UCLouvain

lphys2264 — Atmospheric and oceanic waves and instabilities

2019

In view of the health context linked to the spread of the coronavirus, the methods of organisation and evaluation of the learning units could be adapted in different situations; these possible new methods have been - or will be - communicated by the teachers to the students.

5 credits	30.0 h	Q2

This biannual learning is being organized in 2019-2020

Teacher(s)	Crucifix Michel ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	Elementary concepts of dynamical stability, fundamental equations of geophysical fluid dynamics, conservation of vorticity, shallow-water model (quasi-hydrostratic approximation and two-layer model), linear wave theory and applications (equatorial waves, sea-waves, tides), unstable waves, linear theory (Kelvin-Helmholtz, baroclinic and barotropic instability), non-linear waves, oscillation and relaxation phenomena in the ocean-atmosphere system across scales (annual to millennial) and their contribution to the spectrum of variability, critical phenomena.
Aims	a. **Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1)** 1.1, 1.2, 1.5 2.3, 2.5 3.1, 3.2, 3.3 4.2 5.1, 5.2, 5.3, 5.4 6.1, 6.2, 6.3, 6.5 7.1, 7.2, 7.3, 7.4, 7.5, 7.6 1 8.1 **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able to : 1. explain the principle of linear stability analysis ; 2. derive the shallow-water model and explain its interest for atmospheric and ocean waves ; 3. apply the principle of linear stability analysis to derive theories for atmospheric and oceanic waves (gravity waves, Rossby waves, Kelvin waves) and instabilities (baroclinic and barotropic instabilities) ; 4. develop models of non-linear waves ; 5. demonstrate the link between these theories and actual phenomena in the ocean-atmosphere system (tides, El-Nino, Madden-Julien instability) and discuss their limitations and importance for our understanding of the ocean-atmosphere dynamics ; 6. analyse a specific phenomenon involving atmospheric and oceanic waves and instabilities or oscillations on the basis of available literature and communicate this analysis to colleagues ; 7. criticise the presentation and provide constructive feedback to colleagues on the scientific aspects of the presentation. - - - - *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Feedback during the flipped classes. Case studies : oral presentation and final report.
Teaching methods	**Due to the COVID-19 crisis, the information in this section is particularly likely to change.** Fundamental material presented by teacher(s) (blackboard and slides). Applications of fundamental notions and case studies to be presented by the students, with the support of the lecturer, following the principle of flipped classes. A portfolio of authoritative reviews on case studies is made available by the teacher.
Content	1. Revisions 1. Dynamical stability: elementary concepts 2. Fondamental equations of geophysical fluid dynamics 3. Conservation of vorticity

	2. Linear waves
	  1. Shallow-water model
	  2. Gravity waves, Poincare waves
	  3. Two-layer model and effective gravity
	  4. Equatorial waves
	  5. Kelvin coastal waves (and tides)
	3. Hydrodynamical instability (linear theory)
	  1. General principle
	  2. Kelvin-Helmholtz instability
	4. Quasi-geostrophic model
	  1. Rossby waves
	  2. Conditions of instability in a 2-layer model
	5. Non-linear waves
	  1. Solitons as a model of the tsunami
	6. Oscillations and relaxtion phonomena
	  1. General background and principles
	  2. Applications et modèles conceptuels
	7. Critical phenomena
	  1. Principles of adjustment and dissipation
	  2. Application to storm tracks and other critical phenomena
	8. Case studies (to be presented by students)

Bibliography	R. Sadourny, P. Bougeault, Dynamique de l'Atmosphère et de l'Océan (French), Editions de l'École Polytechnique. B. Cushman-Roisin et J. M. Beckers, Introduction to Geophysical Fluid Dynamics, Volume 101, Elsevier. H. Dijkstra, Nonlinear climate dynamics, Cambridge University Press.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Aims
Master [60] in Physics	PHYS2M1	5		
Master [120] in Geography : Climatology	CLIM2M	5		
Master [120] in Physics	PHYS2M	5		