**Hydrology and
Earth System
Sciences
Discussions**

Interactive comment on "Factors influencing chloride deposition in a coastal hilly area and application to chloride deposition mapping" *by* H. Guan et al.

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1. General comments

The manuscript presents the correlation analysis as tool for estimating spatial atmospheric bulk chloride deposition (BCD) in east of Adelaide, South Australia. The BCD data are needed for spatial groundwater recharge estimation through the chloride mass balance (CMB) method. They are few successful experiences on the CMB method application in hilly coastal areas. In these areas, the high spatial gradients of BCD can constraint accurate groundwater recharge estimation. Nevertheless, the statistical ap-

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proach developed in this work not entirely improves the estimation that classically could be achieved by geostatistical methods, such as kriging with external drift, co-kriging, etc. Analyzing a well-known set of variables controlling the BCD in hilly coastal areas, no general rules are introduced. The role of dry deposition in BCD is not defined or quantified. Without a clear justification, some anomalous samples are removed in order to reduce uncertainty, artificially. This means a serious problem to justify the goodness of the correlation analysis. Uncertainty due to spatial errors and those derived from approaches are added to the natural variability needed to asses' long-term groundwater recharge variation due to land uses changes. Conceptually precipitation and their stable isotope signature can be modelled by quasi-linear relationships with temperature or similar potential induced covariates as elevation, but not the chloride content in rainfall (as authors propose), nor the wind-blown halite from marine aerosol and sea-breezes, urban and industrial activities and lithology, which are unknown in the study area. Section 2.1. A brief hydrogeological description is needed. Provide data on population density, industrial activities, etc., as well as other climatologic data as temperature, potential and actual evapotranspiration, soils, vegetation cover and lithology.

2. Specifics comments

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Line 6-9. This asseveration requires providing a tentative groundwater turnover time value. Line 10. Show generic applications. Chloride deposition maps are needed for,... This is a new methodology that improves ... Line 14. What means terrain aspect?. Line 16-17. What type of gradient?, average in the catchment, from the coastline, ... Line 20. Average uncertainty. What type?. Due to natural or inter-annual variability, as kriging uncertainty by spatial interpolation, due to simplifications in approaches to calculate BCD?. Define and comment...

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Line 3. Describe accurately the CMB methodology for generic cases: A typical... Line 6-7. Precipitation in the catchment?. May be effective precipitation to the land?. Line 7.Cg is not in groundwater. Theoretically, it is below the root zone and assumed to be equal in groundwater (Scanlon, 2000). Line 6-9. Improve these sentences. Define the CMB method for transient condition with possibility of chloride retention in the soil, and steady conditions for average recharge evaluations (in the sampling period o from yearly values). They are a problem of time-scale. Line 13-14. Some mixing cells numerical methods are based on groundwater and surface flow asseverations. See publications of Adar and Neuman (1988) Adar et al. (1988), Gieske and De Vries (1990). Line 14-15. Classically the CMB method was a very uncertain method in mountainous coastal areas (see Gasparini et al., in Canary Islands, Rosenthal in Israel, etc...).

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Line 2. Describe other possible not evaluated sources of chloride in deposition in coastal areas, such as lithological and anthropogenic, which can be relevant up to 30 % of bulk chloride in coastal plains and up to 50 % in summit coastal areas in polluted zones. See the use of the Cl/Br ratio for identifying sources of CBD in Spain (Alcalá and Custodio, 2008b). Line 19-20. References about wind direction and intensity controlling CBD should be attached. Line 24-25. Minor et al. in Nevada (USA) or Carratalà et al. in Eastern Spain used similar geographical covariates for mapping CBD.

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Line 5-7. Explain it better and reference. Line 16-17. Hypotheses (2) is mistaken. They are many references. Line 17-19. This assumption (and relationship) was found and developed by several authors from the ninety (Rosenthal, 1988; Gasparini et al., 1989; Herrera and Custodio, 2008; Contreras et al., 2008; ...) in other hilly coastal areas. This is not a novelty. Line 20-23. See comment on the Cl/Br ratio.

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Line 10-12. This detailed study requires to asses separately wet and dry deposition into bulk deposition before interpolate and derivate covariates. Line 10-13. Clarify wind stations in Figure 1. Line 15-20. You can asses land uses changes impact on groundwater resources for only 2-years long record of chloride deposition?. They are long series in the region?. Then, what is the expected natural variability of chloride deposition?. Line 23-25. Describe the analytical method to determine chloride in Laboratory, as well as accuracy and reproducibility. Line 28. Website of BOM.

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Line 18. MATLAB software requires copyright?. Line 19. t-distribution. Describe better with references, examples and potential ranges. Line 21. r is rxy(z). Follow notation. Line 23. For t (Eq. 3), what units (supposedly dimensionless) and potential ranges are theoretically expected for uncorrelated and well correlated variables. All variables are linearly correlated. They are exponential and other type of correlation?. What is the weight of N (length of the series) in t?. Explain the relevance of t values and rxy(z) for short series with different N.

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Line 1-3. What may be the canopy effect on deposition (dry and wet separately). Natural or induced forest and stubble fires are nowadays frequents?. Line 5-10. The procedure is probably satisfactory but its novelty limited. You can explain clearly the improvement of this method over the kriging with external drift, the co-kriging, etc. Kriging provide a suitable spatial error estimation with a clear meaning not found here. Line 6-7. Residual maps are a measure of spatial uncertainty?. Can you explain better this sentence?. Line 12-15. Dry deposition measures are needed, as well as to study the source of chloride to identify predictable marine sources from punctual and/or regional anthropogenic or lithological sources largely dependent of wind intensity and periods of production (industrial factories) or urban pollution (winter and summer with

probably most population by tourism activities and pollution admitted by see-breezes). Line 24-25. Explain better sentences and definitions with details. What means b0. How is introduced cos (α-ω) into Eq (4)?. Line 26. Only in southern areas?, not in urban or industrial areas?. Locate and rename stations in Figure 1 and Figure 3. Define density of BCD sites, as well as a simple BCD kriging variance map.

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Line 5-15. Justify divergences from bibliographic sources before exclude samples which are then necessary to interpolate and quantify spatial uncertainty. If dry deposition is too irregular, linear correlation methods should be excluded as suitable tool for regionalizing BCD. Probably, heterogeneity can be reduced grouping samples seasonally. See Gustafsson and Larsson (2000). The ASOADeK method do not seems to improve estimation of BCD spatial variability in coastal areas.

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Line 4-8. This is a well-documented scale effect. Probably you are sampling the first part of a regional exponential trend inland-ward. Line 9. Over that other coastal study areas?. See pioneer studies of Eriksson and Khunakasem (1969) conducted in Israel to the current studies based on GIS support (Minor et al., 2007). Line 10-13. You can include dry chloride deposition as independent term in equations to improve correlation, externally. Line 21. They are references on canopy effect on bulk chloride deposition?. Line 23. This is evident and need to be assessed for mapping chloride deposition at that catchment scale.

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Line 15. Where is the distance between first rainwater samplers and the coastline?. Line 17. Gradients of 2 g m-2 year-1 km-1 reported by Alcalá and Custodio (2008) refer only for spurious data adjacent to the coastline in northwestern Iberian Peninsula. The rest of the data are between 0.05 and 0.5 g m-2 year-1 km-1, and usually between

0.05 and 0.25 g m-2 year-1 km-1 in the Mediterranean non polluted coastal areas (see Figure 7 in Alcalá and Custodio 2008). Line 27. Show range of MAE relative to D measures. It is low for coastal places but very high for inland stations (up to 50%). Explain.

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Line 11-13. Define equation for mapping uncertainty with examples and references Line 17-18. See comments before. Line 20. Conservative?. Explain better. May be a mistake in error propagation equation?. Define error equation. Line 29. Explain better the sentence.

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Line 5-6. Scanlon (2000) studies the Eagle sedimentary basin. This is an inland flat area. The relations are reliable?. Line 15. It is a well-know rule in most coastal zones. It is not compensated by elevation but the canopy effect. Several papers focus the atmospherically contributed nutrients to the land through wet and dry depositions. Line 25. This assumption was demonstrated in many papers. At the rainfall event starts chloride increases by washing the initial chloride-rich see breezes and then chloride decreases... They are information on sea-waves size in addition to the wind intensity?.

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Line 10-28. This is a speculative sentence with light implications, without new contents of general interest or data acquisition, formulations and CMB method applications or improvements. Discussion should be improved with the contribution of the paper.

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Line 1-15. Out the scope to calculate groundwater recharge through the CMB method Line 8-9. If they are air pollutants in the area, they can be evaluated to justify low correlations in variables.

3. Technical corrections

Figure 1 need a large improvement. 4 maps are needed (1) regional location in Australia; (2) a good quality contour map with places cited in the text, rivers, coastline, etc.; (3) precipitation map; (4) 1-km DEM; (5) aquifer contour and a representative section. Geographical coordinates, etc... Clarify wind and BCD stations.

Figure 7. The Peninsula of Gulf of St Vicent is cut in b through f and data are missing.