The Need to Extend the Cascadia Initiative Two More Years: Enabling Definitive Results for a Critical Region

Emily Roland, Paul Bodin, Joan Gomberg, Heidi Houston, John Vidale, Will Wilcock
University of Washington

We propose that, in order to optimize the value of the Amphibious Array (AA) to both the scientific community and to society, OBS deployments in Cascadia continue at a reduced level for two more years, augmented by funding to process the results to a more broadly useful state. Specifically, this extension would redeploy in offshore regions with poor data return and where the science objectives require longer deployments. It would also construct a protocol to generate necessary basic data products that would be used widely by the scientific community. The latter would make AA data much more useful not only in the case of Cascadia, but from all future regions of study.

The defining feature of the AA is its amphibious nature. The greatest potential scientific gains come from integrating its onshore and offshore components across the land-sea boundary, providing the capability to observe plate boundary behavior from the trench to the frictional transitions well inland.

Historically, the Cascadia Initiative (CI) deployment of the AA was brought to fruition by the sudden availability of ARRA funding. Through heroic and remarkable efforts, OBS instruments were produced and offshore deployments were accomplished quickly. Guiding the deployment plan were scientific objectives outlined in the 2010 Portland workshop. The objectives emphasized the importance of illuminating the patterns of seismicity and characterizing the transitions between locked and slipping behavior on the thrust interface. As a first-of-its-kind monitoring experiment, CI has inevitably been a learn-as-you-go process with many technical issues being addressed. Even in the third year, portions of the deployment have faced challenges that have limited the total data return, particularly in the shallow-water environment, where the continental shelf and slope overlie the locked portion of the subduction interface in Cascadia. Moreover, integrated and community accessible data products, such as noise-optimized data channels and an earthquake catalog that combines on and off-shore data, have been slow in coming or are not yet even planned. The process of generating such products would facilitate the finding and fixing of data shortcomings; indeed this was a validated motivation underlying the products generated by Earthscope’s Array Network Facility. This would enable researchers to spend their efforts probing beyond the tedious generation of these basic products, on to the exciting science that is built on them. Proposals to make these foundational, ‘routine’ products often do not fare well in research panels, when competing with others offering exciting novel science. Development of these products, aided by strategic continued deployments to fill critical gaps in offshore recordings, should be considered part of the operational facility, and funded accordingly.

The bottom line is that the community has not had adequate time to acquire, evaluate and use the data from the CI deployment. We propose that the resources for the enhanced
facility noted above, and costs of ‘learning from where we went’, be realized by extending the AA in Cascadia for an additional two years, with a reduced scope of OBS deployments over the subduction margin. Much of the onshore portion of the AA in Cascadia may remain in place permanently, operated by other agencies. The geodetic array onshore will stay, and the State of Oregon is attempting to purchase the 15 AA seismic stations in the state for permanent operation. We are seeking similar funding to retain the 7 sites in the State of Washington, perhaps in support of earthquake early warning. If (when?) early warning is implemented, the broadband coverage on land will be substantially fortified.

In addition to the practical benefits of our proposal for an additional two-year, scaled-down field deployment of the AA in Cascadia, there are great potential scientific payoffs. Recent global studies have highlighted a number of important geophysical processes to look for in Cascadia that a couple more years of optimal operation would facilitate.

Since the CI deployment started, we have seen important signals from offshore networks in other subduction zones that may have significant implications for Cascadia. These include observations of tremor from OBS data in New Zealand (Wech et al.) and in Japan, and important patterns of seismicity and deformation related to megathrust earthquakes in Japan and Chile. For example, prior to the 2011 Tohoku-Oki and 2014 Chile earthquakes, slow migrations of seismicity shallow in the subduction zone appear to indicate slow slip transients in the vicinity of the subsequent great earthquake hypocenters (e.g., Kato et al. 2012; Kato and Nakagawa 2014). It is crucial to lay the foundation for monitoring offshore seismicity in Cascadia. But, although CI instruments have recorded seismic phenomena associated with slow slip (i.e., repeating earthquakes), due to both relatively low data return from focus-array CI instruments and as yet insufficient time to compete analyses of the available data, it is currently unclear whether slip transients updip of the locked zone occur in Cascadia. Completely removing the marine portion to deploy in another region might cause us to miss such patterns.

Furthermore, a few more years of CI data may allow for important advances in ground motion simulation, that likely will be difficult to achieve with the sometimes-problematic data acquired in years 1-4. Both recordings of moderate and large offshore earthquakes and noise recordings for Greens Function correlation will prove useful in assessing risk of strong motion.

Workshop attendees should discuss which mix of community-driven OBS redeployments and amphibious data products would best comprise a ~2-year extended Cascadia Initiative. We suggest that these deployments factor in these goals:

I. Advance ‘routine’ but necessary activities such as:
   • production of an amphibious earthquake catalog
   • noise characterization and suppression via “shield” design and vertical-channel noise reduction on the horizontal channels.
   • merging complete onshore and offshore data compilations (including contributions from Regional Seismic Networks)
   • producing “envelope” functions that reveal tremor episodes
The methods and procedures used in these activities will also serve as prototypes to increase the efficiency and effectiveness of future deployments.

II. Identify seismicity and possible slow slip from seismic or other signals, particularly in the shallow reaches of the subduction zone. Recent cases in Japan and Chile prior to recent destructive great earthquakes highlight the importance of this effort for both subduction-zone science and societal hazard.

III. Use noise-derived empirical Greens functions to determine potential ground motions from future megathrust earthquake (where no earthquake data are available).