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Biogeosciences Discussions

Interactive comment on "Investigating the effect of historical treatments on wheat yield over multiple spatial frequencies" *by* A. E. Milne et al.

Anonymous Referee #2

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The paper by Milne et al is an interesting application of an advanced spatial statistical technique to nitrogen dynamics and distribution in agricultural soil. The objective of the paper is to find a spatial scale at which the effect of a prior addition and uptake of nitrogen can be identified in yield of melons and a wheat crop used as an indicator. There are two treatments with different characteristic spatial scales, (i) combined irrigation with water and fertiliser acting as a source of nitrogen and (ii) melon cropping acting as a nitrogen sink.

The first experiment follows a split-plot design with irrigation at main plot level and nitrogen levels in subplots. The second experiment followed the harvest of melons and involved sowing and sampling a wheat crop. Although the full design was used to analyse the melon crop, only a small subsample (on a transect) was used to analyse

the combined effect of sources (fertirrigation) and sinks (melons) on wheat crop. The experiment is quite complicated and many processes are taking place between the start and the sampling of wheat, particularly since 14 months pass from its start to its end.

At this stage the paper becomes confusing. The introduction clearly states that one of the objectives of the paper is to study the effects of fertirrigation on the melon crop. However, no results are shown for melons and the paper instead concentrates on wheat. Section 3 starts with the sentence 'Figure 3a shows the plant weights. . .' – I am assuming this is wheat, not melons. If the analysis is limited to wheat, then the data represent only a very small subsample of the experimental layout shown in Fig. 1. If this is so, I do not see any reason to include the full layout. It also seems that there is potentially much more data available in the experiment and the authors choose to concentrate on a tiny subsample.

Figure 3 shows the results of the wheat experiment. While the effects of nitrogen are very clear, there appears to be very little effect of irrigation or melon pre-cropping. The same results can be seen in the wavelet analysis. Figure 3 could be improved by consistently ordering the treatments within the blocks: (W1,N1), (W1,N2), (W1,N3) etc. – at the moment irrigation is consistent, but nitrogen is not (N2, N1, N0 followed by N1, N2, N0 and N0, N2, N1).

The data are analysed using an advanced spatial statistical method of MODWPT which is a form of wavelet analysis. Although it is an interesting technique, I am wondering how much improvement it offers as compared to a standard linear method. The only spatial scales of interest are introduced by treatments with known locations and I would imagine that the strong effect of nitrogen and the weak effect of melon crop would have been picked up by a standard technique. Wavelets are very powerful techniques, but I do not really see any reason for using it to analyse what is a relatively simple system. The only possible case would be if the authors were to look explicitly at nitrogen dispersal/leaching across the treatment boundaries, but this would probably require a

much higher resolution.

If we, however, accept the method, than the maths behind it and the short summary of the technique are fine. Two things are, however, missing: There is no formula for the Daubechies wavelet function used in the analysis. The choice of the best basis is also not explained, even as a short summary. We are referred to the paper by Constantine and Reinhall, but still a short summary (or an Appendix) would have been useful.

The only really significant effect on wheat yield is at the lowest frequency. It is very likely the effect of nitrogen treatment, but interestingly it is the lowest possible frequency that has the greatest effect. In a spectral analysis this is usually associated with boundary effects and so I am wondering whether the same applies here. There is no perdiodicity associated with nitrogen, the spatial size of plots in the transect vary and this makes the analysis difficult. If anything, there are only really two cycles of nitrogen treatment (see figure 4) which again makes any spectral or wavelet analysis difficult.

There is a small effect associated with melons (which introduce a periodicity with a good number of periods), figure 7, but the correlation is very weak (figure 8) and not at the right frequency. Figure 7 is difficult to interpret, as we do not know what size of peaks are 'significant' compared to, eg„ random noise.

I also have a number of small comments and suggestions:

Figure 3: ordering of treatments Figure 6: perhaps repeat figure 4a at the top Figure 7: What are different lines? Nothing in the text or in the caption suggests what they are. I presume they are 95% confidence intervals – how calculated? Also, it would be useful to add at a bottom an axis with a period in addition to frequency – same for Fig 8.

I suggest that the paper is rejected in the present form. Although the results are moderately interesting and the analysis is correct, I cannot really see what we are learning from the results. It is well known that the addition of nitrogen increases wheat yield. It is also clear that the previous crop would act as a nitrogen sink. Two questions are

potentially interesting: Is there enough nitrogen mixing to wipe out any effect of fertirrigation? Can we use wavelets to learn about different scales of plant-soil interaction? While the paper is a step in the right direction, I am not sure it goes far enough to guarantee a publication in Biogeosciences.

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