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Turbulence in the wintertime northern Adriatic Sea under strong atmospheric forcing

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In February 2003, we observed the response of the shallow, $\sim$40 m deep northern Adriatic Sea to strong surface forcing by 40 knot winds and 300 W m^{-2} net upward heat flux related to cold bora winds blowing onto a relatively warm sea through gaps in the Croatian mountains. Ocean turbulence throughout the water column was observed with a microstructure profiler and a bottom-mounted, upward-looking, 5-beam, acoustic Doppler current profiler (ADCP), part of the "bottom lander." Microstructure-based dissipation rates (ε) were of the order of 10^{-6} W kg^{-1}, and corresponded approximately to similarity scaling of the surface wind stress. The surface buoyancy flux, related to oceanic heat loss, was much smaller than the observed ε, an indication that the turbulence was dominantly related to the surface shear stress rather than convectively forced. However, convective surface forcing was reflected in sustained unstable stratification. Macroscale RMS turbulent velocities from the bottom lander were of the order of 0.02 m s^{-1}. The turbulence was horizontally isotropic but showed higher horizontal than vertical variance. Velocities are resolved at periods larger than about 2 min, with the surface gravity wave signal also rising above the instrumental noise. At first glance, the turbulent velocity field appears random with little coherent structure. The typical vertical scale was 10 m, much smaller than the water depth, and there was no correlation in the vertical structure of adjacent 2-min averages. However, there also was small, yet significant vertical coherence to scales approaching the water depth. In the velocity spectra, we identify an "energy-containing band," a shoulder at frequencies of 1–30 cycles per hour. In this band, distributions of the vertical velocity were skewed with an excess of relatively large downward and relatively small upward mo-

tions. The energy-containing band shows large, broadband coherence between the vertical velocity and the horizontal velocity in the direction of the low-frequency currents. The preceding indicates the existence of broadband, anisotropic overturning motions with a tendency toward narrow, faster downdrafts and broader, slower updrafts. These motions were aligned with the direction of the mean current and had widely varying angles to the direction of wind and waves.

The turbulence measurements were embedded in surveys of the mesoscale ocean variability. Part of the observations were set in a sharp, 100–200 m wide front with little density contrast. As the bora wind relaxed, the front began to develop a highly stratified “foot” undergoing intense mixing. This work is part of the DOLCEVITA Experiment (*Dynamics of Localized Currents and Eddy Variability in the Adriatic*).