PROGRESS TOWARDS BALLOON-BASED SEISMOLOGY ON VENUS IN 2019-2020. S. Krishnamoorthy[1], A. Komjathy[1], M. T. Pauken[1], J. A. Cutts[1], D. C. Bowman[2], Q. Brissaud[3,4], J. M. Jackson[3], L. Martire[5], Y. Chaigneau[5], R. F. Garcia[5], D. Mimoun[5], and J. Izraelevitz[1]
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Introduction: Adverse conditions on the surface of Venus have thus far prevented long-duration seismic studies. While Mars has hosted a fleet of rovers on the surface and the InSight lander has studied the interior of Mars for nearly two years, a similar experiment on Venus is decades away. In this presentation, we will explore the possibility of performing planetary science on Venus using infrasound (pressure waves with frequencies less than 20 Hz) as a remote sensing tool and discuss the progress our group has made in the last year.

Infrasound and Atmospheric Remote Sensing: Infrasound has been recorded from a variety of events on Earth. Of particular interest to Venus exploration are infrasound signals from quakes, volcanic eruptions, thunderstorms, and meteors. Venus offers a unique opportunity for the use of infrasound as an investigative tool for surface ground motion – due to its dense atmosphere, energy from seismic activity couples with the Venusian atmosphere up to 60 times more efficiently than Earth. As a result, infrasound waves from Venusquakes are expected to be an almost exact replica of ground motion. Infrasound is also known to propagate long distances from generating events with relatively little attenuation, thereby making it an effective alternative to placing sensors on the surface of Venus. Lastly, acoustic sensors used to capture infrasound may also be used to investigate low-frequency, large-scale planetary atmospheric features such as planetary-scale gravity waves, which have recently been observed by JAXA's Akatsuki mission.

Balloon-based Infrasound Detections on Venus: The main advantage of performing balloon-based infrasound science on Venus is the extension of mission lifetimes by virtue of being in a more benign environment. Compared to 460 C temperature and 90 atmospheres pressure on the surface, atmospheric conditions are more Earth-like at 55-60 km altitude on Venus. Further, acoustic sensors greatly benefit from being on a platform that floats with the wind, leading to higher coverage and lower wind noise. Krishnamoorthy et al. recently showed that acoustic waves from artificially generated seismic signals can be detected from balloons, show the same spectral character as epicentral ground motion, and can be utilized to geolocate seismic activity by using an array of airborne barometers. From a scientific perspective, there are also several challenges with performing such an experiment. Signals are often weak compared to the noisy background. Multi-channel correlation is difficult, since balloon platforms have payload restrictions and cannot feasibly support a large number of instruments. In the presence of a variety of infrasound-generating events, source discrimination and localization also represent challenges that need to be overcome. However, measurements made for infrasound source discrimination can also contribute to high priority VEXAG atmospheric science goals.

Recent Progress: Our team has been involved in a campaign to use the Earth's atmosphere as an analog testbed for Venus to demonstrate the feasibility of balloon-based infrasound science on Venus and address the challenges associated with it.

In this presentation, we will share a progress report using results from multiple flight tests and simulation studies in the past year, which include the deployment of tethered balloons near buried chemical explosions in Glanes, France, solar balloon overflights of the aftershocks in the Ridgecrest, CA area in the aftermath of the July 2019 earthquakes, and the development of an integrated infrasound sensor for future Venus balloon application. Further, we will discuss our preparation for our summer 2021 flight campaign in Oklahoma for the detection of infrasound from natural seismic activity from the stratosphere. The success of this remote sensing technique can greatly accelerate the study of Venus' interior by circumventing the need to use high-temperature electronics.