

Forces on Top of the Earth and the Seismic Waves They Produce

Rivers, glaciers, volcanic eruptions, landslides, hurricanes, and ocean waves all exert transient forces on the surface of the solid Earth. In all of these cases, the transients can be large enough in an appropriate frequency band to produce observable seismic waves. Recent studies have shown that seismology can be used to determine equivalent force systems and provide insights into the coupling processes. The combination of pervasive global networks and dense, high-frequency instrumentation have allowed the new observations. Seismology can be useful for accessing difficult to measure quantities. For instance, rivers produce seismic signals that can be interpreted as indicative of rock movement during storms. Similarly, single force source models can be interpreted to reflect mass discharge in explosive volcanic eruptions. In addition, sometimes seismology reveals qualitatively new processes, such as the stick-slip behavior of the Whillans Icestream. This discovery provided important information for glaciologists on the range of slip behavior possible on glaciers. The glacial slip events also provide constraints on the special conditions that can lead to slip predictability of earthquakes. The primary challenge facing seismologists has been to understand the underlying physics of the surface processes well enough to pose appropriate questions for the observations.