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Comment on esurf-2021-90

Anonymous Referee #3

Referee comment on "Spatio-temporal variability and controlling factors for postglacial denudation rates in the Dora Baltea catchment (western Italian Alps)" by Elena Serra et al., Earth Surf. Dynam. Discuss., <https://doi.org/10.5194/esurf-2021-90-RC3>, 2022

The Manuscript by Serra et al present a suite of Be-10 derived basin-averaged erosion rates from the European Alps and relates them to various topographic and lithological metrics. Additionally, they consider the implications of sediment supply and mixing between sub-catchments and contrast their rates with those derived for the area over longer and shorter timescales. They propose lithological and relief-based parameters as being most important with regards to driving denudation. They suggest high erosion of the Mont Blanc area dominates the sediment production of the larger catchment area, and also that frequency magnitude effects, and/or bias in the Be-10 concentrations due to working in a glacial setting can best explain slower modern rates versus the TCN derived rates.

A problem with applying the basin-wide cosmogenic Be-10 approach to determine erosion rates of glacial/post glacial areas is that you risk violating several of the key assumptions inherent in the method. We might not expect glacial topography to have experienced steady-state erosion for a few multiples of the averaging time and that the concentrations in the surface bedrock/soil cover being eroded are in some approximate equilibrium with the rate of erosion. In addition, these landscapes often contain glacial deposits (moraines, tills, fluvio-glacial sediments, etc), which which confound the basin-wide approach if they are being introduced significantly into the fluvial system. The Be-10 work I'm familiar with that attempts to constrain erosion in glacial/post-glacial regions has generally tried to understand the amount to which the rates might be biased in such settings by sampling contributing glacial features and different landscape elements within the basins (e.g. Wittmann et. al., 2007; Norton et al., 2010; as cited in the MS), or at least performing some sensitivity analysis of the effects (e.g. Dixon et al., 2016; as cited in the MS). The authors recognize these potential problems, e.g. the end of section 5.1, or 5.4, where they suggest it can explain why the Be-10 derived rates differ from modern sediment export rates. Based on the discord between the low rates of the contributing catchments rates versus the high rates inferred for the trunk stream, I would say potential bias is a fair assessment and so one that needs some consideration in relation to the robustness of the denudation rate results. However, this is not quantitatively addressed and assertions are made about (assumed linear) correlations, or lack of, between the derived denudation rate and topography, lithology, precipitation, etc. This is the main problem I have with the

manuscript. I want to be convinced that the Be-10 derived rates are reflecting actual rates of erosion to subsequently accept later interpretations but the manuscript doesn't achieve this. The discussions about sediment mixing and the interesting result about the high concentrations in the tributaries versus the trunk stream are useful and likely valid. However, they are based on results that suggest the application of the technique to derive denudation rates, despite the efforts the authors have gone to in order to constrain appropriate production rates, might be flawed, and this needs tested before making statements about what the denudation rates mean.

In my view, major restructuring is required to reduce the manuscripts focus on correlations of the denudation rates with various metrics (that are at best showing weak correlations), and to place more emphasis on the robustness, or not, of the results in this setting, and the implications of their results for sediment mixing. Alternatively, the authors should include convincing support for their interpretation of Be-10 concentrations as valid denudation rates.

Some other comments/concerns listed by line number/figure are:

It's not entirely clear how lithology/quartz content is being dealt with in regards to the Be-10 approach.

Specifically:

- L458, how would carbonate dissolution contribute to the Be-10 results?
- Are the areas excluded from contributing to the Be-10 inventory because of lithology also excluded from the topographic (etc) metrics? I don't see this mentioned in the methods.
- Are these exclusions not somehow biasing the conclusion that resistant lithologies are a main driver of the rates (assuming the rates are valid, see above)?
- Do the exclusions also get taken into account for the sediment mixing/contributing area interpretations, e.g. the suggestion that Mont Blanc regions contributes the most to the downstream sediment yield?

L160 "geophysical relief" needs more explanation. It needs to be more clearly stated how it's derived and how it represents "locally increased erosion".

Related to the correlations given in the plots of Figs 4 and 5: why assume linear relationships? We already have a lot of evidence showing, for example, slope and denudation rate are non-linear at such steep slope values?

Suggested language edits and minor points:

On a few occasions I found the text difficult to follow/understand (for example, but not limited to, point (1) on L458) and proof reading of any future versions before submission would be recommended. Some other minor points about the text are:

L31 around the globe covers the Alps

L38 What is meant by "recent" in this context?

L74 "greater than" 4000m peaks?

Section 2 (and later section 5.4) over-use parentheses

L109 Is this rate a result, or background info? Better to say - was obtained by Wittmann et al (2016, sample T12). The similar location to the sample measured here can be mentioned in the methods.

L124 Is the blank values used from a long-term lab average, or a blank measured at the same time as the samples?

L159 It's worth acknowledging that slope may be underestimated at the resolution of the DEM. For example, see Zhang and Montgomery (1994) Digital elevation model grid size, landscape representation, and hydrologic simulations. *Water Resources Research*, 30(4), 1019-1028.

L184 1.49 ± 0.13 mm/yr is not in the table.

Table 1 Give units for the coords (decimal degrees?).

L403 The Be-10 concentrations were normalized to the basin averaged production rates. Is this not commensurate with simply using the denudation rate (also a normalization of concentration to the production rate)?

L460 How is the landscape dissected by sediment export?