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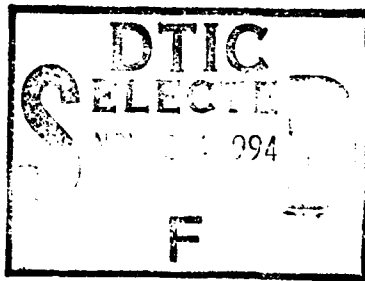
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Reciprocal acoustic transmissions made in the Northwest Atlantic have been analyzed to determine the general circulation of the region between Bermuda and Puerto Rico. Six tomographic transceivers were moored from March 1991 to March 1992 in the region centered at 25°N, 66°W during the Acoustic Mid-Ocean Dynamics Experiment (AMODE). The goals of the research performed under this contract have been (i) to study large-scale (300 to 1000 km) circulation and variability in temperature, current, and relative vorticity fields, (ii) to study mesoscale eddy kinematics and dynamics, and (iii) to study the value of integral constraints on eddy-resolving numerical ocean models. Large-scale range averages (over 300 to 700 km sections) of temperature and velocity and large-scale areal averages (over regions comprising 10⁵km²) of relative vorticity in the upper 3500 m of the water column have been estimated through inversion of the tomographic travel time data.

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FINAL TECHNICAL REPORT

Oceanographic Analysis of the Acoustic Mid-Ocean Dynamics Experiment

ONR Contract N00014-93-1-0461

1 November 1992 - 30 June 1994

Peter Worcester Bruce Cornuelle David Chester

Research Goals:

The goals of the research performed under this contract have been (i) to study large-scale (300 to 1000 km) circulation and variability in temperature, current, and relative vorticity fields, (ii) to study mesoscale eddy kinematics and dynamics, and (iii) to study the value of integral constraints on eddy-resolving numerical ocean models.

Tasks Completed:

Reciprocal acoustic transmissions made in the Northwest Atlantic have been analyzed to determine the general circulation of the region between Bermuda and Puerto Rico. Six tomographic transceivers were moored from March 1991 to March 1992 in the region centered at 25°N, 66°W during the Acoustic Mid-Ocean Dynamics Experiment (AMODE).

The raw acoustic data have been beamformed and tracked, yielding absolute travel times for each source and receiver pair of the array. Sources of noise, such as mooring position, clock drifts, and tides, have been largely removed from the travel time data. The tracked acoustic data is the highest quality to date for a tomographic venture. This is in large part due to GPS positioning of the mooring location, with rms position uncertainties reduced to roughly 1 m.

Large-scale range averages (over 300 to 700 km sections) of temperature and velocity and large-scale areal averages (over regions comprising 10^5 km^2) of relative vorticity in the upper 3500 m of the water column have been estimated through inversion of the tomographic travel time data.

Scientific Results:

Initial inversions of the travel time data indicate that the barotropic and first baroclinic mode are well resolved by the acoustic sampling, with poorer resolution of the second baroclinic mode. The 300-day mean circulation of the region is described by a general westward flow of a few cm s^{-1} in the surface and thermocline waters. An active and resolvable mesoscale eddy field is present in the AMODE region, with variability typically dominated by motions with spatial scales of 100–200 km, and with a general westward drift of mesoscale eddy features. The inverted sound speed (temperature) field is consistent with that estimated from the Moving Ship Tomography component of AMODE. Variability is similar in level and scale to that observed during the MODE experiment, but AMODE provides much larger spatial coverage. Areal-averaged relative vorticities are typically three order of magnitude smaller than the local planetary vorticity, with significant variability on mesoscale time-scales.

The analysis of the acoustic data is ongoing, as is the blending of the AMODE data into a numerical ocean model to test the detailed model evolution against the observations. A nonlinear quasi-geostrophic numerical ocean model has been tailored to the region, and is being used as a dynamic interpolator for the tomographic and hydrographic data. The model is presently being initialized with the high-resolution Moving Ship Tomography fields, and run forward in time. The mismatch between the observations and the evolved model field is used to adjust the initial conditions in order to evaluate the impact on model parameter evolution. Optimized model forecasts will then be used to investigate the evolution of a realistic oceanic eddy field.

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