Subduction Zone Observatory

- Observations made with simple tools can provide important scientific constraints. (can also combine with more sophisticated measurements).

- Standardized well-planned marine intertidal surveys will pay-off in the long-run. (tectonic deformation)

- In the short-run, can be used to study a variety of environmental processes and provides an excellent educational platform.

- Comparative studies engender multi-disciplinary cross-cultural collaborations.

Vertical deformation from measurements you can make after an earthquake….

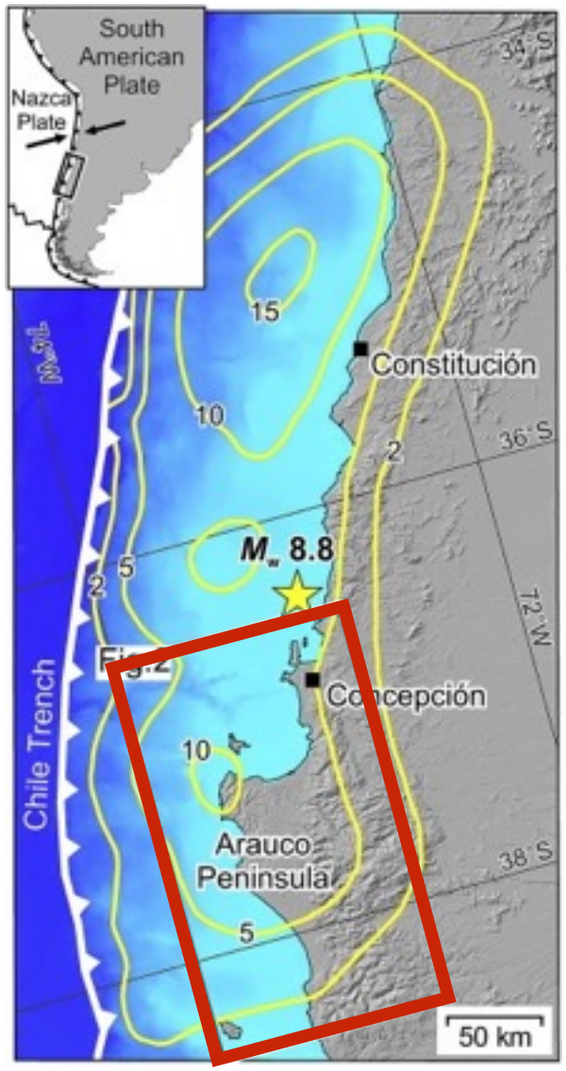
- Fundamental driver: Relative sea level.

- Sessile organisms span different elevation ranges w.r.t. tides.

- Limits depend on environmental/ecological conditions. (predation, competition, climate)

- Interplay of tidal range and biological zonation width to deformation range is critical. (can “saturate”, or overestimate)

- Relationship to long-term geomorphic observables.



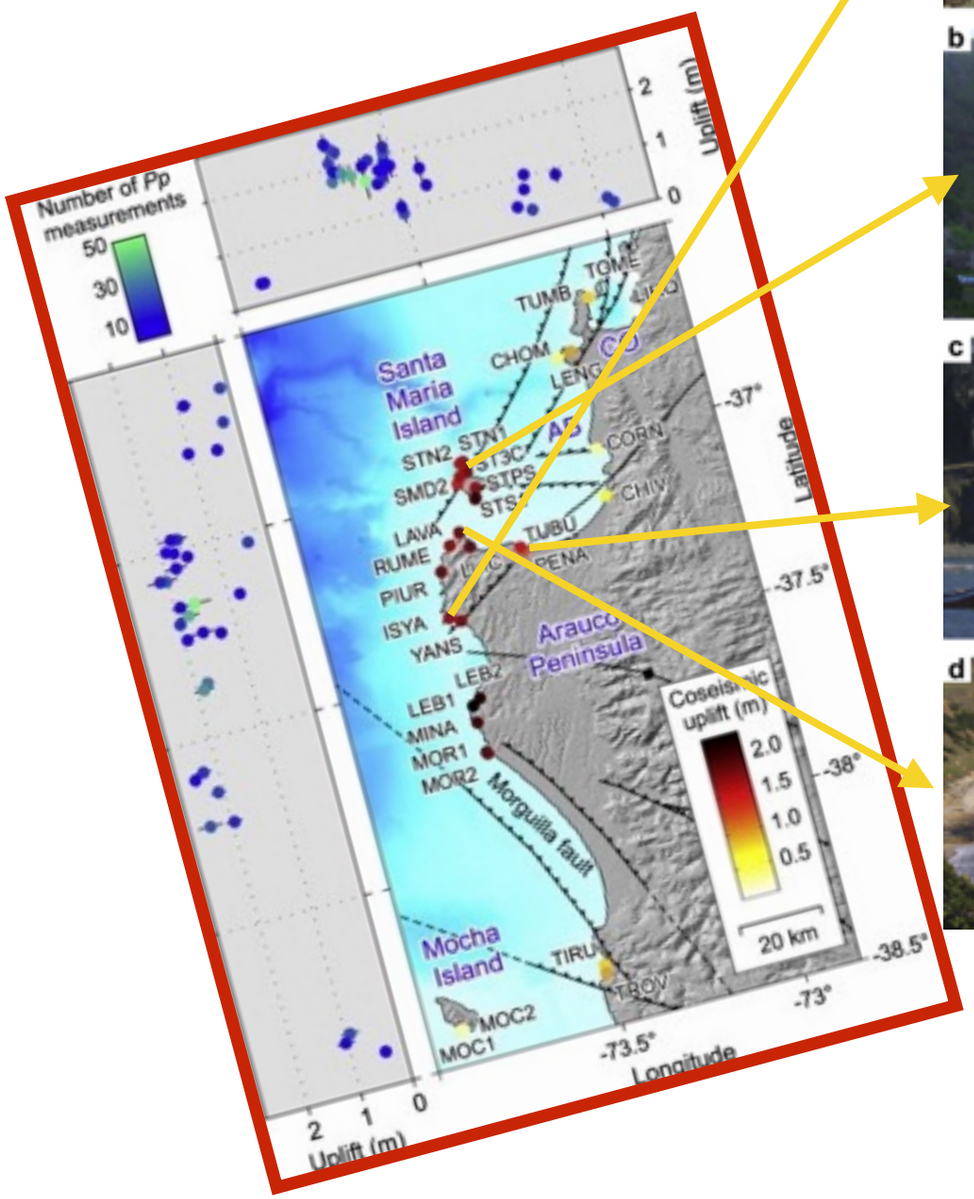


Fig. 1 Tectonic setting of the 2010 Maule, Chile earthquake. Yellow lines show slip contours in meters from <ce:cross-ref refid="bib43"> Moreno et al. (2012)</ce:cross-ref> . Slip contours from <ce:cross-ref refid="bib43"> Moreno et al. (2012)</ce:cross-re...

Fig. 2 Coseismic uplift in the southern segment of the 2010 earthquake using *Perumytilus purpuratus* (*Pp*). The color scale in the latitudinal and longitudinal profiles indicates the number of *Pp*<...

http://www.geo.cornell.edu/geology/faculty/RWA/research/current_research/chile-m-88-earthquake-page/darwins-description-of-the-.html

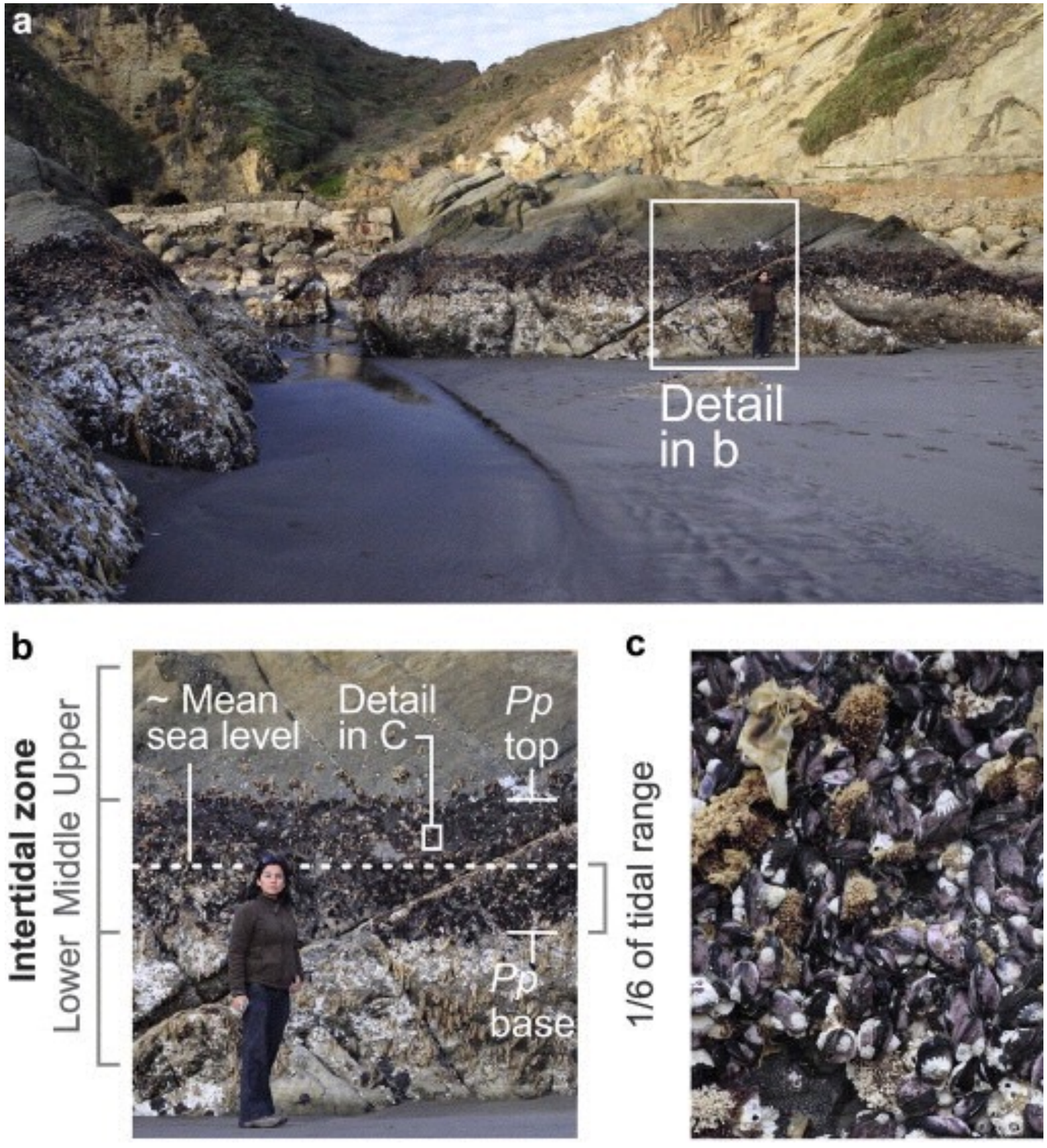
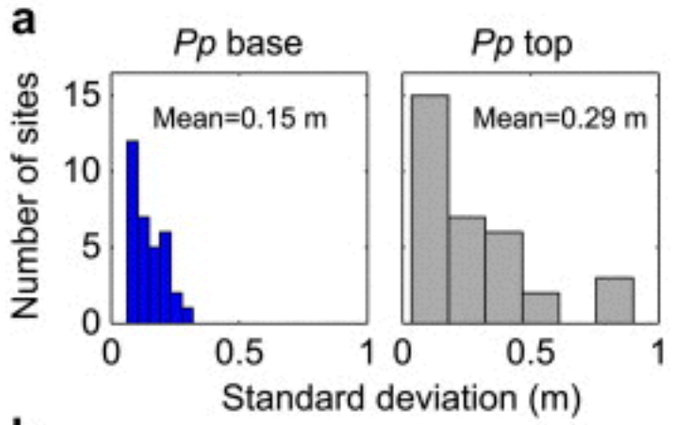


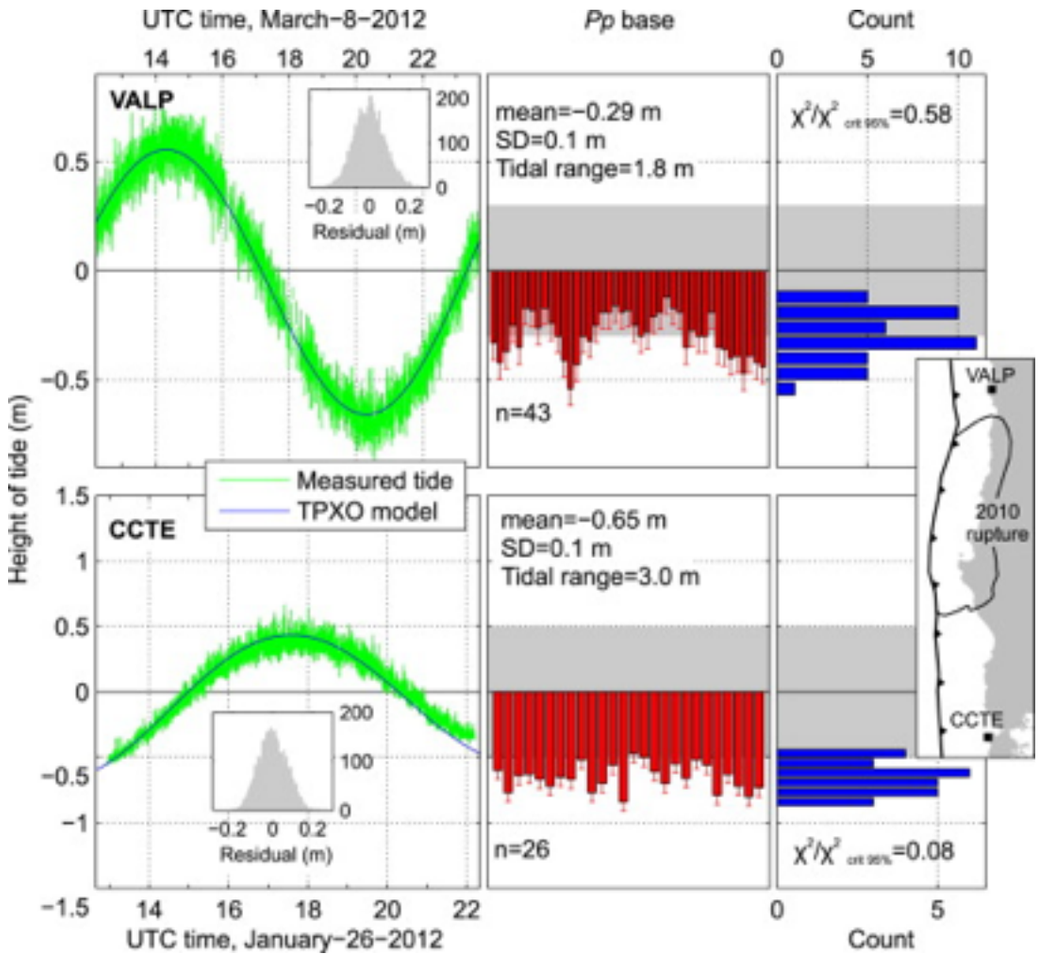
Fig. 4 Field views of the *Pp* belt. a) Overview of site LEB2. b) Detailed view of the belt indicating its limits. Note the sharp lower limit. The white coating that coves the exposed rocks below the belt is bleached coralline algae ...

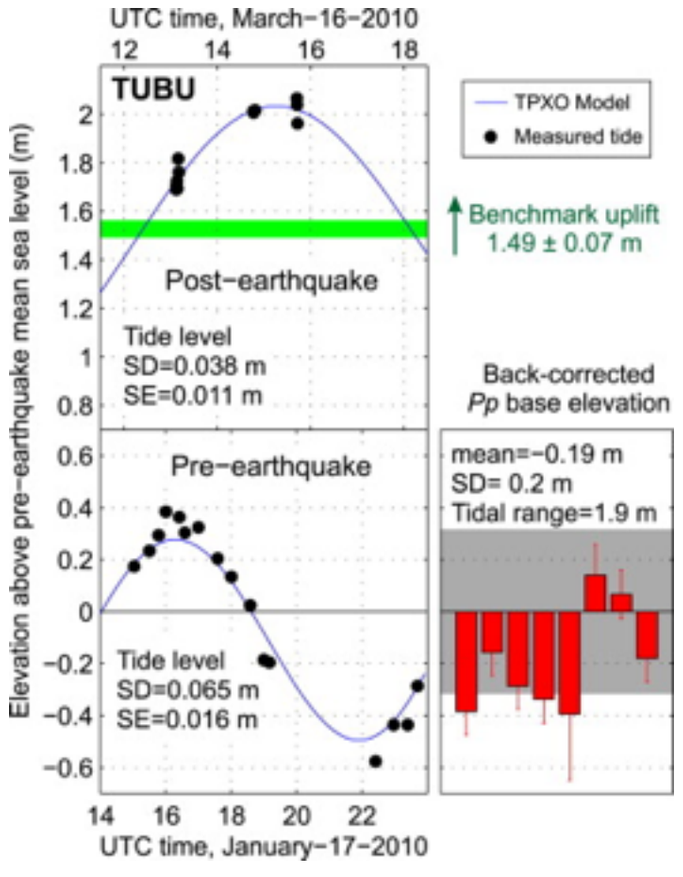
Darwin Speaks

The most remarkable effect of this earthquake was the permanent elevation of the land, it would probably be far more correct to speak of it as the cause. There can be no doubt that the land round the Bay of Concepcion was upraised two or three feet; but it deserves notice, that owing to the wave having obliterated the old lines of tidal action on the sloping sandy shores, I could discover no evidence of this fact, except in the united testimony of the inhabitants, that one little rocky shoal, now exposed, was formerly covered with water. At the island of S. Maria (about thirty miles distant) the elevation was greater; on one part, Captain Fitz Roy found beds of putrid mussel-shells still adhering to the rocks, ten feet above high-water mark: the inhabitants had formerly dived at lower-water spring-tides for these shells. The elevation of this province is particularly interesting, from its having been the theatre of several other violent earthquakes, and from the vast numbers of sea-shells scattered over the land, up to a height of certainly 600, and I believe, of 1000 feet. At Valparaiso, as I have remarked, similar shells are found at the height of 1300 feet: it is hardly possible to doubt that this great elevation has been effected by successive small uprisings, such as that which accompanied or caused the earthquake of this year, and likewise by an insensibly slow rise, which is certainly in progress on some parts of this coast.

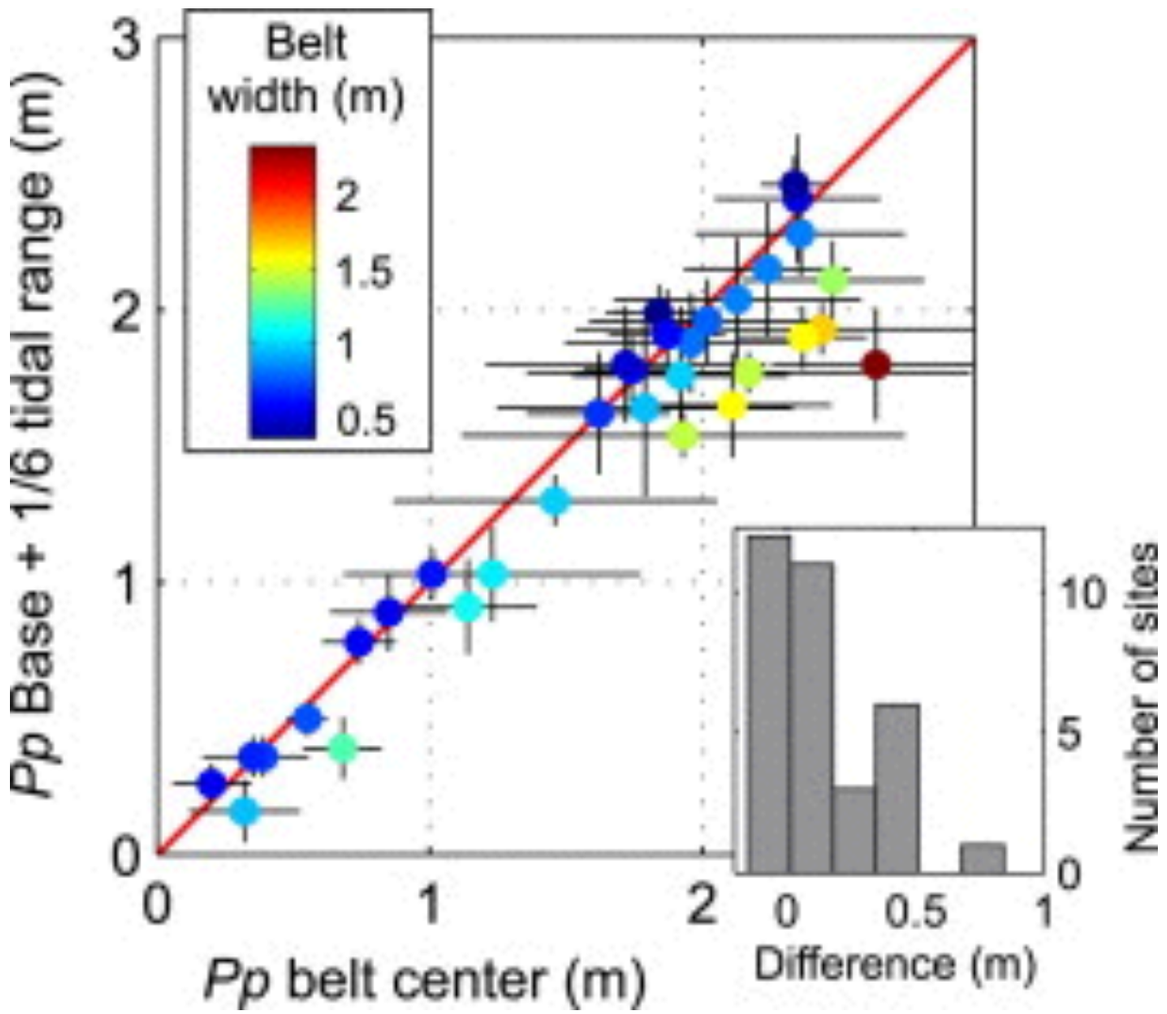
- Section 3: *Perumytilus Purpuratus* particulars, survey, tide models, benchmark leveling at TUBU and STPS, and GPS uplift (other investigators).



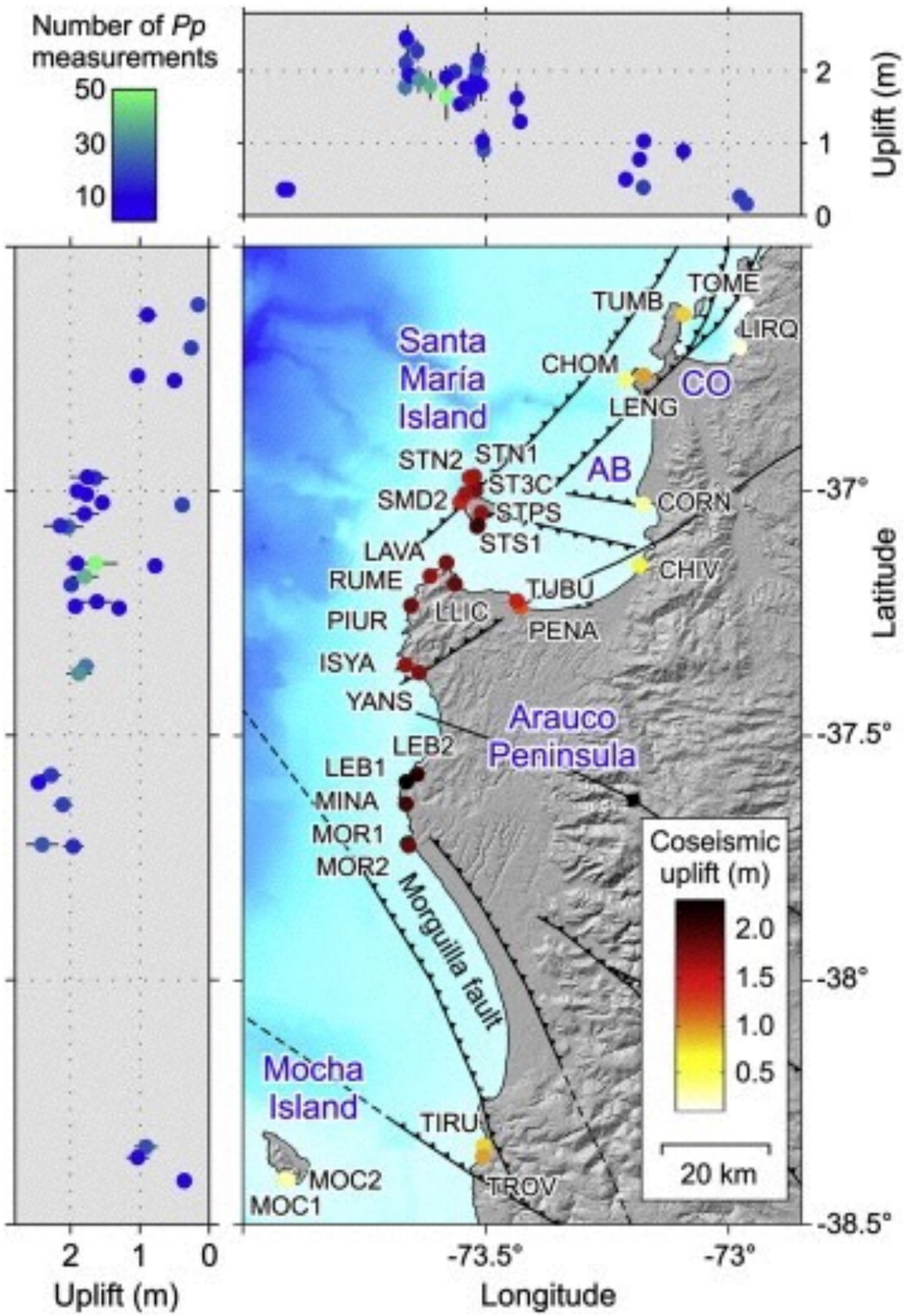


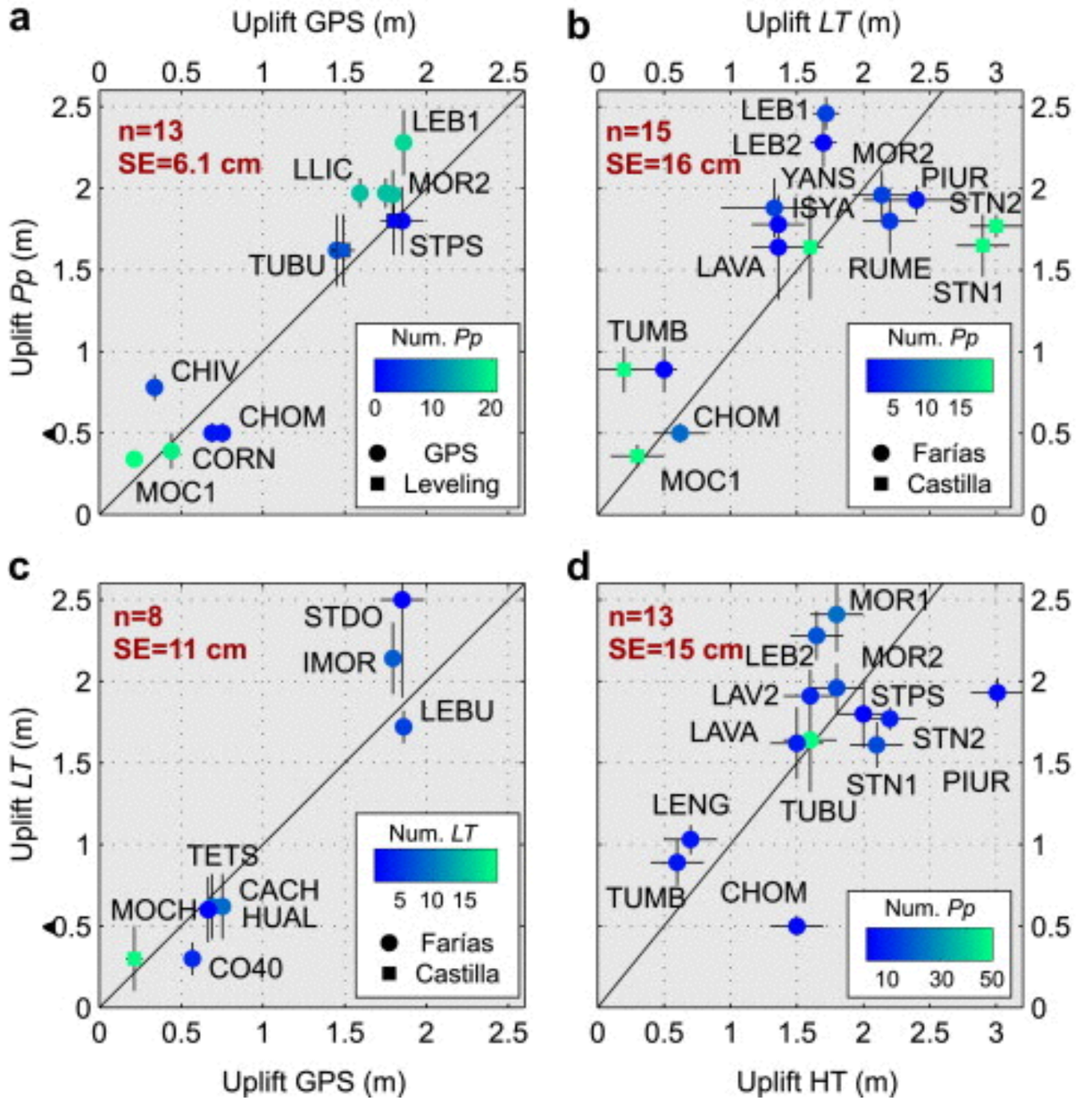


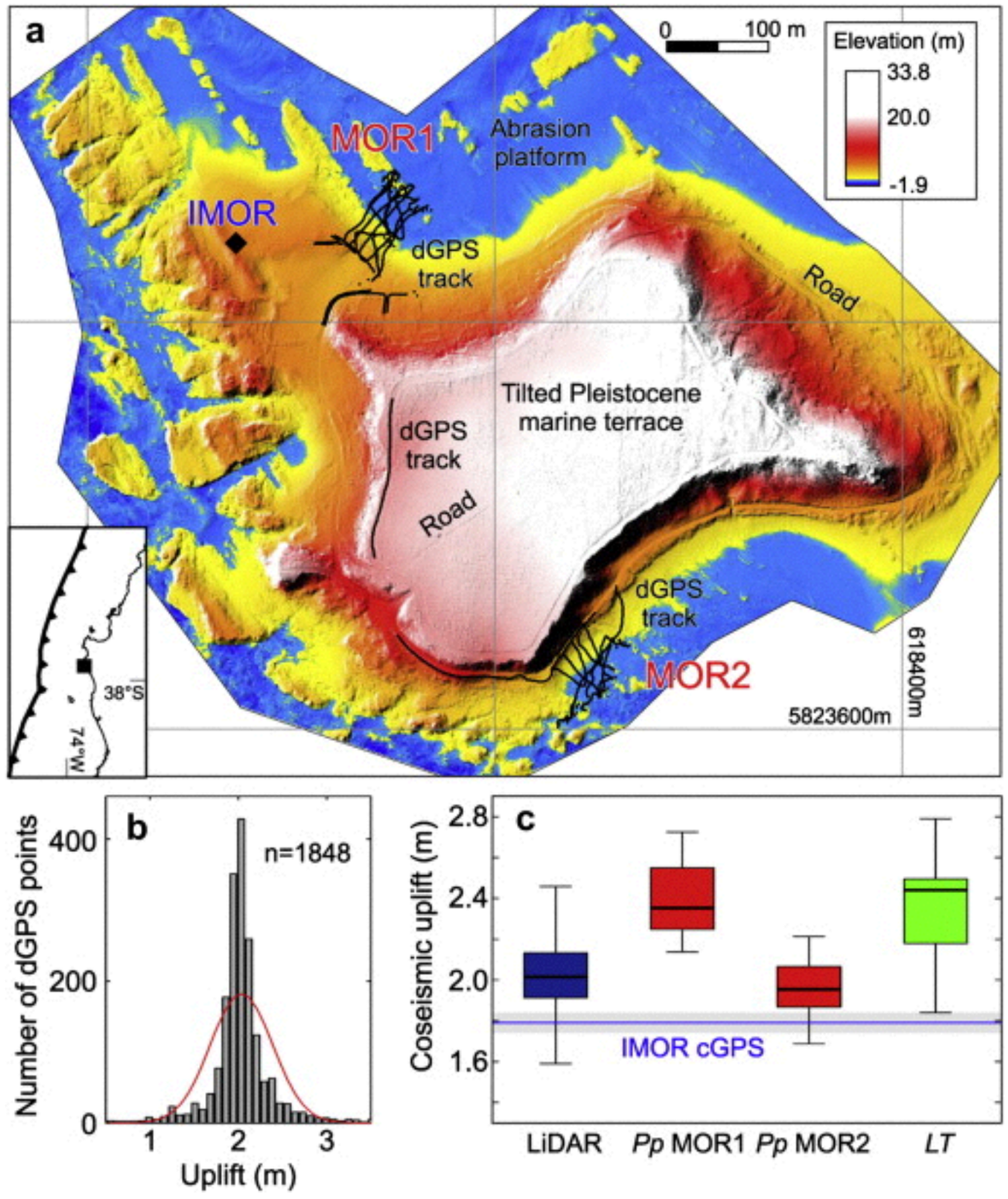
- Section 4: Results - much statistics to capture variability. Center of Pp belt at mid-tide, extent of belt “should be” 1/3 tidal range. Could just find post-eq mid-tide, measure to old center of belt, and be done. Except for variability. So instead, they measure elevation of base of belt + 1/6 of belt width.



- Section 4 continued: Other estimates. LT (Lithothamnium), GPS, High-tide marks, High resolution topography.






a
0
100 m
Elevation (m)
33.8
20.0
-1.9
MOR1
Abrasion
platform
IMOR
dGPS
track
Road
Tilted Pleistocene
marine terrace
dGPS
track
Road
dGPS
track
MOR2
5823600m
618400m
38°S
74°W
b
n=1848
Number of dGPS points
400
200
0
1
2
3
Uplift (m)
c
Coseismic uplift (m)
2.8
2.4
2.0
1.6
IMOR cGPS
LiDAR
Pp MOR1
Pp MOR2
LT

Discussion

- Base of *Pp* belt most precise - but controlled by predation, so needs careful study.

- Lithothamnium more variable, but don't need tides. Wave splash a complicating factor (protected sites best).

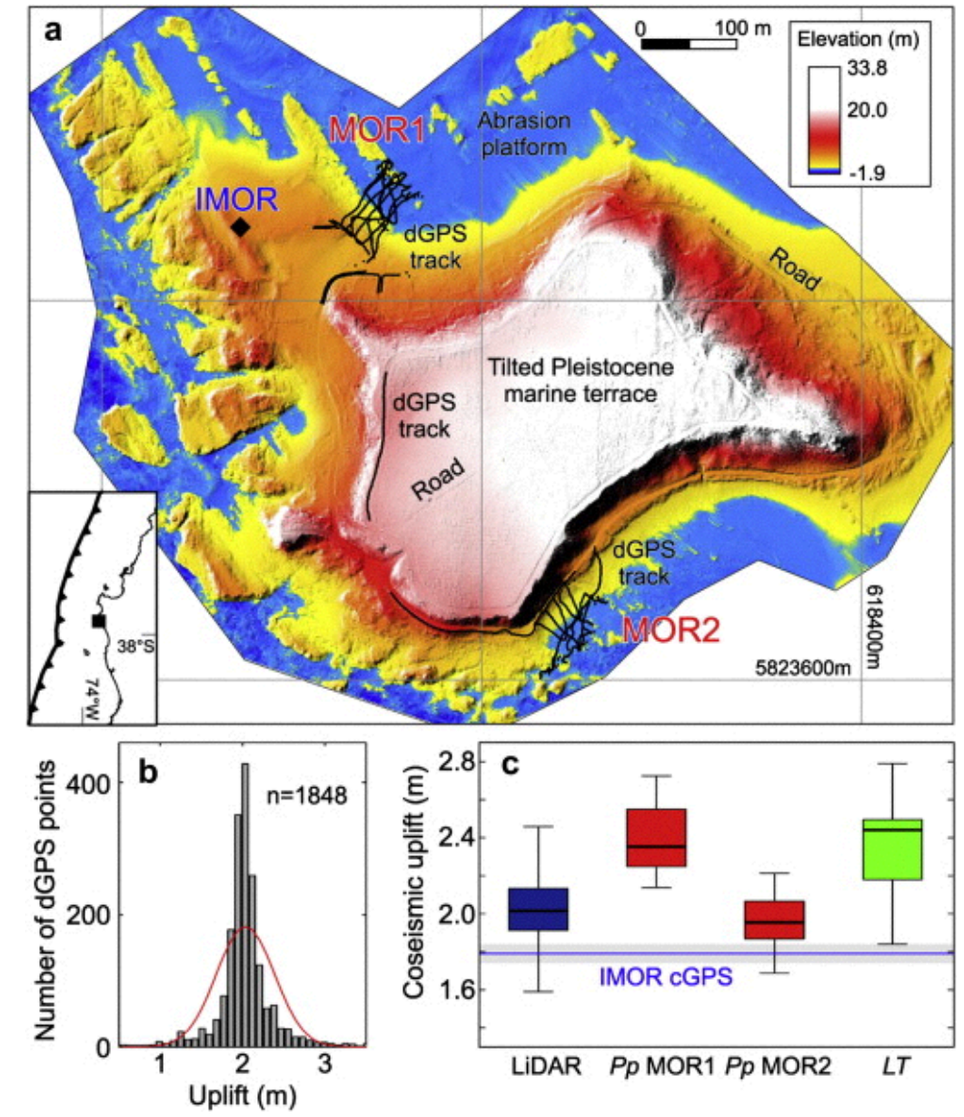
- Portable tide gauges a good tool. (but need some baseline measures)

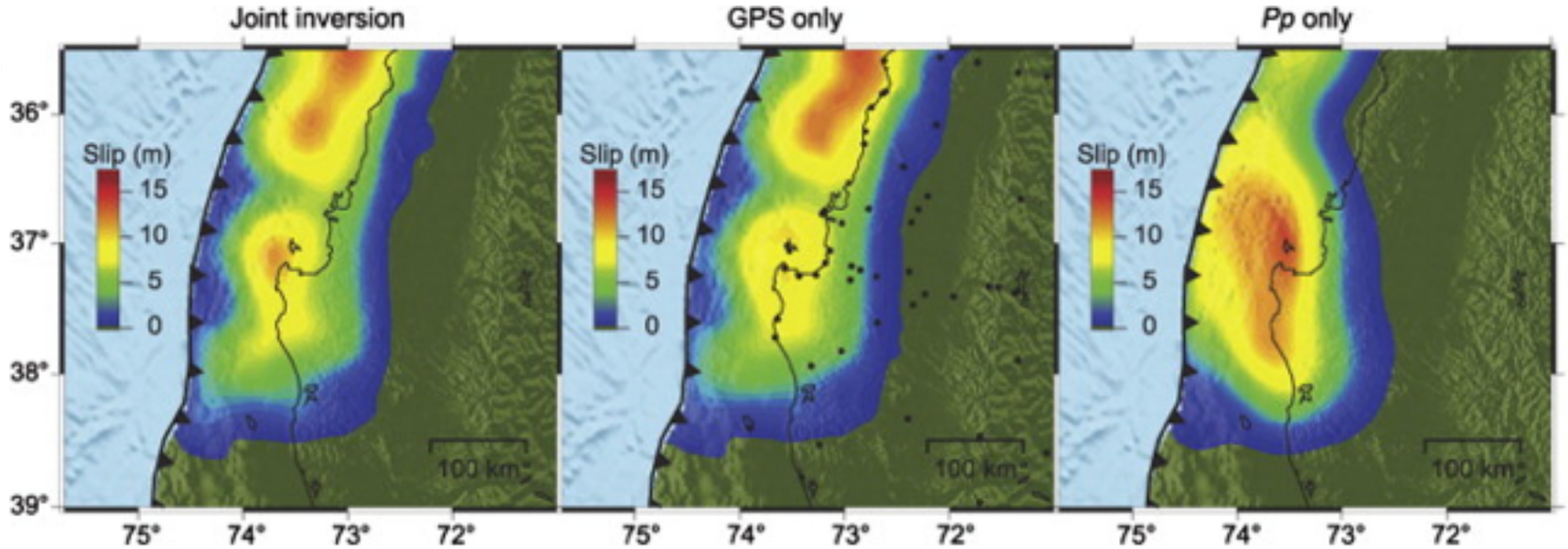
- High-tide marks take some time to establish post-earthquake. Uncertainties ≥ 20 cm?

Conclusions (mostly mine)

- Most biological estimates seem to overestimate cGPS observed uplift.
- Nevertheless, measurements make geophysical sense overall.
- May be used to constrain slip model (includes post-seismic slip…)
- May be motion on crustal reverse fault (Morguilla) too).

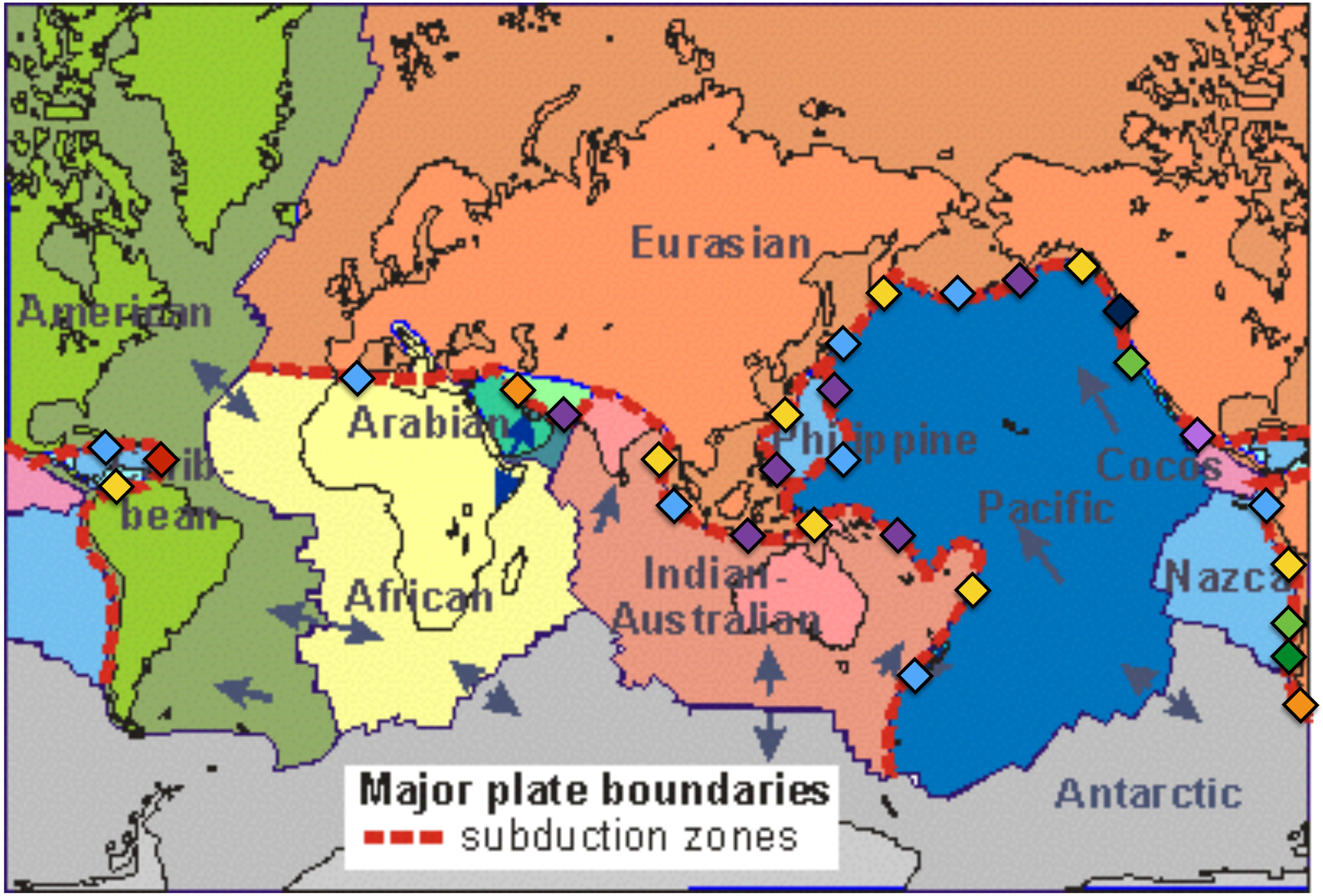
Would have been helped by pre-earthquake transects.





SZO Multi-laboratory

Science participation for everyone



Basic Idea

- Coordinated (loosely?) survey transects across the intertidal (+ nearshore & onshore if possible) zones of numerous subduction zone locales.

- Re-surveyed regularly.

- Could use mixture of “unsophisticated” and “sophisticated” techniques…whatever’s available.

- Fundamental observable: Relative Sea Level and biological/geomorphic distributions about it.

- Big database to store & share observations

“Less Sophisticated”

- Tidal markers
- Sessile intertidal organism stratification
- Geomorphological landmarks (shoreline angles, platform elevations)
- Tsunami deposits (& other interesting features like drowned trees)
- Biostratigraphy of sedimentary deposits

“More Sophisticated”

- Leveling (optical, gps)
- Tide gauges (portable, ties to permanent)
- Gravity survey
- Campaign GPS
- Remote sensing

Target: Trends and Variation

- Seasonal variation

- Secular trends (global sea-levels are rising >~4mm/yr)

- Along-shore variations

- Comparison between different environmental settings. (Latitude, Climate, Tide-range, Intertidal ecodynamics).

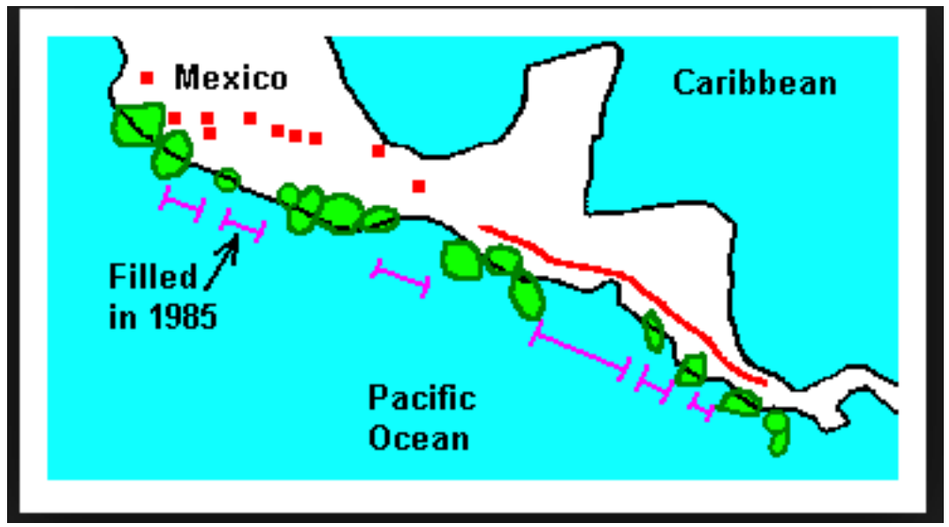
Subduction Processes

- Interseismic assessment (coupling patterns)

- Post-earthquake assessment (co-seismic slip, post-seismic adjustment, secondary crustal fault slip)

- Paleoseismic assessment (identify possible rupture barriers?)

- Could try to target “seismic gaps” (if there are such things…)



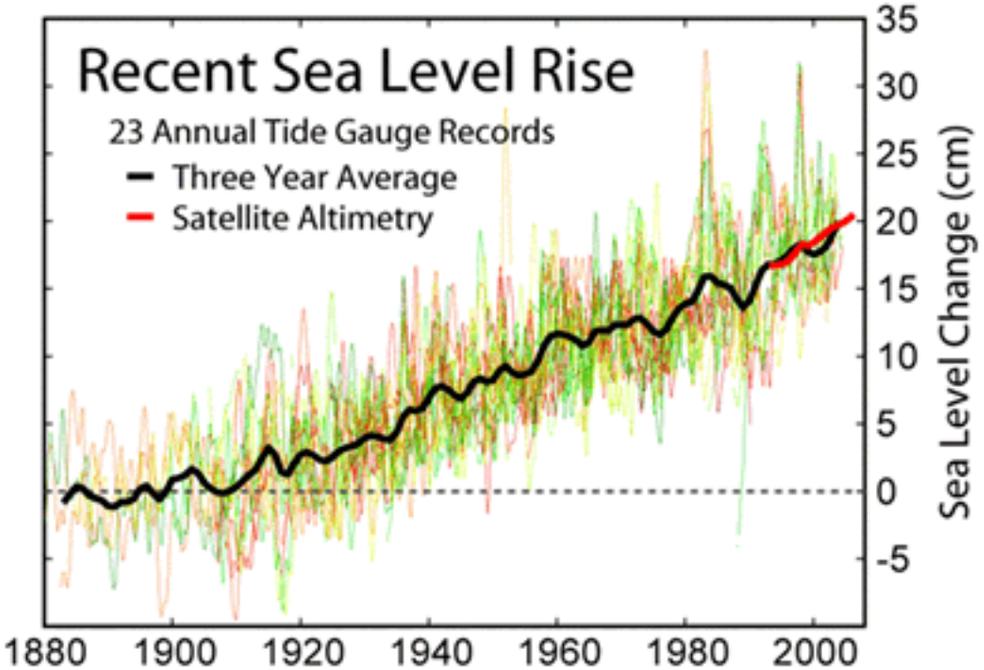
Broader Impacts

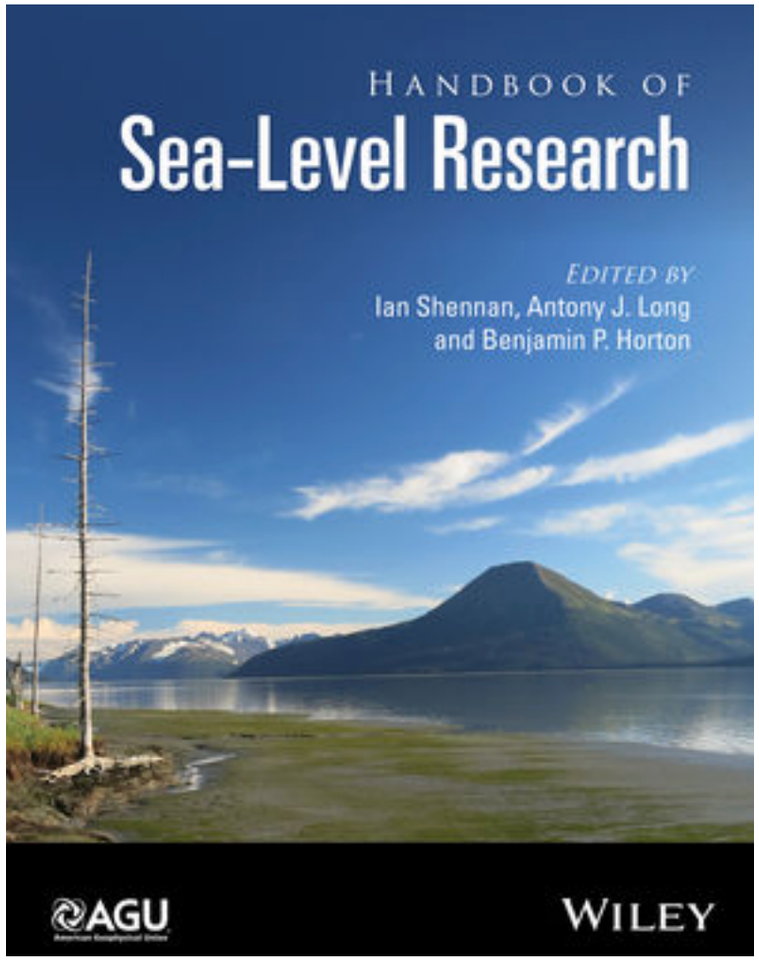
- Rising relative sea-level? (global average > 4mm/yr)

- Ecological/Biological response to secular changes

- Ecological responses to sudden changes

- Non-tectonic events (floods, storms, terrestrial changes like fires, droughts, oil spills, fishing pressure, etc.)





SZO Multi-lab Organization?

- Identify principals in different places
- Build database for organizing efforts, and archiving/accessing data (open access)
- Advisory committee coordinates overall effort
- Small grants to cover reasonable costs
  - local and global business partners contribute?
- Annual tele-meeting