#6187

The Forward Scattering Meteor Radio Echo Observation using a GPS-synchronized Multiple Receiving Stations.

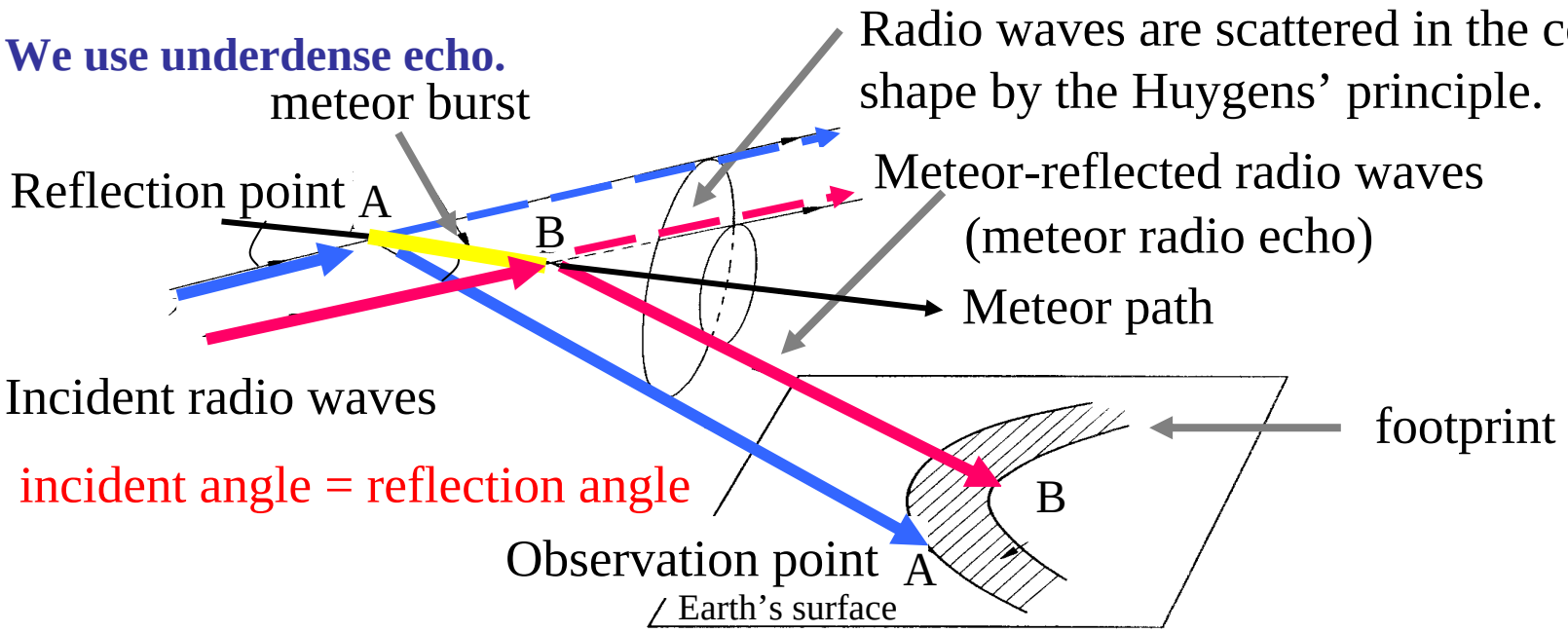
○Hideto YOSHIDA[1], Toshio TERASAWA[2], Hideaki MIYAMOTO[2], Takashi USUI[3], Noriyuki YAGUCHI[3], Ichiro YOSHIKAWA[1]

[1]The University of Tokyo (School of Sciences),
[2] The University of Tokyo (Institute for Cosmic Ray Research) ,
[3] The Nippon Meteor Society

SCHOOL OF SCIENCE
THE UNIVERSITY OF TOKYO

The principle of the multiple receiving stations method 1

We use underdense echo.



The time lag of the reflecting point A and B is equal to the time lag of the observation point A and B.

If the number of observation point is increased, we can determine the trajectory and the velocity of a meteor with the time lag of each observation point.

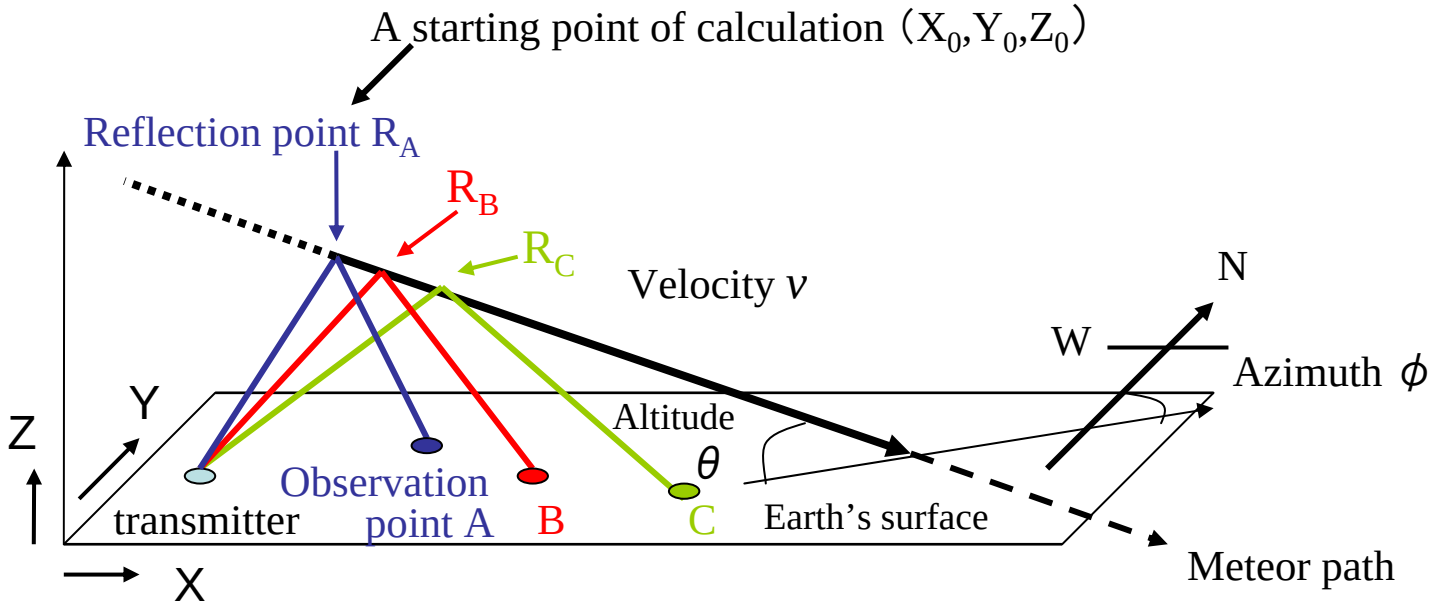
The principle of the multiple receiving stations method 2

The number of free parameters is six.

(The starting point of calculation[X_0,Y_0,Z_0],azimuth ϕ ,altitude θ and velocity v)

Since one parameter can be determined except for velocity from a geometric consideration, the number of free parameters is five.

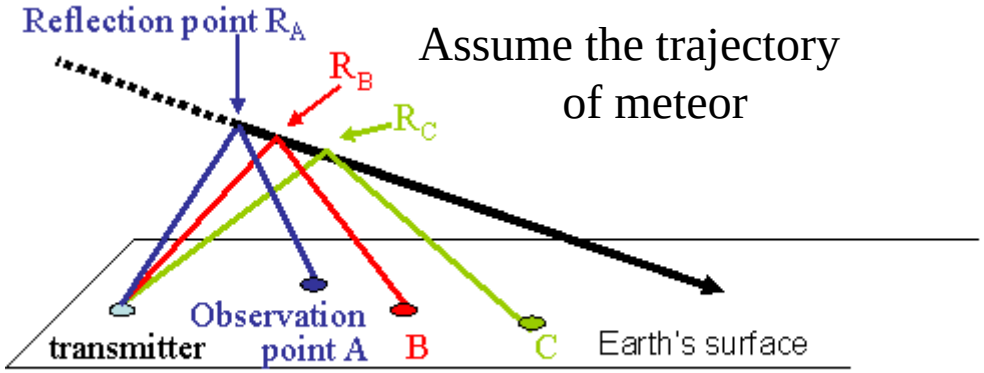
Because one of the observation points is the starting point of time, the observation point of at least six points is needed.



The observation point A is the starting point of time.

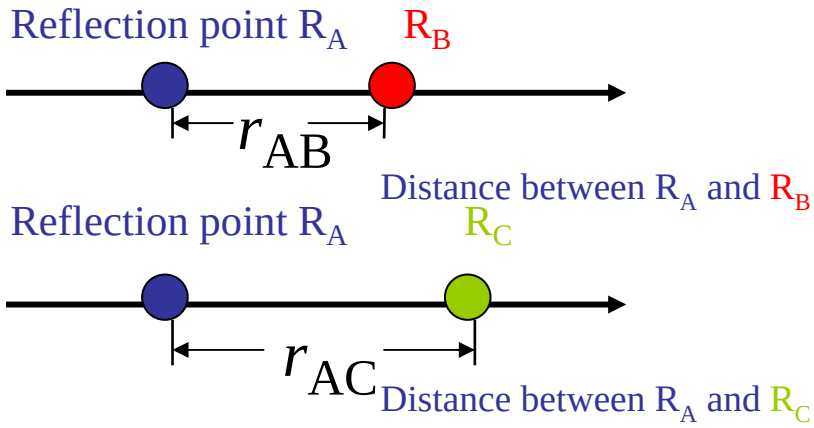
We synchronized the time of each observation point with GPS.

The principle of the multiple receiving stations method 3



Assume the trajectory of meteor

The observation point A is the starting point of time.



The time lag of the observation point
(Observation data) τ_{AB}、τ_{AC}、…

Calculated distance which assumed geometry
(calculated value) r_{AB}、r_{AC}、…

We assume that the velocity of a meteor is constant. $v \cdot \tau_{AB} = r_{AB}$

$$\tau_{AB} : \tau_{AC} : \ldots = r_{AB} : r_{AC} : \ldots$$

Each ratio should become equal.

normalization

$$\Sigma_\tau \equiv |\tau_{AB}| + |\tau_{AC}| + \ldots$$

$$\bar{\tau}_{AB} = \tau_{AB}/\Sigma_\tau、\ \bar{\tau}_{AC} = \tau_{AC}/\Sigma_\tau、\ \ldots$$

normalization

$$\Sigma_R \equiv |r_{AB}| + |r_{AC}| + \ldots$$

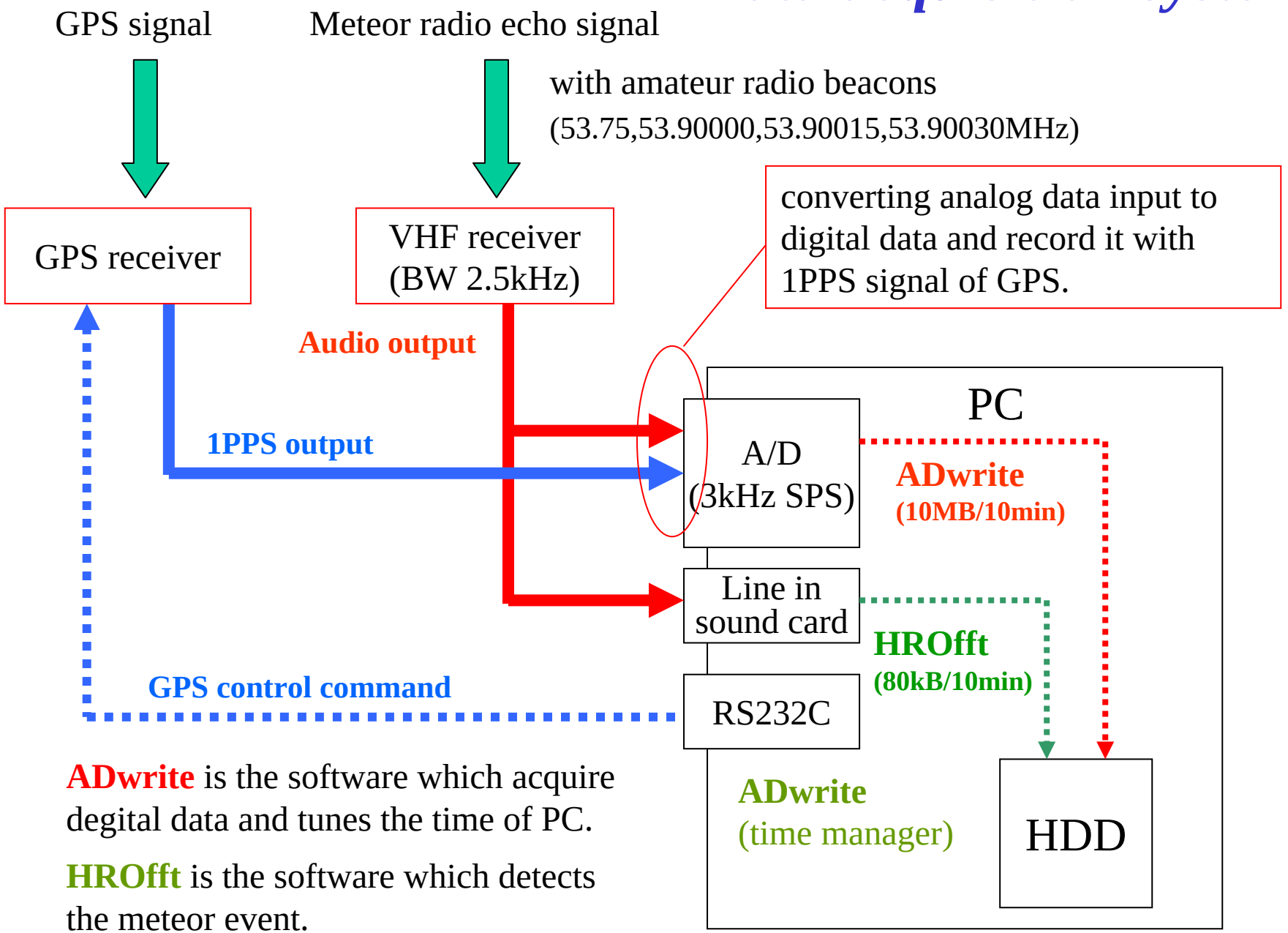
$$\bar{r}_{AB} = r_{AB}/\Sigma_R、\ \bar{r}_{AC} = r_{AC}/\Sigma_R、\ \ldots$$

$$I = \sum_{\#=B,C,D,E,\ldots} (\bar{\tau}_{A\#} - \bar{r}_{A\#})^2$$

We calculated the parameter set to minimize the ***I*** parameter with least mean square method.

Velocity : $V = \Sigma_R/\Sigma_\tau$

Data acquisition system



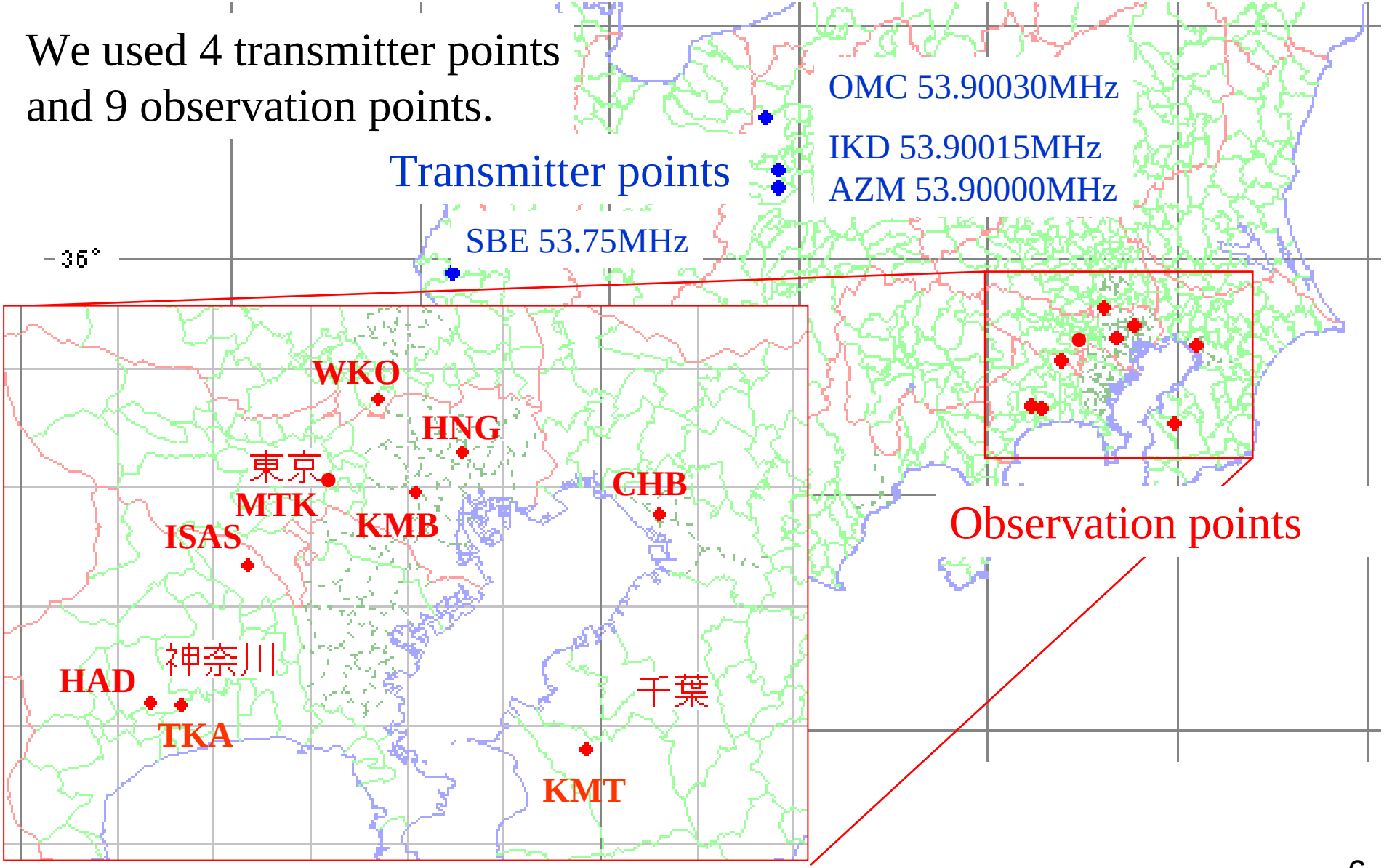
ADwrite is the software which acquire degital data and tunes the time of PC.

HROfft is the software which detects the meteor event.

Example of distribution of transmitters and observation points

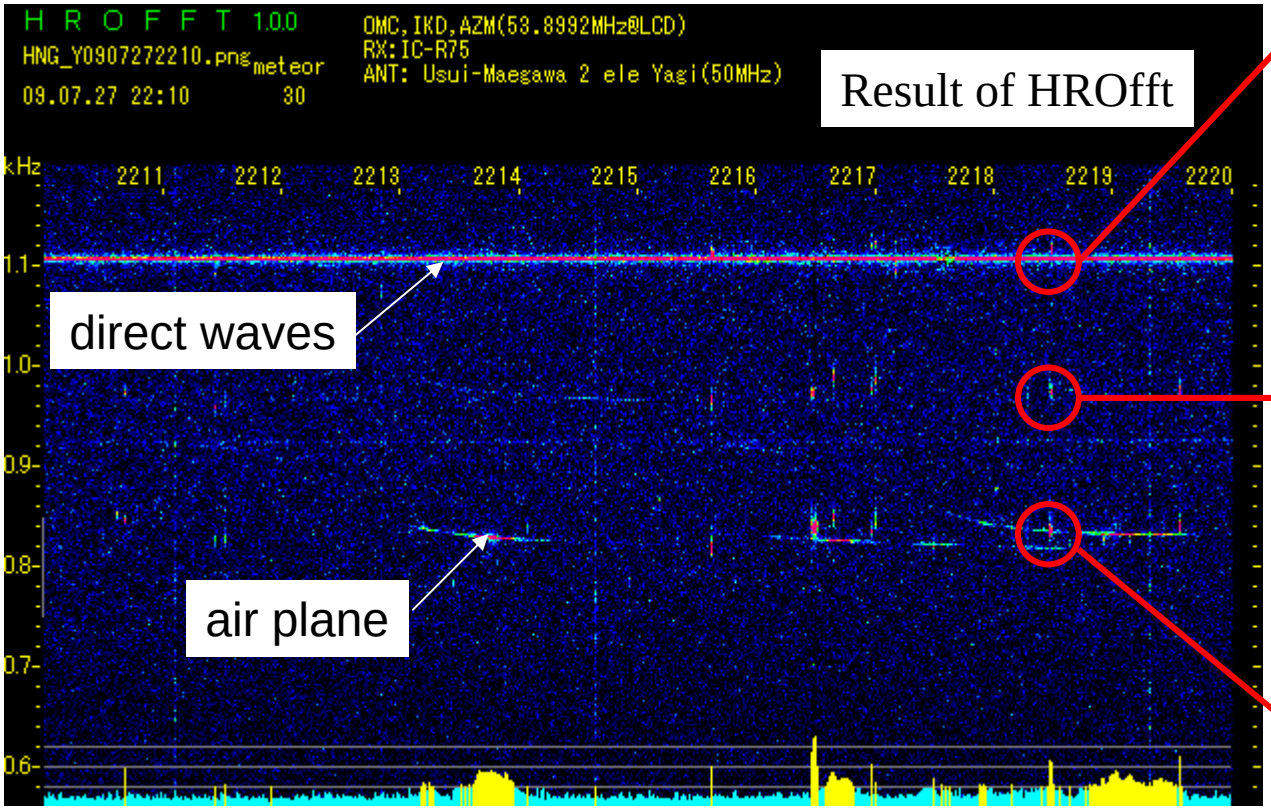
(from 18h00m(JST) on 2009 July 25 to 7h00m on Aug. 3)
(from 09h00m(UT) on 2009 July 25 to 23h00m on Aug. 2)

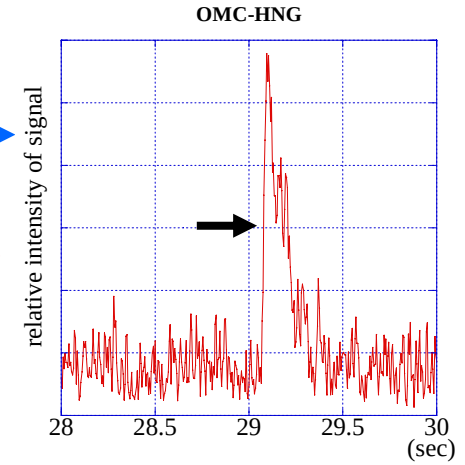
We used 4 transmitter points and 9 observation points.

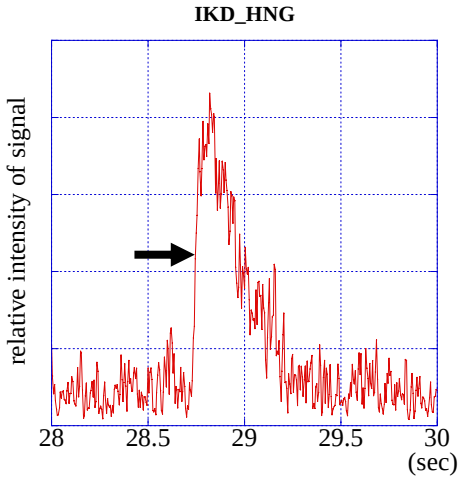


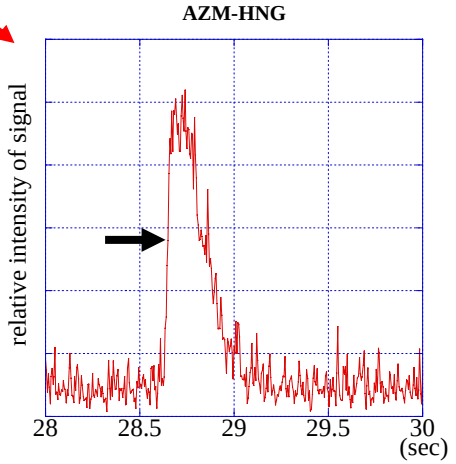
Example of observed meteor radio echo

Results of 3kHz sampling data









Transmitter points : OMC,IKD,AZM
Observation point : HNG

Event time defined half value of steep rise of an echo.

Example of results

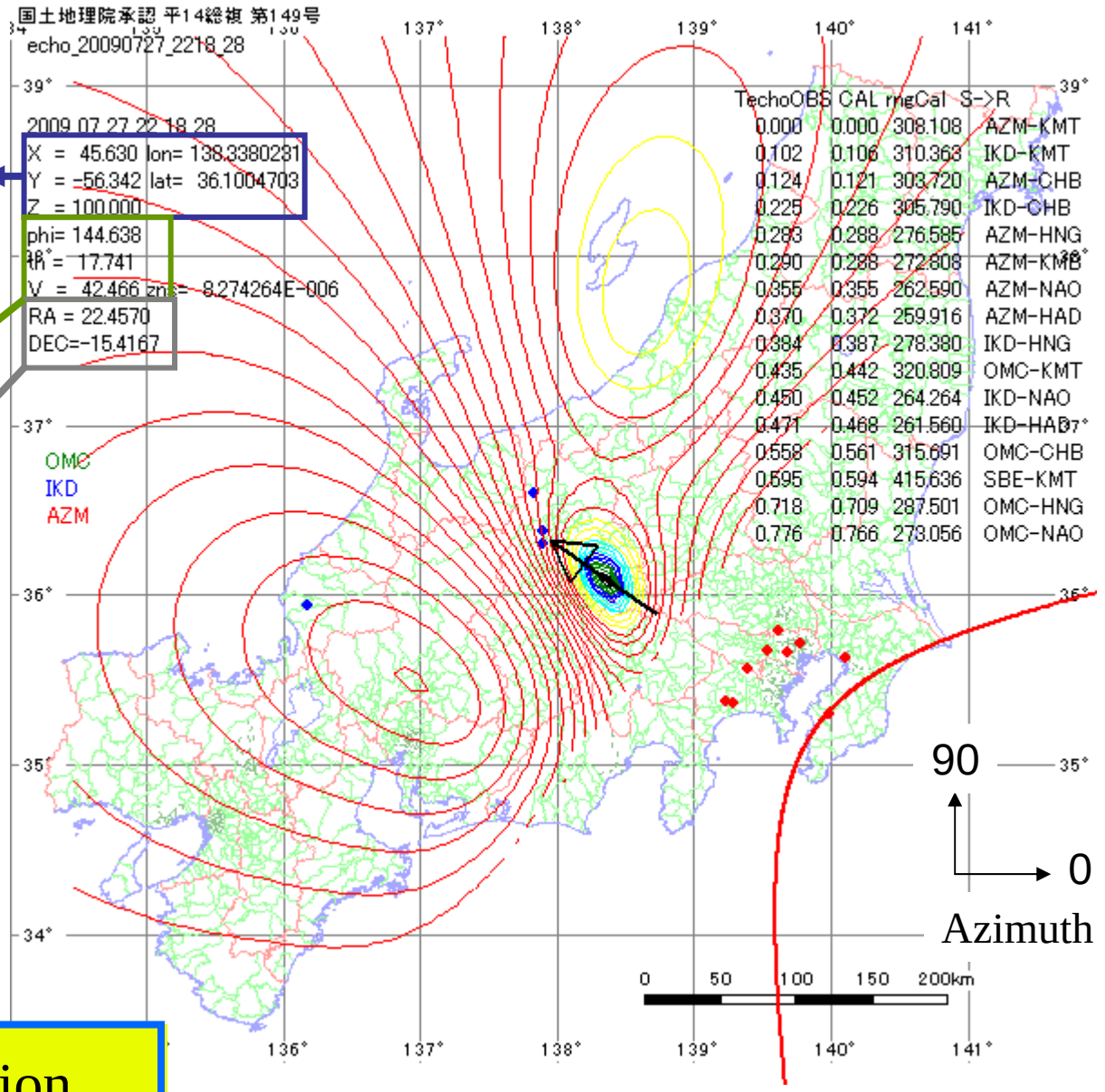
The first echo reflective point
The east longitude 138.3 °
The north latitude 36.1 °
Altitude 100km

Azimuth 144.6 °
Inclination 17.7 °
Velocity 42.5km/s

Radiant point
R.A. 22.5h
Decl. -15.4 °

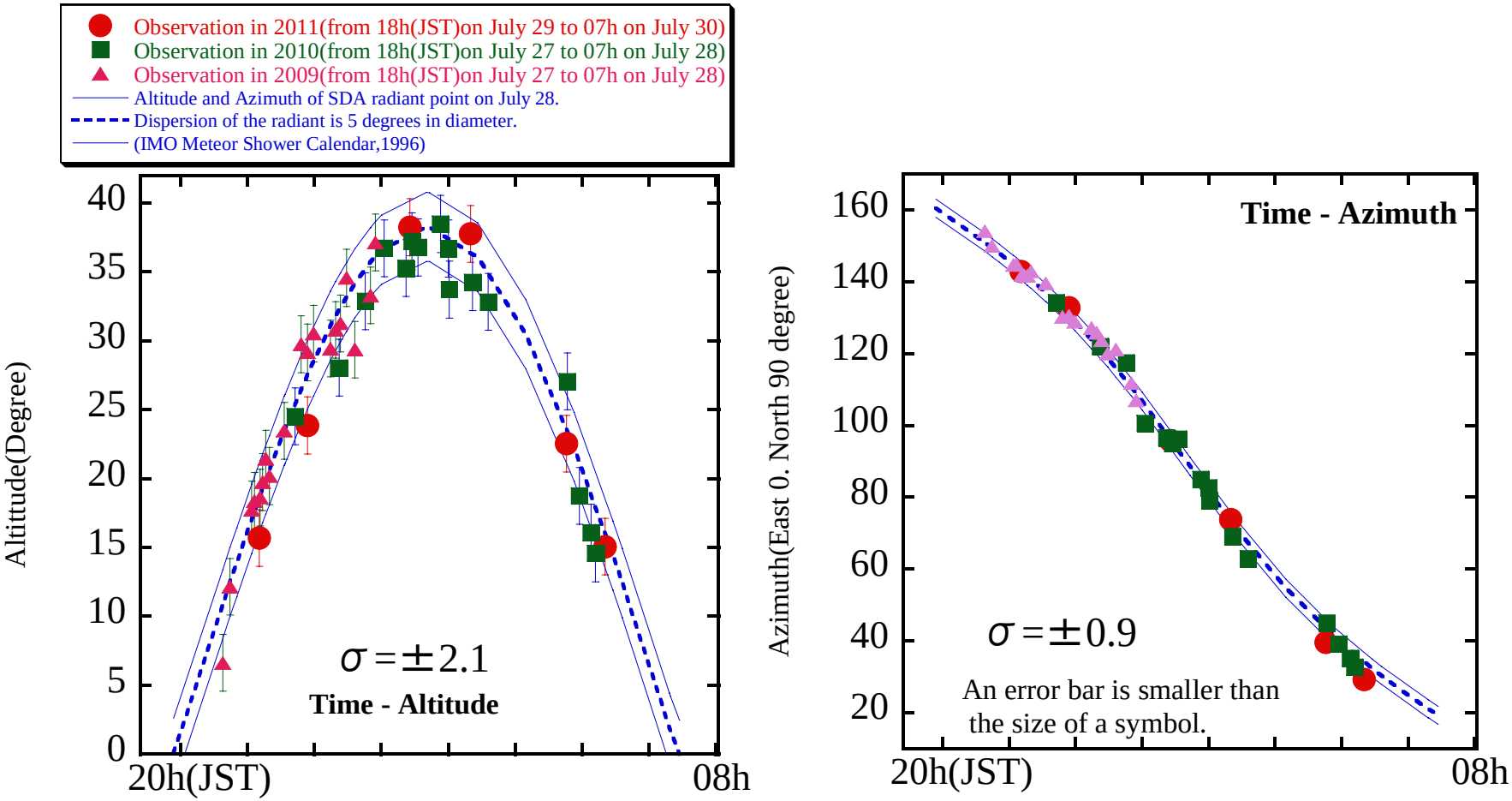
The parameter of the South. delta Aquariids (SDA)
R.A. 22.6h
Decl. -16 °
Velocity 41Km/s

We succeeded in detection of the South. Delta Aquariids.



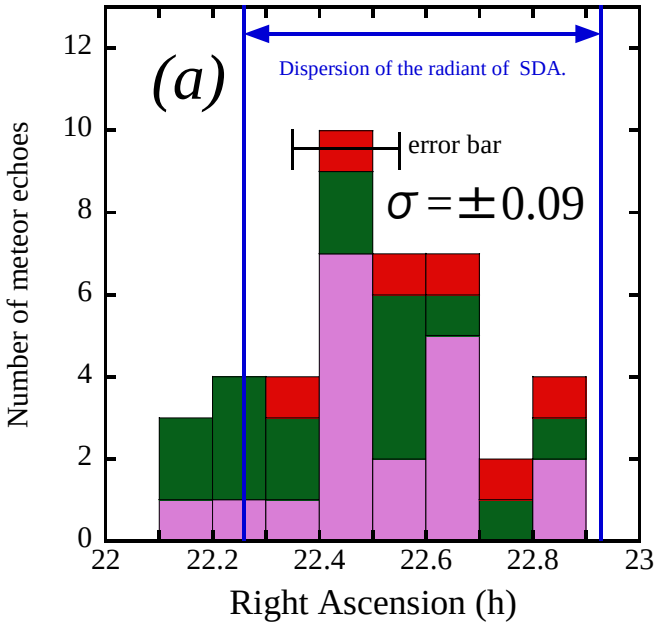
Contour lines show that residuals becomes smaller at red, yellow, a light blue, blue and black in order.

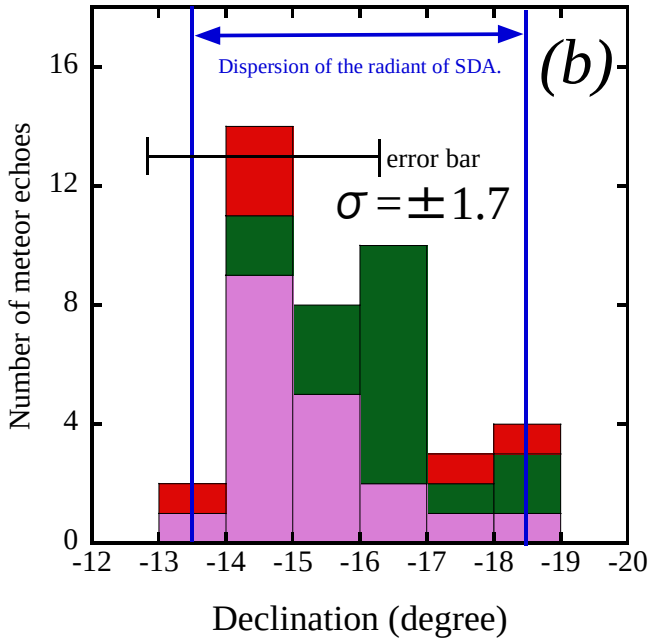
Evaluation of the accuracy of this method

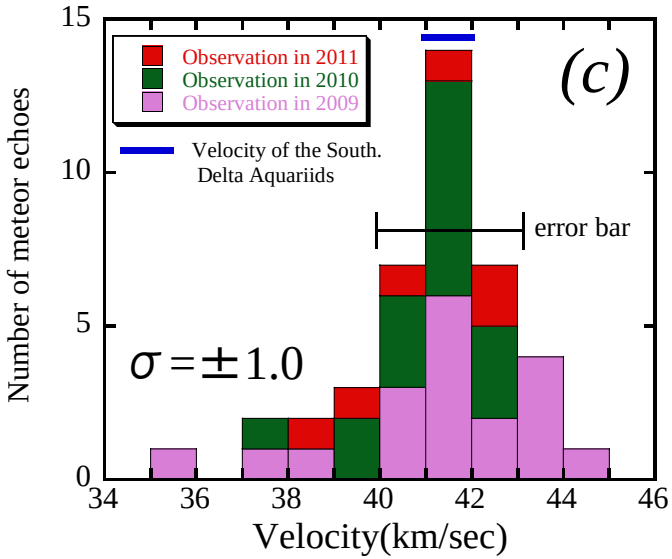


The observation result is consistent with position change of SDA radiant point.

Comparison between observation result and parameters of SDA.





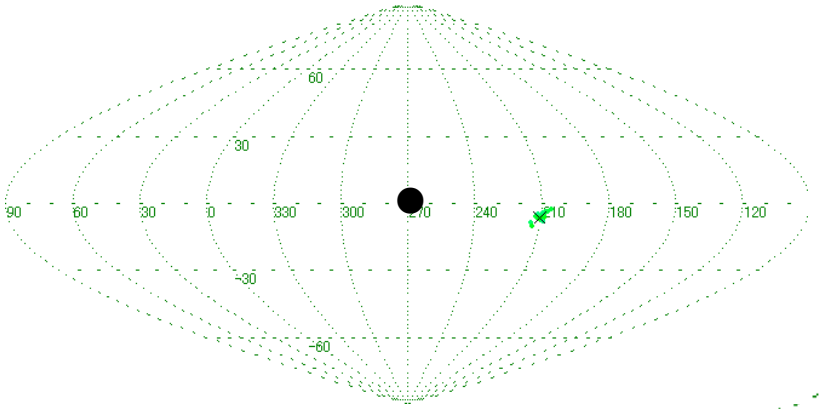


Considering dispersion of the radiant (5 degrees in diameter : IMO Meteor Shower Calendar, 1996), the observation results are consistent with the radiant parameter of SDA. (Figs. a, b).

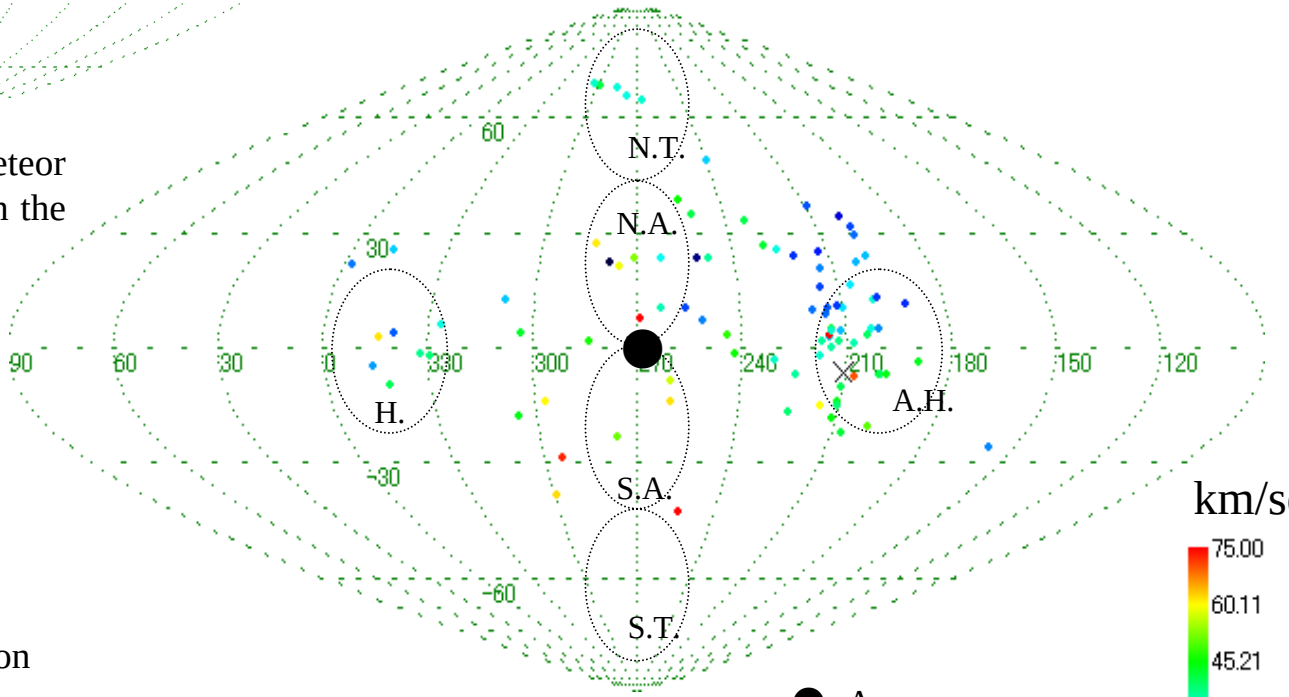
Although velocity is scattering widely, it consistent with a velocity parameter of SDA (Fig. c) .

Example of sporadic meteor radiant distributions in 24 hours

(2009/7/27 03:00 - 7/28 03:00(UT))



The figure extracted only the meteor which has parameters of SDA in the same time zone.



N.T.:North Troidal
N.A.:North Apex
S.A.:South Apex
S.T.:South Troidal
H.:Helion, A.H.:Antihelion

km/sec

● : Apex

×： radiant point of South. Delta Aquariids

The maps in a Sun-centered ecliptic coordinate system, Which is from the prospective of an observer looking towards the Apex. The ellipses in this map correspond to the meteor sources according to Jones and Brown(1993),Taylor and Elford(1998).

Summary

- We could determine parameters of a meteor by forward scattering meteor radio echo observation with a GPS-synchronized multiple receiving stations.

- The results of observed the South. Delta Aquariids are consistent with it's parameters.

- The radiant point of observed sporadic meteor is consistent with already reported sporadic meteor sources.

Future prospect

- We are going to develop the method of ranging the meteor. (Please see Usui et al. : poster)

- We are going to develop an interferometer in the future.