(http://www.ncdc.noaa.gov/snow-and-ice/nesis.php), and according to the RESIS the Jan. 10-11 storm was a category 2 (“significant”).

Severe winter storms garner a lot of attention. From a meteorological point of view, they can be complex and challenging to forecast. From the point of view of city planners, they can be well-anticipated but still overwhelming. And people of any profession can appreciate the beauty of a fresh snowfall, or the annoyance of lingering cold and deep snow. In a national sense, this winter has not been highly unusual, but severe winter weather has still had notable impacts on several U.S. cities.

Interview with Gabriele Hegerl

Hans von Storch

Dr. Gabriele Hegerl, Professor at the University of Edinburgh.

Dr. Gabriele Hegerl is a mathematician by training. She obtained a Ph.D. in applied mathematics, on a topic of numerical fluid dynamics at Ludwig-Maximilians University, Munich in 1992. She worked on detection and attribution of climate change at the Max-Planck Institute for Meteorology in Hamburg to 1997, and then spent two years at the Department of Atmospheric Sciences at the University of Washington, Seattle, US, under a Feodor Lynen Fellowship by the Alexander von Humboldt Association. After research positions at Texas A&M University and Duke University she moved as a reader to the School of GeoSciences, University of Edinburgh in 2007 and was promoted to Chair of Climate System Science in 2009. Gabriele has contributed to the last three Intergovernmental Panel on Climate Change Assessment report, to the last one as Coordinating lead author and member of the summary for policymakers writing team, and is a lead author in the upcoming 5th report. She also serves and served on many research committees (US Climate Research Council, CLIVAR expert teams) and advisory board. She is married and has two sons.

You have "moved" in different ways. Once from mathematics to atmospheric sciences, from Bavaria over to Hamburg, and then from U.S.A. to Scotland. Would you like to comment on these moves? Was is random walking or did you have an agenda?

I have indeed moved a lot although I definitely do not enjoy the process of moving! I applied to the Max-Planck Institute in Hamburg because the research topic of climate change interested me. I studied mathematics in Munich and pursued a Ph.D. there in numerical fluid dynamics. In my free time I had done a lot of hiking and skiing in the mountains, and I was surprised that the glaciers were often quite a bit further up the mountain compared to their position on the relatively old maps my friends and I had rented for our outings. That made me curious about climate change, which was just beginning to be discussed by the general public. And climate models also seemed wonderfully complex applications of numerical fluid dynamics. My time at Max Planck Institute was wonderful, and I never regretted my decision to go there, although it meant to accept a temporary position far from Munich rather than a permanent position in Munich. I applied fingerprint methods to recent observed temperature trends under the really inspiring guidance of Klaus Hasselmann and Hans von Storch, and what I learned there, for example, on the origin of low-frequency climate variability, and about statistical techniques in climate research, still influences me today. I also collaborated with climate modellers, for example, Uli Cubasch, on analyzing recent model simulations. This collaborative work environment in Hamburg was quite different from the environment during my Ph.D. and I found that to be much more fun. The next move then was to Seattle, on a Feodor-Lynen fellowship from the Alexander von Humboldt Association. My goal was to learn more about climate dynamics and the atmosphere. Also my husband to be was an American, so a move to the U.S. seemed like a good plan. The moves after that were all attempts to find suitable positions for two people at the same time, which was quite difficult – both at Texas A&M and at Duke I was on a soft-money funded research position, which on one hand gave me a lot of freedom to pursue my own research agenda, and to reduce my working time while my children were very small. On the other hand, I could never be quite sure what would happen when the next grant ran out. The move to Edinburgh offered a permanent position for both my husband and me. The fact that Edinburgh is back in Europe and closer to my family made the decision easier.

So the agenda behind moving was first one, then two careers in science. It was always hard to uproot and move on, particularly later, once we had children. It is of course a big adventure every time, and every move broadens one’s perspective – things are done differently than at home in other countries and other work environments, and that questions one’s prior assumptions and judgements, which I found quite a broadening experience.

How is the situation of females now in atmospheric sciences? Has the situation improved in the last ten years?

I think there is more consciousness now, compared to the beginning of my career, that there are a number of inequalities which are quite pervasive and not easy to overcome. There are now quite a few top female scientists in influential and highly respected positions. There is also a more widespread realization that diversity, not only in gender but also other aspects such as nationality and background, is an advantage. However, the representation of women in top positions is still limited; for example, many departments have only a small fraction of female professors.

Women have a number of difficulties to overcome. Much more often than men, women take breaks or sharply reduce hours when having small children. I have done that as well, and it was very rewarding but also a bit scary to realize that I was competing for funding and positions with people with very straight careers without interruptions and complications, people who could easily work long hours and pursue anything they wished to pursue. At the same time I felt I had to prove to myself that I am not a ‘Rabenmutter’ and that my wish to continue my research career did not short-shrift my children. I had very good at-home childcare. I still pick up from school one day a week almost every week, and I used to stay home first several, then one day per week to spend time with my kids, their friends, and attend playgroups and music classes. A science career is in many ways more flexible than corporate jobs, and allows working whenever it’s feasible, during naptimes, and at night after the children are in bed. I also found my family to be a wonderful balance for the pressures of an academic career.

I realize that there are also men who are closely involved in rearing their children, and know cases where a father is the primary parent, but the majority are still women. A higher percentage of women in positions of leadership may help to raise consciousness of the need to balance family and work, and convince people that unorthodox work hours do not mean lack of commitment.

Integrating family and children is, of course,

not the only problem women face. I believe (and I have seen occasionally studies that seem to support this) that on average, women express themselves differently, and prefer collaborative to competitive situations more than men. This is sometimes interpreted as weakness. I have sometimes felt ignored with suggestions only to hear a male's identical suggestion enthusiastically welcomed. That experience seems not to be unique to me. There also sometimes seems to be a prejudice of what makes excellent science – the lone author paper challenging prior beliefs is still valued particularly high in some circles. I find collaborative papers, maybe with an interdisciplinary authorship, that address an interesting problem as completely as possible, at least as useful type of science, and one that I enjoy more.

Throughout my career, I have encountered wonderfully supportive colleagues, men and women, who encouraged and supported me. As more women make it further up the top (and that seems to be slowly happening), I hope that their skills will be better and wider appreciated. But there is still a way to go. Until then, it is important to encourage and support a diverse set of colleagues and enjoy the breadth that comes with it.

You worked for a while for a large international company - why did you move back to science?

My Ph.D. thesis was supported by the research department of Siemens AG in Germany. The Siemens research campus in Munich is a research environment, although under a corporate sponsorship, and with more applied priorities. Some of my colleagues there were scientists at heart as much as my university colleagues, but that was less the case for the leadership. When I interviewed for "regular permanent and pensionable" positions after my Ph.D. I found that the corporate world away from research just didn't attract me to the same extent that science did. After moving to the Max-Planck Institute I appreciated how much difference it makes to have an outstanding scientist rather than an administrator to lead the research groups – I found that environment fantastic.

What would be your advice for a young female student, who has to decide about going in to science?

My main advice to her would be to follow her interest and do what she would like to do most, irrespective if it seems rational, logical, or straightforward. My winding career path via mathematics and Max-Planck Institute, into the U.S. and back to Europe is an example of this working. My second advice is to find a supportive mentor whom she can trust and

At home: Gabriele and her son.

whom she can ask for advice on career questions. I found it incredibly important to be able to vent and worry aloud, and I had some wonderful, female and male, mentors. And then there is the not-quite-serious advice that it would help to find a mate with a moveable career....

What would you consider the most two significant achievements in your career?

I am quite proud of my work estimating the human contribution to late 20th century warming, and attributing it to greenhouse gas increases. I wrote one of the first papers showing that late 20th century warming trends were highly unusual in pattern and magnitude compared to long-term trends that can occur due to internal climate variability. The follow-up paper used several fingerprints to distinguish between climate change caused by different external drivers, for example, greenhouse gas forcing, aerosol forcing and solar forcing. Our paper introduced a new method to attribute climate change to causes which is, after excellent later modifications by Myles Allen and Simon Tett, still the main method used for this purpose.

I worked on a number of other topics, including changes in climate extremes, causes of climate change in the last millennium, estimating climate sensitivity. The latter was a fascinating and challenging topic and I would still like to improve on it. I am also proud of my contribution to the IPCC 4th Assessment report. I was coordinating lead author and member of the summary for policymakers writing team. Working on the IPCC report was an amazing experience, scientifically very rigorous, Susan Solomons leadership was outstanding, and I learned lots from the excellent group of colleagues that worked on that report.

When you look back in time, what where the most significant, exciting or surprising developments in atmospheric science?

I am not sure I can speak for atmospheric science as a whole. In terms of climate science, I find the increasing confrontation of models with data from longer timescales fascinating. Investigating to what extent models can reproduce changes in climate at times when the climatic mean state was quite different, and the forcings were different is a very useful test of climate models. The uncertainties are large of course. Related to that, I also find earth system modelling an amazing step forward. If we better understand the role of vegetation and carbon cycle changes in the past, this will give much better confidence into predictions. Another interesting development was the recognition in the late 90's that climate change is affecting modes of variability, and recently, that it is affecting precipitation and extremes.

Is there a politicization of atmospheric science?

No doubt climate science is politically relevant. The question of how to address climate change is a very difficult one, and one that needs input not only from climate scientists, but also economists, energy specialists, humanities, and much more. Therefore, climate scientists don't have all the answers. We have answers about the observed and projected changes in climate assuming certain emission scenarios, and some information about how much of a problem climate change might turn out to be, on what timescales it is reversible, and how much change to expect.

For me, this means that I am happy to provide scientific input, for example, through the IPCC, but I also believe it benefits the discourse if scientists avoid making direct policy recommendations, since we will not have all the information necessary for a good decision. On the other hand, it is important to try to ensure that the public and politicians are informed in a rational and effective way about what our scientific findings mean for them, and for the generations to follow. As a publicly funded scientist I believe it is my duty to provide information to society, via committees like the IPCC, and also via the media.

So, to address the question: of course the results of climate science are politically relevant. Although that makes it difficult to keep politics out of it, I believe that society and science benefit from some level of separation of science and politics. That is true for climate science to the same extent as for other sciences.

What constitutes "good" science?

Good science to me is asking an interesting question that can be addressed, and answering it objectively and rigorously. Identifying the interesting and important questions is a key part of good science and may well be the most important step. Good science means that the scientist is open-minded about what the answer may be, and sceptical about his or her theories. It should be welcomed when data raise questions about a theory or method, because that means we are about to learn something new and surprising, which after all makes science so much fun. A good scientist also should have not just a narrow problem in mind, but the broader context of a problem, and find and emphasize the most important aspect of a problem.

What is the subjective element in scientific practice? Does culture matter? What is the role of instinct?

Instinct is very important – I followed my instinct in the somewhat twisted way my career went, and many people call it "gut feeling" that a result is right, or that something is either wrong or missing 'instinct'. I am not sure it is instinct – I think our mind processes a lot of information in a semi-conscious manner and so we cant always point the finger at what looks wrong, but this 'instinct' that something isn't right often means that this contradicts other information we have. Society and culture may influence to some extent what questions we ask and how we ask them. But I also know that there are absolute truths – things that can be logically shown to be true, hypotheses that are supported by data, hypotheses that are not, or statistically unlikely to be, reconcilable with the data. Also, the scientific community as a whole, who continues to challenge each other and compete with each other, minimizes in my view the role of culture and the subjective element.

The opinions expressed in this interview do not necessarily represents those of the reviewer or the AGU.

An Indo-Norwegian Research Collaboration on Climate Change

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In today's climate discussions, challenges persist to follow sustainable development due to different factors such as: large scale regional variations in availability of observed datasets for validation at desired scales, limited understanding and capabilities across regions in the quantification of observed climate change, present day climate variability and future expectations of the change. The latter could in turn have a high impact on the development pathways aimed for a sustainable future. We are presently in an era where the quantification of climate change impacts is essential and intrinsically linked with all life forms on Earth including ecosystems and livelihoods.

A special event in The Delhi Sustainable Development Summit to discuss the status of the Indo-Norwegian project. Delegates from Norway and India were present. Photo source: TERI, India.

The challenges of climate change

The challenges in today's global climate system can be mainly attributed to tipping points of different impacts due to climate change induced by human interventions. The progress in this direction would be to assess the nature of the tipping point, whether it is going to increase the occurrence of extremes or to change the intensity and the pattern of occurrence. The WMO (2010) report shows a snapshot of different spatial regions, where the increase in extreme events has been very prominent in the last decade. The assessment of these extremes, using state-of-art Earth System models, can provide feedbacks of all the processes in the Earth System to pave the way forward.

An Indo-Norwegian Project

In this context, an initiative has started between the frontier scientists at the Bjerknes Centre for Climate Research (BCCR) in Norway and The Energy Resources Institute (TERI) in India. The aim is to increase the understanding of the Earth System processes that would further facilitate impact assessments with finer resolution information to approach towards defining adaptation strategies. India, a developing country, is extremely vulnerable to changes in climate owing to the fact that a large part of the population still relies on climate sensitive sources for a living. As part of this project, a special event was held during the Delhi Sustainable Development Summit 2010 to discuss the initiatives and the requirement of improved climate projections both at the global and local scales, for better impact assessments within the Indo-Norwegian project.

Professor Eystein Janse, Director of BCCR and Professor Arabinda Mishra, Director of the Earth Science and Climate Change Division at TERI shared their views on the importance of this project for future collaborations between Norway and India, and the value addition and capacity building required in a developing country like India for better impact and vulnerability studies.

This Indo-Norwegian project makes use of the Norwegian Earth System Model (NorESM) for the global simulations. The project is also aimed at downscaling the NorESM data using the Weather Research and Forecasting model, a state-of-the-art dynamical downscaling model developed at the National Center for Atmospheric Research in the United States. The model simulations will make use of the new AR5 scenarios of the Intergovernmental Panel on Climate Change. These scenarios are called Representative Concentration Pathways (RCP), which represent the radiation imbalance on top