IS-ENES3 Deliverable D3.2

Report on Evaluation of three IS-ENES3 Schools 'Climate data use for impact assessments' (2020-2021) and the IS-ENES3 Summer School on Data Science for Climate Modelling (2022)

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ABSTRACT

Between 2020 and 2022 the IS-ENES3 consortium organized three virtual Schools on 'Climate data use for impact assessments' and one on-site Data Science Summer School. The virtual Autumn school took place in November and December 2020, the virtual Spring School in March and April 2021, and the virtual Summer School in May and June 2021. The Data School took place in Greece and comprised lectures, group exercises, keynote speakers and social events over the course of a week in September 2022.
Each course was followed by an evaluation survey. The participants valued the courses highly, especially the work on the case studies. All lectures were seen as useful or very useful. The more practical lectures were valued the highest. This report describes the course and analyses the three evaluation surveys.

Dissemination Level	
PU	Public

Revision table			
Version	**Date**	**Name**	**Comments**
V1	04/01/2023	Judith Klostermann, Janette Bessembinder	Executive summary still has to be added
V2	16/01/2023	Judith Klostermann, Janette Bessembinder	Executive summary added
V3	15/02/2023	Sophie Morellon	Review: Comments added and correction made
V4	03/03/2023	Janette Bessembiner, Sophie Morellon	Finalized

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Executive Summary

This report describes the schools organized by the IS-ENES3 project. A considerable number of young scientists and scientists from Eastern Europe was reached.

Impact schools: Two interdisciplinary schools of one week each on 'Climate data for impact assessments' were planned with about 30 persons per school. Due to the COVID-19 pandemic, it was decided in July-August 2020 to convert the physical schools into three virtual schools of 20 persons per school. In November and December 2020, the IS-ENES3 consortium organized a virtual Autumn School. This was followed by a Spring School (March-April) and a Summer school (May-June) in 2021. The aim of the Impact schools was to help researchers to make better use of available climate data and knowledge, in order to produce higher quality research outputs and services. We aimed for a mix of disciplines so that participants could learn from each other. In total, 60 persons participated (20, 19 and 21 respectively).

We offered the participants the opportunity to gain some additional knowledge before the schools started, by asking them to follow specific online lessons of the User Learning Service (ULS) of the Copernicus Climate Change Service. The total length of each School was six weeks. In the first three weeks, interactive lectures were provided on climate models, data, impact modeling and climate services on Wednesday and Friday mornings. During the last three weeks, participants worked on case studies in small groups. The case studies were meant to guide participants across the hurdles, showing them how to handle and solve certain problems.

In the evaluation, about 80% of the respondents gave the highest rating for the schools (5 out of 5). Between the Autumn school and the Summer school a shift took place from the majority using the C4I portal, to the majority using the CDS. 80% of the respondents expected to use the knowledge from the course in the next 6 months, and a 20% said maybe they would use it. Based on the feedback of the participants of the Impact schools, we organized additional webinars or short workshops on bias-adjustments and the ESMValTool, and on CDO and ICCLIM. We also organized a session at the EGU2022. Several of the participants also participated in these activities.

Data school: The IS-ENES3 Data Science School took place on-site on the premises of NCSR "Demokritos" in Athens in Greece between 1-7 September 2022. The aim of the Data Science school was to increase expertise and skills on theoretical and practical concepts of Data Science, building upon and mainly targeting how to accelerate scientific discovery from data.

Participants were introduced to methods to analyze, visualize and report on massive datasets, in the scientific domain as well as how to apply data-intensive and data-oriented paradigms and solutions to address scientific discovery in Climate Science. The School attracted 102 applications, 40 persons were selected and the final number of students attending the summer school was 37.

Keynote talks were held by distinguished international scientists and researchers. The overall rating of the school was very good (39%) to excellent (52%). The course clearly increased the level and skills of the participants (according to themselves). Participants were also asked what they missed.

Most answers related to more hands-on practical exercises. The time available during the school was however limited, but a few indicated that they would have preferred more practical exercises and less lectures.

Conclusions and recommendations: Although virtual schools have some disadvantages (less personal contact, less options for networking), they also have some advantages (easier to record presentations, no traveling costs, sometimes easier to combine with work). A combination of virtual training and training at location is therefore seen as the best option for future training.

In both the Data school and the Impact schools participants indicated that they would have liked to have more practical exercises. One school is not enough to practice enough. Therefore also continued contact and follow-up support and training are advised, also for including the participants in the network on climate modeling.

1. General introduction

The project 'Infrastructure for the European Network for Earth System Modelling' (IS-ENES3, 2019 - 2022) is a Horizon 2020 project that aims to develop a better understanding of past, present and future climate. It is the third phase of building the distributed e-infrastructure of the European Network for Earth System Modelling (ENES). The project fosters collaboration between 22 European climate research institutions. IS-ENES3 projects future variability and changes of the climate through the development and sharing of model components, modeling tools and data infrastructure. The IS-ENES3 main objectives are to:

- Pursue the integration of the Earth's climate system modeling community and will prepare the sustainability of its infrastructure;
- Foster the common development of models and tools, and the efficient use of HPC;
- Support the exploitation of model data by the Earth system science community, the climate change impact community and the climate service community.

As part of the original project plan, the work package on "Community engagement" (WP3-NA2), Task 2: Training and resources: nurturing the community, planned to organize 2 different schools, one on climate data for impact assessments (Impact school) and one on big data (Data School). This report describes these schools and provides some advice for further training after the IS-ENES3 project.

2. Impact schools

2.1 Background

Climate and impact modeling communities show little overlap, as typical intercomparison experiments concentrate on one of these realms. However, proper climate change impact analysis governed by projections requires a good understanding of the propagation of uncertainty, predictability and information content through the chain between climate drivers, climate projections, downscaling activities and impact assessments. Therefore, in the original plan, two interdisciplinary schools were planned (1 week each and about 30 persons per school, mo18 and mo30) concentrating on this chain of model assessments with the help of realistic case studies, which would contribute to building a network of experts that can oversee and connect this chain.

The first school was originally planned to take place in June 2020. Since the update and restructuring of the Climate4Impact took longer than expected, it was decided in 2019 to postpone it to the Autumn of 2020. This first school was planned to take place in Prague in the second half of October 2020. Due to the COVID-19 pandemic it was decided in July-August 2020 to convert the physical schools into virtual schools. In order to foster interactions between participants and collaborative work on case studies, we proposed to let them work in pairs of 2 and we decided to have a maximum of 20 persons per school. In order to reach the originally planned 60 persons, it was decided to organize one extra virtual school.

In November and December 2020 the IS-ENES3 consortium organized a virtual Autumn School ‘Climate data use for impact assessments’. This was followed by a Spring School (March-April) and a Summer school (May-June) in 2021.

2.2 Aims and learning objectives of the Autumn, Spring and Summer Schools

The virtual schools relate to the third objective of the IS-ENES3 project mentioned above, where specific emphasis is put on extending the network in Eastern Europe. For the schools, the IS-ENES3 consortium formulated three aims which were translated to five learning aims for the participants, as listed below.

Aims of the Impact schools:

- To make knowledge of the IS-ENES consortium available for future scientists all over Europe;
- To give VIA-researchers (Vulnerability, Impact and Adaptation), climate services providers, etc. basic knowledge for working with climate data
- To enhance interaction between climate scientists and impact researchers.

Learning objectives:

- What are the advantages and limitations of the various climate data sources, and how they can and cannot be used.
- How global and regional climate models work (basic principles, required hardware and time).

- How impact models work, and methods and tools are available (e.g. statistical and dynamical models).
- Steps required for climate impact studies (data quality checks, downscaling, bias adjustments, creating indices).
- Challenges in transdisciplinary projects, demonstrate the value of interaction, learning to understand each other's way of working to make future cooperation more effective,

2.3 Methodology

2.3.1 Advertising the schools

The schools were announced on the IS-ENES3 project website (see box for a summary of the text). The schools were also announced with short messages through the following channels:

- IS-ENES3 network and networks of the partners, Climate4Impact network
- PANNEX network
- EU-projects networks, websites and twitter: Climateurope, PRIMAVERA, ICOS RI, Copernicus
- ISIpedia/ISIMIP
- JPI-Climate, ERA4CS, ClimateADAPT, ECCA2021
- Climate-KIC, SENSE
- CLIMLIST

Box: Summary of the announcement for the Autumn school (example)

First IS-ENES3 virtual Autumn School on Climate data use for impact assessments

The aim of the School is to help researchers make better use of available climate data and knowledge, in order to produce higher quality research outputs and services. This, in turn, will help to combat and adapt to climate change. Other aims are to develop a network of researchers who can turn to each other in the future for advice and cooperation. Researchers from **the IS-ENES consortium** will interact directly with the participants. Through the Schools, the IS-ENES consortium intends to make its knowledge available for scientists all over Europe.

When? The school will be organized as a virtual course **with 2 online sessions during six weeks** (from **Nov. 4th to Dec. 11th, 2020**), combined with self-study and case studies in small groups.

The target groups of this virtual School are **climate scientists, Vulnerability, Impact and Adaptation (VIA) researchers and consultants offering climate services**. We aim to create a mix of these different disciplines so that participants can learn from each other. As a result, climate scientists will better understand what kind of outputs VIA researchers need. VIA researchers will learn how to use the products of climate science in an effective and valid way. Participants can be PhD students, Postdocs, professionals and consultants, including climate services providers. An MSc in the natural sciences is required for fruitful participation.

(https://is.enes.org/training-detailed/#autumn-school)

2.3.2 Target groups and participants

The target groups of the virtual Impact Schools were:

- Climate scientists interested in providing climate services and working with people from other disciplines;
- Vulnerability, Impact and Adaptation (VIA) researchers;
- Consultants offering climate services.

We aimed at creating a mix of disciplines so that participants could learn from each other. As a result, climate scientists would learn to understand what kind of outputs VIA researchers needed, while VIA researchers would learn how to use the products of climate science in an effective and valid way. IS-ENES wanted to reach out especially to Eastern and Southern Europe, so participants from these regions were encouraged to apply.

In total there was room for 20 participants in each school. The number was limited to achieve full commitment of the participants as well as active participation during the meetings. The application procedure comprised a motivation letter and a CV explaining the applicant's relevant background. There was no fee for participation.

The selection of participants was done by a selection committee, which consisted of Tomáš Halenka, Vladimir Djurdjevic, Judith Klostermann, Janette Bessembinder and Rutger Dankers. In October 2020, 20 participants were selected from a total of 74 applicants. An application evaluation format was developed based on the following criteria:

- Currently based in Eastern Europe or Southern Europe
- Has an MSc in natural sciences
- Good English language level
- CV quality (advanced beginners or professionals in using climate data)
- Motivation quality (clear aims, interested in impact study/interdisciplinary work)

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Table 1. Number of participants, background and country where they were located

Impact School	Nr. Partici-pants	Male/ female	Climate/ impact/ climate services	From Eastern Europe *	From outside Europe *	Working/studying in
Nov-dec 2020 (online)	20	13 / 7	10 / 9 / 1	13	0	Czech Republic, Hungary, Poland, Romania, Serbia, Ukraine Greece, Ireland, Italy, Norway
Mar-Apr 2021 (online)	19	10 / 9	9 / 9 / 1	4	3	Hungary, Latvia, Serbia, Ukraine Belgium, Germany, France, Italy, Spain Brazil, India, Kenya
May-Jun 2021 (online)	21	11 / 10	9 / 11 / 1	5	1	Czech Republic, Hungary, Poland, Romania, Ukraine Germany, France, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden Kenya
Total	**60**	**34 / 28**	**28 / 29 / 3**	**22**	**4**	

*For this the country in which people worked/studied was used. Regularly people from outside Europe were working/doing a PhD in a European country.

About 50 of the 74 applicants fulfilled these criteria so we proceeded with selecting a group of 20 participants that would fit well together. The announcement and selection of the Spring and Summer schools was done in one effort. 44 participants applied (with 11 re-submissions from the Autumn school) and 40 were admitted to the two schools. For each school, we tried to select about 10 climate scientists and 10 VIA researchers/climate service providers. We focused on those interested in impacts on water, agriculture, forestry, nature, or urban adaptation. We also aimed for a gender balance (34 male and 28 in total for the schools).

2.3.3 Preparation before the Schools

One of the challenges in the organization of the course was the potential difference between participants in background knowledge on climate data, climate modeling, impact modeling and climate services. We offered the participants the opportunity to gain some additional knowledge before the schools started, by asking them to follow specific online lessons of the User Learning Service (ULS) of the Copernicus Climate Change Service (C3S; https://uls.climate.copernicus.eu/).

For the VIA-researchers/climate service providers we suggested these lessons to get some basic knowledge on climate data:

- Data resources: introduction

- Data resources: climate models
- Data resources: re-analysis
- Climate change uncertainties
- Data resources: observations (optional)
- Bias correction and downscaling (optional)
- Climate projections (optional)

For the climate scientists we suggested the following lessons on impacts in different sectors:

- Sectoral application: agriculture
- Sectoral application: water
- Sectoral application: energy (optional)

2.3.4 Programme of the Impact Schools

The total length of each School was six weeks. In the first three weeks, 2.5 to 3 hour virtual meetings were held on Wednesday and Friday mornings. In these sessions interactive lectures were provided on climate models, data, impact modeling and climate services. During the last three weeks, participants could bring in their own case study. They worked on these in groups of 2-3 persons. During the case study weeks, lecturers from IS-ENES were available for questions and help.

The program of the Summer school is shown in Table 2. There were small differences between the schools, for example, the lectures of Christian Pagé and Alessandro Spinuso were combined into one lecture by Christian; and David Hassel replaced Eric Guilyardi for a lecture. Because of recurring questions, a lecture on bias adjustment by Ana Casanueva was added in the Spring and Summer schools.

Table 2: Program of the Summer school

Week 1: climate data and climate models	
Webinar 1 (9:00-12:45 CEST)	**Wednesday 19th of May**
9:00-9:15	**Judith Klostermann:** Introduction to the course: aim, learning objectives, set-up
9:15-10:05	Introduce yourself and your potential case study in 2 slides: one slide on yourself and one about your case study (3-4 min per person) Led by: Judith Klostermann
10:05-10:15	Break (10 min)
10:15-11:30	• **Sylvie Joussaume** (45 min): Climate models and the international landscape of climate research and modelling and current developments • **Klaus Zimmermann** (20 min): Climate model evaluation and the ESMValTool • Questions (10min)
11:30-11:40	Break (10 min)
11:40-12:45	Continued: Introduce yourself and your potential case study Led by: Judith Klostermann

Webinar 2 (9:00-12:30 CEST)	**Friday 21st of May**
9:00-9:15	Questions related to the information presented in Webinar 1 Led by: Janette Bessembinder
9:15-10:05	Case study start ● **Janette Bessembinder** (10 min): short example of what a case study presentation could look like ● Proposal by organizers who will work together (in groups of 2 persons) and explanation on how groups were made based on case study proposals (5 min) ● Discussion within the proposed groups to define a combined case study subject: who is the user, what impact, what area (in break out groups; 30 min) Led by: Judith Klostermann
10:05-10:15	Break (10 min)
10:15-11:00	● **Tomáš Halenka** (40 min): downscaling techniques and regional modelling
11:00-11:10	Break (10 min)
11:10-12.30	● **David Hassell** (15 min): formats and standards for climate data, CMIP experiments ● **Lars Barring** (25 min): climate indices standards, challenges in use of climate data Questions and wrap up: most important information/messages for case studies Led by: Judith Klostermann

Week 2: climate impacts and climate services	
Webinar 3 (9:00-12:00 CEST)	**Wednesday 26th May**
9:00-9:20	Interactive session (wrap up of the preparation material from C3S ULS lessons): Led by: Janette Bessembinder
9:20-10:10	● **Rutger Dankers** (20 min): approaches used in impact modelling ● **Vladimir Djurdjevic** (30 min): examples of impact studies for water
10:10-10:30	Break (20 min)
10:30-11:00	● **Rutger Dankers** (30 min): examples of impact studies
11:00-11:30	Further questions and discussion on how to use the presented information for climate impact studies Led by: Judith Klostermann
11:30-12:00	Optional: discussion in case study groups (in break-out rooms)
Webinar 4 (9:00-12:00 CEST)	**Friday 28th May**
9:00 – 9:15	Interactive session on climate services Led by: Janette Bessembinder

9:15 – 10:10	• **Rutger Dankers** (45 min): Climate services
10:10-10:20	Break (10 min)
10:20-11:00	• **Christian Pagé** (30 min): landscape of portals, tools with climate data and other data
11:00-11:10	Break (10 min)
11:10-11:30	• Wrap-up: what do the participants consider the most important information/ messages for their case study, work, study and what information is missing? • Homework for week 3: case study proposals in 3 slides Led by: Judith Klostermann
11:30-12:00	Optional: discussion in case study groups (in break-out rooms)

Week 3: Setting up climate impact studies and access to climate data through the Climate4Impact portal	
Webinar 5 (9:00-11:30 CEST)	**Wednesday 2nd June**
9:00 - 10:00	Aim of the case studies, set-up of the work • **Judith Klostermann:** Introduction to the steps required for climate impact case studies and challenges in multi/transdisciplinary work
10:00-10:15	Break (15 min)
10:15-11:30	• Interactive session in which the case study proposals are presented and first discussions on the approach of a few groups (whole group; 5 min/group) Break after the first 5 groups Led by: Janette Bessembinder
Webinar 6 (9:00-11:30 CEST)	**Friday 4th June**
9:00-9:30	Interactive session with reflection on webinar 5. Led by: Janette Bessembinder
9:30-10:30	• **Christian Pagé**: Introduction to the Climate4Impact portal and some examples on possible analyses (current version of the portal), including short introduction to the new version of the Climate4Impact portal under development
10:30-10:50	Break (20 min)
10:50-11:30	• Breakout groups to explore C4I portal (25 min) • Further questions and discussion on how to use the presented information for climate impact studies (15min) Led by: Judith Klostermann

Week 4: Work on case studies	
Meeting (9:00 – 11:30 CEST)	**Wednesday 9th June**

9:00-11:30	Session to answer questions of participants. A few groups are asked to present some of their ongoing work and to discuss this with the group. ● **Ana Casanueva** (30 min): Bias-adjustment methods Optional: discussion in case study groups (in break-out rooms)
Meeting (9:00 – 11:30 CEST)	**Friday 11th June**
9:00-11:30	Session to answer questions of participants (participants are asked to send in questions in advance as much as possible) ● **Rutger Dankers**: short introduction to the C3S Climate Data Store ● **Janette Bessembinder**: short introduction to the Climate Explorer Optional: discussion in case study groups (in break-out rooms)

Week 5: Work on case studies	
Meeting (9:00 – 11:30 CEST; optional)	**Wednesday 16th June**
9:00-11:30	Session to answer questions of participants (participants are asked to send in questions as much as possible in advance) Optional: discussion in case study groups (in break-out rooms)
Meeting (9:00 – 11:30 CEST)	**Friday 18th June**
9:00-11:30	Session to answer questions of participants. A few groups are asked to present some of their ongoing work and to discuss this with the group. ● **Janette Bessembinder** (15 min): Some examples on communication of information on climate data Optional: discussion in case study groups (in break-out rooms)

Week 6: Work on case studies and presentation of case studies	
Meeting (9:00 – 11:30 CEST)	**Wednesday 23th June**
9:00-9:30	Session to answer final questions of participants.
9:30-11:00	Presenting and discussing case studies 1-5 (including break)
Meeting (9:00 – 12:00 CEST)	**Friday 25th June**
9:00-10:30	Presenting and discussing case studies 6-10 (including break)
10:30-12:00	Evaluation of the course Handing over the certificates and closing words

2.4 Results

This section presents the way we tried to optimize the learning process during the course, with special attention to the fact that the whole school was online. The next paragraphs both contain the measures we took beforehand and the measures we learned while we were underway. Regarding the content of the course we refer to the learning materials available online on the IS-ENES3 website (https://is.enes.org/training-detailed/#autumn-school).

2.4.1 Lecturers and presentations

The course lecturers were all from the IS-ENES3 team. The content of the presentations was discussed beforehand with the lecturers to avoid overlap and comment on the length, accessibility and attractiveness (e.g. presence of illustrations). Most presentations from the Autumn school could be re-used directly in the Spring and Summer School, while a few needed some shortening, update or other adjustments.

Interaction between lecturer and participants was considered important for the learning process, so we aimed for the lecture itself not to take more than 2/3 of the allocated time. The personal contact with experts was one of the added values of the sessions. If not all questions of the participants could be answered during the session, we emphasized that the remaining questions could be answered during a later session or by e-mail.

An advantage of the online course was that all sessions were recorded and became available before the next session. This gave the participants the option to listen to the presentations and discussions a second time. Occasionally a participant could not join during a session, and then this participant could watch the video later on.

Although the set of lectures was composed with care, we had not explained the structure to the participants of the Autumn school. Because of this, the relevance of some of the lectures may not have been clear to the participants during the first school in the autumn. For the Spring and Summer courses we made an overview of how the different lectures were connected and we presented this in the introduction session.

In weeks 4 and 5 a few short lectures/additional explanations were added based on our own informal session evaluations:

- Extra Q&A on the Climate4Impact portal;
- Additional information on other data portals than C4I: a lecture on the Climate Data Store and the Climate Explorer; and one short lecture on the CDS API;
- An additional session on visualization of results and pitfalls.

Summary of advice for preparing lectures:

- Always ask a draft presentation and comment on its length, accessibility and attractiveness (illustrations) to avoid overlap between lectures and to safeguard the space for interaction.
- Discourage ‘extra slides because you never know’. Instead, presenters might add a slide with suggestions/ links for further reading.
- Make sure the organizers also have a copy of the presentations. In case of internet problems at the presenter side, the host can share the presentation.
- Discourage animated slides or a pdf-version of the presentations. In case of animated slides the presenter will have to ask the host very often to “go to the next slide”. In case of pdf-versions, the presentation cannot always be presented in an optimal way.

2.4.2 Climate4Impact website

Christian Pagé showed the current Climate4Impact (C4I) website and explained access (including the need to create the right accounts) as well as the use of the website. This website was recommended to be used in the case studies. The old C4I portal still functioned, but was not actively maintained anymore (available time is spent on the new version of the portal). In some cases the portal did not work properly. We had postponed the course from the summer of 2020 to the autumn so the new C4I portal might be ready, however, the new C4I website was still not operational at the end of 2020, or, for that matter, during the Spring or Summer schools.

In the Autumn school Alessandro Spinuso showed the new C4I portal for which the publicly accessible beta version was expected in June 2021. During the virtual schools it was accessible to persons who wanted to be alpha testers; the participants were invited. Janette explained this in an email after the session. One participant offered to be an alpha tester.

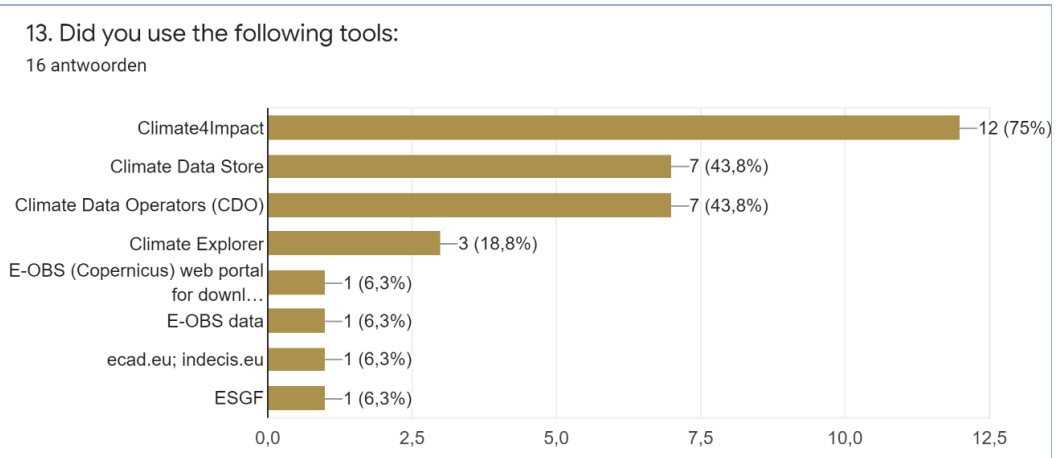
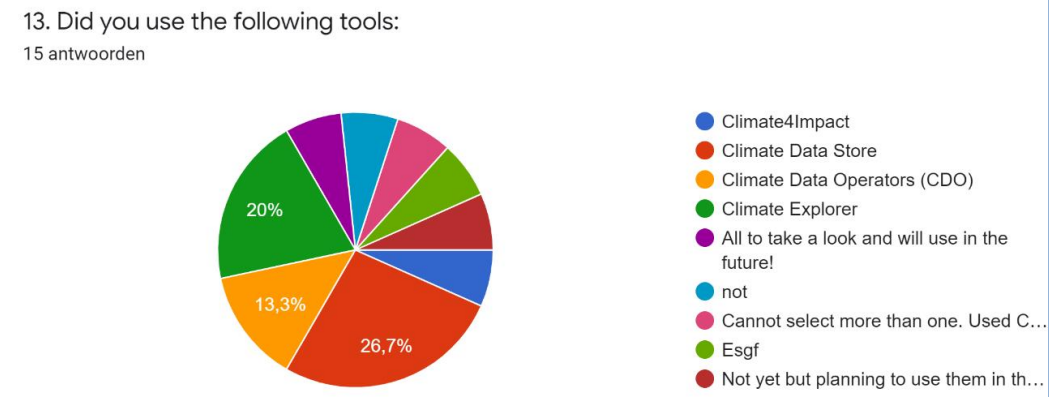
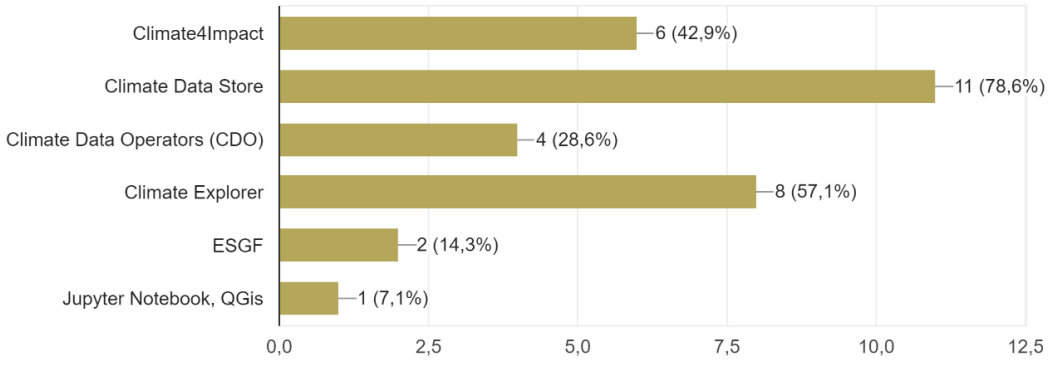
Alessandro did some polls to which participants responded in the chat:

- Familiar with Python? 14x no/very little, 2 have some experience. Other languages are used such as R, Fortran, IDL.
- Familiar with Jupyter? 3x yes, 1x just a bit.
- Familiar with Gitlab? 6x no.

We prepared screenshots of how to use the (old) C4I portal, so they would recognize what they should see when using it. Christian was available for another half hour on Wednesday 2 December to answer questions from the participants. To compensate for the difficulties with C4I, we decided to add information on two other data portals, the Copernicus Climate Data Store (including the Toolbox) and the Climate Explorer that was developed at KNMI and is now supported by WMO. Furthermore, we introduced the CDS API. The CDS Toolbox can be used to play around with datasets and check them before downloading. This can also be done with the C4I portal. Both portals give access to somewhat different climate data sets. The CDS at that time did not have CMIP6 data nor CORDEX adjusted data yet.

In the course evaluations for the Autumn, Spring and Summer schools, we asked what portals they used. The results are in Table 3. The table shows that in the Autumn school, the C4I was the most used platform. In the Spring school survey, the question did not have the correct settings so that the respondents could click only one option; assuming that they then would click their most used option, we see that it is not the C4I anymore but the CDS and the Climate Explorer. This change is confirmed in the Summer school outcome. We also see that users tend to use more than one data source, with an average of about 2 platforms per user. CDO is a solution to process data locally; but this is only for those who can program in Python. A limited internet connection can also be a barrier. Tools such as API and CDO take time to get acquainted with, but then processing becomes easier.

Table 3: Preferred data sources for the school participants.

Autumn school	
Spring school	
Summer school	

We did not ask for a reason why they used which platform, but our assumption is that on one hand, the CDS and Climate Explorer are more intuitive for less experienced users, and on the other hand the C4I offers the latest datasets to the more advanced users.

2.4.3 Case studies

The information from the lectures could be applied step-by-step by the participants through the case study assignment. As a first assignment we asked them to write half a page about what impact study they would want to perform in the areas of water, nature, agriculture or forestry. This half page was used to look for combinations of one impact researcher and one climate scientist. We also made matches by combining more experienced with less experienced participants, and by combining participants from different countries.

In the Autumn school we chose to create subgroups of two persons to maximize each person's involvement as they would be dependent on each other's knowledge. In the Spring school one person quit one week after the start of the course, and because of the uneven number we created one group of three. That seemed to function well and in the Summer school we had two groups of three. In the evaluation survey of the Summer school we had a question about the group size and a group of three was in fact the preferred option.

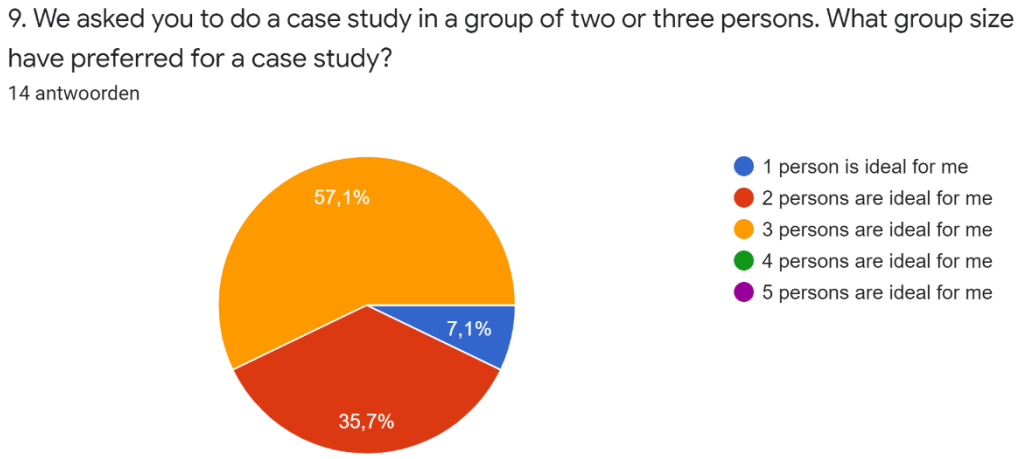


Figure 1: Preferred number of persons for the case studies

In each school we sent the participants into a breakout session to compare their proposals and decide what case study they would work on together. In the Autumn school this moment was in week 4. Because of feedback after the Autumn and Spring schools that they wanted more time for their case study, we planned the moment of group creation in week 1. After the breakout session in which 8-10 groups discussed the potential case study, they all had decided on an idea. Sometimes the idea was too broad, so we had to encourage them to focus more.

Since case studies can take a lot of time and they had relatively little time available, we tried to indicate what we expected from the case studies and what we did not. The following figure was used for this:

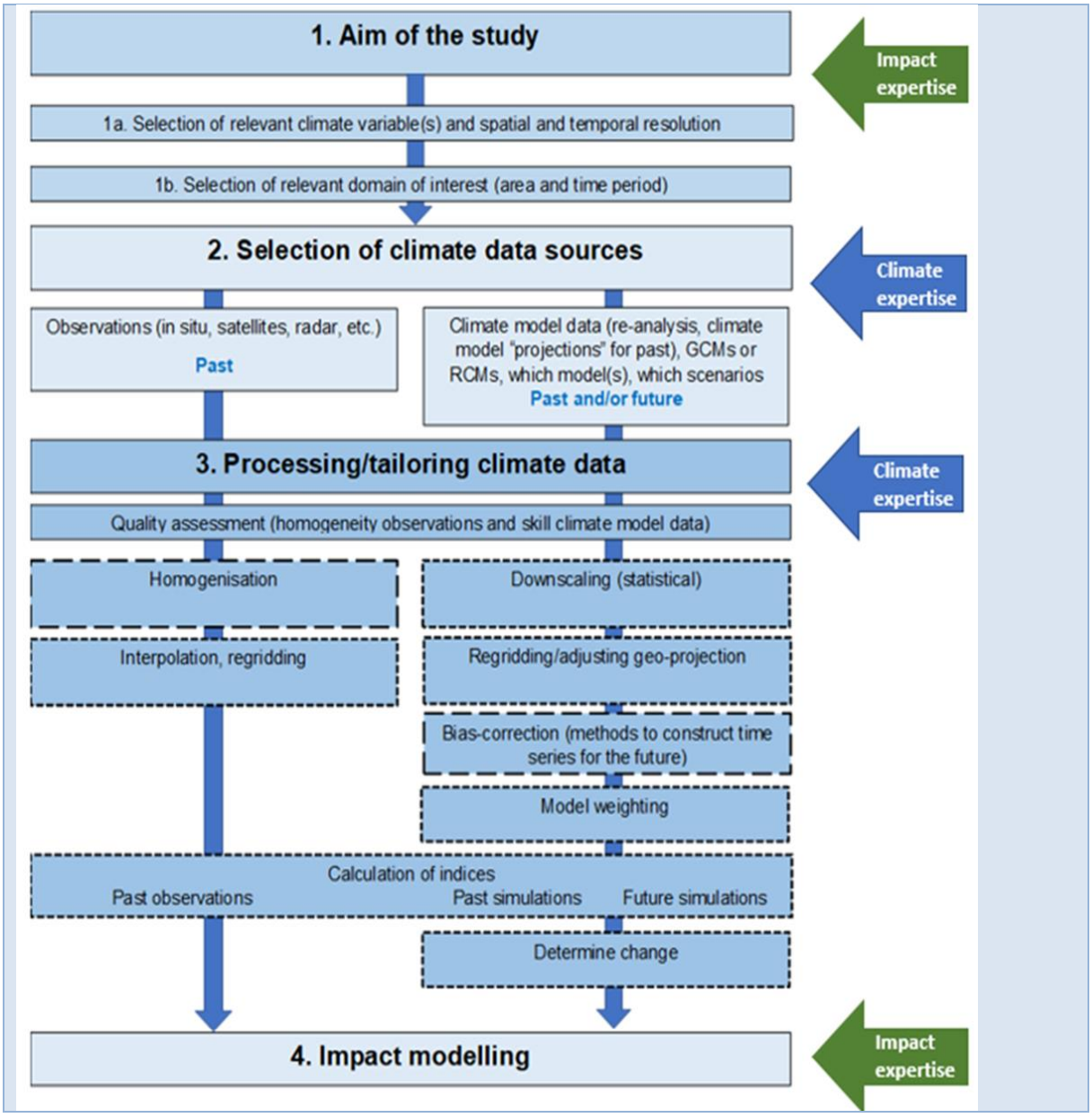


Figure 2: Steps in studies on the impact of climate change.

We considered it important that they would acquire some experience with the four main steps mentioned above, plus a fifth step on communicating the results to a user. The sub-steps in the figure were not all mandatory, and depended on the case study as well as the available datasets.

The participants regularly had problems limiting their case study to e.g. one climate index, or limiting the number of climate runs that they analyzed. We had to remind them that it was not necessary to do a full case study, but that it was sufficient if they only analyzed one of the relevant climate indices, or only one of the climate models that they had selected for their case study. For the Spring and Summer courses we developed an example of a case study, to explain how such a simplification process could work.

In between the sessions, four of the lecturers were available for guidance of the case study groups. To lower the threshold for asking questions about the case studies we assigned 2-3 participant groups to each of the four lecturers, based on their expertise on water, agriculture, urban issues, or forestry.

To keep the participants involved in weeks 4 and 5 we communicated that the Wednesdays were optional but they were all expected to be there on the Fridays. Additional information sessions were planned on the Fridays. In these two weeks we asked them to present their ongoing work. This was not meant as a control measure, but to encourage them to ask for advice and to learn from other groups. Since we had a mix of less and more experienced participants, this led to participants helping each other.

Doing a climate impact study involves difficult choices related to the data. Many data are available, so how to make a useful selection? Although several tools and portals are developed for selecting and processing climate and impact data, users still need to do a lot of processing themselves. People with little background knowledge on climate data and programming experienced many practical problems. The case studies were meant to guide participants across the hurdles, showing them how to handle and solve certain problems. At the same time, we raised an awareness that the field of climate services is very much under construction and that even experienced climate data users may struggle with a platform or a dataset. The way to solve this is to create a network of experts where each individual participant could ask for advice after the course was completed. Knowing when to ask for advice or help was one of the learning aims of this school. The sessions in which they shared their results also made clear that there is not one way to do a climate impact study; the method depends on what data is available, what the users want to know and how much time is available for the impact study.

After each session, we as organizers evaluated the session: what went well and what problems were identified. For several problems immediate adaptations were made in the program; for example, additional short lectures; more structured involvement of lecturers in the case studies; and modified instructions for the participants. Based on our experiences during the discussion of the case studies we made the following adjustments in the course:

- We wrote some guidance material on how to choose between climate models and sent it to the participants of the Autumn school. Although no exact instructions can be given, some advice can be given on what aspects should be taken into account (e.g. relevant time horizon) for selection to present the range of climate change in the future (e.g. to avoid a biased selection).

- The spatial scale of climate models is often too coarse to represent all spatial differences in e.g. mountainous areas. Some advice was provided on how participants could deal with that.
- We often encouraged participants to focus on just one type of users instead of a broad range. Each user group may have different information needs. In the Autumn school we presented additional slides about communication with users of climate services.
- Participants shared papers and other links through the chat. These papers and links were collected and shared through the Google Drive created specifically for the school.

During each school, we were positively surprised by the extent of the work accomplished. In most groups the cooperation went well; however, looking back, groups of three might have been more resilient than groups of two. There was also some interaction between groups, and in the Spring and Summer schools we encouraged this more by offering additional breakout sessions on topics proposed by the participants. Next to this, we started offering breakout sessions for the case study groups that wanted to use the webex platform for their interaction.

In the final week (week 6) we planned 2 sessions with 3-5 presentations. For each case study 20-30 minutes were available: a presentation of maximum 10 minutes and 10 minutes for questions and discussion. For the final presentations we provided this format:

- Context, users and user needs.
- What data did you want/ which ones did you select/download and why?
- What processing did you try?
- Graph/ map / result/ draft conclusion.

Table 4 shows an overview of the case study topics. In total 27 case studies were done in the frame of the three schools. The time to do each case study had been limited to around 20 hours per person, but most still achieved results in the form of a conclusion or a visual of an indicator.

Table 4: Subjects of the case studies during the Impact schools

Autumn school	Spring school	Summer school
1. Precipitation and water stress for citrus fruits in Spain	11. Norway spruce and summer drought in Northern Europe	20. Maize farming in Narok county, Kenya
2. Anomalous temperatures and rainfall and potato yield in Ireland	12. Norway maple in Serbian cities at higher altitude	21. Crop water demand in Iran
3. Impact of temperature change on grapes in the Balkan region	13. Drought impact on maize production in Kenya	22. Impact of heat waves on canola yield in France
4. Frequence of droughts in Pakistan	14. Drought and food security in sub-Saharan Africa	23. Impact of hot temperatures on people in Italy
5. Streamflow and flood risk in Poland	15. Impact of extremely high temperatures on a crop in Europe	24. Flash floods in Italian cities
6. Drought indices for farmers and water management in Central Asia	16. Surface runoff in Norway and impact on hydropower	25. Artificial snow in central Eastern Europe
	17. Flooding of coastal areas in France in the long term and impact on economy	26. Drought in Belgium
		27. Sea level and flooding in Bangladesh

7. Frequency of frost days in April and impact on Raspberries in Serbia: **8.** Long term growing season for beach forests in Serbia **9.** Urban impacts over forestry area in Czech Republic **10.** Extreme precipitation and flash floods in Prague and Venice	18. Pakistan catchment: link precipitation and river discharge 19. Aerosols and precipitation observation data in India	

2.4.4 Facilitation of virtual sessions

Bringing people together in a face-to-face school would have been a method for encouraging networking of the participants, one that we took for granted in pre-Covid-19 times. Because we had to rely on virtual means for this course, we took several measures to approach the same kind of commitment and bonding as would have happened in a face-to-face course.

In a virtual session there is little non-verbal feedback from the group to the lecturer. During the sessions we reminded participants that every lecture became available for re-watching and that everything would be revisited in the case studies. We asked regularly whether the participants were still following the speaker. After the second week we did a quick poll through the chat whether the participants found it too difficult / too easy / just about right.

Table 5: Responses to the feedback question on how the participants had experienced the Autumn school after two weeks.

• The most important lesson is about bias corrected data and other practical information on using data according to our questions and also various sources from where we can access that data • Models selection is 100% clear for me now and a lot of practical info from today • Same thing, the impact part was new for me. • The unclear thing is selecting the right model and the data • The climate services presentation was a very practical description of how to use the climate change data • One surprising information for me was that the plotting and visualization of the data play such a big role in understanding by users. Are there any best practices in visualization the data to be understandable in a right way for end-users? • Information on bias adjustment was really useful • ISIMIP for impact studies and portal for adaptive data seems to be very interesting to me • The unclear part for me is how to use the Climate indices • I found very useful anything about agriculture (...). Bias corrections are very useful for my thesis too • The presentations and discussions helped me to make clear several aspects in almost all lectures - standards, statistical downscaling, impact modelling, climate services. All the lectures were clear and very useful!

- I think most important to have an efficient communication between the climate scientist/climate services and the users. To provide a documentation about the procedure of the file and result creating. Understand each other's needs.
- I find it very important to know about uncertainties and cautions in climate models, and that choice must also be performed based on the specific impact goal.
- I now know various data sources and tools to access climate for impact studies which is quite beneficial
- Success stories from impact models and climate services is missing.
- By the way, all lessons were useful, so thank you very much!

We took several measures to enhance interaction between the participants. A first measure was already before the course started: to limit the number of participants to 20. A smaller group results in more commitment to the group and more interaction, while participants can become invisible in a larger group. We let them cooperate in groups of 2 for the case studies. We took care of combining more experienced with less experienced participants. We also took their research interests into account. We encouraged continuous participation in the sessions; if they had not let us know they were absent we would chase them through email (in a friendly manner). We encouraged those who were absent for a session to watch the recording. In the Autumn school all 20 participants completed the course; only one person quit after one week in the Spring school and the Summer school.

We started each session with an interactive part: questions about 'homework'; other questions prepared by us, and an open questions round. We explicitly discussed and encouraged interaction between the participants (not only between participants and lecturers) during the sessions as well as in emails: "We enjoyed seeing that you participated actively and that you also started answering each other's questions!" For sufficient interaction between participants it was important that lecturers do not give comments directly, but allow the participants to take the floor. We formulated 'asking for help' as an explicit learning aim. We emphasized that for impact studies, different kinds of expertise are needed and that they should try to use each other's knowledge.

We encouraged participants to tell us about their own experiences (e.g. with communication, or with processing of data), and especially those things that did not go well. This way they saw that others have similar difficulties, and they could learn from each other's solutions. We tried to create a safe environment for sharing by sharing our own doubts and solutions.

In the Autumn school we arranged for some informal interaction (which would have come about naturally in a face-to-face week). We recommended participants to put on their camera during the discussions so they could get to know each other. We had informal intermezzo's like the 'name game' in the first session (everyone tells a short narrative about their own name). Another time we made pictures outside of our windows and discussed the weather and the landscape; we made a group picture based on screenshots and made it available on the Drive. However, many participants seemed uncomfortable to do these kinds of things in a plenary setting. In the Spring and Summer schools we organized more breakout sessions for them in which they could meet in smaller groups, and that worked better.

Webex was chosen as the online meeting tool, because KNMI had an account and it allowed for recording the sessions. It mostly worked well. Some people (temporarily) located outside of Europe suffered from connection problems (no sound, connection breaking up etc.). With them we occasionally had to rely on the chat function for communication. A good connection was applied as a criterion in the selection of participants for the Spring and Summer schools. For the presentation of the case studies we asked the participants to send us their PowerPoint so we could share the screen if their internet connection was breaking up.

A shared and secure folder was opened on Google Drive where all course items could be shared: Powerpoint presentations, session recordings, written assignments, and the chat discussions. We invited the participants to use the shared folder for working on the case studies together. The google drive file access was limited to the lecturers and the participants.

We encouraged the use of the chat for participants to raise questions, respond to each other or provide tips and references. This channel was used very actively by the participants, especially to interact with each other.

2.4.5 Wrap-up of the course

The final session consisted of case study presentations, and we had an oral evaluation round. We announced that we would send a written evaluation form as well.

We reserved an hour for a wrap up that was a bit festive and memorable, again, as if it was a live course. We asked IS-ENES3 project leader Sylvie Joussaume for a short speech. Furthermore, we had prepared a certificate for each participant with the help of Sophie Morellon.

In the Summer school we implemented an idea from the Spring school participants: we sent them all a small package with Dutch tea, coffee and snacks to share in the final session. This was appreciated very much; although the package had not arrived (on time) in perhaps one third of the group.

Finally, we discussed the follow-up:

- For each school we organized a small follow-up session with a bonus lecture, about two months after the end of the school;
- Help from lecturers was offered with their further work on the case studies after the course was over;
- The Spring school participants set up a Slack channel, and after the Summer school a Linked-in group was created for all participants;
- Webinars inspired by their suggestions were organized, such as a webinar on bias adjustment
- Follow-up sessions in EGU and EMS conferences (including dinner) were suggested. At the EGU 2022 we indeed organized a dinner with a small number of participants from different virtual schools and some lecturers.

2.4.6 Evaluation of the course by the participants

In this paragraph the results of the evaluation surveys for the schools are summarized..

Question 1, how do you rate the school, shows a rating of 5 out of 5 for 70-80% of the respondents, indicating that a majority appreciated all three of the schools very much (figure 3).

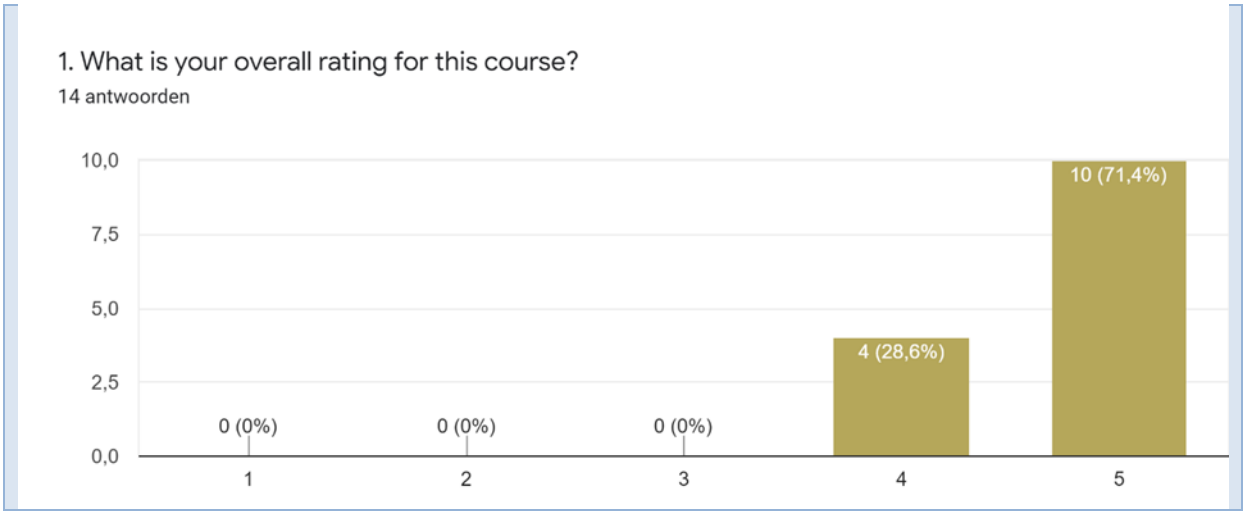
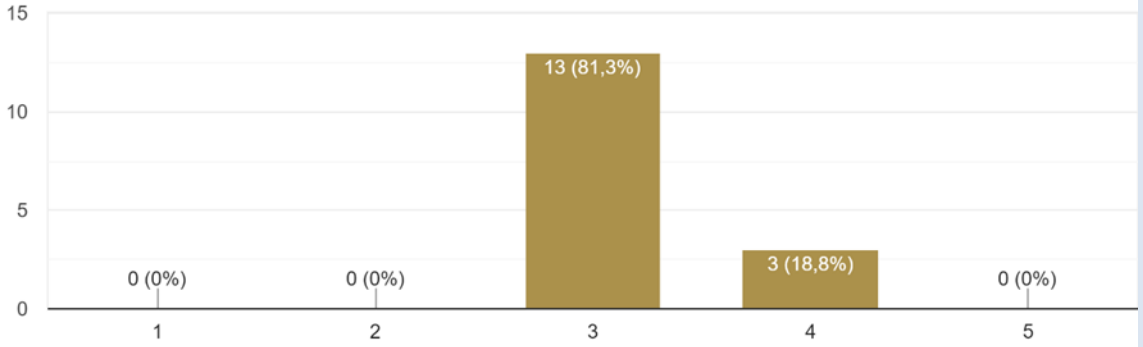


Figure 3: Overall rating of the Summer school (1=lowest rating, 5=highest rating)

Question 2 was an important question for us: was the course too easy or too difficult? Most participants scored a 3 in the Autumn and Spring school, which is what we wanted to see (not too easy and not too difficult). In the Summer school, the result is less good with almost half the participants experiencing it as too difficult. This is probably due to the fact that we were a bit less strict with our selection of participants for the Summer school.

2. The Autumn School was:

16 antwoorden



2. The Spring School was:

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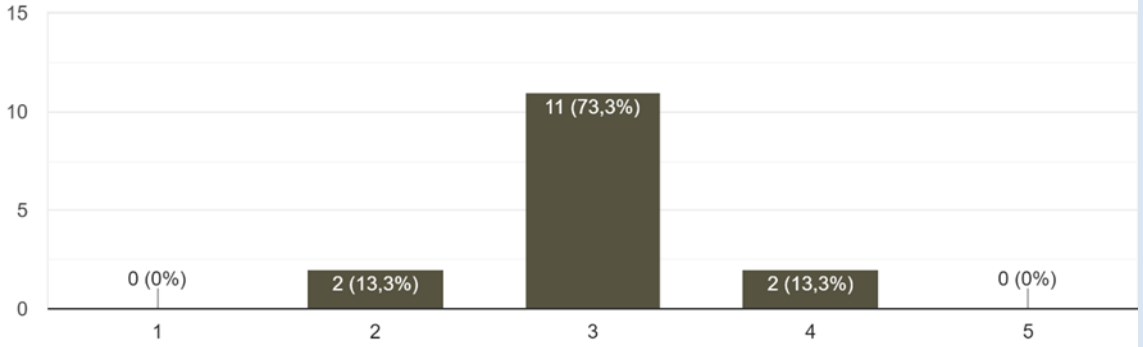


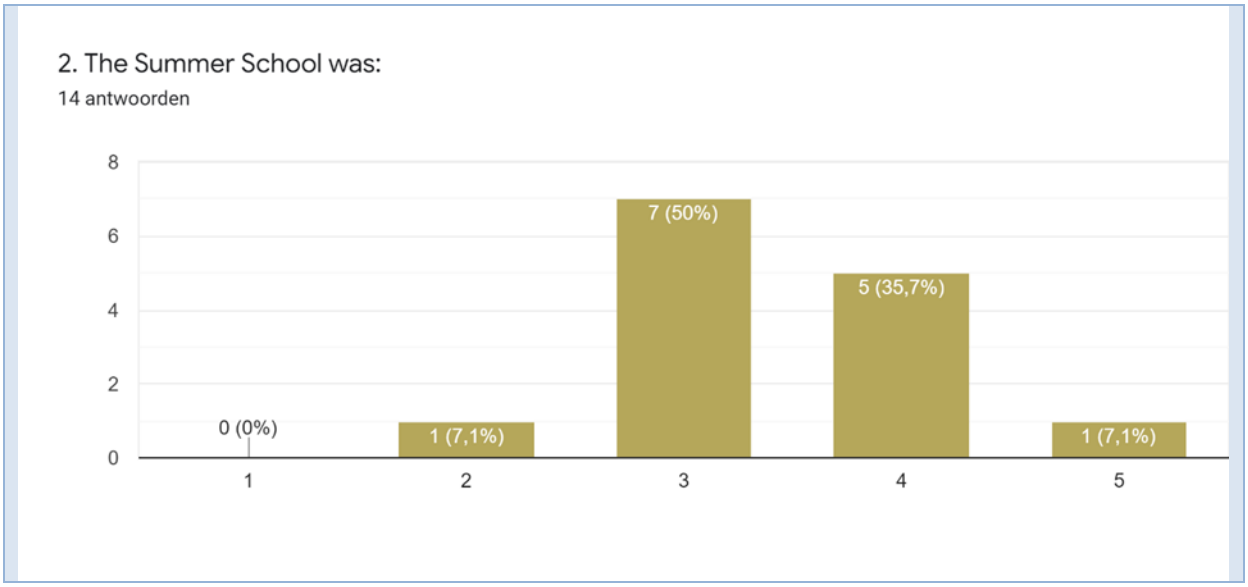


Figure 4: was the course too easy or too difficult (1=too easy, 5=too difficult)

Question 3 if they had missed anything in the school gave mostly answers about more detailed information on processing climate data, and more specifically, on bias correction and downscaling. Some also wanted more information on CDO, on impact modeling and on hydrological modeling. Another idea was a live session with one of the lecturers processing data or executing a case study or demonstrating a tool.

Question 4 was about the time investment, if the estimate of 56 hours was accurate, and if this amount of time fitted their needs. The answers are quite different for the three schools. More than 90% of the participants of the Autumn school considered the estimate as correct and they were also satisfied with this amount of time. In the Spring school, however, only half the respondents thought it was accurate while 40% had spent more time on it. In the Summer school the answers were in between these results: about 70% thought the estimate was accurate and the time investment was OK for them. The difference may have to do with the different periods of the year in which the courses took place. The Autumn participants had commented that the end of the year, and especially December, was a bit too busy for doing such a course, thus, they may not have had the extra time to spend on the case study. The Spring school, on the contrary, had included one extra week for Easter holidays, and the participants may have spent this extra time on their case studies.

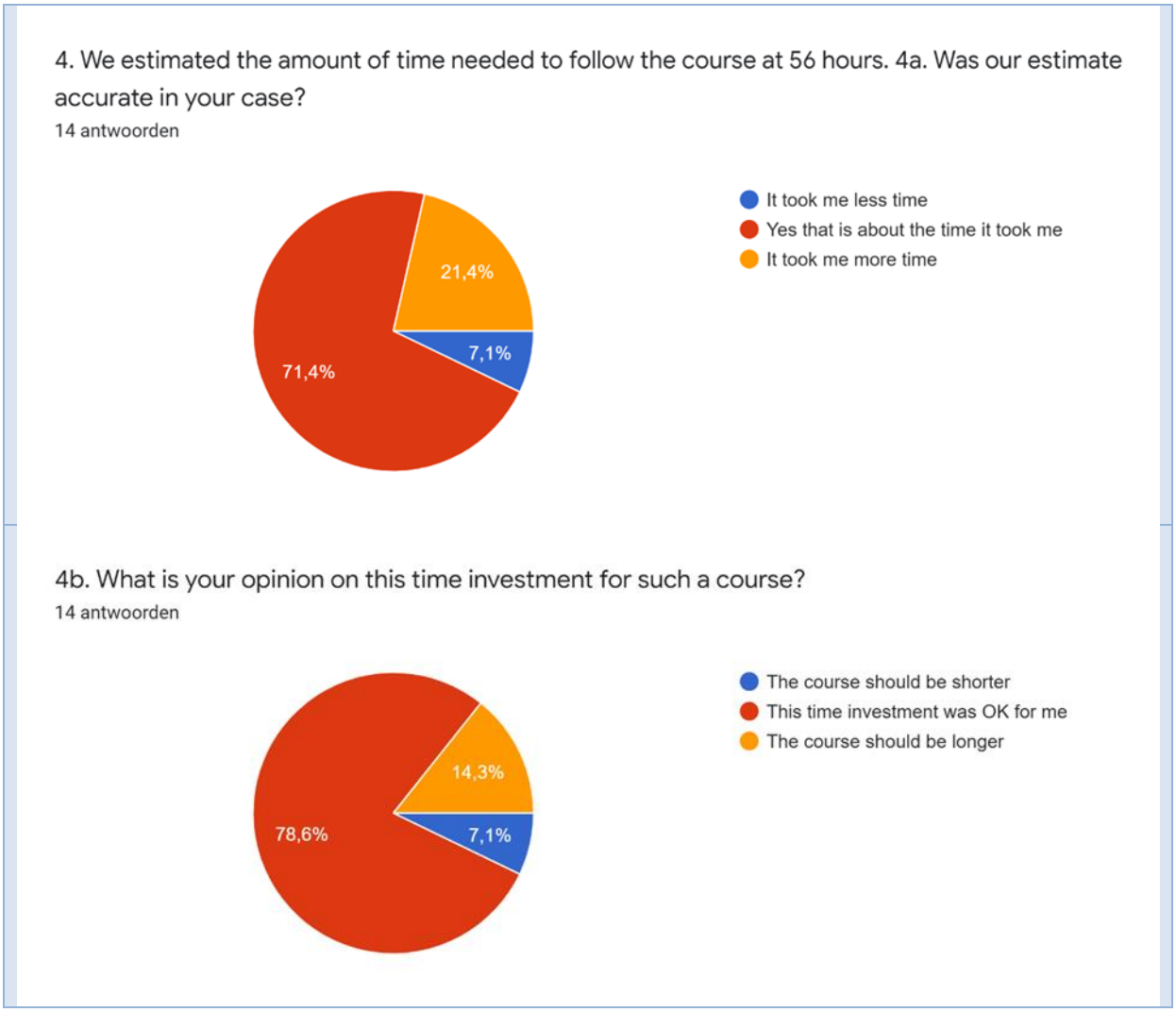


Figure 5: Results on time spend on the Impact school for the Summer impact school

Question 5 is about achieving the predefined learning aims of the course. Figure 6 shows the results for the Autumn and Summer impact school for the 5 learning objectives mentioned in section 2.2. Learning aims a. (on data sources) and e. (on transdisciplinary projects) seem to be achieved the most, with no red or blue in any of the schools. Learning aim d (the case study steps) is the most important one and seems to have improved between the Autumn and Summer school. Learning aim b (about climate models) and c (about impact models) are achieved the least; but the time in this course was too short to do any real modeling; the aim was only to present some background on how climate data were produced.

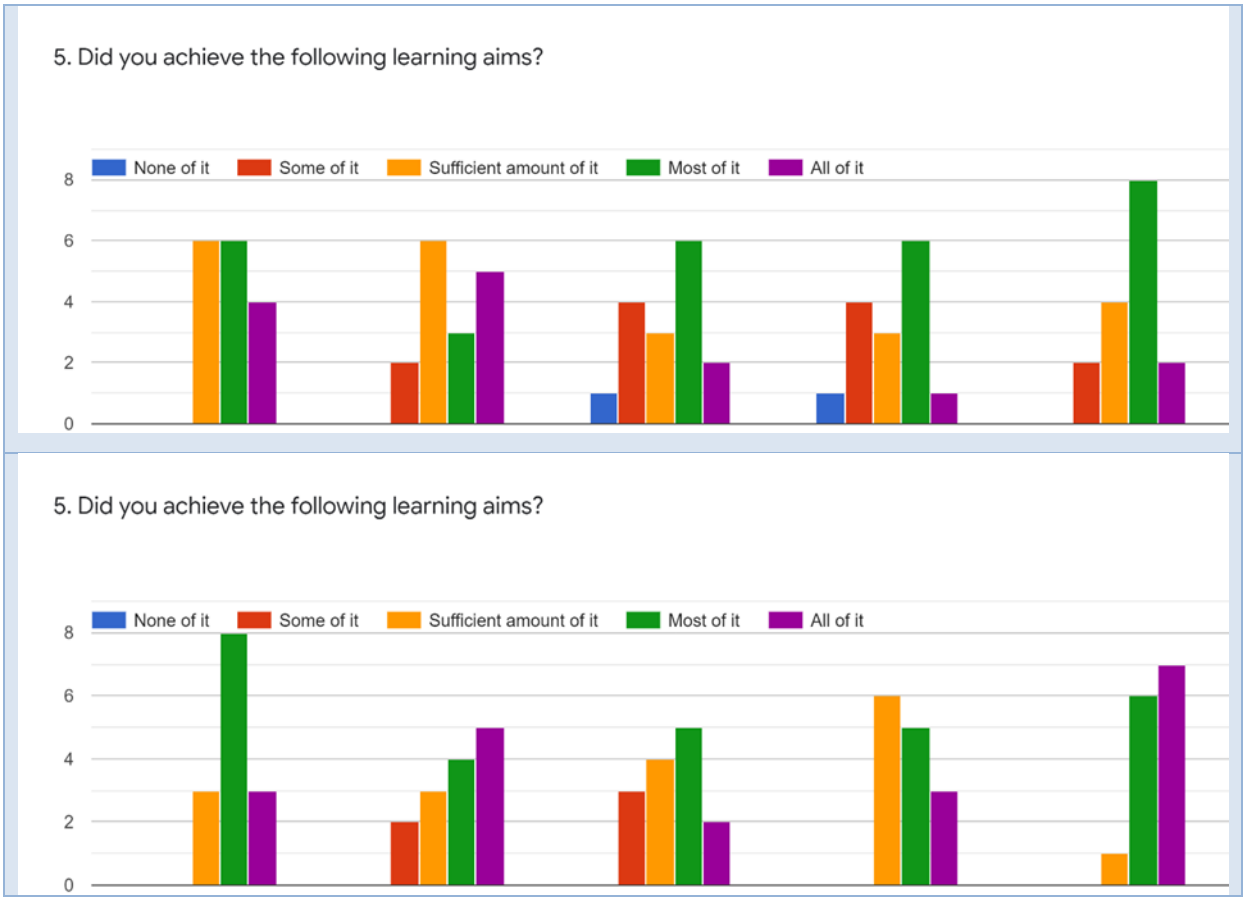


Figure 6: Learning aims in the Autumn and Summer school (see section 2.2; left= first objective, right=last objective)

Question 6 asked participants if they preferred a live or an online course. Interestingly, the group that prefers live shrinks over time and the group that prefers a blended course grows. In the Autumn school, the Covid-19 crisis was younger and the use of online meeting tools newer; probably everyone had gotten used to it in the Summer school, and had started to see the advantages. The open answers in green show some of the thoughts behind the preferences: in a live course people get to know each other better, while an online course is an opportunity for those who cannot travel so easily due to financial restrictions or due to obligations at work or at home.

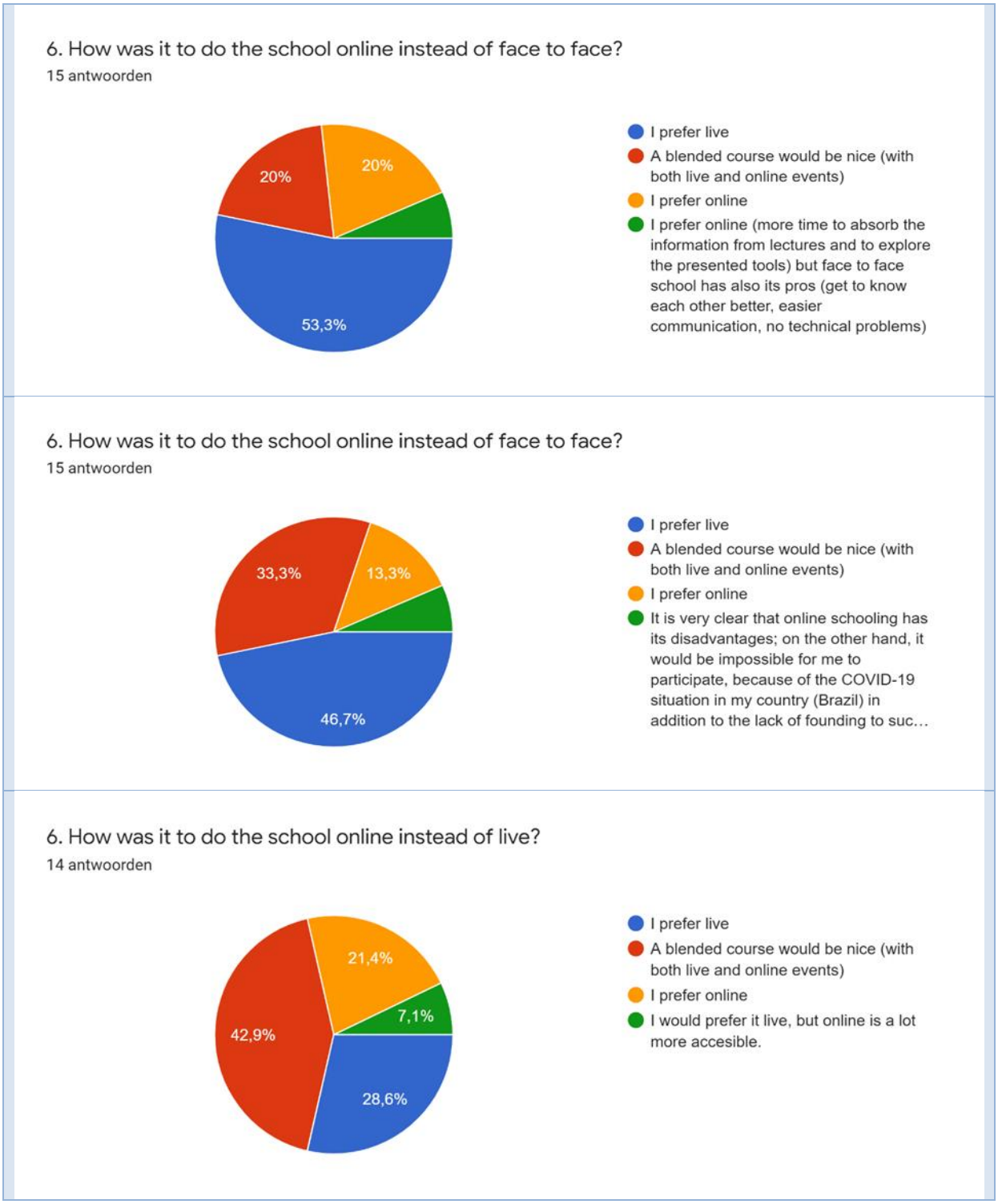


Figure 7: Preferences for live versus online in the three impact schools (top= autumn, bottom=summer school)

Question 7 was about the usefulness of the individual lectures (figure 8). Over time the blue disappears (not useful), and the yellow grows (very useful); this can be because some of the individual lectures got more adapted to this audience's need, but also because we explained the structure of the course better.

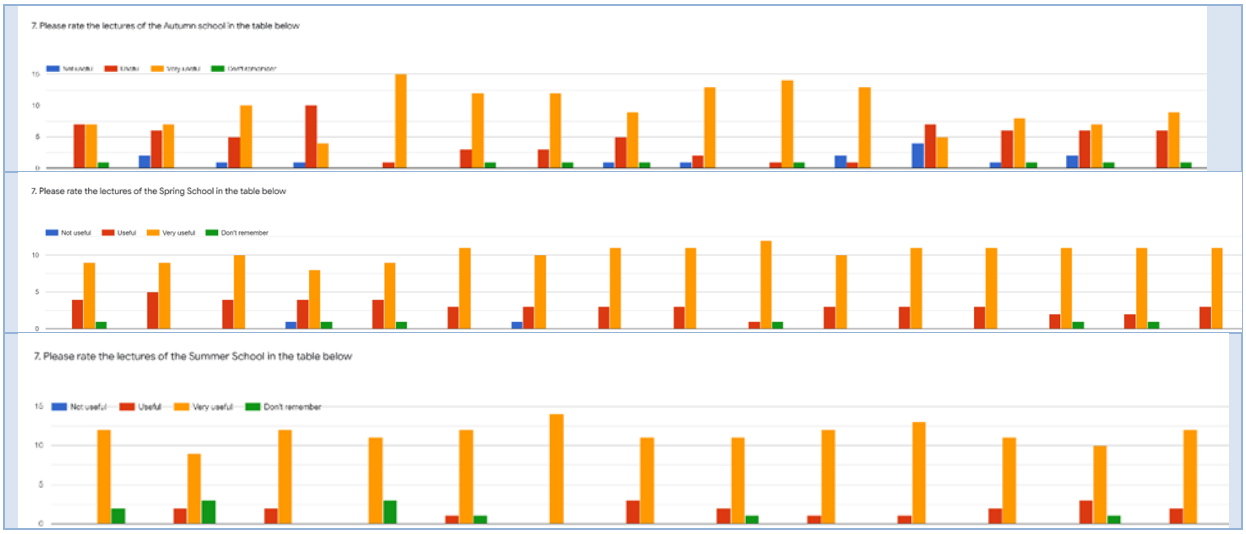


Figure 8: Results on usefulness of the lectures from Autumn, Spring and Summer schools (left = first lecture during the course, right = last lecture during the course; blue=not useful, red=useful, yellow=very useful; green=don't remember)

Question 8 asked what elements in the course were superfluous. Both in the Autumn and Summer school we got 7 answers that nothing was superfluous. In the Spring school, there were again 4 answers that nothing was superfluous, while 4 answers were more critical: some lectures were too long, there was some overlap between lectures, and climate science was prevailing (over impact research?). So the content and structure of the course is fine for most participants; the only potential improvement is more precise time management for the lectures.

Question 9 was about the case studies in 2 by 2 groups. In the Autumn and Spring school survey, this was an open question, while in the Summer school it was a multiple choice question (see graph for the Summer school outcome). It turns out that groups of 2 force the partners to work harder, but it also makes everyone dependent on the quality of just one other group member. Or, as one respondent in the Spring School mentions: 'I was lucky to have a good partner'. Looking back, groups of three might have been a better option. In the Spring school we had already one group of three, and in the Summer school two groups of three.

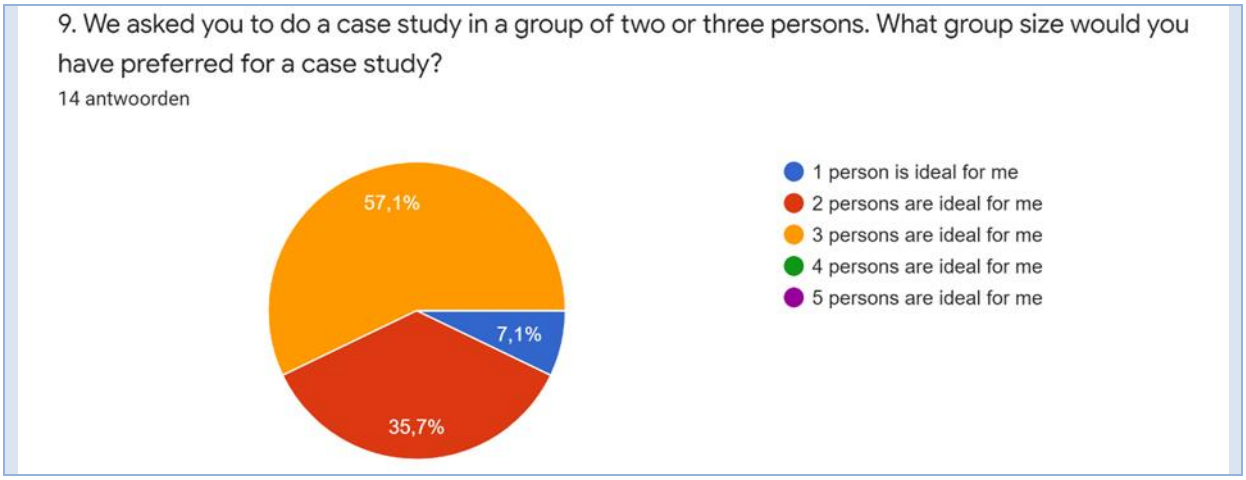


Figure 9: Preferred number of persons for case studies in the Summer school

Question 10 was about the internet connection. Between 2 and 5 of the participants per school (of about 20 participants each) experienced some problems with the internet. Especially participants located outside Europe during the course suffered from internet problems. For the Spring and Summer school we added good internet as a criterion to participate, and for those two schools the scores then improved somewhat compared to the Autumn school.

Question 11 asked if there was enough help with the case studies by the team of lecturers. Here all open answers are very positive, and the lecturers assigned to each team are specifically mentioned. "Excellent quality of help (suggestions, comments, solutions, additional documentation)." The question was perhaps a bit biased, a better phrasing might have been: How was the help with your case study? And then give answer categories bad- sufficient – good.

Question 12 was about the session recordings that would be made available each afternoon after the sessions. In each school, most participants considered them useful to very useful. There are also a few participants who did not find them useful, perhaps because they were too busy to watch them.

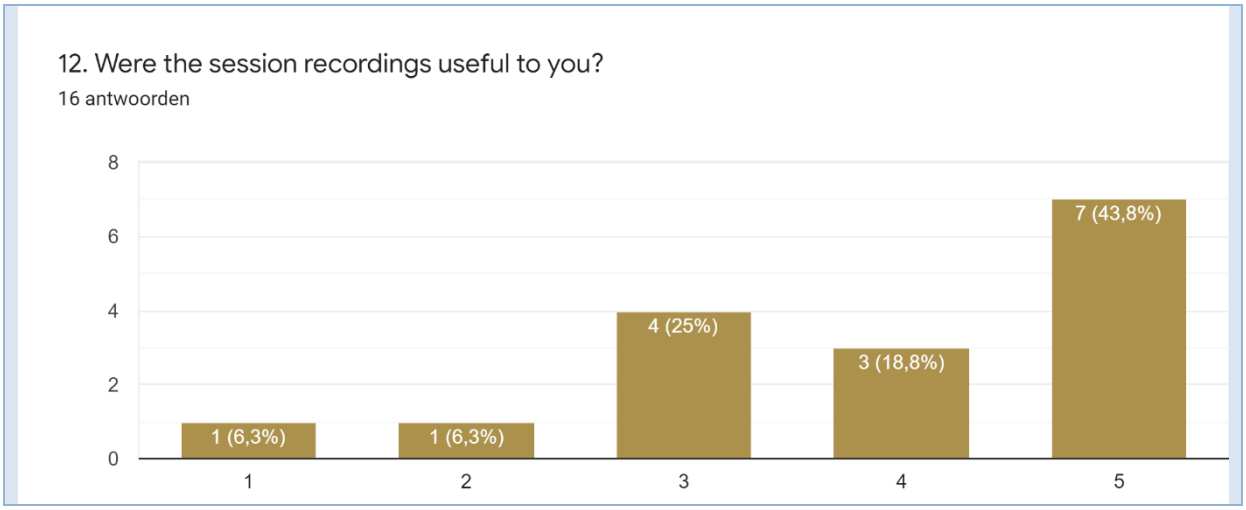
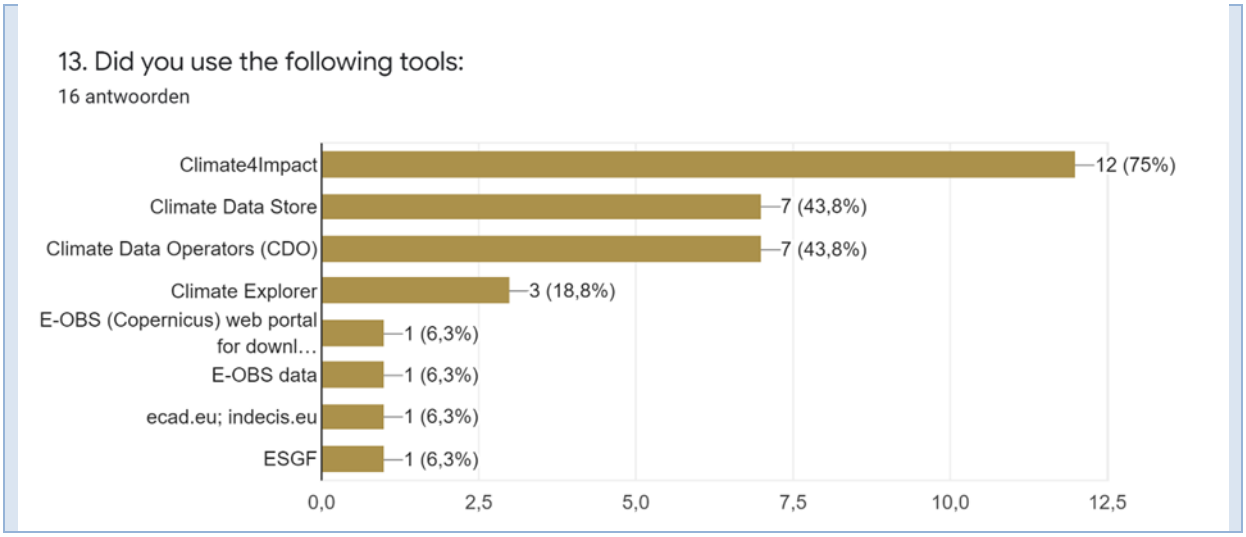


Figure 10: Usefulness of the recordings of the sessions for the Autumn impact school

Question 13 asked which of the data portals and tools the participants had used for their case studies. Between the Autumn school and the Summer school a shift took place from the majority using the C4I portal, to the majority using the CDS. (Unfortunately, question 13 had flawed answering categories in the Spring school evaluation). The shift may have taken place due to our extra lectures on the CDS and the Climate Explorer. Respondents also used platforms we did not inform them about like CDO; this is probably because some of them were already experienced climate researchers. A good thing is that most respondents have used more than one option; the average number per participant is 2 portals.



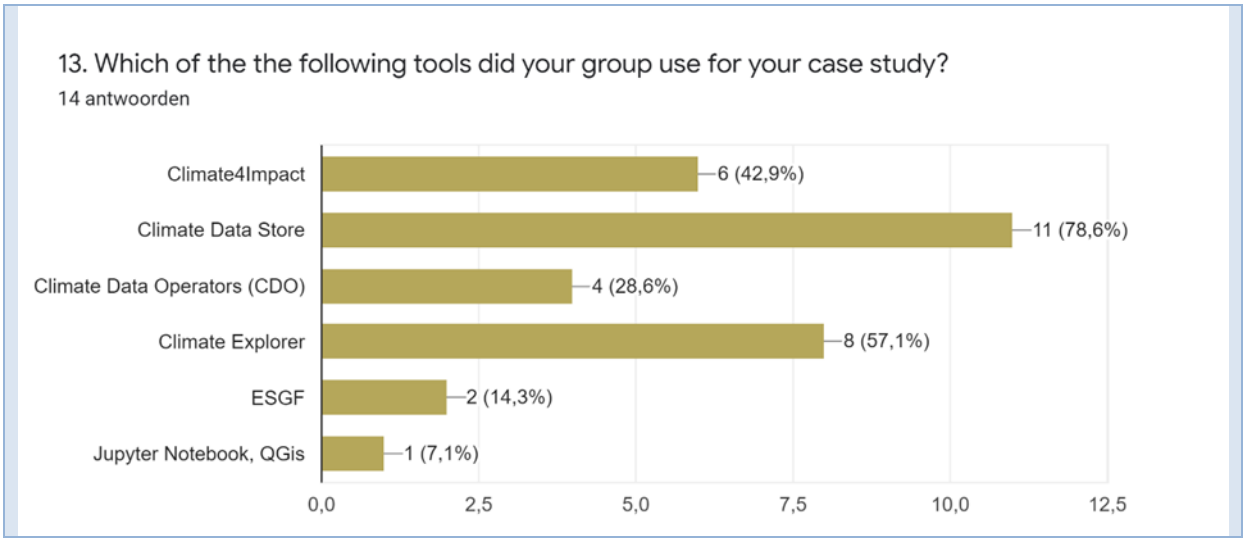


Figure 11: Use of climate data portals during the Autumn and Summer impact school

Question 14 asked if the respondents expected to use the knowledge from the course in the next 6 months. In each school, a large majority said yes, and a minority said maybe. No one said no.

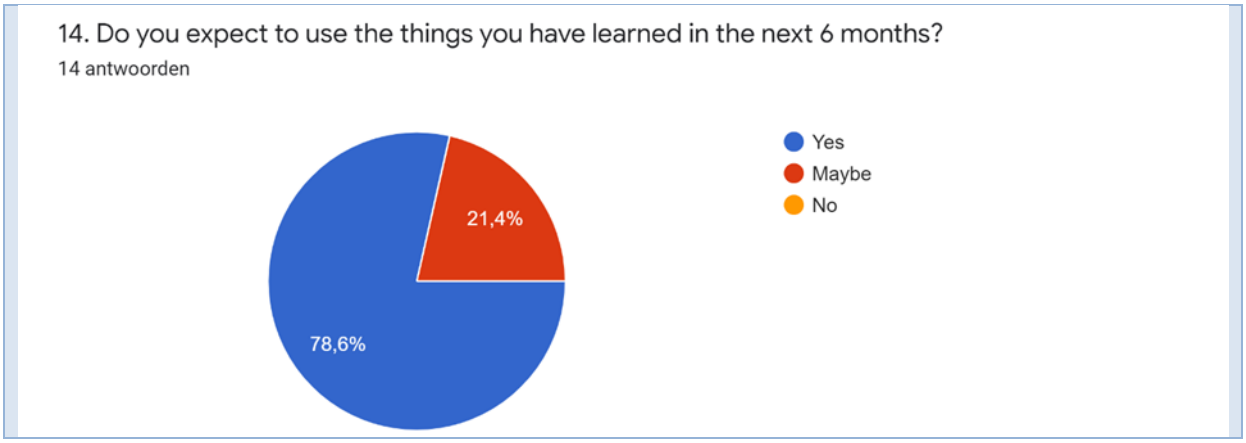


Figure 12: Number of participants who expected to use information from the Summer school

Question 15 asked for ideas for follow up in the form of separate webinars. This question was added in the Spring and Summer surveys and was not yet present in the Autumn survey. The respondents provided the following ideas:

- Fully practical workshops to run a complete pre-prepared case study from 0 to the end including all elements required. Applied examples, future climates of different places and their applications for specific projects in different places. Practical applications in agriculture
- Case studies with combined use of climate data and other environmental data
- Practicalities on the climate data portals and tools for use in analysis

- Climate Data Operators
- Application of Python and R in solving climate problems
- Bias adjustment, practical step by step example on bias adjustment methods
- Statistical downscaling
- Intensity-Duration-Frequency studies
- Selection of CMIP6 models (ideal/suggested combination of GCM and RCM) useful for impact application
- Strategies to deliver results to climate services users (managers, rule/police-makers, decision-takers, etc.)

Question 16 asked for any other advice (in the Autumn school this was Q15). A summary of the open answers: Mostly praise ("No, you did a great job"), and also a few suggestions:

- more step by step application of the knowledge in practice during the course, include small tasks to solve each week.
- more time for breakout rooms with small groups, less time for discussing cases in the plenary group
- a virtual school alumni meeting place like Slack

Overall, the schools can be considered successful. If there is a continuation of the course somehow, the step-by-step approach suggested by the former participants definitely would be an improvement.

2.4.7 Time investment and costs

We want to reflect briefly on the investment of time for this course. For participants we estimate that time investment was more intense compared to a 1-week course at location. The formal time investment for participants was estimated at 56 hours, including some hours for preparation before the course, the twelve three-hour sessions themselves and about 20 hours for the case study per participant. Some participants indicated that they invested more time in the case study, since it was divided over 3 weeks. Some indicated that the case study work was difficult to combine with their normal work or study, especially in the busy month of December.

For the lecturers who only did one (and in one case, two) presentations it may have taken about one day per lecture including preparation of the lecture. Fortunately, the lectures from the Autumn school could be reused with few adaptations in the next two schools. For the four lecturers who assisted with the case studies it took more time (40-50 hours), because they often were also present during the sessions and had meetings with the case study groups in between sessions.

For the organizers it took much time to organize everything before the schools started, and also during the school; especially for the Autumn school when a lot of optimizing was still needed. We had also spent quite some time on selecting a location in Prague that now became unnecessary. Dealing with the certificates and the recordings took some time in which we were assisted by Sophie.

Because the schools were virtual, everyone saved traveling time. On the other hand, we now organize three instead of two schools to arrive at the intended number of 60 participants. The direct costs of the school were less because there were no travel costs for the participants, no hotel costs or catering costs for the IS-ENES3 project, apart from the small packages we sent to the Summer school participants.

3. IS-ENES3 Summer School on Data Science for Climate Modelling

The IS-ENES3 Data Science School took place on the premises of NCSR "Demokritos" in Athens (Agia Paraskevi) in Greece between 1-7 September 2022 (https://www.iit.demokritos.gr/is-enes-summer-school/). After discussions with the Coordinator and other IS-ENES3 colleagues and stakeholders, it was decided to host the School later than initially anticipated. This was mainly due to the COVID-19 pandemic and the difficulty to host it in person before the scheduled time.

3.1 Objectives

The aim of the Data Science school was to increase expertise and skills on theoretical and practical concepts of Data Science, building upon and mainly targeting how to accelerate scientific discovery from data. Young scientists were introduced to methods to analyse, visualize and report on massive datasets, in the scientific domain as well as how to apply data-intensive and data-oriented paradigms and solutions to address scientific discovery in Climate Science. Driven by the theoretical background provided by domain, data and computer science experts, the school has adopted a hands-on approach for maximizing results focusing on the usage of datasets linked to the IS-ENES data services. The school aimed to strengthen the individual expertise of the participating climate and computer scientists, as well as, leverage and emphasize the need of collaboration between them, helping early career scientists and researchers with different backgrounds to meet and network.

3.2 Methodology

3.2.1 Advertisement

The School was advertised through various channels so as to reach the targeted students. The two main channels of promotion were the IS-ENES3 website (https://is.enes.org/training-detailed/#ds-school) and the dedicated webpage for the School on the website of the Institute of Informatics & Telecommunications of the hosting organisation NCSR Demokritos (https://www.iit.demokritos.gr/is-enes-summer-school/). The websites held all the relevant information regarding the School schedule, the tutors and the application process for students.

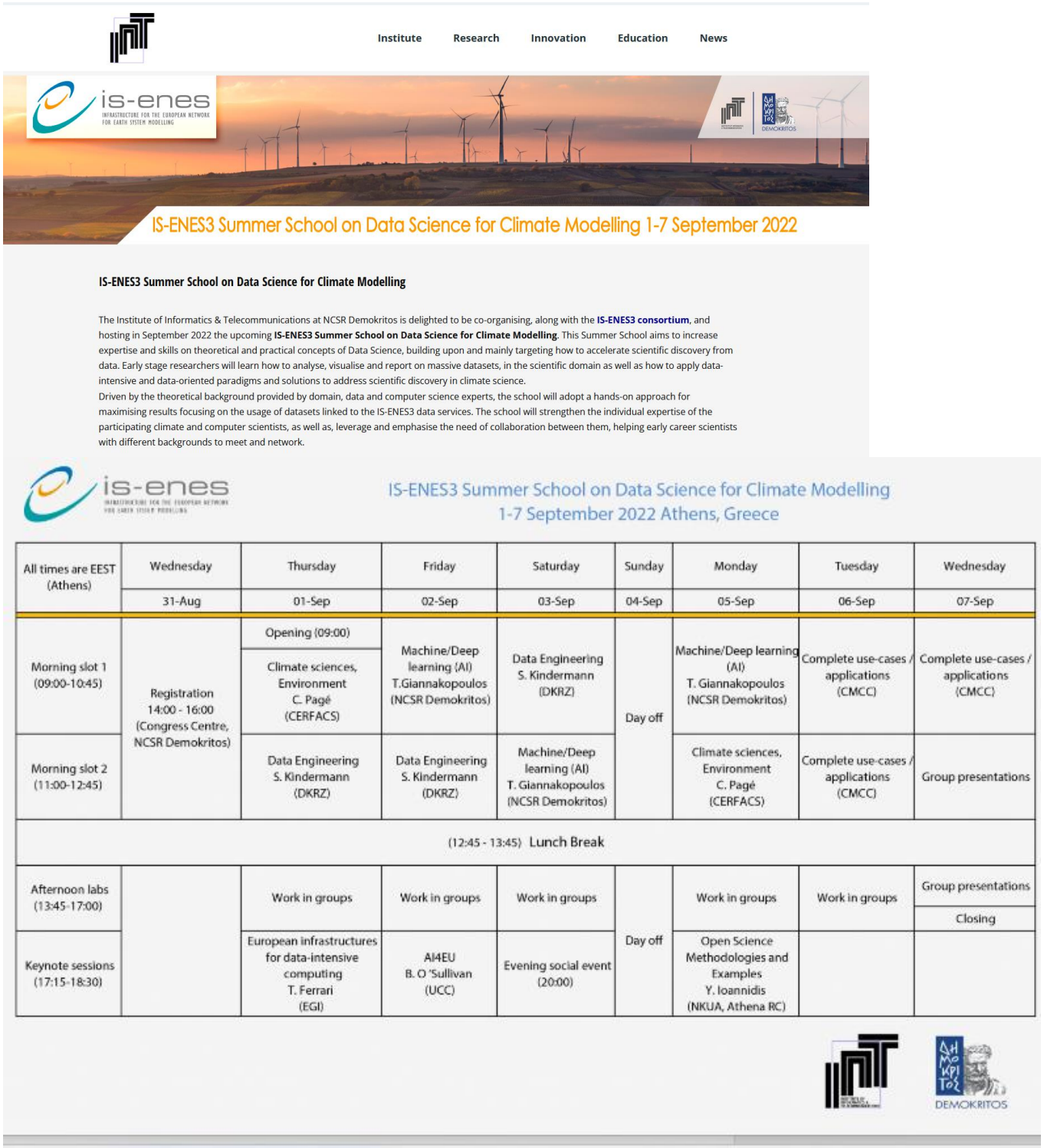


Figure 13: The IS-ENES Summer School website, September 2022

In addition to the websites, the social media of both organisations were utilized to attract applicants. In addition, dedicated emails were created and sent to mailing lists in Universities and research centers across Europe.

Electronic banners promoting the application for the School were created and used online in all forms of communication.

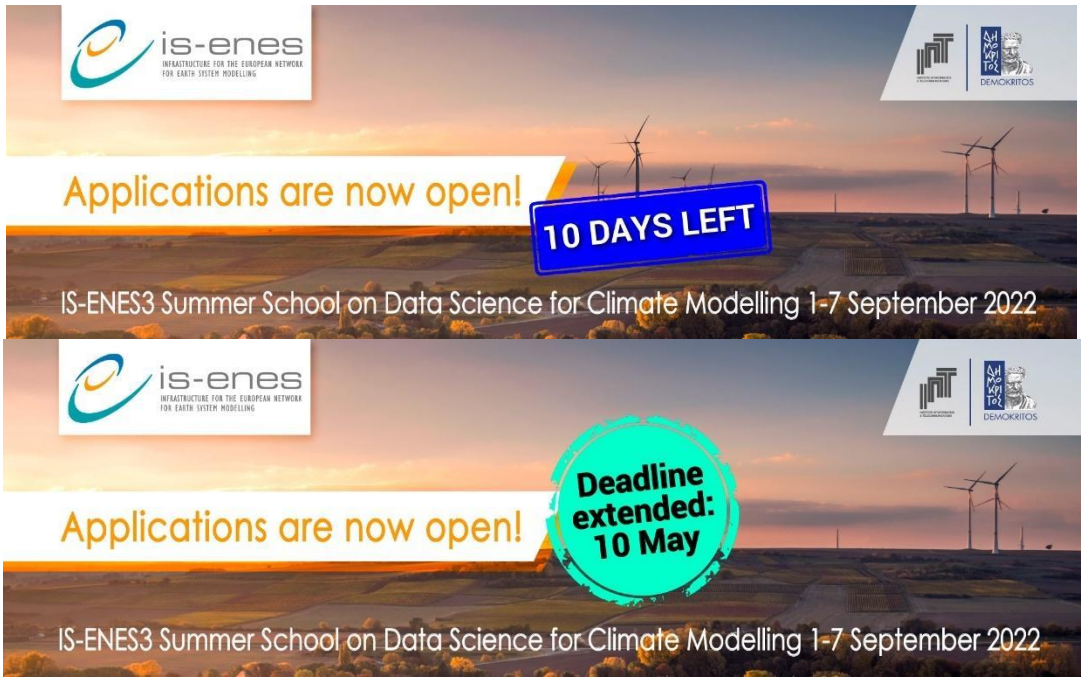


Figure 14: Electronic banners promoting ISENES Summer School applications

3.2.2 Target groups and participants

The main target group identified for the Data School was the ***early-stage researchers***. This group includes PhD students or even highly capable advanced undergraduate or MSc students working in relevant areas. It also includes researchers coming from the industry working on related matters. The School attracted 102 applications with a balanced gender mix of 55% Male and 47% Female.

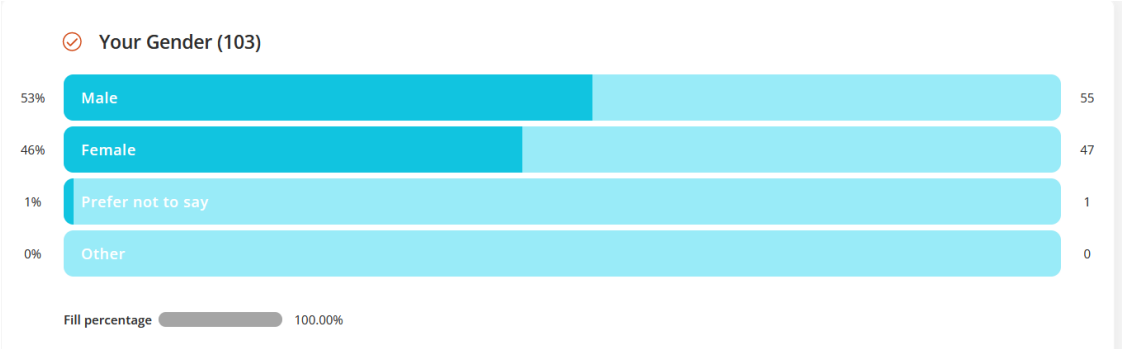


Figure 15: Gender mix of Summer School 2022

Applications were received from around Europe representing most European countries however there were also applications from countries such as Chile, Turkey, Brazil, Kenya and India thus indicating the heightened interest in the Summer School. Table 6 shows the gender balance, background and how many of the final participants were from Eastern Europe.

Table 6: Number of participants, background and where they were located for their work/study.

Data School	Nr. Partici-pants	Male/ female	Climate/Machine Learning/both	From Eastern Europe*	From outside Europe*	Working/studying in
Sept 2022 (Greece)	36	18 / 18	17/13/6	34	2	Hungary, Serbia Belgium, France, Germany, Greece, Italy, Norway, Spain, Sweden, Switzerland, Columbia, India

*For this the country in which people worked/studied was used. Regularly people from outside Europe were working/doing a PhD in a European country.

3.2.3 Organisational preparations before the School and selection of participants

In preparation for the School, a number of online teleconferences took place, during which a number of tutors and other stakeholders from the IS-ENES3 project were involved. The objectives of the School were confirmed as well as the target groups, the tutors, the modules to be taught, the schedule and the methodology around hands-on exercises. The School was designed to mainly attract young researchers of academic as well as of industrial backgrounds.

Selection procedure for the applications: Applications were received electronically, via an online form (https://forms.app/). The main sections of the application form included the following:

1. Personal information (name, gender, country of residence, affiliation etc.)
2. Motivation
3. Experience in Machine Learning
4. Experience in Climate data methods and infrastructures
5. Experience in Programming
6. A recent CV

It was decided that each of these sections was to receive up to 2 marks (with half marks allowed). Therefore, applications were marked from 0 to 10, and then ranked in reverse order, with top applications ranked at the top.

The school received **102** applications and the initial marks are shown below.

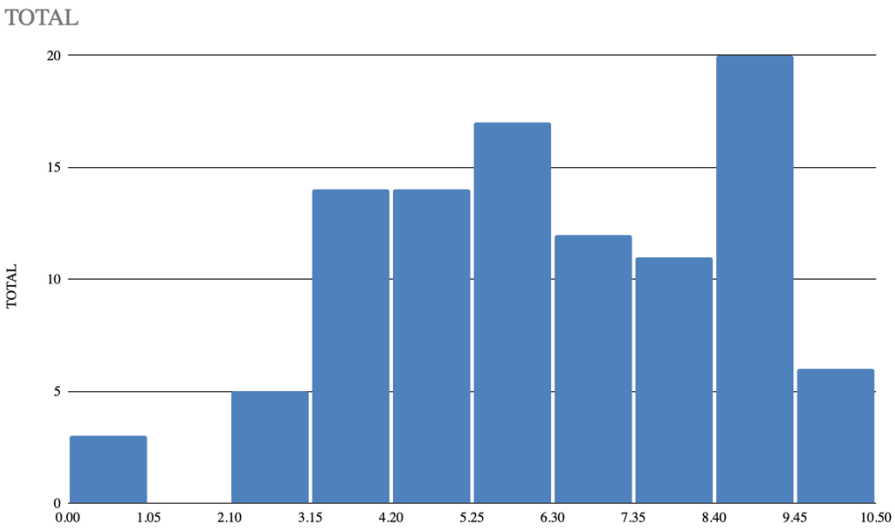


Figure 16: Distribution of marks for the applications for the Data School

Organisational preparations for the School had started a year before its realization in September 2022. A dedicated team at NCSR Demokritos began preparations and sourced vendors for all foreseeable needs of the School. Content for the website and social media was produced regularly and was communicated as the organisation of the School progressed while the schedule and the tutors were announced.
Students that were chosen to attend the school were to be provided with full boarding and accommodation in Athens. The local organising team at NCSR Demokritos researched potential hotels for students and chose one with good access to public transport and a reasonable distance from NCSR Demokritos where the classes took place. All participants stayed at the same venue (Athinais Hotel) in the center of Athens.

The local organising team monitored all 102 applications and contacted each candidate individually to inform them of their application results following the decision of the committee. The number of successful candidates was 40 persons, however as some of them were unable to attend, the organisers went through the next shortlisted candidates according to the points they scored in the assessment.
The final number of students attending the summer school was 37 after last-minute cancellations due to illness or other personal issues of the applicants.

To fully welcome students to the School, organisers put together and distributed to all students and tutors a welcome pack which included a customized fabric tote bag, a water bottle, a notebook, a pen and the School programme.

Figure 17: Welcome bag for students of summer School September 2022

Before the arrival of participants, the local organising team informed all candidates via email about the schedule of the School activities, provided instructions and suggestions for their stay in Athens.

3.3 Results

3.3.1 During the Summer School

The Summer School took place at the NCSR Demokritos campus, in three different lecture halls which were reserved for courses and workshops throughout the days of the School. Lunch and coffee breaks were provided to students free of charge throughout the School.
To guide students upon arrival and to mark the summer School throughout the week, signage was put in place in the form of roll-up banners on campus while a QR code provided immediate access to the slack channel for assistance by the Secretariat.

Figure 18: Signage onsite during the Summer School

The keynote talks were held by distinguished international scientists and researchers in the amphitheater of the NCSR Demokritos. Furthermore, the talks were made available for remote participation via Zoom to specific participants. All keynote talks are showcased on the Summer School webpage and are also available on the Institute's YouTube channel.
The School's keynote speakers were the following:

- Tiziana Ferrari, EGI
- Barry O'Sullivan, University College Cork and
- Yannis Ioannidis, National and Kapodistrian University of Athens and Athena RC

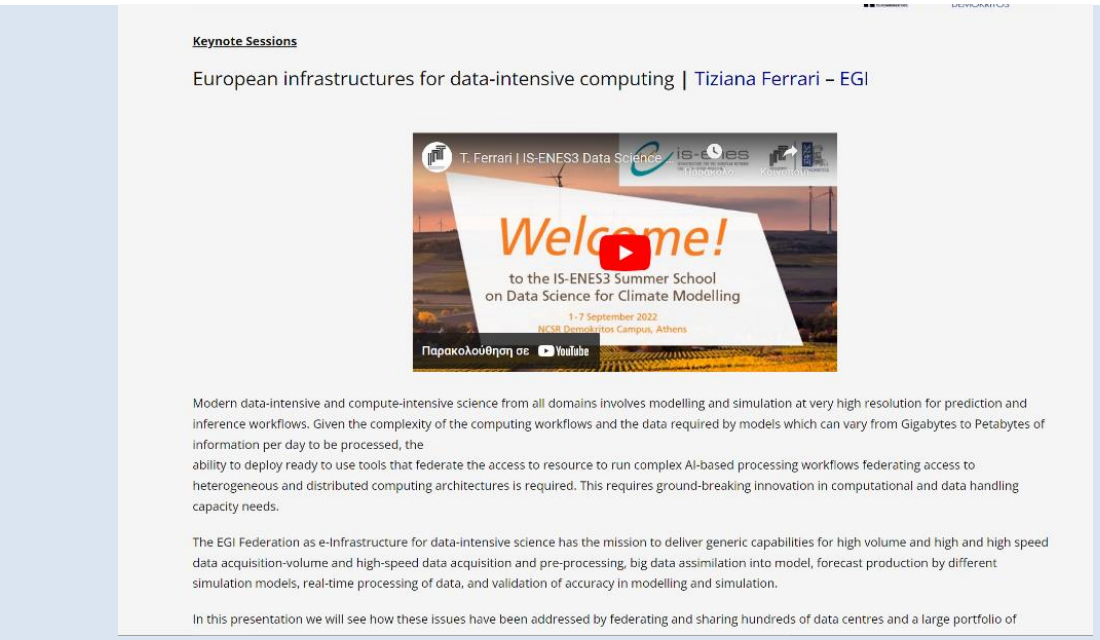


Figure 19: Tutor videos available on the School webpage

All courses and tutor materials were recorded and were made available to all participants through the shared GDrive of the IS-ENES3 Summer School which was created as part of the activity. During the School, students worked in groups on different projects which were then presented to teachers and students at the School.

Figure 20: Signage onsite during the Summer School

During the School a filming professional shot video footage and created a video of the School which is made available to be used by IS-ENES for promotional purposes in the future. The video is posted on the IS-ENES3 and NCSR-D YouTube channel (https://youtu.be/3J3PTeZSrDs).

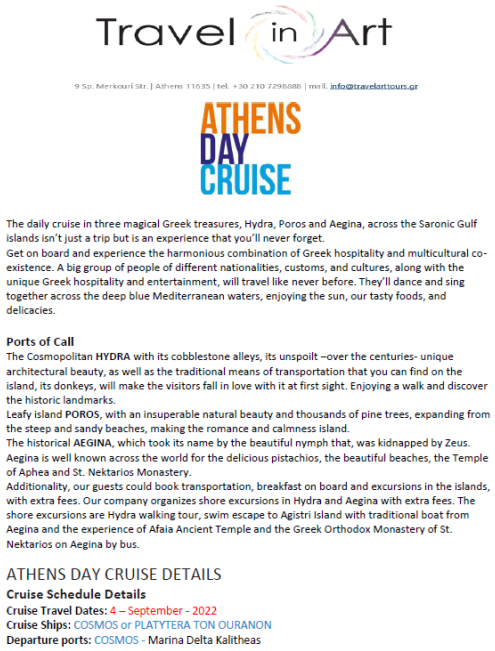
Figure 21: Promotional video of the Summer School

During the School a catering service was provided throughout the day and provided participants with meals and drinks during coffee and lunch breaks, and snacks. The catering menu was prepared according to the dietary habits and requirements of the participants (students and tutors).

Figure 22: Catering services for participants

The local organising team provided support throughout the Summer School and was present during the full week of the School to ensure the smooth running of the activities.

Aside from the courses, social activities were also organised for students and a complimentary dinner party on the seaside of Athens. On Saturday 3 September, a social dinner was held at Bolivar beach bar, where everyone was transported by shuttle bus and enjoyed the Athenian Riviera, with music, good food and dancing. On Sunday 4 September, an optional one-day cruise to the nearby Greek islands in the Argosaronic Gulf was made available.



Travel in Art

9 Sp. Merkouri Str. | Athens 11635 | tel. +30 210 7296886 | mail. info@travelarttours.gr

ATHENS DAY CRUISE

The daily cruise in three magical Greek treasures, Hydra, Poros and Aegina, across the Saronic Gulf islands isn't just a trip but is an experience that you'll never forget.
Get on board and experience the harmonious combination of Greek hospitality and multicultural co-existence. A big group of people of different nationalities, customs, and cultures, along with the unique Greek hospitality and entertainment, will travel like never before. They'll dance and sing together across the deep blue Mediterranean waters, enjoying the sun, our tasty foods, and delicacies.

Ports of Call
The Cosmopolitan **HYDRA** with its cobblestone alleys, its unspoilt –over the centuries- unique architectural beauty, as well as the traditional means of transportation that you can find on the island, its donkeys, will make the visitors fall in love with it at first sight. Enjoying a walk and discover the historic landmarks.
Leafy island **POROS**, with an insuperable natural beauty and thousands of pine trees, expanding from the steep and sandy beaches, making the romance and calmness island.
The historical **AEGINA**, which took its name by the beautiful nymph that, was kidnapped by Zeus. Aegina is well known across the world for the delicious pistachios, the beautiful beaches, the Temple of Aphea and St. Nektarios Monastery.
Additionality, our guests could book transportation, breakfast on board and excursions in the islands, with extra fees. Our company organizes shore excursions in Hydra and Aegina with extra fees. The shore excursions are Hydra walking tour, swim escape to Agistri Island with traditional boat from Aegina and the experience of Afaia Ancient Temple and the Greek Orthodox Monastery of St. Nektarios on Aegina by bus.

ATHENS DAY CRUISE DETAILS
Cruise Schedule Details
Cruise Travel Dates: 4 – September - 2022
Cruise Ships: COSMOS or PLATYTERA TON OURANON
Departure ports: COSMOS - Marina Delta Kalitheas

Figure 23: Social events organised for students

Figure 24: The Students of the 2022 Summer School in Athens

3.3.2 Evaluation of the Data School by the participants

Also for the Data School at the end an evaluation took place. Below some of the results are shown. In Annex 1 all results can be found.

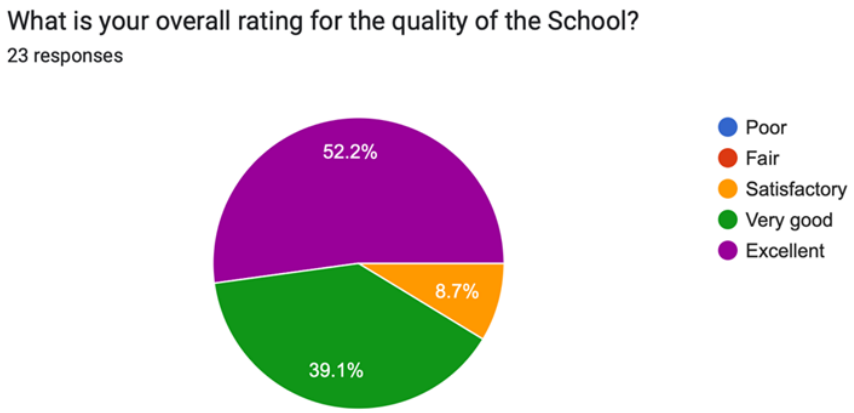


Figure 25: Overall rating of the Data School by the participants

The overall rating of the school was very good to Excellent (figure 25). The course clearly increased the level and skills of the participants (according to themselves). The level of the course was about right for the participants (figure 26). During the selection care was taken that the participants had some background knowledge so they could follow the course. None of the lectures were rated as poor and especially for the subjects "Climate and the environment" and "Use cases and applications" most lectures were rated as at least very good (figure 27). In Annex 1 more details are given on the aspects that participants considered most useful. Participants were also asked what they missed. Most answers related to more hands-on practical exercises. The time available, however, during the school was limited, but a few indicated that they would have preferred more practical exercises and less lecturers.

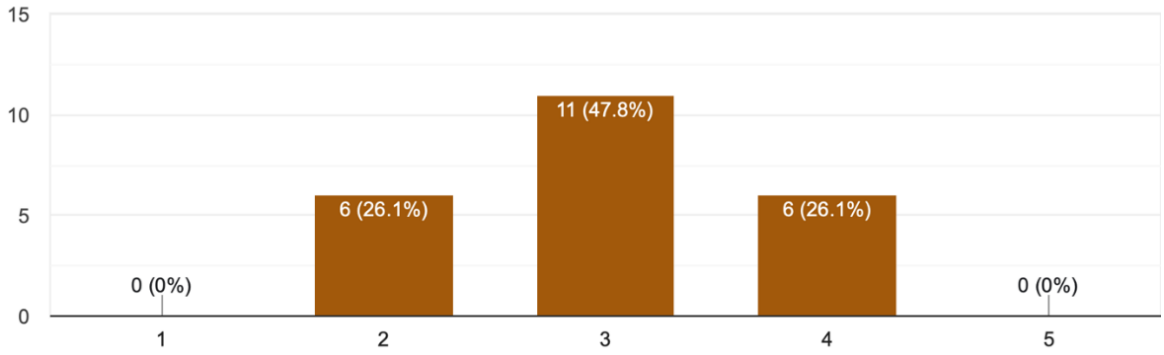


Figure 26: Difficulty of the Data School (1: too easy for me – 5: too difficult for me)

Figure 27: Rating of the lectures during the Data School

Most participants considered the working groups as a good to excellent way of working. It is not clear why a few participants had less positive reactions. The technical support when implementing the group exercises was also considered good to excellent by most participants. Also here it is not clear why a few had less positive experiences. It may be due also to their more limited background in data handling and programming. In the evaluation one person indicates that there should have been more technical support. It could be good to check this also during a course, to see whether a bit more support can be given to specific participants.

As figure 28 indicates, around 70% of the participants who responded expect to use the things they learned during the data school in the coming half year. The rest indicated that maybe they will use it.

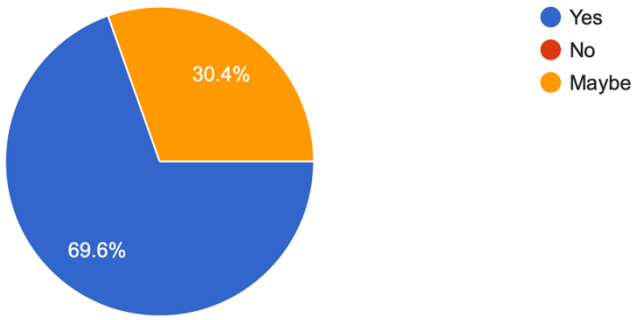


Figure 28: Do you expect to use the thing you have learned during the Data School in the next 6 months? (23 responses)

The accommodation, catering and support of the organizational team were all rated very good to excellent. There were only some remarks on the time needed to travel from the accommodation to the location for the course. Also the social event was highly appreciated (91% excellent).
The participants also gave some advice on how to improve a potential next Data School. The main suggestions were:

- More practical exercises, preferably with own use cases

- More information and exercises on machine learning and add notebooks related to the Deep Learning/Machine Learning techniques part, so to apply directly the theoretical concepts discussed during the lectures to real case studies
- No random working groups, but groups based on interest/subject and having a broad range of backgrounds (experience with programming, knowledge of climate and climate data, balance gender and age). These groups can also be formed based on brainstorming sessions during the school
- More diversity in the organisation and lecturers team
- Pay special attention to participants that have less background in programming, data handling, etc. This can be done by more personal and hands-on assistance, some additional preparation before the course, or coupling these participants with participants with more experience.

4. Conclusions and Recommendations

- A considerable number of young scientists and scientists from Eastern Europe was reached

The third aim of the IS-ENES3 project was to "Support the exploitation of model data by the Earth system science community, the climate change impact community and the climate service community". By organizing these schools a considerable number of people from the science community were reached, also young scientists, scientists from other disciplines than climate science and scientists from Eastern Europe. This way also the network was extended.

- Adjust the format of the schools to the on-site or online context

Although virtual schools have some disadvantages (less personal contact, less options for networking), they also have some advantages (easier to record the meetings and look back, some people can participate in a virtual school, whereas they would not have been able to participate in a school at location due to their work schedule, costs for traveling). In general, the Impact schools and Data school were evaluated very positively. We believe that the fact that also the virtual Impact schools were evaluated positively, was also due to the fact that we adjusted the set-up of the schools. A similar set-up of five full days online probably would not have worked.

- More focus on application of the offered information

In both the Data school and the Impact schools participants indicated that they would have liked to have more practical exercises. It is always difficult to balance between providing sufficient background information (especially through lectures; some people also asked for more information on specific subjects) and hands-on exercises. This is also difficult due to the differences in background of the participants. To overcome this problem information can be offered on specific subjects before a course, as was done during the impact schools or afterwards by offering a list of documents, videos, etc. for "more reading". It may be useful to have short (online) sessions to discuss this additional information and to answer questions.

- One school is often not enough to learn how to apply the offered information.

As the participants indicated, they would have liked to have more hands-on exercises, probably because they felt that they did not have enough knowledge/experience applying all the knowledge. This can be overcome partly with more exercises during the schools, but probably it is important to have follow-up support and activities too. Based on the feedback of the participants of the Impact schools we organized additional webinars or short workshops (on bias-adjustments and the ESMValTool, and on CDO and ICCLIM) and we organized a session at the EGU. Several of the participants also participated in these activities.

- Important that the participants create a network with different disciplines

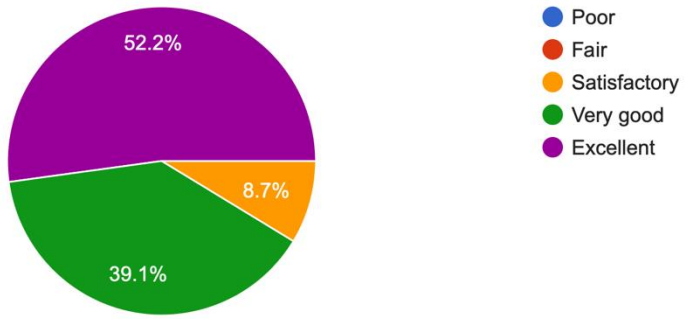
In both schools it was emphasized that people often need different expertises, e.g. for a good climate change impact study, expertise on climate data and impact modeling is needed. These expertises are often not found within one person. For communication between expertises it is important that people have at least some knowledge of each other's disciplines. Schools such as the ones organized for IS-ENES3 may help with this.

Annex 1: Results of the evaluation of the Data School

(Blank responses or responses containing only symbols (e.g. "–") were removed for clarity.)

What is your overall rating for the quality of the School?

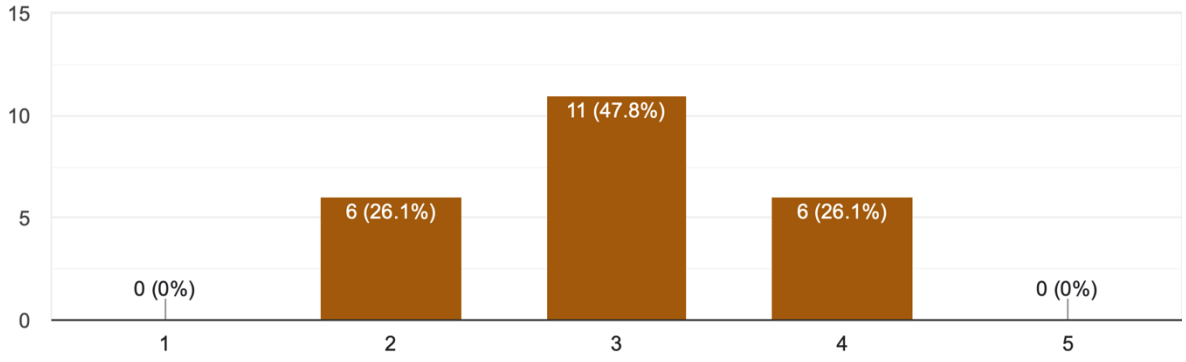
23 responses



Contribution to learning

The Summer School was:

23 responses



(1: too easy for me – 5: too difficult for me)

Please rate the quality of the lectures offered

What aspects of this course were most useful or valuable?19 responses

1. Networking
2. Social talks
3. Data engineering by Dr Stephen are very helpful
4. The use cases were very informative and gave me a lot of ideas using machine learning and deep learning techniques to develop better model predictions for climate modeling.
5. point of view on many different subjects. Meeting new scientists and people
6. The data engineering and climate sessions were very useful and brought many new things to me

7. I appriciated the python notebooks, because this language was new to me.
8. Machine Learning cases of uses in climate sciences.
9. Practical application with prof. Kindermann
10. Data engineering: parallelizing methods
11. Personally data engineering tools were the most useful, because I can apply this during my climate research. Also machine learning seems very interesting, though I am not entirely sure we can use this in my institution.
12. Showing examples
13. Data Engineering
14. Scripts availability; Access to talkers like Christian Pagé.
15. The projects for workgroups.
16. The working groups, as the fastest learning for me was made at those moments.
17. The notebooks released
18. It was really interesting working with big volume of climate data.

Was anything missing from this Summer School that you had expected to learn?

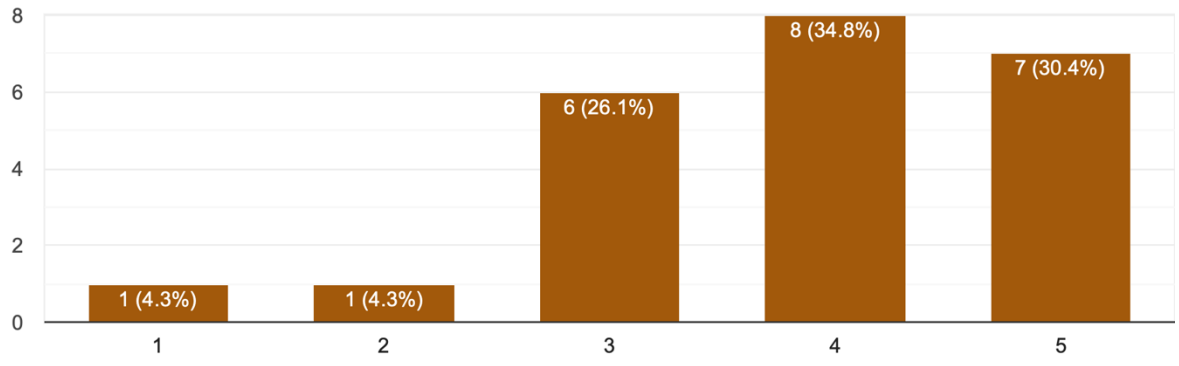
18 responses

1. Nope
2. Practice of applying deep learning, we just had only theoretical lecture, it would have been better if coding session or some sample notebooks on how to apply deep learning on climate could have been provided
3. I would want an intro with the basic concepts of climate modeling, not just an overview of models and tools to lay the grounds much smoother.
4. Climate data processing
5. Showing practical use of ML on some small problem so students can try it during class
6. I was hoping for a more hands-on approach on the ML/DL part, with stronger focus on the Deep Learning (which was almost non-existent). Nevertheless, the school was great and if a new one with a scope laser focused on DL would be offered I'd definitely apply
7. Some more use-cases about the neural networks and some exercises to practise
8. More Deep Learning structures in relation with climate.
9. I hoped to learn more about machine learning models that are in particular useful for climate modelling (I found the class on machine learning good but too general and basic). Also, I expected to dedicate more time to case studies on AI for climate and the team project itself. I guess that needing such long introductions to the basics of both climate and AI was a consequence of putting interdisciplinary people together with very different backgrounds. However, as a researcher who works already on AI for climate modelling, I would not have needed these introductions and I would have been interested in digging a bit deeper instead. Maybe these introductory courses can be recorded and offered as preparation with a test for the next edition of the summer school? This would level up the knowledge before the school and leave more time to actually develop projects and dive deeper into the topic during the summer school itself. Moreover, the data preprocessing lecture was very well prepared (in terms of all the scripts the professors developed) but the material was too much and the class went too fast in order to follow it. Receiving these scripts beforehand would also have been useful.

10. Practical application with prof. Giannakopoulos
11. State-of-the-art ML techniques, such as explainable AI techniques.
12. I missed a little bit more hands-on in data enginering. Like small tasks to perform on different level to try these libraries personally. In group work our task did not cover those packages I was interested and however, I am grateful for the ready example notebooks, it will take time trying and understanding all.
13. More practical task by tutors
14. Practice more Tools for actual climate data analysis
15. More AI applied to climate (yet, there are very few experts on that domain)
16. The speakers could have covered fewer topics, but more detailed and practical examples.
17. Some time expended on trying any Machine Learning algorithms on a climate case of use
18. Nothing, it meet my expectations

How would you rate your experience in the working groups?

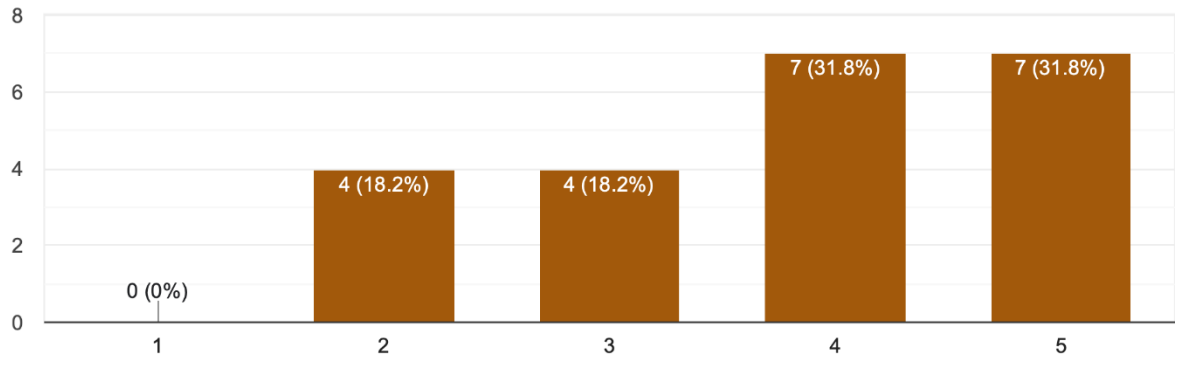
23 responses



(1: poor, 5: excellent)

How would you rate the technical support you received when implementing the group exercises?

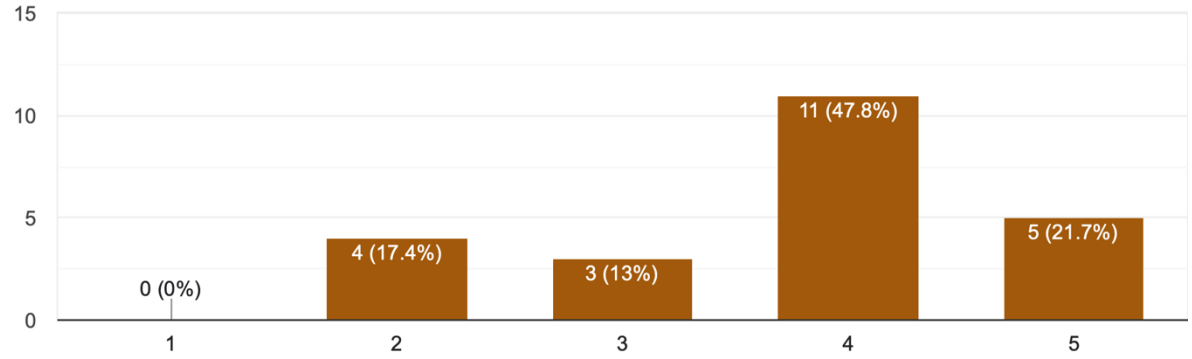
22 responses



(1: poor, 5: excellent)

How would you rate the quality of the keynote sessions ?

23 responses



(1: poor, 5: excellent)

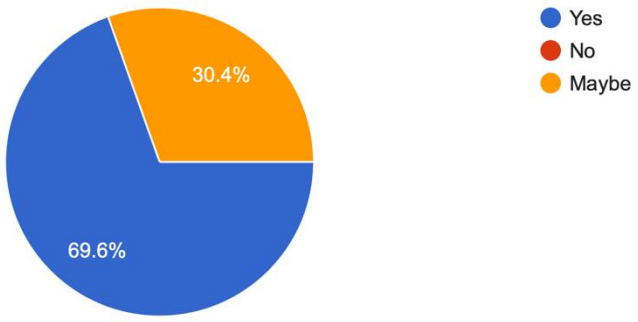
Do you have any comments or feedback about the keynote sessions ? 14 responses

1. –
2. Boring
3. Excellent keynotes
4. Very Informative

5. No
6. None.
7. I would shift them all to the first days and leave more time for group work by the end of the summer school.
8. After the whole day of classes and application, the general attention was low. Maybe better change the schedule.
9. The EGI presentation was one of the most interesting for me to see how esgf server system work. Other was O'Sullivan's presentation about different aspects of AI. Thanks for them!
10. With regard to Open Access, it might also be important to talk about academic freedom. Especially with specific reference to the current police incidents in the universities.
11. Nope
12. Thank you for the talkers! I enjoyed the session about Open Science. But I would expect topics directly related to climate.
13. The lack of interactivity with the students made them a little heavy and boring.

Do you expect to use the things you have learned in the next 6 months?

23 responses



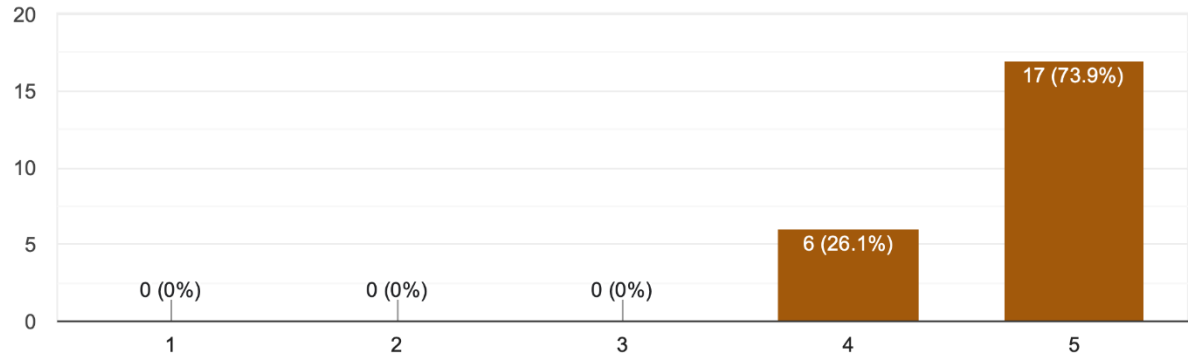
Do you have any advice for us on how to improve the school ?

16 responses

1. Tables on the outside space! Remove keynotes and make the projects more in depth with more technical supervisors
2. Practice or sample notebooks should have been there, may be you can organise a school just focusing on deep learning with use cases and students can learn and apply for their own use cases
3. I would suggest that we should select the subject/project first and then the groups will be formed according to it, always having a variety of people in each one. An other suggestion that I think it might be useful has to do with the machine learning in its project. I think it should be as an equal part as the climate modeling and not a optional quest.
4. Some more small exercises to practice your newly learned skills
5. None.

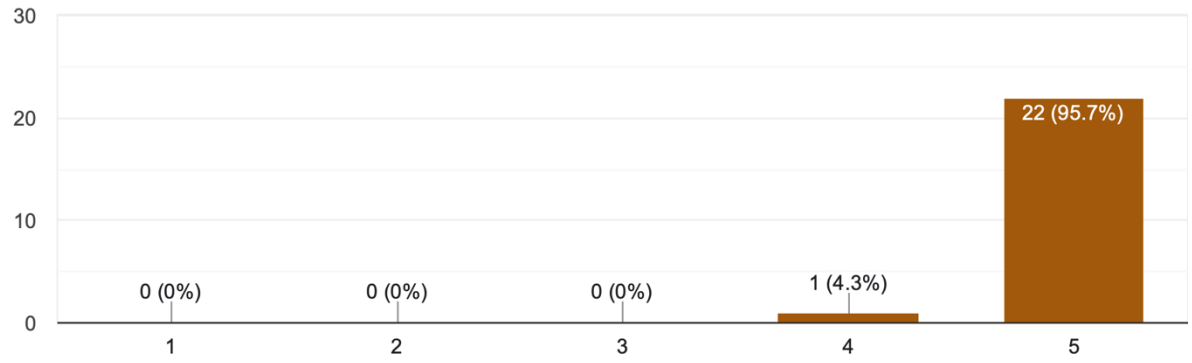
6. Random work groups can be problematic, in particular, if the participants have such a broad range of backgrounds and levels. For the tasks we received, it would be important to make sure that in each group at least 3/5 people code regularly, at least 3/5 people have some knowledge related to climate, and balance out genders and ages.
7. Increase practical application with ML methods, not just focus on the theoretical part.
8. Instead of predefined working-group topics, I would leave time for brain-storming. I understand the complexity of gathering people with different background and experience. However, this could also be a source of potential for interesting future studies and collaborations.
9. Maybe just to have personal hands-on as well. I am aware that it is very difficult to organise that for many persons, but it would be really useful for those, not having much experience with different techniques. Sometimes it was difficult to follow scripts and methods and I got lost in them, despite of being very interested. Thought I would like to emphesize that it is great thing being able to download scripts and examples, so we can check it later in our on tempo.
10. I expected more practice during labs by tutors especially related to ML.
11. It is important to have not only a diverse spectrum of participants but also of lecturers. There was only one woman and no People of Color. For me as a woman this is really discouraging .
12. Keep doing the goid job
13. The organization team did a great job! My only suggestion is for the Professors team, they could approach less topics, but with more details and practical activities. We had no guidance for doing the final challenge. Besides, I would expect a professor team compund by 50% male and 50% female professionals.
14. Not substantial advice. The general structure of the summer school was very nice, only some little changes on the keynotes sessions would be needed in my opinion (more interactive maybe...)
15. I would suggest to add notebooks related to the Deep Learning/Machine Learning techniques part, so to apply directly the theoretical concepts discussed during the lectures to real case studies
16. Everything was well organized. The only thing I would recommend is adding a transportation from the hotel (or a close location) to the school and back. That would have free more time for the participants to walk around the city, enjoy the breakfast etc

How would you rate the support provided by the organisational team before and during the school (level of information provided before the start of t... with travel, information given during the school)?
23 responses



(1: poor, 5: excellent)

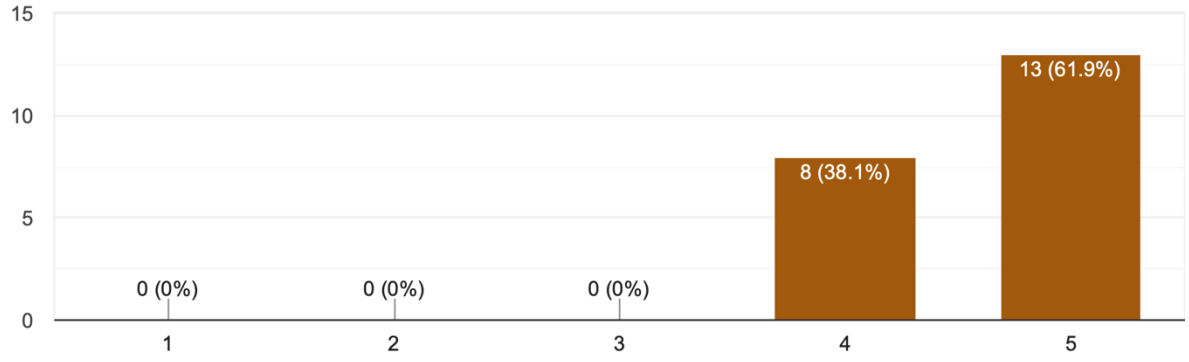
How would you rate the catering (breakfast, coffee breaks, lunch) ?
23 responses



(1: poor, 5: excellent)

How would you rate the choice of accommodation provided?

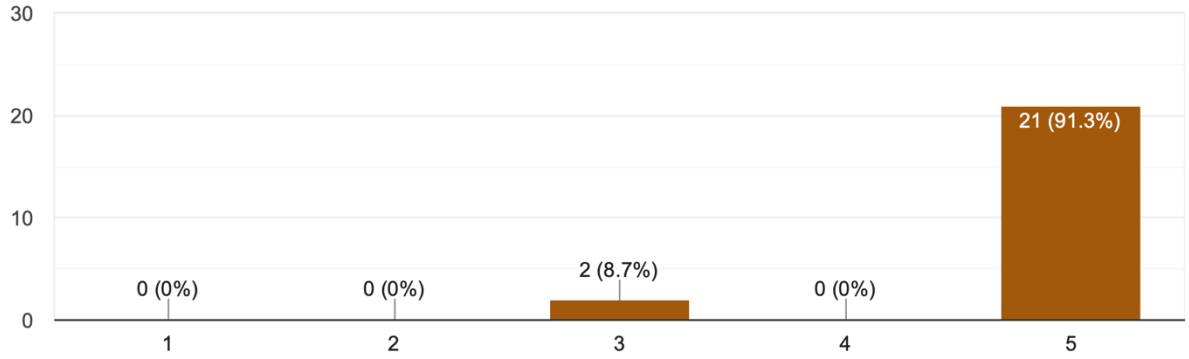
21 responses



(1: poor, 5: excellent)

How would you rate the Saturday evening social event ?

23 responses



(1: poor, 5: excellent)

Do you have any final comments for the organisers ? 19 responses

1. Thanks
2. The logistics were great, nice hotel although far from demokritos, Saturday evening was good, teachers were also good, maybe next time organise a school for applying deep learning on climate use cases
3. It was a very informative and productive week for all of us and I hope to collaborate with you again.

4. Transport from and to Demokritos could be made easier if there was a minivan or a bus, because lots of hours and energy are spent on transportation, especially during rush hours. Two more days would help, so the courses wouldn't last too many hours during the day.
5. Social events and catering were perfect!!! Thank you for organising such beautiful and good summer school!
6. Everything was great, but the commuting from hotel to institute was a bit long (>45 min)
7. Thank you! I am so grateful for all the experiences I had during the summer school.
8. None, the work carried out by the organisers was amazing.
9. Amazing organisation! Super friendly and helpful organisers and catering people! This absolutely exceeded my expectations! The only issue I was a bit sad about was the fact that I could not stay at the hotel for the last night and had to book a separate accommodation to later find out that many participants were actually offered that option...
10. Great job!
11. Thank you for the opportunity for taking part in the summer school! I really enjoyed it and organisation was great!
12. Thank you very much! :)
13. It would have been nice to get to know the institute a bit better, f.ex. with a guided tour at the first day.
14. amazing organization and best food ever
15. Thank you everyone! You were really organized!
16. Hotel reservation only until the last day of the programme caused some problems due to a lack of flights back in the evening of the same day.
17. In my opinion, a factor that made this summer school great was the cool vibe among the students, so as long as you stimulate the friendship and interaction among us (students), you'll succeed!
18. Ohh, I answered that to the previous section.