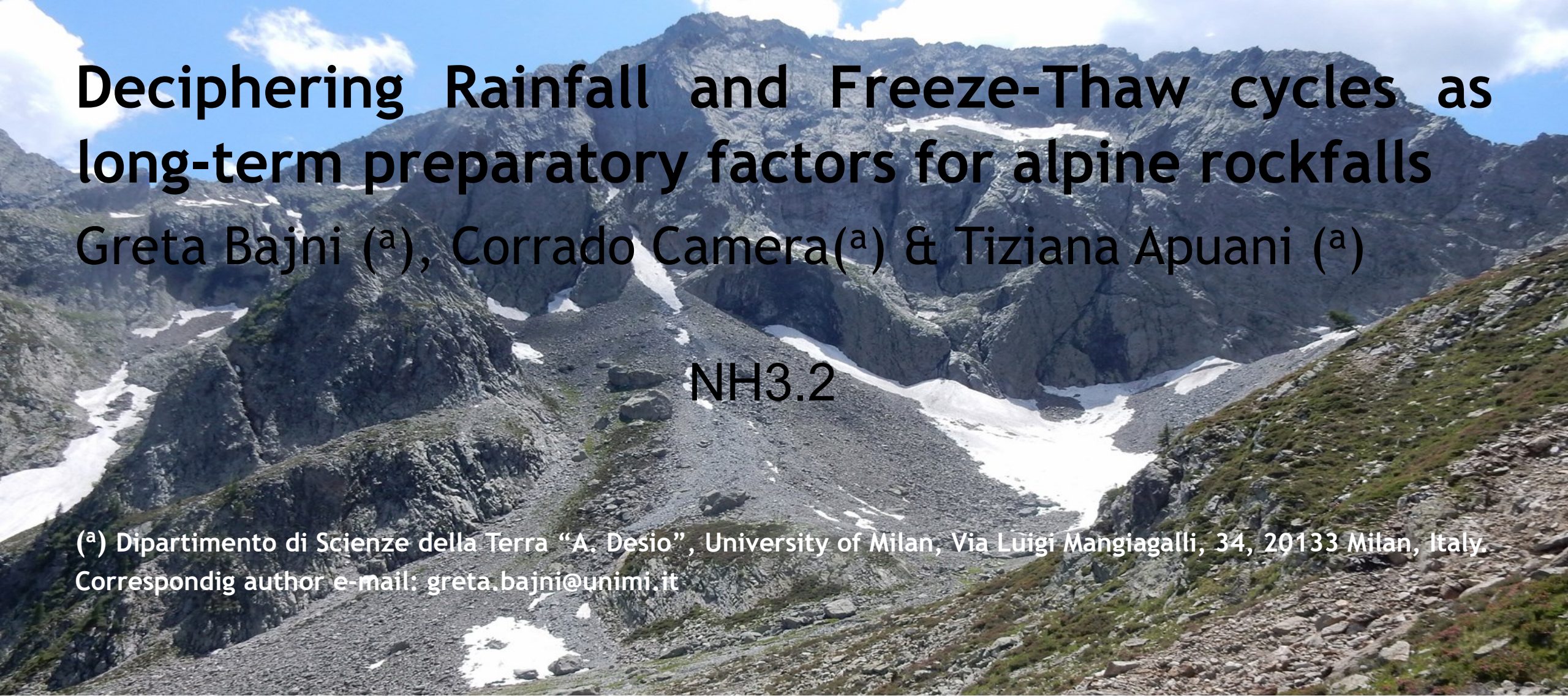
Deciphering Rainfall and Freeze-Thaw cycles as long-term preparatory factors for alpine rockfalls

Greta Bajni ([a]), Corrado Camera([a]) & Tiziana Apuani ([a])



NH3.2

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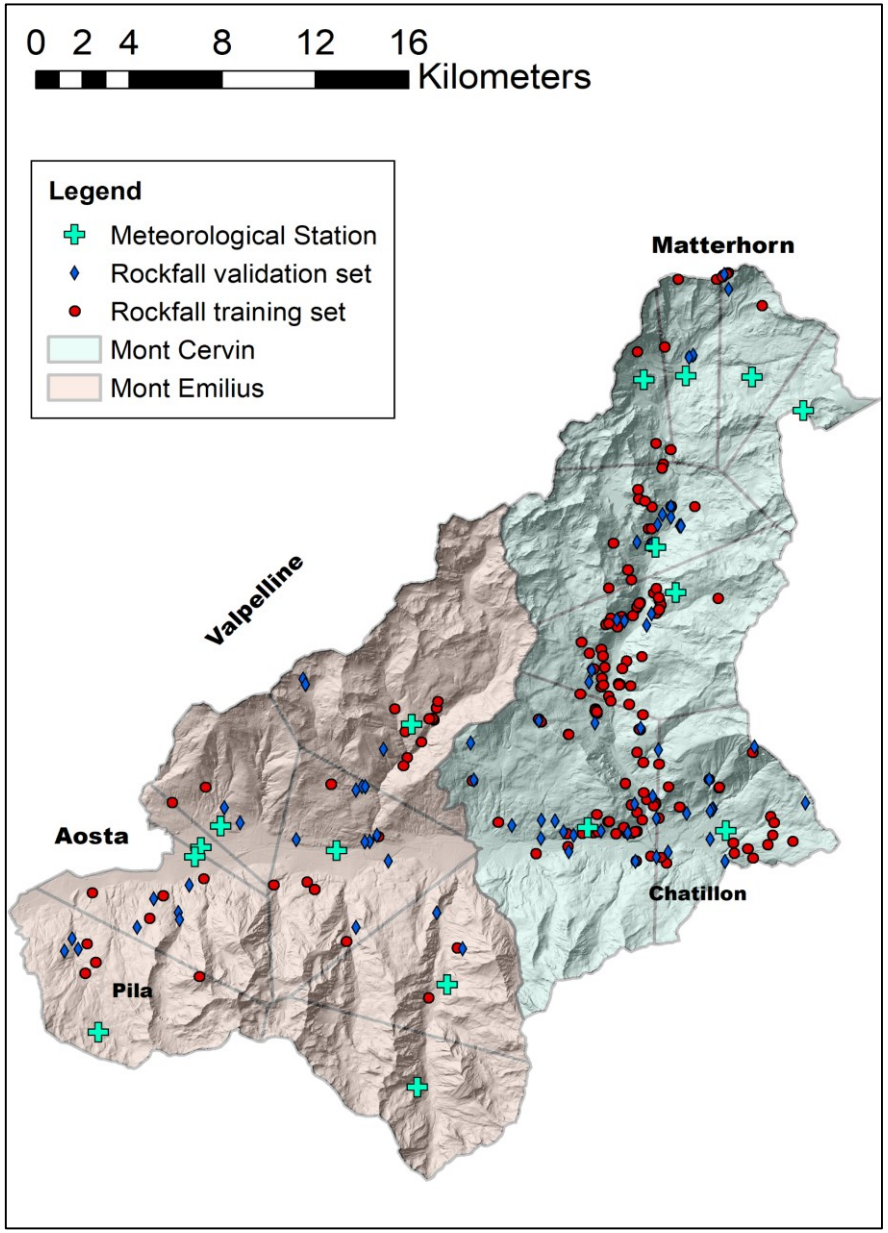
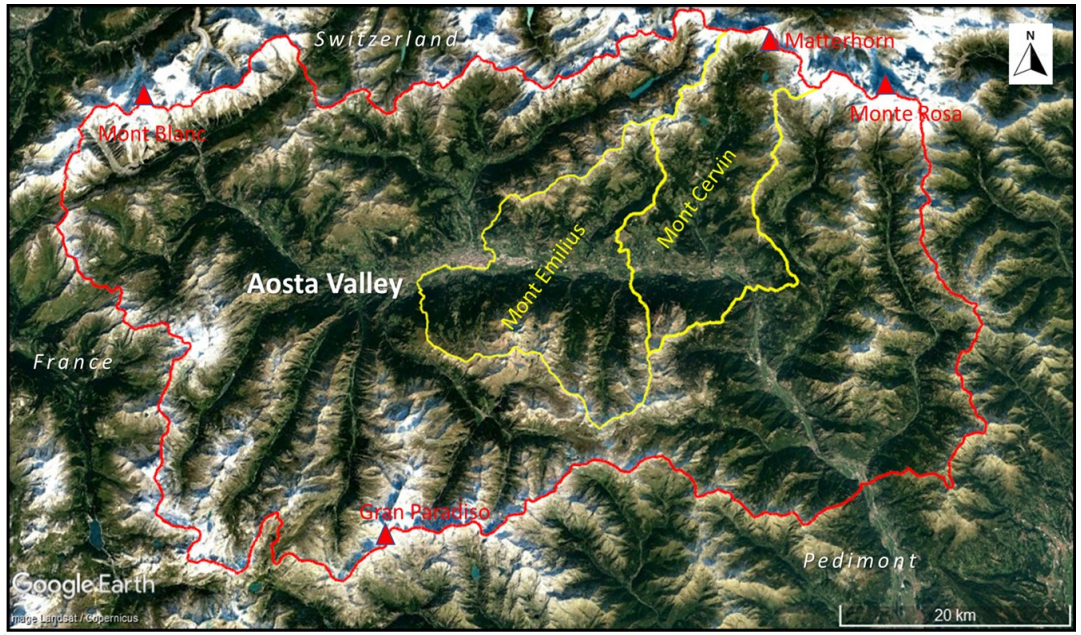
DATA and STUDY AREA



Mt CERVIN and Mt EMILIUS Mountain Communities of Aosta Valley (ITA)



16 meteorological stations (30 min to 1 day temporal resolution)

168 rockfall 1990-2018→exact date of occurrence

75 rockfall 1990-2018→only year of occurrence

1) Revision and homogenization of the rockfall database

2)Homogenization and choice of the relevant meteorological stations

3) Association of each rockfall to the closest meteorological station

4) Reference temporal period to perform the analysis 1990-2018.

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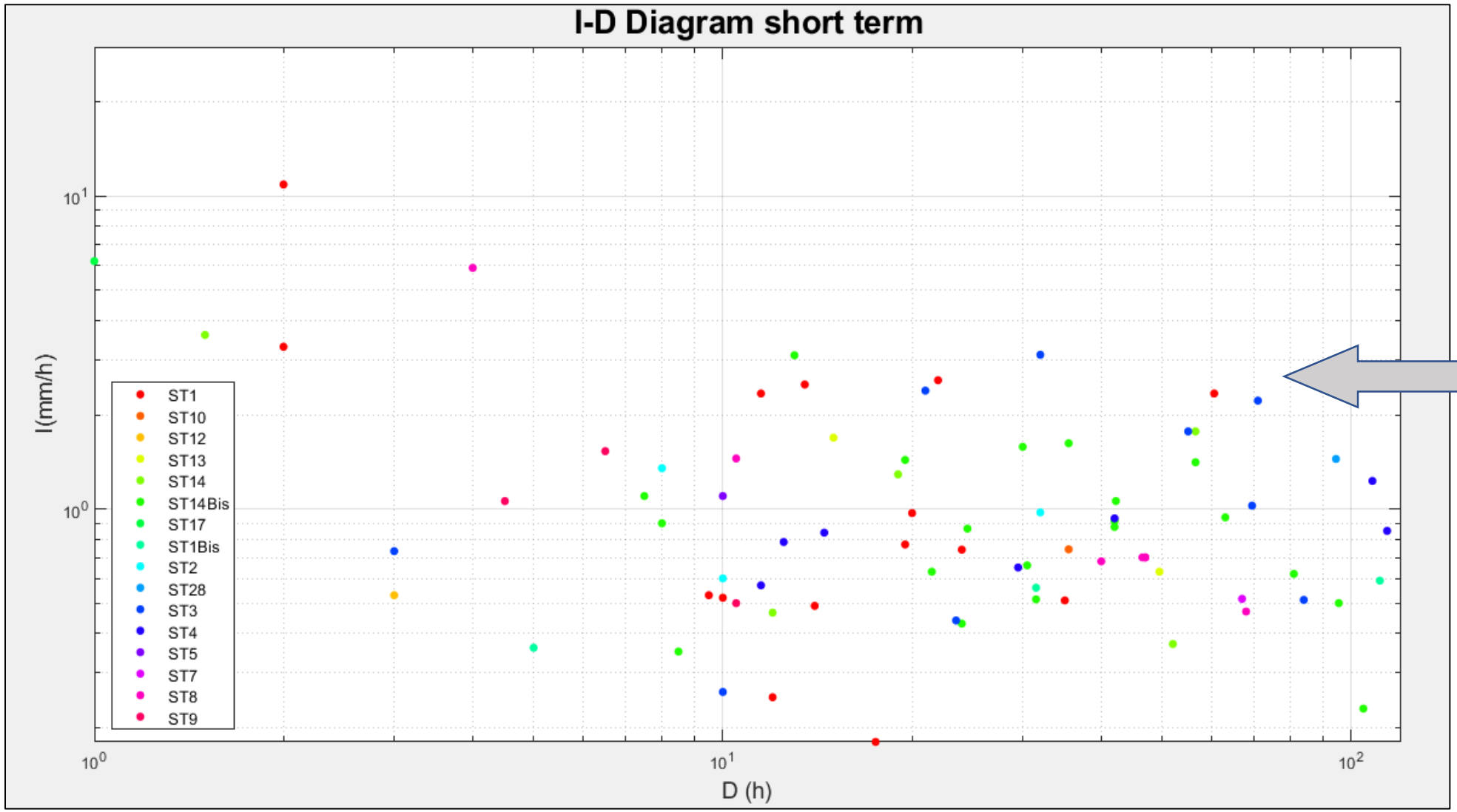
Intensity-Duration of rainfall in mm/hour → Traditional Approach



NO RECOGNIZABLE TREND

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LONG TERM PRECIPITATION (multiple events)

Bajni et al.

Physical Effect: long term joint water pressure

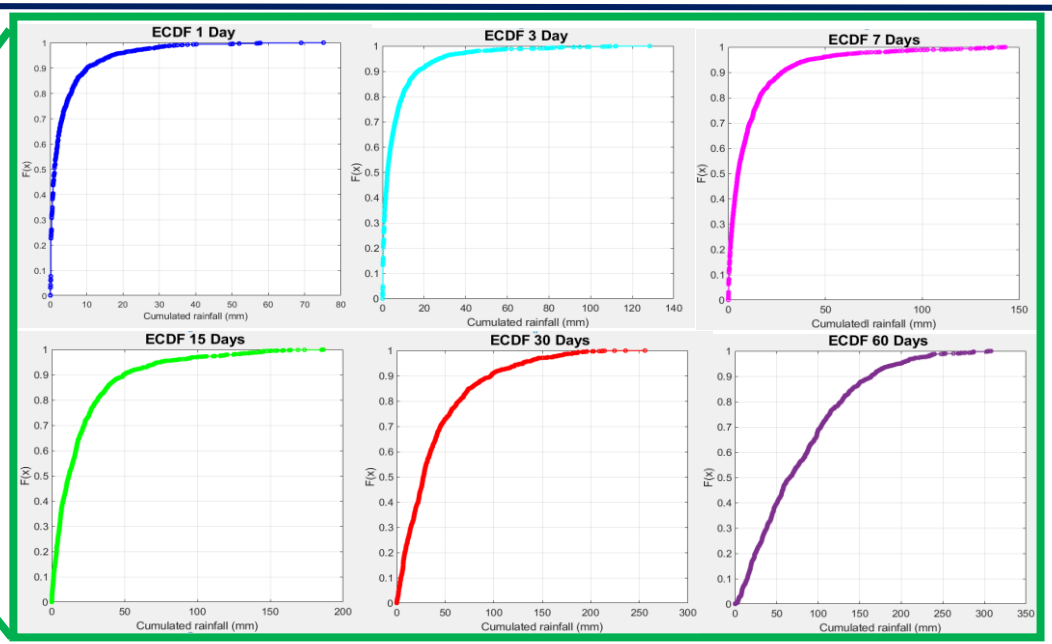
For each meteorological station and each related rockfall

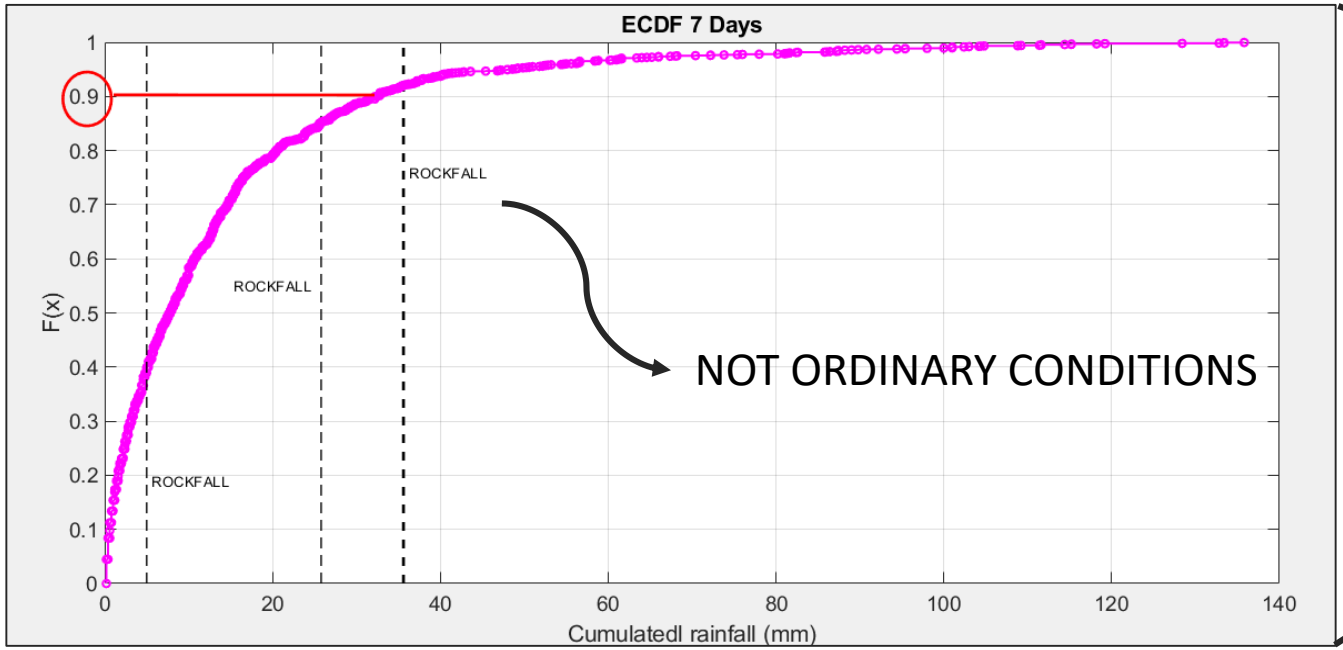
1,3,7,15,30,60 days cumulated rainfall before rockfall occurrence

Data resolution 1 day

+

Comparisonn with Empirical distribution function ECDF containing all available data





>50% of the rockfall associated to at least 1 value **over 0.9 of the ECDF curve**

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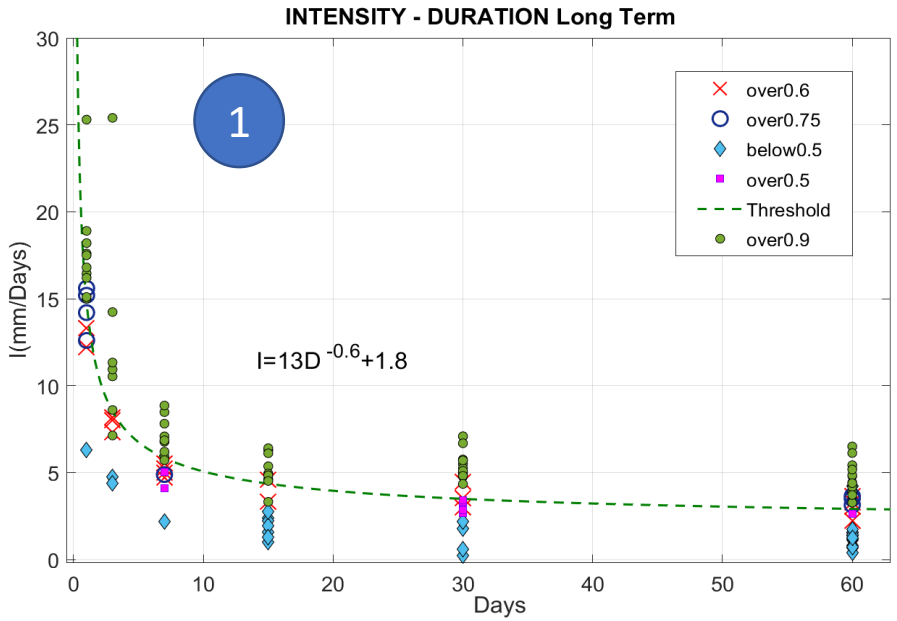
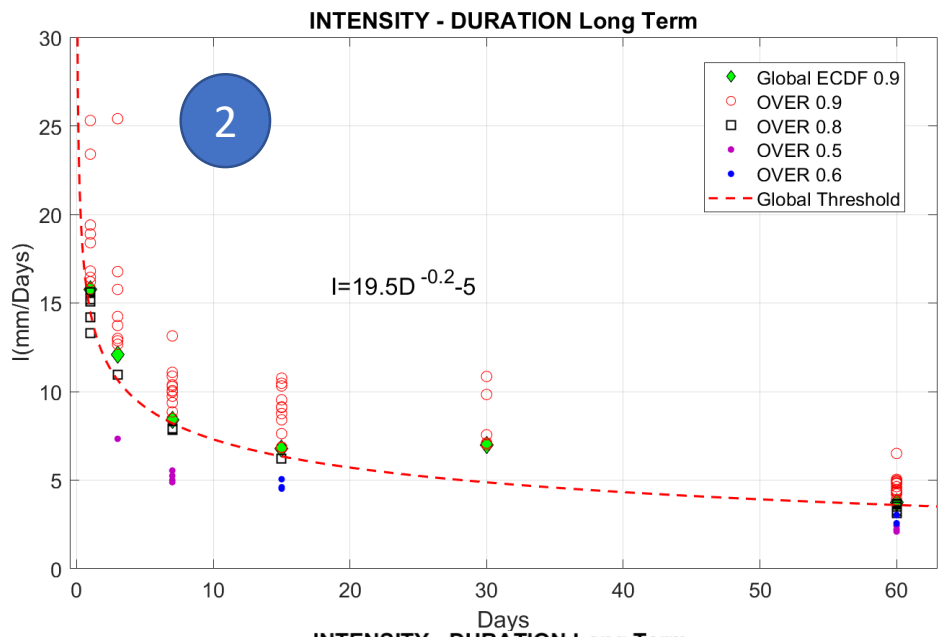
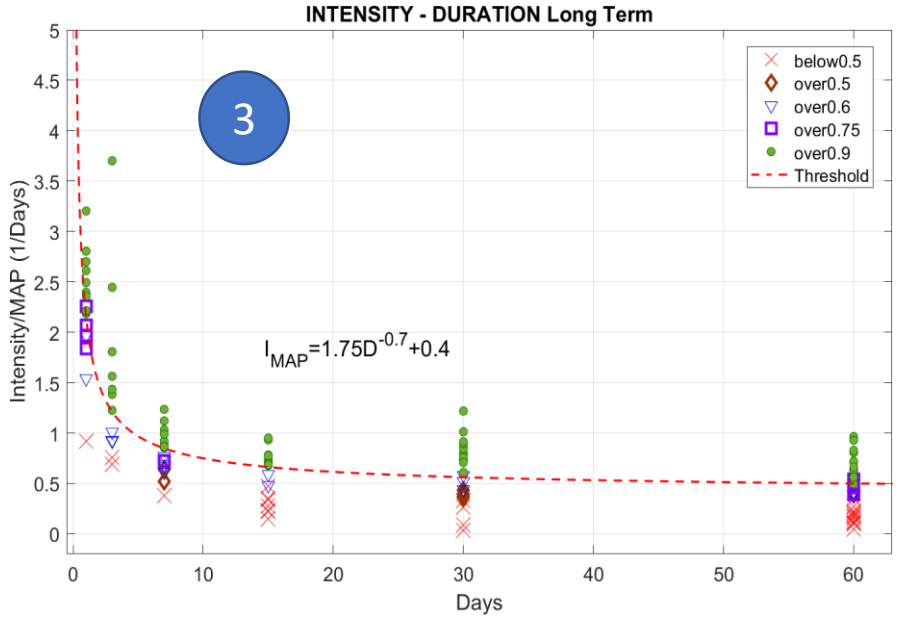
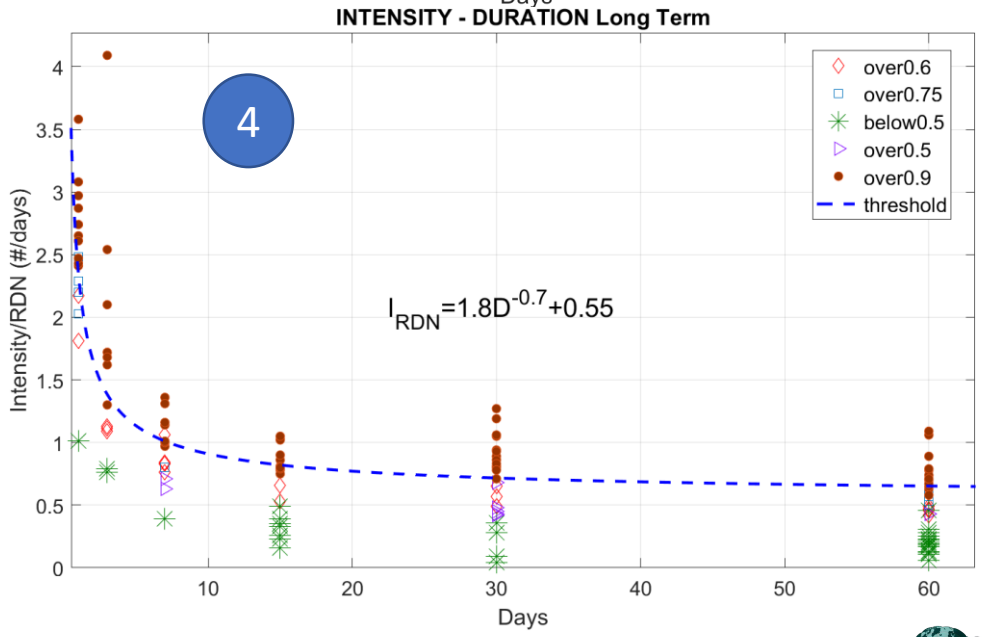
LONG TERM PRECIPITATION (multiple events)

Bajni et al.









Different Long term Intensity-Duration threshold evaluation

1) 0.9 station ECDF exceedance
2) 0.9 Global ECDF exceedance
3) Normalization to MAP (mean annual precipitation
4) Normalization to RDN (Rainy days normal)

Common procedure
Only over 0.9 values above the threshold

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WET and DRY EPISODES

Bajni et al.

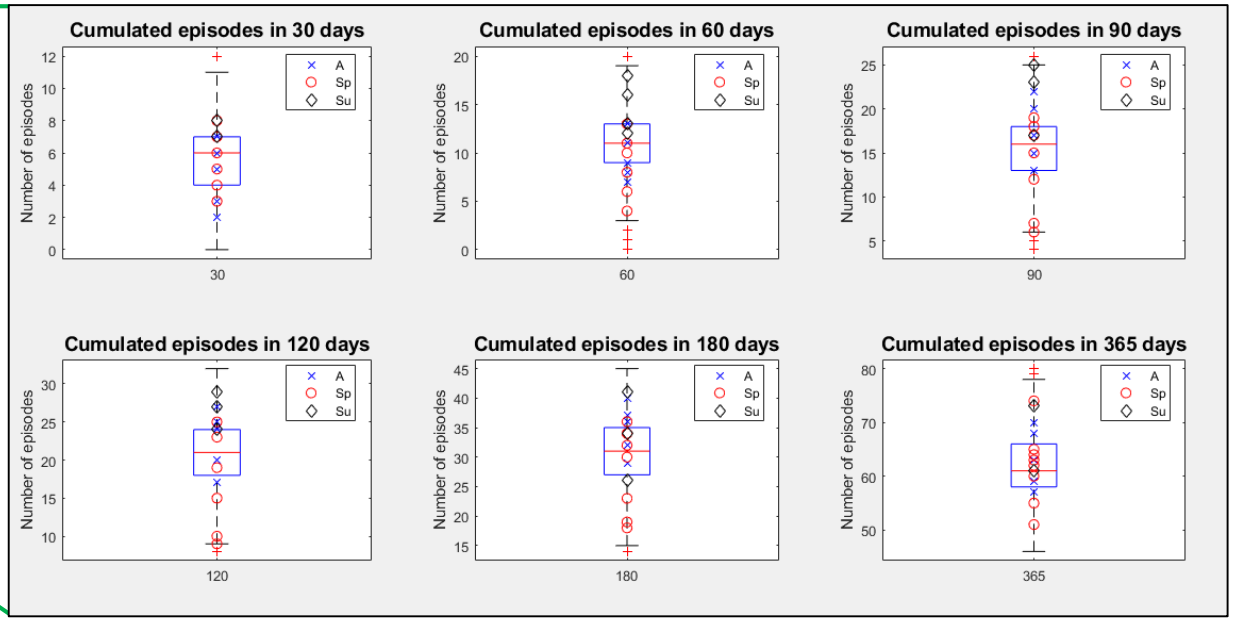
Physical Effect: long term wet and dry stress cycles on intact rock and moisture variation

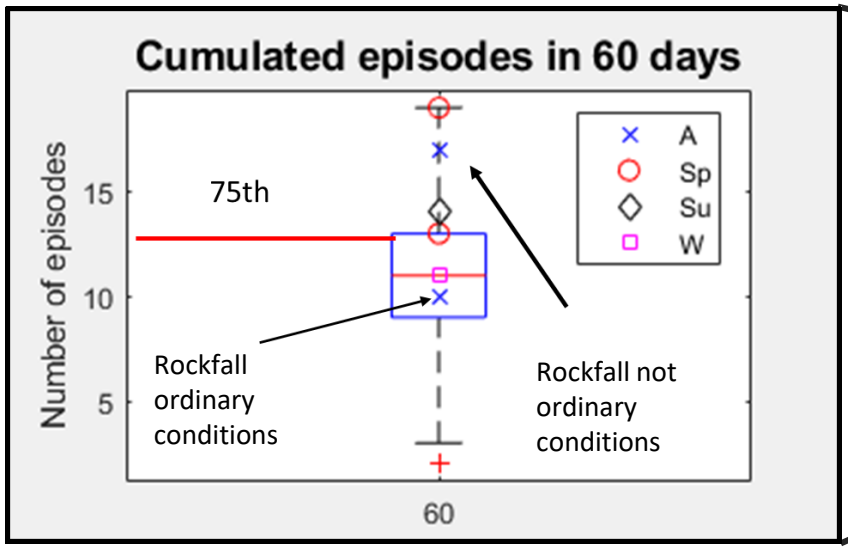
For each meteorological station and each related rockfall

30,60,120,180,365 days total number of episodes before rockfall occurrence

Data resolution 30 minutes.
24 hours interval wet-dry

Comparison with statistical distribution containing all available data





60% of the rockfall associated to at least 1 value **over 75th percentile**

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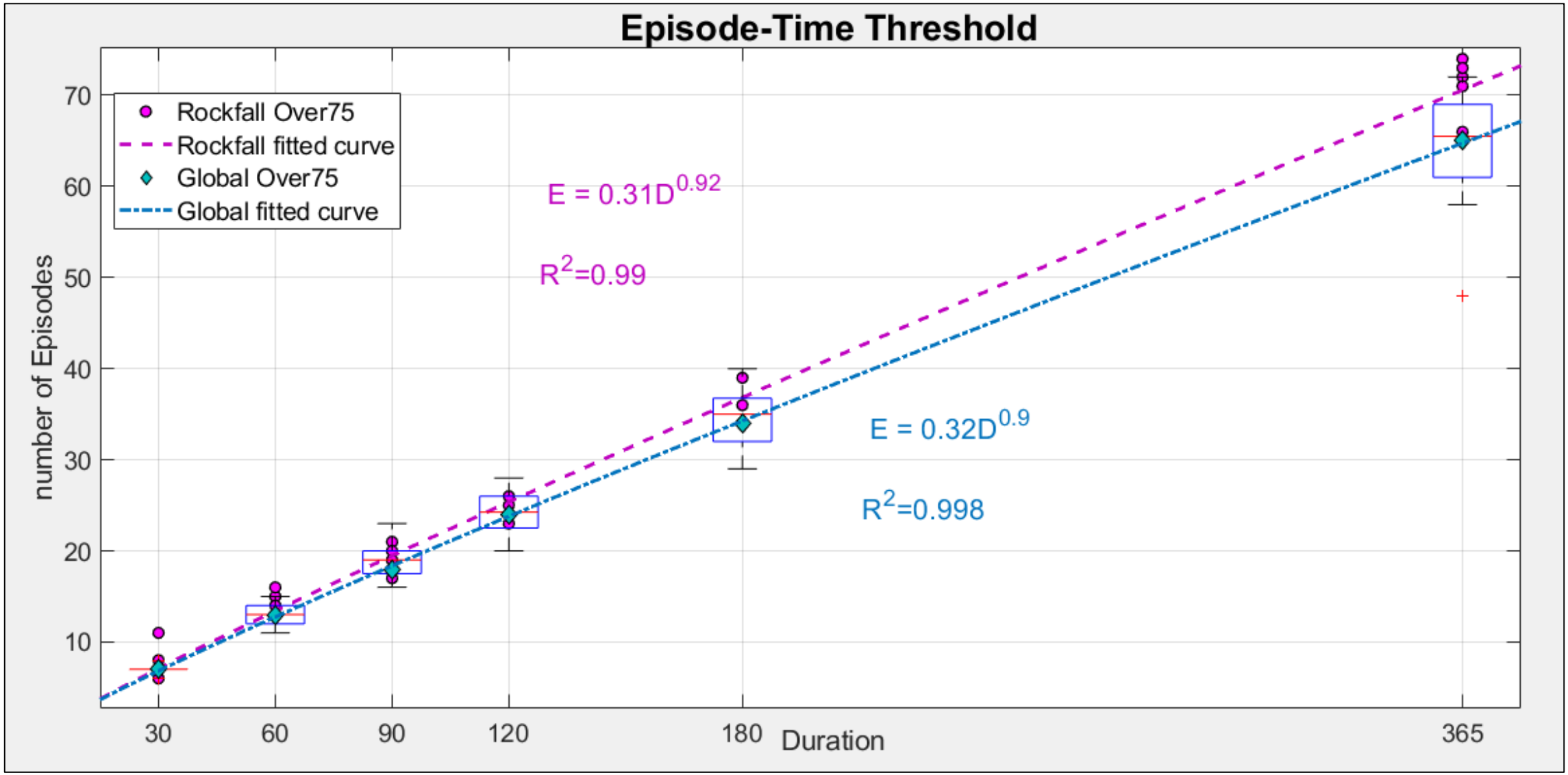
WET and DRY EPISODES

Bajni et al.



Episode-Time(Duration) Thresholds → Very similar

1) 75th percentile exceedance by station
2) 75th percentile exceedance global statistical distribution

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FREEZE-THAW CYCLES

Bajni et al.

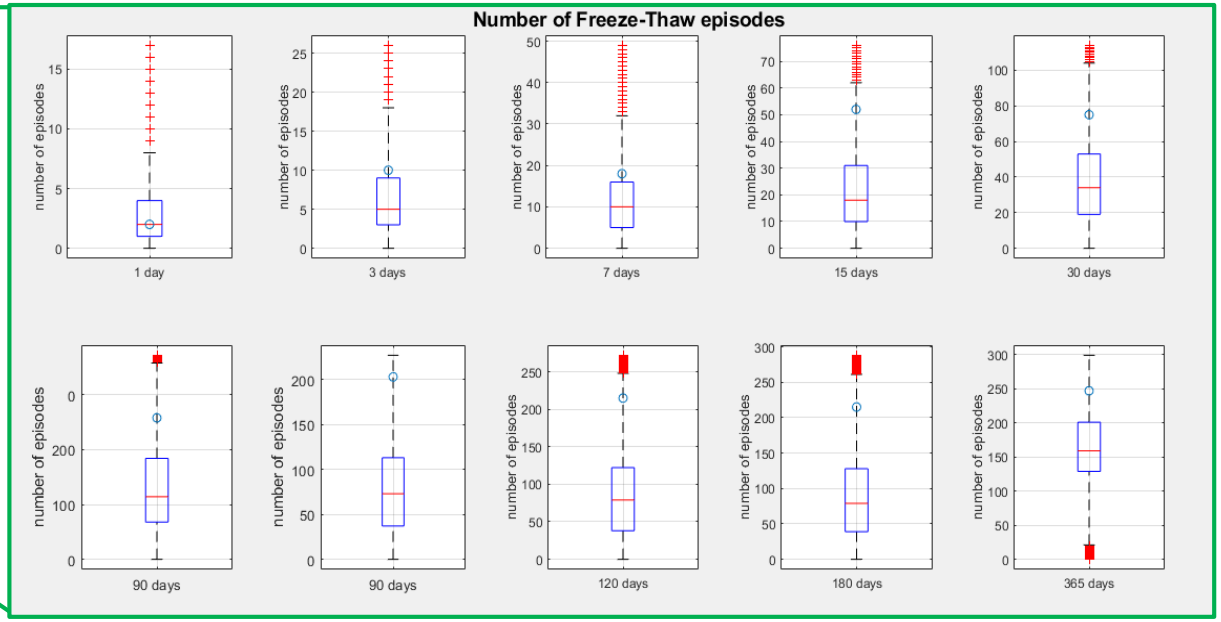
Physical Effect: long term thermal degradation + joints subjected to cyclic ice pressure

For each meteorological station and each related rockfall

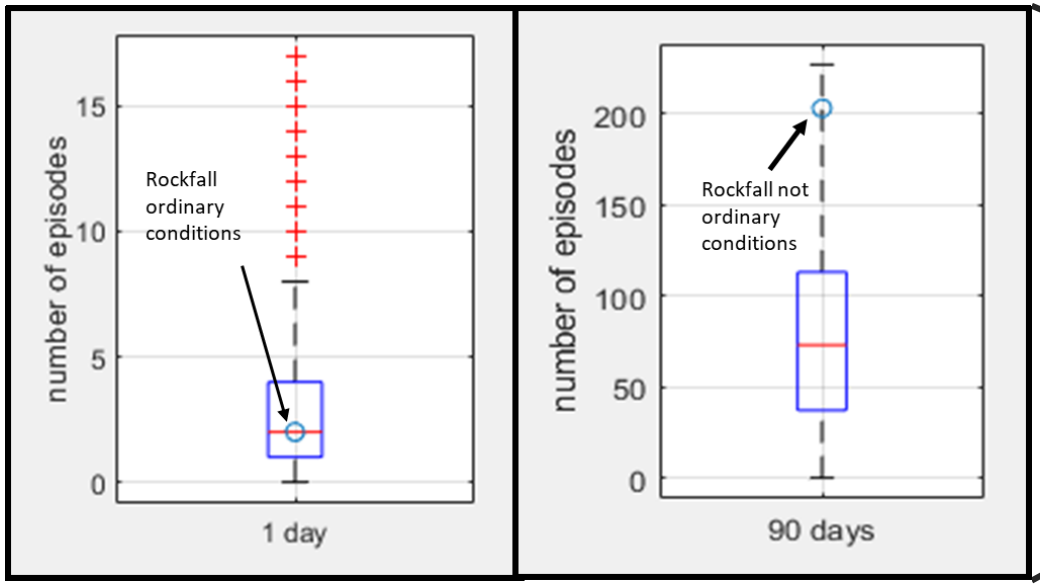
1,3,7,15,30,60,120,180,365 days total number of cycles before rockfall occurrence

+

Comparison with statistical distribution containing all available data



Data resolution 30 minutes. Cycle: Crossing 0°C
For every rockfall→correction T data series with ALRT



50% of the rockfall associated to at least 1 value **over 75th percentile**

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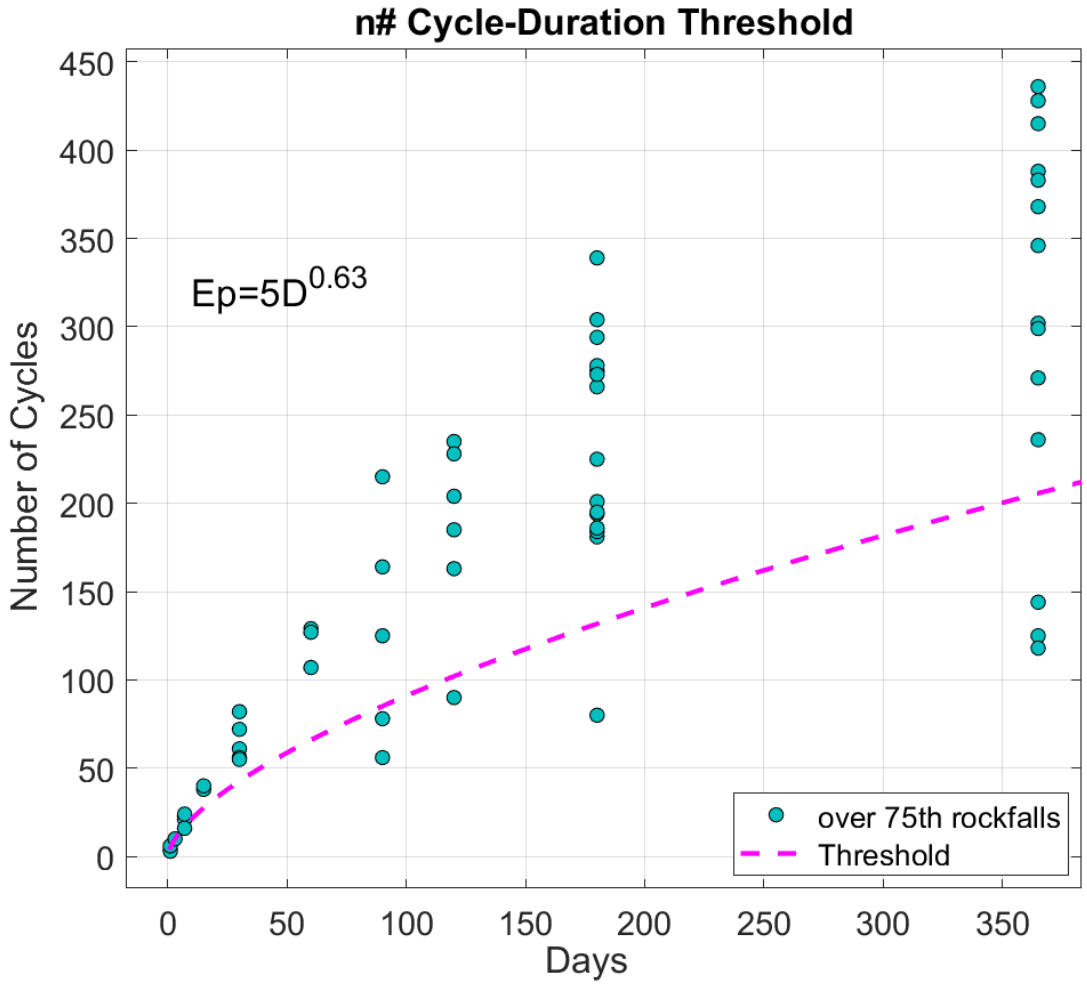
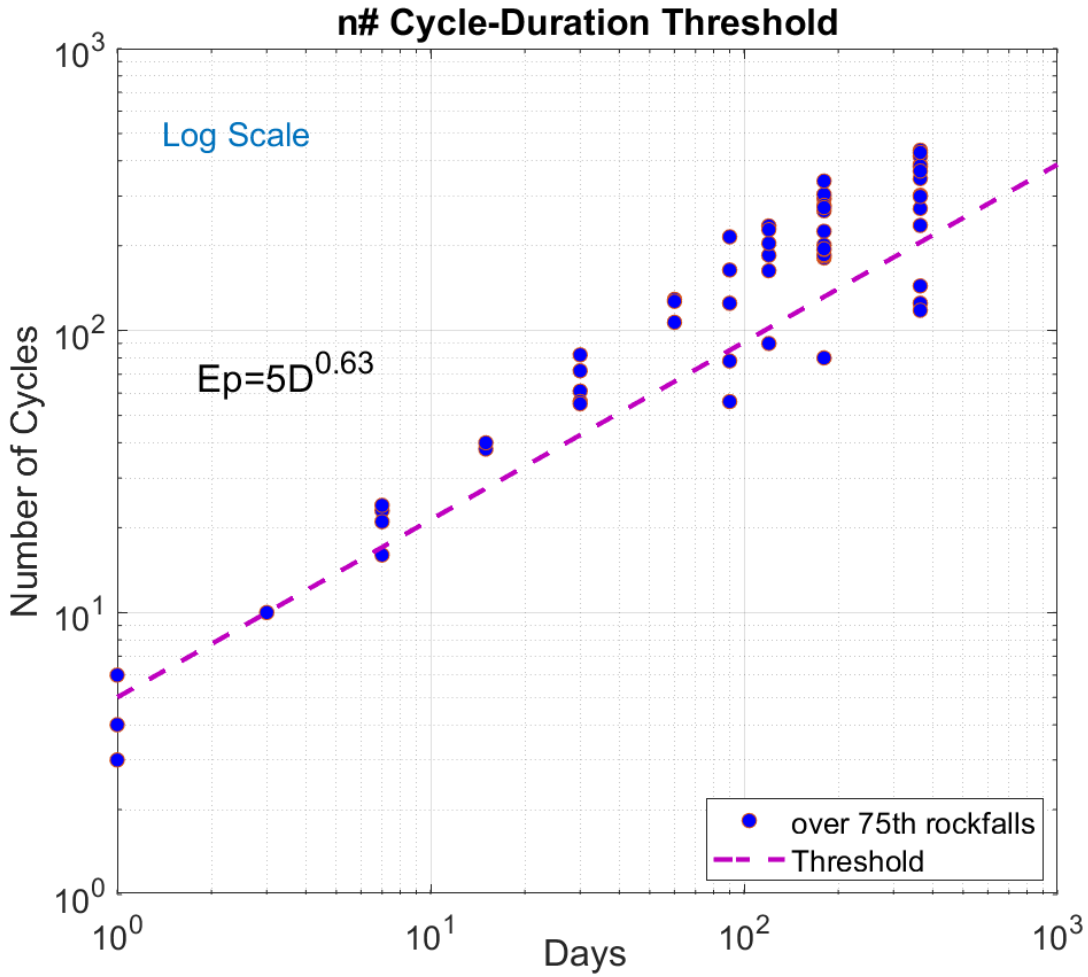
WET and DRY EPISODES

Bajni et al.





Cycles-Time(Duration) Thresholds

1) 75th percentile exceedance by station

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WET and DRY EPISODES

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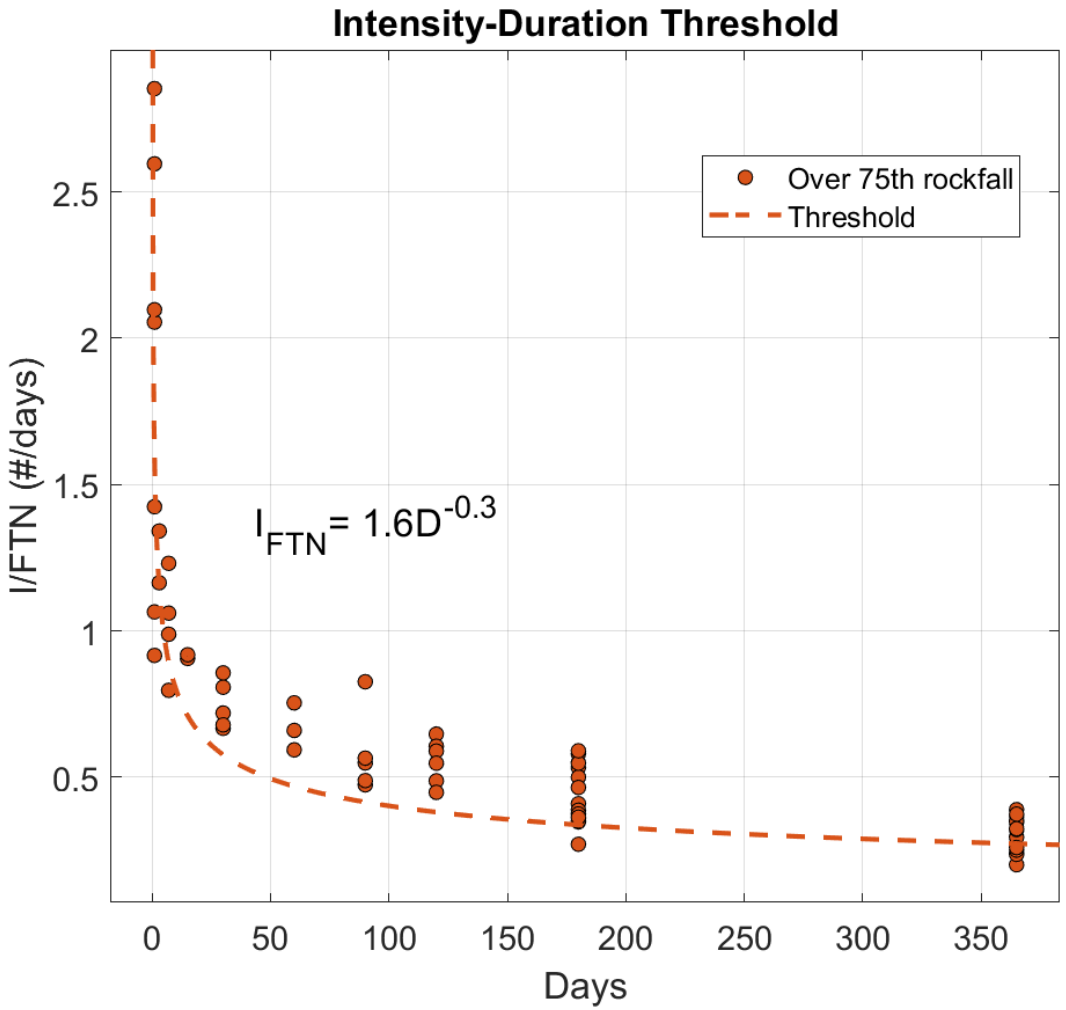

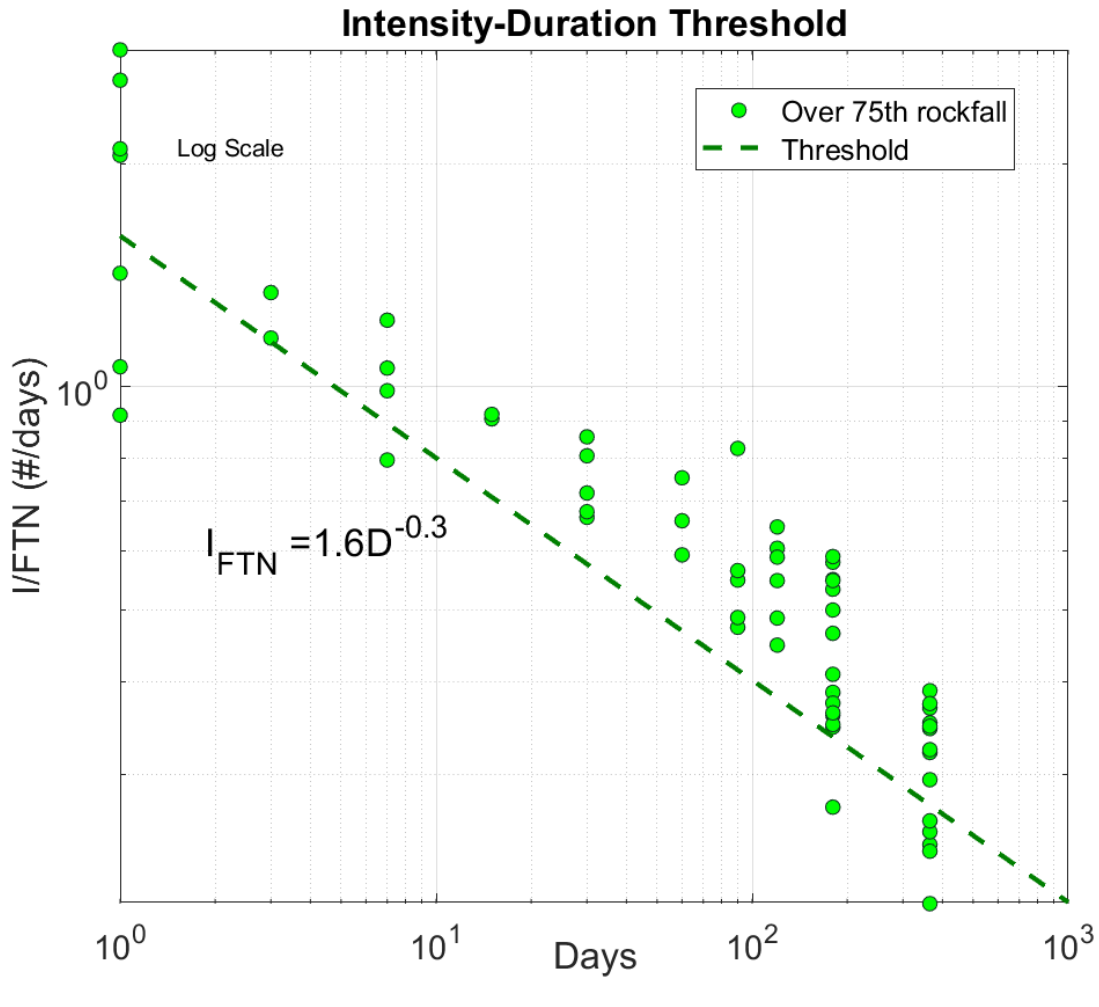

Cycles intensity-Time(Duration) Thresholds

2) Normalization of cycle intensity to FTN= Mean annual FTcycles/Mean Annual across 0°C days (inspired by RDN normalization for rainfall thresholds)

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CONCLUSIONS: TRIGGER TYPES & ONGOING WORK

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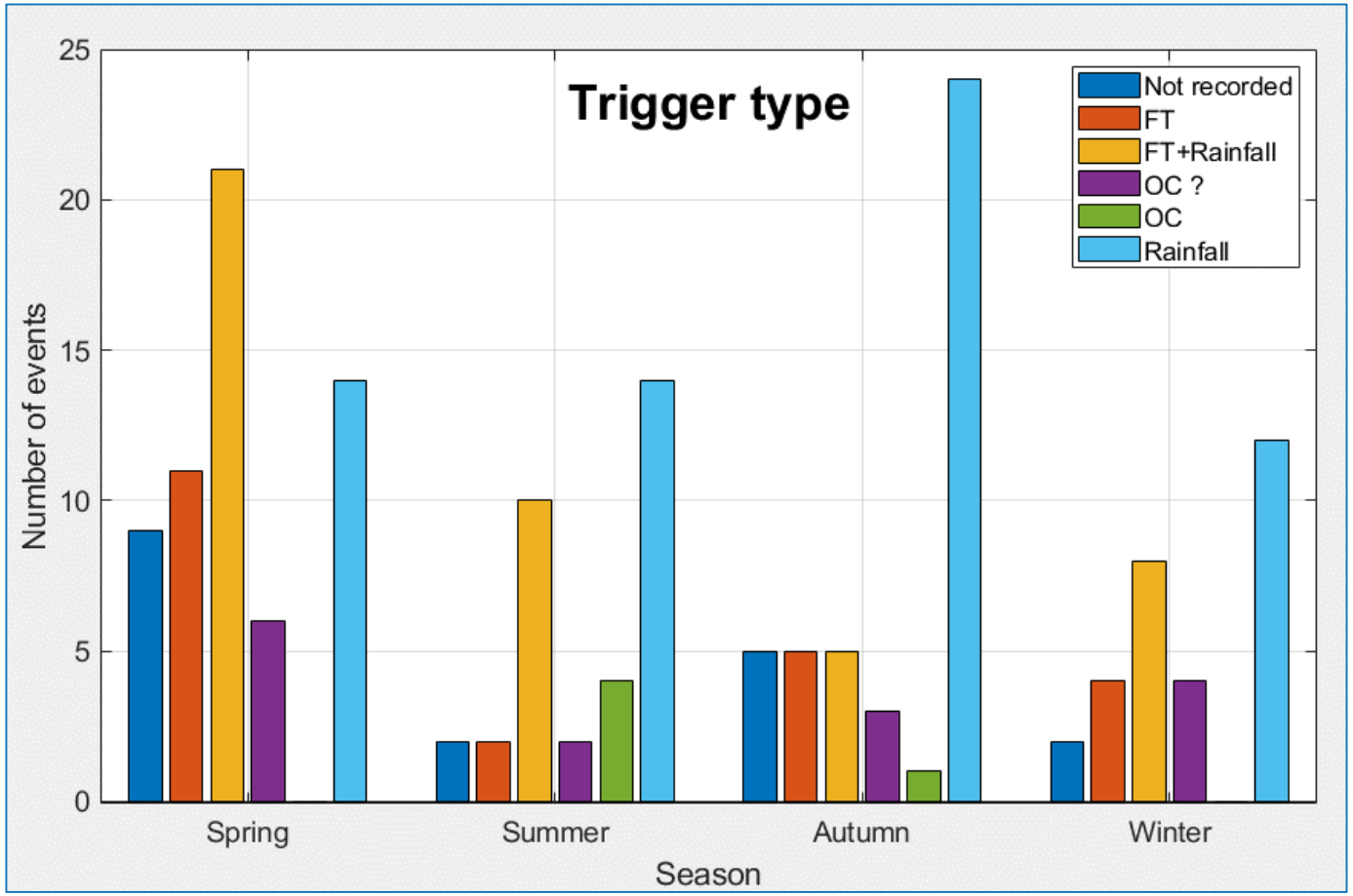

Most of the rockfall analysed were associated with non-ordinary conditions for one or more of the three climate indices analysed (0.9 of ECDF and 75th percentile). Using these cut-offs, long-term thresholds have been built, even normalized to compare different microclimatic conditions present in the study area (valley bottoms and high mountain environments).

Not recorded (not recorded climatic data during rockfall occurrence)	18
OC (+OC?) Ordinary conditions (or not recorded climatic data for one ore more indeces)	5(+15)
Rainfall (Includes cumulated rainfall and number of wet and dry episodes)	64
FT	22
Rainfall+FT	44
With trigger	130 out of 168

Long term, not ordinary climatic conditions could represent preparatory and/or triggering factors for rockfall phenomena in the study area

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