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Multiple seismological observations of the prompt elastogravity signals highlight their potential for earthquake monitoring

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In the time window between earthquake origin time and P-wave arrival, a high-quality seismometer records more than the usual seismic noise. Indeed, large earthquakes displace huge quantities of mass, resulting in tiny gravitational changes that take place everywhere, immediately after the earthquake initiation. The associated signals (referred to as prompt elastogravity signals - PEGS) therefore have the potential to provide information on the earthquake global characteristics, more quickly than any other seismic data.

The recent first observations of the PEGS induced by the 2011 Mw=9.1 Tohoku megathrust earthquake generated interest in how these signals might best be observed, especially for lower magnitude events. We will show that clear PEGS are observed for all types of large earthquakes, as illustrated by the observations made during the 2012 Mw=8.6 Wharton Basin earthquake (strike-slip) or during deep earthquakes (the 2018 Mw=8.2 Fiji and 1994 Mw=8.2 Bolivia events). Detection is even improved when an earthquake is recorded by a number of good-quality stations, allowing for stacking techniques. Thanks to the deployment of the USArray network across Alaska, the recent 2018 Mw=7.9 Off-Alaska earthquake (strike-slip) is thus observed with an excellent signal-to-noise ratio. Array stacking is also shown to reveal the PEGS induced by the large 2010 Mw=8.8 Maule megathrust earthquake, for which individual observations are impeded by the long-lasting radiation generated by a distant large earthquake. As a whole, PEGS have now been observed and successfully modeled for six earthquakes in the [7.9 - 9.1] magnitude range.

These findings demonstrate that, even without considering promising future instruments, PEGS detection is not restricted to exceptional events, confirming their potential for magnitude and focal mechanism determination within the few minutes following a large earthquake. In the context of the South America margin, we will finally review which kind of future earthquakes could be detected with the existing instrumentation, and how this detection threshold could be lowered by arrays of seismometers in the sub-Andean domain.