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Hydrology and Earth System Sciences
Discussions

Interactive comment on "An Extended Kriging method to interpolate soil moisture data measured by wireless sensor network" *by* Jialin Zhang et al.

Anonymous Referee #1

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General comments:

This interesting study published in HESSD proposes a technique for the spatial interpolation of soil moisture measurements obtained by wireless sensor networks (WSN). Remote sensing data of NDVI and albedo are used as an additional information in the novel approach referred as Extended Kriging. The acronym NDVI is not clearly defined in the text and it is assumed that it refers to the vegetation index abbreviated by VI in line 17 of page 1. The interpolation technique is based on transferring the standard spatial assumptions of Ordinary Kriging to a combination of spatial distance and additional information related assumptions.

The results are presented in a good and mostly comprehensible form and the structure of the paper is reasonable. However, the manuscript contains some spelling and

grammar errors and the formulations could be more concise at some points. The figure captions could generally contain more information. Furthermore, it is not entirely clear how the interpolation techniques were applied. In total, there are several points that need further explanation and require additional work. Due to this, I recommend the paper to be returned for major revision.

Specific comments:

(1) Data pre-processing is often crucial for the interpolation performance of geostatistics. The information given in Sec. 2.2 is not sufficient. It should be explained how the exclusion of abnormal WSN data was performed.

(2) It is not clear why vegetation index in combination with albedo was selected as additional information. This needs to be discussed more. A short correlation analysis for several variables might help to justify this choice.

(3) The equations of Ordinary Kriging (Eq. 1, 2, 3 and 4) are not explained entirely. For many readers it might be clear that n refers to the number of adjacent measurements taken into account for the spatial estimation, nevertheless it should be mentioned somewhere in the text. The actual number of points considered for the interpolations using Ordinary Kriging and Extended Kriging should be mentioned as well in the methodology.

(4) It is not entirely clear how the variogram fitting was conducted and whether an automatic or manual approach was used for this. What exactly is shown in Figs. 2, 3, 4 and 5? Are these average experimental semivariograms or the experimental semivariograms of a specific time step? Figure 2 can be omitted.

(5) It is not sufficiently described how the interpolation was performed. The 5 min WSN measurements were aggregated to daily estimates of soil moisture, but only five clear-sky satellite images were available for specific days. Did you apply the ordinary kriging and Extended Kriging interpolation only for these five time steps? The performance

curves (Figs. 10 and 11) show more than five sampling points. Theoretically, all days of the investigation period need to be interpolated. Is it possible to apply this method for days without satellite information, for instance by using averaged spectral variables? This might be particularly interesting for the implementation of temperature data.

(6) I suppose that the correlation discussed in section 4.2 refers to the correlation of soil moisture maps interpolated by Extended Kriging with precipitation and irrigation data. Is it possible to show also the correlation using Ordinary Kriging? It might be interesting to see whether the implementation of satellite information can improve it.

(7) I strongly recommend comparing the performance of Extended Kriging with the performance of a standard multivariate geostatistical technique, for instance Cokriging or Kriging with External Drift. It is true that Extended Kriging is somewhat simpler. Nevertheless, it would be useful to achieve a better indication of interpolation performance. The second objection stated in the lines 6 to 8 on page 12 is not valid. Multivariate geostatistics is often applied to data without a direct physical relation.

Minor technical corrections:

(1) What is the reason for the tilted perspective or the masking of the borders in the maps of Figs. 6 and 7? Simple two-dimensional plots might be a better solution. I recommend preparing Fig. 1 in a consistent way, i.e. use the same masking. What is the background colour shading in Fig. 1?

(2) The term uncertainty analysis refers usually only to evaluations regarding the kriging standard deviation. I suggest renaming section 4.3 to cross validation and uncertainty analysis.

(3) Page 3, line 30 and other occurences: The correct spelling is cokriging.

(4) Page 7, lines 5-6: Why is the spherical model in particular important for structural and spatial interpolation? I recommend removing this clause.

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