

New understanding on Jupiter's lightning in the atmosphere as revealed by Juno

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Since 5 July, 2016, the Juno spacecraft has toured Jupiter in a 53-day eccentric polar orbit. During each perijove, Juno has monitored a copious amount of Jupiter's lightning at the radio, optical, and ultraviolet wavelengths with five onboard instruments. The radio and plasma wave (Waves) instrument has recorded two kinds of low-frequency electromagnetic waves related to the lightning. The first is comprised of Jovian low-dispersion whistlers observed at frequencies below 20 kHz. These radio signals may possibly propagate up to several thousand kilometers horizontally away from lightning strokes below the ionosphere before ultimately escaping into the inner magnetosphere, but their direct vertical propagation cannot be excluded. The second kind consists of dispersed millisecond pulses called Jupiter dispersed pulses (JDPs), observed at frequencies below 150 kHz but above the maximum plasma frequency encountered during the wave propagation through the ionosphere. JDPs propagate directly from lightning strokes but can leak into the inner magnetosphere only where ionospheric density is low. The high-temporal observations of either whistlers or JDPs by Waves showed variations of lightning-related processes on the order of submilliseconds. Another type of the lightning-induced radio signature is the ultrahigh frequency (UHF) sferics recorded at 600 MHz and 1.2 GHz by the Microwave Radiometer (MWR). The UHF sferics freely traverse the ionosphere from the source lightning strokes as straight-line propagation. In addition to three kinds of radio signatures, clouds illuminated from below by nightside lightning have been captured by two navigation cameras (Stellar Reference Unit (SRU) and Advanced Stellar Compass (ASC)), while the ultraviolet spectrograph (UVS) discovered Transient Luminous Events in the upper stratosphere, thought to be associated with tropospheric lightning. Imaging data from the Hubble Space Telescope have been instrumental in associating many of these phenomena with actively convecting regions, especially cyclonic vortices. In the theoretical domain, Juno team members proposed a new precipitation mechanism involving high altitude ammonia-water clouds which potentially accounts for the shallow lightning seen with the SRU and allows for the creation of "mushballs" which may explain the deep depletion of ammonia detected by the MWR. In this presentation, we report an overview of the recent observations of Jupiter's lightning in the atmosphere as revealed by Juno.

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