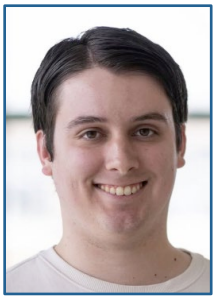
PERSPECTIVES ON EARLY CAREER AND HIGH-LEVEL TRAINING FOR CLIMATE AND ENVIRONMENTAL CHALLENGES

SUMMARY: An interview between an early career researcher and two professionals about their thoughts and perspectives on the challenges associated with climate, the environment, and education.





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In recent years, many new challenges have developed with the progression of climate change. One such challenge has been navigating how we, as scientists, can adjust our research and training to consider the importance of the environment. Whether we are looking at the reagents we chose for our experiments, or simply the energy needed to power our research, there are always potential environmental impacts that should be considered, no matter the scientific discipline. One of the best ways to address these challenges is to stay educated and be aware of our environmental footprint, and to take measures to reduce our impact whenever possible – this all starts with training.

As early career professionals, it is helpful to be aware of how researchers are adjusting their perspectives toward science, training, and student development. Speaking directly with experts in the field allows students to learn about the shift in thinking that is required to address challenges related to climate change and to be successful in their careers.

In this interview, an early career researcher (Jake Breen) spoke directly with two professionals (Dr. Rachel Chang, a professor of atmospheric science, and Dr. Kris Poduska, a professor of physics) about their thoughts and perspectives on dealing with the challenges associated with climate and the environment. The interview addresses how they deal with these challenges directly in their research, how they have shifted their training of new students, the importance of collaboration, and what steps

you, as the reader, can take to make positive changes in the world. Photo highlights from their field work are shown in Figs. 1-4.

THE INTERVIEW – QUESTIONS AND ANSWERS

TOPIC ONE – ADJUSTING OUR RESEARCH

1 - How do you deal with complicated systems involving many variables that are common in climate / environment research?

Rachel Chang: *One helpful way to think about this is to realize that none of our findings are "the truth", because the conditions are always varying and we cannot constrain every parameter. However, our research can still help us understand a part of our environment, such as which parts of the parameter space are more important.*

Kris Poduska: *Sometimes, it can be helpful to look at simpler "toy models" that are trying to capture what the most important variables are in a given experiment, simulation, or model. That being said, I think that some of the most interesting and challenging research questions arise when lab experiments or simulations fail to capture what happens in real-life.*

2 - Geographic location is important in climate-based research. How does location influence the type of research and/or which research projects you get involved with?

Rachel Chang: *It's fascinating when unique processes occur in the location that you study. For example, I am really interested in how aerosols affect cloud droplet formation, and when I started my research career at Dalhousie, I took advantage of the prevalent fog in Halifax to study aerosol-droplet interactions. The challenge, however, is determining whether the insight that we learn about our location can be extended to other locations.*

Kris Poduska: *I used to brag that I could do my research (hard condensed matter) in a basement lab anywhere in the world! However, now that I am intentionally focusing on climate change mitigation work, local and regional relevance has become very important to me. With field work, each location functions like a different lab; travel is often interesting, but it changes the type and scope of work that can be done, and collecting data in the field often comes with an intense timeline.*

3 - How do you bridge research in the field with lab and/or modelling work?

Rachel Chang: *Field observations can sometimes differ significantly from model simulations. When this happens, it usually reveals a process (or processes) that was not sufficiently represented in models, suggesting that there was a gap in our understanding. Inputs and processes in the models can then be added or adjusted to better understand the processes that led to the observed phenomena, thus advancing the science. Similarly, control experiments in the laboratory can be used to constrain exact parameters used to represent a process in models.*



Figure 1. Dr. Rachel Chang and team working in the field. Photo provided by Rachel Chang through MEOPAR.

TOPIC TWO – TRAINING NEW RESEARCHERS

1 - How does your experience in environment / climate research inform how you train new researchers?

Rachel Chang: *Since environmental research is so interdisciplinary, I try to emphasize to new researchers that everyone's perspective can contribute to the field. At the same time, it also means working continuously to broaden everyone's perspectives, myself included, so that we can approach problems from new angles.*

Kris Poduska: *Complex problems – like many that appear in environment/climate research – can seem overwhelming. My strategy for training new researchers focuses on helping people to learn how to coarse grain a problem in order to break it into smaller pieces that are more manageable to address.*

2 - What key skills do you prioritize in training new researchers? What skills / experience do you want your trainees to remember in their future careers?

Rachel Chang: *In our current era of seemingly unlimited data available on the internet, it is really important that new researchers understand the origins of the data that they are working with as well as their limitations. Whether they are working with numbers from observations, model simulations, or*



Figure 2. Dr. Kris Poduska completing field work in Port au Choix, Newfoundland and Labrador.

AI, thinking about the assumptions upon which the calculations are based serves as an important check. Similarly, it is important to think critically about the results from their own analysis and consider whether they are realistic and believable.

Kris Poduska: *I want to train problem solvers! Complex research questions have a lot of details and a large scope, and I think that the physics approach to problem solving – coarse graining a complex problem so that it is more manageable – is a very valuable approach to many different real-life situations.*

3 – Are there any resources you would recommend for new researchers to develop their skills / knowledge of climate and the environment?

Kris Poduska: *Read broadly from trusted sources! One way to get a very broad perspective is to read about the United Nations Sustainable Development Goals, which cover many different topics including climate action, disaster risk reduction, food security, and sustainable cities (https://sdgs.un.org/topics*).

TOPIC THREE – THE VALUE OF DIFFERING PERSPECTIVES

1 - Environment / climate research often involves researchers from a variety of disciplines. How do you combine your expertise in physics to work effectively in interdisciplinary environments?

Kris Poduska: *When I work in teams, I find that I'm most successful when I'm curious and not afraid to ask questions. Physics helped train me to look at the big picture and not to get too bogged down in*



Figure 3. Dr. Rachel Chang at work during a field study. Photo provided by Rachel Chang through MEOPAR.

details that aren't the most important parts of the problem. It's not that the details don't matter, but it's often not practical to consider all factors at the same level of detail.

2- What value have you gained from connecting with researchers who have a different focus, in terms of lab work / field work / modelling?

Rachel Chang: *Here's a specific example of when working with modellers has been super rewarding for me. Our field observations showed that new particle formation (i.e. particle nucleation from gases) occurs frequently in the summer in the Canadian Arctic, but we had no idea what gas was driving the particle formation and growth, nor its source. Our modelling colleagues added new sources and processes into their model and determined that ammonia from bird guano contributed to the new particle formation, and that the particles grow by the condensation of organic vapours originating from geographic regions coinciding with open waters.*



Figure 4. Field work. Photo provided by Dr. Kris Poduska.

3 - How does your background in physics / atmospheric science influence how you approach climate / environment research? What value does the perspective of a physicist / atmospheric scientist add to this field?

Rachel Chang: *The atmosphere is connected to all the other components of the Earth systems (e.g. cryosphere, hydrosphere) and is an important transport pathway for many nutrients and contaminants. As an atmospheric scientist, I bring the perspective that the faster changes that happen in the air can have important impacts on slower-changing parts of the Earth.*

Kris Poduska: *There are so many aspects of physics that are involved in climate and environment research: thermodynamics, energy, waves, condensed matter, phase transitions, soft matter, modelling and simulations. I could keep going! In my opinion, what physics brings to the table is a respect for integrating models with data to aim for predictive power.*

TOPIC FOUR – CLIMATE SCIENCE FOR THE GENERAL PUBLIC

1 - What skills or information from environment / climate research would you teach to the general public, if given the opportunity?

Rachel Chang: *Again, in our current era of seemingly unlimited information available on the internet, it is really important that users understand the origins of the information that they are working with as well as their limitations. It is essential to think critically about the information, considering their sources and the context, and think about whether they are realistic and believable.*

Kris Poduska: *Science literacy and numerical literacy are really important skills. I'd like to help people have the confidence to question how information and numbers are interpreted.*

CONCLUSIONS

The responses from Dr. Poduska and Dr. Chang provide valuable insight into the shift in research perspective that is happening as our environment and climate changes. Through a series of different questions and topics, Poduska and Chang shared the importance of problem solving, simplifying complex ideas, interdisciplinary work, and above all, asking questions. Additionally, they emphasized the necessity of understanding the source of information both in the media and in scientific research, and how this impacts the analysis.