International course of lectures "Geophysical turbulence and boundary layers: nature, theory and role in Earth's systems" (corrected announcement 09.03.07)

University of Helsinki and Finnish Meteorological Institute
"Dynamicum", Erik Palménin aukio 1, 00561 Helsinki, Finland
28 May - 1 June 2007

Organising Committee:
S. Joffre (FMI), H. Savijarvi (UH), M. Sofiev (FMI; Course Director), S. Zilitinkevich (UH / FMI)

Summary

The main objective of this course is to summarise current knowledge on the nature, theory and parameterisation of geophysical turbulence, planetary boundary layers (PBLs) and meso-scale boundary-layer type flows relevant to numerical modelling of weather, climate, air-pollution and both terrestrial and marine ecosystems. From the physical point of view, these are the very high Reynolds number, stratified, rotating, turbulent flows. Their improved parameterisation is becoming a challenging problem in view of new demands from operational modelling employing very high resolution general circulation models (GCMs), especially the coupled atmosphere-soil/sea/ice-biosphere model suites needed to realistically predict local consequences of the climate change. The course will cover the following main topics:

- Nature and theory of geophysical turbulence and PBLs
- Turbulence closure problem
- Radiation and turbulence PBLs
- Semi-organised structures and fully chaotic turbulence: similarity and difference
- Observation of the turbulent and mean structure of PBLs
- Large-eddy simulation (LES) of PBLs
- Flow-surface interaction and turbulent fluxes at the surface[1]
- Turbulent and mean structure of air flows within vegetated and urban canopies
- Meso-scale and urban turbulent flows
- Weather and climate problems essentially dependent on PBLs
- PBLs and turbulence in ecosystem modelling

[1] Air-sea interaction has been the subject of a recent summer school (28 August – 1 September 2006, FMI, Helsinki).

Programme

Nature and theory of geophysical turbulence and PBLs	
Fundamentals of turbulence (2 h)	Prof. Arkady Tsynober, UCL, UK
New effects in turbulent aerosol transports: theory, lab and field experiments (2 h)	Dr. Igor Rogachevskii, BGU, IL
PBLs in stable, neutral and unstable stratification: theoretical models and parameterizations for use in GCMs (5 h)	Prof. Sergej Zilitinkevich, UH / FMI, FI
Turbulence closure problem for stable stratification:	
Turbulence energetics and critical Richardson number (1 h) Energy and flux-budget (EFB) turbulence closure model: (a) local model (1 h) (b) non-local model (1 h)	Prof. Sergej Zilitinkevich, UH / FMI, FI
Quasi-normal scale elimination (QNSE) model (1 h)	Prof. Boris Galperin, USF, USA
Radiation and turbulence in PBLs	
Radiative heat transfer and its role in stable PBLs (2 h)	Prof. Hannu Savijärvi, UH, FI
Semi-organised structures and fully chaotic turbulence: similarity and difference	
LES "portraits" of typical semi-organised eddies (1 h)	Dr. Igor Esau, NERSC, NO
Semi-organised structures in convective boundary layers (2 h)	Dr. Nathan Kleeorin, BGU, IL
Observation of the turbulent and mean structure of PBLs	

What do we want to measure in turbulence, why and how? (2 h)	Prof. Arkady Tsynober, UCL, UK
Remote sensing observation of PBLs (2 h)	Dr. Ari Karppinen, FMI, FI
Large-eddy simulation of PBLs	
Large-eddy simulation of PBLs (2 h)	Dr. Igor Esau, NERSC, NO
Flow-surface interaction and turbulent fluxes at the surface	
Interaction of air-flow with ice and snow (2 h)	(to be coordinated)
Surface fluxes: demands from operational models & algorithms (a) Stable stratification, (b) Unstable stratification (2 h) Very rough surfaces (1 h)	Prof. Sergej Zilitinkevich, UH / FMI, FI
Turbulent and mean structure of air flows within vegetated and urban canopies	
Turbulence and transports in vegetation canopies (2 h; 14.05)	Prof. Timo Vesala, UH, FI
Urban boundary-layers: models, data and application (2 h)	Dr. Alexander Baklanov, DMI, DK
Meso-scale and urban turbulent flows	
Modelling of boundary-layer type flows: sea breezes, katabatic winds and internal boundary layers (2 h)	Prof. Hannu Savijärvi, UH, FI
Meso-scale meteorological models: correcting model errors and limitations (1 h) Characteristics of urban PBLs (1 h) Urbanized meso-scale meteorological models (1 h) Global-warming induced reverse-reactions: summer daytime coastal-cooling	Prof. Robert Bornstein, SJSU, USA

(1 h)	
Boundary-layer aspects in shallow-water approximations (1 h)	Prof. Arakel Petrosyan, IKI RAS, RU
Weather and climate problems essentially dependent on PBLs	
Deep drilling of the Antarctic ice sheet: past four climatic cycles (1 h)	Prof. Vladimir Kotlyakov, IG RAS, RU
The role of the PBL parameterization in operational numerical weather prediction: HIRLAM experience (2 h)	Dr. Carl Fortelius, FMI, FI
The role of the PBLs parameterization in operational air quality modelling: SILAM experience (2 h)	Dr. Mikhail Sofiev, FMI, FI
PBLs and turbulence in ecosystem modelling	
Modelling of turbulence within vegetation canopies (1 h)	Dr. Andrey Sogachev, UH, FI
High resolution atmosphere–sea–water ecosystem model suite: the general architecture and the role of turbulence (2 h)	Dr. Rein Tamsalu, UT, EE

Glossary

BGU = Ben Gurion University of the Negev
DMI = Danish Meteorological Institute
FMI = Finnish Meteorological Institute
GCM = general circulation model
IG RAS = Institute of Geography, Russian Academy of Sciences
IKI RAS = Institute of Space Research, Russian Academy of Sciences
LES = large-eddy simulation
NERSC = Nansen Environmental and Remote Sensing Centre
PBL = planetary boundary layer
SJSU = San Jose State University
UCL = University College, London
UH = University of Helsinki (Division of Atmospheric Sciences)
USF = University of South Florida
UT = University of Tartu