Additional comments

<u>Comment #1</u>

During the time in the review, we further analysed our data and found an interesting aspect of the area-volume scaling we think should be part of a revised manuscript. We have adapted the manuscript at several locations where we describe the area-volume scaling (methodology), report the scaling coefficients (results) and compare them to the previous studies (discussion).

Abstract (L15 - 18): "We found a reliable power-law scaling relationship between RTS area in the optical RTS inventory and calculated volume change, with α-values ranging from 1.20 ± 0.01 and 1.30 ± 0.01 (R^2 = 0.87, $p < 0.001$) depending on the regression model used, which may readily transform planimetric RTS area into volume estimates at scale on the QTP."

Introduction (L86-101): "The volume of eroded material of an RTS scales with its area following power-law relations that characterise its growth dynamics. Several studies adapted the so-called area-volume or allometric scaling from temperate landslide research (Jaboyedoff et al., 2020). Commonly, area-volume scaling is performed using an ordinary least squares (OLS) approach to fit a linear model to the log-transformed RTS area and volume (change) to obtain scaling coefficients. However, distinct differences in the estimated scaling laws can be present between geographic regions and based on the methodological approach used. Bernhard et al. (2022a) used instead of OLS an orthogonal distance regression (ODR) (Boggs and Rogers, 1989) to fit the straight line to the log-transformed RTS area and volume change based on TanDEM-X DEM pairs (2010 - 2016) assuming that both δV and δA are affected by measurement error. The authors report a scaling coefficient of 1.15 for several Arctic sites. Dai et al. (2025) reported a pan-Arctic scaling coefficient of 1.30 based on OLS and ArcticDEM pairs (2012 - 2022) while Kokelj et al. (2021) and Van Der Sluijs et al. (2023) report coefficients of 1.36 and 1.41, respectively, in the Canadian Arctic based on OLS and pre-disturbance terrain reconstruction (until 2018). A recent study estimated a scaling coefficient of 1.20 for almost 1,500 RTS on the QTP (Ma et al., 2025) based on DEM mosaics and commercial stereo-optical DEMs with varying dates (until 2021 - 2025). Robust empirical scaling relationships can be helpful to potentially constrain regional-scale estimates on material erosion and carbon mobilisation when only optically derived RTS area estimates are available. However, differences in the scaling model and temporal and spatial resolution of the elevation data impair the (inter-) regional transferability of the estimated coefficients."

Methods (L186-190): "Since previous studies use different methods to fit a straight line to the log-transformed RTS area and volume change, we apply two common models: We use (1) an orthogonal distance regression (ODR) model (Boggs and Rogers, 1989) used by Bernhard et al. (2022a) for several North American and Siberian RTS sites, and (2) an ordinary least squares (OLS) approach applied by Kokelj et al. (2021); Van Der Sluijs et al. (2023) to predict the eroded volume δV based on the planimetric area δA with an exponential scaling coefficient α and a scaling factor c (Jaboyedoff et al., 2020) for the time interval T1 - T2."

Results (L266-278): “When fitting a linear model to the log-transformed area δA and material erosion volume δV based on 1) OLS and 2) ODR, we found power law relationships for the area-volume scaling of RTS on the QTP (Fig. S1 a) of

$$\delta V_{ODR} = (0.09 \pm 0.01) \cdot \delta A^{1.30 \pm 0.01} \text{ with } R^2 = 0.87 \ (p < 0.001) \quad (6)$$

and

$$\delta V_{OLS} = (0.22 \pm 0.01) \cdot \delta A^{1.20 \pm 0.01} \text{ with } R^2 = 0.87 \ (p < 0.001). \quad (7)$$

For ODR, we obtain the same scaling coefficient (α_{ODR} = 1.30, c = 0.05, Fig. S1a) when we use the entire area of the RTS delineations A_{Xia} instead of solely the ablation area δA yet a lower scaling coefficient for computations based on OLS (α_{OLS} = 1.11, c = 0.29, Fig. S6 a). However, the fit is slightly noisier and manifests itself in a lower confidence (R^2_{ODR} = 0.75, R^2_{ODR} = 0.77). An α value between 1.11 and 1.30 indicates that RTS on the QTP followed a relationship between a growing scar zone with constant depth (α = 1.0) and growth with a constant area-depth ratio (α = 1.5) during the last decade and falls in the range of soil landslides (1.1 - 1.4) based on the investigated scaling relations of landslides in temperate locations (Van Der Sluijs et al., 2023; Jaboyedoff et al., 2020).”

Fig.4a: We included the scaling coefficients for both ODR and OLS in the error bar plot and adapted the caption: “... RTS material erosion and area-volume scaling coefficients for the subregions with R^2-values between 0.77 / 0.79 ($p < 0.001$, West) and 0.89 / 0.90 ($p < 0.001$, Central) computed based on ODR (black dots) / OLS (purple dots).”

L288-291: “The scaling coefficients range from α_{ODR} = 1.27 - 1.34 (R^2_{ODR} = 0.77 - 0.89, $p < 0.001$) and α_{OLS} = 1.11 - 1.23 (R^2_{OLS} = 0.79 - 0.90, $p < 0.001$) in the West to East subregions to α_{ODR} = 1.47 ± 0.05 (R^2_{ODR} = 0.87, $p < 0.001$) and α_{OLS} = 1.34 ± 0.04 (R^2_{OLS} = 0.87, $p < 0.001$) in the northeast QTP.”

Discussion (L351-353): “The studies also used different model fitting approaches: OLS (Kokelj et al., 2021; Van Der Sluijs et al., 2023; Dai et al., 2025) and ODR (Bernhard et al., 2022a). Ma et al. (2025) did not explicitly report the model choice hence we assume the authors potentially used the more common OLS.”

L358-361: “This range of scaling coefficients for similar regions as well as our results for QTP (Fig.4a and S1) highlight the challenge in comparing scaling studies based on different methodologies and datasets. Moreover, minor differences in the scaling coefficient have strong impacts on the scaling: A difference of, for example, 0.1 in α leads to a factor - two increase in the volume estimation (Van Der Sluijs et al., 2023).”

Comment #2

A new study has been published on August 6th, 2025, in Global and Planetary Change, Volume 254, November 2025, 105012 investigating area-volume scaling for 1,429 RTS on the QTP based on differencing commercial stereo-optical satellite Goafen-7 data (several acquisitions between 2021 and 2025) with open-source global DEM mosaics (spatial resolution 30 m, based on acquisitions after 2011). Due to the relevance of the topic, we included the study in the manuscript.

The scaling coefficient for QTP is in a similar magnitude as our results. However, the authors do not report details about the scaling method. It is not clear which statistical model (ODR or OLS) for fitting the linear model to the log-transformed area as well as which part of the RTS area and RTS volume (including / without deposition) has been used. Based on the estimated scaling coefficient, the authors modeled SOC loss from RTS mass wasting for QTP between 1989 and 2022. Comparing the results to our study is difficult due to a different time frame, approach in OC mobilisation quantification and underlying datasets, and RTS segmentation method. We included the study in the discussion (section 4.1 and 4.2)

L329-331: "Some research has been previously performed to investigate material erosion volumes (Lantuit and Pollard, 2005; Kokelj et al., 2015; Günther et al., 2015) and allometric scaling relations for thaw-driven mass wasting, most of them for regions < 10,000 km^2 in the Arctic (Kokelj et al., 2021; Van Der Sluijs et al., 2023) and on the QTP (Ma et al., 2025)."

L376-379: "RTS on the QTP are reported to be generally smaller and shallower than at Arctic hotspots (Liu et al., 2024). It is therefore possible that the coarse resolution of the TanDEM-X DEM might not correctly capture the area and volume change for these small areas, skewing the scaling models. However, Ma et al. (2025), using high-resolution stereo-optical DEMs, found a scaling coefficient like our α_{OLS} of 1.20 ± 0.01 (n_{RTS} = 1,429)."

L425-427: "Ma et al. (2025) modelled a total annual SOC loss of 4.12 × 10^7 kg C a^{-1} (95% CI: 3.06 × 10^7 kg C a^{-1} – 5.12 × 10^7 kg C a^{-1}) from RTS mass wasting for the QTP between 1989 and 2022 based on optical RTS inventories and allometric scaling relations, which is of a similar magnitude as our results ($3.53^{10.13}_{0.15}$ × 10^7 kg C a^{-1})."