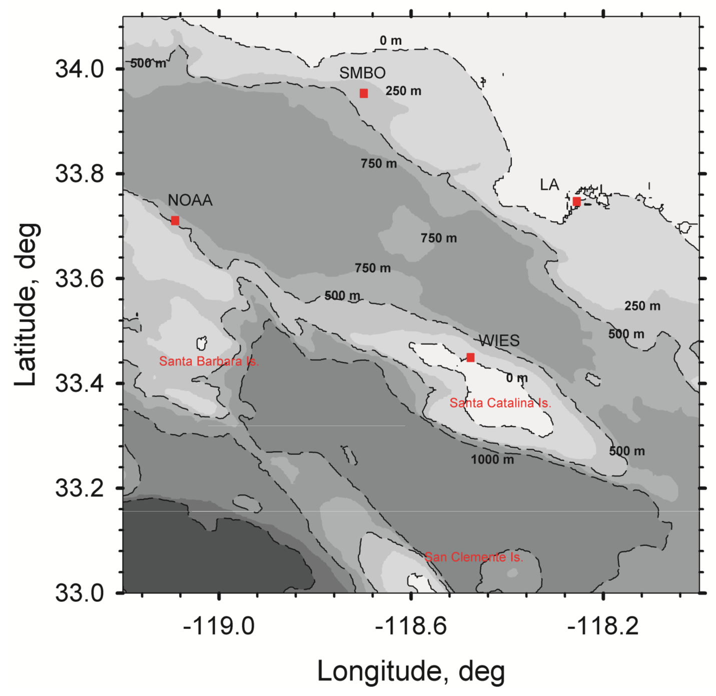
MOMENTUM AND THERMAL DIFFUSION OFF THE COAST OF SOUTHERN CALIFORNIA

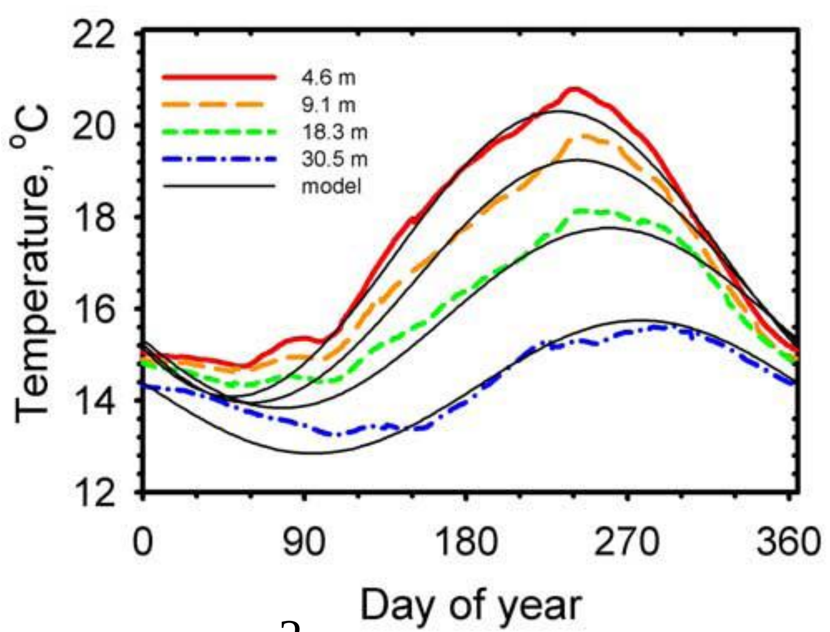
C. Gelpi[1] and A. Leinweber[2]

[1]Catalina Marine Society, craig@catalinamarinesociety.org [2]University of California, Los Angeles, anita.leinweber@gmail.com

The Santa Monica Bay Observatory was deployed from 2001 to 2010 off the coast of Los Angeles. It measured current, temperature, salinity and meteorological data. We have analyzed time series of currents in the diurnal frequency band to compute their coherence and power as a function of depth. These measurements permit the calculation of the momentum-diffusion coefficient for currents driven by the diurnal wind. Well-behaved values obtained from the phase and amplitude variation with depth during the summer deployments indicate a value for the coefficient of 4-8 cm^{2}s^{-1}. These values are similar to those computed from nearby temperature measurements for the vertical thermal eddy diffusion coefficient, namely 1 cm^{2}s^{-1}.

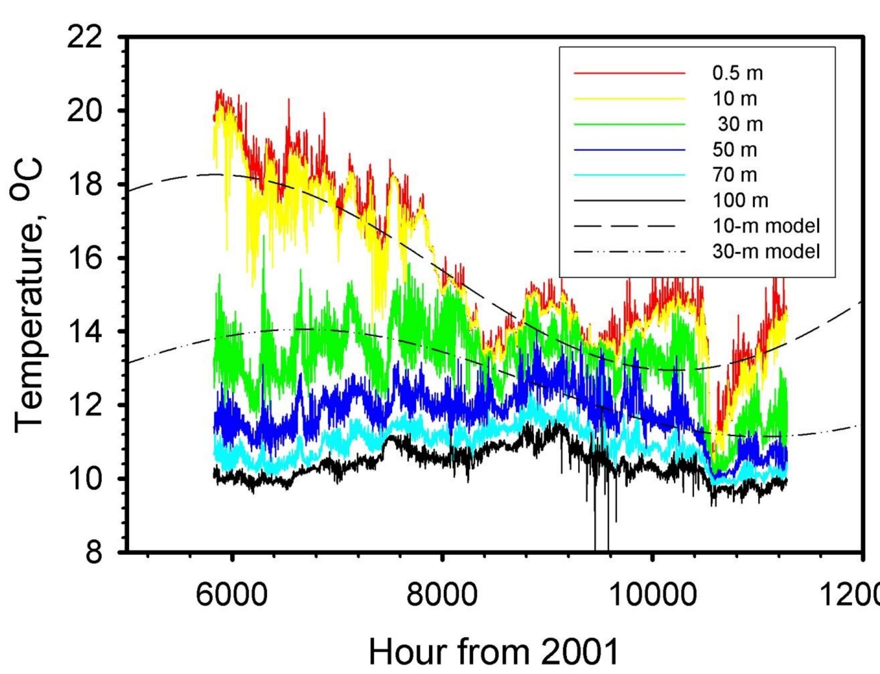


SMBO deployed in Santa Monica Bay, CA

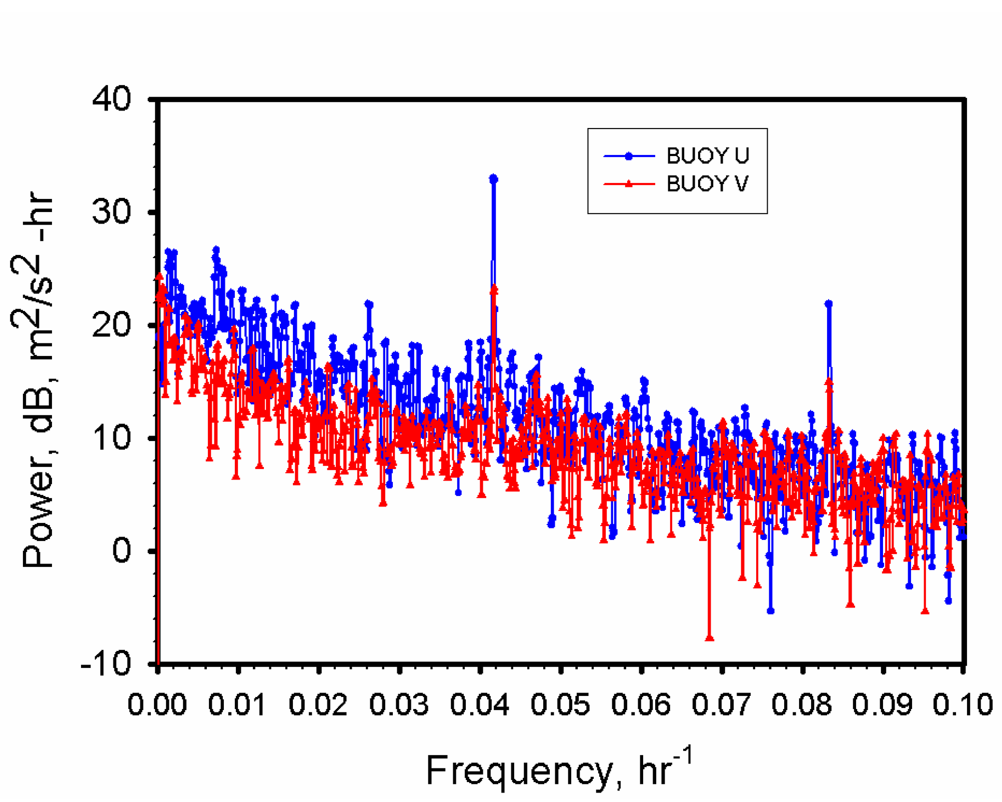


$$\frac{\partial T}{\partial t} - \kappa_T \frac{\partial^2 T}{\partial z^2} = S \qquad \kappa_T \sim 1\ \mathrm{cm^2 s^{-1}}$$

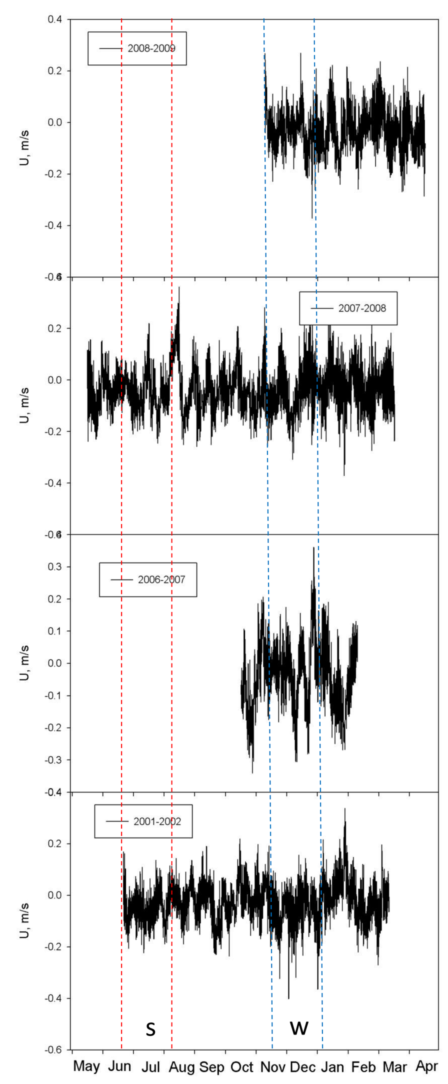
Long-duration, average temperatures and model, derived from Catalina island data.



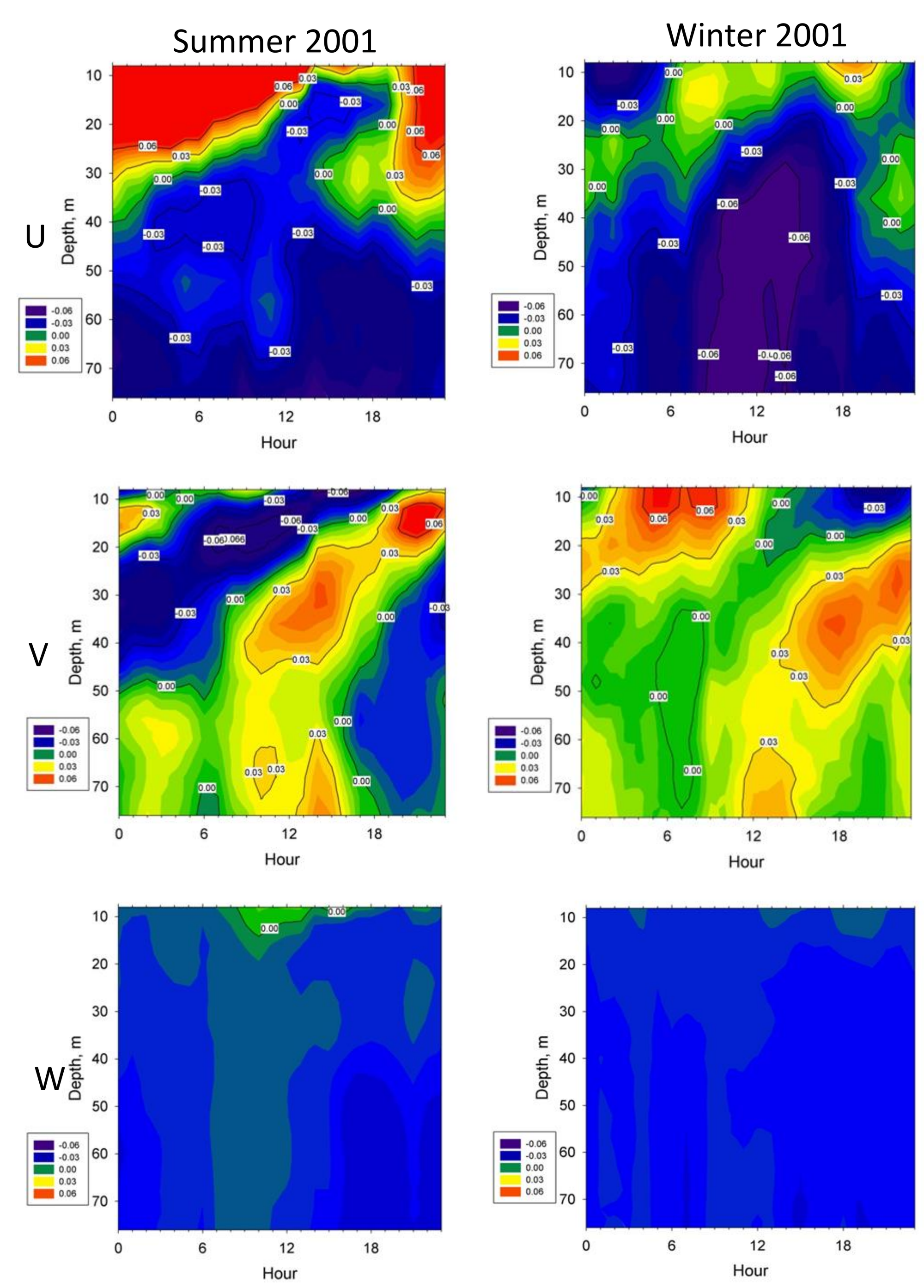
Seasonal temperature variation at SMBO is consistent with model



Power spectral density of wind as measured by nearby NOAA buoy, showing strong diurnal component.



Temporal coverage of SMBO deployments shown as measurements of east current at 44 m. We studied 6 intervals each 50 days in duration. The summer interval started June 22 and was covered by 2 datasets, the winter interval started November 8 and had 4 datasets.



Average day-hour modulation for 2001 summer and winter currents. The currents exhibited upward phase propagation.

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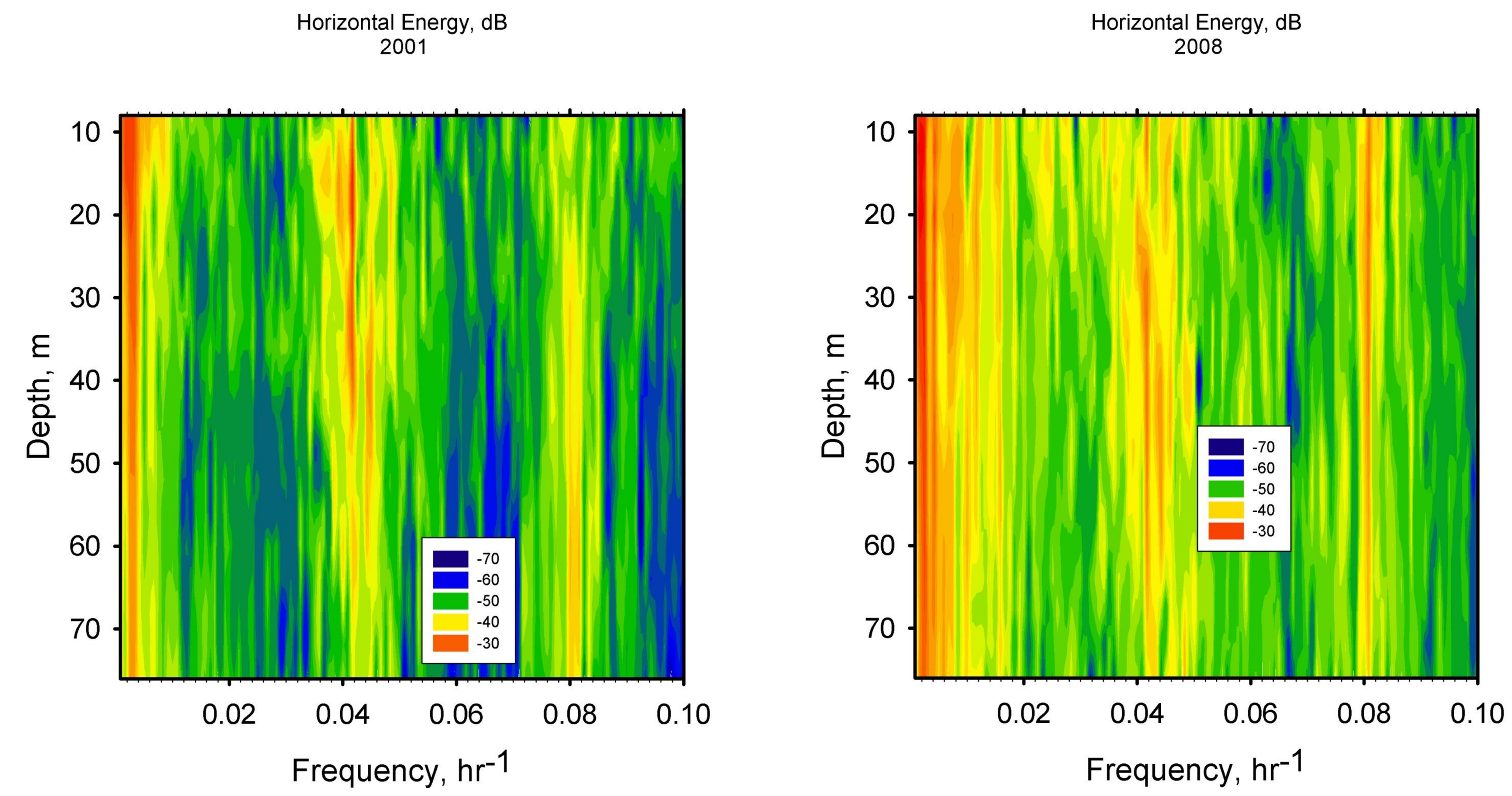
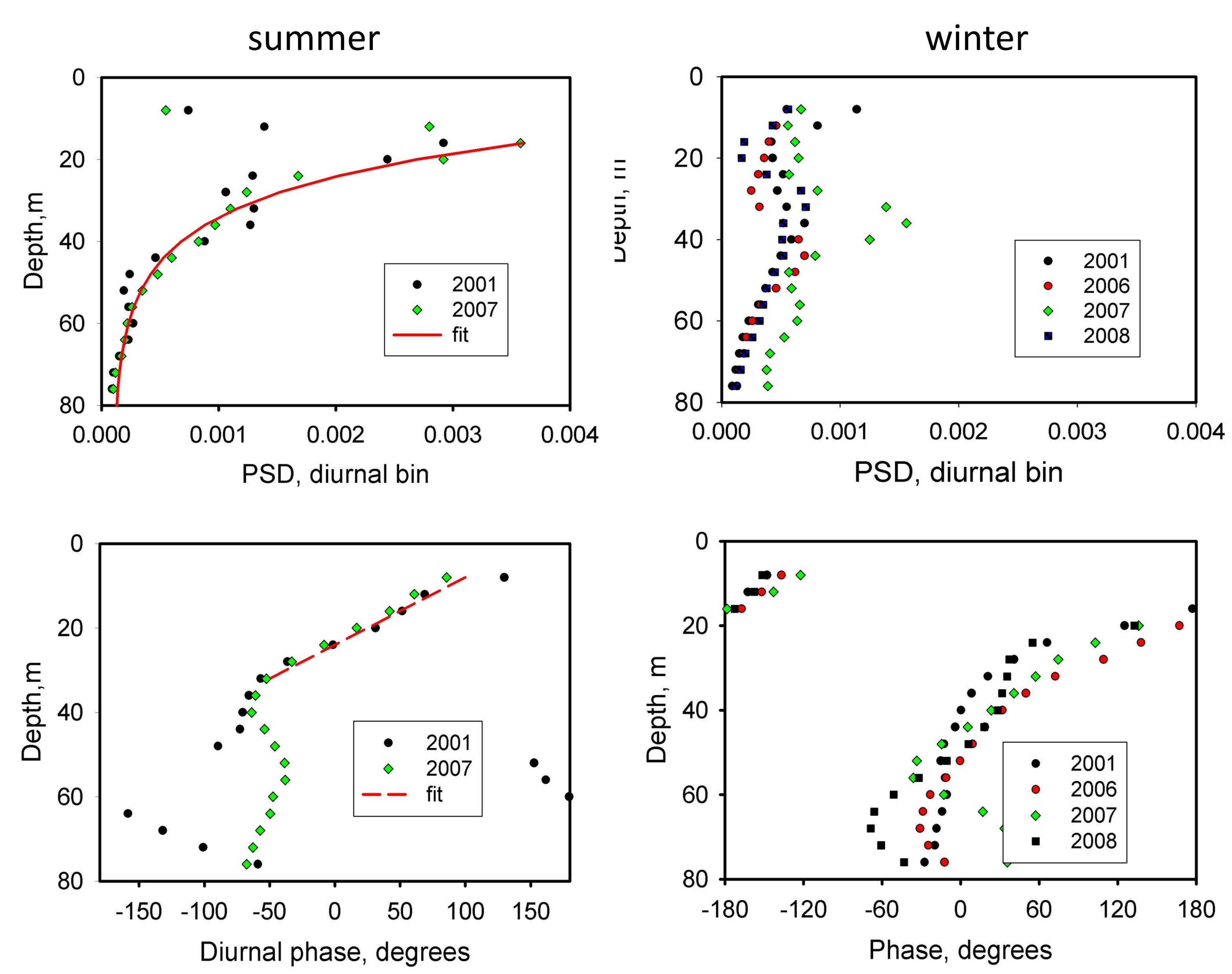


Horizontal current power spectral density vs depth for summer 2001 and winter 2008. Strong diurnal (0.04167 hr^{-1}) power, especially in summer data.

$$\left(\frac{\partial}{\partial t} + if\right)(u+iv) = \kappa_M \frac{\partial^2}{\partial z^2}(u+iv)$$

Momentum diffusion equation and solution.

$$u+iv = Ce^{-\sqrt{\frac{f-\omega}{2K_M}}z}\, e^{-i\left[\sqrt{\frac{f-\omega}{2K_M}}z+\omega t\right]} = Ce^{-\alpha z}e^{-i\beta z}$$



Power and phase for 6 intervals. Fits to summer data are shown.

$$\alpha = 0.075\mathrm{m^{-1}} \Rightarrow \kappa_M = 7.7\,\mathrm{cm^2 s^{-1}}$$

$$\beta = 0.10\mathrm{rad\ m^{-1}} \Rightarrow \kappa_M = 4.3\,\mathrm{cm^2 s^{-1}}$$

Summary

The two seasons exhibited very different behavior. The summer data indicated large horizontal current energy at shallow depths and large current shear with depth. The well-defined characteristics with depth allowed calculation of the momentum diffusion coefficient, ~ 6 cm^2 s^{-1}.