

Earth Surf. Dynam. Discuss., referee comment RC1
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Comment on esurf-2021-12

Anonymous Referee #1

Referee comment on "Last-glacial-cycle glacier erosion potential in the Alps" by Julien Seguinot and Ian Delaney, Earth Surf. Dynam. Discuss.,
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The study of Seguinot and Delaney presents a time-integrated model on the glacial erosion potential over the last 120 ka in the Alps. Authors tie the calculations on a previous study by Seguinot et al. 2018 who modeled the glacial extent over Alps' last glacial cycle by testing three different records on palaeo-temperature (GRIP, EPICA, and MD01-2444). Calculated basal velocities which base on the Parallel Ice Sheet Model PISM were used to test different glacial postulated erosional laws (Koppes et al., 2015; Herman et al., 2015, Humphrey and Raymond, 1994; Cook et al., 2020) focusing on the Rhine glacier area.

The main achievement of the study is to combine a realistic, high-resolution model of glacial extension over a glacial cycle in a mountain range with assumptions on glacial erosion. Even though the utilized PISM code does not account for feedbacks of glacial erosion on bed topography, which makes it not directly comparable with common landscape codes on glacial erosion (e.g. Egholm et al. 2009; Sternai, et al., 2013), some relevant findings could be derived by this integrated high-resolution approach. This includes the observation of low erosion during glacier advance and maximum glacier extension, and the role of profile steepening during deglaciation and related increasing erosion rates.

General comments

Authors decided to keep the paper short, referring most information on glacial model set up and resulting ice cover to the Seguinot et al. 2018 paper. This makes it not always very easy to read and needs checking in the original manuscript (for example, ice cover deviations model – field bases LGM extension).

The introduction gives a nice, relatively long (in relation to other chapters) overview on different aspects of glacial erosion and resulting features, and guides through problems to investigate them. Here, I don't see very clear how different aspects or parts in the introduction are specifically addressed in this study, i.e. which problems are exactly aimed to be solved of this large portfolio of mentioned gaps in the understanding of glacial processes. I think this could be better formulated and balanced.

I think the study could also well contribute to the discussion on the elevation distribution of the cumulative glacial erosion over several cycles in the Alps (high elevations vs low elevation, e.g. Valla et al., 2011). A plot showing the integrated glacial erosion potential over (e.g. 100 m) elevation bins would be easy to do and eventually an enlightening supplement summing up Fig. 5a.

I would also recommend to make some regional statements on the distribution of the glacial erosion potential (Fig. 2). It is quite obvious that some tectonic massifs can readily be discriminated, e.g. the Tauern Window, Oetzal Crystallin complex, the Aare Massif, Mt. Rosa - Gran Paradiso and Pelvoux Massif. Is it the steepness of these low erodible crystallin massifs making the erosional potential appearing strikingly high? I think this should/could be discussed..

Specific comments

Line 24 Maybe a bit odd to use 4 very old references from the Alps only (you hardly used more than 2 references throughout the MS and there are also high variety of glacial landforms in other mt ranges as you mentioned).

Line 33 I think that's not very easy to understand what landform you refer to? The "periglacial blockfields topped by glacial erratic boulders" (Wirsig et al., 2018)? Eventually be more precise on this would help readers.

Line 101 Could be misleading as (glacial and periglacial) cirque erosion processes are not really covered by any glacial erosion law discussed here (or any other I am aware of, Sanders et al., 2012).

Line 116 ..while much OF the intra-montane..

Line 127 Higher precipitation increases ice flux and thus erosion, I guess? Would eventually be helpful to mention (even though it might be referred in Seguinot et al., 2018).

Line 140 Can you be more precise what you mean by realistic? You mean because of the localized pattern? Maybe I am wrong but shouldn't the erosion potential at least at the lake Constance overdeepening (Fig. 7) not in the order of hundreds of meters (cf. Preusser et al., 2010) and the best fit rather (b) or (c) - at least from what I read from the transect (e-h)? Visually (a)-(d) seem not to correspond to (e)-(h) if (a)-(d) is also presented in meters (annotation at the bar is missing). For example, in (b) the maximum erosion potential is like >>1000 m (if in meters) while in corresponding (f) it seems clearly lower than 1000 m.

Furthermore, isn't the impression of the fit potentially very dependent on the initial model parametrization (Seguinot et al., 2018), i.e. the ice flux velocity? You should address these dependences!

Line 163 Observing Alpine topography I find this result important, which can maybe also serve as explanation why e.g. (low erodible) areas away from the big troughs covered during glacial maxima only, do surprisingly often show no/very low degree in glacial modification (e.g. Ticino; Kelly et al., 2004).

Line 187 "time-transgressive radial pattern". I don't understand what you mean..

Line 195 Very much share this view!

Line 197 Would recommend to be more precise. Guess you know that there are many, many cirques in the Alps as low as 1500 m (and even below) e.g. forming in areas outside

the connected ice stream network in the SW and easternmost Alps. This can be revealed by a quick check at any higher resolution DEM or google earth.

In the MS the word "yet" is very often used. Eventually consider reducing. The frequency is a bit irritating when reading.

Figures

Fig. 2 Please indicate the outline of the connected ice stream network during the LGM (like in Fig. 4 of Seguinot et al., 2018). Especially in the eastern and SW Alps coverage largely deviates from what has been suggested from field data compilation (e.g. Ehlers and Gibbard, 2004). Even though outcomes might not be changing much, it might be helpful to know how much the %overlap is - erosional potential might change as fluvial topography turns into glacial one (e.g. Harbor, 1988) and this is probably not what you want to mix, I guess.

Fig. 5 I have to confess Fig. 5a surprises me, there are really glaciers as low as 500 m.a.s.l (and even below) from 110 – 40 ka in the Seguinot et al., 2018 model?

References not in the manuscript:

Egholm, D.L., Nielsen, S.B., Pedersen, V.K., Lesemann, J.E., 2009. Glacial effects limiting mountain height: *Nature*, v. 460, p. 884–888.

Ehlers, J., Gibbard, P.L., 2007. The extent and chronology of Cenozoic Global Glaciation. *Quat. Int.* 164–165, 6–20.

Harbor, J.M., Hallet, B., and Raymond, C.F., 1988. A numerical model of landform development by glacial erosion: *Nature*, v. 333, p. 347–349.

Kelly, M.A., Buoncristiani, J.F. and Schlüchter, C., 2004. A reconstruction of the last glacial maximum (LGM) ice-surface geometry in the western Swiss Alps and contiguous Alpine regions in Italy and France. *Eclogae Geol. Helv.* 97, 57–75.

Mey, J., Scherler, D., Wickert, A.D., Egholm, D.L., Tesauro, M., Schildgen, T.F., and Strecker, M., R., 2016. Glacial isostatic uplift of the European Alps: *Nature Communications*, v. 7.

Preusser, F., Reitner, J.M., and Schlüchter, C., 2010. Distribution, geometry, age and origin of overdeepened valleys and basins in the Alps and their foreland: *Swiss Journal Geoscience*, v. 103, p. 407–426.

Sanders, J.W., Cuffey, K.M., Moore, J.R., MacGregor, K.R., and Kavanaugh, J.L., 2012. Periglacial weathering and headwall erosion in cirque glacier bergschrunds: *Geology*, v. 40, p. 779–782.

Sternai, P., Herman, F., Valla, P.G., Champagnac, J.-D., 2013. Spatial and temporal variations of glacial erosion in the Rhône valley (Swiss Alps): Insights from numerical modeling. *Earth and Planetary Science Letters*, 368, p. 119–131.

Valla, P.G., Shuster, D.L., van der Beek, P.A., 2011. Significant increase in relief of the European Alps during mid-Pleistocene glaciations. *Nat. Geosci.* 4, 688–692.