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Investigating the Concept of Using Airglow Measurements to Detect Seismicity on Venus

Balthasar Kenda (1,2), Philippe Lognonné (1), Attila Komjathy (2), Bruce Banerdt (2), Jim Cutts (2), Lauriane Soret (3), and Jennifer Jackson (4)

(1) Institut de Physique du Globe de Paris, Paris, France (kenda@ipgp.fr), (2) Jet Propulsion Laboratory, (3) Laboratoire de Physique Atmosphérique et Planétaire - Université de Liège , (4) California Institute of Technology

The internal structure and dynamics of Venus are poorly constrained by observations. Seismology is among the best candidates for probing the interior of the planet, and it would also provide indispensable information about the present-day tectonic activity of Venus. However, due to the extreme surface temperatures, a long-duration seismic station seems to be beyond the technical capabilities achievable today. Nonetheless, the thick and dense atmosphere, which strongly couples with the ground, gives rise to the attractive option of detecting seismic waves from quakes within the atmosphere itself (Garcia et al., 2005, Lognonné and Johnson, 2007, 2015) using in-situ or remote-sensing measurements (Cutts et al., 2015).

Here, we consider the bright airglow emission of O_2 at 1.27 μm on the nightside of Venus and we model the intensity fluctuations induced by Venus quakes. Synthetic seismograms in the airglow layer, at 90-120 km altitude, are computed using normal-mode summation for a fully coupled solid planet-atmosphere system, including the effects of molecular relaxation of CO_2 and a radiative boundary condition at the top of the atmosphere (Lognonné et al., 2016). The corresponding variations in the volumetric emission rate, calculated for realistic background intensities of the airglow (Soret et al., 2012), are then vertically integrated to reproduce the signals that would be seen from orbit. The noise level of existing airglow cameras suggests that the Rayleigh waves generated by quakes of magnitude 5 and above occurring on the nightside of the planet may be detectable up to about 60° in epicentral distance. A significant advantage of this technique is that a single orbiting camera may be sufficient to serve the role of a seismic network. By identifying and tracking the waves it is indeed possible to locate the source, estimate the magnitude and measure the horizontal surface-wave propagation velocities on Venus. In particular, it is expected that this would significantly constrain seismicity on Venus and, through the analysis of Rayleigh-wave dispersion, the structure of the crust and upper mantle.