Imaging Cascadia coupling: optimal design for an offshore seafloor geodetic network

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The Cascadia subduction zone in the Pacific Northwest of the United States of America is known to produce magnitude 9.0 earthquakes and accompanying tsunamis, most recently in 1700. Terrestrial geodetic observations, including those from GNSS, are commonly used to image strain accumulating on a fault before it is released in an earthquake. Seafloor geodetic technology, which combines GNSS and underwater acoustic ranging (GNAA-A), enables previously inaccessible observations of the earth's surface to better image seismogenic portions of the Cascadia subduction zone. However, these seafloor geodetic instruments, and the time and logistics associated with making such observations, can be cost-prohibitive. It is important to identify where deploying seafloor geodetic instruments will provide information that cannot be obtained through a similar investment in onshore geodetic networks. To identify optimal locations for future geodetic observations we take advantage of the theory of information entropy. Information entropy is a measure of the amount of missing information about parameters whose values are uncertain. In this case, the uncertain parameters are subduction zone locking and tectonic block motions within a kinematic block model of Cascadia tectonics. We identify optimal seafloor observation locations by minimizing the information entropy due to adding new observations. This study will establish the degree to which testing hypotheses about subduction zone behavior and mapping potential future earthquake hazard requires offshore geodetic observations in addition to conventional onshore observations.