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Seasonality in internal wave energy and internal mixing in a continental shelf sea

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Over 17 months (March'14 − July'15) of density and velocity data from a site on the NW European continental shelf provide unprecedented coverage of the seasonal cycle of internal wave activity. The data were collected from the central Celtic Sea, approximately 120 km on shelf from the continental shelf break. These long-term observations reveal a seasonality within the internal wave energy, with energy at a maximum during summer months relative to the seasonal cycle in stratification (represented by the Brunt-Väisälä frequency, N^2). Observations were compared to the results from a model that employed three different commonly used internal wave parameterisations; (background diffusivity; Kantha and Clayson, 1994; Canuto et al., 2001). Each model run managed to predict some degree of seasonality in internal mixing however, contrary to observed results, summer months were predicted to undergo a minimum in internal mixing, with enhanced mixing observed during spring and autumn transitional periods of stratification. This failure in each model was attributed to the lack of realistic levels of enhanced baroclinic energy and shear (S^2) that would naturally be attributable to internal waves. Our observations revealed a close relationship between N^2 and S^2, resulting in a near continuous state of marginal stability, where the gradient Richardson is maintained at a level close to criticality. Due to the strong dependence of internal wave energy and internal mixing on stratification, a modified version of the MacKinnon and Gregg (2003a) turbulence scaling was employed. The resulting model output successfully managed to reproduce the observed seasonality in internal mixing. Our results suggest that to accurately reproduce internal mixing, models must replicate the seasonality in the internal wave field, which is naturally aligned with stratification via baroclinic conversion. A simple turbulence scaling, modified slightly for local conditions, was shown to dramatically improve the predictive capability of internal mixing on the continental shelf.