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Broadband characterization of large subduction earthquakes through the combination of coherent rupture imaging and kinematic modeling

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In recent years the seismic observation has made a huge leap forward in terms of coverage and density of recording stations. This instrumental effort has fostered the development of new approaches to the study of the seismic rupture, which can potentially support and complement the classical finite source kinematic modeling.

The availability of dense seismic arrays makes today possible to image the earthquake extended source through the coherent interferometry of the wave radiation emitted during the rupture propagation. One of the advantages of this approach is to deliver images of the source emissivity that do not need a-priori information on the rupture speed or on the fault geometry, while they can constrain these parameters for kinematic inversion. Moreover, coherent interferometry provides intrinsically high frequency images of the rupture, since it works at frequencies that are generally one or two order of magnitudes higher than those used for kinematic slip inversion.

The combination and the joint interpretation of coherent imaging and finite source slip modeling opens up new perspectives in the study of the rupture processes, in relation to the geometry and the strength of the fault asperities.

We effectively combined coherent rupture imaging and kinematic modeling for the study of the rupture process of two mega-thrust events: the 2010, Mw 8.8 Maule earthquake (Chile) and the 2011, Mw 9.0 Tohoku earthquake.
The joint analysis of the rupture images shows, for both the earthquakes, distinctive patterns in the space-time distribution of high-frequency emissivity and low-frequency coherent slip.
We interpret these results in terms of their implications on the geometry and mechanical properties of the subduction interface and the dynamical properties of the rupture.