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# A new instrument in earthquake early warning system by detection and modeling of prompt gravity signals

Kevin Juhel[1], **Jean-Paul Montagner**[1], Jean-Paul Ampuero[2], Matteo Barsuglia[3], Pascal Bernard[1], Giovanni Losurdo[4], and Martin Vallée[1]

[1]I.P.G. - Paris, Laboratoire de Sismologie, Paris, France (jpm@ipgp.fr)
[2]IRD, Université Côte d'Azur, Sophia-Anipolis, France,
[3]A.P.C., Université de Paris, Paris, France
[4]I.N.F.N., Pisa, Italy

The recent finding of prompt elastogravity signals (PEGS) before the arrival of P-waves, associated with the M9.1 2011 Tohoku earthquake (Montagner et al., Nat. Comm., 2016; Vallée et al., Science, 2017) and a few earthquakes of magnitude larger than 8.5 (Vallée and Juhel, JGR, 2019) opens the new field of speed-of-light seismology. The systematic detection of PEGS on real-time might help saving a few seconds before the arrival of destructive seismic waves and to obtain an accurate determination of the magnitude of the earthquake at the end of rupture. So the potential application to earthquake early warning is obvious.

However, the use of classical broadband seismometers for detecting PEGS has severe limitations for detecting earthquakes of magnitude smaller than 8.5: first of all, the background seismic noise and second of all, the partial cancellation of the gravitational perturbation by the inertial induced acceleration recorded by seismometers (Heaton, Nature Comm., 2017). Two different approaches can be explored for detecting for earthquakes of magnitude smaller than 8.5. Either, by using a dense array of broadband seismometers (more than 100 receivers) or by designing completely new instruments such as gravity strainmeters. These new detectors must be able to measure the difference in gravity acceleration between two masses, making this instrument isolated from the seismic noise. A sensitivity of $10^{-15}$ $Hz^{-1/2}$ at 0.1 Hz is required for detecting earthquakes of M>7 (Juhel et al., JGR, 2019) and the technology developed by the gravitational wave physicists can be used for reaching such a sensitivity. The simulation of the expected gravity strain signals based on analytical model of gravity perturbations associated with a network-based matched filter approach show that a network of 3 gravity strainmeters might make it possible to reach such a challenging goal. Gravity strainmeters could therefore open new ways to investigate the first seconds of the earthquake rupture, speed up the estimate of earthquake magnitude, enhance tsunami warning systems and complement other EEWS in the future.