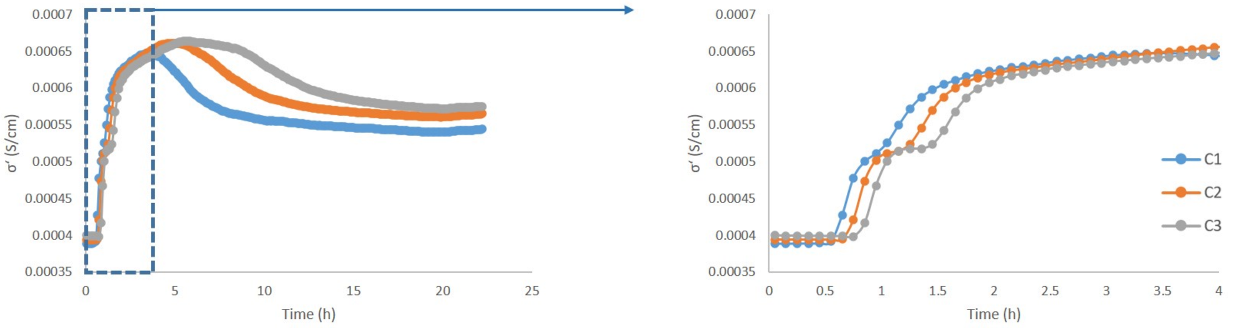
Response to anonymous referee #1

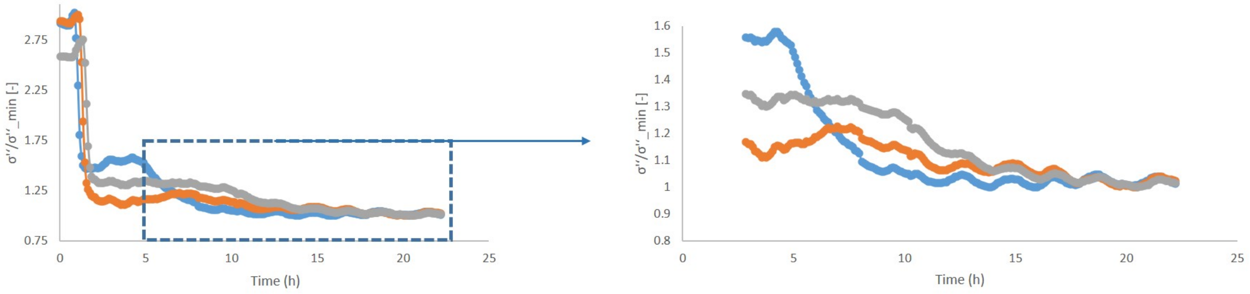
We would like to thank anonymous referee #1 for the comments.
The main concern of the reviewer is related the applicability of the method to real world problems.

We address this concern in the following reply.

As the reviewer correctly pointed, we currently present a fairly simple case of solute transport and ion-exchange. To demonstrate the applicability of SIP-based analysis of these processes, we intend to expand our work to include reactive transport of additional contaminants. In a series of experiments, we examined a few alternatives (e.g ZnCl, cationic dyes). The results of these experiments qualitatively support the findings presented in the original manuscript, but naturally add complexity by including other processes such as precipitation

We hereby present some of the result of our additional experiments. The following results show the real and imaginary components of the complex conductivity (at 1 Hz) over time in a sand column during a continuous Zinc injection.





The results clearly show the BT of the non-reactive ions around t=1h (the Cl^- anion and Na^+ cation that behaves as a non-reactive solute since the experiment started after a long $NaCl$ pre-wash). A second geo-electrical BT is observed around t=1.7h. This BT corresponds to the increased concentrations of Ca^{2+} that was washed out during the Zn injection and was detected by ICP. The subsequent drop in σ' is probably the result of Zn precipitation. PhreeqC simulations confirmed a positive precipitation potential of $Zn(OH)_2$, which is expected to be the dominant species in the system.

The imaginary conductivity presented a slight increase initially and then decreased significantly (similarly to our $Ca^{2+} - Na^{+}$ exchange experiment). A second pattern of increase and decrease is observed between t=2-14h. This pattern corresponds (timing-wise) to the observed drop in σ' and hence is likely to be related to the Zn precipitation process. Further laboratory work and analysis are still needed to complete this experiment. We are also currently testing similar setups for monitoring of organic pollutants and other metals.

Further, as suggested by the reviewer, the discussion will be expanded: the limitations of the method will be presented and possible applications to different areas of environmental study will be presented.