The bistatic radar experiment at Vesta using the Dawn communications antennas

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Abstract. During the Dawn mission's year-long orbit of asteroid Vesta, we conducted an opportunistic bistatic radar (BSR) experiment using the spacecraft's communications antennas and the Deep Space Network (DSN) 70-meter antennas—providing a unique opportunity to investigate the radar properties of Vesta's surface, which are affected by variations in surface roughness and the presence of volatiles. In this configuration, Dawn's communications antennas continuously transmit a right-handed circularly polarized wave (at X-band frequency; 3 cm wavelength) toward Earth, while one of the DSN 70-meter antennas receives on Earth. As the Dawn spacecraft passes behind Vesta from Earth's perspective, i.e. an occultation, the signal received at Earth falls to noise levels until the spacecraft exits from occultation again. The fall (and rise) of the signal as the spacecraft enters (and exits) from occultation corresponds to times during which the transmitted waves graze Vesta's surface and are then received at Earth. By analyzing the power and polarization of these surface echoes—relative to the original, direct signal transmitted from the Dawn spacecraft—we can assess surface roughness, and the reflecting and attenuating properties of the surface material. Since this is the first BSR experiment to be conducted at a small body, it also presents unique challenges: (1) a small Doppler shift between the direct signal and a surface echo due to low incidence angle and to the slow rotation of Vesta relative to the orbital speed of the spacecraft, and (2) a small window of time during which the transmitted signal grazes Vesta's surface. We present our analysis of the received power and polarization for 13 different occultations.