Current status of VERA geodetic analysis system

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The circumstances of the Mizusawa geodetic-analysis-tools development

- Software of Mizusawa evolved uniquely, because we did not get *HP-UX* and *hp*-fortran, in the h eyday of mk3db. The bid result of the computer in Mizusawa is not necessarily decided to *HP-U X* by open competition.

- Un-use of *HP-UX* was evidently inescapable, so, we completed the analysis system by ourselves.

- The Mitaka FX correlator is used to correlation of VERA observation data. This correlator is deve loped for Radio Source Imaging use. In order to use this correlator for geodesy and astrometry, data set developer and data convertor for geodetic analysis is constructed.

- Updating to a newer model and analysis system is under continuation. The way using PIVEX wa s adopted for public open 10 years ago, however it was stopped, a new format is under grope n ow.

Main processes of VERA geodetic VLBI analysis

- Correlation

  Engine is GICO3 developed by NICT, and wrapped by SOFTCOS operation system.

  File system of output correlation data is CODA F/S

  Data supplied to analysis is reformatted to FITS-IDI.

- Delay and Corr. Coefficient estimation

  frangia (Single FITS mode) and cfrang (Wideband Multi FITS combine mode), developed by Jike

- Precise geocentric-time-system-based delay calculation, time system conversion

  fxcalc, developed by Jike.

- Precise station-time-system-based delay prediction

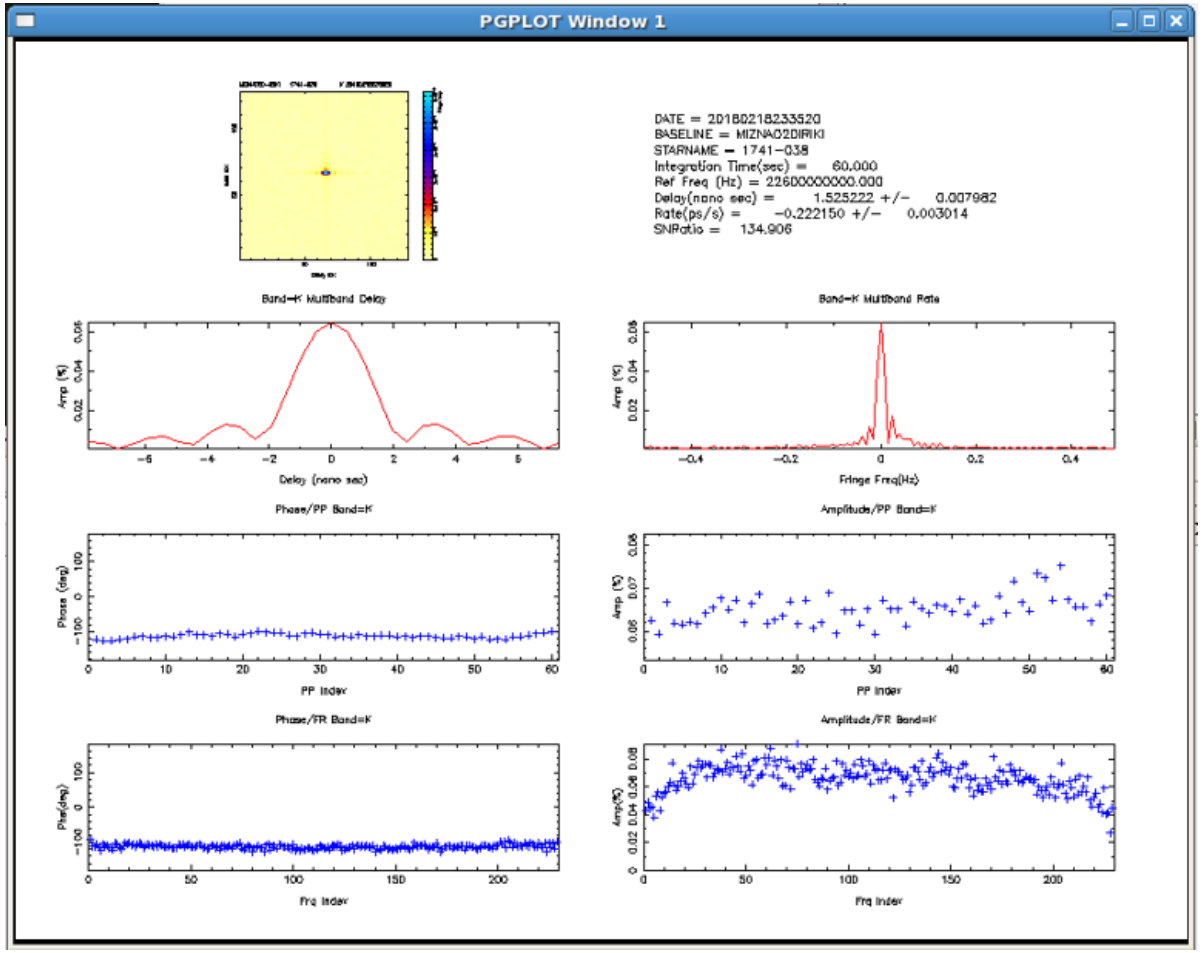
  calc, developed by Manabe, and re-constructed by Jike.

- Astronomical and Geodetic Parameter Fitting

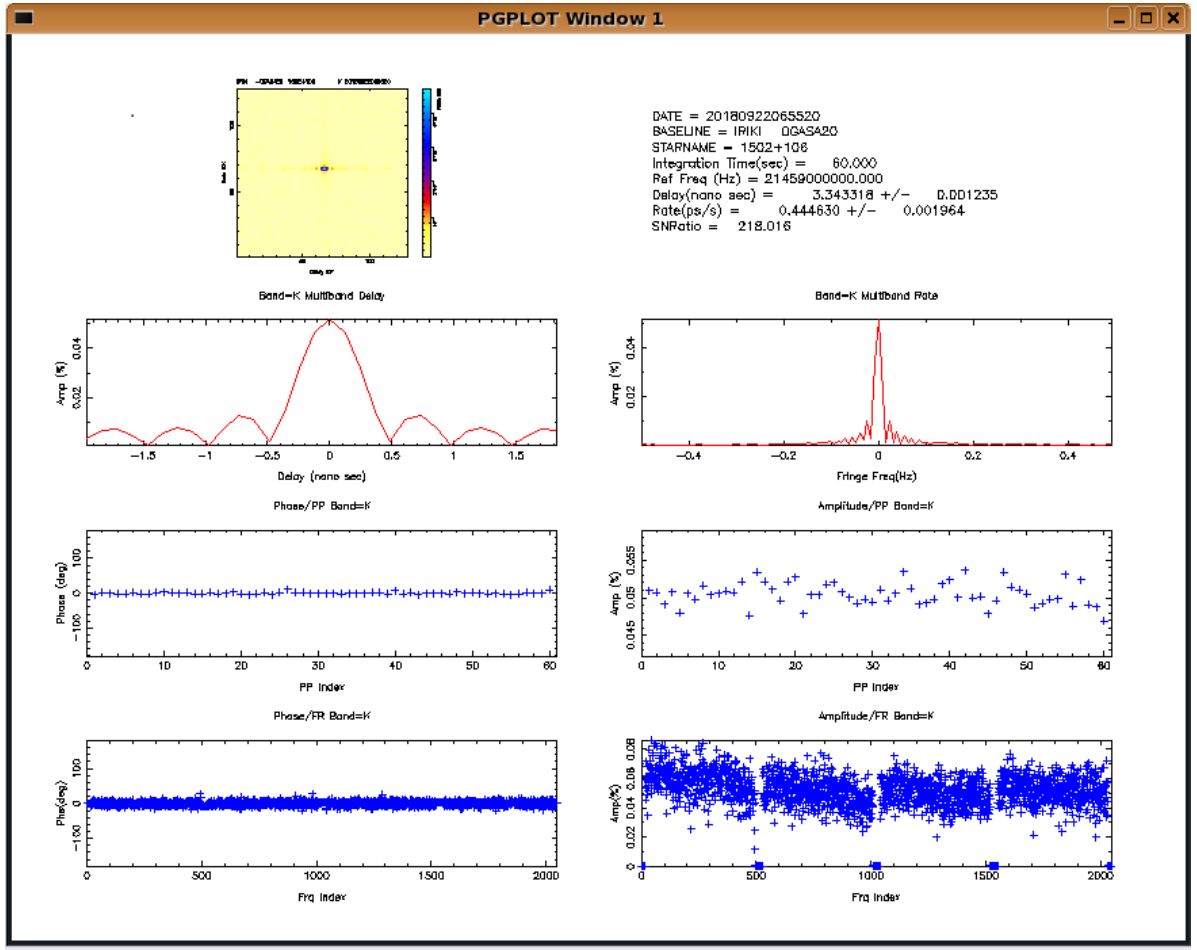
  msolv, developed by Manabe, and modified by Jike.

Output of frangia (delay search)

Single FITS Mode

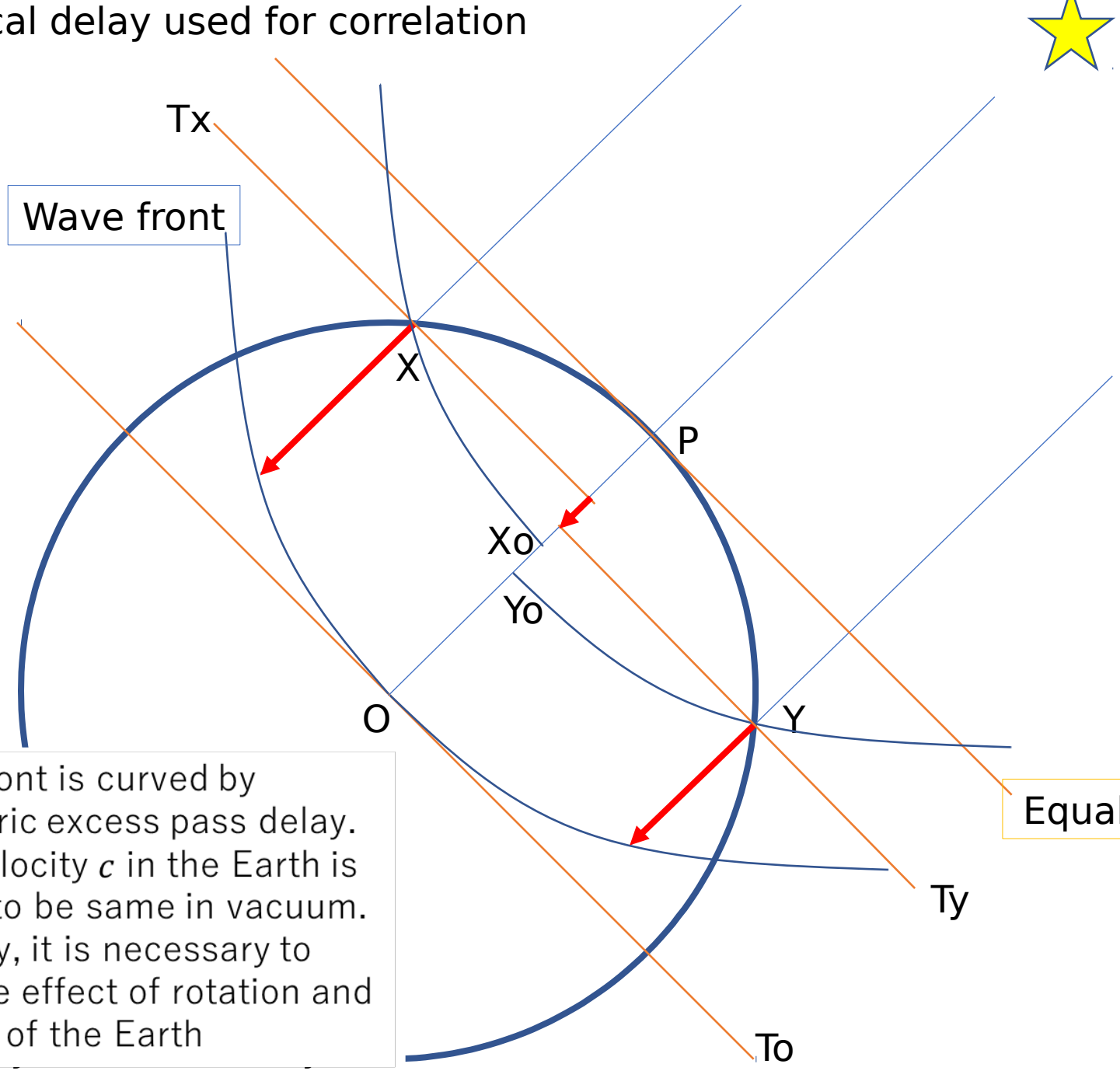


Four FITSs Combine Mode



Time system of this estimated delay is geocentric, and converted to site-based is necessary. Output file is created using FITSIO.
As for the data in- and output of pretreatments before execution of calc/msolv, FITSIO is used.

Geometrical delay used for correlation



Equal time line

・Wave front is curved by atmospheric excess pass delay.
・Light velocity c in the Earth is assumed to be same in vacuum.
・In reality, it is necessary to correct the effect of rotation and revolution of the Earth

correct the effect of rotation

Site based delay τ_x, τ_y @ T_o
is the time when wave front passes Geocenter.

These are a-priori delays for fringe tracking.

Baseline based delay: @

$$\begin{aligned}\tau_{xy} &= \tau_x - \tau_y \\ &= T_x - T_y \\ &= (X_o - Y_o)/c\end{aligned}$$

This is the estimated delay by bandwidth synthesis delay search.

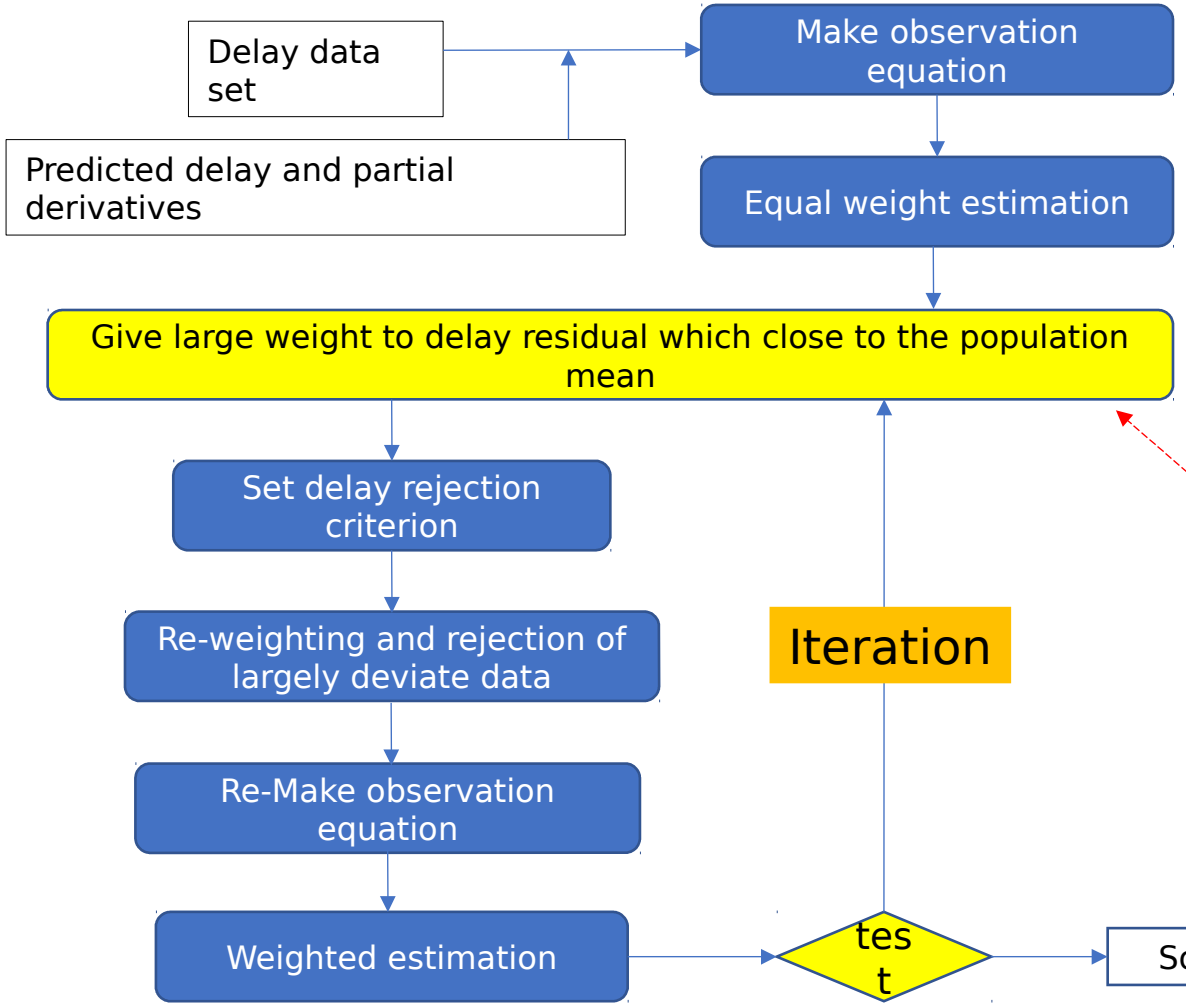
$$T_x - T_y = \tau_{xy(To)} = \tau_{b(Tx)}$$

$\tau_{b(Tx)}$ is the delay used in geodetic analysis.

Main Models of calc and fxcalc

Precession and Nutation: IAU2000 model and IERS daily EOP solutions
Earth Rotation Parameter: get from IERS and polynomial interpolation
Earth Tide: IERS Conventions 1996
Pole Tide: Wahr 1985
Atmospheric Excess Pass Delay: Global Mapping Function and its partial derivative
Ocean Tide Loading: NAO99b Ocean tide model and GOTIC2
UT1 tide: Wahr and Sasao, Yoder
Planet Ephemeris: JPL DE430 (.now)
Theoretical delay: Fukushima theoretical delay or Eubanks consensus model

System configuration of msolv



msolv can estimate –

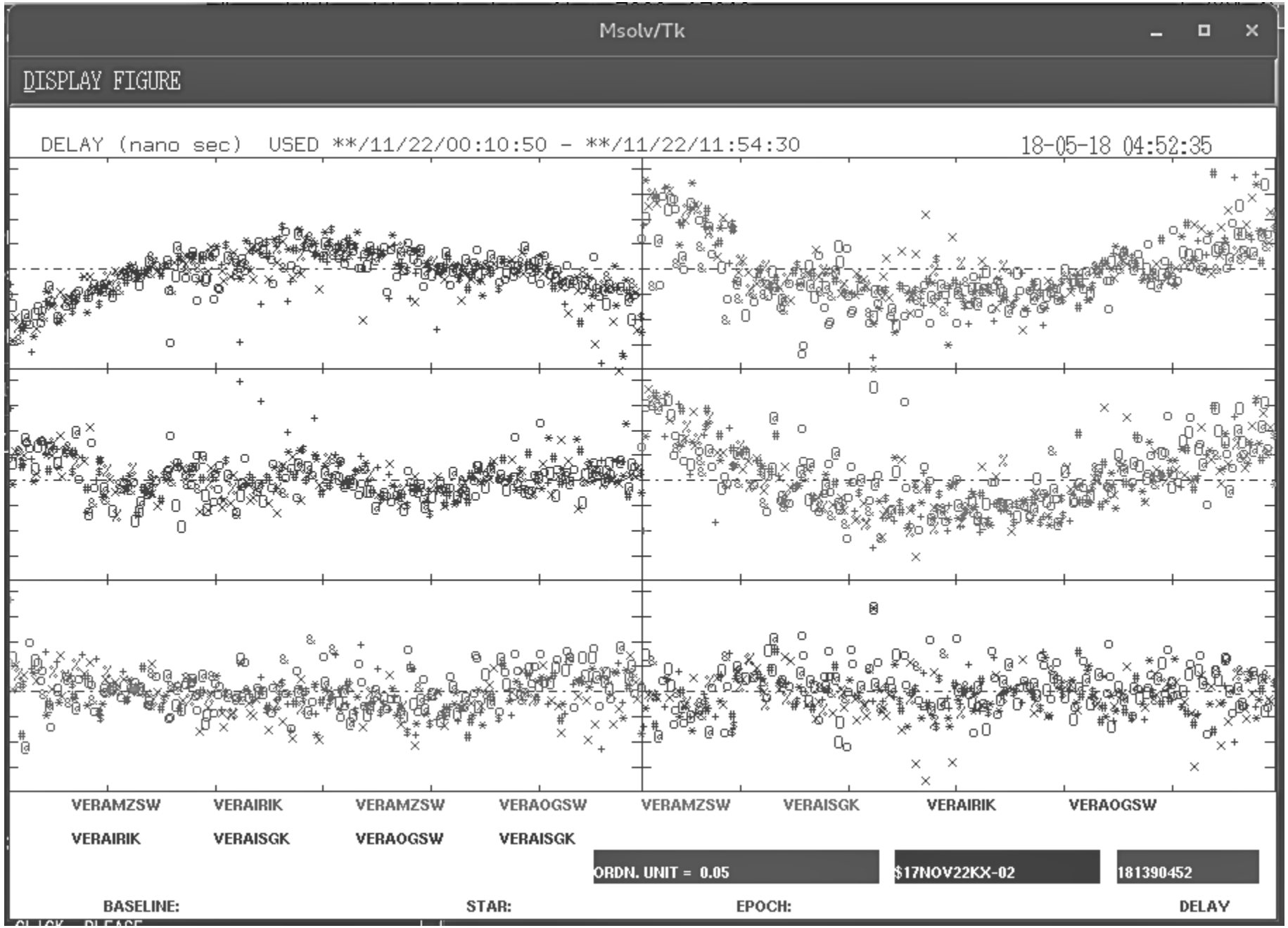
- Site coordinates,
- Sources coordinates,
- EOP (XP, YP, UT1, Δε, Δψ), epoch,
- Zenith Path Delay and its rate,
- Polynomial of Clock offset and rate,
- Axis offset,
- etc.

Source code

- fortran90, tk(wish8.4)

Magnitude of weight dose not follow S/N.
Distribution of weight follows distribution of post-fit delay residual.

Example of MSOLV estimates (estimate average clock offset and average zenith pass delay)



Prepare for open-use of VERA geodetic VLBI data

policy

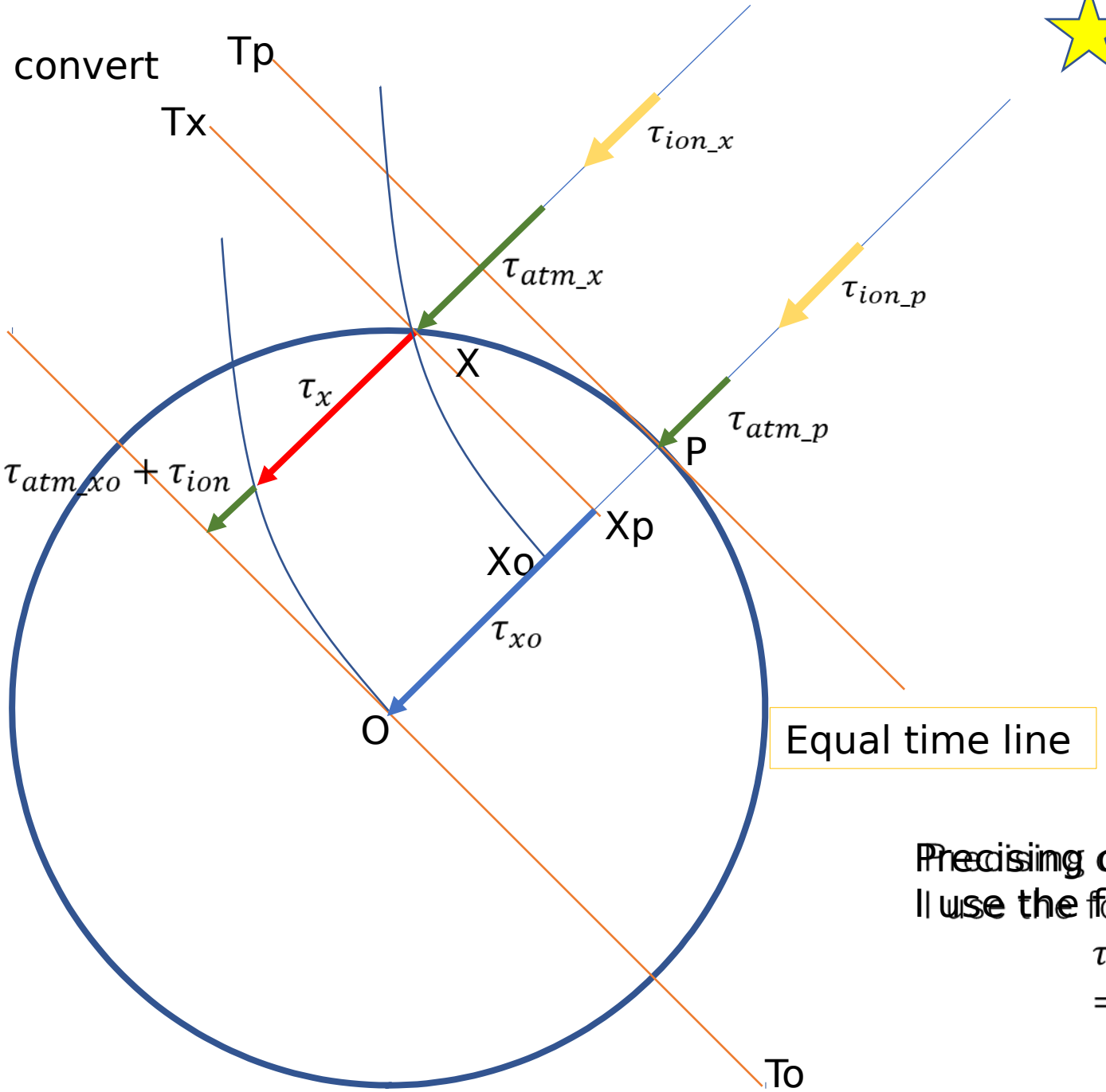
- The open rule follows the policy of NAOJ data public open.
- The data use purpose enables use only to astronomy and geoscience. Sublease of data and result is forbidden.
- There may be judgment to the request of data. Not anonymous and correspond to the request.

format

- The format of the file which can be released immediately is FITS form, because it is excel in portability.
- The open way in other formats is still undecided. netCDF? Now, I am during trainin g of how to use netCDF.

Thank you for your attention.

Time convert



Equal time line

$$T_x = T_o + \tau_x$$

T_x is the time when wave front passes X.
τ_x becomes a negative value.
Time is expressed as TCG or TCB.

$$\tau_{x(To)} = \tau_{xo(To)} - \tau_{atm\_xo(Tx)} - \tau_{ion(Tx)}$$

$$\tau_{atm\_xo(Tx)} = \tau_{atm\_x(Tx)} - \tau_{atm\_p(Tp)}$$

$$\tau_{ion(Tx)} = \tau_{ion\_x(Tx)} - \tau_{ion\_p(Tp)}$$

$\tau_{atm\_p(Tp)}$ is zenith atmospheric excess pass delay at P.
It is not so accurate, because there is no meteorological data in P and the terrestrial position of P changes every moment by rotation of the earth.

Precising of $\tau_{atm\_p(Tp)}$ is in preparation.
I use the following convenient formula now.

$$\tau_{atm\_xo\_conviniense(Tp)} = \tau_{z\,atm\_x(Tx)} \times (GMF_{(Tx,EL_x)} - 1.0)$$