

Ocean Dynamics and Acoustic Variability in East China Sea

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LONG TERM GOALS

Study the effects of ocean dynamics on acoustic propagation and underwater communication in the East China Sea (ECS).

OBJECTIVE

Conduct a joint shallow water acoustic experiment with KIOST (Korea Institute of Ocean Science and Technology) to study the coupling of oceanography, acoustics, and underwater communications in the ECS. Carry out measurements of the space and time environmental and channel impulse response characteristics along with satellite imagery for internal wave activities in the experimental area.

APPROACH

The ECS and surrounding area is an extremely complex region from the perspective of oceanography, hydrography, and bathymetry. In turn, the internal wave activity within this region is also extremely complex [1]. Within the ECS, there are several mechanisms for generating internal waves including: tidal forcing, forcing by the Kuroshio, Tsushima, and Yellow Sea Circular currents, upwelling induced by the intrusion of the Kuroshio across the continental shelf (mostly in the southern region near Taiwan), and freshwater discharged from Yangtze River, as illustrated in Fig. 1(a). Bathymetry is also an important factor in internal wave generation and propagation.

While the impact of acoustic field variability associated with internal waves propagating from deep to shallow water (e.g., South China Sea) has been studied extensively, the impact of internal waves in shallow water and broad shelves (e.g., Yellow Sea and ECS) and their interactions still is poorly understood.

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During August of 2008, the ONR-sponsored Transverse Acoustic Variability EXperiment (TAVEX) was carried out in shallow water (70-80 m) within the northern ECS denoted by a red box in Fig. 1(a), southwest of Jeju Island, South Korea, with major emphasis on the effects of internal waves on signal coherence along a bottom-mounted horizontal line array [1]. SAR images are superimposed in Fig. 1(b) to display internal wave activities and direction in the TAVEX experimental area. Separately, the Asian Seas International Acoustics EXperiment (ASIAEX) involving several countries was conducted in the spring of 2001 to understand properties of the shallow-water boundaries governing propagation and reverberation in the ECS along with geo-acoustic properties of the seabed [2-9].

On the Korean side, KIOST (Korea Institute of Ocean Science & Technology) scientists also expressed their interest in participating in a collaborative research effort with the US to explore and better understand the coupling of oceanography, acoustics, and underwater communications in this very dynamic region of the Western Pacific. Motivated by the common interest in the region, SIO and KIOST recently have agreed to collaborate on a joint research program involving a field experiment in the area of interest as a first step forward.

The overall objective is to study the coupling of oceanography, acoustics, and underwater communications in the ECS [11] and a joint field experiment with Korea (SAVEX15, Shallow-water Acoustic Variability Experiment 2015) is planned for May 2015 with a major emphasis on Ocean Acoustics (OA).

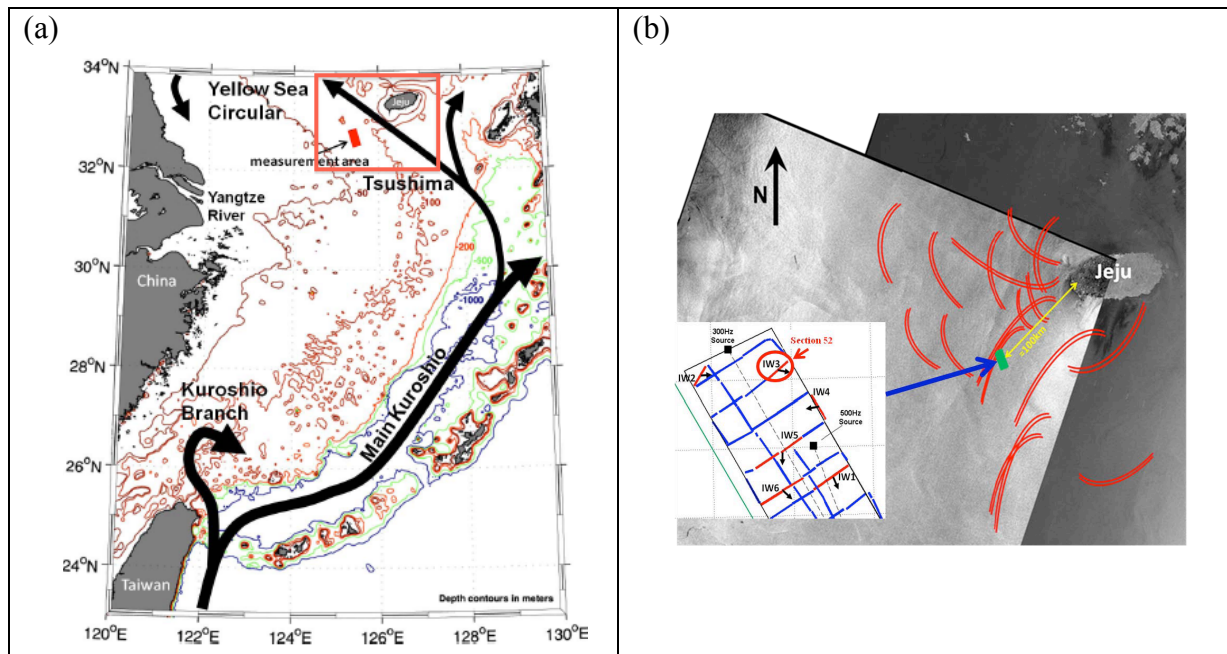


Figure 1. (a) Bathymetry and major currents of the ECS region. (b) SAR images are superimposed to display internal wave activity and directionality around Jeju Island denoted by a red box in (a), during the TAVEX experiment conducted in August 2008. Visibly apparent internal waves are highlighted in red.

WORK COMPLETED

To discuss and promote the SAVEX15, we visited Korea in August/September 2013 including several universities and research institutions. Basically KIOST and SIO have agreed to conduct the SAVEX15 experiment in May 2015. The experimental site will be close to TAVEX08 near Eardo, but a bit toward east (e.g., 100-km south of Jeju Island) on the order of 100-m water depth. *SIO will provide most acoustic-related equipment and KIOST will supply the research vessel (R/V Onuri), a majority of oceanographic measurements including the remote sensing data for the internal wave activities, and the environmental impact statement (EIS).* In addition, KIOST in Daejeon plans to host a pre-cruise workshop in May 2014 to bring together all potential scientists in Korea who are expected to participate in SAVEX15 and to draft a preliminary experimental plan during the meeting.

IMPACT/APPLICATIONS

In the future, we see an opportunity to grow a collaborative program with South Korea utilizing their substantial facilities and assets, while their benefit is interaction with our ocean acoustics group and expertise.

References

- [1] C. M. Smith. Effects of propagating internal waves on shallow-water acoustic propagation during the transverse acoustic variability experiment of 2008. MS thesis, Penn State University, PA, 2010.
- [2] P. H. Dahl. ASIAEX, East China Sea Cruise Report of the Activities of the R/V Melville, Tech. Rep. APL-UW TM 7-01, Applied Physics Laboratory, Seattle, Washington, 2001.
- [3] Ji-Xun Zhou, X.Z. Zhang, P.H. Rogers, J.A. Simme, P. Dahl, G. Zin, and Z. Peng, "Reverberation Vertical Coherence and Seabottom Geoacoustic Inversion in Shallow Water," *IEEE J. Oceanic Eng.*, Special Issue (2004).
- [4] Chen-Fen Huang and W. S. Hodgkiss, "Matched Field Geoacoustic Inversion of LowFrequency Source Tow Data From the ASIAEX East China Sea Experiment," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).
- [5] D. J. Tang, "Fine-scale measurements of sediment roughness and subbottom variability," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).
- [6] James H. Miller, Lous R. Bartek, Gopu R. Potty, Dajun Tang, J. Na, and Y. Qi, "Sediments in the East China Sea ," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).
- [7] Jie Yang, Shihong Zhou, Ji-Xun Zhou and James F. Lynch, "Internal Wave Characteristics at

the ASIAEX site in the East China Sea," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).

- [8] Jeewoong Choi and P.H. Dahl, "Mid to High Frequency Bottom Loss in the East China Sea," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).
- [9] Zhaohui Peng, Ji-Xun Zhou, Peter H. Dahl and Renhe Zhang, "Seabed acoustic parameters from dispersion analysis and transmission loss in the East China Sea," *IEEE J. Oceanic Eng.*, 2004 (Special Issue).
- [10] H. C. Song, "Time reversal communications in a time-varying sparse channel," *J. Acoust. Soc. Am.* 130, EL161-EL166, 2011.
- [11] S. Kim, Y.G. Kim, Y.N. Na, and A. Turgut, "Geo-acoustic inversion using ship radiated noise in the TAVEX," TAVEX workshop, 2009.
- [12] J. D. Skinner and W.S. Hodgkiss, "A broadband, multi-channel source-receive array for ocean acoustics research," *Proc. Oceans* 2009, 1-9, 2009.
- [13] J. D. Skinner and W.S. Hodgkiss, "A networked/autonomous receiving array system," *Proc. OCEANS* 2008: 1-6, DOI: 10.1109/OCEANS.2008.5151902 (2008).
- [14] W.S. Hodgkiss and J. Preisig, "Kauai Acomms MURI 2011 (KAM11) experiment," *Proc. ECUA '12*, 993-1000, 2012.