Geophysical Research Abstracts
Vol. 20, EGU2018-14049, 2018
EGU General Assembly 2018
© Author(s) 2018. CC Attribution 4.0 license.

Modelling whistler wave propagation of signals produced by hypothetical lightning in Venus: Comparison with observations by PVO and VEX

Francisco J. Pérez-Invernón (1), Nikolai G. Lehtinen (2), Francisco J. Gordillo-Vázquez (3), and Alejandro Luque (4)

(1) Instituto de Astrofísica de Andalucía (IAA-CSIC), Solar System, Granada, Spain (fjpi@iaa.es)., (2) Birkeland Center for Space Science, Institute of Physics and Technology, University of Bergen, Norway (Nikolai.Lehtinen@uib.no)., (3) Instituto de Astrofísica de Andalucía (IAA-CSIC), Solar System, Granada, Spain (vazquez@iaa.es)., (4) Instituto de Astrofísica de Andalucía (IAA-CSIC), Solar System, Granada, Spain (aluque@iaa.es).

The existence of lightning in the Venusian atmosphere has been widely discussed in the last decades. The Pioneer Venus Orbiter (PVO) and the Venus Express (VEX) spacecraft reported some of the most convincing evidence of their existence. The recorded signals were identified as whistler waves, circularly polarized waves usually related with lightning in the Earth. According to measurements of these spacecraft, these signals propagated from the source to the detectors through the so-called “ionospheric holes”. These structures are ionospheric regions with a background magnetic field where the electron density is reduced as a consequence of the solar winds. This low density of charged particles could favor the propagation of electromagnetic waves. However, some authors claimed that these signals could also be produced by ionospheric processes, probably related with the interaction between the atmosphere and the solar wind [1].

We have adapted the Full Wave Method (FWM), developed in [2], to the case of the Venusian ionosphere. This model has allowed us to simulate the propagation of hypothetical lightning produced whistler waves through the ionosphere of Venus. According to our results [3], if the observed signals are generated by lightning, either the average energy released by Venusian lightning is considerably greater than the terrestrial lightning energies (by more than a factor of ten), or ducted wave propagation is common in the ionosphere of Venus, allowing Very Low Frequency waves to propagate without suffering geometric attenuation.

The Akatsuki Spacecraft of JAXA, currently orbiting Venus, is equipped with high temporal resolution cameras that could detect fast transient optical emissions from lightning discharges. If Akatsuki does not success in its search of lightning, future missions with dedicated instrumentation to take precise measurements of plasma parameters together with radio wave signals could be useful to determinate the source of the radio signals observed by the PVO and VEX missions.

References

[1]: Cole, K. D., & Hoegy, W. R. (1997). Nonlinear whistlers: Implications for 100 Hz electric fields observed in the Venus ionosphere. Journal of Geophysical Research: Space Physics, 102(A7), 14615-14623, doi: 10.1029/97JA00564.

[2]: Lehtinen, N. G., and U. S. Inan (2009), Full-wave modeling of transionospheric propagation of VLF waves, Geophys. Res. Lett., 36, L03104, doi: 10.1029/2008GL036535.

[3]: Pérez-Invernón, F. J., Lehtinen, N. G., Gordillo-Vázquez, F. J., & Luque, A. (2017), Whistler wave propagation through the ionosphere of Venus. Journal of Geophysics and Engineering Space Physics, 122, 11,633–11,644, https://doi.org/10.1002/2017JA024504.