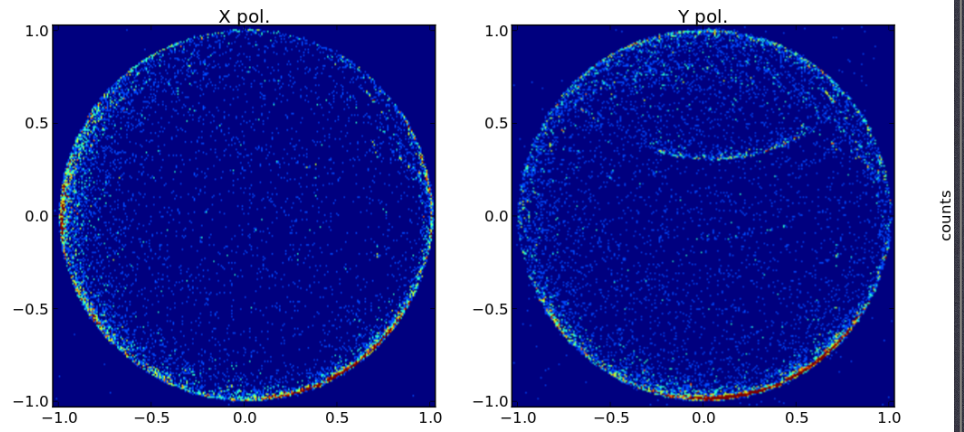


Meteor Survey

Sophia Cockrell

LWA Users Meeting - July 2014

Survey overview

Meteor stream - closed loop orbit of cometary debris

- parallel orbits with same velocity

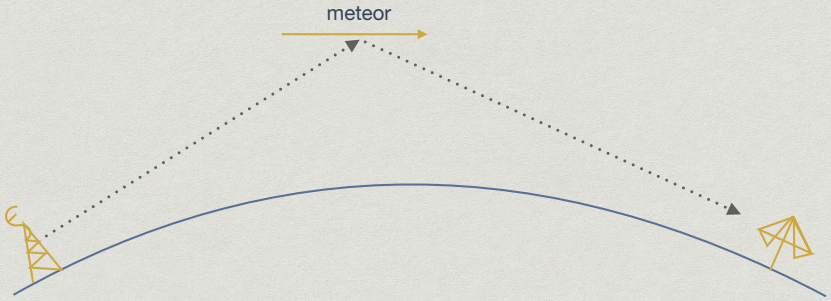
Our aim: a once-around-the-Sun survey of meteor streams along Earth's orbit.

Why? To get a better census of material in our region.

Implications: Hopes to inform Solar System evolution studies.

A time sensitive opportunity! Major transmitters switching to digital next year.

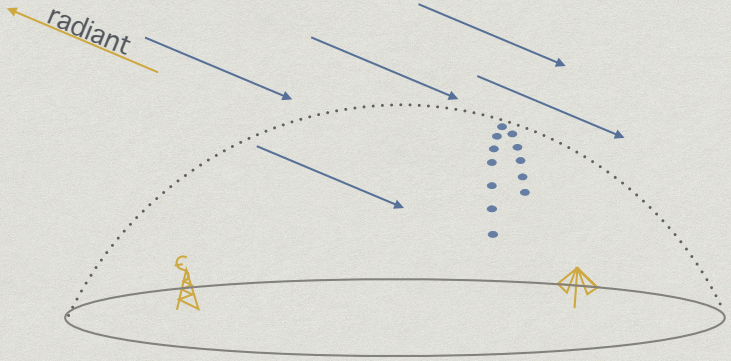
Detection



- Meteors create dense ionized gas column of gas in the lower ionosphere.
- Specular reflection - well established method
- A meteor stream should display an arc in all-sky image

Meteors (as small as 10-5 g) entering the atmosphere create dense quasi-linear structures of ionized gas in the lower ionosphere (85 - 105 km high) during ablation 10s of km long.

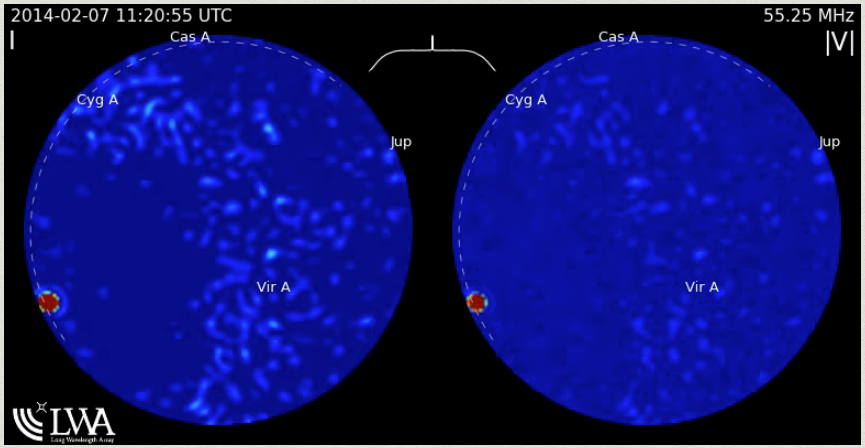
A meteor stream should display as an arc in all-sky image who's characteristics are determined by orientation of the stream and locations of the receiver and transmitter.



- Detection occurs on an ellipse surface with the transmitter and receiver as foci.
- For a given meteor orientation, specular reflection only occurs at a fixed distance.

- Analog TV stations broadcasting at 55.25 MHz together with LWA1 TBN mode detect ~9,500 meteors per hour *(Helmboldt et al. 2013)*.
- Hour long observations every 40 hrs.

PASI - raw at 55.25 MHz



Point out features and what they represent

Methodology

Each image made:

- 5.079s of data
- 32 frequency channels
  - each 6.10 Hz wide

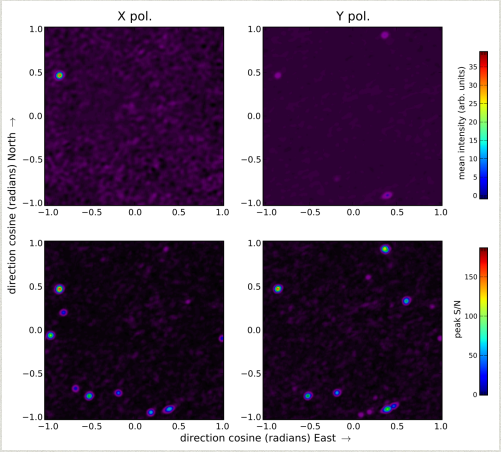
Mean image over all channels identifies brightest meteor trails.

Beam form to each source with a single 195.3 Hz wide channel.

The peak channel, sky position, flux density, intensity, and image RMS are recorded separately for X and Y polarization

For a single 5.079s period:

Mean images over all channels compared with maximum S/N.



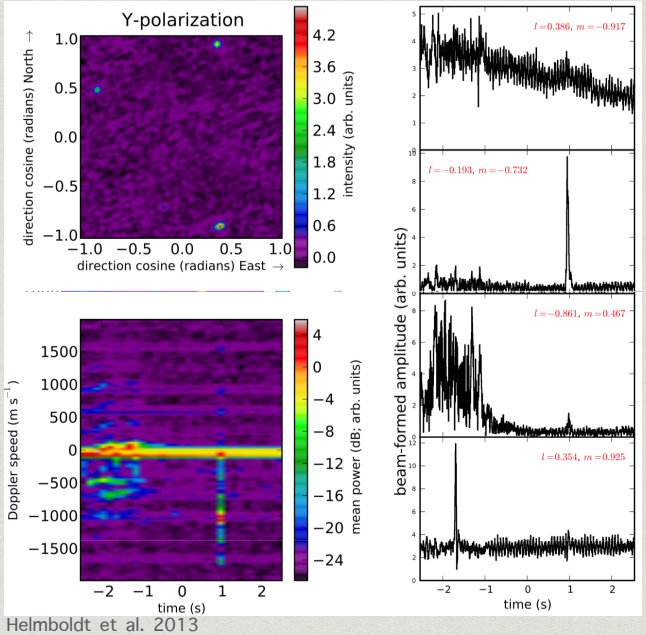
Helmboldt et al. 2013

Each image is made using 5.079s of data imaged within 32 frequency channels, each 6.10 Hz wide. Initially, a mean image is made over all channels to identify the brightest meteor trails. For each of these detections, the antenna data are used to generate high-resolution(5.12ms) by beam forming to each source using a single 195.3 Hz wide channel.

For each significant detection within each cube, the peak channel, sky position, flux density/intensity, and image RMS are recorded. Separately for X and Y polarization

IMAGE: For a single 5.079s period, (upper) the mean images over all channels in X and Y polarization as compared with (lower) images of the maximum S/N over the entire image cube, with the image from each channel normalized by its own estimated noise level.

Filtering strong signals

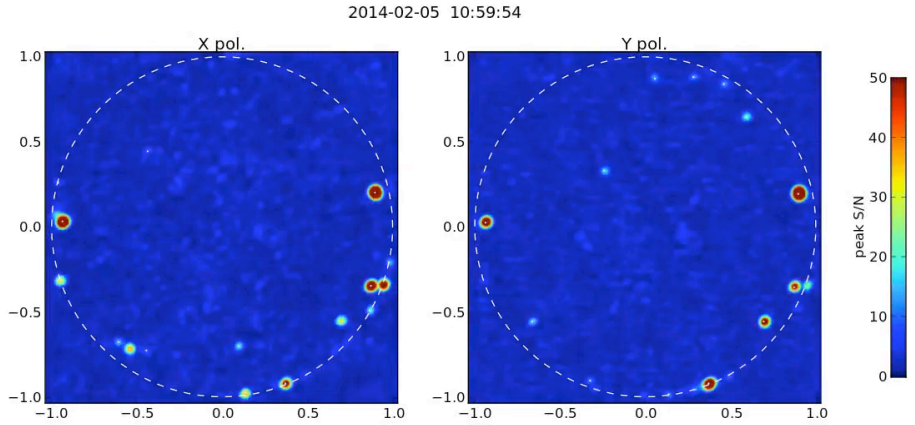


Helmboldt et al. 2013

Strong spectra:

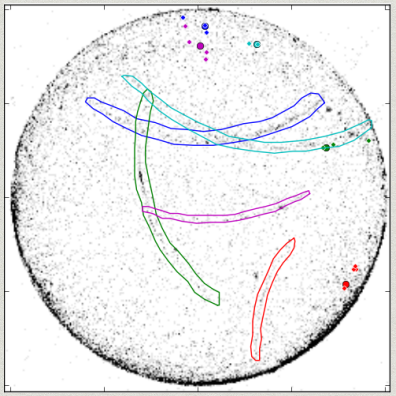
- “non-trails”
- trails with smooth exponential decays
- substantial deviations from smooth decays

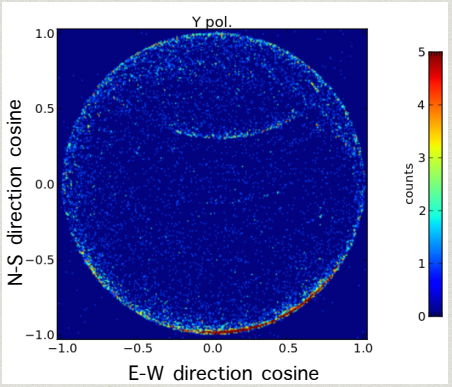
How streams develop



Detected streams

- All-sky image of an hour long TBN mode observation
- 25 stream-like detections to date.

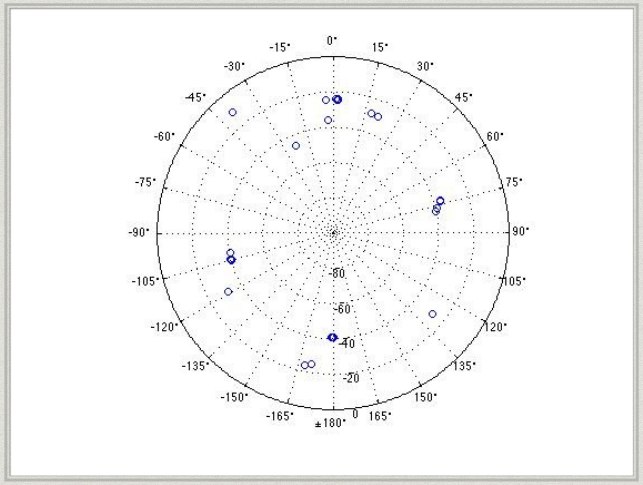




- Radiant - point where meteors seems to originate
- Determined by averaging (based on geometry and signal strength) potential transmitters.

Radiant analysis

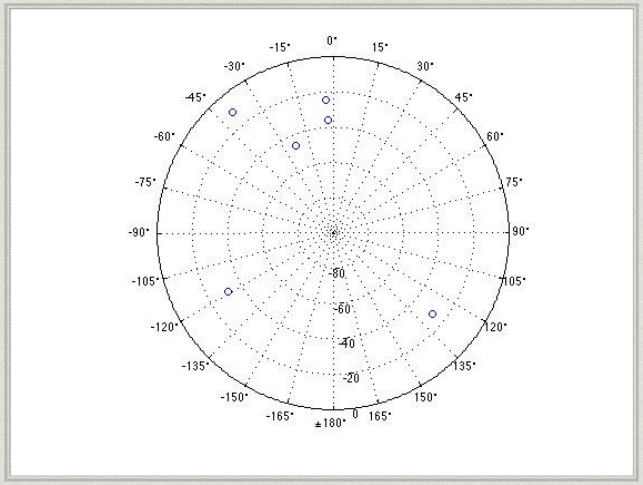
Az and Alt of stream radiants



Radiants with same Alt/Az probably airplane artifacts

Radiant analysis

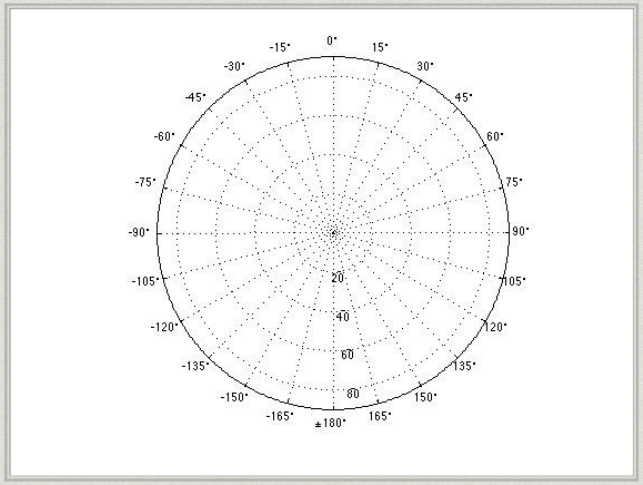
Az and Alt of stream radiants



Displaying only radiants with unique Az and Alt

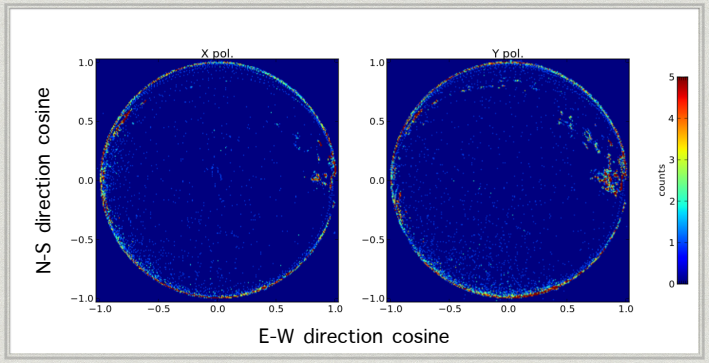
Radiant analysis

Az and Alt of stream radiants



Displaying only radiants that grow in sporadic fashion

Sporadic - E

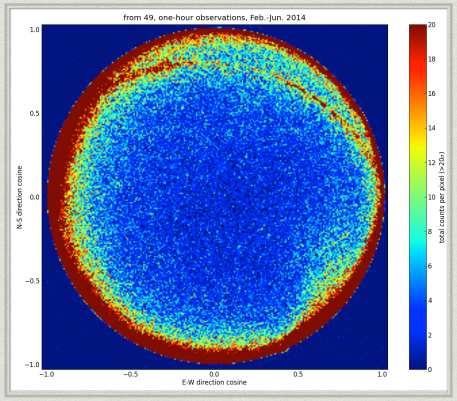


- Clouds of unusually ionized atmospheric gas in the lower E region.
  - Activity peaks in summer months.
- First detected on May 18. Since then, 16% of observations contain this feature with 75% of them occurring at 9pm.
- Confirmed sporadic-E activity during these times with Boulder, CO digisonde data.
- Concentrated toward the Northern arc, perhaps due to increased concentration of meteors.
- See Joe Helmboldt's talk.

Zodiacal dust

Interplanetary dust particles 10-300 μm in diameter confined to ecliptic plane

- Arc present in only and all early morning observations (leading edge)
- Radiant close to zenith
- RA increases gradually with Earth's orbital direction.
- Stream grows gradually and sporadically



Conclusions and Future Work

- We have no potentially new, un-catalogued streams to date.

BUT…

- Density profile survey of the Zodiacal dust could be promising.
- Meteor and sporadic-E relationship determination may be possible.

In the Future:

- Continue survey at 55.25 MHz
- Work on a better identification method for separating artifacts from real streams.
- Need to catch a catalogued meteor shower!
- Attempting 15 MHz and 20 MHz frequencies for distance measurements and hopefully decrease airplane artifacts.