Reply to comments made by Anonymous Referee #1 (doi:10.5194/tc-2016-136-RC1).
We thank Anonymous Referee #1 for its review and suggestions for improvement. Referee comments indicated as “RC:”, author reply as “AR:”. Only sections requiring a reply are reproduced.

RC: GENERAL COMMENT 1. Analysis methods are in places not understandable: e.g. Section 4.2. Some newly defined terms (e.g. OFST, LRM+) also do not seem to represent the actual features, so they are difficult to understand.
AR: We revised and clarified the whole method section. In particular, the LRM+ model was removed. Although it reproduced quite well fracture kinematics, it was not crucial for the main focus and analysis of this manuscript and could confuse readers. We changed the term “summer offset” to “summer shift” with the abbreviation “SHT”. An improved explanation of this shift is given on page 10, line 25.

RC: GENERAL COMMENT 2. Why temperature is represented by data at 85 cm depth (instead of surface T)? Does the value best correlate with deformation? If it is true, why?
AR: Surface temperature is strongly influenced by daily fluctuations. The temperature is strongly attenuated with depth and is a more suitable representation of a seasonal signal. We added a table (Table 1 in manuscript on page 9) with an overview of all available temperature measurements (rock temperature at different depths and temperature in fractures). In the revised manuscript, we applied a best fit analysis using all available rock and fracture temperature data. With this we determined the most representative temperature measurement for modeling the reversible thermo-mechanically induced fracture kinematics. The best trainings periods are shown in Table 2 on page 13.

RC: P1 L8 Insert ‘that’ after assuming.
AR: Done.

RC: P2 L32 Does ‘thermal expansion’ here mean D2 or include also D3? Ice pressure and its release by melting can also produce reversible movement.
AR: We agree, the initial conceptual model was not consistent and contained some weaknesses. To be more precise, we now use the term “fracture kinematics” instead of “fracture dynamics”. We refocused the the conceptual model to an overview of the processes and related environmental controls and clarified the aim and research questions of the study in a separate section. We also clarified in the manuscript that ice pressure and its release by melting can also produce reversible fracture kinematics.

RC: P3 L4 Insert ‘us’ after allows.
AR: Done.

RC: P6 L31 . . .strong wind results in a preferential snow deposition in fractures. . . (Insert ‘s’ and delete comma.)
AR: Done.

RC: P7 L4 Does ‘along fracture’ mean that the crackmeter does not cross a fracture? A photo or illustration of the installation will be helpful.
AR: We adapted Figure 3 (new Figure 5 on page 8) and added a photo with a sketch that illustrates locations instrumented with two crackmeters.

RC: P8 Fig.3 caption Scap of the 2003 rockfall.
AR: Done.

RC: P8 L9 Why did you use T at 85 cm depth?
AR: This point was addressed in detail in GENERAL COMMENT 2.

RC: P9 L3 Where is ‘ti’ in Eq. 2?
AR: This was a mistake. We have removed it.

RC: P10 L8 Insert ‘of’ after ‘approximation’?
AR: Done.

RC: P10 L16 What does ‘date(Trock < −1 C)|May 1’ mean?
AR: This issue was addressed and clarified by a more detailed explanation on page 11, lines 1-3.

RC: P10 L27-29 Should this be described in Section 4.4 (equation 6)?
AR: This is correct and addressed in the previous referee comment RC: P10 L16.

RC: P11 L19 Perhaps ‘installation’ could be deleted.
AR: Done.

RC: P12 Fig. 5 caption L2: I suggest to insert (a) after ‘at 85 cm depth’.
AR: We inserted labels referring to all subfigures.

RC: L3: I suggest ‘. . . represented by (b) perpendicular to and (c) along fracture’.
AR: We inserted labels referring to all subfigures.

RC: P13 Fig. 6 Why deformation does not start from zero (cf. Fig. 5).
AR: The observed crackmeter data represents the extension of the crackmeter itself. Dealing with fracture kinematics, we changed the initial deformation and set it to zero at beginning of measurements (Figure 6-8).

RC: P13 Fig. 6 caption Replace ‘parallel’ by ‘along’?
AR: Done.

RC: P13 L4-5 Note that. . .: I cannot understand this sentence.
AR: This section was removed.

RC: P14 L3 Insert comma after ‘Assuming’.
AR: Done.

RC: P14 L13-14 Hinting on. . .: Also not understandable. Lacking a verb.
AR: This paragraph has been clarified by rephrasing to: " ... TDD are not computed if the temperature time series contain a gap during summer. A weak correspondence is apparent (see Fig. 14 in appendix A) for locations with aspects to the north and east. This hints on a substantial influence of rock temperature and therefore incoming conductive energy fluxes. Interestingly, …". See 13, lines 13-15.

RC: P14 L17 Replace ‘Section 5’ by ‘Figure 5’?
AR: We wanted to refer to the first paragraph of “Results and interpretation”, which describes the evolution to the rock fall event at location *mh02* in a few sentences. We rephrased the text in the brackets to: "… The local break-off at location *mh02* occurred in summer 2015 (described in first paragraph of Section 4, page 11).". See page 14, lines 1-2.

RC: P15 Fig. 7 Why deformation does not start from zero?
AR: This issue is addressed. See author response AR to RC: P13 Fig. 6.

RC: P18 L8-9 Which data do show ‘this summer offset seems to correlate slightly with an increasing total amount of energy available (TDD)’?
AR: We added an additional figure to the appendix presenting the summer shift of kinematics perpendicular to fracture against yearly thawing degree days with a black line indicating the regression function. See Figure 14, page 23.

RC: P18 L32 What is ‘the hypothesis of Hasler et al. (2012)’?
AR: Hasler et al. (2012) hypothesized a thermo-mechanically and cryogenic forcing of fracture kinematics. We addressed this issue by rephrasing the sentence to: “… Such thermo-mechanically

and cryogenic forcing of fracture kinematics has been hypothesized by Hasler et al. (2012), but their data was not fully conclusive on this point due to the short duration of the data set (1–2 years)" See 19, lines 22-24.

RC: P19 L7-8 'the water can easily drain through the strongly fractured rock and the water availability is limited': Does this situation fit any places in the rockwall? Aren't there any locations topographically favorable for water storage?
AR: The investigated field site is very steep and strongly fractured. We tried to measure water pressure in fractures without success. But we agree there might be topographically favorable spots for water storage, even close to the ridge and limited water supply. To clarify it, we rephrased this paragraph to: " If the water and/or heat supply is high enough, the water column can rise and enhance hydro pressure. But high water columns are rather unlikely at the Matterhorn field site, because it is located on the ridge with steep, laterally open fractures. " See page 19, lines 34ff.