Phase and Pattern Calibration of the Jicamarca Radar Using Satellites

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The Jicamarca Radio Observatory (JRO) main 50 MHz radar array antenna system with multiple receivers is being used to study the meteors using various interferometric configurations. In such systems, one of the major challenges is to know the phase offsets between the different receiver (interferometric) channels (legs). Such phase offsets are intrinsic to any such system and are due to different cable lengths, filters, attenuators, amplifiers, antenna impedance, etc. In response to investigating some ambiguous features in meteor head-echo results, we present a "new" calibration technique that employs satellites to produce accurate phase and pattern calibrations. Since the satellite is a point target and its orbit is gravitationally well defined, satellite returns can be used to test characteristics of the JRO interferometry process. In particular, the satellite yields a reliable source for phase and thus trajectory calibration. Using several satellites identified during standard meteor observations, we derive satellite orbital parameters by matching observed and modeled 3-D trajectory and Doppler results. This approach uncovered subtle phase distortions that lead to interferometry derived trajectory distortions that are important only to point targets. Additionally, the accuracy of this approach is such that we can suggest the origin of the phase errors and even adjust the vector orientation of the plane of the antenna array. The basis for this accuracy is the comparison of satellite range, Doppler, and trajectory properties relative to the corresponding gravitation orbit even thought the satellite is observed for only a few seconds. We present the array calibration and radar imaging of satellites results from our 15/16 April 2010 and summer 2012 meteor observations. Future observations of a priori known orbit satellites would likely yield significantly more accurate calibrations.