

## SIMULTANEOUS OPTICAL AND METEOR HEAD ECHO MEASUREMENTS USING THE MIDDLE ATMOSPHERE ALOMAR RADAR SYSTEM (MAARSY)

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**Introduction:** We describe a two year campaign of simultaneous automated meteor optical and head echo radar measurements conducted with the Middle Atmosphere Alomar Radar System (MAARSY). This campaign was established with the following goals:

Compare trajectories as measured by MAARSY and the two optical stations for a range of meteoroid masses.

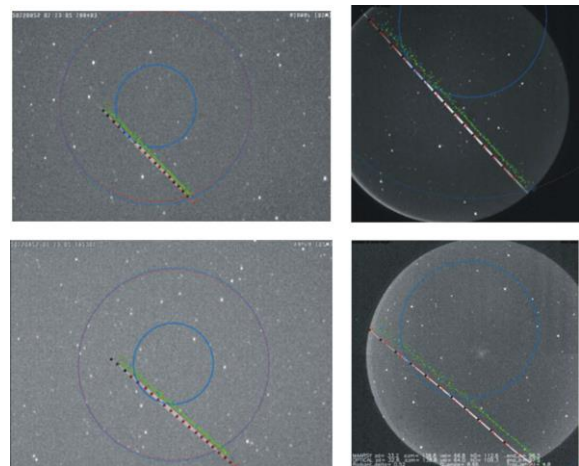
Compare photometric and dynamic mass measured optically with radar-derived masses (intercalibration of mass scales).

Use the best observed simultaneous events to fuse all metric, photometric and ionization estimates together and apply different ablation models to self-consistently model these highest quality events.

**Initial results:** 105 double-station optical meteor events have been simultaneously observed by MAARSY as head echoes. Metric comparisons establish that the absolute interferometry for MAARSY is in generally excellent agreement with optical meteor trajectories, though a slight systematic offset of a few tenths of a degree is commonly noted. We find a median deviation in radiant between radar and optical radiants of 1.5 degrees, with 1/3 of events having radiant agreement to less than one degree. MAARSY tends to record average speeds roughly 0.5 km/s above the optical values as the head echoes also are detected, on average, 1.3 km higher than the first optical registration. This bias is larger near the center of the beam demonstrating that MAARSY is more sensitive to the start of ablation than the cameras.

Using just the ratio of the number of common optically detected to not detected head echoes we find that the MAARSY head echo limiting meteoroid mass lies in the  $10^{-9}$  kg to  $10^{-10}$  kg for speeds from 30-60 km/s

There is a clear general trend of higher peak RCS with brighter meteors as predicted by scattering theory. A significant number of common head echo – optical meteors show large variations in RCS relative to their optical lightcurve over common height intervals. These events may reflect fragmentation or possibly differential ablation.



**Figure 1.** Event as seen by WATEC cameras (left) and narrow field intensified (right) cameras. Alomar is at the top and Saura at the bottom. The blue circle in each optical field represents the 3 dB points of the main MAARSY beam projected to 100 km altitude. Each green dot represents pulse-to-pulse interferometric tracking and projection on the plane of sky at the site using the actual head echo height measured from the MAARSY range and interferometry. The outer purple circle on the Watec images (left) represent the first null in the MAARSY radar gain beam.

**Acknowledgments:** This work is supported in part by the Natural Sciences and Engineering Research Council of Canada, the NASA Meteoroid Environment Office through co-operative agreements NN61AB76A and NN65AC94A, and grant STO 1053/1-1 (AHEAD) of the Deutsche Forschungsgemeinschaft (DFG).

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Helpful discussions with S. Close and R. Mar-  
shall are gratefully acknowledged.