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Field Tests of the DOLPHIN--A Remotely Operated Survey Vehicle

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Pacific westerly wind anomaly in mid-January, when Typhoon Ekeka developed east of 160°W. Taken together, these three pulses account for much of the sea-level rise and subsequent equatorial warming observed in the eastern Pacific.

Summary: Several important implications should be noted. First, long time-scale events in the tropical ocean are driven, at least in part, by highly energetic but short-lived atmospheric anomalies. Thus, long-range predictions of ENSO may suffer if the models used are too coarse to resolve these scale interactions. On the other hand, high-resolution global oceanic and atmospheric models can be used to understand complex, large-scale interactions that influence events far from the source of the original anomalies Such knowledge will lead to improved, longer-range forecasts of both climatic and synoptic scale events around the globe.

[Sponsored by ONR]

References

1. P.A. Phoebus and J.C. Kindle, "Events Preceding the 1991-92 El Niño, Part I: A Study of Westerly Wind Bursts Depicted by an Operational Analysis/Forecast System," submitted to *J. Geophys. Res.*, 1993.
2. J.C. Kindle and P.A. Phoebus, "Events Preceding the 1991-92 El Niño, Part II: The Ocean Response to Operational Westerly Wind Bursts," submitted to *J. Geophys. Res.*, 1993. ■

Field Tests of the DOLPHIN—A Remotely Operated Survey Vehicle

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Remotely operated vehicles (ROV) instrumented with state-of-the-art ocean survey systems are a potential force multiplier for the Navy's reduced fleet of oceanographic survey ships. The Oceanographer of the Navy (N096) tasked the Naval Research Laboratory (NRL) to test and evaluate the Deep Ocean Logging Platform with Hydrographic Instrumentation and Navigation (DOLPHIN) as a Navy survey platform. DOLPHIN is a diesel-powered semisubmersible developed by International Submarine Engineering (ISE). NRL, in conjunction with the National Oceanic and Atmospheric Administration (NOAA), the Naval Oceanographic Office (NAVOCEANO), and the Canadian Hydrographic Service (CHS) conducted DOLPHIN field tests in August 1992. The joint survey was conducted with NOAA's ship *Whiting*, NAVOCEANO's ship USNS *Littlehales*, and CHS's DOLPHIN over the Norfolk Canyon, 62 nmi east of Cape Charles, Virginia.

DOLPHIN: The DOLPHIN vehicle, Fig. 5, is constructed of aluminum alloy, weighs approximately 3500 kg (dry), and measures 7.44 m in length. It has a Sabre 212-hp turbocharged, diesel engine with endurance up to 26 h at 12 kt (or 312 nmi) on 90 gal of diesel fuel. The vehicle uses differential Global Positioning System (DGPS), attitude sensors, and a gyrocompass for navigation. The DOLPHIN's DGPS and radio link antennas are attached to a snorkel at the mast's top (Fig. 5). The DOLPHIN's submerged draft is 4.57 m. The vehicle performs automatic linekeeping; manual override is available for stopping, turning, or maneuvering. The DOLPHIN requires a 20-ton crane and approximately five people for launch and retrieval. Brooke Ocean Technology (BOT) designed a ship-based, articulated crane specifically for DOLPHIN that can launch and retrieve the ROV in up to sea state 5.

Multibeam Systems: The DOLPHIN tested has a Simrad EM-100, a 95 kHz multibeam sounding system [1]. The DOLPHIN transmits the EM-100 bathymetry data to the ship at 9600 baud over a UHF radio link. The EM-100 operates in three different modes: narrow, wide, and ultrawide, covering depths from 10 to 600 m. The EM-100 operates with a maximum of 32 receiving beams and athwartship beam apertures of 3.75, 2.5, or 2.0 deg.

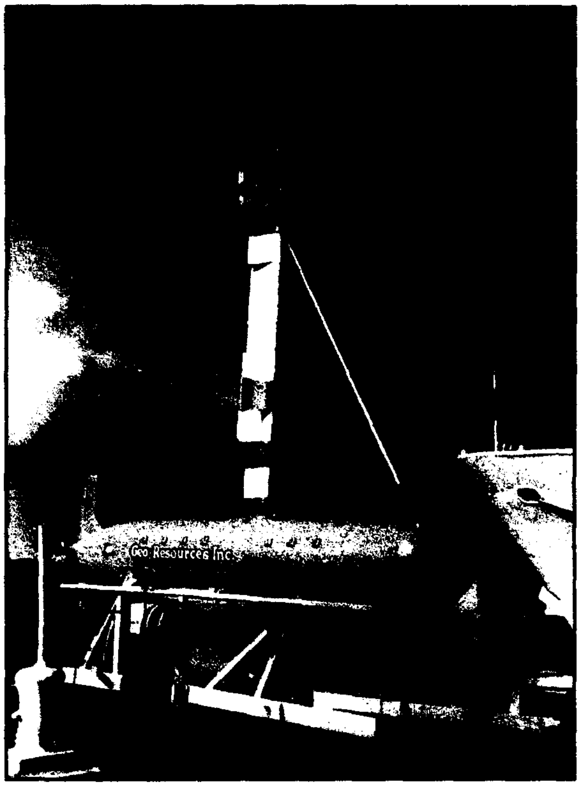

Fig. 5 — The deep ocean logging platform with hydrographic instrumentation and navigation (DOLPHIN)

The maximum coverage is 100 deg, corresponding to 2.4 times the water depth. The *Whiting* has General Instrument Corporation's Hydrochart II (HC), a dual-transducer multibeam-sonar system that operates at 36 kHz. The system uses a cross-fan transducer array to form 17 beams, 9 each for port and starboard, with overlapping near-nadir beams. The swath coverage of the Hydrochart II is 2.5 times the water depth or 105 deg. The *Littlehales*, like DOLPHIN, has a hull-mounted EM-100.

Test Survey of Norfolk Canyon: The ships and ROV collected data along the contours of the Norfolk Canyon, with several cross tracks. Patch tests were run to evaluate the system's attitude and handling. The platforms collected data over the same lines on two different days, surveying approximately 30 nmi. The DOLPHIN's automatic linekeeping worked well except when the DGPS position jumped to a location 100 m off the programmed track, making the DOLPHIN respond with an abrupt turn in an effort to correct its course. The DOLPHIN's sensors detected the excessive acceleration and therefore shutdown and surfaced the ROV. The DOLPHIN was immediately restarted and on track within 5 min.

Survey Results: Figure 6 shows a comparison of pitch records for the DOLPHIN and *Whiting* over the same time interval. The DOLPHIN showed less pitch for line B03 (headed into prevailing seas) than the ship; however, results for line B04 (heading with the seas) showed more pitch for the ROV. DOLPHIN performance and stability are marginally superior when running into the seas as opposed to running with the seas. This is due to the response of the stabilizing planes, which produce a more rapid vehicle response in bow seas. Running with the seas, the DOLPHIN's relative speed is reduced, some surfing occurs, and less water is passing over the stabilizer planes. With a conventional monohull vessel, the converse is true; running into the seas produces thrusts on the bow at different intensities, resulting in pitching. A ship running with the seas results in less thrust and less pitch with a longer period.

Bathymetry analysis showed the HC-II root-mean-square (rms) noise levels to be about 0.28% of depth, DOLPHIN's EM-100 noise levels to be about 0.2% of depth, and the *Littlehales's* EM-100 data to be about 0.17% of depth. The rms noise difference, 0.03% of depth, was not significant. Some noise on the DOLPHIN was attributed to the power supply, which was subsequently replaced with a quieter one.

Figure 7 shows georeferenced 50-m bathymetry contours from the three platforms over an area of the Norfolk Canyon. The rms depth differences between DOLPHIN and *Whiting* data were 1.9% of depth, and between DOLPHIN and *Littlehales*, the rms was 2.0% of depth. The rms depth difference between the two ships was 2.3% of depth. Although differences between the two ships varied more than between either ship and the ROV, the mean difference between the two ships was almost a meter smaller than for the DOLPHIN and the

Fig. 6 — Pitch observations for DOLPHIN (yellow) and NOAA *Whiting* (red) travelling into bow seas (top) and heading with the seas (bottom)

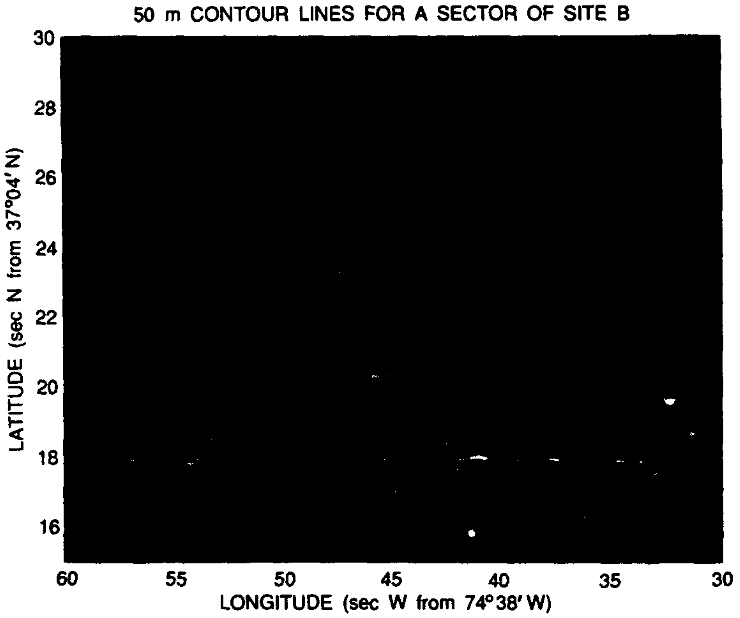

Fig. 7 — Bathymetry contours of the Norfolk Canyon for DOLPHIN, *Whiting*, and *Littlehales*

ships. Reference 2 shows that the mean difference between the ships was 0.48 m and was −1.7 and −1.3 m, respectively, between the DOLPHIN and *Littlehales* and DOLPHIN and *Whiting*. A calibration error in the DOLPHIN's depth setting caused the DOLPHIN to sound shallower than the two ships by about a meter.

Conclusions: One DOLPHIN surveying parallel to a survey ship could double the amount of data collected per ship-survey mile. Tests conducted over the Norfolk Canyon showed the ROV to be robust to sea state, noise, and data dropouts. Plans to implement a DOLPHIN-like vehicle with an imaging-multibeam, sediment classifier, and high-rate telemetry are underway between NRL's Marine Geosciences Division and NAVOCEANO. This system will be fielded in FY95 to provide the Navy with an advanced, data-collection platform that will serve as a force multiplier to NAVOCEANO's oceanographic survey fleet.

[Sponsored by the Oceanographer of the Navy]

References

1. D.R. Peyton, "The DOLPHIN/EM100 Ocean Mapping System," *The Hydrographic Journal*, No. 65 (July 1992).

2. E.J. Kaminsky and M.T. Kalcic, "Multibeam Data Evaluation for DOLPHIN and Ship Collection Platforms," NRL/MR/7441--93-7034, July 1993. ■

Impacts of Weather Model Forecasts on Tactical Environmental Decision Aids

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Although modern weapon systems are designed to be "all-weather," they are not immune to the effects of weather or environmental conditions. To mitigate the effects of environmental factors, the U.S. Navy has developed numerical weather prediction models that forecast meteorological conditions and Tactical Environmental Decision Aids that predict the performance of weapons and sensors. The bases for such decision aids are frequently computer-simulation models of weather-dependent physical processes, for example, transport and diffusion or propagation. Recently, we interfaced two computer models to weather model output to demonstrate weather effects on tactical systems. This evaluation of impacts on system performance, as influenced by atmospheric mesoscale phenomena will help to determine future weather model resolution and accuracy requirements.

The Weather Prediction Models: The U.S. Navy has developed both global and regional weather prediction models. The Navy Operational Global Atmospheric Prediction System (NOGAPS [1]) is the large-scale global model that provides weather forecast guidance for up to 5 days. NOGAPS also provides high-quality forecast fields that are used as boundary conditions for higher resolution models that cover smaller domains. One such model, a vertically nested, second-order closure variant of NORAPS (Navy Operational Regional Atmospheric Prediction System) [2,3] is currently used to provide regional or mesoscale weather forecast guidance for up to 24 h. This research version of NORAPS is being used to examine detailed variations of the atmosphere in the southern and central California littoral region in participation with the Variability of Coastal Atmospheric Refractivity (VOCAR) experiment.

Figure 8 compares 2-h forecasts from NOGAPS and NORAPS (interpolated to 0700 PDT by using the analysis at 0500 and the 6-h forecast at 1100). The NOGAPS forecast shows winds flowing somewhat down the coast from the north, with a circulation over land and stable air near the surface. In contrast, the NORAPS forecast shows winds flowing down the coast, but with an eddy in the shelter of the southern California bight. The eddy was created by NORAPS at 2300 PDT the previous evening and verifies well with surface wind data observed at 0700 PDT. The air's buoyant instability is more varied for the NORAPS forecast with stable air over water except in the eddy where winds are weaker and over mountains (upper left) where air tends to be less stable.

Downwind Hazard Prediction: The first example of tactical impact is illustrated using the Vapor, Liquid, and Solid Tracking (VLSTRACK) [4] computer model recently developed by the Protection Systems Department at the Naval Surface Warfare Center. The VLSTRACK model estimates the transport and diffusion of a Gaussian plume to provide downwind hazard predictions for a wide range of chemical and biological agents and munitions.

Cumulative dosages predicted by VLSTRACK (Fig. 9) show the trajectory of the plume when driven by NOGAPS or NORAPS data. Both agents are released at the same point and time, but the NOGAPS and NORAPS winds