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THE OSIRIS-REX SAMPLE RETURN CAPSULE RE-ENTRY: INITIAL RESULTS FROM A HISTORIC GEOPHYSICAL RECORDING CAMPAIGN AGAINST AN 'ARTIFICIAL METEOR'

Elizabeth A. Silber[1], Daniel C. Bowman[1], Siddharth Krishnamoorthy[2], Chris G. Carr[3], Robert A. Haaser[3], Brian Elbing[4], Milton Garcés[5], Charles Langston[6], Jeremy Webster[3], David P. Eisenberg[7], Eric Lam[8], Benjamin Fernando[9], Cleat Zeiler[10], Yasuhiro Nishikawa[11], Richard D. Lewis[12], Luis Ocampo Giraldo[13], Stephen Arrowsmith[14]

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Abstract #: 10713

OVERVIEW

- Artificial and natural objects entering Earth's atmosphere at hypervelocity generate ***powerful acoustic waves***, but well-characterized observations of entries are exceptionally scarce
- Artificial objects arriving from interplanetary space have the parameters well known *a priori*
- Can serve as ideal ***proxies*** for studying meteoric phenomena and are critical for improving global monitoring
- However, only a handful of spacecraft have re-entered from interplanetary space since the end of the Apollo era

OSIRIS-REX SAMPLE RETURN CAPSULE

- The most recent ‘artificial meteor’ was the re-entry of NASA’s OSIRIS-REx sample return capsule (SRC) on September 24, 2023

Image credit: NASA

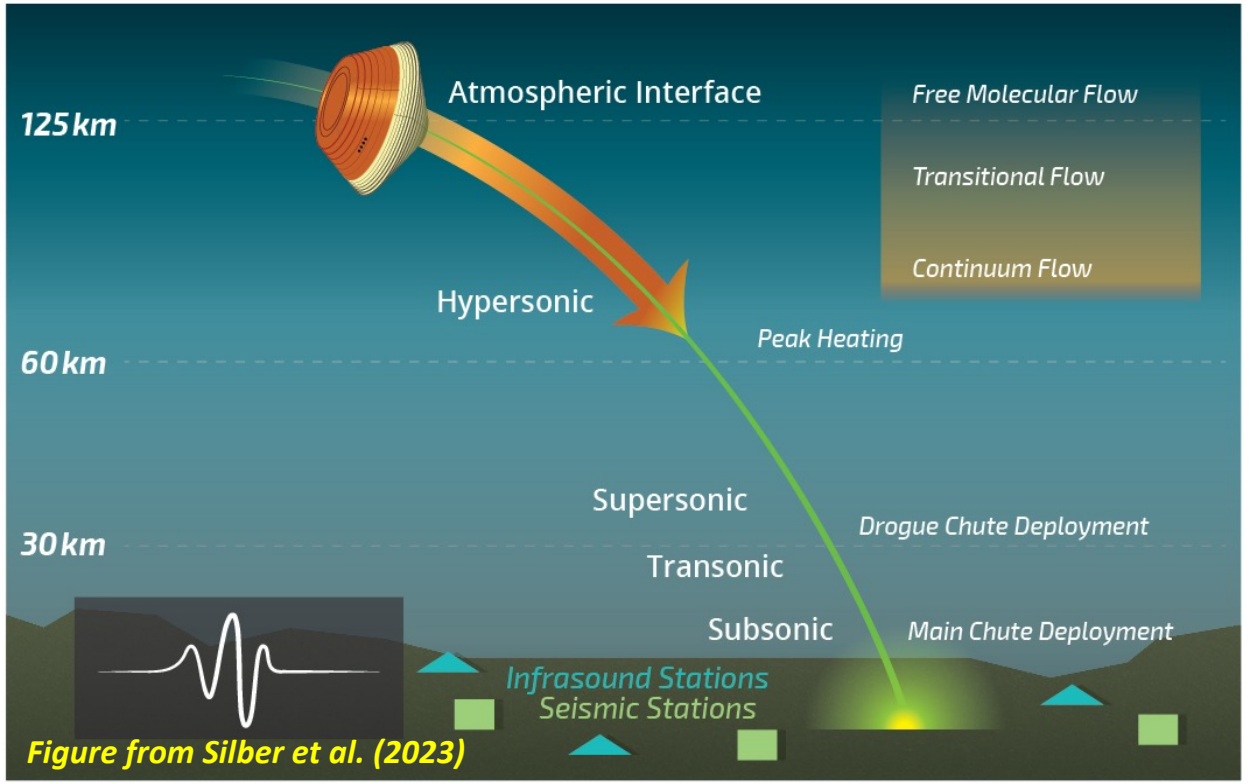
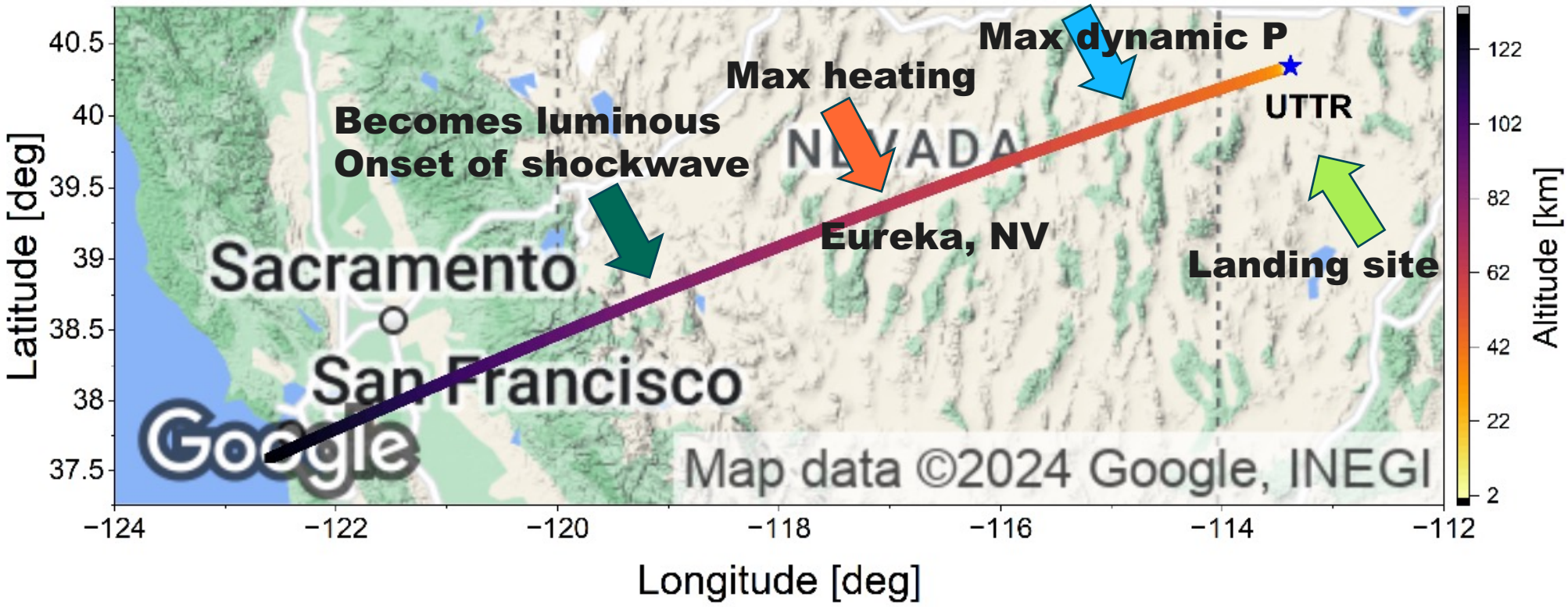
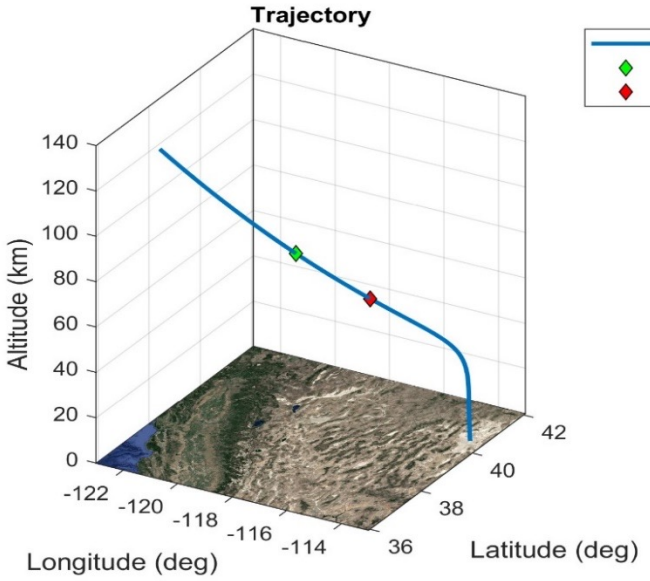
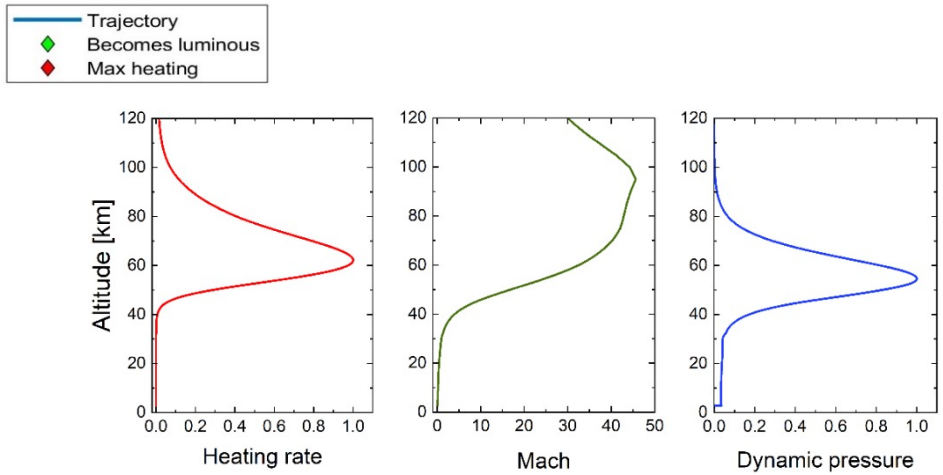


Figure from Silber et al. (2023)

- A multi-institutional effort resulted in the ***largest to-date observational campaign*** to capture ***geophysical signals*** generated by an object as it re-entered the atmosphere from interplanetary space



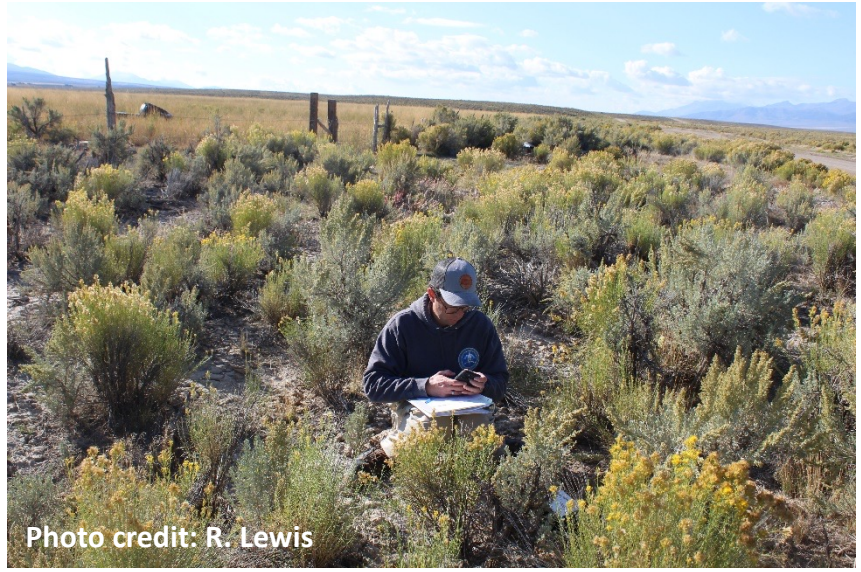




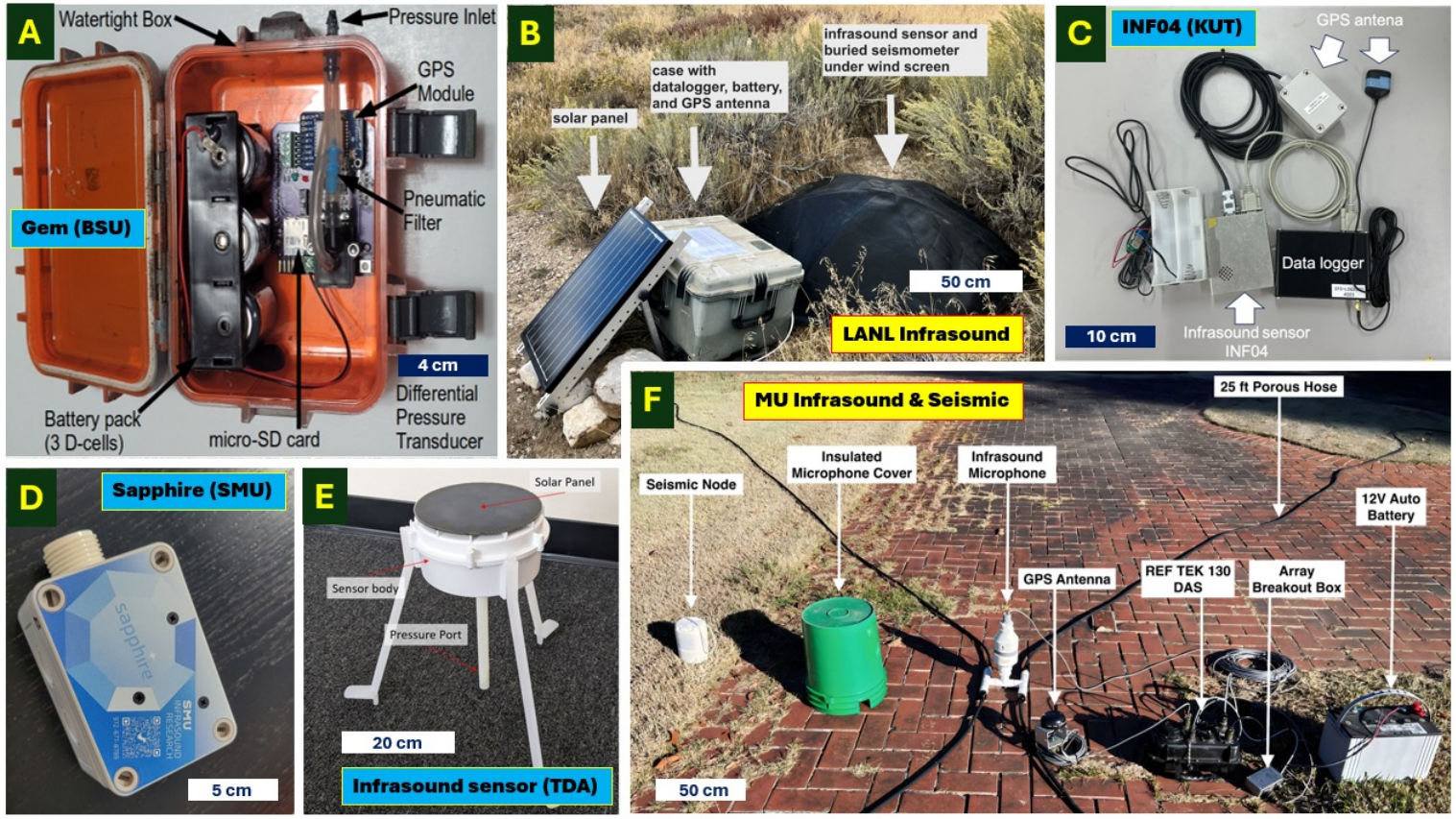
Some considerations

- Signal detection and data collection locations
- Cost considerations
- Instrument synergy and deployment
- Environmental and infrastructure impact
- Personnel allocation
- Timeline and coordination

DEPLOYMENT AND DATA COLLECTION



- Approximately 80 investigators from over a dozen institutions participated in this historical observational campaign
- The sensing modalities included infrasound (ground-based and airborne), acoustic (audible), seismic, DAS, and GPS, deployed in several regions



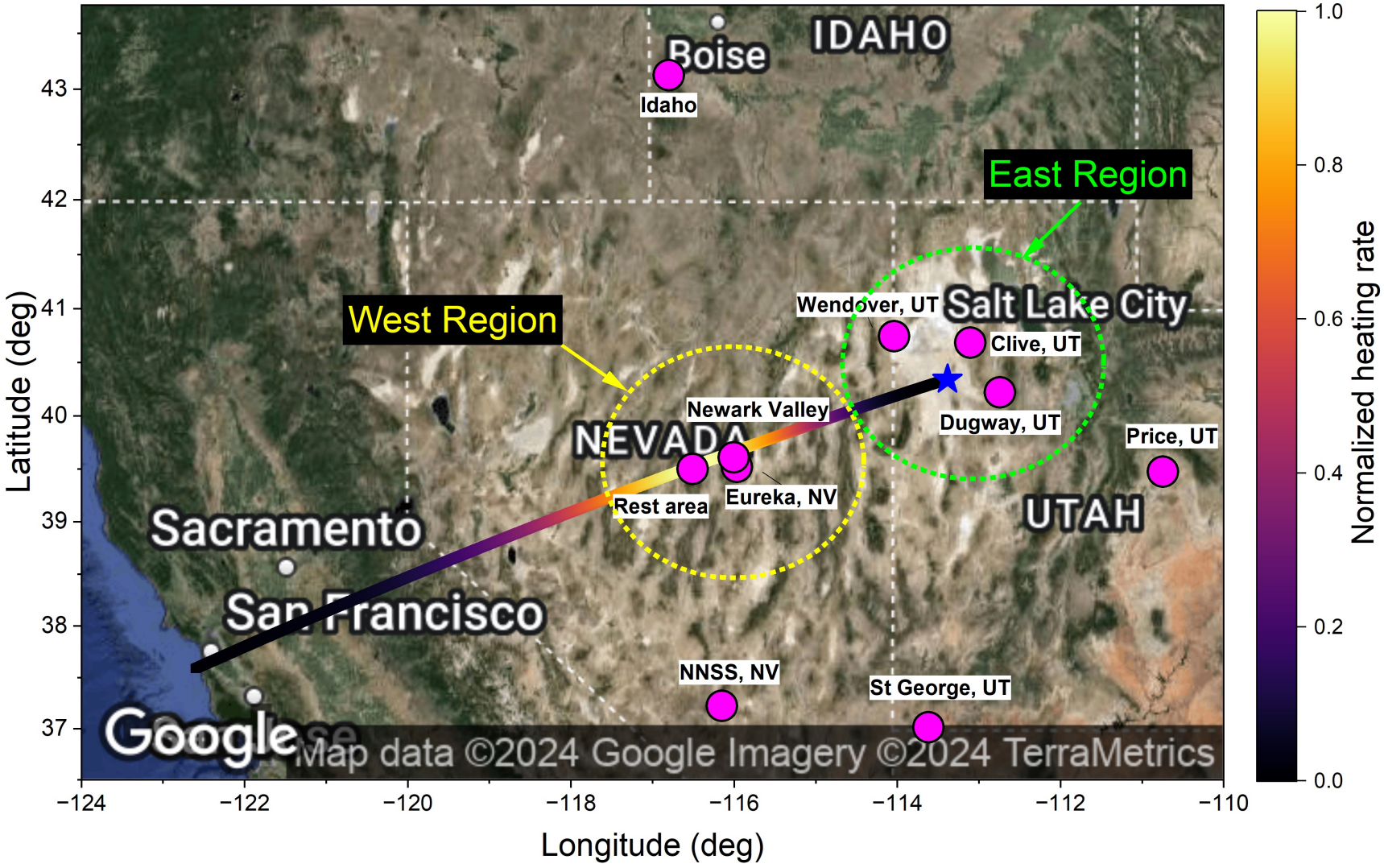
DEPLOYMENT: MULTI-INSTITUTION PARTICIPATION

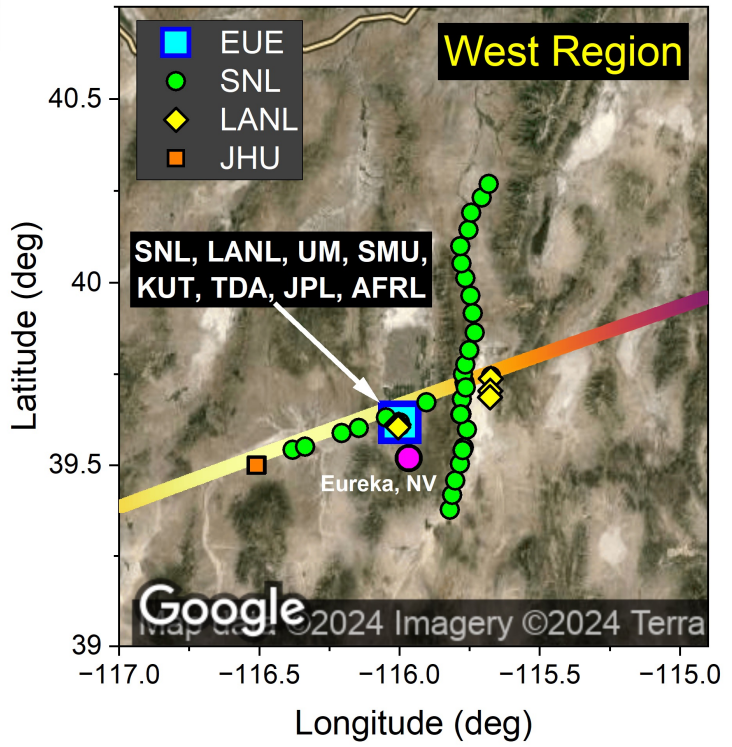
- Sandia National Laboratories (SNL)
- Los Alamos National Laboratory (LANL)
- NASA Jet Propulsion Laboratory (JPL)
- Air Force Research Laboratory (AFRL)
- Atomic Weapons Establishment (AWE) Blacknest
- Boise State University (BSU)
- Defense Threat Reduction Agency (DTRA)
- Idaho National Laboratory (INL)
- Johns Hopkins University (JHU)
- Kochi University of Technology (KUT)
- Nevada National Security Site (NNSS)
- Oklahoma State University (OSU)
- South Methodist University (SMU)
- TDA Research Inc. (TDA)
- University of Hawaii (UH)
- University of Memphis (UM)

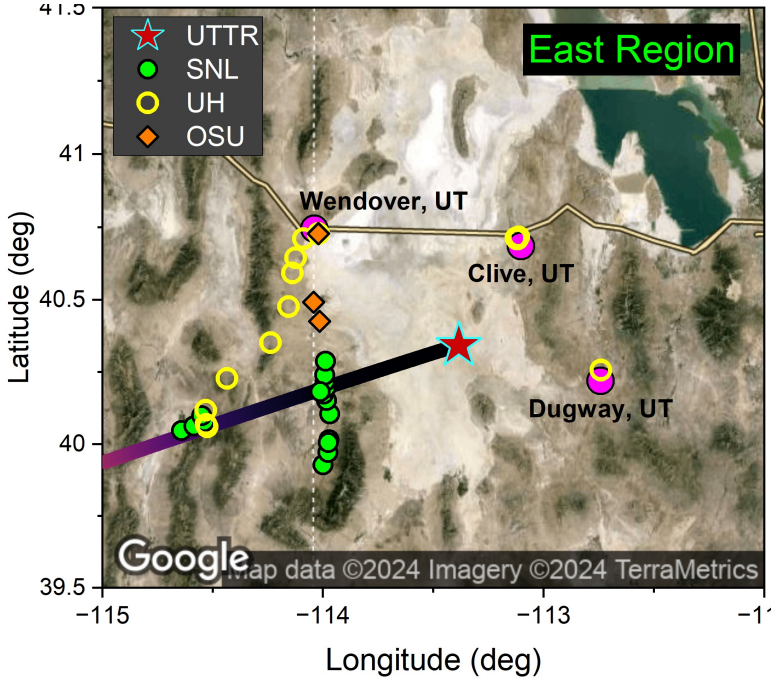
Over 450 instruments deployed

Institution	Infrasound (single sensor station)	Infrasound (array)	Total number of sensors in arrays	Large N-array (number of sensors)	Audible microphone	Smart phone	Seismic	DAS	GPS	Balloons
SNL	47	3 (x4)	12	-	-	2	19	-	-	6
LANL	6	2 (x4) + 1 (x6)	14	-	1	1	6	2	5	
AWE	-	1 (x4)	4	-	-	-	-	-	-	
BSU	-	3 (x4), 1 (x44)	56	-	-	-	-	-	-	
JHU	-	-	-	-	-	-	11	-	-	
JPL	-	-	-	-	-	-	-	-	-	2
KUT	-	1 (x4)	4	-	5	-	-	-	-	
OSU	12	1 (x4)	4	-	-	-	-	-	-	
SMU	-	1 (x4)	4	-	-	-	-	-	-	
TDA	-			114	-	-	-	-	-	
UH, AFRL, INL	-	-	-	-	-	33	-	-	-	
UM	-	2 (x4)	8	-	-	-	20+96	-	-	
	65	**16**	**106**	**114**	**6**	**36**	**56**	**2**	**5**	**8**

West Region			East Region		Distal stations
Eureka Airport	Newark Valley	Bean Flat Rest Area	West Wendover Airport	NV/UT	
SNL, LANL, UM, SMU, KUT, TDA, JPL, AFRL	SNL, LANL	JHU	OSU, UH	UH, AFRL, INL	LANL, AWE, BSU, NNSS







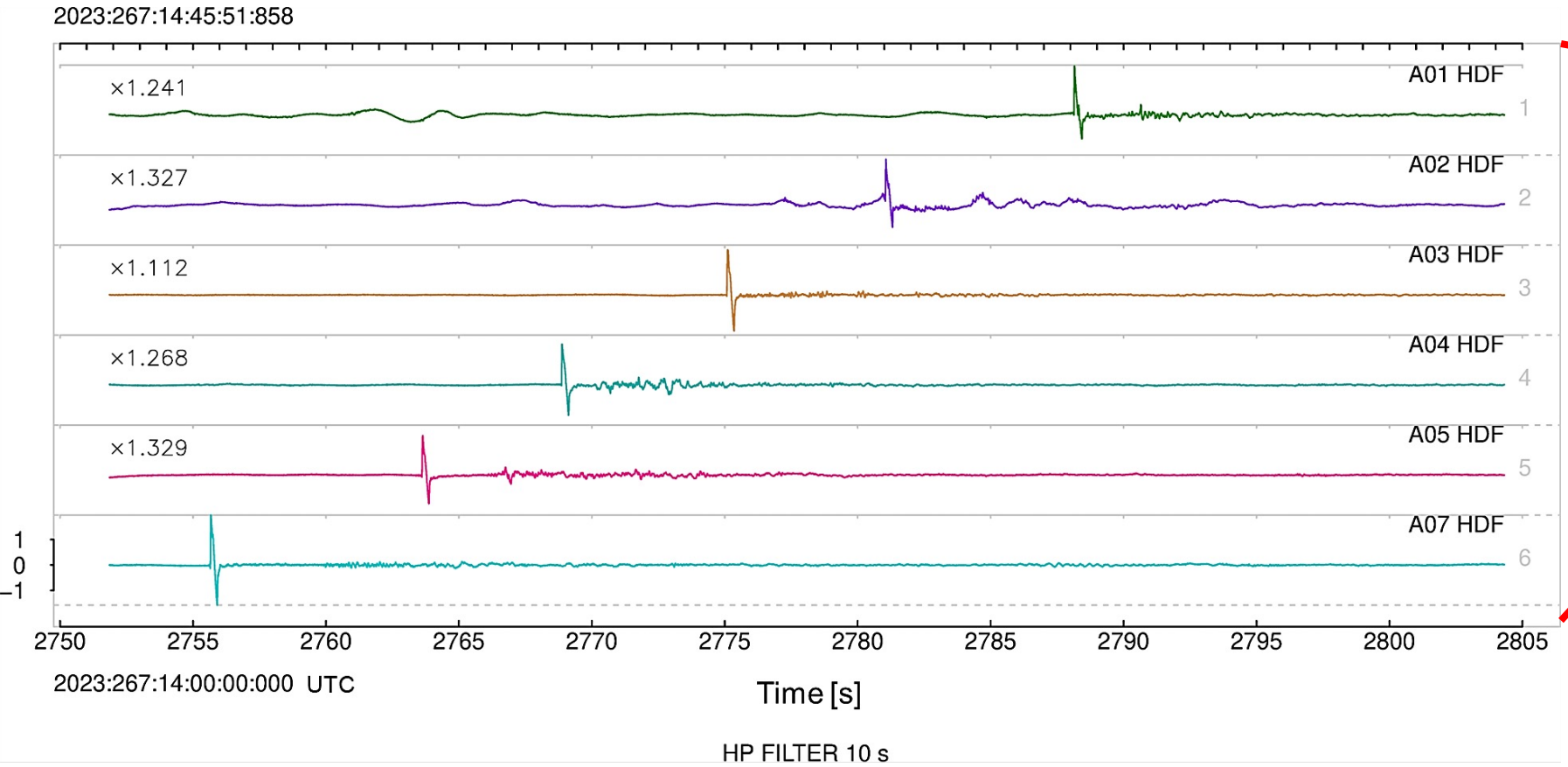
OSIRIS-REX RE-ENTRY

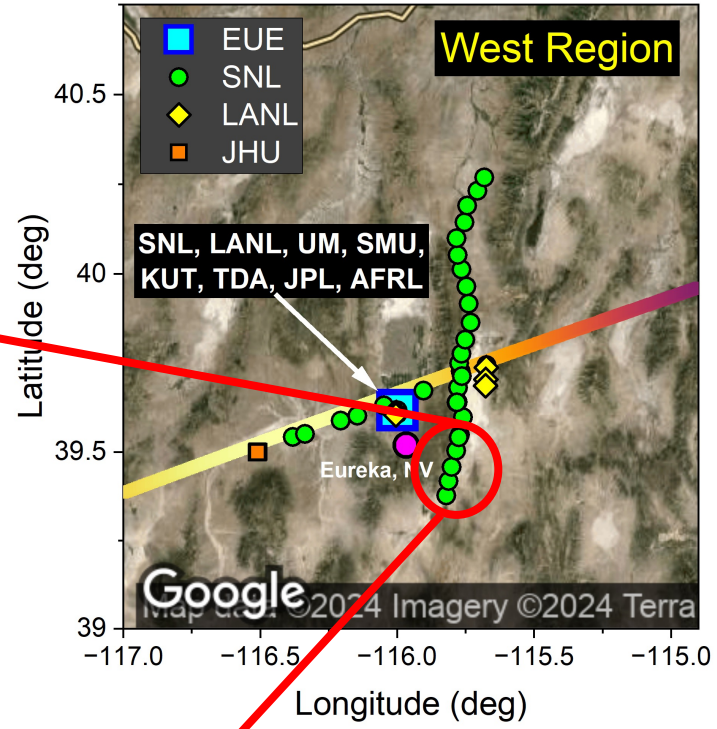
- Overflight was at 07:42 am local time
- Calm day, clear skies
- Teams in all regions heard audible sounds heard (single and double “thud”)
- All operational instruments detected signals

Photos credit: R. Lewis

PRELIMINARY RESULTS: WEST REGION

Sandia National Labs
POC: E. Silber and D. Bowman

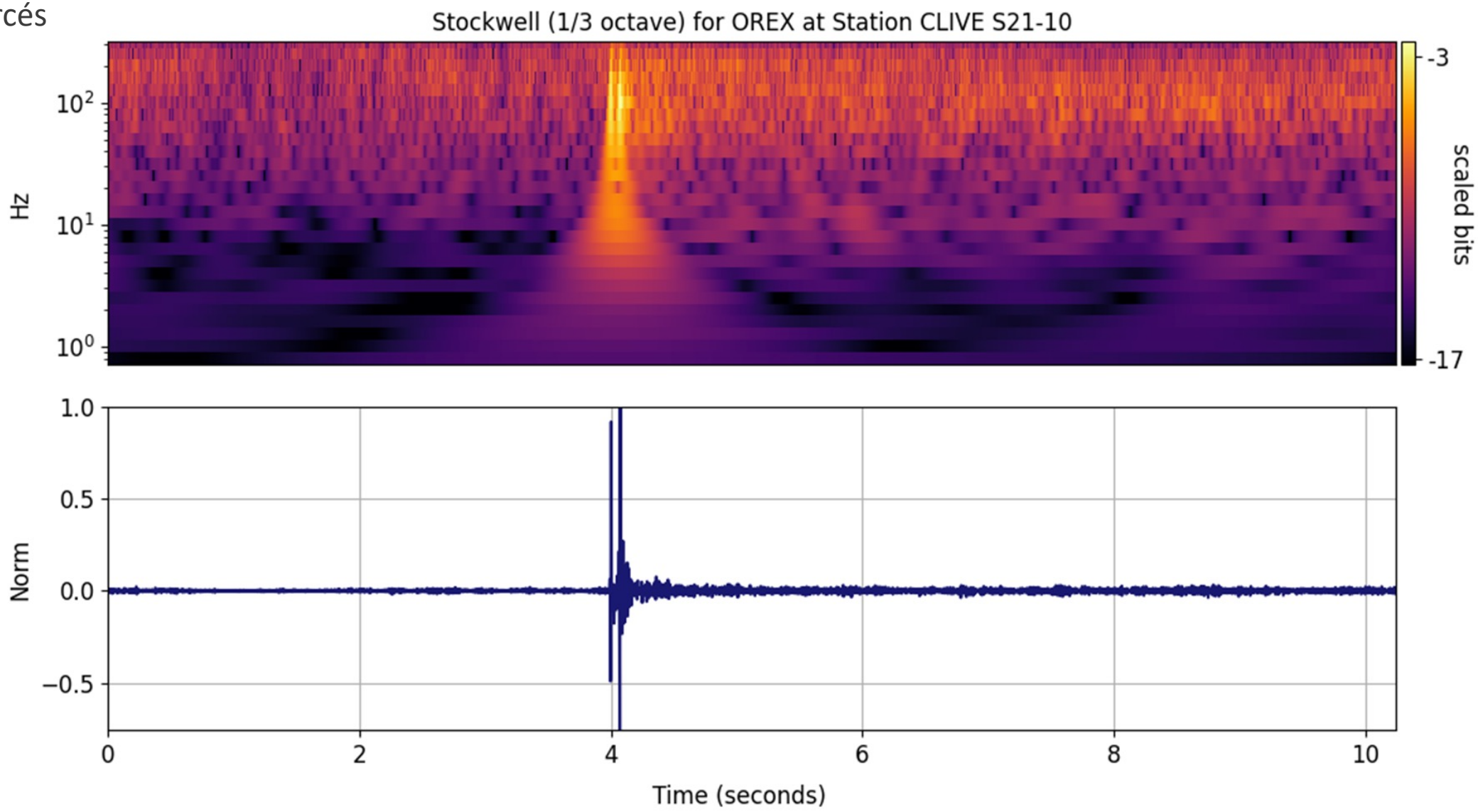




An N-wave with some coda was detected at all operational single sensor stations

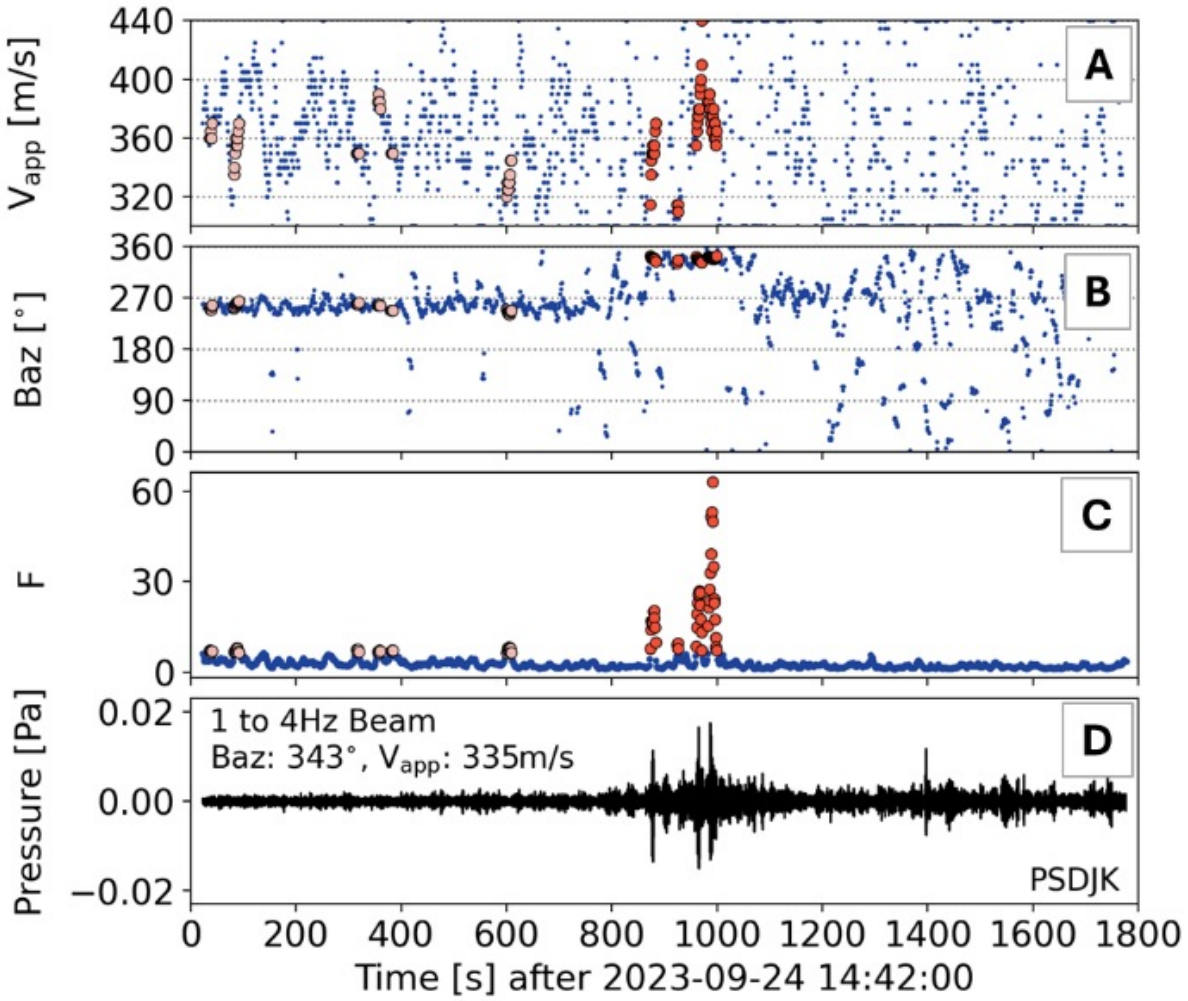
PRELIMINARY RESULTS: EAST REGION

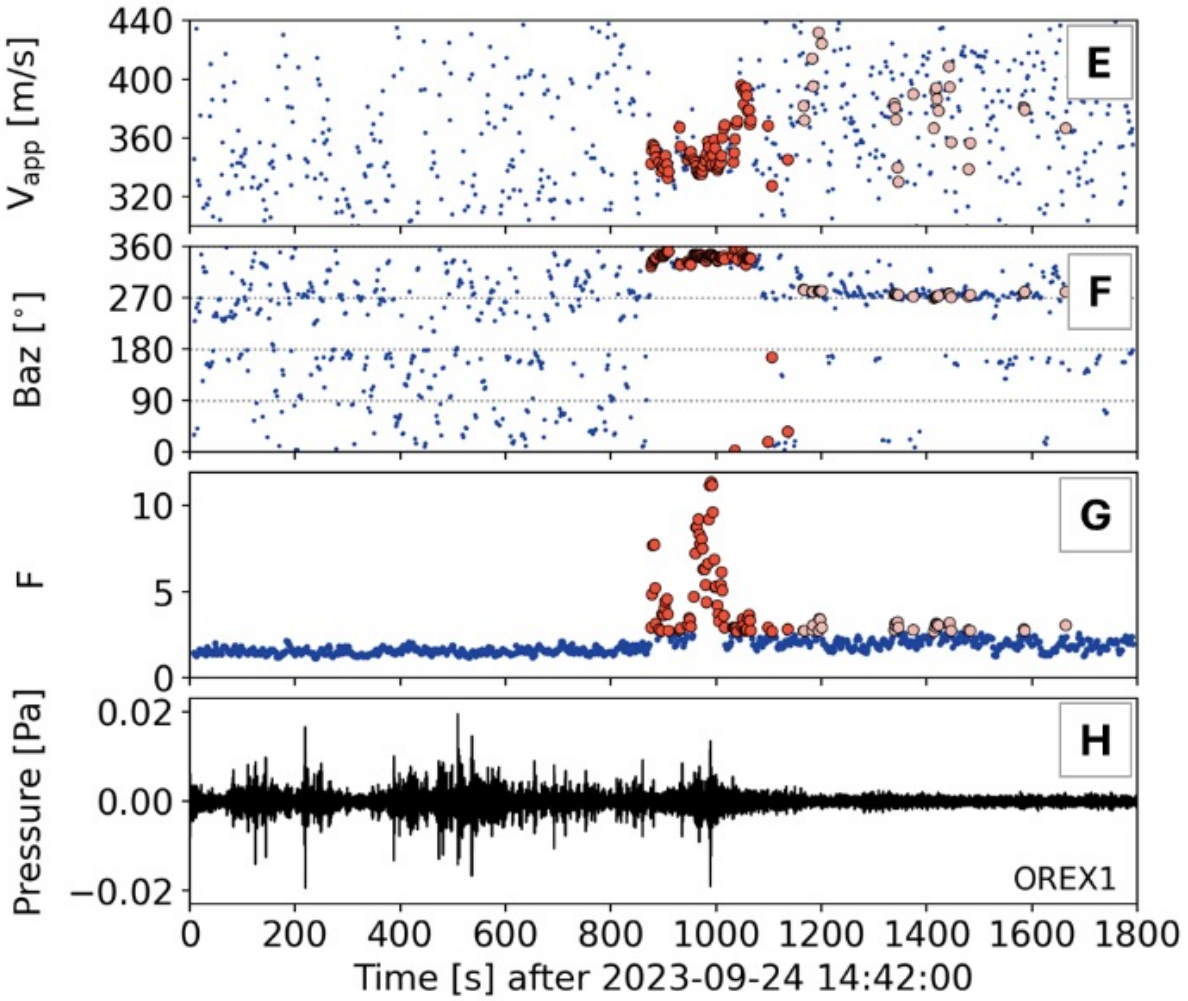
University of Hawaii and RedVox team
POC: M. Garcés



PRELIMINARY RESULTS: DISTAL STATIONS

Los Alamos National Lab and AWE Blacknest
POC: J. Webster





CONCLUSIONS

- The observational campaign was very successful
- We detected strong infrasound signals at nearly all sensors in NV and UT
- The results have implications for future observational efforts on Earth as well as capturing shockwave signatures on other planetary bodies with atmospheres (e.g., Mars, Titan, Venus)

Photos credit: R. Lewis

SPECIAL THANKS

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THANK YOU!