Insights from Operations of the U.S. Ocean Bottom Seismograph Instrument Pool

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OBSIP Overview

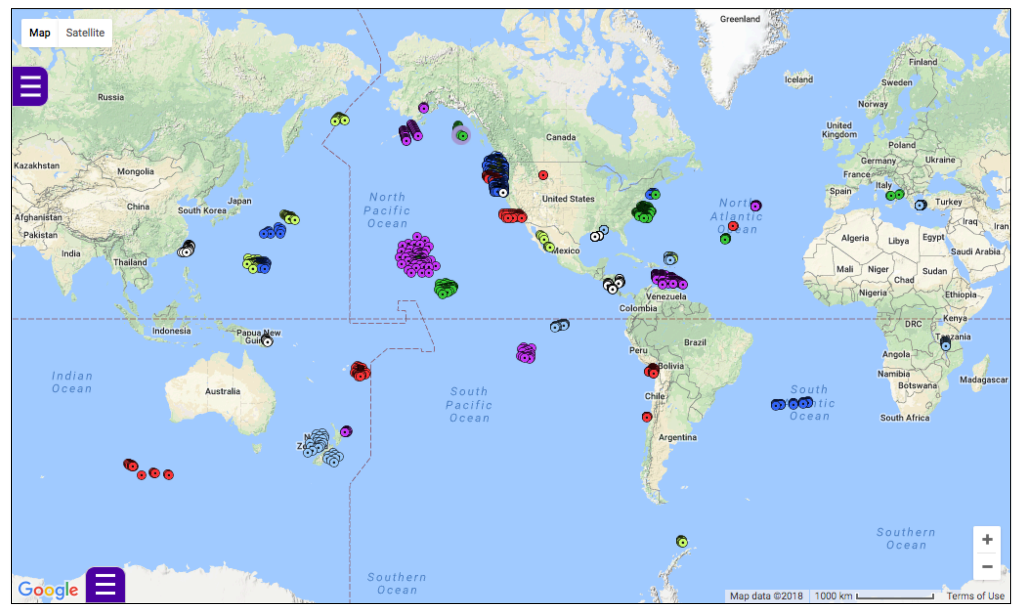
The Ocean Bottom Seismograph Instrument Pool was established in 1999 as a National Science Foundation (NSF) facility that provides ocean bottom seismometers to support research and further our understanding of marine geology, seismology, and geodynamics.

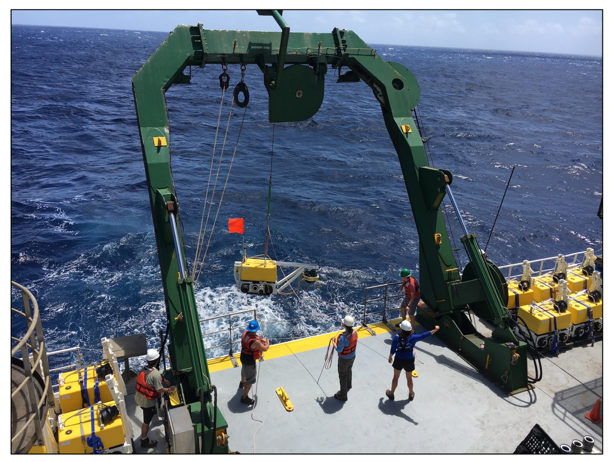
OBSIP is funded by NSF and is currently comprised of a Management Office (IRIS) and three Institutional Instrument Contributors (IICs): Lamont-Doherty Earth Observatory (LDEO), Scripps Institution of Oceanography (SIO), and Woods Hole Oceanographic Institution (WHOI).

OBSIP operates both short period (SP) instruments and long period/broadband (LP) instruments with a variety of capabilities to operate in shallow or deep environments for both short and long durations.

OBSIP Instrument Pool Holdings

	SP	LP	Cascadia (LP)	Total
LDEO	-	30	29	59
SIO	60	39	15	114
WHOI	30	30	20	80
Total	**90**	**99**	**64**	**253**

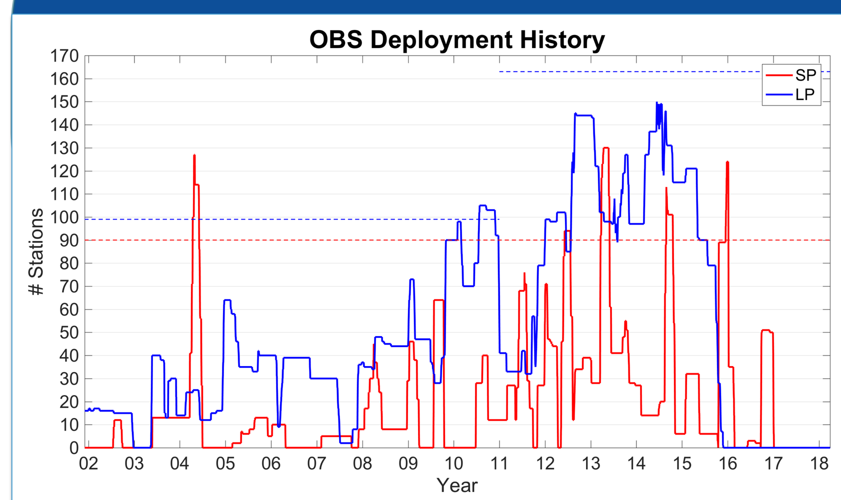




Preparing to release a SIO OBS from the R/V Kilo Moana (April 2018)

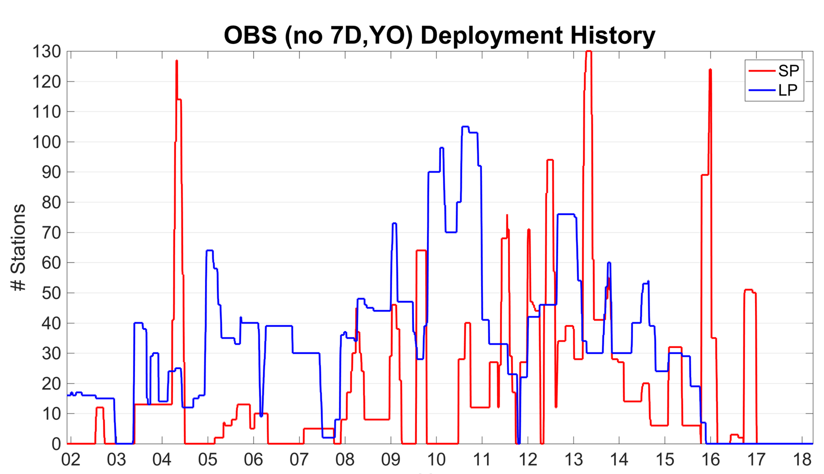
Since 2001 there have been 55 SP, LP, and mixed-mode OBSIP experiments in a wide variety of marine environments. Nearly all of these have been archived with IRIS and are discoverable via the metadata aggregator (ds.iris.edu/mda/) and OBSIP website: www.obsip.org/experiments/experiment-table/

Instrument Usage

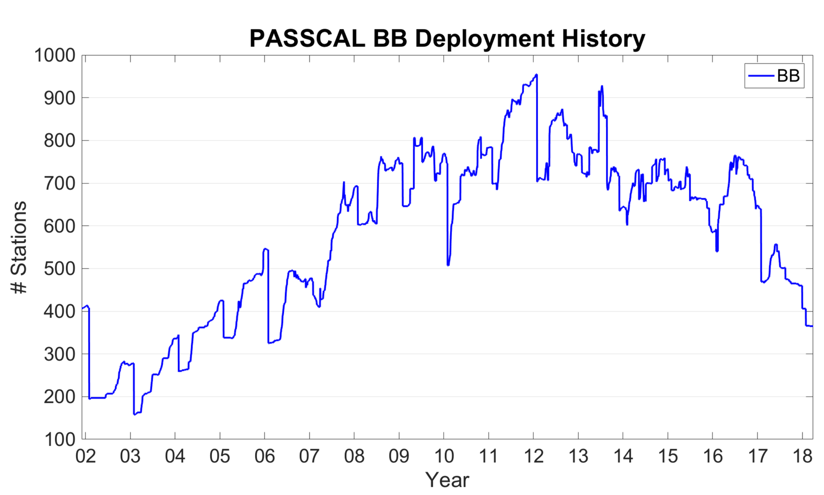


Left: OBSIP utilization starting on 12/1/2001, with one month padding pre- and post-deployment to account for staging and shipping equipment. Dashed lines mark the size of the pool (~99 LP pre-2011, ~163 LP after, 90 SP throughout). Instruments, especially SPs, may be deployed more than once during a cruise and thus in a few cases counts may appear to exceed inventory.

Right: OBSIP utilization excluding the ENAM and CASCADIA community experiments.



It appears that at present funding levels an instrument pool of 90 SP instruments and perhaps as few as 70-80 LP instruments may be adequate for typical pool usage (i.e., excluding periods of major community experiments).

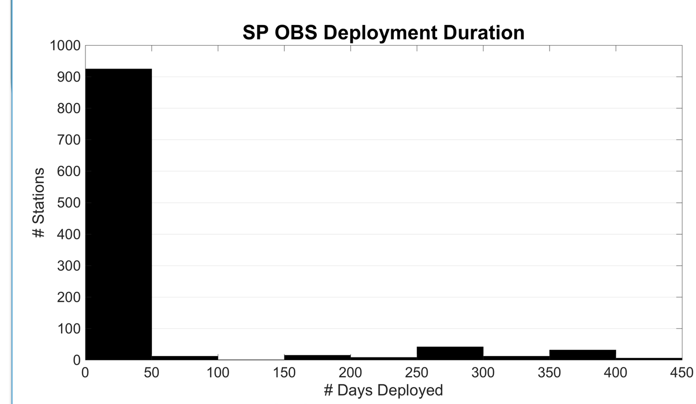


Left: Utilization of PASSCAL broadband instruments during OBSIP, also starting on 12/1/2001 and including one month before and after deployment.

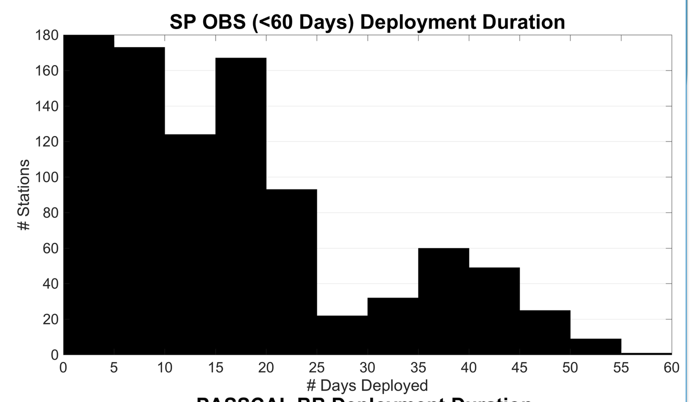
PASSCAL usage may indicate what the actual underlying demand may be were it possible to operate or deploy as many OBS as land instruments.

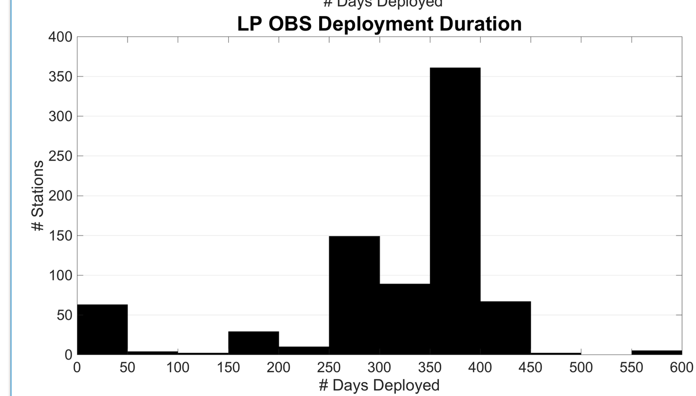
Characteristics of Deployments

Duration

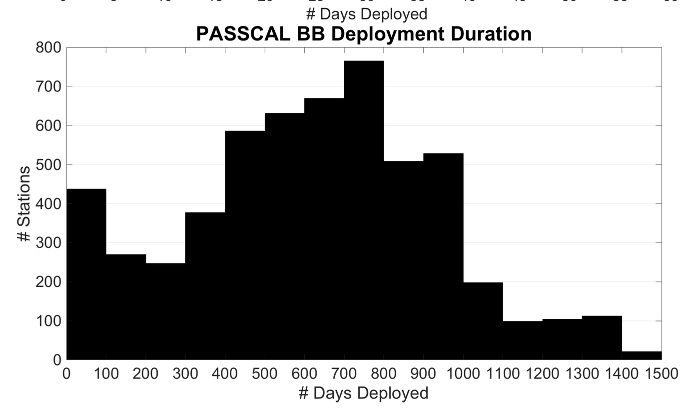


Histogram of deployment duration for all SP experiments (left) and only short duration uses (right).



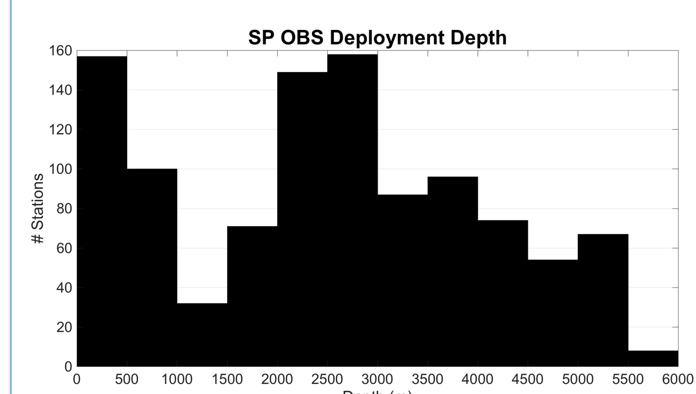


Histogram of deployment duration for all LP experiments (left) and all PASSCAL broadband experiments during OBSIP (right).

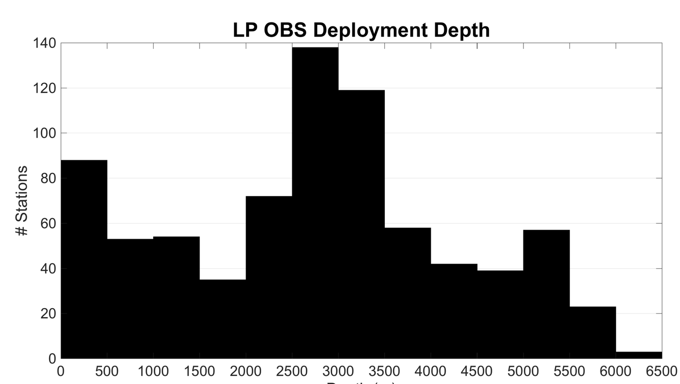


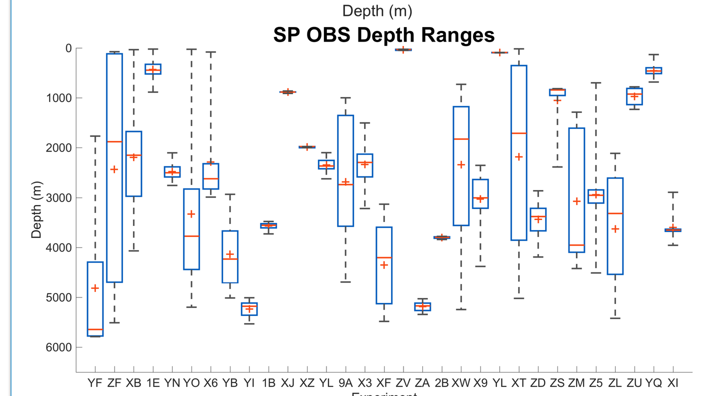
Deployment duration is clearly limited by instrument capabilities. Again, the comparison to PASSCAL may provide a better indication of durations driven by the science and not artificially limited by instrumental capabilities.

Depth



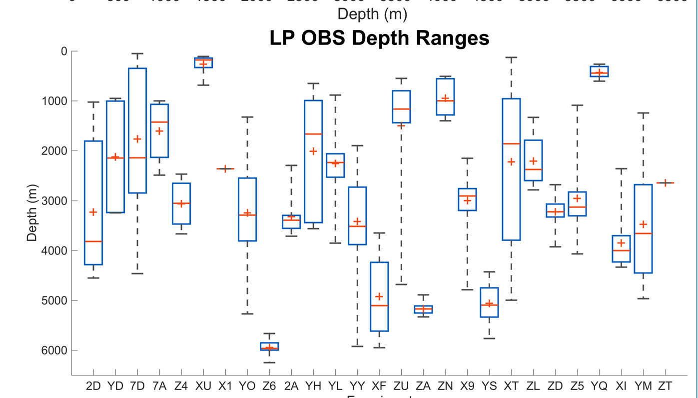
Depths deployed, all uses of SP (left) and LP (right) instruments.





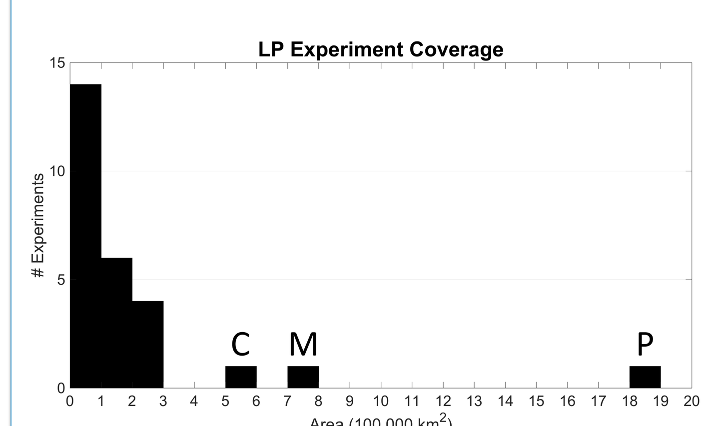
Depth ranges for each SP (left) and LP (right) experiment.

Symbols: mean (+), median (–), 25-75% percentile (□), min. & max. depths (--)

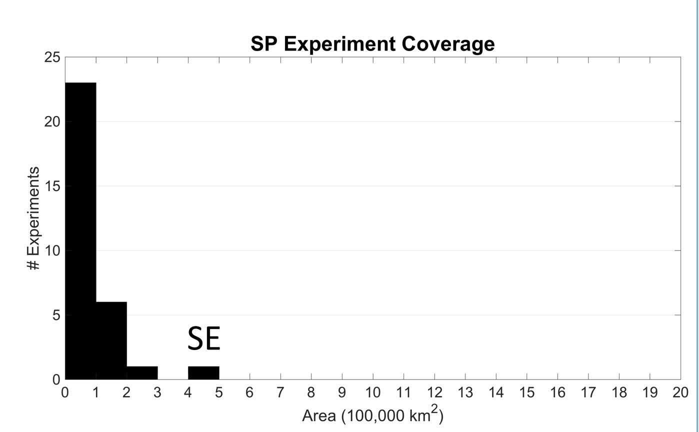


The deployment depth analysis indicates that it may be difficult to incorporate shallow-water-only instruments in the fleet (though such instruments may be cheaper to purchase and operate).

Areal Coverage

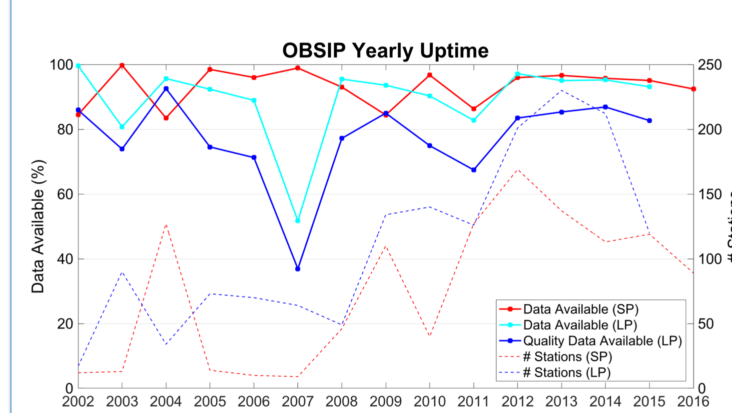


Areal distribution of LP (left) and SP (right) experiments. Outliers are the S.E. Caribbean Passive Experiment (SE), Cascadia Initiative (C), MOANA (M), and PLUME (P).



The analysis of areal coverage indicates that most experiments are deployed over areas that are less than ~300 x 300 km in dimension. The relatively modest inter-station spacing that is implied thus puts a premium on the ability to prepare and deploy instruments rapidly, with minimal on-ship preparation time.

Data Uptime



Left: For archived LP and SP experiments, we show the number of stations deployed and average yearly uptime using MUSTANG and LASSO. Mean data availabilities are 93% (SP) and 89.4% (LP). After discarding dead channels the quality data availability is 77% (LP).

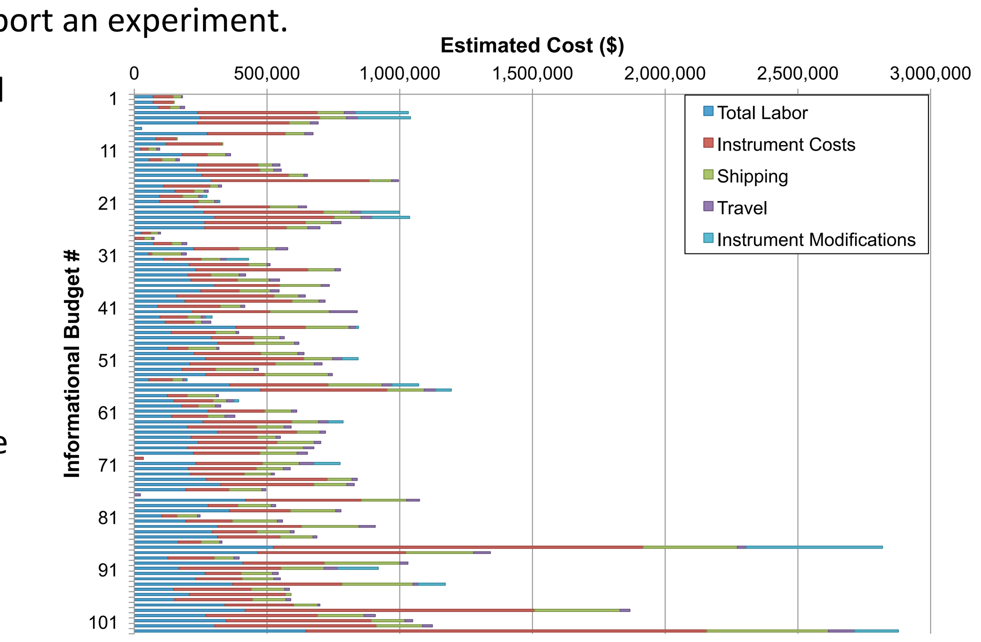
We can and should strive for better performance. Deployments on land typically achieve a mean uptime >85%. The differential between SP and LP likely indicates that the longer an instrument runs, the greater the opportunity for problems.

Cost Considerations

Proposals planning to use OBSIP include informational budgets produced by OBSIP management. IRIS has prepared 103 informational budgets during its operation of OBSIP since 2012. Only a subset of these experiments were eventually funded. Prior analysis indicates that informational budgets track reasonably well with funds actually expended to support an experiment.

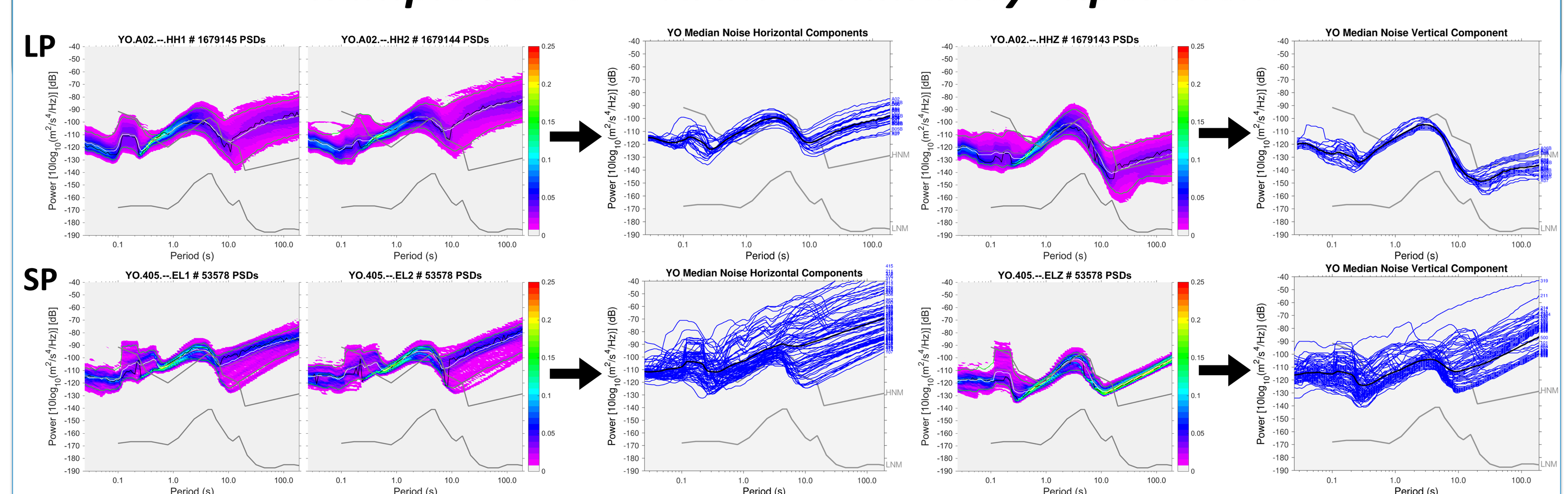
Right: A compilation of past informational budgets shows that the labor required to support the instruments and the actual instrument costs (largely batteries and drop fees) are the dominant cost drivers. Apart from ship-time considerations, the high current cost of performing OBS experiments makes it obvious why only a small number of experiments per year are funded.

A multi-faceted approach is required to reduce experiment costs.



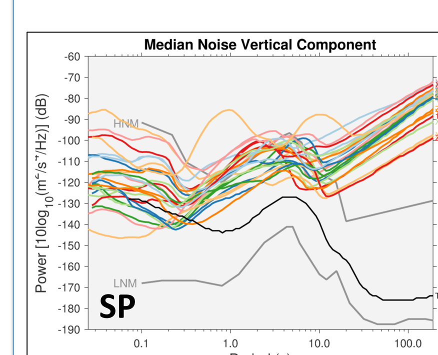
OBS Noise Performance

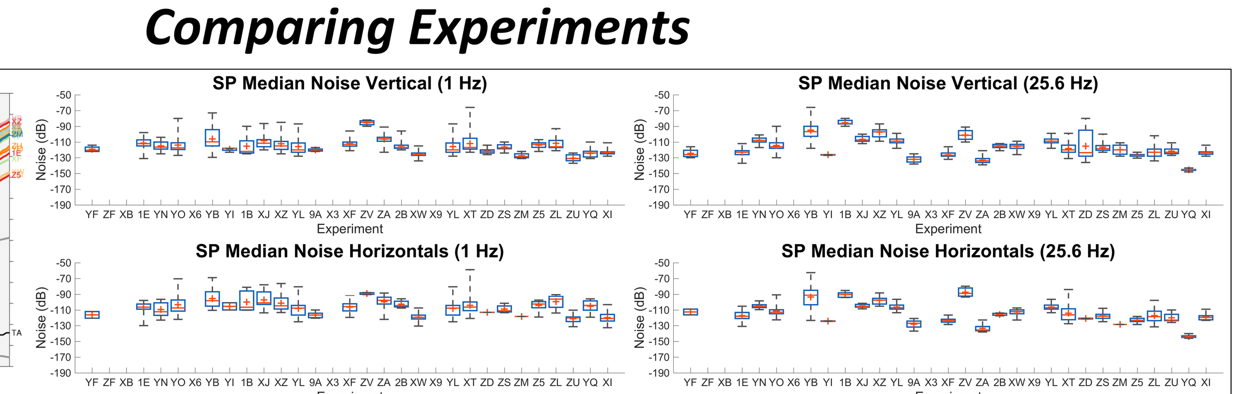
Example PSDs – ENAM Community Experiment

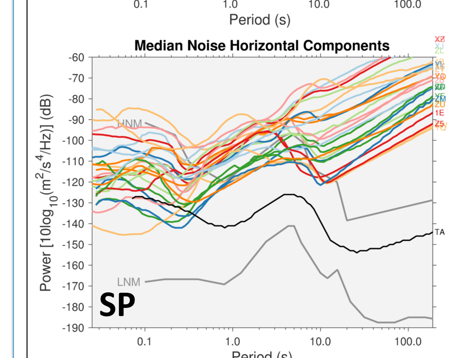


Above: Probability Density Functions of Power Spectral Density calculations for archived seismic timeseries, from the recent ENAM Community Experiment. From these we obtain the median noise performance for each component/station/experiment.

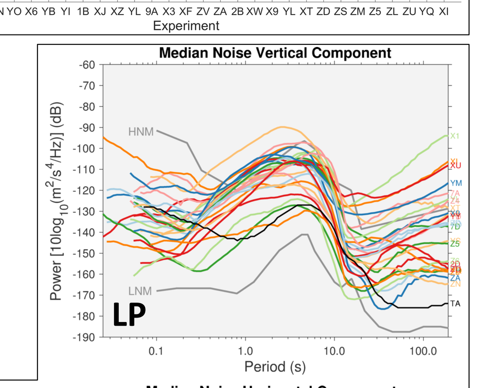
Comparing Experiments

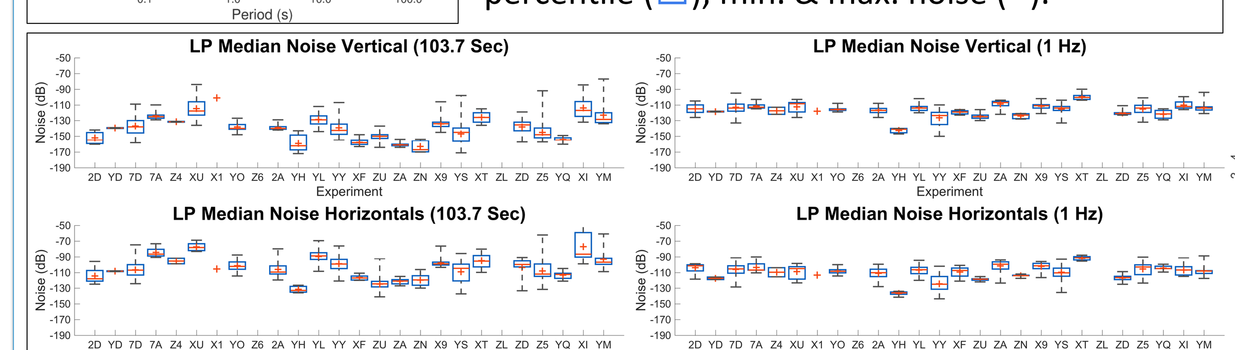


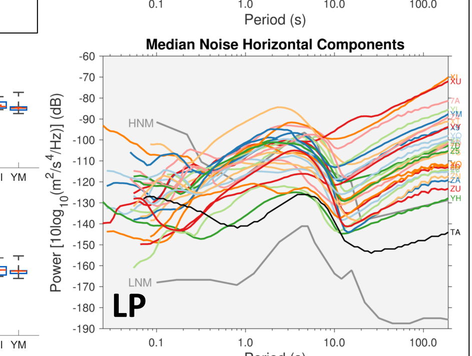




Comparing noise performance for SP (above-left) and LP (below-right) experiments. Each experiment is colored differently. The span of median noise for each station is encompassed in the range plots, ordered by experiment name. Symbols: mean (+), median (–), 25-75% percentile (□), min. & max. noise (--).







OBSIP deployments are typically noisy. Improved emplacement design and procedures have been shown to lower the noise level across a range of periods. More effort towards improved emplacement is critical.