Challenges in conditioning a stochastic geological model of a heterogeneous glacial aquifer to a 1 comprehensive soft dataset.

Author: Koch et al.

Reviewer: Fabrizio Felletti

This is an interesting paper that shows how a vast conditioning dataset (SkyTEM) can be incorporated in the stochastic modeling process (TProGS simulation). The categorized SkyTEM dataset is used to define the lateral model of spatial variability, whereas borehole data are used for the vertical direction.
The subject is very interesting and I feel the paper suitable for the publication, after revisions.

My principal concerns are on the geological/sedimentological model. The geostatistical approach (and the way to incorporate soft data for conditioning the TProGS simulations) is essentially correct and well explained.
In my opinion, the authors should devote more attention to describe the depositional environments, facies and facies associations, lateral and vertical facies transition, sedimentological logs description, etc. This part is completely missing and the authors do not characterize the degree of heterogeneities of the depositional system. These informations are essential to evaluate the results of the simulations.
The authors describe (and simulate) the geology as "binary": sand or clay. In my opinion this is an excessive simplification of the reality. A geological model built only with two facies, defined uniquely on texture, difficultly could be used for an hydrogeological flow modeling, as Authors state later in the text . Unfortunately the geology is not "binary". Within your glacial deposits, don't you have any gravels, sandy-gravels, gravelly sand, muddy sand, etc? The choice of using only two categories to describe your deposits certainly simplifies the simulation but definitely reduces excessively the degree of heterogeneity of these sediments.
I suggest a couple of references where the problem of sedimetological heterogeneities at different scale is discussed:
-   Felletti et al 2006, Journal Sediemtary Research. Geostatistical simulation and numerical upscaling, to model ground-water flow in a sandy-gravel, braided river, aquifer analogue

-   dell'Arciprete D., FellettiF. & Bersezio R.(2010). Simulation of fine-scale heterogeneity of meandering river aquifer analogues: comparing different approaches. In P.M. Atkinson and C.D. Lloyd (eds.), geoENV VII – Geostatistics for Environmental Applications, Quantitative Geology and Geostatistics. Springer, Volume 16, p. 127-137

Your dataset contains 112 boreholes. In my opinion, you should show at least some borehole stratigraphy. Why don't you show a correlated geological cross-section or a stratigraphical scheme?

It is not clear the vertical resolution of the SkyTem method. Is it possible to characterize facies heterogeneities at a depth of 20-30 m with this method? If I understand, in vertical direction you computed 40 cell, 2m thick. Consequently your investigation depth is 80 meters. Is it correct? In this case, how can you compute the horizontal transition probabilities at different depths, if your computation is exclusively based on relatively low resolution SkyTem data.

Could you better explain Section 4.5, "Performance criteria" ?. I think it is not clear enough.

Section 4.5.3: What do you mean with the term "geobody"? You have to define what a geobody is. Which order of architectural element of a depositional system do you refer?

Section 5.4.3. Geobody connectivity . You should better explain which nature of connectivity you expect . I suggest you the following reference where different type of connectivity are discussed:

Giudici M., Bersezio R., Felletti F., Baratelli F., Cattaneo L., Cavalli E., dell'Arciprete D., Mele M., Pessina L., Vassena C. (2012) – A multidisciplinary study of sediments' connectivity and transport parameters for aquifer analogues. Models – Repositories of Knowledge, IAHS Publ. 355, pp. 223-228