Radar Observations of Highly-Transient Meteor and Related Plasma Phenomena at Jicamarca Radio Observatory

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We describe a variety of MLT (Mesosphere, Lower Thermosphere) transient—microsecond through a few seconds—phenomena observed at the Jicamarca Radio Observatory (JRO) with a few additional examples from Arecibo Observatory (AO). The primary source of these transient events is the meteoroid flux. However, a significant fraction are likely electrodynamic in nature and include EEJ- (Equatorial ElectroJet) and 150 km echo-related phenomena. These results introduce new HARM (High Altitude Radar Meteor; B. Gao, and J. D. Mathews, *Mon. Not. R. Astron. Soc.*, *446*, 2015, pp. 3404-3415, doi: 10.1093/mnras/stu2176) events extending to ~180 km altitude. Also given are examples of meteoroid fragmentation and flaring and detailed observations of Field-Aligned Irregularity (FAI) and RSTE (Range-Spread, Trail-Echo) development following meteoroid flares. New features of these observations include the simultaneous use of six-receiver interferometry (holography) for angle-of-arrival-ambiguity removal and a hybrid interferometry/compressed-sensing technique that yields unprecedented spatial and temporal resolution of transient events.

A detailed interpretation of the radio science aspects of radar meteors—and other similar transient events that have not been identified—is required in order to understand the physical, plasma, and electrodynamic processes giving rise to the radar events we present. Examples presented underscore the emerging recognition of B-field-parallel diffusion yielding rapid development of FAIs that, as the JRO beam includes the geomagnetic equator, appears to result in enhanced coherent scattering and thus greater visibility. We show 3D “movies” of incoming meteors and subsequent FAI development following flaring. Additionally, the vast majority of radar meteors exhibit interference patterns indicative of fragmentation and many exhibit flaring along the trajectory as well as complex terminal flaring. There is considerable emerging evidence that the meteoroid flux influences EEJ and 150 km echo properties.