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Supplementary information

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

In the format provided by the authors and unedited

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Video legends for the supplementary videos accompanying the study:

Months-Long thousand-km-scale wobbling before great subduction earthquakes (Bedford et al., 2020; Nature)

Video 1: Video showing the effect of removing common-mode noise and seasonal oscillations from the F3 daily GNSS displacement solutions. The colours correspond to the stations plotted in Figure 1a. Steps found imposed with (or found by) GrAtSiD have been removed and the time series have been detrended for clearer demonstration of the de-noising.

Video 2: Video showing the effect of removing common-mode noise and seasonal oscillations from the South American daily GNSS displacement solutions. The colours correspond to the stations plotted in Figure 1b. Steps found imposed with (or found by) GrAtSiD have been removed and the time series have been detrended for clearer demonstration of the de-noising.

Video 3: Video of daily displacement from Japanese F3 solutions modelled between 2006/01/01 and 2011/03/08 with GrAtSiD (seasonal, steps, and residuals removed to leave behind the first order polynomial and multi-transient terms only). Due to abundance of GPS stations, displacements have been spatially averaged: Median horizontal displacements of detrended time series for all stations within regions of approximately 2 x 2 degrees are represented by the green arrows and the scale is given by the black vector. Note that the velocities shown for each region have been evaluated from a minimum of three stations. Detrending is done by evaluating the median velocity of each time series and correcting for

this rate (as is done elsewhere in this paper where detrending has been applied). Vertical velocities are indicated by the colour scale, with red being uplift and blue being subsidence (cm/yr). Earthquake epicentres from the NEIC catalog are shown with red circles (magnitude scale shown by red-dashed circles).

Video 4: Same as Video 3, except for a shorter time period (2010-09-01 until 2011-03-08).

Video 5: Left panel shows the horizontal displacement of the pre-Maule network solutions in daily increments between 2005-01-01 and 2010-02-25. The time series have been modelled with GrAtSiD (seasonal, residual, and steps removed) before being detrended. We represent the median velocity within 5 x 5 degree regions to mitigate differences in the individual GrAtSiD solutions that would otherwise appear noisy in the video. Right panel Shows the same processing flow as the left panel but for the vertical component. Earthquake epicentres from the NEIC catalog (occurring in the final day of the time period of each frame) are shown with red circles (magnitude scales shown with dashed red circles).

Video 6: Same as Video 5, except for a shorter time period (2009-04-01 until 2010-02-25).

Video 7: Top panel shows the kinematics on the fault for an individual model using the displacements determined that day (green vectors in the bottom panels). Red indicates up-dip dislocation, and blue indicates down-dip dislocation. Note that this model projects the source of all deformation onto rectangular faults that follow the geometry of the subducting Pacific and Philippine Sea plates – whereas dislocation along these fault planes might not be the actual deformation mechanism. Model displacement predictions are shown with gold arrows in the bottom panels. The elastic dislocation solution (top panel) is also projected onto both bottom

panels with the same colour scale. Note, that for days when too many data are unavailable, the kinematic model is not plotted. The threshold for this case is when, across each region on the surface from which surface velocities are averaged, there median percentage of available data is less that 20%.

Video 8: Video of the horizontal daily displacements modelled from the PPP solutions of pre-Tohoku-oki earthquake for the time period 2010-01-01 until 2011-03-08. GrAtSiD modelling and calculation of daily displacements is the same as explained in videos 1-4. To mitigate differences in the individual GrAtSiD solutions that would otherwise appear noisy in the video we calculate median de-trended displacements in 10 x 10 degrees regions. We see that the wobble is also captured in the horizontal PPP solutions.