A MODEL FOR THE POSTSEISMIC DEFORMATION FOLLOWING THE 2000 WESTERN TOTTORI EARTHQUAKE (REVISITED)

Manabu Hashimoto[1)], Takao Tabei[2)] , Takeshi Sagiya[3)] and Takeo Ito[3)]

1: RCEP, DPRI, Kyoto University,

2: Kochi University

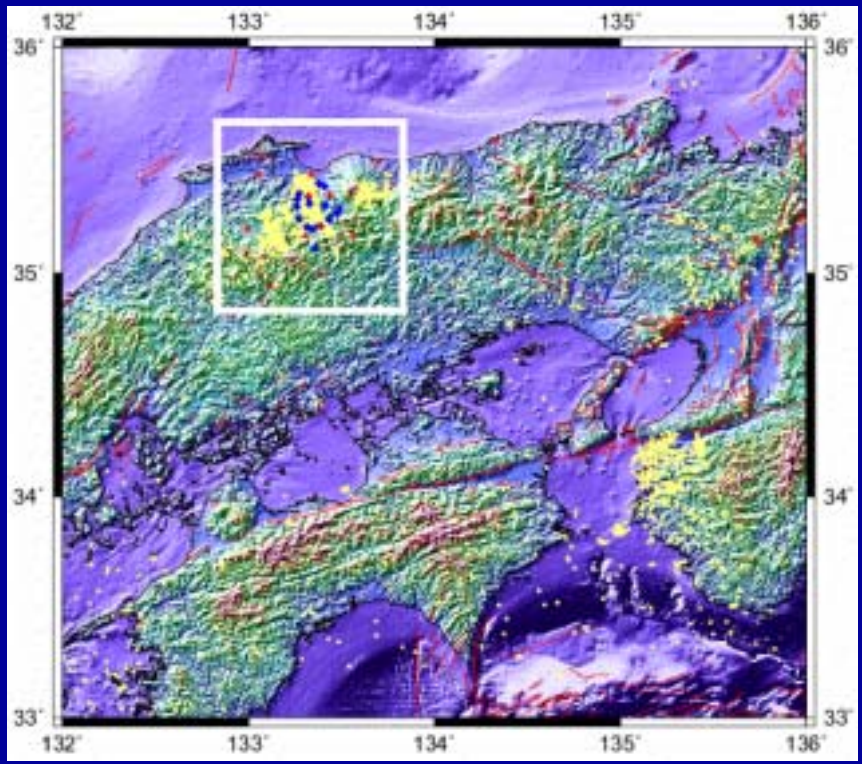
3: Nagoya University

Motivations and Objectives

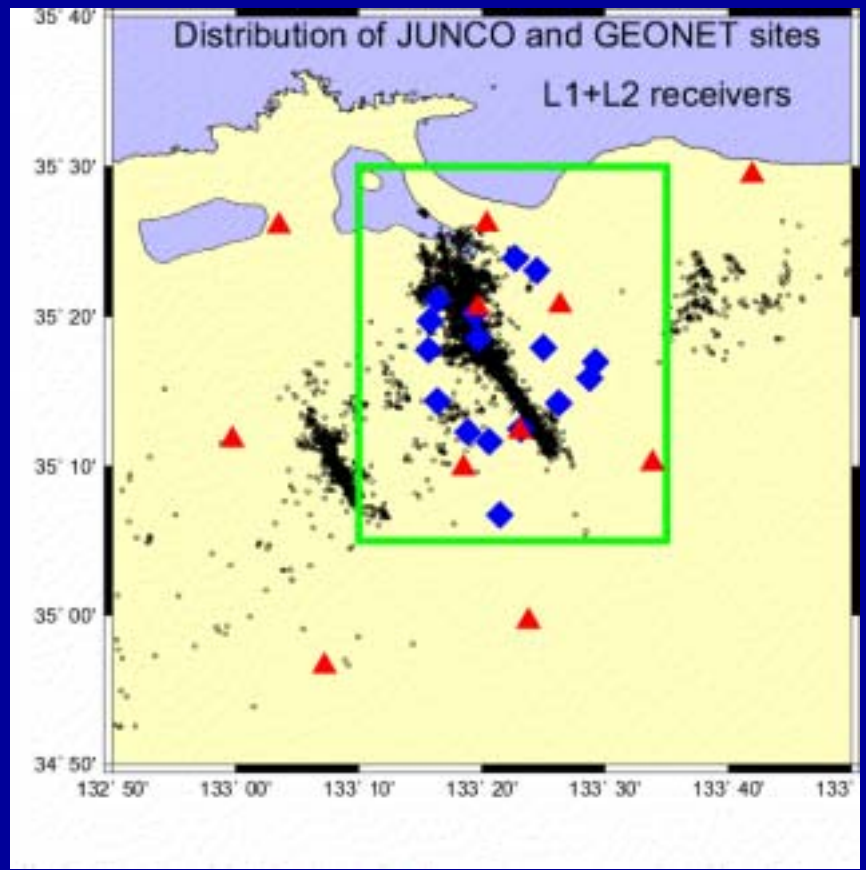
- Modeling of postseismic deformation obtained by JUNCO and GSI after the 2000 Western Tottori earthquake
- Modeling with exponential function and afterslip

  → inconsistent
- Fitting with logarithmic function based on rate-state dependent friction law
- Estimate of variable slip distribution
- Estimate of poroelastic rebound

Location and Distribution of GPS Sites

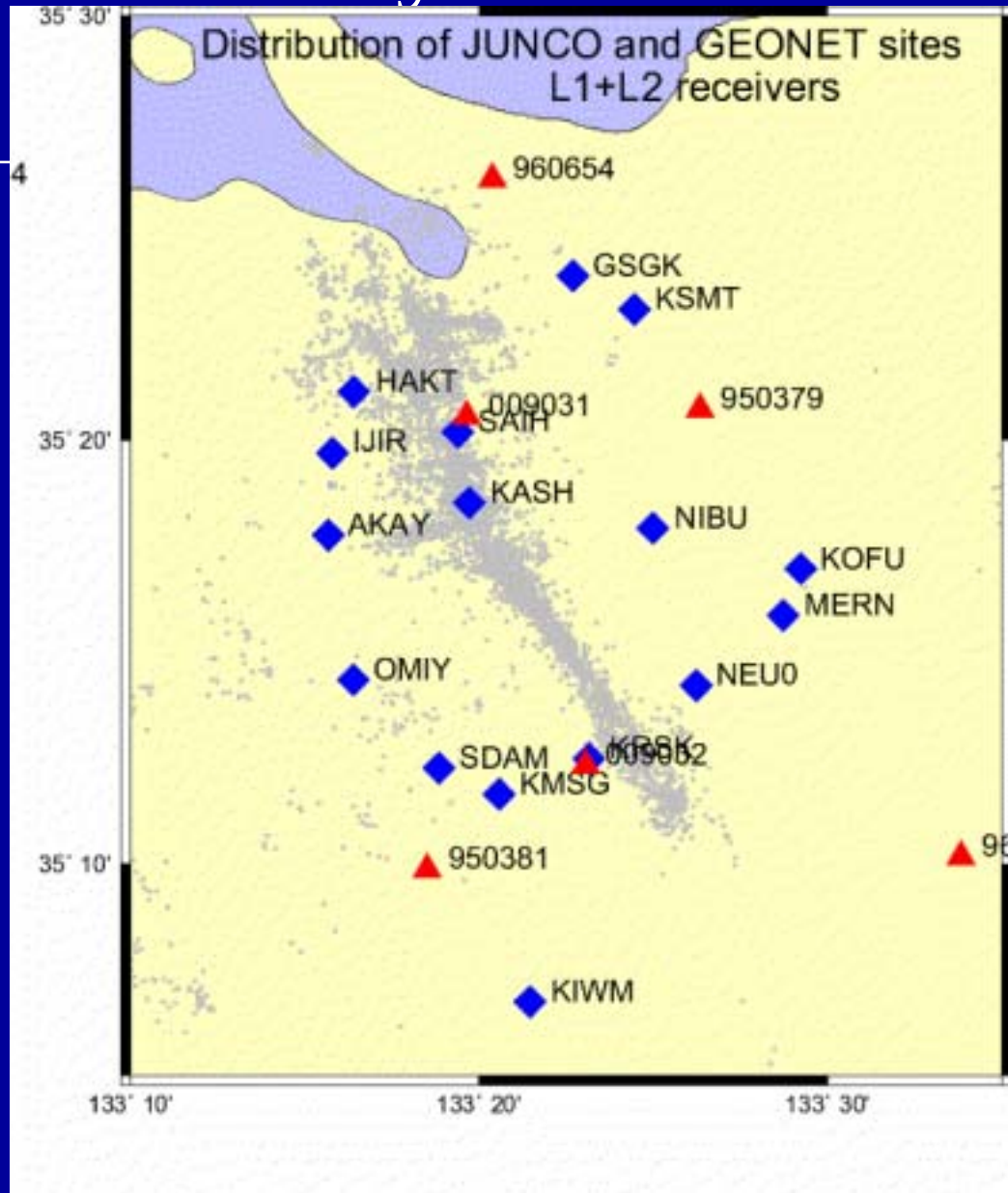


Terrain data by Kisimoto (1999)



Hypocentral data by JMA (2000)

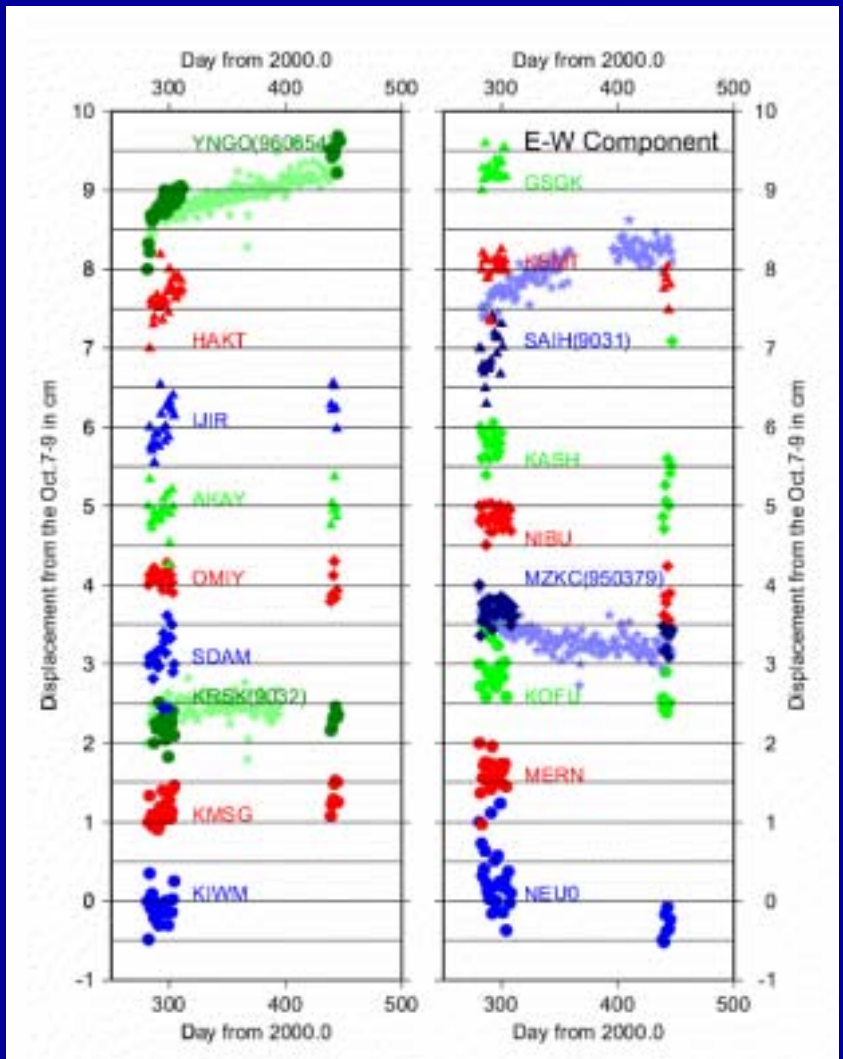
Distribution of GPS Sites by JUNCO and GSI

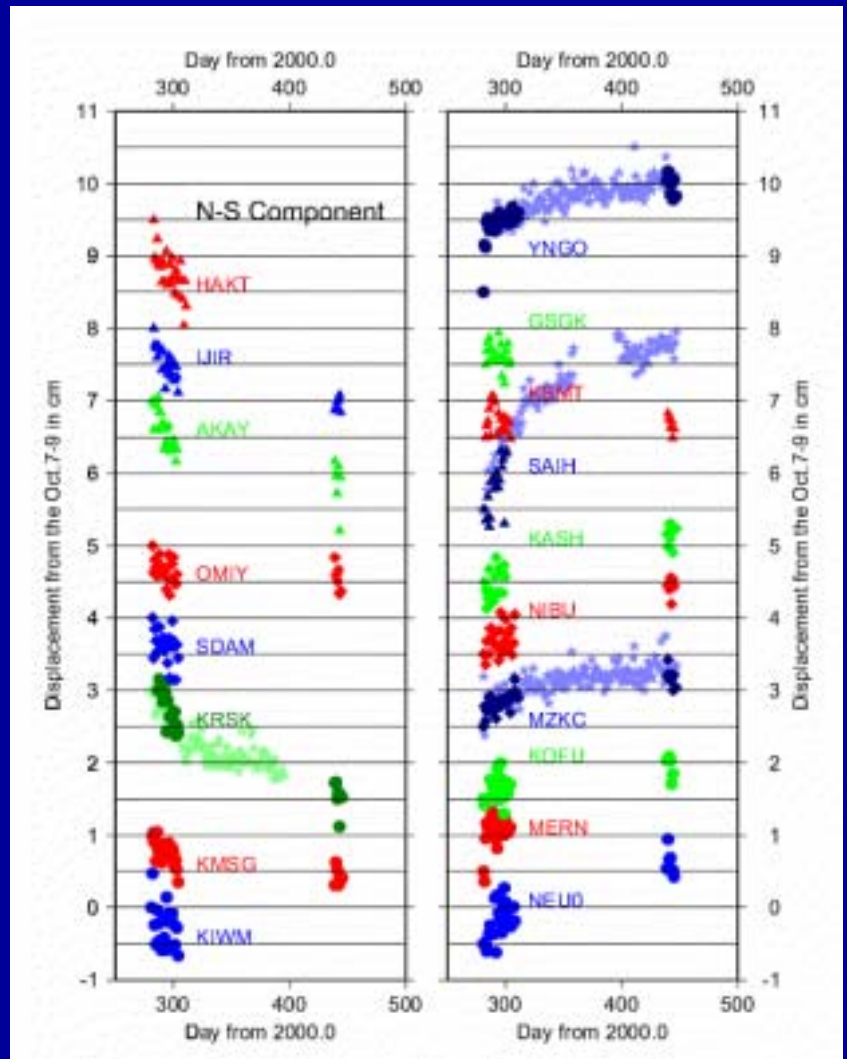


Summary of Observation and Data Processing

- Dual freq. receivers (Ashtech for JUNCO, Trimble and Ashtech for GEONET)
- 30sec sampling, 24 hour, Elevation mask 15deg.
- Static analysis with Bernese 4.2
- Displacement is converted to those w.r.t. GEONET 950378 (Shikano, E Tottori)

Temporal Variations in E-W and N-S Components of GPS sites (DOY280-447)





Formula by Marone et al.(1991)

$$U_p(t) = \alpha \ln\left(\frac{\beta}{\alpha} t + 1\right) + V_0 t + U_{ref}$$

α：Parameter related to (a-b) in the velocity-strengthening layer

β：Coseismic velocity

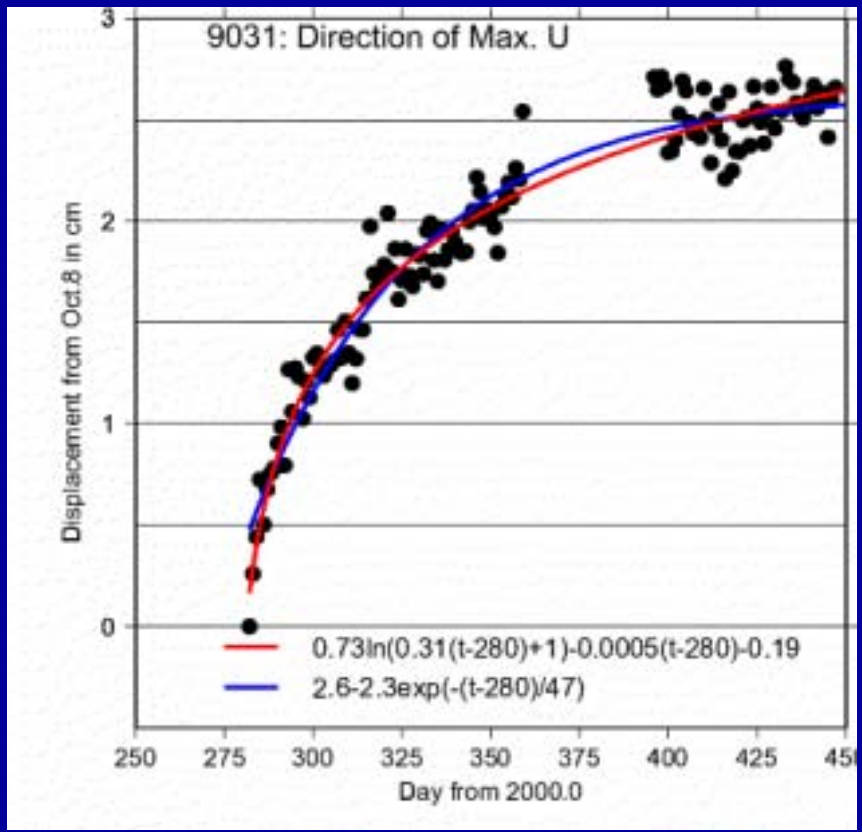
V_0：Steady state velocity

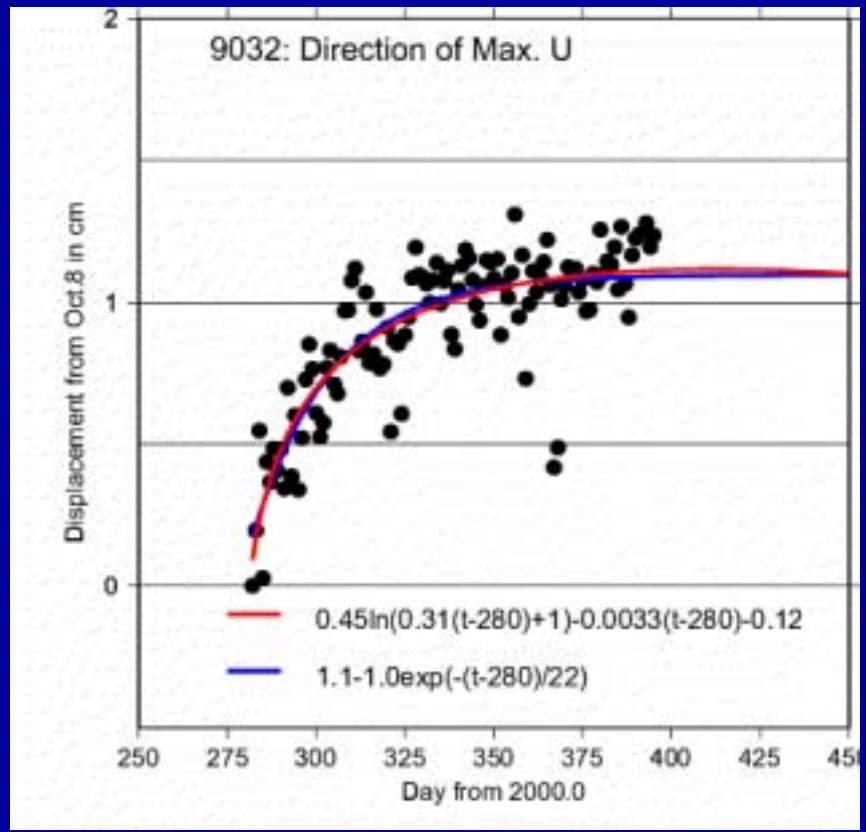
U_{ref}：Offset of displacement at the start of observation

Procedure of Fitting

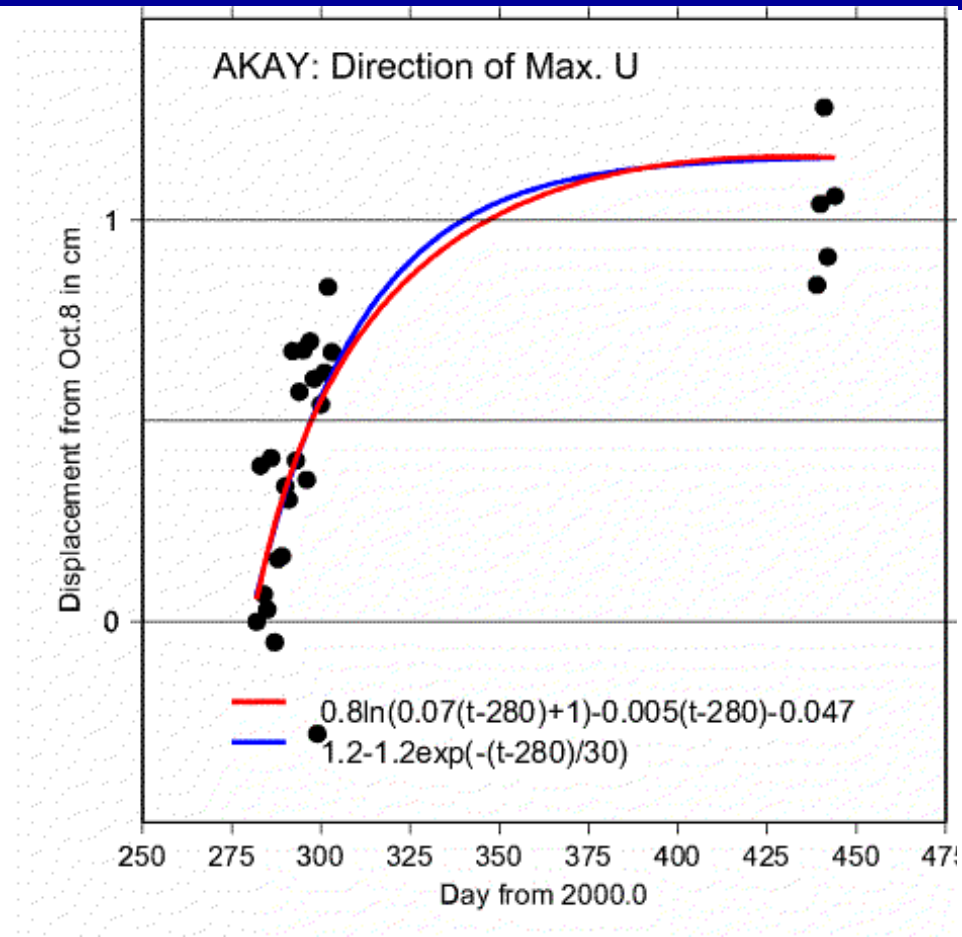
- Generate time series of movement in the direction of the maximum displacement
- Grid-search for β / α (0.001~500)
- Estimate α, V_0, U_{ref} for all grid point of β / α using the least square method
- Non-linear fitting of exponential function to the same time series for comparison

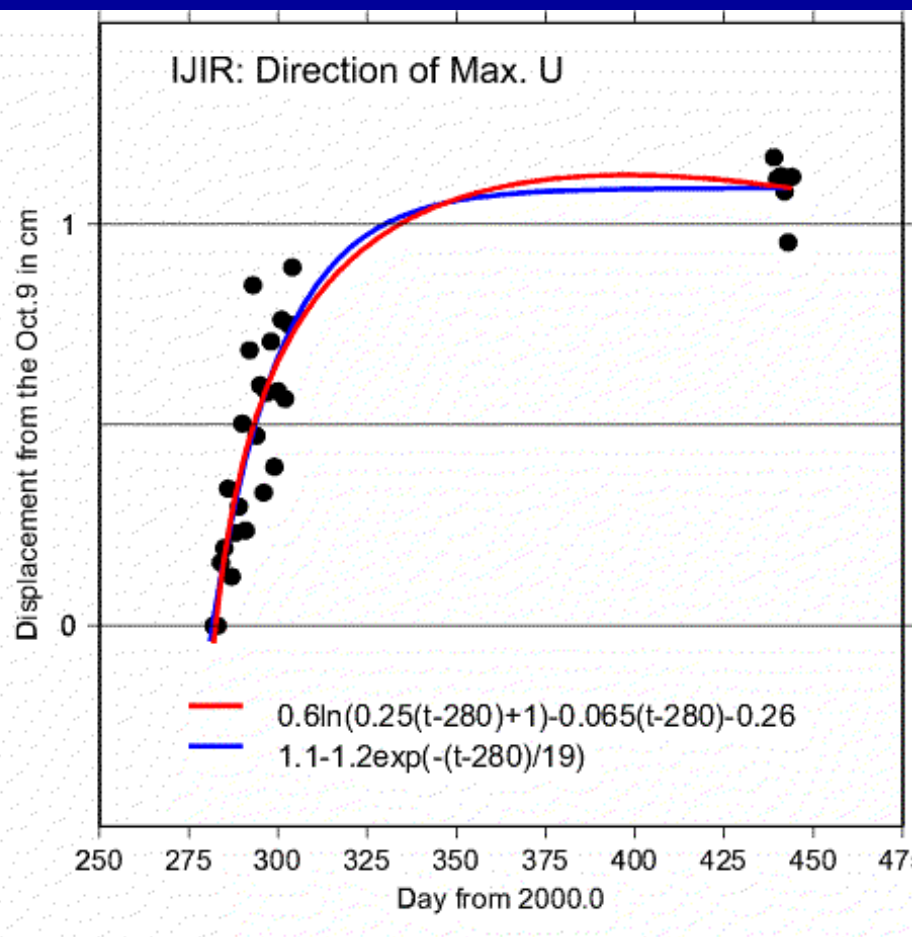
Movement of 9031 and 9032



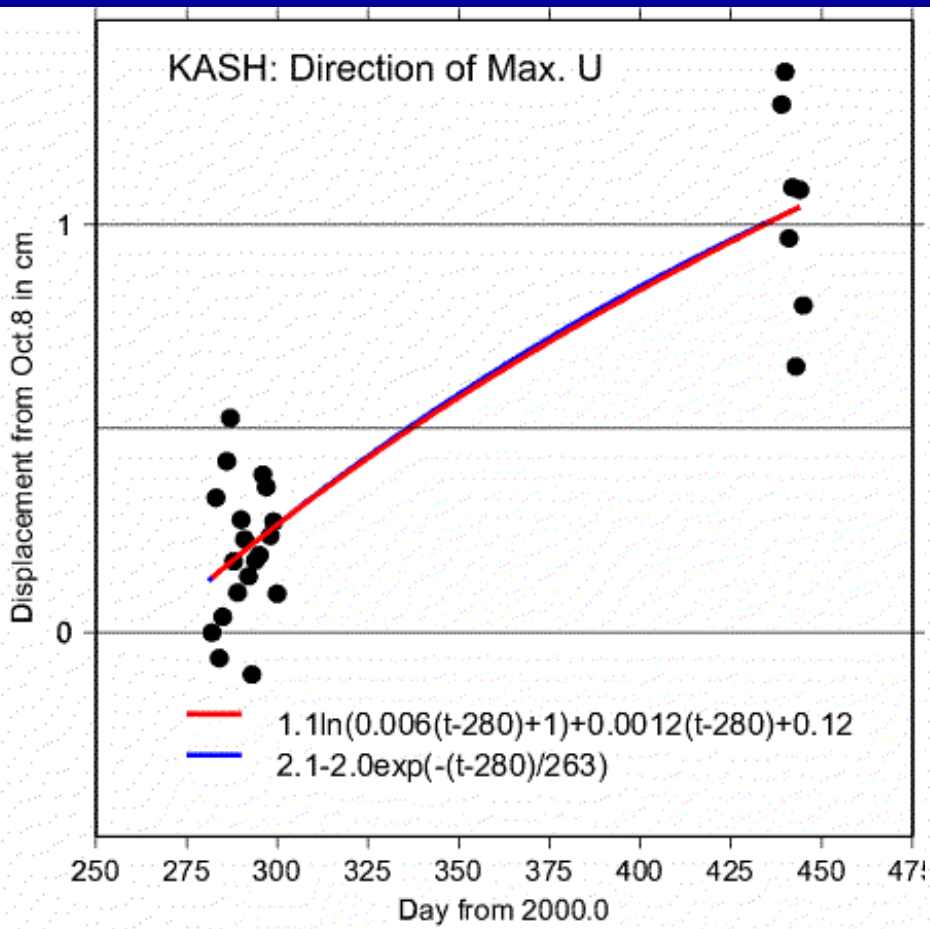


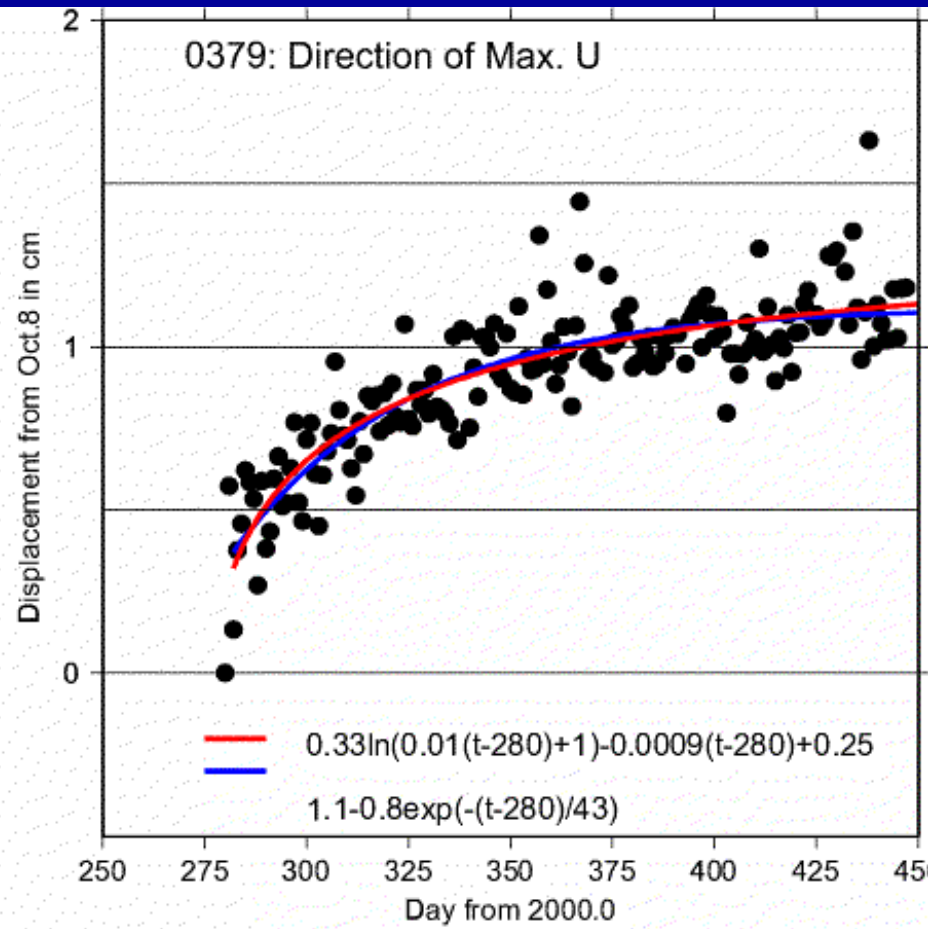
Movement of AKAY and IJIR



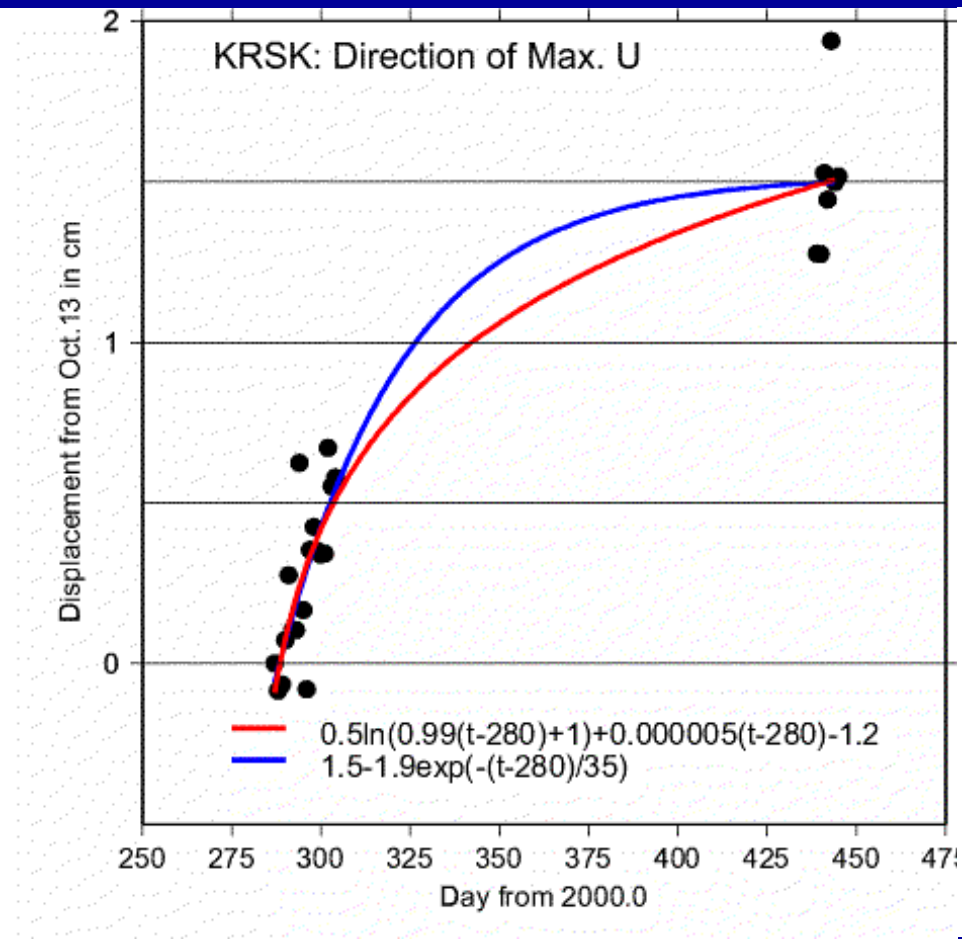


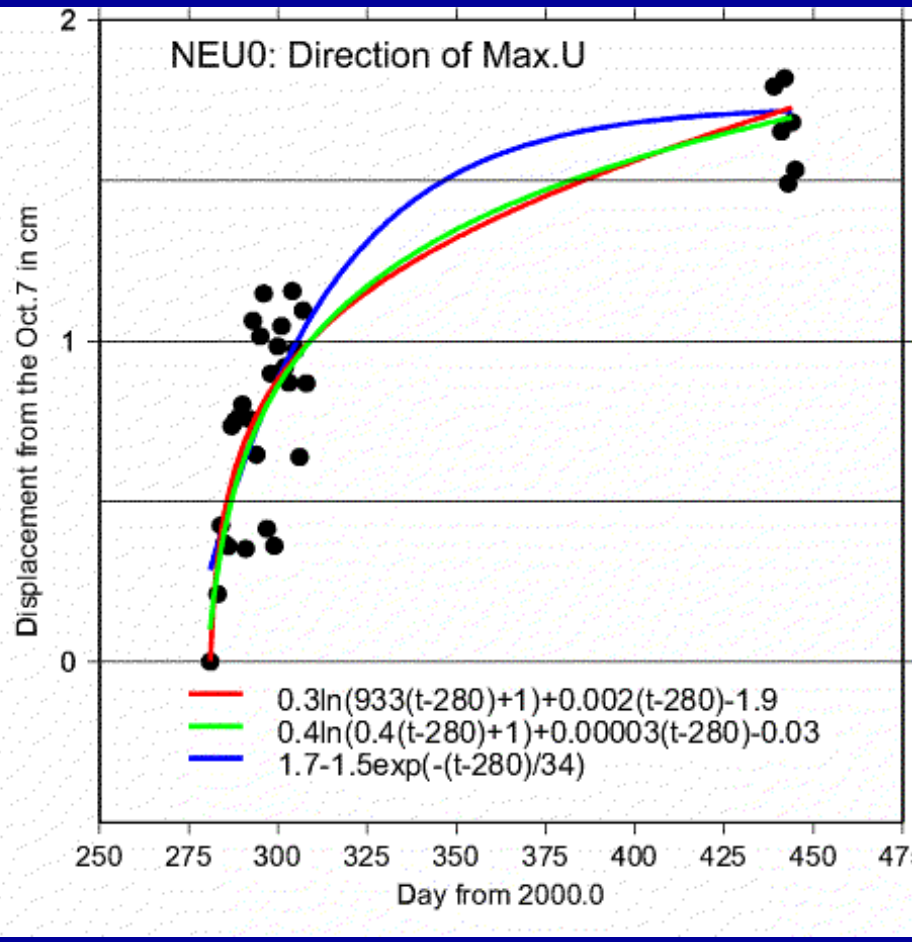
Movement of KASH and 950379



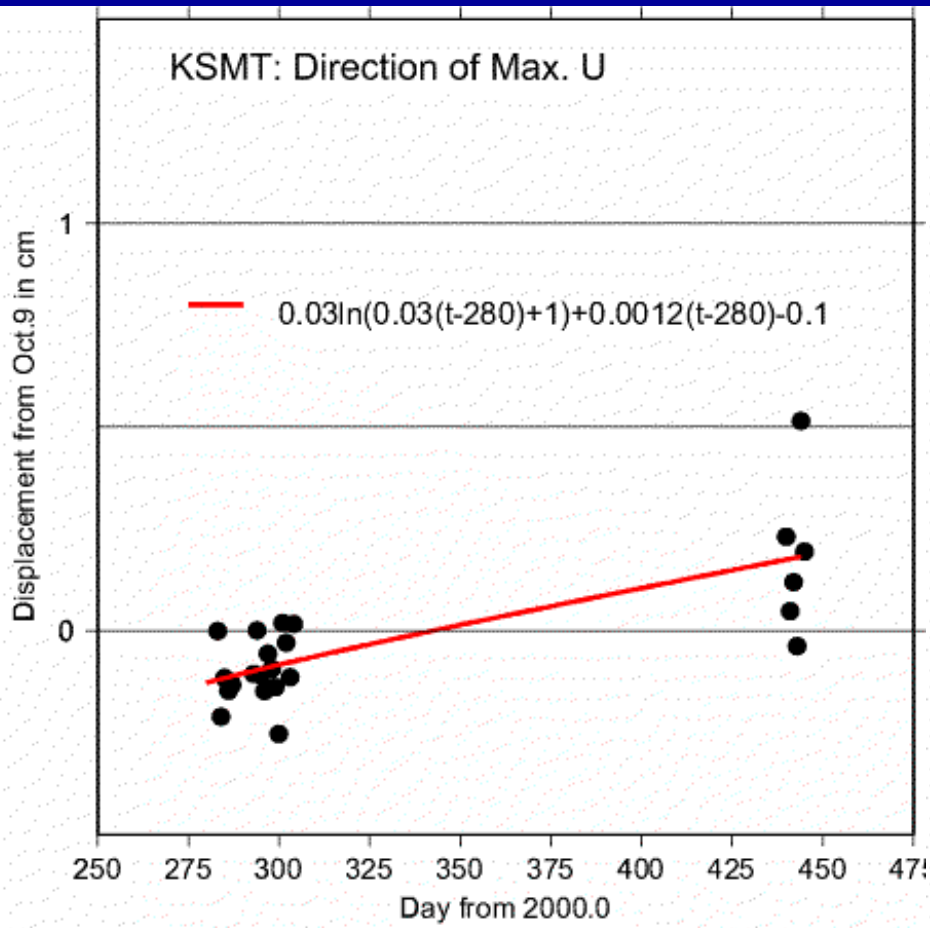


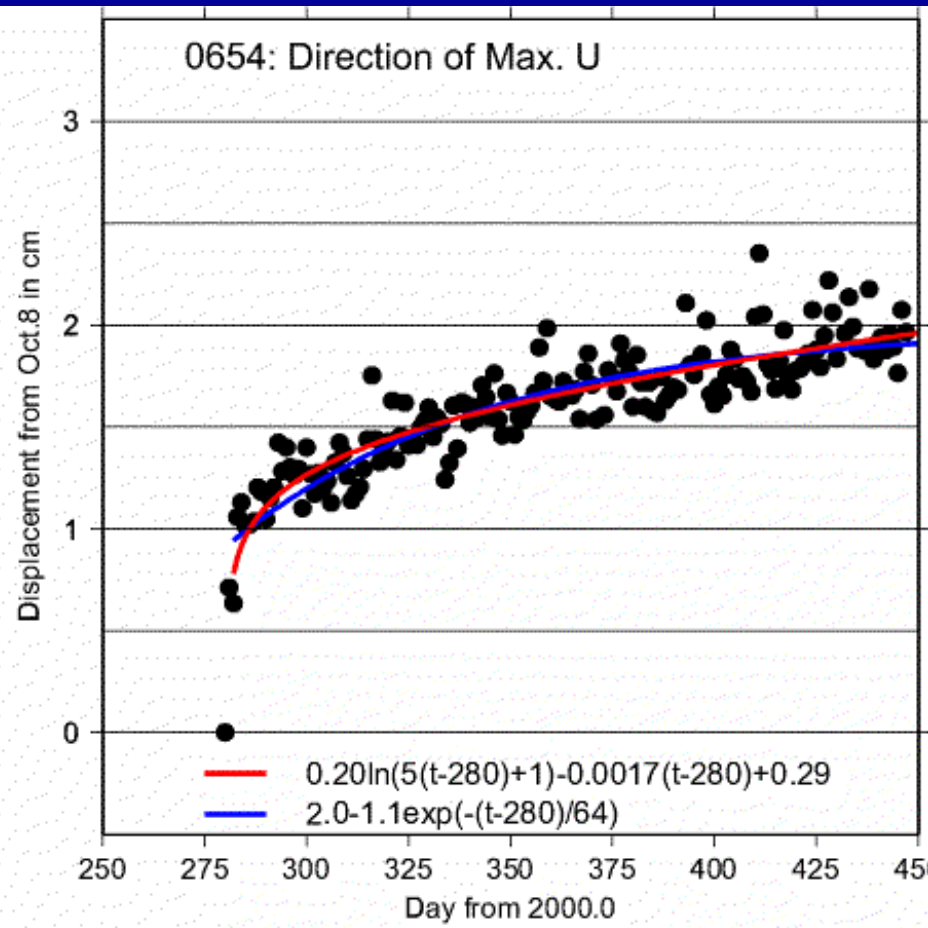
Movement of KRSK and NEU0



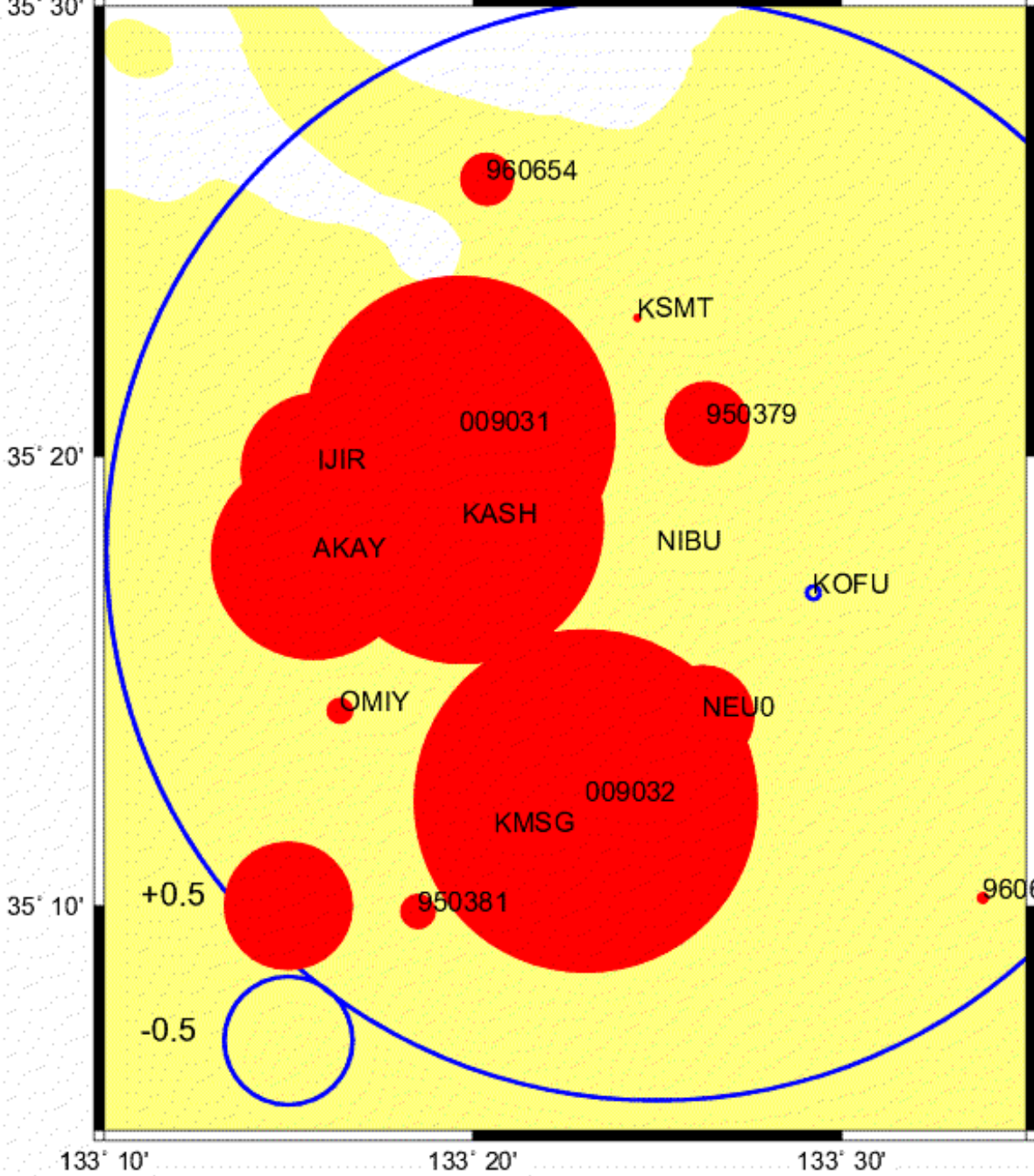


Movement of KSMT and 960654

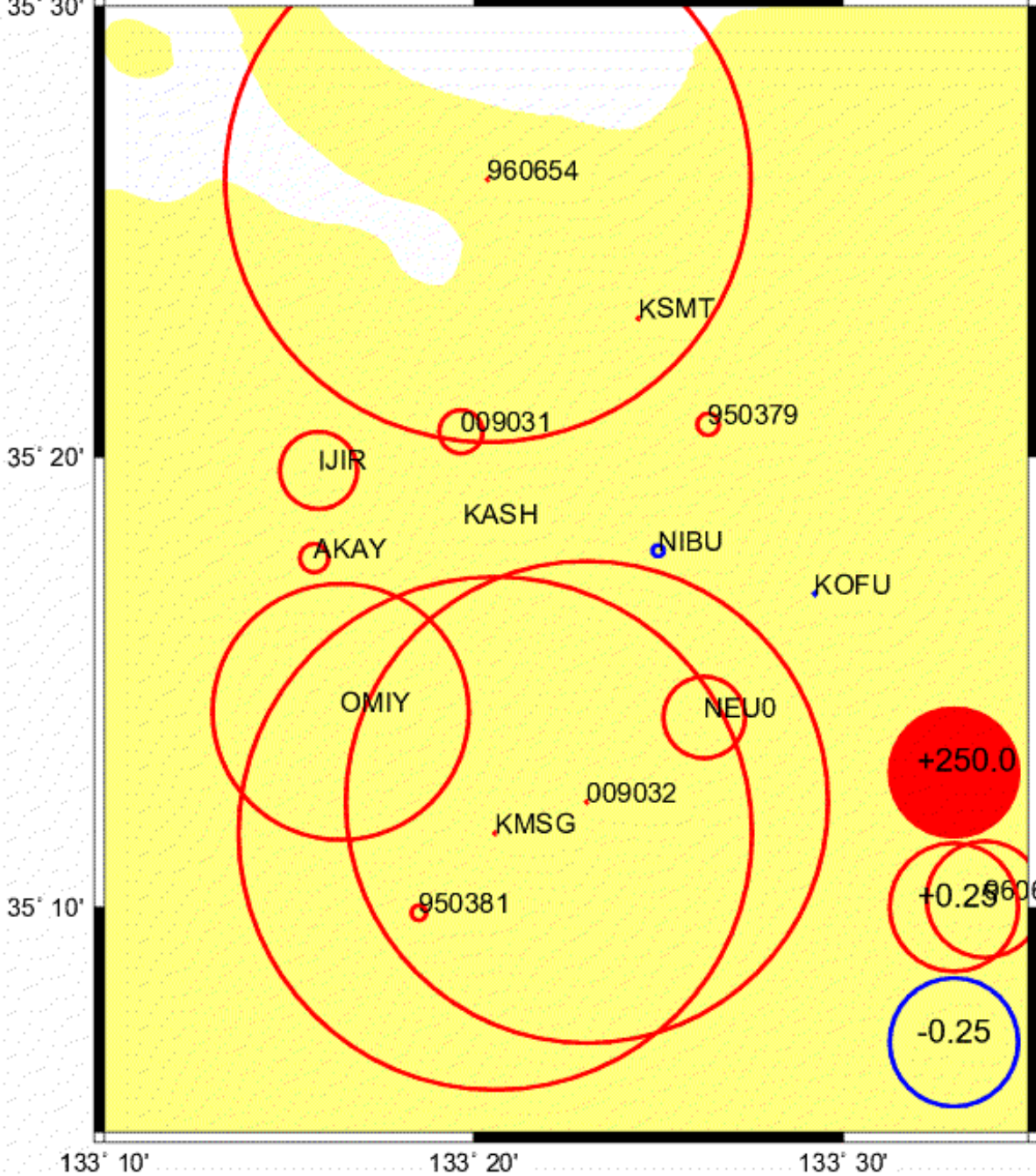




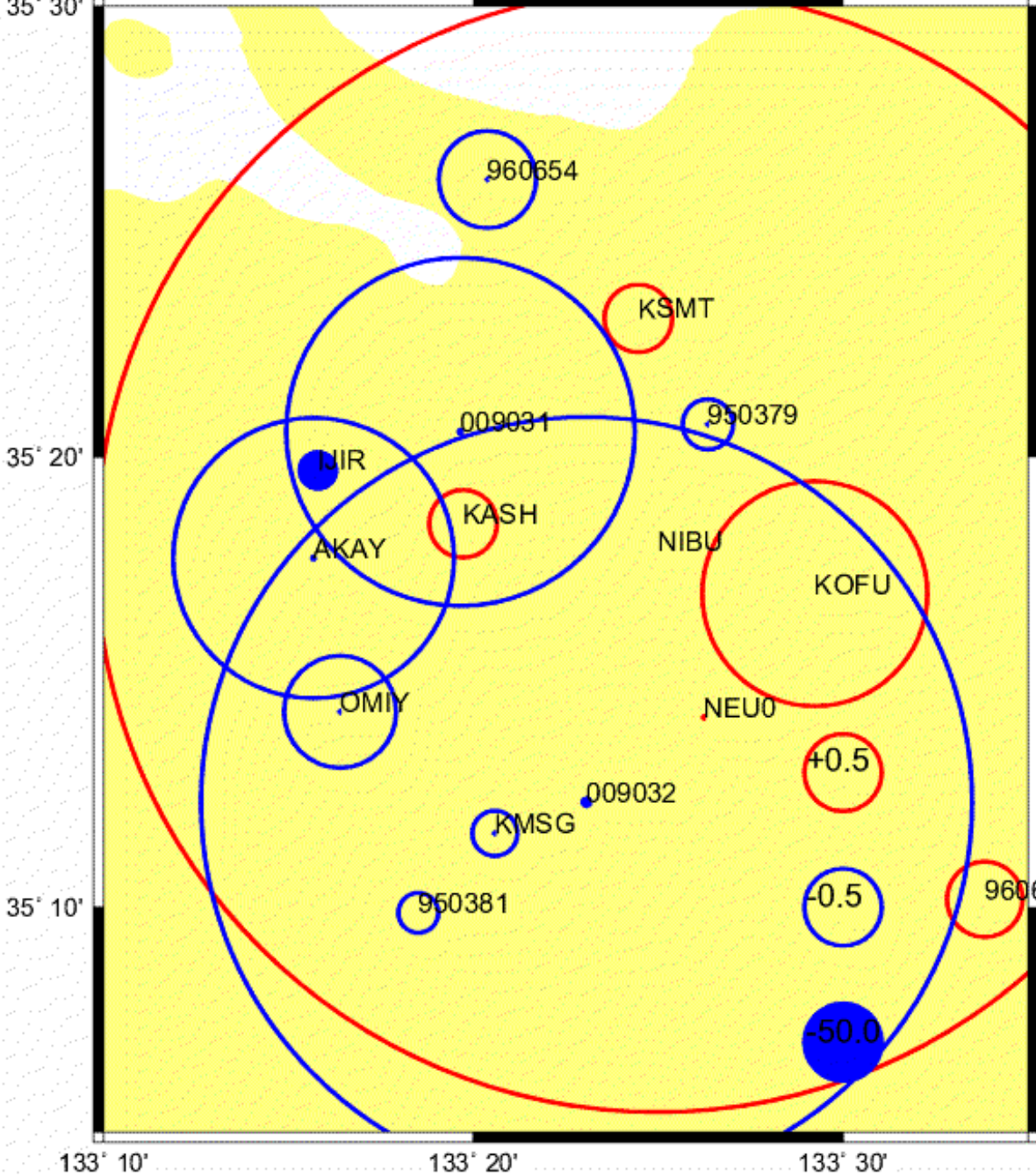
Distribution of α



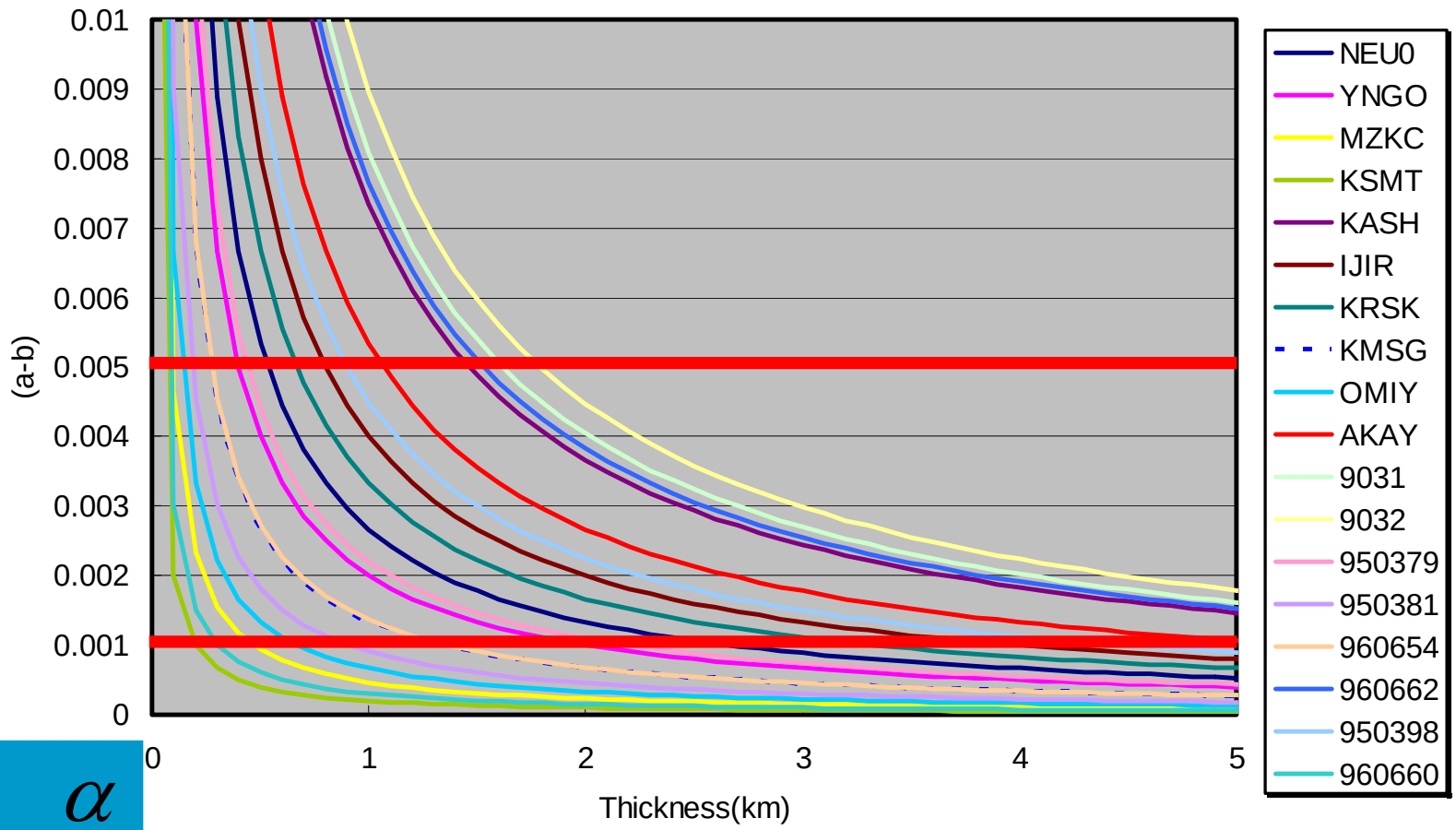
Distribution of β



Distribution of V_0



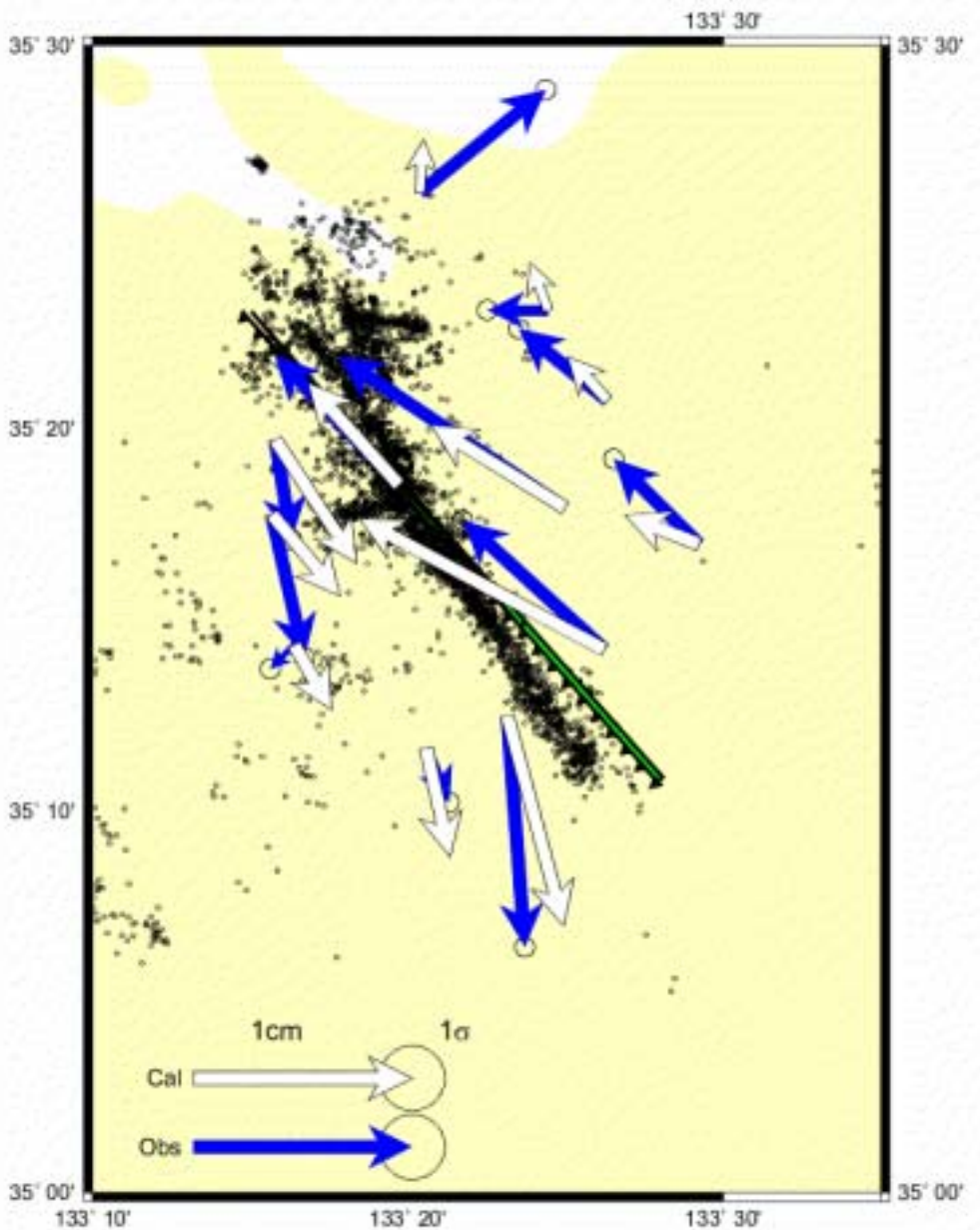
Estimate of (a-b)



$$(a-b) = c\frac{\alpha}{h}$$

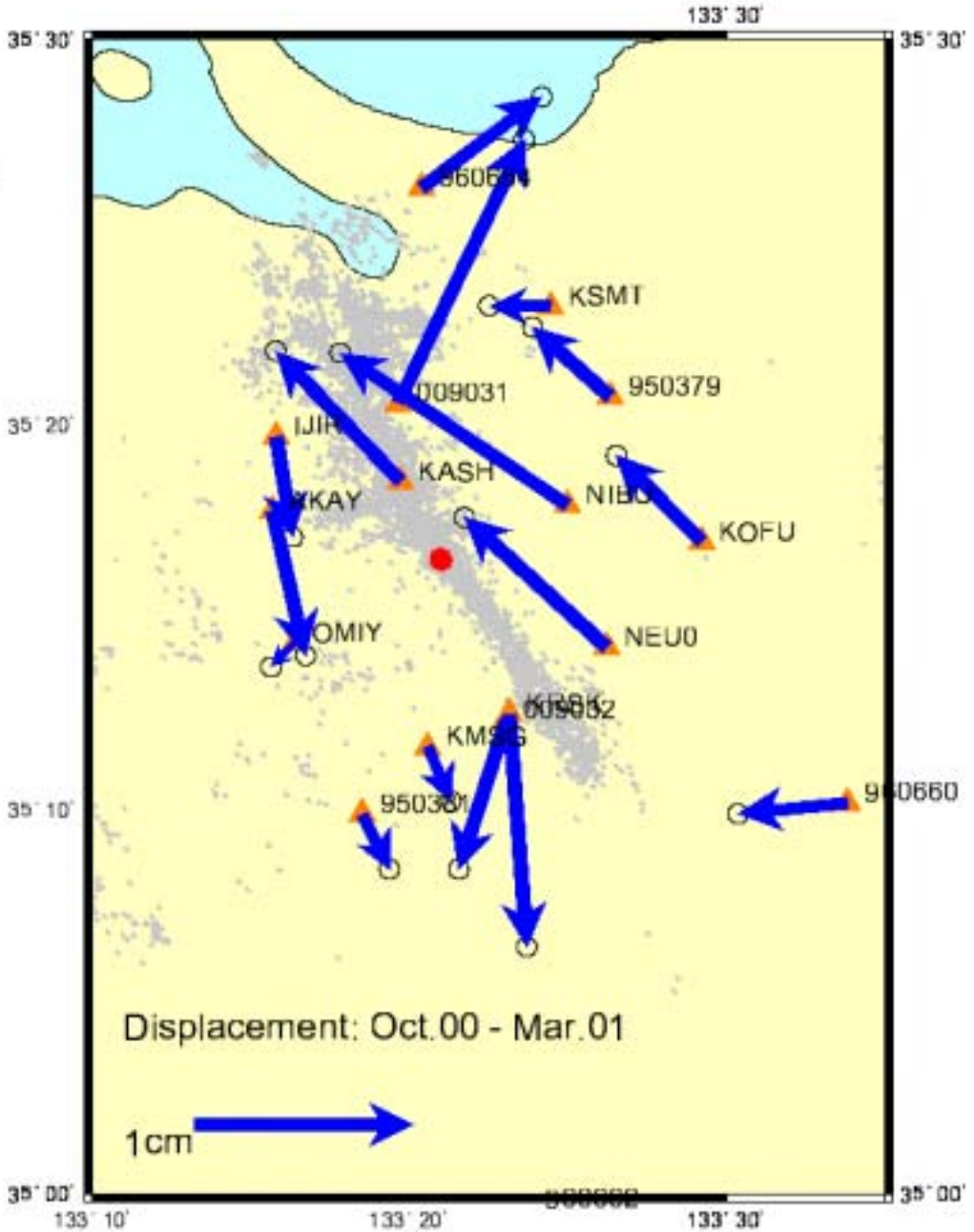
Afterslip Model (JUNCO data)

- Using only JUCNO data
- Shallow strike slip
  - Left lateral ~5cm



Observed Postseismic Displacement (Oct.25~31 – Mar.15~21)

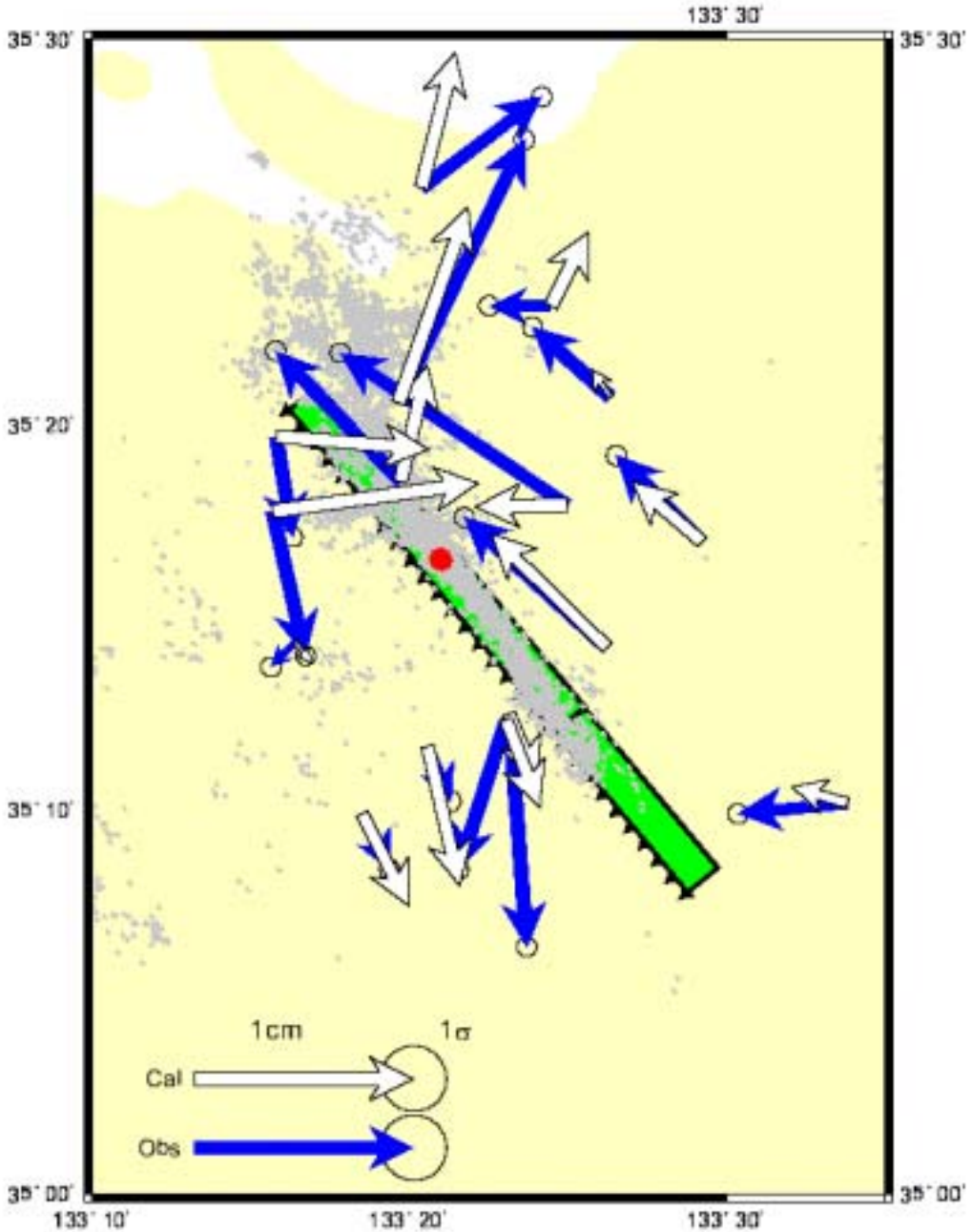
- Left lateral displacements
- Larger on the east side of aftershock zone
- Larger in the vicinity of aftershock zone
- implies shallow source

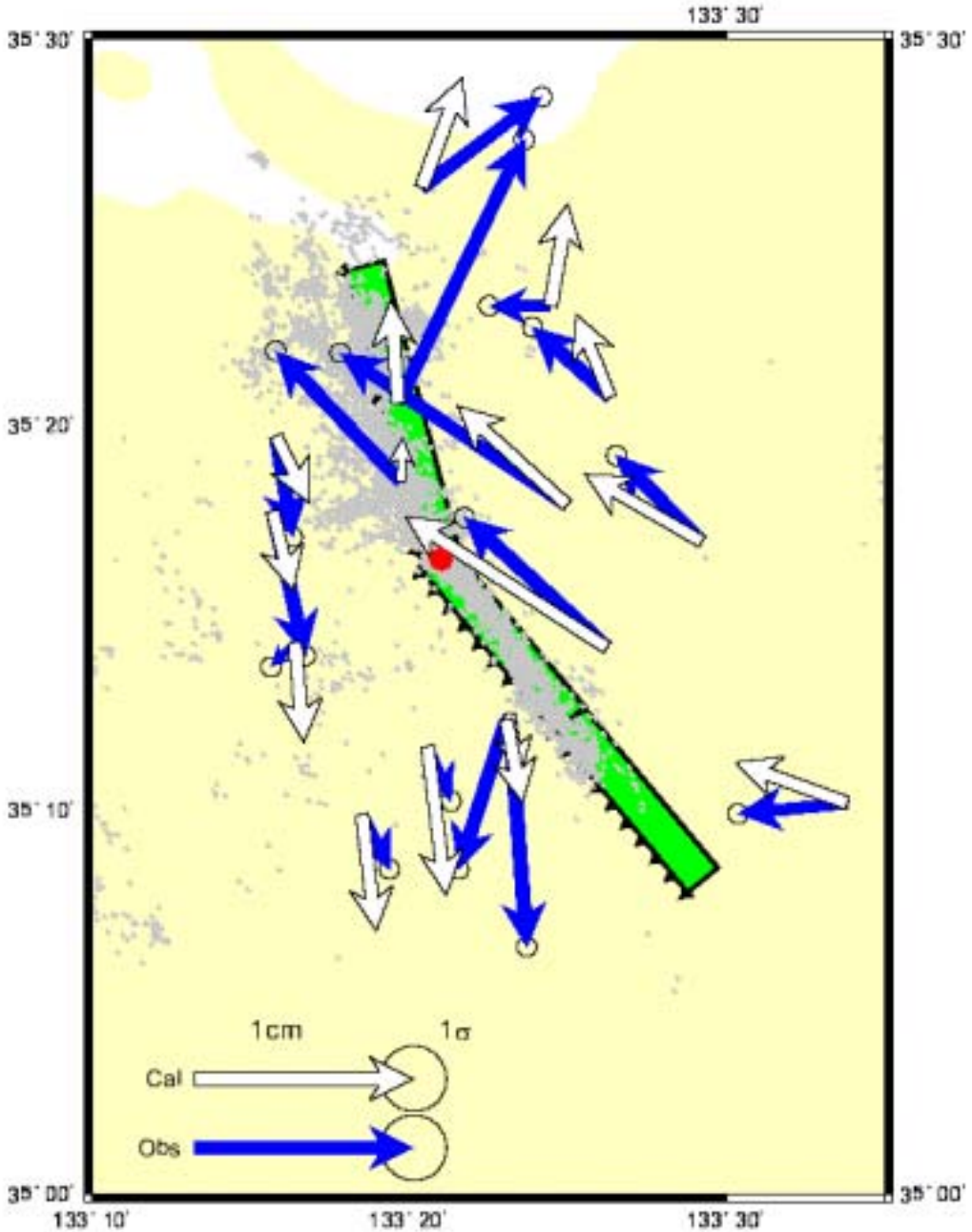


But….

Afterslip Model

- 3 segments(10x21km^2)
- N141E, Dip 95deg
- Dislocation
  - 6cm (326deg)
  - 3cm (102deg) !!
  - 4cm (332deg)



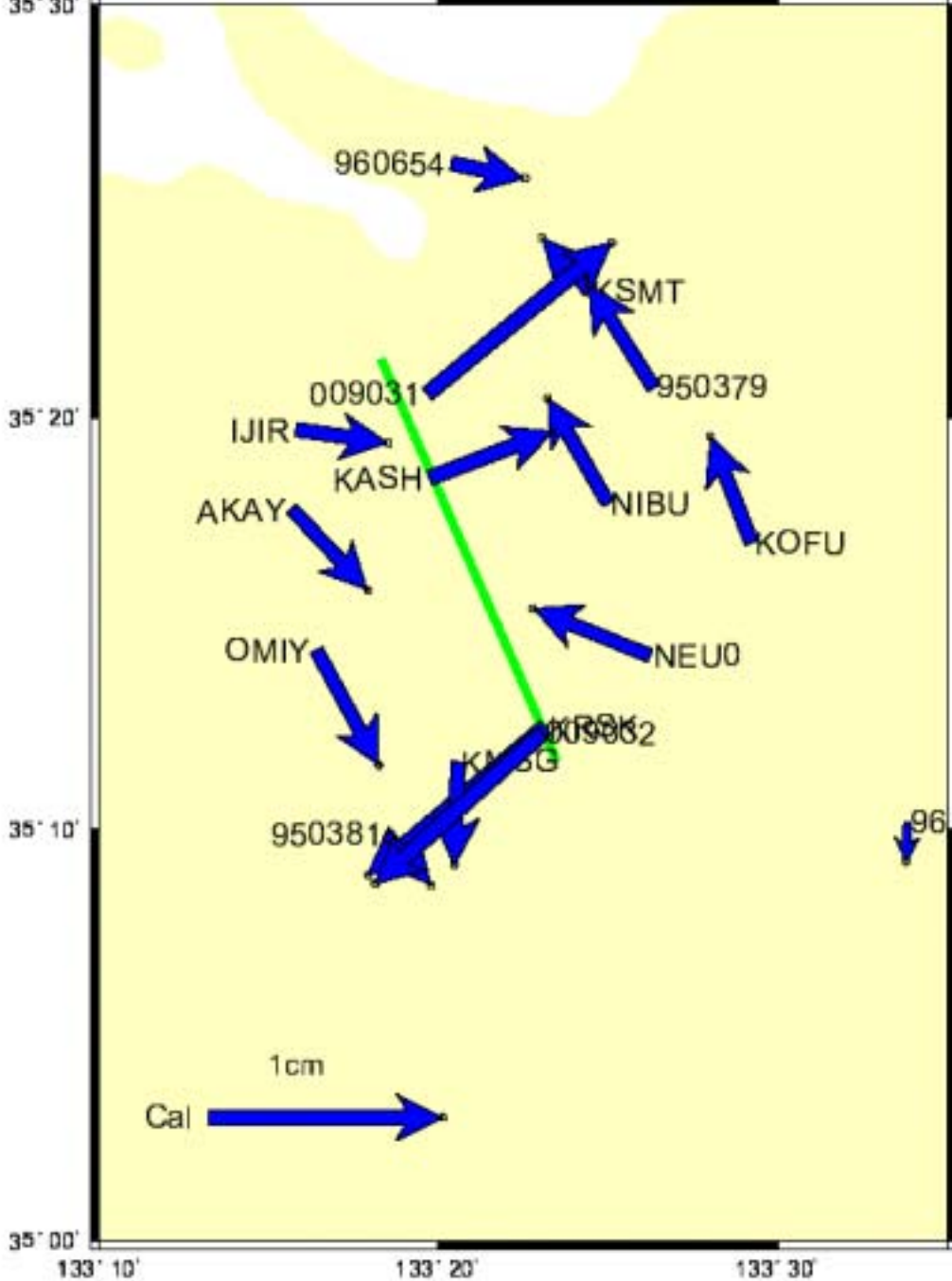

133° 30'
35° 30'
35° 30'
35° 20'
35° 10'
35° 00'
35° 00'
133° 10'
133° 20'
133° 30'
1cm
1σ
Cal
Obs

What should we do for it?

- Other source than afterslip
- Viscoelastic adjustment – Possibly NO
- Poroelastic rebound
  - Coseismic response with high Poission's ratio
  - Transient flow of groundwater
  - Drained state with low Poisson's ratio

Poroelastic Rebound

- Sagiya et al's. (2001) one fault model
- Poisson's Ratio
  - Undrained=0.31
  - Drained=0.27
- Difference between undrained and drained displacement field



Summary

- Logarithmic function fit the data as well as exp.
- Large α in the vicinity of source region
- Opposite sign for V_0on the both sides of the fault
- Complicated afterslip distribution
- α's give (a-b) consistent with lab. data if the velocity strengthening layer is as thin as 5km.
- Poroelastic rebound might explain the displacements at 9031and NIBU etc.