

Two-way atmospheric radio occultation: a powerful new technique for probing tenuous planetary atmospheres

T.R. Spilker, N.J. Rappaport, and E.D. Archer, Jet Propulsion Laboratory, California Institute of Technology, MS 301-169, 4800 Oak Grove Drive, Pasadena, CA 91109-8099

The Radio Science Atmospheric Occultation (RSAO) technique has a history of producing excellent science results for a wide range of denser planetary atmospheres. Overwhelmingly, the specific technique used so far has been the "downlink" technique, whereby a spacecraft transmits one or more USO-referenced signals through a planetary atmosphere to a ground station, where the signals are referenced to an extremely stable oscillator and recorded for later data reduction. Doppler signatures and phase perturbations recorded in the data yield vertical profiles of ionospheric electron densities, and neutral atmospheric densities from which temperature-pressure profiles can be inferred. Results from occultations of tenuous atmospheres (surface pressures of a few microbars) are much sparser, partly due to not encountering many such bodies, and partly to limitations associated with the downlink RSAO method.

We will discuss a new RSAO technique, "Two-way atmospheric radio occultation", applicable to bodies with tenuous atmospheres such as Triton, Pluto, and possibly Io and Charon. Similar to radio occultation solar conjunction experiments, it relies on the small perturbations from a tenuous atmosphere, and the extreme stability of ground-based frequency references for both the initial transmitted signal and the information-carrying returned signal. The high-power uplink signals (two widely-separated frequencies are best) pass through the subject atmosphere, are received and transponded at the spacecraft, then pass again through the atmosphere and back to the ground station. Using the ground-based oscillator for both the initial and final frequency references, and doubling the amplitude of the perturbations induced by the planetary atmosphere, yields a far higher SNR than one-way techniques.

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