Preface

Impact of Small-scale Physics on Marine Biology

This special issue collects some of the papers presented at the 2nd Warnemünde Turbulence Days, held during September 28–30, 2005. This meeting is organised by the Baltic Sea Research Institute at Warnemünde, Germany on a biannual basis (see http://www.io-warnemuende.de/phy/wtd). Its aim is to provide a discussion forum for experts interested in aquatic turbulence research with short presentations and ample opportunities to exchange ideas in a relaxed environment.

Research on aquatic turbulence has gained considerable momentum during the last decade. Among the reasons, we may highlight: 1) the development of new and better sensor technologies has made turbulence measurements more routinely accessible, and therefore greatly promoted the generation of accurate and statistically significant data sets for a wealth of key processes; 2) the increase in computer processing power and in algorithm development is facilitating the incorporation of turbulence in ocean models; and 3) the experimental realisation that turbulence may influence a whole range of aquatic organisms and processes provides a global biogeochemical implication framework. The advent of so much new data from almost uncharted waters only adds to and stirs the research discovery excitement.

The topic for the 2005 meeting was “Impact of small-scale physics on marine biology”. Hydrodynamics and marine life interact at several scales. Vertical mixing interacts with the distribution of particles and the nutrient and light fields that plankton experiences in the water column determining its population dynamics. Small-scale turbulence seems to increase the flux of nutrients towards diffusion-limited cells, to promote the encounter rate of prey particles with their predators and to interfere with the physiology of some planktonic organisms, such as dinoflagellates. Turbulence also interacts with suspended particles by aggregating and disaggregating particulate organic matter with important consequences for the export flux of organic matter to deep waters. Benthic organisms may modify the hydrodynamic regime around them with structures that modify the boundary layer and consequences for their feeding and growth. These are just a few paintbrushes of interactions between hydrodynamics and plankton subject to ongoing research. This topic is growingly important for solving societal problems such as fisheries sustainability, harmful algal blooms, coastal eutrophication and climate change impacts. Consequently, it is included in a range of international programs: IMBER (http://www.imber.info), LOICZ (http://www.loicz.org), GOOS (http://www.ioceoos.org), GEOHAB (http://www.jhu.edu/scor/GEOHABfront.htm) and GLOBEC (http://www.globec.org), to name just a few.

The meeting was organised in six plenary sessions: 1. Advanced instrumentation; 2. Small-scale turbulence: field studies and modelling; 3. The impact of turbulence on plankton; 4. Particle interaction and behaviour; 5. Stochastic model studies; and 6. The impact of turbulence on the ecosystem. The meeting was attended by 40 plus researchers from 12 different countries. In total, there were 27 oral presentations.

The present collection of papers includes 7 manuscripts covering all 6 topics. The manuscript by Mohrholz et al. demonstrates how advanced instrumentation in conjunction with sophisticated data analysis may result in long-term data coverage also for a quantity as difficult to measure as the turbulent dissipation rate. In this manuscript, the structure function approach previously known from radar meteorology is applied to data from an Acoustic Doppler Profiler (ADP) mounted close to the sea bed in a dense bottom current in the Western Baltic Sea, covering a range of about 2 m. The data agree sufficiently well with profiles of the turbulent dissipation rate observed with a free-falling microstructure profiler.

In a field study of small-scale turbulence, Sato and Yamazaki demonstrate how the microstructure of fluorescence can be quantified by processing fluorometer observations taken by means of a conventional CTD. By using a log-normal mixture probability density function, the authors show how to statistically extrapolate
the intermittency in such a way that the results agree well with microstructure data observed at the same station directly with a free-falling profiler.

The impact of turbulence on plankton is the topic of the manuscript by Ross and Sharples who numerically simulate the mixing of a fraction of the phytoplankton in the subsurface chlorophyll maximum at the base of the thermocline into the underlying, tidally driven bottom boundary layer (BBL). The authors discuss whether the ability of cells to actively swim upwards helps them to survive. They conclude that BBL turbulence periodically moves them close to the thermocline which they may then reach by active swimming.

Aspects of particle interaction and behaviour are discussed in two papers. Schmitt and Seuront investigate the phenomenon of preferential concentration, i.e., the accumulation of inertial and neutrally buoyant particles in regions of relatively low vorticity due to intermittency. The authors conclude that preferential concentration may be relevant for copepods, with the consequence that the encounter rates between them may be significantly increased by this process compared to the assumption of no preferential concentration. Mariani et al. present numerical simulations of copepods feeding on dinoflagellates, based on a kinematically generated flow field and copepod behaviour depending on local flow conditions. With these settings, the authors are able to reproduce laboratory experiments of the copepod feeding behaviour. For the topic of stochastic modeling, Visser provides a review of random walk (Lagrangian formulation as individually tracked particles) and Fokker-Plank methods (corresponding Eulerian formulation). The issue of model validation is raised by the author, which in the most simple case of diffusion is the well-mixed condition, but may require more information if the individual organism state or behaviour are considered.

The impact of turbulence on the ecosystem is topic of the final manuscript, presented by Debolskaja et al., who discuss the impact of stable stratification in the shallow Azov Sea on near-bed oxygen concentrations. They show how the joint effect of high organic river load, strong heating, low winds and the formation of a near-bed halocline lead to a significant anoxic event.

We are grateful to the German Research Foundation for their financial support to this workshop. For their support to the local organization, we are indebted to Karin Wrobel, Dietmar Rüss, and Hannes Rennau. Furthermore, we would like to thank ISW Wassermess-nik (Hartmut Prandke and family) for a barbeque reception at their facilities, and the captain and crew of the R/V Professor Albrecht Penck for their on-board reception and guided tour.

Guest Editors

Hans Burchard
Baltic Sea Research Institute Warnemünde
D-18119 Rostock, Germany
Corresponding author.
E-mail address: hans.burchard@io-warnemuende.de.

Lars Umlauf
Baltic Sea Research Institute Warnemünde
D-18119 Rostock, Germany

Francesc Peters
Institut de Ciencies del Mar, CMIMA (CSIC)
E-08003 Barcelona, Catalunya, Spain