# Acoustic and Microseismic Characterization in Steep Bedrock Permafrost on Matterhorn (CH)



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Supporting Information for

# Acoustic and micro-seismic characterization in steep bedrock permafrost on Matterhorn (CH)

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Figures S1 to S4

## Introduction

The supporting information contains four additional figures, which are referred in the manuscript:

- S1: Time-lapse camera pictures
- S2: Traces and spectrograms after 33-67 Hz bandpass and bandstop filtering
- S3: Micro-seismic response to fracture and failure event on 14 August 2015
- S4: Annual trigger sensitivity of applied STA/LTA algorithm

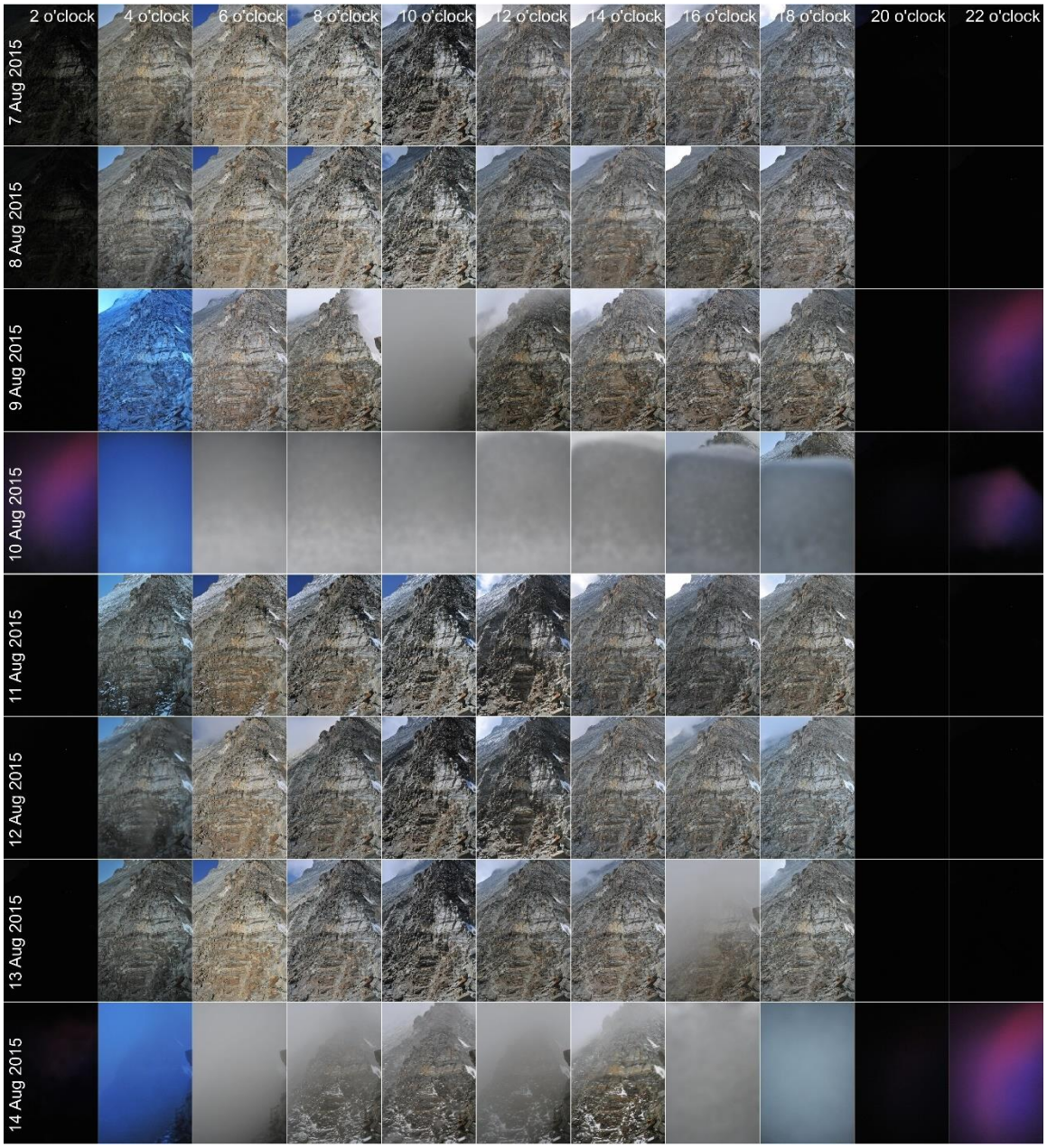


**Figure S1.** Time-lapse camera pictures for the time period prior to the rockfall on 14 August 2015 indicating abrupt weather change. The rockfall event occurred in the dark followed by a few days with no visibility due to bad weather conditions.

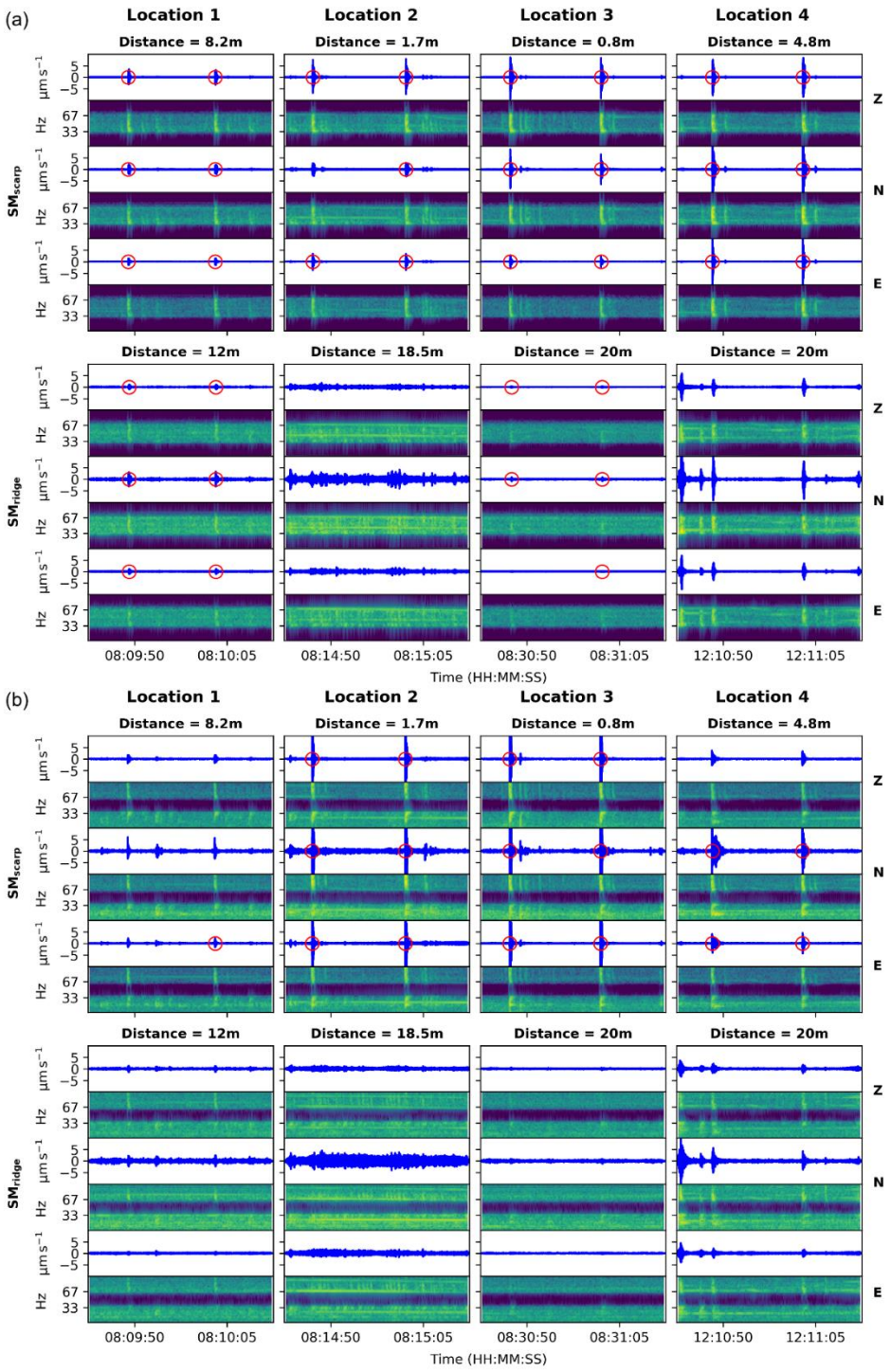


**Figure S2.** Traces and spectrograms after 33-67 Hz (a) bandpass and (b) bandstop filtering of the rebound hammer-impulse signal measured at both seismometers. A STA/LTA algorithm with 0.5 s and 10 s averages was used for event detection, indicated with red circles. The logarithmic power spectral density from blue to yellow indicates increasing values (same scale as Fig. 3).

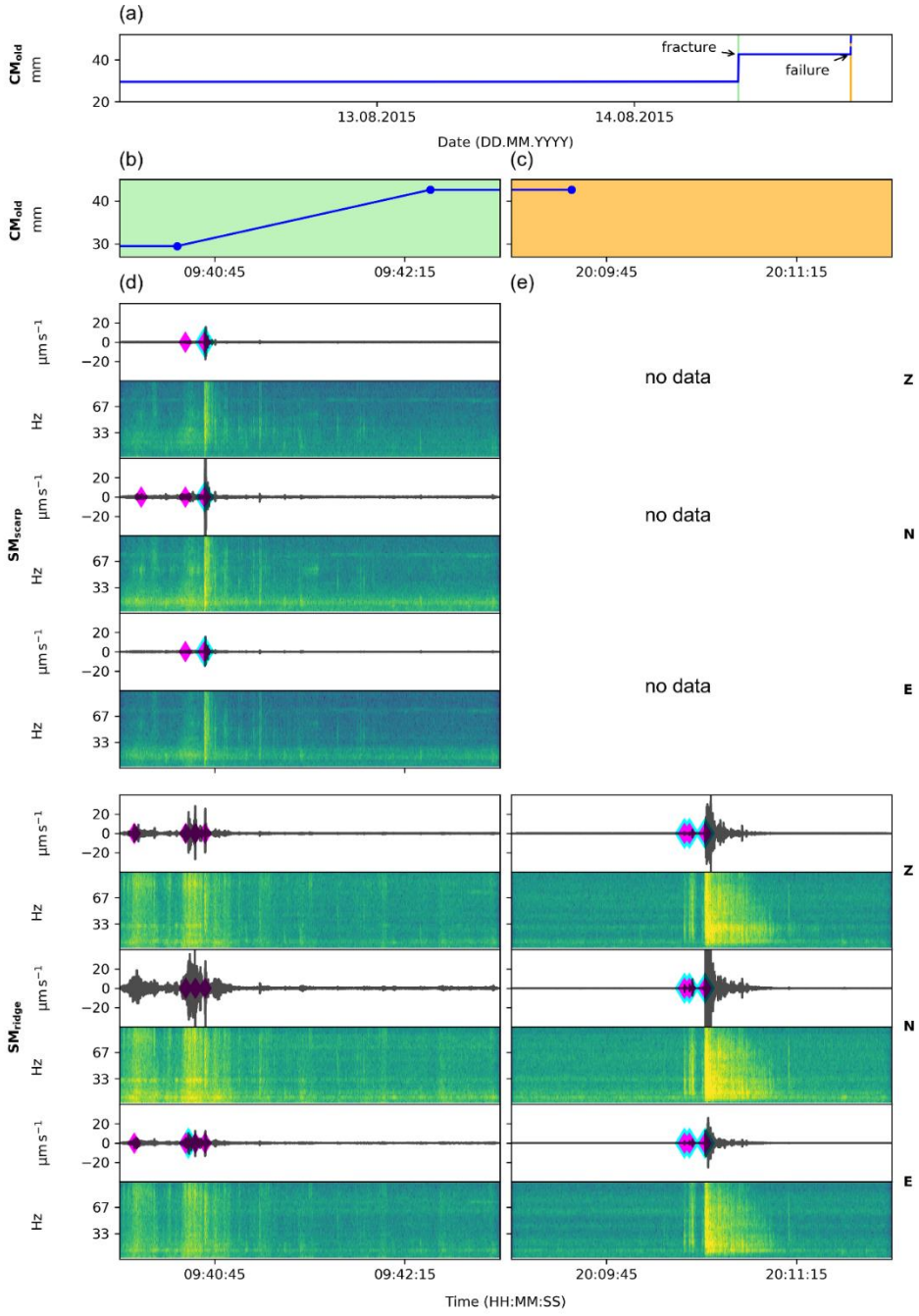


**Figure S3.** (a) Fracture displacement measured at crackmeter $CR_{old}$ in summer 2015 with a zoom in at the (b) green and (c) orange bar. (d-e) Seismic activity during irreversible fracture displacement and failure (14 August 2015) measured at both seismometers. No data for the seismometer $SM_{scarp}$ was available for the failure event because of a system failure. The events were detected by a STA/LTA algorithm with 0.5 s and 10 s averages. Cyan diamonds indicate triggered events without filtering while magenta diamonds indicate triggered events for the seismometers in the 33-67 Hz range. The logarithmic power spectral density from blue to yellow indicates increasing values (same scale as Fig. 3). No acoustic events were detected.

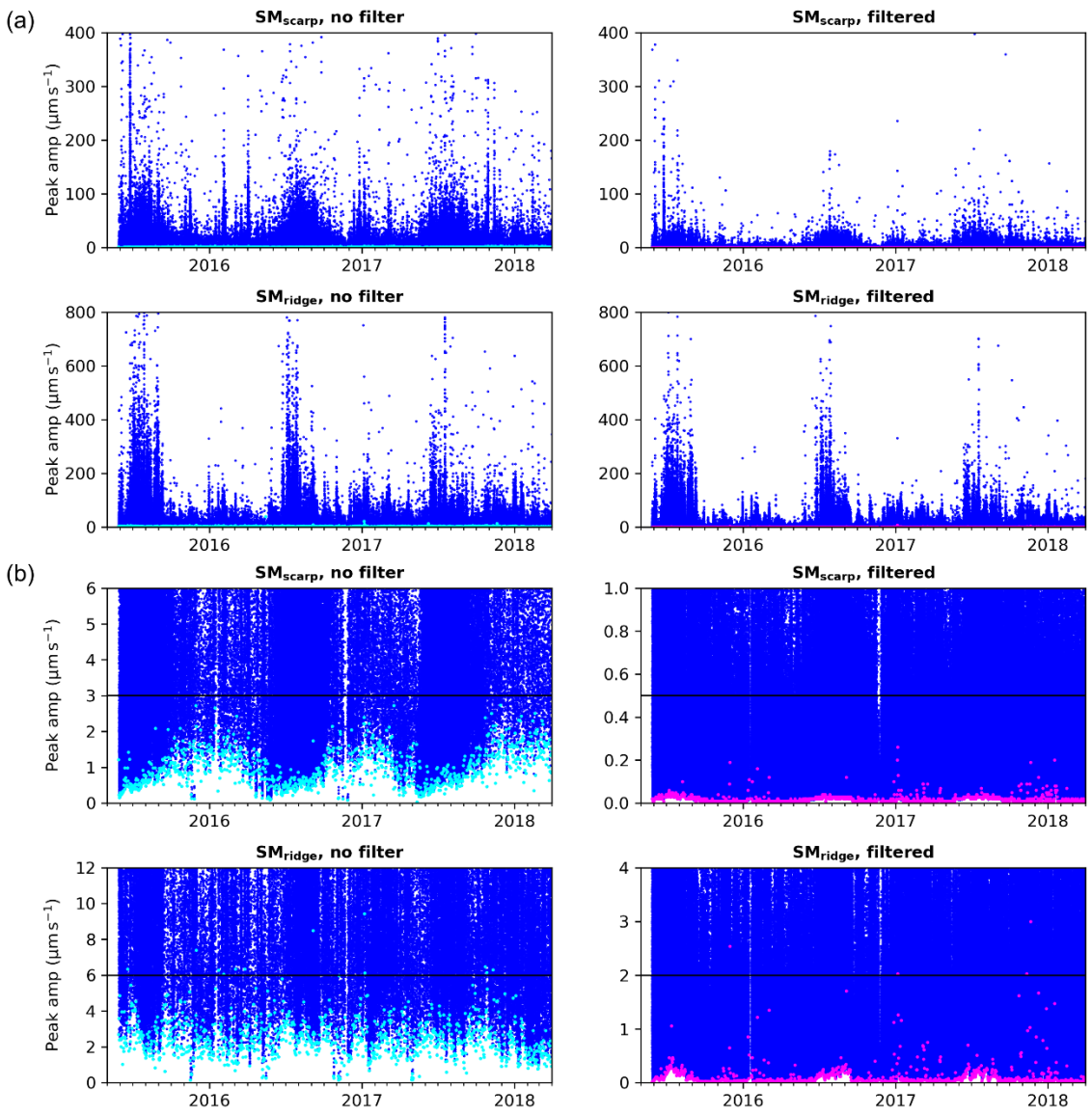


**Figure S4.** Seismic activity at the Matterhorn Hörnligrat field site measured with two seismometers. Each blue dot corresponds to one event triggered by a STA/LTA algorithm with 0.5 s and 10 s averages. For illustration purposes, the strongest 0.1% of the signals are not shown in (a) while (b) shows a zoom in. The weakest events triggered, a proxy for trigger sensitivity with temporal variations, are used to set the lower peak amplitude level (i.e., $3\times10^{-6}$ ms-1 without the filter and $5\times10^{-7}$ ms-1 in the band 33-67 Hz for the seismometer in the scarp and $6\times10^{-6}$ ms-1 respectively $2\times10^{-6}$ ms-1 for the seismometer on the ridge) and to select the events, which were strong enough to be triggered at any time.