CONTROL ID: 1801781

TITLE: Reconciling Pre- and Co-Seismic Deformation at Megathrusts: Tohoku Informing Cascadia

AUTHORS (FIRST NAME, LAST NAME): Kevin P Furlong[1], Rob M A Govers[2]

INSTITUTIONS (ALL): 1. Geosciences, Penn State Univ, University Park, PA, United States.
2. Geosciences, Utrecht University, Utrecht, Utrecht, Netherlands.

ABSTRACT BODY: One of the outstanding goals of earthquake science is to effectively anticipate the earthquake characteristics of a future event - magnitude, rupture area, slip history - through the judicious application of models that use observations of inter-earthquake deformation and the history of earthquakes along that plate boundary segment. The series of great earthquakes over the past decade since the 2004 Mw 9.2 Sumatra earthquake have demonstrated both the sobering reality that our current models of subduction zone earthquake genesis are insufficient but more positively have provided a wealth of data and observations that can be used to develop improved framework models of the lithospheric behavior through the earthquake cycle in subduction zones. Some of the issues that recent observations raise are straightforward, while others imply aspects of the subduction process that have not been previously considered important. Based on observations of a range of great earthquakes since 2004, and with a particular focus on the 2011 Mw 9.0 Tohoku event we can identify a suite of key issues that include: (1) Patterns of inter-seismic deformation (strain accumulation) are not simply the converse of the co-seismic elastic strain release. (2) Deformation of the slab during the earthquake cycle is a common occurrence and its role in buffering upper-plate deformation is a key consideration in the potential tsunamigenic character of a subduction system. (3) Rates of pre-earthquake deformation (e.g. observed upper-plate GPS displacements) and inferred slip deficit accumulation on the megathrust are inconsistent with co-seismic displacements/fault slip and recurrence intervals. (4) Patterns of megathrust locked patches, degrees of coupling and other parameterizations that are used to define earthquake potential have only a loose agreement with the actual patterns of slip and moment release seen in the ensuing great earthquake. Simple elastic models do provide a general agreement between processes along the megathrust and observations regionally - i.e. with such models (e.g. Okada-type solutions) we find reasonable agreement among geodetic and seismologic models. In assessing sensitivities in our preliminary modeling, we find that depending on the strength and rheologic considerations in the model, similar patterns of displacement in the upper plate in the typical observing zones (on-shore, ~ 100+ km from trench) can have significantly different displacement effects in the vicinity of the earthquake rupture and trench - the areas most critical to tsunamigenesis and assessing earthquake magnitude. Also although it is perhaps reassuring to see that there is general agreement between the seismologically determined finite fault models (FFM) and the observed surface deformation; this information after-the-fact does not tell us why the slip deficit accumulated as it did. Here we report on improved (numerical) models of the strain accumulation and release cycle in megathrust zones that better incorporate variations in rheology, the effects of plate boundary character (pre- and co-seismic), and the relationships between pre-earthquakes observed deformation and co-seismic rupture characteristics.

KEYWORDS: 8170 TECTONOPHYSICS Subduction zone processes, 8159 TECTONOPHYSICS Rheology: crust and lithosphere, 7240 SEISMOLOGY Subduction zones.

(No Image Selected)

(No Table Selected)

Additional Details

Previously Presented Material: 20% at 2012 AGU Meeting

Contact Details

CONTACT (NAME ONLY): Kevin Furlong

CONTACT (E-MAIL ONLY): kevin@geodyn.psu.edu

TITLE OF TEAM:
