

Icequakes in Greenland

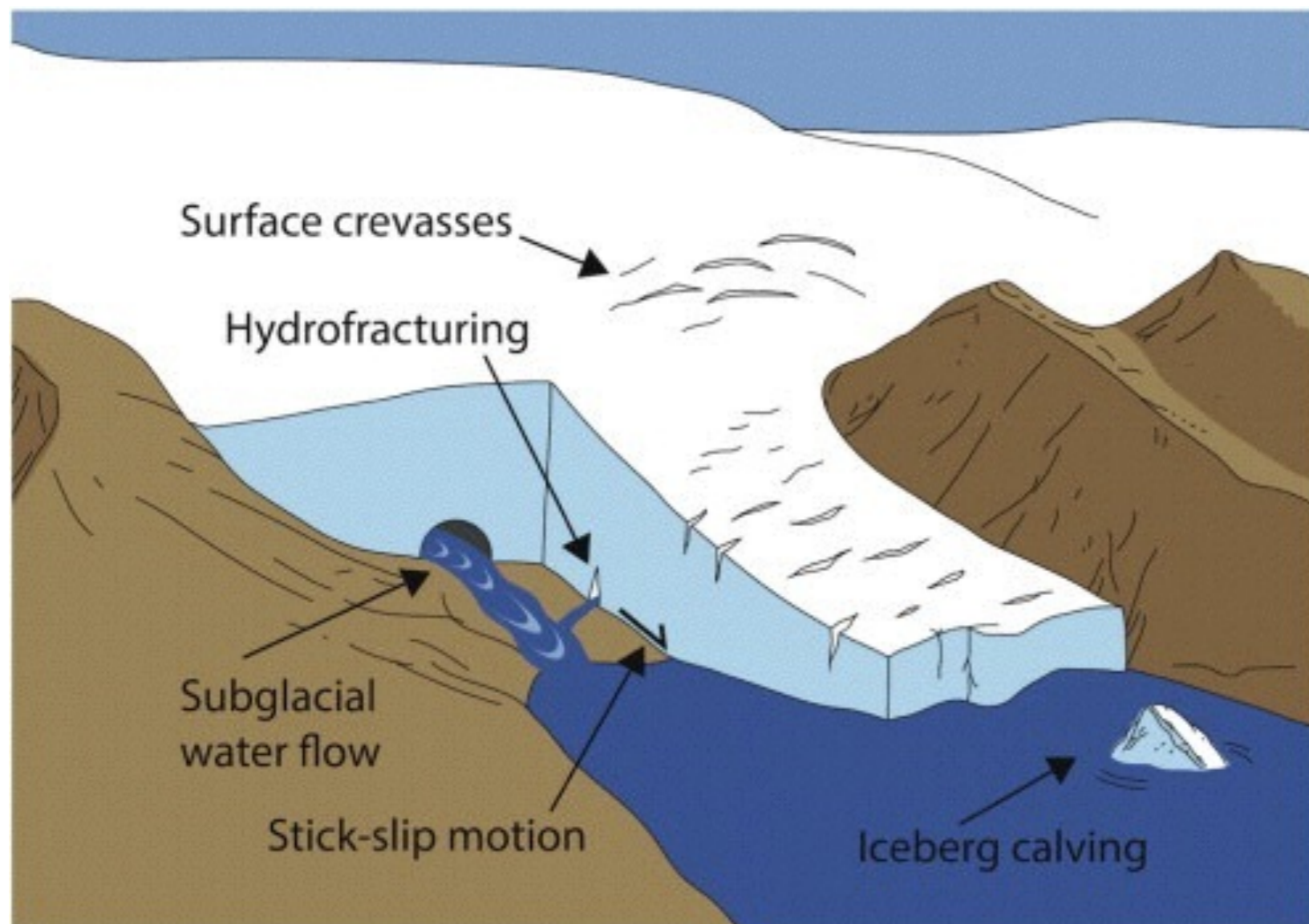


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M. Funk ², F. Walter ², R. Genco ³,
S. Tsutaki ^{1, 4}, M. Minowa ¹, and
M. Ripepe ³**

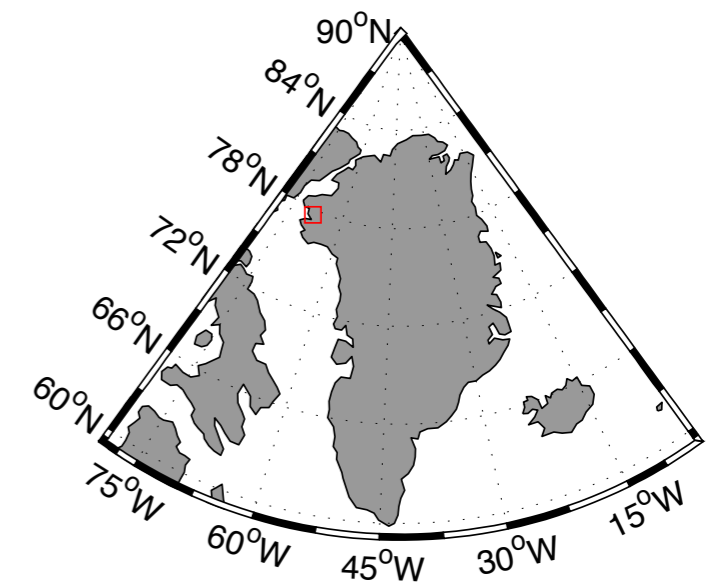


What produces icequakes?

- monitor difficult-to-access
- rapid processes
- high temporal resolution
- vast spacial coverage



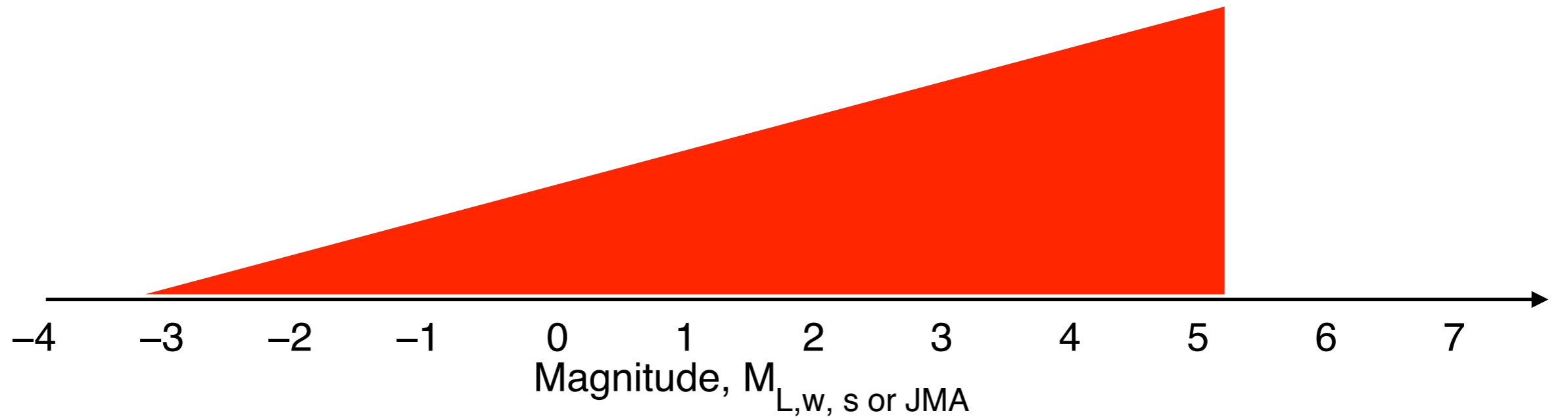
for understanding mechanisms influencing glacier dynamics



Tide-modulated ice speed
[Sugiyama et al., 2015]

Larose et al., 2015

icequake magnitude



local

regional

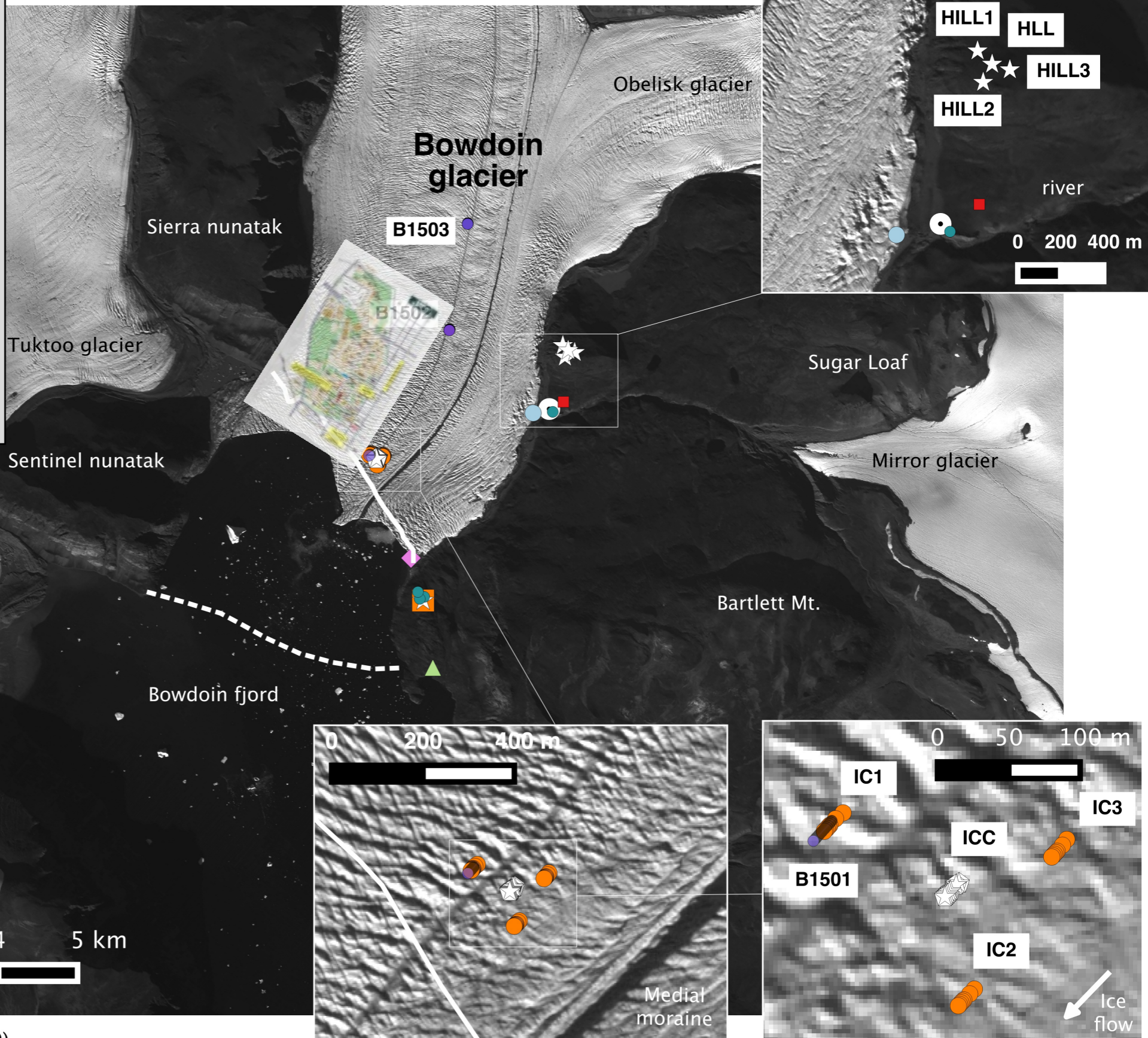
teleaseismic

*Podolskiy and
Walter, in prep.*

7-19 July 2015

Legend

- Base camp
- AWS
- Seismic stations (SP, 3)
- Seismic station (BBS)
- ◻ Seismic station (LP)
- GPS stations (3)
- ☆ Infrasound sensors (6)
- Time-lapse cameras (4)
- ◆ Water pressure sensor
- - - Front position (after Chamberlin, 1897)
- Front position (DigitalGlobe, 12/6/2015)
- River gate ice chasm
- ▲ Location of R. Peary's cabin



Background: ALOS PRISM (4 Sep 2010)

On-ice drifting seismic array

0 100 200 m

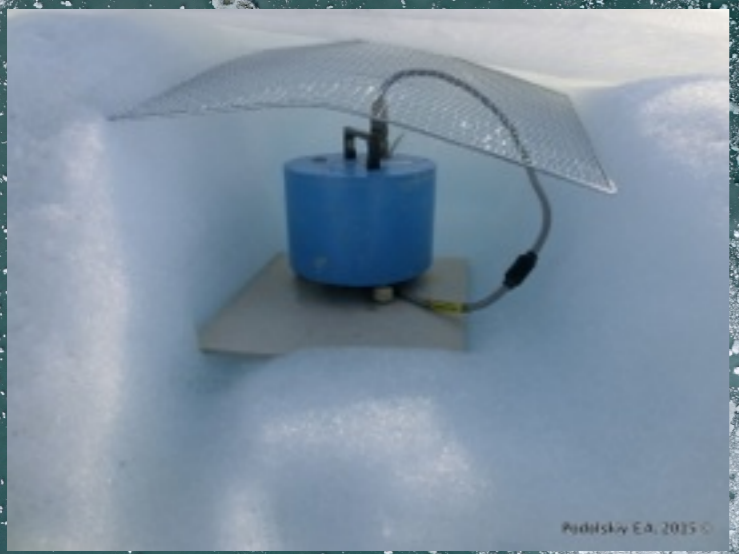
courtesy of
Y. Weidmann &
G. Jouvét
ETH

IC1 -> 07.07.2015 16:00

IC3 -> 07.07.2015 16:00

ICC -> 07.07.2015 16:00

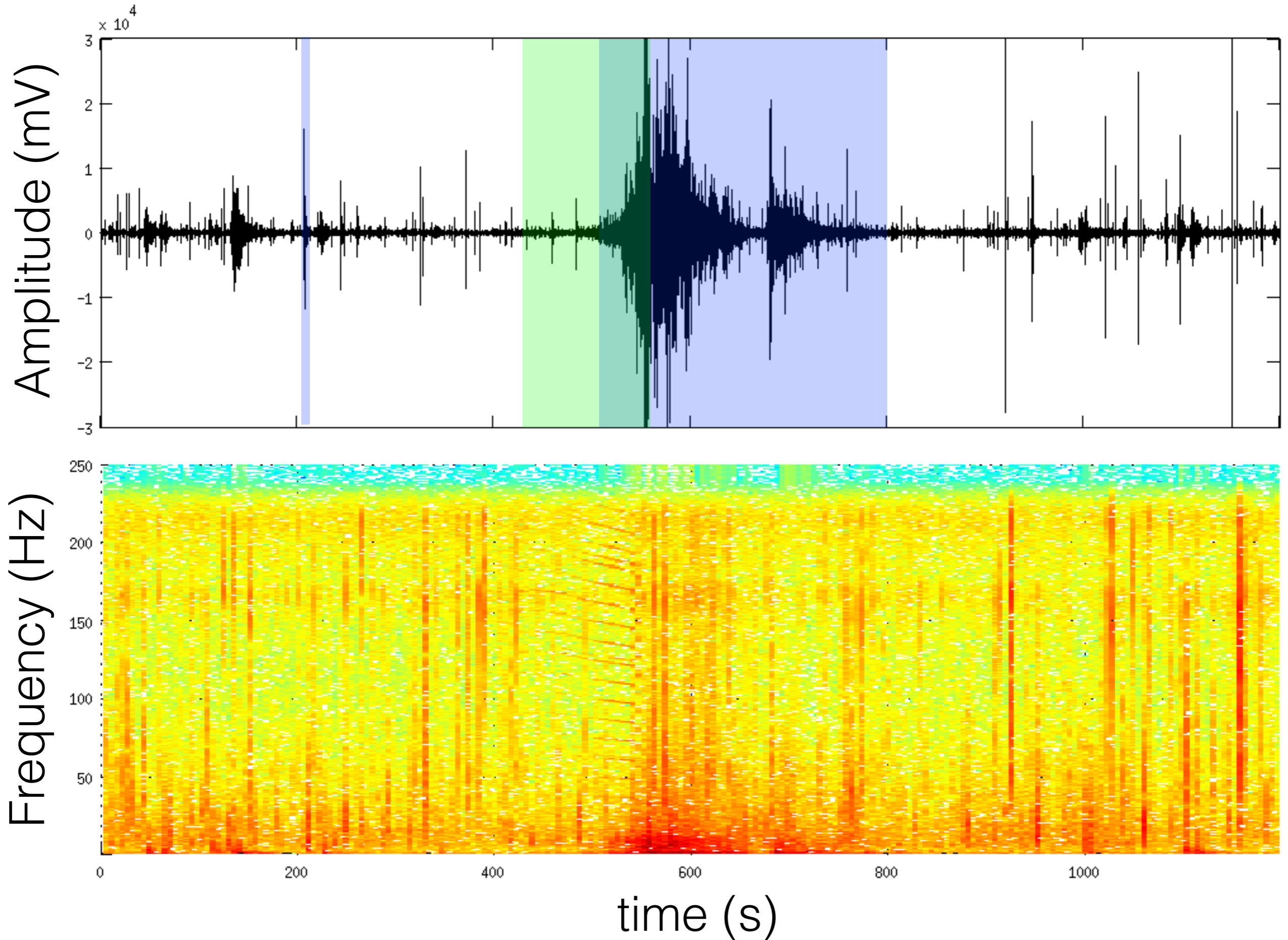
IC2 -> 07.07.2015 16:00



Fault opening prior
to major collapse



20 min record of ice vibrations

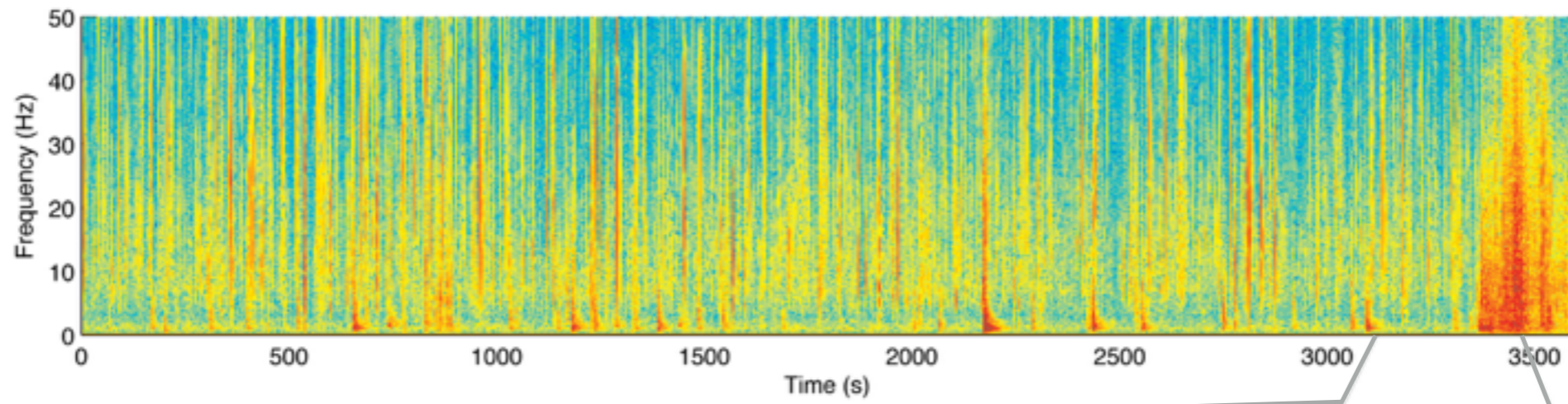
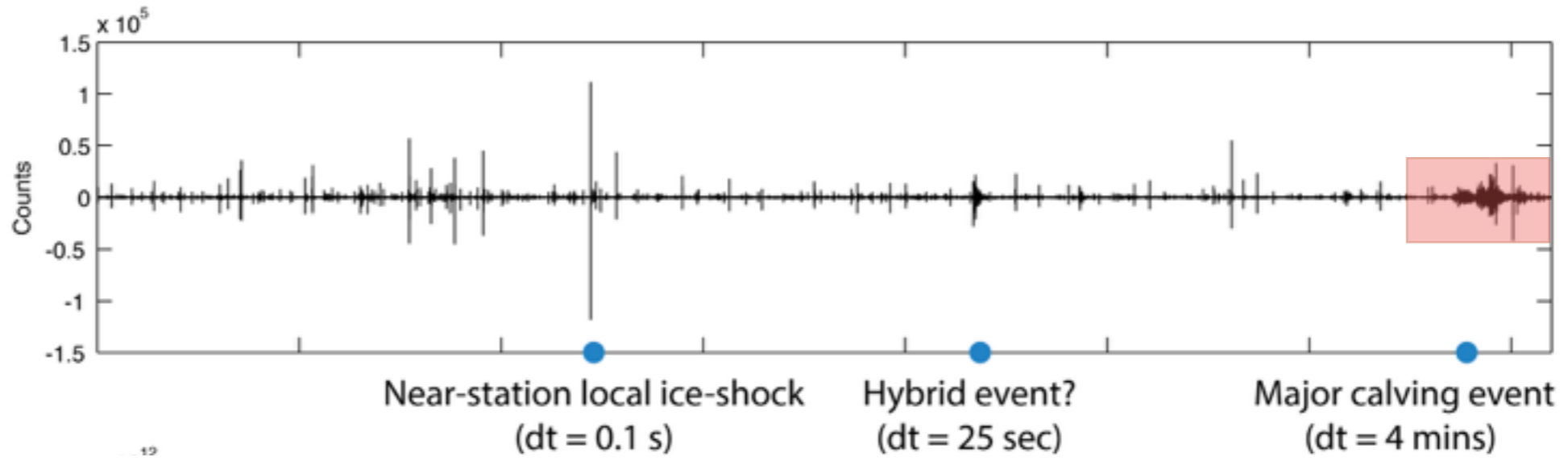


Sound of icequakes

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F. Walter
S. Tsutaki
M. Ripepe



1 hour seismogram, IC3, 18/07/2015, 08:00-09:00 UTC



Time-lapse, 08:52 UTC



Time-lapse, 08:58 UTC

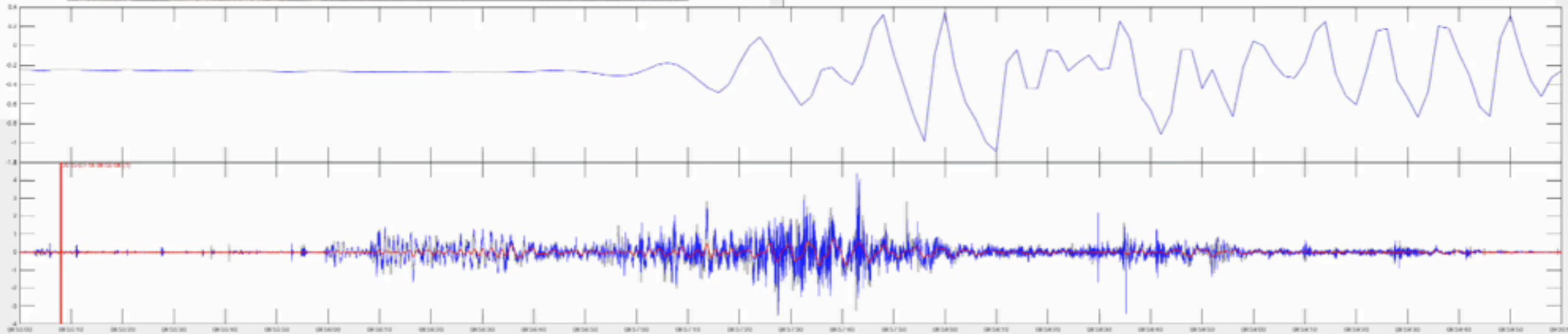
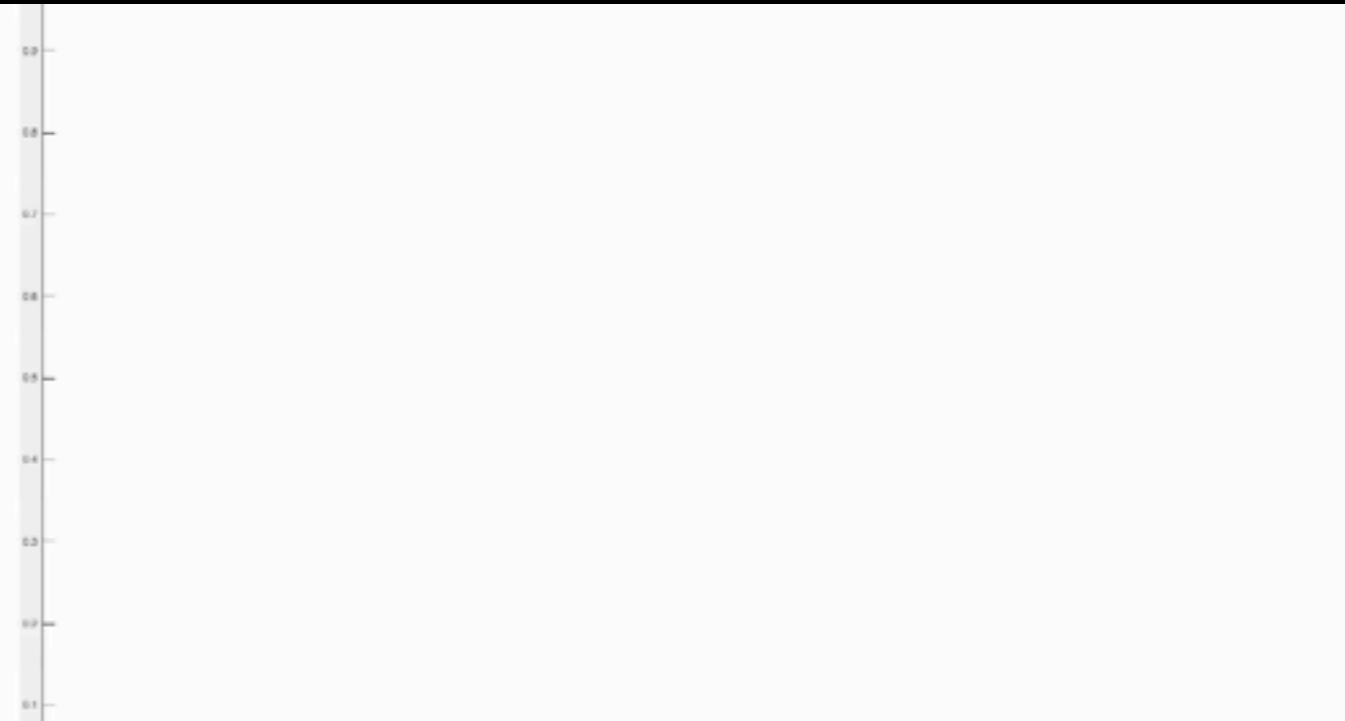
YouTube: "Icequakes and calving"



photo is made every 10 seconds

Image processing: tsunami & seismic

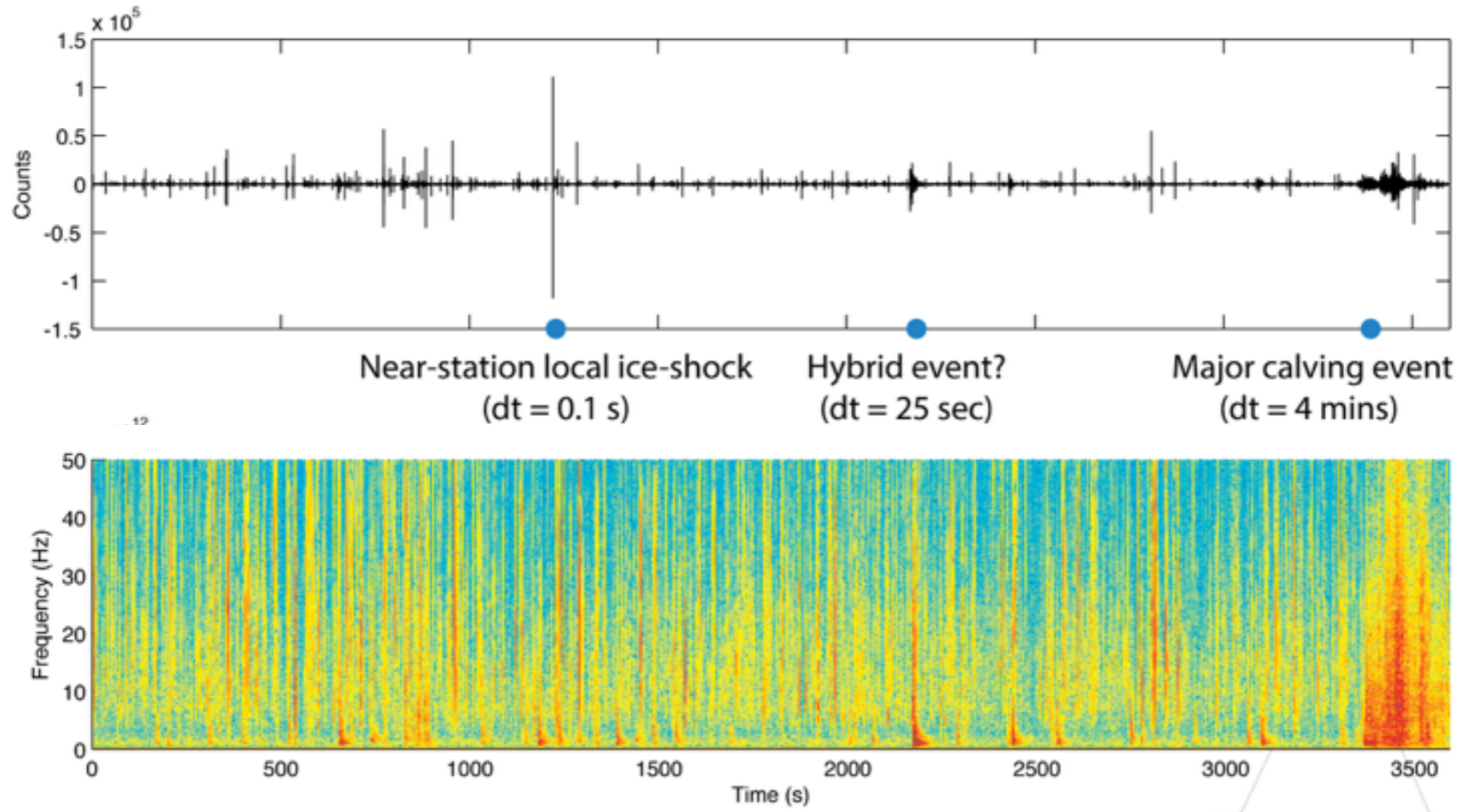
18-Jul-2015 08:55:08



08:55:00

09:00:00

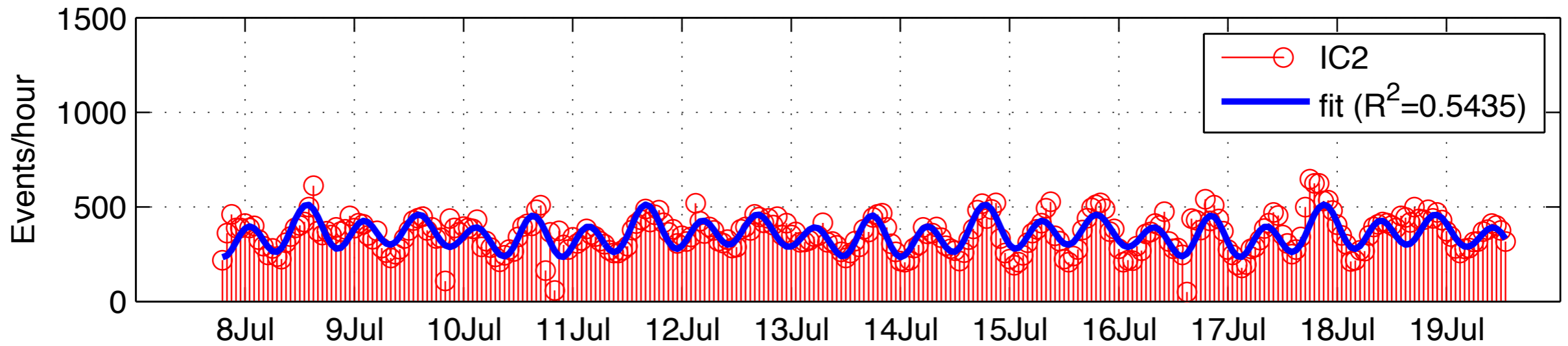
1 hour seismogram, IC3, 18/07/2015, 08:00-09:00 UTC



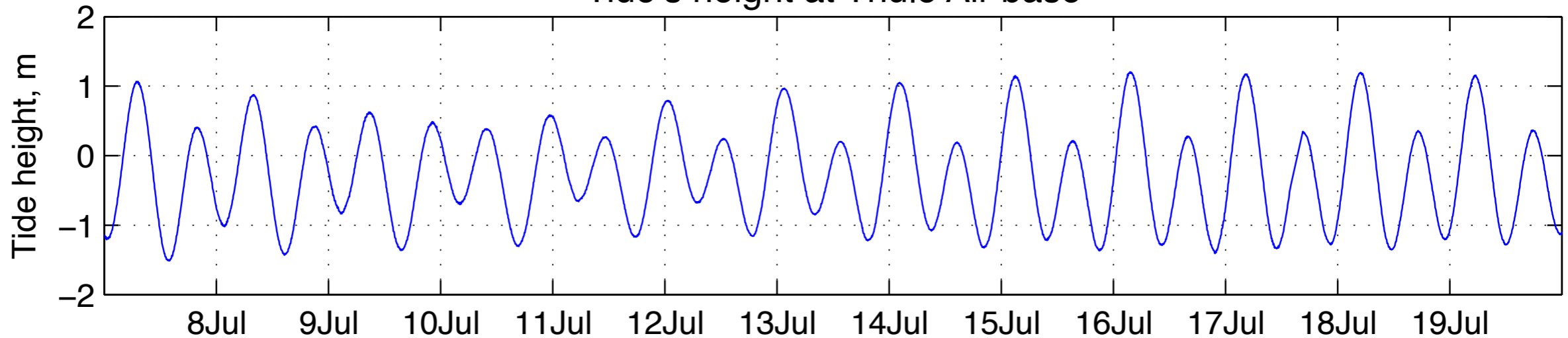
How many icequakes are there every hour?

Temporal pattern

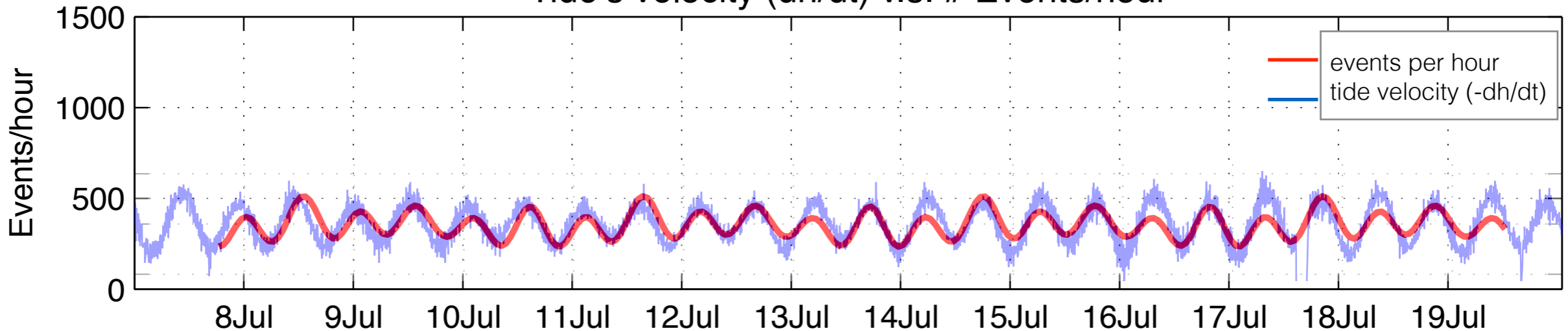
Triggering (STA/LTA=0.2s/5s, BWG2, raw, ON6, OFF0.5)



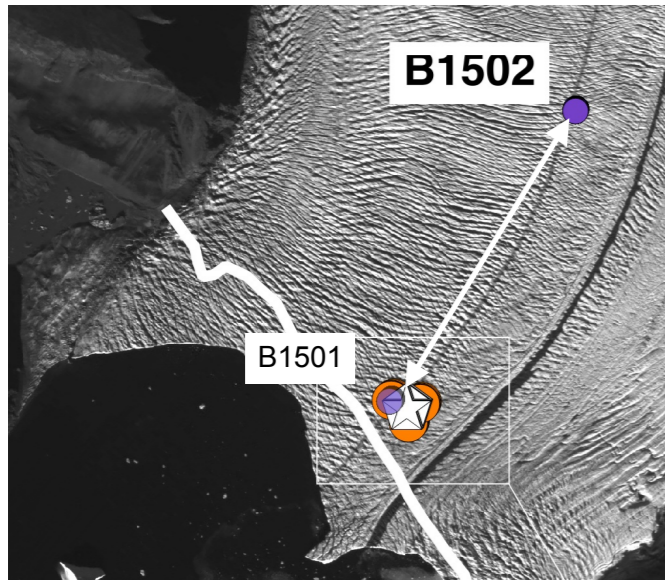
Tide's height at Thule Air base



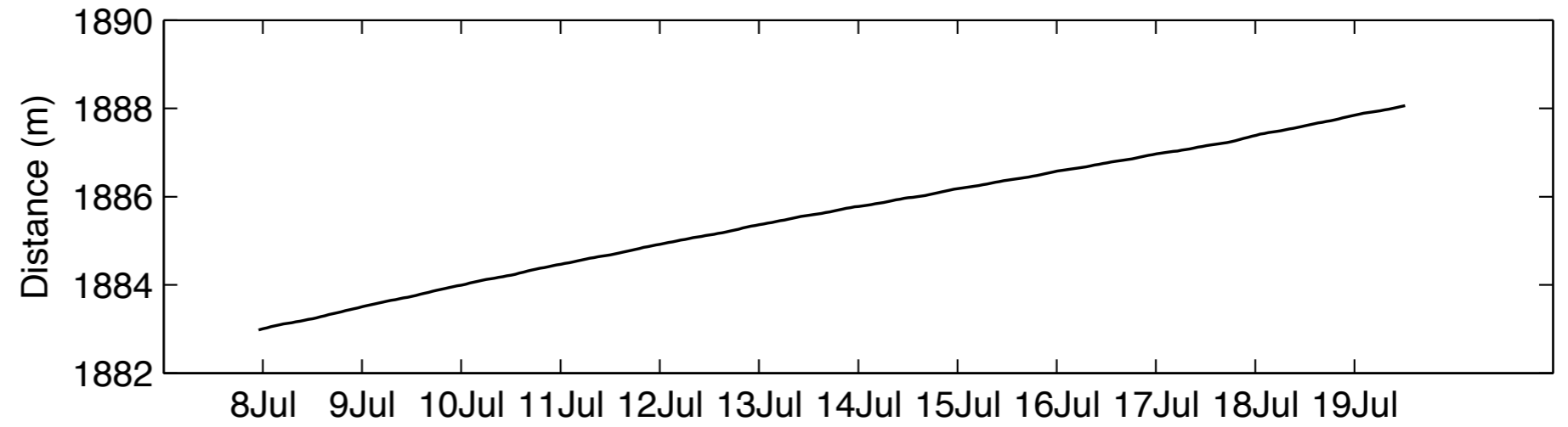
Tide's velocity (dh/dt) v.s. # Events/hour



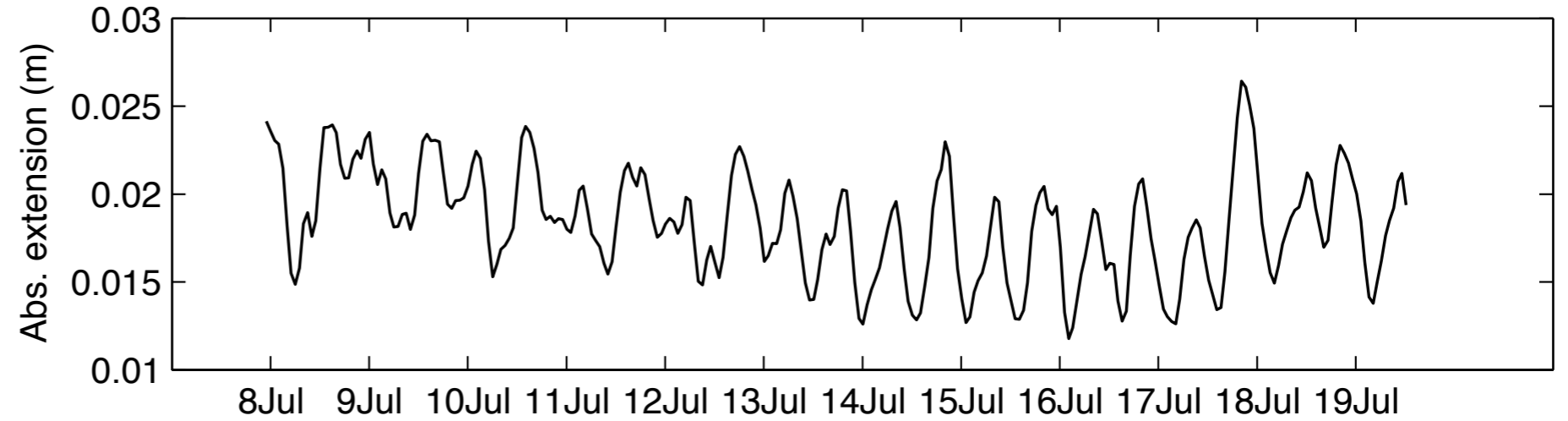
Max. of micro-seismicity -> falling tides



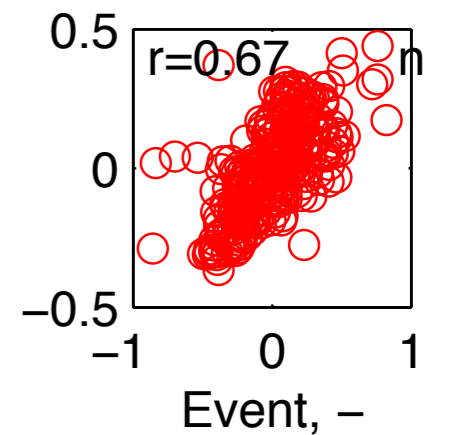
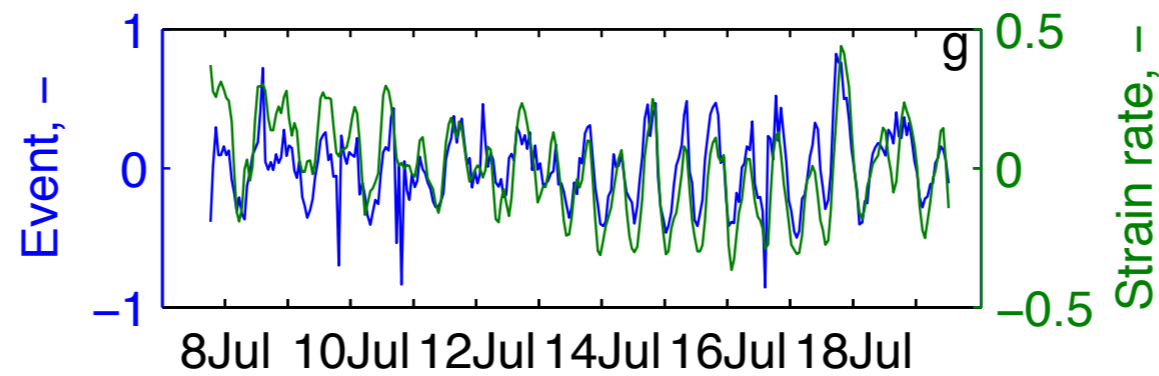
Absolute distance between GPS stations B1501 and B1502 (L_i)

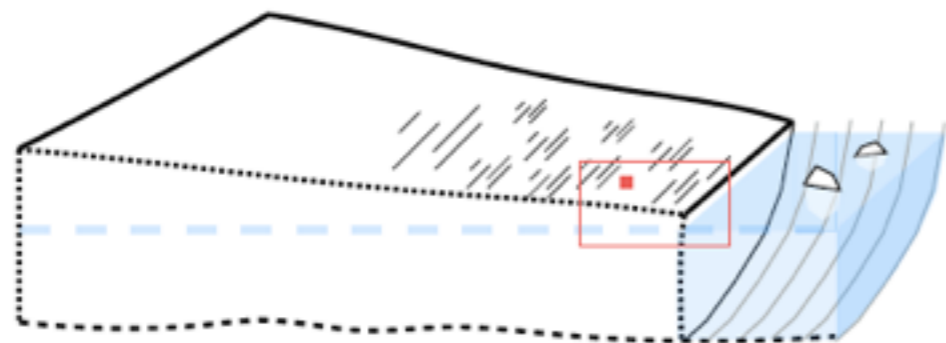


Hourly stretching between GPS stations ($dl=L_{i+1}-L_i$)

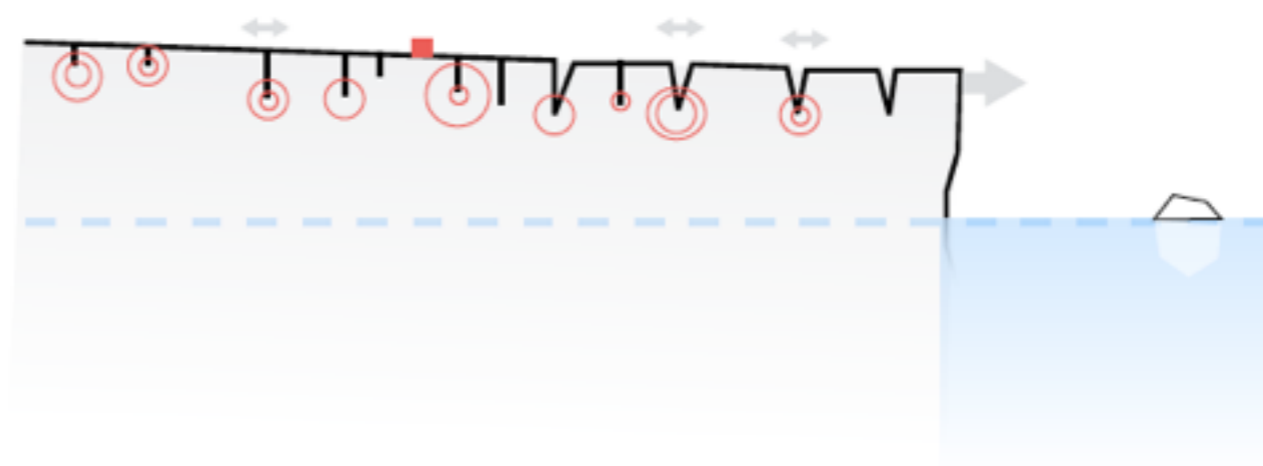


shown as
anomaly

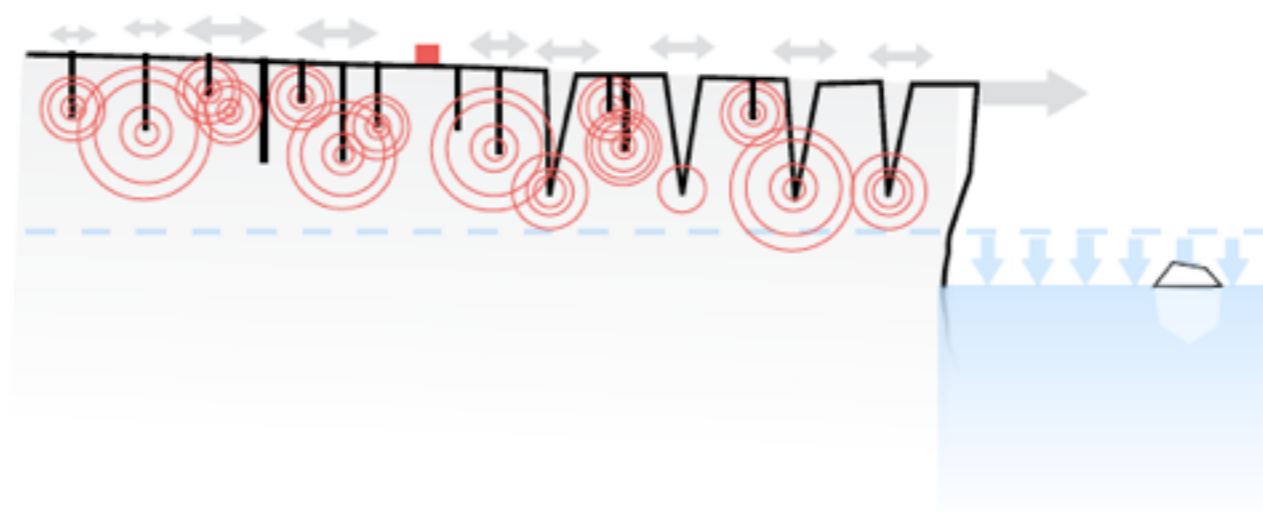




high tide



falling tide



Results so far

1. First evidence of tidal-modulation of cryo-seismic activity in Greenland
2. Strain rates drive micro-seismicity
3. Staying at the calving front at low tide is a bad-bad idea

Podolskiy et al. *Geophys. Res. Lett.*, 2016