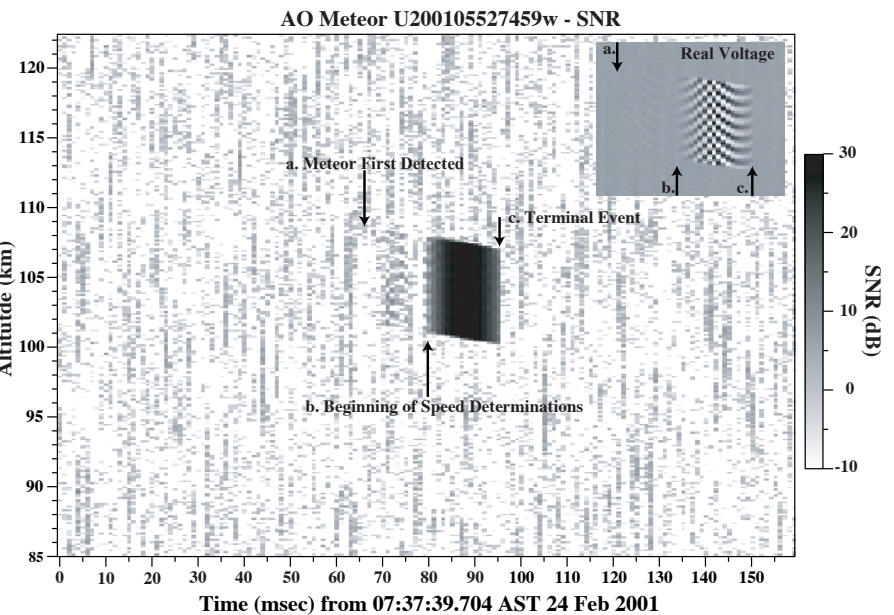
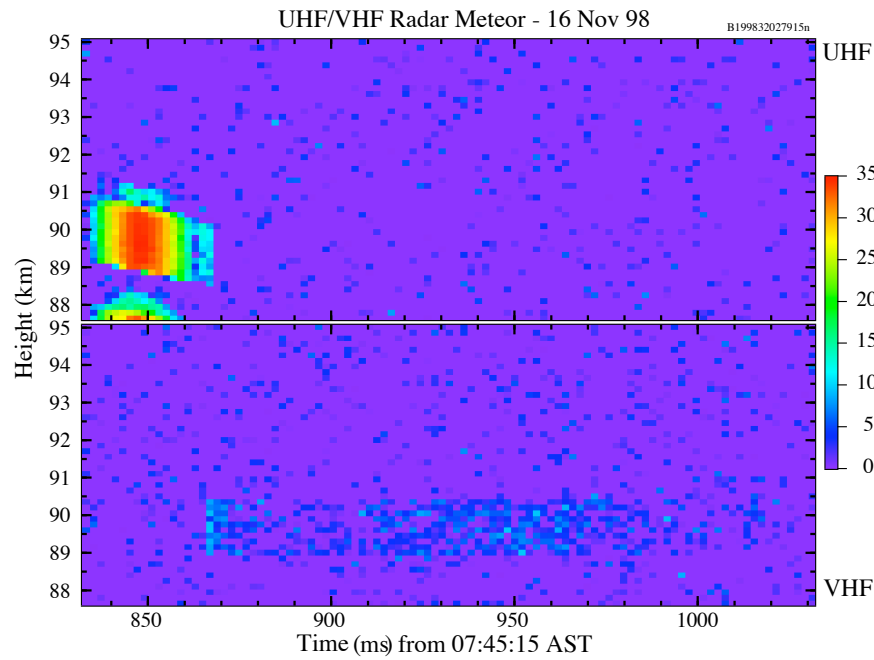


Meteor Science and Aeronomy Using the Arecibo Radars.

Bolide AIDA 1989

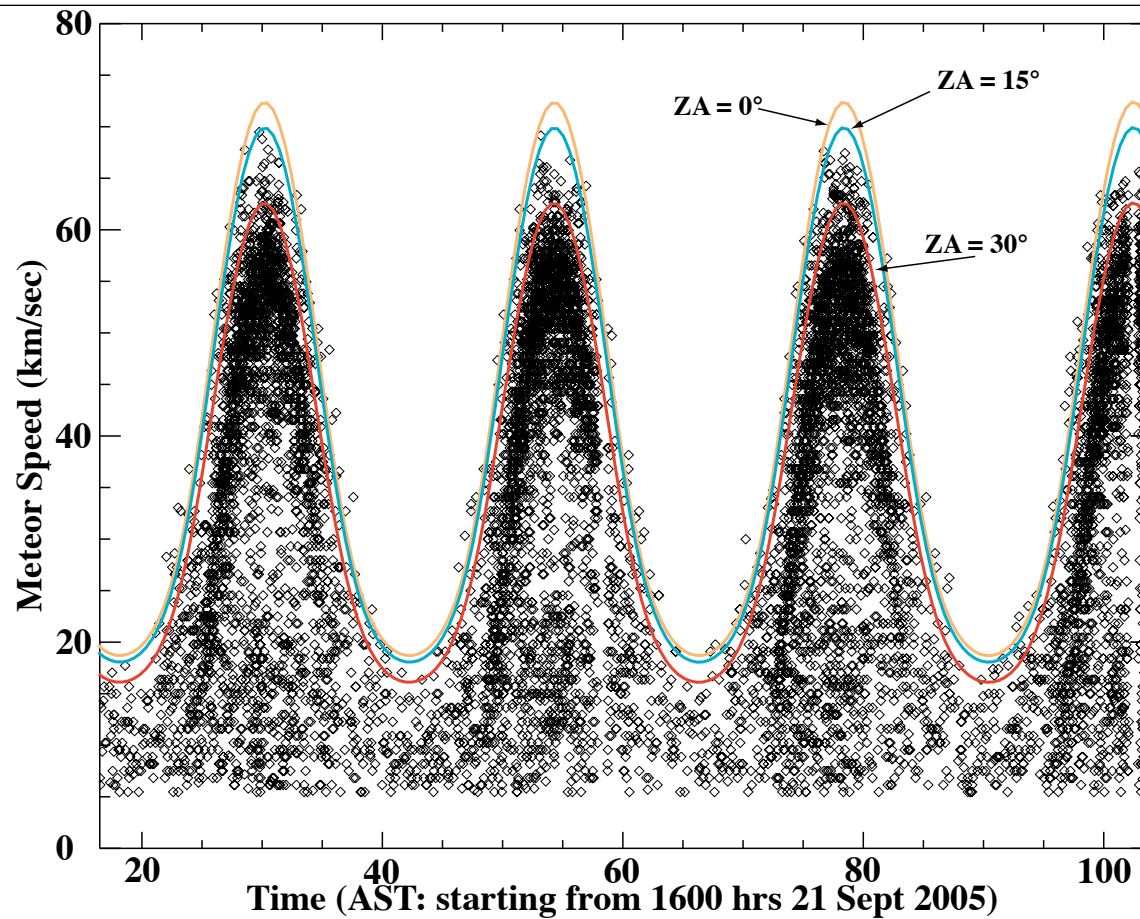
Bolide AIDA was in a near-earth asteroidal orbit with $V_{\infty} \sim 15.5$ km/sec, a period of ~ 1.4 yrs, aubritic composition, ~ 30 kg initial mass. The meteorite may still be discovered in the jungles of the Arecibo river valley south of Arecibo... Although the event was not seen by the radar, its debris apparently drifted through the radar a few minutes later. Thus the modern era of meteor observation at Arecibo began with a -12^m flourish!

4-08-89 1:27:43A



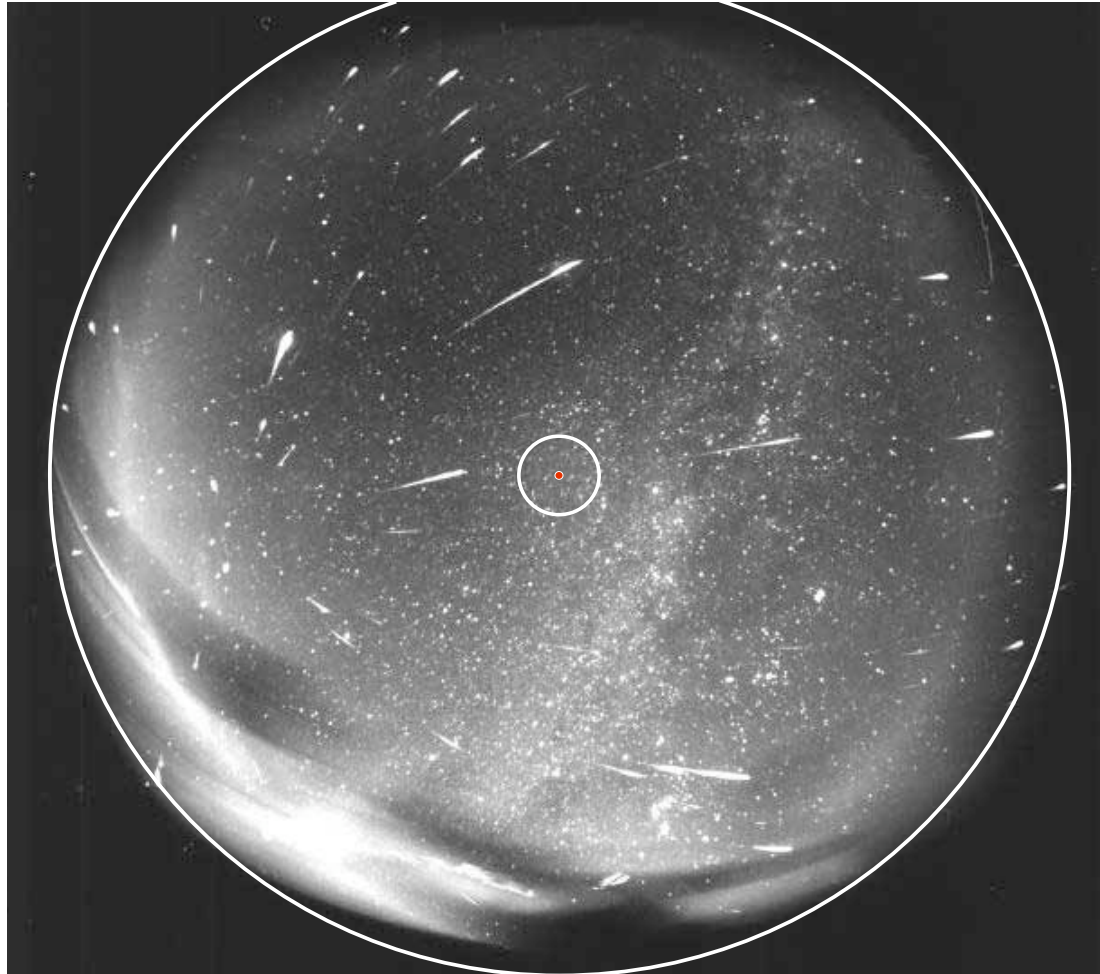
Radar Scattering Mechanisms: Early Arecibo dual-pulse VHF/UHF observations of a radar meteor terminal event. UHF meteors are always observed as head-echoes associated with the “plasma” in the immediate region of the meteoroid. The low-power VHF radar sees the plasma “blob” following the terminal event. This event underscores the radio science aspects of radar meteor observations.

RTI (Range-Time-Intensity) plot showing a meteor event that begins at 102 km altitude with a range extent corresponding to the 45 μ sec uncoded radar pulse—the pulse is repeated every 1 msec. The inset shows the “real” voltage for the same event—the pattern in the voltage is due to the \sim 158 kHz Doppler frequency offset corresponding to the \sim 55.3 km/sec speed. The pattern in the noise background is due to “elemental” incoherent scattering from the ionosphere.



The AO diurnal radar meteor radial speed distribution (in atmosphere) derived from vertical-looking 430 MHz incoherent scatter measurements of the ionosphere. Note the strong modulation of speeds and flux from dawn with the radar looking very close to the apex-of-Earth's-way (autumnal equinox) to dusk with the radar looking near the antapex. The curves indicate the top-of-atmosphere parabolic limit for meteoroids entering the atmosphere at the indicated zenith angles. Extra-solar particles are observed and form a basis for exploring the local galactic environment.

Arecibo sees a (micro)meteor storm every sunrise!



This 4-hour all-sky (120°) exposure from Modra Observatory (Slovakia) shows 156 Leonid bolides from the 1998 maximum. The faintest events are about -2 magnitude. The peak AO **microgram** micrometeor event rate is 30-60 per minute in each $1/6^\circ$ (300 m @ 100 km) patch of sky. The central dot is 1° or about 1.75 km across and would display ~ 1100 -2200 events/min while the 10° circle would display $\sim 110,000$ -220,000 event/min. This “storm” occurs each sunrise but is only visible to the 430 MHz AO radar. At high latitudes the picture is more complex...

Unique Arecibo meteor observations & future impacts.....!

Observational Aeronomy: Uniquely able to separate meteor events from the ionospheric incoherent scatter results in order to accurately measure E-region ionization levels and thus study ionization sources including metal ions from the micrometeoroid flux! These results can then be compared with the metals lidar results.

Theoretical: The radar scattering mechanism(s) for meteors must be understood in order to interpret the observational results. The 430 MHz, 46.8 MHz, and the new HF (ionospheric heater) radar will uniquely allow simultaneous observations of meteors at three vastly different frequencies enabling radio science studies.

Meteoroid Atmospheric Entry Processes: Meteoroid interaction the atmosphere results in ablation of individual atoms and fragmentation processes. The 3 Arecibo radars and the metals lidars offer a unique opportunity to study these processes.

Aeronomy: What is the meteoroid mass flux as a function of season and latitude? What form—individual ablated atoms or dust/smoke—does this flux take? The lidars are critical to this study.

Electrodynamics I: More to be said on meteoroid dust and smoke formation and dusty plasmas physics and on the plasma physics of meteor RSTE (Range-Spread Trail-Echoes) formation!

Electrodynamics II: Direct meteor influence on sporadic-E and QPEs (Quasi-Periodic Echoes)?

Planetary & Local Galactic Astronomy: Addition of radar interferometry will allow highly accurate meteoroid orbit determination allowing detailed study of sources such as asteroids, comets (Kuiper & Oort Clouds), and the local galaxy (Orion arm)—about 5% of all meteors observed at Arecibo are extra-solar in origin.