



Winter short course on

Modelling mixing and transport in lakes, harbors and estuaries

Local organizers: Dr. J.Niemela (ICTP); Prof. V. Armenio (University of Trieste)

Location: Adriatico Guest House, The Abdus Salam International Centre for Theoretical Physics, Trieste, Italy

Time: 1-3 of February 2016

Duration: 3 days, 18 hours

Abstract

A reliable modelling of hydrodynamics and transport of substances in water basins, such as lakes, harbors and estuaries, is typically a difficult task because of the intermittent external forcing (mainly wind), the internal stratification (usually due to the vertical distribution of temperature and/or salinity), the possible onset of internal waves, and the complex diffusion processes that characterize these environments. In particular, simulating the mixing associated with turbulence requires suitable models, which vary from very simple algebraic empirical closure for the eddy diffusivity, to more elaborate systems of differential equations for the transport of the turbulence properties, up to complex and computational demanding Large Eddy Simulations that are nowadays becoming a viable option also to study real problems. This course aims at providing the basic background on the boundary conditions and the physical processes in lakes, estuaries and semi-enclosed basins as well as the modelling tools to understand and exploit the recent developments in this field. The course is intended for researchers and practitioners willing to become mature and aware users of the commercial software available in the environmental fluid dynamics engineering community.

Topics and lecturers:

1. **Physics of lakes** – 4 h

Alfred Johnny Wüest (EPFL and EAWAG, Switzerland;

http://www.eawag.ch/about/personen/homepages/wuest/index_EN,

<http://people.epfl.ch/alfred.wueest>)

2. **Numerical modelling of transport and mixing in lakes and estuaries** – 4 h

Hans Burchard (Leibniz Institute for Baltic Sea Research, Germany;

<http://www.iowarnemuende.de/hans-burchard-en.html>)

3. **Large eddy simulation in closed and semi-closed basin** – 4 h

Vincenzo Armenio (University of Trieste, Italy;

<http://www.units.it/data/curricula/4391.pdf>)

4. **Simple models for lake dynamics** – 3 h

Marco Toffolon (University of Trento, Italy;

<http://webapps.unitn.it/People/it/Web/Persona/PER0003456#INFO>)

5. – **The ecological quality of reservoirs** -3 h

Enrique Navarro (Pyrenean Institute of Ecology -CSIC-, Spain;

<http://www.ipe.csic.es>

<http://www.enriquenavarro.com>)

Logistic

The course will be held at Kastler Lecture Hall, Adriatico Guest House, Lower Level 1, ICTP.

A limited number of rooms has been reserved at Adriatico Guest House (ICTP) for participants

<http://www.ictp.it/visit-ictp/accommodation/guesthouses.aspx>.

Detailed maps and information on how to get there are <http://www.ictp.it/visit-ictp/transportation.aspx>.

Useful info are available at <http://www.ictp.it/visit-ictp/about-trieste.aspx> and <http://www.ictp.it/visitictp/pre-arrival-guide.aspx>.

The registration fee is 350 EU and it covers course material, coffee breaks, 2 lunches and course dinner.

Payments should be made exclusively by bank transfer

Please, complete the attached registration form and return it by email to:

armenio@dica.units.it

PROGRAM

Monday Feb. 1		
9.00-9.15	<i>Opening</i>	
9.15-10.15	Wüest	The lake as a living organism: the biogeochemical cycles imbedded into the vertical structure of lakes. Density and lake stratification related to the seasonal natural processes.
10.15-11.15	Wüest	Currents and internal waves in lakes – an empirical overview.
11.15-11.45	<i>Coffee break</i>	
11.45-12.45	Toffolon	Scale-dependent processes: how the mathematical modeling changes with size and averaging (e.g. dispersion as a diffusive process in averaged models).
12.45-14.00	<i>Lunch</i>	
14.00-15.00	Burchard	From the Navier-Stokes equations via the Reynolds decomposition to a working turbulence closure model for the shallow water equations: The compromise between complexity and pragmatism.
15.00-16.00	Burchard	How to make a three-dimensional numerical model that works for lakes and estuaries?
16.00-16.30	<i>Coffee break</i>	
16.30-17.30	Armenio	Numerical methods for turbulent flows.
17.30-18.30	Armenio	Large Eddy simulation: principles and requirements.
20.00	<i>Dinner</i>	<i>“Tavernetta al Molo”, Riva Massimiliano e Carlotta, 11 - Grignano, Trieste.</i>
Tuesday Feb. 2		
9.00-10.00	Wüest	Surface boundary layer processes in lakes (such as constant flux layer, wave affected surface layer, non-stratified turbulence and relation to air-water exchanges).
10.00-11.00	Wüest	Bottom boundary layer processes in lakes (such as constant flux layer, non-stratified turbulence and relation to the viscous and diffusive boundary layer and sediment-water fluxes).
11.00-11.30	<i>Coffee break</i>	
11.30-12.30	Toffolon	Diapycnal diffusivity in stratified flows: strengths and weaknesses of simplified empirical models.
12.30-14.00	<i>Lunch</i>	

14.00-15.00	Burchard	Periodic straining, a process which lakes (due to seiches) and estuaries (due to tides) have in common.
15.00-16.00	Burchard	Numerical model applications to lakes and estuaries with focus on transport and mixing of tracers.
16.00-16.30	<i>Coffee break</i>	
16.30-17.30	Toffolon	Examples of different mechanisms of vertical transport in stratified lakes: deep water renewal due to thermobaric instability; double diffusion.
17.30-18.30	Navarro	Assessing the ecological quality of Iberian reservoirs.
Wednesday Feb. 3		
8.30-9.30	Navarro	The settlement success of <i>Dreissena polymorpha</i> in a Spanish reservoir: the role of hydrological conditions.
9.30-10.30	Navarro	Global change impacts in freshwater ecosystems: a long-term and high resolution watershed study of a highly regulated river (because the reservoirs).
10.30-11.00	<i>Coffee break</i>	
11.00-12.00	Armenio	Large eddy simulations of environmental flows.
12.00-13.00	Armenio	Large eddy simulation of mixing in harbours.
13.00-13.10	<i>Closure</i>	