

## **Review of “HadISDH land surface multi-variable humidity and temperature record for climate monitoring” by Kate Willett and co-authors**

This paper provides a mostly clear account of a very good piece of work, and certainly merits publication, subject to revision to clarify its comparison with ERA-Interim, and to take into account the other comments given below as the authors see fit.

### *Comments related to ERA-Interim (and JRA)*

1. The HadISDH data are described (Abstract, line 31, and Conclusion, page 18, line 45) as a “unique tool” for climate monitoring of a number of humidity variables. It is unique in the sense that it is different to ERA-Interim, but ERA-interim is just as appropriate for studying all these variables. This is because ERA-Interim is made available as six-hourly analysis values from which monthly means of all the humidity values available from HadISDH can easily be computed using standard routines for converting humidity data. Yes, HadISDH takes some of the work away for the user, but ERA-Interim provides the user with six-hourly values (and other meteorological variables), and globally complete values, which HadISDH does not. Anything said for ERA-Interim applies also for the JRA-55 reanalysis, which similarly provides analyses of synoptic humidity observations. So it would be fairer to say that HadISDH offers a tool that is complementary to what is provided by reanalysis, not that it provides a unique tool. Or simply omit the word “unique”.
2. In this regard, Figure 12 (and the discussion in the paragraph from lines 27 to 42 on page 16) is misleading. ERA-Interim plots are shown for several humidity variables, but not all of them. There is no logic to this. The only ERA-Interim surface air humidity variable for which monthly-means are archived and made available as standard is dew point.  $q$  and RH are also shown in Figure 12 but not  $T_w$  and  $e$ . Why? The  $q$  and RH values must have been calculated from the archived 6-hourly  $T_d$  and associated non-humidity variables – probably by me in providing values to the lead author for her use in the BAMS State of the Climate article, if I interpret the paragraph on page 16 correctly. But  $T_w$  and  $e$  could equally have been calculated. So Figure 12 should include time series from ERA-Interim for these values also.
3. Discussion of the geographical distribution of the recent decrease in RH could also have been done a little more carefully. There’s nothing to complain about the discussion of mid-latitude values. What is not acknowledged in this HadISDH paper is that it was shown in Simmons et al. (2010) that RH was increasing, overall, in high northern latitudes in ERA-Interim, and that  $T_d$  was increasing in the 60N-90N region in both ERA-Interim and the JRA-25/JCDAS predecessor of JRA-55. This leaves the Tropics, where the discussion gets a little difficult. Simmons et al. showed RH to be increasing recently over India and West Africa, which is reproduced in HadISDH. The Caribbean seems to be an area of disagreement. HadISDH misses a large part of the tropical land mass by having almost no values over central Africa. ERA-Interim produces drying there, but this is regarded as unreliable, in view of rainfall shifts discussed by Dee et al. (2011) and by Simmons et al. (2014) with regard to a suspect linked temperature trend. But it should at least be acknowledged that HadISDH does not have sufficient coverage of the Tropics to make a definitive statement of what is happening to relative humidity there in an average sense.

### *Other comments:*

4. Page 2, line 49. I suggest adding “availability of” before “water”.

5. Page 3, line 32. "Reanalysis products" would be better than "Reanalyses products".
6. Page 4, line 15. One can argue over the words "first operational"; I dislike this wording for the same reason I dislike the reference to HadISDH as a "unique tool". Again, I would prefer HadISDH to be advertised as complementary to reanalysis.
7. Page 5, line 17. Although it may not be "possible to identify which instruments were used", it should be possible, for most data at least, to identify whether they came from a manual or an automatic station, and stratify data statistics accordingly. If the metadata are not in HadISD, most of its data can probably be matched with what is in ECMWF archives, where we do have the information. See Simmons and Poli (DOI: 10.1002/qj.2422) for an example of use in study of Arctic temperatures. This is not something I recommend for this paper, but it is something that should be kept in mind for future work, and could be identified as such in the text. It is also something that needs to be brought up with WMO with regard to what they are doing for metadata from now onwards, under WIGOS. The Met Office is well placed to do this.
8. Page 5, line 27. Why were *monthly-mean* reanalysis data for Pmsl used? Values are usually available at least 6-hourly from reanalyses. If not for 20CR (I've not checked), then ERA-40/ERA-Interim, JRA-55 and ERA-20C are alternatives that could be explored. Of course instantaneous reanalysis values of Pmsl will not be perfect, but they surely will be better than monthly means, especially if a reanalysis with higher spatial resolution (better orography) is used. JRA-55 is probably the best for this, as it is the newest comprehensive reanalysis. This is something that should be investigated for fixing at the next release of HadISDH, and it should be acknowledged in the paper that this issue is likely fixable with only a little work. In this context, it should be noted (see comment 2) that if the monthly q values for ERA-Interim shown in Figure 12 are the ones I calculated, then the six-hourly ERA-Interim surface pressures were used in converting from Td to q.
9. Page 6, line 22. Figures 2 and 3 should be rethought. It is almost impossible to see the differences between many of the panels. For Figure 2, perhaps one could show a single map of the observation locations that provide data for all variables, and then in other maps show just the extra data for each variable. Either way, something needs to be done. Also, the label for map g) in Figure 2 is wrong, as it lacks the word "depression". Same is true for panel g) of Figure 3.
10. Page 6, line 24. The drop-off post-2005 in the data entering the ISD archive is very disconcerting. This does not happen for the GTS data received operationally at ECMWF (and doubtless also the Met Office), and these GTS data are used in ERA-interim, which is quite competitive with HadISDH, so the GTS data cannot be that bad. Is a rethink needed as to whether ISD is the most appropriate source of input data for HadISDH? OK the name HadISDH might have to change. If the decision is to stick with ISD, steps need to be taken to address the post-2005 drop-off. This needs a sentence or two of extra discussion in the paper.
11. Page 6, Section 3. Was consideration given to making use of the background-observation values from reanalysis in the homogenisation? Haimberger has used this with some success for radiosonde data.
12. Page 7, line 27. There are lines of text running from the a), the b) and the c) in Figure 4 that I could not read in the printed version I worked from. Is the intention simply to delete them in the final version of the paper?
13. Page 8, line 2. "are" should be "is".

14. Page 10, lines 24 to 39. See comment 7. One should be able to do something with metadata identifying the station as manual or automatic.

15. Page 13, lines 27 and 28. The phrase “increasing ... trends” is ambiguous. An “increasing trend in q” could mean that the trend in q is getting larger as time progresses. But I suspect the alternative, better stated as “the trend for q to increase”, is what is meant here. I suggest that the sentence be reworded.

16. Page 13, line 44. I suggest that the Clausius-Clapeyron relationship be referred to as “basic physics” rather than “theory”.

17. Page 15, line 46 and 47. This paper indeed shows a continuation of the decline in RH noted by Simmons et al. (2010), but this has also been shown in BAMS State of the Climate articles for the years since 2010, so it would be fairer to refer to the BAMS articles, and state that this paper confirms what is shown there.

18. Page 16, line 47. “(and ERA-Interim)” could be added after the words “support to the validity of HadISDH”.

19. Page 19, line 12. See comment 16, concerning use of the word “theory”.

20. Page 19, line 35. “comes from” is perhaps better than “is driven by”.

A handwritten signature in black ink that reads "Adrian Simmons". The signature is written in a cursive style with a long, sweeping underline.

Adrian Simmons