Preliminary programme (updated May 5)

Monday July 2, 2018

8:30	**Welcome, café**
8:45	**Stefano Berti** (Lille University, Mechanic Unit), **Enrico Calzavarini** (Lille University, Mechanic Unit), **François Schmitt** (CNRS, LOG, Wimereux) : **Introduction and presentation of the School**
9:00	**Federico Toschi : Turbulence fundamentals**
10:30	**Coffee break**
11:00	**John Taylor: Ocean turbulence and mixing I**
12:20	**Lunch** (buffet)
13:40	**Catherine Jeandel: Illustrating marine geochemistry I**
15:00	**Coffee break**
15:30	**Emilio Hernandez-Garcia: Ocean transport, coherent structures and their impact on chemical and ecological marine processes I**
16:50	**10 short talks of participants (10 min each)**
18:30	**Free time and free diner for participants**

Tuesday July 3, 2018

9:00	**Guillaume Lapeyre: Upper ocean turbulence at submesocale**
10:30	**Coffee break**
11:00	**Peter J.S. Franks: Oceanic turbulence from a planktonic perspective I**
12:20	**Lunch** (buffet)
13:40	**Catherine Jeandel: Illustrating marine geochemistry II**
15:00	**Coffee break**
15:30	**John Taylor: Ocean turbulence and mixing II**
16:50	**Emilio Hernandez-Garcia: Ocean transport, coherent structures and their impact on chemical and ecological marine processes II**
18:10	**Free time and free diner for participants**

Wednesday July 4, 2018

9:00	**John Taylor:** Ocean turbulence and mixing III
10:20	**Coffee break**
10:50	**Catherine Jeandel:** Illustrating marine geochemistry III
12:10	**Field trip to 2 Capes, lunch & visit of Cape Blanc-Nez and Cape Griz-nez**
20:00	**Gala dinner of the Summer School**

Thursday July 5, 2018

9:00	**Aleksandra M. Lewandowska:** The role of phytoplankton diversity in bloom formation
10:30	**Coffee break**
11:00	**Emilio Hernandez-Garcia:** Ocean transport, coherent structures and their impact on chemical and ecological marine processes III
12:20	**Lunch** (buffet)
13:40	**Peter J.S. Franks:** Oceanic turbulence from a planktonic perspective II
15:00	**Coffee break**
15:30	**Franz Peters:** Effects of turbulence on bacteria: can they be real?
16:50	**Fillippo De Lillo:** Large and small scale clustering of phytoplankton in turbulence
18:20	**Free time and free diner for participants**

Friday July 6, 2018

9:00	**Yannis Cuypers:** Turbulence observation in the stratified ocean
10:30	**Coffee break**
11:00	**Peter J.S. Franks:** Oceanic turbulence from a planktonic perspective III
12:20	**Lunch** (buffet)
13:40	**End of the Summer School** **Departure of the participants**

John Taylor (University of Cambridge, UK)

Ocean turbulence and mixing. Ocean fronts and the surface boundary layer. Impact of turbulence on micro-organisms

I will give an overview of the sources and importance of turbulence in the ocean, introduce frontal dynamics and submesoscales, describe the interaction between small-scale turbulence in the upper ocean and submesoscales, and describe how all of these physical processes might influence ocean biology.

Lecture 1:
- Scales of ocean circulation
- Energy sources and sinks
- Boundary layer turbulence (Ekman layers and convection)

Lecture 2:
- Horizontal density gradients and frontogenesis
- submesoscale instabilities (specifically baroclinic instability and symmetric instability)
- Forward energy cascade from submesoscales to 3D turbulence
- mixed layer re-stratification

Lecture 3:
- Modulation of boundary layer turbulence by submesoscales
- Triggering of phytoplankton blooms through the critical turbulence mechanism
- Influence of submesoscales and turbulence on buoyant and dense material (time-permitting)

Franz Peters (Institut de Ciències del Mar (CSIC), Spain)

Effects of turbulence on bacteria, can they be real?

Marine bacteria are smaller than 1 µm in size and live in a diffusion-limited nutrient environment. Under typical marine turbulent conditions, turbulent inertial motion should have negligible effects on the the diffusivity of solutes towards the cells and thus be unable to enhance uptake and growth. However, marine bacterial growth often benefits from water turbulence treatments. I will elaborate on different aspects related to size and organic matter to explain such contradiciton.

Outline :
- Heterotrophic bacteria
- Turbulence and shear
- Kolmogorov and Batchelor scales

- Molecular diffusion, solute flux
- Direct and indirect effects of turbulence on bacteria
- Sherwood numbers, large molecular weight substances
- Bacterial aggregate formation

Aleksandra M. Lewandowska (Tvärminne Zoological Station, University of Helsinki)

The role of phytoplankton diversity in bloom formation

The onset of the spring phytoplankton bloom depends on both water column mixing and trait combination of phytoplankton community. In this seminar, we will discuss how stratification and turbulent mixing affect phytoplankton community composition and which phytoplankton traits are crucial at the bloom onset.

Guillaume Lapeyre (Laboratoire de Météorologie Dynamique/IPSL, Paris)

Upper ocean turbulence at submesoscale

In this talk, I will present our new vision of the ocean circulation at scales 5-500km. In addition to mesoscale eddies (of typical diameters ~ 200km) that concentrate the horizontal kinetic energy, lies a sea of submesoscales (typical scales 5-50km) that concentrate vertical motions. I will discuss transport and mixing associated with these structures.

Outline :

- Description of typical properties of a turbulent flow involving meso and submesoscales (3 to 500 km induced by large-scale currents
- Interior vs Surface dynamics. Link to QG and SQG theories
- 3d organisation of vertical fluxes and transport related to surface dynamics at meso and submesoscales

Catherine Jeandel (LEGOS, CNRS, Toulouse)

Illustrating Marine Geochemistry: the oceanic REE cycle story

Researches in marine geochemistry are focused on quantifying the fluxes and processes that govern the chemical state of the ocean. With this aim, marine geochemists are developing trace element and isotope measurements in seawater and marine particles. This scientific approach will be illustrated by the story of the oceanic Rare Earth Element concentrations and neodymium isotope cycle, tracers of water mass circulation and mixing, dissolved-particulate processes and land-ocean exchange.

Emilio Hernandez-Garcia (IFISC, CSIC-University of the Balearic Islands, Palma de Mallorca, Spain)

Ocean transport: coherent structures and their impact on chemical and ecological marine processes

Ocean currents move, deform and mix fluid parcels. The way this occurs has profound impacts on biogeochemical processes occurring in the sea and shapes ecosystems. In this set of lectures I will review some techniques from Lagrangian fluid dynamics and dynamical systems suited to understand ocean transport and use them to characterize its biological effects at several scales.

Peter J.S. Franks (UC San Diego, Scripps Institution of Oceanography)

Oceanic Turbulence from a Planktonic Perspective

Turbulence is often invoked as an essential dynamic controlling the interactions among the plankton. However, oceanic turbulence is very weak. Furthermore, the statistics of turbulent properties are very skewed, with low probabilities of strong shears and vorticities. Plankton are largely Lagrangian, but most turbulence theory for plankton is Eulerian. It is time to incorporate a more plankton-centric view of oceanic turbulence into our understanding of plankton ecology.

Filippo De Lillo (Dipartimento di FIsica and INFN, Università di Torino, Italy)

Large and small scale clustering of phytoplankton in turbulence

Swimming and buoyancy may interact with oceanic turbulence and affect the small and large scale distribution of phytoplankton. At large scale, this interaction may be relevant for the formation of structures like thin phytoplankton layers. At small scale, the trajectories of transported microorganisms deviate from those of ideal tracers allowing for the emergence of non-trivial, fractal distributions. We discuss how numerical modeling can be used to investigate these phenomena.

Yannis Cuypers (Laboratoire d'Océanographie et du Climat: Expérimentations et approches Numériques, Paris, France)

Turbulence observation in the stratified ocean

We will review in this lecture the existing methods and parametrization to characterize the turbulence dissipation rate from usual fine scale (~1m resolution) observations of hydrology and currents to the more specific microstructure measurements (~1cm resolution).

Federico Toschi (Eindhoven University of Technology, Eindhoven, The Netherlands)

Turbulence fundamentals

In this lecture, we will review the basic fundamental properties of fluid dynamics turbulence with emphasis on both Eulerian and Lagrangian viewpoints.