



Earth, Jupiter and Saturn as guides for extrasolar planets and brown dwarfs: a lightning climatology study

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Large-scale electrostatic discharges (i.e. lightning) have been observed in the Solar System. Apart from Earth there are direct detections from Jupiter and Saturn and indirect (only radio) detection from Uranus and Neptune. Recent observations made by the Venus Explorer revealed radio signals that may be related to lightning. Observations indicate that clouds form on extrasolar planets and brown dwarfs. The conditions in these clouds may be good for lightning to occur, which can be a main ionization process in these atmospheres (lightning in mineral clouds e.g.: Bailey et al. 2014, *ApJ*, 784, 43; Helling et al. 2013, *ApJ*, 767, 136; Helling et al. 2013, *P&SS*, 77, 152).

In this study our aim is to compare lightning climatology from Earth, Jupiter and Saturn and use these statistics as a guide to study potential lightning on extrasolar planetary objects. Earth is a fair analogy for rocky or ocean planets while Jupiter and Saturn resemble giant planets and brown dwarfs. To give an estimate on the total lightning energy (or power) that can reach us from a particular extrasolar body, we need to know how much lightning can occur on the object globally. We will show the possibilities in the number and quality of the giant planet data sets, which may give a fine comparison of future observations of extrasolar giant gas planets and even brown dwarfs.

Data were obtained from Lightning Imaging Sensor (LIS)/Optical Transient Detector (OTD) (e.g.: Cecil et al. 2014, *Atmospheric Research*, 135, 404), Sferics Timing and Ranging Network (STARNET) (e.g.: Morales Rodrigues et al. 2011, 2014, XIV and XV International Conference on Atmospheric Electricity) and World Wide Lightning Location Network (WWLLN) (e.g.: Hutchins et al. 2012, *Radio Science*, 47, RS6005), four major lightning detecting networks, which monitor lightning occurrence in the optical or radio range on Earth. We compare flash/stroke rates in space and time and use the data to refer to Earth as a transiting exoplanet. We analyze flash rates from a certain celestial direction (as if looked at Earth from outside the Solar System from a fixed location) to see how they vary as the planet orbits the star. The same comparison studies are conducted for Jupiter and Saturn from Galileo, Cassini and New Horizons data.

The comparison of Earth-data shows the importance of the networks' detection efficiency (detected lightning over the total amount of lightning in percentages) and the location of the individual instruments of the networks. Characterizing exoplanets is a difficult task, however, there are planets in our Solar System, which are better studied. Here we show how using the knowledge we have on these planets is a key aspect of exoplanetary sciences.

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