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Analysis of surface deformations related to the 2010 Maule earthquake based on GPS data

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The Chilean subduction zone is one of the most seismically active regions on Earth, due to the shallow depth of the seismogenic zone in combination with the high coupling coefficients and high plate convergence rate. On February 27, 2010, the Maule earthquake, which is one of the strongest instrumentally registered megathrust earthquakes, occurred in Darwin seismic gap – a seismically calm zone existed near the coast of Chile since 1835. We use the keyboard model of generation of strong subduction earthquakes [Lobkovky et al., 1991] to analyze the peculiarities of seismic deformation cycle (SDC) related to the Darwin seismic gap and the 2010 earthquake. Keyboard structure of the South American continental margin near the source zone of the Maule earthquake is confirmed by seismological and geological data. Using of keyboard model allows us to associate interseismic, coseismic and postseismic deformations observed by satellite geodesy with the action of particular geodynamic processes and, therefore, to study their features. To achieve this aim, we analyze the data of almost 10 years of continuous observations at 76 stations of the Chilean GPS network deployed along the source zone of the 2010 Maule earthquake. The analysis of variations in surface deformation fields is based on displacement rates fields of GPS stations estimated over 1-year intervals. On the basis of registered coseismic displacements we construct a model of slip distribution in the source zone of the Maule earthquake and determine the magnitudes of instantaneous shifts of seismogenic blocks towards the ocean, which reached 1-3 meters. In the first two years after the 2010 earthquake GPS stations shift toward the ocean over the whole Central Chile region, which indicates passing of aftershock stage of the SDC. Over the next 7 years of observations, the observed displacements can be mainly explained by the process of restoring the stationary state of stress accumulation for seismogenic blocks in the frontal part of the subduction zone in combination with the continuing displacement of the rear massif by a viscous asthenospheric flow. To assess the time of transition of seismogenic zone to stationary state of accumulation of elastic stresses we construct models of frictional afterslip and viscoelastic relaxation in the asthenosphere. The durations of the afterslip and viscoelastic relaxation processes for the Maule earthquake are according to our estimates about half a year and more than 15 years respectively. Understanding of the features of the SDC plays a significant role in the seismic hazard assessment of the Maule and Biobio regions of Chile.