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Andreas Muenchow**

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Scripps Institution of Oceanography,
Marine Life Research Group
9500 Gilman Drive
La Jolla, CA 92093-0209

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**Author at time of original submission of this report was no longer with Scripps but was with Rutgers University, New Brunswick, NJ, 908-932-6555, Ext. 255, email: andreas@ahab.rutgers.edu

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PROJECT TITLE: Dynamics over Arctic canyons
PRINCIPAL INVESTOGATOR: Andreas Muenchow
INSTITUTION: Scripps Institution of Oceanography
San Diego, CA
(presently Rutgers University, New Brunswick, NJ)
TELEPHONE (voice): 908-932-6555 ext. 255
TELEPHONE (fax): 908-932-8578
E-MAIL: andreas@ahab.rutgers.edu
GRANT NUMBER: N00014-94-1-0041
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The main objective of this grant was to describe and to understand the dynamics of wide canyons in the Arctic Ocean. Barrow Canyon at the north-western tip of Alaska is such a wide canyon, because its width is large relative to its internal deformation radius. This canyon was the focus of a dynamical study from aboard the CCGS Henry Larsen in the summer of 1993. An acoustic Doppler current profiler was towed besides the icebreaker and provided data that described the velocity field within the canyon in all three spatial dimensions. Hydrographic data from a CTD (provided by Dr. Carmack of the Institute of Ocean Sciences, Canada) and currentmeter mooring data (generously provided by Dr. Weingartner of the University of Alaska) complements the data set that was analyzed as part of this grant.

The first step in the data analysis was the calibration and testing of the equippment in its first operational application in the Arctic Ocean. Muenchow et al. (1995) describe the towed ADCP, its performance both at mid- and at high latitudes, and a specifically designed calibration routine. The second step in the data analysis was to describe the basic velocity and density fields. The observational results are described in detail in Muenchow and Carmack (1996) and thus are not repeaed here. Highlights include:

1. intensification of the Beaufort gyre near Barrow Canyon;

2. along- and across-canyon isopycnal slopes of the same order of magnitude that support thermal wind shears of about 50 (cm/s)/100m;

3. ventilation of upper halocline waters within the canyon during strong upwelling favorable winds;

4. a northward flowing jet carrying 1.1+-0.11 Sv (10^6 m^3/s) of water into the Arctic Ocean from the Chukchi shelf, 30% of which are warm Bering Sea waters;

5. an anti-cyclonic recirculation within the canyon with horizontal Rossby numbers reaching 0.5;

6. potential vorticity appears to be conserved along streamlines within the study area.

The third and last step of the completed data analysis extended the originally proposed and funded work. In order to more dynamically interpret the data, Drs. Signorini and Haidvogel of Rutgers University and I configured a three-dimensional numerical model for the Barrow Canyon area. The results of this process study are reported in Signorini et al. (1996) and are not repeated here. The model successfully though not completely reproduces the major feature of the density and velocity observations which can be explained by an oscillating upstream inflow (from Bering Strait) that generate both a mean down-canyon transport, an anti-cyclonic circulation within the canyon, and vorticity waves. As the numerical data covers a much larger spatial and temporal domain than do the observations, it places the limited observations into a more complete frame of reference. The observations, however, were essential in providing both guidance in the model design and model verification.

Publications supported by this grant:

Muenchow, A., C.S Coughran, M.C. Hendershott, and C.D. Winant. (1995). Performance and calibration of a subsurface towed acoustic Doppler current profiler. J. Atmos. Ocean. Tech., 12, 435-444.

Muenchow, A. and E.C. Carmack (1996). Synoptic flow and density observations near an Arctic shelf break. Submitted to J. Phys. Oceanogr.

Signorini, S.R, A. Muenchow, and D. Haidvogel (1996). Flow dynamics of a wide Arctic canyon. Submitted to J. Geophys. Res.