POLYMODE NEWS

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NOTES from the Editor

This issue and the next of POLYMODE News will contain abstracts of the presentations given at the POLYMODE Scientific Assembly, held in late March. This set of abstracts gives an overview of most of the American scientific work now underway on POLYMODE results. These should be seen as descriptions of work in progress. Their principal value is to stimulate contacts during the critical period of the analysis of results.

The POLYMODE Scientific Assembly took place at the University of Rhode Island, on the 27th and 28th of March. More than two dozen presentations of work in progress were made. Those making the presentations were asked to supply abstracts, and we have abstracts now for all but one or two. We have not followed the order of presentation in arranging the abstracts in POLYMODE News. The presentations at Rhode Island were not explicitly grouped by subject. We have grouped them and added section headings simply as an aid to arrangement.

We hope to have later articles in POLYMODE News on many of these results. At this time, we encourage readers who are interested to contact the authors for further information and to provide comments.

--F. W.

The POLYMODE* News is produced at the Woods Hole Oceanographic Institution. It is edited by Ferris Webster and Catherine Herrity.

Material of interest for this newsletter may be sent to Catherine Herrity at the Woods Hole Oceanographic Institution, Woods Hole, MA, 02543, Telephone (617) 548-1400, ext. 2550, TWX 710-346-6601; or to Ferris Webster at NOAA/RD, 6010 Executive Blvd, Rockville, MD, 20852, Telephone (301) 443-8344.

*POLYMODE is derived from the names of the USSR POLYGON experiments and the Mid-Ocean Dynamics Experiment (MODE).

POLYMODE OFFICE NOTES

Proposals for National Science Foundation funding beginning 1 January 1980 must be submitted to the IDOE Office by 1 August. Proposals for renewals and supplements to existing grants should be sent to the POLYMODE Executive Office at the same time for distribution (Room 54-1418, MIT, Cambridge MA 02139). New proposals should, if possible, be sent to the POLYMODE Executive Office ahead of time for review.

Note that no funding is anticipated for further experimental work in POLYMODE. Proposals will be for analysis of results or for theoretical and numerical modelling work.

ERRATUM

(POLYMODE News No. 64)

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ARRAY RESULTS

VORTICITY BALANCES FROM ARRAY II DATA

W. Brechner Owens
Woods Hole Oceanographic Institution

Abstract:

Calculations of vorticity and vorticity balance are presented from a moored array cross centered at 36°N, 55°W, which is on the western flank of a seamount. These estimates indicate that the flow is that of a stratified Taylor column, with upstream velocities larger than critical so that there is not a trapped vortex over the seamount.

ARRAY III CLUSTERS A & B RESULTS

Lee-Lueng Fu
Massachusetts Institute of Technology
Woods Hole Oceanographic Institution

Abstract:

Eddy kinetic and potential energy in Clusters A and B (A,B hereafter) are comparable to those from MODE-I in the thermocline, but much less than MODE at 4000 m. Vertical structure is extremely baroclinic. At 200 m and 1500 m, eddy energy is homogeneous in each cluster with B slightly higher than A; at 4000 m, energy is comparable in A and B, and a rapid decrease away from the mid-Atlantic Ridge was found in B. Square integral time scales are 30 days in A and 57 days in B at 200 m and 1500 m; 25 days in A and 16 days in B at 4000 m. At the upper two levels, meridional kinetic energy is dominant in A, while changes from equipartition and/or meridional dominance near the Ridge to zonal dominance away from the Ridge were found in B. For periods from 65 to 340 days, horizontal coherence scales are about 130 km for u, v, and T at 200 m; 180 km for u, v at 1500 m; less than 50 km for u, v, and 80 km for T at 4000 m. There is no vertical coherence between 4000 m and the upper two levels for velocity. A single in-phase surface intensified empirical mode can account for over 95% vertical structure for velocity, while two modes are needed to describe temperature, with the dominant one similar to the first dynamical mode. Westward propagation was found for u, v, and T in the lowest frequency band in both A and B, with dominant wavelength about 300 km for u, v, and 500 km for T. Significant polarization of velocity with a period of about 4 days was found in some deep records in B.

ARRAY III, CLUSTER C RESULTS

Thomas Keffer and Chester Koblinsky
Oregon State University

Abstract:

Mean flow was observed to be to the west at 150 m and to the north at 4000 m. There was no mean flow at 2500 m. The observed mean flow and mean shear were shown to agree in magnitude and direction with historical geostrophic calculations. Mean eddy kinetic energy decreased with depth while mean eddy potential energy had maximums at the surface and at 300 m. Time scales generally increased in the direction of mean flow. Significant horizontal coherences were observed in three bands: 30-100 days; 2-10 days; and the M2 tidal band.

BIO GULF STREAM EXPERIMENT

Ross Hendry
Bedford Institute of Oceanography

Abstract:

Current and temperature measurements from a deep zonal array near 55°W under the mean Gulf Stream show strong correlations over 90 km scales, and zonal homogeneity in the mean and in second-order eddy statistics. The eddies propagate to the west with speeds between 15 and 30 km/day.

GEOSTROPHIC VORTICITY BALANCE

Harry L. Bryden
Woods Hole Oceanographic Institution

Abstract:

The advection of planetary vorticity and vortex stretching are estimated from moored current meter measurements of eight months duration in the western North Atlantic balance within small errors.

INERTIAL OSCILLATIONS OBSERVED IN MOORED ARRAYS

Lee-Lueng Fu
Massachusetts Institute of Technology
Woods Hole Oceanographic Institution

Abstract:

Velocity spectra near inertial frequencies observed in POLYMODE arrays can be roughly classified into three types based on the peak height above ω^{-2} background: (1) 10~15 dbar -- upper ocean (less than 2000 m); deep ocean (4000 m) over rough bottom and/or under the Gulf Stream; (2) ~7.5 dbar -- deep ocean over smooth bottom; (3) no apparent peaks -- deep ocean over smooth bottom near huge seamounts. Coherence scales are found to be over 30 km in the horizontal at all depths and 200 m in the vertical just below the thermocline, indicating a westward zonal wavelength about several hundred km and an upward "local" wavelength of 450 m. However, the wavelength estimates are subjected to aliasing. Type 2 spectrum is in good agreement with a model spectrum which basically is an extension of Garrett and Munk (1975) to inertial frequency using uniformly valid asymptotic solutions of the latitudinal wave equation (Laplaces tidal equation).

Reference

Garrett, C. and W. Munk (1975) Space-time scales of inertial waves: a progress report. J. Geophys. Res., *80*, 291-297.

XBT & DENSITY RESULTS

HISTORICAL DATA ANALYSIS

Curtis C. Ebbesmeyer
Evans-Hamilton, Inc.

Bruce Taft
University of Washington

Abstract:

Hydrographic data in the upper 2 km from the period 1914-1973 have been analyzed in the western North Atlantic between 22°-36°N and 66°-74°W. Expendable bathythermograph (XBT) data are also analyzed and compared with the hydrographic data. Means and standard deviations of depths of the 15° and 17°C isotherms are comparable if only those XBTs reaching 700 m depth are used.

Evident in the main pycnocline (~500-1200 m depth) are pronounced vertical and horizontal changes of potential energy density (PED), dynamic height standard deviation ($\sigma_{\Delta D}$), and salinity standard deviation (σ_S) on potential density (σ_θ) surfaces. Beginning near 28°N, at the southern boundary of the Gulf Stream Return Flow, PED and $\sigma_{\Delta D}$ both increase markedly toward the north and west. It is concluded that the PED gradient, at least in part, is associated with energetic features other than Gulf Stream Rings. South of the Return Flow there is a narrow eastward flowing countercurrent which has its maximum expression above 200 dbar.

At the southern boundary of the Return Flow a high-salinity tongue of Mediterranean Sea Water is centered near 29°N between ~600-1700 m depth. Horizontal gradients indicate that the tongue abruptly ends near the western boundary; comparison with contours of selected individual cruises suggests

that the tongue varies considerably in latitudinal position.

The σ_S has a minimum near 18°C; a pronounced maximum in the main pycnocline (∿0.07°/$_{oo}$); and markedly lower values (∿0.02°/$_{oo}$) at greater depths. This vertical structure is uniform within the region in contrast to the horizontal variation of PED and $\sigma_{\Delta D}$ gradients. The vertical variation of PED south of 30°N is small but to the north maximum PED occurs in a tongue centered in the main pycnocline.

SALT-ANOMALY FIELDS IN THE MODE REGION

Colin Shen and Bruce Taft
University of Washington

James McWilliams
National Center for Atmospheric Research

Curtis Ebbesmeyer
Evans-Hamilton, Inc.

Abstract:

The problem of advection of water masses by mesoscale eddies has been examined for the MODE measurements. The salt-anomaly fields on different density surfaces are mapped using the objective analysis technique. The preliminary results show that there is a qualitative correlation between the eddy pressure field and the anomaly field in the lower part of the thermocline (∿1500 dbar), where the anomaly field is also vertically coherent. The correlation is lost and the field is less coherent vertically in the upper thermocline (∿500 dbar). The preliminary examination of the statistics of the salt-anomaly field shows that the horizontal variability, i.e., the standard deviation, of the salinity field is the largest in the thermocline (∿800 dbar) in accordance with the historical data. The scale of the mesoscale size variability is about 100 km below the thermocline and somewhat larger (∿150 km) above it.

XBT ACCURACY

George Seaver
Aero Management Associates

Abstract:

The results of 100 XBT-Istok (STD) comparisons taken aboard R/V Mikhail Lomonosov in November-December of 1977 were presented. Analytical explanations of the mean XBT depth error involving temperature-viscosity changes, dereeling errors, and temperature axis errors were explored. Causes of the random error involving the probes boundary layer, ballast errors, and thermistor variations were discussed.

The XBT is seen as possessing a potential accuracy comparable to the aggregate of the STDs now in use.

SYNOPTIC XBT MAPPING

William G. Metcalf
Woods Hole Oceanographic Institution

Abstract:

The 15° isotherm depth charts from the Synoptic XBT Program were reviewed, and 10 major mesoscale features were identified: 4 warm eddies, and 6 cold eddies. Some of the eddies contained water with very distinctive temperature-depth characteristics which aided in tracking the eddy from survey to survey. A SOFAR float became temporarily entrained in a cold eddy as the float drifted across the path of the eddy.

IGOSS SUPPORT FOR POLYMODE

William Gemmill and Richard DeRycke
NOAA/National Weather Service

Abstract:

The Integrated Global Ocean Station System (IGOSS) is a joint World Meteorological Organization/Intergovernmental Oceanographic Commission program for the exchange and processing of oceanographic data. The IGOSS portion of POLYMODE was a one-year test of the effectiveness of IGOSS to support an oceanographic research project. The IGOSS communication procedures were used to transmit XBT data from the POLYMODE ships to the National Meteorological Center where weekly maps of subsurface thermal structure were prepared and relayed to the POLYMODE office at MIT. The maps were also transmitted to sea via a NWS transmitter on Long Island.

LOCAL DYNAMICS EXPERIMENT RESULTS

PRELIMINARY RESULTS OF CTD MAPPING DURING THE LOCAL DYNAMICS EXPERIMENT

Bruce Taft
University of Washington

Abstract:

Seven (200 km diameter) CTD surveys with 25 km resolution and five higher-resolution (12 km) surveys were carried out during the Local Dynamics Experiment. In the upper thermocline, the 15°C isotherm varied by 270 dbar during the two-month period. The range of pressure at 15°C during the surveys was in excess of ±2 standard deviations of the historical fluctuations. During the middle of the survey period, a very strong pressure gradient developed in the northwest sector which was vertically coherent down to 3000 dbar. The gradient region appeared to shift northwestward at a speed of 2-3 cm/sec. This feature had a horizontal scale which was considerably larger than the survey region. Relative to 3000 dbar, the maximum geostrophic flow in the upper thermocline was 60 cm/sec across the gradient region.

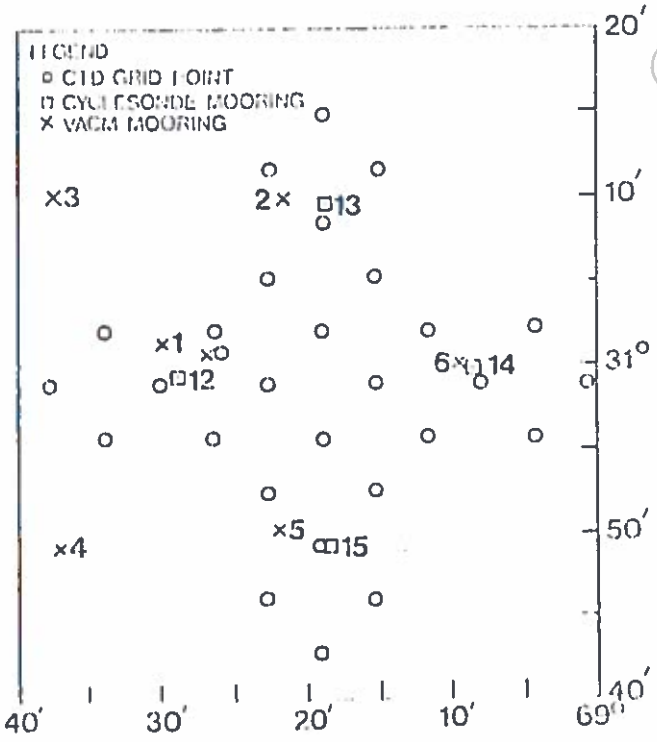
Two 50-km-scale highly baroclinic features were observed. In the lower thermocline there was a feature on the first three surveys with cyclonic shear above 1500 m and anticyclonic shear between 1500 and 3000 dbar. The shear above and below 1500 dbar was equal in magnitude so that there was no expression in the middle thermocline. Associated with the feature was a low salinity anomaly of 0.04 °/₀₀. This feature moved in a south by southwest direction at 10 cm/sec. On surveys 4 and 5 a cyclonic structure occurred at temperatures between 11° and 17°C. It moved at a speed of 18 cm/sec along a track which was parallel to the deeper feature.

PROGRESS REPORT OF RSMAS LDE WORK

John Van Leer
University of Miami

Abstract:

Rosenstiel School of Marine and Atmospheric Sciences work in the Local Dynamics Experiment was carried out by John Van Leer, Kevin Leaman, and Hank Perkins aboard the R/V Gilliss from 19 May to 24 June 1978. An array of cyclesonde moorings was imbedded in the WHOI LDE area, and a grid of about 100 CTD stations to 1000 m was occupied centered near 31°N, 69.3°W (shown in Figure 1).



Local Dynamics Experiment array locations.
Figure 1 (Van Leer)

In spite of the loss of two cyclesondes, over 200 velocity profiles were recovered in the depth range of 40-400 m. Preliminary analysis of these data reveal the presence of vertical current structure of inertial period, particularly during the first Gilliss leg when mean currents were weak. During the second leg, strong eddy/frontal structure was in the area with strong currents. Inertial motion below the seasonal thermocline was markedly reduced suggesting an absorption process.

NEAR SURFACE CURRENTS DURING THE LDE

Lloyd Regier
Scripps Institution of Oceanography

Abstract:

Measurements of currents in the upper 90 m were obtained during the Local Dynamics Experiment using a shipborne Doppler acoustic current meter. An objective analysis of the data yielded stream function maps quite similar to the maps of dynamic topography obtained from simultaneous density measurements. A preliminary analysis of the correlation function of velocity magnitude indicates no change in vertical structure from 10-90 m although there is a shear present, typically 6×10^{-3} sec^{-1} between 23 m and 37 m. The spatial structure of the currents is polarized in a more north-south direction than the structure of dynamic topography.

SOFAR FLOAT OBSERVATIONS FROM THE LOCAL DYNAMICS EXPERIMENT

James C. Price and H. Thomas Rossby
University of Rhode Island

Abstract:

SOFAR float data reveal the rich spectrum of mesoscale motions present during the Local Dynamics Experiment. At the low wavenumber end, there were two small (approximately 30 km diameter) intense (approximately 20 cm/sec) baroclinic eddies, one near 700 m, one near 1300 m. At the high wavenumber end, there was a wavelike motion having a 60-day period which propagated east to west and caused NE-SW float displacements of roughly 200 km. The consequent exchange of planetary and relative vorticity can be clearly seen in the 1300 m data.

Kinetic energy density in the LDE area was approximately 3 times greater than in the MODE-I area, consistent with Ebbesmeyer and Taft's analysis of the historical hydrographic data base. The mean flow was westward at approximately 2 cm/sec at 700 m and 1300 m. Two particle dispersion statistics indicate that the relative dispersion of the floats was similar to that expected from two-dimensional turbulence.

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