The Benefit of Hindsight in Observational Science

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ABSTRACT
Usually seismic interferometry is used to perform seismic tomography of the Earth's subsurface using only background vibrational noise. Seismometers can be turned into virtual (imagined) sources of energy that produce real seismograms. Real energy sources (e.g., earthquakes or active-source seismic shots) can also be turned into virtual seismometers perhaps deep inside the solid Earth. Interferometry also provides novel schemas for computational modelling of acoustic, elastic and electromagnetic phenomena, and embodies completely new Optical Theorems of Physics.

In this talk I will focus on some of the most recent interferometric advances using the theory of Source-Receiver Interferometry (SRI: Curtis and Halliday, 2010). SRI allows us to record earthquake seismograms on seismometers that were installed (perhaps years) after the earthquake occurred - a result that can be generalised to acoustic, electromagnetic, electro-kinetic and a range of other phenomena. This offers the benefit of hindsight in observational science since receivers can be physically installed in the knowledge of where an event of interest has taken place, and recordings of the event can still be obtained. SRI also provides new generalised, nonlinear methods to form seismic images of the Earth's interior using active sources. In addition, SRI leads to data-driven methods to decompose observed multiply-scattered wavefields into their constituent inter-scatterer components. I will introduce the theory of SRI, then these various results, and will discuss their applications and implications.