THE CHINESE UNIVERSITY OF HONG KONG

Micro-Module Courseware Development Grant

Scheme 1: Basic Scheme

Final Report (2016-17)

Report due 30 April 2018
Please return by email to The Ad hoc Committee on Planning of eLearning Infrastructure mmcd@cuhk.edu.hk

PART I

Project title:	Micro-Modules on Geology, Climate Feedback, and Geophysical Fluid Dynamics
Principal supervisor:	Andie Au-Yeung Yee Man (andie.ay@cuhk.edu.hk)
Co-supervisor(s):	Tammy Pui Yuk Tam (tampuiyuk@cuhk.edu.hk)
Department / Unit:	Earth System Science Programme (ESSC)
Project duration:	From May 2017 to April 2018

Date report submitted: 3 May 2018

1. Project objectives

Is the project on track to meet its objectives?
Have the objectives been changed as a result of the experience of working on your MMCDG project?

Micro-Module A: Rocks and Minerals Gallery

Objectives of this micro-module include: (1) to digitalise the physical resources in our petrology lab, which include a large amount of rock samples, mineral samples and petrographic thin sections; (2) to carefully organise the newly produced digital resource for educational purpose so as to provide an easily accessible resource pool to our students, which is not limited by time or venue; and (3) to recruit a group of student helpers who have shown good abilities and great interest in Earth System Science subject. By supervising these student helpers working for the project, we expect that an extra opportunity can be created for them to both further develop their abilities and have their knowledge consolidated. All activities conducted by now for developing the micro-module of Rocks and Minerals Gallery strictly

meet the needs to achieve these objectives. Not have the objectives been changed with the process of the project, but our experience has proved that they are feasible and instructive.

Micro-Module B: Climate Feedback Model

The objectives of this micro-module are to (1) develop interactive simulation on how different factors affect climate feedback, (2) allow users to visualize different kinds of climate feedback (global warming/cooling), (3) give student helpers a chance to learn digital graphics and interactive animation at the same time and (4) raise the awareness of global warming/climate change issue after the interactive tool is put on the public website. The tool can be used in courses ESSC1000 and ESSC2020.

Micro-Module C: Geophysical Fluid Dynamics (GFD)

Several objectives of the GFD micro-module include (1) expressing advanced-level GFD equations in computer codes, (2) producing animations which visualize the fluid (air or water) motion described by the GFD equations and (3) corresponding MATLAB codes available for students to download and they can learn the coding skills there. The micro-module allows students to learn how to turn the knowledge obtained in class (traditional GFD equations) into practical computer codes which can carry out the air motion simulations.

Micro-Module D: Getting Started with Python Programming in Earth System Science

We have also developed a micro-module that was not mentioned in the application form but it was mentioned in the interim report. This module aims to give Earth System Science students more computer programme experience. especially in terms of the scientific calculations needed in earth system science analysis. The micro-module acts as a crash course for programming beginners and hopefully will be useful in their future careers as python is the most popular language in the industry regarding to scientific programming. The objectives of the micro-module includes (1) to allow students to learn programming from scratch to cope with data analysis in Earth System Science and (2) to allow students to revise on the programming skills they have already obtained in the computer science course.

Micro-Module E: Continuation on Producing Videos for the "Weather in a Tank" Experiments

This part of the project focused on making the last two videos for the elearning videos for the "Weather in a Tank" experiments. The first 6 experiments shooting and video editing were already finished and supported by a previous funding. The aim of this module is to allow students to understand some natural phenomena observed in the atmosphere and ocean through the fluid (in this case water) in a rotating frame with colored dyes indicating air/water motion in our earth system. With some animations and illustrations, the complicated concepts can easily be illustrated.

2. Process, outcomes or deliverables

Please specify the number of micro modules produced, and the course(s) (with course codes and titles) that have used the micro modules in Part IV, and provide more detailed descriptions here. Must specify duration of each micro-modules (in terms of students online contact hours), total duration time of all deliverables and style. (With reference to the "Summary of video presentation styles" developed by CLEAR)
Has the nature of the deliverables been changed?
Have you adjusted your timeline?
Overall, was the project completed satisfactorily?

Four micro-modules (A to E) are listed in here and all of them are completely finished. The details of each modules are summarized at the end of each sections in the Module Summary.

Micro-Module A: Rocks and Minerals Gallery [link]

To respond to the aforementioned objectives of developing the Rocks and Minerals Gallery, the following activities have been conducted.

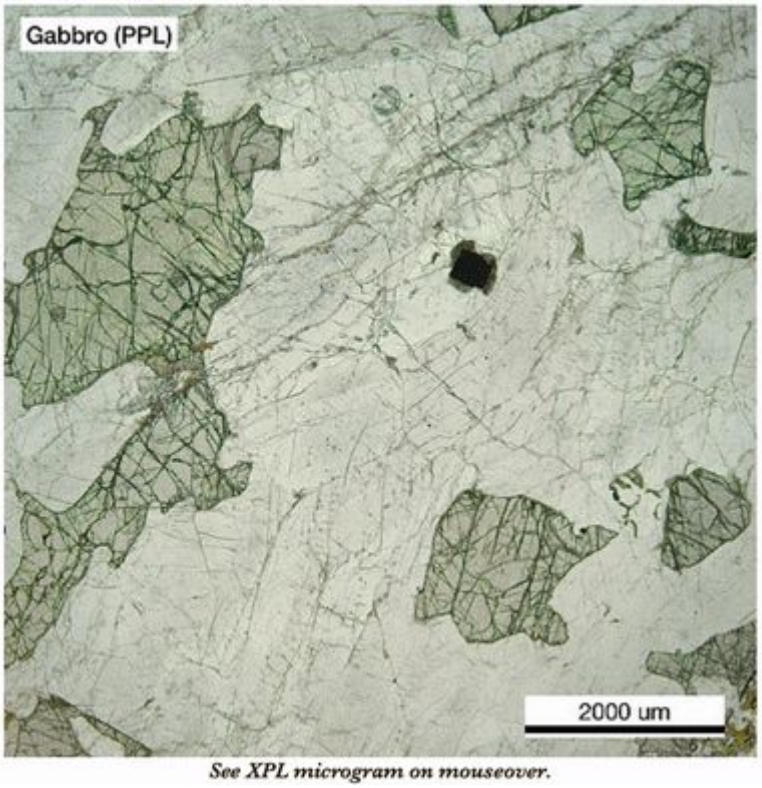
(1) High resolution photos have been taken for each of our rocks and minerals samples, including three main types of rocks (igneous rock, metamorphic rock and sedimentary rock) and two main types of minerals (transparent mineral and metallic mineral). Detailed annotation for each rock photo has been added mainly based on the reference book "A Dictionary of Geology and Earth Sciences (4 ed.), Oxford University Press".

(2) In addition to the digitalisation of hand specimen, typical micrographs have been taken using the petrographic microscope and the camera system for each of our petrographic thin sections. Micrographs can clearly show the physical characters of the common rock-forming

minerals under PPL (plane polarised light) and XPL (cross-polarised light). Besides, these micrographs could also help students better understand rocks textures from the microscopic aspect, such as the differences among the phaneritic, aphanitic, and porphyritic textures of igneous rocks; the forming of foliated textures of the metamorphic rocks, etc. Both the sample photos and the thin section micrographs have played an important role in our digital resource pool. Detailed annotation for each micrograph has been added based on the work of our student helpers.

Here is an example of the high resolution photos:

Here is an example of thin section micrographs (please note the mouse-over function):



See XPL microgram on mouseover.

GABBRO

Gabbro is a mafic intrusive igneous rock, which is coarse grained because of the slow cool down process. This also infers that Gabbro is possibly formed in a magma chamber underground such that the time for crystallisation is longer. In the specimen, most of the minerals are in large, blocky shape. Under XPL, pyroxene shows a sharp interference colour (3rd-4th order). On the other hand, there are relatively more abundant plagioclase, which shows yellow, white and grey interference colour. Albite twinning is common in plagioclase. - Eugenia Lai

(3) A website to integrate all digital resources from our unit has been built, where the Rocks and Minerals Gallery and the Minerals in Thin Sections are two important components. The **mouse-over function**, which is easy-to-use, free and stable, is used to showcase our sample photos and thin section micrographs, which are carefully arranged in order to assist the syllabus of the petrology course. Students now can use the 24/7 self-service online to approach those limited resource in the lab no matter where they are.

(4) The successful development of the digital resource cannot be achieved without our student helpers team. A team of 10 senior students who have taken the petrology course (ESSC4120) worked for this micro-module for three months. They had extra time, compared with other peers, to work with rocks, minerals and microscopes. Adept skills in identifying rocks and minerals are required, therefore, regular discussions between student helpers and teaching or teaching supportive staff were spontaneously encouraged.

Please note : This part would be similar to one part of the MMCD scheme 2 in the same unit. It is the same micro-module, however Scheme 1 (by Dr Andie Au-Yeung) supported the purchase of the rock and mineral samples and Scheme 2 (by Dr Tammy Tam) supported the productions of the photos and gallery.

Module Summary

Products Produced :

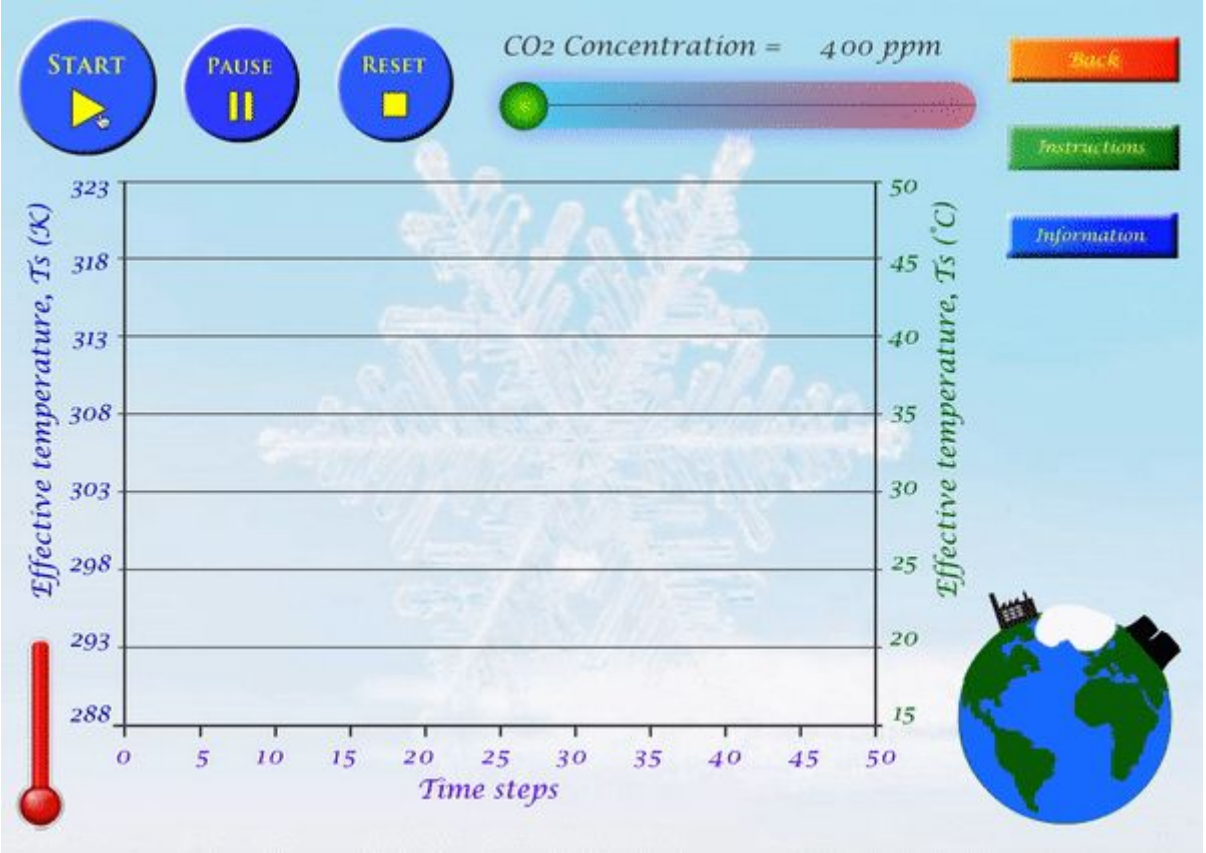
(1) high resolution rock samples photos with detailed annotation;
(2) micrographs of petrographic thin sections with detailed annotation;
(3) Webpage: Rocks and Minerals Gallery;

Total Estimated Duration Time :	4 Lab sessions involved (ESSC4120)
	(Self-paced study for afterclass review)
Video Presentation Styles :	N/A (Photos are produced here)
Course(s) involved :	ESSC1000, ESSC2010, ESSC4120

Micro-Module B: Climate Feedback Model [link]

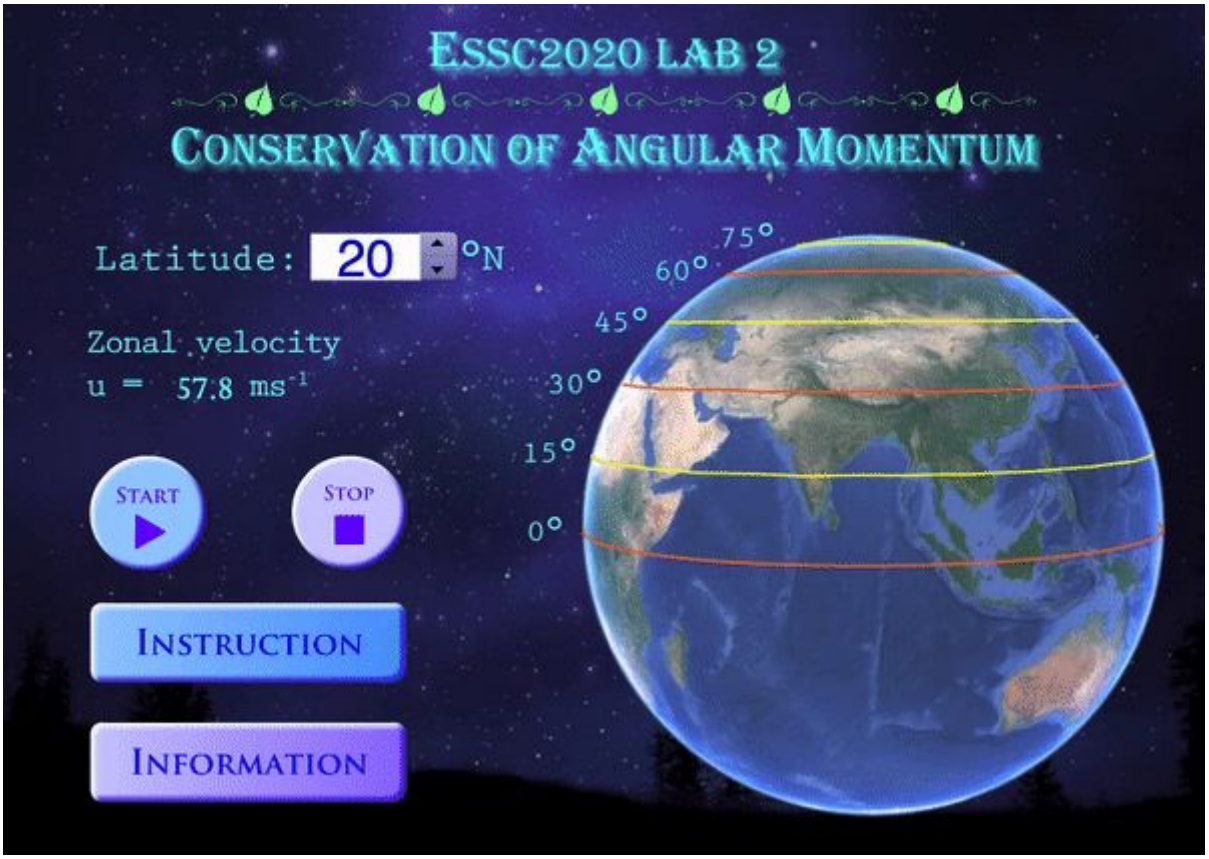
We have trained a student helper to code the preliminary simulations for our climate feedback model. Users can adjust the carbon dioxide (CO_2) concentration in the air to let the atmosphere to response to an equilibrium level with a certain temperature. They can even change the CO_2 concentration in the middle of the simulations. There are two sub-experiments inside this part, the climate influenced by water vapor feedback and by ice-albedo feedback. The higher greenhouse gas concentration is illustrated by the stack of smoke coming out from the factory and the ice cap in the North Pole also changes with the global temperature change. The simulation always starts at 400ppm (parts per million) CO_2 because it is approximately the current concentration in our atmosphere.

Here is an example of CO_2 concentration increasing rapidly and the stars are showing the response of the temperature,
e.g. 400ppm to 700ppm to 1300ppm in this case,



The second simulation demonstrate the idea of angular momentum increases (faster air motion) with increasing latitude. In other words, the distance of the air parcel from the earth rotation axis decreases, the speed has to be higher to maintain the same momentum. Users can decide on the latitude of the air parcel and tap on the “start” button. The air parcel moves according to the latitude.

Here is a screen shot of the fast moving air parcel at higher latitudes,



We hope that these small animations are not only small tools our teachers can use in class, but also they can be played by the public since it is on the ESSC elearning website already. Unfortunately by the time we are finished with this module it is already week 10 in semester 2 and we could not use this elearning material in class. However we will definitely use it next year.

For this module we did not adjust the timeline. The student helper we recruited was very passionate about this project and we are glad that he learnt a lot and was very productive at the same time.

Module Summary

Products Produced :	2 major interactive animations (2 sub-experiments are included in the 1st major animations
Total Estimated Duration Time :	N/A
Video Presentation Styles :	N/A (animations instead of videos)
Course(s) involved :	ESSC2020

Micro-Module C: Geophysical Fluid Dynamics (GFD) [KEEP]

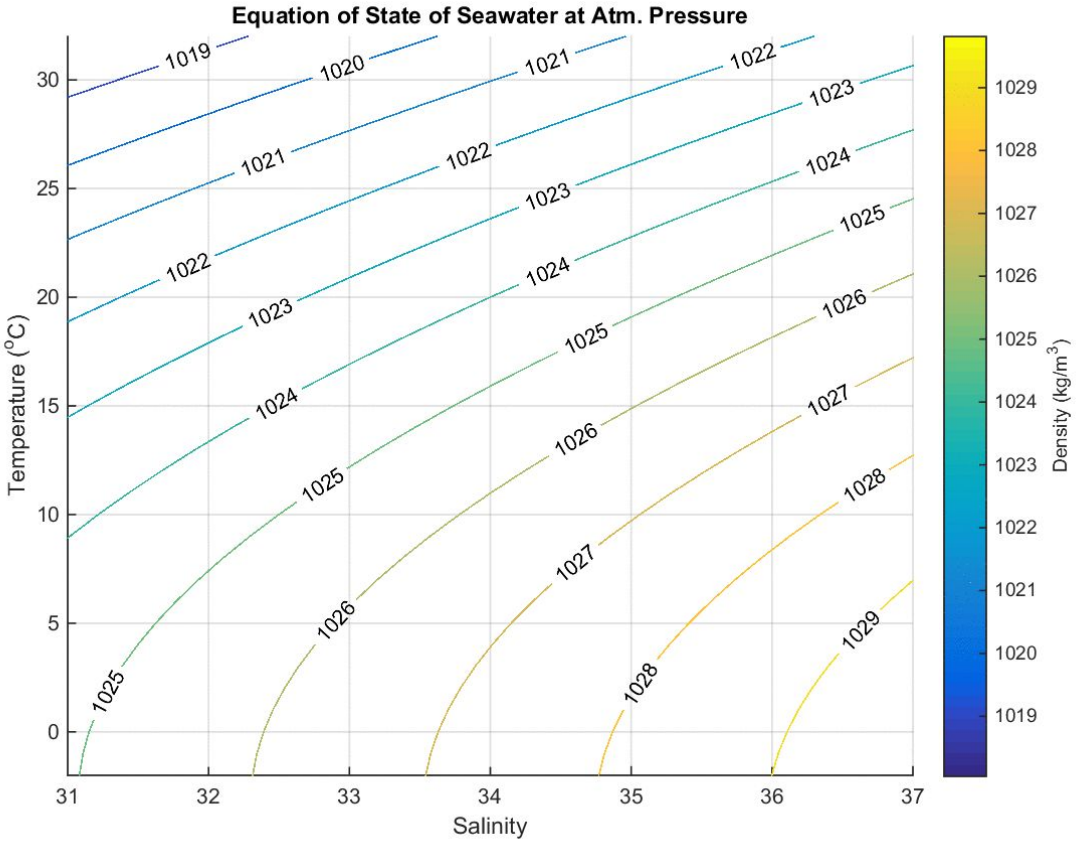
As we have reported last time in the interim report, we have finished covering 6 chapters of MATLAB codes in the book "Introduction to Geophysical and Fluid Dynamics". The main output of this module includes 5 groups of animations which appear as videos on the KEEP platform and small gif animations in the slides of the courses involved. The materials are more advanced and are appropriate for senior students. Therefore one one of the animations was used in ESSC3800.

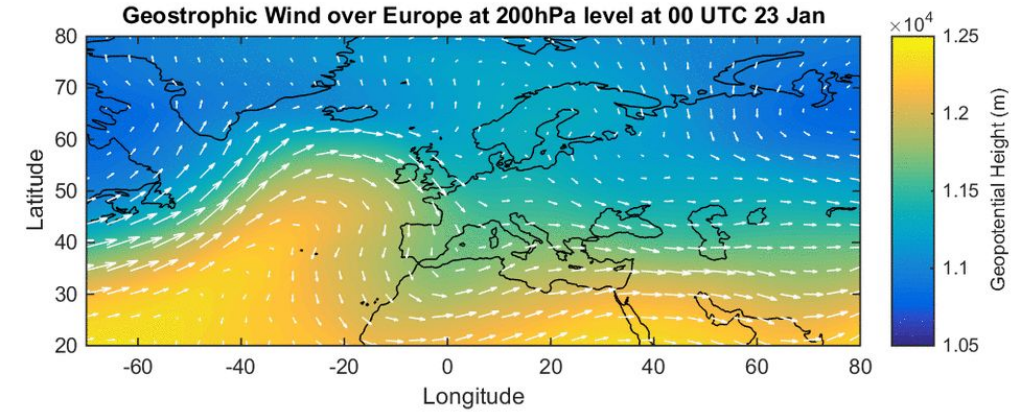
There was no adjustment in the timeline for this module.

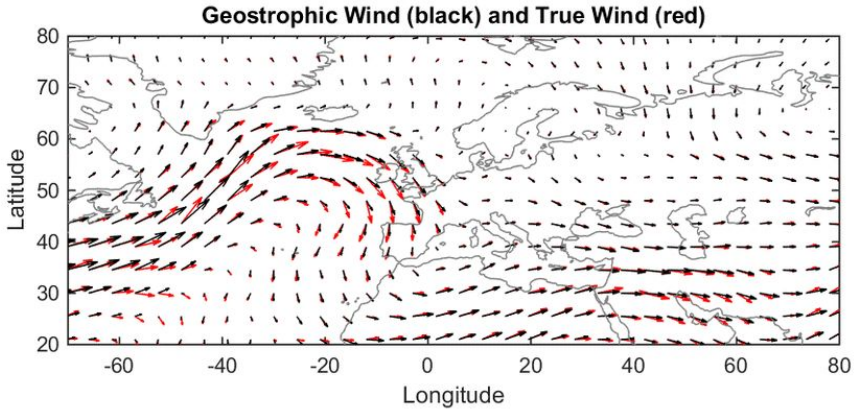
Module Summary

Products Produced :	5 groups of animations
Total Estimated Duration Time :	2 lessons (ESSC3300), 1 lesson (ESSC3800), 1 lesson (ESSC5104)
Video Presentation Styles :	N/A (gif animations instead of videos)
Course(s) involved :	ESSC3300, ESSC3800, ESSC5104

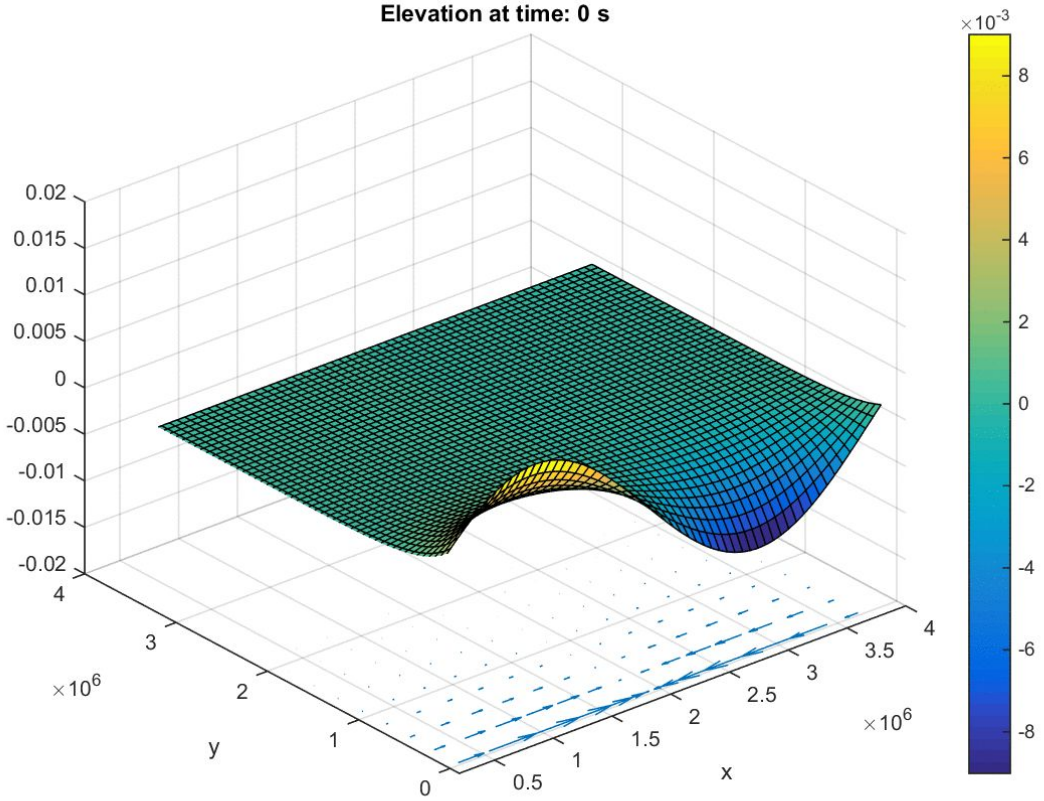
Attached here are the main animations produced:

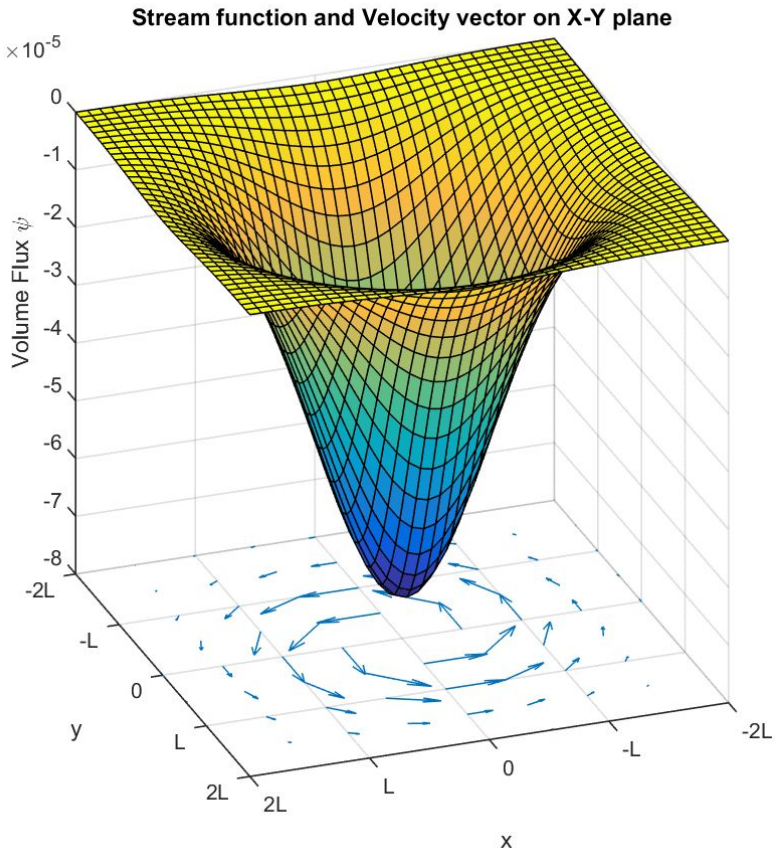


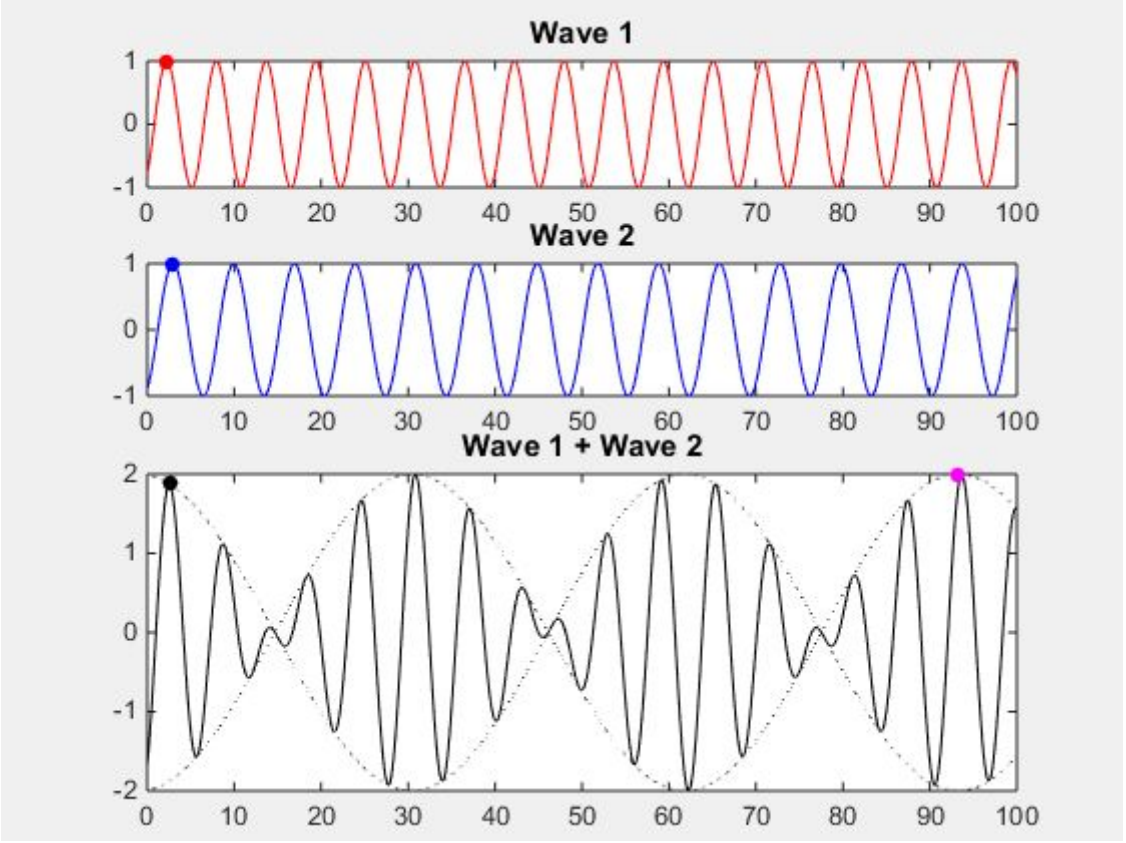




Kelvin waves propagation:




Stream function and Velocity vector on X-Y plane
×10^-5
0
-1
-2
-3
-4
-5
-6
-7
-8
Volume Flux ψ
-2L
-L
0
L
2L
y
2L
L
0
-L
-2L
x

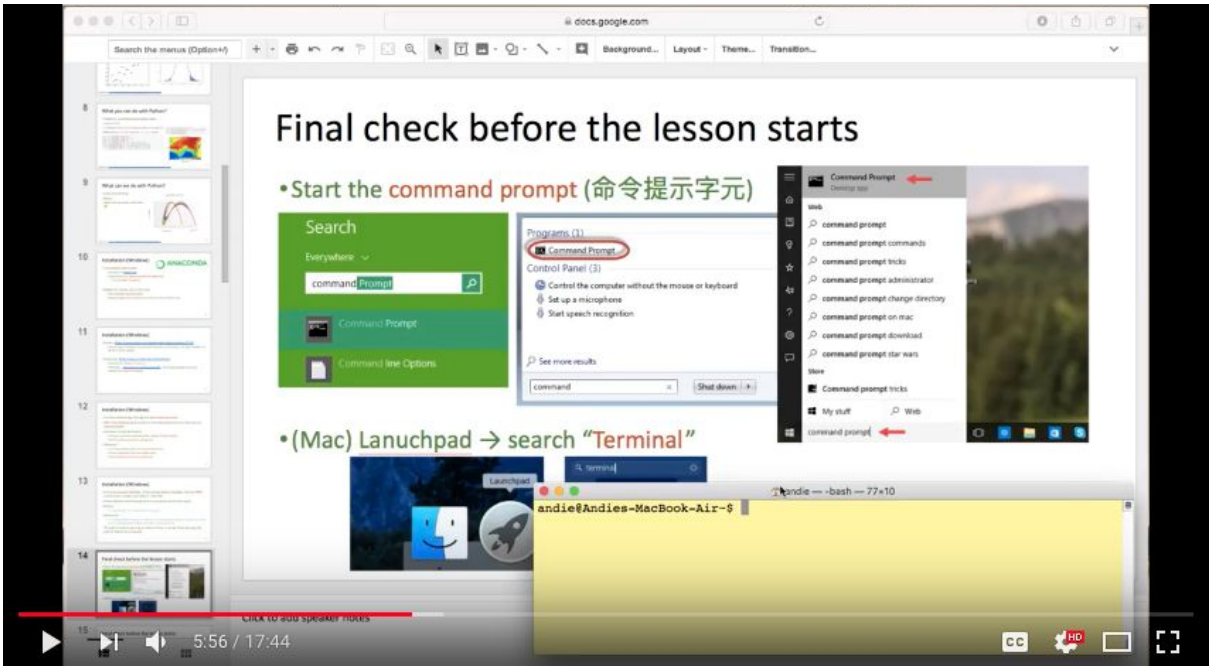

Wave 1
Wave 2
Wave 1 + Wave 2
0
10
20
30
40
50
60
70
80
90
100

Micro-Module D: Getting Started with Python Programming in Earth System Science [KEEP]

As reported in the interim report, five sections of self-learning materials were produced and they are available on the KEEP platform. After the interim report, we have also made two videos according to the first two sections in this module,

Getting started with Python 1
https://youtu.be/TkMEgTqUISY

Getting started with Python 2
https://youtu.be/5NxK3ojmeGA



The videos were used as a flipped classroom trial for the course ESSC4520 and students were asked to do exercises in class after watching the videos before they entered the classroom. ESSC3800 is not offered this semester.

The timeline for this module remained unadjusted.

Module Summary

Products Produced : 5 sessions of self-learning materials in Python,

1. Installation and Basic Commands
2. Scripts, Functions and Arrays

3. Booleans and Flow Control
4. Reading and Writing .nc File with Netcdf4 Module
5. Figures Plotting

Each section has

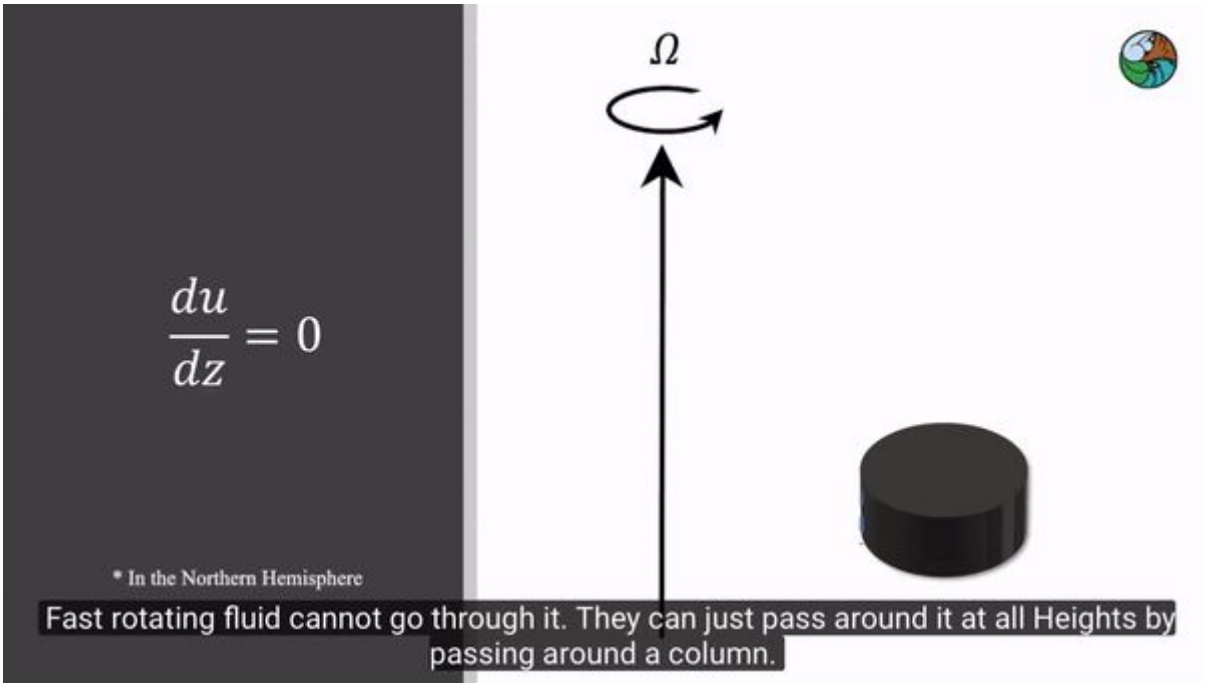
(a) explanation
(b) corresponding screen captures
(c) corresponding graphs plotted
(d) programming exercises for students

Total Estimated Duration Time :	2 lessons (4 hours in total)
Video Presentation Styles :	S1
Course(s) involved :	ESSC3800, ESSC4520

Micro-Module E: Continuation on Producing Videos for the "Weather in a Tank" Experiments [link] [Youtube]

Two videos are produced here to illustrate the fluid motion in our earth system. By fluid we mean either air or ocean water. The video #6 (Taylor Columns) and #8 (Balanced Vortex) were put together by two ESSC students. The experiments were shot in the last semester and were supported by another elearning funding. The two student helpers assisted in the module by editing the experiments and adding animations so that other science students, or the general public, can understand the science demonstrated in the experiments. The two students were brilliant in the whole process and they basically learnt the some advanced concepts on their own (one of them is even from year 2) so that they can explain the phenomenon with animations and narration.

This module was not included in the proposal and we are very proud of the two student helpers. The videos are put on the youtube and we hope to use them in the open day.



Module Summary

Products Produced :	2 videos
Total Estimated Duration Time :	N/A (Open to public and our own students, total number of views of the 8 videos is above 2000 views, please refer to the evaluation part)
Video Presentation Styles :	S9 + S12
Courses involved :	N/A

3. Evaluation Plan

Have you altered your evaluation plans?
What monitoring data did you collect?
Does your evaluation indicate that you have achieved your objectives?

Micro-Module A: Rocks and Minerals Gallery [link]

The gallery resource will be released to a series of courses, such as ESSC1000, ESSC2010, ESSC3100 and ESSC4120. The course teachers will demonstrate how to approach the resource and how to use them to conduct self-paced study after class or before class. For junior courses ESSC1000 and ESSC2010, the gallery mainly plays a role in providing an

optional chance for those high ability students to study beyond. For ESSC3100, the resource will provide supplementary knowledge to help students understand better on topics of Structural Geology. For ESSC4120 Petrology, students are required to study the material and answer questions on the KEEP platform. Therefore, three different ways will be employed to evaluate the effectiveness of this module. The first method is to conduct sampling interview from the junior courses of ESSC1000 and ESSC2010. The second is to collect questionnaire on senior courses of ESSC3100 and ESSC4120. The third is to analyse the students submission data on KEEP platform. Currently, we have conducted some interview for ESSC1000 and all interviewees give positive feedbacks. Two of them later become a part of the student helpers team and contributed to other e-learning modules. The current result shows that the Rocks and Minerals Gallery could arouse/enhance junior students interest on Earth System Science and help to form a stronger bond between students and the teaching team. We are still collecting other evaluation data and would like to share the result by follow up report and/or on CUHK Expo 2018 in the near future.

Micro-Module B: Climate Feedback Model [link]

The animations will be used in our CUHK open day in 2018 October and visitors will be able to play with it. Student helpers can give a brief feedback on the response of the visitors towards the interactive animations. We will find out if the visitors are interested in it or not.
The interactive animations will also be used in ESSC2020 and questionnaire will be used to find out if the students find the elearning materials useful or not.

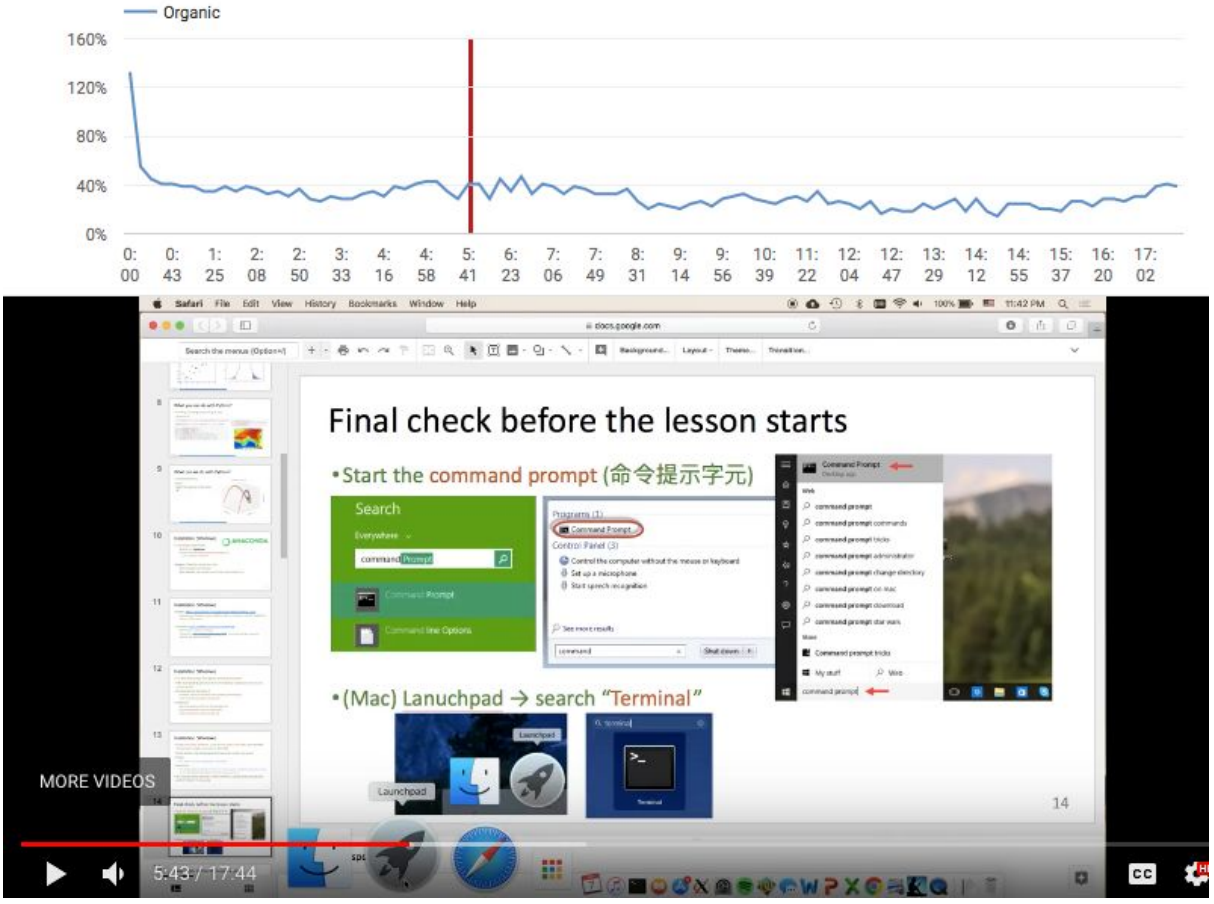
Micro-Module C: Geophysical Fluid Dynamics (GFD) [KEEP]

The micro-module was used as the teaching materials in ESSC3300, ESSC3800 and ESSC5104. The two teachers responsible for these three courses found that generally students were more responsive when the animations were used and it was much easier to explain the difficult concepts in Earth system science. Before using the animations produced from the this micro-module, students reflected that they had a hard time understanding the ordinary graphs from textbooks. Students from this year did not have similar complains.

Micro-Module D: Getting Started with Python Programming in Earth System Science [KEEP]

We have used materials from two of the sections and produced two youtube videos to have two flipped classrooms in ESSC4520 this semester.
The evaluation of the videos can be found by looking at the analytics from youtube and student's performance in doing in-class exercise after watching the videos.

Here is the "**absolute audience retention**" statistics for the first python video



The higher percentage is resulted from re-watching, we can see that around 30%-40% of the students who tabbed into the video finished the whole video. They paid more attention at around 5:00 in this video since it was the instructions to use python in the windows and mac platforms.

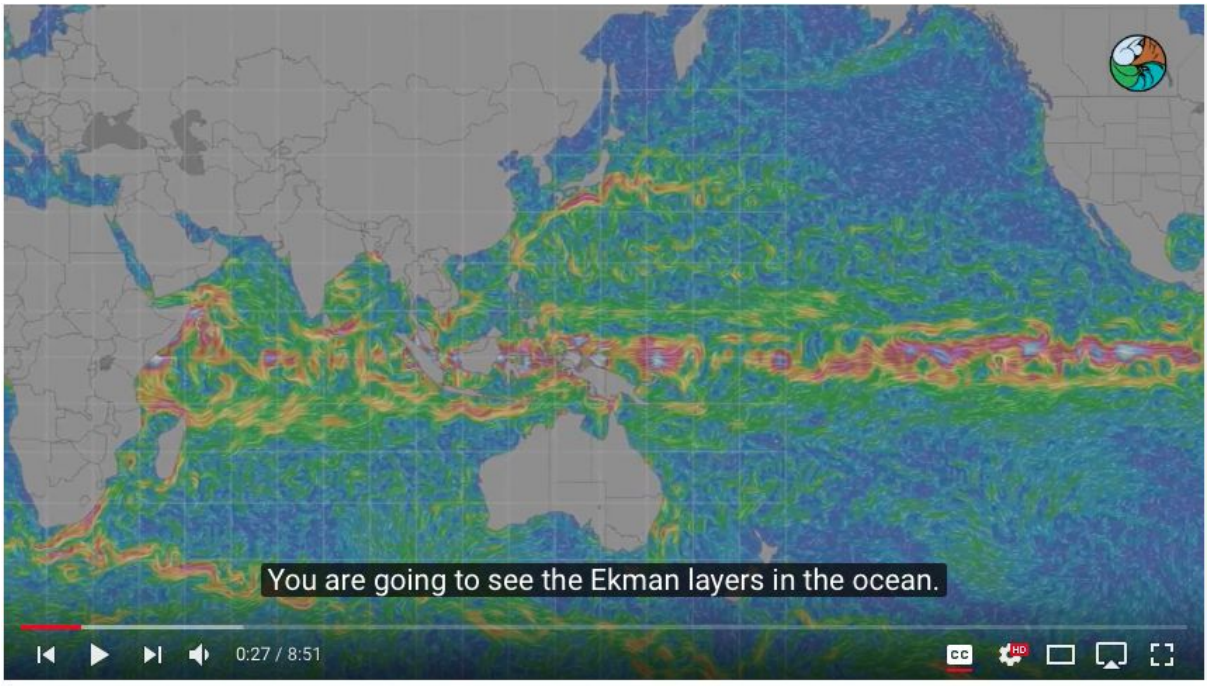
Another pattern we can see here is that students tend to watch the video by jumping every now and then to see if they needed that part. Students with different level of ability can choose to watch the videos by jumping a lot or watch different parts again.

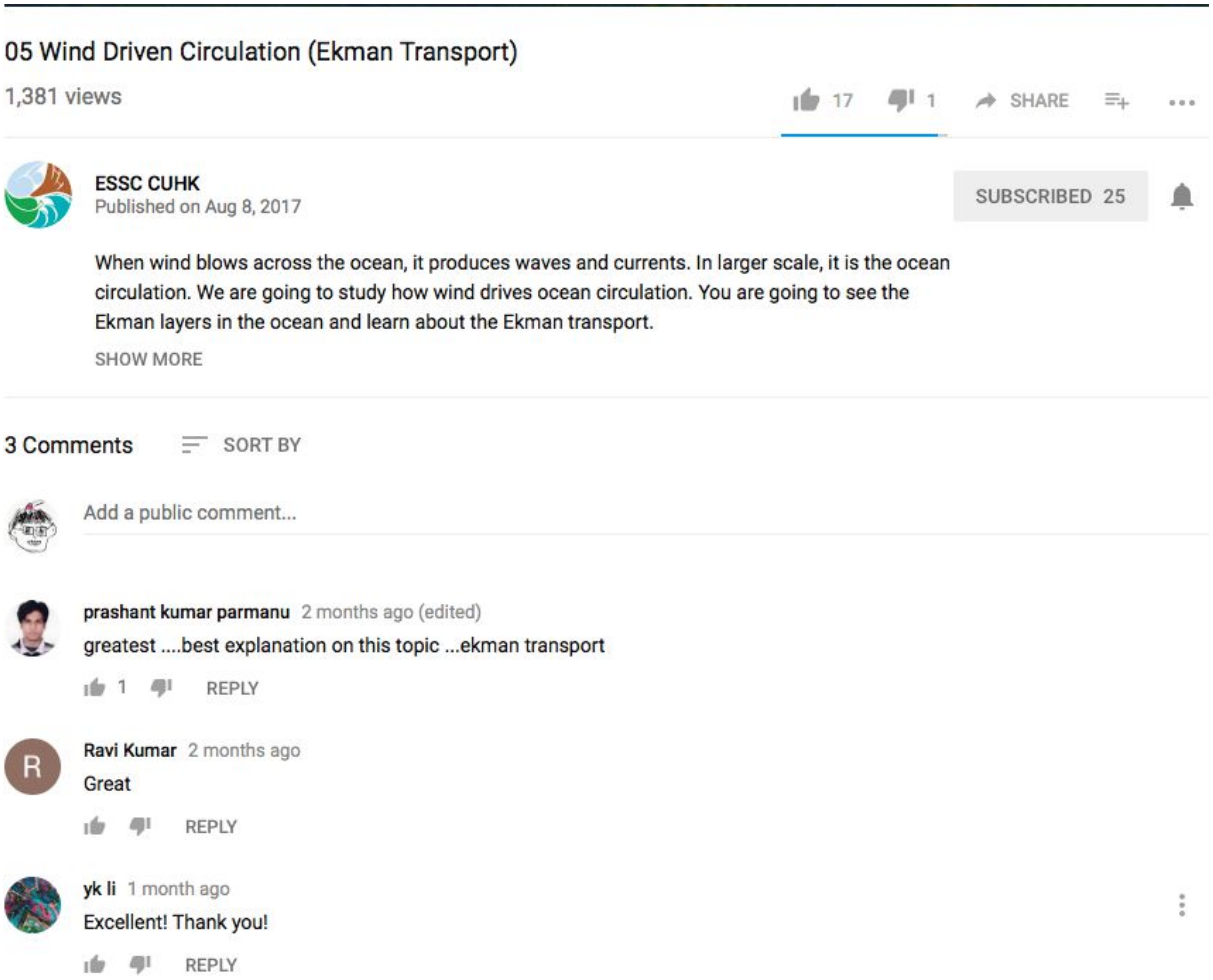
The ESSC program is very liberal towards students choice in learning and that creates a problem for the teachers in here. In both of the flipped classroom lessons, students performed really well with the programming homework and that proves that the videos had helped. them

Micro-Module E: Continuation on Producing Videos for the "Weather in a Tank" Experiments [link]

The number of views of the 8 videos of the playlist "Weather in a Tank" is above 2000 since we have launched the playlist 8 months ago. The project supported the production of the last two videos : video #6 (Taylor Columns) and #8 (Balanced Vortex). Since we have just uploaded the two videos, the number of views is limited. However we could see the potential of the weather in a tank educational series by looking at the total number of views of the first 6 videos. We hope that the the videos can be used to demonstrate fluid motion concepts for the atmosphere and the ocean to the public and our own students.

For the video with the highest view number, there were even foreigners leaving nice comments beneath the video:





4. Dissemination, diffusion and impact

Please provide examples of dissemination: website, presentations in workshops or conferences, or publications.
Please provide examples of diffusion: how the project results/process/outcomes/deliverables have been used in your unit and other parts of CUHK or other institutions?
Please provide examples of impact: how the project results (micro modules) can be adapted to other disciplines.

Micro-Module A: Rocks and Minerals Gallery [link]

The materials can be found in here
https://cuhkesscelearn.wixsite.com/home/rocks-minerals

Micro-Module B: Climate Feedback Model [link]

The climate feedback model can be found in here
https://cuhkesscelearn.wixsite.com/home/copy-of-structure-models

Micro-Module C: Geophysical Fluid Dynamics (GFD) [KEEP]

The advanced GFD materials including the animations used in class can be found in the KEEP platform
https://edx.keep.edu.hk/courses/course-v1:CUHK+ESSC5002+2017_01/course/

Micro-Module D: Getting Started with Python Programming in Earth System Science [KEEP]

The materials are on the KEEP platform
https://edx.keep.edu.hk/courses/course-v1:CUHK+ESSC4520+2017_01/course/

And the two videos are on youtube
Getting started with Python 1
https://youtu.be/TkMEgTqUISY

Getting started with Python 2
https://youtu.be/5NxK3ojmeGA

Micro-Module E: Continuation on Producing Videos for the "Weather in a Tank" Experiments [link]

The video video #6 (Taylor Columns) and #8 (Balanced Vortex) can be found in here,
https://cuhkesscelearn.wixsite.com/home/video-resource

PART II

Financial data

Funds available:

Funds awarded from MMCDG	$ 59,000

Funds secured from other sources (please specify) $ 0

Total: $ 59,000

Expenditure:

Item	Budget as per application	Expenditure	Balance
Rocks Hand Specimen Samples	2500	29740[A]	29260
Minerals Hand Specimen Samples	6500		
Rocks and Minerals Thin Section Samples	10500		
Website for Rocks and Minerals Gallery	5000	0[B]	
Equipment : Mac Mini + Monitor	10000	11040	18220
PowToon Educational Plan - Classroom ELITE annual subscription	3000	0[C]	
Climate Feedback User Interface	5000	18205[D]	15
Student Helpers (for a total of 200 hours)	16500		
Total:	$59,000	58985	15

Please note that,

A: The purchase is more expensive than we have anticipated because we used the price from the direct purchase from the US rock providers. However the US company refused to sell us the rock samples and refer us to the Hong Kong local vendor which sold us the rocks at higher prices

B: We have used a free website instead

C: We found that training our own students to work on the animations would be better since the PowToon could produce some animations irrelevant to the science concepts we wish to deliver.

D: We have use part of the funding to pay a student helper to do the Climate feedback model

PART III

Lessons learnt from the project

Please describe your way forward.

Please describe any of the following item(s) accordingly:

- *Key success factors, if any*
- *Difficulties encountered and remedial actions taken, if any*
- *The role of other units in providing support, if any*
- *Suggestions to CUHK, if any*
    - *Example: what should be done differently?*

The project has reminded me a lot on the years I have spent as a student and the years I have spent as a teacher. The project did not only produce some elearning materials for further self-learning opportunities for our students, but it also kept me alert. I am now more aware about how students perceive their learning process and how I can adapt to help them not only to learn more, but to see the fun in earth science. It seems to me that the problem does not lie in lack of information, but student's interest in science. Whenever we have to teach something more technical in studying earth science, for example programming, students might find it less interesting and this is when the elearning materials can help. With the help of the flipped classroom videos, students can choose to learn it any time in any speed they want. That could make the whole learning process smoother and less tedious for them.

It has also come to my attention that the student helpers learnt a lot in producing the elearning materials. For example, one of our helpers Cindy is a year 2 student and she helped editing the Weather in a Tank video #6 (Taylor columns). Since she has not taken some major courses in earth system dynamics and she discussed with me thoroughly about the concept needed in making the video. She learnt the concept on her own and produced clear illustration in the video. I believe she will remember this more than anything she has learnt in class. Therefore my suggestions to CUHK is that we could do more projects like this and make the learning process continues outside the classrooms.

PART IV

Information for public access

Summary information and brief write-ups of individual projects will be uploaded to a publicly accessible CUHK MMCDG website. Please extract from Part I the relevant information to facilitate the compilation of the publicly accessible website and reports.

1. Keywords

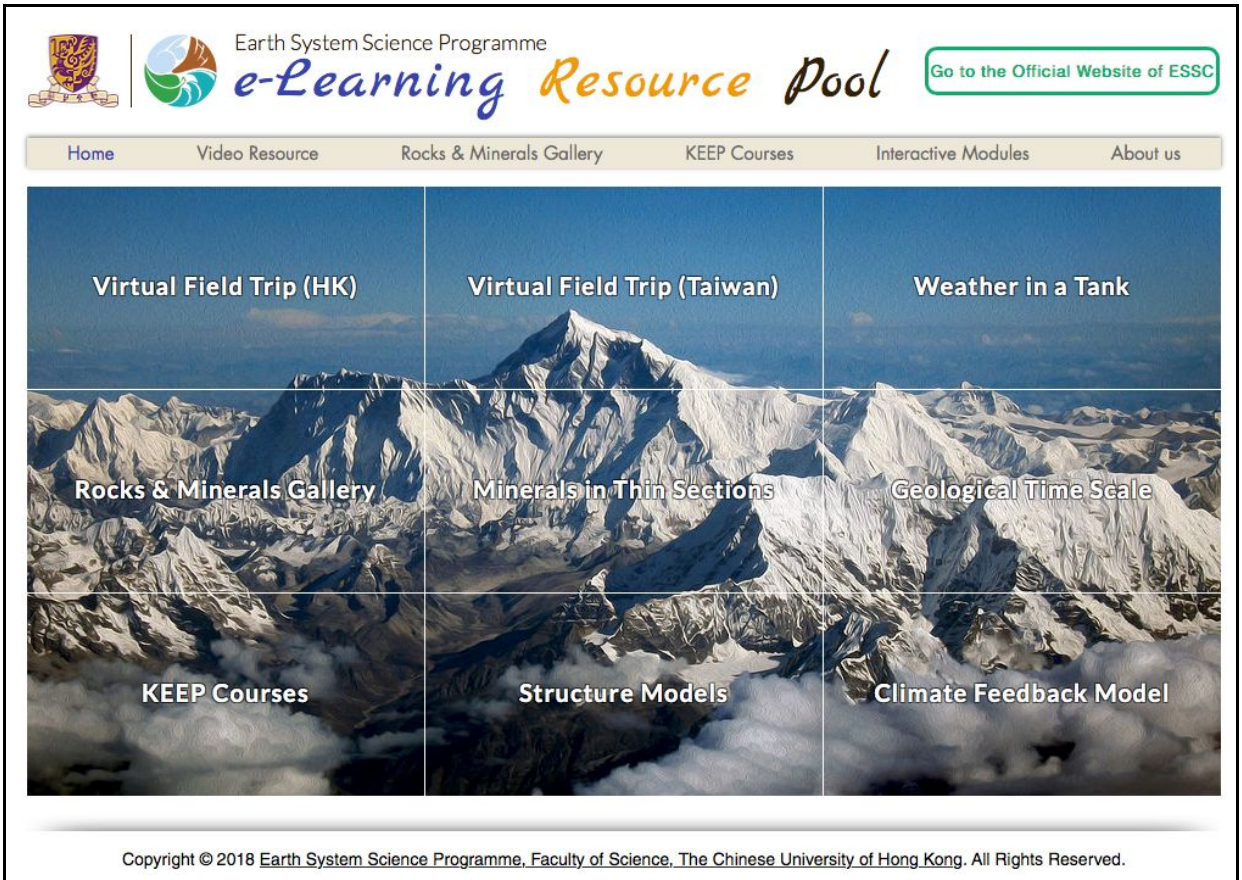
Please provide five keywords (in the order of most relevant to your project to least relevant) to describe your micro-modules/pedagogies adopted.

(Most relevant)	Keyword 1: Earth Science
	Keyword 2: Weather
	Keyword 3: Geology
	Keyword 4: Rocks Minerals
(Least relevant)	Keyword 5: Programming

2. Summary

Please provide information, if any, in the following tables, and provide the details in Part I.

Table 1: Publicly accessible online resources (if any)
(a) **Project website:** *If a publicly accessible project website has been constructed, please provide the URL.* https://cuhkesscelearn.wixsite.com/home



(b) **Webpage(s):**

If information of your project is summarized in a webpage (say a page in the department's or faculty's website), please provide the URL(s) here.

We have already setup a elearning resource website, therefore we don't have a webpage in the department's website.

(c) **Tools / Services:**

If you have used any tools or services for the project, please provide names of the tools or services in here.

N/A

(d) **Pedagogical Uses:**

If any flipped classroom activities have been conducted, please provide information in here. If relevant, please indicate how your project output can be used to support flipped classroom activities.

We have done two flipped classroom lessons.

Getting started with Python 1
https://youtu.be/TkMEgTqUISY

Getting started with Python 2
https://youtu.be/5NxK3ojmeGA

(c) **Others (please specify):**

Table 2: Resources accessible to a target group of students (if any)			
If resources (e.g. software) have been developed for a target group of students (e.g. in a course, in a department) to gain access through specific platforms (e.g. Blackboard, facebook), please specify.			
Course Code/ Target Students	**Term & Year of offering**	**Approximate No. of students**	**Platform**
ESSC 3300	*3rd-4th year students*	*7*	*Blackboard*
ESSC 4520	*3rd-4th year students, 1 PG student*	*14*	*Blackboard*
ESSC 5104	*PG students*	*5*	*Blackboard*

Table 3: Presentation (if any)	
Please classify each of the (oral/poster) presentations into one and only one of the following categories	**Number**
(a) In workshop/retreat within your unit (e.g. department, faculty)	*None*
(b) In workshop/retreat organized for CUHK teachers (e.g. CLEAR workshop, workshop organized by other CUHK units)	*None*
(c) In CUHK ExPo jointly organized by CLEAR and ITSC	*1 (poster presentation in Teaching and Learning Innovation Expo 2017)*
(d) In any other event held in HK (e.g. UGC symposium, talks delivered to units of other institutions)	*Please insert no*
(e) In international conference	*None*
(f) Others (please specify)	*None*

Table 4: Publication (if any)	

Please classify each piece of publication into one and only one of the following categories	**Number**
(a) Project CD/DVD	*None*
(b) Project leaflet	*None*
(c) Project booklet	*None*
(d) A section/chapter in a booklet/ book distributed to a limited group of audience	*None*
(e) Conference proceeding	*None*
(f) A chapter in a book accessible internationally	*None*
(g) A paper in a referred journal	*None*
(h) Others (please specify)	*None*

3. A one-page brief write up

Please provide a one-page brief write-up of no more than 500 words and a short video.

This project aims at providing high resolution pictures, self-learning videos and interactive animations to smooth the learning experience of the Earth System Science students and the general public who are interested in weather, climate science, geology, rock types and the application of programming in earth science data analysis.