Impact Case Study: Strengthening scientific capacity for African climate science through the LaunchPAD project

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Country / Region:	Pan-African
Project or Programme:	Model Evaluation Hub LaunchPAD
Relevant Area of Change[1]	2. Strengthening scientists' capacities (and 1. Enhancing scientific knowledge).

Type/purpose of case / story *(Please note that more than one box may be marked if relevant)*	**Learning**	x
	Illustrative	
	Comparative	
	Representative	

Introduction (suggested 10%)

Key message: The LaunchPAD project has strengthened scientific capacity for African climate science research, through building a team of scientists from multiple regions and career stages (i), who are working on both scientific and technical development (ii); and adapting approaches to foster remote collaboration during the Covid-19 pandemic (iii).

Aim of the project: LaunchPAD is the first phase of the Climate Model Evaluation Hub for Africa. The aim of LaunchPAD is to develop climate model evaluation tools focusing on processes which matter in African regions, which can be automated to run across models. These tools will substantially improve understanding of how climate models represent Africa. This understanding is fundamental to support further improvement of models over Africa, and to inform the use of climate model data in adaptation planning. The project therefore addresses vital scientific and technical developments which are needed in order to improve the credibility of future climate information.

[1] FCFAs Areas of Change are:

1. Enhancing scientific knowledge and prediction of African climate and new understanding of the resulting impact on the robustness of future climate change scenarios.
2. Strengthening scientists' capacities to develop decision-relevant climate information.
3. Increasing the capacities of users/decision making bodies/institutions to appropriately integrate climate information within medium-term decision-making.
4. Approaches that support co-production of decision-relevant climate information and enable channels for on-going dialogue between the providers and users of climate information.
5. Identifying social, political, behavioural and economic barriers to the use of climate information in long-term decision-making, working to elicit solutions which support effective integration of climate risks within decision making across scales, sectors and social groups.
6. Approaches to climate science research and climate-sensitive risks within medium-term decision making which enable active participation and address of the specific concerns of women and marginalised groups.

The LaunchPAD approach: To achieve the goals of LaunchPAD, it was important to bring together expertise in African climate systems, knowledge of climate models and climate model evaluation, and experience in software development. This was achieved by building a team of climate model evaluation experts from the UK (including University of Oxford (UOx) and the UK Met Office (UKMO)) and scientists from Central, West, East, and southern Africa, as well as hiring a dedicated scientific programmer. Since substantial scientific analysis is required to design evaluation tools which capture representation of key processes, 10 early career "fellows" were recruited in African regions, to work with an experienced scientist (Co-Investigator) in their own institution. To facilitate collaboration between the teams, two workshops were planned, as well as a one-month secondment for fellows to the UK.

The baseline: Prior to LaunchPAD, the 5 teams in African universities were conducting important research of regional climate systems, and some had already been working to evaluate climate models through the IMPALA project or the CORDEX programme, or running their own experiments with regional models. Several of the team members were also involved in weather or seasonal forecasting and related research. Therefore, the teams had strong regional climate expertise, and some experience with weather and climate models. However, accessing and analysing the global climate models most commonly used for future projections was challenging due to the size of the datasets, and therefore most had limited experience with these datasets. The 10 fellows were at a range of career stages, from new masters students to postdoctoral researchers, with a range of scientific and technical experience. There was also variation between the African universities, and the fellows, in terms of access to computing, internet, publications, and international networks. The UK teams in UOx and UKMO had begun working with several of the African team members during the IMPALA project, and were eager to deepen the collaborations and follow through upon promising scientific and technical progress that had begun during IMPALA. The team members were also eager to embed their analysis of African climate systems into automated evaluation systems, to be routinely deployed during model development. This had proved challenging previously, due to the level of programming experience and time needed.

The influence of Covid-19: The pandemic created many challenges for the team. Working from home, many team members had reduced access to suitable computers, internet, or library services. Some had additional responsibilities to balance with work, for example childcare and farmwork. Power cuts in suburbs or rural locations further interrupted home working for some. Several team members faced short-term illness during this time, including malaria associated with moving to rural locations.

Adapting the LaunchPAD approach: To address these challenges, the LaunchPAD project was extended through support from FCDO and SouthSouthNorth (SSN). With travel restricted, some travel funding was used to extend staff time, and to support home working, primarily through direct support for internet connections (through data bundles or subscriptions). New platforms were set up for online collaboration, including on Microsoft Teams, GitHub, and Whatsapp. With the secondments postponed, the emphasis was shifted to online collaboration, including a "virtual secondment" made up of 3 day working meetings, "ask me anything" afternoons, online science presentations, "drop-ins", and a writing group.

Referring to the FCFA Theory of Change, this case study aligns with Output 4 and Impact Pathway 2.

The change story (suggested 30%)

LaunchPAD has made great progress in developing scientific understanding of how models represent African climate systems, and in generating model evaluation tools. In the process, scientific capacity has developed within the team. There are three aspects of the LaunchPAD approach which we believe have been key to successful scientific capacity development (SCD) and here we address each of these in turn.

(i) Building a pan-African team.

Many of the team members had worked in international projects before, however, it had often been the case that only one team member had been invited from each institution, or they had been invited to participate in a sub-section of the project, or for a limited period. In addition, it was rare to see a project which brought together researchers from multiple African regions. In LaunchPAD, the five teams from African universities (each with a

Co-I and fellows), are at the core of the project. This allows for learning between different career stages within each institution, and across institutions, and regions. This has enhanced understanding of pan-African climate processes (see Figure 1).

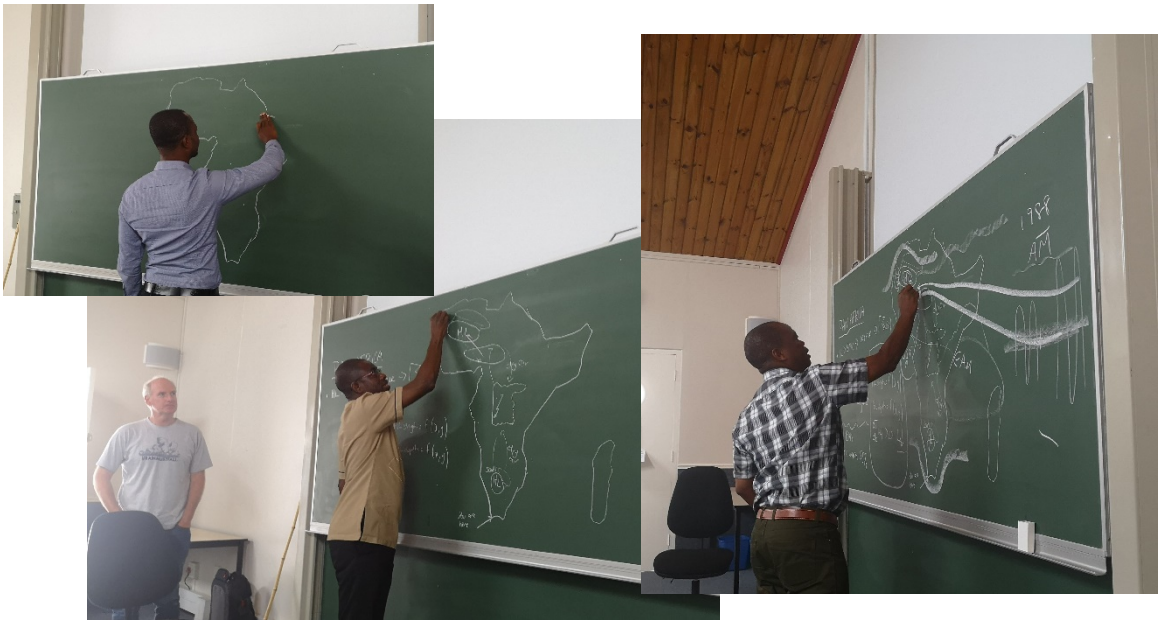

Figure 1. Photos from Cape Town workshop: Experts from different regions discuss how regional climate processes interact, building up an understanding of pan-African climate on the blackboard.

SCD has also been maximised for the 10 fellows, who each have their own research project, and are supported not only by the Co-I in their own institution, but also through collaboration with team members from other institutions, including more senior researchers and peers (Figure 2). This is informal in some cases, and more formalised in others (for example the Co-I from Yaounde is a co-author on a paper with a fellow from Cape Town, and we expect to see more such joint publications). The fellows are themselves at a range of career stages, enhancing peer-to-peer learning. In February 2020, this collaboration was bolstered through a 2-day informal session for fellows ahead of the 3-day workshop, allowing the fellows to get to know each other, and to work with the scientific programmer and early career researchers from the UK (Figure 3).

Figure 2. Photo from Cape Town workshop: Discussion between researchers at different career stages (senior, postdoc, PhD, MSc), and countries (UK, Kenya).

Figure 3. Photo from Cape Town, February 2020: Researchers from different regions get to know each other by teaching the team how to say "hello" in their language.

The collaborative environment was highlighted by one fellow in an SCD analysis led by SSN: "*I think in the LaunchPAD environment, you can really freely talk to anyone and can call them with their first name and that makes it very comfortable for you to be open".* Although there are likely still challenges associated with communicating between career stages, and different working cultures, we believe the relationships developed through the project have already enhanced SCD. Fellows have developed their scientific skills, through working on a research project with support. We have noticed a step up in the scientific analysis being conducted (evidenced in scientific presentations during September), and already, 1 has finished a draft for a scientific paper, and 2 have written masters theses. By getting to know each fellow individually, and building trust and more open communication over time, it has been easier for us (as Coordination Lead and more senior researchers in the project), to identify their support needs. Often, different fellows need support for different things: for example, one might need a data top-up because they are working from home, one might need some advice about how to analyse extreme rainfall events, one might need help downloading data, one might like a second opinion about their write up. This has also been a learning experience for the UK researchers: learning how to supervise, learning about the kind of support that is needed, and where things are less useful. One researcher said: "I have learned a lot about how to support the fellows along the way, [they] have been great teachers in that respect".

(ii) Bringing together scientific and technical development.

The goals of LaunchPAD required both new scientific research and new software tools. This also allowed for enhanced SCD, in that the fellows were able to develop technical skills in the process of their core research. By employing a scientific programmer to work with the fellows, the fellows were able to learn new skills, but at the same time the barriers to their engagement were reduced.

The final evaluation tools are written in python (a programming language) and iris (a set of python libraries), to be included in a GitHub repository, able to run across CMIP6 models (approximately 40 global climate models), and to be included in the Met Office AutoAssess system. These systems were developed and managed by the scientific programmer, with support from the research associate at UOx. The evaluation tools are based on the fellows' scientific analyses and their code. 8 of 10 fellows now have a diagnostic in the GitHub repository (and others are continuing to work on this). The suggested requirement from fellows was to analyse a subset of approximately 5 CMIP6 models, and to organise their code (in any programming language), and explain it to the programmer, who would then translate it (if necessary) and automate it.

However, the fellows also had the option to write in python, and to work with iris, GitHub and auto-assess. This flexible approach allowed all the fellows to advance their technical skills at different levels. SSN's SCD analyses suggested that this was appreciated, for example one fellow noted that they had not worked with python yet, but would learn it during the course of the project "*I definitely do want to learn it though, because I think it's really useful and it's widely used".* One of the unexpected outcomes of the process was that, whilst fellows might not have previous experience with the specific tools which we were using to develop the tools, several had other programming experience which was useful (for example from web design), and there is great potential for peer-to-peer learning (Figure 4). There was also a great deal of collaboration as we all learned to use a new server (JASMIN), and fellows and the Oxford team worked together to identify and download datasets for each fellow's project.

Figure 4. Photo from Cape Town, February 2020: Fellows from South Africa and Ghana discuss their code.

(iii) Fostering remote collaboration.

In March 2020, as the UK went into lockdown, we were forced to cancel the secondments to the UK (originally planned for April-May) and move collaboration online. After trying out various options (Figure 5), we set up a workspace on Microsoft Teams, and GitHub.

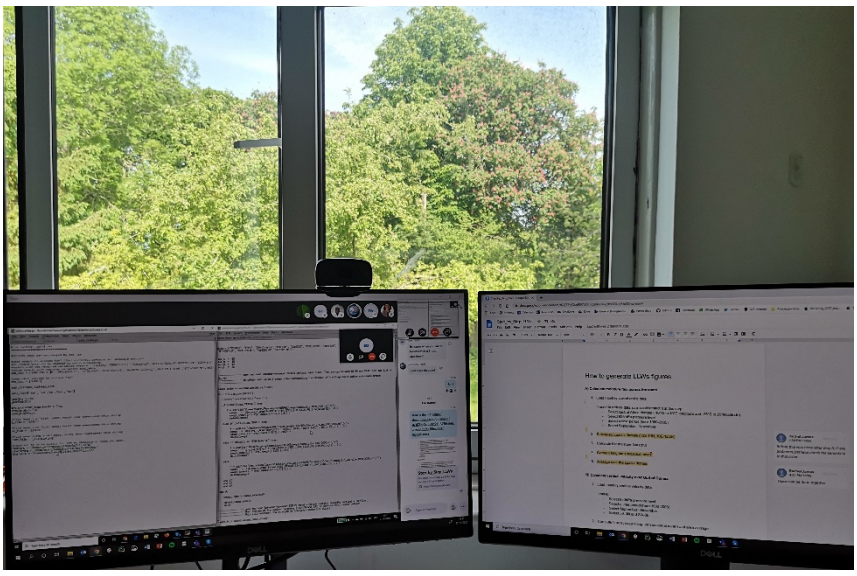

Figure 5. Early efforts to work together online during UK Spring: A skype call between the Oxford and Yaounde teams, where the software developer shares a screenshot comparing the fellows original code, with the new version designed to run across models. Meanwhile, the documentation is being updated in google docs.

This was not our first experience of engaging online, as we had already been meeting virtually. However, we had been relying on the in-person interactions for the most productive collaboration. When this option was taken away, we invested more time and resources in improving online modes of communication and data analysis, with great success. By directly funding internet connections, trying different web-calling software, and allowing more time for online meetings, we noticed a substantial improvement in our ability to communicate online (it was much more likely that everyone was able to connect and to hear each other). Part of this process was troubleshooting the challenges associated with web calls and access to online tools. As evidenced in the SSN SCD survey results from February 2020 (Figure 6), there are quite a number of obstacles associated with online working including hardware, internet reliability, latency, and power cuts. Previously, when someone was not able to connect to a call we were not sure which of these was the barrier. Now, we have a much better idea of what is the problem and how to solve it. Also, it became normal to communicate more frequently and casually especially on a platform where we could return to conversations, and files could be shared (Teams). We could have multiple work streams on the go with fellows and this meant we were able to finish some pieces of work to a deadline because we could keep updating each other even with some significant time differences (for example between UK and Kenya).

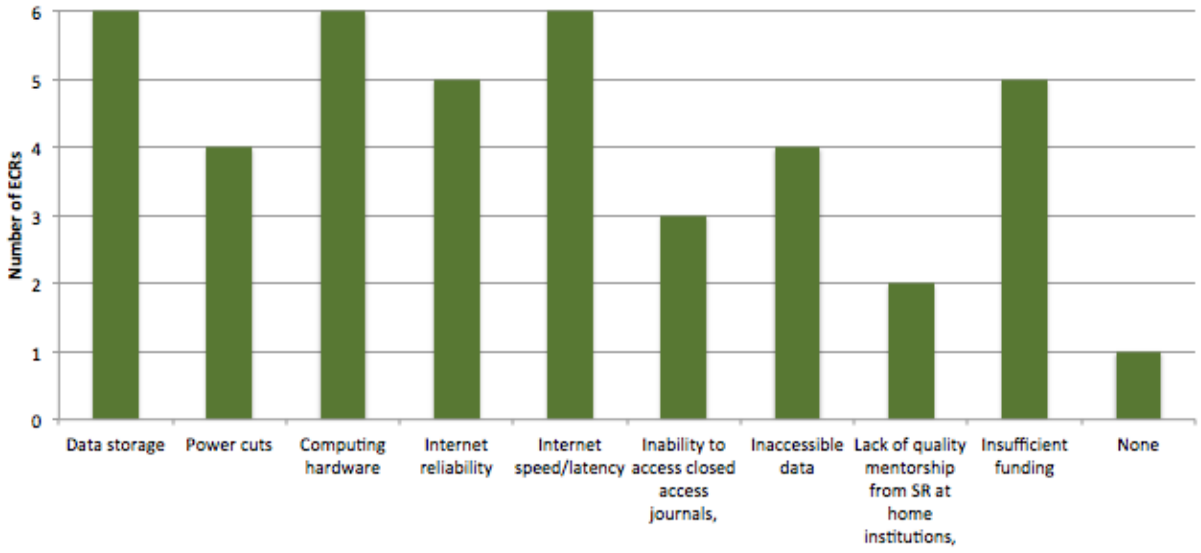

Figure 6. Data from the LaunchPAD SSN SCD survey: Barriers that hindered the fellows' ability to work on LaunchPAD activities (n=10). (Note: They had the option to select multiple responses.)

We were also able to improve access to JASMIN, a UK data cluster, which we have used to enable access to and analysis of the large CMIP6 datasets. In the SSN SCD analysis, this was one of the technical aspects where fellows identified the least experience (Figure 7). By February 2020, all of the fellows had succeeded in accessing JASMIN, however, it was still quite challenging to use, as one fellow politely noted "*So the experience that I have with JASMIN is that the procedure is a bit complex.*". Troubleshooting was useful to identify specific challenges. Unfortunately one of the challenges identified was that the servers themselves were undergoing a lot of updates and disruptions due to Covid-19, and so it is still not a completely smooth process, but much more well understood.

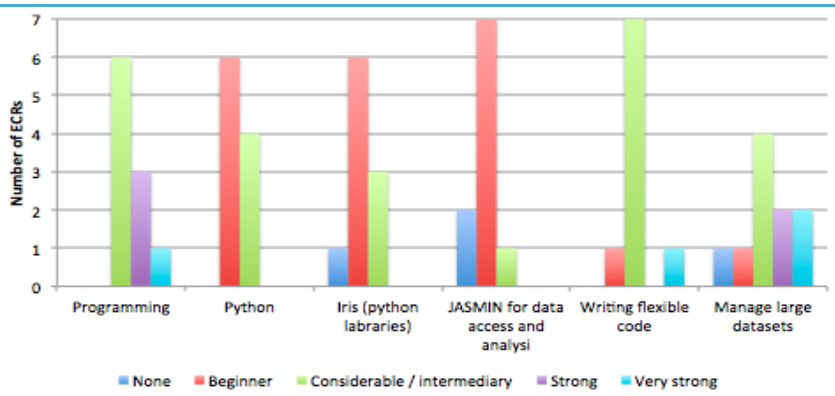

Figure 7. Data from the LaunchPAD SSN SCD survey: The computing skills of the fellows (n=10).

Analysis (suggested 30%)

In analysing the impacts of these changes, we will again focus on the three aspects of the approach.

(i) Building a pan-African team.

The benefits of the collaboration vary between team members. The SSN SCD survey demonstrates that, near the beginning of the project, there was variation between fellows in their estimated skill levels (Figure 8). The more junior fellows perhaps have the most to gain, particularly in terms of access to data, support, and international networks.

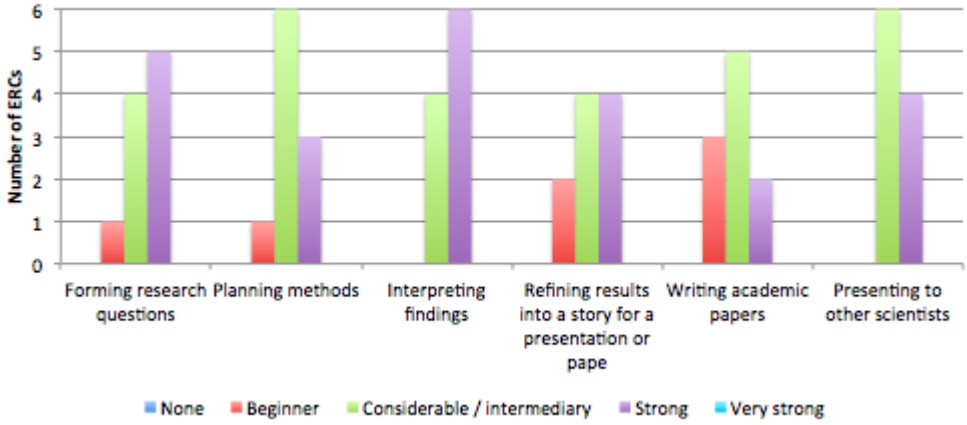

Figure 8. Data from the LaunchPAD SSN SCD survey: The scientific skills of the fellows (n=10).

We believe that all team members will now be much more well equipped for their next career stage, for example some are preparing to apply for PhDs or postdocs. The Coordination Lead was able to secure a permanent academic position drawing on experience from LaunchPAD, and one of the Co-Is now leads the CORDEX Africa analysis groups. One of the fellows secured a prestigious FLAIR fellowship, and has been an IPCC author. We have all learnt valuable lessons for future collaborative projects, and hope to sustain the collaboration within our team, including by seeking funding for “phase 2” of the Climate Model Evaluation Hub. Our learning is largely attributable to the LaunchPAD project, including the extension, and also benefited from existing collaboration through IMPALA and also the CORDEX regional analysis groups (which several team members are engaged in).

(ii) Bringing together scientific and technical development.

There is variation between team members as to their technical development during the project, depending on the baseline. It is worth highlighting that the scientific programmer also learnt more about how to evaluate climate models. The hope is that all of the scientists will take lessons for how to organise and share their code, and will have learnt to use tools they can apply in future projects (python, JASMIN).

(iii) Fostering remote collaboration.

The value of support to work online was again variable between the team members. Covid-19 had differential impacts due to the differences in severity of the outbreak between countries, and variation in personal access to internet, or barriers to internet connection in different places, as well as personal family circumstances. In general, Covid-19 appears to have imposed the greatest barriers on the more junior members of the team, and we hope that they have therefore benefited the most from the additional support, although the impacts of the pandemic cannot be mitigated entirely. Although the negative repercussions of Covid-19 will be felt for years to come, we also all have improved our experience and ability to collaborate online. In future projects, we will no longer wait to meet in person to work together. This will address one of the challenges raised in the SSN SCD survey, where a senior researcher noted: "*There have been gaps in our communication and then I discover later that there's a problem and it's just kind of dragging for a long time because we haven't been talking*". The ability to communicate more freely and frequently online will hopefully avoid this situation in future. This change is in large part attributable to LaunchPAD, and particularly the flexibility from FCDO and SSN to extend the project. It was additionally benefited by other means of support (for example University of Cape Town provided students with data bundles). Finally, it is important to mention that the success of the project during Covid-19 is also attributable to the dedication and determination of the team members, who have achieved a great deal under difficult circumstances.

Learning (suggested 30%)

There are some useful lessons here for future research programmes.

1. **Including African Early Career Researchers (ECRs) in the core of the research team, for as long as possible, has great potential to enhance SCD.** In the UK, we train researchers through research masters, PhDs, and postdocs, with long-term supervision, and support and training that varies depending on their individual needs. This is arguably the aim of many research degrees in African universities as well, however, sometimes the resources to provide that support are more limited. It was extremely beneficial therefore that the LaunchPAD project, and the funding from FCDO, allowed us to support fellows over more than a year (and in some cases the collaboration was continuing from IMPALA). There is perhaps a shift in emphasis here from "capacity development" whereby the training of African scientists is sometimes separated from the core research objectives, to "diversity and inclusion" whereby African ECRs are included in all the aspects of the research. This was also enhanced by encouraging each ECR to pick their own research topic, which allowed for more autonomy, development of skills in research design, and it also meant that for some fellows it as possible to integrate the work with their research degree. We have seen the benefits of this approach and would encourage donors to continue supporting the inclusion of African ECRs in the core of research consortia.
2. **Building capacity of groups has potential for greater benefit than focusing on individuals.** The LaunchPAD project included teams from each African institution, including Co-Is and fellows. This approach had many benefits. The experienced researchers benefit because they play an important leadership role in the project, build their research groups, and they also don't have to commit to deliverables they might not have time to work on. The more junior researchers conduct the bulk of the research, and they get more support to develop their skills and careers. We hope this will lead to stronger groups in each institution, with stronger connections internationally and with other African

regions. We would encourage donors to continue supporting the inclusion of teams, and considering research groups (as well as individuals) in capacity development efforts.

3. **Postdoctoral researchers can play an important role in SCD for more junior scientists.** We have found that there has been great potential for postdocs/more senior ECRs to support junior scientists, in part because they have more time available than Co-Is, and in part because it can be easier to build an informal relationship. This was enhanced by our 2 day "pre-workshop" informal session in Cape Town, and later has been continued online. This kind of support often happens informally in large labs and research groups within institutions, and we have found it to also be beneficial between institutions. Future funding calls could advocate an explicit role for more senior ECRs (postdocs) to support more junior ECRs, and explicit mechanisms to facilitate this (e.g. funding to meet together and work together in the same room, working together online).
4. **Embedding software development within a science project has potential to improve technical skills.** When technical capacity development is discussed, there is often an emphasis on training workshops. We have found more progress through technical training that is embedded within the project deliverables and science projects. We did have one isolated training workshop (on an evaluation system called "ESMValTool"), and this does not appear to have been used since. However, for the tools which we are directly using for the project (GitHub, JASMIN), we have seen much greater development, because training has been put into practice. Future funding calls could highlight that technical training workshops are more valuable if they are linked to specific scientific or technical objectives, so that skills can be put into practice with continuing support (particularly the opportunity to work through questions and issues as and when they come up). They could also highlight the value of technical outputs alongside scientific (for example a GitHub repo published alongside a paper). There is also potential benefit from engaging scientific programmers/research software engineers in climate science research. Currently it is quite hard to recruit people with appropriate expertise, because their skills are highly renumerated within tech industries. Efforts to highlight their value and also to allow for their salaries to be supported would be a step in the right direction (and we are grateful that this has already been supported within LaunchPAD).
5. **Investing time and funding into remote collaboration and working environments is good value for money.** Our progress in connecting online has demonstrated the value of investing time to persevere with remote collaborations. The funding invested in supporting internet connections was also extremely good value for money (and a relatively small investment). Working online also forced us to confront some of the challenges that researchers experience in different contexts, which may not have been unique to the pandemic, but which we are not usually aware of. In particular, when troubleshooting issues associated with working from home, it became clear that some of the issues were associated with very slow-running personal computers and power cuts. In future, it would be very helpful (and excellent value for money) to be able to use funding to support hardware (personal computers) and other infrastructure (for example some of the more senior colleagues and universities use back up generators, and it may be worthwhile to fund these in other places too).