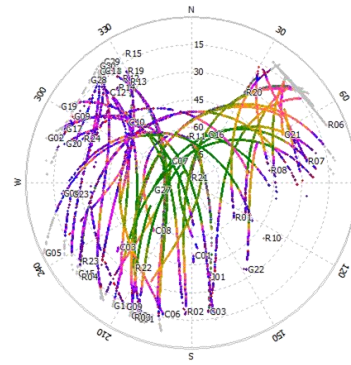


Examining GNSS Sky blockages using Fisheye camera view images

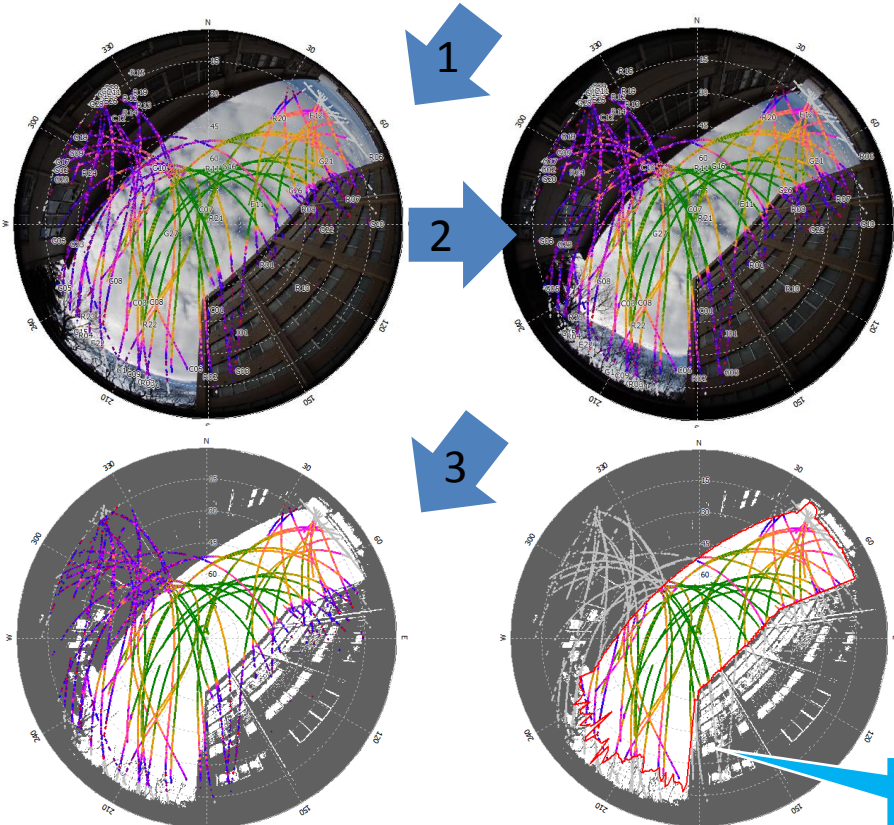
Materials

- Software: RTKLIB 2.4.3 b5~ RTKPLOT
- Fisheye view images

Goal for this tutorial



Observed signal strength with equidistant projection



SNR=... 45 .. 40 .. 35 .. 30 .. 25 < 25 [dB-Hz]

Procedure for building mask (database of mask angles)

1. Azimuth adjustment
2. Projection adjustment
lens calibrating tools for initialization
3. Mask Making

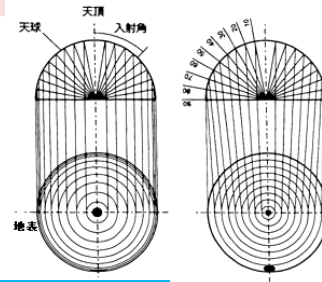
Converts image to binary

Projection



RTKLIB
2.4.3 b5~

Open source software to make a mask with the fisheye view image

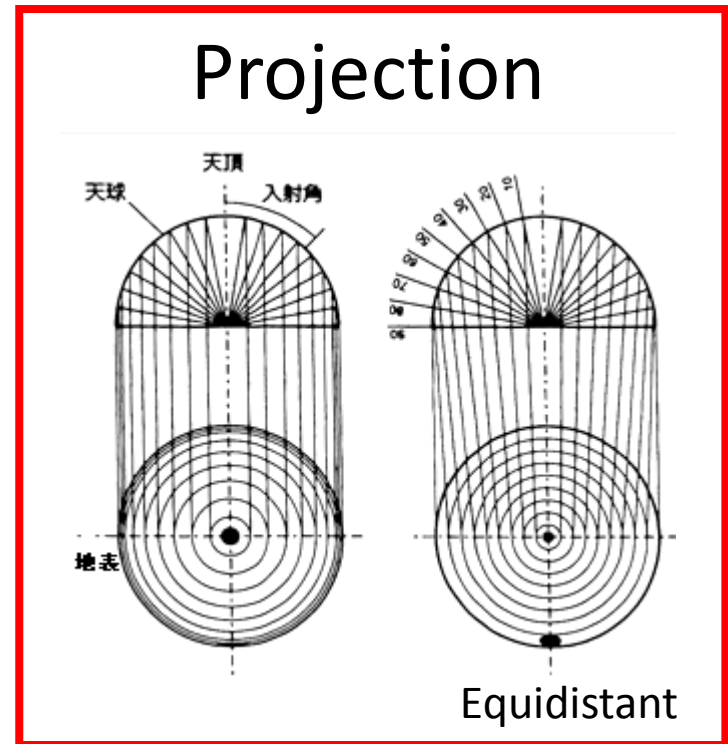


Mask: Red line
(Expressed by elevation for every 1 deg. Of azimuth)

Initial preparations

Obtaining profiles of fisheye view lens

- Fisheye view images need calibration to perform equidistant projection



<http://www.yasuhara.co.jp/madoka/index.html>

Initial preparations

Obtaining profiles of fisheye view lens

- Open lens calculation software



University of Zurich **Davide**



Scaramuzza

 Search this site

OCamCalib Omnidirectional Camera Calibration Toolbox for Matlab > OCamCalib Toolbox Download Page

If you use this code please cite these references

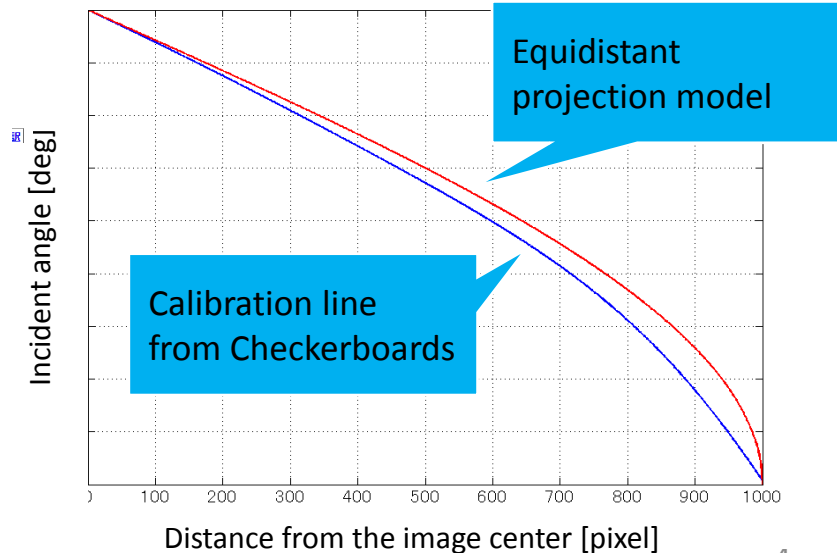
1. Scaramuzza, D., Martinelli, A. and Siegwart, R. "A Flexible Technique for Accurate Omnidirectional Camera Calibration and Structure from Motion", Proceedings of IEEE International Conference of Vision Systems (ICVS'06), New York, January 5-7, 2006 [PDF]
2. Scaramuzza, D., Martinelli, A. and Siegwart, R. "A Toolbox for Easy Calibrating Omnidirectional Cameras", Proceedings to IEEE International Conference on Intelligent Robots and Systems (IROS 2006), Beijing China, October 7-15, 2006 [PDF]
3. Ruffi, M., Scaramuzza, D., and Siegwart, R., Automatic Detection of Checkerboards on Blurred and Distorted Images, Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2008), Nice, France, September 2008 [PDF]

Package name	Description	Updates/Releases/Bug fixes
OCamCalib Toolbox v3.0	The new version of the toolbox with automatic checkerboard extraction. The checkerboard extraction code is already	Check bug fixes First release November 16, 2013

- Home
- Research
- Publications
- Tutorial on Visual Odometry
- Biography
- News
- OCamCalib Toolbox
- Tools

<https://sites.google.com/site/scarobotix/ocamcalib-toolbox/ocamcalib-toolbox-download-page>

• Results for our lens



Steps for making masks

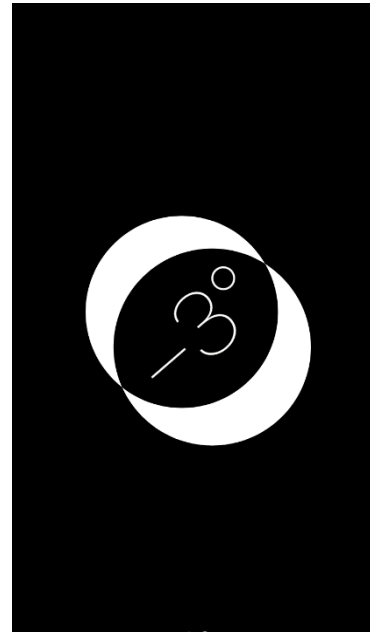
1. Taking photo by Fisheye view lens camera

- Same place as GNSS antenna
- 'Up' Image direction has to face North
- Lens has to be set up horizontally relative to the ground

Example using iPhone Compass App



Azimuth

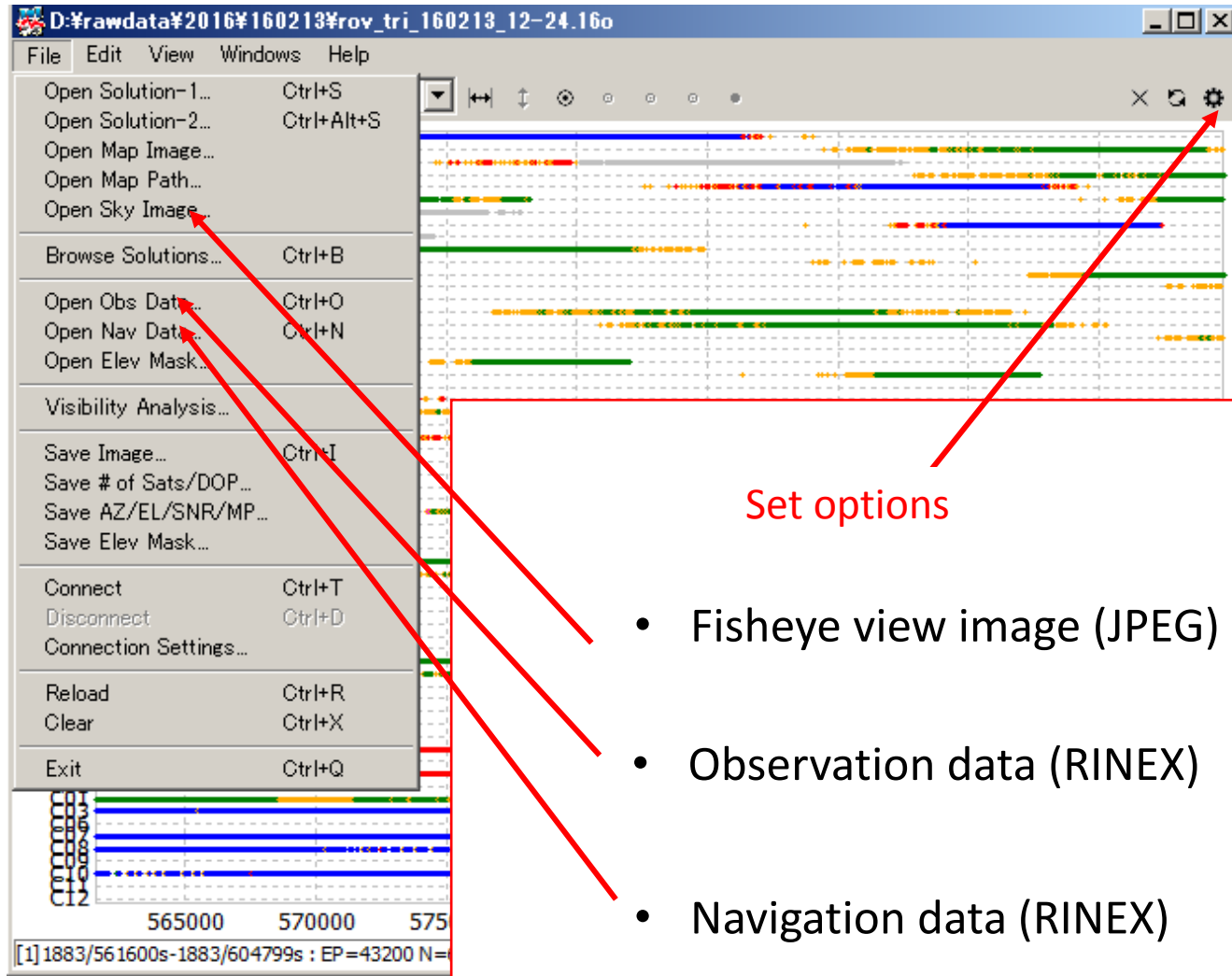


Horizontal with ground



Steps for making masks

2. Read data using RTKLIB SKYPLOT



The screenshot shows the RTKLIB SKYPLOT software interface. The main window displays a sky plot with various colored lines representing satellite tracks. A menu is open on the left side, listing several options. A red box highlights the 'Set options' menu item, which is linked to a list of options: 'Fisheye view image (JPEG)', 'Observation data (RINEX)', and 'Navigation data (RINEX)'. Red arrows point from the 'Set options' menu item to the list of options, and from the 'Open Sky Image', 'Open Obs Data', and 'Open Nav Data' menu items to the sky plot area.

Set options

- Fisheye view image (JPEG)
- Observation data (RINEX)
- Navigation data (RINEX)

Steps for making masks

2. Read data using RTKLIB SKYPLOT (Results)

The image displays the RTKLIB SKYPLOT software interface. The main window shows a sky plot with a grid of elevation and azimuth angles. The plot contains numerous colored lines representing signal paths. Annotations include:

- A red box around the 'Skyplot' dropdown menu in the toolbar, with a red arrow pointing to it and the text 'Select Skyplot' in a white box.
- A red box around the 'Sky Image...' option in the 'View' menu, with a red arrow pointing to it and the text 'Calibration of sky image' in a white box.
- Two blue callout boxes labeled 'Discrepancy' pointing to specific areas on the sky plot.

The status bar at the bottom of the window displays the following information: 00 GPST-02/13 23:59:59 GPST : EP=43200 N=691715 SNR=...45...40...35...30..

Steps for making masks

3. After reading data

Sky plot results and sky image options

The screenshot shows a software interface for processing sky data. A dialog box titled "D:\rawdata\2016\160213\DSC00394.JPG" is open, displaying various settings for a sky plot. The "Image Size W/H (pixels)" is 5456 x 3632. The "Plot Center (pixels)" is X: 2728.00, Y: 1816.00. The "Plot Radius (pixels)" is 1816.00. The "Plot Radius" field is highlighted with a blue selection box, and a red line points from it to a text box labeled "Automatically input".

The sky plot itself is a circular projection showing a network of colored lines (purple, green, yellow, orange, red) representing signal paths. The plot is overlaid on a grid of elevation and azimuth angles. The elevation axis is labeled from 0 to 80 degrees, and the azimuth axis is labeled from 0 to 300 degrees. The plot is titled "15R50153201602131800D.16o...".

At the bottom of the interface, a status bar displays the following information: [1] 2016/02/13 12:00:00 GPST-02/13 23:59:59 GPST : EP=43200 N=691715 SNR=...45...40...35...30...

Automatically input

Steps for making masks

4. Change to equidistant projection

Sky plot results and sky image options

D:\rawdata\2016\160213\DSC00394.JPG

Image Size W/H (pixels) 5456 x 3632 Flip

Plot Center (pixels) Plot Radius (pixels)

X 2728 Y 1816 Plot Radius 1816.00

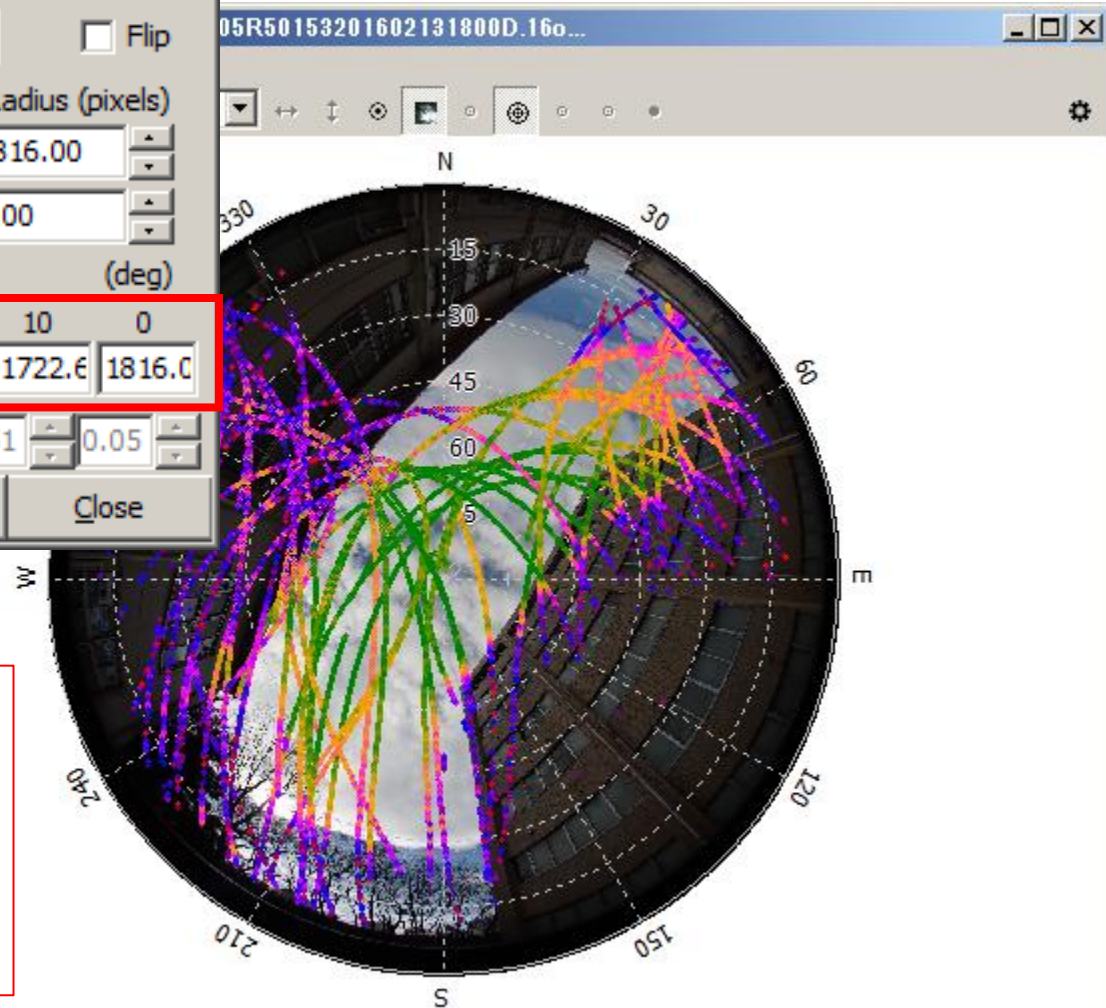
Roll 0.00 Pitch 0.00 Yaw 0.00

Pixels from Center - Elevation (deg)

80	70	60	50	40	30	20	10	0
296.2	566.4	838.4	1087.1	1298.0	1468.6	1606.8	1722.6	1816.0

Elevation Mask Resample NN Binarize 0.51 0.05

Save Tag Load Tag... Gen Mask Update Close

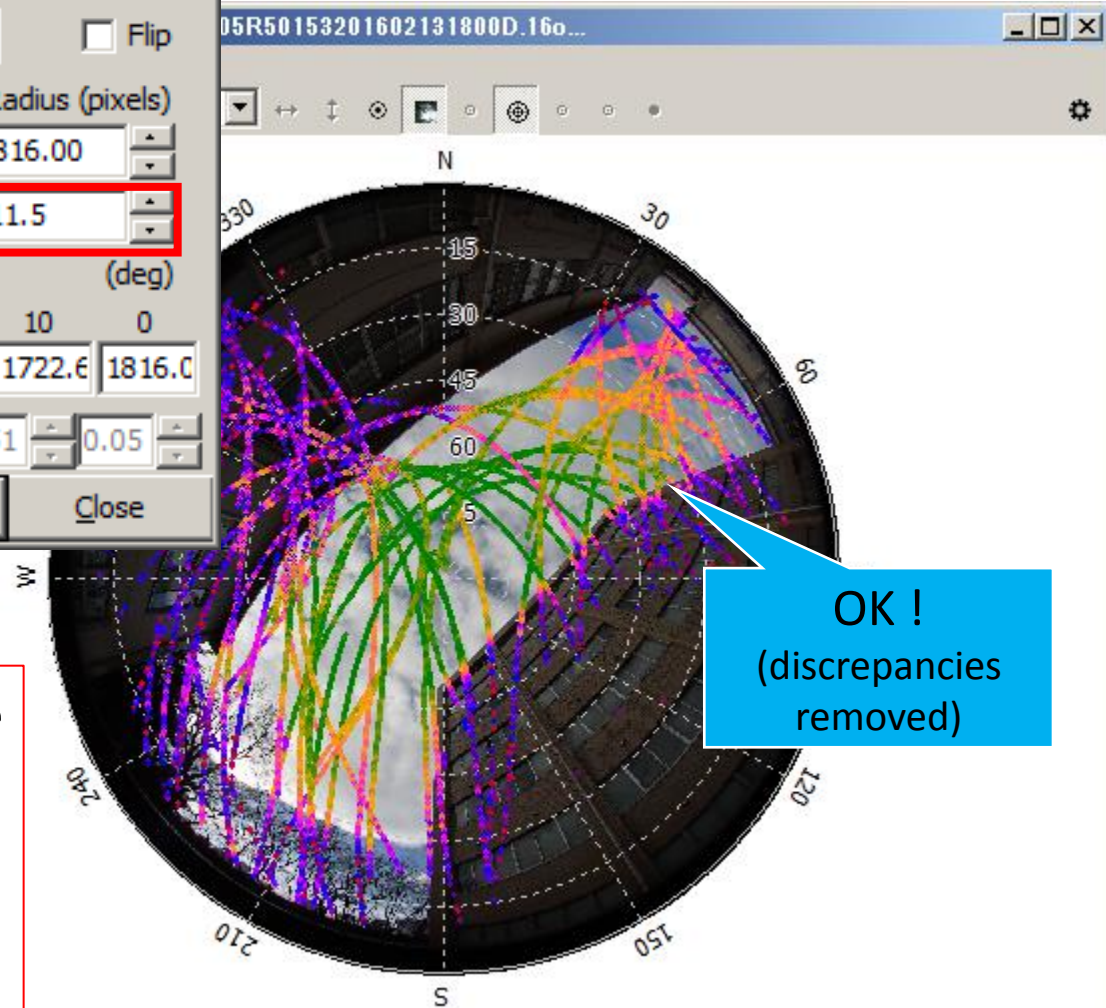
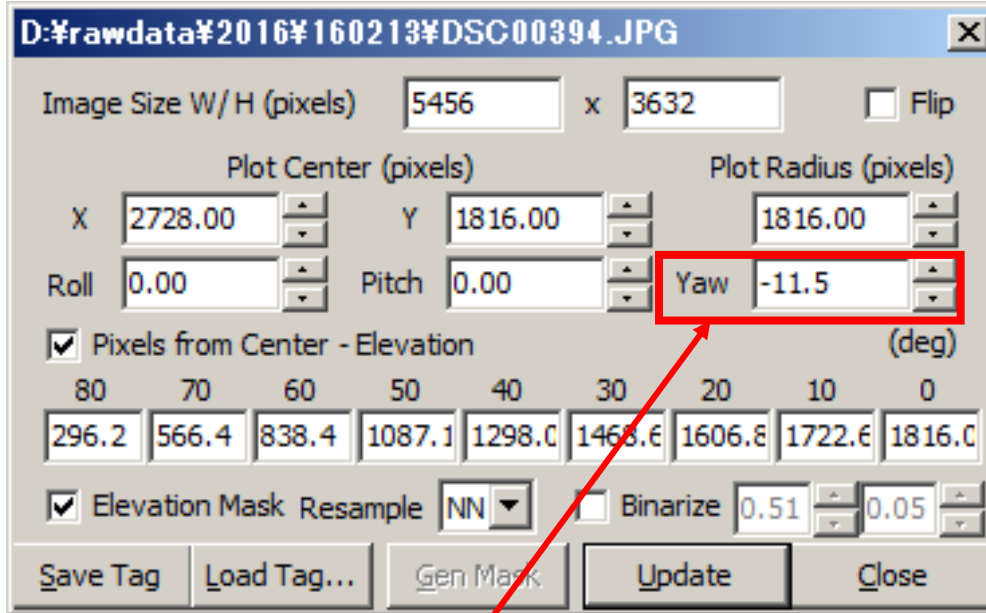


Change manually based on computed profiles of fisheye view lens (see slide 4)

Steps for making masks

5. Change direction

Sky plot results and sky image options



Change manually to reset the image 'up' direction to North (Using map of buildings as a reference or some other means..)

Steps for making masks

6. Show the elevation mask

Options

Time Format: h:m:s GPST
Lat/Lon Format: ddd.dddddd
Show Statistics: OFF
Cycle-Slip: OFF
Parity Unknown: OFF
Ephemeris: OFF
Elevation Mask (%): 0
Elev Mask Pattern: ON
Hide Low Satellite: OFF
Max NSAT/DOP: 40
Max Multipath: 10
Receiver Position: Lat/Lon/Hgt
Satellite System: GPS GLO Galileo QZSS SBAS BeiDou
Excluded Sats: 0 (+Sn: Included)

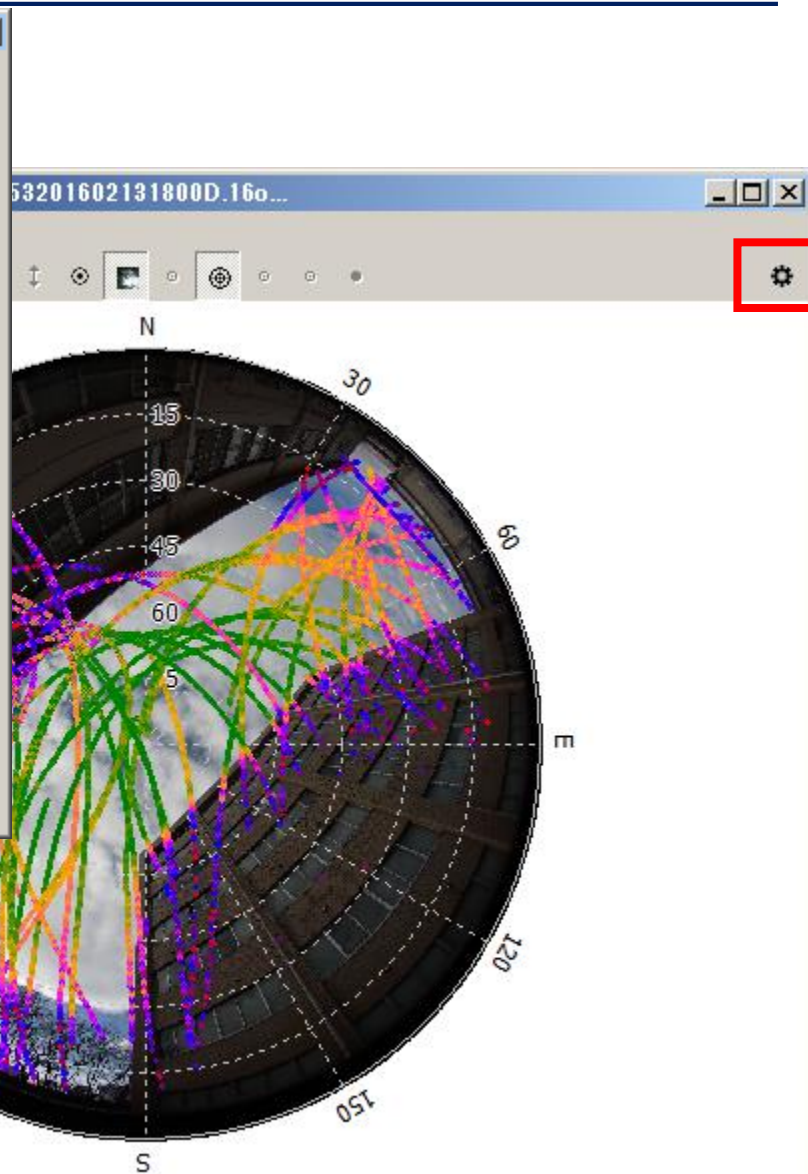
Error Bar/Circle: OFF
Direction Arrow: OFF
Graph Label: ON
Grid/Grid Label: Grid/Label
Compass: ON
Scale: ON
Auto Fit: OFF
+Range (+/-): 50
RT Buffer Size: 10800
Coordinate Origin: Lat/Lon/Hgt
QC Cmd: teqc +qc +sym +l -rep -plot
RINEX Opt:
TLE Data: D:\work\RTKLIB\rtklib_2.4.2\data\3le160827.txt
TLE Sat No: D:\work\RTKLIB\rtklib_2.4.2\data\TLE_GNSS_SA

Mark Color 1 (1-6): [Color palette]
Mark Color 2 (1-6): [Color palette]
Line Color: [Color palette]
Text Color: [Color palette]
Grid Color: [Color palette]
Background Color: [Color palette]
Plot Style: Mark
Mark Size: 2
Font: Tahoma 10pt
Animation Interval: 10
Update Cycle (ms): 100

Lat/Lon/Hgt: 35.666502710 139.792380500 59.4189

OK Cancel

Change to ON

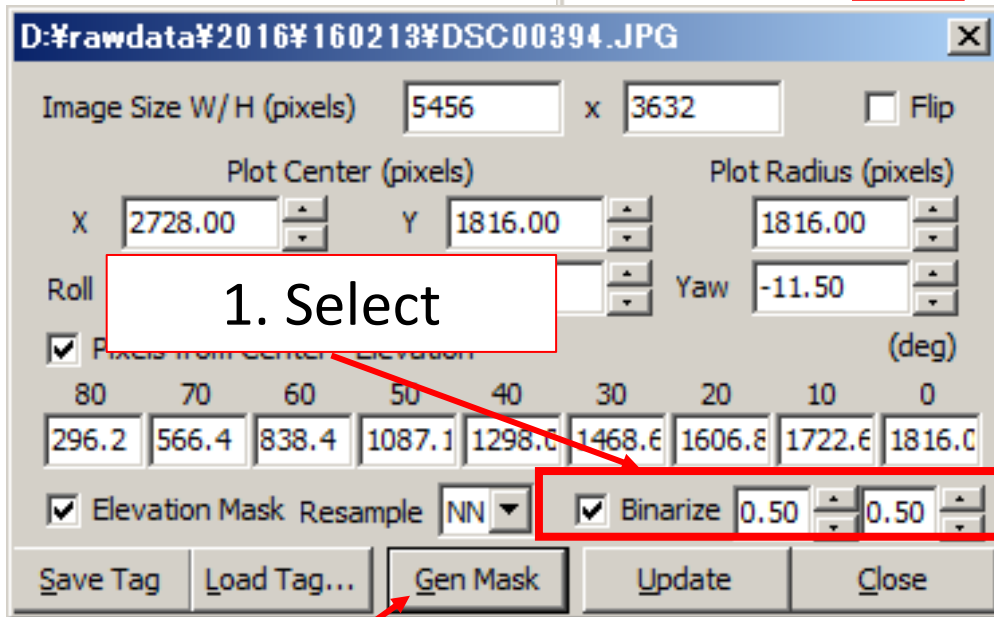


Steps for making masks

7. Create Binary Image

Sky plot results and sky image options

Select a few satellites for simplicity



1. Select

2. Click

Not Good – Need to adjust further

Steps for making masks

8. Adjust binary image processing as needed

Sky plot results and sky image options

For simplicity

1. Adjust image filter

2. Click

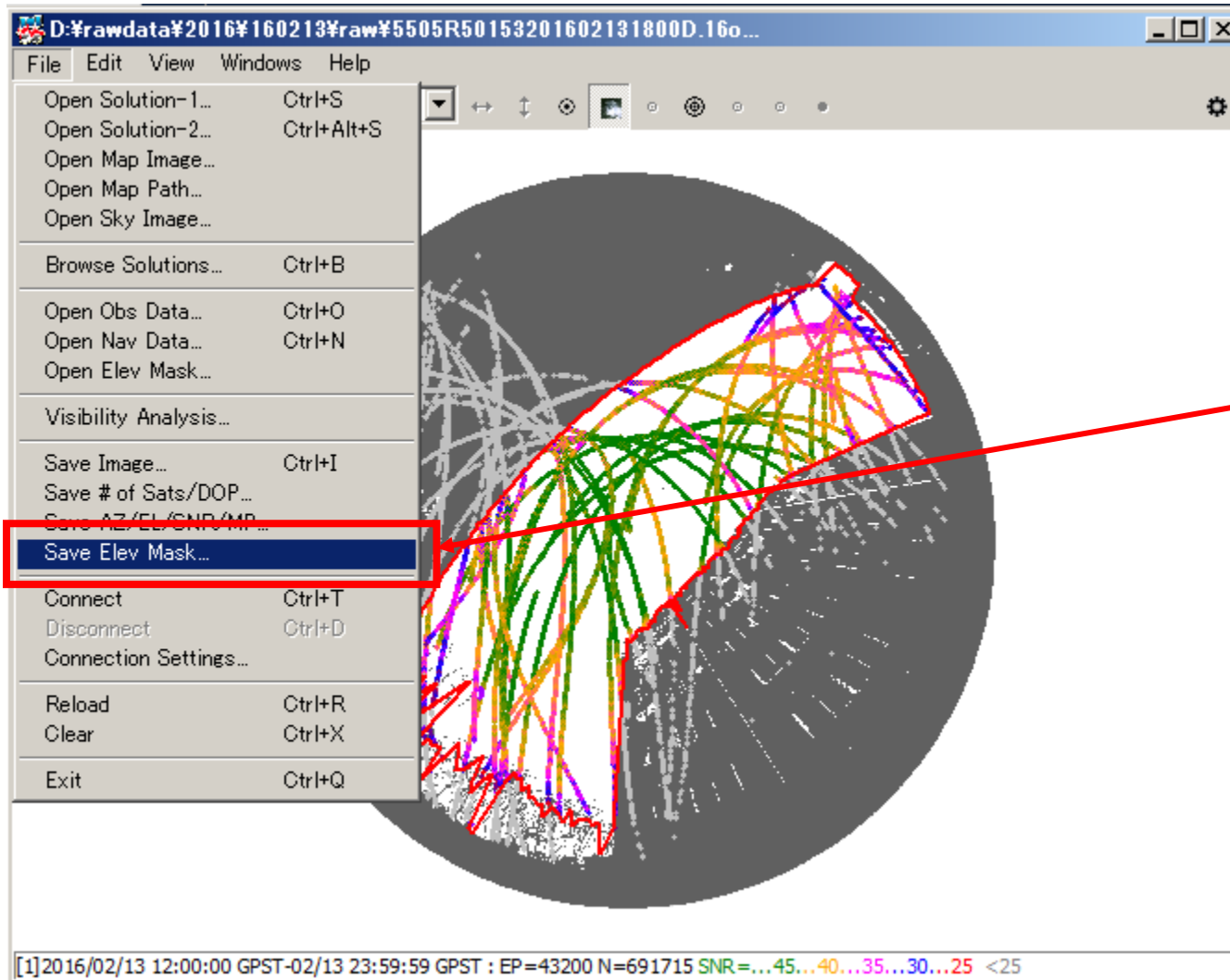
3. Close option

Now OK !

1]2016/02/13 12:00:00 GPST-02/13 23:59:59 GPST : EP=43200 N=691715 SNR=...45...40...35...30..

Steps for making masks

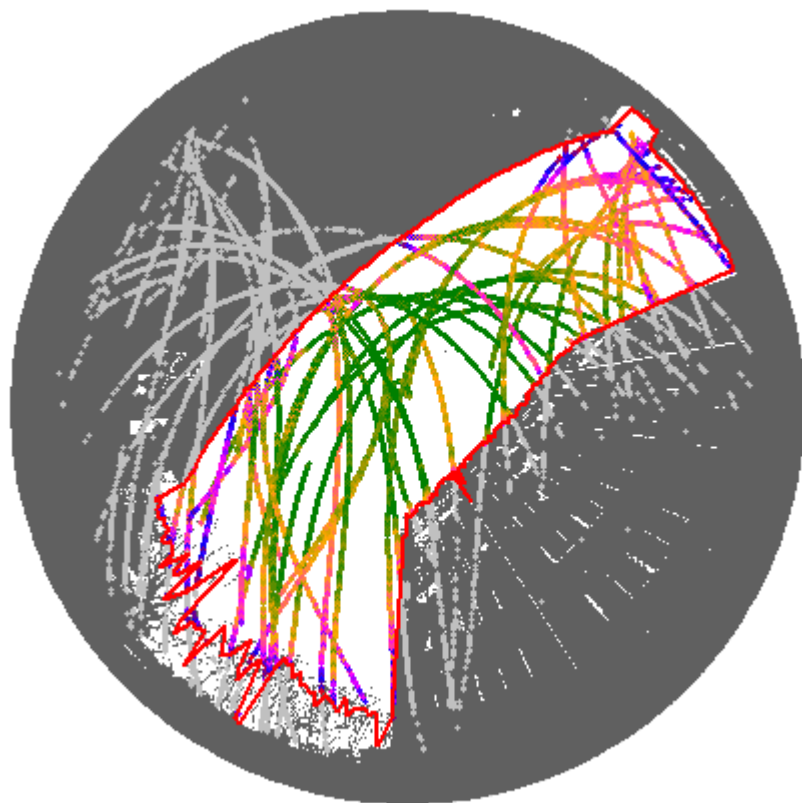
9. Save the completed elevation mask



- Open
- Named
- Save the file

Steps for making masks

10. FINAL



```
D:\rawdata\2016\160213\elemask te...
ファイル(F) 編集(E) 検索(S) D:\rawdata\2016\160213\el
ツール
% Elevation Mask+
% AZ(deg) EL(deg)+
0.0 50.7+
1.0 50.3+
2.0 49.7+
3.0 49.2+
4.0 48.5+
5.0 47.9+
6.0 47.3+
7.0 46.5+
8.0 45.9+
9.0 45.1+
10.0 44.3+
11.0 43.6+
12.0 42.8+
13.0 41.9+
14.0 41.2+
15.0 40.4+
16.0 39.3+
17.0 38.4+
18.0 37.1+
```

- ASCII data format
- Azimuth-dependent elevation mask angles

Example for one satellite (G06)

Show one satellite

