Months-long thousand-kilometre-scale wobbling before great subduction earthquakes

By: Bedford, JR (Bedford, Jonathan R.)[1]; Moreno, M (Moreno, Marcos)[2]; Deng, ZG (Deng, Zhiguo)[1]; Oncken, O (Oncken, Onno)[1,3]; Schurr, B (Schurr, Bernd)[1]; John, T (John, Timm)[3]; Baez, JC (Baez, Juan Carlos)[4]; Bevis, M (Bevis, Michael)[5]

View Web of Science ResearcherID and ORCID

NATURE
Volume: 580
Issue: 7805
Pages: 628-+
DOI: 10.1038/s41586-020-2212-1
Published: APR 2020
Document Type: Article

View Journal Impact

Abstract

Observed reversals in GNSS surface motions suggests greatly enhanced slab pull in the months preceding the great subduction earthquakes in Maule (Chile, 2010) and Tohoku-oki (Japan, 2011) of moment magnitudes 8.8 and 9.0.

Megathrust earthquakes are responsible for some of the most devastating natural disasters(1). To better understand the physical mechanisms of earthquake generation, subduction zones worldwide are continuously monitored with geophysical instrumentation. One key strategy is to install stations that record signals from Global Navigation Satellite Systems(2,3) (GNSS), enabling us to track the non-steady surface motion of the subducting and overriding plates before, during and after the largest events(4-6). Here we use a recently developed trajectory modelling approach(7) that is designed to isolate secular tectonic motions from the daily GNSS time series to show that the 2010 Maule, Chile (moment magnitude 8.8) and 2011 Tohoku-oki, Japan (moment magnitude 9.0) earthquakes were preceded by reversals of 4-8 millimetres in surface displacement that lasted several months and spanned thousands of kilometres. Modelling of the surface displacement reversal that occurred before the Tohoku-oki earthquake suggests an initial slow slip followed by a sudden pulldown of the Philippine Sea slab so rapid that it caused a viscoelastic rebound across the whole of Japan. Therefore, to understand better when large earthquakes are imminent, we must consider not only the evolution of plate interface frictional processes but also the dynamic boundary conditions from deeper subduction processes, such as sudden densification of metastable slab.

Keywords

KeyWords Plus: TOHOKU-OKI EARTHQUAKE; PORE FLUID PRESSURE; SLOW SLIP; CRUSTAL DEFORMATION; ZONE; DISPLACEMENTS; TREMOR; PROPAGATION; IQUIQUE; RELEASE

Author Information

Reprint Address: Bedford, JR (reprint author)

+ Helmholtz Ctr Potsdam, GFZ German Res Ctr Geosci, Potsdam, Germany.

Addresses:

+ [1] Helmholtz Ctr Potsdam, GFZ German Res Ctr Geosci, Potsdam, Germany
+ [2] Univ Concepcion, Dept Geofis, Concepcion, Chile
+ [3] Free Univ Berlin, Inst Geol Sci, Berlin, Germany
+ [4] Univ Chile, Natl Seismol Ctr, Santiago, Chile
+ [5] Ohio State Univ, Sch Earth Sci, Columbus, OH 43210 USA

E-mail Addresses:jbed@gfz-potsdam.de

Publisher

NATURE PUBLISHING GROUP, MACMILLAN BUILDING, 4 CRINAN ST, LONDON N1 9XW, ENGLAND

Journal Information

- **Impact Factor:** Journal Citation Reports

Categories / Classification

Research Areas: Science & Technology - Other Topics
Web of Science Categories: Multidisciplinary Sciences

Document Information

Language: English
Accession Number: WOS:000529600500013
PubMed ID: 32350476
ISSN: 0028-0836
eISSN: 1476-4687