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Interactive comment on "Impact of sediment-seawater cation exchange on Himalayan chemical weathering fluxes" *by* M. Lupker et al.

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This study addresses a rather overlooked component of chemical weathering fluxes: the exchange of cations in near-coastal estuaries due to interaction between river water and seawater. To do this, the authors measure the cation exchange capacity (CEC) of sediments in the Ganges-Brahmaputra (GB) system with a number of different methods. They find that CEC scales with the Al/Si ratio (a proxy for grain size), but that the proportion of cations adsorbed to suspended sediments is independent of the Al/Si ratio, with [Ca2+] dominating the fraction of adsorbed cations. Finally, the authors calculate maximum and probable exchange fluxes, concluding that these exchange fluxes contribute approximately 5% more [Ca2+], while removing an additional 15% of the [Na+] flux.

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Discussion paper

The study is elegantly simple, and, as far as I know, doubles the number of major river systems for which cation exchange has been constrained. Given the purported importance of the GB river system to global sediment, chemical, and water fluxes, this study is particularly timely. The manuscript is well-written and the figures and tables informative. In short, I believe this manuscript is suitable for ESurf. I would characterize my suggested revisions as moderate-to-minor. Below I detail my primary concerns and suggestions, most of which focus on trying to make this manuscript as accessible to a wide audience as possible. Following these are more technical and grammatical comments that I have made in an attached, annotated PDF.

1) I am somewhat confused as to precisely where these cation exchange fluxes occur. On page 2, 2nd paragraph, the authors explain that these fluxes occur in estuaries as river water is transferred to the ocean. However, should not these exchange fluxes be potentially occurring along the entire length of the river system, as tributaries with somewhat different dissolved and adsorbed chemistries contribute water and sediment to the main trunk? Or is the chemical difference between river water and seawater so substantial that this is where the largest cation exchange fluxes are expected? I understand that the authors sampled between the mouths of the Ganges and Brahmaputra and also in the Lower Mengha; however, is the Lower Mengha considered an estuary or still primarily freshwater? A more specific explanation, linked to the hydrology of the GB and Lower Mengha, would greatly help the reader follow the precise mechanism and setting in which these exchange fluxes occur.

2) I do not follow how the probable exchange fluxes are calculated. I understand that the authors used Eq. 2 to show that Kv is approximately constant across sampling locations (and similar to the Amazon); however, I can only see how Eq. 2 applies to the exchange of Ca2+ for Mg2+. Is this same equation (or a similar one) used to calculate the probable fluxes for Na+ and K+? Or is the fact that the proportion of adsorbed cations is constant across Al/Si ratios somehow used to then calculate probable Na+ and K+ exchange fluxes? Regardless, I think the authors should spell

out this calculation (particularly as it applies to Na+ and K+) more clearly since these probable fluxes are the primary point of the paper.

3) One change that might make this manuscript more widely accessible would be to address whether measurements such as presented here should be more widely made as part of river sampling campaigns. For example, it appears as if the methodology presented here is widely applicable and could be more widely implemented. Though the authors conclude that these exchange fluxes have a relatively limited importance when compared with the long-term carbon cycle, some of the corrections here (ie, 5% of the Ca2+ flux) are of a similar magnitude to corrections for precipitation and cyclic salts (see, for example, Appendix Tables in Torres et al. (2015)). Thus, it would be helpful to note whether this method should be more broadly applied, given that many other corrections to weathering data are being made that are similar in magnitude to the one presented here. Perhaps globally the effect of cation exchange negates the correction for atmospheric inputs of divalent cations?

4) Finally, it does not appear that errors have necessarily been fully propagated, and the authors should check that their reported errors are accurate. For example, on page 5, 2nd full paragraph, the authors write that the "average total CEC is 8.0 ($\pm$0.9)...for the Ganga, Brahmaputra, and lower Mengha." These numbers are calculated using the linear regressions on Figure 3, though it does not appear that the uncertainty on these regressions is accounted for in these errors. Since the authors do go to the trouble of reporting errors, it would be appropriate if the full range of errors were accounted for.

References cited: Torres, M., West, A.J., and Clark, K.E., 2015, Geomorphic regime modulates hydrologic control of chemical weathering in the Andes-Amazon: Geochimica et Cosmochimica Acta, v. 166, p. 105–128, doi: 10.1016/j.gca.2015.06.007.

Please also note the supplement to this comment:
http://www.earth-surf-dynam-discuss.net/esurf-2016-26/esurf-2016-26-RC1-supplement.pdf

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