Interplate Coupling Derived From the GPS Surveys in Kii Peninsula and its Implication to the Groundwater Changes Preceding the 1946 Nankai Earthquake

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Objectives

- To delineate the coupling region of the Philippine Sea and overriding plates
- To detect the possible temporal changes in coupling region

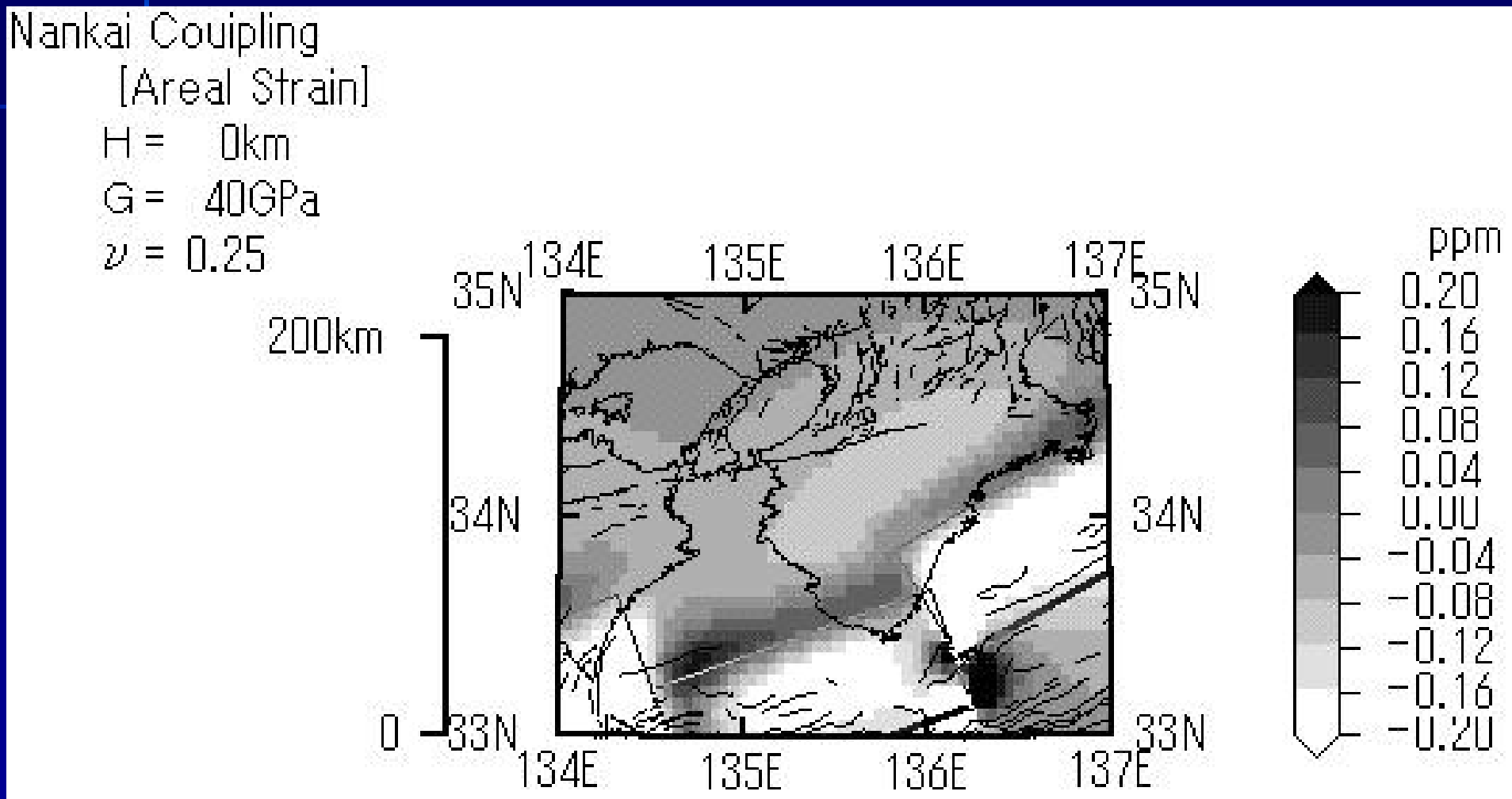
GPS Traverse Campaign Across the Hinge Line

- Two traverse lines crossing the Hinge line in southern Kii peninsula
- Fill the gap of GEONET by GSI
- 10 sites
- Average spacing ~5km

Why Hinge-Line?

- Hinge-Line = boundary between coseismic uplift and subsidence ~ lower margin of coseismic fault
- Strains remarkably change across the hinge-line.

Simulation of Strain Field:
Full Coupling on the 1946 Fault



Reduction of Width by 10km

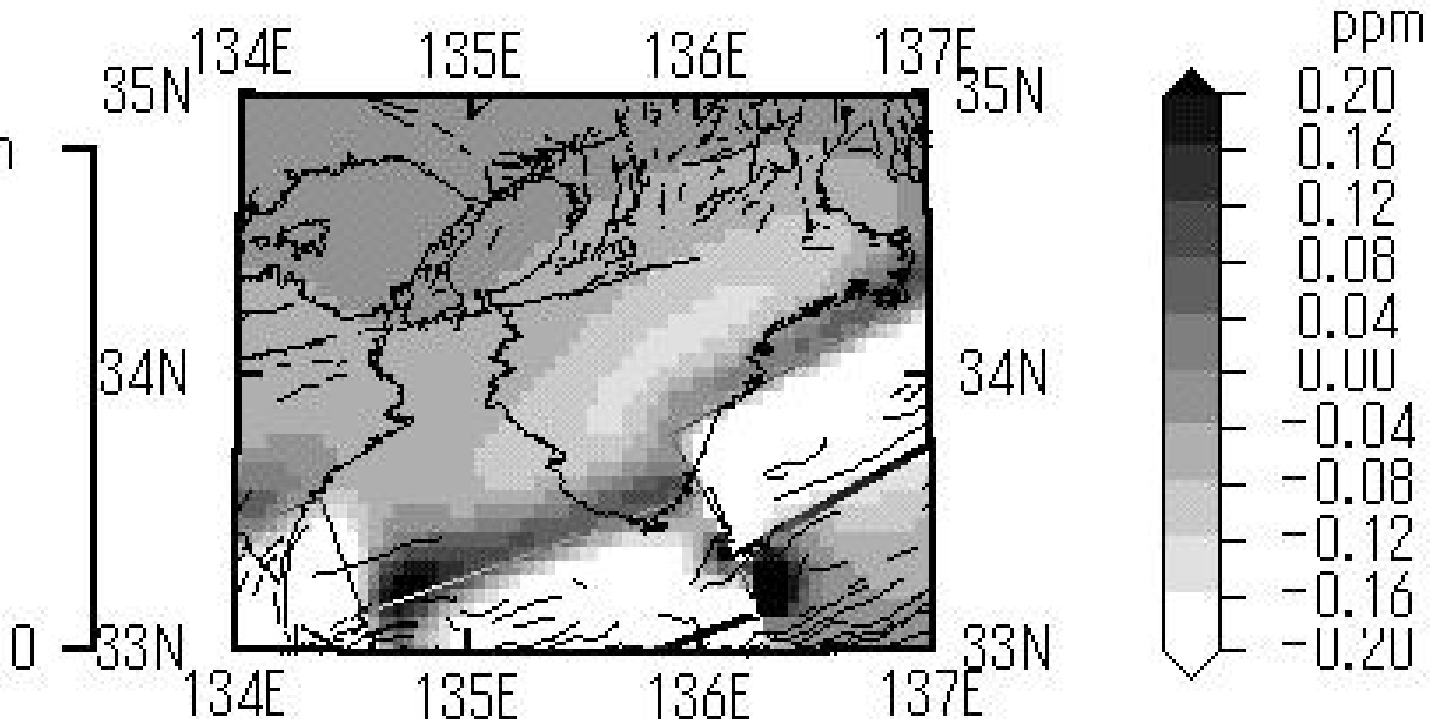
Nankai Couipling

[Areal Strain]

H = 0km

G = 40GPa

ν = 0.25



Further Reduction of Width by 10km

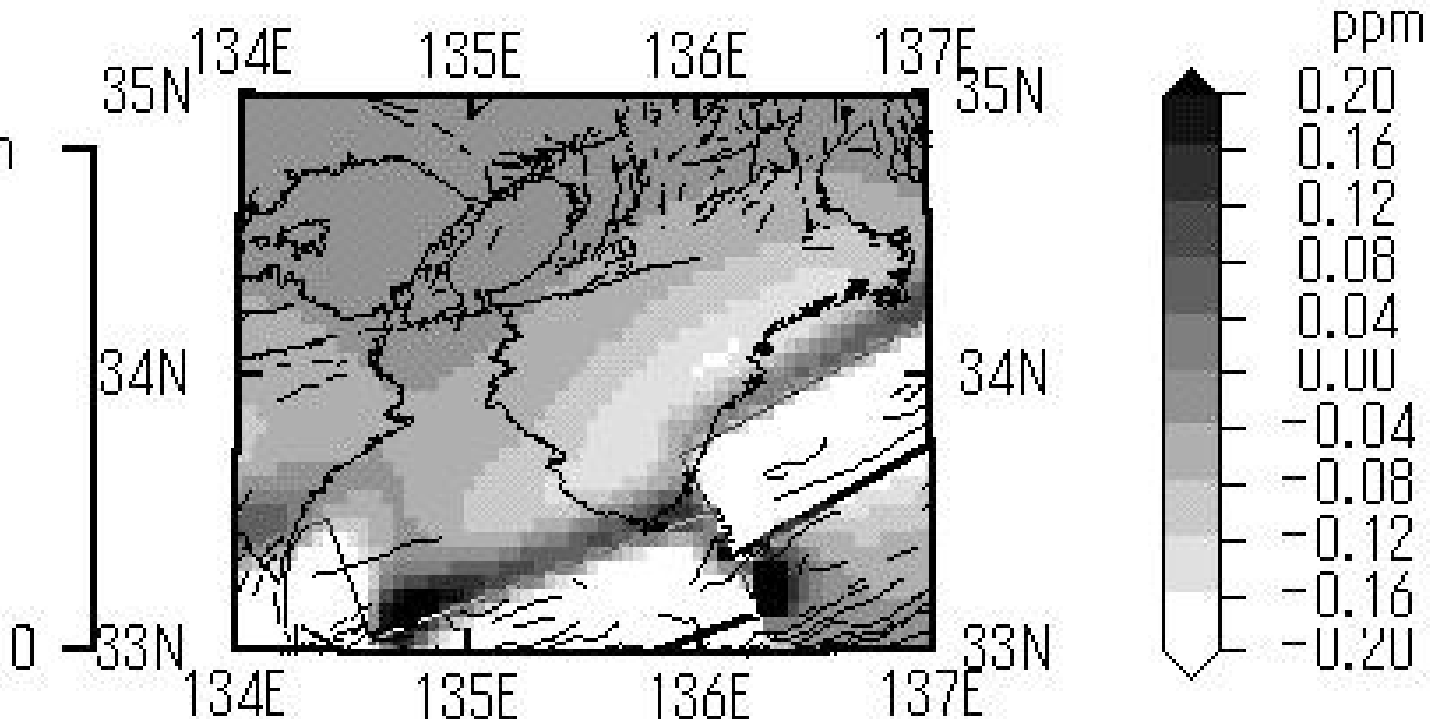
Nankai Couipling

[Areal Strain]

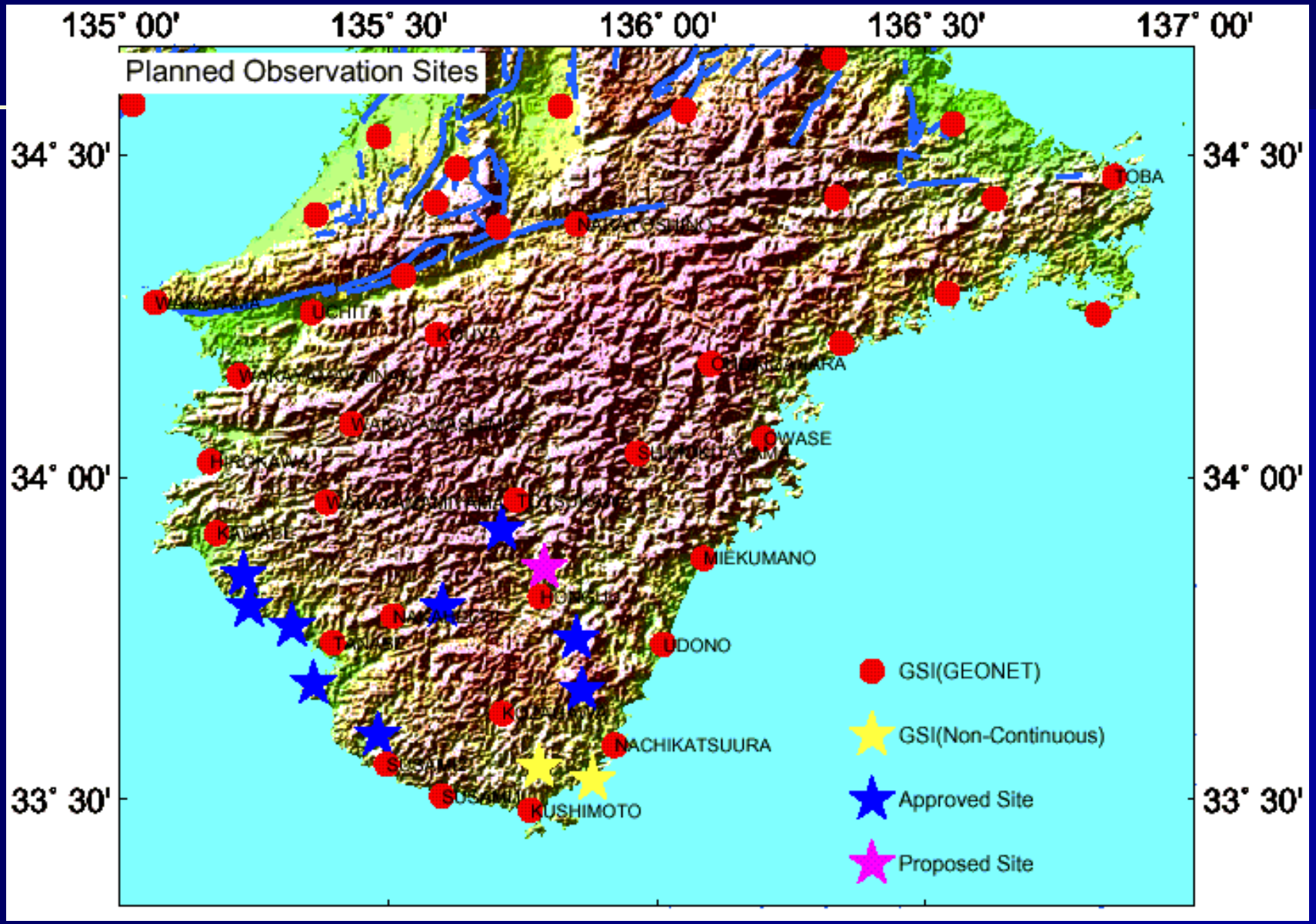
H = 0km

G = 40GPa

ν = 0.25



GPS sites in Kii peninsula




Newly Established Tower

Newly Established Tower

New Receiver: Javad Legacy-E

Observation Epoch

- Establishment of DPRI's sites in 2000
- 1st observation in Mar. 2001 (9 sites)
- Establishment of FUSI site in Fall, 2001
- 2nd observation in Mar.2002 (10 sites)
- 3rd observation in Mar.2003 (10 sites)

Observation Scheme

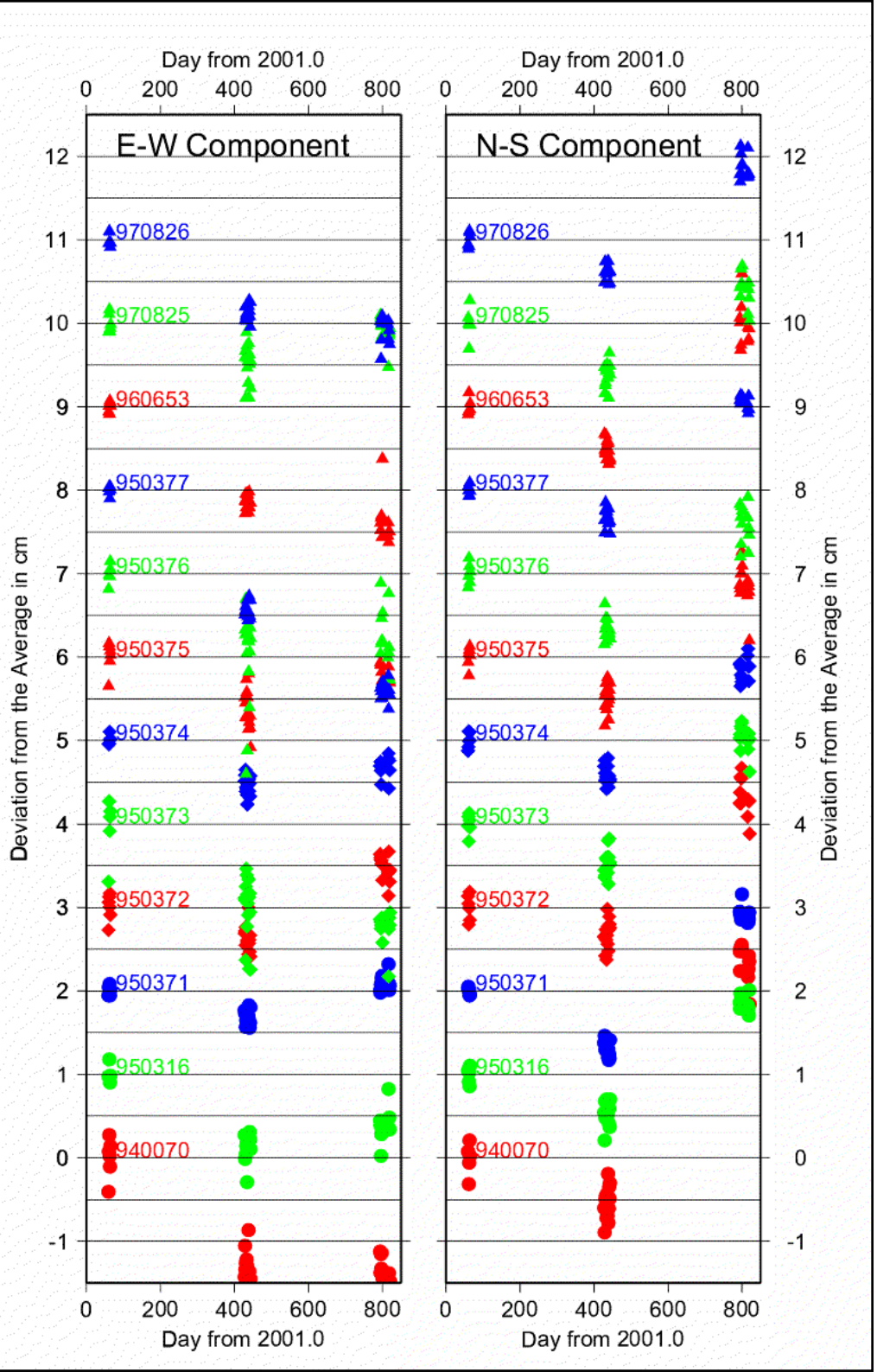
- 30 sec sampling, 24 hours
- Elevation mask = 15˚
- Receivers and antennas
  - Ashtech Z-12 with Rev.B/D type antenna
  - Javad Legacy-E (FUSI)
  - Javad Legacy-E with rubidium frequency standard (SRHM in 2003)
  - Trimble 5700 with Zephyr antenna (HIKI, MINB in 2003)

Analysis Strategy

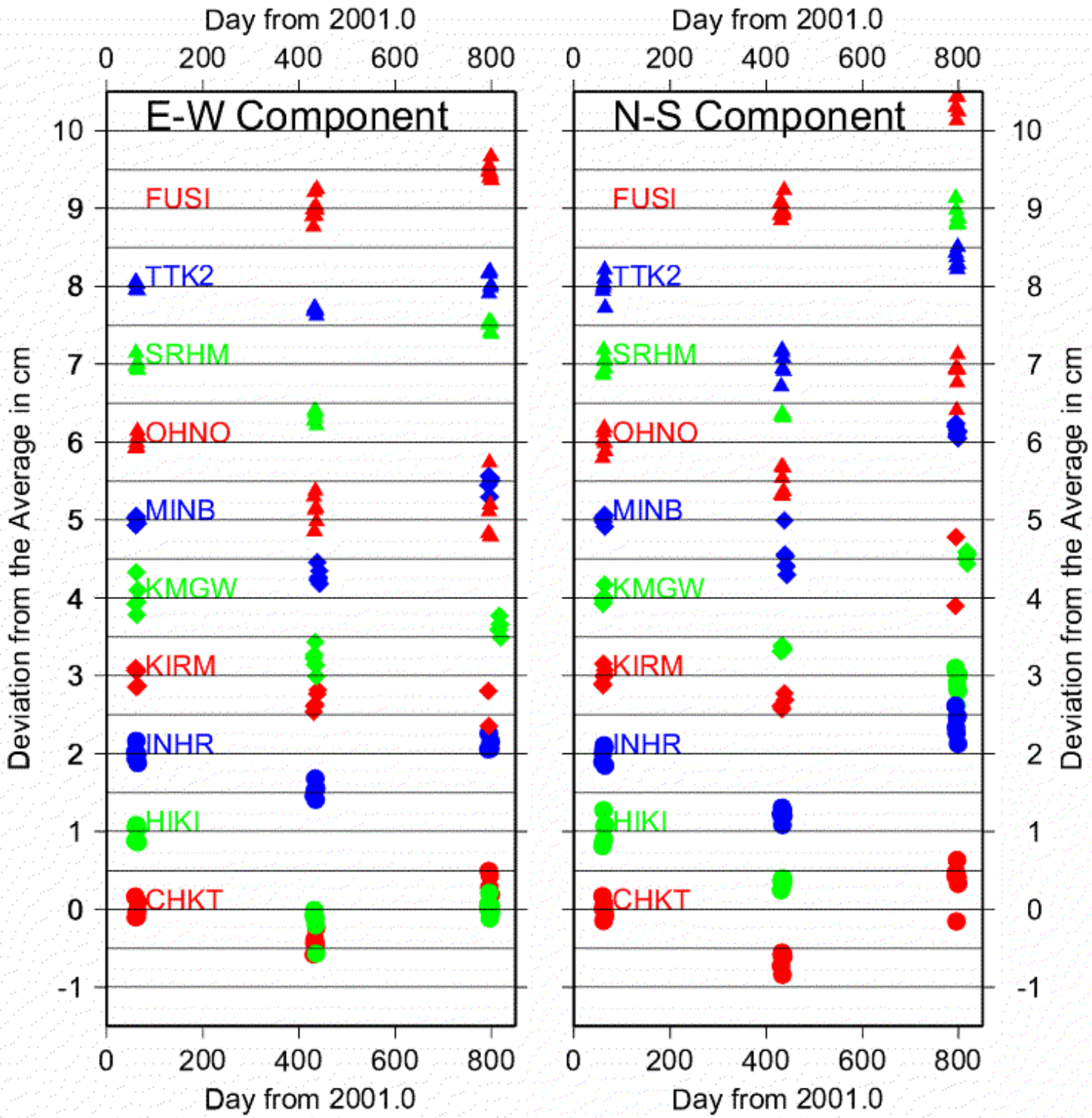
- Determine 5 GEONET sites using IGS data (TSKB, USUD, SUWN, WUHN, SHAO) in ITRF2000
- Average coordinates of 5 GEONET sites during the campaign
- Determine other sites fixing 5 GEONET sites
- Bernese 4.2
- IGS final ephemeredes with IGS pole
- Ocean load: prepared by AIUB
- Zenith delay estimated every 2 hours
- PHAS_IGS.01 by AIUB for phase center variation

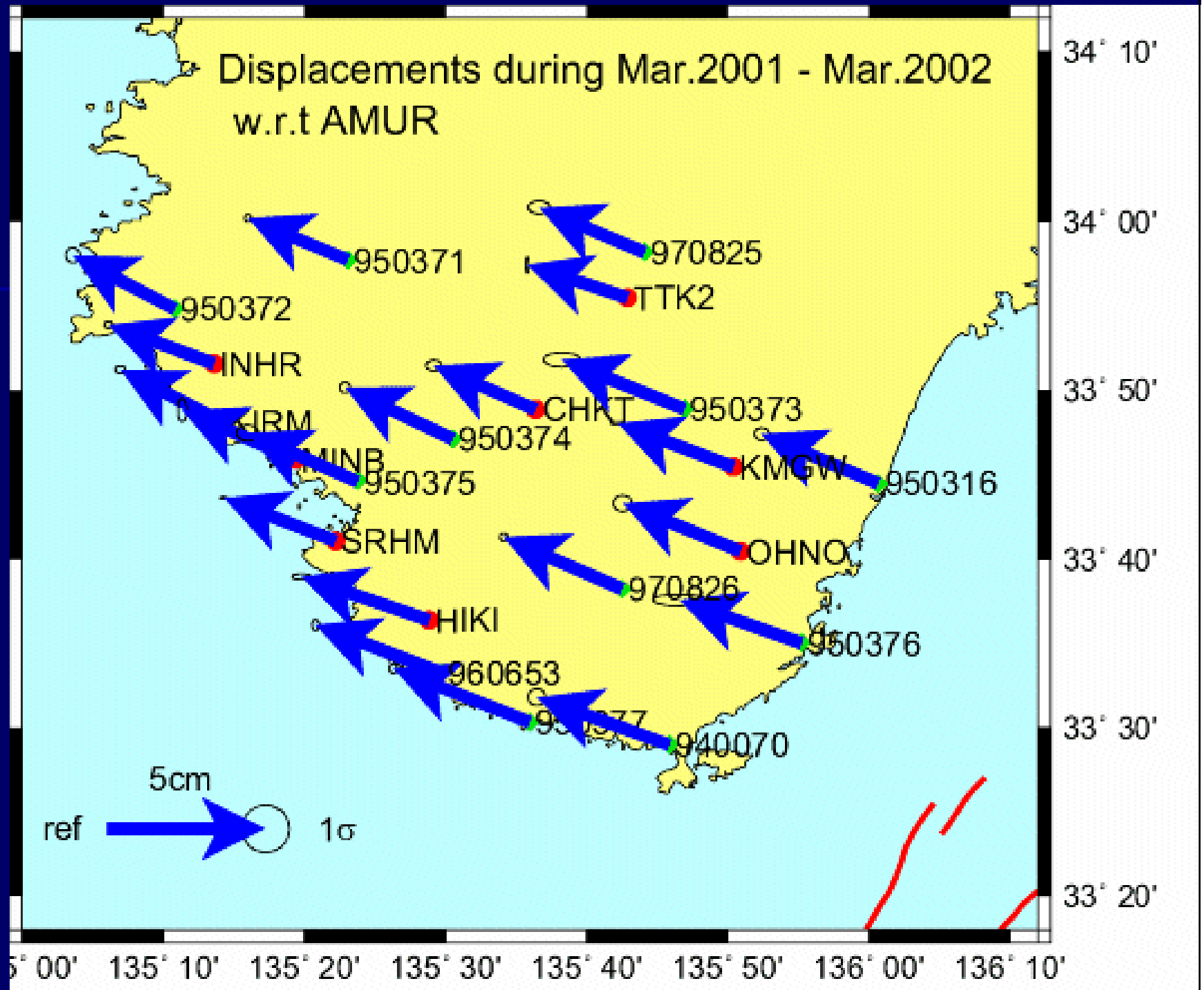
Daily variation in coordinates (GSI sites)

- Replacement of receiver and antenna at many GEONET sites in 2003
- Large shift of coordinates may be caused by improper PCV, because new PCV data have not yet been available.
- Data of 2003 campaign will be reanalysed!

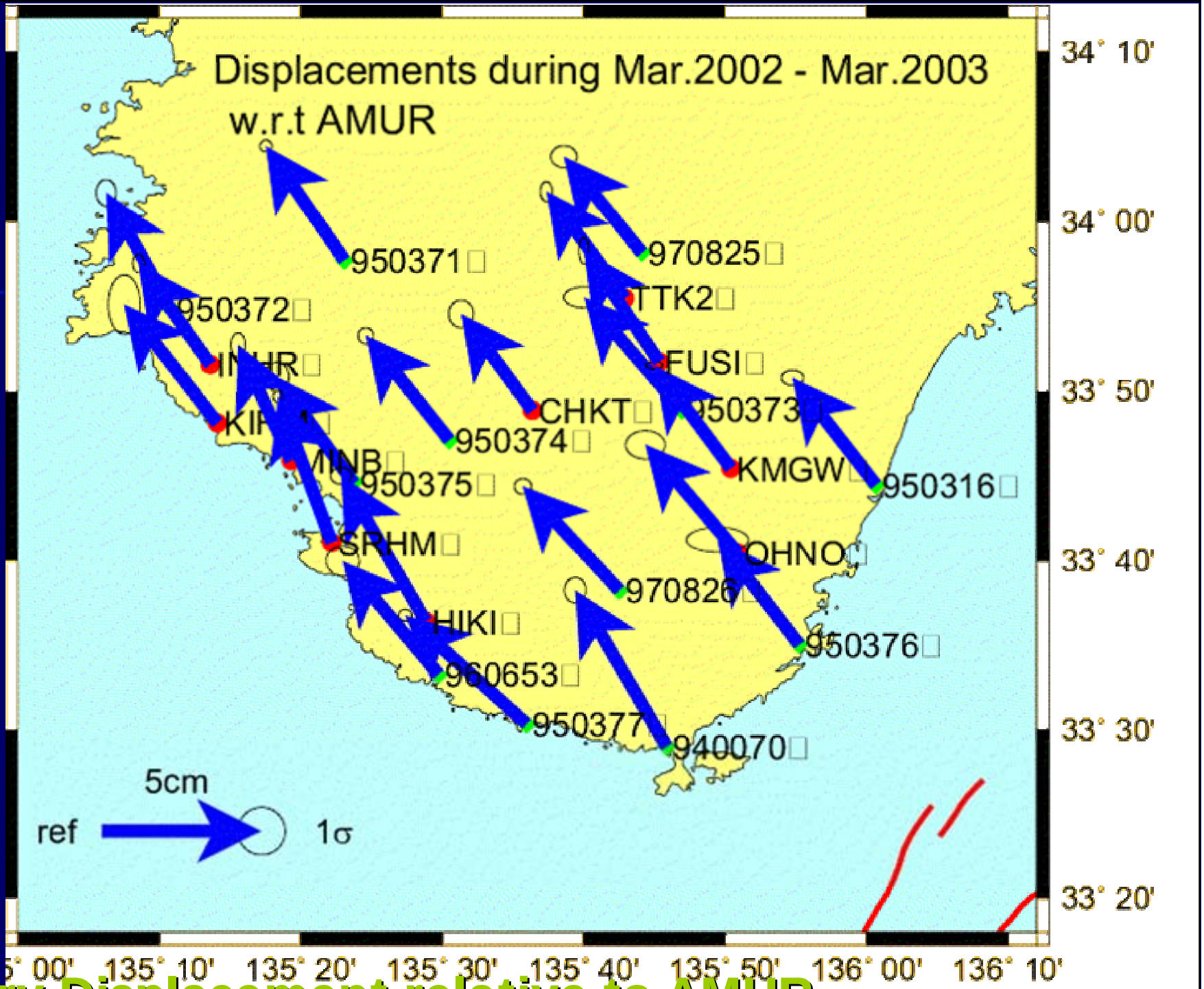


Daily variation in coordinates (DPRI sites)

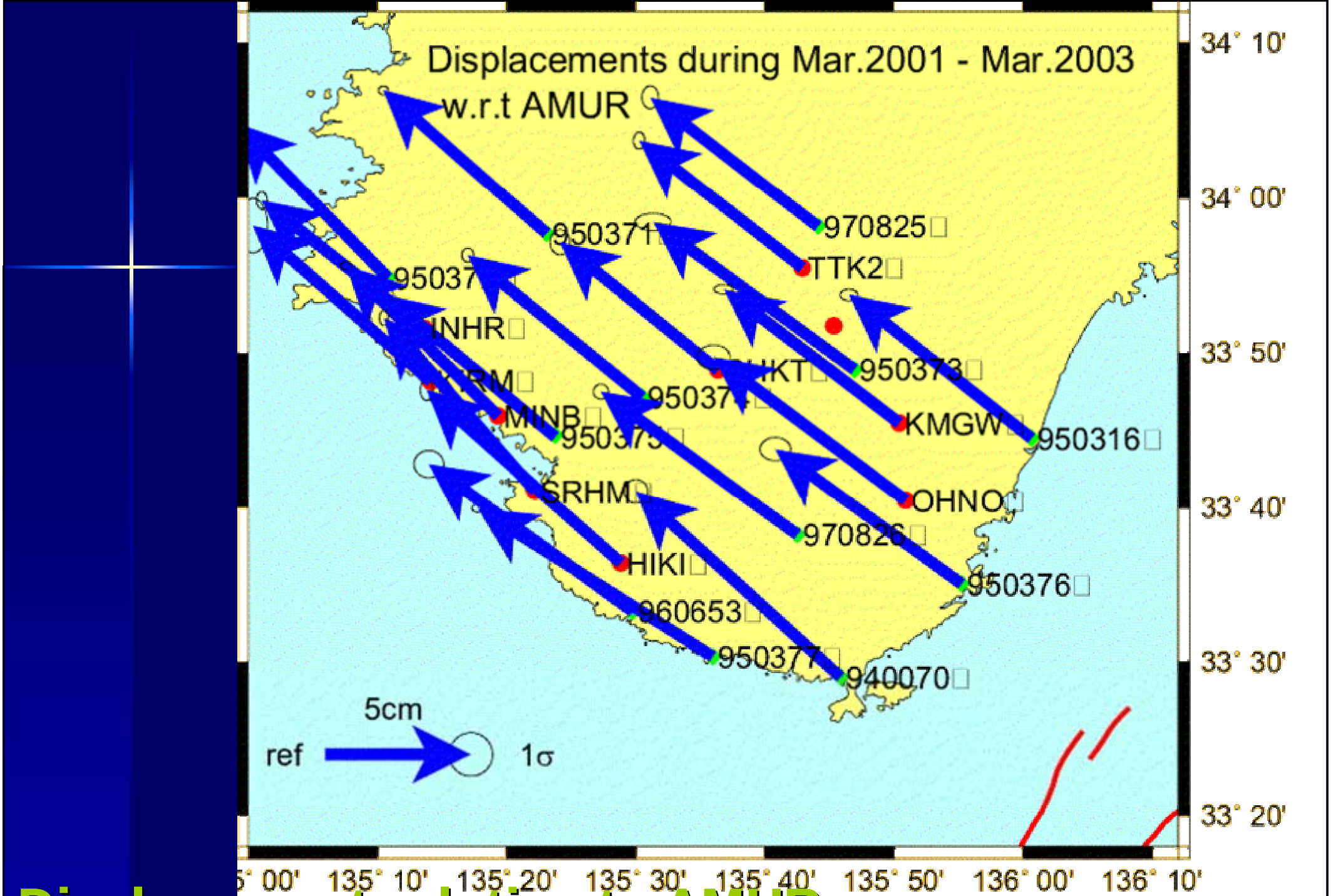




Displacement relative to AMUR (2001~2002)

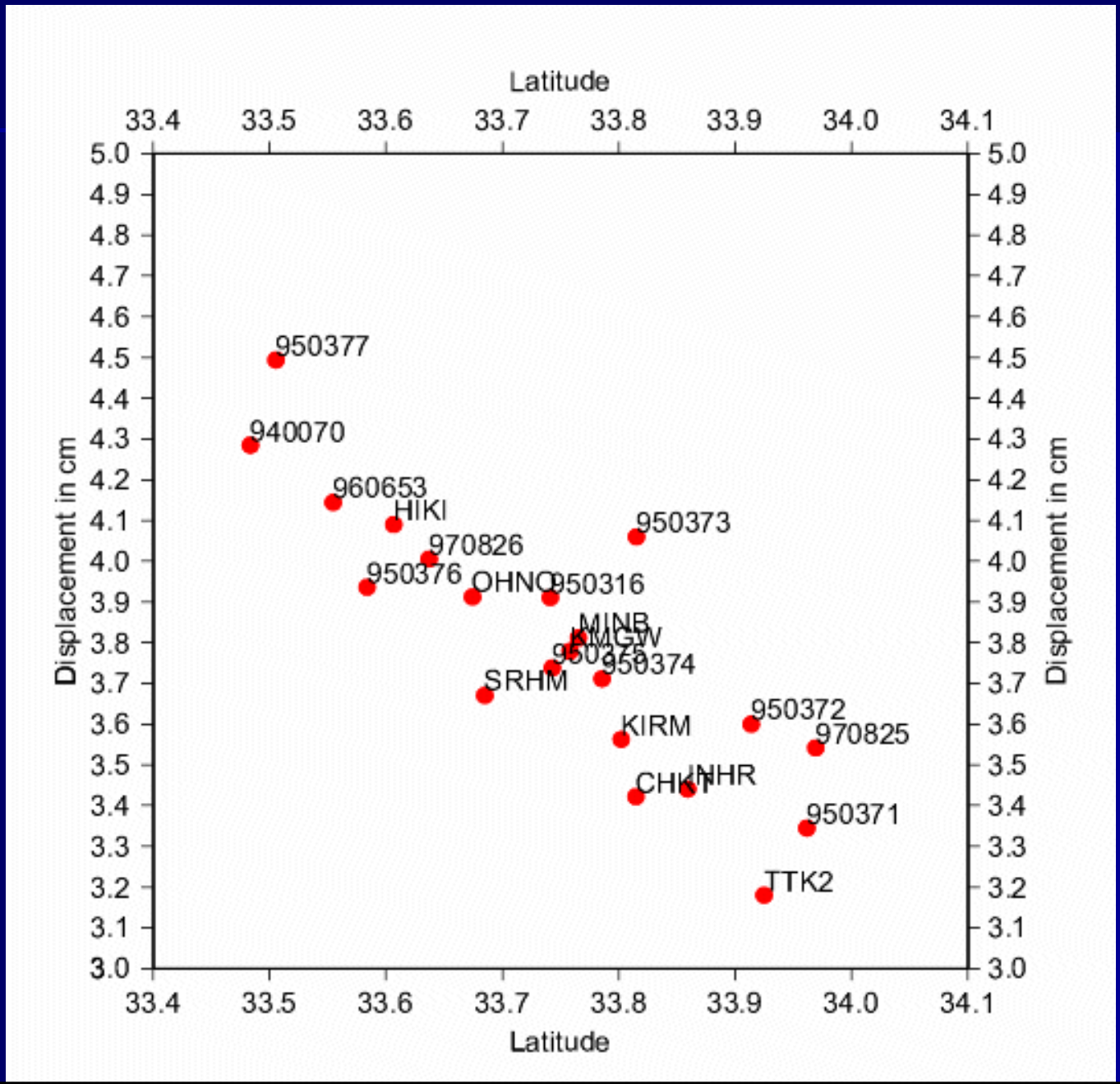


Preliminary Displacement relative to AMUR (2002~2003)

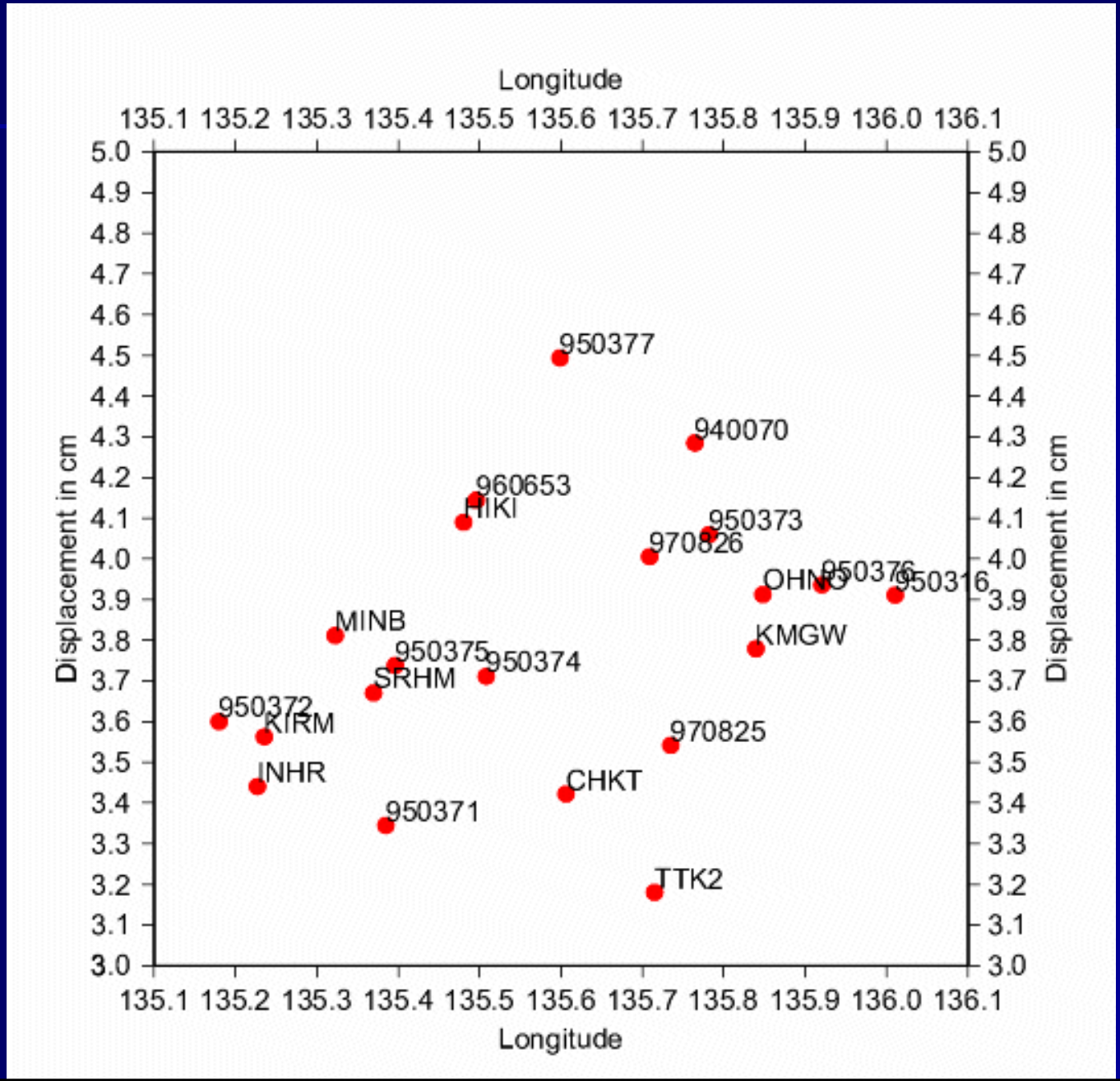


Displacement relative to AMUR (2001~2003)

Latitudinal distribution of components parallel to AMR-PHS motion (2001 – 2002)



Longitudinal distribution of components parallel to AMR-PHS motion (2001 – 2002)



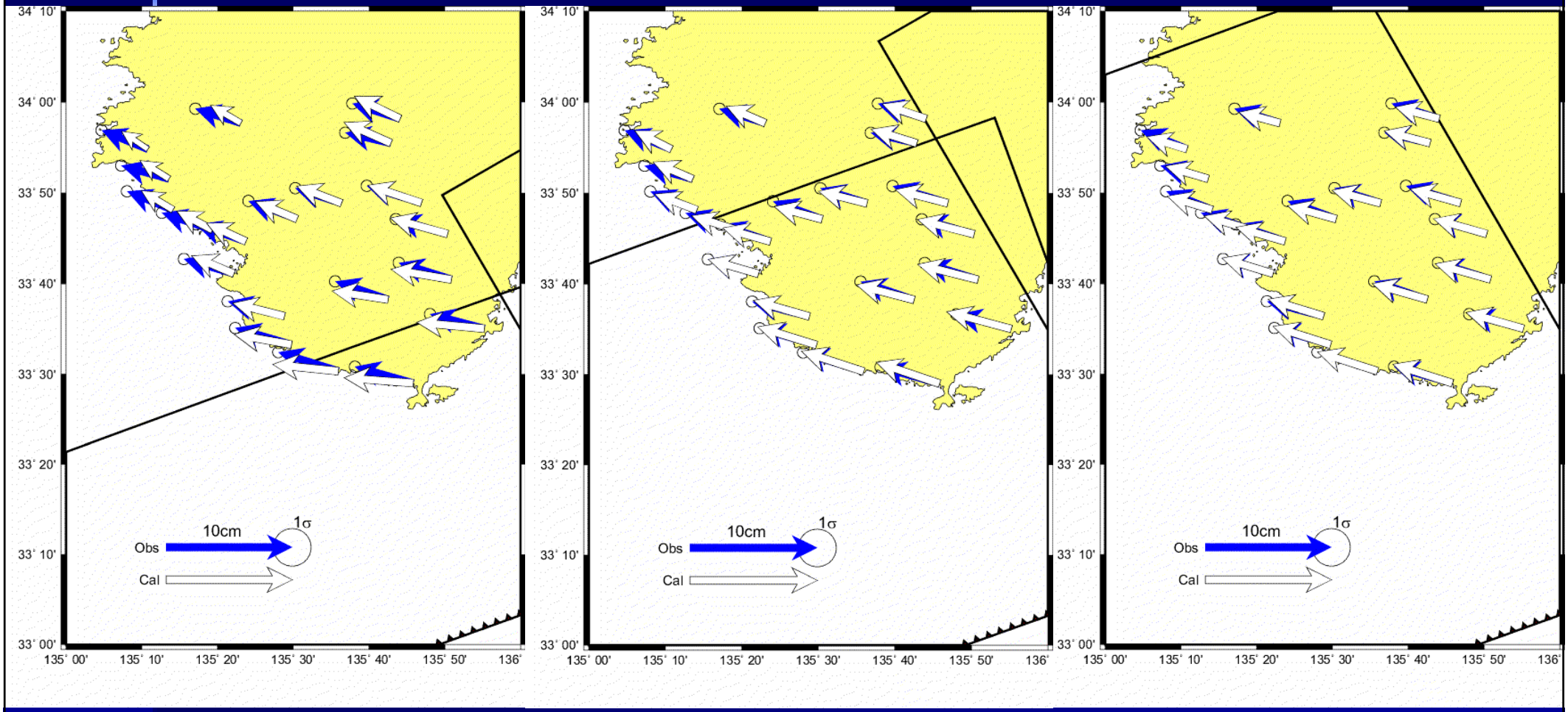
Features in Derived Velocity Field

- ~4.5 cm in south, and ~3 cm in the middle of Kii peninsula (2001 – 2002) w.r.t AMUR
- WNW ~ NNW
- Smooth decay in the direction of AMUR – PHS motion
  - No clear indication of local strain variation
- Larger velocities in west than those in east

Fitting of Slip Deficit Model

- Assumption:
  - Multi-fault with uniform dislocation
  - Ando's (1975) fault B and C
  - Fitting with deeper extension

Fitting of Ando's(1975) fault model and its modification to observed displacement



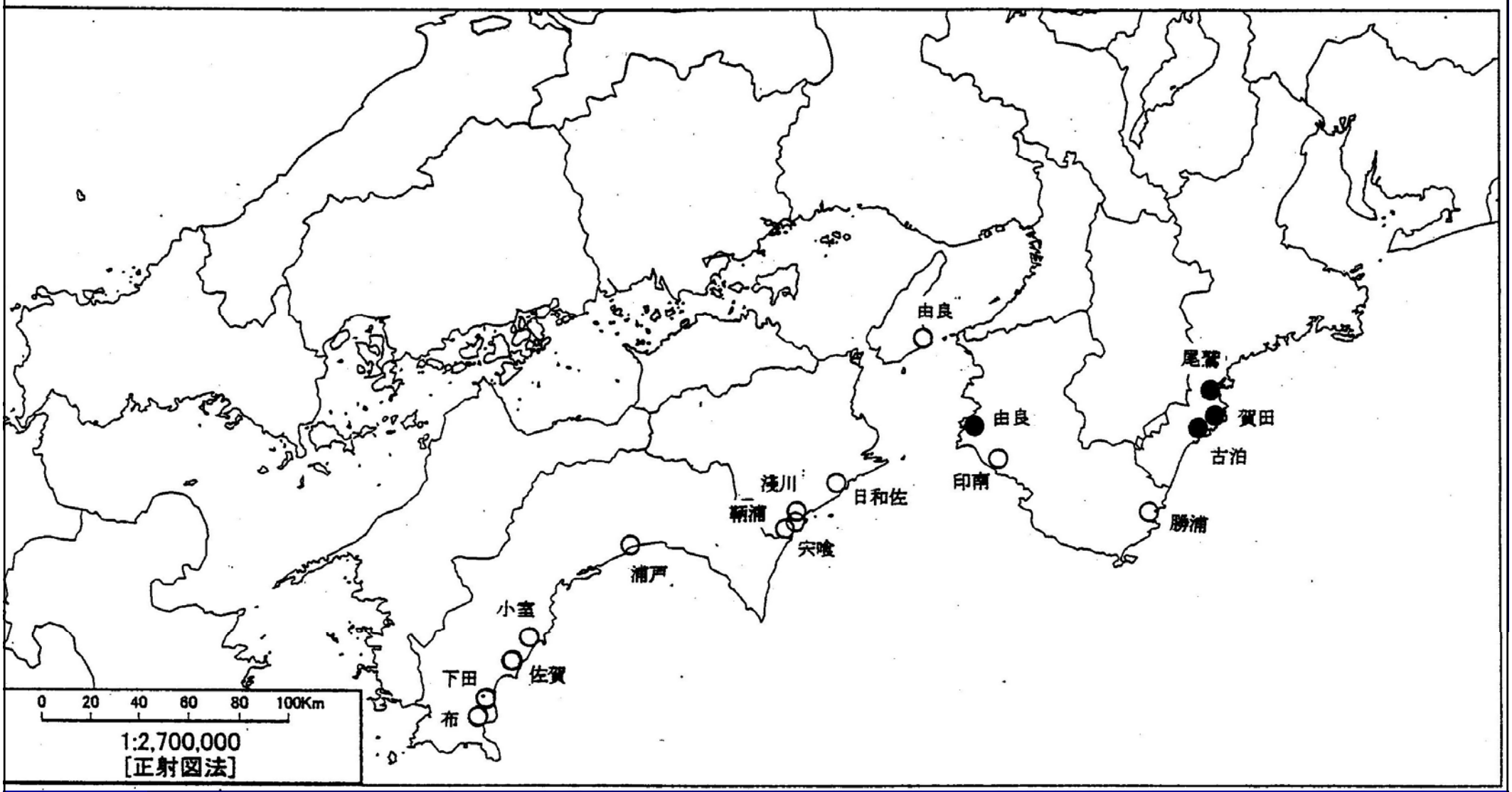
Width of fault: 70km 110km 150km

D~13cm D~10cm D~9cm

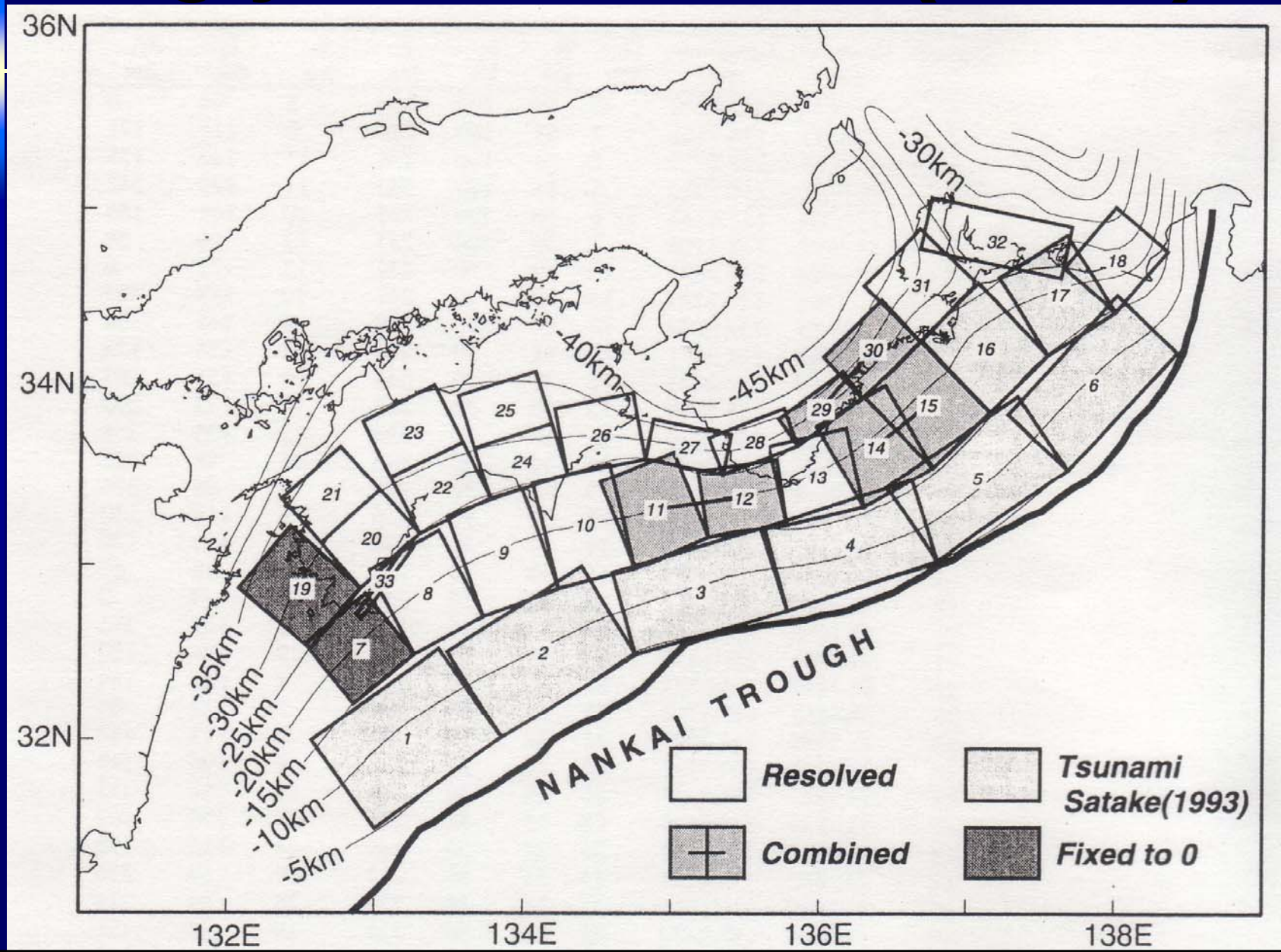
Result of Fitting

- Original coseismic fault cannot explain velocity of sites in the middle of Kii peninsula.
- Wider fault can fit observed velocity better.
- Suggestion: Coupling extends to deeper part than coseismic fault?
- Are there any indication of deeper coupling?

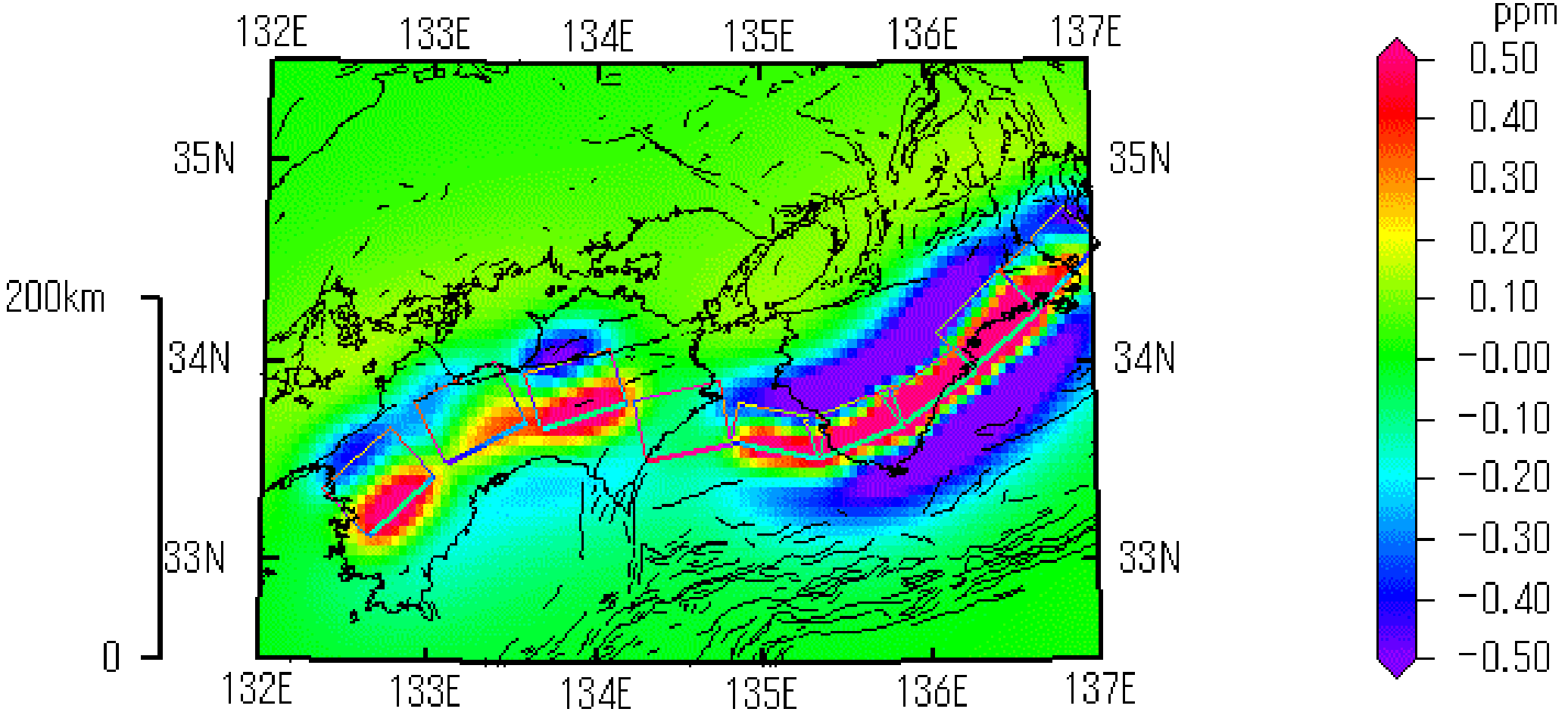
Site of anomalous groundwater level changes before the 1946



Coseismic fault model by Sagiya & Thatcher (1999)



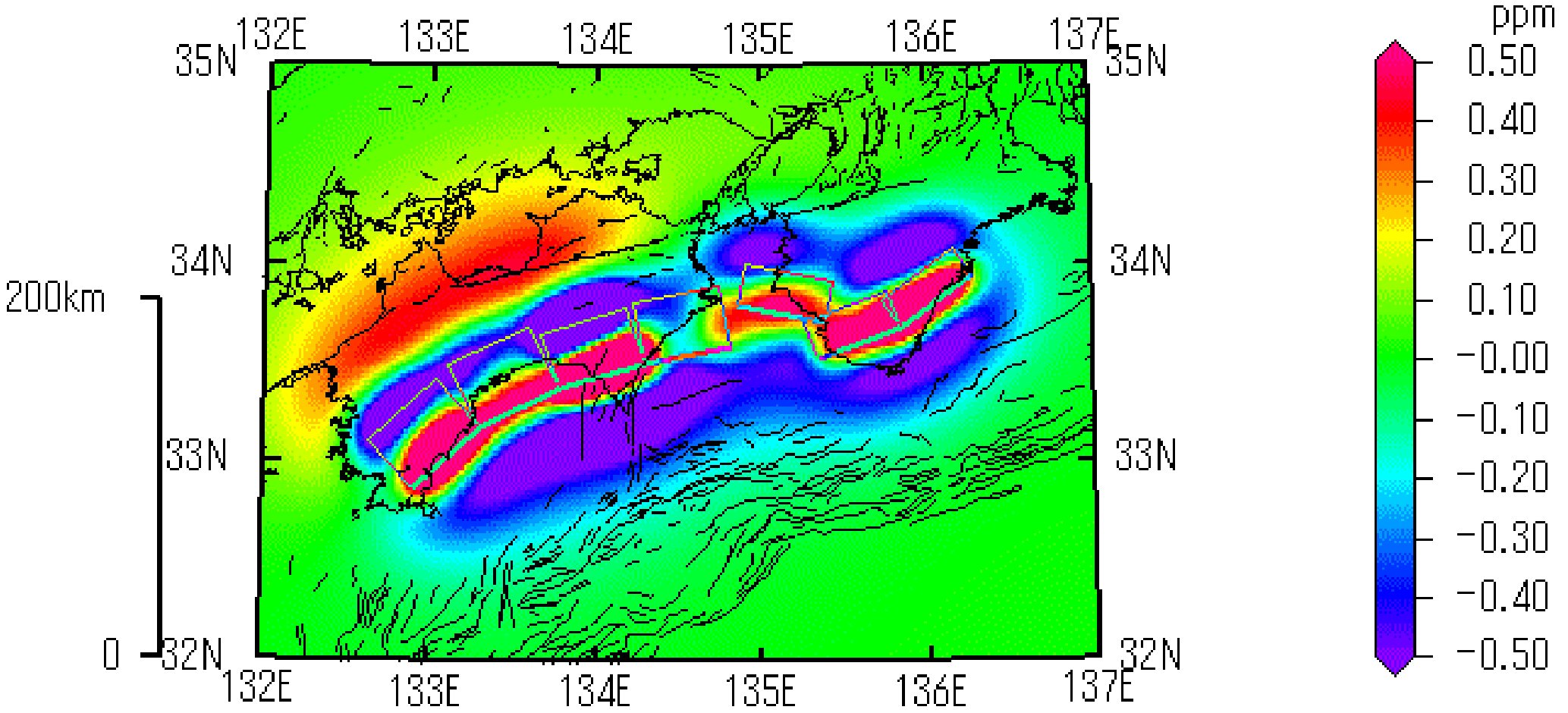
Dilatation Generated by Slip on the Deepest Part of Sagiya & Thatcher's Model



Contraction in the middle of Kii peninsula!

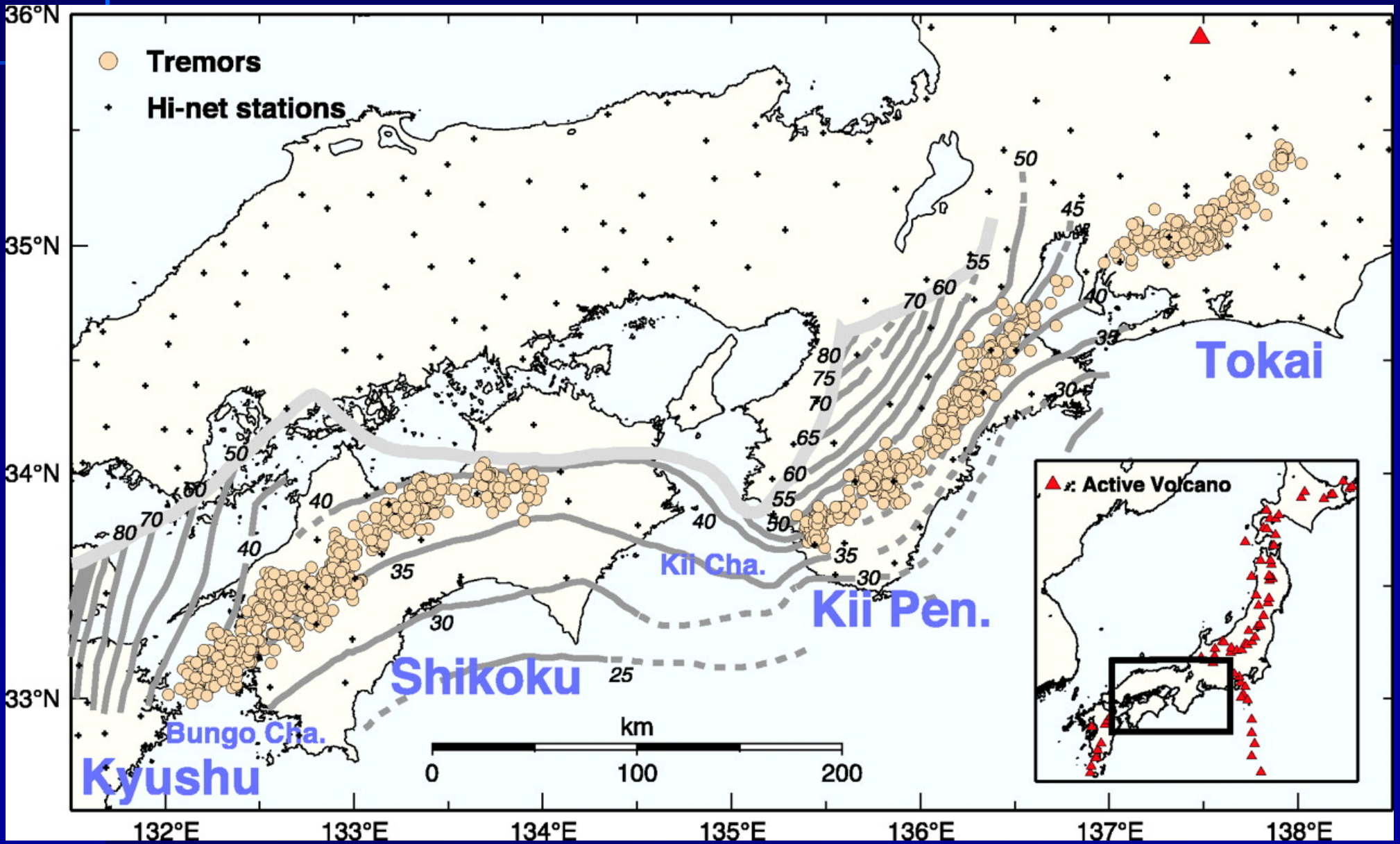
Lat.	Lon.	Depth (km)	Length (km)	Width (km)	Strike	Dip	Rake	Dis.(m)
33.17	133.293	25	50	37	228	8	104	0.252
33.373	133.773	25	50	40	243	7	126	0.184
33.509	134.285	25	50	33	252	9	117	0.422
33.597	134.812	25	50	36	259	16	160	0.12
33.716	135.387	35	50	25	281	23	133	0.32201
33.679	135.843	25	50	24	249	24	133	0.199
33.948	136.277	25	50	21	233	29	69	0.236

Possible model for preseismic groundwater changes: Dilatation



Slip on the deeper extension of fault can explain preseismic change.

Distribution of Deep Low Frequency Tremor (Obara,2002)



Conclusion

- Campaign survey in Kii peninsula since 2001
- Velocity field across the hinge-line in Kii peninsula
  - ~4.5 cm in south and ~3 cm in the middle of Kii peninsula (2001 – 2002) w.r.t AMUR in WNW ~ NNW
  - Smooth decay in the direction of AMUR – PHS motion
  - Larger velocities in west than those in east
- Deeper coupling than the coseismic fault
- Preseismic groundwater drop may have been caused by a slip on the deep coupled region.
- Spatial correlation between coulping and DLF EQ