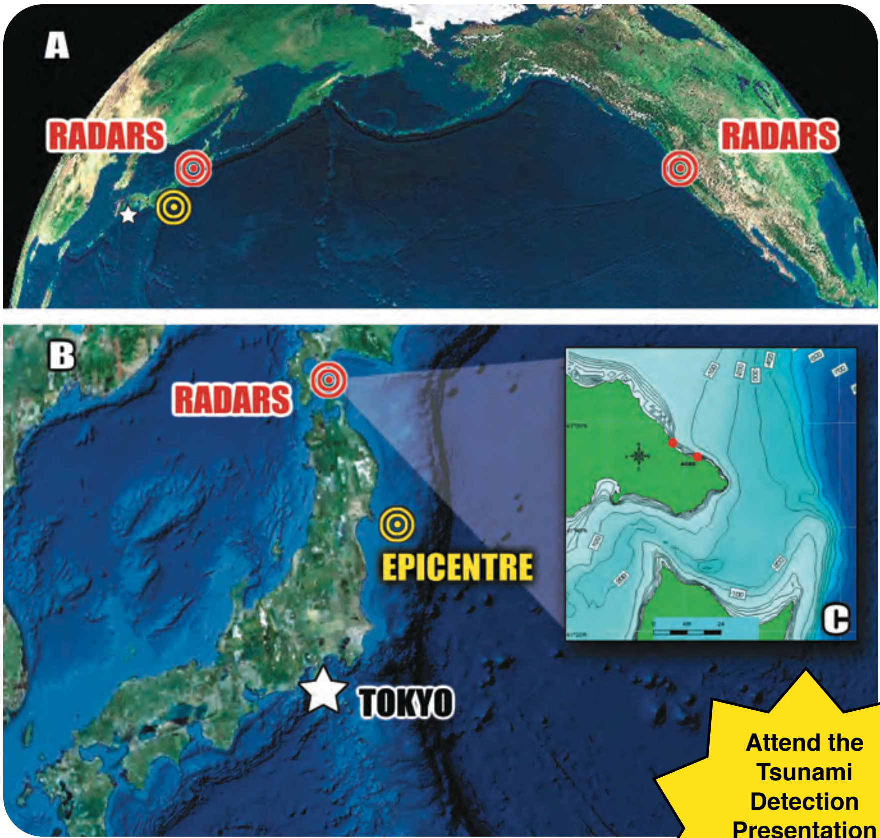
CODAR CURRENTS NEWSLETTER
CELEBRATING 25 YEARS 1986 ~ 2011
CODAR OCEAN SENSORS
THE LATEST IN HF RADAR TECHNOLOGY & APPLICATIONS
Spring / Summer 2011

SeaSondes See Japan Tsunami on Two Continents



Attend the Tsunami Detection Presentation by Dr. Barrick at Oceans '11 Kona

SeaSonde HF radars have been providing real-time data to agencies in several countries on both sides of the Pacific Ocean for more than a decade. This wide distribution made them well placed for detecting the March 2011 tsunami in a variety of locations and configurations. This article highlights several methods, radar frequency bands, and tide gage sensor measurements that all confirm the validity and robustness of SeaSonde tsunami detections.

Tsunami Detected by Multiple HF Bands
Two High-Res (42 MHz) SeaSondes installed on Hokkaido, northernmost of Japan's four main islands, were the closest to the earthquake epicenter and the first HF radar systems to observe the tsunami - as shown in the figure on the cover. Being close to the source, the ~40-minute period was clearly visible in the SeaSonde-observed surface current velocity data from both sites. Nine hours later and over 8000 km away, Mid-Range (13 MHz) and Long-Range (5 MHz) SeaSondes on the West Coast of the Continental U.S. were also observing the tsunami signature.

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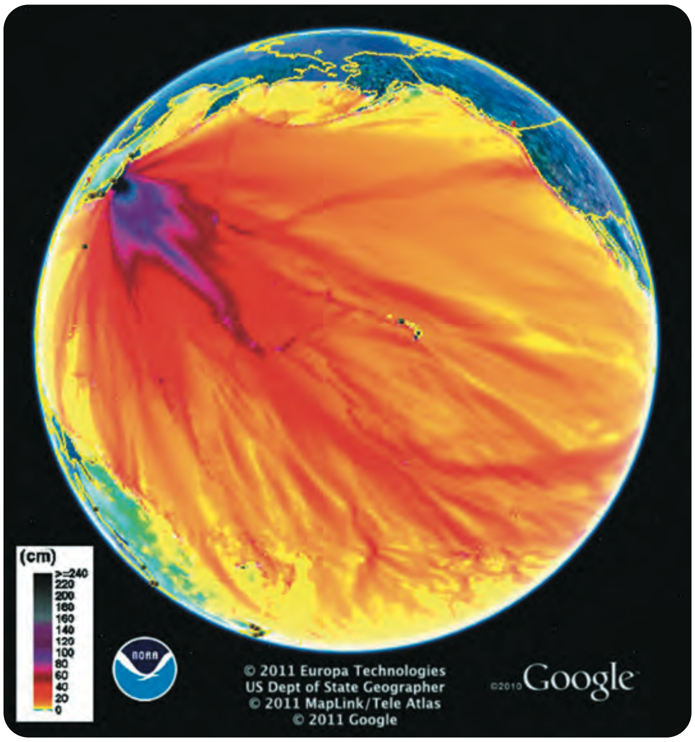
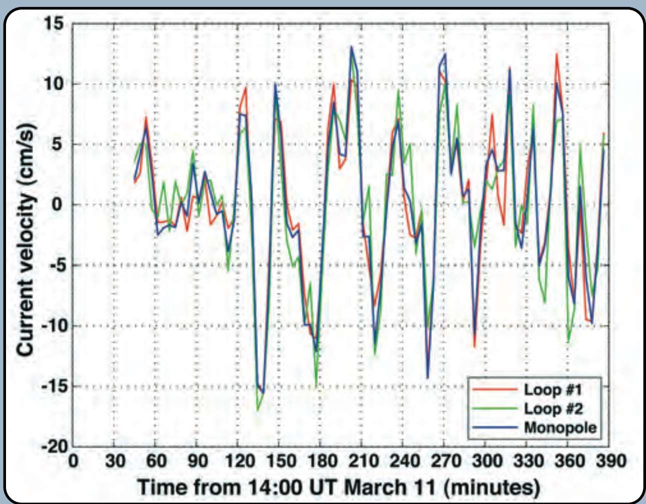
More complexity was observed in the measured periods (25 - 40 min) in the U.S. due to multiple paths and directions of arrival - as illustrated by the NOAA (http://nctr.pmel.noaa.gov/) tsunami wave energy map (shown at right). In all cases, the tsunami was observed at three different stages of current velocity processing and by sensors independent from the SeaSondes, as described below.



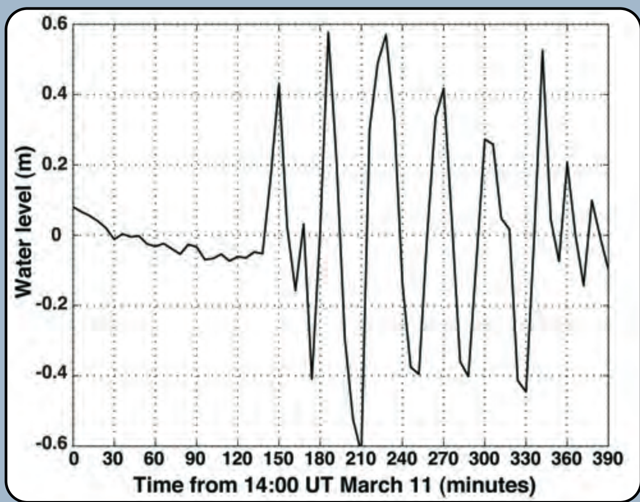
Tsunami Signatures Confirmed by Coastal Tide Gages

How do we know for certain we saw the tsunami? Tide gages on the coast give water level and, in the U.S., data from these are made available to the public by NOAA via website. Tide gages are meant to respond to the slowly varying tides with diurnal and semi-diurnal periods, but they see the tsunami signals very well. What do the tide gages tell us?

- Both sensors show a slowly varying tidal background until the tsunami arrived, when both observed the more rapid 25-40 minute period response - as shown below.
- Signals at the coast on the tide gages were delayed from those recorded by the radar offshore, from 10 to 30 minutes. The tide gages verified the SeaSondes were, in fact, capturing the tsunami event. One may ask the question why do SeaSondes measure the tsunami before the nearby tide gages do?
- The signals in the current seen by the radars offshore were further "upstream" toward the tsunami source. As it traveled across the ever-shallower water to get to the coast, it slowed down, as predicted by wave theory, over the path distances from 25 - 40 km.
- A quarter-cycle delay happens near shore between velocity and height. If the water starts at normal height and velocity begins to push the mass of water toward shore, it takes time for the height to increase. When the tsunami height reaches its maximum level, velocity must be zero or the height would continue to increase. For ~40 min period, the quarter cycle delay is ~10 minutes.
- The delay seen by the West coast radars and tide gages is about nine and a half hours, which is exactly as predicted for travel time across the Pacific based on both models and observations.



Radial current velocity measured from SeaSonde at Commonweal, 25 km Northwest of Golden Gate Bridge in California



Water level observed in San Francisco under Golden Gate Bridge

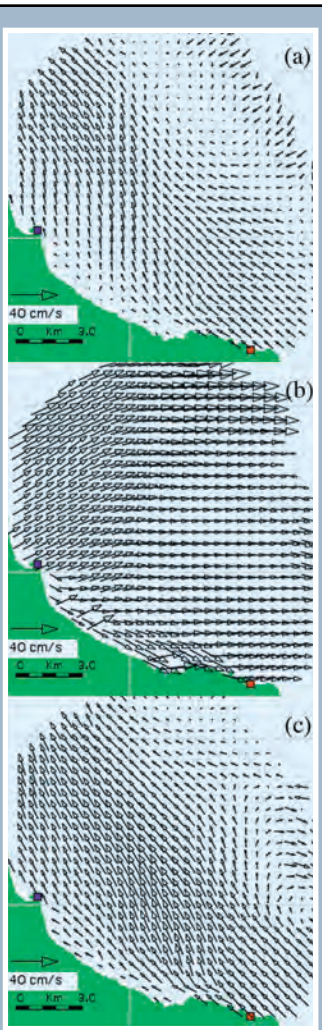
Optimum Sampling and Conditions for Tsunami Detection

There is a tradeoff between how often a radar can output information (temporal sampling resolution) and the increment of the observable data (velocity resolution). Since a tsunami is a hazardous event, it is natural to want the highest sampling rate possible. Theory and experience has proven, however, that if the velocity sampling is too coarse, it is of little or no value. For any 13 MHz radar regardless of its make or brand, a 30-second output means the best possible velocity resolution is 38 cm/s. This is nearly useless, because the tsunami generated currents seen by all of the radars had crest/trough values more like 10-20 cm/s. Using 4 minute outputs gives about 3.5 cm/s resolution, which does a nice job. With this sampling rate, 10 samples were available per tsunami period, which is more than adequate. The CODAR tsunami detection approach does not force any fixed sampling rate. Instead, several output rates (velocity resolutions) are computed simultaneously to maximize the possibility of detection and it has zero impact on standard current processing operations.

In addition to sampling rate, observation time before the tsunami reaches shore depends on water depth -- the shallower and longer the shelf, the greater the time to reach shore. Unlike the Mid-Atlantic states along the Eastern seaboard, both Japan and the U.S. West coast are not optimal with narrow shelves of shallow water. Yet, the tsunami was seen in all cases at distances to 20 km and water depths to 200 m.

Tsunami Signals in Multiple Stages of Processing

HF radar systems have several stages of data processing. Tsunami signals, in general, may be evident in three of them: Doppler Sea Echo Spectra, Radial Velocities and 2-D Current Vector Fields. The Japan tsunami was evident in all three stages of SeaSonde processing as described below:



- 2-D Current Maps: The HF radar output with which everyone is familiar are current vector maps requiring two or more coastal radars combining data. 2-D velocity fields show the onset of tsunami-generated currents is in figure at left. This method has the advantage of producing a nice image of the currents that is easily interpreted visually, but requires data to be transmitted between two or more sites and extra processing time. It is most useful for post-processing and analysis, but not real-time tsunami detection.

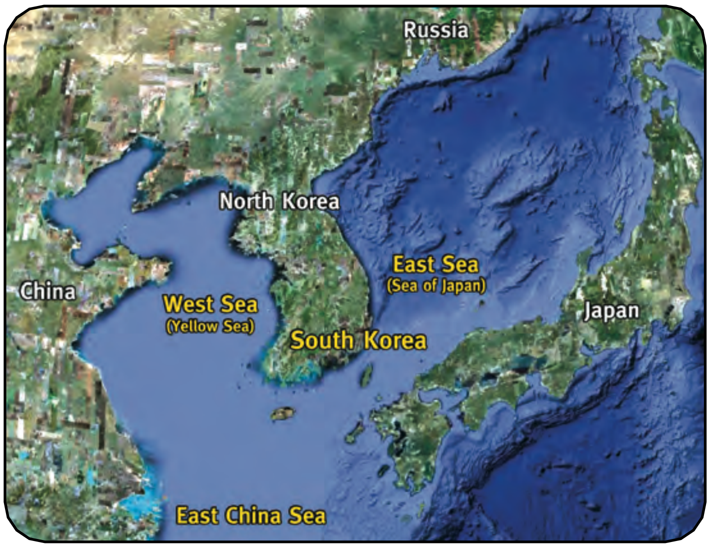
- Radial Velocity Maps Radial velocity currents from a single site provide robust data for tsunami detection and are the basis of CODAR SeaSonde Tsunami Software. Certainly the individual vectors can be post-processed to observe tsunami effects. More useful to quickly detect the onset of a tsunami is the CODAR tsunami detection pattern recognition software, which resolves the radial velocities sensed by a single radar into strips parallel to the bathymetry contours. Physics forces the velocity vectors to be essentially perpendicular to these contours, regardless of the direction of the epicenter source. Indeed, velocities resolved in this manner show the tsunami period, and also the variation with distance offshore that is expected.

- Doppler Sea Echo Stepping back even further in the processing stream (before the direction-finding method is applied and radial velocity maps are made), we looked at the variation in the width and centroid of the Doppler sea echo with time as a direct measure of the overall tsunami current. The results of this are illustrated in the time series figures shown above. This stage of processing is even faster to reach than radial maps and is the focus of future improvements to CODAR SeaSonde tsunami detection.

HF Radar Tsunami Detection First Described by CODAR

It was over 32 years ago that Barrick first described how an approaching tsunami could be measured from its HF radar-observed current pattern in a 1979 Remote Sensing of Environment article. With few HF radars operating at that time and sizable tsunamis being a rare or infrequent occurrence, this research went largely unnoticed for many years. Following the 2004 Indian Ocean tsunami, Lipa and Barrick revisited the topic by developing a tsunami pattern recognition algorithm that worked against the ambient background flows. The methods described in their 2006 paper formed the basis for the first and only commercial HF radar tsunami detection software package available on the market.

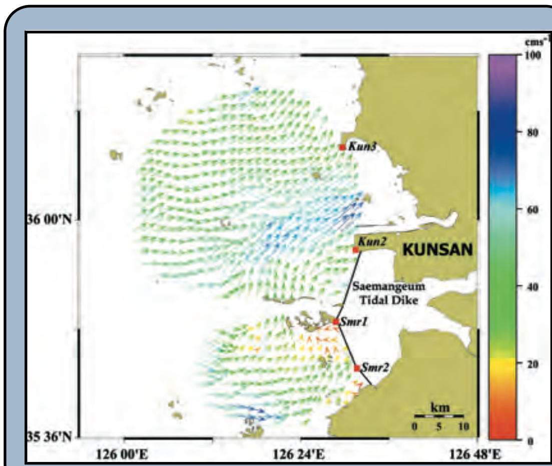
On The Radar: South Korea



Those who regularly read our newsletter know that we like to devote some space to showcasing the unique activities or research interests of SeaSonde users. This time, it occurred to us to showcase the activities of not just one particular customer, but those of an entire country. South Korea is nearly surrounded by water with the Yellow Sea (West Sea) to the West, the Sea of Japan (East Sea) to the East and the East China Sea and Korea Strait to the South. These bodies of water are shared with North Korea, China, Japan and Russia with the economies of each heavily reliant on them for shipping, aquaculture and tourism, among others. It makes sense, then, that South Korea has emerged as one of the most active countries in the world in building a national surface current monitoring program. By the end of 2011, South Korea will have more SeaSondes than any country outside of the U.S. and will lead the world in HF radars per length of coastline. South Korea's introduction to HF radar current mapping came in 1992 when some of the first SeaSonde production units were used in a short term demonstration near Kunsan for the Korean Ocean Research and Development Institute (KORDI). Several years later, the first units were purchased by Dr. Jae-Chul Lee of Pukyoung University in Busan. Since then, SeaSondes have been providing real-time current maps and wave parameters for a variety of customers and purposes all around this country.

SeaSonde Networks in Korea Today

Dr. Sang Ho Lee of Kunsan National University owns and operates a SeaSonde network that is mapping surface currents outside of the Saemangeum Sea Wall, the longest seawall in the world, located on South Korea's west coast. The sea wall was built between the Yellow Sea and the Saemangeum estuary as one of the largest land reclamation projects in history at 410 km². Dr. Lee's research has shed light on the effect the new seawall has on the circulation outside of the estuary. Since 2007, Dr. Kyung Tae Jung of KORDI and his team have studied the structure of changed flow after Saemanguem Sea Wall construction with Kunsan National University. Moreover, they introduced another SeaSonde network and finished studies to observe the current structure inside the Straits of Jeju.



The Korea Hydrographic and Oceanographic Administration (KHOA) is engaged in more operational pursuits, providing real-time data to a wide variety of end-users. Since KHOA installed SeaSondes near Incheon for the first time in 2002, they have continued to add new SeaSonde sites. Presently, KHOA owns and operates 4 SeaSonde sites in Yeosu Bay and 2 sites in Busan New Port. Yeosu Port is one of the major harbors having heavy traffic and Busan New Port, recently opening big container terminals, is emerging as a main logistics hub port.

This year KHOA plans to install four additional SeaSonde sites for the purpose of monitoring Tsushima current running between Busan and Tsushima Island. In 2012, they plan to establish and manage a portal hub linking to the HF radar sites of several universities and institutes, expecting an efficient and united national radar data product display service.

National Dialogue

While today's HF radar community in South Korea is spread across university and government entities engaged in both academic and operational pursuits, the diverse community members still effectively manage to exchange information and share experiences. Currently, Ocean Radar Forum, composed of 20 people, holds a workshop for experts every year to discuss each institution's plan and newly developed technology. Oceantech -- the long-standing local sales and service partner of CODAR -- is sharing information through this kind of regular meeting and providing technical support for many research institutes and universities allowing efficient SeaSonde operation. Furthermore, Oceantech plans to assume the O&M responsibility for 10 SeaSonde stations from KHOA later in 2011.

International Collaboration

The South Korea HF radar community has not only been focused on their own research interests and development but have also been forming collaborative partnerships globally. This has most recently resulted in a Korean delegation participating in the April 2011 Radiowave Operators Working Group (ROWG) workshop and building relationships with other participants from the U.S., Italy and Taiwan. As part of their efforts to build out a national HF radar network, KHOA has also entered into a Joint Project Agreement with NOAA's U.S. IOOS program to exchange information on the use of HF radar data in the context of an ocean observing system.

Now, marking nearly 10 years since the first Korean SeaSonde installation, plans are now actively underway to populate the Korean coast with SeaSondes, with the firm belief that this national network will offer significant benefits to their society for coastal monitoring in Korea.

CODAR engineer, Hardik Parikh talking with members of South Korea delegation at 2011 ROWG workshop

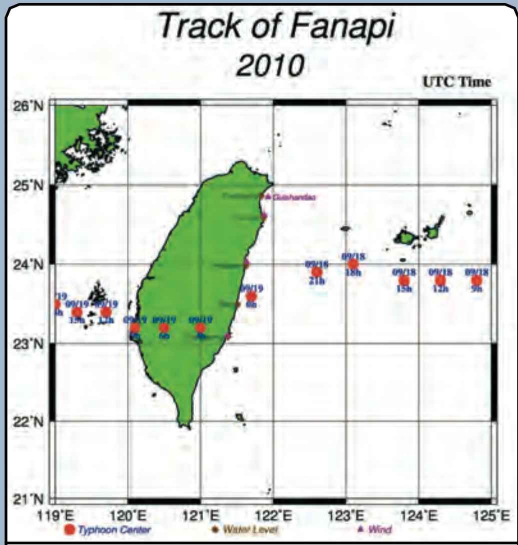
Storm Chasing: Taiwan SeaSonde Network Typhoon Observations

國家實驗研究院 NARL National Applied Research Laboratories

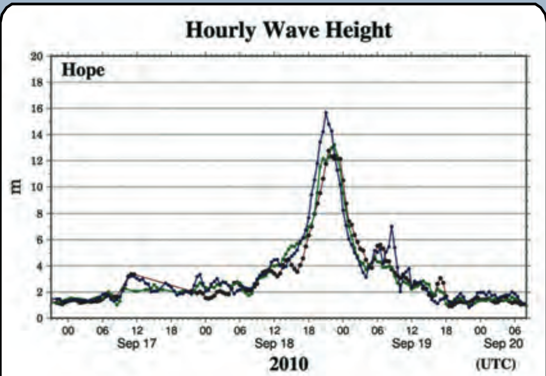
TORI 台灣海洋科技研究中心 Taiwan Ocean Research Institute

If routine measurement of the powerful Kuroshio western boundary current isn't exciting enough, the Long-Range SeaSonde network operating along Taiwan's east coast occasionally captures the effects of powerful typhoons migrating through the Pacific.

In the Autumn of 2010 these three radars, which are part of a larger SeaSonde network established by the Taiwan Ocean Research Institute (TORI), measured the effects of Typhoon Fanapi on the ocean surface currents, as well as measuring the impact this event had upon waves in the area. These results were presented at the 5th Radiowave Operator's Working Group (ROWG-5) meeting in Santa Barbara, California this past April 2011.



Above: Track of center of Typhoon Fanapi. Courtesy of Center Weather Bureau.



Significant waveheight produced by the northernmost of the Long-Range SeaSondes (HOPE) during Typhoon Fanapi passage. Each of the three plots are wave measurements from a different range cell. The maximum wave height is about 15m.

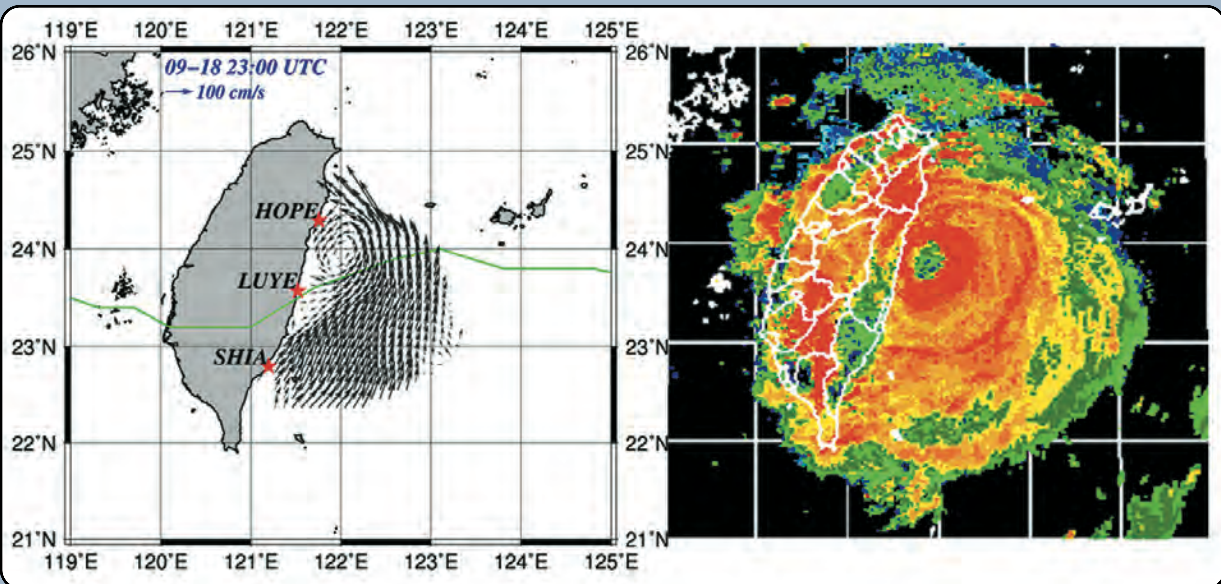
TORI, established in 2008, is part of the National Applied Research Laboratories, supported by the National Science Council of Taiwan. The HF radar program was initiated nearly immediately upon TORI establishment and is one of the organization's initial foci. Phase 1 of the TORI radar program calls for 16 SeaSondes, with 10 of those already in place.

TORI SeaSonde in Taiwan

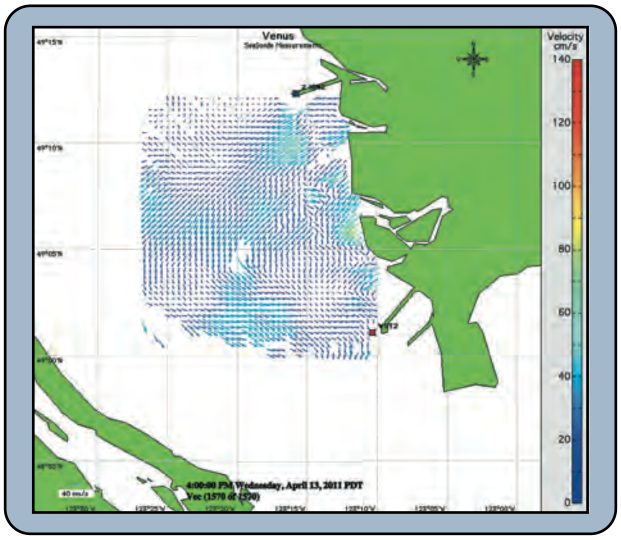
The data from this network will be provided to various organizations for research and application use, especially for search and rescue.

Below: Offshore vectors are surface currents measured by three Long-Range SeaSondes on Taiwan's east coast. Each radar location is represented by a red star (HOPE, LUYE & SHIA). The green line is the typhoon eye track. The location center of typhoon (seen in satellite data) and the ocean vortex shown in the CODAR data match well, with currents having been affected by the strong typhoon winds.

For further information contact CODAR local sales and technical services partner based in Taipei, Taiwan, Mr. Alan Chuang of Sino Instruments Co. Ltd., e-mail: sinoalan@ms1.hinet.net.



Welcome University of Victoria to the CODAR Community



University of Victoria has established a SeaSonde network, running in high-resolution mode, for monitoring inside the Strait of Georgia near the Fraser River Delta. This network is part of their Victoria Experimental Network Under the Sea (VENUS) program and will complement the many in-situ instruments collecting other ocean parameter data sets.

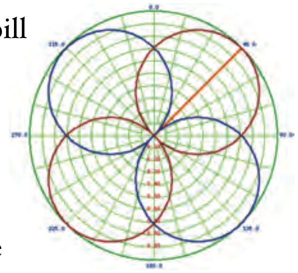
The 2-D surface current map shown was collected by the SeaSondes in April 2011 during temporary test deployments conducted to determine the best installation locations. The photos displayed were taken during this temporary deployment, and show the SeaSonde antenna propped up sufficiently by a simple makeshift stand, and the boat loaded with transponder which was used inside of the calibration and site quality analysis procedures.

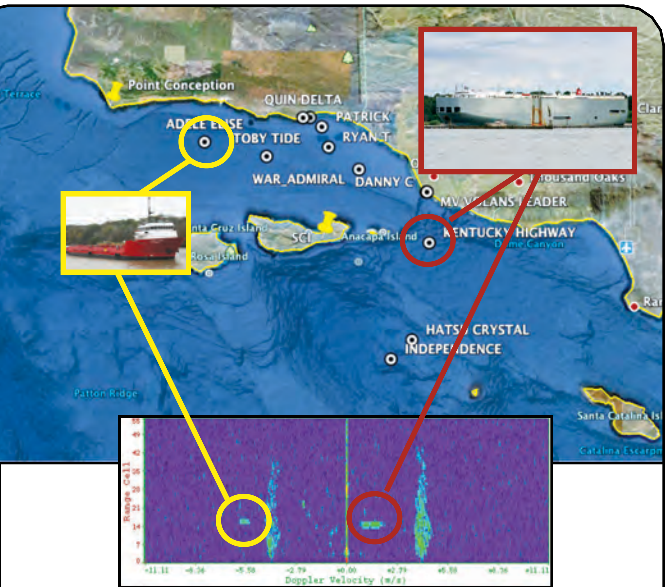
Permanent installation of this network will occur once the electrical power is brought to the sites later this summer.

For further information on SeaSondes in Canada, contact CODAR's local sales and technical services partner: Dr. Brian Whitehouse, President, OEA Technologies Inc, Halifax, Canada, E-mail: info@oeatech.com.

Antenna Patterns Made Even Easier

As the use of HF radar current maps for operational purposes such as search and rescue and spill response is increasing, so too is the need to ensure that each system is producing the highest quality data products possible. One of the most important steps operators can take to this end is to measure the directional response of the receive antenna, referred to as its pattern. While HF antennas leave the factory perfect, they will have interaction with the near-field environment, altering its pattern. This interaction, which occurs with all HF antennas, has been both understood and dealt with for decades. At CODAR, we have worked to streamline this antenna pattern measurement (APM) process over the years to make it easier both to perform the measurement and implement the field pattern data in real-time processing, as part of the calibration process. With the only commercially available HF transponder and a suite of user-friendly software to process the signal, it can take as little as an hour to begin processing data with a fully-calibrated SeaSonde antenna pattern.





Two vessels in the Santa Barbara Channel. Their positions, as provided by AIS, are associated with peaks found in spectra by matching range and Doppler frequency (speed).

Going back beyond 30 years, the traditional method for APM includes mounting a transponder device to a small boat, airplane or helicopter which makes a pass along an arc trajectory around the HF antennas. As streamlined as this process has become, however, developing an automated method for APM collection will be even simpler and increase the likelihood that a system remains calibrated, in accordance with best practices guidelines.

In 2010, CODAR, in partnership with Brian Emery and Libe Washburn of the University of California Santa Barbara, was awarded a Phase I SBIR from NOAA to develop a method for automatically making antenna pattern measurements by combining Automatic Identification System (AIS) data and HF Doppler echoes of passing vessels. With the installation of a VHF receiver collecting vessel speed, direction and position broadcast from its AIS transponder, each vessel Doppler echo can be associated with its vessel's bearing. This is intended to run in real-time alongside standard surface current processing. While transponder-based pattern measurements will still be recommended during installation or in time-critical situations, an automated process such as this under development will save time and money on maintenance measurements and could even warn operators when a pattern may have changed. The SBIR Phase I funding has provided the opportunity to prove the feasibility of this method and now Phase II funding is being sought to bring this technology to market.

Visit The Newly Improved CODAR Support Web Area
support.seasonde.com

We are pleased to announce that our rapidly expanding collection of technical documents, photos and video tutorials has been given a functional "facelift" that includes a web-based "Search Tool" for locating documents and tutorial videos quickly. The CODAR knowledge base is divided into several general categories that are delineated by the disclosure bars shown in the illustration below. The "Recent Additions" disclosure bar provides quick links to the most recent additions for savvy users who want to stay up-to-date with HF radar technology and SeaSonde products. The "SeaSonde Information" disclosure bar reveals sub-sections covering SeaSonde principles of operation, site selection, site preparation and installation, while another reveals links to materials about operational issues, data acquisition and QA/QC of data. SeaSonde owners will be also be pleased to know that our new site will have data upload/download capabilities for transferring diagnostic and data file samples.

One of the most rapidly expanding features is the number of video tutorials. Our goal is to have short 5-10 minute video tutorials for the most widely requested topics. Our current focus for video production is "How to's" for setting up our new Dome Transmit/Receive SeaSondes. A link to the written dialog (in English as a pdf file) is available to assist our clients whose first language is not English. In the future, CODAR's YouTube Channel will mirror these antenna setup videos making them available in the fast-streaming YouTube format. CODAR's official YouTube channel is: http://www.youtube.com/user/CodarOceanSensorsLtd.

All sections of the knowledge base will remain open to the public except for access to software releases, administrative forms and private client upload/download access.

Register For SeaSonde Fall 2011 Training

The next SeaSonde Training event takes place in Bodega Bay, California 10-13 October 2011. This course is recommended for new SeaSonde operators and is a good refresher for experienced users as well. Event details and registration form can be found at http://www.codar.com/CODAR_training_15_Fall_2011.shtml.

How CODAR Deals with Interference

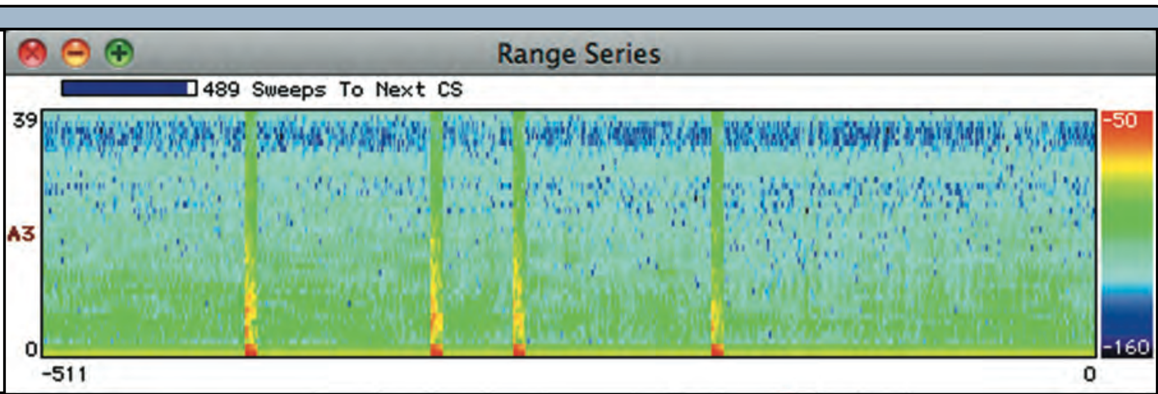
Every radar must detect target echoes against a background of unwanted noise. In our case, desired echoes may be first-order Bragg scatter (from which we get current and tsunami information); second-order (from which sea state is obtained); or ship echoes. Normal background in microwave radars is "white" Gaussian noise. White means that -- in the absence of echoes -- it is flat in frequency space. Much of the time at HF we see and deal effectively with Gaussian noise. However, all too often we see much more. Because HF radar is our only business at CODAR, we stay on top of it. Our science team has developed special, effective methods to deal with this additional unwanted background, which we refer to as interference. We review all four of them here:

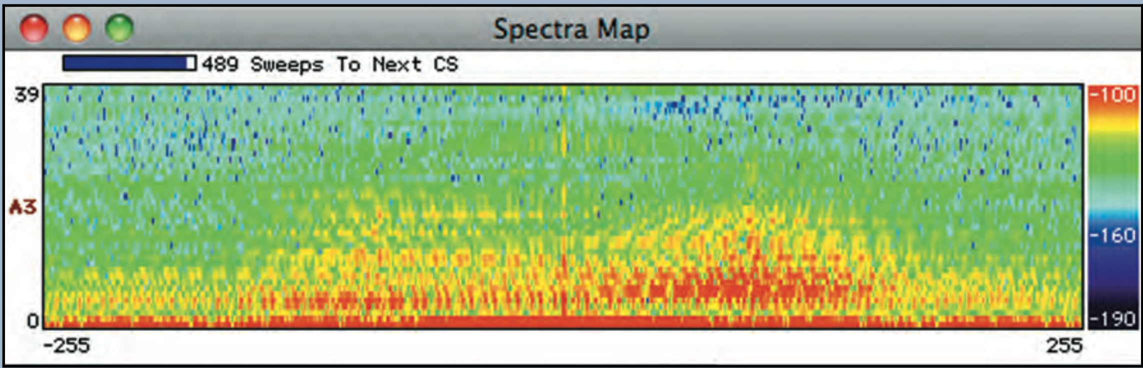
Ship-Type Echo Removal: Ship velocities span the same Doppler region as sea echoes. When present, they interfere with accurate sea-surface information extraction. Over 25 years ago, we developed an algorithm to detect and get rid of ship-type echoes. It is based on the fact that a ship with given radial velocity stays in a given Doppler bin only for a predictable period of time, based on the size of the range cell and the radar frequency. If a "blip" suddenly appears in Doppler spectral bins of interest, we test for these properties: does it stay in the bins for the correct time, or for much longer? If the former, then those bins get withheld. If much longer, then we conclude that the background has risen to a new level, and we must live with it, not withhold it or the data will get unacceptably stale. In that case, normal white Gaussian noise thresholding methods are applied. This algorithm has been used successfully well over two decades, yielding good current and wave data that are not contaminated by outliers due to these frequent "ships passing in the night" (or similar types of longer-duration interferers).
Time scale for ship-type echo interference: Several minutes.

Ionospheric-Type Echo Rejection: When our lower-frequency radars began seeing beyond 90 km about 12 years ago, we faced another nuisance. Echoes from the ionosphere directly overhead spanning from 90 km - 300 km might be seen at certain times of the day and night. These layers of charged particles ionized by the daytime sun act like a mirror. Often (but not always) they are restricted to two or three range cells, but they can be spread over many Doppler bins because the ionosphere is in motion. We developed an algorithm to find and excise this type of interference. It has been optimized by over a decade of experience. The algorithm knows what to look for, and simply removes all data from the offending range cell and Doppler bins. Often this is necessary only on one side of the positive/negative Doppler span (which fortunately contain redundant current and wave information), so that a range gap does not always occur. Without this algorithm, obviously wild "current" vectors would have appeared, spread in angle across the entire range cell -- an unacceptable contamination.
Time scale ionospheric-type echo interference: Half hour to two hours.

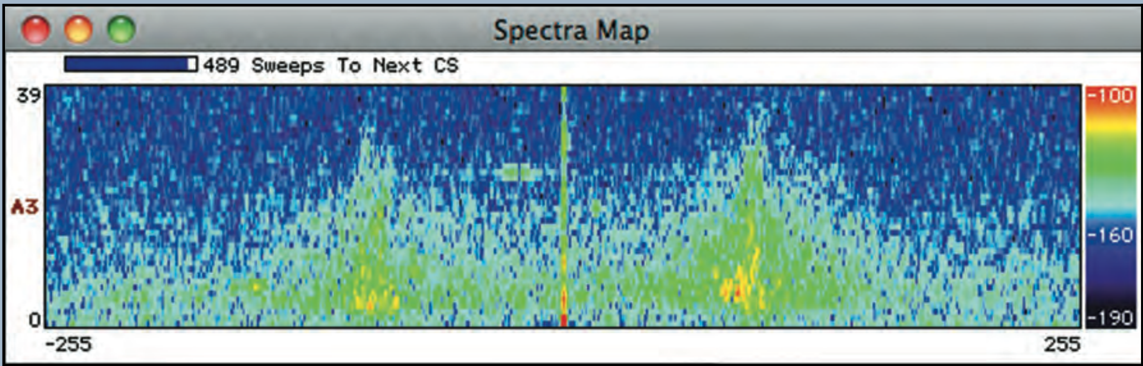
Impulse Removal: Much external noise seen at HF comes from the atmosphere: thunderstorms worldwide generate radio noise that originate far away. Typically 2000 thunderstorms are active in the world at any given time, producing 100 lightning strikes per second. When these lightning sources are distant, they add up to a noise that looks continuous and Gaussian. Those closer to the radar are impulsive in nature, and Gaussian methodologies no longer work in this case. A single blast from a nearby strike can ruin an entire Doppler spectrum collected over several minutes, even though the impulse duration is only a millisecond. Some time ago CODAR developed and optimized an impulse detector, done after range processing before Doppler processing (typically every 0.5 - 1 second). When it detects a burst exceeding a preset threshold above the background, it excises that time sample and replaces it with an interpolated value across this gap. An example of "before and after" is shown below for West Florida, which is "thunderstorm alley" among our U.S.-based SeaSondes and was used in this development. This technique can reduce impulsive background interference as much as 15-20 dB when storms are nearby.
Time scale for impulse noise interference: Less than a second.

Plot of signal strength (color) vs. time (horizontal axis) and range (vertical axis) showing four lightning/impulsive interference bursts over 256 seconds.





Sea-echo Doppler spectrum contaminated by the impulse bursts shown in prior time series.

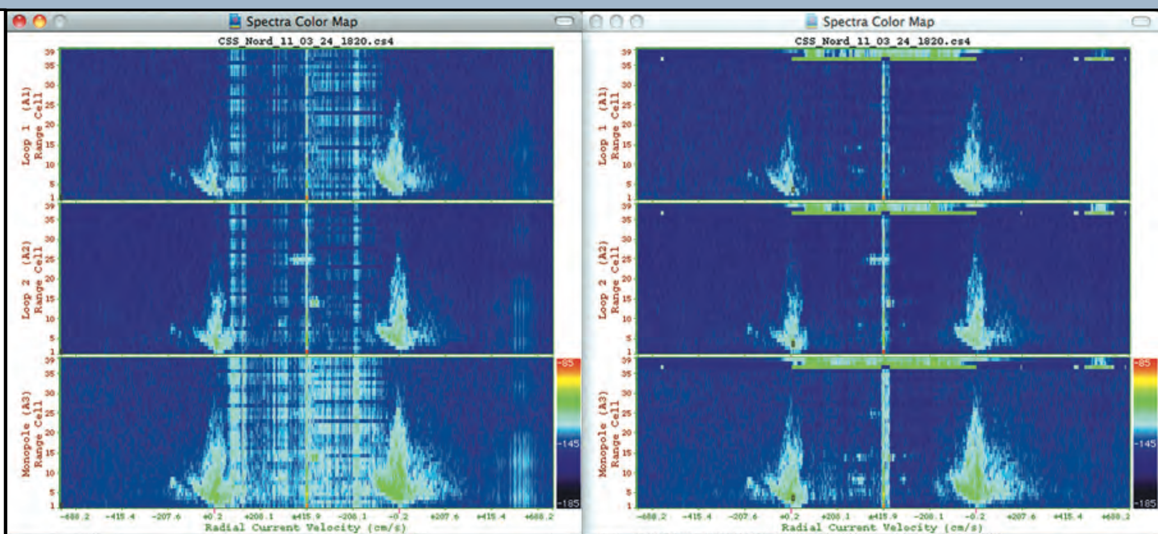


Acceptable sea-echo Doppler spectrum after excision of impulses in first time-series panel.

- **Radio Station Interference Rejection:** The HF band has been used historically for radio communication and broadcasting -- HF radar is a newcomer to the this frequency region. Although radio broadcasters as well as radars have frequency licenses, all too often distant radio stations interfere with us. These may be radiating illegally, or may result from unavoidable duplication of authorizations on the same channel because of the scarcity of separate spectral spaces for everyone. Usually the signals that interfere with us are propagated by skywave (purposely reflecting from the ionosphere), because this is where HF excels for radio broadcasters by reaching great distances. They therefore adjust their frequency throughout the day to take advantage of the best propagation conditions. As a result, when we hear radio interference, it typically may last for a couple hours before the broadcaster moves on to a more favorable frequency. With the FMCW modulation that we all use, these interfering radio signals appear spread in range but confined in Doppler. Therefore, they can at times look like a Bragg peak, second order echoes, or mask a ship while appearing like a ship echo themselves. However, based on their range-spread nature, we can identify and deal with them. This is done by recognizing that -- because of our I/Q processing -- radar echoes are seen only for "positive" range cells, while interference bands appear symmetrically at both positive and negative ranges. Unlike others, we don't simply subtract all negative from positive cells, for this too often actually increases other types of background interference. We do a careful search for the expected patterns of this radio-signal interference, subtracting just that portion, but only if it exceeds a threshold based on background levels and expected I/Q balances. Check out the example below to observe how effective this can be, when done properly.

Time scale for radio signal interference: A broadcaster may use a given frequency for two-three hours. The interfering constant-range bands will move in Doppler spectral position every processing period (e.g., 4 - 17 minutes).

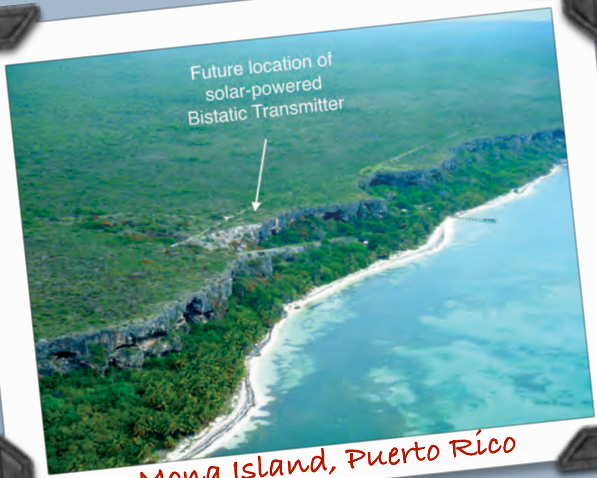
Color spectral plot on left shows significant vertical interference stripes over range, with radial velocity from the Doppler spectral shift as the horizontal axis, for the three antennas of the 13 MHz SeaSonde at Nordoy in Norway. Plot on right shows same spectra using suppression method described here. The first and second order Bragg areas are seen more clearly, and several ship echoes are uncovered when this interference is excised. The very top of the right plots purposely retains interference levels before removal for reference.



CODAR 2011 Photo Album

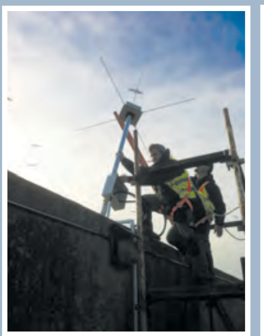
ROWG-5 Workshop

Santa Barbara, California ~ April 2011



Mona Island, Puerto Rico

Galway



Cliffs of Moher

Ireland ~ February 2011

SeaSonde Basic Operator Training
Monterey, California
~ May 2011

SeaSonde Install
Angel Island, SF Bay, California ~ April 2011

First SeaSonde in Vietnam

January 2011

SeaSonde Advanced Training
CODAR HQ ~ January 2011

THE 2011 IEEE/OES TENTH
CURRENT, WAVES AND TURBULENCE
MEASUREMENT WORKSHOP (CWTM)
20-23 March 2011 - Monterey, California
IEEE
OES

CELEBRATING 25 YEARS 1986 ~ 2011
CODAR
OCEAN SENSORS

CODAR Grillmaster
in Action

ocean business 2011
National Oceanography Centre, Southampton, UK • 5 - 7 April 2011

oceans SANTANDER 2011 SPAIN IEEE/OES
Oceans of Energy for a Sustainable Future

SeaSonde Installation

Phuket, Thailand ~ July 2011

2011 American Idol Winner
Scotty McCreery
is a Huge CODAR Fan!

April 2011

CODAR Presentation at Resources
Conference ~ Sakhalin, Russia

Gibraltar ~ January 2011

Come Celebrate CODAR's 25 Year Anniversary
~ Island Style ~
at the
MTS/IEEE Oceans '11 Kona

CELEBRATING 25 YEARS 1986 ~ 2011

CODAR OCEAN SENSORS

Highlights of CODAR activities at Oceans '11 Kona to Include:

- ***CODAR company President Dr. Don Barrick will be awarded the IEEE Life Fellow of the Oceanic Engineering Society, for development of high frequency radars and applications.***

- ***Presentation on the Japan Tsunami Detection by Multiple SeaSondes in Japan and U.S.*** will be given by Dr. Barrick.

- ***Stop by the CODAR Exhibit Booth (#10) to say Aloha!*** and receive special commemorative gift (while supplies last).

- ***SeaSonde Deployment in Kona***
  Since August a SeaSonde network has been operating along the Kona coast. This deployment is performed by CODAR in cooperation with NOAA Fisheries Pacific Islands Center, The Natural Energy Laboratory of Hawaii Authority (NELHA), Liquid Robotics Inc., and NOAA's U.S. Integrated Ocean Observing System (IOOS). Data collected will be made available to benefit a number of local research projects including fish larval transport studies and circulation modeling. Some data from this project will be displayed in the CODAR Exhibit Booth.

Contact CODAR Director of Marketing Laura Pederson, email laura@codar.com if you would like to schedule a radar facilities tour or have access to data.