Response to Reviewer #2's Comments

(egusphere-2024-2371)

General remarks:

An interesting paper describing the computation of critical loads of S and N for the whole of Canada, which is done here for the first time (earlier studies dealt with subregions only). The paper is well written, with some (minor) issues to be clarified, specially about Cl-deposition (see below). Thus, I suggest that the paper should be published with minor revisions. The corrections/amendments listed below should be addressed before re-submission.

Response: We would like to thank this reviewer for a very thorough parsing of the text and the identification of many minor issues that on correction will greatly improve readability and understanding.

The Cl deposition with regards to the issue of BCdep/Bcdep has been clarified in the methods section with the following explanation: The assumption is that Nadep = Cldep, in the absence of a Cldep map. We acknowledge this needs clarification and have added the following sentence to section 2.5 (Base cation deposition):

"In the absence of a modelled Cl_{dep} map, and since the air quality model estimates non-marine BC_{dep}, Cl_{dep} was assumed to equal sodium deposition; BC_{dep} is therefore referred to as Bc_{dep})."

Detailed remarks:
Note: 'X'→ 'Y' means: replace 'X' by 'Y' (in the text).

Abstract:
L[ine] 20: "Soil critical loads of nutrient nitrogen ... model.": That's already said in the first sentence!
Response: It is repetitive, the sentence in line 20 has been removed.

1 Introduction:
L28: "... and acidic deposition ...": a bit superfluous, since it is S and N deposition that forms acidic deposition ... Drop or reformulate!
Response: The sentence has been reformulated to "...reductions in sulphur (S)) and nitrogen (N) deposition..."

L46: Delete 'acidic' – this also holds for nutrient N CLs.
Response: "Acidic" has been deleted from the sentence.

L57: Insert 'soil chemistry' after 'steady-state'.
Response: "Soil chemistry" has been added to the sentence.

L61: 'disharmony': isn't there a better word? (incompatibility?)
Response: Incompatibility is a good suggestion, it has replaced "disharmony".

L72: 'effect' → 'effects'.
Response: "Effect" has been updated to "effects".

L73: 'estimated ' → 'assessed'.
Response: "Estimated" has been updated to "assessed".

L75: Insert '(i.e. S+N)' after 'acidic' (?).
Response: S+N has been inserted after "acidic".

L78: 'criterion' → 'criteria'.
Response: "criteria" has been updated to "criterion".

2 Methods:
L113: Delete 'and defined as'.
Response: "and defined as" was removed.

L116: 'BCdep': In the text all mathematical variables are in upright font, whereas in the equations they are in italics! I suggest to make it in italics everywhere (?)
Response: The manuscript has been updated to make the mathematical variables that appear within the text in italics.

L138: The parentheses could be left away ... [also in some other equations]
Response: As suggested, the parentheses were removed from eq. 4 and 5 but retained in eq 2 ($ANC_{le,crit}$) for readability (the exponents otherwise look strange).

L152: What is 'WGS84'?
Response: The sentence has been updated to clarify WGS84 is the World Geodesic System 1984 projection system of the map.

Table 1: (a) Reference(s) for 'Biomass' is/are missing; (b) Remove parentheses around 'CEC, 2018'; same for 'Galmarini ...' and 'Moran ...'.
Response: The biomass references have been added and the parentheses removed.

L161: What does 'Generalised' mean in this context?
Response: This was poorly worded and "generalised" has been removed from the sentence.

L171: What do you mean by '× 5g kg-1'? Clarify!
The organic carbon map sourced from Hengl and Wheeler is provided in units x5g kg-1. This is perhaps too much unnecessary detail and the conversion is provided in the data notes provided by Hengl and Wheeler, so we have removed the reference to x5g kg-1 to avoid confusion.

L182: 'Bcdep': In eq.1 it's BCdep! But since you are never mentioning again Cldep (from eq.1), I presume that you have assumed that Nadep = Cldep, and thus BCdep – Cldep in eq.1 becomes Bcdep!? This has to be corrected/explained!
Response: Yes, the assumption is that Nadep = Cldep, in the absence of a Cldep map. We acknowledge this needs clarification and have added the following sentence to section 2.5 (Base cation deposition) at line 194:

"In the absence of a modelled Cl_{dep} map, and since the air quality model estimates non-marine BC_{dep}, Cl_{dep} was assumed to equal sodium deposition; BC_{dep} is therefore referred to as Bc_{dep})."

L250: Delete 'scenarios'.
Response: "Scenarios" was removed from the caption.

Table 2: Insert '(mol/mol)' after 'Bc/Alcrit' in header.
Response: The table has been updated to add mol/mol.

L263:'… all other regions were set to 0' → '… in all other regions it was set to 0'.
Response: The text was changed to "in all other regions it was…"

L278: 'against' → 'using'.
Response: "against" was replaced by "using".

L290: Explain 'CPCAD'.
Response: CPCAD was defined in the introduction; however, it has been re-defined here for clarity (Canadian Protected and Conserved Areas Database).

3 Results:

L309: 'estimate' → 'estimated'.
Response: "estimate" was changed to "estimated".

L326: 'under 5% and 20% growth reduction scenarios' → 'for 5% and 20% growth reductions'.
Response: This suggestion was implemented.

L329: 'coverage' → 'averages' (?) [otherwise, what do you mean?]
Response: Yes, thank you, this has been changed to "averages".

L335: BCdep: Why suddenly upper-case 'C'?
Response: This is a typo, it has been corrected to lower-case Bcdep.

L338: 'loss of definition': What do you mean? [is this a technical term well known?]
Response: This sentence has been reworked to read "at the cost of lowering average Bcdep".

L338: The value after smoothing (68) is higher than the pre-smoothing value (52)?
Response: This was an error in the text, and has been corrected to show the after smoothing average is lower than the pre-smoothing average.

L372: Delete '(Figure 12B)' – it shows nothing about acidity CLs.
Response: Figure 12B was removed from this line.

L386/7: A bit strange text; maybe write 'Modelled annual average (2014-2016) total deposition of sulphur (Sdep, panel A) and nitrogen (Ndep, panel B). Maps were …'
Response: This is a good reworking, it has been adopted.

L389: Insert 'average' before '2014-2016'. (?)
Response: added "average" before "2014-2016".

L394: '... result of higher CL...' → '...result of lower CL...'. !!
Response: Thank you for catching this terrible reversal, it has been changed to "lower"

L403: 'plus' → 'and'. (also L409)
Response: Good distinction, "plus" was changed to "and" in both these lines.

L407: 'including' → 'using'.
Response: "Including" was changed to "using".

L425: 'reducing' → 'increasing'! [adding Bcdep allows more N-uptake, leading to higher CLs, and thus lower/less exceedances (5% instead of 9%)]
Response: Thank you for catching another reversal, it has been changed to "increasing".

4 Discussion:

L438: 'of' → 'in' (?)
Response: "In" sounds much nicer, "of" has been changed to "in".

L454: 'Mcnulty' → 'McNulty'.
Response: McNulty has been properly formatted here and in the references.

L458: Delete 'map', twice. (?)
Response: The second "map" in the sentence was removed.

L472: '7.26 ×' → '7.26 times'.
Response: The x was reformatted to "times".

L502: 'region' → 'ecosystems'.
Response: "Ecosystems" replaced "the region".

L522: 'Pine' → 'pine'.
Response: The capital was corrected.

L524: 'ha-1' → 'ha^{-1}'; also for 'yr-1')
Response: The superscripts have been corrected.

5 Conclusions:

L540: Delete 'to several parameters'.
Response: "to several parameters" was removed.

L545: insert 'average' after 2014-2016.
Response: "average" was inserted after 2014-2016.

L553: 'they provide' → 'as providing'.

Response: "they provide" was changed to "as providing".

References:

General: The references are not given in a consistent style: In some the title of the paper/report is with upper-case first letters, in some not. In some the DOI is given, in others not. In some, especially for reports and book chapters, the place and/or publisher is missing.

Specific:
L674: 'Mcnulty' → 'McNulty'.
L700/1: Is this an article? In which Journal? Or a report?
L707: Spell out "Nord. Counc Minist Cph,Den."
L763: 'AL' → 'Al'.
L773: 'de Vries' → 'De Vries'; and move up to the other 'De Vries …'!
L775: Why "McDONALD"?
Note: These are only those 'flaws' seen when glancing thru the Refs. I guess that there might be more … In any case: Please check and harmonise the References

Response: Yes, it seems that a number of the references that were generated using a referencing software package were poorly formatted. In addition to fixing the above noted errors, the references have been checked and manually re-formatted as necessary.