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Short communication: Updated CRN Denudation datasets in OCTOPUS v2.3

We wish to thank the reviewer for taking time to consider our manuscript and for providing constructive criticism that will greatly improve the manuscript and ultimately the OCTOPUS effort.

We provide answers to each point below and hope that we can keep the discussion going and the reviewer will answer some of our queries before the public discussion phase closes on the 5th of January.

RC – Reviewer comment
AR – Author response

RC1	*My only major comment is that the authors should consider recalculating erosion rates using a time-variant scaling and removing topographic shielding, since they already acknowledge the problems with these approaches in the manuscript. The authors argue that this would cost too much computational time. However, all the basin-average effective atmospheric pressures have already been calculated already, therefore, the time-consuming pixel-based production rate calculation should be necessary anymore. Aren't all the necessary parameters for, e.g., Riversand now pre-calculated and the actual denudation rate calculation should be reasonably fast?*
AR1	The answer to this comment is complicated: There are a total of 284 studies in CRN International and CRN Australia and re-calculating denudation rates using CAIRN would take a minimum of 2 to 3 months with the IT resources that are available to us for this purpose. While recalculating some studies takes only a few minutes, others will take many hours, and a few will take days. One can distribute CAIRN processes across a cluster of computers, but we do not have access to this. Ignoring topographic shielding shifts the calculated denudation rate by a few percent. The 10% quoted by the reviewer (see RC6) is the difference obtained for the basin with the highest topographic shielding – so it is the absolute maximum – and in most case the difference will be a few percent. Compared to this, the median uncertainty on the calculated ^{10}Be denudation rates is ~20%. Topographic shielding is a non-issue in our opinion, and probably not worth two to three months of recalculating time. Given that OCTOPUS provides all the data necessary for recalculating rates, however, means that these recalculations can be done on a case-by-case basis by the users themselves, if necessary. Using RIVERSAND requires some processing of the CAIRN input data – such as reprojecting rasters and shapefiles (in CAIRN rasters are in UTM coordinates but sample data is in geographic coordinates; OCTOPUS exports shapefiles in Web Mercator coordinates) and fixing no-data issues (i.e., reclassifying no data pixels), and creating the required input table. Running RIVERSAND with the 284 studies will not take months but it is not a trivial exercise given the large number of studies. As we show in Figure 3, recalculating denudation rates using the basin centroid latitude and effective

	atmospheric pressure obtained from CAIRN produces values that are virtually identical to those obtained using RIVERSAND. Therefore, we do not see the advantage of using RIVERSAND in this case. The basin-averaged effective atmospheric pressure is calculated for all CRN Int and CRN Aus basins and can be used with the Balco calculator – this is what was done for the purposes of Figure 3. However, for new studies added to the OCTOPUS database, we would still need to run CAIRN to calculate the basin-averaged effective atmospheric pressure before loading the values in the Balco calculator. As we explain in Section 3, we prefer CAIRN over other approaches, mainly due to it being automated and also for it being part of LSDTopoTools. The latter allows CRN denudation rate calculations to seamlessly integrate with other topographic analyses within unified workflows – something not yet meaningfully exploited by people, but in our opinion something with great potential. Thus we are not keen on abandoning CAIRN.
RC2	***Time-invariant scaling:*** *As has been argued, e.g., by Greg Balco in a blog post https://cosmognosis.wordpress.com/2020/10/10/version-3-erosion-rate-calculator-benchmarked-finally/* *time-invariance can really become a problem for slow erosion rates. The bias arises because the current magnetic field strength is high and was lower in the past, and most calibration data are from the past 20kyr, where field strength was high. I quote from the Balco blog: "Samples with lower erosion rates reflect production during longer-ago periods of weaker magnetic field strength and higher production rates, so an erosion rate computed with time-dependent scaling will be higher than one computed with non-time-dependent scaling. " Balco shows that this bias can be up to 40% and is therefore quite significant.* *As the authors argue, many people download Octopus data for global studies and therefore use a large range of low and high erosion rates in their studies. In such a case, time-invariant production rates is a problem because it introduces a systematic bias. For instance, many studies investigate the non-linear relationship between erosion rate and river steepness (ksn) (Adams et al., 2020). Using time-invariant scaling and having a large range in erosion rates, the Ksn-E relationship would become more non-linear just due to the bias introduced by not accounting for magnetic field variation.*
AR2	We fully agree with the reviewer and Greg's blog-post is what motivated us to improve interoperability between OCTOPUS and the Balco online calculators.
RC3	*From my perspective, an option would be to switch from CAIRN to RIVERSAND (Stübner et al., 2023), as has been done for calculations in figure 3. I understand that requesting the recalculation of all rates using a time-dependent scaling scheme is a big ask, but I invite the authors to assess whether this is feasible.*
AR3	See our response in AC1. Given the similarities between the rates in Figure 3C&D, the question is not whether we should switch or not to RIVERSAND, but rather (1) whether we should include the

	recalculated Lm and LSDn rates in the database, or (2) whether we should – as we did in the current version – include the centroid latitude and effective atmospheric pressure in the data tables and let users run the recalculations themselves. If we subscribe to the mantra of a transparent middle-layer for data management and analysis (as outlined in Balco 2020, 10.1016/j.quageo.2007.12.001), denudation rates are most reliable when freshly calculated. Therefore, providing the centroid latitude and effective atmospheric pressure in the data tables is the most appropriate approach – given that we tend to refresh OCTOPUS only every couple of years as a substantial number of publications become available. We include input data for the Balco online calculators in the Zenodo repository created for out manuscript: https://zenodo.org/records/14014985. Should we also include this in the OCTOPUS data tables or should we also add the Balco calculator output to the OCTOPUS data tables? **We would appreciate the opinion of the reviewer or of the broader community here.**
RC4	*If the authors choose to stay with the CAIRN calculation, it would be valuable to show a comparison like in Fig. 3C/D, however, using the Octopus CAIRN-St rates versus the Riversand Lm or LSDn rates. The authors selected high-relief basins for their current approach. However, for a figure comparing the time-invariant and time-variant scaling schemes, the author should select studies that contain a large gradient in erosion rates.*
AR4	We could certainly do this. However, both Greg Balco's blog-post and the RIVERSAND paper (https://doi.org/10.1017/rdc.2023.74) do an excellent job by showing such a figure (note that OCTOPUS CARIN-St rates are similar to the online calculator St rates for most basins – Figure 3B) and so we are not sure whether we would be contributing with anything new.
RC5	***Lithology:*** *More details are warranted for the estimation of quartz percentage in the basins. This is a really useful addition to Octopus. However, the authors do not describe, which lithology classes in GliM are assumed to be quartz bearing. GLiM contains layers such as mixed sediment that can be full of quartz or devoid of it. Please, provide more detail on how this crucial number was estimated.*
AR5	We agree fully. We did an embarrassing job here and we will add more information in the revised manuscript. Moreover, it is important to emphasize, as we have done in the manuscript, that the estimation of quartz percentage is very crude and is intended to serve primarily as a 'warning flag' rather than a precise measurement.
RC6	***Topographic shielding****: The authors state that topographic shielding likely creates a bias towards too low erosion rates. Given that this bias can be up to 10%, it seems like a good idea to remove shielding from the erosion rate calculations once and for all. The authors argue that this is not feasible given the high computational cost. Is the re-calculation of erosion rates really so computationally expensive? As far as I understand, the computationally-expensive part is the pixel-based averaging performed on DEMs. But*

	that part is already done. Therefore, shouldn't you be able to recalculate erosion rates fairly quickly without shielding and with time-variant scaling scheme, with the output parameters from CAIRN in a different calculator?
AR6	See our responses in AC1 and AC3. Certainly re-calculating rates in the Balco online calculator without shielding would be quick given all the data we provide in OCTOPUS. However, we return to the question we posed in AC3. Should we do this calculation or should the users do it?
RC7	*L 54: What is UOW? I don't see this defined.*
AR7	UOW stands for the University of Wollongong. It is not defined here as UOW is part of the name of the data collection.
RC8	*L54-48: I'm confused. What is the purpose of CRN Large Basins and DRN Denudation UOW? The article mentions that these include the published denudation rates. If that is the only reason for the existence of these two collections, why aren't the published rates added as fields to CRN International&Australia? Please, clarify.*
AR8	CRN Large Basins and CRN Denudation UOW (in preparation) are two data collections that hold ^{10}Be and ^{26}Al data that we did not wish to include in CRN International and CRN Australia for various reasons – we explain this in detail in our first OCTOPUS description paper (Codilean et al 2018; 10.5194/essd-10-2123-2018). To summarise: CRN Large Basins includes studies with very large basins – too large for CAIRN and also so large that one might question the meaningfulness of calculating denudation rates for these basins. Nevertheless, for completeness, we wanted to have a collection where we compile this data and let users decide how to handle them. CRN Large Basins includes the published denudation rates but no CAIRN-recalculated denudation rates. CRN Denudation UOW (in preparation) is a repository of University of Wollongong samples that we are currently working on.
RC9	*L82: Please, state the AMS standard for normalization.*
AR9	We will add this information to the revised manuscript.
RC10	*L83: It would be nice to have approximately 2-3 sentences telling the reader about the main characteristics of CAIRN: pixel-based production rate, exponential approximation of production rates, topographic shielding, etc.*
AR10	We will add this information to the revised manuscript.