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Fine Spatial Scales in the Low Frequency Circulation of the Ocean

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Determining the structure of the mean circulation of the ocean is hampered by the often small separation in space scales between eddy and mean (or more correctly low frequency) components of the flow. This presents difficulties in both observing and modelling the circulation. Recent results from high resolution, low viscosity, ocean general circulation models show a remarkable structure at depth. The flow averaged over a number of years is dominated by a series of jets that have a large zonal coherency (sometimes stretching the width of an ocean basin), and which have a meridional wavelength of between 300–500km. This structure is present from the thermocline to the bottom of the ocean. The intensity of the jets is greatest in regions where the surface flow is most energetic: the ACC, the tropics and underneath the extension of western boundary currents such as the Gulf Stream and Kuroshio. The analysis of a number of model runs shows the characteristics of the zonal jets to be independent of the sub–grid scale parameterization in the model. The spatial variation in the meridional scale, $\mathcal{L}$, of the jets is consistent with the theory of Rhines for geostrophic turbulence in the presence of a variable Coriolis parameter, namely $\mathcal{L}^2 \sim u'/\beta$.

A region for easy comparison of the model results with observations is the tropical Pacific. Here a number of repeated meridional sections have been conducted for more than a decade at a number of longitudes across the width the ocean. The observations show a very similar multiple jet zonal structure, which is persistent with time and is present across the width of the meridional sections ($\sim$ 10^{o}S–10^{o}N) and from 200m depth to the bottom of the sections ($\sim$ 500m).

The presence of relatively fine scale structure to the zonal flow in the ocean has implications for both the dispersion of tracers and the way sub-grid scale processes are parameterized in coarser models. The meridional shear of the flow will significant

enhance zonal dispersion. Estimates of its effect will be presented.