Supplementary Material: Assessing Raspberry Shake and Boom sensors for recording African Elephant acoustic vocalisations

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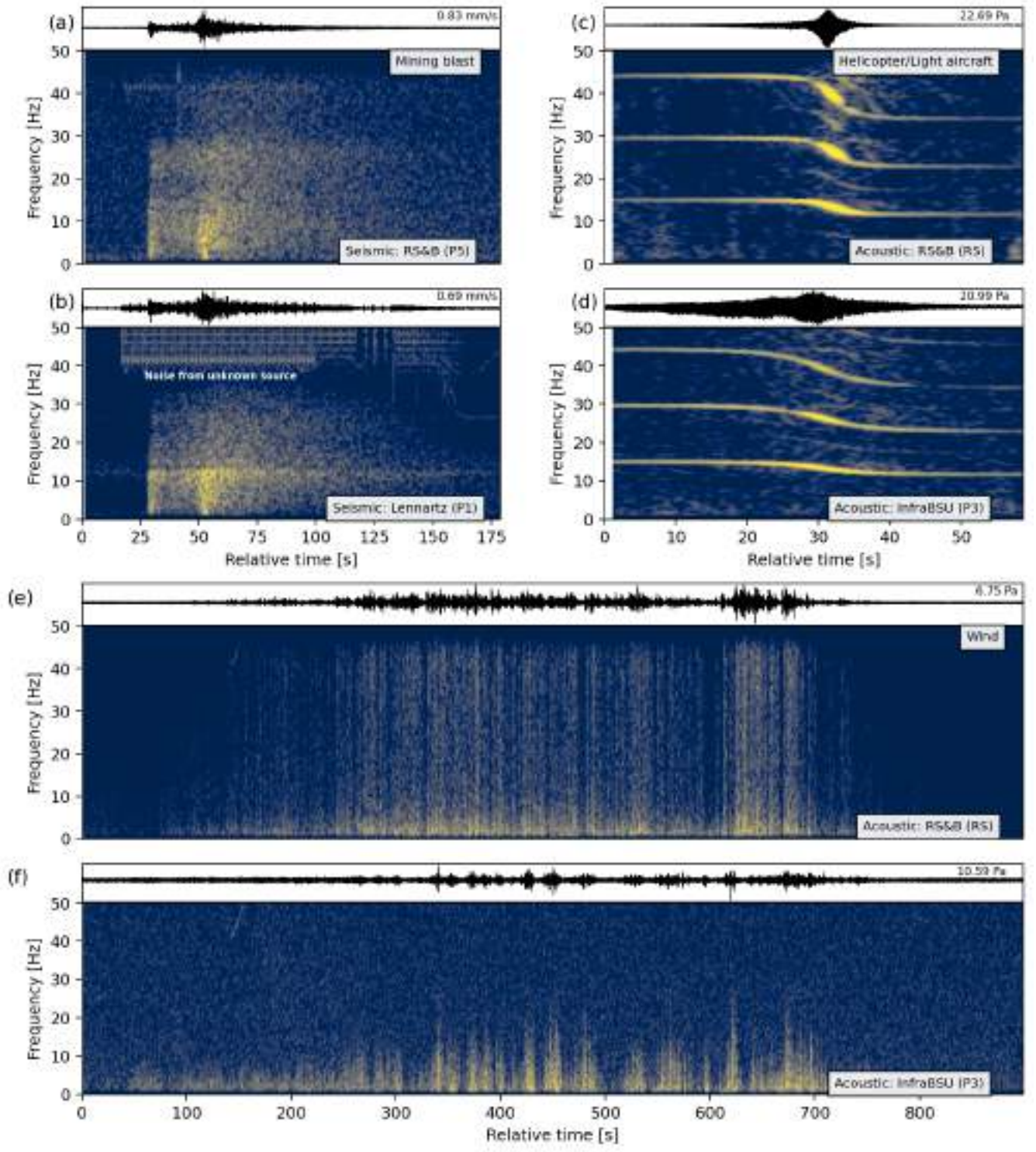

Figure S1. Examples of noise recorded by Raspberry Shake and Boom units and other stations during the deployment. Seismic waves from regional mining blast as recorded by (a) the RS&B geophone and (b) the Lennartz seismometer (note the noise from an unknown source has interfered with the waveform, as labeled in the spectrogram). Acoustic waves from a helicopter or small aircraft doing a flyby, as recorded by (c) the RS&B acoustic sensor, and (d) a InfraBSU sensor. Acoustic noise generated by wind, as recorded by (e) the RS&B acoustic sensor, and (f) the InfraBSU sensor. Each example includes the recorded waveform (top panel) and the frequency spectrogram (bottom panel). The station names of each sensor are indicated in the brackets in the bottom left of each spectrogram; see Fig. **??**C for the location of each station. The peak absolute amplitude measured is noted in the top right of each waveform panel.

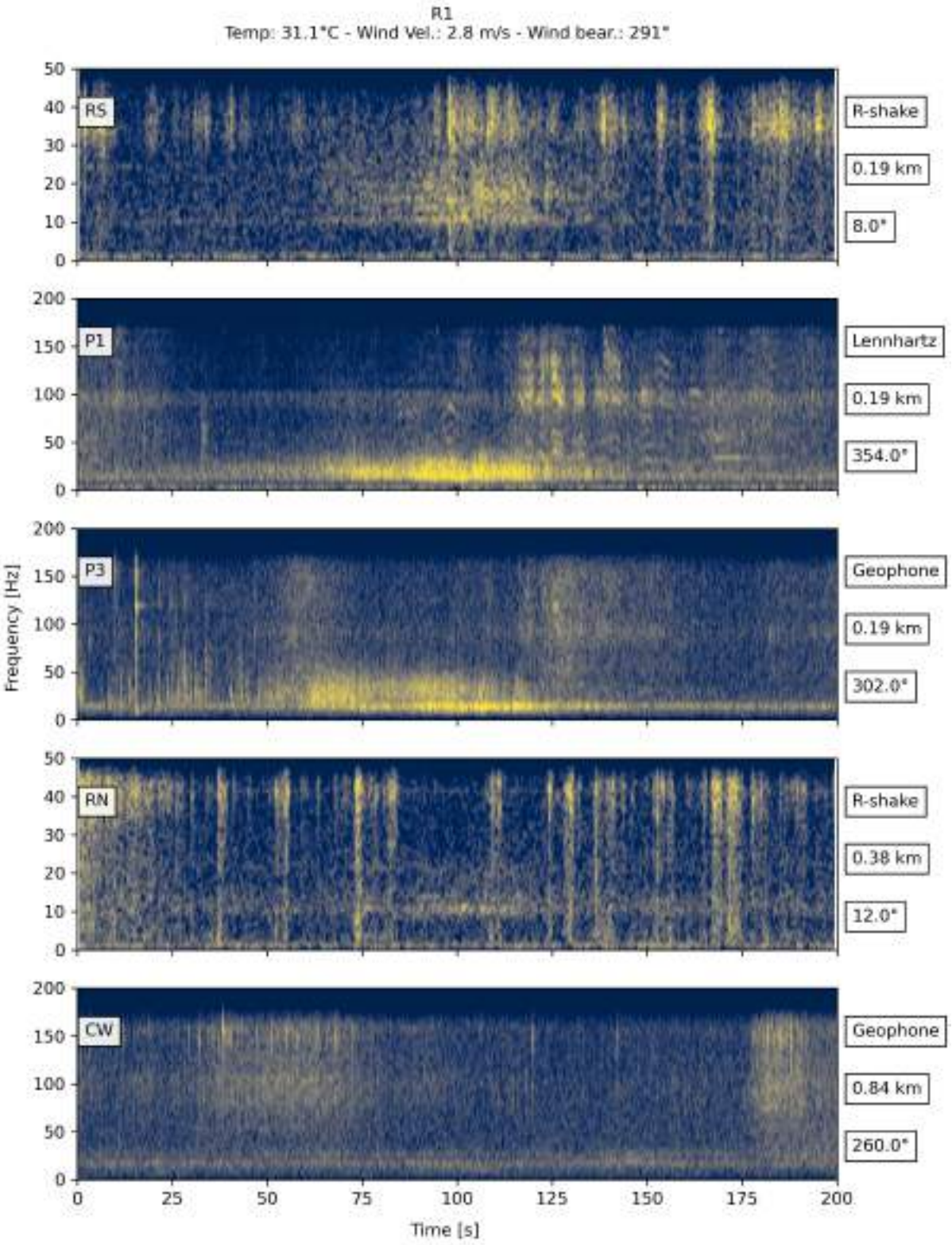

Figure S2. Spectrograms for seismic data as recorded during Reunion 1, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure. Note that data from stations P5, P7, and P9 are not plotted here due to technical issues with the stations.

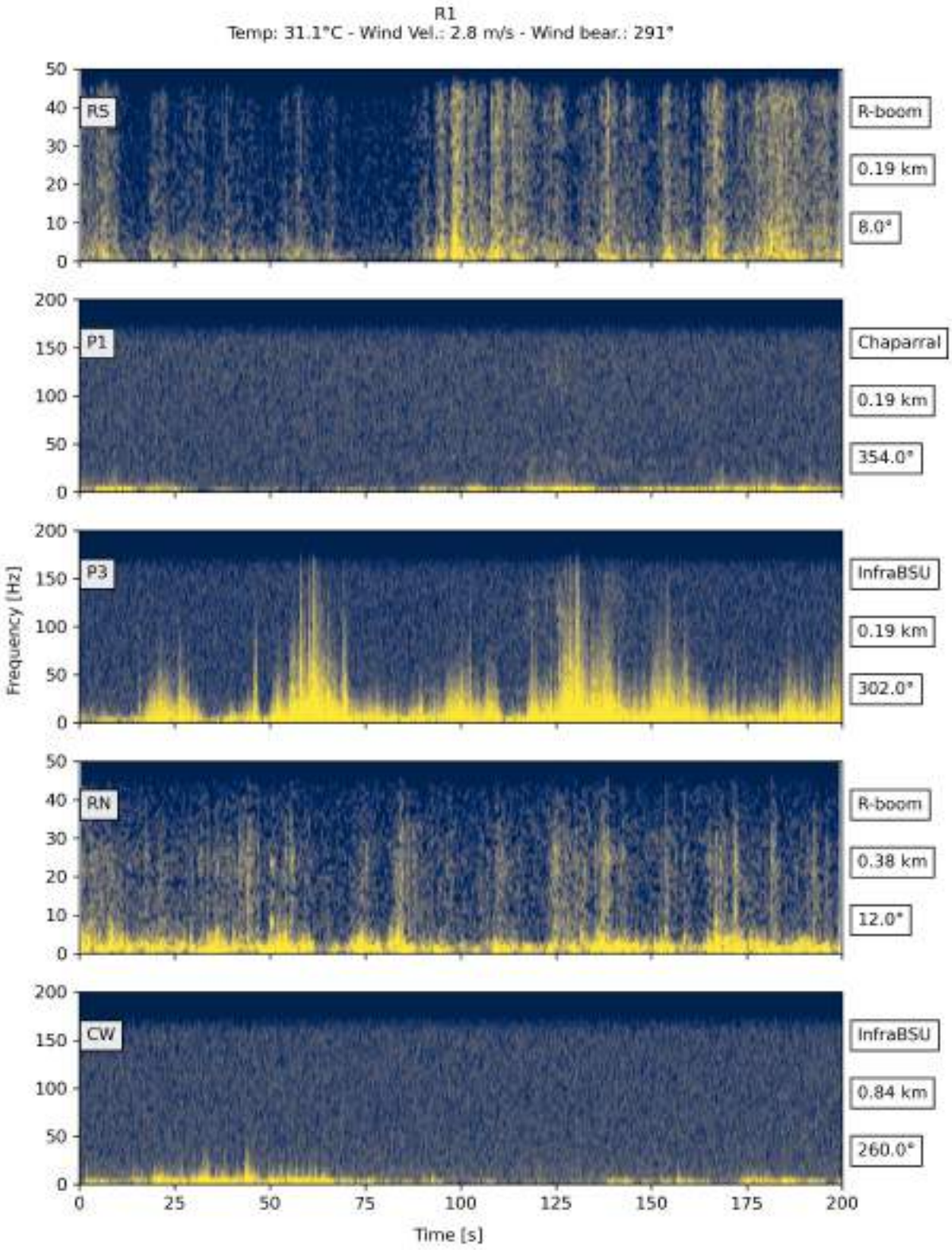

Figure S3. Spectrograms for acoustic data as recorded during Reunion 1, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure. Note that data from stations P5, P7, and P9 are not plotted here due to technical issues with the stations.

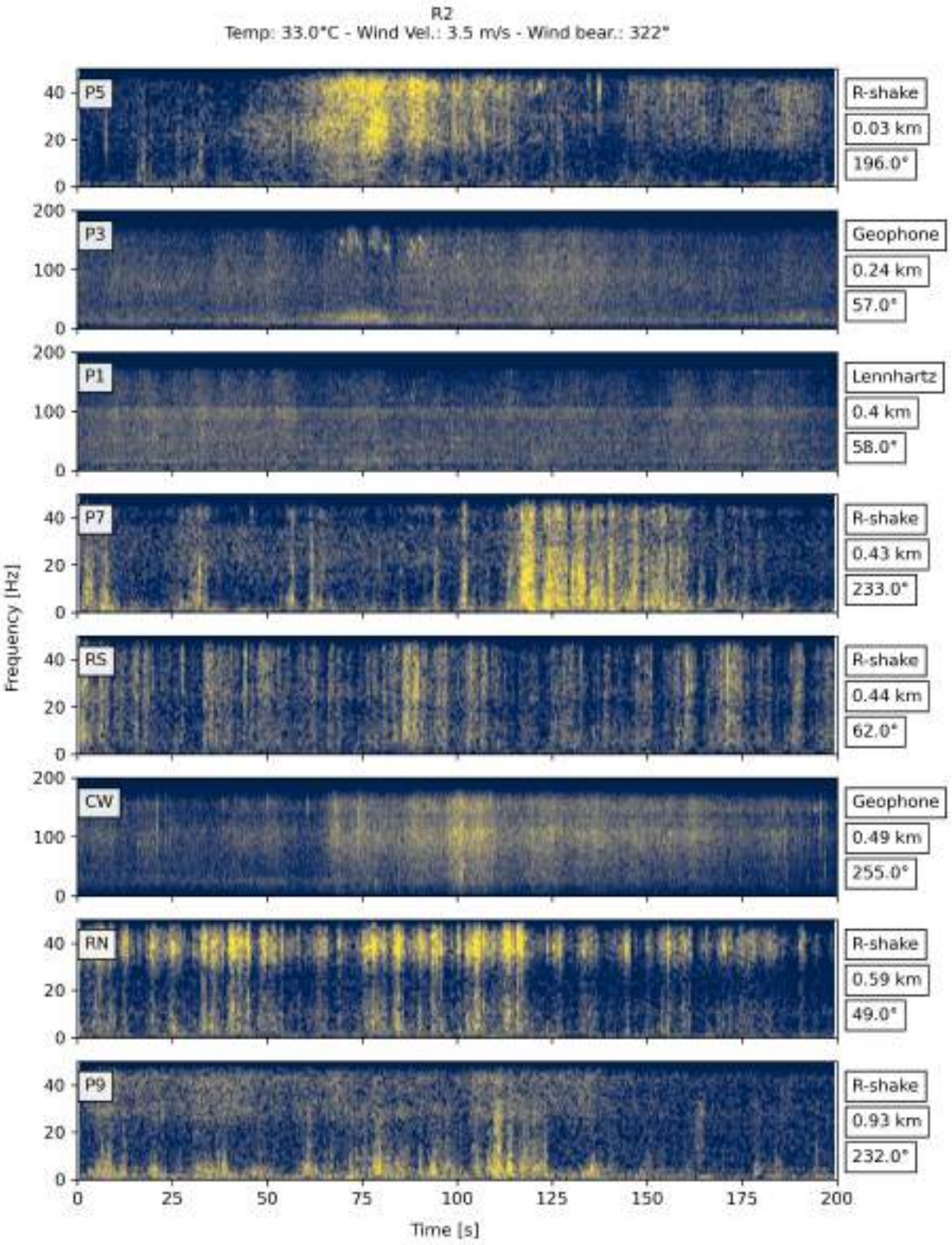

Figure S4. Spectrograms for seismic data as recorded during Reunion 2, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

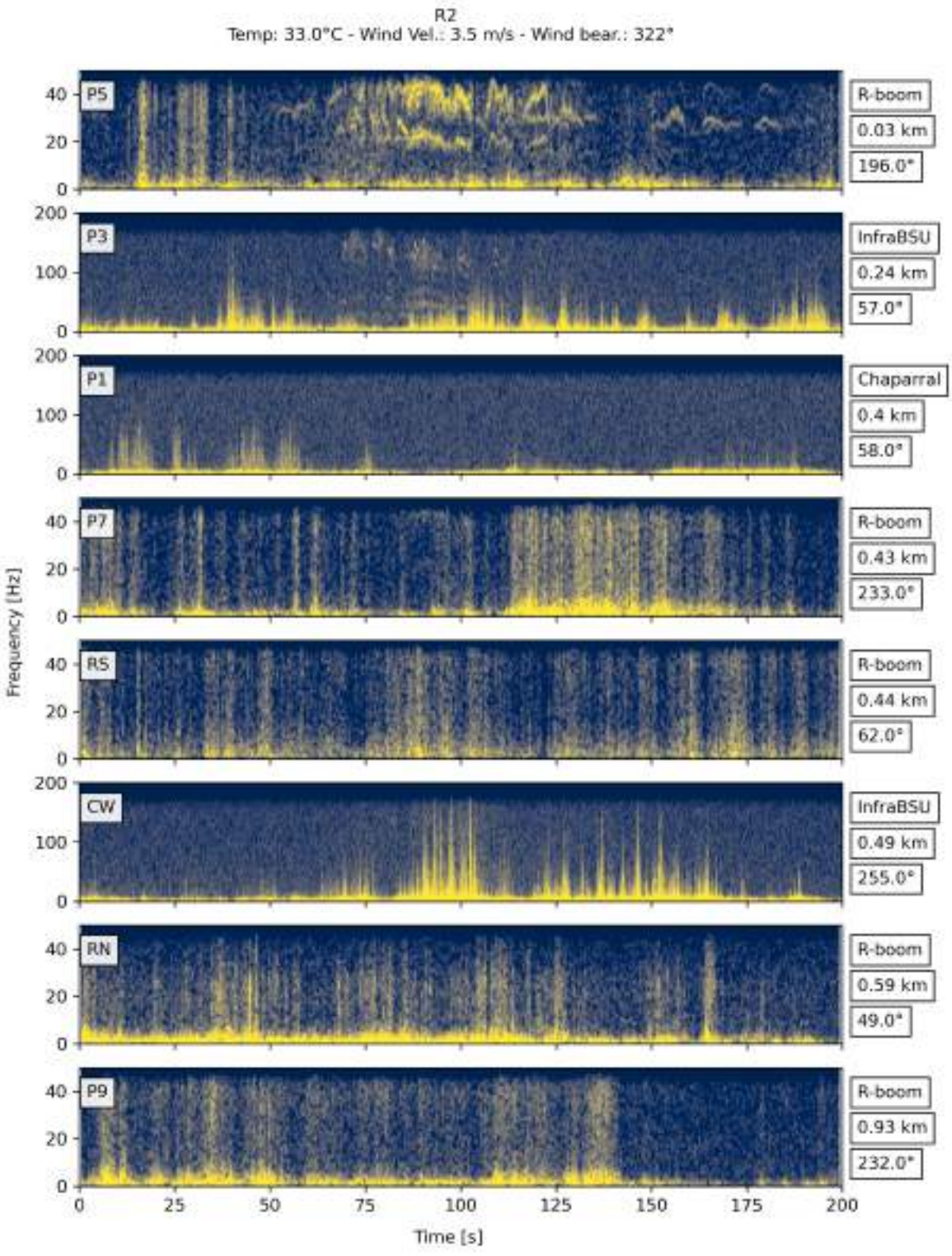

Figure S5. Spectrograms for acoustic data as recorded during Reunion 2, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

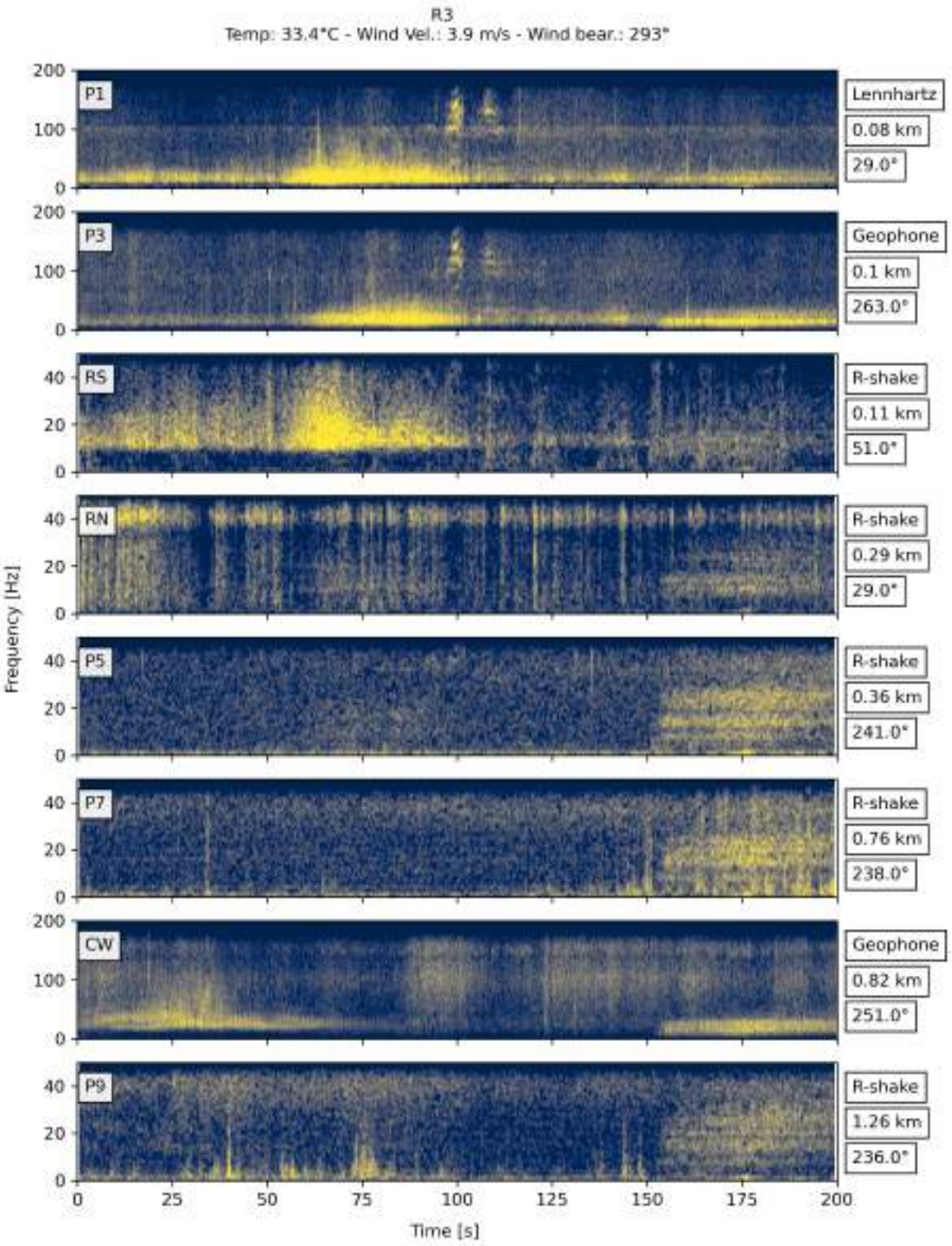

Figure S6. Spectrograms for seismic data as recorded during Reunion 3, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

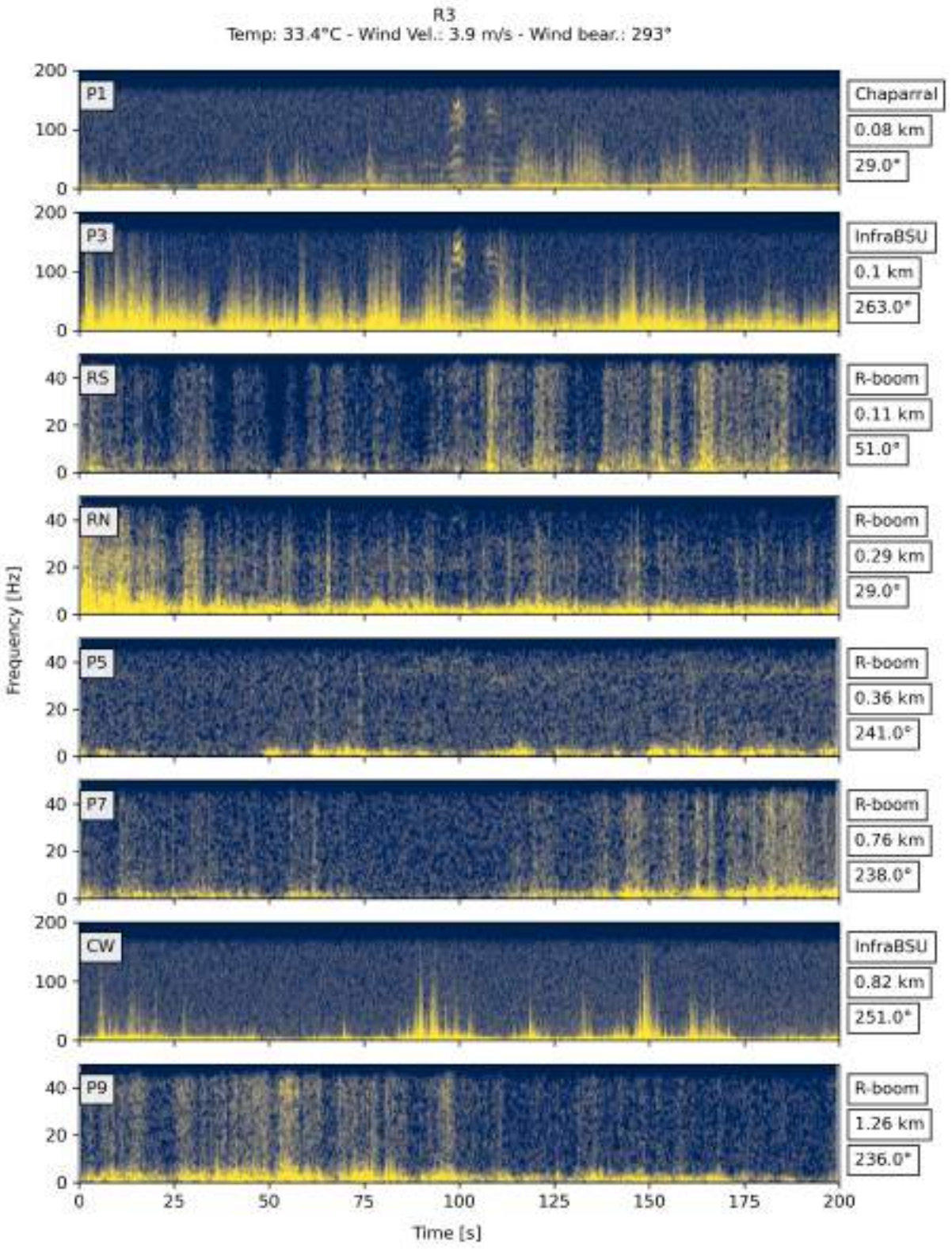

Figure S7. Spectrograms for acoustic data as recorded during Reunion 3, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

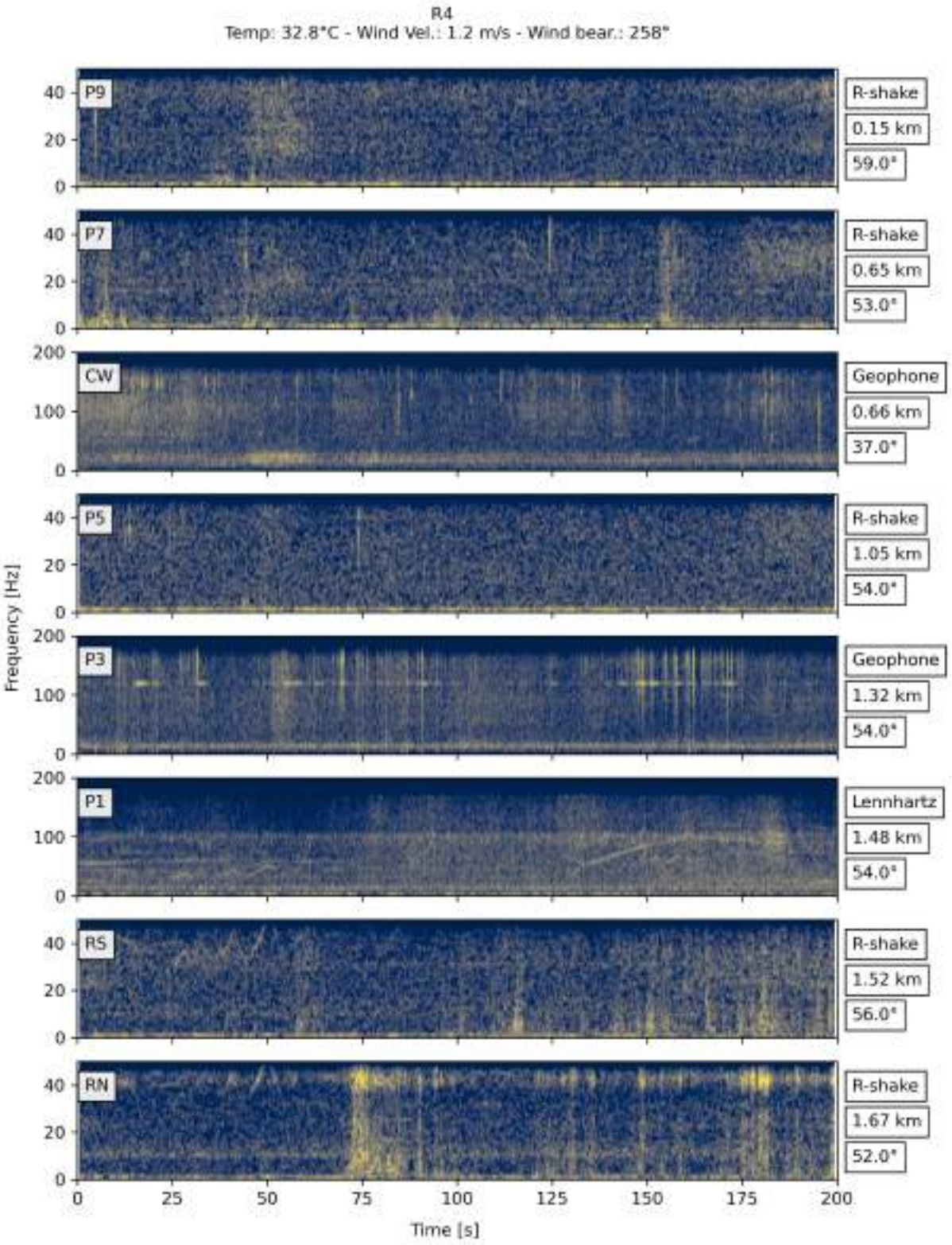

Figure S8. Spectrograms for seismic data as recorded during Reunion 4, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

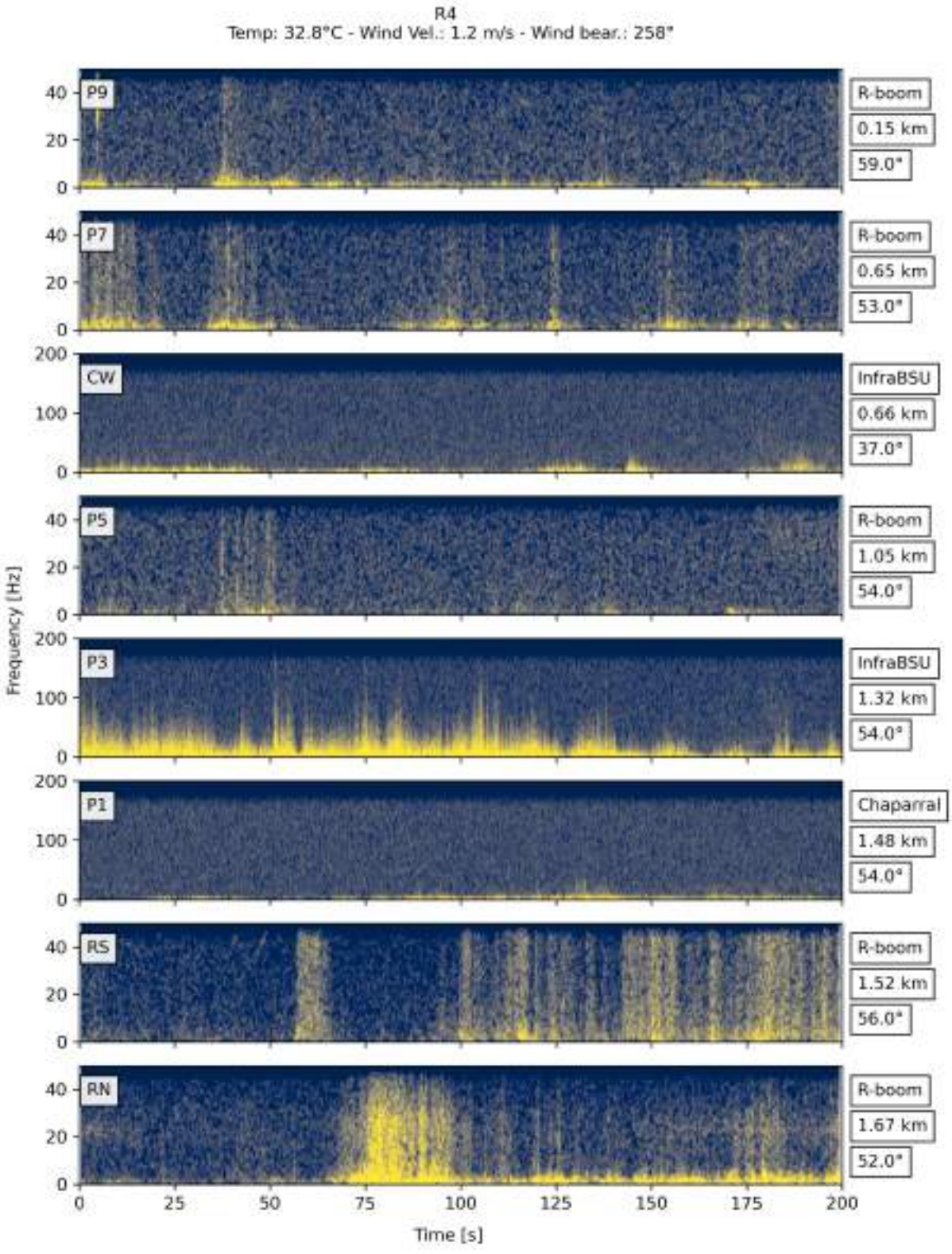

Figure S9. Spectrograms for acoustic data as recorded during Reunion 4, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

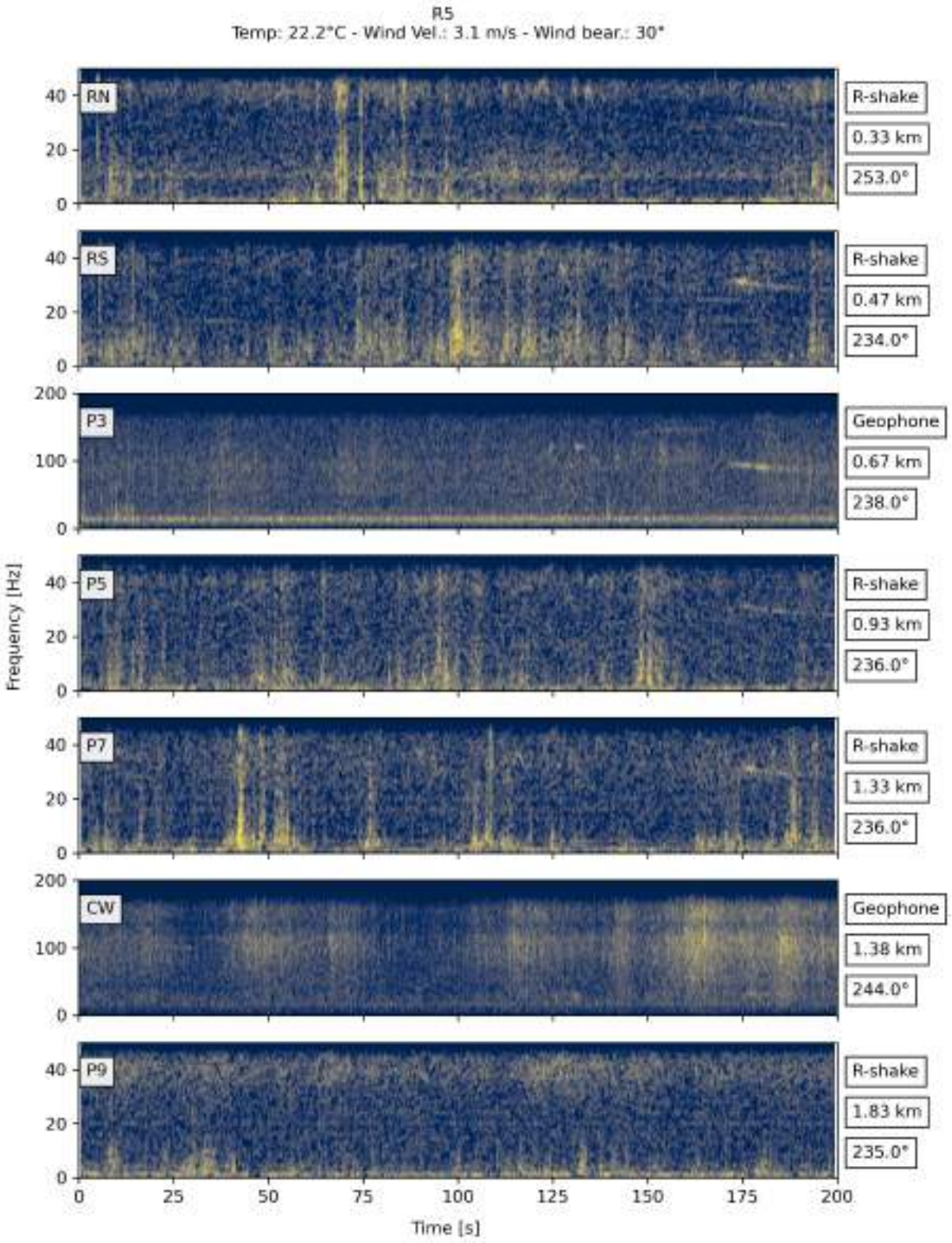

Figure S10. Spectrograms for seismic data as recorded during Reunion 5, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

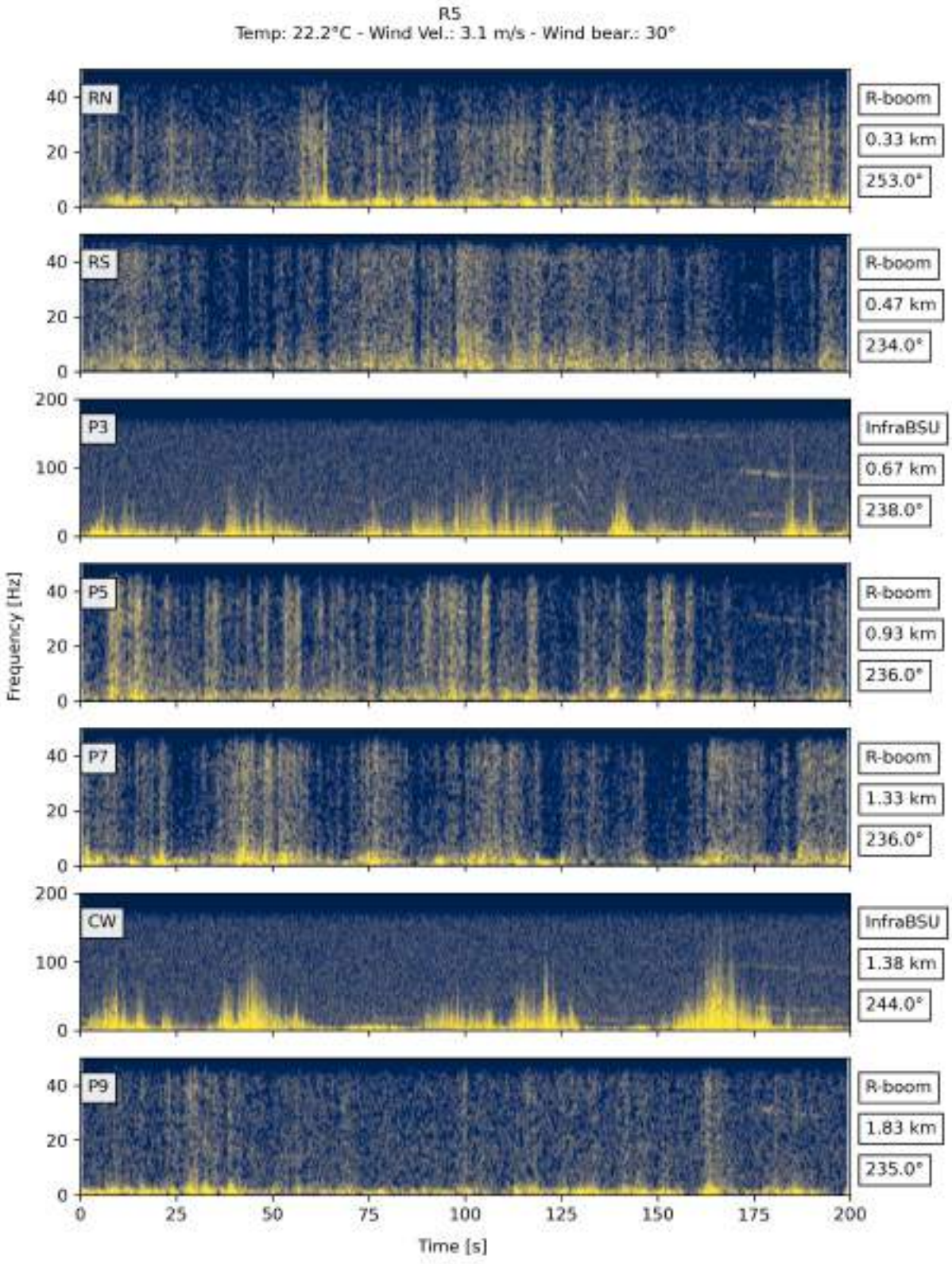

Figure S11. Spectrograms for acoustic data as recorded during Reunion 5, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure. Note that station P1 is not plotted due to technical issues with the microphone.

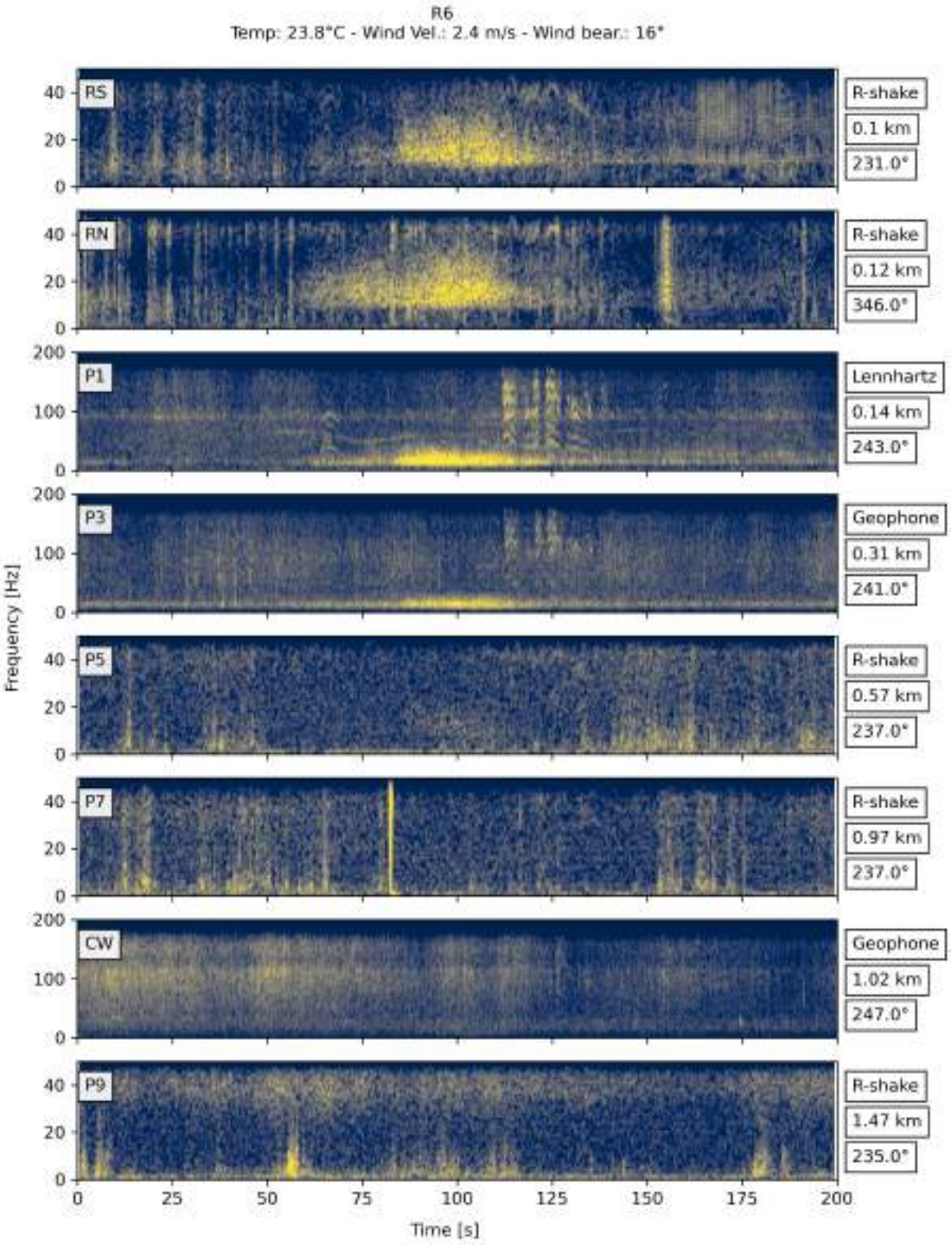

Figure S12. Spectrograms for seismic data as recorded during Reunion 6, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure.

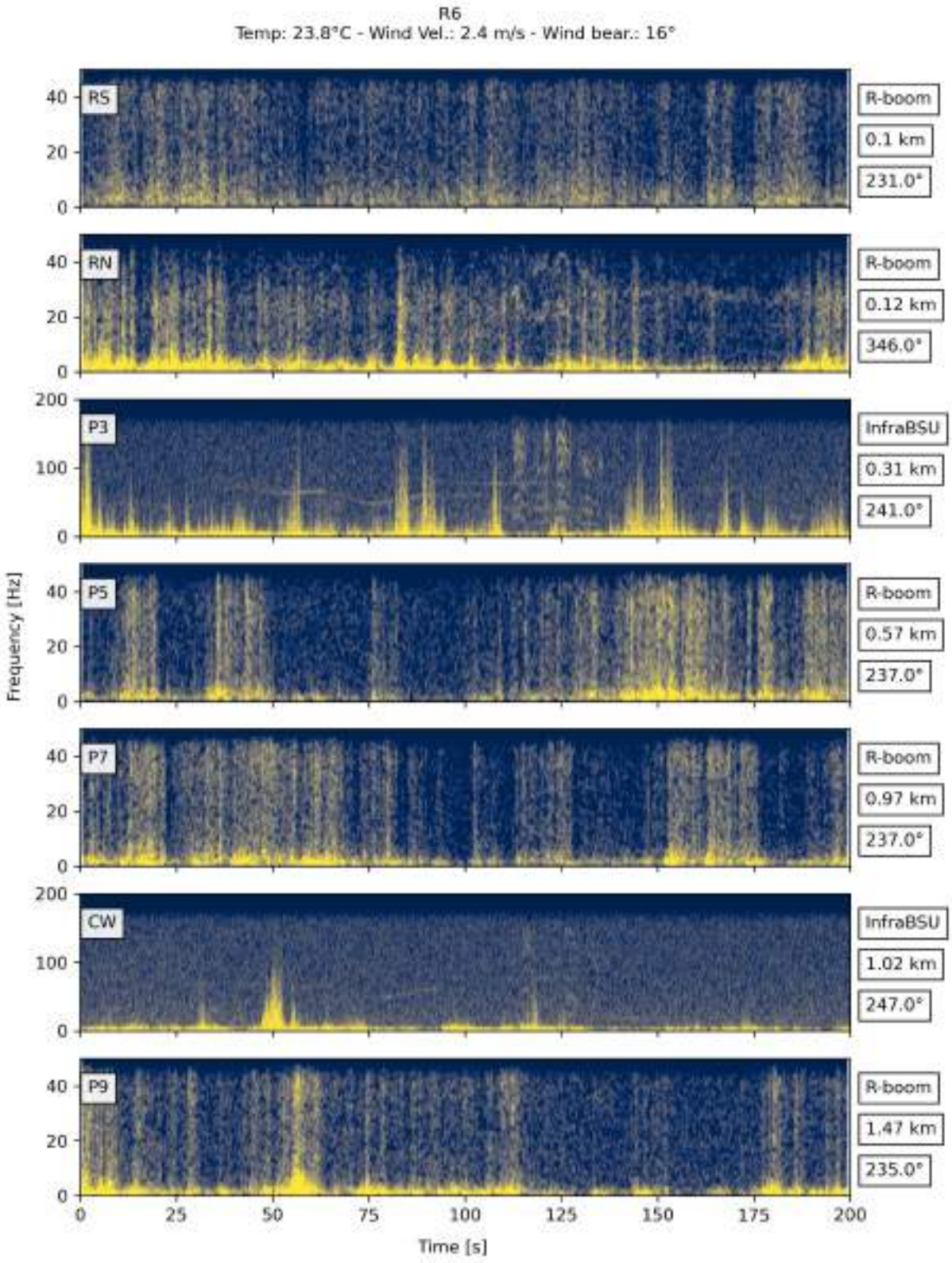

Figure S13. Spectrograms for acoustic data as recorded during Reunion 6, plotted in order of distance of station from the event. Station names are labeled in top left of each panel. Details on the sensor, distance from reunion, and bearing from reunion location to station are labeled by the right side of each panel. Atmospheric temperature and wind conditions are stated at top of figure. Note that station P1 is not plotted due to technical issues with the microphone.

1 TABLES

1.1 Sensor specifications

Table S1. Specifications of the Raspberry Shake and Boom unit and the sensors within.

Unit	
Parameter	**Value**
Dimensions	110x100x65 mm
Weight (approx.)	0.4 kg
Operating temperature	0 - 60 °C (Limited by On Board Computer)
On Board Computer	Wifi-enabled Raspberry Pi 3 Model B
Maximum recording rate	100 samples per second
Storage device	8 Gb micro SD card
Timing	Network Timing Protocol, NTP (default), GPS timing supported
Power supply voltage	5 V DC (2.5 A supply)
Power consumption	Startup: 3.1 W; Run-time: 1.9 W
Cost per unit (2020)	$864.99
Microphone	
Parameter	**Value**
Type	Differential pressure transducer
Bandwidth (estimate)	-3 dB points at 1 - 44 Hz
Clip level (estimate)	$\pm$120 Pa
Geophone	
Parameter	**Value**
Type	Single component 4.5 Hz Ohm vertical Racotech RGI-20DX geophone with electronic extension to $<$1 Hz
Bandwidth (estimate)	-3 dB points at 0.7 - 44 Hz
Clip level (estimate)	21 mm/s peak-to-peak at 0.1 - 44 Hz
Sensitivity (estimate)	3.9965e8 counts/m/s

Table S2. Specifications of the comparison sensors.

Datacube data recorder	
Parameter	**Value**
Dimensions	100x100x83 mm
Weight	0.85 kg
Operating temperature	-20 - 70 °C
Recording rate	50, 100, 200, or 400 samples per second
Storage type	32 Gb SDHC internal memory card
Timing	GPS synchronized free running internal quartz
Power supply voltage	5 - 24 V
Power consumption	120 mW
Cost per unit (2019)	$1,250.00

Lennartz vertical component seismometer	
Parameter	**Value**
Type	Force balance seismometer
Dimensions	85 mm diameter, 55 mm height
Weight (approx.)	1.1 kg
Bandwidth	- 3 dB at 0.1 - 100 Hz
Clip level	± 7 V
Cost per unit (2019)	$1,930,00

RT Clark 4.5 Hz vertical geophone	
Parameter	**Value**
Type	Single component 4.5 Hz vertical geophone
Dimensions	25.4 mm diameter, 33.3 mm height
Weight (approx.)	0.089 kg
Sensitivity	23.4 V/m/s
Cost per unit (2019)	$79.00

InfraBSU 131 infrasound logger	
Parameter	**Value**
Type	Differential pressure transducer
Dimensions	50 mm diameter, 70 mm height
High-pass corner	0.16 - 0.48 Hz
Clip level	±125 Pa
Cost per unit (2019)	$400.00

Chaparral infrasound sensor	
Parameter	**Value**
Type	Differential pressure transducer
Dimensions	95 mm diameter, 43 mm height
Bandwidth	-1 dB points at 0.06 - 200 Hz
Clip level	22 V peak-to-peak, ±11 V max, signal to ground
Cost per unit (2019)	$3,250.00

1.2 Detection results tables

The frequency spectrograms that were used to assess if a reunion was detected are provided in the supplementary materials. Note: Entries marked with * indicate data was not recorded due to technical issues with sensor during the reunion event.

Table S3. Detections of reunion events by acoustic sensors.

Station	Instrument	Reunions					
		R1	R2	R3	R4	R5	R6
RN	R-boom	x	x	x	x	x	✓
RS	R-boom	x	x	x	x	x	x
P1	Chaparral	x	x	✓	x	x*	x*
P3	InfraBSU	x	✓	✓	x	✓	✓
CW	InfraBSU	x	x	x	x	x	✓
P5	R-boom	x*	✓	x	x	x	x
P7	R-boom	x*	x	x	x	x	x
P9	R-boom	x*	x	x	x	x	x

Table S4. Detections of reunion events by seismic sensors.

Station	Instrument	Reunions					
		R1	R2	R3	R4	R5	R6
RN	R-shake	x	x	x	x	✓	✓
RS	R-shake	x	x	x	x	x	✓
P1	Lennhartz	✓	x	✓	x	x	✓
P3	Geophone	x	✓	✓	x	x	✓
CW	Geophone	x	x	x	x	x	x
P5	R-shake	x*	✓	x	x	x	x
P7	R-shake	x*	x	x	x	x	x
P9	R-shake	x*	x	x	x	x	x