

Interactive comment on “Extending the Coverage Area of Regional Ionosphere Maps Using a Support Vector Machine Algorithm” by Mingyu Kim and Jeongrae Kim

Anonymous Referee #1

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Extending the Coverage Area of Regional Ionosphere Maps Using a Support Vector Machine Algorithm The Ionospheric Delay Data (IDD) from a certain number of GNSS ground stations distributed inside an inner region, is exploited by the Support Vector Machine Algorithm (SVM) and Neural Networks (NN), to extrapolate IDD values in the outside region.

The results of SVM, NN, and BRDC (the Klobuchar model of the GPS navigation message), evaluated in terms of the RMS show unequivocally that SVM provides a higher prediction performance. The paper is well written and organized.

The possibility to extend, in real time, a regional coverage map of ionospheric de-

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lay also where IDD are not available, through the extrapolation method proposed by authors, has an important scientific value because it represents an important info in Space Weather context. That's why I feel that this paper deserves to be published after some clarifications have been made and some incongruences resolved.

1) In the introduction (before the reference of Leandro and Santos) you write: "Ionospheric delay observations were used as the input parameters, and the TEC outside the coverage area was predicted". Therefore I would assume that the output is TEC, but looking at figure 4 on the y axis is written ionospheric delay. Therefore it would be better to eliminate this incongruence writing and the ionospheric delay outside the coverage area was predicted.

2) In section 2, Parameter modelling, you write "An extrapolated ionospheric delay, TECext, may be represented. . . ." Why you label the ionospheric delay as TECext? Again, after Eq. (3), you talk about ionospheric delays but then in Eq. (4) you refer to observational parameters as TEC obs. It seems that you identified ionospheric delay with TEC. This sounds me strange because, to be meticulous, the ionospheric delay is proportional to the TEC therefore they are not exactly the same thing. To avoid this "incongruence" I suggest to replace in Eq. (4) TEC1 obs with ID1 obs, TEC2 obs with ID2 obs, TECN obs with IDN obs.

3) In section 3, subsection 3.1 again you write "y is the target that represent the true TEC in the extrapolation region". For the reasons written above I suggest to replace true TEC with true ionospheric delay.

4) In section 3, subsection 3.1, in Eq. (5), in the term WT the meaning of T is missing, T stands for? Moreover in Eq. (5) x should be replaced with xSVM to follow the same nomenclature adopted in the flow chart of figure 1 where you write xSVM = [xt xe xobs].

5) You write, at page 4 after figure 1, "Targets include the true TEC in the j-th extrapolation point", and looking at the flow chart of figure 1, I read ySVM = TECJext.. Therefore I ask you if it is not the case to replace in Eq. (6) and subsequently in the text, y with

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ySVM .

6) At the end of subsection 3.1 you write "...using the interior point method", please provide a reference here.

7) At page 7 you write: "...the high ionospheric delay season is more appropriate when evaluating the extrapolation algorithm than the low ionospheric delay season". This sentence is not clear. Could you explain in other words this concept. What do you mean with "more appropriate" .

8) Looking at the caption of figure 4, I note some incongruences : a) you write "One year variation. ...(October 01, 2013 to October 30, 2014)" . This period is made by 13 months so it is a year + one month.

Probably it would be better to write the caption as: Ionospheric delay for the training period (01 October 2013 - 30 September 2014), and prediction period (01 - 31 October 2014). This is compatible with what you write before figure 4, i.e, "The training period is set to one year from October 1, 2013 to September 30, 2014."and "The prediction period is set to one month from October 1 to 31, 2014".

9) At the beginning of Section 5.1 you write "the variation of the TEC and the...". But given that the figure 5 shows on the y axis the ionospheric delay, again, I think it would be better to write: "ionospheric delay variations and the extrapolation results are analyzed for the data from October 28 2014, when. . . ."

10) In figure 5 the acronym BRDC is not defined, it should be defined in the caption.

11) After looking at figure 5, showing the ionospheric delay trend for the direction north (N5) and south (S5), I would have expected to see in figure 6 the extrapolation error trend still for the direction north and south, but strangely you provide the results for the east direction (E5). Why?

12) At pages 8 and 9 you provide the coordinates only for N5 and S5, then you mention the points E5, W5, N15, S15, E15, W15 without giving any info about their coordinates.

For completeness, I suggest to delete the info about the coordinates of N5 and S5, providing however a table where are reported all the coordinates of the key points involved in this analysis.

13) For completeness, in addition to figures 7 and 8, I suggest to insert also a new figure showing the results for 10° extrapolation regions.

14) With regard to Table 1, you write: “In the east and west points. . . . but the improvement increases as the distance of the extrapolation region increases”. If I look at the errors for the direction east and west for SVM and NN, I note the following differences: 0.03, 0.20, and 0.13 (east direction), and 0.01, 0.01, and 0.17 (west direction) for 5°, 10°, and 15° respectively. So, to be meticulous, it is not fully true what you say, because in the east direction $0.13 < 0.20$ and in the west direction practically there is not difference between 5° and 10°. Therefore I suggest to delete the sentence “but the improvement increases as the distance of the extrapolation region increases”.

References a) The reference Kim and kim (2014) is in the text, but it is missing in the list of reference

b) The reference Kim et al., 2014 is in the text, but it is missing in the list of reference

c) The reference Kim et al., 2014b is in the list of references, but it is missing in the text

d) Please replace in the list of references McKinella with McKinell

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