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Monitoring surface deformation during the seismic cycle at natural and artificial active continental margins

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Active continental margins are the Earth's principal regions of significant earthquake hazard. Some 90% of global seismicity and nearly all interplate megathrust earthquakes with magnitudes >8 occur in the seismogenic coupling zone between the converging plates. At the Chilean convergent margin the largest instrumentally recorded earthquake occurred in 1960 near Valdivia (Mw = 9.5).

The TIPTEQ project (from The Incoming Plate to mega-Thrust EarthQuake processes) studies the processes, which generate large subduction earthquakes. Amongst 13 TIPTEQ subprojects, the presented study aims at imaging and identification of typical patterns of seismogenic surface displacements. For this we combine geodetic techniques and analogue simulations at the scale of the seismic cycle. The earthquake simulations include rate- and state-dependent frictional-elastic and viscoelastic rheologies and are monitored by a high spatio-temporal resolution image acquisition and correlation system. The obtained 3D information about surface deformation is then reduced to datasets, which are directly comparable to natural DInSAR and GPS datasets.

The European Remote Sensing satellites (ERS-1/2) acquired global Synthetic Aperture RADAR (SAR) scenes with a recurrence of 35 days. Using these data the Interferometric SAR (InSAR) technique provides the determination of a Digital Elevation Model (DEM) with height accuracy in the order of ten-of-meters. Two overlapping SAR scenes with certain attributes (small baseline, high coherence etc.) are necessary to carry out the InSAR processing chain to determine the topography. If additional SAR scenes or an independent DEM are available, the enhanced method Differential InSAR (DInSAR) provides the unique possibility to determine changes of the topography in the order of centimetres between well conditioned scenes on a large scale (about 100 x 100 km).

In our study area, the coastal region of the South American active margin in central Chile between 22˚ S and 30˚ S, we apply the DInSAR technique to quantify co-, post- and interseismic surface deformation. These snapshots of the seismic cycle will be compared with results from analogue seismic cycle modeling and GPS campaigns to improve seismic hazard assessment strategies. Furthermore we contribute to a refinement of an existing finite element model of this area.