

## ***Interactive comment on “Modelling climate change effects on a Dutch coastal groundwater system using airborne Electro Magnetic measurements” by M. Faneca Sánchez et al.***

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Reply to Interactive comment on “Modelling climate change effects on a Dutch coastal groundwater system using airborne Electro Magnetic measurements” by M. Faneca Sanchez et al.

Comment referee

Page 6140. Geology. The definition of the aquifers as first and second can be confusing; I would recommend a less arbitrary terminology as shallower/deeper or upper/lower. Also in this part it would be interesting a brief description of the hydrodynamics  
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(maybe with some modifications of the figure 2) to explain how the water is moving from the different aquifer layers and the role of the Holocene layer. This would make easier to understand the later explanations about seepage-infiltration and the final discussions in the model results.

Page 6142. It is stated that “We collected groundwater samples and we measured both (EC) total and EC(groundwater). . .” I guess that if you collected only groundwater samples you can’t measure the EC(total). This should be better explained.

Page 6147. Lines 15-19. It is stated that “the EC data derived from geophysical measurements (borehole-logging, AEM, ECPTs) was interpolated. . .” so the authors are giving the idea that they mixed all the different data for obtaining the final 3-D model. I guess that they used the AEM and the other two datasets were useful for calculating the FFi or the correlation with the CI and EC. This could be explained more clearly. As the methodology that the authors proposed included many different calculations and methods I think that a new figure with a scheme of all the procedures, databases and applications of each data would be necessary. This would synthesize all the work presented in this paper.

Page 6149. Lines 15-16. It is commented that the interpolation of the AEM measurements is proved to be better than older measurements techniques but I don’t see where this is proved or discussed.

Page 6150. Lines 4-5. The authors decided to use the initial 3-D chloride concentration after 15 years of simulation time and I think that is a good idea. But I don’t know if this is affecting to the 2005 simulation results. In the year 2005 we would be under these non-equilibrium conditions that the authors detected. This should be clarified.

Page 6151. Model calibration. After reading the model calibration section it is not clear for me which properties were modified and if the results were fitting well with field measurements (of the hydraulic properties). Did you use any automatic calibration software? Did you observe a big change compared with the initial hydraulic properties?

In general this part would need some extra information.

Page 6153. Present situation 2005 AD. Did you check if the results presented in the model are fitting well with “true observations” related to the seepage and infiltration fluxes zones, rainwater lenses thickness, EC of the groundwater. . . ?

Page 6155. Line 4-5. This is a very interesting interpretation; the authors can give some approximated values of the differences in the bathymetry to use as a reference for other research areas.

Page 6156. Line 10. The sentence about previous studies was not commented before in the text and also it should include a reference.

Page 6156. Lines 11-16. The explanation about the time for reaching the equilibrium is good but, in this case, as you are reaching it in only 15 years (but then you are modeling 100) can produce some misunderstandings. Technical corrections I found some sentences not very relevant that could be removed or better explained for justify their presence in the text. They are marked as unnecessary.

Page 6138, lines 15-16. Unnecessary

Page 6139, lines 4-5. Unnecessary

Page 6142, lines 3-9. This is explained later in more suitable context.

Page 6142. Lines 26-27. Unnecessary

Page 6143. Line 7. The order of the references should be checked.

Page 6144. Lines 2-3. The explanation about constant thickness that is variable results confusing.

Page 6145. Lines 22-23. The information about the DINO database was already commented, is unnecessary.

Page 6147. Line 16. “ as mentioned. . .” Unnecessary

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Page 6150. Line 26. Is the first time that the KNMI is mentioned, it should be explained instead of later in the page 6152.

Page 6155. Line 2. What is PZH?

Page 6155. Line 13. Unnecessary

Reply:

Page 6140: We will do that, thank you for the advice.

Page 6142: The total EC is measured using a well-log instrument that records conductivity in the well or with the ECPT. The results are interpreted as the EC(total) since the conductivity that is measured is the combined conductivity of the sediment and the groundwater in the sediment. In the same fashion is the EC from the airborne EM interpreted: measured EC from AEM is the EC(total), the combined response of the sediment + groundwater.

Page 6147. The procedure for the calculation of the EC will be described more precisely. A diagram of the entire workflow is indeed a good suggestion.

Page 6149: Answer for both referees: We consider the field created with AEM measurement better than those created with older techniques because the interpolation is done using a high number of measurement. In this case, the interpolation in some cases wasn't needed because the flying lines of the helicopter were about 100m far from each other. Maybe the phrase must be reformulated because it didn't prove to be better, but it is better due to the higher density of data and the quality of the data.

Page 6150 We chose to use the field after 15 years although it could have also been that one of 13 or 16. It is very difficult to precisely choose the moment when the system is in a “natural non-equilibrium”. What we can assure is that the changes occurring in the system in the first 10-15 years are not those of a natural system in non-equilibrium except if the system has suffered extreme events like tsunamis, or anthropologic changes.

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Page 6151 The calibration was done by hand, no automatic method was used. We had to change the hydraulic properties of the till and finally we used a vertical conductivity of 0.003m/d for all the till. That improved the matching between head measurements and head model results. We didn't calibrate the model on variables like the concentration.

Page 6153 Although we didn't validate the model with specific measurements, the seepage and infiltration areas were discussed with the stakeholders of the area and recognized by them in big terms. Other results like the thickness of the rain water lenses were validated with knowledge of the area but no with concrete measurements.

Page 6155. Line 4-5 We will check on that and see if we can give other references.

Page 6156 Line 10 We will remove the sentence because there are different studies all with different times, and the 30 years was an average but it is not the same for all the studies.

Page 6155 line 11 We will rewrite this piece to make it more clear and avoid confusion.

Page 6138 We find it important to mention that this is not the only study where AEM has been combined with hydrogeological modeling.

Page 6139 We will remove the sentence

Page 6142 We consider this sentence is good here because it gives a total summary of the use of the AEM data.

Page 6142 lines 26-27 It can be removed

Page 6143 We will put them in the right order

Page 6144 We will try to explain it clearer

Page 6145 ok

Page 6147 ok

Page 6150 Correct, we will change it

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Page 6155 PZH is the Province Zuid Holland model, we will write all the words

Page 6155 Ok

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