Future Trends in Atmospheric Radio Occultations: Crosslink and Uplink

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The planetary exploration field of Radio Science utilizes communication links to investigate planetary atmospheres via occultation techniques traditionally performed in downlink mode where the signal is transmitted by a spacecraft in orbit or flyby of a planet and received at a ground station, having propagated through the atmosphere of the planet. These method, though effective, has two primary limitations: the received signal-to-noise ratio, especially from the outer solar system planets, and limited coverage, tends to be confined to the polar regions for orbiter missions. To overcome these limitations, the Radio Science community has developed alternate methods such as spacecraft-to-spacecraft occultations (also known as crosslinks) and uplink occultations. New instrumentation is being developed to enable and optimize these methods on future missions. The crosslink occultations were recently demonstrated for the first time at Mars at UHF frequencies between the Odyssey and Mars Reconnaissance Orbiter spacecraft currently in orbit around Mars and equipped with communication-based proximity links, not designed for Radio Science experiments. Lessons learned from this experience will be applied towards development of instruments that optimize the performance for Radio Science (e.g., phase stability, spectral purity, bit depth, etc.). Uplink radio occultation is already a prime objective of the New Horizons mission at Pluto. A recent demonstration of the concept will be attempted with Huygens Probe Support Avionics in order to, again, develop lessons learned to optimize the Pluto and other future experiments of this type. This paper will discuss these future trends in atmospheric radio occultations with emphasis on possible instrumentation to enable them on future missions.