

## ***Interactive comment on “Techniques for analyses of trends in GRUAN data” by G. Bodeker and S. Kremser***

### **Anonymous Referee #2**

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This paper describes several methods for long-term trend analysis of climate data using a step-by-step pedagogic approach. It starts from the most simple linear least squares model and works up to a much more complex model by explaining factors such as seasonality and autocorrelation, as well as how best to determine uncertainty in the trends calculated. The examples given and the figures clearly illustrate various important points. Overall most of the methods presented are well established in the literature, however, this paper provides an overview of the important aspects needed for a full understanding of how to analyse long-term climate data. Although the paper does not describe substantial new methods or ideas, it provides a very clear and well-structured description of techniques that can be used to assess high quality climate observations, and will thus be a valuable resource to the community.

## Major comments:

P11964, L8: It is pointed out that choosing the number of Fourier pairs to use 'is a judgment call'. Given the pedagogical approach of this paper it would be useful to provide some further instruction or point to further methods that can be applied to help one determine this more subjectively.

Sect. 2.3: This section would become clearer if the different elements of fig. 3 were referred to so as to better illustrate the points being made. For example (P11964, L27-28 continued on to P11965, L1), it is not entirely clear why the same but opposite cannot be said of the red line, even though the calculated trend is not significant.

Sect. 6.2: The explanations in this section are somewhat difficult to understand. For example, the trends in May at  $\sim 13\text{km}$  are smallest in the all-orthog fit, but only the all or reduced fits are discussed – the explanation in 'interpretation 1' is tricky to interpret in itself. Also in this section, the last paragraph referring to the 12:00 UTC results feels somewhat superfluous. It doesn't help further illustrate what is already discussed in this section, nor does the inclusion of fig. 8.

The conclusions are very short, which, to some extent is understandable given the nature of the paper. However, it would likely make sense to again point out what is so clearly discussed in the abstract: – that a proper understanding of how to analyse GRUAN data is necessary to make full use of the enormous effort put into determining measurement uncertainties, etc.

## Minor comments:

P11961, L18: Why is the ENSO basis function so specifically given as the 'normalised Tahiti minus Darwin SLP'? Given that there are several ENSO indices as well as several options for including QBO or solar cycle basis functions, it perhaps makes more sense to leave this out.

P11963, L16: Maybe it's worth pointing out how many Fourier pairs are used in the

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equation shown in L18?

P11964, L15: The grey shaded area is referred to earlier in the sentence and it would make sense to refer to the vertical error bars in terms of the fits to the individual months.

P11964, L24: The significance of trends is discussed but no values are given in the text, nor are the values shown in fig 3b referred to – this might be useful to the reader to better illustrate the point. It may also be useful to point out that it is the blue line?

Fig. 5: The text in this figure is very small, particularly of the colour bar.

Fig. 7: Putting the numbers on the colour bar horizontally would greatly improve readability.

Grammar/typographical errors:

P11965, L11: Fig 3a was probably meant to be referred to rather than Fig. 3b.

P11966, L4: I am by no means a mathematician, but it is not clear why when substituting the X into Eq. 2 there is a – rather than a +. (This is again the case on L11 of the same page).

P11968, L3-4: ... e.g., Steinbrecht et al. (2003) and Sioris et al. (2013), ...[the brackets are missing].

P11971, L4: The reference to Weatherhead et al. (1998) can be written as W98.

P11971, L24: ..., and that are not affected by... [that are rather than to be; affected rather than effected].

P11971, L27: Uncertainties [capital U].

P11972, L6: No [capital N].

P11972, L12-13: approaches [rather than approach].

P11977, L28: Should interpretation (2) not rather be referred to?

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Fig. 2 caption: . . .(shown in inset). . . [including these brackets would make the caption easier to understand].

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