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Finding Plankton Blooms in Turbulence

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Wide ranging observations of aggregations of phytoplankton in ocean mixed layers has led to considerable research efforts being devoted to their underlying causes. Various mechanisms have been put forward as to the means by which the effects of the strong turbulent mixing properties associated with the ocean surface layer can be overcome, and so give rise to localised patches of high biological concentrations. In this talk the problem of planktonic patch formation is examined from a much more general viewpoint, with aim of answering the question as to when biological aggregations can be expected to form in the ocean mixed layer in opposition to the background turbulent mixing, and at what level is the latter simply too strong for any such aggregations to occur? This question is investigated by studying the biological evolution of a generic type of nutrient-phytoplankton-zooplankton (NPZ) model coupled to a three dimensional large eddy simulation (LES) of the ocean mixed layer, subject to fixed levels of wind forcing. Initially uniform and interacting PZ concentrations are introduced into the LES model, which is subjected to a steady, non uniform, nutrient source, acting as a stimulus for patch formation, as might be derived from a sustained deep ocean upwelling event or from a river estuary flow. The resulting biological concentration fields are analysed over periods of weeks, to try to predict when patches are likely to be observed in spite the dissipative actions of the background turbulent mixing, and to ascertain the key correlations between the biological and physical parameters most conducive to the formation of biological aggregations.