preciptation at any time, I find the consistency surprising. What does the distribution of MAE across New Zealand look like throughout time? (This is especially important since one of you major points is that your data are better than others because you have gridpoint values of uncertainty.) What does the distribution look like a few particular times at different locations?

Why do you expect the MAE to be lowest during the period of the climatological data used to calculate anomalies? Why does that fact not argue against your use of anomalies, and for using the unadjusted data?

I disagree that the MAE is "far more pronounced pre-1910" in all the timeseries shown (c.f. the precipitation and the minimum air temperature). Can you be more quantitative? Is it necessary, or physically justified, to have a same time cut-off for all the timeseries?

12) INTERPOLATION VALIDATION (lines 130-134): How does "the spatial variability of uncertainty in Figure 3" explain the variations in the "pattern of MAE over time" shown in Figure 4?

The statement that "while the number and location of weather stations may vary from month to month, the weather patterns may change dramatically making some months easier to interpolate than others" makes no meteorological or computational sense and seems highly speculative.

13) USING THE UNCERTAINTY DATA: This entire section is extremely weak. The choices to pull random values of monthly weather data from a uniform distribution and to have the range of that distribution equal the uncertainty, is not explained and is troubling since precipitation and temperature variations are not typically uniformly distributed. The claim that "the trend can be established precisely" is over-reach. The remainder of the section is no more convincing. This section would be best omitted, and interested users left to explore reasonable statistical uses on their own.

14) LIMITATIONS AND FUTURE RECOMMENDATIONS (lines 180-182): I doubt that increasing the resolution to 100m is going to be an improvement if elevation is not accounted for.

15) LIMITATIONS AND FUTURE RECOMMENDATIONS (lines 192-194): The statement about the possible dependence of MAE again raises the question of what benefits the climatological assistance is and why it outweighs the distortions it appears to generate.

16) DATA AVAILABILITY: This section needs a little more information than "non-proprietary file formats" are available. A sentence or two of explanation of what a *.7z file is and how to unpack it would be useful. Many if not most members of the meteorological and climatological communities are familiar with *.tif files as image files, and have no idea how to extract numerical data from them; that information here would be useful. Size estimates for the unpacked data would also be helpful.

17) REFERENCES: The references are difficult to read and would benefit from a blank line separating references. The format for datasets seems nonstandard, disagrees with the way they are cited in the text (c.f. GDAL/OGR, CliFlo). Information on how to obtain Leathwick et al. (2002) is needed.

MINOR COMMENTS:

a) TABLE 1:
• The abstract of Fick and Hijmans (2017), the first data set listed in this table, says its spatial resolution is "approximately 1 km^2", not "≈4 km" as stated in the table.
• WorldClim 2 currently spans 1970-2000, not 1968-2018 (https://www.worldclim.org/data/worldclim21.html; Fick and Hijmans, 2017).
• "WorldClim 2" and "CHELSA" are improperly capitalized.
• The caption is misleading. Datasets such as WorldClim or CHELSA are not properly considered to be Year1–Year2 timeseries with monthly resolution, but rather sets (or "climatologies", to use the language of both references) of monthly averages spanning Year1–Year2. It would be helpful to indicate in the Table which of these datasets are in the form of long-term monthly means and which are long timeseries of monthly means like HOWZA.

b) INTRO (lines 24 & 57, repeated throughout): The phrase "weather grids" is unusual in the earth sciences; "gridded weather data" would be more easily understood. Similarly, "spatial uncertainty grids" is unusual and confusing; "uncertainty at each gridpoint" or similar would be much clearer.

c) INTRO (line 32-3): "In New Zealand" implies that the data sets are stored or created in New Zealand; "For New Zealand" would better indicate that the focus is data about New Zealand weather.

d) INTRO (line 33): Whose "currently optimal criteria" specify 1km^2 and monthly resolution over the last century?

e) INTRO (lines 52 & 57; repeated throughout manuscript): "Units of measurement" is unusual and open to confusion because some things are measured in one unit but typically reported in another. Referring to "the variables' units" is compact and clear, although their are many other ways to reword this.

f) INTERPOLATION VALIDATION (lines 121): "the number of data cells (which equates closely to the number of weather stations)" is a curiously vague statement. Please clarify.

g) FIGURES 1 & 3: These would benefit from some visual separation of the top set of small multiples and the bottom set, e.g. a fine solid line splitting the horizontal white space between the top & bottom sets or a noticeably wider white space.

h) FIGURE 2: What do the small squares on all panels except 2b indicate? What are the units on 2d?

i) FIGURE 4: These would benefit from a small label on each panel (e.g. in the upper-right corner) indicating "rainfall", "air temperature", "minimum temperature", etc.

j) FIGURE 5: These 3 pairs of plots would benefit from a small label above or to the right of each giving a summary of the condition. Also, what is a "reliable trend" versus "no reliable trend"?

k) FIGURE 5: These would benefit from a simple subtitle or label in each part (a & b). Also, the meaning and utility of the inset colored grid to the west of New Zealand remains completely obscure to me. Finally, some indication of horizontal scale, position on the globe (lat/lon) and the words "New Zealand" in the caption would be useful.