

# ANALYSIS OF SUBSURFACE VELOCITY DATA FROM THE ARCTIC OCEAN

Dr. Albert J. Plueddemann  
Dept. of Physical Oceanography, MS-29  
Woods Hole Oceanographic Inst.  
Woods Hole, MA 02543-1541  
aplueddemann@whoi.edu  
voice: 508-563-3568, fax: 508-457-2181  
Award No. N00014-97-1-0135

## LONG TERM GOALS

The long term goal of this work is to document the characteristics of the subsurface velocity field in the Arctic Ocean and investigate the dynamics which determine those characteristics.

## OBJECTIVES

The specific objectives are (1) to determine whether low-frequency (sub-inertial) currents play a role in modifying the parameters of near-inertial internal waves found over the Yermak Plateau, and (2) to document the regional and temporal variability of internal waves, tides, and eddies in the Beaufort Sea.

## APPROACH

Subsurface velocity data spanning the upper 250 m of the water column were obtained from two special purpose, Arctic drifting buoys (Honjo *et al.*, 1990; Krishfield *et al.*, 1993). Velocities were measured with Acoustic Doppler Current Profilers (ADCPs) suspended at a depth of about 10 m below the buoy with their transducers facing downwards. One buoy drifted over the Yermak Plateau and the other made a partial circuit around the Beaufort Gyre.

## ACCOMPLISHMENTS

Wavenumber-frequency spectral analysis has been completed for the depth-time record of velocities over the Yermak Plateau. A unique approach to the estimation of horizontal wavenumber was applied to some parts of the record in order to establish the parameters of the semidiurnal wave groups. Parameter variation in the presence of low-frequency currents was determined. A 23 month record of velocity was recovered from the Beaufort Gyre ADCP by means of Argos satellite telemetry. This record was substantially longer than could have been obtained from in-situ recording and proved the worth of a data processing and telemetry module developed for the purpose (Plueddemann *et al.*, 1992). A combination of frequency band filtering and complex demodulation was applied to the Beaufort Gyre velocity record to isolate the signals of interest.

## SCIENTIFIC/TECHNICAL RESULTS

Scientific analysis of the Yermak Plateau data has been completed, and the results submitted for publication (Konyaev *et al.*, submitted). Previous results (Plueddemann, 1992;

# Report Documentation Page

Form Approved  
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE <b>30 SEP 1997</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-1997 to 00-00-1997</b>	
4. TITLE AND SUBTITLE <b>Analysis of Subsurface Velocity Data from the Arctic Ocean</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Woods Hole Oceanographic Institution, Department of Physical Oceanography, Woods Hole, MA, 02543</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT <b>unclassified</b>	b ABSTRACT <b>unclassified</b>	c THIS PAGE <b>unclassified</b>			

D'Asaro and Morison, 1992) have established that the internal wave field over the Yermak Plateau is dominated by clockwise-rotating currents in the semidiurnal band, and has considerably greater energy than typically found within the Arctic Basins. Our new results show that groups of intense semidiurnal internal waves and high-mode, low-frequency waves emerge nearly simultaneously. The semidiurnal waves have frequency above the M2 tide and have the characteristics of upward-propagating near-inertial waves, presumably generated at the bottom. The low-frequency waves consist of both upward and downward propagating components which often create an interference pattern in the upper 150 m, with large velocities and large vertical shears. The most intense semidiurnal waves appear near the high-shear zones of the low-frequency waves. It is hypothesized that refraction by the low-frequency shear leads to intensification of the semidiurnal waves and to their eventual dissipation in the upper layer.

Preliminary analysis of the Beaufort Gyre data has been completed and the results have been submitted as a short note (Plueddemann *et al.*, submitted). Spectral analysis showed that an "eddy band" (2-5 day periods) and the semidiurnal band dominated the horizontal kinetic energy. It has been known for some time that eddies populate the Beaufort Sea and Canada Basin (e.g. Manley and Hunkins, 1985), but in our observations eddies were found further to the south and east than previously reported. Based on a tidal model (Kowalik and Proshutinsky, 1993), which showed very small semidiurnal tidal amplitudes over most of the drift track, the semidiurnal band was presumed to be dominated by near-inertial motions. The amplitude of these inertial motions varied seasonally (largest in late summer and smallest in late winter). Diurnal tides were weak except over a shallow portion of the Chukchi Shelf, showing some inconsistency with the tidal model which predicted enhanced tides over portions of the Chukchi Plateau.

## **TRANSITIONS**

None.

## **RELATED PROJECTS**

The subsurface velocity measurements over the Yermak Plateau and within the Beaufort Gyre were a part of the Arctic Environmental Drifting Buoy and Ice-Ocean Environmental Buoy projects, respectively, initiated by S. Honjo (Woods Hole Oceanographic Institution) in cooperation with the Japan Marine Science and Technology Center. The Yermak Plateau analysis benefited from hydrographic observations made during the Cooperative Eastern Arctic Experiment. Logistical support from the Arctic Leads Experiment was integral to the successful deployment of the Beaufort Gyre buoy.

## **REFERENCES**

- D'Asaro, E. A., and J. H. Morison, 1992. Internal waves and mixing in the Arctic Ocean, *Deep-Sea Research*, **39**, Suppl. 2, S459-S484.
- Honjo, S., R. Krishfield and A. Plueddemann, 1990. The Arctic Environmental Drifting Buoy (AEDB): Report of field operations and results, *Technical Report WHOI-90-02*, Woods Hole Oceanographic Institution, Woods Hole, MA, 128 pp.
- Krishfield, R., K. Doherty and S. Honjo, 1993. Ice-Ocean Environmental Drifting Buoys (IOEBs): Technology and development in 1991-1993, *Technical Report WHOI-93-45*, Woods Hole Oceanographic Institution, Woods Hole, MA, 138 pp.

- Konyaev, K. V., A. J. Plueddemann and K. D. Sabinin, Semidiurnal internal waves over the Yermak Plateau and their connection with low-frequency currents, *Deep-Sea Research*, submitted.
- Kowalik, Z. and A. Y. Proshutinsky, 1993. Diurnal tides in the Arctic Ocean, *Journal of Geophysical Research*, **98**, 16,449-16,468.
- Manley, T. O. and K. Hunkins, 1985. Mesoscale eddies of the Arctic Ocean, *Journal of Geophysical Research*, **90**(C3), 4911-4930.
- Plueddemann, A. J., 1992. Internal wave observations from the Arctic Environmental Drifting Buoy. *Journal of Geophysical Research*, **97**(C8), 12,619-12,638.
- Plueddemann, A. J., A. L. Oien, R. C. Singer and S. P. Smith, 1992. A data processing module for acoustic Doppler current meters. *Technical Report WHOI-92-05.*, Woods Hole Oceanographic Institution, Woods Hole, MA, 64 pp.
- Plueddemann, A. J., R. Krishfield, T. Takazawa, K. Hatakeyama and S. Honjo, Upper ocean velocities in the Beaufort Gyre. *Geophysical Research Letters*, submitted.

#### **PUBLICATIONS:**

- Dickey, T., A. J. Plueddemann and R. A. Weller, Current and water property measurements in the coastal ocean, In: *The Sea*, Vol. 10, The Global Coastal Ocean, Part A., K. H. Brink and A. R. Robinson, Eds., Wiley Interscience, New York, accepted.
- Feng, M., M. A. Merrifield, R. Pinkel, P. Hacker, A. J. Plueddemann, E. Firing, R. Lukas and C. Eriksen, Semidiurnal tides observed in the western equatorial Pacific during TOGA COARE, *Journal of Geophysical Research*, submitted.
- Harris, C. L., A. J. Plueddemann and G. G. Gawarkiewicz, Water mass distribution and polar front structure in the western Barents Sea. *Journal of Geophysical Research*, accepted.
- Konyaev, K. V., A. J. Plueddemann and K. D. Sabinin, Semidiurnal internal waves over the Yermak Plateau and their connection with low-frequency currents, *Deep-Sea Research*, submitted.
- Plueddemann, A. J., R. Krishfield, T. Takazawa, K. Hatakeyama and S. Honjo, Upper ocean velocities in the Beaufort Gyre. *Geophysical Research Letters*, submitted.