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Exploring the interior structure of Venus with balloons and satellites

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Although present daily in our sky as the brightest object at dusk and dawn, many characteristics of Venus remains a mystery. Its dense atmosphere hides the surface from orbital viewing, and the extreme conditions experienced at its surface (460°C, almost 100 bar of pressure at the surface) pose a formidable challenge to the sustained survival and operation of planetary landers. Despite their sharply contrasting atmospheres, Venus is not very different from Earth in size, its composition should be very similar, its orbit is very close to be circular and it is only a little closer to the Sun (0.7 A.U). So what are the processes that turned the twin sister of our planet into such a different object? And how can we better understand the processes that have shaped the terrestrial planets, and to understand their formation history?

With its harsh surface environment, conventional seismology on Venus, requiring seismometers to be deployed at the surface for months or even years seems impractical. In June 2014, the Keck Institute for Space Studies (KISS) at the California Institute of Technology sponsored a one-week workshop with 30 specialists in the key techniques and technologies relevant to investigating Venus's interior structure focusing on alternative approaches to seismology .

As the vertical component of surface motion on Venus is very efficiently coupled into the atmosphere as infrasonic waves, especially at low frequency, several alternative approaches to detecting seismic events can be considered. Seismo-acoustic waves propagate upwards producing pressure fluctuations in the middle atmosphere of Venus and the seismic wave energy is ultimately dissipated by local heating, ionospheric perturbation, or airglow. These atmospheric perturbations can therefore be recorded either in-situ (with a barometer network, deployed on balloons floating in the cloud layer near 55 km) or remotely via optical imaging or electromagnetic sounding deployed on a spacecraft. A report, describing the findings of a workshop, sponsored by the Keck Institute of Space Studies (KISS), concludes that seismic investigations can be successfully conducted from all three vantage points – surface, middle atmosphere and space; these three vantage points being complementary in the information they provide.

These novel techniques open a new window for the exploration of the interior structure of Venus, and enables a roadmap leading to a dedicated geophysical mission to our sister planet.