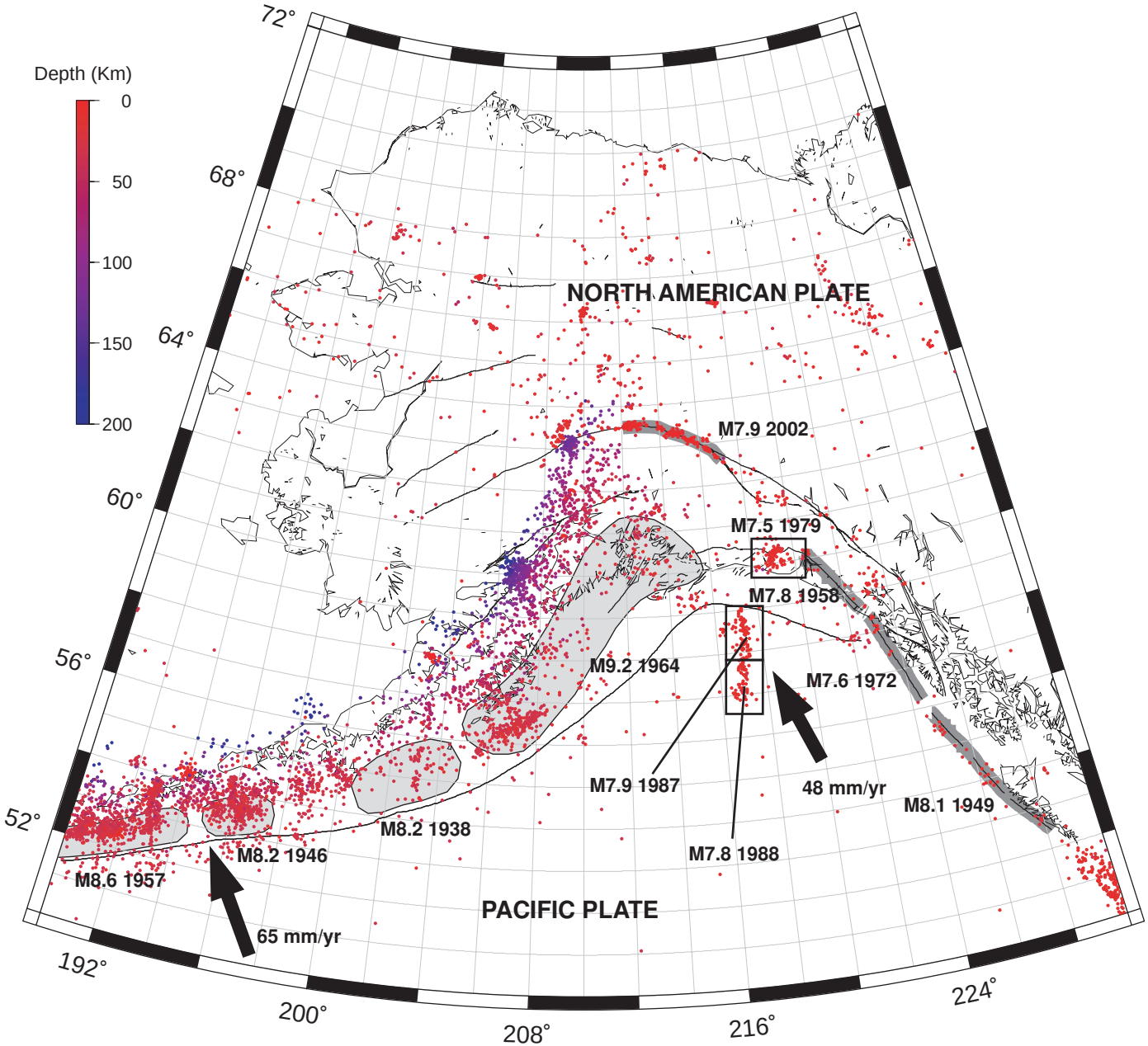
Contemporary deformation in southcentral Alaska

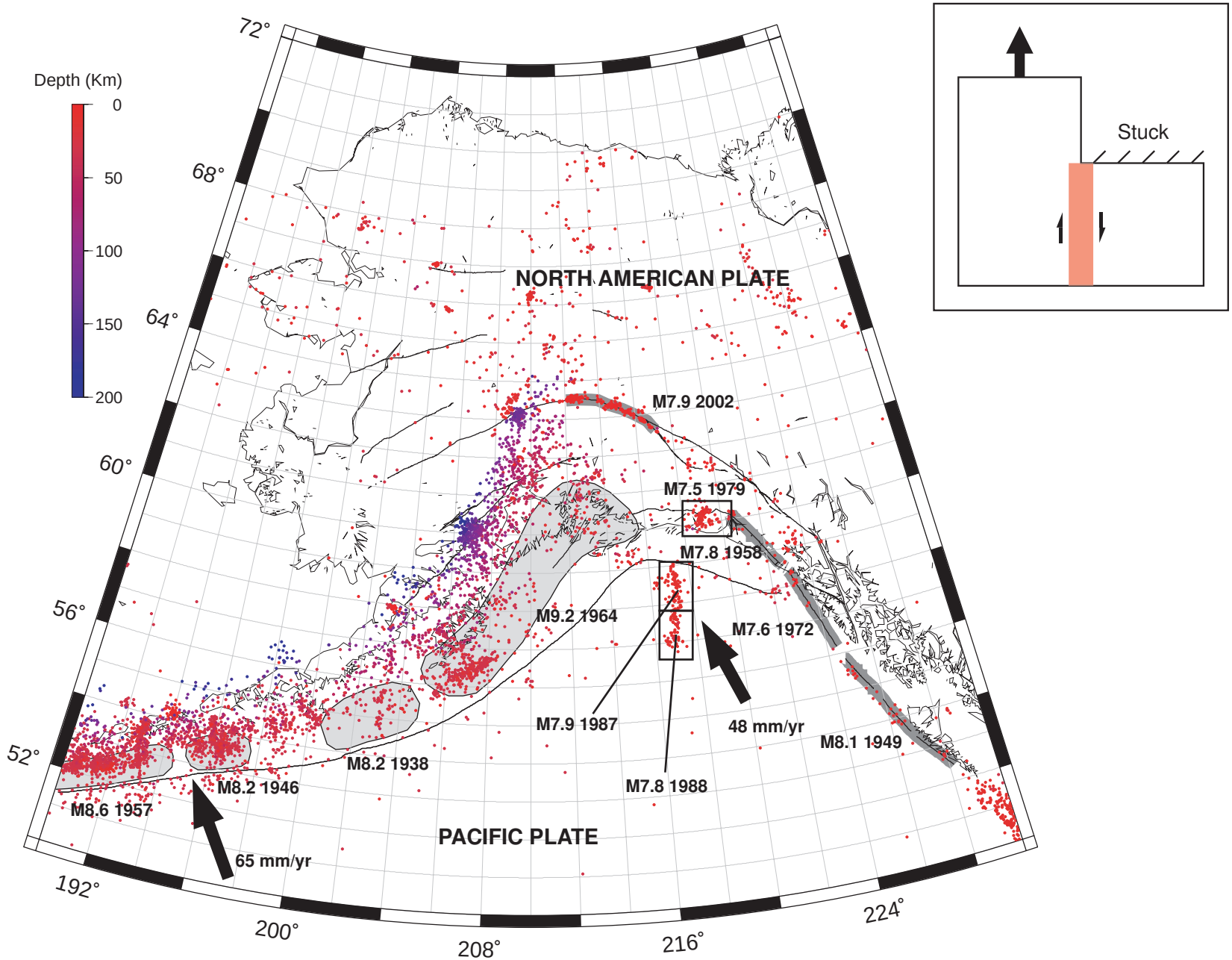
Tabrez Ali

University of Wisconsin - Madison

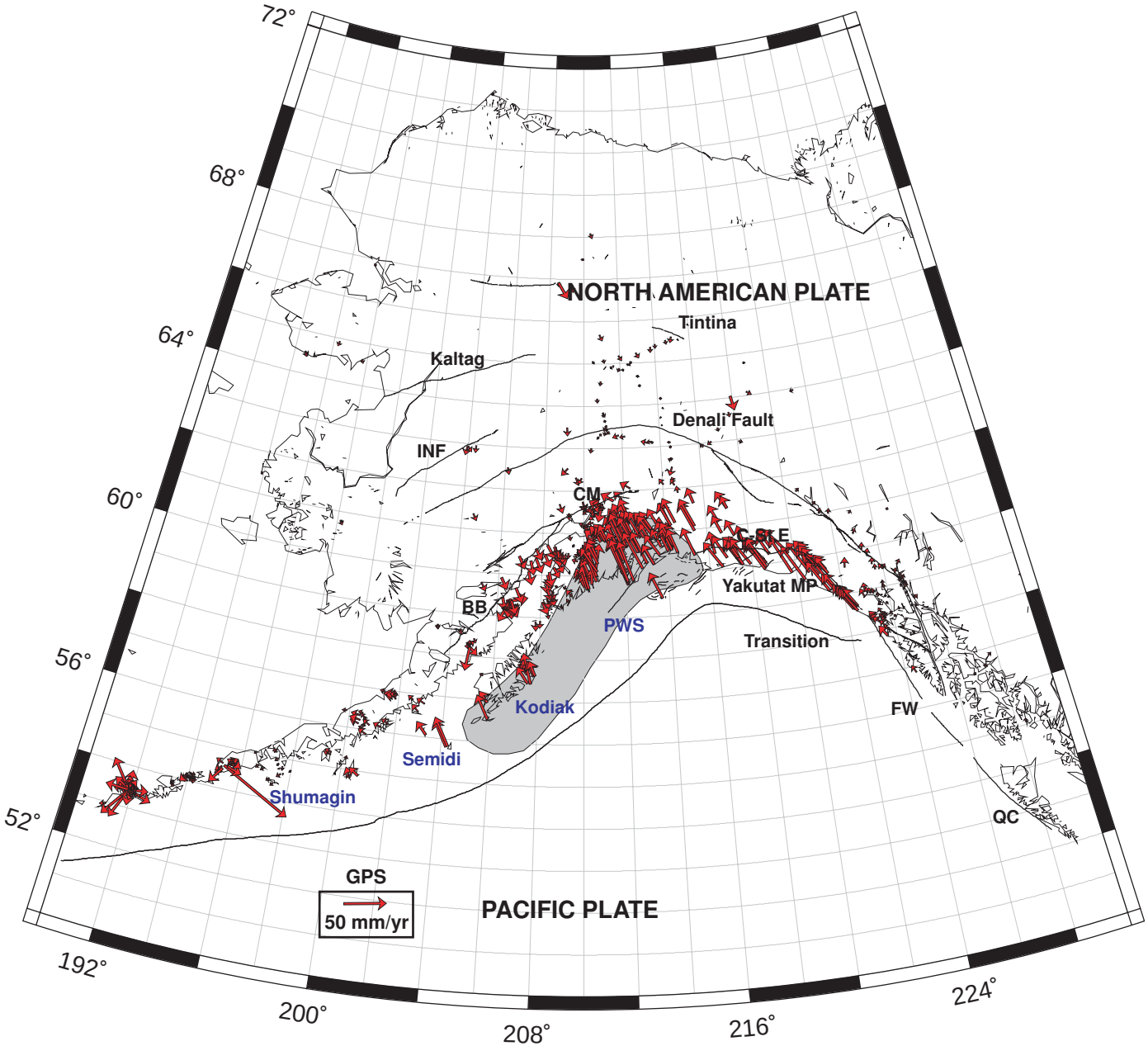
Alaska: Seismicity



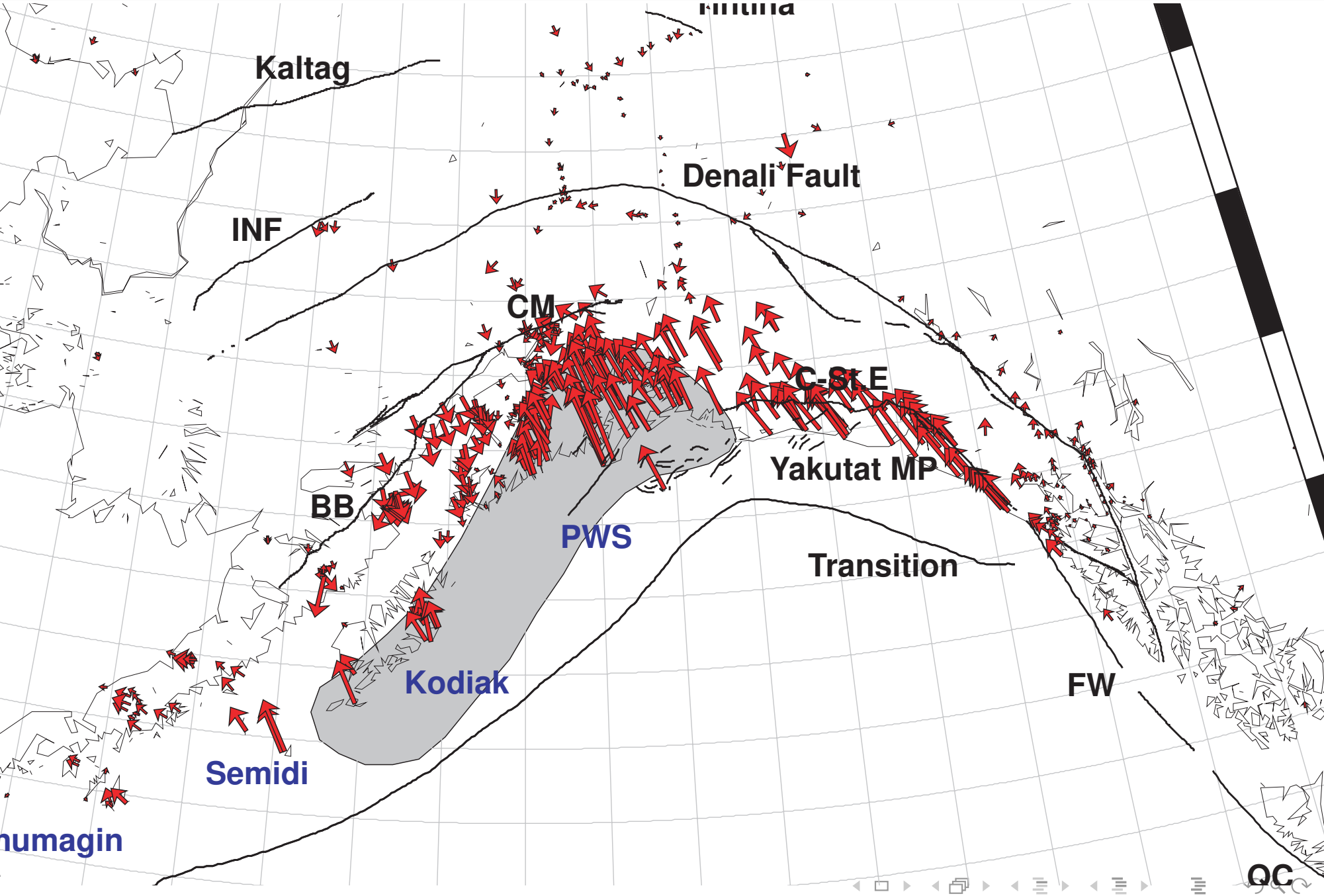
Alaska: Seismicity



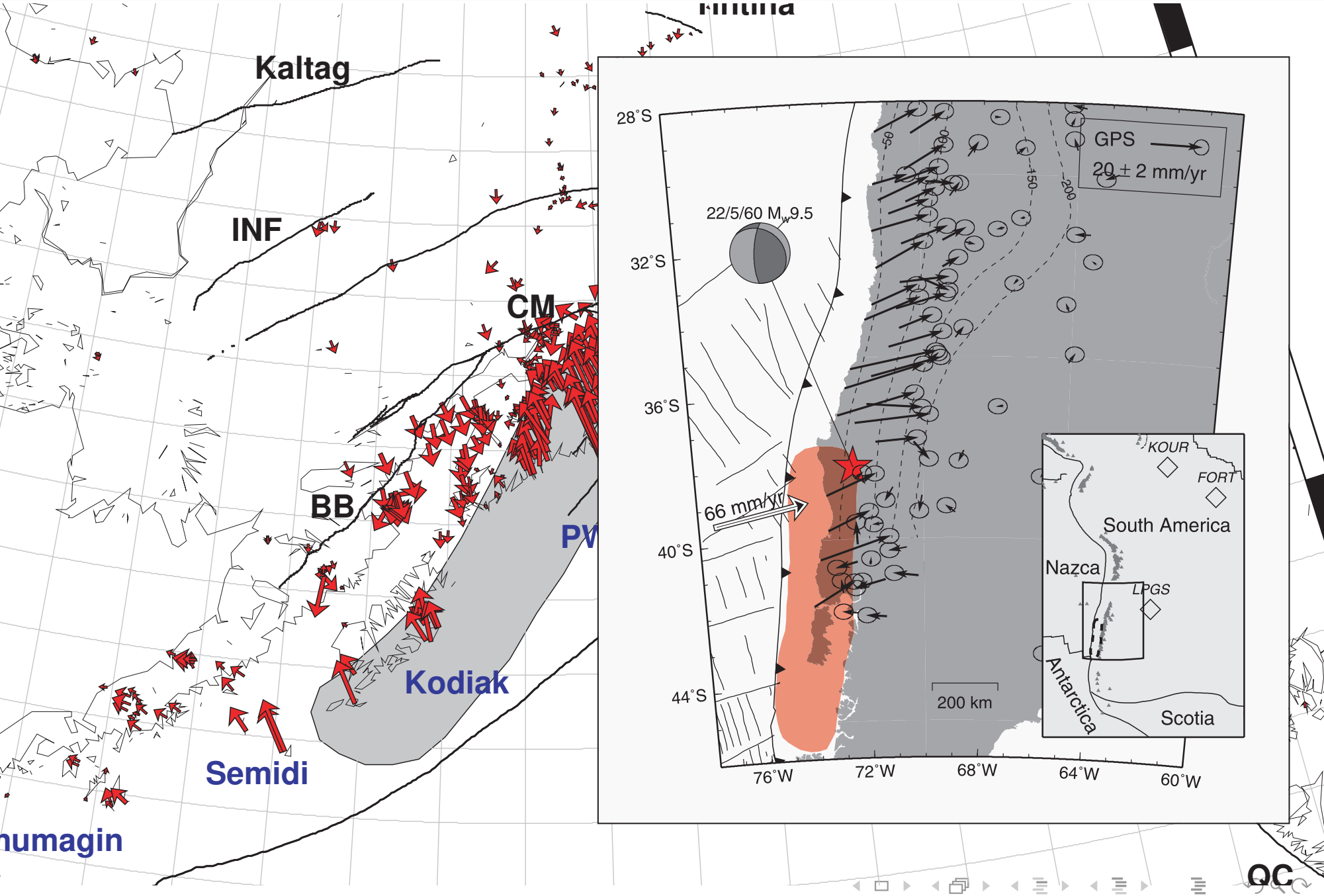
GPS


72°
68°
64°
60°
56°
52°
192°
200°
208°
216°
224°
NORTH AMERICAN PLATE
Tintina
Kaltag
Denali Fault
INF
CM
C-ST-E
Yakutat MP
BB
PWS
Transition
Kodiak
FW
Semidi
Shumagin
QC
GPS
50 mm/yr
PACIFIC PLATE

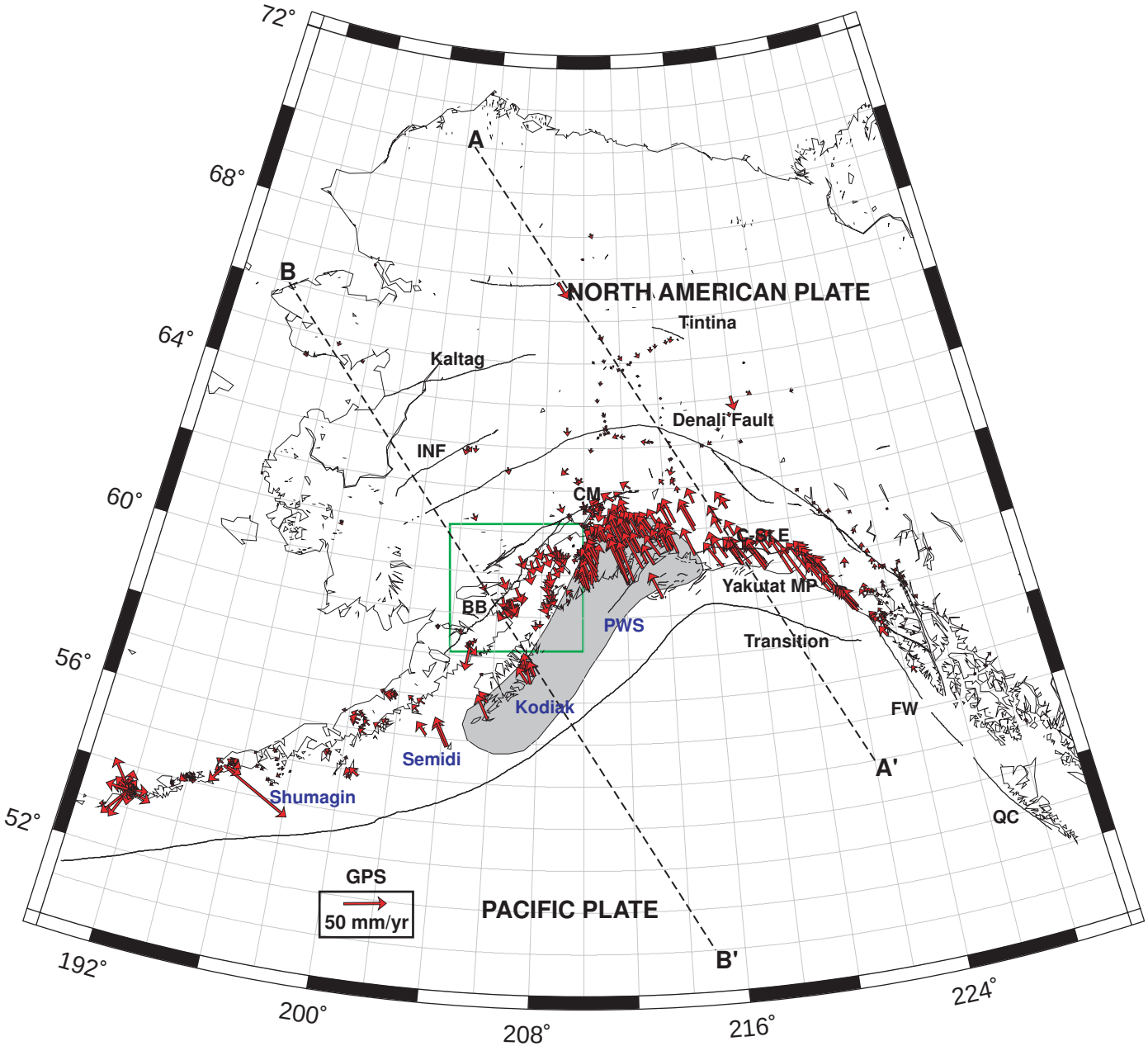
GPS


Kaltag
Denali Fault
INF
CM
C-St.E
Yakutat MP
BB
PWS
Transition
Kodiak
FW
Semidi
QC

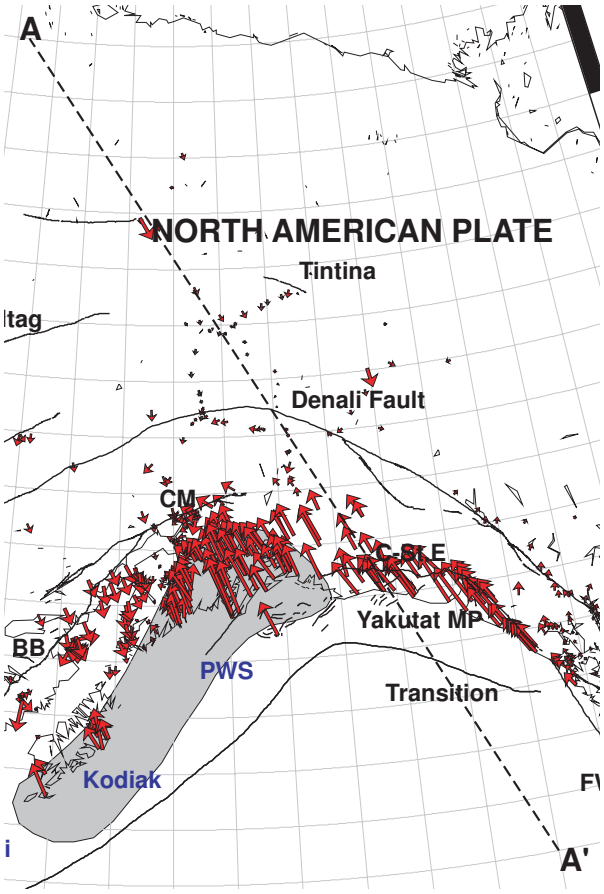
GPS


Kaltag
INF
CM
BB
PV
Kodiak
Semidi
humagin
28°S
32°S
36°S
40°S
44°S
76°W
72°W
68°W
64°W
60°W
22/5/60 M$_w$9.5
GPS
20 ± 2 mm/yr
50
100
150
200
66 mm/yr
200 km
KOUR
FORT
South America
Nazca
LPGS
Antarctica
Scotia

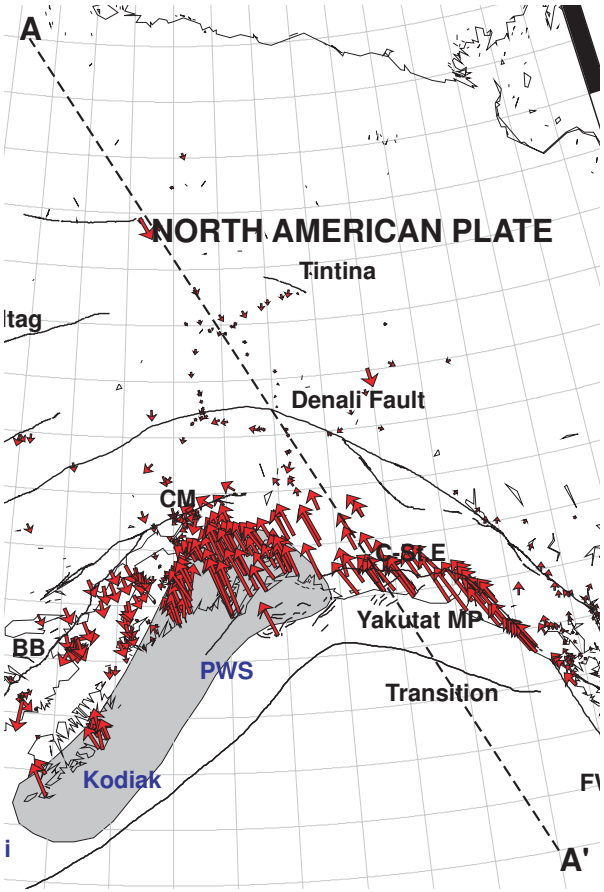
Cross-sections used for the 2D models



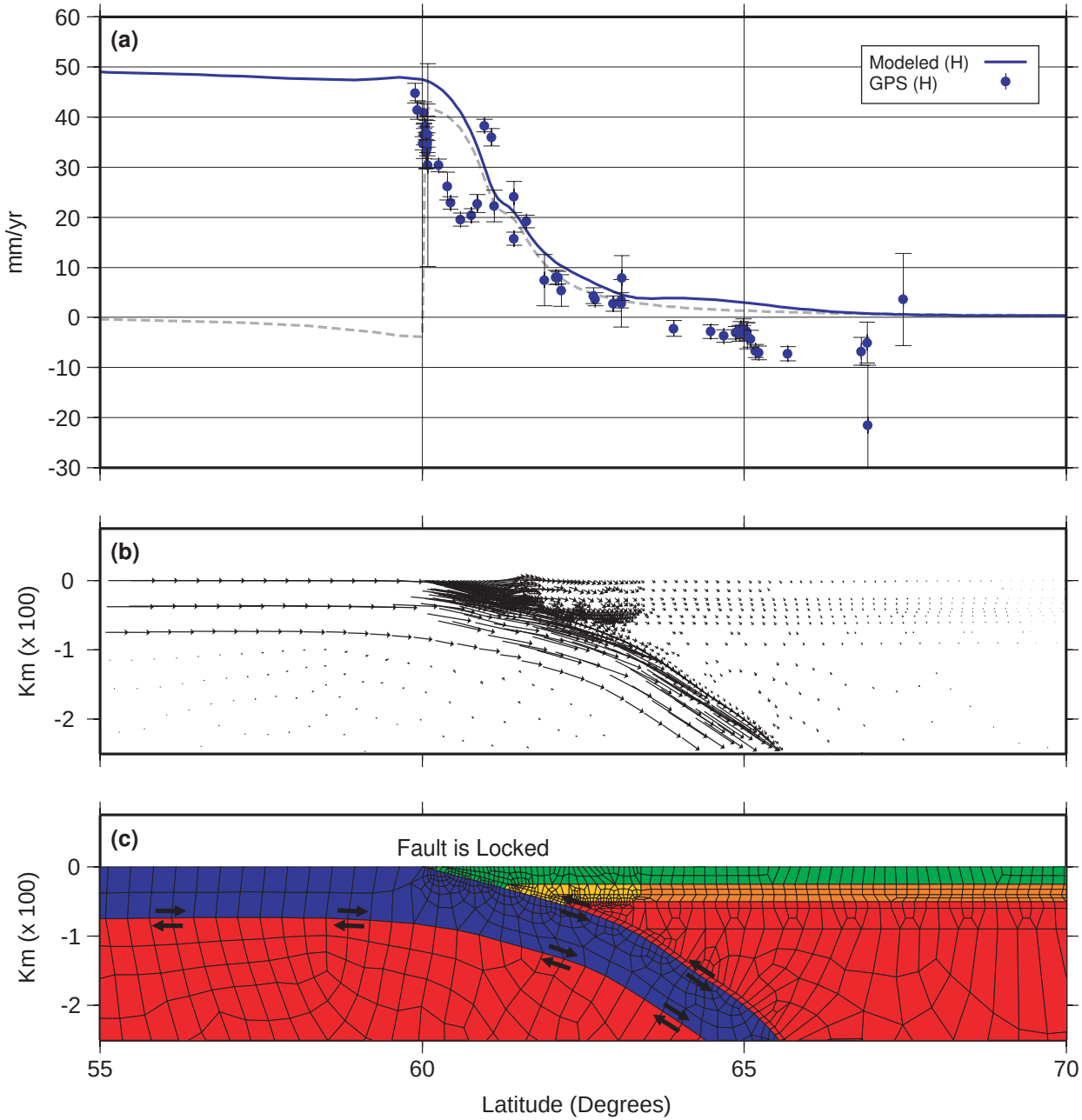
Interseismic deformation rate along A-A'



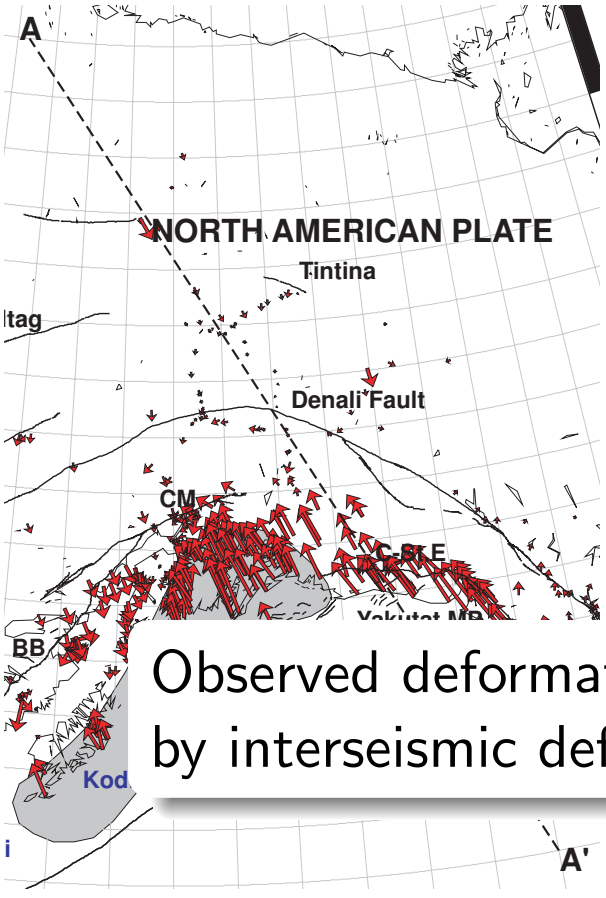
Interseismic deformation rate along A-A'

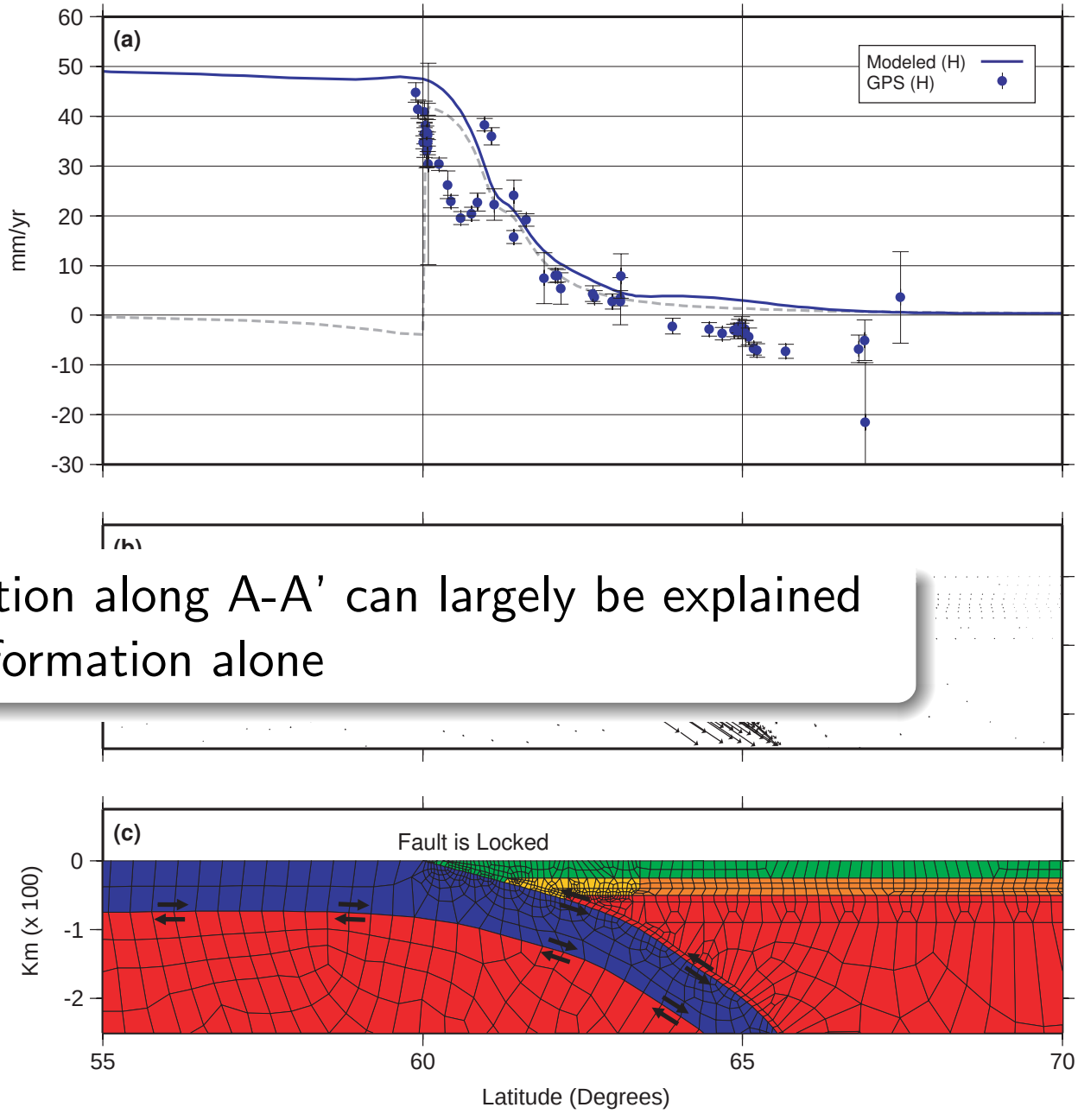


Modified Backslip Model



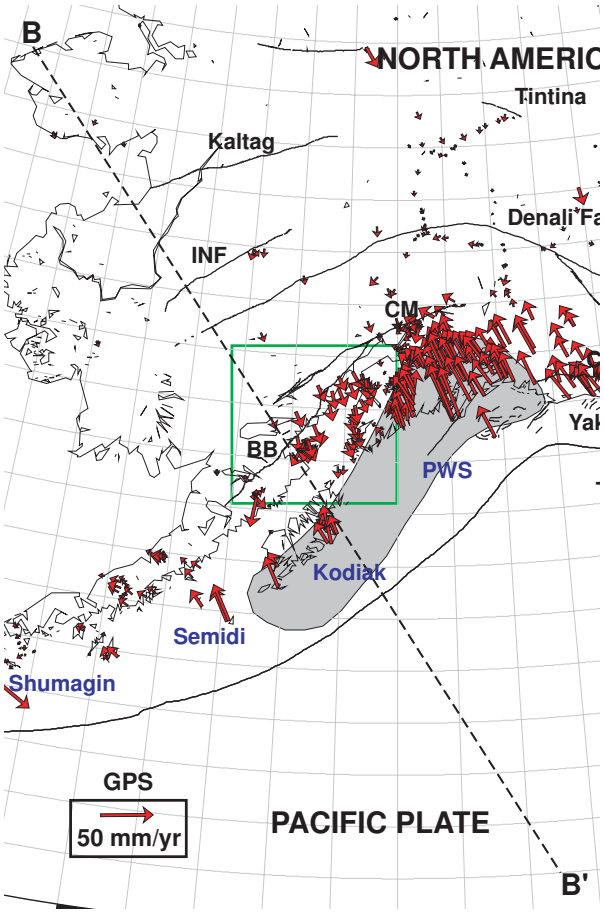
Interseismic deformation rate along A-A'



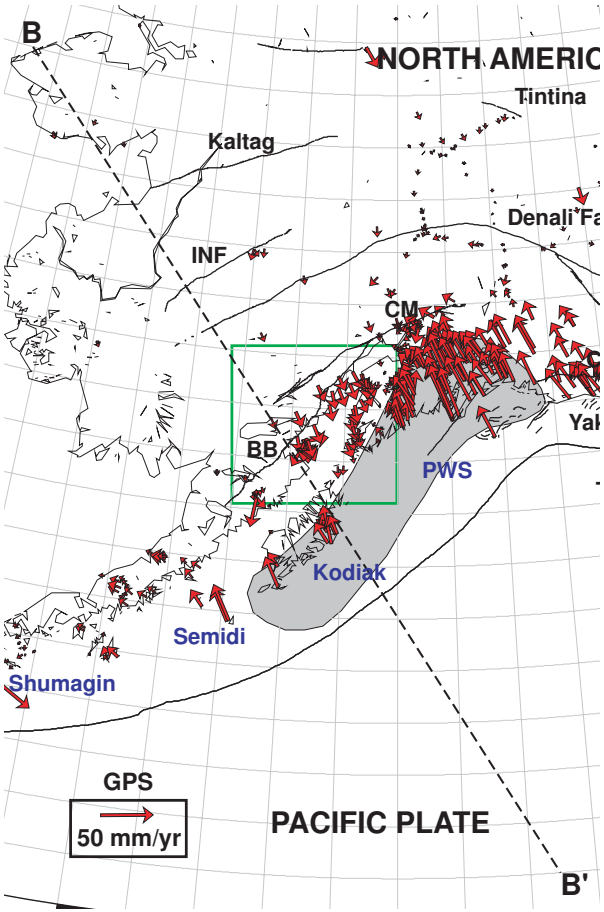


Observed deformation along A-A' can largely be explained by interseismic deformation alone

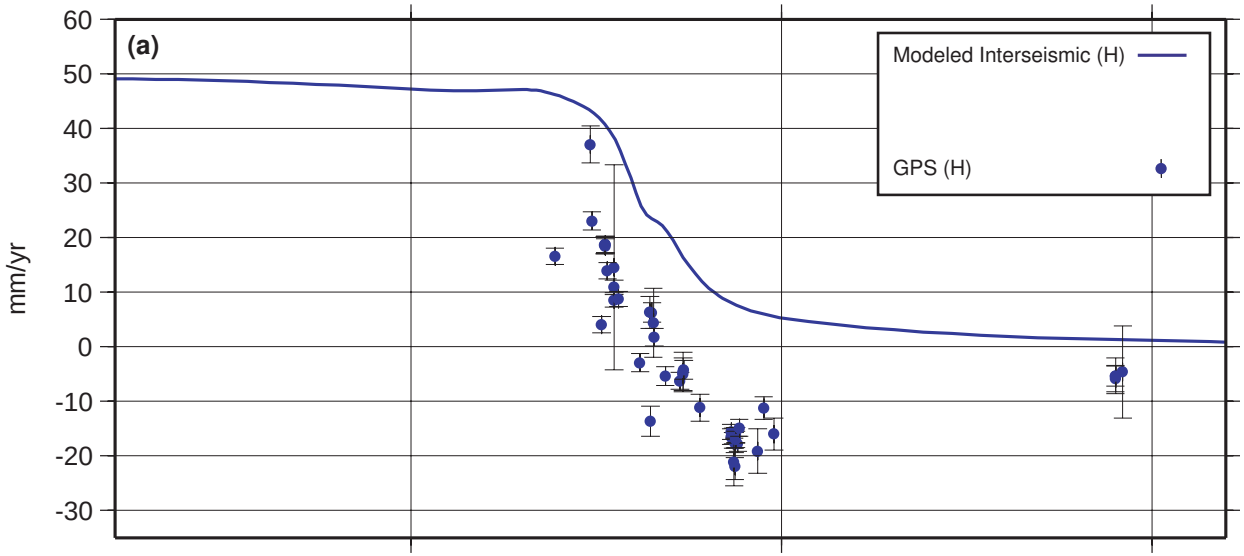
Modeling deformation rate along B-B'

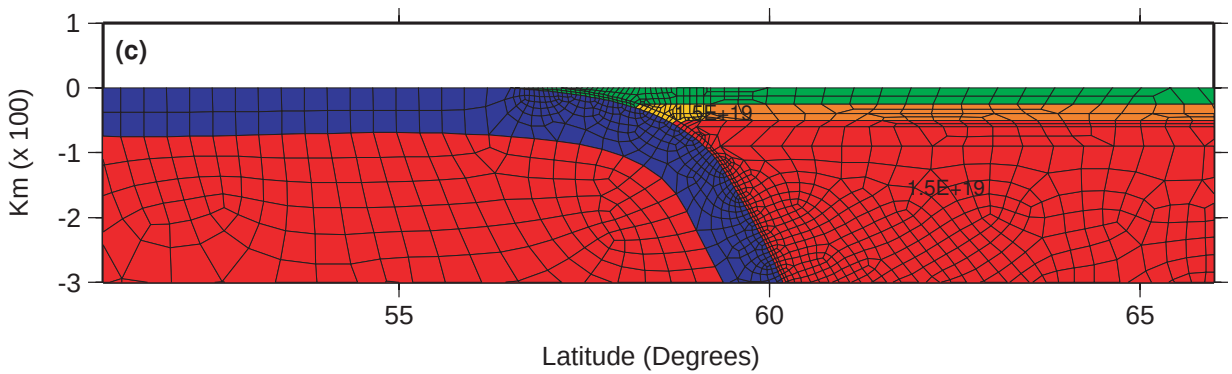


Modeling deformation rate along B-B'

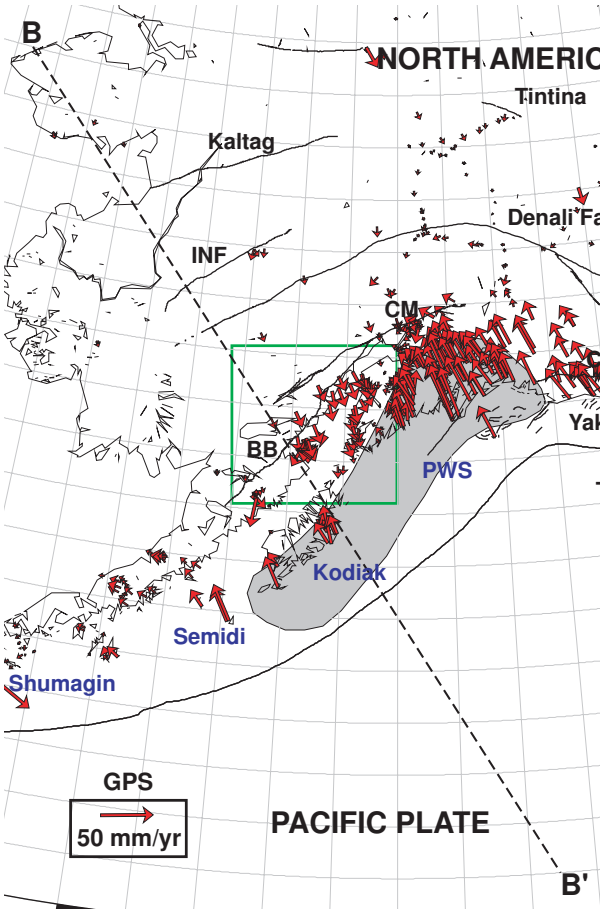


Interseismic deformation rate

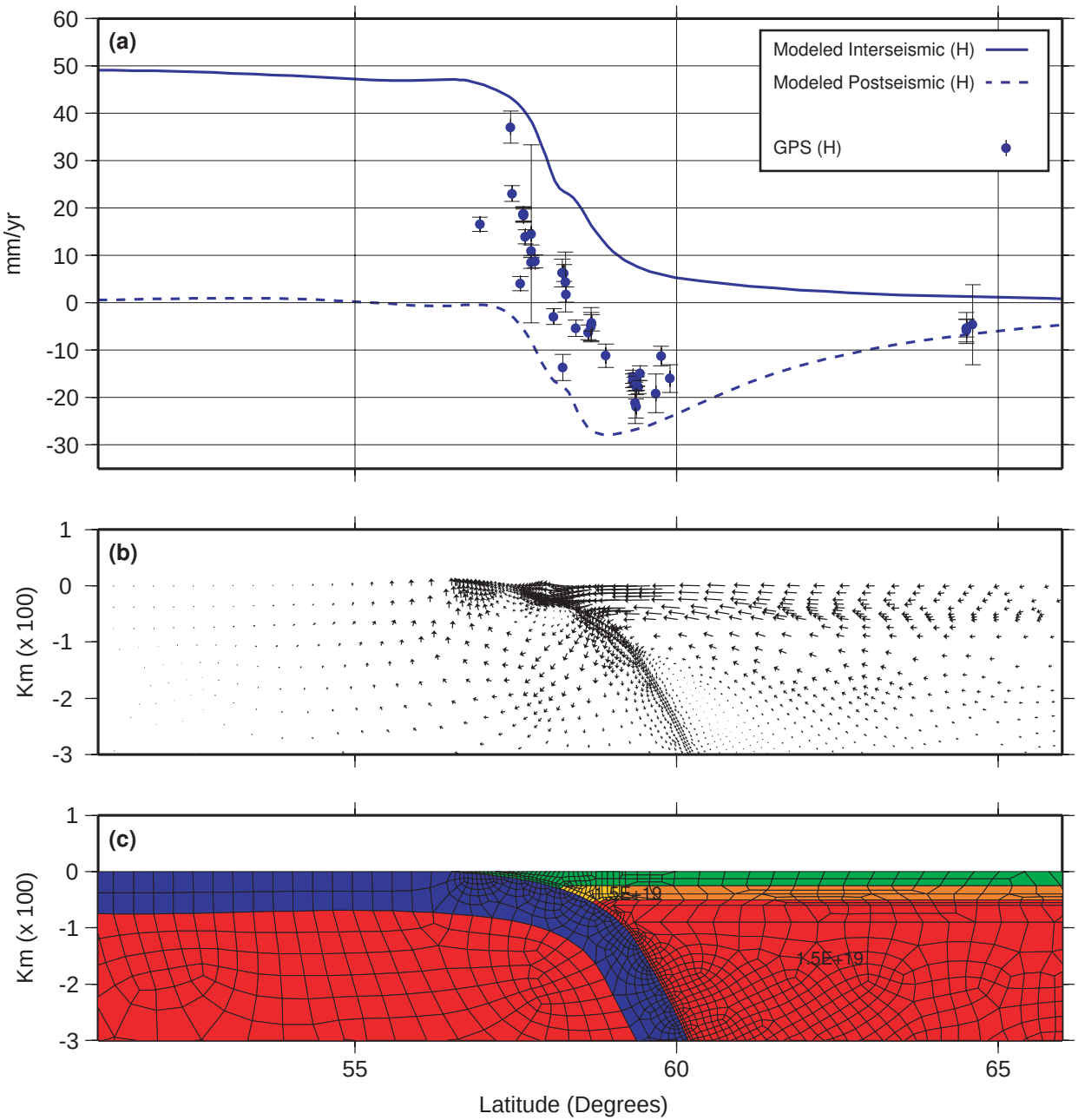




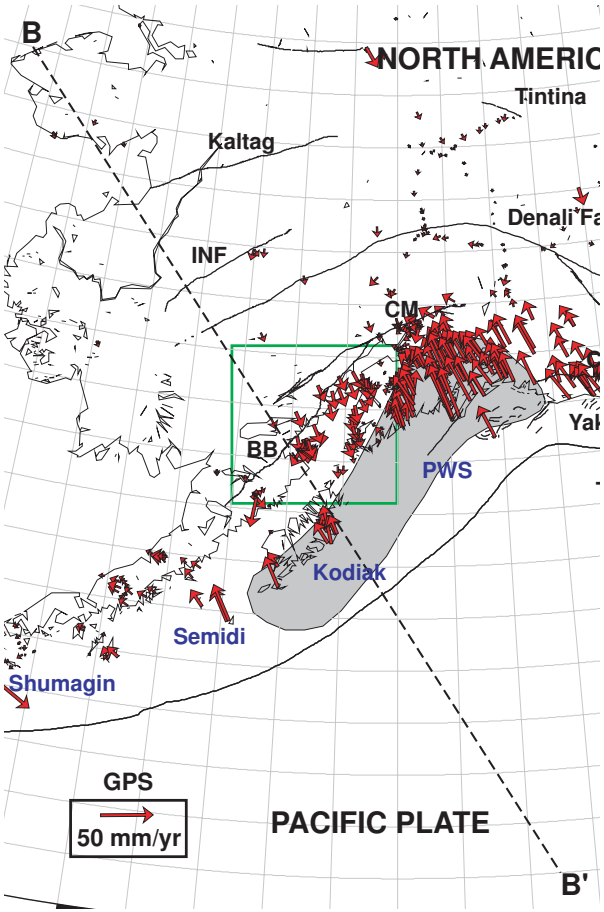
Modeling deformation rate along B-B'



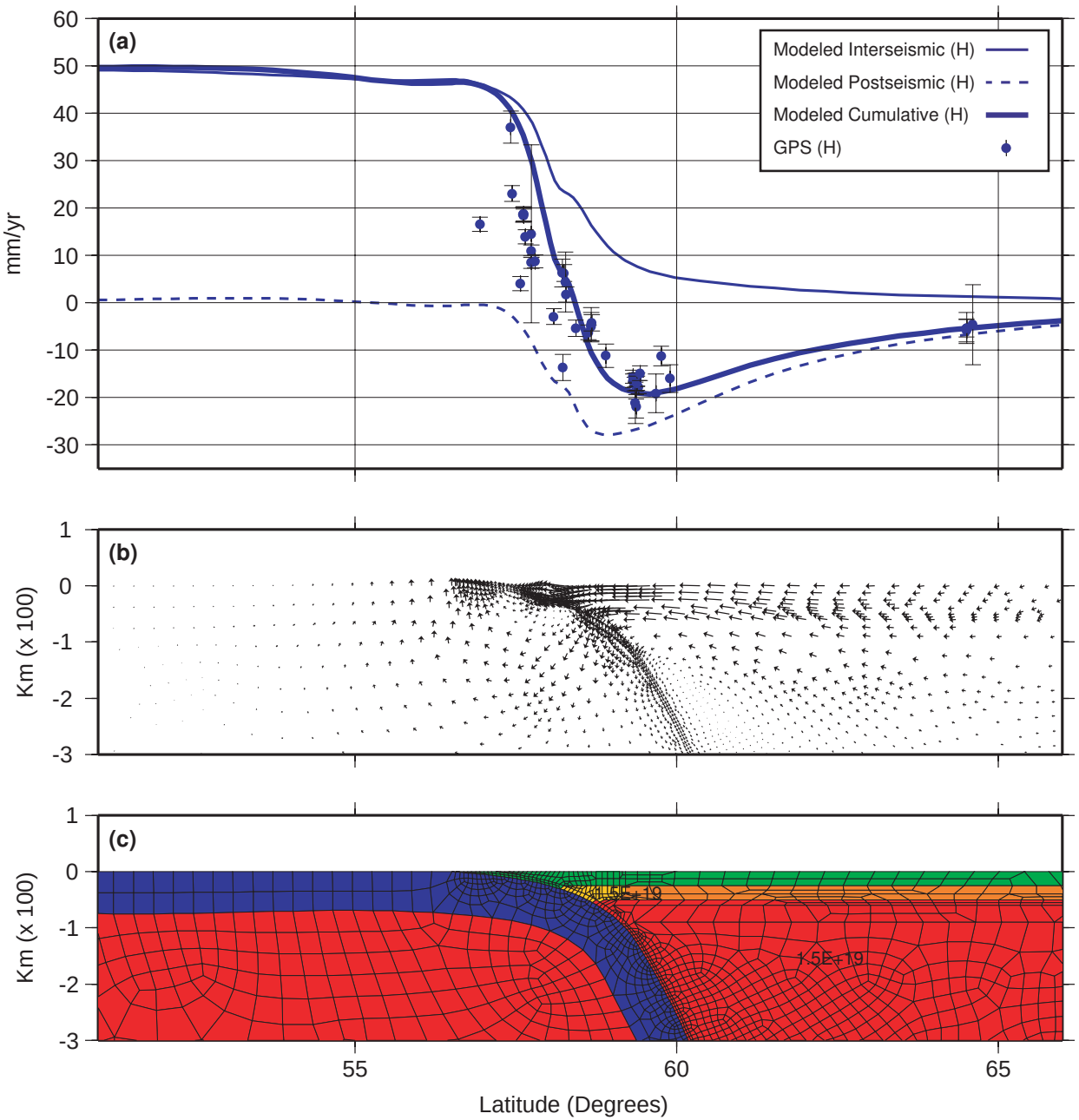
Postseismic signal in 2001



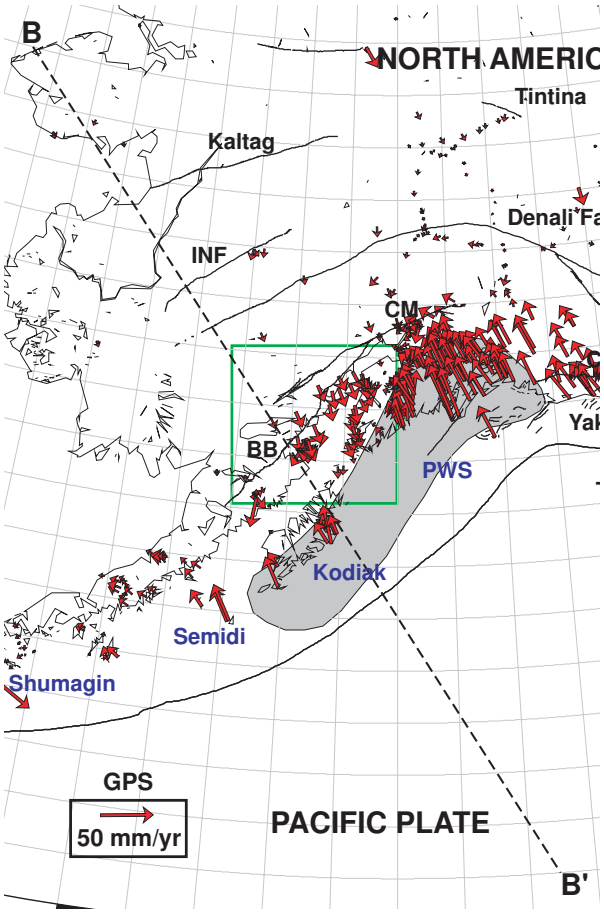
Modeling deformation rate along B-B'

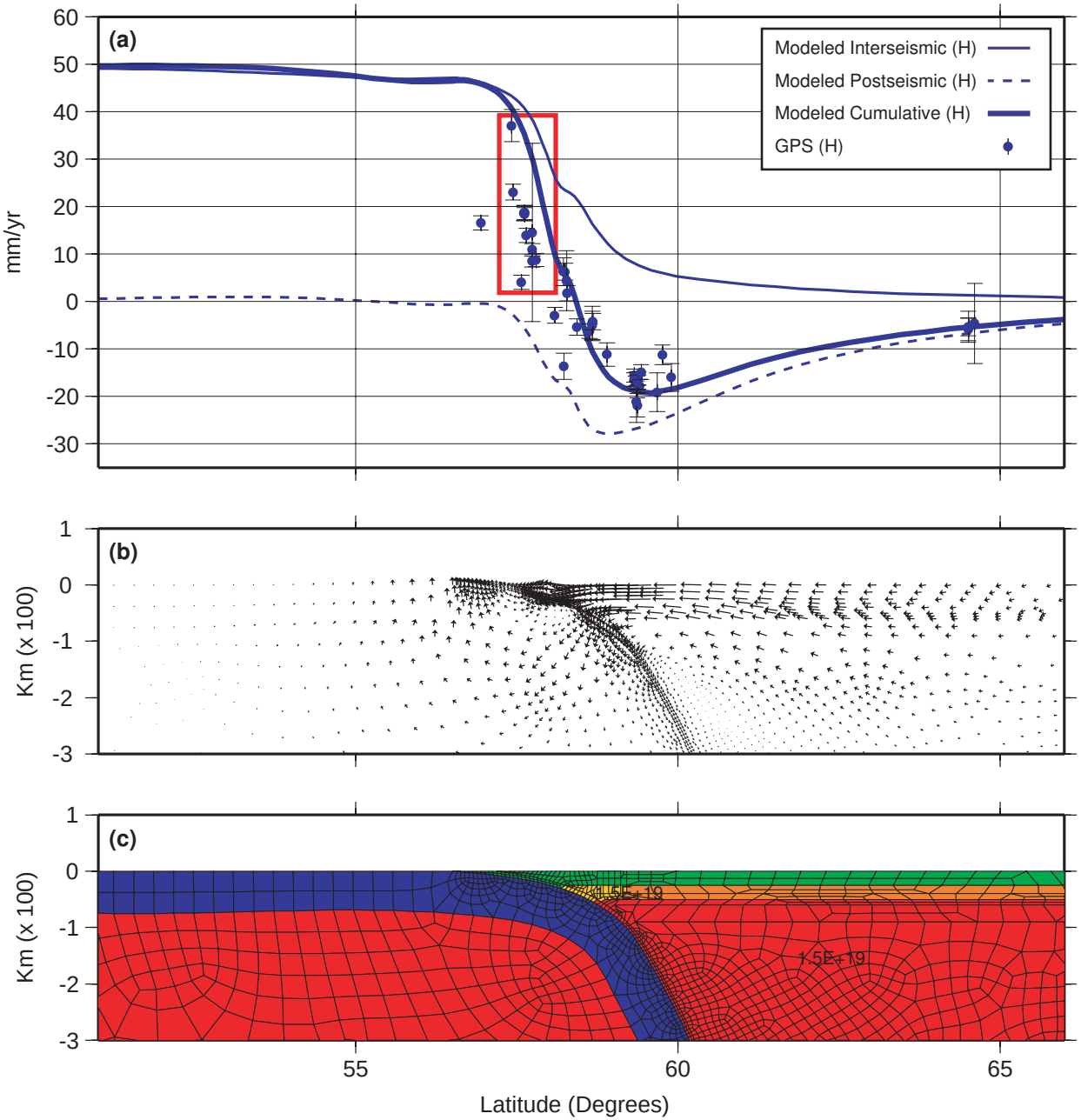


Cumulative signal in 2001

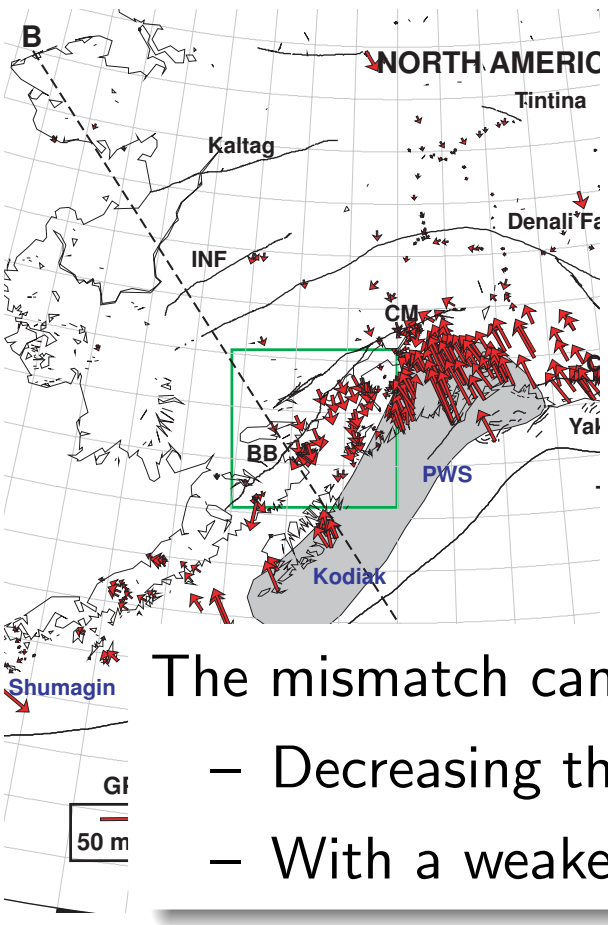


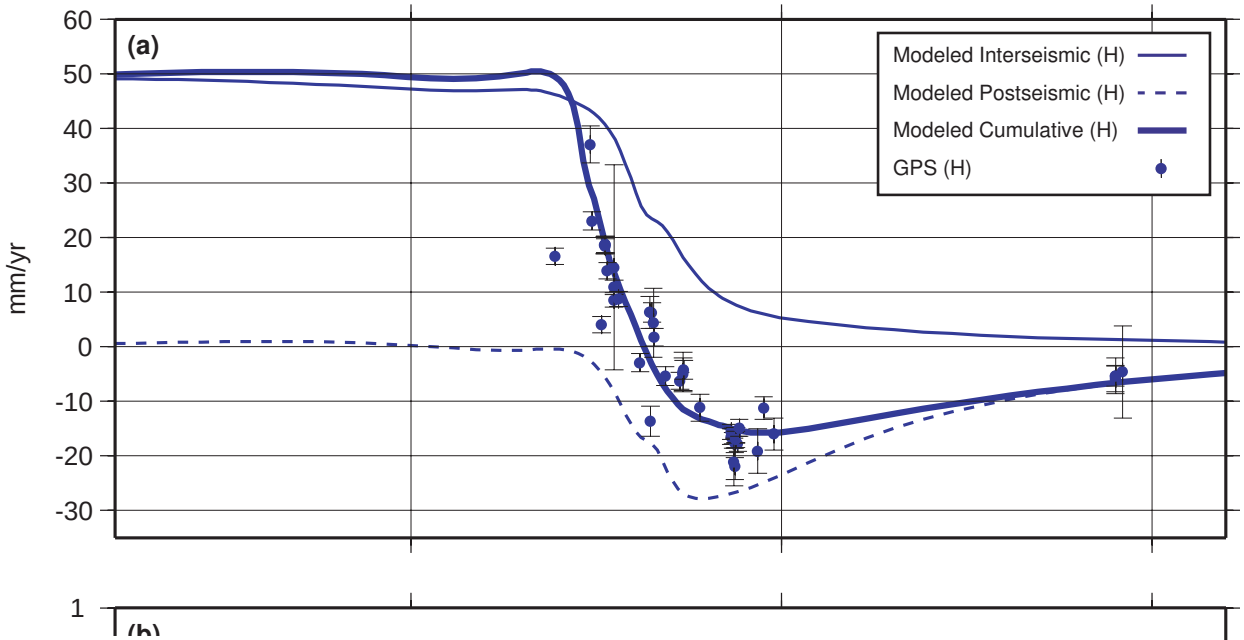
Modeling deformation rate along B-B'





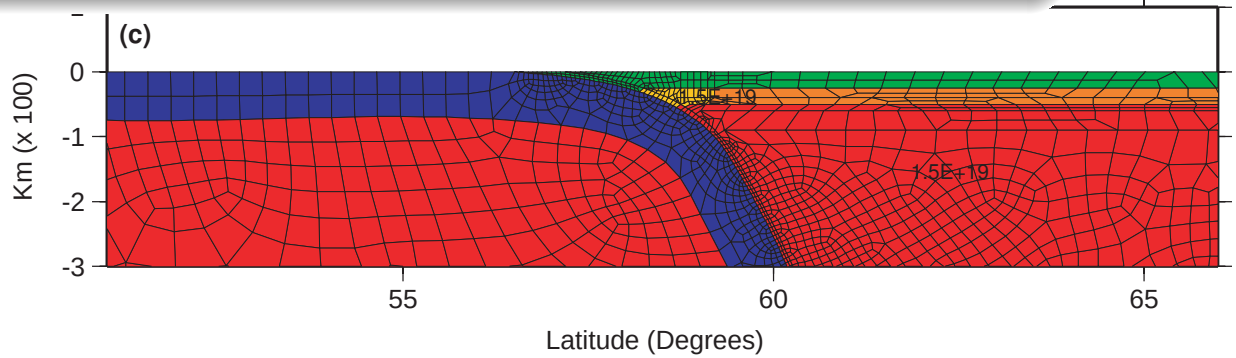
Modeling deformation rate along B-B'



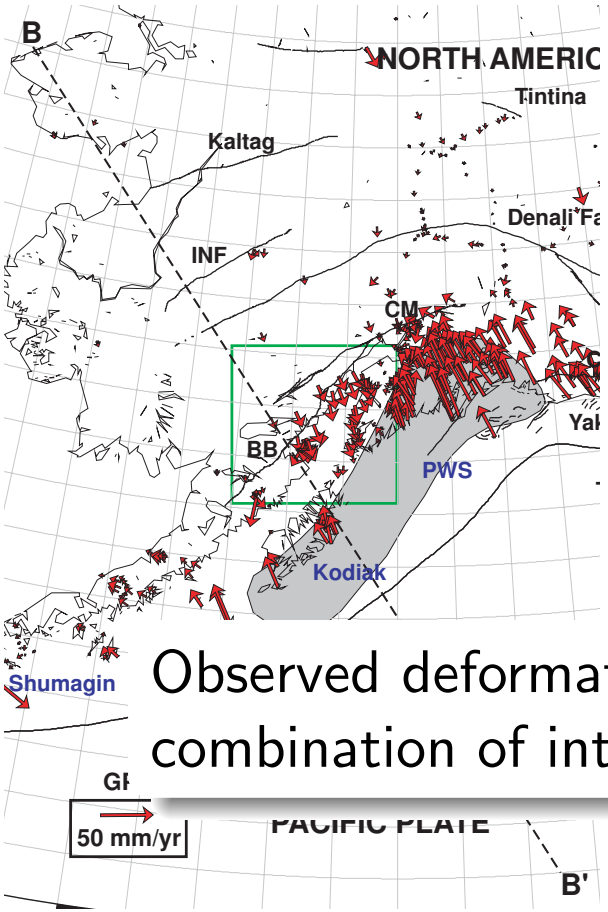


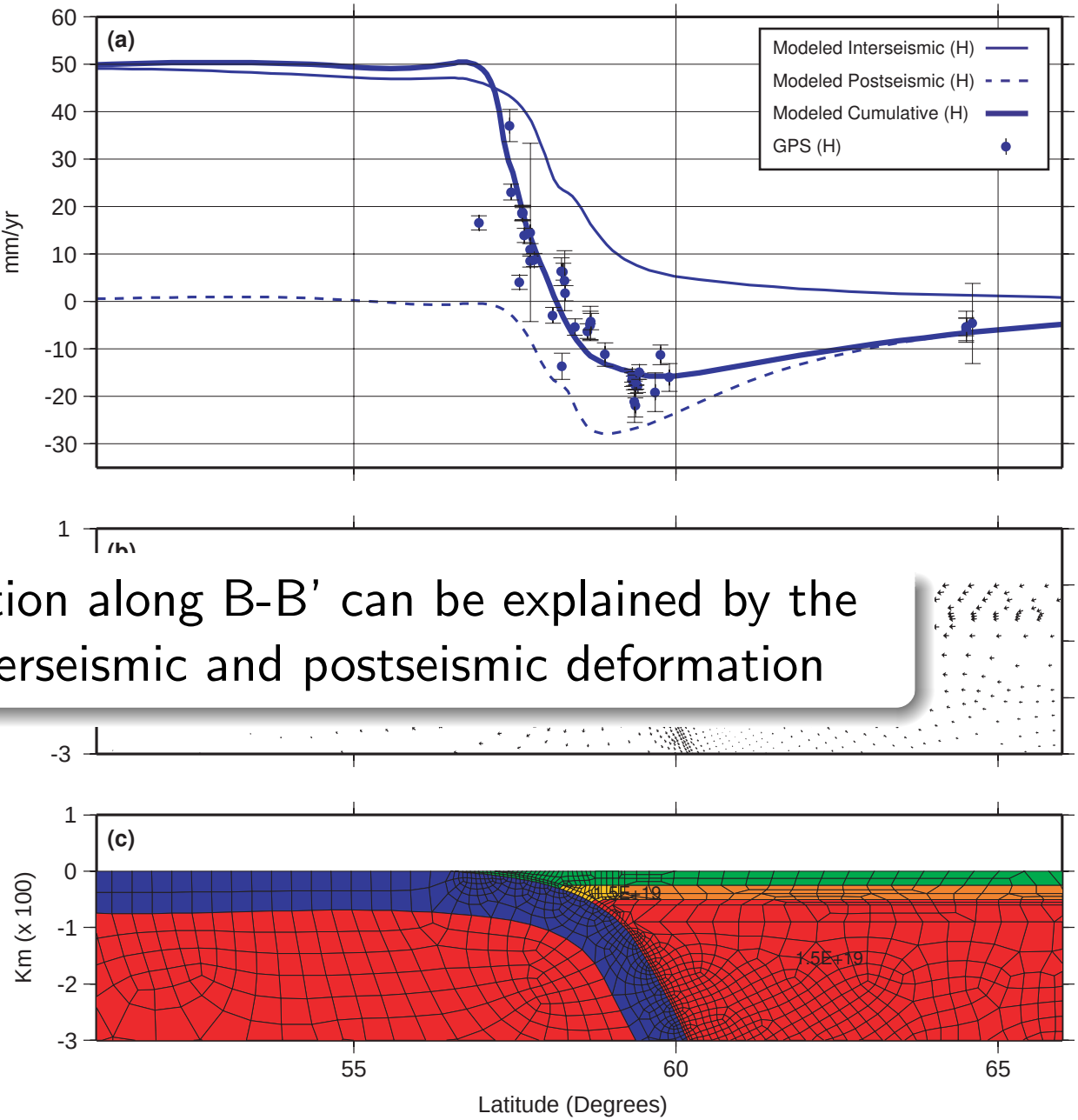
The mismatch can be fixed by either:

- Decreasing the locking depth
- With a weaker lower crust above the mantle wedge



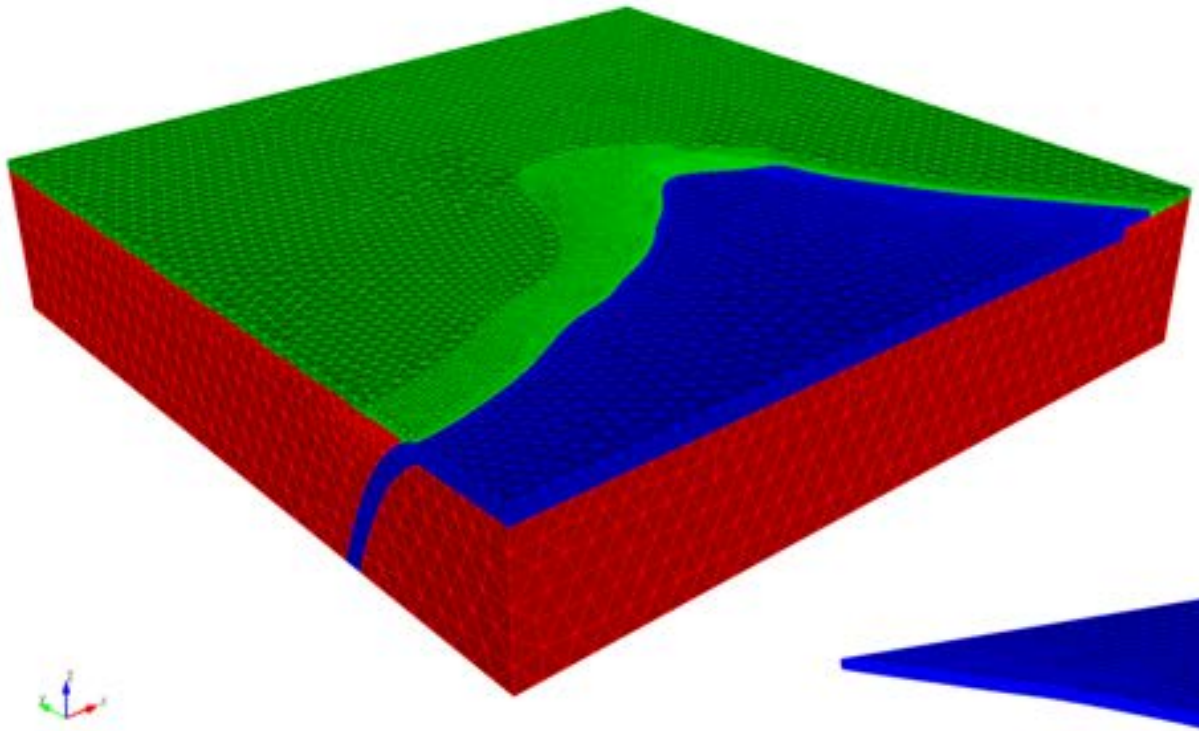
Modeling deformation rate along B-B'

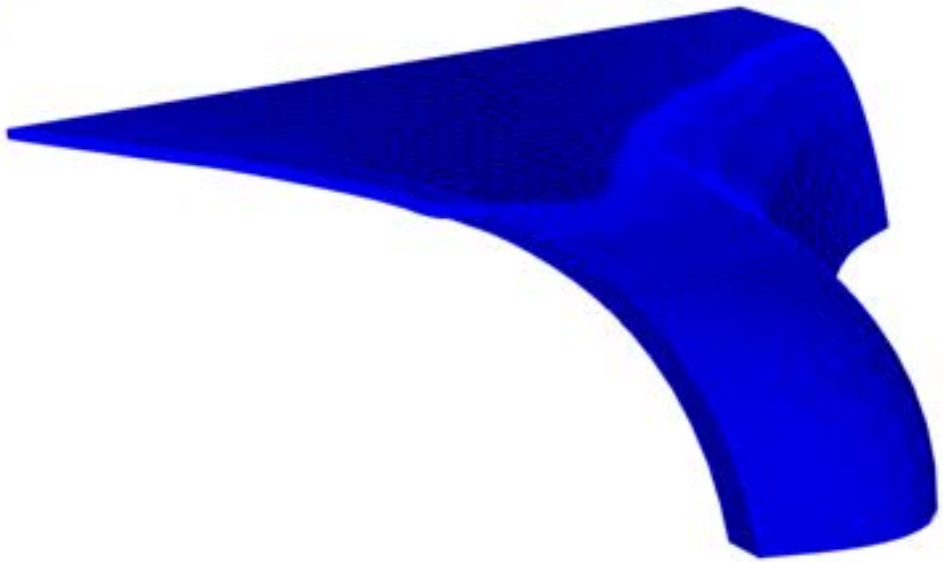




Observed deformation along B-B' can be explained by the combination of interseismic and postseismic deformation

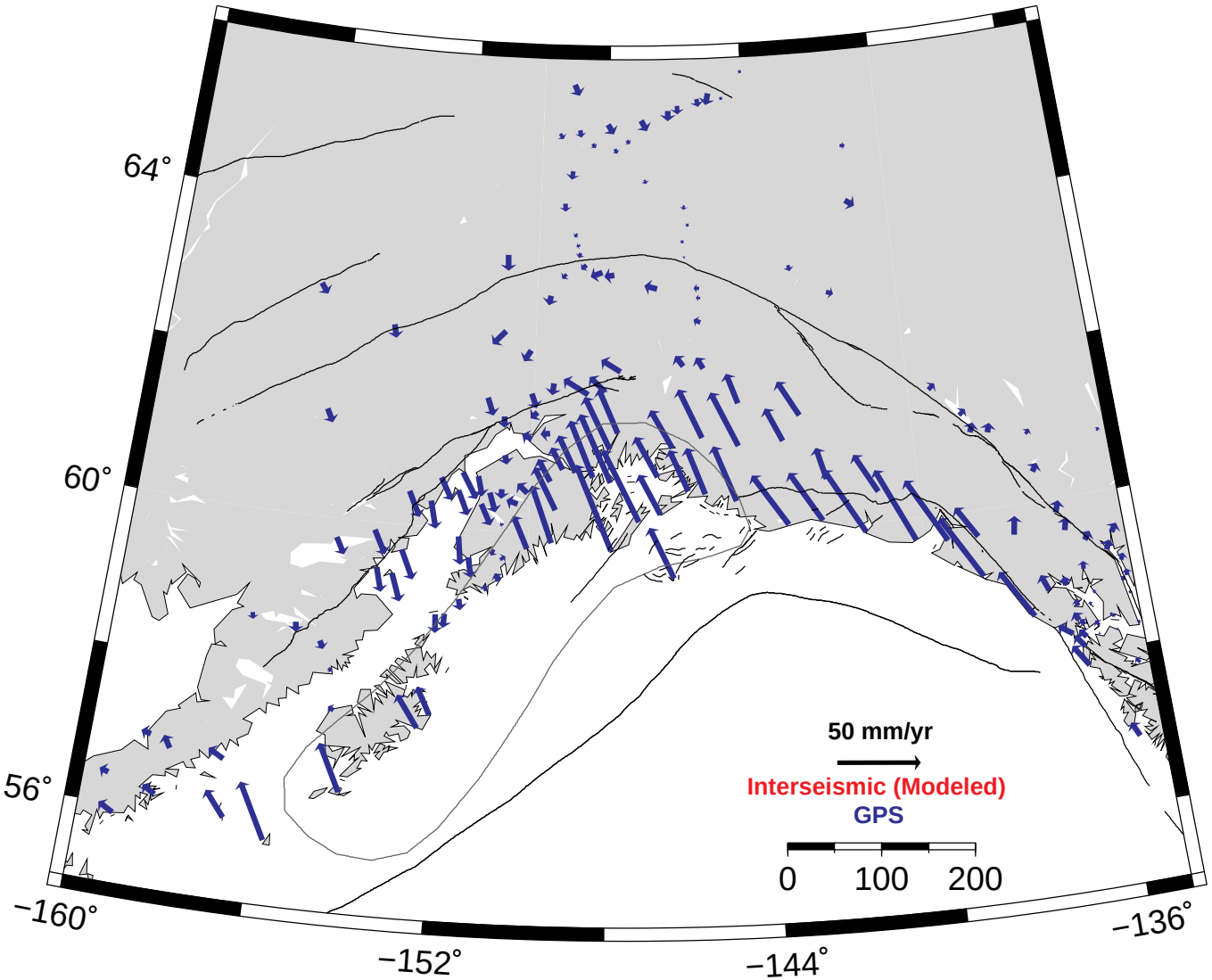
Modeling deformation in 3D: Discretized geometry





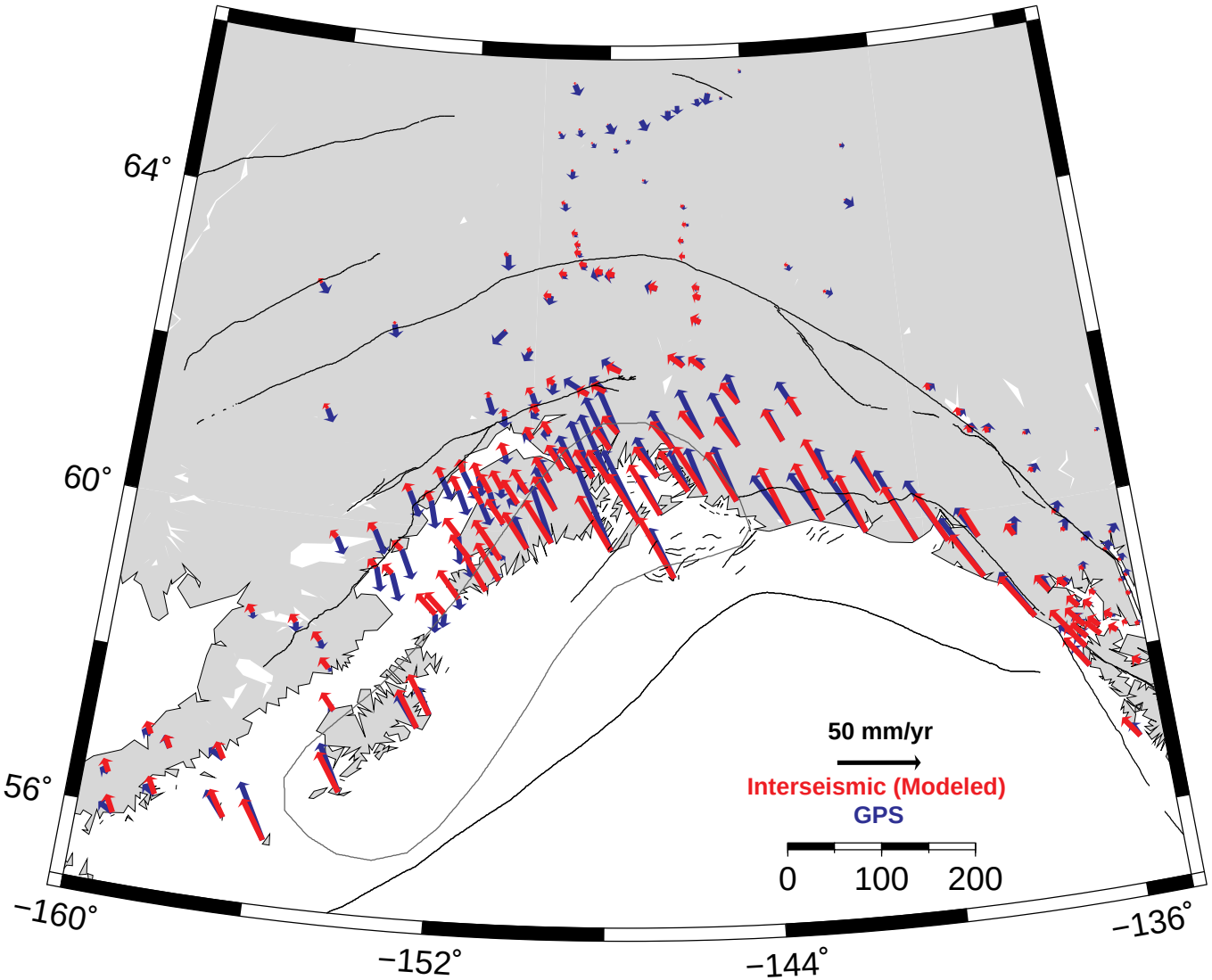
Interseismic deformation in 3D

GPS velocities

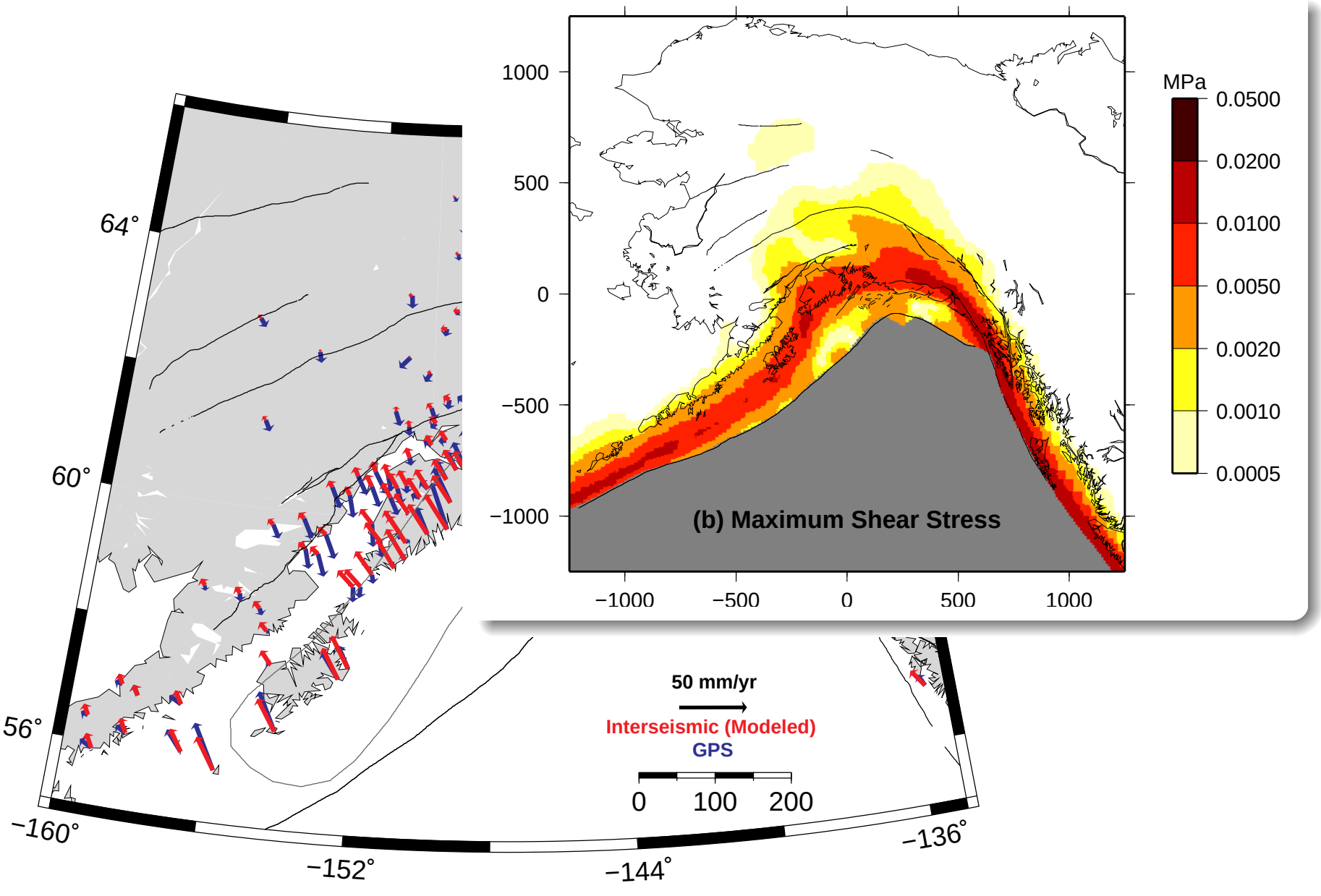


Interseismic deformation in 3D

GPS and modeled velocities

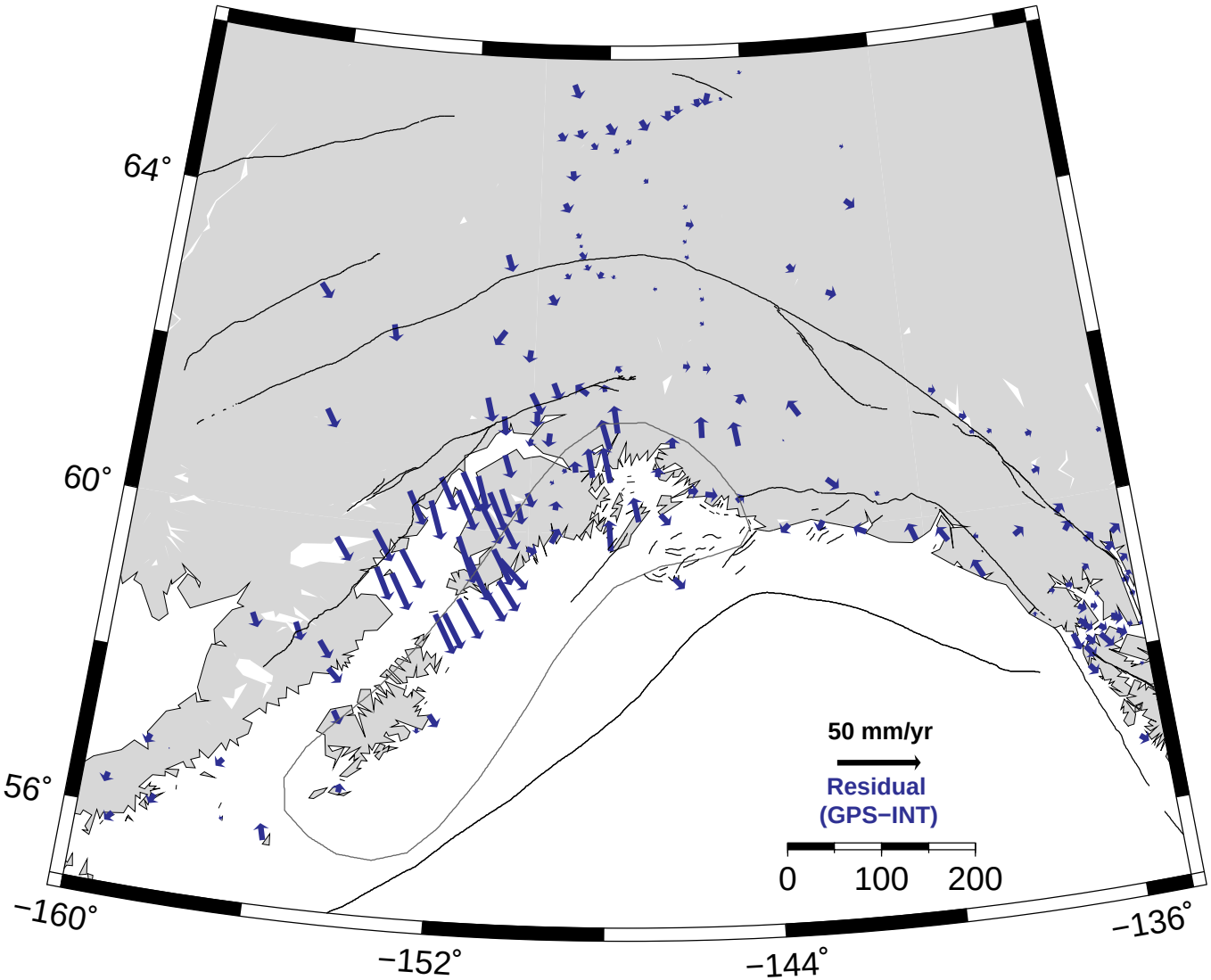


Interseismic deformation in 3D



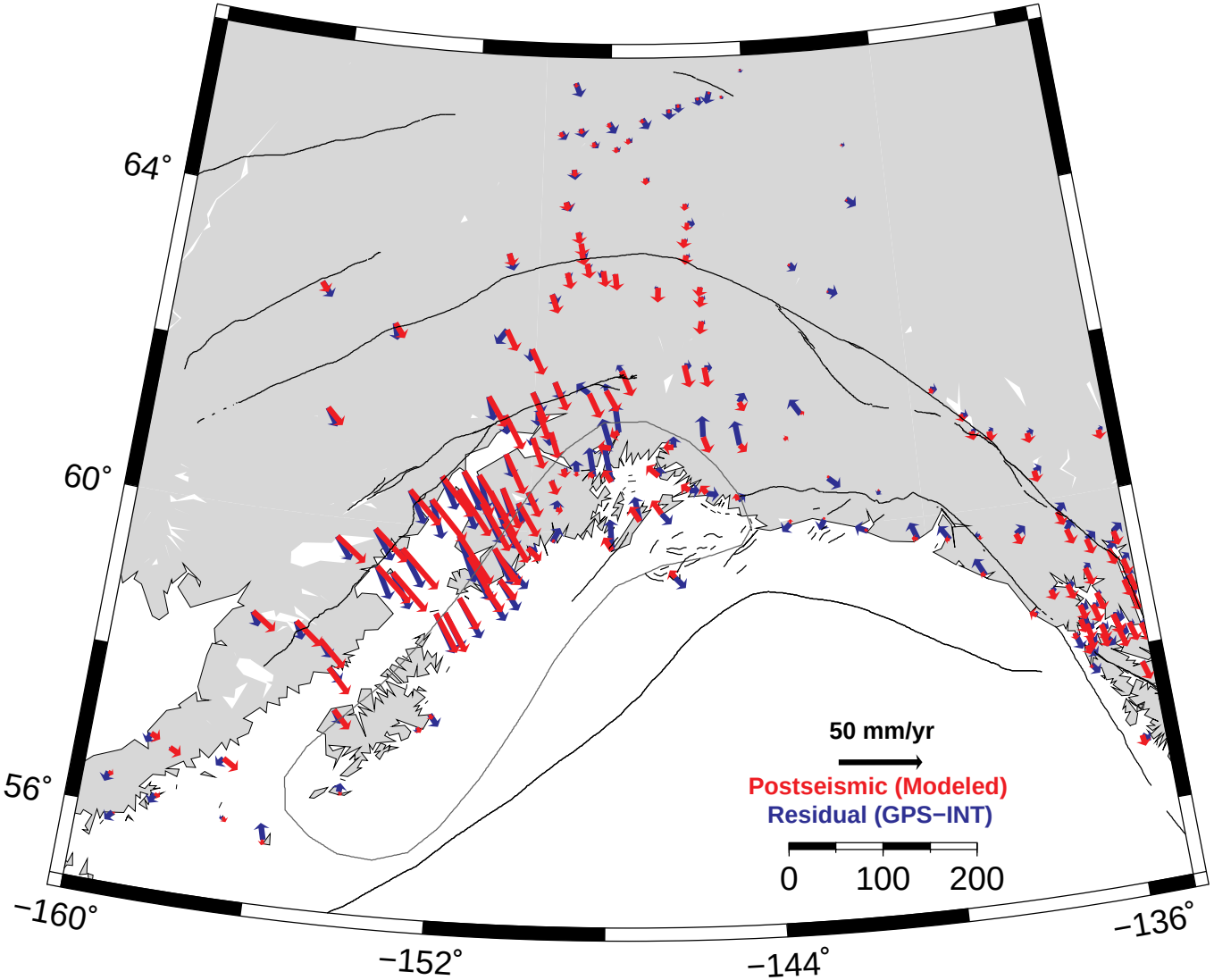
Residual velocities

GPS-Modeled velocities



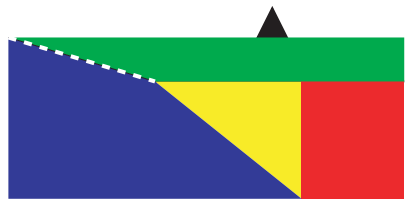
Postseismic deformation in 3D

Modeled postseismic velocities with viscous relaxation alone + a weaker lower crust above the mantle wedge

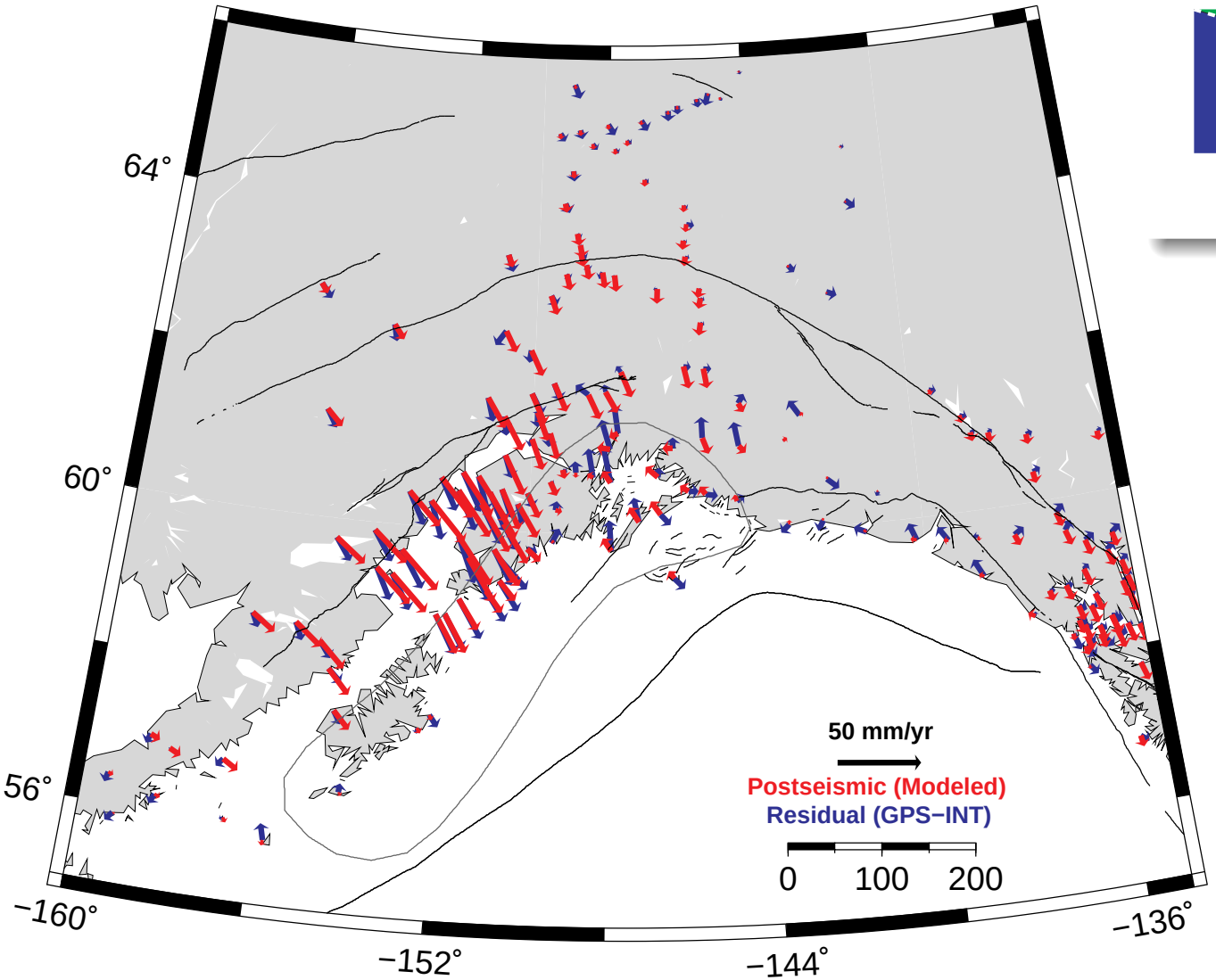


Postseismic deformation in 3D

Modeled postseismic velocities with viscous relaxation alone + a weaker lower crust above the mantle wedge

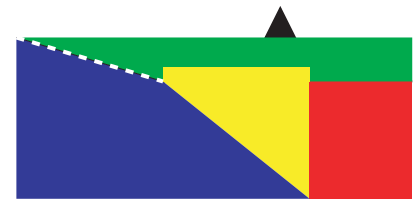


Normal setting

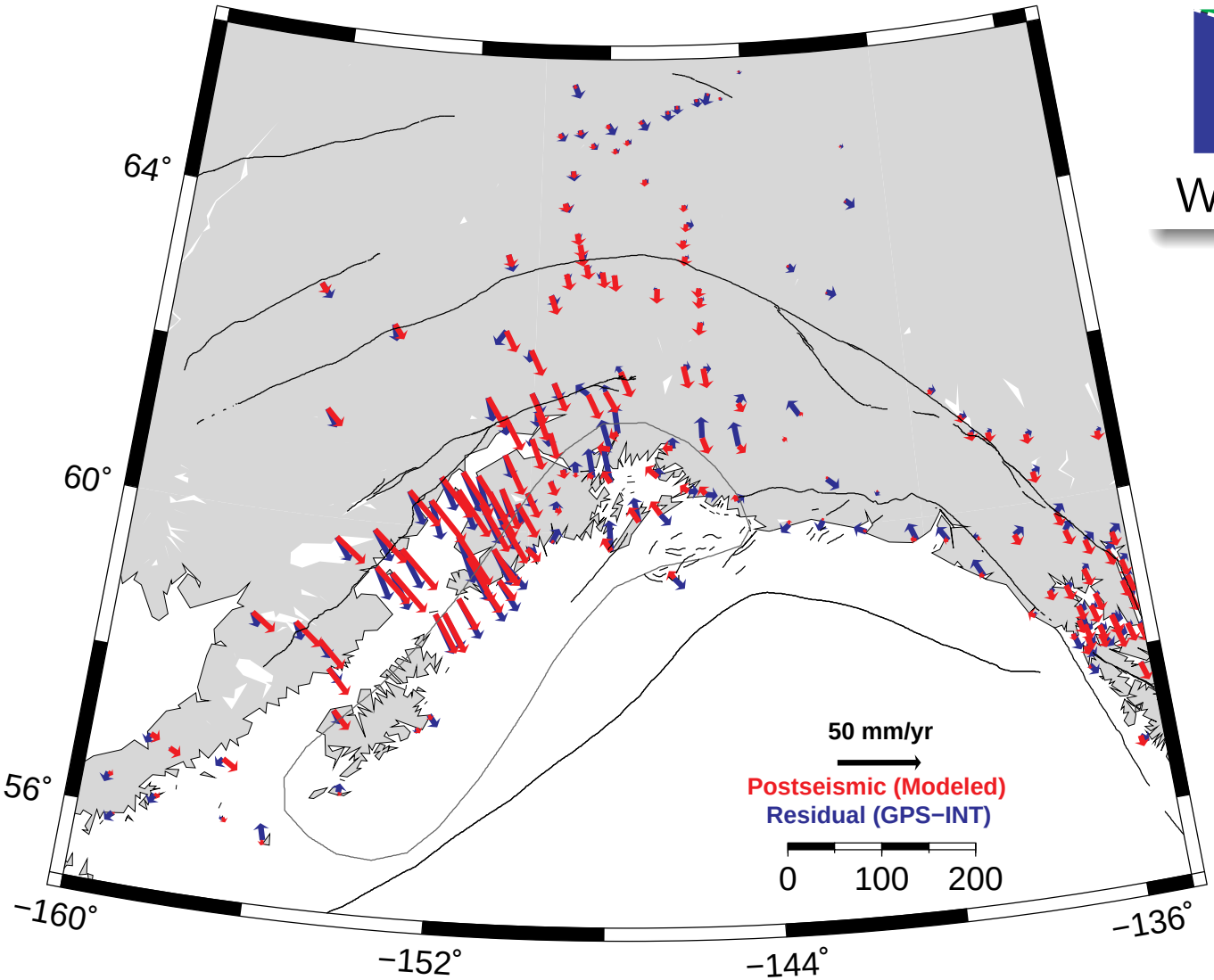


Postseismic deformation in 3D

Modeled postseismic velocities with viscous relaxation alone + a weaker lower crust above the mantle wedge

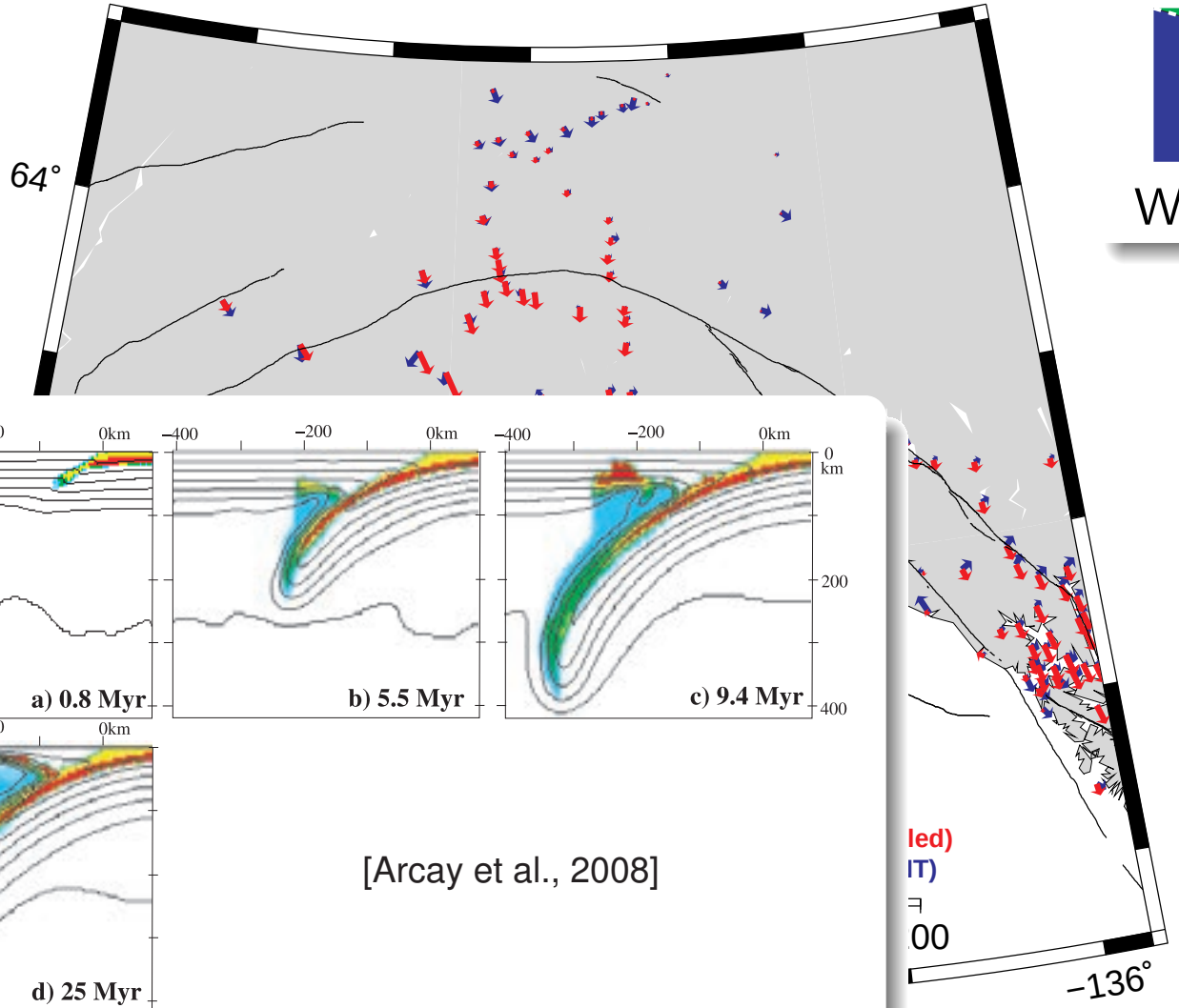


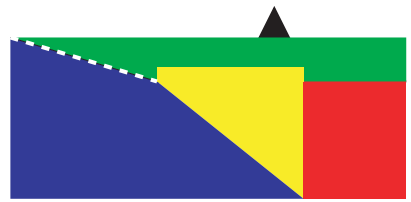
Weaker lower crust



Postseismic deformation in 3D

Modeled postseismic velocities with viscous relaxation alone + a weaker lower crust above the mantle wedge



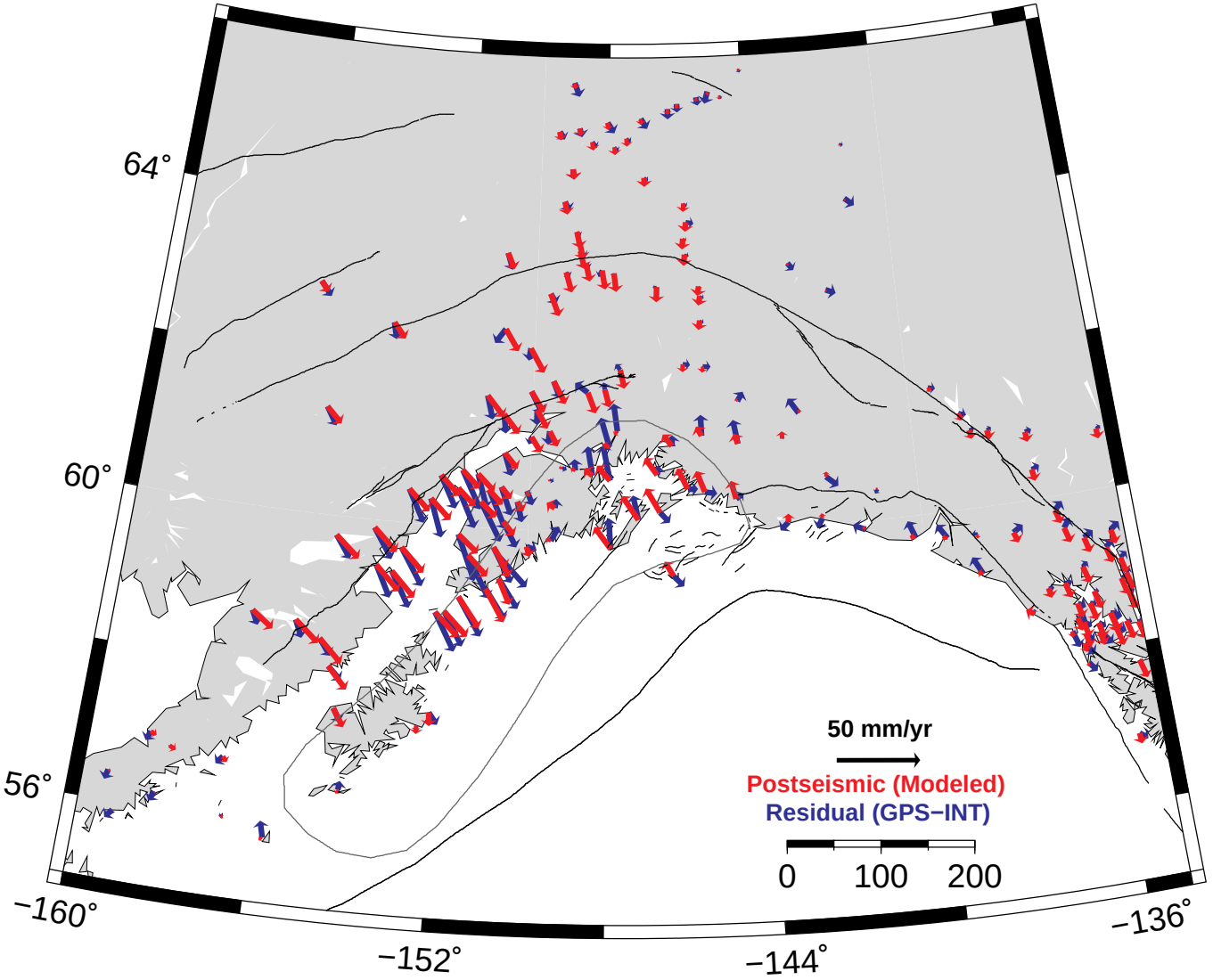


Weaker lower crust

[Arcay et al., 2008]

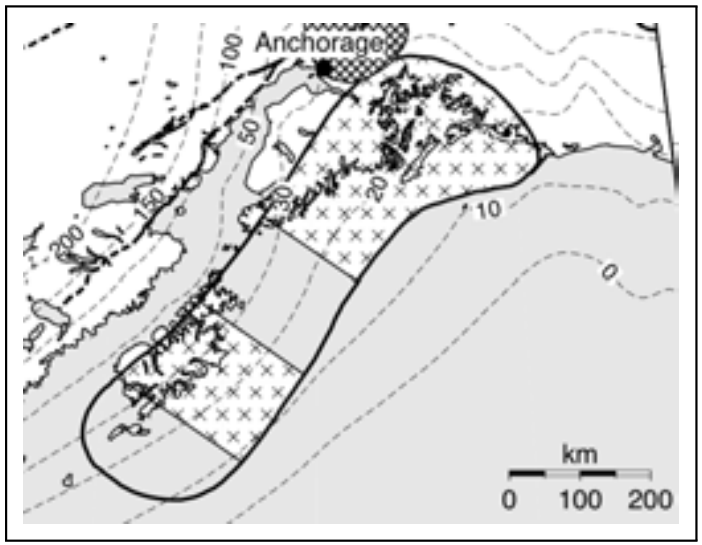
Postseismic deformation in 3D

Modeled postseismic velocities with viscous relaxation alone + shallower locking depth



Postseismic deformation in 3D

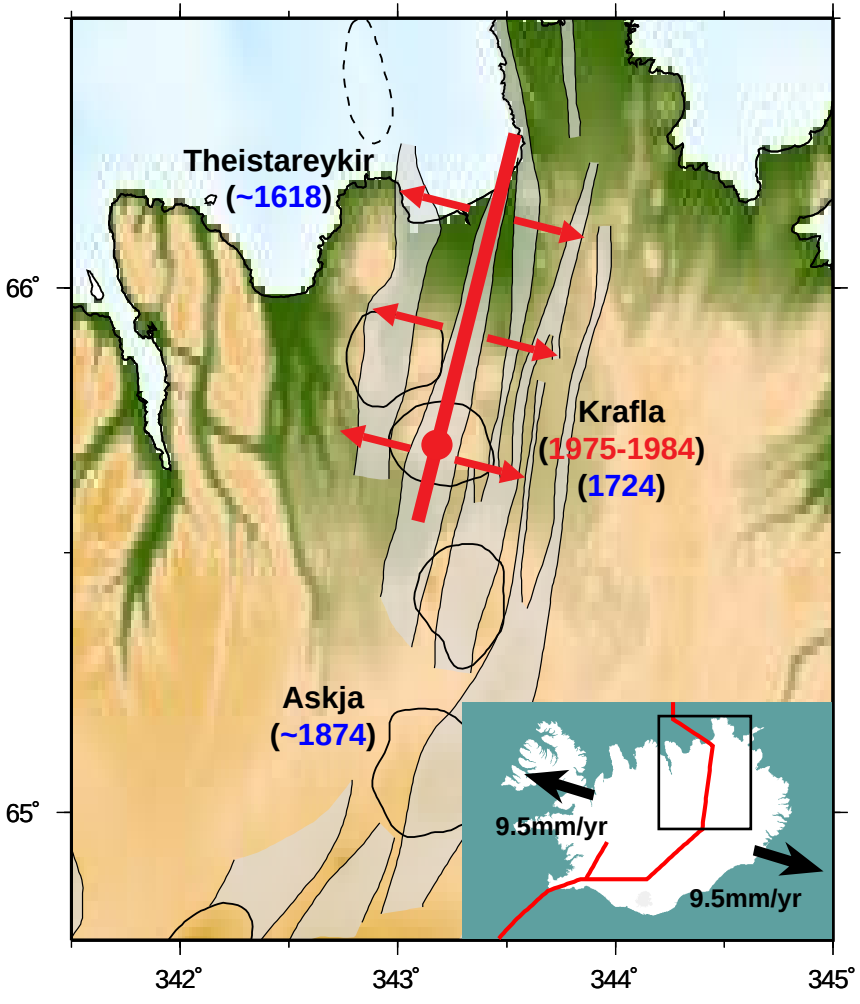
Modeled postseismic velocities with viscous relaxation alone + shallower locking depth



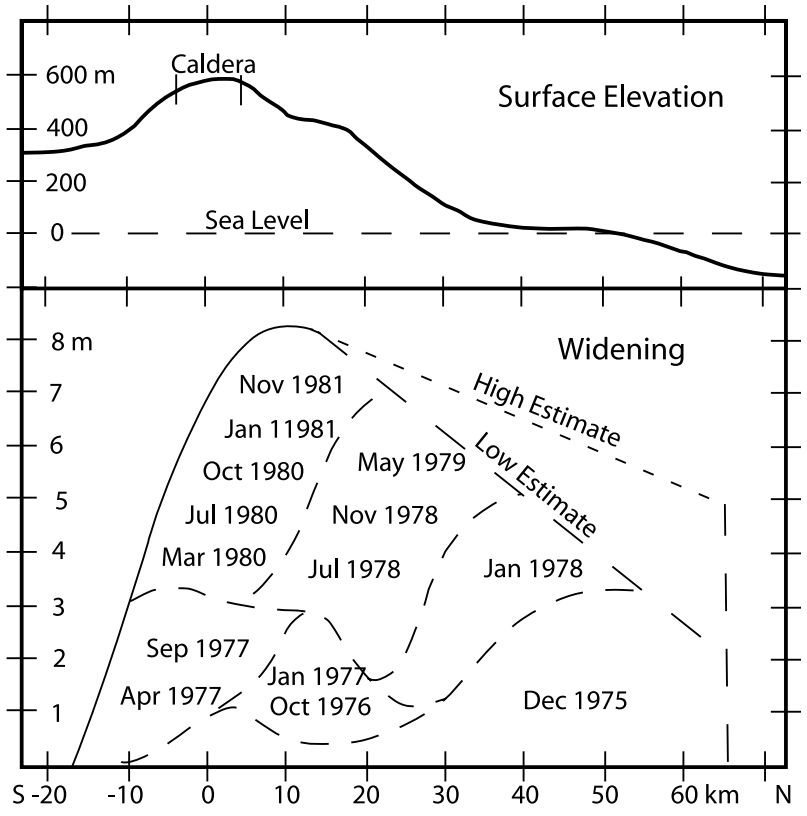
[Suito et al., 2009]

64°
60°
56°
−160°
−152°
−144°
−136°
50 mm/yr
Postseismic (Modeled)
Residual (GPS−INT)
0 100 200

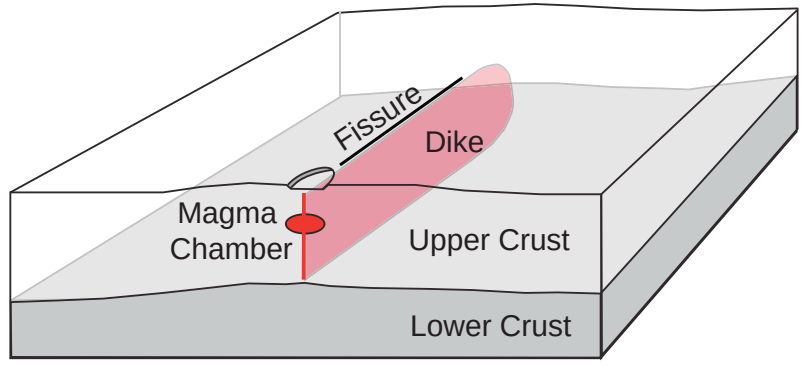
Iceland



Northern Volcanic Zone and Krafla Volcanic System

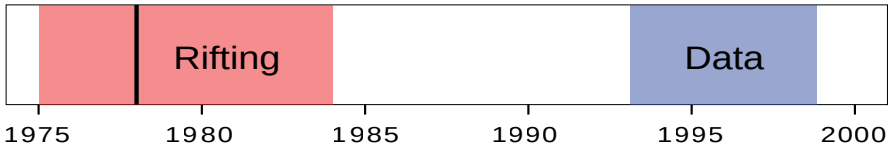


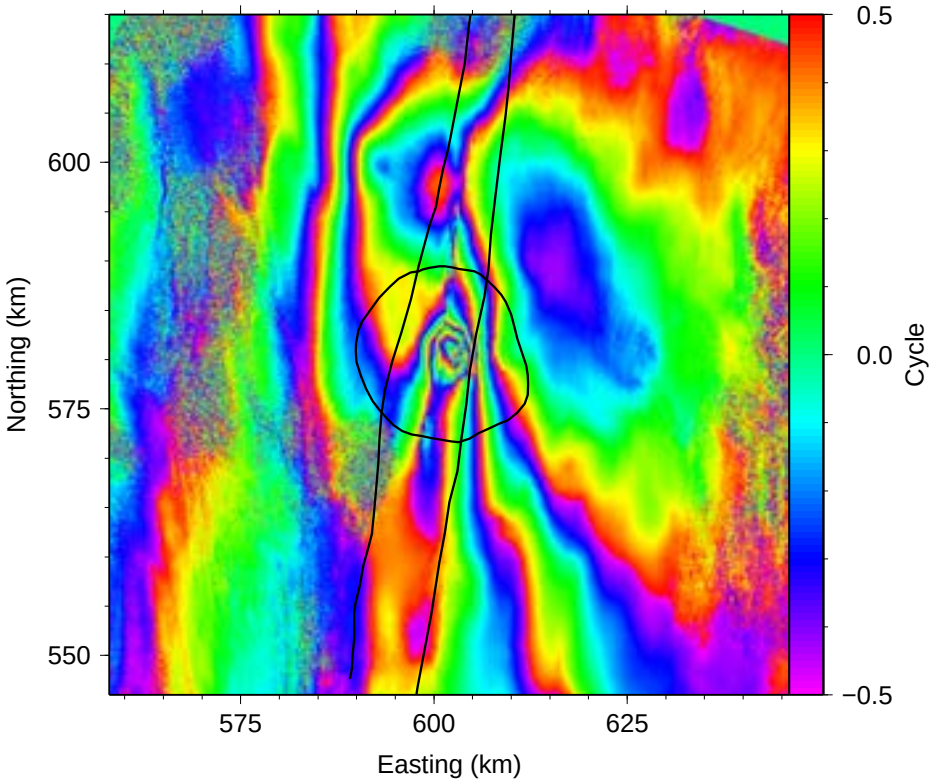
[Tryggvason, 1984]



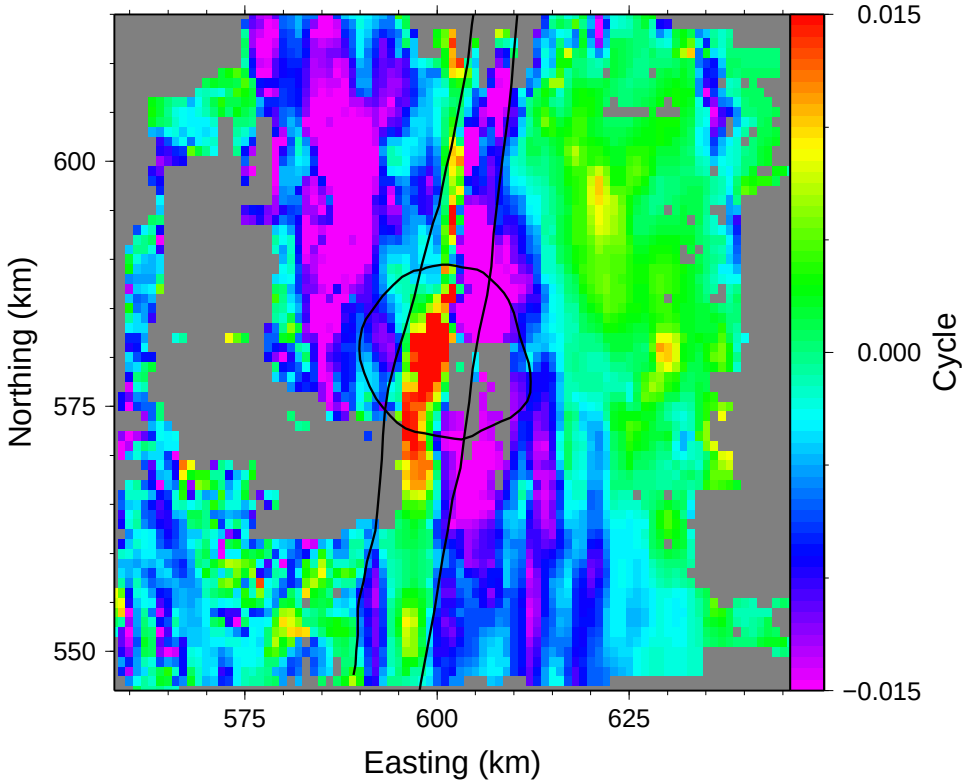
[Buck et al., 2006]

InSAR observations



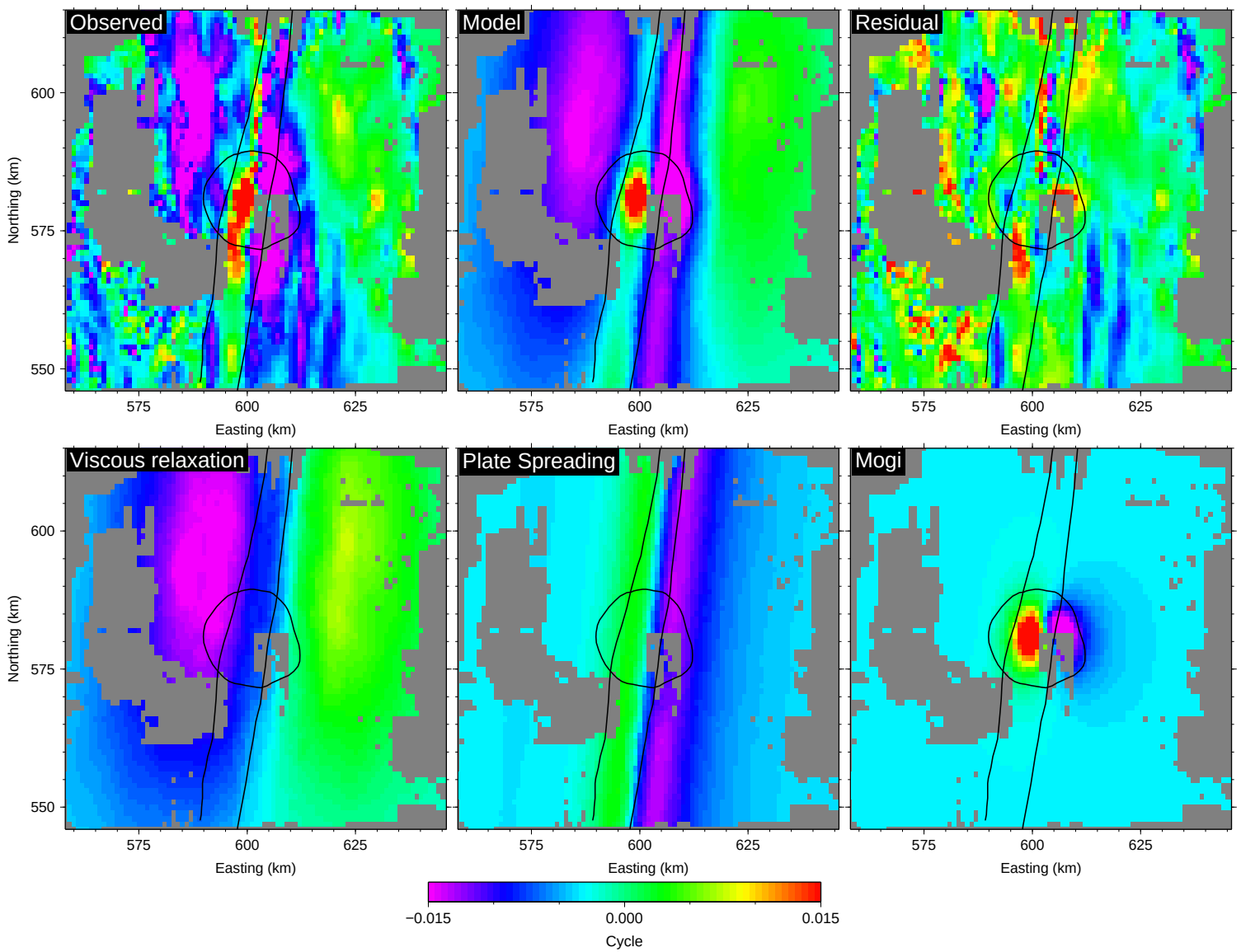


(Measures a component of displacement)



(Measures a component of strain)

Individual Contributions



Conclusions

- GPS velocities in southcentral Alaska can be explained by a combination of interseismic deformation and postseismic viscous relaxation following large recent earthquakes

- Best fitting model needed to match transient deformation requires postseismic viscous relaxation of mantle along with:

  - Shallow locking depth on part of the segment between the Kodiak and Kenai asperities, or
  - A weaker lower crust above the mantle wedge