GPS RESULTS MODELLING

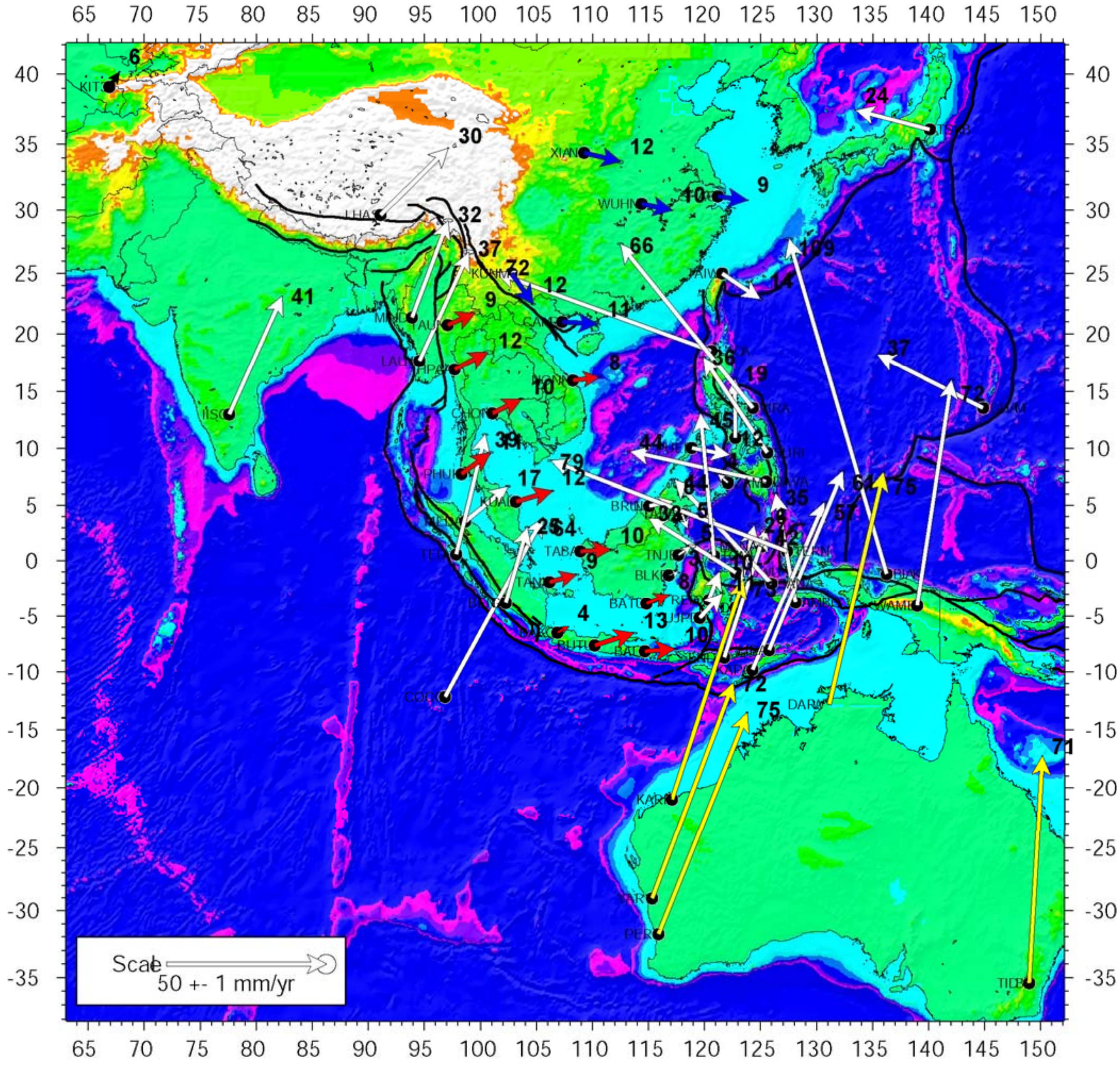
GPS usefull for many purposes

- Navigation (real time)
- Datum definition
- Cadastrial definition
- Border tracing
- Etc etc etc….

1. Quantify **rigid plates** or blocks tectonics
2. Study **active faults** and Earthquakes

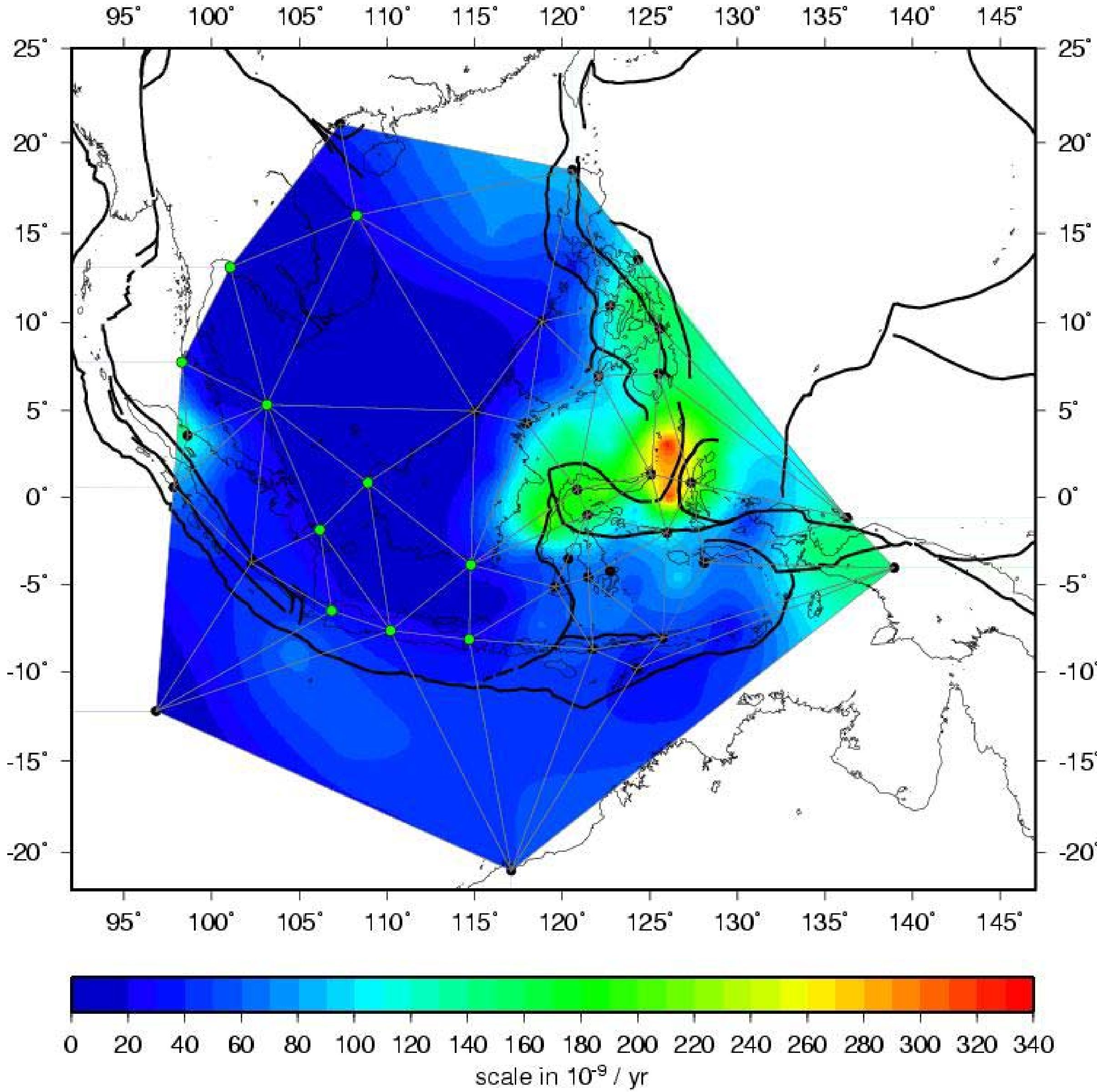
South-East ASIA 94-96-98-00 (ITRF2000)

ENS solution / NNR-Nuvel-1A Eurasia (50.6,-112.4,0.23)



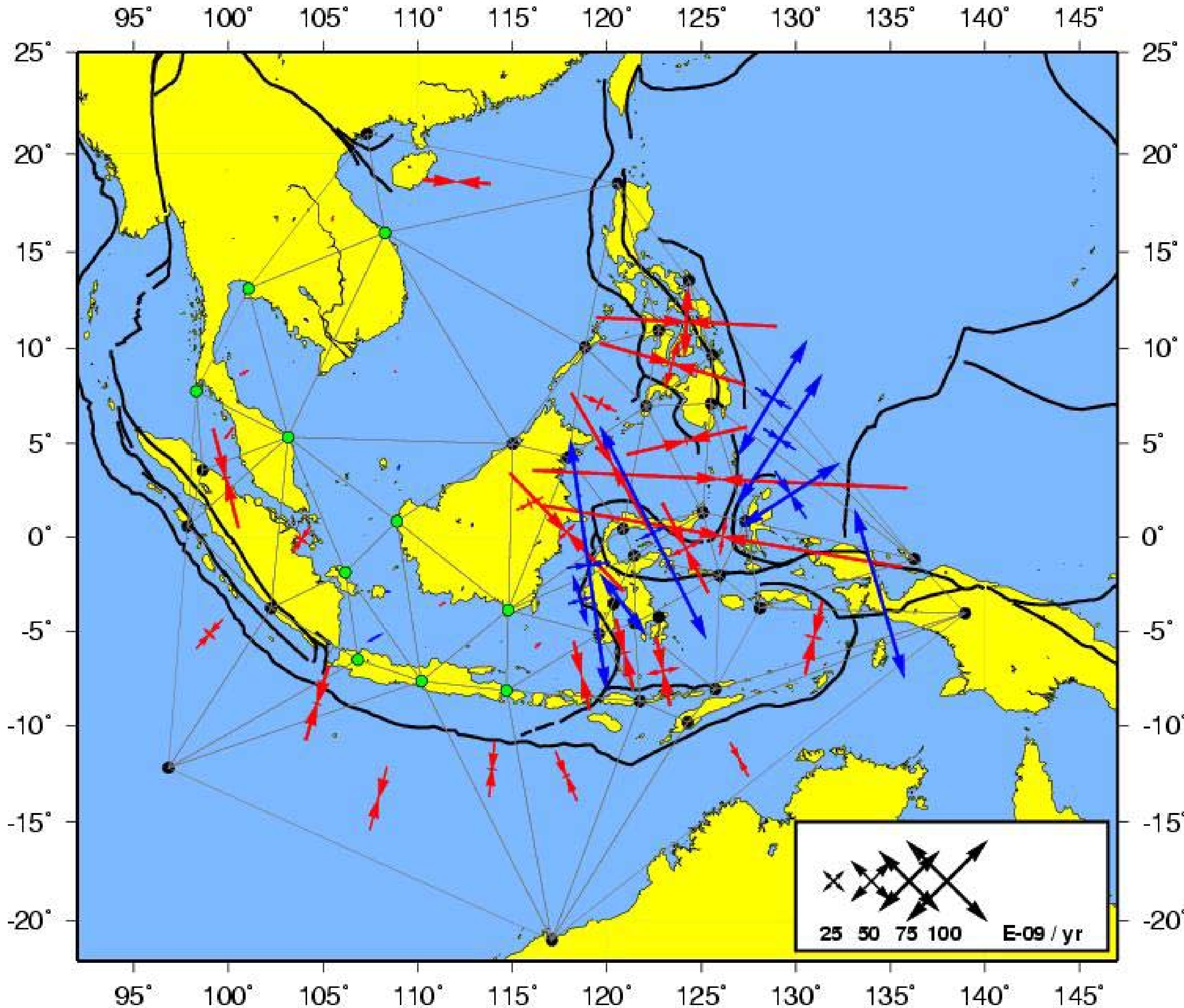
94-96-98 GEODYSSEA combined solution

Intensity of strain rates in Delaunay triangles



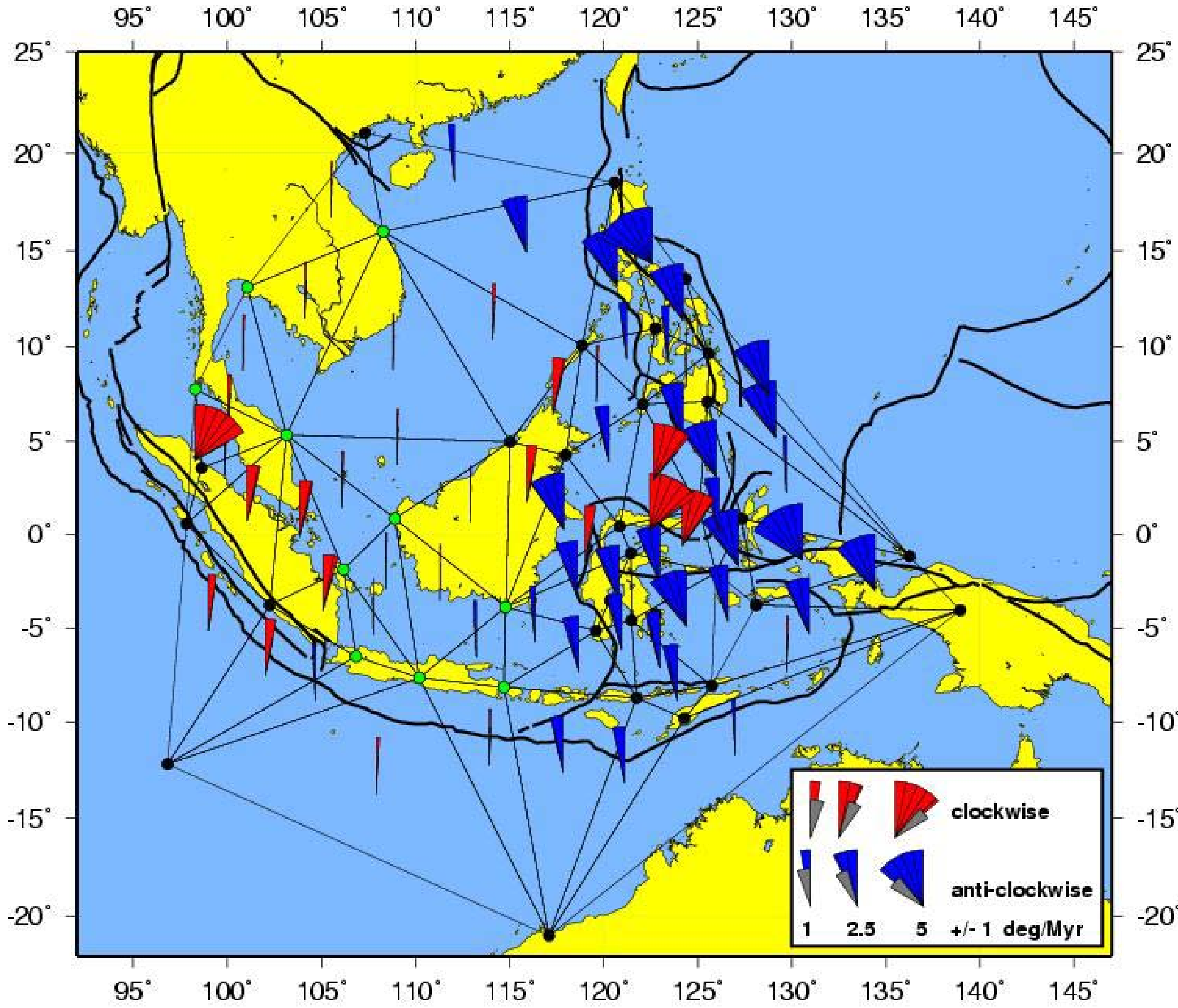
94-96-98 GEODYSSEA combined solution

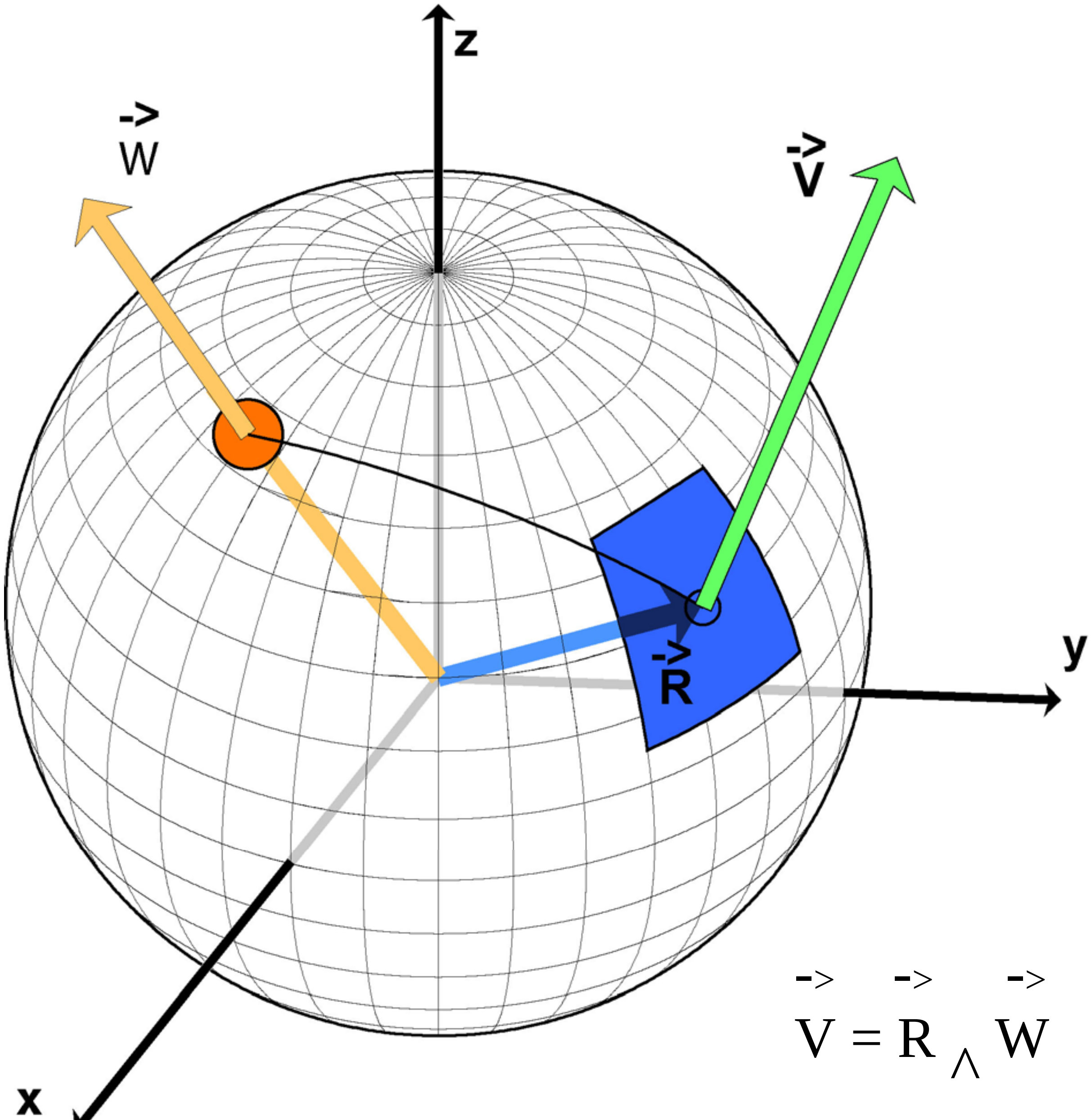
Strain rates in Delaunay triangles



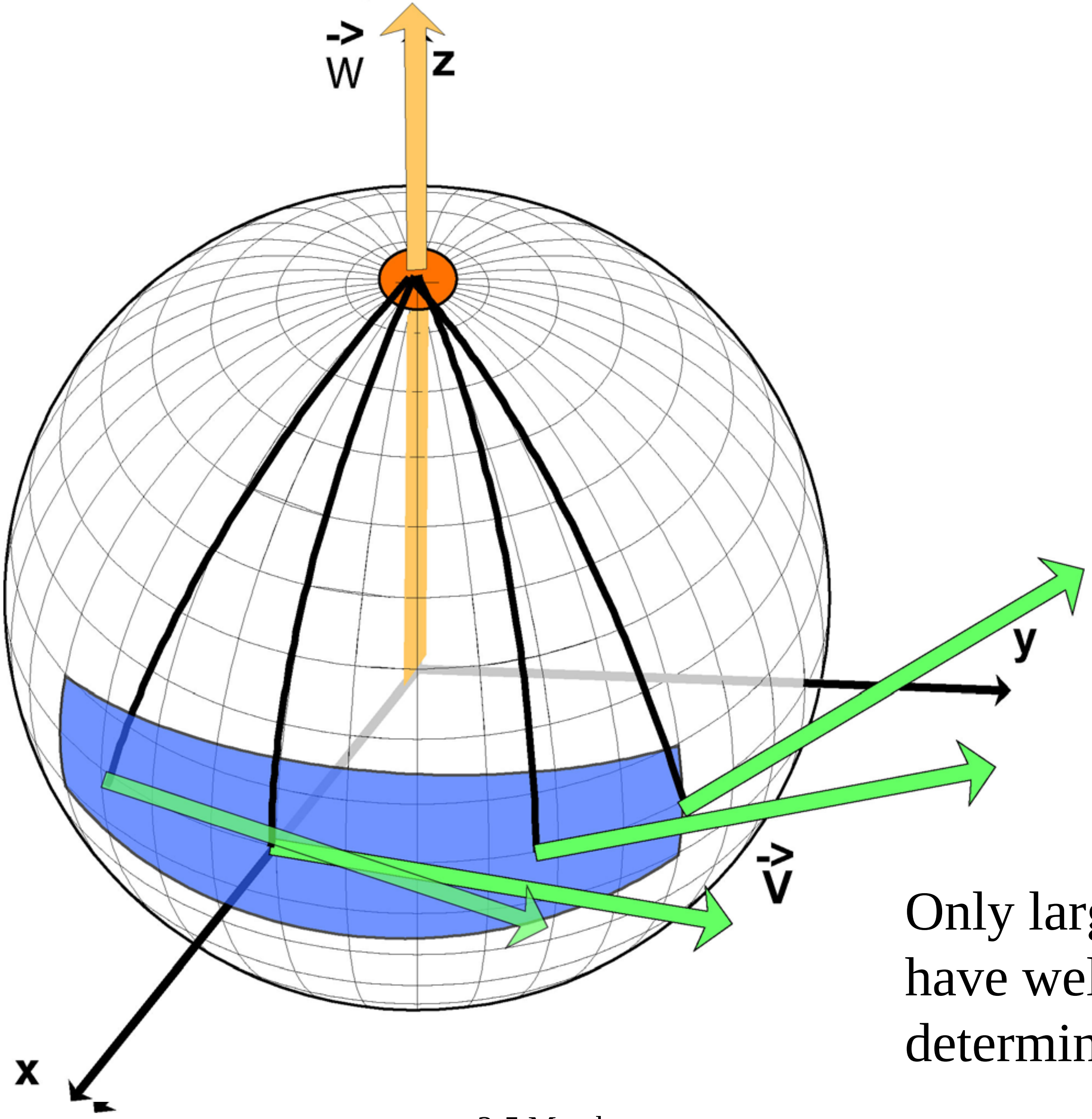
94-96-98 GEODYSSEA combined solution

Rotation rates in Delaunay triangles

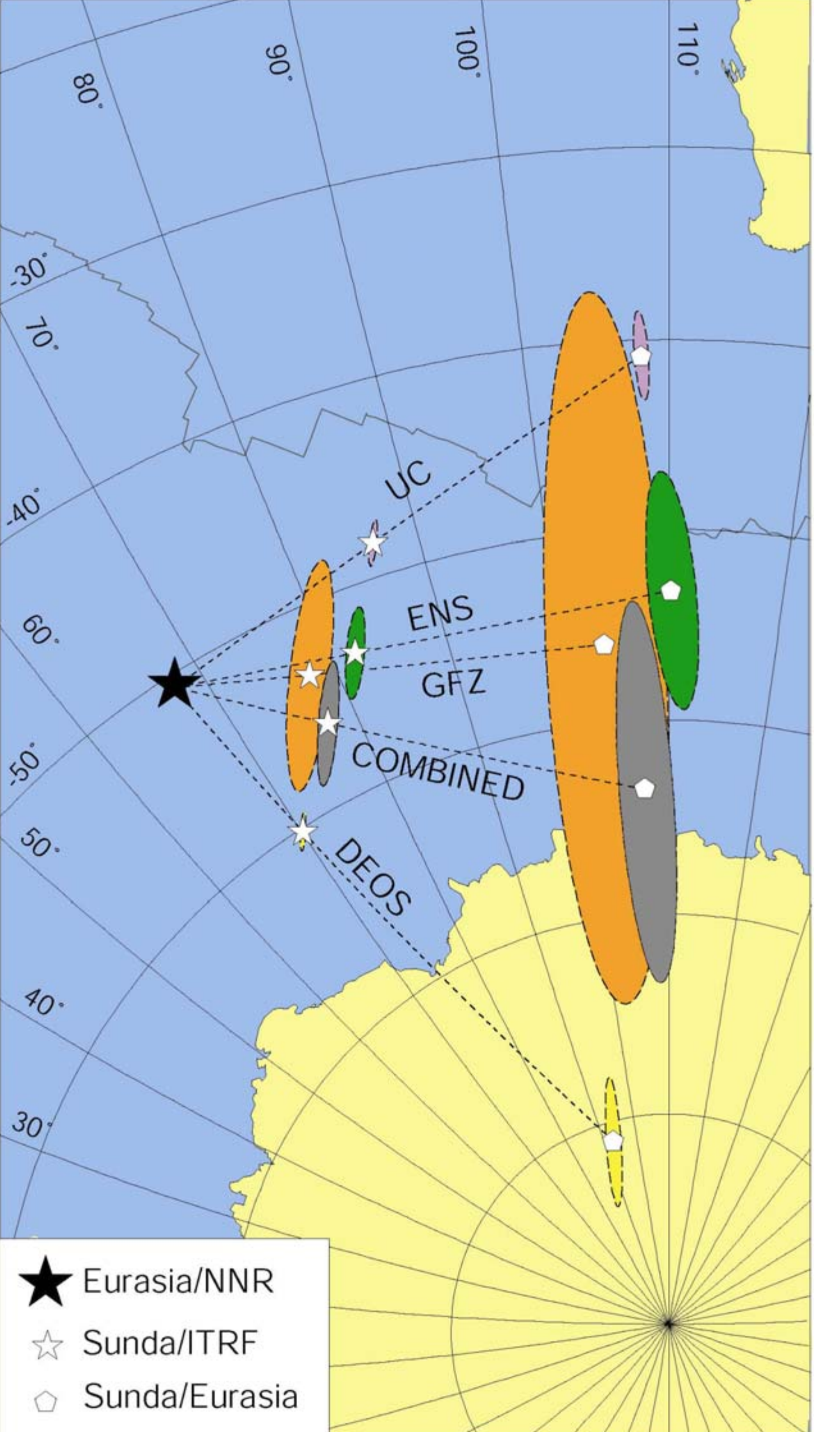


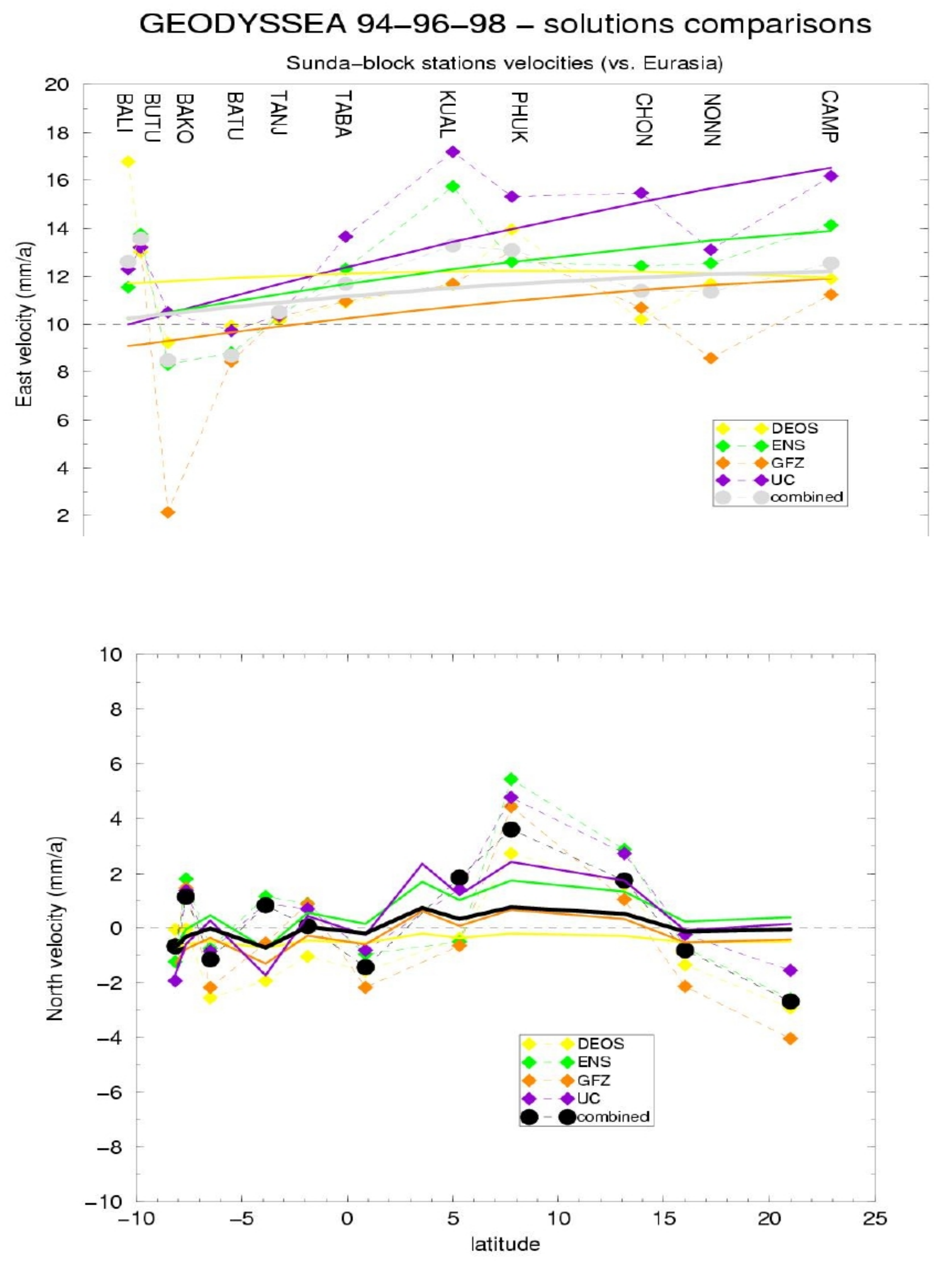


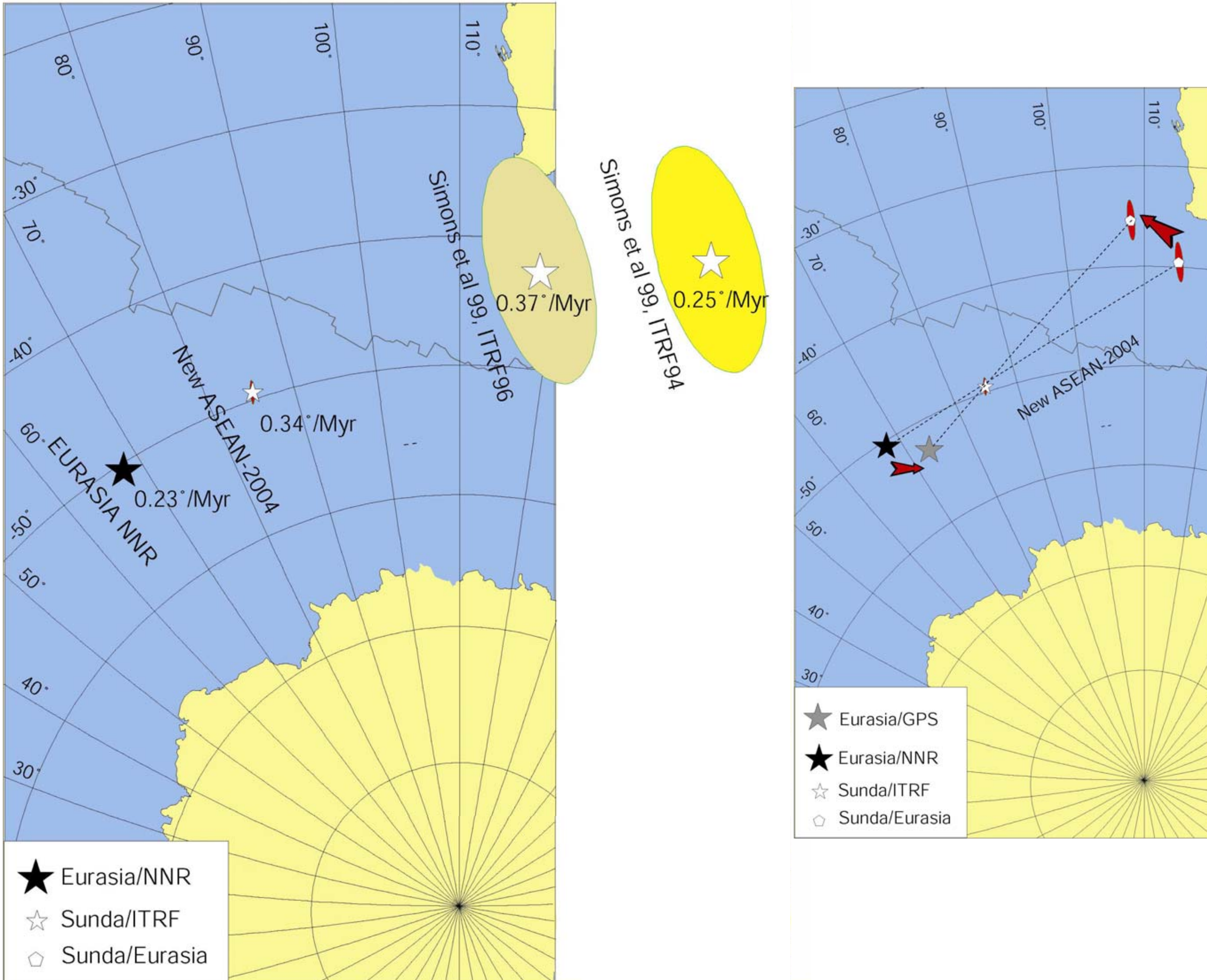
$$\vec{V} = \vec{R} \wedge \vec{W}$$



Only large plates have well determined poles

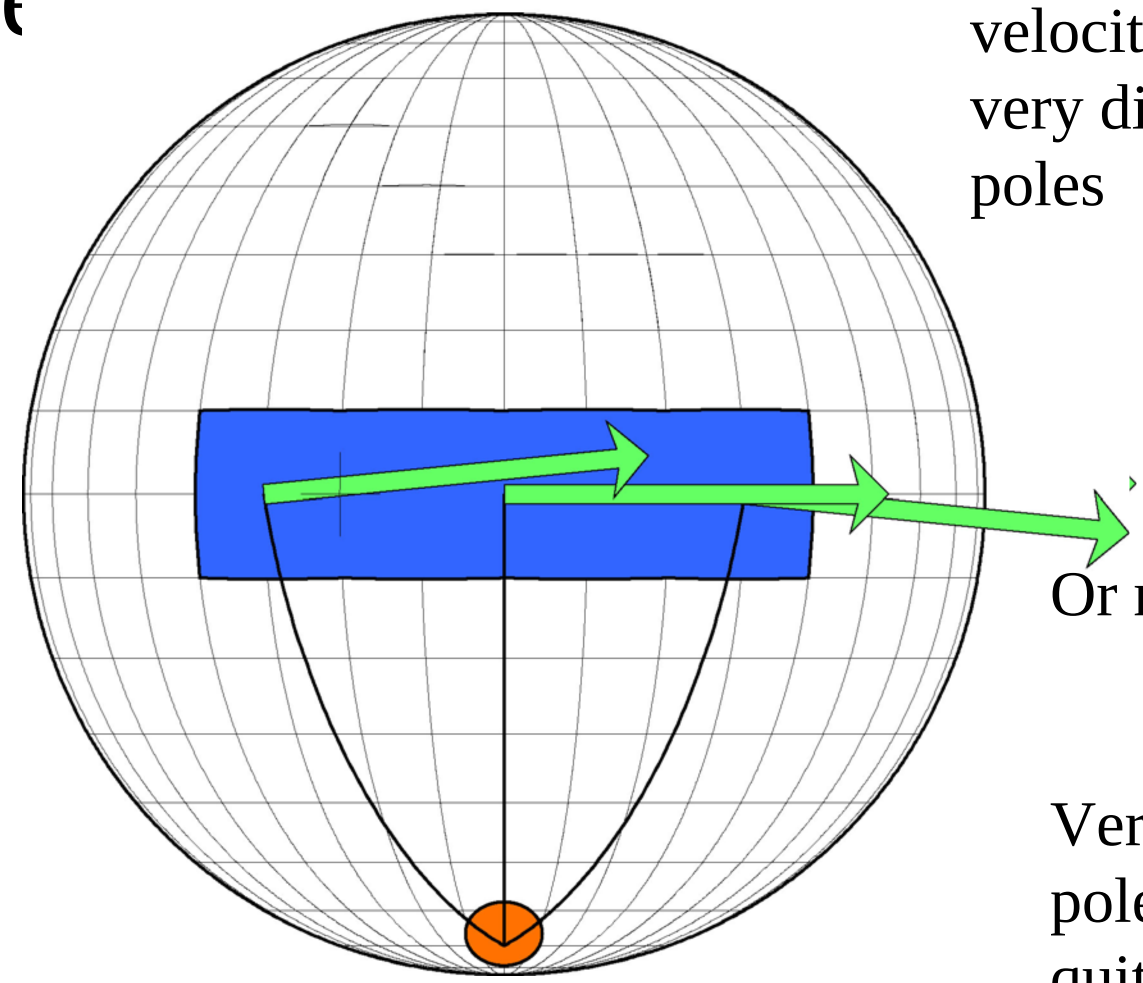

80°
90°
100°
110°
-30°
70°
-40°
60°
-50°
50°
40°
30°
UC
ENS
GFZ
COMBINED
DEOS
Eurasia/NNR
Sunda/ITRF
Sunda/Eurasia


GEODYSSEA 94–96–98 – solutions comparisons
Sunda–block stations velocities (vs. Eurasia)
BALI
BUTU
BAKO
BATU
TANJ
TABA
KUAL
PHUK
CHON
NONN
CAMP
East velocity (mm/a)
DEOS
ENS
GFZ
UC
combined
North velocity (mm/a)
latitude
DEOS
ENS
GFZ
UC
combined



80°
90°
100°
110°
-30°
70°
-40°
60°
-50°
50°
40°
30°
Simons et al 99, ITRF96
0.37°/Myr
Simons et al 99, ITRF94
0.25°/Myr
New ASEAN-2004
0.34°/Myr
EURASIA NNR
0.23°/Myr
Eurasia/NNR
Sunda/ITRF
Sunda/Eurasia
Eurasia/GPS

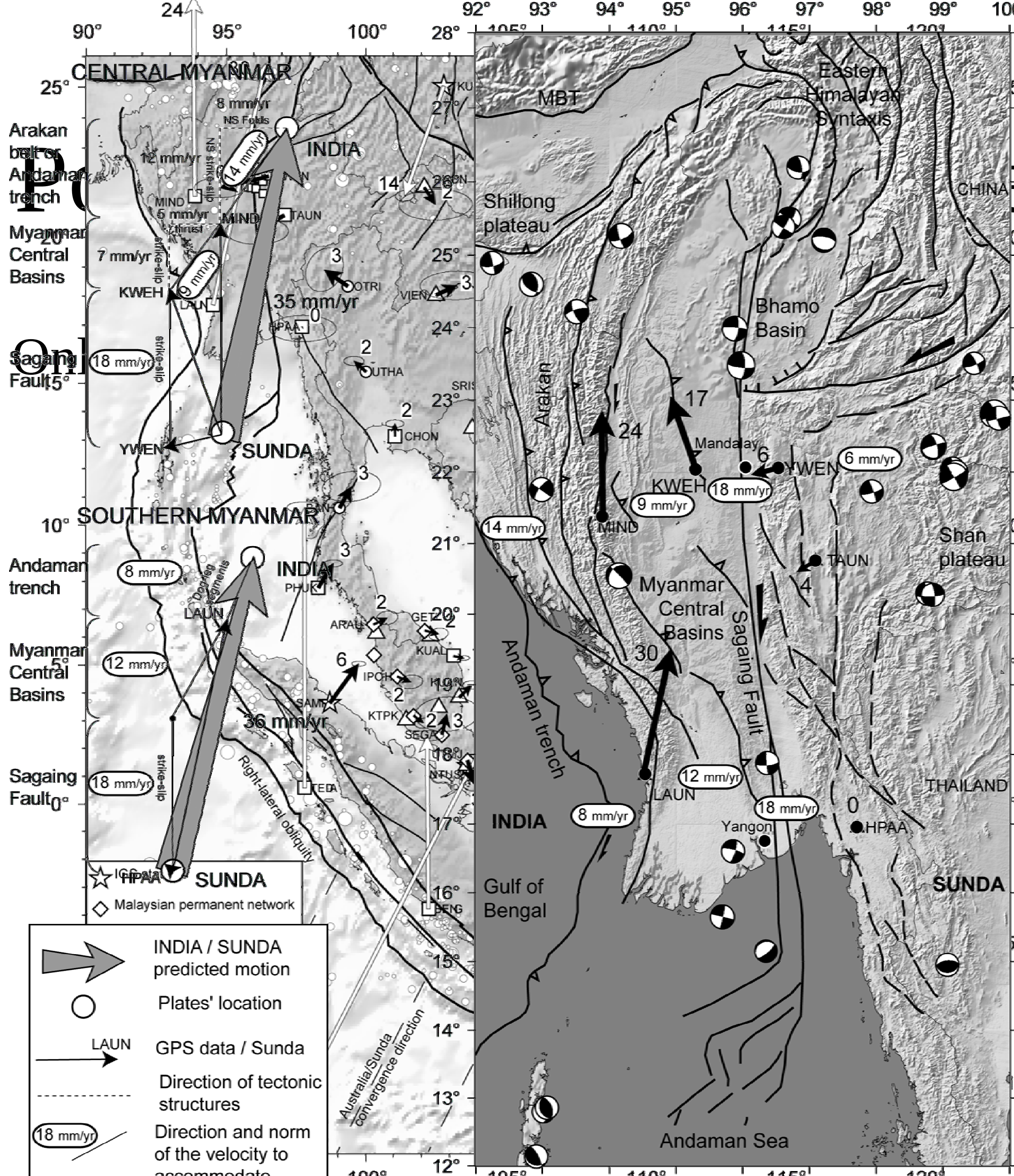
Effe ties



Slightely different velocities can give very different poles

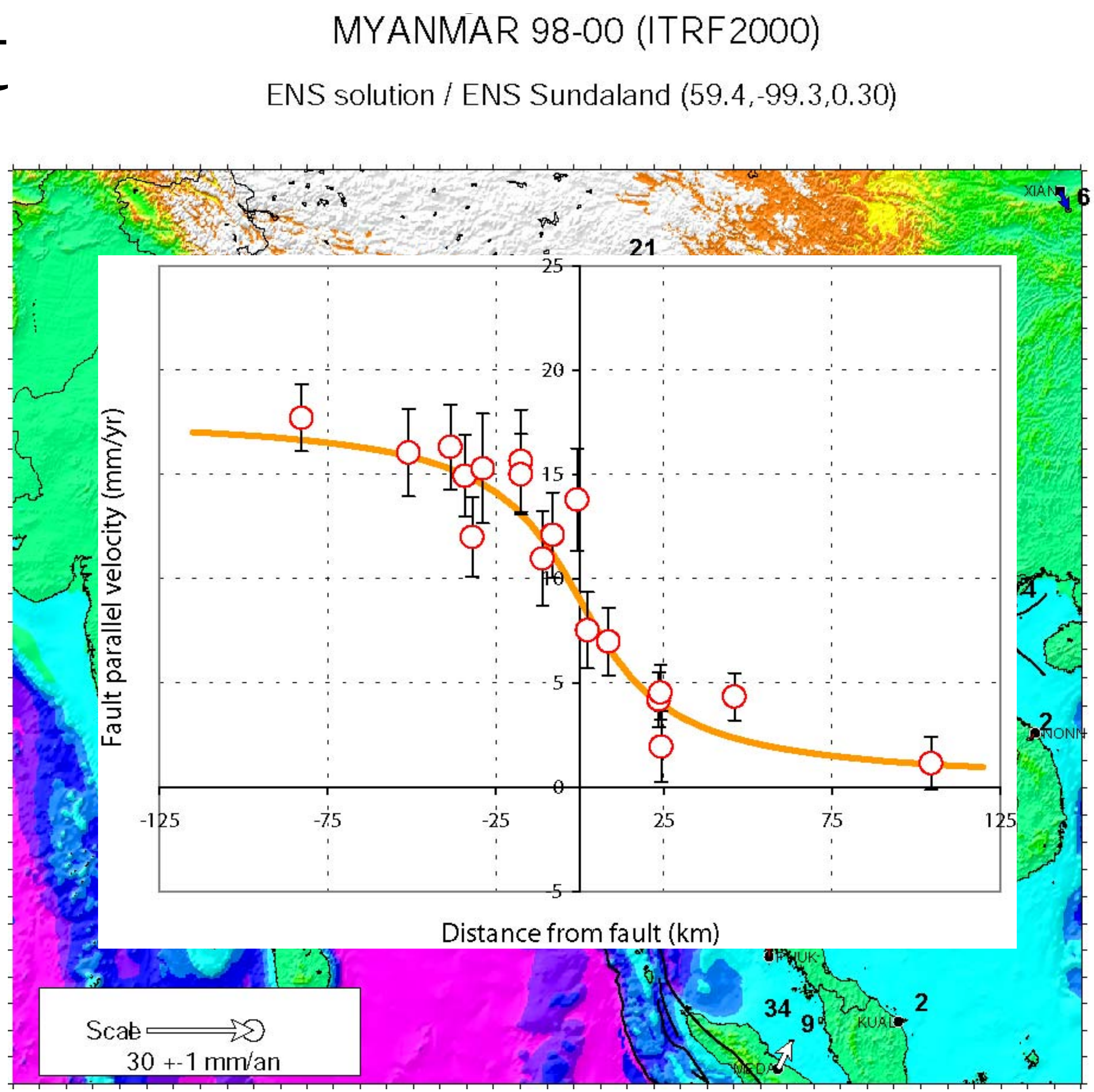
Or reverse :

Very different poles can give quite similar velocities

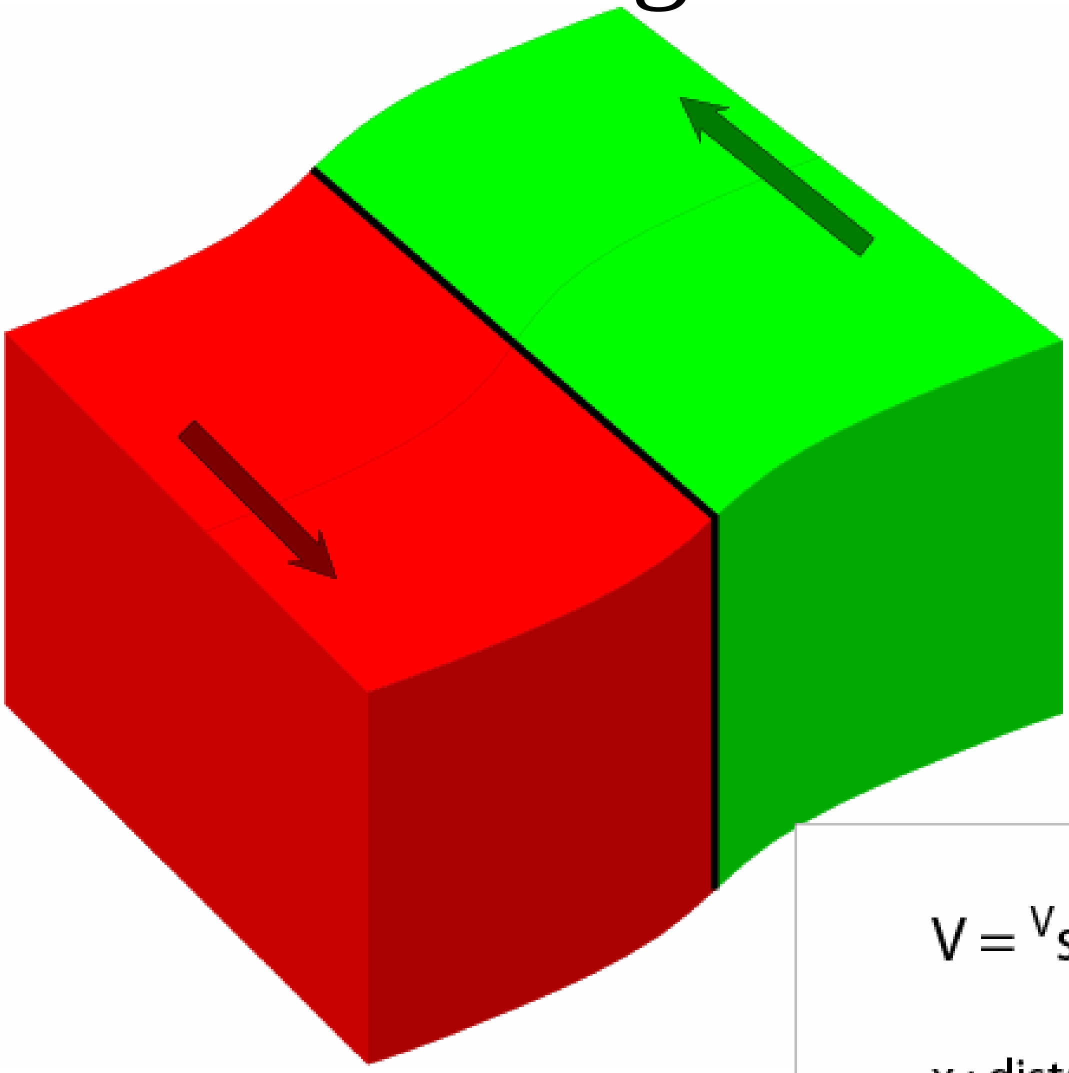


CENTRAL MYANMAR
Arakan belt or Andaman trench
Myanmar Central Basins
Sagaing Fault
8 mm/yr
NS Folds
12 mm/yr
14 mm/yr
INDIA
5 mm/yr
Thrust
MIND
TAUN
7 mm/yr
9 mm/yr
KWEH
LAUN
35 mm/yr
HPAA
OTRI
VIEN
UTHA
18 mm/yr
strike-slip
YWEN
SUNDA
CHON
SOUTHERN MYANMAR
Andaman trench
8 mm/yr
Myanmar Central Basins
12 mm/yr
Sagaing Fault
18 mm/yr
PHUK
ARAU
GETI
KUAL
IPOH
SAMP
KTPK
SEGA
36 mm/yr
TEDA
Right-lateral obliquity
HPAA
SUNDA
IGS data
Malaysian permanent network
INDIA / SUNDA predicted motion
Plates' location
GPS data / Sunda
Direction of tectonic structures
Direction and norm of the velocity to accommodate
Australia/Sunda convergence direction
MBT
Eastern Himalayan Syntaxis
CHINA
Shillong plateau
Arakan
Bhamo Basin
24
17
Mandalay
6
YWEN
6 mm/yr
KWEH
18 mm/yr
9 mm/yr
MIND
14 mm/yr
TAUN
4
Shan plateau
Myanmar Central Basins
Sagaing Fault
30
Andaman trench
12 mm/yr
LAUN
THAILAND
INDIA
8 mm/yr
18 mm/yr
0
HPAA
Yangon
Gulf of Bengal
SUNDA
Andaman Sea

St nd


MYANMAR 98-00 (ITRF2000)
ENS solution / ENS Sundaland (59.4,-99.3,0.30)
Fault parallel velocity (mm/yr)
Distance from fault (km)
25
20
15
10
5
0
-5
-125
-75
-25
25
75
125
XIAN
6
21
4
2
NONN
PHUK
34
9
KUAL
2
MEDA
Scale
30 +-1 mm/an

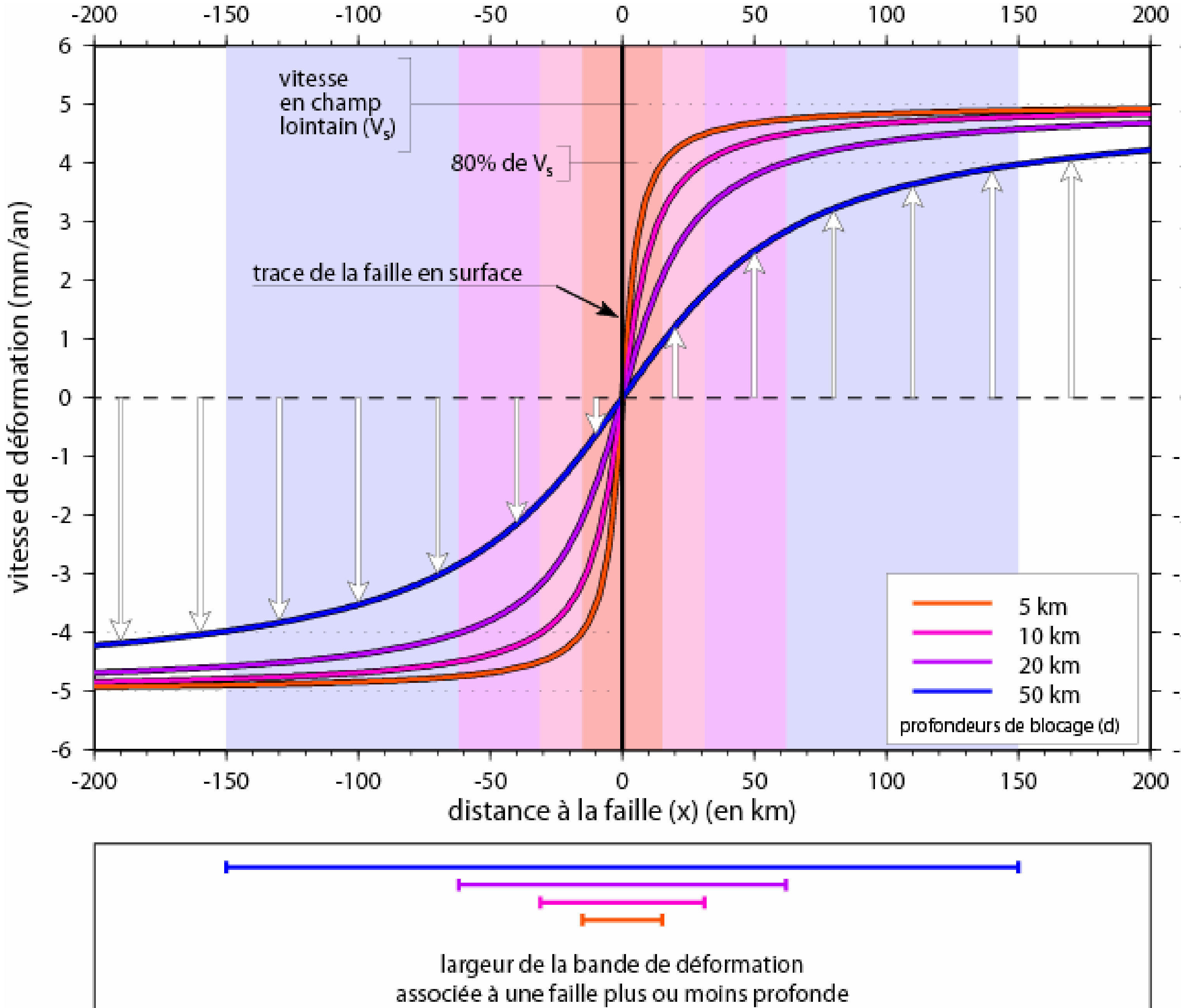
Elastic loading on a locked fault



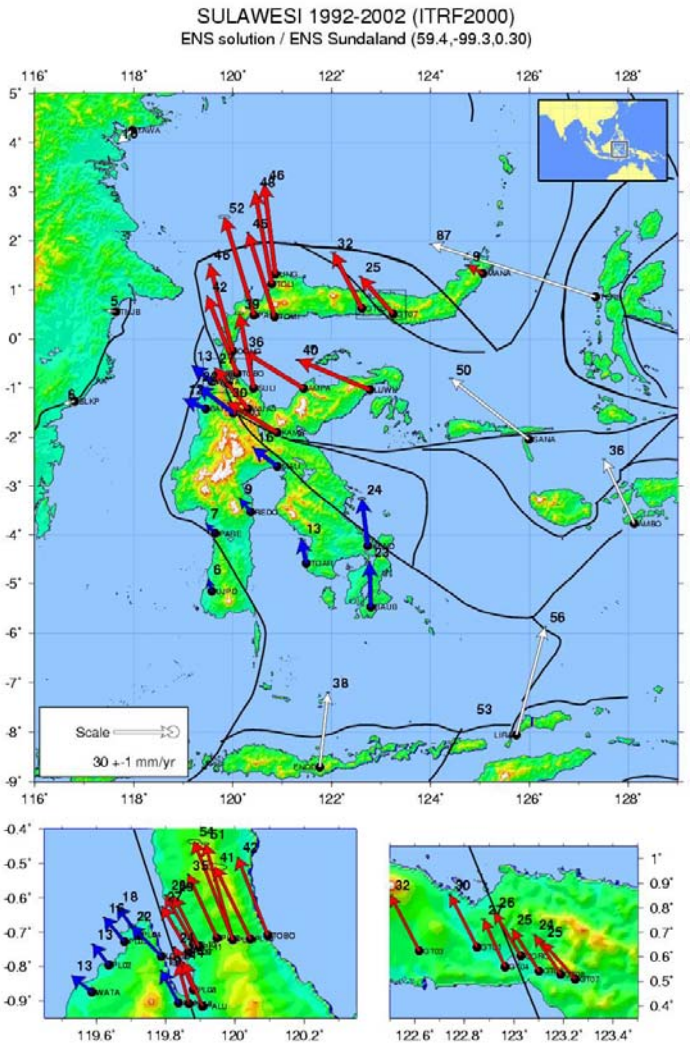
$$V = \frac{V_s}{\pi} \operatorname{arctg}\left(\frac{x}{d}\right)$$

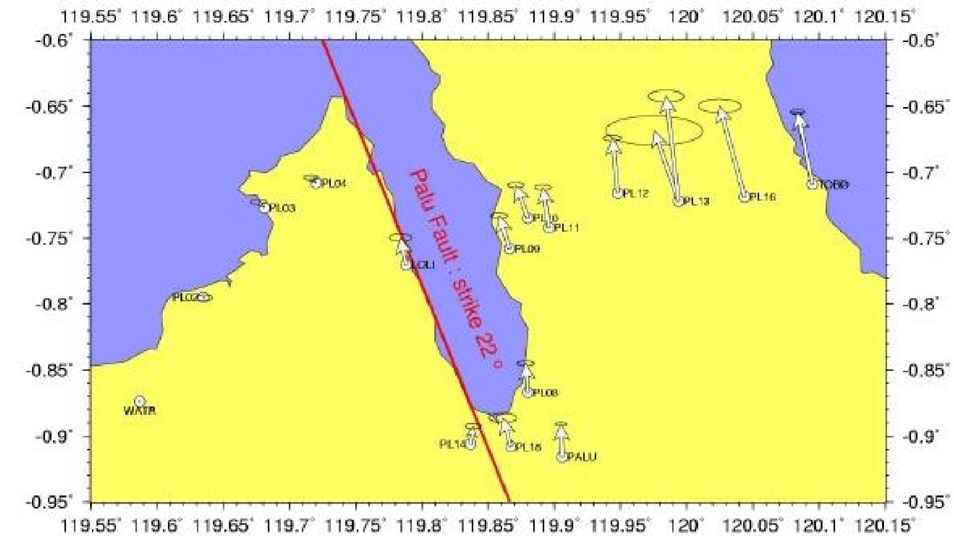
x : distance à la faille
d : profondeur de la faille

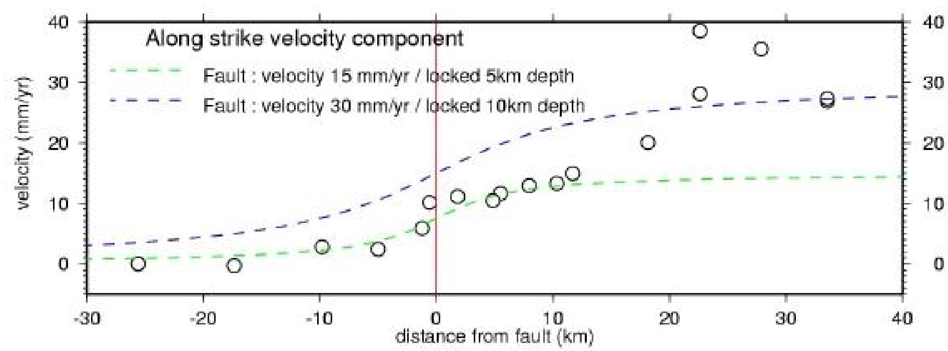
Arctangent profiles



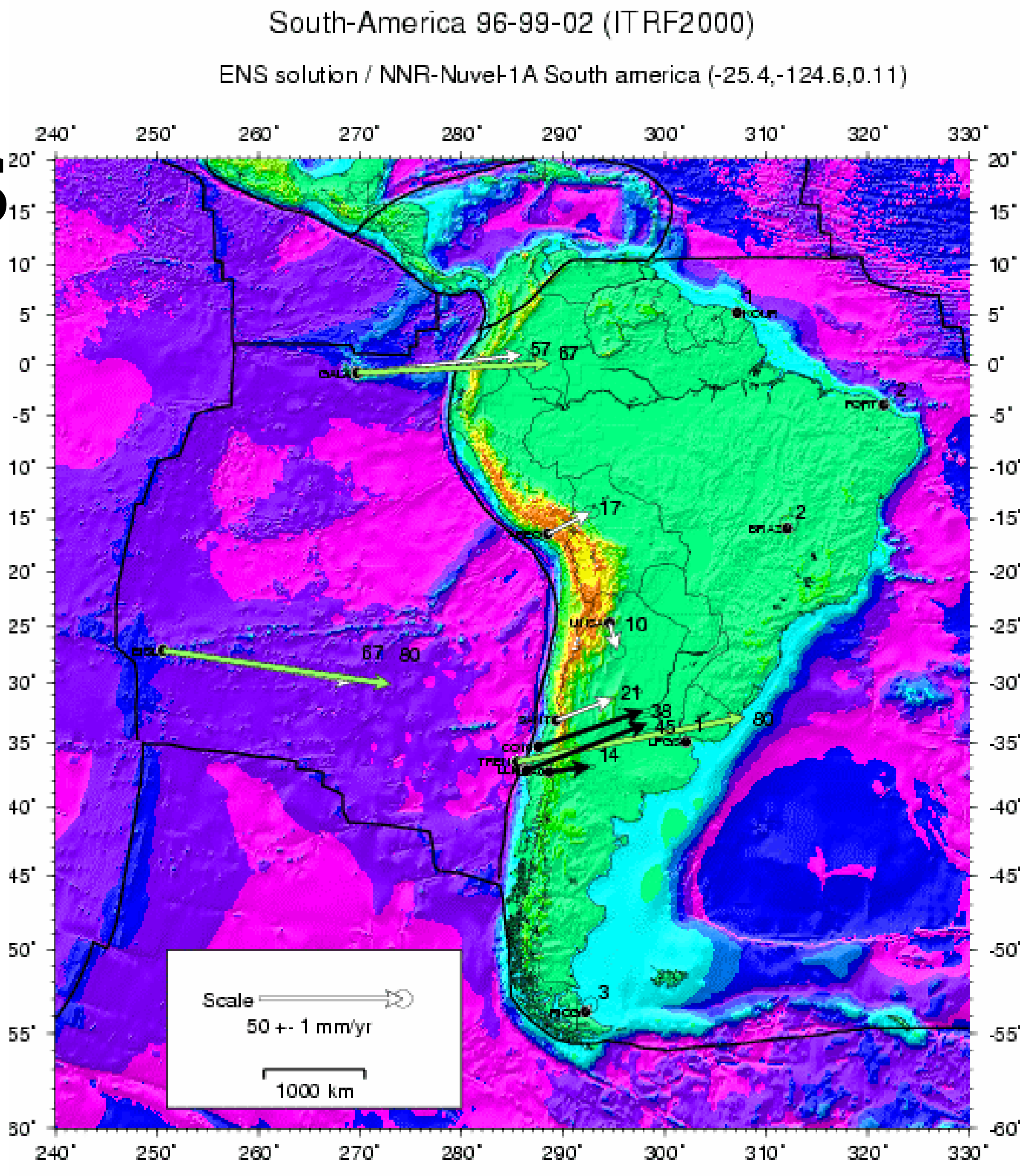
Palu Fault, Sulawesi



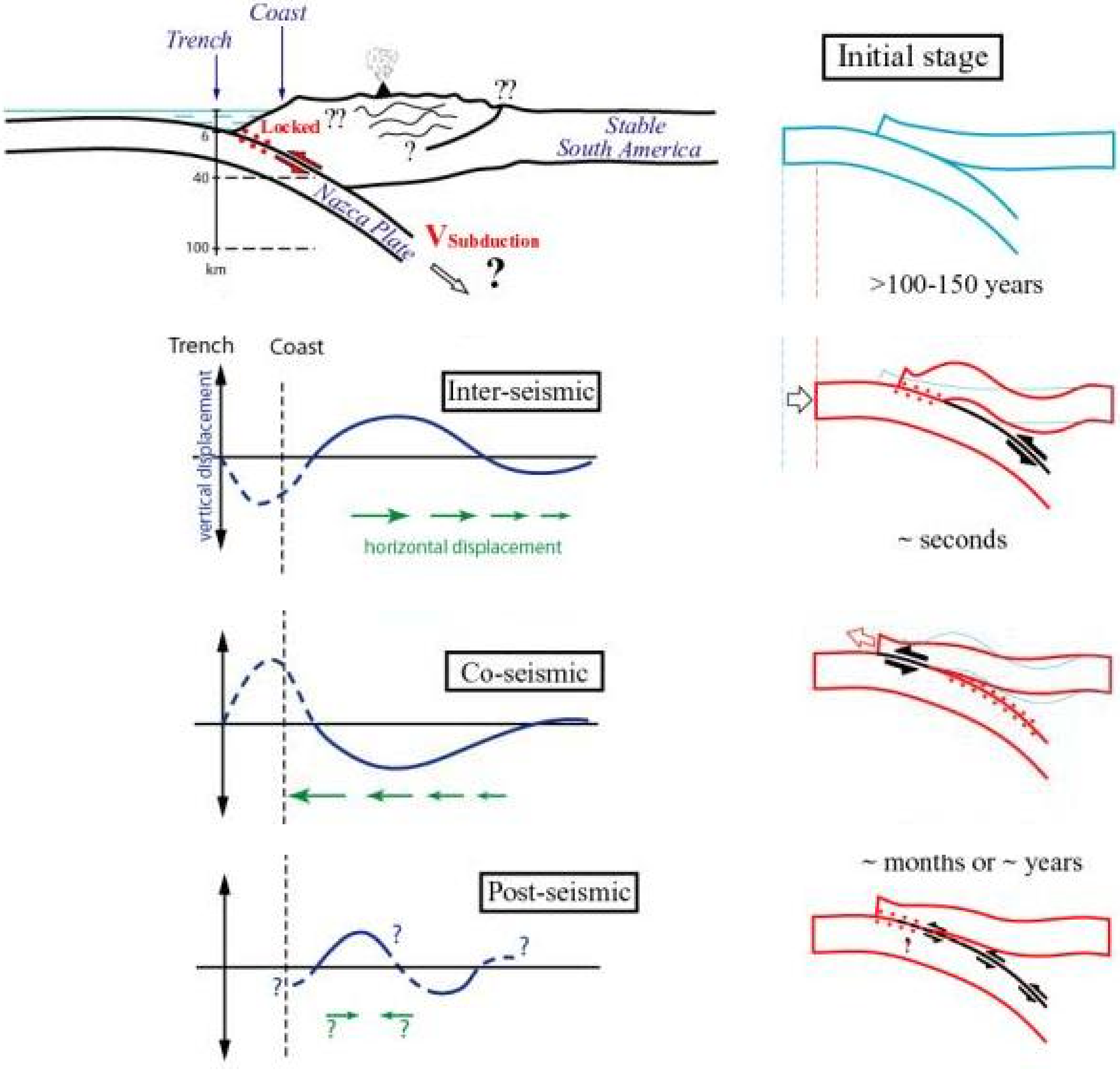




S ca

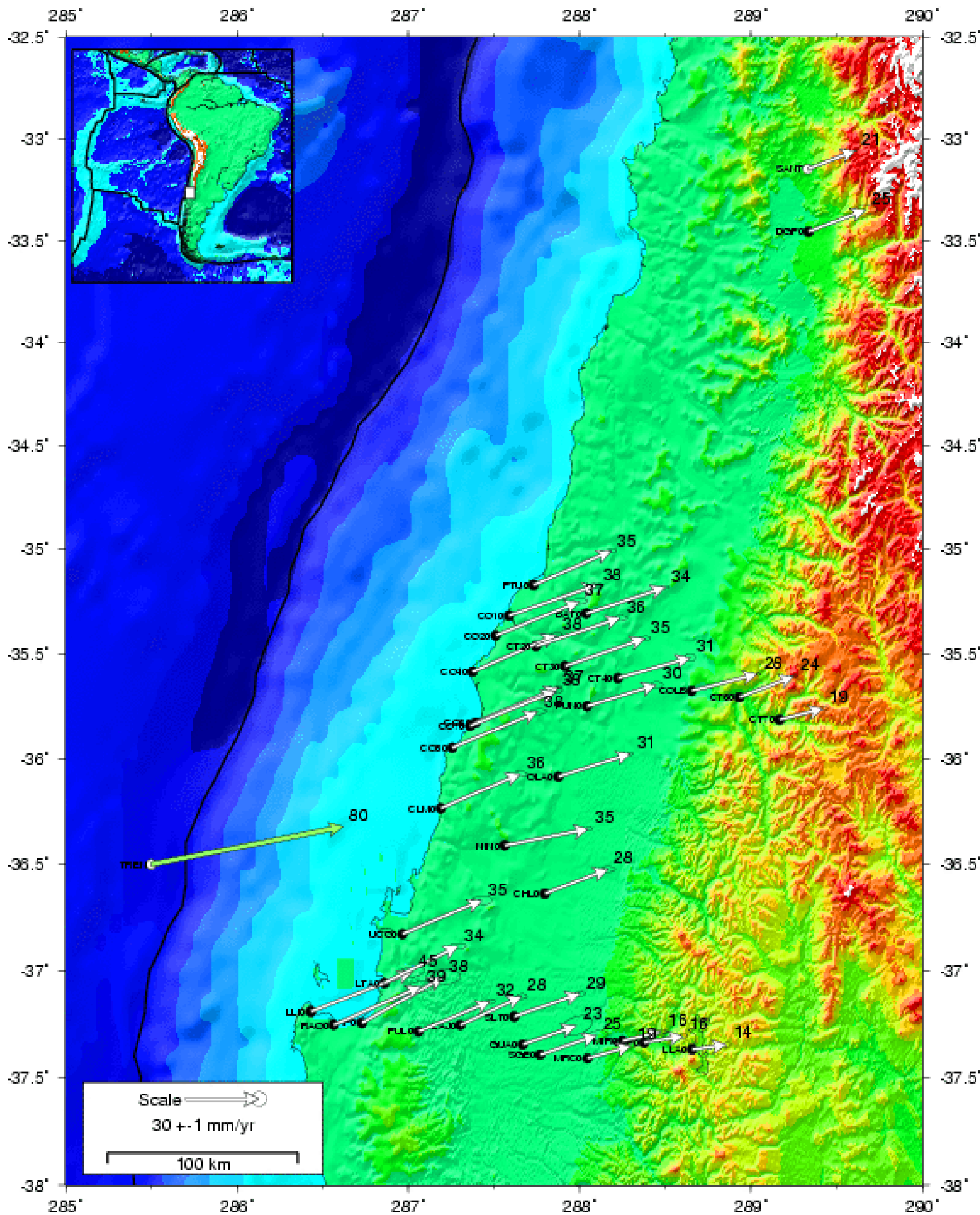

South-America 96-99-02 (ITRF2000)
ENS solution / NNR-Nuvel-1A South america (-25.4,-124.6,0.11)
Scale
50 +- 1 mm/yr
1000 km
57
67
17
10
21
39
45
1
80
14
2
3
67
80

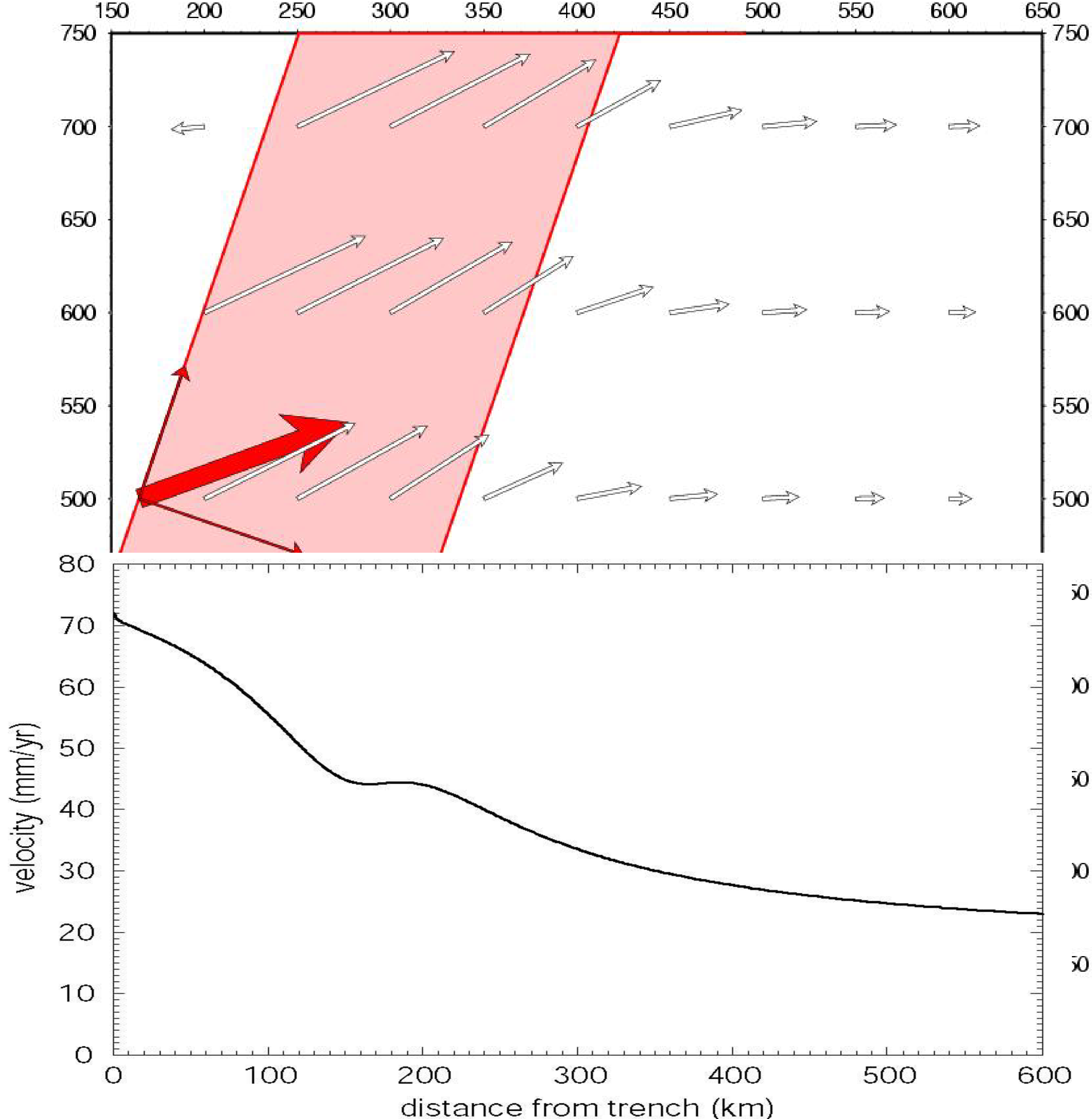
Seismic cycle in subduction context



SUR CHILI 96-99-02 (ITRF2000)

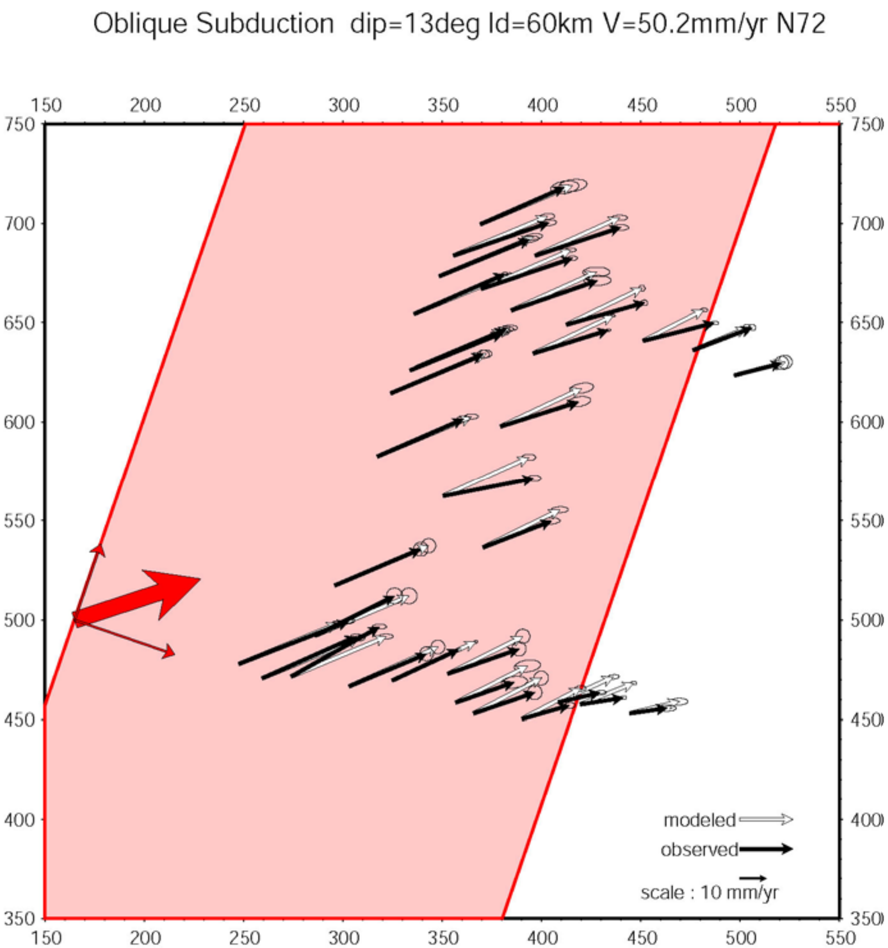
ENS solution / NNR-Nuvel-1A South america (-25.4,-124.6,0.11)



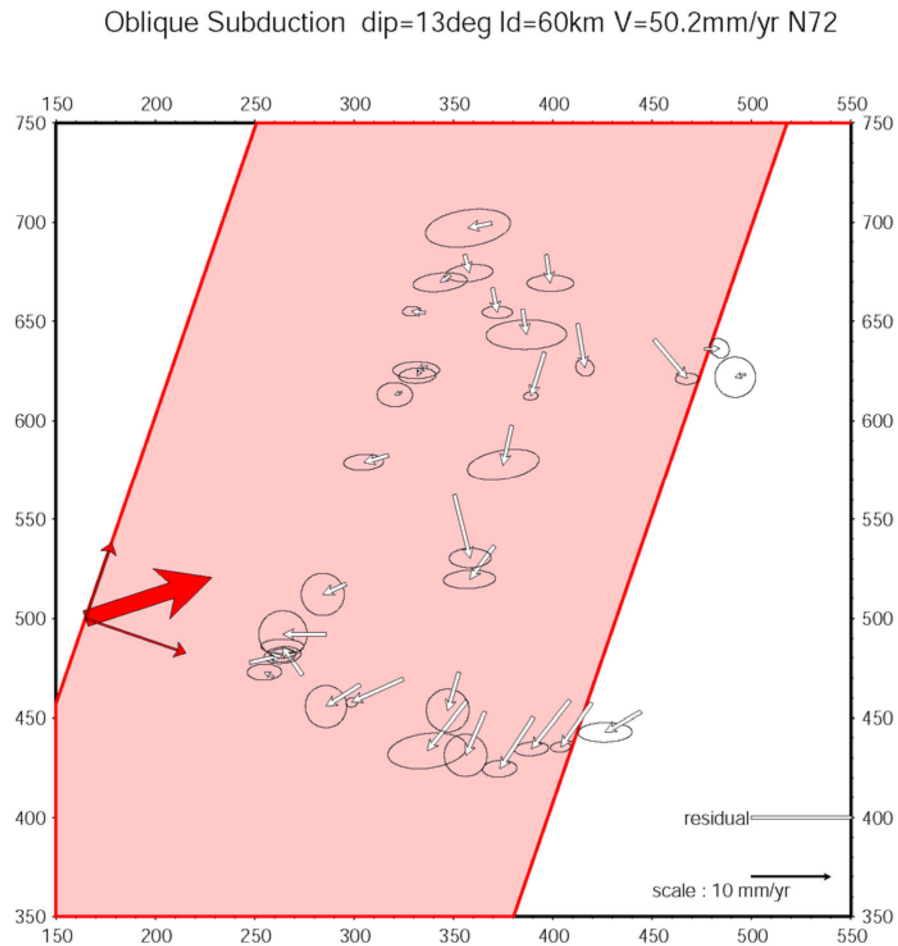


150 200 250 300 350 400 450 500 550 600 650
750 700 650 600 550 500
80 70 60 50 40 30 20 10 0
velocity (mm/yr)
0 100 200 300 400 500 600
distance from trench (km)

Subduction parameter adjustments

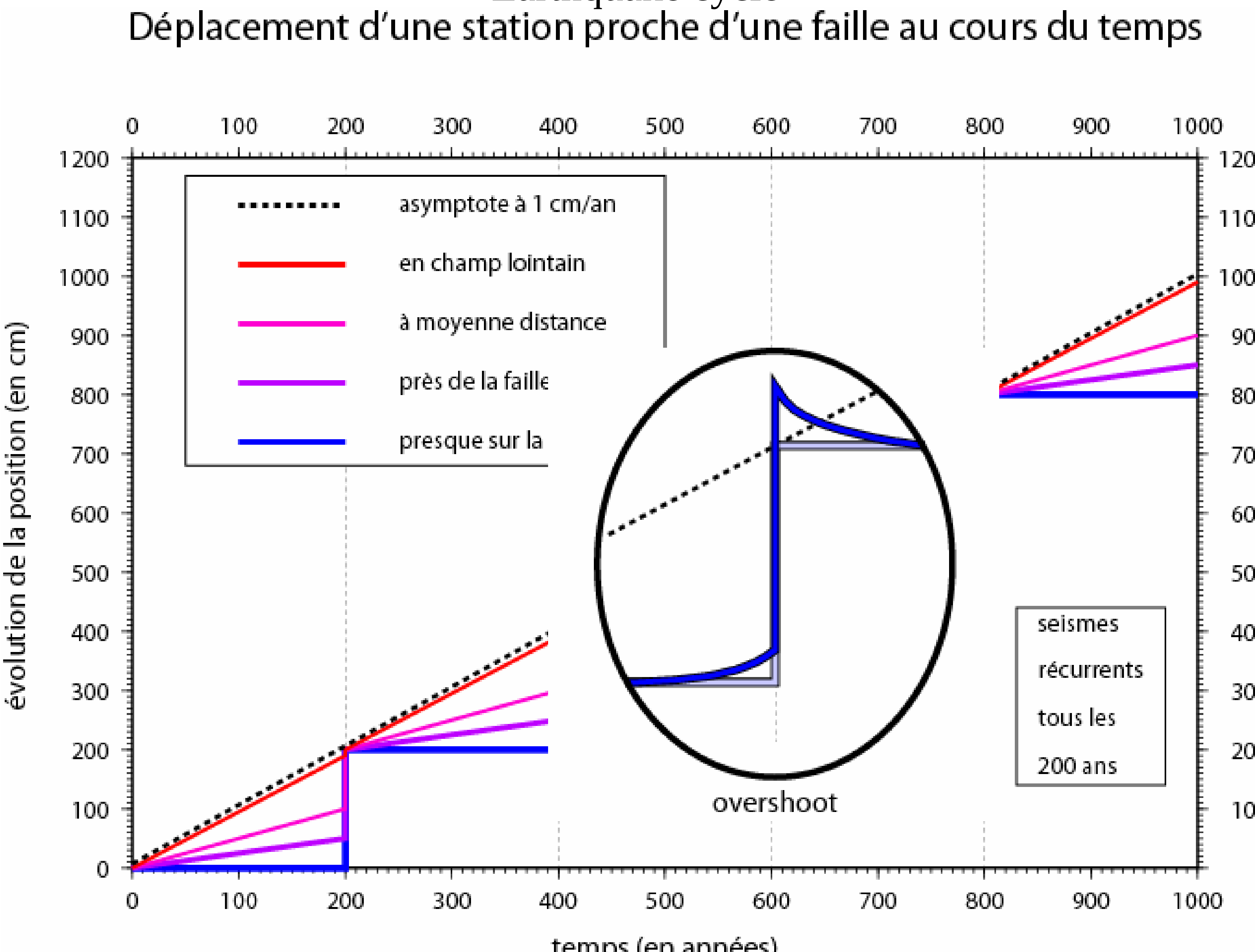


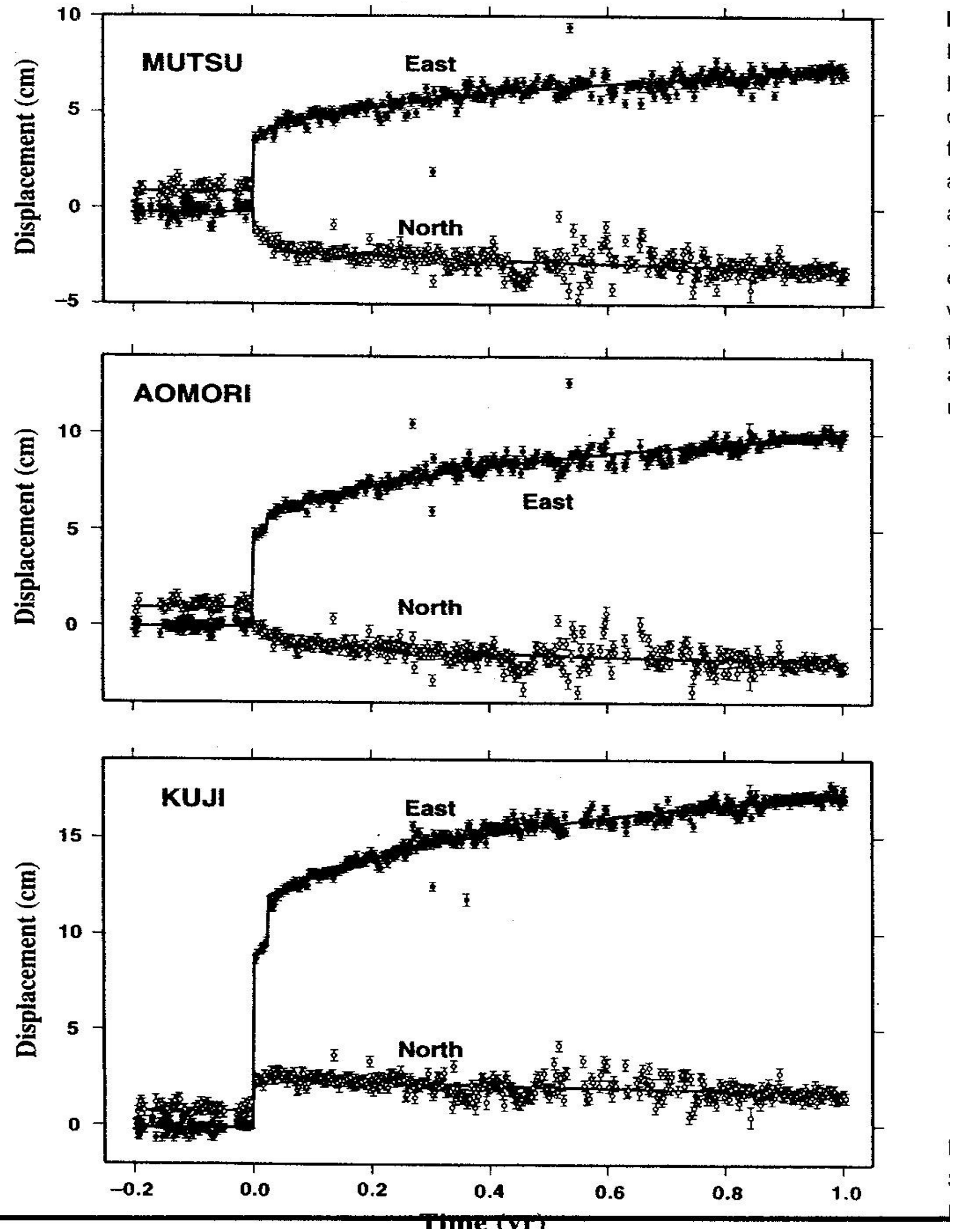
Model and data



Residuals

Earthquake cycle



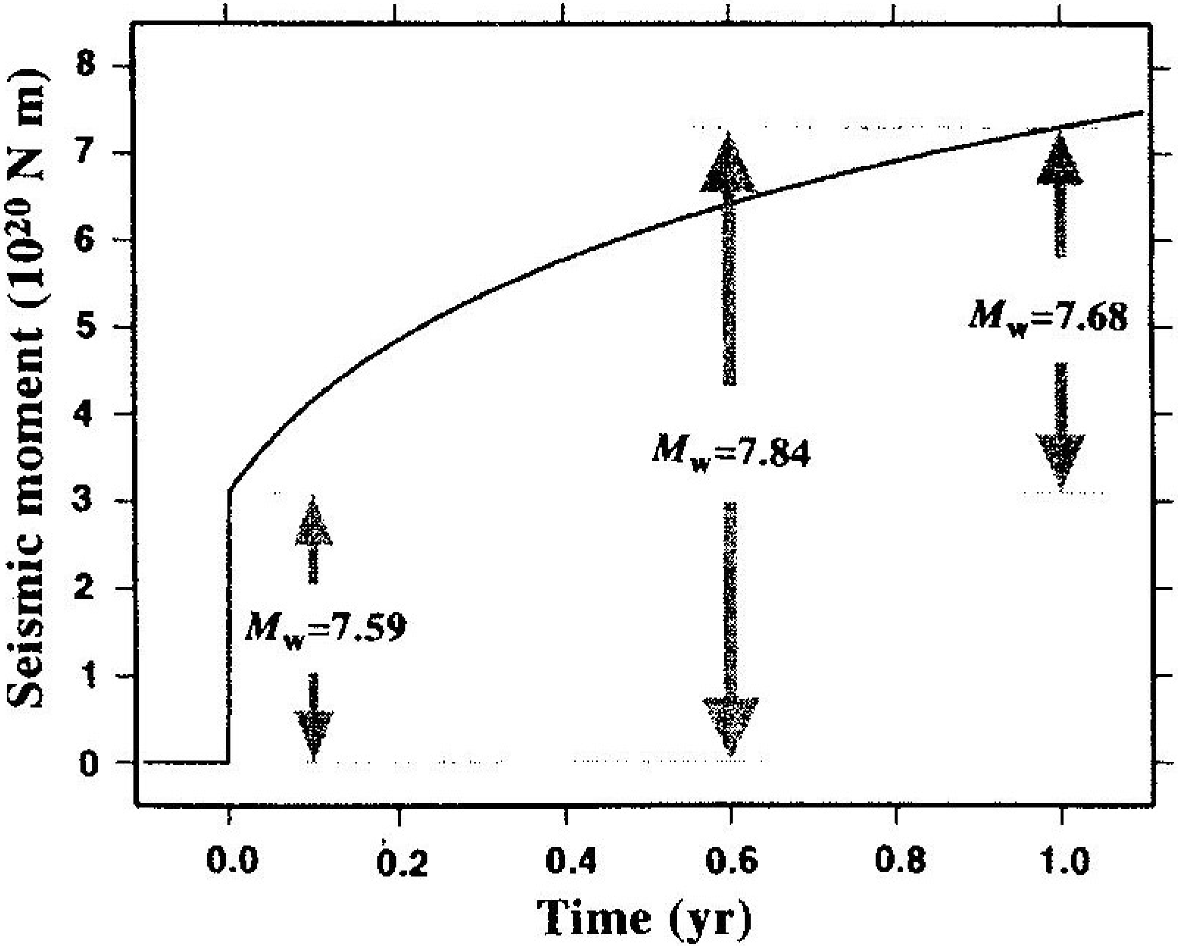


K HEKI, Nature 1997

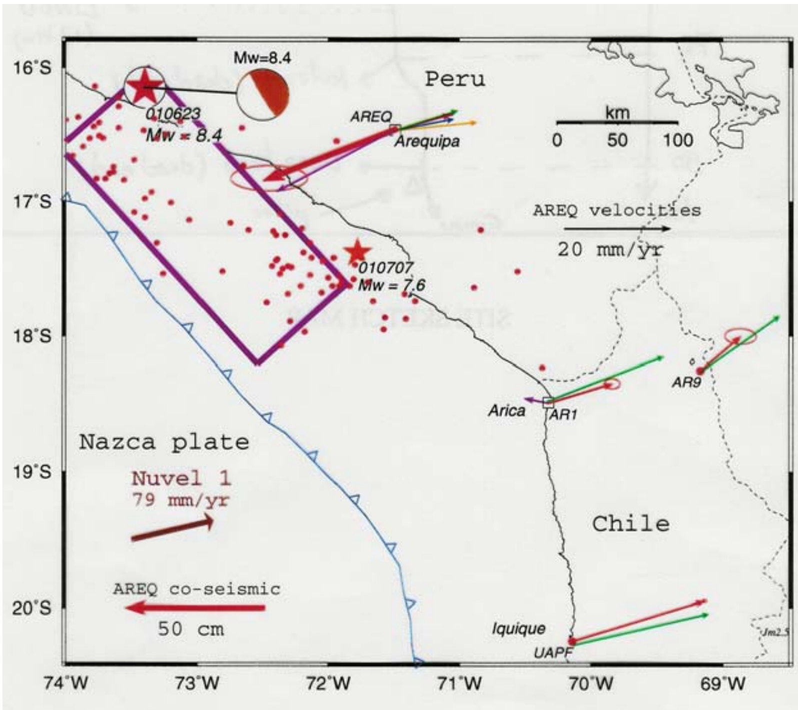
Silent fault slip following an interplate thrust earthquake at the Japan trench

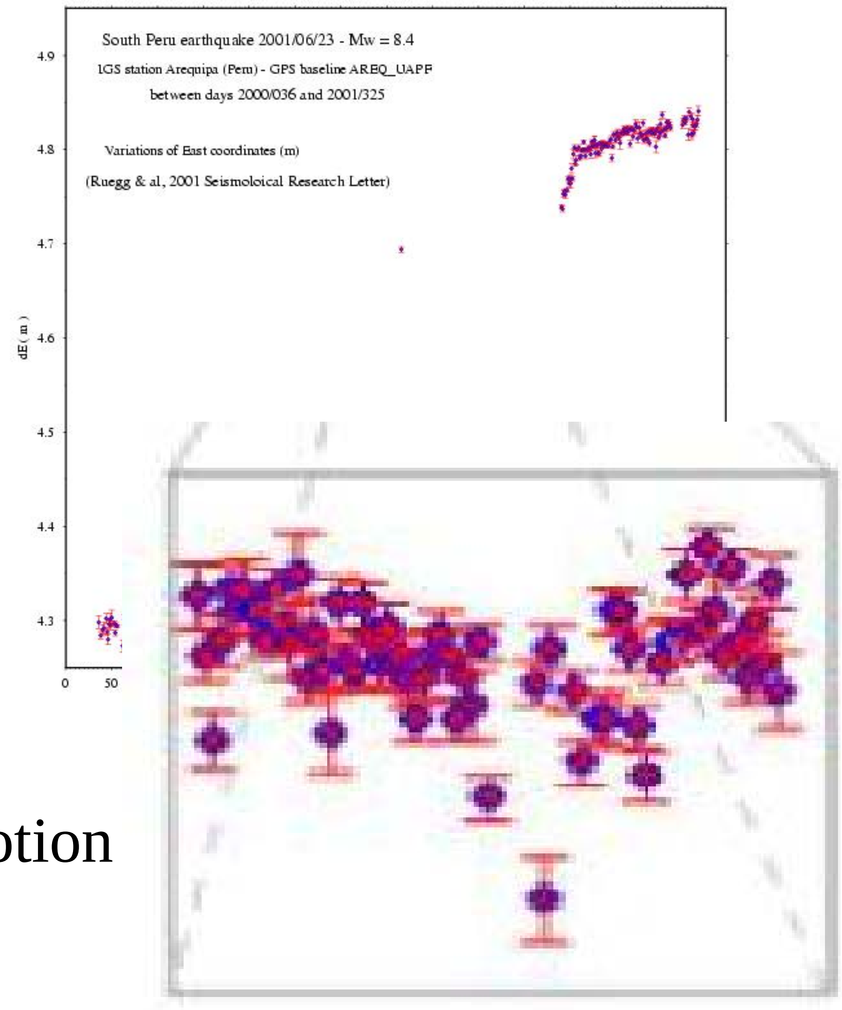
Horizontal coordinate time series before and after the **1994 Sanriku-haruka-Oki earthquake** observed at three GPS stations : Mutsu, Aomoriand and Kuji. Dots denote north and east components. Black lines are the model curves (stationary for t < 0, logarithmic decay for t > 0, discontinuity for t= 0).

Sanriku-Haruka-Oki sequence

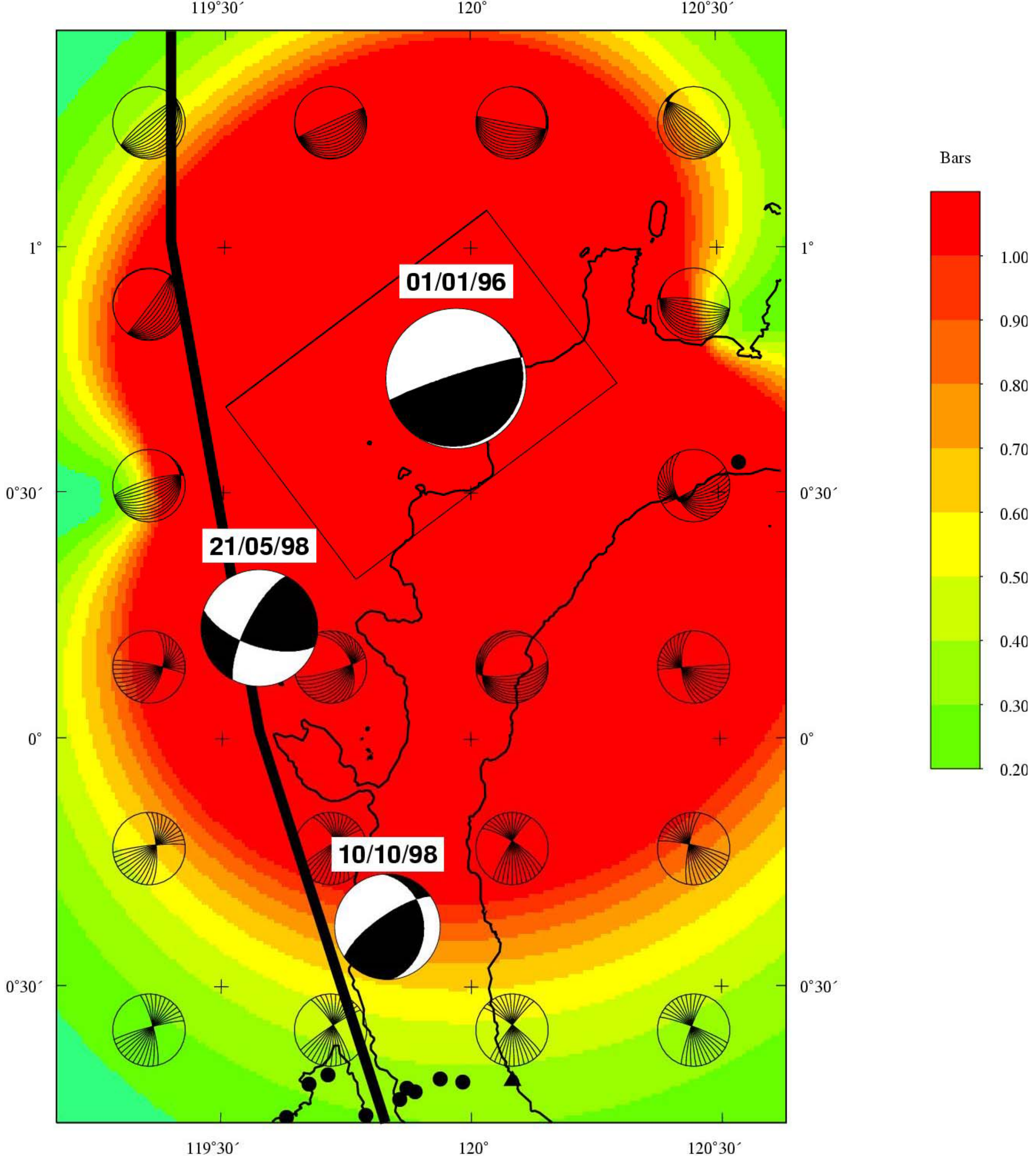


Ruegg et al., 2001, *seismological research letters*





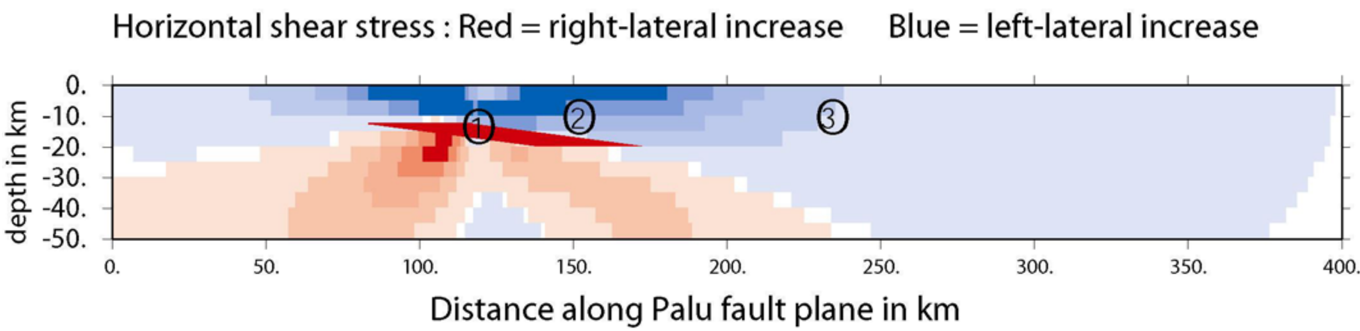
Towards detection of **preseismic** motion



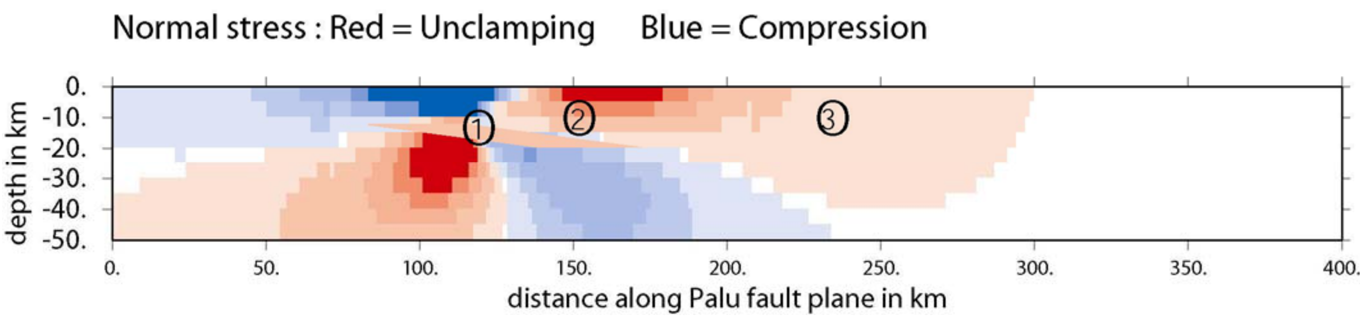
119°30´
120°
120°30´
1°
0°30´
0°
0°30´
01/01/96
21/05/98
10/10/98
Bars
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20

Coulomb Stress on Palu fault plane generated by 01/01/96 Eq

Shear stress on fault plane is increased => slip on fault



Normal stress on fault is decreased =>unclamping of fault



Tregoning, 2002, *unpublished*

From coseismic jump …

… to kinematic measurement of position **during** the earthquake