A intercomparison of interferometric meteor radar calibration techniques

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Interferometric techniques are commonly used in all-sky meteor radar systems to determine the meteors' position in the sky. Before correctly conducting the task of estimating the direction-of-arrival (DOA) of the meteors, effective and reliable calibrating the phases of the system is required. Although different methods have been reported, there is no satisfactory technique published. This study thoroughly discusses the current and prospective calibration techniques. Generally speaking, phase calibration is implemented by measuring the phase difference between the receivers for a signal produced by a source with known locations. Next the phase offsets can be estimated by comparing the measured phase difference with the expected phase difference between the antenna pairs. Use of a low elevation ground antenna was reported by Valentic (1997) as the calibration source to estimate the receiver's phase offsets. The advantage of this method is that the antennas can be mounted easily moved to a range of azimuths. Measurements from these positions can thus be averaged to increase the accuracy of the estimated phase offsets. However, the angle estimation error at low elevation angles is larger than at high elevation angles, which will degrade the performance of the calibration technique. Unmanned vehicle (UAV), because of the low cost and operating flexibility, received more concerns recently, and is under development for autonomous antenna calibration (Pisano et al, 2005). This approach requires a robust navigation system in addition to GPS for system stabilization and operation is dependent on weather conditions. Besides man-made sources, using a radio star as natural source has also been attempted to calibrate the interferometer. Use of a radio star has apparent advantage because its position can be determined from an astronomical catalog and no effort is needed in building man-made sources. Palmer et al (1996) published experiment results using Cygnus A to calibrate the Middle and Upper (MU) Atmosphere radar. However the receiving array of the MU radar is composed of directive yagi antennas. Combinations of these yagi antennas can produce a very narrow beam, which makes the detection a stellar source possible. However, for an all-sky meteor radar system, low receiving power will make even the strongest stellar source such as Cygnus A and Cas A buried below the noise floor. Therefore the possibility of detecting such a source still remains a question. Recently, Holdsworth (2004) presented work using meteor echoes to calibrate the phase offset. Lau (2006) then modified this algorithm. These techniques can be implemented during routine observations, so no additional sources or scheduled down time are needed to make the

measurements. However, after implementation of these algorithms, it is shown that this technique can only narrow down the phase offset to several possible solutions. Care is still needed to remove the remaining ambiguity. Although there are still problems that need be solved, calibration with a stellar source and meteor echoes appear to be the most convenient, low cost, and accurate methods compared to the alternatives.