The Himalayan Seismogenic Zone and Some Outstanding Questions

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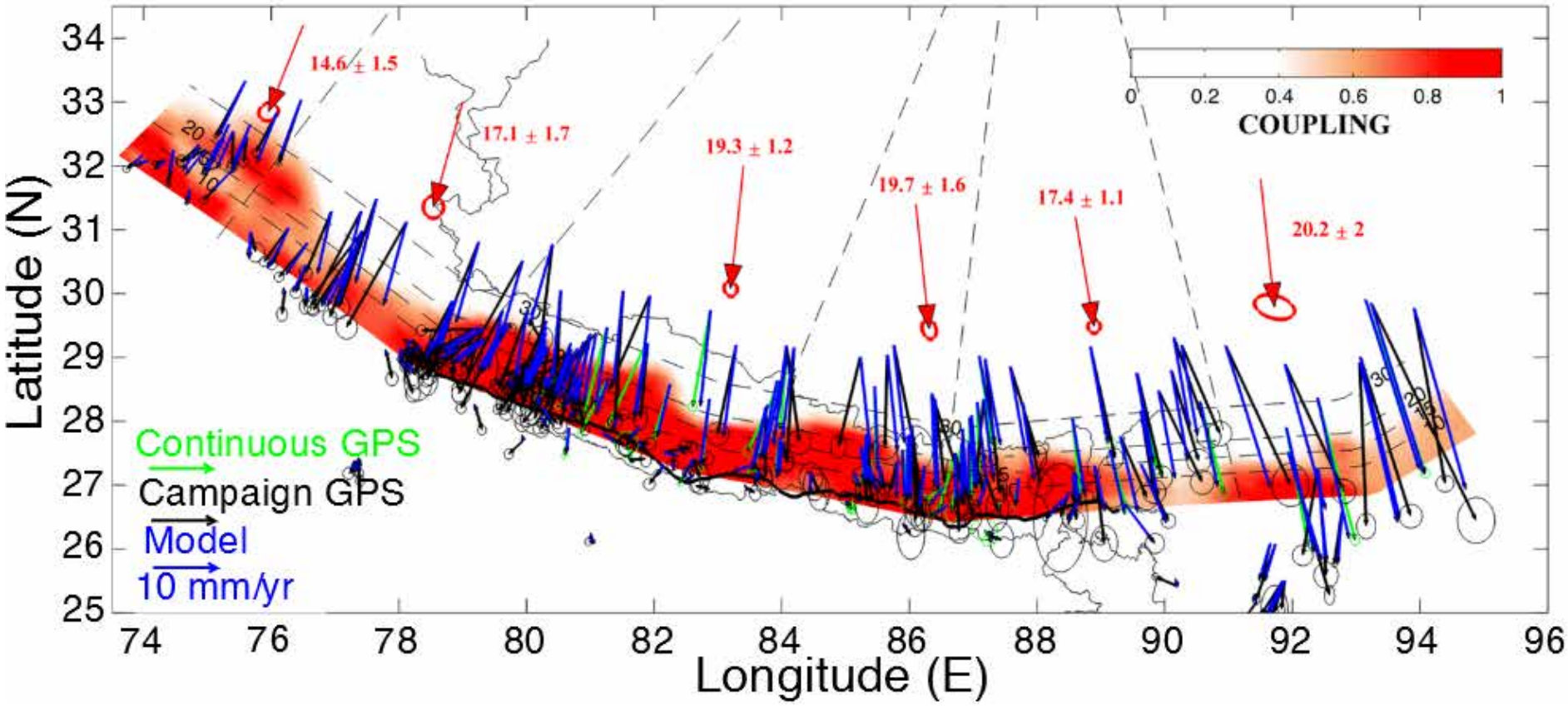
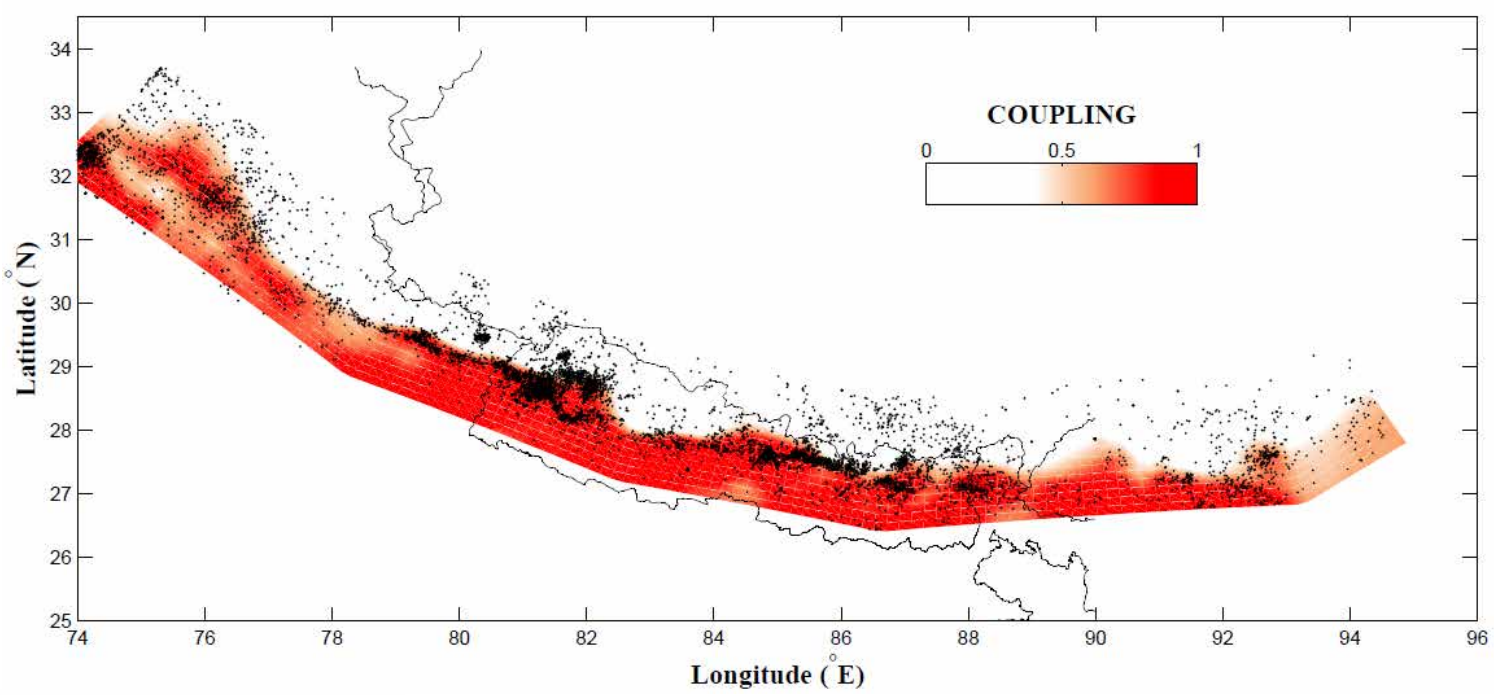
Interseismic Coupling-Slip rate on MHT

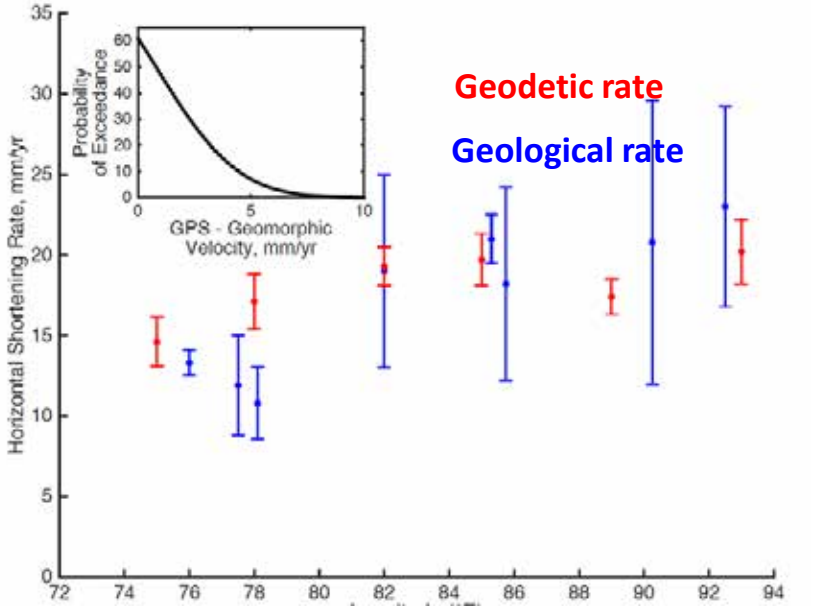


S42-2832

(Stevens and Avouac, GRL, 2015)

The moment deficit accumulates in the interseismic period at a rate of **18 x10^{19} Nm/yr.**

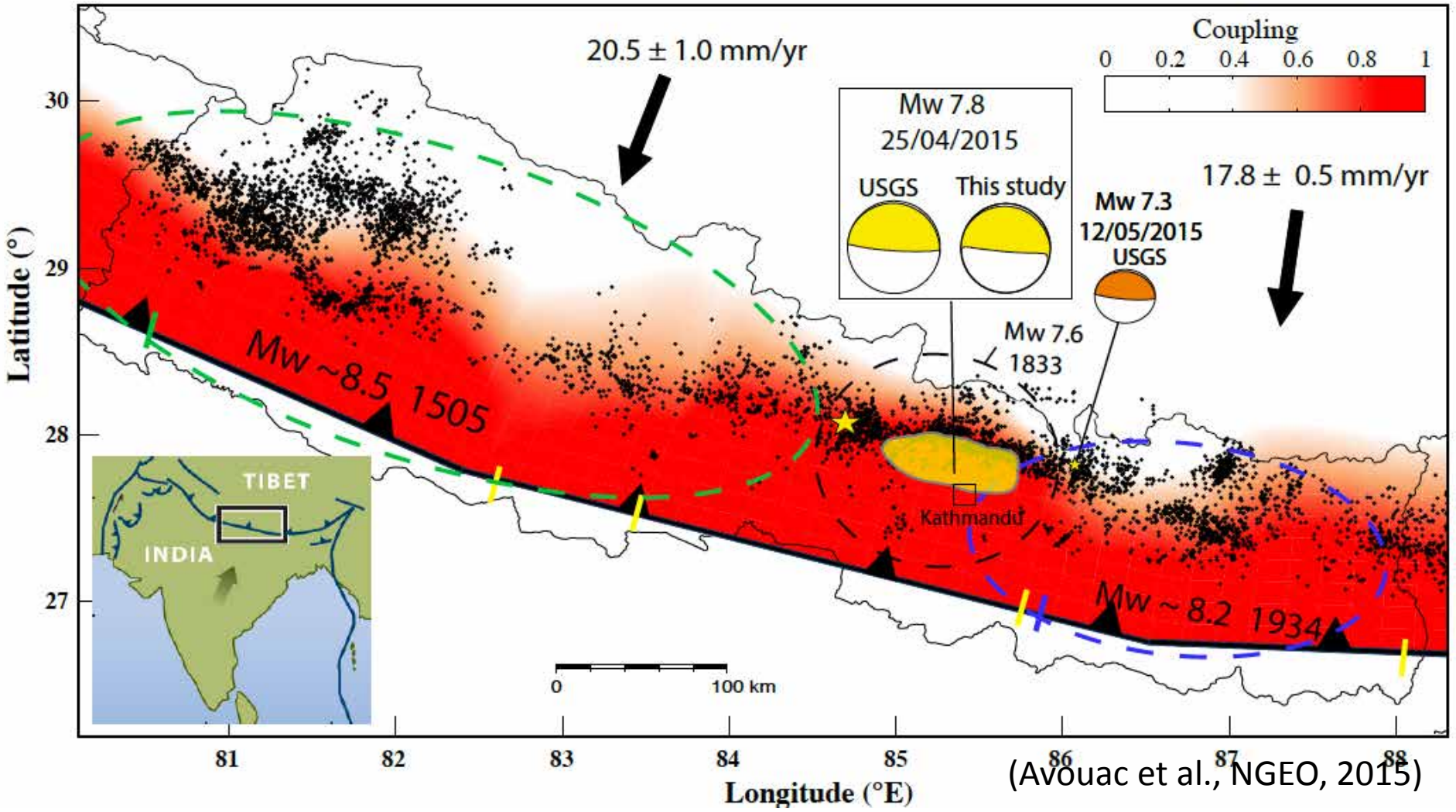




(Stevens and Avouac, GRL, 2015)

The Mw 7.8 Gorkha Earthquake

More, larger EQs to come? How big when?



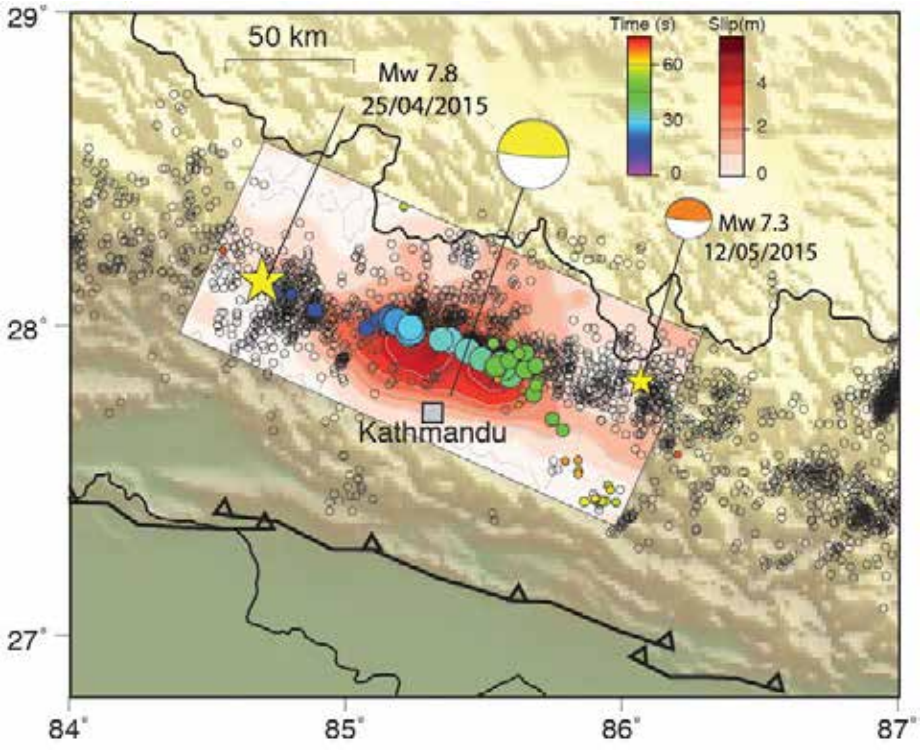
(Avouac et al., NGEO, 2015)

- The MHT is similar to a subduction Megathrust.
- Most of the questions asked about subduction Megathrust apply to the MHT.
- Main difference is long term build up and erosion of the high topography
- The Himalayan Seismogenic Zone is ultimately exhumed and accessible to geologist (P,T, deformation mechanism, paleopiezometry,…)

Some intriguing observations

- Origin of high frequency waves during he Gorkha Earthquake
- Possible segmentation despite little along-strike variation of ISC.
- Correlation of topo with interseismic uplift and seismicity
- Correlation of mid-crustal ramp with ISC and seismicity
- Sensitivity of Himalayan seismicity to the Monsoon cycle.

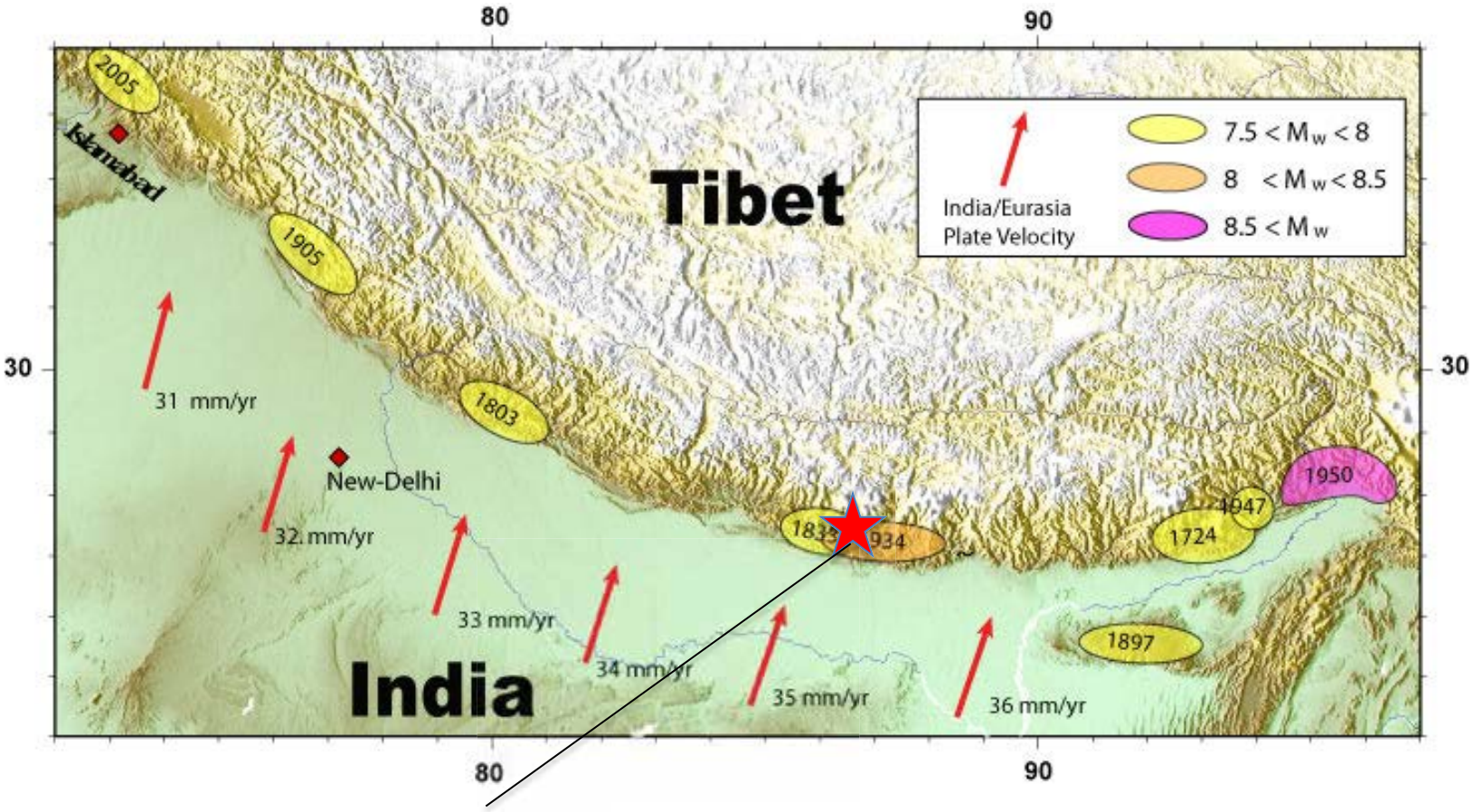
Origin of high frequency waves during he Gorkha Earthquake



(Avouac et al., NGEO, 2015)

(Galetzka et al. ,Science, 2015)

Possible segmentation despite little along-strike variation of ISC

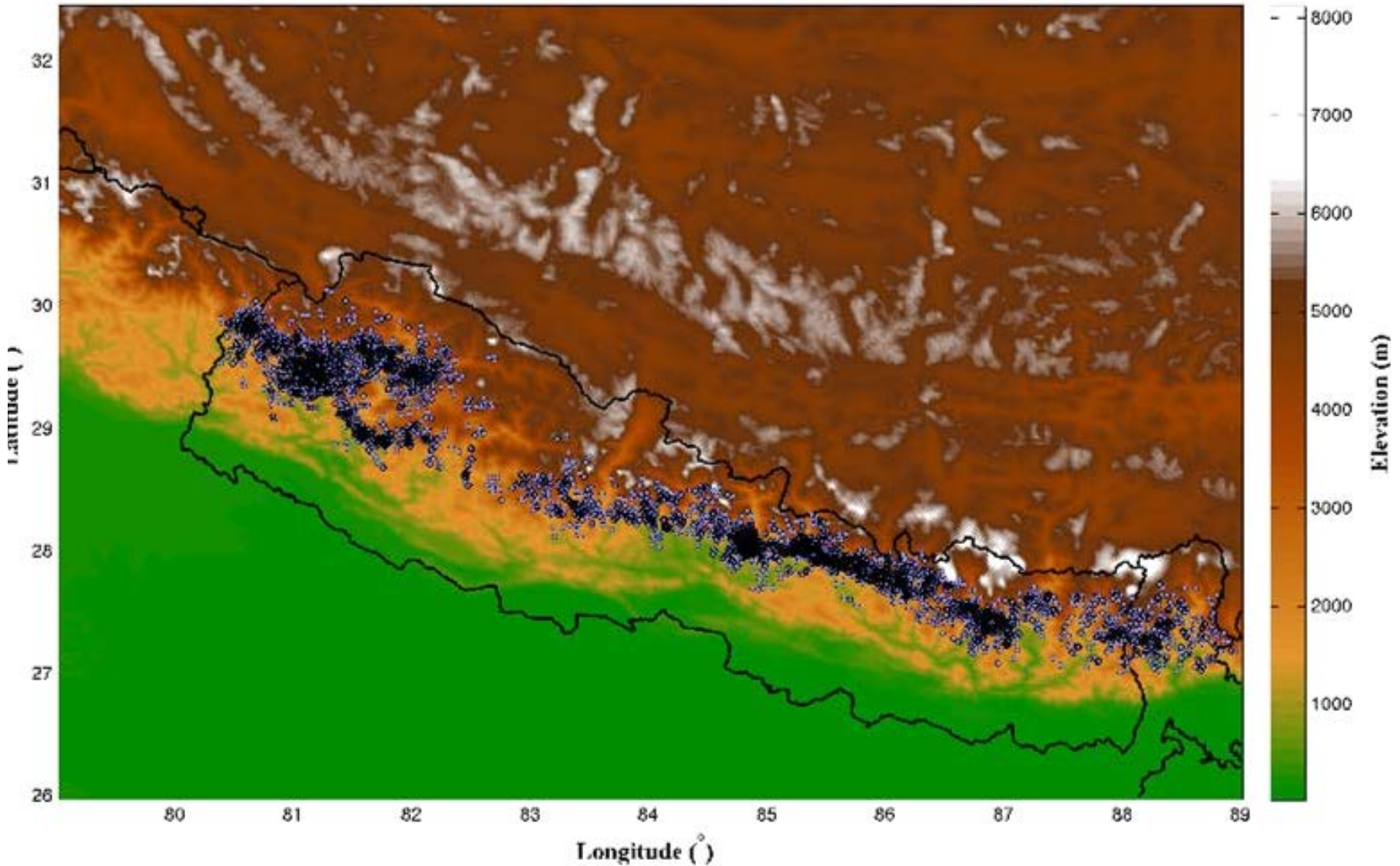


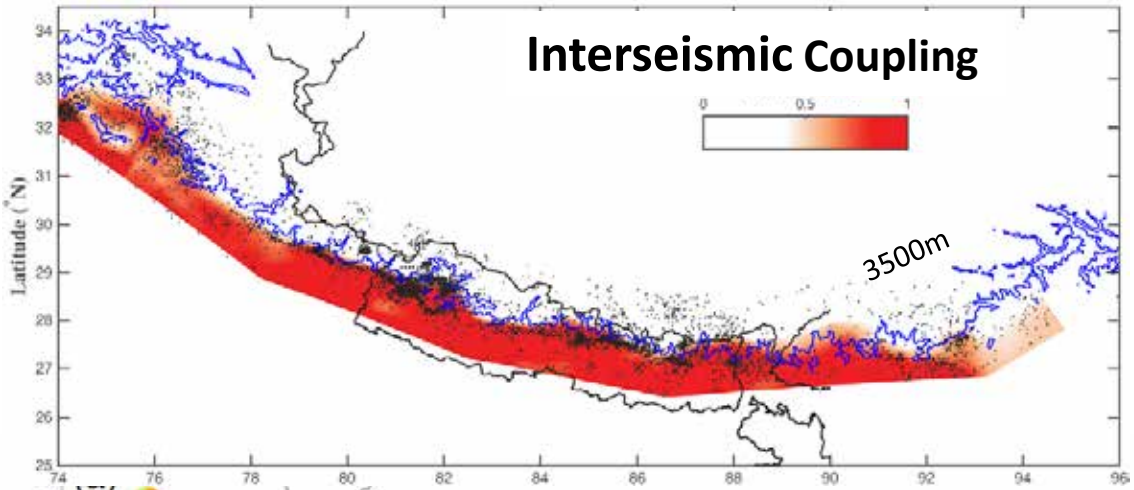
Mw 7.8, April 25, 2015

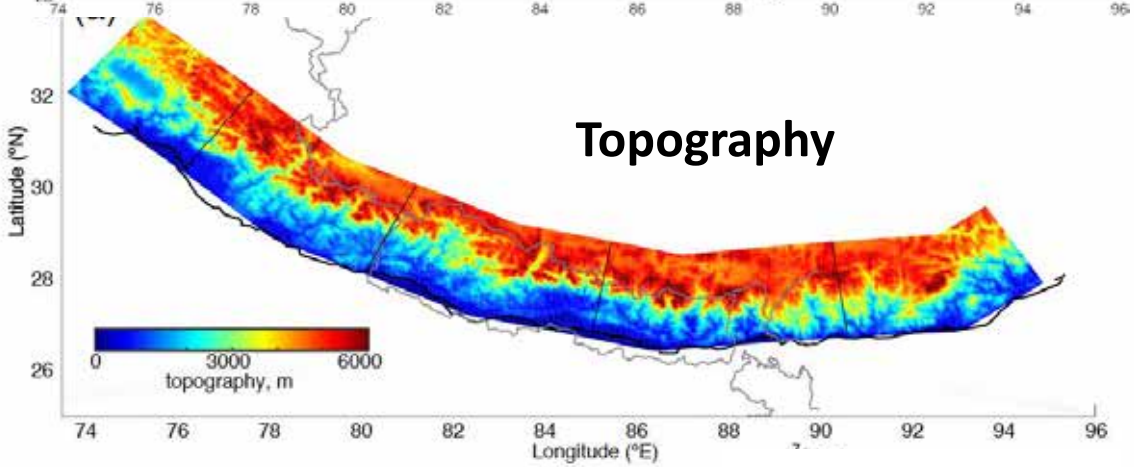
Previous earthquakes: 1934, 1833, 1681
1408, 1344, 1255,…

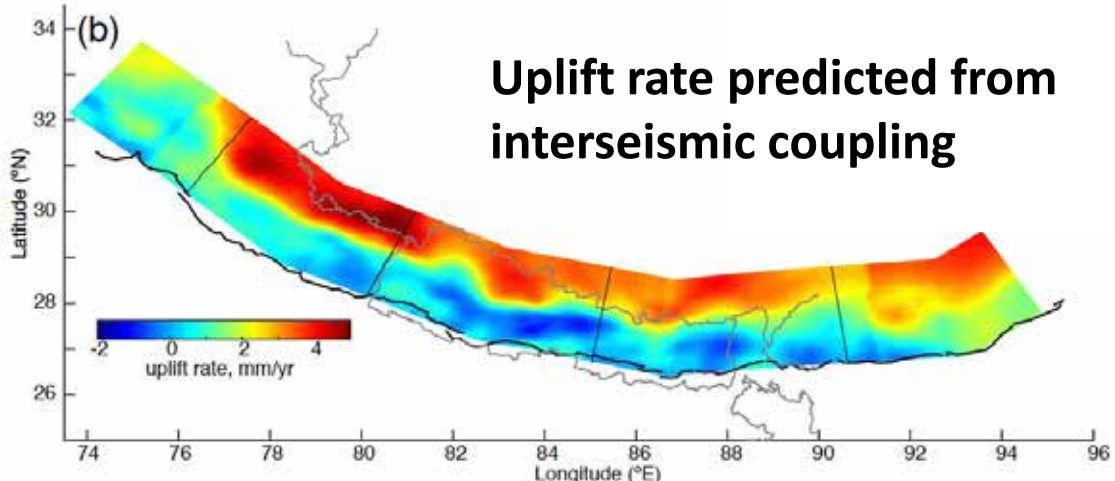
Estimated rupture areas of major earthquakes in the Himalaya since 1700 (e.g., Ambraseys and Bilham, 2000; Hough et al, 2005).

Correlation of topo with seismicity

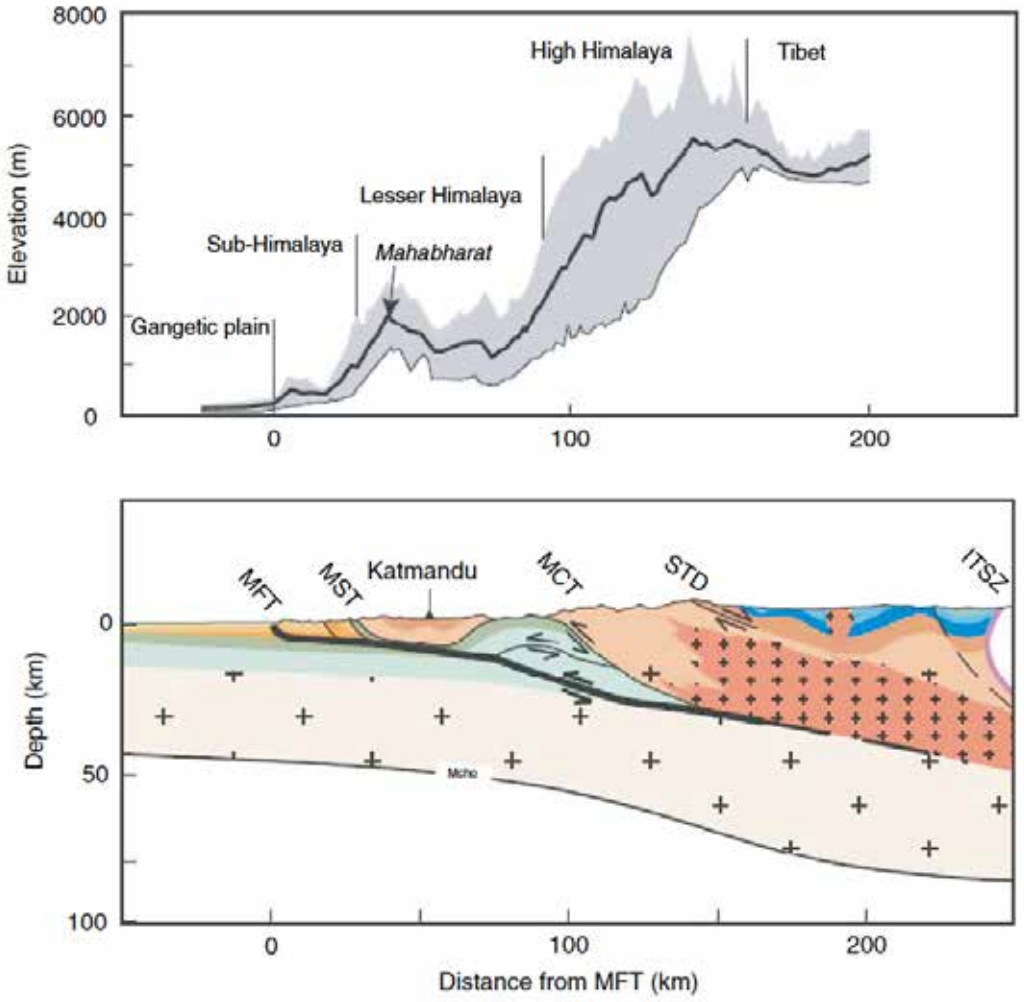








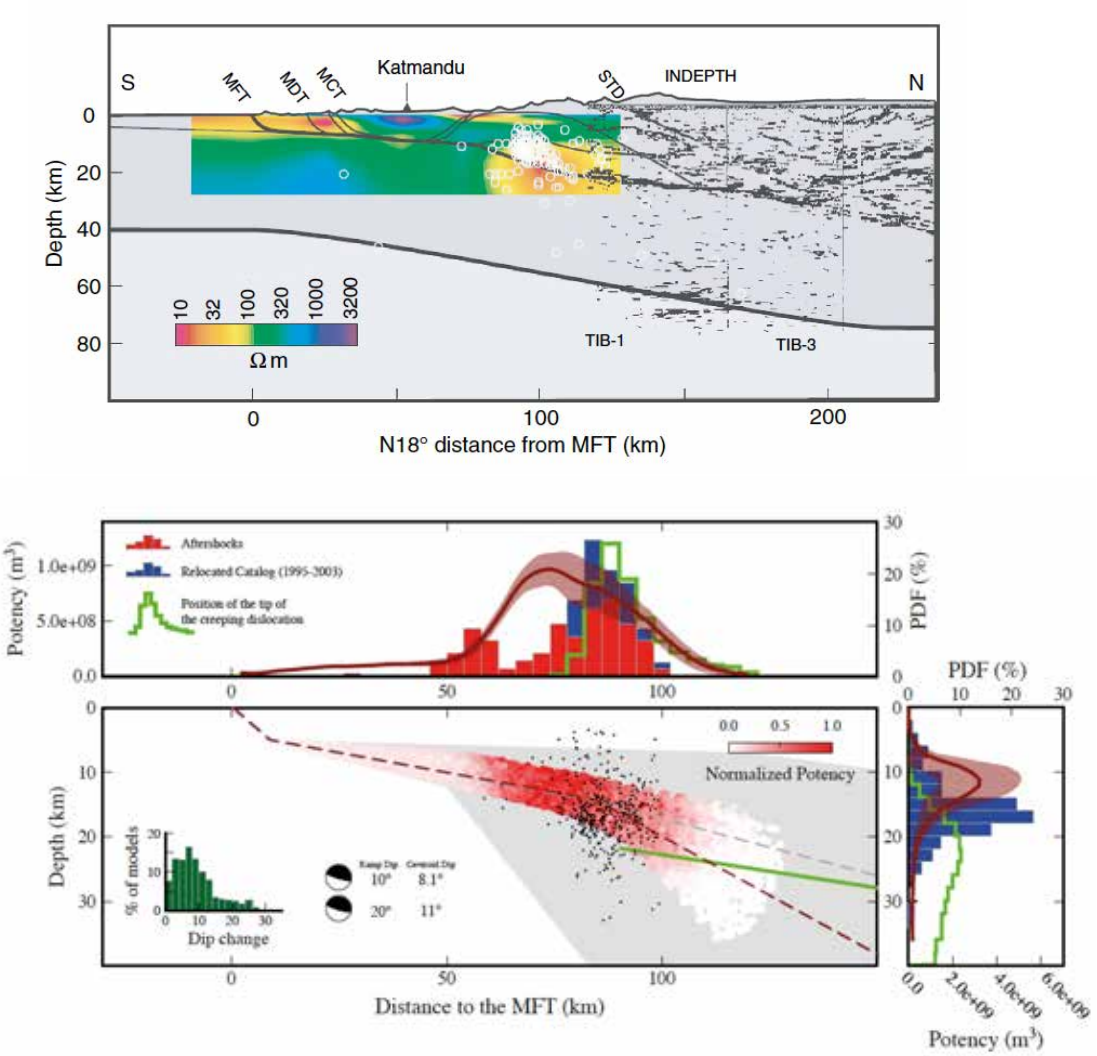
Correlation of topo with interseismic uplift and seismicity



(Pandey et al, 1995)

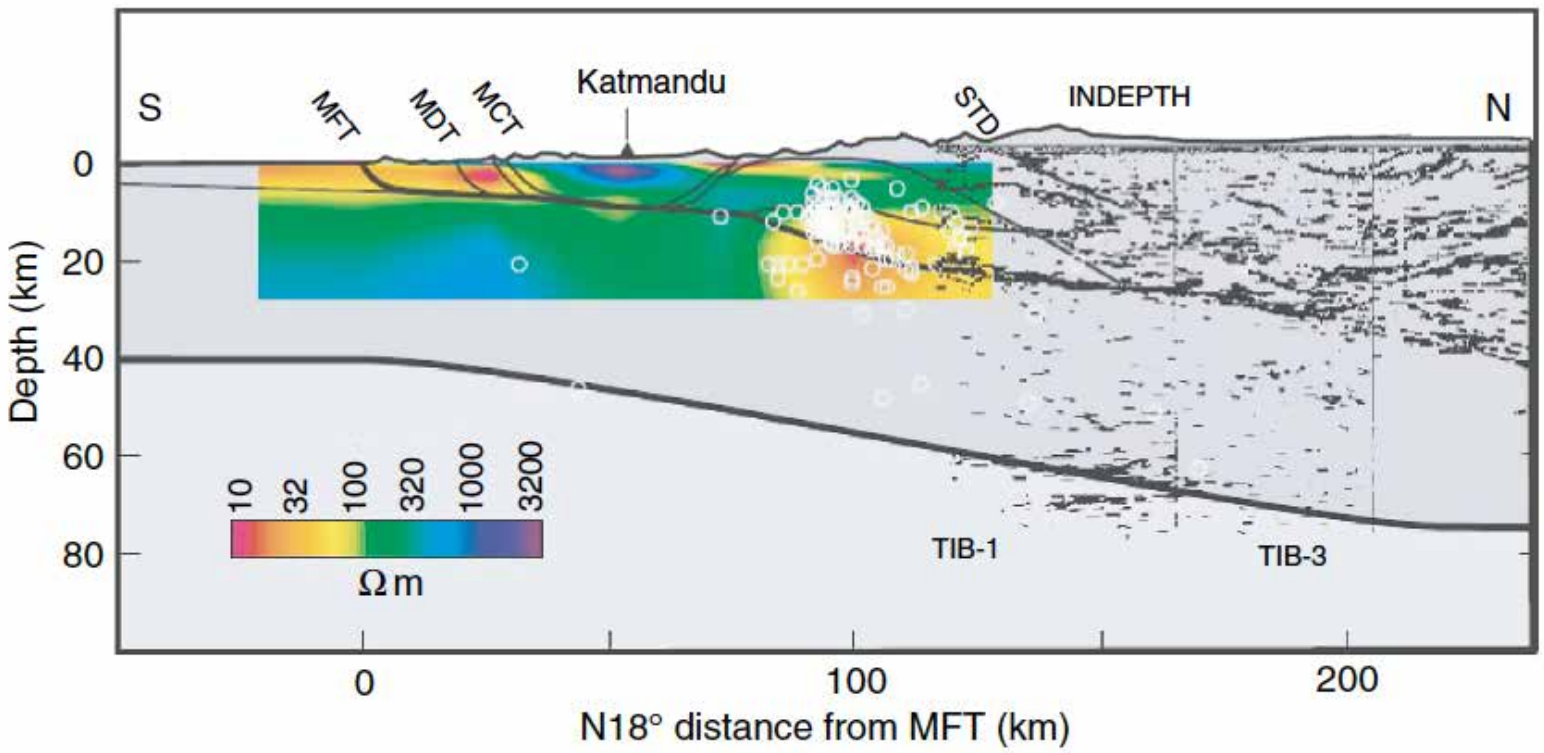
- Origin of the steep front of the HH? (out-of-sequence thrusting or ramp+ duplex?)
- Why is the effective friction on the MHT so low (<0.1) (dynamic weakening? fluid pressure?)

- Does the mid-crustal ramp really exist?



S42-2821&S42-2822 (Elliott et al., NGEO, in press)

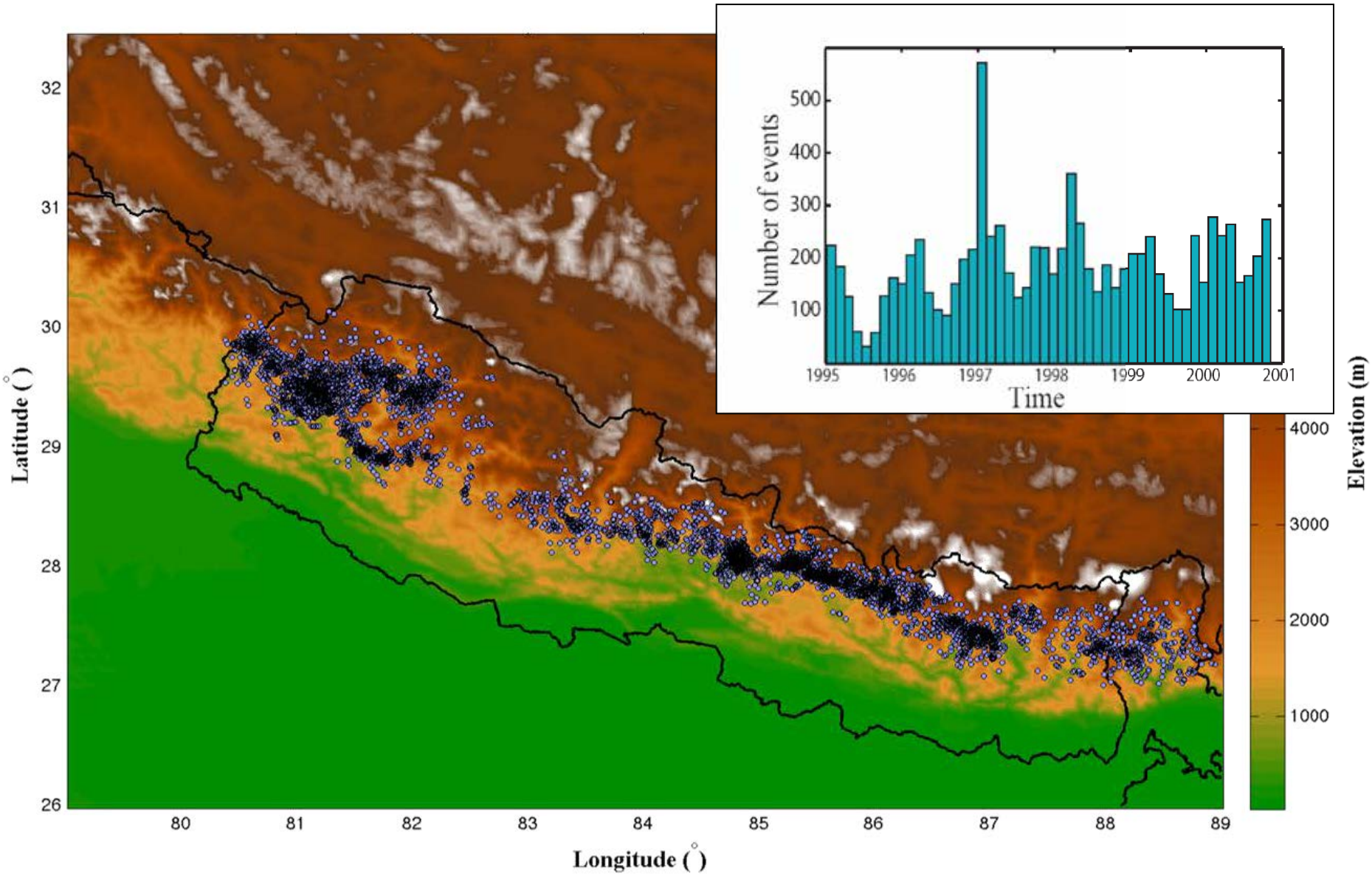
Correlation between structure, eletrical resistivity and seismicity



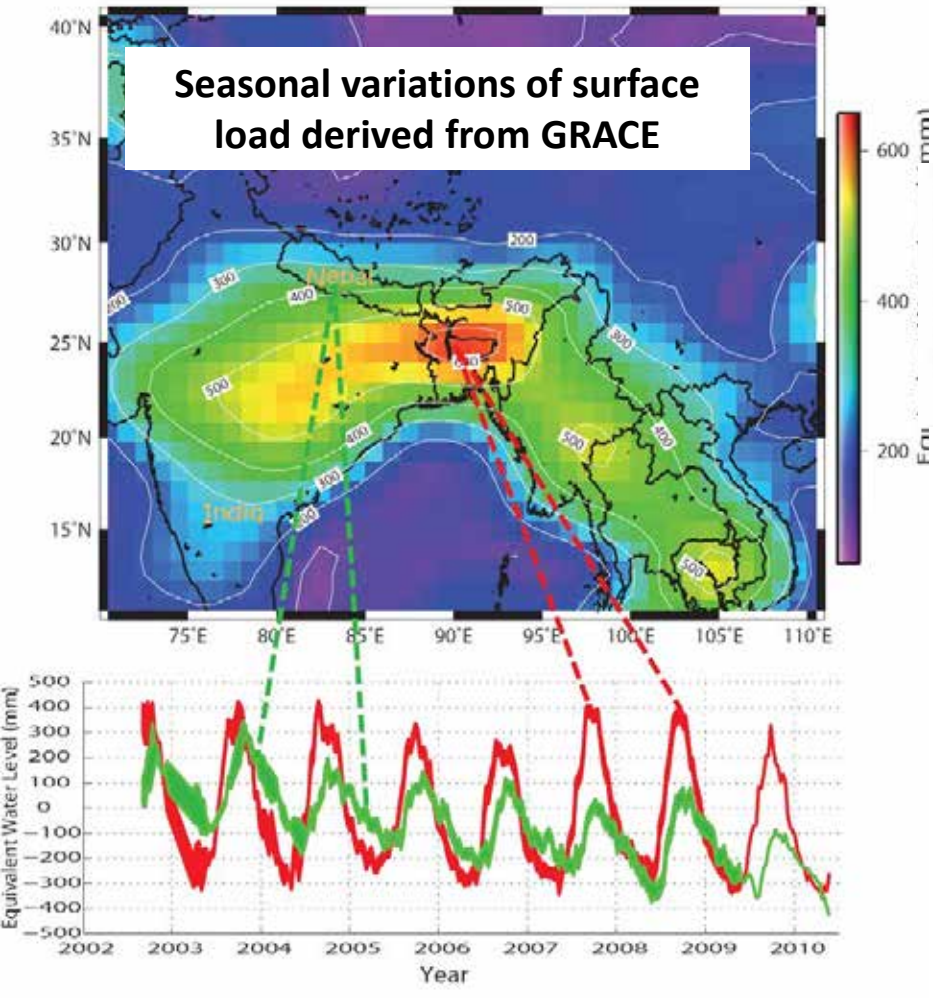
Avouac (2003), based on Lemmonnier et al (GRL, 1999) and Cattin and Avouac, (2000)

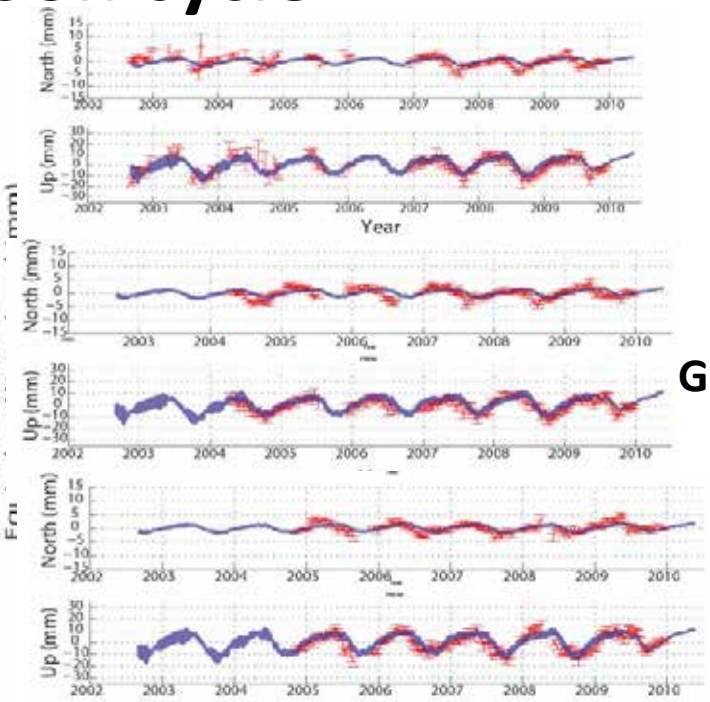
- Origin of low resistivity? (metamorphic fluids?)
- Suggests interplay between fluid flow and seismicity
- Relation to ramp?

When the Monsoon Rocks the Himalaya

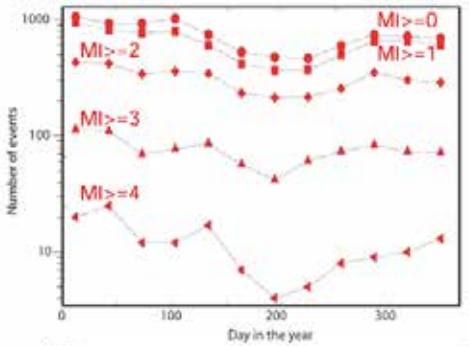


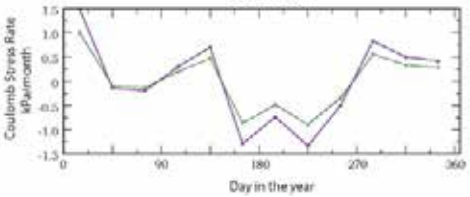
Sensitivity of Himalayan seismicity to the Monsoon cycle





GPS time series





(Bettinelli et al, 2007, Chanard et al., JGR, 2014)

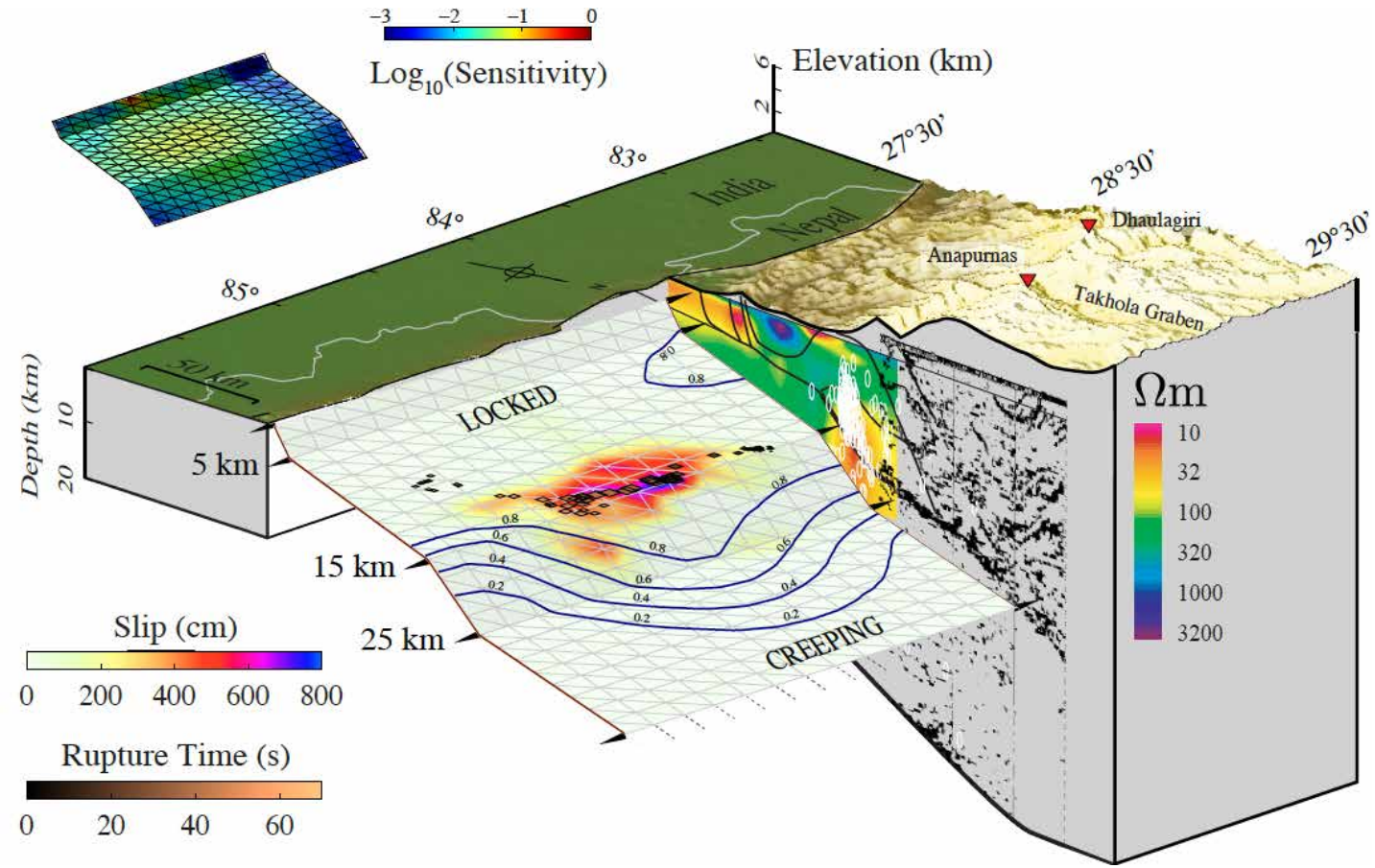
Some outstanding questions

- How big and how frequent is the largest earthquake in the Himalaya?
- What factors might control the location and extent of seismic ruptures? (lateral segmentation?)
- Geometry of the MHT?
- How is the steep front of the High Himlaya maintained?
- What fraction of surface geodetic strain is really elastic?
- What controls downdip variations of slip mode.
- Why is Himalayan seismicity so sensitive to small seasonal stress variations?
- Why is seismicity and ISC so well correlated with topography?
- Why is effective friction on MHT so low?

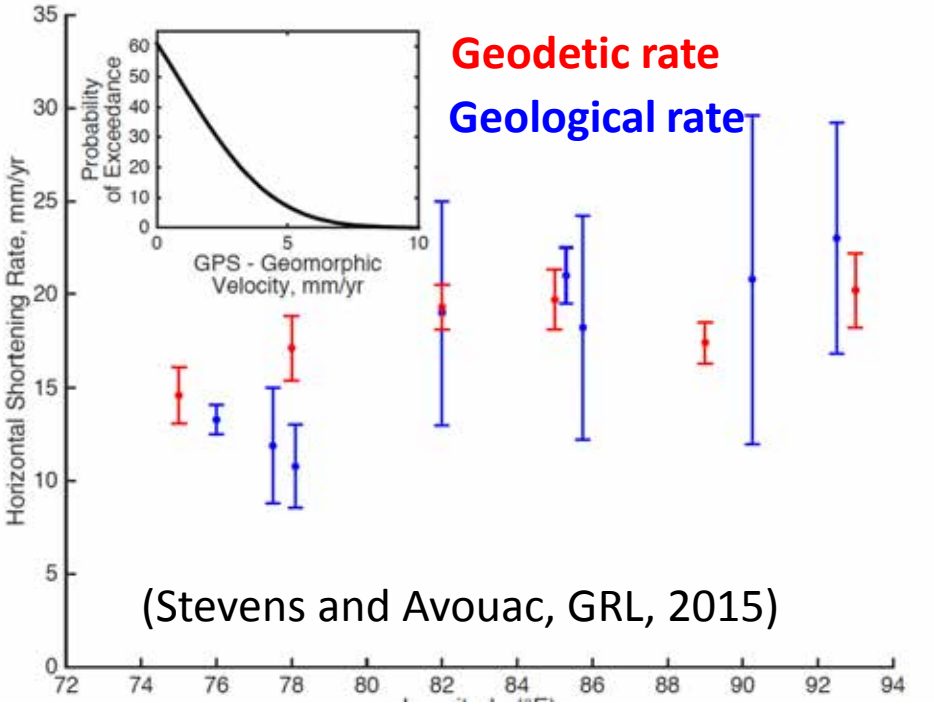
My wish list

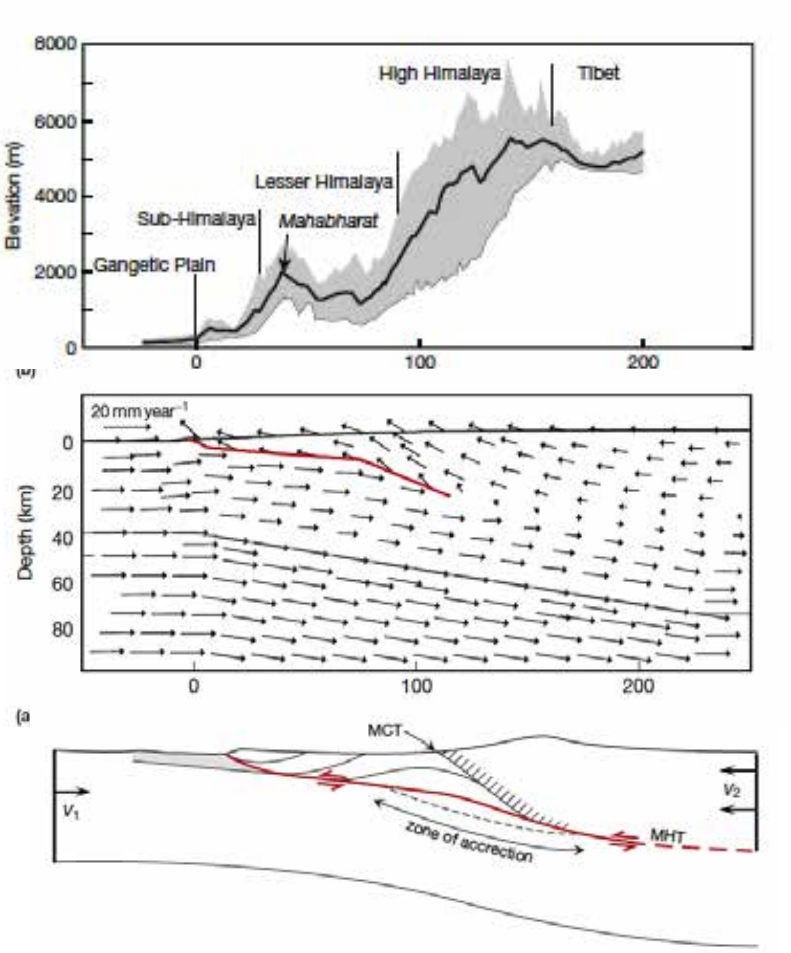
- Active seismic imaging
- New MT profiles
- More/better constrained geological slip rates from geomorphology and fold modeling.
- Accelerometric network to complement the
- Better seismological monitoring (e.g., temporal variation of Vp/Vs from seismic noise tomography?

Geometry of the MHT



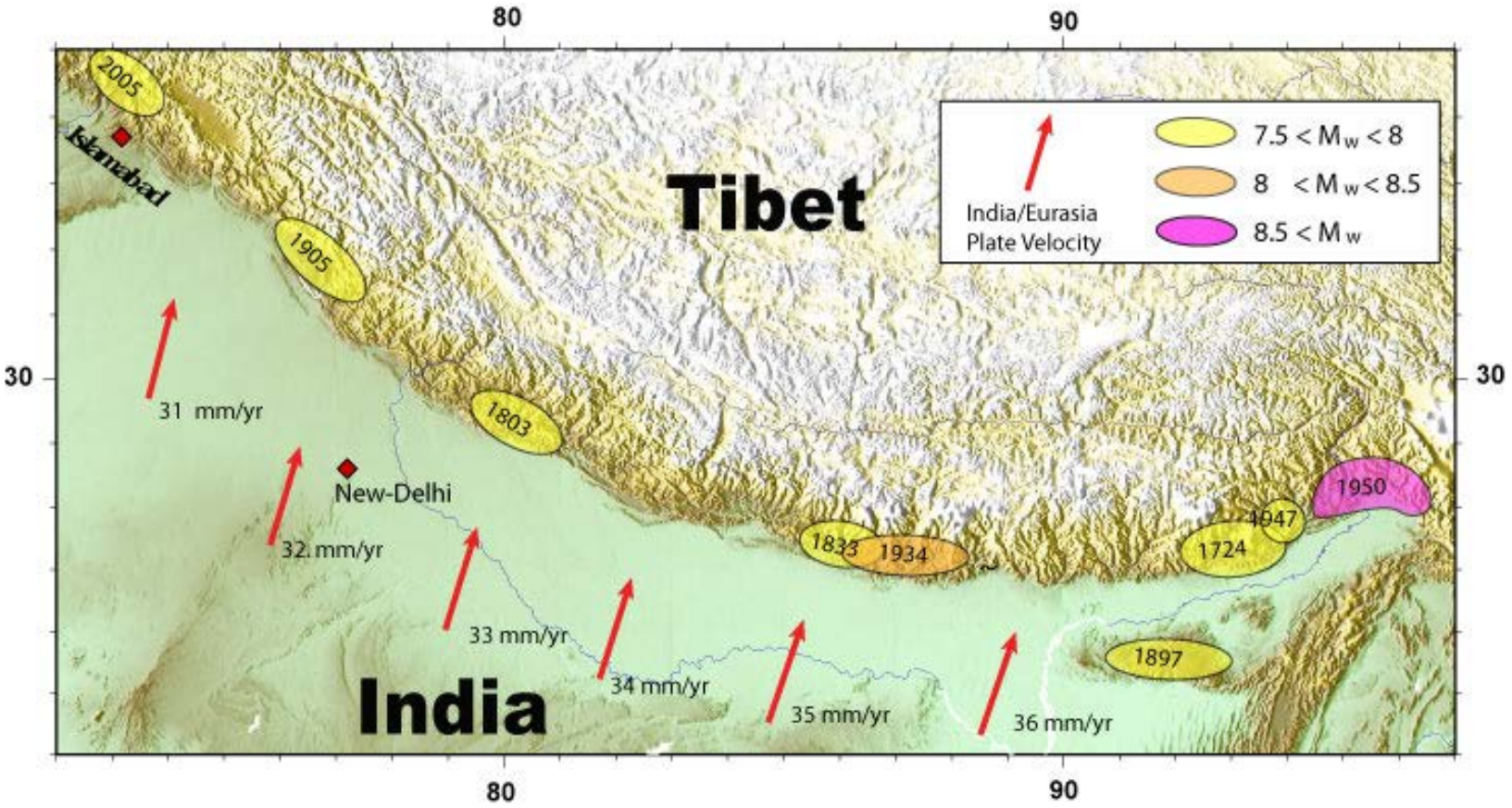
(Elliott et al., NGEO, 2015)





Topography of the higher Himalaya is maintained by a combination of ramp overthrusting and underplating (no significant internal shortening of the wedge).

Q1: How big



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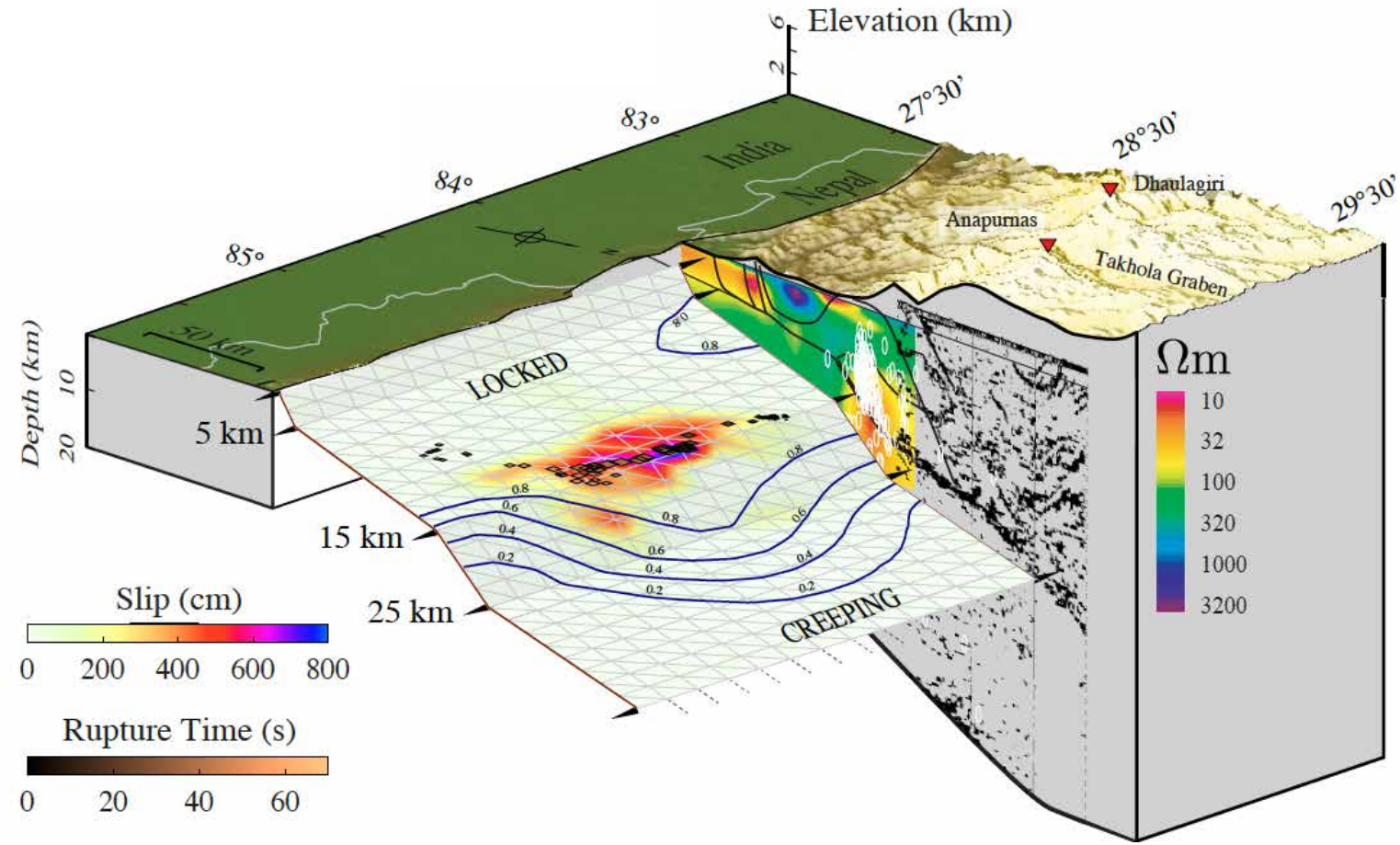
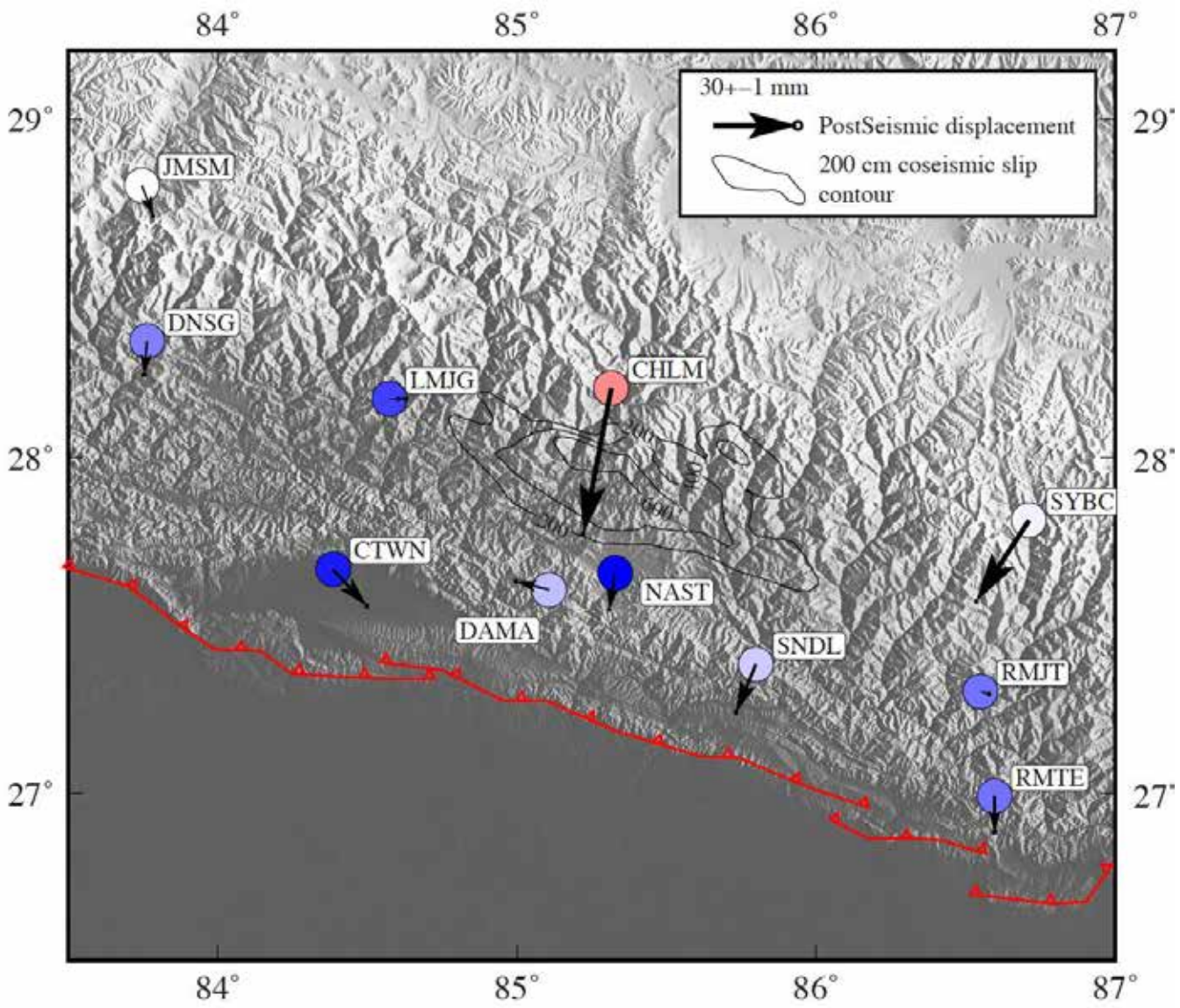
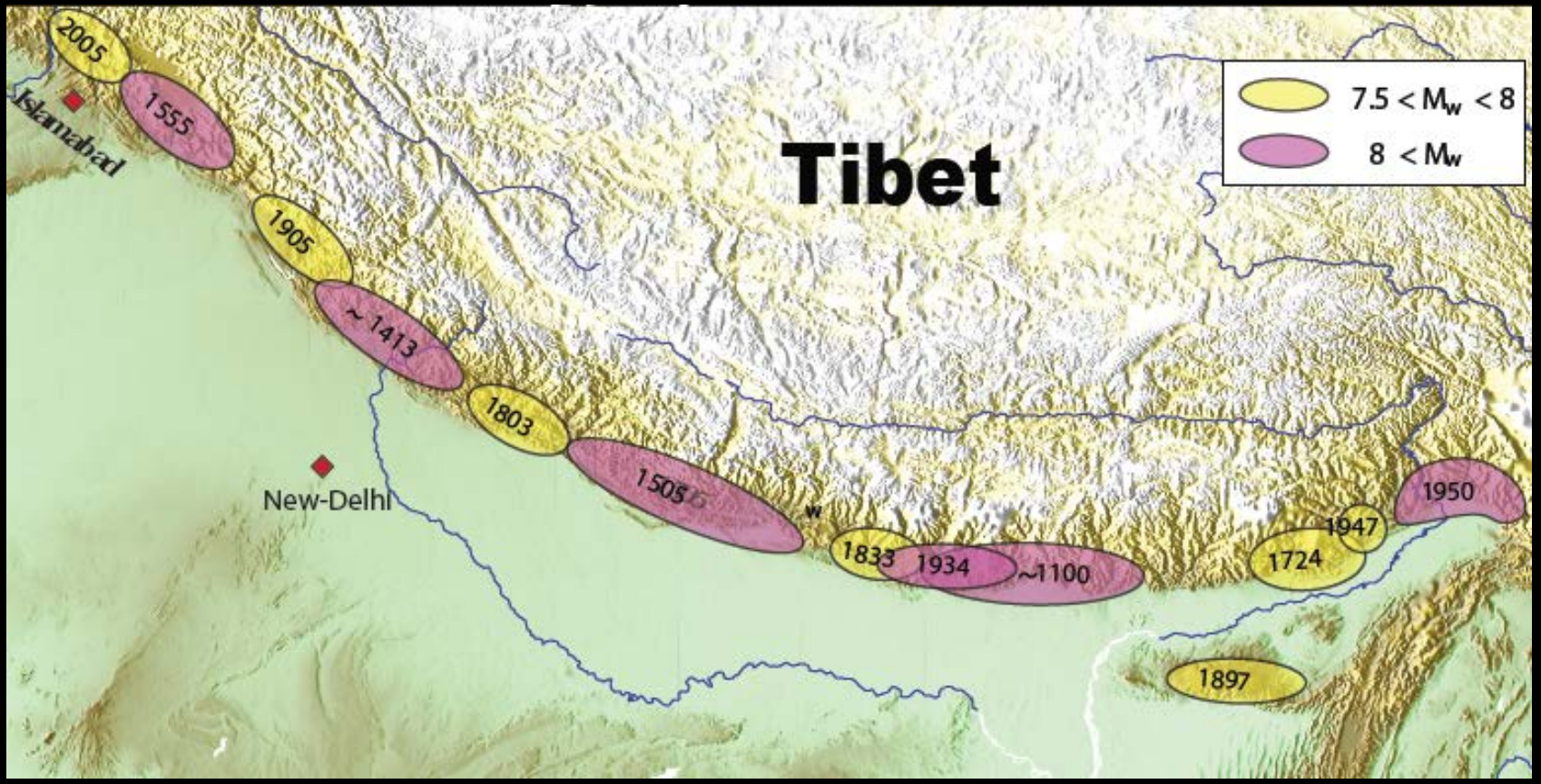


S42-2821&S42-2822

(Elliott et al., NGEO, 2015)


84°
85°
86°
87°
29°
28°
27°
30+−1 mm
PostSeismic displacement
200 cm coseismic slip contour
JMSM
DNSG
LMJG
CHLM
SYBC
CTWN
DAMA
NAST
SNDL
RMJT
RMTE
−20
−10
0
10
20
Vertical displacement (mm)


Tibet
7.5 < Mw < 8
8 < Mw
2005
1555
1905
~ 1413
1803
1505
1833
1934
~1100
1724
1947
1950
1897
Islamabad
New-Delhi