Geophysical Research Abstracts, Vol. 7, 09382, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09382

Large Eddy Simulation of the Marine Surface Boundary Layer during the Spring phytoplankton bloom: preliminary results

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In order to reproduce a realistic turbulent marine environment, as an example of the conditions experienced by the suspended plankton in springtime, a Large Eddy Simulation (LES) model has been developed. At mid-latitudes Spring phytoplankton blooms occur under peculiar physical conditions, that is weak stratification (due to the winter deep mixing), large cooling and warming events on daily and weekly scales and, possibly, intense wind events. The turbulent marine environment appears thus complex, being simultaneously determined by several phenomena and still not well known. The LES model is based on a second order Finite Volume (FV) spatial discretization in the framework of a second order time-accurate projection method for pressure-velocity decoupling. The variables are collocated on a structured grid, non-uniform in the vertical direction. A suitable procedure is adopted to enforce the continuity constraint up to the machine accuracy. The momentum and thermal energy equations are filtered on the FV box, the sub-grid scale (SGS) stress terms being modeled by means of a dynamic procedure. More specifically, according to the stratification-free procedure considered, two independent dynamic procedures are developed for computing the momentum and energy SGS model coefficients in the FV integral equations. The LES model is validated for a preliminary turbulent model-flow in which, starting from a weak stratification, the turbulence is driven only by the effect of surface cooling. Preliminary results are obtained for a moderate Reynolds number flow. This way, a fully-resolved Direct Numerical Simulation (DNS) is performed in order to verify LES results. After this preliminary study, the marine turbulent environment can then be made more realistic by adding both intermittent wind stress and

cooling at the surface. The effect of the wave-induced Stokes drift and wave breaking can also be considered.