Educational booklet: Climate PBL 2023

"Water and Environment" course of the second year of MFEE training

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1. Introduction

1.1 Project-based learning (PBL)

Welcome to the “Climate PBL” (“APP Climat”) program, based on several pedagogical formulas:

- Traditional Transmissive Teaching: teachers present knowledge
- Project Based Learning (PBL): students build their knowledge by being active
- Progressing in Groups: group work allows for more effective learning
- Reverse course: groups of students learn by preparing pedagogical content

This booklet should be seen as the instruction manual, a guide, or the rules of the course. It is essential to read it in its entirety from the first session.

1.2 Targeted learning outcomes

At the end of the Climate PBL, engineering students will be able to:

- Locate and process climate data from public access websites
- Apply statistical treatment to climatic data
- Describe the predominant phenomena of the water cycle and atmospheric circulation
- Explain the mechanisms responsible for climate change and its impacts
- Organize a sequence of processes using conceptual diagrams
- Integrate multiple pieces of information from scientific literature
- Select key facts to explain complex scientific concepts
- Generate educational resources that can be easily used by other scientists

1.3 Context and purpose of the project

The awareness of the physical and human consequences of climate change has led students and teachers to review their approach to the engineering training they follow or provide. Considered as simple applications of fluid mechanics, courses presenting meteorology or hydrology as reinforcements of the "water and environment" engineer's toolbox now meet a growing expectation for serious information on socio-ecological issues and the engineer's place in the coming decades.

The inclusion of climate-energy issues in engineering education, as recommended in a report by the "Shift Project" ([1]), could be considerably accelerated by initiatives to co-construct teaching modules between students and teachers. The work proposed in this "Project Based Learning" (PBL) type of teaching aims at building easily reusable pedagogical materials to allow for a rapid dissemination of knowledge, following the example of the serious game "The Climate Fresk[1]" whose pedagogical design and portability have allowed for an exponential dissemination of knowledge on climate change issues. The concept of "Active Multimedia Conference" (AMC) is developed and tested in this project.

1.4 Content of the booklet

This booklet details the organization of the "Climate PBL" course. A first part is devoted to statistical analyses of climatic data through 9 sessions of 1h45. The second part with 16 sessions relies heavily on the creation of a mini-fresks, based on the serious game "The Climate Fresk" ([2]). The example of the

[1] Fresk is a special translation of the French word “Fresque”, that is specific to the “Climate Fresk Association”

digital educational resource presenting the mini-fresks of the previous year Climate PBL courses (see [4]-[8]) is given to better situate the deliverables making up the project. The organization of the presentations and the peer review process are explained below.

2. First part: Climate Data Analysis

Statistical analysis of climate data is an important part to understand and manage the environment. During this first part of the Climate PBL, several hands-on subject will be given using climate data set, with short conference on the theoretical ground of the analysis methods. For example, the theory of “Empirical Orthogonal Function” (EOF) also called “Principal Component Analysis” (PCA), “Karhunen-Loève Transform” (KLT) or “Proper Orthogonal Decomposition” (POD) in other fields, will be exposed. Other statistical tools such as “Weather Data Clustering”, will be at the root of the hands-on subjects.

A first exploration of data will be provided thanks to the “IPCC WG1 Interactive Atlas” (https://interactive-atlas.ipcc.ch/) based on the Sixth assessment report of the IPCC Working Group 1 (The Physical Science Basis). A climate model of intermediate complexity, the “Planet Simulator” (PlaSim) developed by the Hamburg University, will be used to generate climate data on available computers. Pacific Ocean data will be provided on Google Colaboratory to study the ENSO (El Nino and the Southern Oscillation) climate variability.

Slots		First part	ST	MS	OP	DA	OT	Total
TDM	1	ENSO variability	1					1
TDM	2		1					1
TDM	3	PlaSim data			1			1
TDM	4				1			1
TDM	5	Hydrology data		1				1
TDM	6			1				1
TDM	7	Tutoring for the projects				1	1	2
TDM	8	Tutoring for the projects		1		1		2
TD	9	Defences of the data analysis projects		1		1		2
		TOTAL	2	4	2	3	1	**12**

Table 1 : The ten 1h45 sessions of the climate data analysis sessions

3. Deliverables of the Data Analysis Project (30%)

Each student must create its own Jupyter notebooks on its own Google Colaboratory account, with a sharing permission “available to anyone with the link”. While team work is allowed, and even encouraged, each notebook must be individual. For example, a common piece of work can give birth to different explorations and personal interpretations. A criterion grid for the evaluation of these deliverable will be published at the beginning of the course.

4. Second part: Conferences and mini-fresks

4.1 Lectures and supervised sessions

Table 2 presents the program of the 16 sessions of the second part of the “Climate PBL”. The first two sessions are grouped into a half-day for an introduction to the course, followed by training in the animation of the Climate Fresk. The last two sessions, also grouped into half a day, are devoted to "reverse lectures", during which three groups of students present a summary of the "Active Multimedia Conference" (AMC) they have constructed. Between these two half-days, the sessions combine lectures by teachers and group work workshops under the supervision of these experts.

Slots		Second part	PD	OL	OP	HR	MB	DA	OT	Total
TD	1	Presentation of the Climate PBL and "Climate Fresk" facilitation training							1	1
TD	2								1	1
CM	3	Additional greenhouse effect							1	1
CM	4	Disruption of the water cycle				1				1
CM	5	Flooding		1						1
CM	6	Cyclones			1					1
CM	7	Carbon Cycle (three cards in the Fresk)	1							1
CM	8	Aerosols	1							1
CM	9	Air Temperature Rise						1		1
CM	10	Ice melting (three cards in the Fresk)		1						1
CM	11	Rising water temperature		1						1
CM	12	Extreme climate events					1			1
TD	13	Tutorring of mini-fresk and data projects						1		1
TD	14	Tutorring of mini-fresk and data projects						1		1
TD	15	Tutorring of mini-fresk and data projects						1		1
TD	16	Defences of the "Multimedia Pedagogical Conferences" projects and mini-fresks				1		1		2
TD	17					1		1		2
		TOTAL	2	3	1	3	1	6	3	**19**

Table 2 : The sixteen1h45 sessions of the conferences and mini-fresks sessions

4.2 Training to the animation of the Climate Fresk

The first activity of the course is a training in the facilitation of "The Climate Fresk", which most of the students had the opportunity to discover during the "Rentrée Climat" of Toulouse INP. This serious game, which lasts three hours, allows a global visualization of the physical mechanisms responsible for climate change and their impacts. The workshop consists of laying out, on a 2 m^2 sheet of paper in class, or on a virtual board (MURAL) at a distance, a sequence of 42 cards linked by arrows connecting causes to consequences (Figure 1).

Several educational resources associated with this game are available:

- A summary sheet for each card describing the incoming and outgoing arrows
- Detailed sheets describing the scientific basis of the phenomena mentioned
- A quiz with questions to test the understanding of the fresk
- Social networks for scientific discussions

- A bibliography to deepen the scientific points

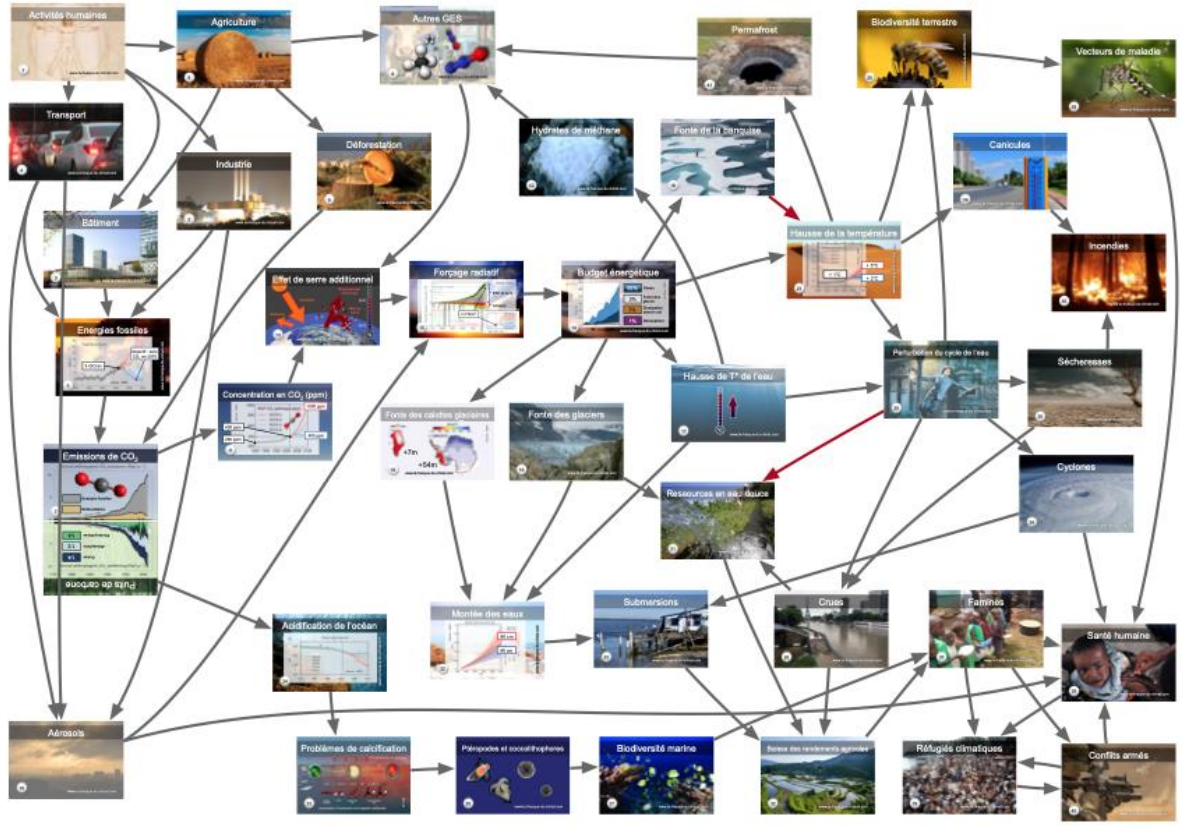

Figure 1 : Example of correction of the Climate Fresk

One of the driving principles of the Climate PBL is to draw inspiration from this serious game and its environment to explore one or more themes in greater depth. The objective is to build an "Active Multimedia Conference" (AMC) dealing with a particular theme, which can be the subject of a reverse lecture presented by other people, students or teachers, by providing them with all the elements enabling them to assimilate the content and to present it. Just as the serious game "The Climate Fresk" owes its success to the portability of its content, based on active teaching, the conference will be designed with a view to facilitating integration into engineering courses.

4.3 Creating mini-fresks

Following the example of the serious game "The Climate Fresk", the students, in groups of three, will have the task of creating mini-fresks, linked to one or more of the "Climate Fresk" cards. Figure 2 shows an example of a mini-fresks with 5 cards from the original set of 42 cards and 7 cards detailing cause and effect relationships from the aerosol emission card. The cards should have a title, an illustration (computer designed or hand drawn), and a short caption. The physical phenomena involved will be the subject of detailed cards collected in a wiki, as in the original serious game. These mini-fresks must be based on extensive documentary research and the sources must be cited in the bibliography of each sheet. The serious game "The Climate Fresk" is mainly based on IPCC reports (see Bibliography) and this source of information should be given priority. Teachers are also available to provide scientific information to students.

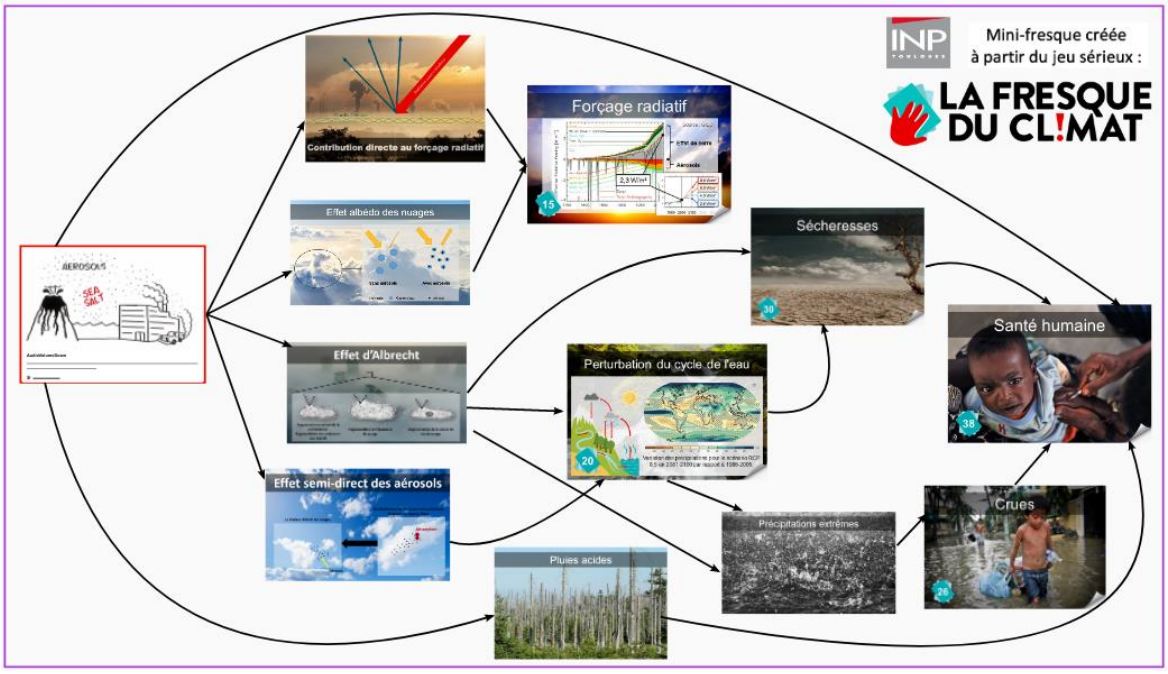

Figure 2 : Example of a mini-fresk "Aerosols", linked to the Climate Fresk

4.4 Open digital learning resources: “Active Multimedia Conference” (AMC)

One important outcome of the group projects is the creation of a digital learning resource answering the criteria of an “Active Multimedia Conference” (AMC). An AMC is a teaching sequence that meets the following criteria (SAPRIDSP):

- **Short**: half an hour should be enough to play it
- **Active:** a serious game, such as a mini-fresk, is central
- **Presented:** a slide show is presented by one or more people
- **Reproducible:** an online video allows the slideshow to be replayed
- **Interactive:** comprehension questions motivate exchanges
- **Documented:** online resources are available to deepen the concepts
- **Self-supporting**: the sequence forms an easily exportable whole
- **Portable:** the resources allow it to be replayed with little preparation

4.5 Format and template for the “Active Multimedia Conference” (AMC)

After exploring various format for this resource, at the beginning of the Climate PBL, a simple a promising format has been selected: a H5P “course presentation” published in a Moodle course. An example of such resource, to be used as a template (Figure 3), is provided in the following Moodle course: https://mooc.inp-toulouse.fr/course/view.php?id=82.

When receiving a group number from the teachers, the group participants must register (LDAP login) in one of the Moodle courses of the following Preprod category:

https://mooc.inp-toulouse.fr/course/index.php?categoryid=17

They will then be attributed the writing rights on their Moodle course to share a common interactive space and publish, eventually, their resources. Hiding the course is recommended during this process.

Figure 3 : First page of the example/template for the H5P resource to deliver

5. Deliverables in the “Active Multimedia Conference” (AMC)

Formed in triads, the students’ objective is to build an "Active Multimedia Conference" (AMC) aimed at deepening and broadening the themes addressed by the Climate Fresk. Like this serious game, which can be animated at the end of a short training course, this CAM must be easily usable by other people, with the aim of facilitating the dissemination of the knowledge synthesized in it.

5.1 Deliverable D1: An H5P file published on a Moodle cours.

Following the format of the AMC example (Les courants océaniques), a .h5p file using the “Course presentation” content format, must be published on the group Moodle course, in the Preprod Moodle category devoted to PBL Climate projects. This slide show is meant to be a support for a 30-minute conference including the animation of the mini-fresk. It must be self-supporting to be easily transferred to various animators, as for the original “Climate Fresk”. Voice recording and information button must be inserted as much as possible. The H5P resource is also meant to ease the transformation of the resources, which must be allowed by an open licence CC BY-SA. The size of the .h5p file must not exceed 20 Mo: the size of the image must be reduced, and the video must be published on an external and public platform.

5.2 Deliverable D2: At least four set of cards of the Mini-Fresk (35%)

The groups must design a mini-fresk including one or more cards from the serious game "The Climate Fresk". The dozen cards of the mini-fresk will be hard cards, either printed directly or build by sticking printed papers on a carboard. As for the original “Climate Fresk”, the front side will contain an image with a short title and the back side will contain a short descriptive text. This text must contain explicit indication for drawing the arrow links between the cards. On set of cards per participant plus one for delivering to the teachers must be produced.

5.3 Deliverable D3: A detailed description for each card

As shown in the AMC example/template (Additional Greenhouse Effect), at each card corresponds a simple description, written on the back side of its physical printing, as well as a more detailed explanation written in the H5P resources. This explanation is the result of in-depth documentary work,

synthesizes the scientific information gathered and must present a consistent bibliography, respecting the rules of documentary citation. It is recommended to use, primarily, IPCC reports ([9]-[10]).

5.4 Deliverable D4: A video clip introducing the conference

A video clip of a few minutes will be constructed to present the learning outcomes targeted by the Active Multimedia Conference (AMC). A presentation of the key information of the content developed by the mini-fresk can be integrated. The video must be posted on a public video broadcasting site (YouTube, Dailymotion, Vimeo, etc.) since the size limit of the .h5p is 20 Mo.

5.5 Deliverable D5: Multiple Choice Questionnaire (MCQ)

A minimum of ten interactive questions should explore the key facts presented.

6. Feedback session and peer review

The last two sessions, grouped together in a half-day, are "reverse lessons" during which a trio presents its lecture and leads its mini-fresk to two other trios.

6.1 Organisation of the feedback workshops (35%)

Each trio has 30 minutes to run their mini-freak and present their Active Multimedia Conference to two other trios. Over the 240 minutes of the half-day, each trio will run two workshops and attend four workshops. As an example, Table 3 shows the program for a class divided into 15 groups.

Slot 1 : 8h-8h40		**Slot 2 : 8h40-9h20**		**Slot 3 : 9h20-10h**	
Facilitators	Participants	Facilitators	Participants	Facilitators	Participants
1	2	2	9	9	1
	9		1		2
4	5	5	10	10	4
	10		4		5
7	8	8	11	11	7
	11		7		8
13	3	3	6	6	13
	6				3
1, 4 et 7	12	12	13	9, 10 et 11	12
Slot 4 : 10h-10h40		**Slot 5 : 10h40-11h20**		**Slot 6 : 11h20-12h**	
Facilitators	Participants	Facilitators	Participants	Facilitators	Participants
1	3	3	10	10	1
	10		1		3
4	6	6	11	11	4
	11		4		6
7	5	5	9	9	7
	9		7		5
12	2	2	8	8	12
	8				2
1, 4 et 7	13	13	12	10, 11 et 9	13

Table 3: Example of workshop programming for 15 groups

6.2 Peer Review and Criterion Grid

Three days before the defence, the three groups will publish their Active Multimedia Conference (AMC) on their Moodle course and have it visible. Each triad will be responsible for evaluating the four triads whose workshops they must attend, as well as their own work. The grading grid presented in Table 4 will be used to assign a score and will be uploaded to the workshop activity. The overall score will be entered with one decimal and a comment may be written by the assessors. The relevance of the evaluation will be assessed, by comparison with the marks given by the other trio and the teachers, which will be given significant weight. The mark awarded for the evaluation will count for 20% of the final mark.

N°	Criterias	Points 0	Points 1	Points 3	Points 4	Mark on 20	Coef (%)
	Mini-Fresk of the Active Multimedia Conference (AMC)						
1	**Choice of images and artistic quality**	Images struggle to illustrate concepts in an attractive way	Images could have been better chosen or arranged.	Images illustrate concepts correctly	Images are beautiful, relevant and well arranged	20	10%
2	**Map captions to describe the phenomena depicted**	The legends are imprecise and give few indications	Some legends could have been improved	The legends describe the phenomena well	The legends are very clear and facilitate the construction of the game	20	15%
	Detailed description of the mini-fresk cards						
3	**Relevance of the scientific content of the in-depth pages**	Many pages are difficult to read or inconsistent	The writing of some pages could be improved	The pages provide necessary and readable information	All pages are informative and very well written	20	15%
4	**Bibliographic references on the extension pages**	Bibliography is poorly constructed or lacking	Some references are missing to cite sources	Bibliography allows verification of sources of information	Bibliography is rich, relevant and accessible	20	10%
	Other teaching aids of the Active Multimedia Conference (AMC)						
5	**Video presenting the learning outcomes and some content**	The video does not make it possible to identify the objectives	Some objectives or content could have been added	The objectives are understandable and the video is informative	The video brilliantly presents the objectives and rich content	20	10%
6	**Multiple Choice Questionnaire for validation of learning outcomes**	Questionnaire does not meet the validation objective	Questionnaire could be improved in some places	Questionnaire explores a lot of knowledge	The questionnaire goes through the entire knowledge	20	15%
	Implementation and portability of the Active Multimedia Conference (AMC)						
7	**H5P digital learning resource integrating deliverables**	Access to some information is difficult or non-existent	Some barriers exist but all information is there	Resource brings deliverables together in a coherent and useful way	Title, layout and content are outstanding	20	15%
8	**Playfulness of the mini-game and logic of its construction.**	The construction of the game does not allow for serious involvement	Imperfections complicate the game and hinder attention	Participants are engaged and involved	The serious game excites participants	20	10%
	Total sur 20 :					**20,0**	**100%**

Table 4 : Criterion grid for the evaluation of Climate PBL project

7. Conclusion

This course is based on a "Project Based Learning" (PBL) approach in which the student builds his or her knowledge through the realization of a project whose objectives are precisely specified. While the choice of subject is left to the initiative of each trio in charge of its project, the framework is set by the serious game "The Climate Fresk" which serves as a reference for this teaching. The main motivation for these projects is to be able to transmit the pedagogical materials of an "Active Multimedia Conference" (AMC) that can be quickly assimilated and used by others, like the facilitators of the Climate Fresco workshops who are able to propagate this serious game after a short training course.

The deliverables of the trinomial projects were designed to meet this objective of portability and transmissibility: a serious game of the mini-fresk type for active pedagogy, detailed descriptions, video clip and a questionnaire, publication in the form of an open digital educational resource and transmission of sources. Ways of improving this pedagogical scenario for the following years could be discussed

during the course of the project, within the framework of a co-construction between the students and the teachers.

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