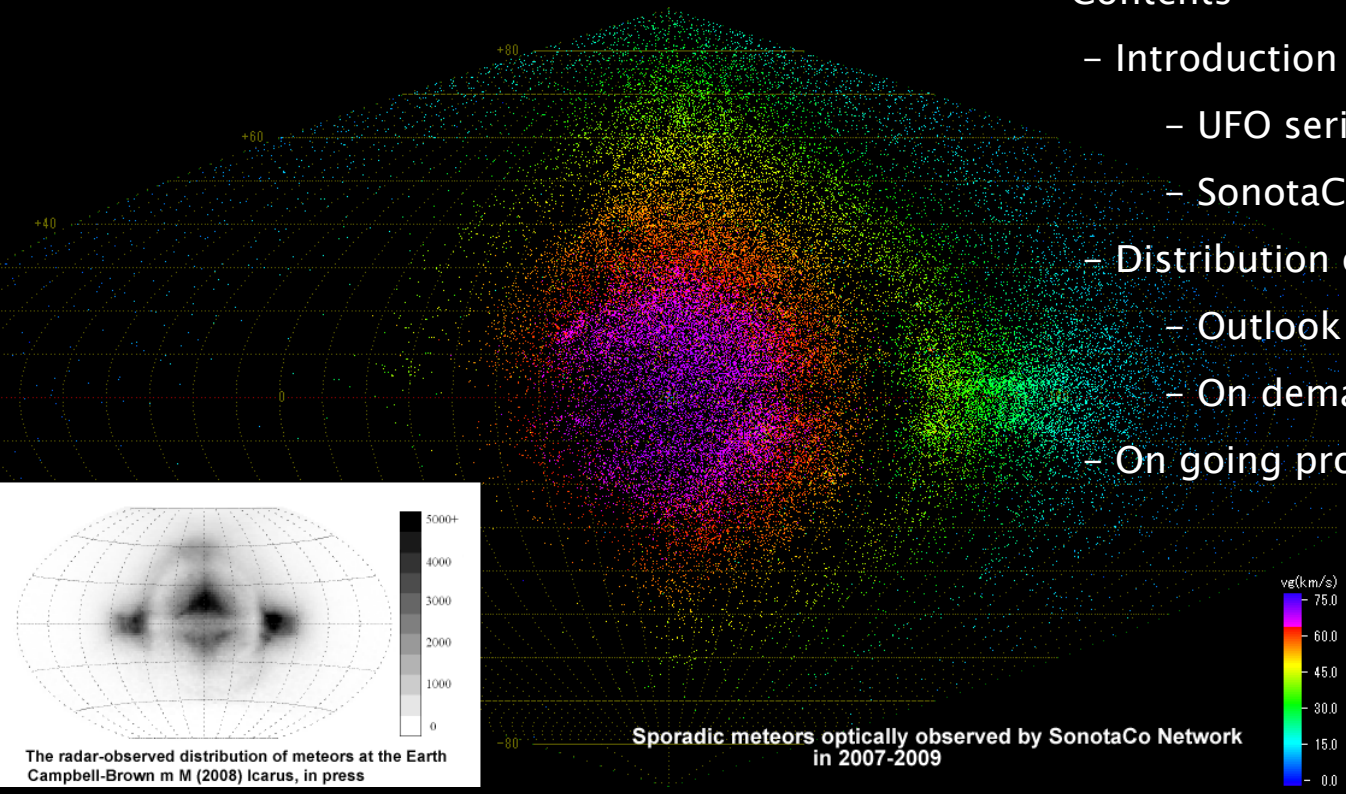
Distribution of 65000 video observed meteors

–Introduction of networked video observation results in recent years –

SonotaCo Nov/2010

Contents



Sporadic meteors optically observed by SonotaCo Network in 2007-2009

The radar-observed distribution of meteors at the Earth
Campbell-Brown m M (2008) Icarus, in press

UFOseries software for meteor observation

UFOCapture (2003) : Single station video observation

UFOAnalyzer : Measurement on video frames

UFOOrbit : Simultaneous observation determination

Trajectory and orbit computation

FireBallInspector : Mass estimation

Touch down point computation

UA2R : Spectrum analysis

UFORadiant : New shower detection

Shower catalog maintenance

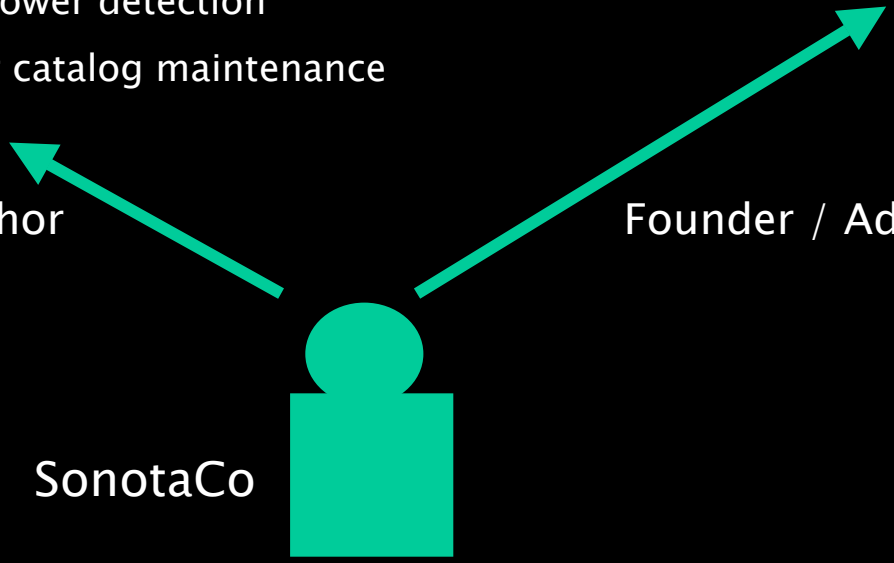
SonotaCo Network

Open scientific community on the internet about night sky events.

Data hub for

triangulation and orbit computation from simultaneous observations in public.

Beautiful scenes and interesting discussions!!



An avatar of a real person on the internet (not a company nor organization).

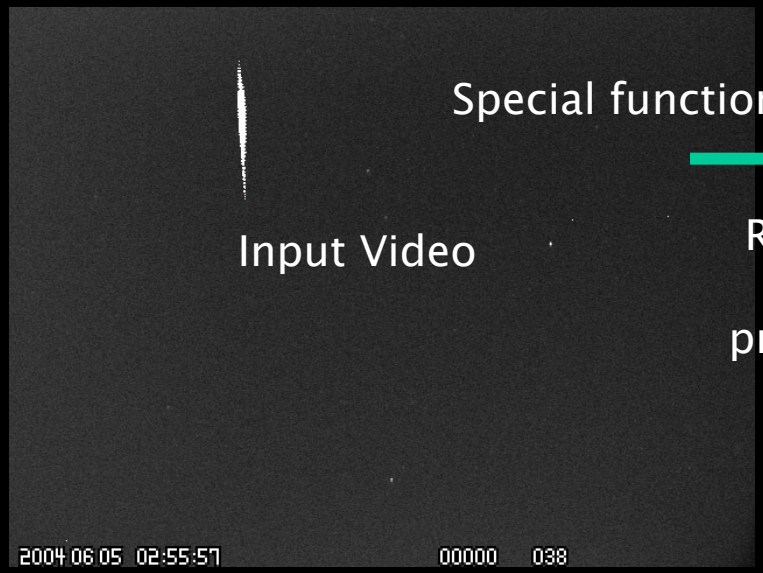
A professional of software development.

Doing night sky works as his hobby.

UFOCaptureV2

Time-Shift-Motion-Detect-Video-Recording

recognizes known objects to reject, and capture all unknown events!!
For un-expectable objects seekers



Input Video

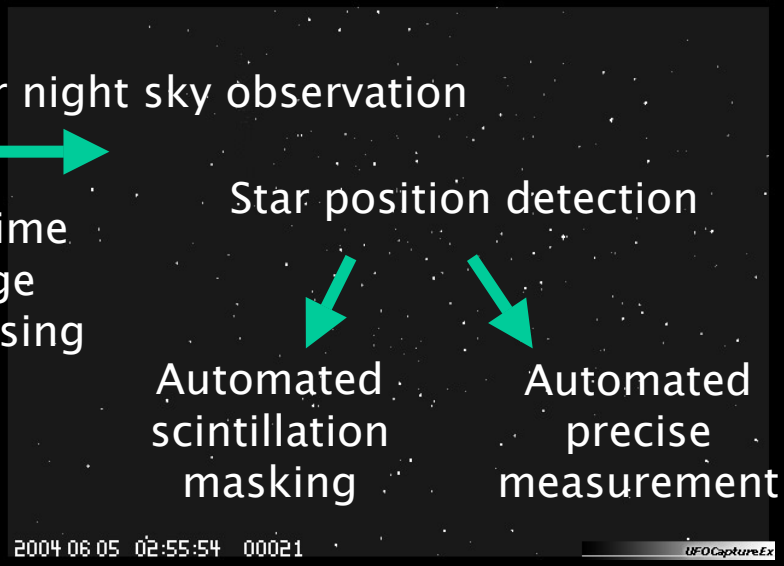
Special functions for night sky observation

Real time image processing

Star position detection

Automated scintillation masking

Automated precise measurement

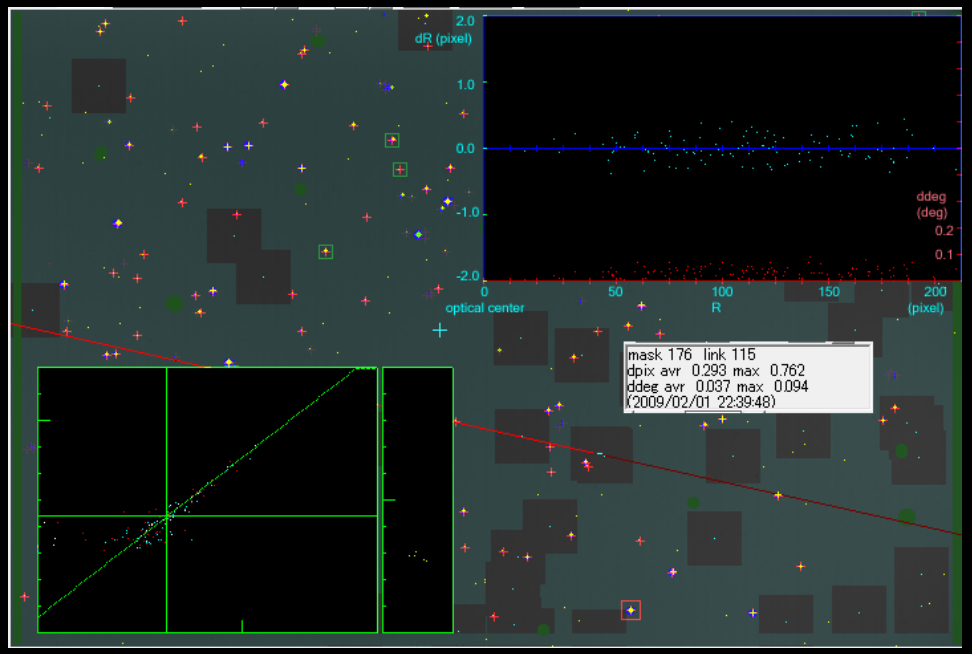


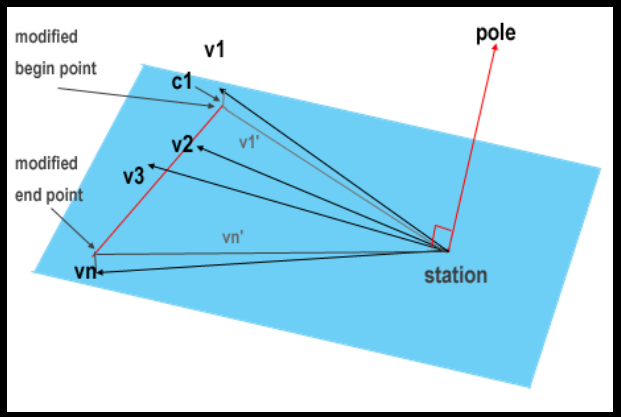
UFOAnalyzerV2

Automated astrometry and photometry on video frames !!

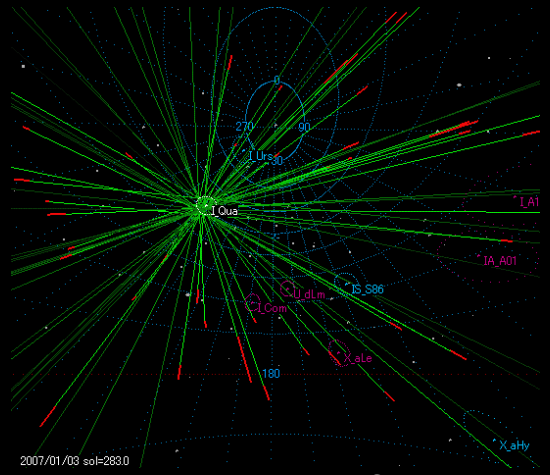
Automated plate parameter adjustment on 10th dimensional space.

→ 0.3 pixel determination accuracy for most of the lenses.

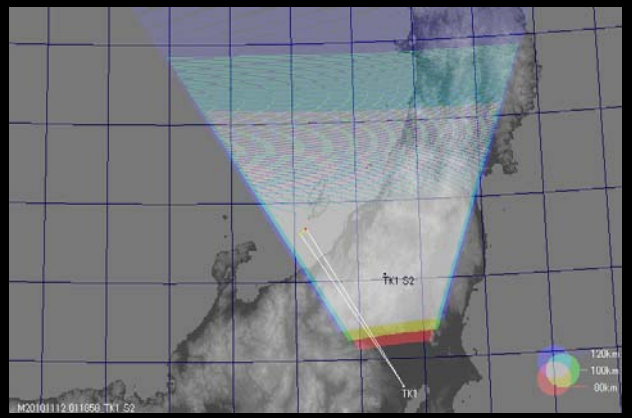




Trajectory determination by least square method



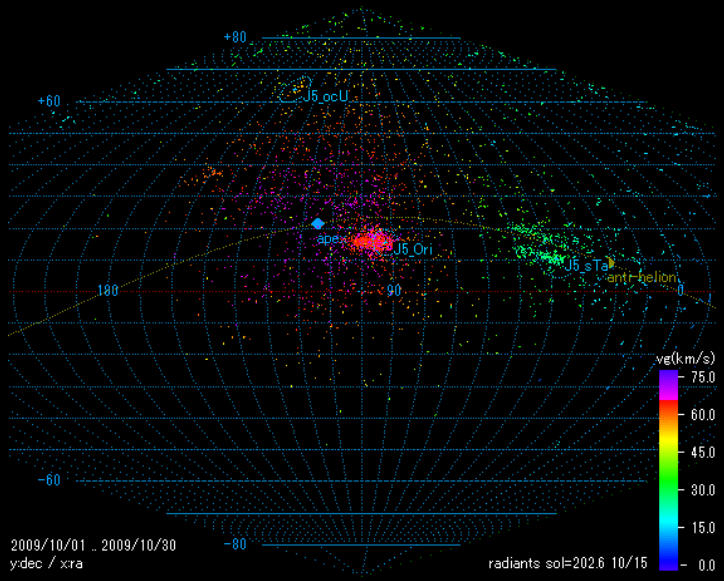
Trail map drawing for single station shower detection

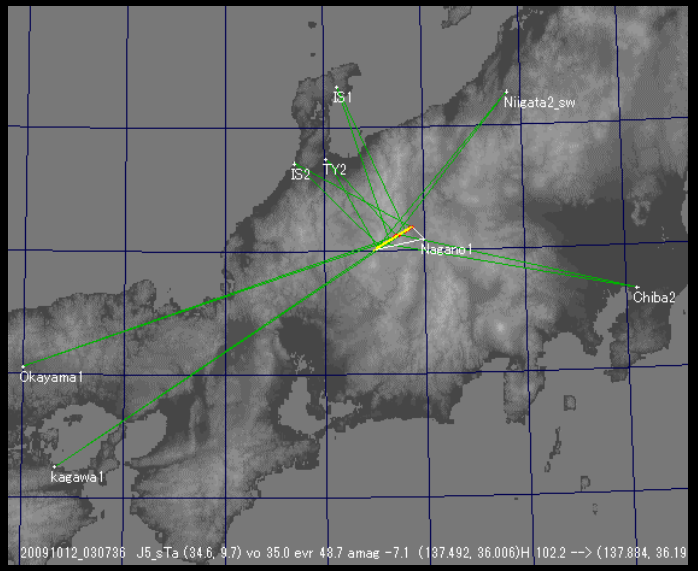


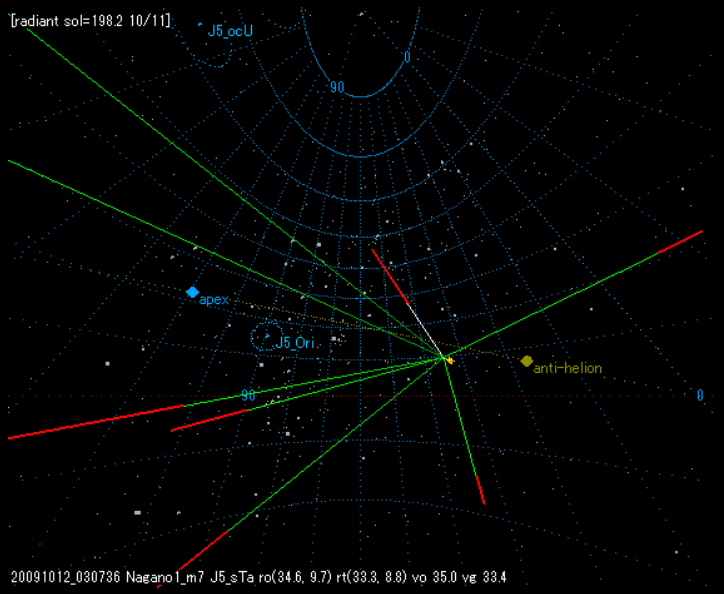
Utilities

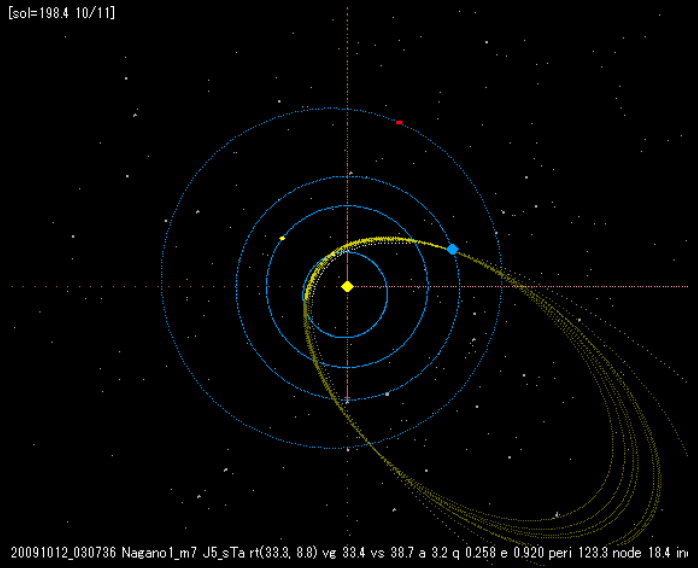
UFOOrbitV2 (UO2)

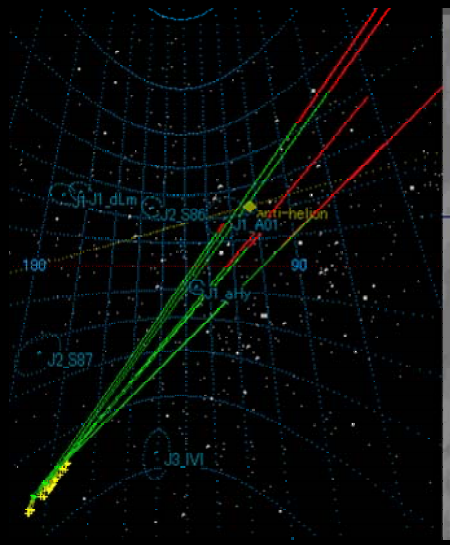
A Tool for Simultaneous Observers

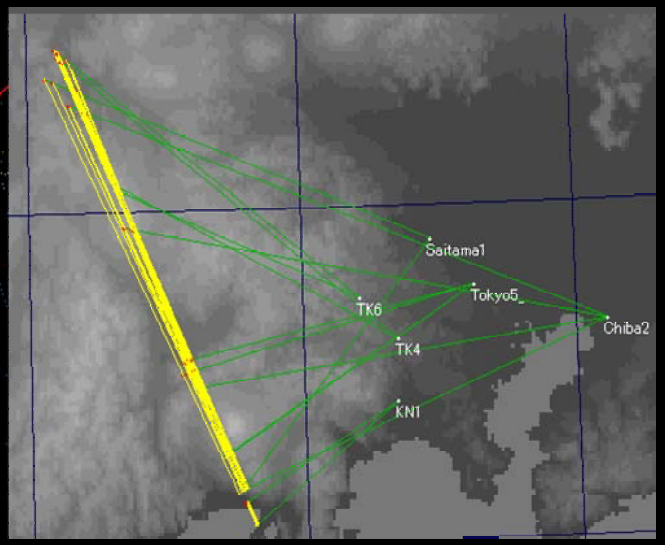






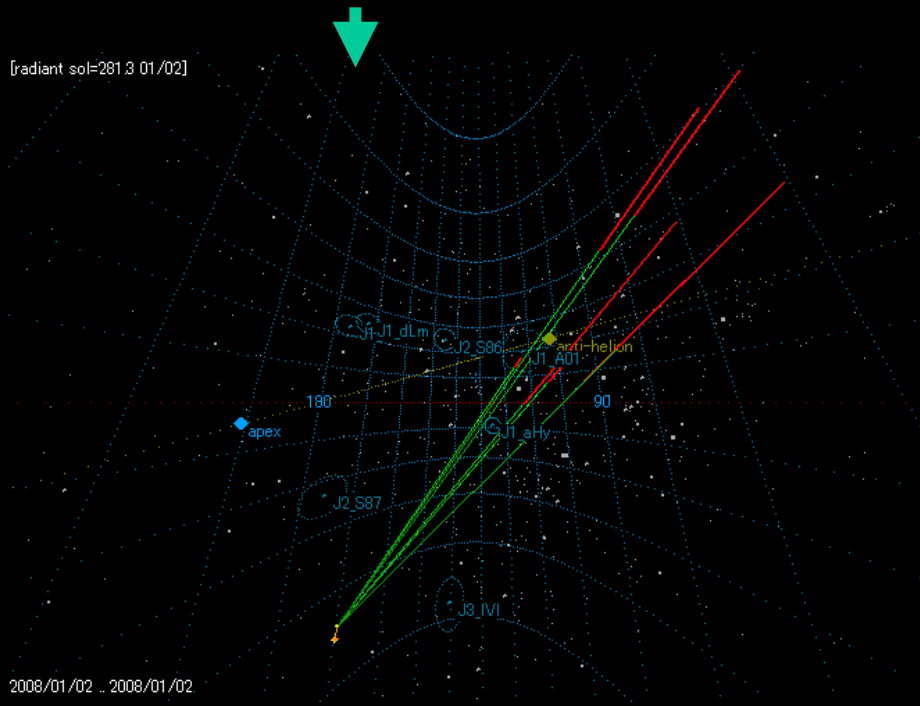


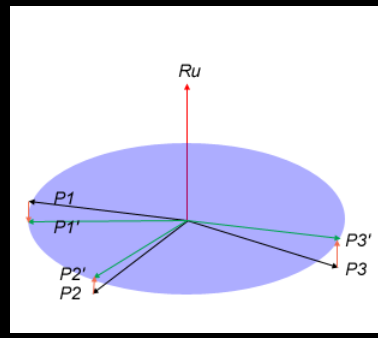




UFOOrbitV2

Unified Radiant computation using least square method on more than 2 simultaneous observations provides most probable single radiant





$$\text{unit vector of pole direction}: Pi = (\lambda_i, \mu_i, \nu_i)$$

$$\text{unit vector of unified radiant direction}: Ru = (\lambda_r, \mu_r, \nu_r)$$

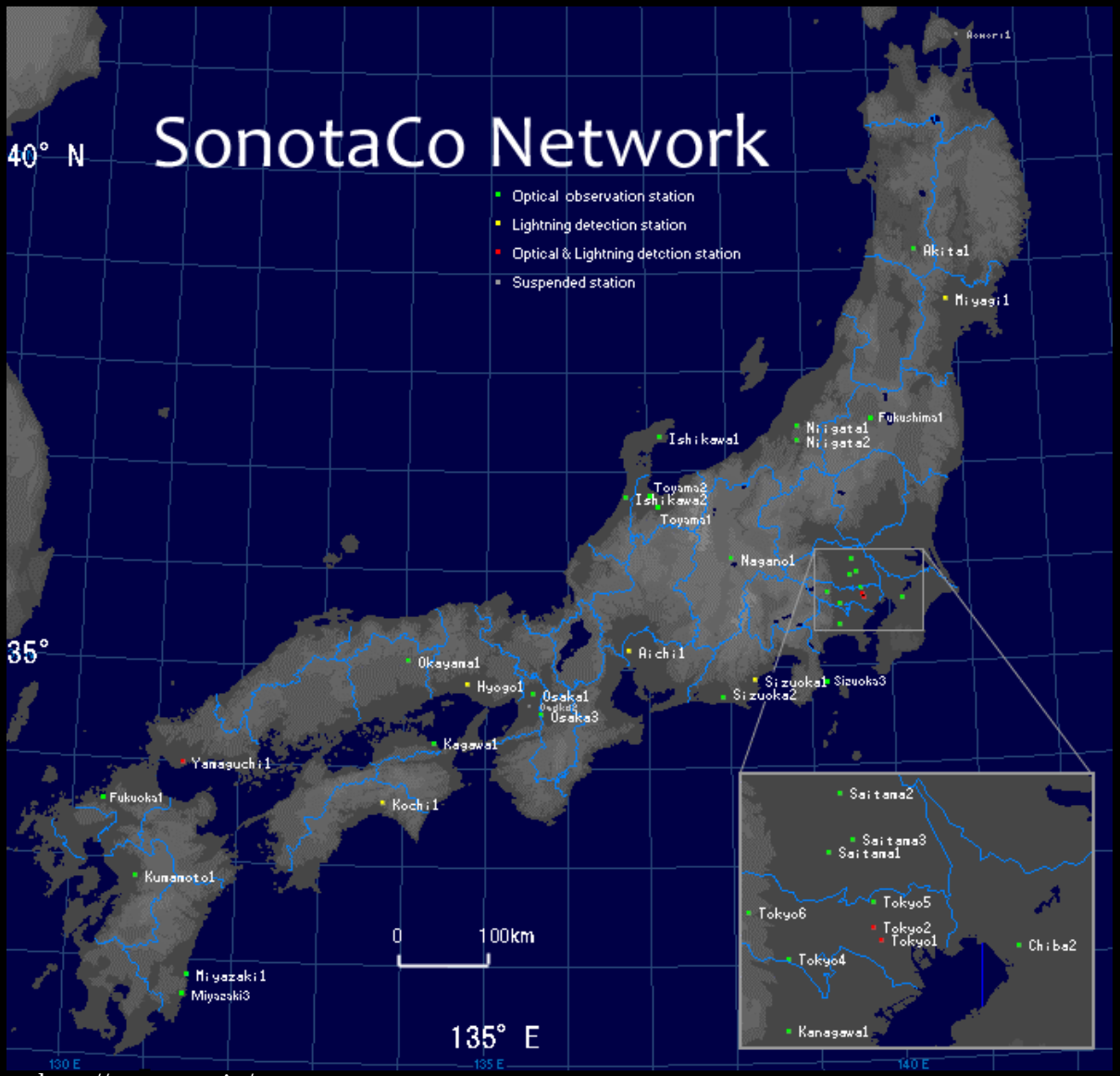
$$\text{TotalError}: E = \sum_i (\lambda_i\lambda_r + \mu_i\mu_r + \nu_i\nu_r)^2$$

$$\frac{dE}{d\lambda_r} = \sum_i \lambda_i^2 + 2\nu_r \sum_i \nu_i\lambda_i + 2\mu_r \sum_i \lambda_i\mu_i = 0$$

$$\frac{dE}{d\mu_r} = \sum_i \mu_i^2 + 2\lambda_r \sum_i \lambda_i\mu_i + 2\nu_r \sum_i \mu_i\nu_i = 0$$

$$\frac{dE}{d\nu_r} = \sum_i \nu_i^2 + 2\mu_r \sum_i \mu_i\nu_i + 2\lambda_r \sum_i \nu_i\lambda_i = 0$$

SonotaCo Network Video Meteor Observation



http://sonotaco.jp/

- Night sky video observation network on the internet, established in 2004.

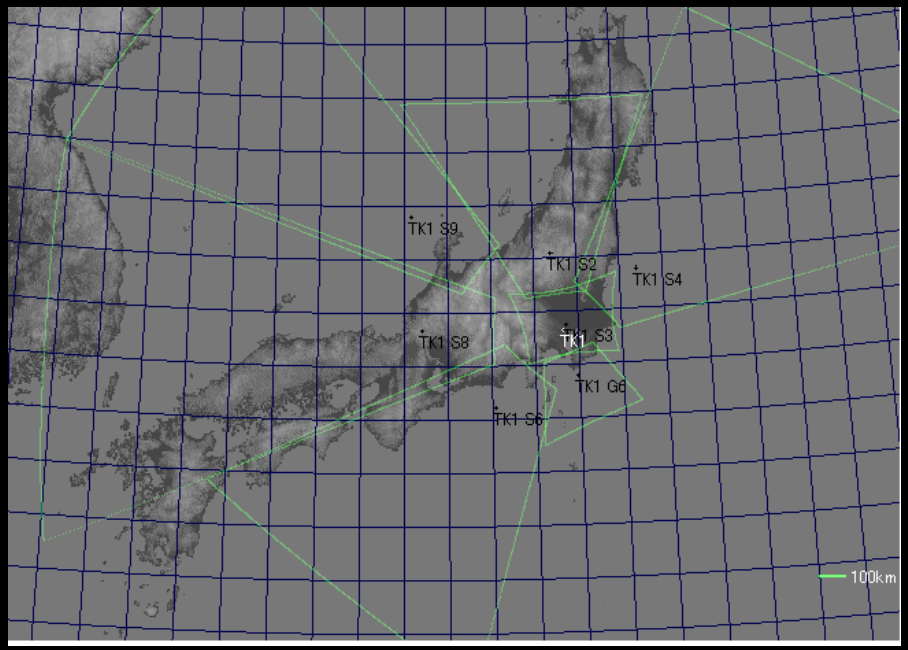
-Observing meteors, TLEs using UFOCapture, 30 to 90 degrees FOV, 640x480 resolution. (order of 0.1 degree/pixel accuracy)

-70 registered stations

(including 22 hi-schools)

- almost 20 stations (daily reporting) cover 50% of sky above Japan

Home observatories



Tokyo1(by SonotaCo) : 8 cameras

Nagano1(by Masuzawa) : 5 cameras

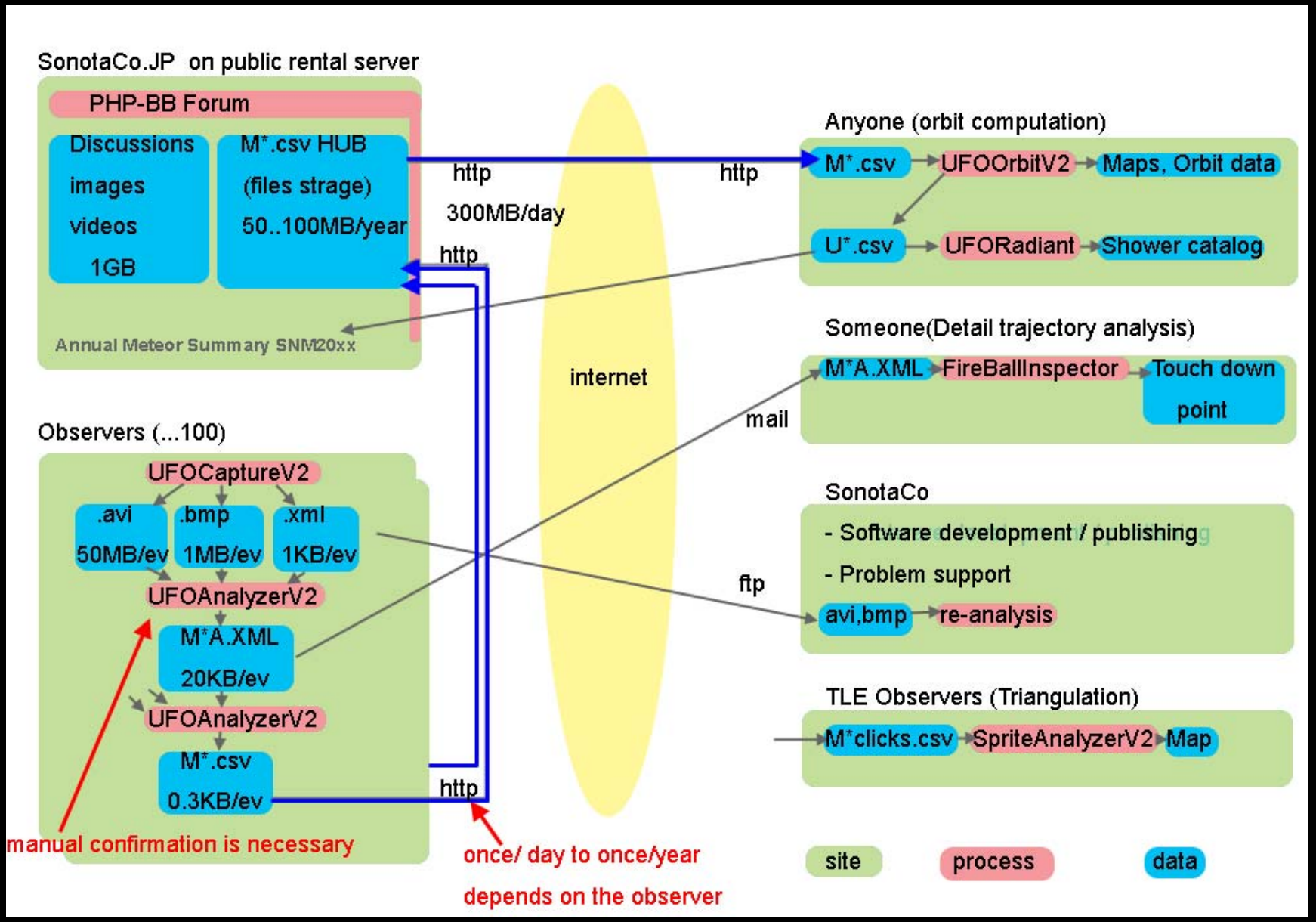
Weather proof housing is very important for stable observation.

Also more rigid camera mount is preferable not to be vibrated by wind.

(Direct Sun light did not harm cameras with auto iris lens, ever.)

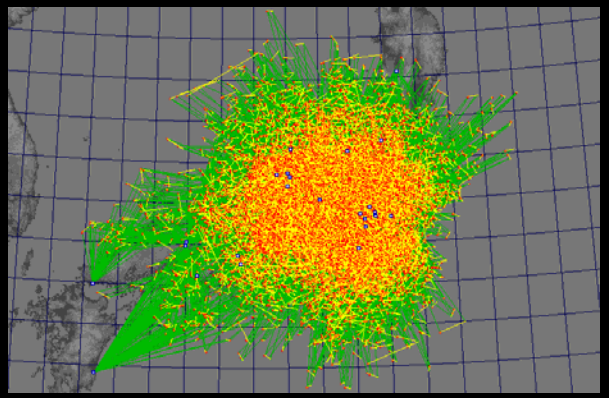
→..

Data flow on SonotaCo Network

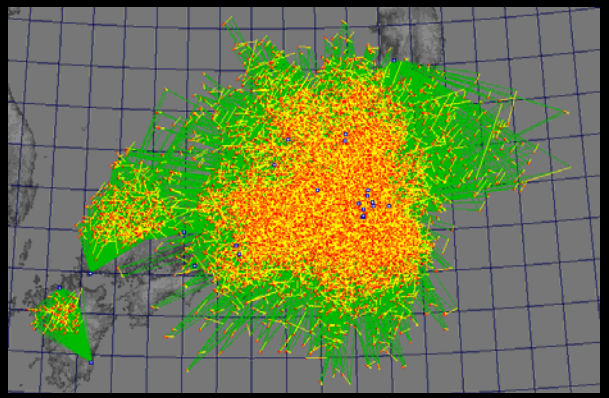


Meteor Observations on SonotaCo Network

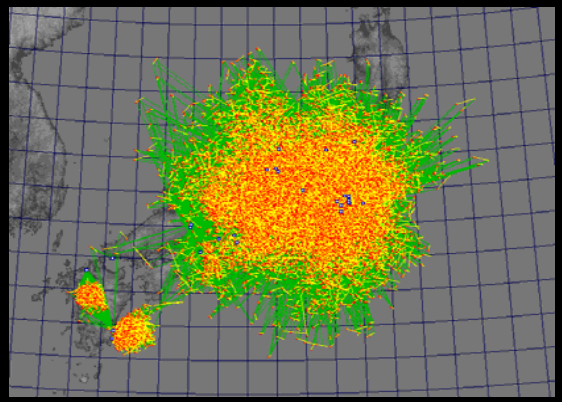
Year	#stations > 100 obs	#single station observations	#simultaneous meteors	Epoch
2003	1	Not analyzed	0	Apr: UFOCapture Sep: UFOCaptureEx (w. S.M.)
2004	10	…10,000	0	Jan: UFOAnalyzer Dec: UFOOrbit, CSV Hub
2005	10	…60,000	Not counted	May: UFOCaptureV2
2006	15	…100,000	7,705	Mar: UFORadiant Oct: Finding of OCU
2007 SNM¥2007.txt	20	163,804	19,274	Jan: UFOAnalyzerV2 Apr: UFOOrbitV2
2008 SNM¥2008.txt	21	146,301	19,436	
2009 SNM¥2009.txt	22 (73cams)	180,735	25,940	Jan: J4 shower catalog Jun: SNM2007,2008



2007



2008



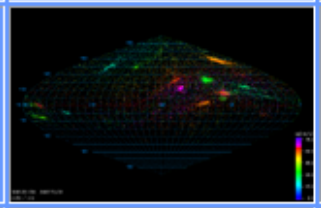
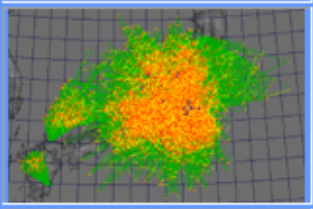
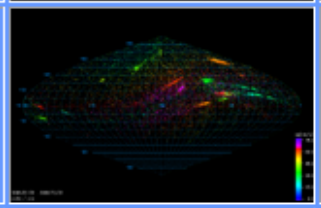
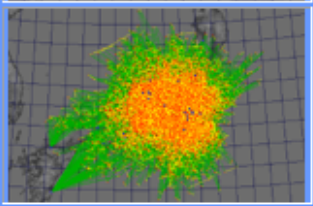
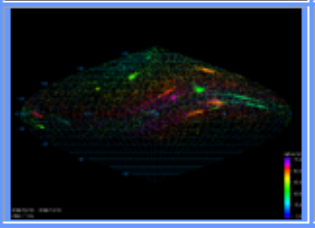
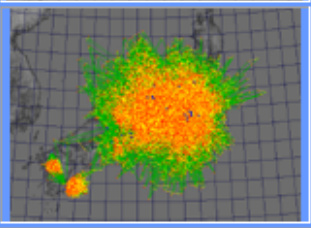
2009

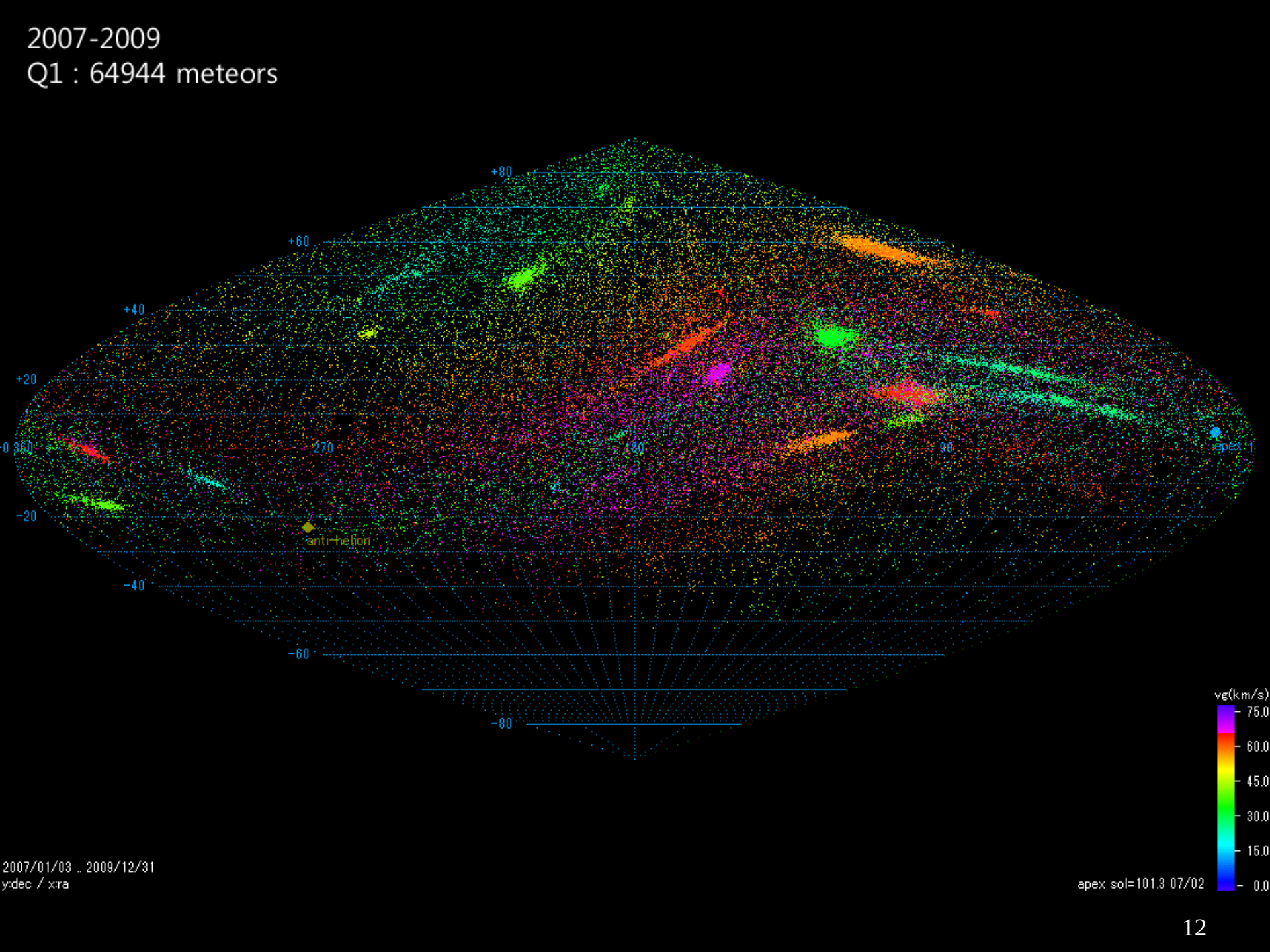
Observation result publication
http://sonotaco.jp/doc/SNM/

SonotaCo Network Simultaneously Observed Meteor Data Sets

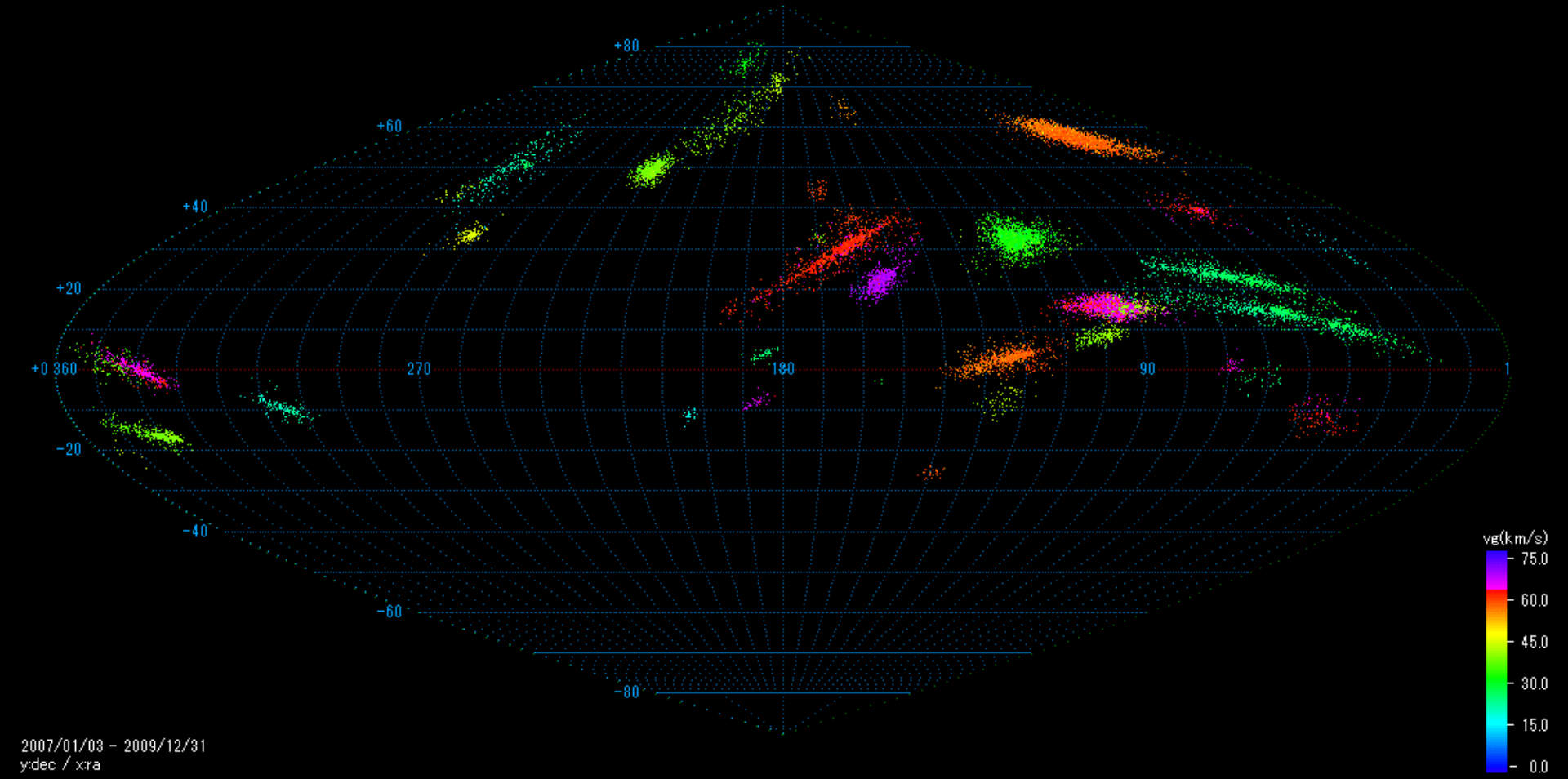
This page contains simultaneously observed meteor data sets reduced from observations by the SonotaCo Network Members.
Note of each file shows the observers and the outline of the sets.

This can be downloaded and used freely for non-profit purpose of scientific research or academic affairs.
For the publishing of the results using these data sets, you should use credit below.
"SonotaCo Network Simultaneously Observed Meteor Data Sets SNM20xxx", http://sonotaco.jp/doc/SNM/

data set name date editor	file(*1)	observation peroid(JST) from to	number of meteors	note	radiant map	ground map
SNM2007A 5/Jun/2009 SonotaCo	SNM2007A.ZIP (4.6MB)	01/Jan/2007 31/Dec/2007	19274	2007.txt		
SNM2008A 5/Jun/2009 SonotaCo	SNM2008A.ZIP (4.7MB)	01/Jan/2008 31/Dec/2008	19436	2008.txt		
SNM2009B 17/Feb/2010 SonotaCo	SNM2009B.zip (6.2MB)	01/Jan/2009 31/Dec/2009	25940	2009.txt		


2007-2009
Q1 : 64944 meteors
+80
+60
+40
+20
0 360
270
180
90
apex
-20
anti-helion
-40
-60
-80
vg(km/s)
75.0
60.0
45.0
30.0
15.0
0.0
2007/01/03 .. 2009/12/31
y:dec / x:ra
apex sol=101.3 07/02

22359 Shower Meteors (using J5 shower catalog)

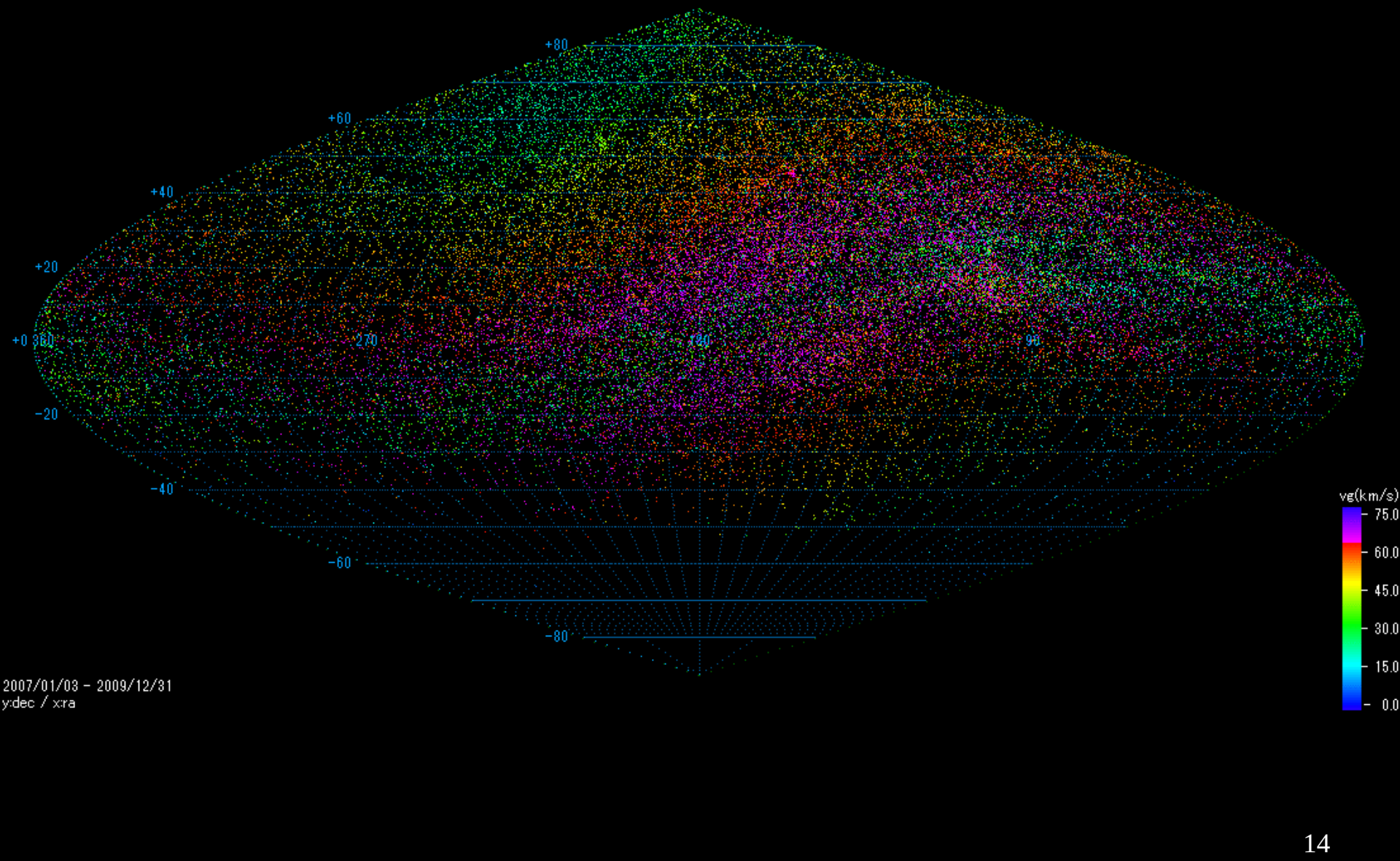


	IAU Established list 2008	SonotaCo J4 2009
Identical	19	19
Merged	11	5
New	–	14
Invisible	26	–
Total	56	38

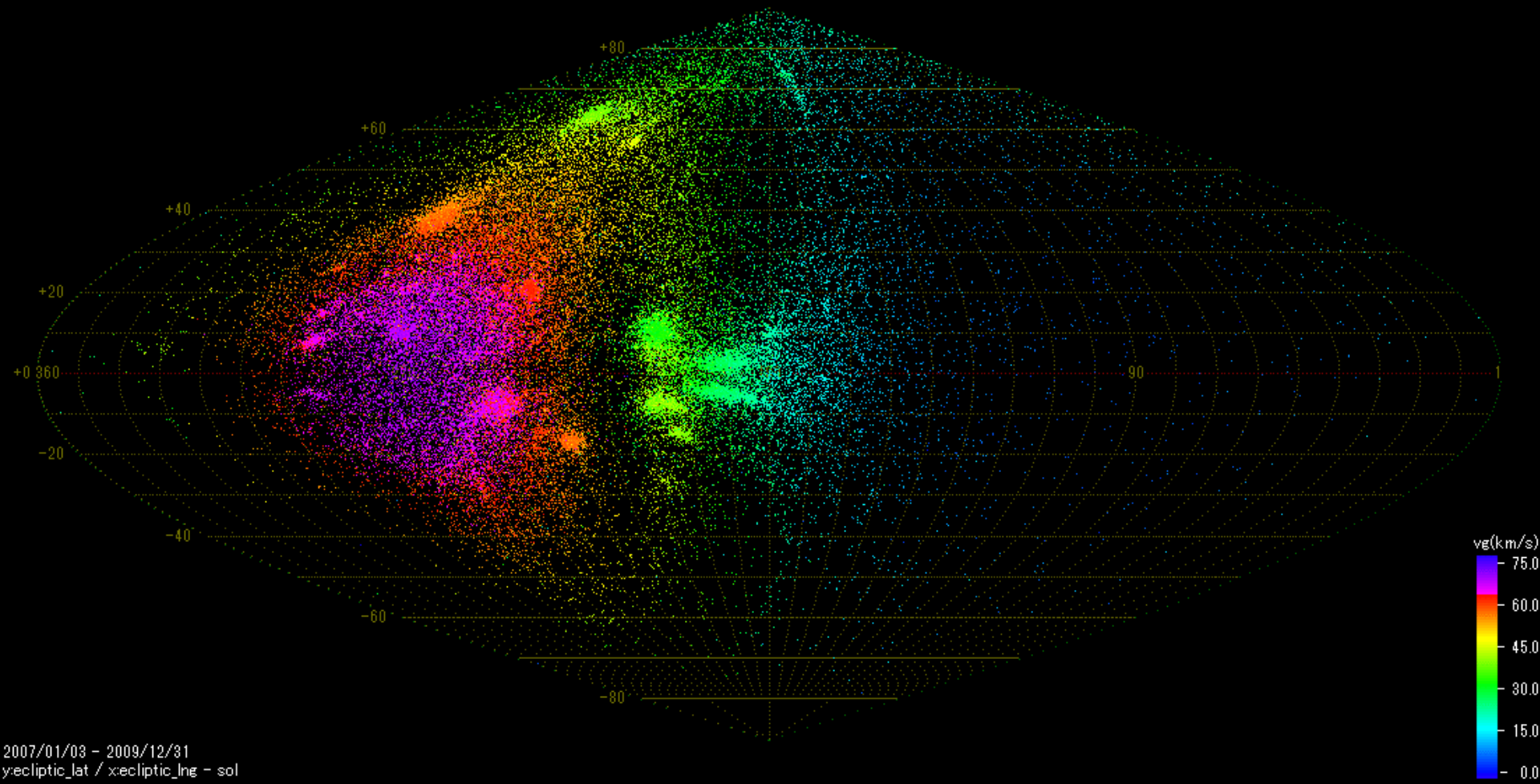
J4:"A meteor shower catalog based on video observations in 2007-2008" on WGN37-2

J5: http://sonotaco.jp/doc/J5/

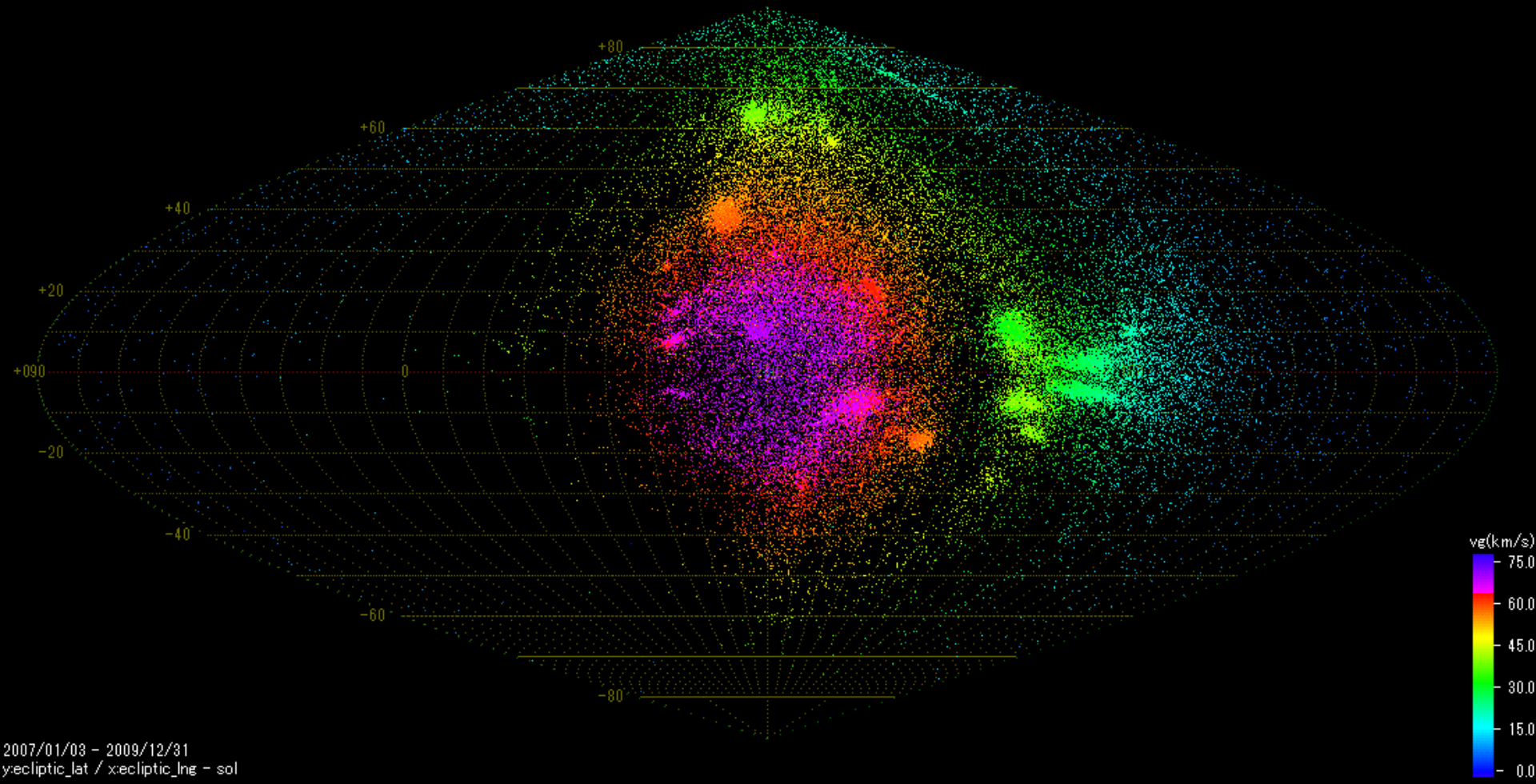
Sporadic 42291 Meteors ra-dec coordinates



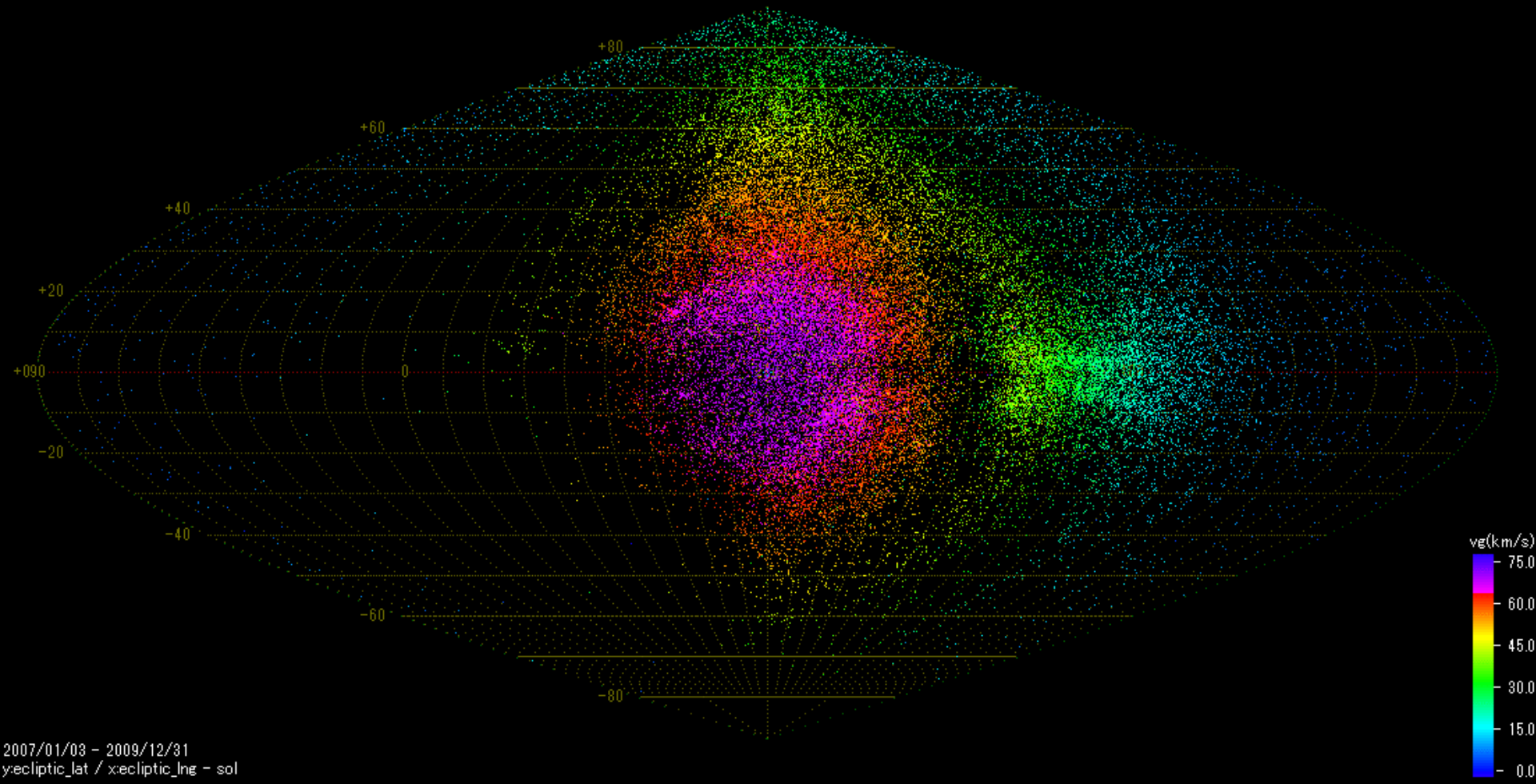
All Meteors (Sun relative (L-LS) coordinates, anti helion center)



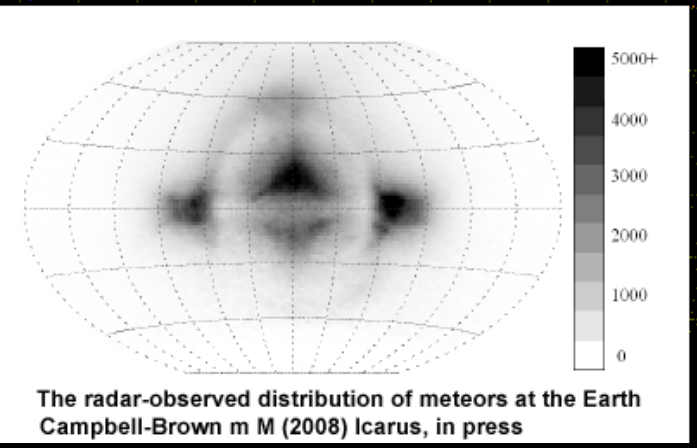
All Meteors (Sun relative (L-LS) coordinates, APEX center)



Sporadic Meteors (Sun relative (L-LS) coordinates, APEX center)



Comparison Video with Rader

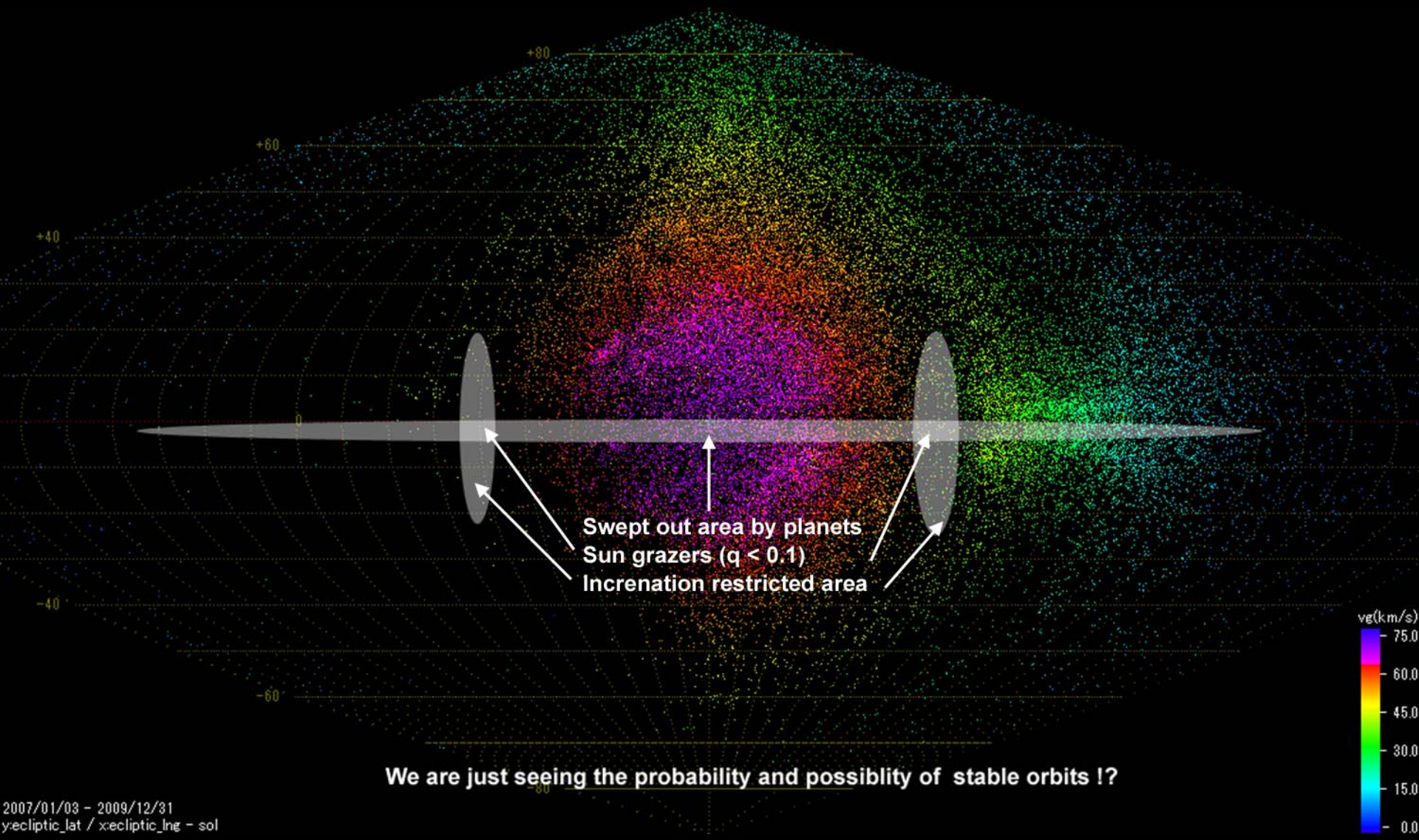


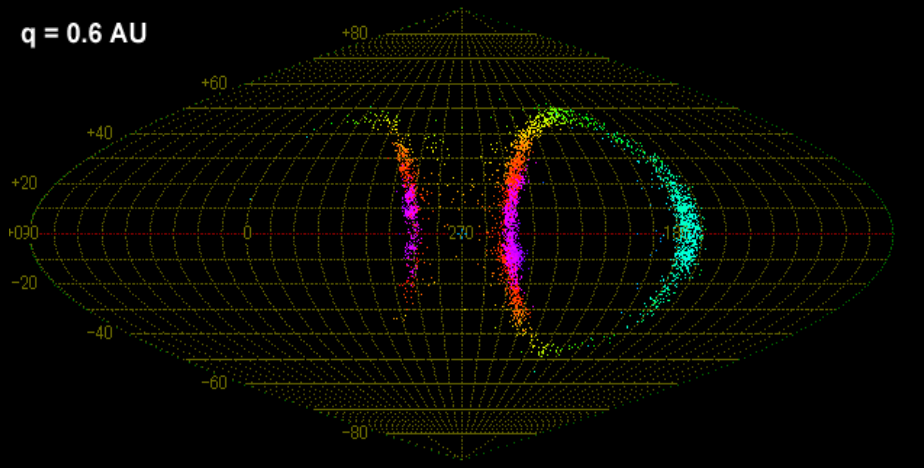
The radar-observed distribution of meteors at the Earth
Campbell-Brown m M (2008) Icarus, in press

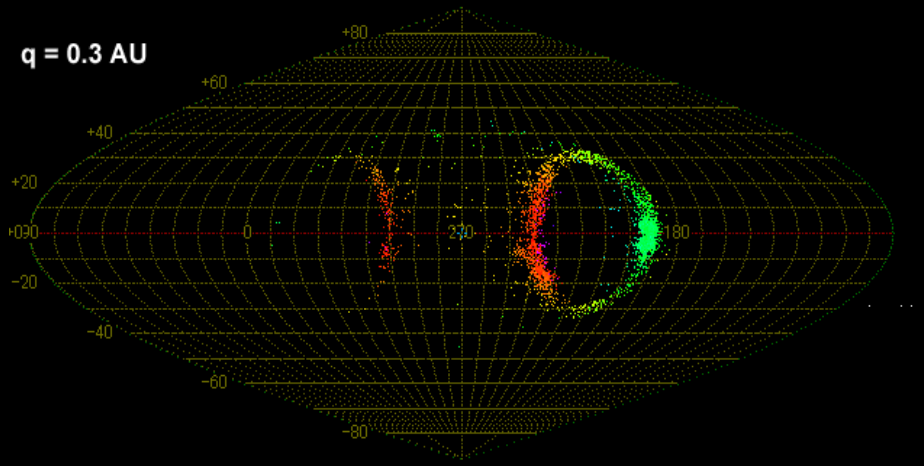
Sporadic meteors optically observed by SonotaCo Network
in 2007-2009

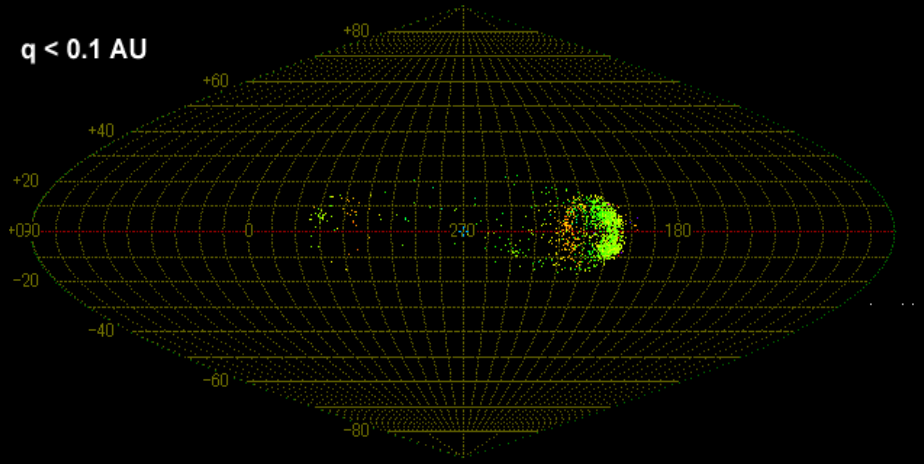
vg(km/s)
75.0
60.0
45.0
30.0
15.0
0.0

Smooth distribution with vacant area that is restricted by orbit condition (Gaps have physical meaning!)









q : Perihelion distance plot

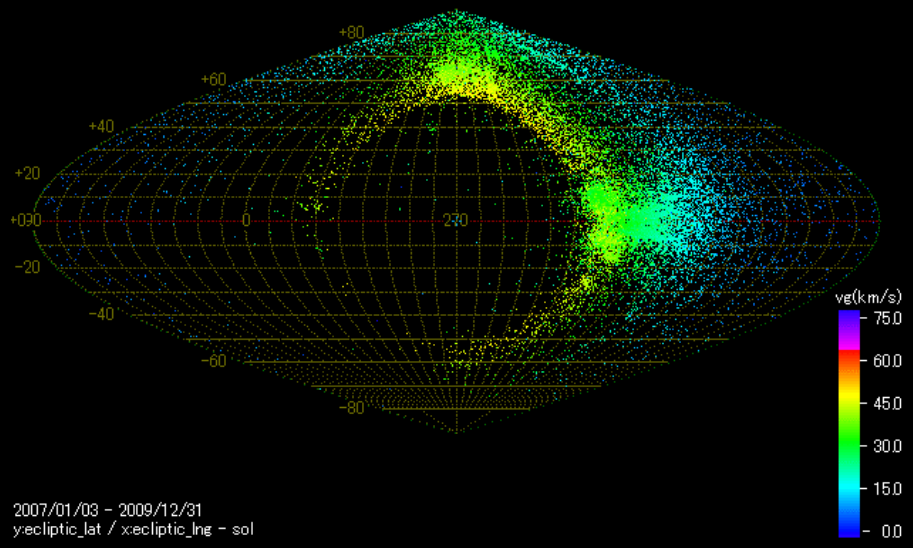
Sun grazing orbit's radiant

L-Ls : around 210 or 330

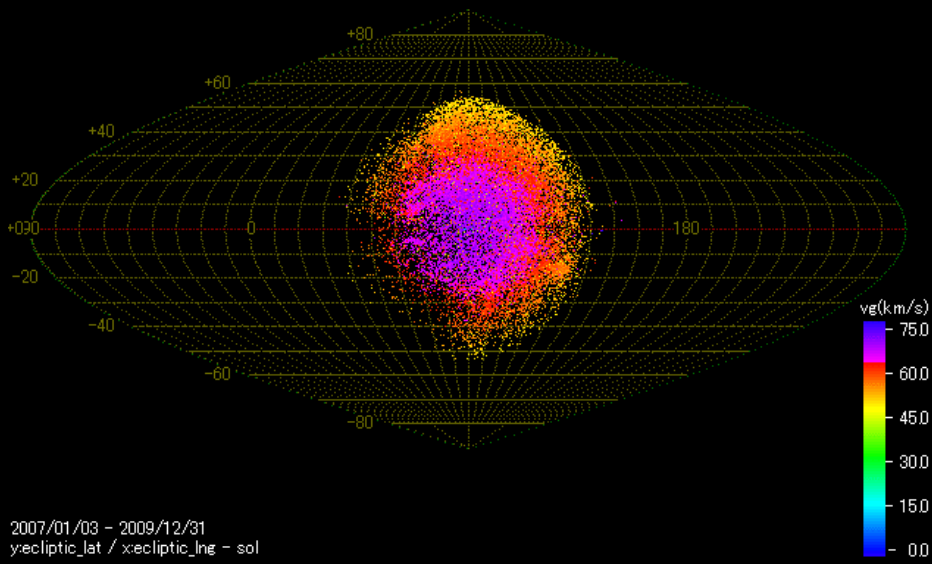
β : small

i : Inclination plot

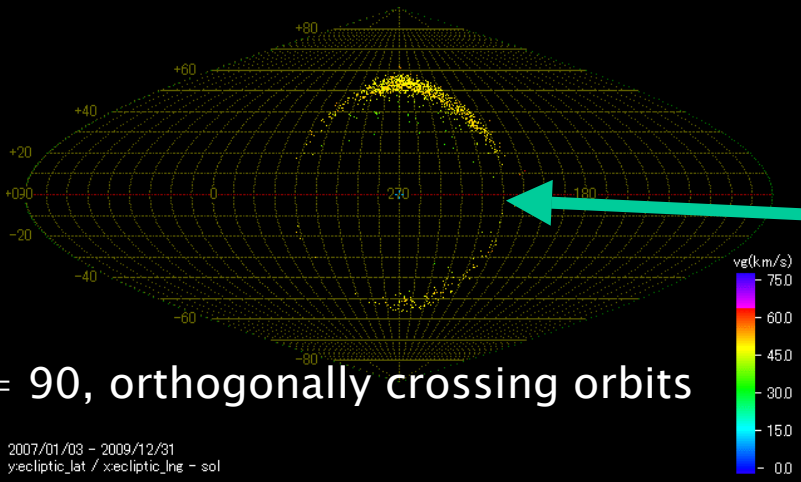
(radiant possibility is tightly restricted by the earth colliding condition on each inclination)



i < 90deg , prograde orbits



i > 90deg, retrograde orbits

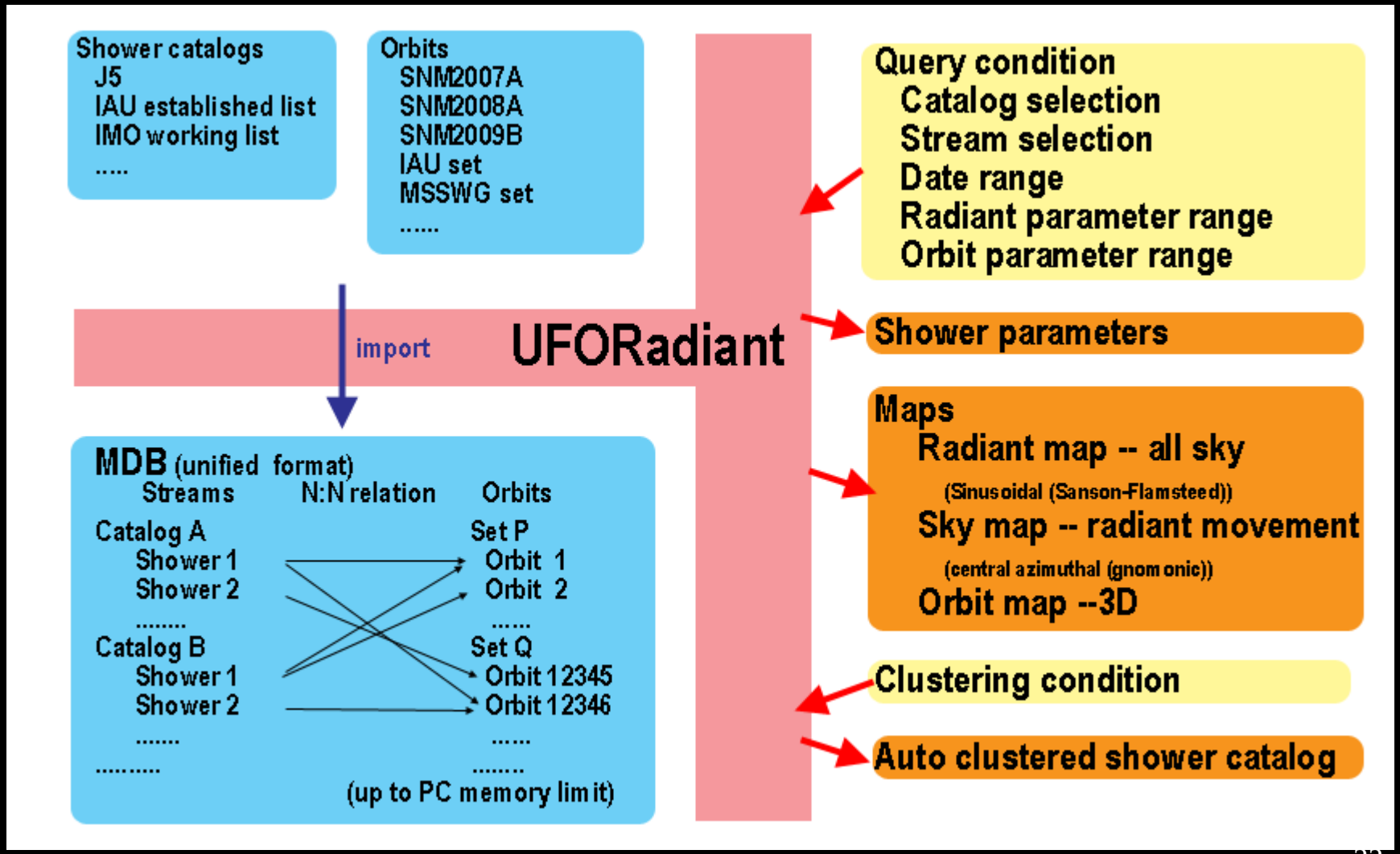


i = 90, orthogonally crossing orbits

Low probability area

Low β and i =90

UFORadiant -- Meteor Database viewer for shower identification
-- Portable on-memory DB with original compact engine
-- Tool for orbits clustering and shower parameter determination



On going projects

Virtual Meteor Observatory
(Real time unified meteor DB on internet)

(… waiting for key person, found or volunteer!!)

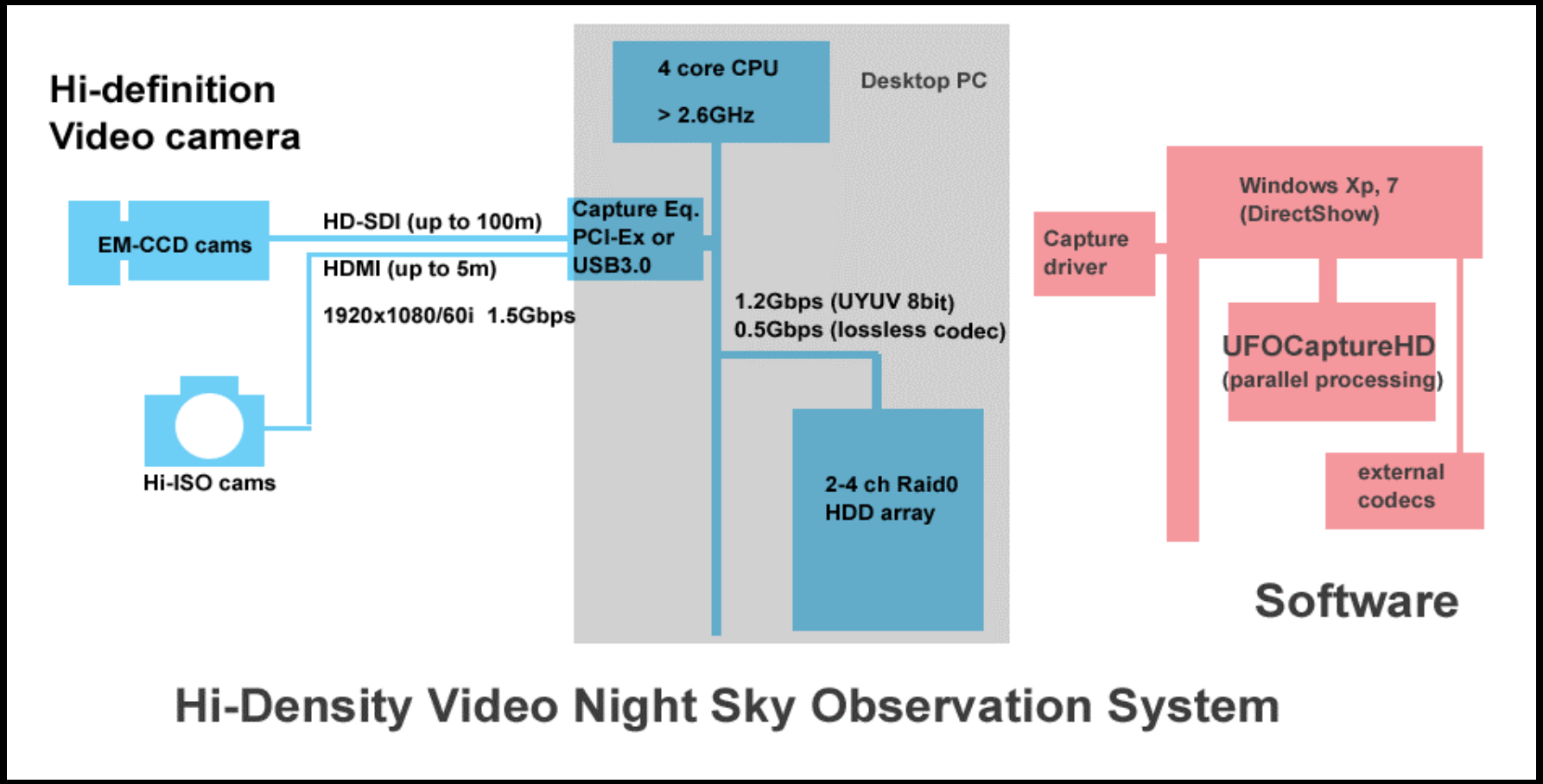
Time shift motion detection on Hi-Definition video
UFOCaptureHD

1920x1080 60i un-compressed(YUV8bit) broadcast quality video!!

Using multi-core-CPU parallel processing!!

Measurement accuracy will be dramatically improved !!

(will come soon!!)

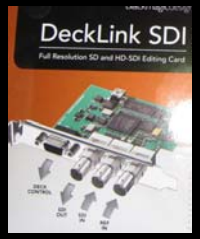


Hi-Density Video Night Sky Observation System

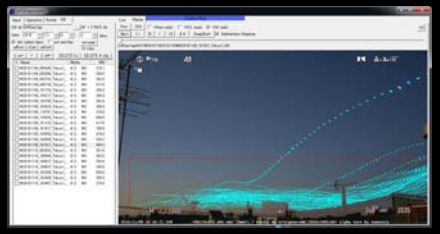
HDMI cam
DMC-GH2 +
50mmF1.2
1920x1080/60i
ISO 12800

HDMI

HD-SDI



4 core CPU with
4ch Raid0 HDD



UFOCaptureHD
prototype

Test system (0.004 degree accuracy !)


2010/11/09 17:18:27.172 V00010+157 DMC-GH2 20mmF1.7 Tokyo1 HD UFOCaptureHD 1920x1080/60i alpha test by SonotaCo

Conclusion

1) Networked video meteor observation, supported by volunteers for the science, have succeeded to get 65,000 meteor orbits in 3 years.

2) Semi-Automated observation enables continuous operation and accuracy keeping. It results homogeneous whole year distribution map of meteors.

3) Comparison between video and radar or re-confirmation by each other now became possible.

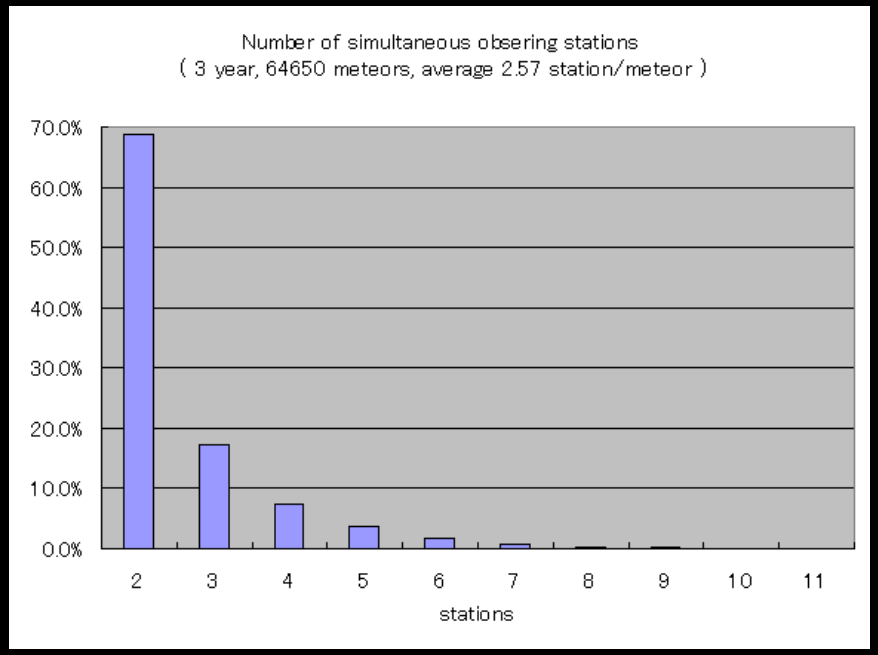
4) Outlooks of actual distribution on video and radar were similar with each other.

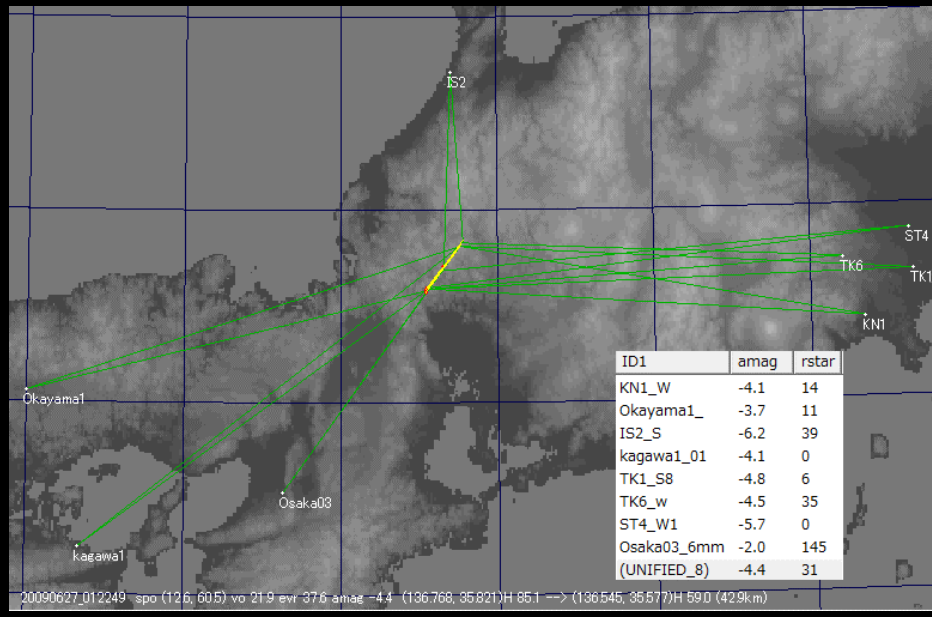
5) Gaps or vacant area in radiant map seems to have physical meanings.

6) Video observation accuracy will be dramatically increased by using HD video, soon.

What happened in Simultaneous Observation

-- Observation by more than 2 station happens often!



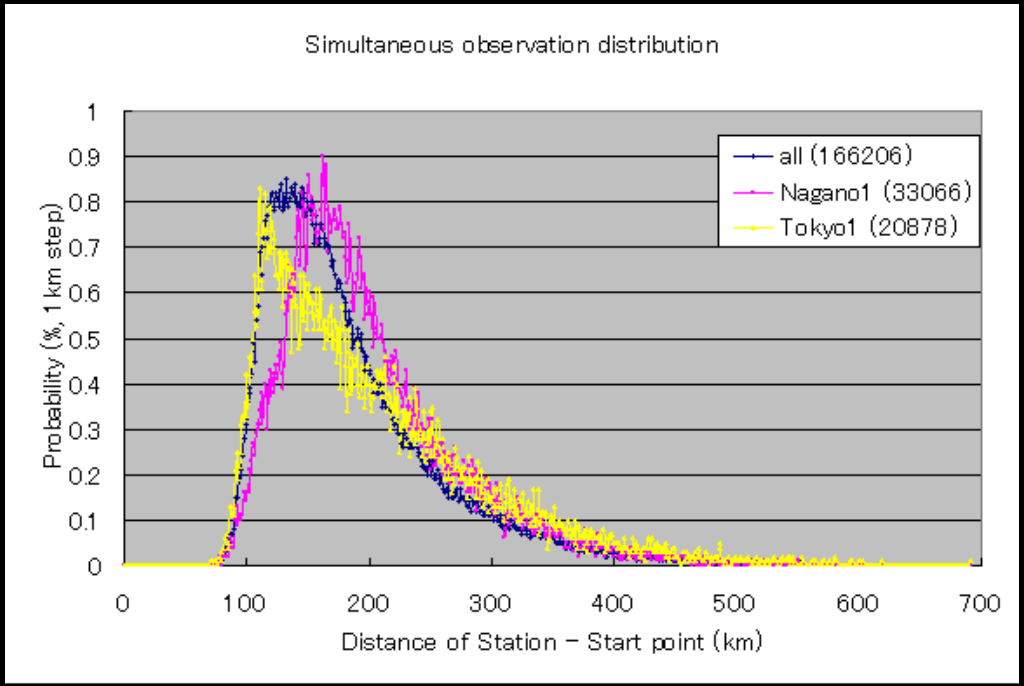


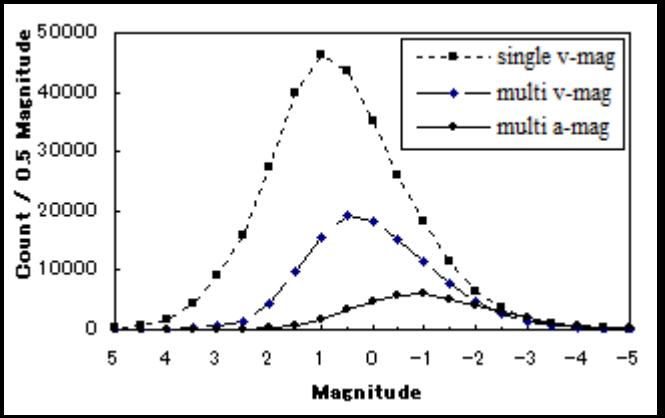
30% are observed by more than 2 stations

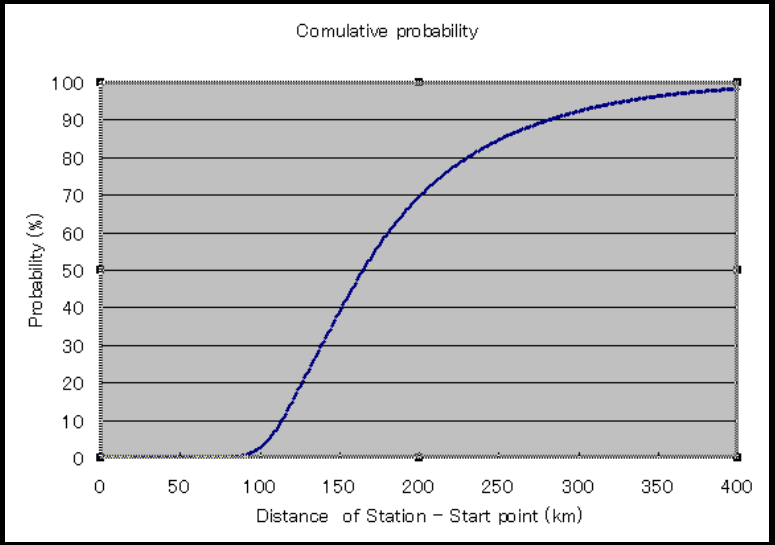
up to 10 stations

Meteor Distance

Magnitude (2007-2008)







< 150km 30%

150 - 200km 40%

200 - 300km 20%

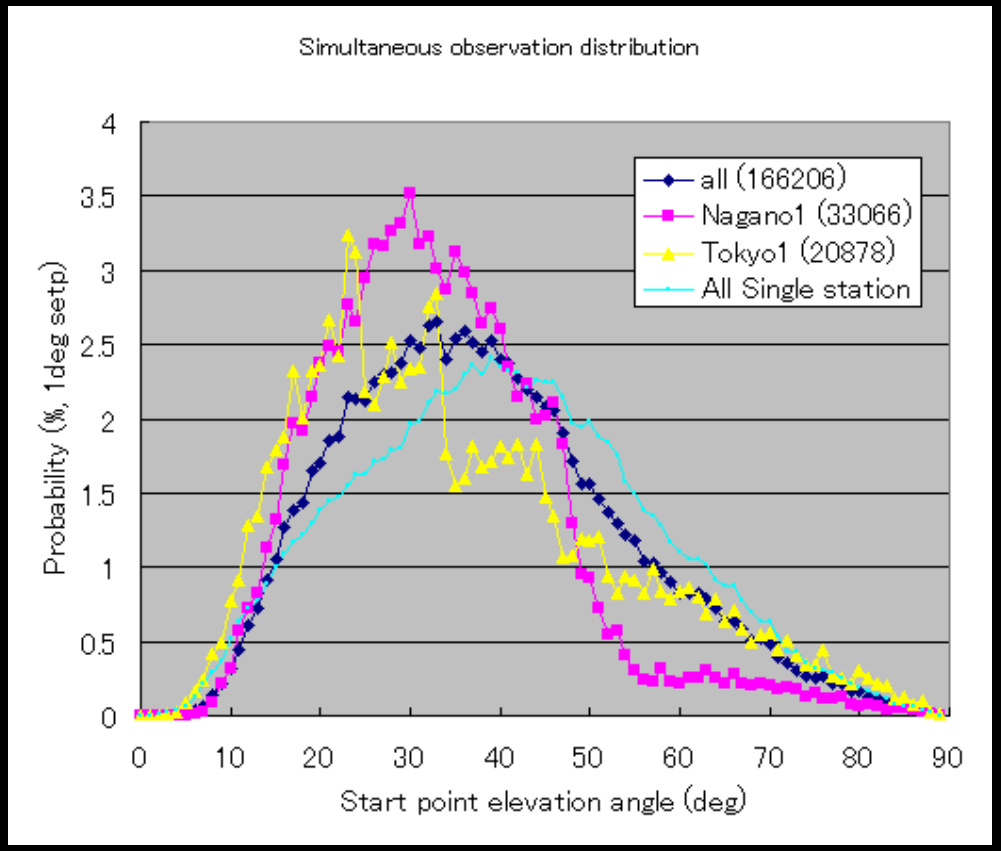
> 300km 10%

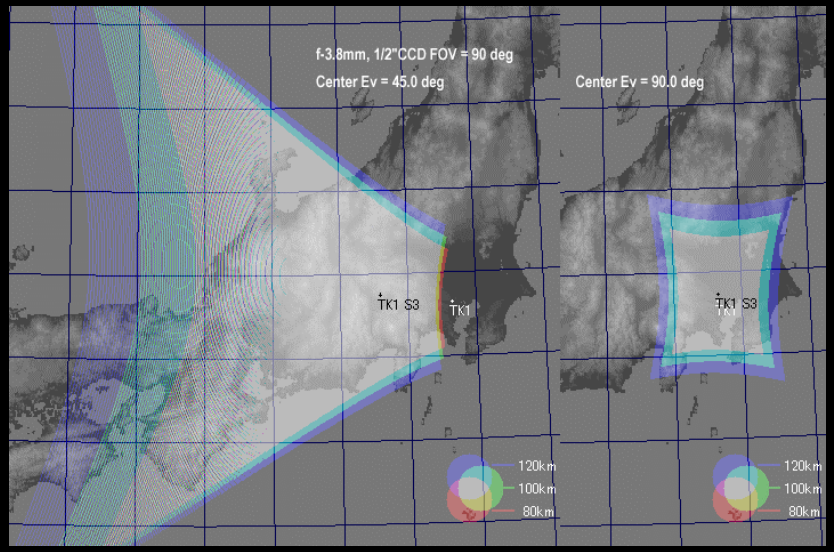
Up to 700km

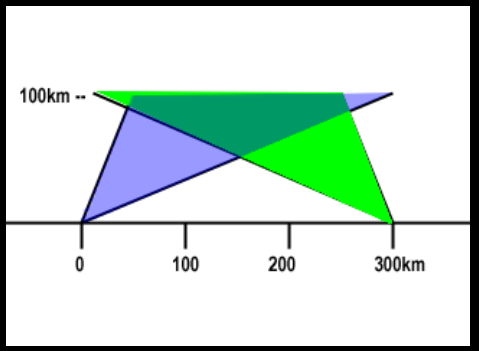
Factors :

- Detection sensitivity
- Natural distribution of meteor magnitude
- Distance and elevation angle of cameras
- Weather equality on the region

Elevation angle (which is the best angle?)





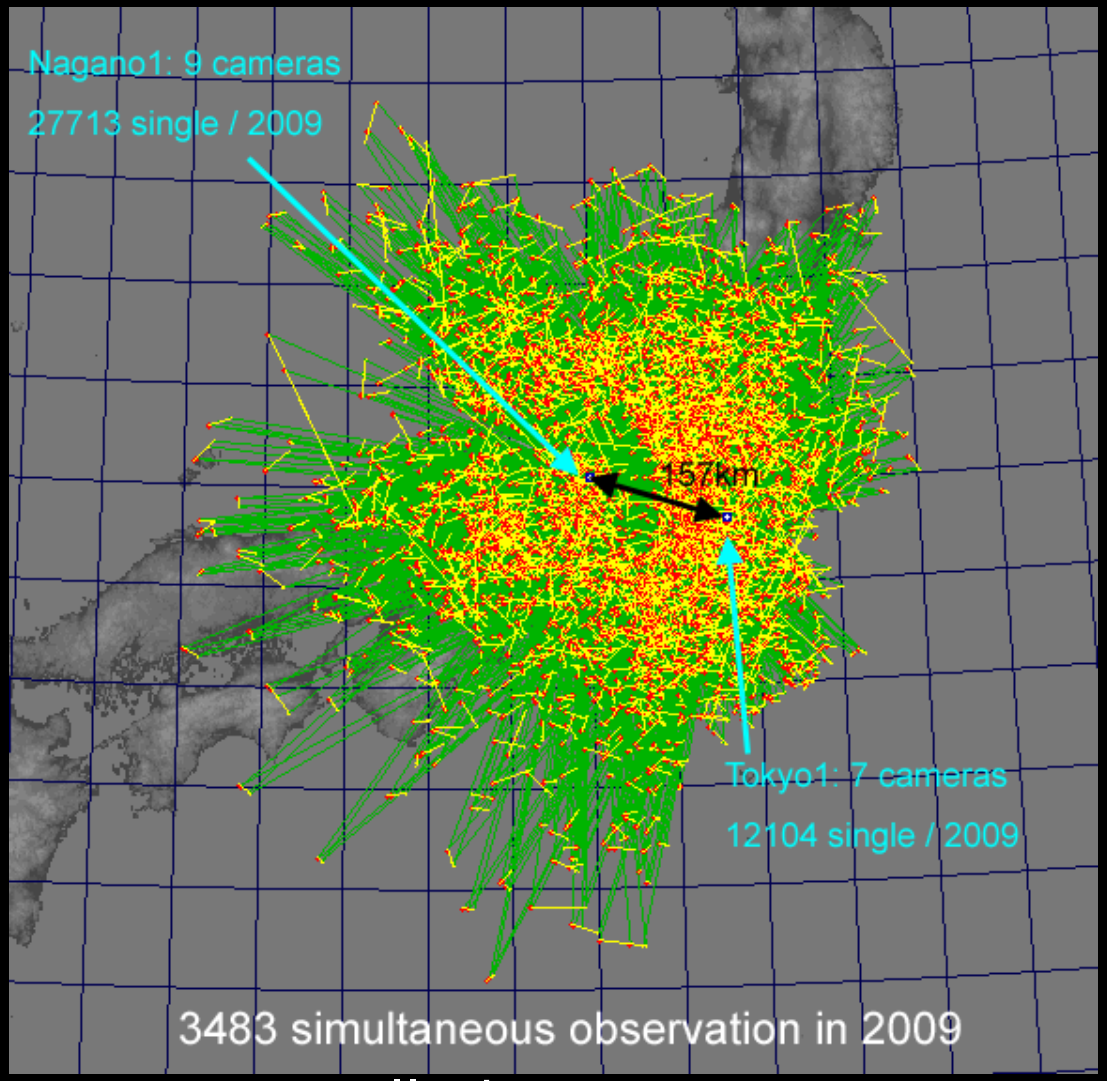


Zenith was not the highest probability direction.

Effective observed area size was the major factor.

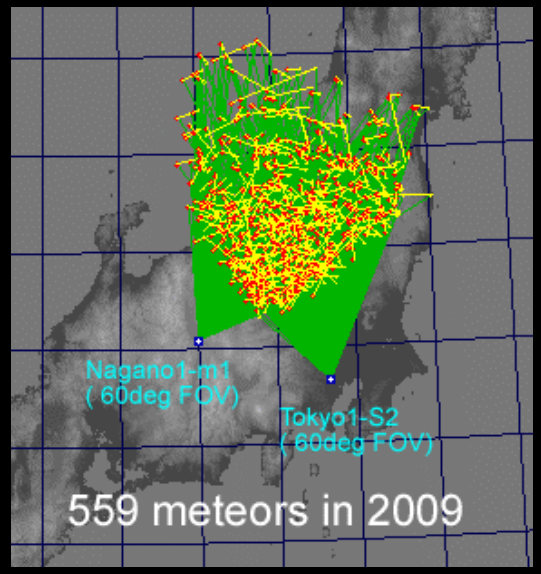
200 to 300km distance of two stations would be the best efficiency ?

What was got by only 2 stations

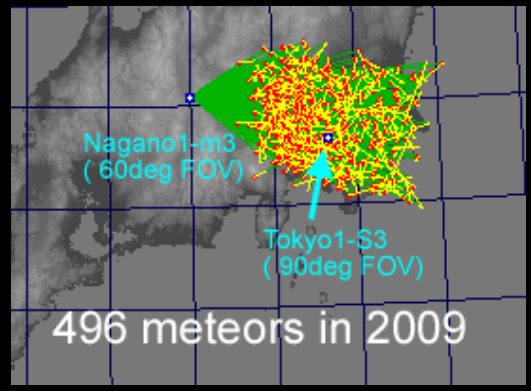


2 all-sky stations

(average Qc = 38.5deg) … 157km is too close!!



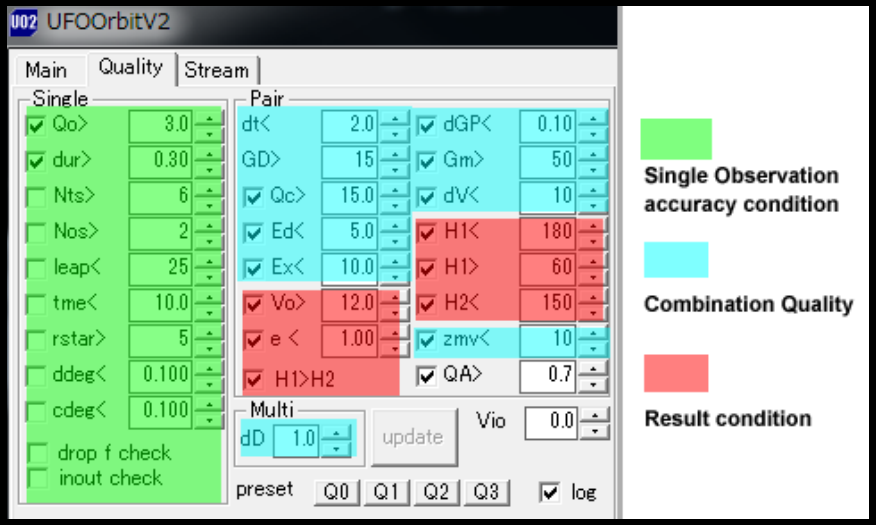
(average Qc = 39.9 deg)



(average Qc = 55.7 deg)

Only 2 cameras

Quality elements on UFOOrbitV2



UO2 original values

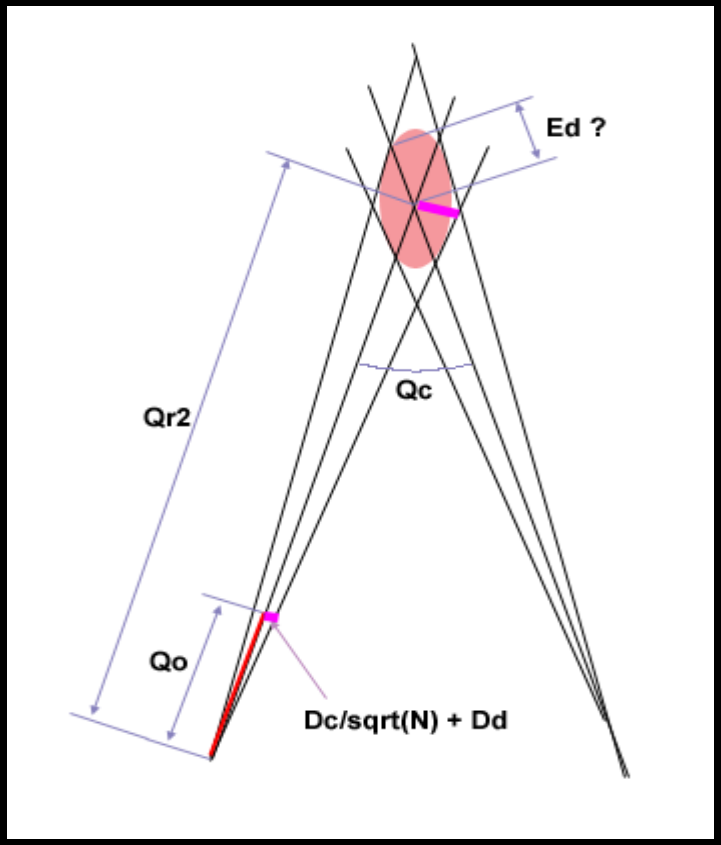
Ed = (Dc/sqrt(N) + Dd)/Qo*Qr2/sin(Qc)

(radiant accuracy proportional value)

Ex = Ed / sin(Qd)

(trajectory accuracy proportional value)

QA : experimental combination of drop, inout, tme, leap, Qo, Vo, e, Ex



Dc: linearity , Dd: FOV accuracy

N: number of samples

Ed is more useful than σRA and σDEC, also having clear physical meaning and easier than covariance !!.

2007-2009

Q2 + Ed < 1.0 : 12415 meteors