A REVIEW OF TWENTY-SIX YEARS OF U.S. WEATHER RADAR DETECTION OF METEORITE FALLS.

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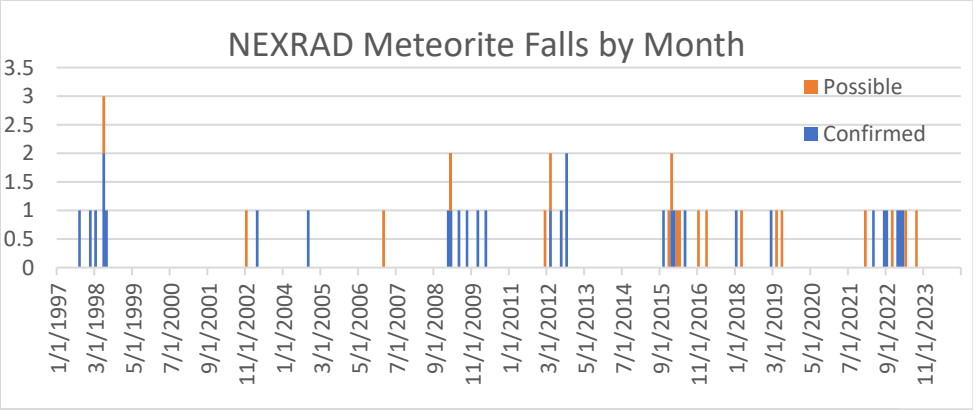
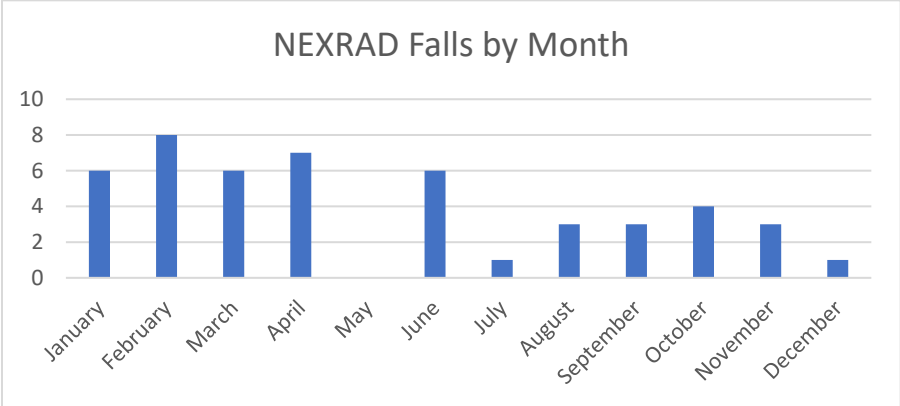
Introduction: Weather radars have proven to be a valuable tool for detection, rapid recovery, and analysis of meteorite falls and fall statistics [e.g. 1-3]. The U.S. operates a nationwide weather radar network (NEXRAD) which will be discussed here, but it is important to acknowledge that weather radars operate worldwide and efforts are underway to utilize this rich resource [4]. By the author's count, since the NEXRAD system came online in the late 1990s it has detected 34 recovered meteorite falls and another 33 unrecovered probable falls. Weather radars are powerful tools because they directly detect meteorites falling after the end of their luminous flight, during the "dark flight" period. This allows rapid recovery through detection and modeling of fall locations down to as little as tens of meters. They are also the only tool that analyzes meteorites that survive their parent fireball, before many or all of them are lost to terrain. This allows direct measurement of meteorite mass, particle size distribution, and with additional work should allow calculation of pre-atmospheric mass and a measure of whole-body strength.

Rapid Recovery: Freshly fallen meteorites are scientifically valuable in that they retain, as best as is possible, a minimally altered state suitable for high fidelity scientific analysis. Weather radar facilitates rapid recovery. At present, social media and other internet-based resources allow detection of meteorite falls within hours of each event. Given the current state of computing power and machine learning and other analyses [5-7] it should be possible to improve this by data-mining the NEXRAD data stream for near-real-time meteorite detection.

Fall Analysis: Weather radar is unique in that it can make measurements on falling meteorites in the period after luminous flight but before they reach the ground. It is possible to calculate the mass of meteorites seen in a given radar pixel from the altitude and time of a given image pixel, as long as the altitude and time of the fireball terminus is known [8]. The number of meteorites present in a given image pixel can also be estimated using the radar reflection strength. For falls where multiple radar detections are made, the mass and number of meteorites can be assembled into a particle size distribution (PSD). It should be possible to use the PSD to estimate whole-body strength of the parent meteoroid, which is an important parameter for any future efforts to divert or destroy hazardous asteroid/meteoroids. It should also be possible to estimate the pre-atmospheric mass as an integration of the PSD curve.

Fall Statistics: We now have 67 meteorite falls and possible falls to work with over 26 years of data collection by the NEXRAD network (Figure 1, below on the left). We can investigate these events in a statistical fashion, addressing questions such as whether any pattern exists in fall frequency or whether patterns are visible by month. Plotting all 26 years of data by the month each fall occurred yields peculiar data (Figure 2, below on the right) that suggests that May is a bad month to search for meteorite falls in the U.S. A sampling of 150 recent, woldwide falls from the Meteoritical Society Bulletin shows no statistically relevant variation by month. Additional data, and further work parsing fall data by region or hemisphere will reveal whether the odd distribution in Figure 2 shows a meaningful distribution or is simply an incomplete data set.





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