

Interactive comment on “Expert modelling of a geological cross-section from boreholes: sources of uncertainty and their quantification” by R. M. Lark et al.

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We are grateful for this referee’s thorough reading of our paper, and we are pleased that he/she finds the study clearly motivated, with a logically related hypothesis and appropriate statistical analyses. We note that the referee makes no scientific objections to our work, and that the comments relate to its presentation, particularly in terms of the wider context of the relevant literature, and the accessibility of the account of the model. We proposed to respond to the referee’s comments as follows.

Literature review We accept that more can be written in the introduction (section 1) about other work done on uncertainty, including the work suggested by the referee,

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and we will expand this section, and section 5 accordingly.

Presentation of the statistical model We accept that more needs to be done to make section 3 more accessible to the geological reader. However, we do not agree that sections 3.2 and 3.3 have a ‘how-to’ style. These sections present the statistical models for the data analysis in the normal format for the applied statistics literature. While this does indeed provide the information the reader would require to repeat our work (which is an essential requirement for any paper which reports what is effectively an experiment), it primarily aims to make a full formal presentation of the model which allows the reader to understand exactly what each model tests, and the assumptions on which it is based. This is essential.

To meet the referee’s request for improved accessibility, while ensuring that a proper presentation of the models is included in the paper, we propose the following.

1. Section 3.1 to be retitled ‘Overview of models and analyses’. The section will start with text along the following lines ‘This section provides a concise overview of the analyses undertaken to test our hypothesis avoiding the statistical detail. The reader will find the technical details of the statistical models and their estimation in sections 3.2, 3.3 and 3.4 [3.2 and 3.3 of the original paper] and these sections can be ignored by the reader who only requires an overview of the statistical methods. Section 3.5 explains how the selected model for cross-section errors was interrogated to represent the cross-section uncertainty with confidence intervals and an analysis of the implications of this uncertainty for a hypothetical application.’
2. The new section 3.1 would then be based on paragraphs 4 and 5 of the current section 3.1 (from line 12 onwards), but written within minimum use of statistical terminology and aiming to give a more intuitive understanding of what the model represents. A new table will be attached to the section summarizing the models.

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3. The new section 3.2 will be based on the first two paragraphs of the current section 3.1, presenting the basic variable to be analysed and the LMM methodology.

Specific comments

1. Page 1690 line 8. Any observation of cross-section error is made at a borehole in the validation subset for the particular geologist who's interpretation are considering. The 'nearest borehole' is the nearest borehole to the validation borehole which was available to that geologist for interpretation. This will be clarified in revision
2. Page 1691 Line 21. We propose a clarification of terms along the following lines. 'The 51 available boreholes which prove the base of the London Clay were subdivided by independent random sampling without replacement into ten non-overlapping subsets of five validation boreholes. We call each of these subsets a validation batch, each is paired with a corresponding interpretation batch – the complementary subset of 46 boreholes.' Later we will write 'As each geologist presented to participate they were allocated one of the interpretation batches of boreholes in order so that a more or less even ...'.
3. Page 1692 Lines '1–8 and 22–27. We agree with the proposed restructuring. We also accept the point about 'expertise' and propose a new title for the paper: 'Interpretative modelling or a geological cross-section from boreholes: sources of uncertainty and their quantification.' In response to the question, the task was presented in GSI3D. All participants had some experience of this software, either as BGS staff or other delegates to the GSI3D workshop.
4. Page 1693 line 4–5. In section 3.1 lines 9 and following we use the term 'observation' to denote both an observation of the elevation of the base of the London

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Clay in some borehole, and the observed error of a particular interpretation in a validation borehole. We shall clarify this earlier in the paper.

5. This is familiar terminology in statistics (between and within-group variation). We shall clarify it in the new section 3.1 along the following lines : 'The random effects represent sources of variation in the observed errors, and here account for differences between batches of validation boreholes (are the mean errors for the different batches significantly different?), between the sites of validation boreholes within batches (are the mean errors for different locations within each batch significantly different from each other?) and between the geologists.'
6. 'However, in the current experiment, each of the geologists is allocated all validation boreholes in a particular batch, and so we must choose an appropriate statistical model for the geologist effect observed at each of a set of boreholes. In model 1a ...'.

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