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Cometary plasma response to interplanetary corotating interaction regions during 2016 June – September: a quantitative study by the Rosetta Plasma Consortium

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Abstract

Four interplanetary corotating interaction regions (CIRs) were identified during 2016 June through September by the Rosetta Plasma Consortium (RPC) monitoring in situ the plasma environment of the comet 67P/Churyumov-Gerasimenko (67P) at the heliocentric distances of ~ 3 and 3.8 au. The CIRs, formed in the interface region between low- and high-speed solar wind streams with speeds of ~ 320 - 400 km s⁻¹ and ~ 580 - 640 km s⁻¹ respectively, are characterized by relative increases in solar wind proton density by ~ 13 - 29 , in proton temperature by ~ 7 - 29 , and in magnetic field by ~ 1 - 4 with respect to the pre-CIR values. The CIR boundaries are well-defined with interplanetary discontinuities. Out of 10 interplanetary discontinuities at the CIR boundaries, 4 are determined to be forward waves and 5 are reverse waves, propagating at ~ 5 - 92% of the magnetosonic speed at angles of $\sim 19.8^\circ$ - 86.6° relative to ambient magnetic field. Only one is identified to be a quasi-parallel forward shock with magnetosonic Mach number of 1.48 and shock normal angle of 41.0° . The response of the cometary ionosphere was monitored by Rosetta from cometocentric distances of ~ 4 to 30 km. A quiet time plasma density map was developed by considering the effects of varying cometary latitude, longitude and cometocentric distance of the Rosetta observations before and after each of the CIR intervals. The CIRs lead to plasma density

enhancements of ~ 500 - 1000% with respect to the quiet time reference level. Ionospheric modeling shows that increased ionization rate due to enhanced ionizing suprathermal (>12 - 200 eV) electron impact is the prime cause of the large cometary plasma density enhancements during the CIRs. Plausible origin mechanisms of the cometary suprathermal electron enhancements are discussed.