Status of the NASA Allsky Camera Network

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In the Beginning...

- There were visual observers (and still are)
- Data limited to radiants and rough estimates of speed and brightness
- Can get very cold during winter nights

Fig. 3-3. Modern visual meteor observing at Springhill Meteor Observatory near Ottawa. Warm air is supplied to the individual compartments.
Photographic Observations

Wide field

Meteorite Observation and Recording Program (MORP)

All sky

Modra Observatory

• All sky systems are nice because only 1 camera is needed per station
Super Schmidt Cameras

- First employed in the 1940’s
- Detected bright meteors (magnitudes $> +3$)
- Large FOV
- Multiple stations and use of rotating shutter enabled location, speed, and orbit determinations

Much of what we know is based on data taken with these systems.
The advent of fast, wide field photographic systems led to the creation of the first meteor networks:

- **European Fireball Network** began in 1958 in Germany and Czechoslovakia.
- **The Prairie Network** began in 1964 in the U.S. Funding was terminated in 1975.

These networks were set up to find meteorites (at least in part), but funding was discontinued due to lack of scientific interest and disappointing number of finds (1 each for Prairie and MORP). Only the European network remains operating today.
Photographic Advantages

- Large dynamic range
- Good photometry
- High resolution
- Precise astrometry
- Can be automated to some degree
Video Observations

• Largely pioneered by Clifton and Naumann in the 1960’s at MSFC (Meteor Physics Branch)

• Advantages:
  • 100x better sensitivity over Super Schmidt cameras
  • 30 fps rate gives better temporal resolution than rotating shutter
  • Unrivaled temporal accuracy thru GPS time stamps

• Disadvantages:
  • Limited resolution compared to photographic
  • Limited dynamic range (most systems are 8 bit)
The Sandia Sentinel Systems

- Sentinel I (1998) - “look down” system with hardware meteor detection. 6 second buffer, parallel connection to computer (Moooo)
- Sentinel II (2004) - conventional all sky with hardware detection. USB connection to computer
- Sentinel III (2007) - all sky system with software detection

Camera: Hi-Cam HB-710E
Lens: Rainbow L163VDC4 1.6-3.4mm f/1.4 lens
# Current Fireball Networks

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<th>System Type</th>
<th>Start Year</th>
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Goals of the NASA Network

- Establish the speed distribution of cm size meteoroids
- Determine which sporadic sources produce large particles
- Determine (low precision) orbits for bright meteors
- Attempt to discover the size at which showers begin to dominate the meteoroid flux
- Monitor the activity of major meteor showers
- Assist in the location of meteorite falls
Station Locations

- 11 more to install!

Monday, August 8, 2011
Automated Lunar and Meteor Observatory (ALaMO)
Station Components

- All-sky Camera
- Low light level video camera
- All sky (fish eye) lense
- heater/fan to prevent dewing
- Computer running ASGARD (All Sky and Guided Automatic Real-time Detection) software
- GPS
- Uninterruptible Power Supply (UPS)
- Internet connection
Detection

# version : 20090611
# num_fr : 20
# time : 20090811 08:24:51.297 UTC
# unix : 1249979091.297046
# ntp : LOCK 62141 181788 31681
# seq : 43288344
# mul : 0 [A]
# site : 02
# latlon : 34.8535 -85.3143 246.0
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# plate : 20090724-094001-02-aut-calib-ID
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# reject : 0

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Calibration

- Need to transform between pixel coordinates to az, el
- Every 30 minutes the camera computer produces a calibration plate (several images stacked together to show lots of stars)
- User runs an IDL script to match stars to image
- A least squares fit is performed to determine plate parameters

The transformation of the plate coordinates $x, y$ to the celestial coordinates $a, z$ is done by means of five equations. The equation for $r$ can be rewritten as

$$ r = C \left[ \sqrt{(x-x_0)^2 + (y-y_0)^2} + A (y-y_0) \cos(F-a_0) - A (x-x_0) \sin(F-a_0) \right], $$

where we introduced the global scale factor $C$ (see below). The other four equations are

$$ u = V r + S(e^{D r} - 1) + P(e^{Q r^2} - 1) $$

$$ b = a_0 - E + \arctan \left( \frac{y-y_0}{x-x_0} \right) $$

$$ \cos z = \cos u \cos \varepsilon - \sin u \sin \varepsilon \cos b $$

$$ \sin(a-E) = \sin b \sin u \sin z $$
From: "asgard (02)"
Date: August 13, 2009 6:03:52 AM CDT
To: "list"
Subject: allsky 20090813

Last sync and disk usage:

01: 20090813 06:00:01 CDT : 280188 / 465365 MB free
02: 20090813 07:00:02 EDT : 282305 / 465365 MB free

Last recorded event and plate:

01: 20090813 100436 UTC : 20090724-094001-01-aut-calib-ID
02: 20090813 102022 UTC : 20090724-094001-02-aut-calib-ID

ASGARD version and NTP status:

01: 20090611 : LOCK 18154 64069 4032
02: 20090611 : LOCK -13559 63498 7150

date time : vel beg end : src
------------------------------------------
+ 20090813 03:16:41 : 01 02 : .... .... .... : ...
+ 20090813 04:01:55 : 01 02 : 59.7 109.8 99.5 : PER
+ 20090813 04:05:44 : 01 02 : 58.1 107.5 95.4 : PER
+ 20090813 04:10:46 : 01 02 : 58.0 103.4 93.5 : PER
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+ 20090813 05:08:56 : 01 02 : 60.6 111.1 85.8 : PER
+ 20090813 05:09:33 : 01 02 : 60.5 102.5 92.1 : ...
BEGINNING POINT:

\[
X = 329.933 \quad Y = -5281.118 \quad Z = 3703.070 \\
.059 \quad .011 \quad .068
\]

GEOGRAPHIC

LAM = -86.69515 \quad FI = 35.16388 \quad H = 87.381 KM
\[.00063 \quad .00078 \quad .040\]

END POINT:

\[
X = 342.215 \quad Y = -5238.779 \quad Z = 3711.185 \\
.052 \quad .010 \quad .058
\]

GEOGRAPHIC

LAM = -86.53255 \quad FI = 35.43644 \quad H = 58.225 KM
\[.00057 \quad .00067 \quad .034\]

Note: LAMBDA approximate (valid for TIME=0)

FOR THE END POINT: AZIMUTH = 26.107 \quad ZNT. DISTANCE = 49.577
\[.131 \quad .162\]
Sensitivity and Response

- Can detect magnitude 0 meteors
- ASGARD software can handle simultaneous events
- Aircraft (flashing lights) made detection algorithm crazy; continual improvements have reduced number of falses
System Requirements

- Pentium 3, 900MHz, 512Mb RAM
- at least 40 Gb data space, in 2 partitions (>20 Gb for video buffer, rest to store events)
- Brooktree 878A framegrabber (Hauppage WinTV card)
- Debian linux version 5
- DSL or faster internet connection
Preliminary Geminid Results
2009 Perseids