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# METAMORPHOSES INSIDE ASH CLOUDS

## TEN CLIMATE RESEARCHERS REPORT

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## TEN CLIMATE RESEARCHERS REPORT

Stories of Earth System Research made in Hamburg

# CONTENT





# THE LATEST NEWS FROM CLIMATE RESEARCH

Climate change raises myriad questions: What will it look like? How could it affect human life? Do we have to adapt our behavior and lifestyle? At Universität Hamburg's Center for Earth System Research and Sustainability (CEN), scientists aim to find answers to urgent questions connected to climatic change. This climate booklet provides you with fresh insights into their research. We help you understand how volcanic eruptions, marine algae, and climate variations are linked, how climate-induced conflicts can be prevented, and whether fostering human awareness about climate change really makes a difference.

Once a month, our researchers' guest contributions to the *Hamburger Abendblatt* take you on an intriguing journey into climate science. Ten of these articles can be found on the following pages.

Enjoy our selection!

# MICRO FOSSILS REVEAL HISTORICAL SEA LEVEL RISE

If you take a walk along a North Sea beach, you will find lots of different things left behind in the wash margin by the tide: plastic rubbish, seaweed, shells, sediment–it depends what was in the water. And over the centuries, layers have also been deposited in the coastal soil. The content of these layers is dictated by the conditions at the time.

Using this "historical message in a bottle" we are reconstructing the rise in sea level along our coasts. We are doing so using new methods developed at the Universität Hamburg's Center for Earth System Research and Sustainability especially for the North Sea coast. They involve using particular microorganisms called Foraminifera. On the North Sea coast most species of this unicellular organism are the size of a grain of sand. They have tests composed of calcium carbonate or sediment particles, which are deposited and survive as fossils—often over thousands of years.

Only a few highly specialised species are able to live at the junction of land and sea. Here, only those that have adapted

to the extreme conditions—sometimes fresh and sometimes salt water, sometimes wet and sometimes dry—are able to survive. So in the salt marshes and intertidal zone there are only a dozen or so species of Foraminifera, each with its own “favorite spot.”

If a species likes, for example, regularly being covered by salt water, it will prefer to live at sea level. Another species may tolerate this less often and so its optimal habitat is perhaps 60 to 80 centimeters above sea level, and so on. We can accurately determine these zones for each of the few species, and so we can obtain a statistical vertical cross section: If species X occurs often, species Y occasionally, and species Z only rarely, a sample can only originate, for example, from approximately 40 centimeters above sea level.

The second step is to take bore samples a few meters deep from the foreshore. Here we find deposits from past centuries layered on top of one another. Millimeter for millimeter, we remove the layers and by analyzing the radioactive decay products we can accurately date them.

Finally we look at which Foraminifera colonies are present and so we can see how far above sea level the sample was in that particular year. Now we just have to “subtract out” factors such as storm tides and local movements in the earth’s crust; since the ice sheets disappeared 18,000 years ago, the earth’s crust has been rising around Norway, while it has been sinking around Holland.

In this way, we are able to determine to an accuracy of a few centimeters the sea level in the past. The first results show that the water level along the North Sea coast has risen by an average of 25 centimeters over a period of 150 years. In places, this figure could be 40 centimeters. This confirms the historical measurements taken and shows that our methods are reliable. Good news, since in the long term we want to determine the sea level over the last 10,000 years and there are no measurements for this period. Data going back this far are vital if we are to make conclusive statements about the extent to which these variations are natural, and to what extent they are due to manmade climate changes.

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**Prof. Gerhard Schmiedl** is a micropaleontologist at Universität Hamburg’s Center for Earth System Research and Sustainability and analyzes historical climate variations.

# THE TRANSFORMATION OF IRON IN VOLCANIC CLOUDS

Volcano eruptions can be climate-relevant. Airborne volcanic ash which reaches an ocean increases the likelihood of algal blooms. Dissolving in sea water, the iron contained in the ash—a natural fertilizer—fosters algal growth.

While spreading, the algae extract $CO_2$ from the atmosphere and absorb it into their biomass with a positive effect on the climate. This is all due to a fascinating natural phenomenon: Upon being ejected from volcanic craters, ash iron is insoluble, whereas it dissolves in the sea. The hows and whys of this modulation were unexplored to date.

It is impossible to take specimens during a volcanic eruption. Therefore, in trying to recreate volcanic activity, my colleagues from Universität Hamburg's Cluster of Excellence CliSAP and I rely on computational models. We employ equations to simulate the physical and chemical processes which take place within the hot cloud of ash and gas. On this basis we can investigate, for instance, what conditions cause changes in the chemical compounds of an ash cloud. Is the varying

temperature inside the volcanic plume decisive? Or are the plate tectonics underneath the volcano—which trigger eruptions in the first place—a crucial factor?

In fact, a series of processes within the volcanic cloud contributes to changing the chemistry of the iron and to literally dissolving it. Initially, volcanoes spew large quantities of ash particles and gases at about 1,000 degrees centigrade. Volcanic ash, however, cannot be compared with common ash. It is best conceived as consisting of the most minuscule lava fragments. My model indicated what happens exactly when a cloud of smoke cools off on its rapid passage into the atmosphere. Its steam condenses at temperatures just below 100 degrees centigrade, forming a kind of shell around the ash particles. The thus created droplets absorb the surrounding gases, such as hydrogen chloride and hydrogen fluoride. Hence, the droplets turn into acid, for example, into the highly corrosive hydrochloric acid which attacks the surface of the ash particles. On account of this etching process, iron ions are released from the ash particles and become soluble in water.

My model helped me find out which processes enhance the iron solubility of volcanic ash. Now, I aim to improve the model to conduct investigations that provide a more detailed insight. Our current research, for instance, is still based on the assumption of a dry milieu. Yet, when volcanoes erupt in tropical regions, the humid climate influences condensation. Clarifying whether more or less iron is released from the ash under humid conditions could be significant, as the intensity of the marine algal bloom will vary accordingly.

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**Dr . Gholam Ali Hoshyaripour** completed a doctorate at Universität Hamburg's Cluster of Excellence CliSAP with a dissertation on iron in volcanic clouds.


# IS SIBERIA THAWING?

Since observational data for barely accessible regions is hard to come by, scientists reconstruct the climate and potential changes with the help of computer models.

They generally use global models, which offer information on various parameters like snow cover or air temperature—for the entire surface of the Earth and for longer timeframes. Though this provides researchers with data describing the climate and changes to it, and even for remote regions, the low resolution leaves out many details.

In order to identify small-scale changes, my colleagues at Universität Hamburg's Cluster of Excellence CliSAP and I have now for the first time applied a regional climate model for Siberia. This approach allows us to see regional and local differences in far more detail than with a global model, even those between adjacent mountain valleys. But it also involves more work and computing power—and raises the question whether the extra effort is justified.

Nevertheless it is still important to know about the global climate, because it serves as a framework of sorts for detailed

reconstructions. Accordingly, I embedded the regional model in the global one—the former is essentially a magnifying glass I can use to zoom in on the latter.

For instance, I used this approach to calculate the snow cover for the last sixty years, a parameter that provides key insights in a region like Siberia. Snow reflects back 90 percent of incoming solar energy, while dark patches of land only bounce back 20 to 40 percent. This difference affects the air, soil and water temperature—and therefore the entire climate system.

The calculations for my research were performed by the German Climate Computing Center's supercomputer. After analyzing the results, I came to the following conclusion: Using the regional model to more precisely simulate Siberia's climate was a worthwhile endeavor. We now have more detailed and realistic data on snow cover in Siberia—covering the whole region and for every day of the last 60 years.

My findings show that the changes in snow cover vary to a far greater extent, both regionally and over time, than indicated by previous models. Especially in parts of northwestern Siberia, the amount of snow cover in the six winter months has declined. Climate change is apparent, and could have serious consequences: If Siberia's permafrost thaws, additional greenhouse gases will be released—and could intensify global warming. The amount and extent of sea ice could also change and affect the shipping routes if temperatures in Siberia rise permanently.

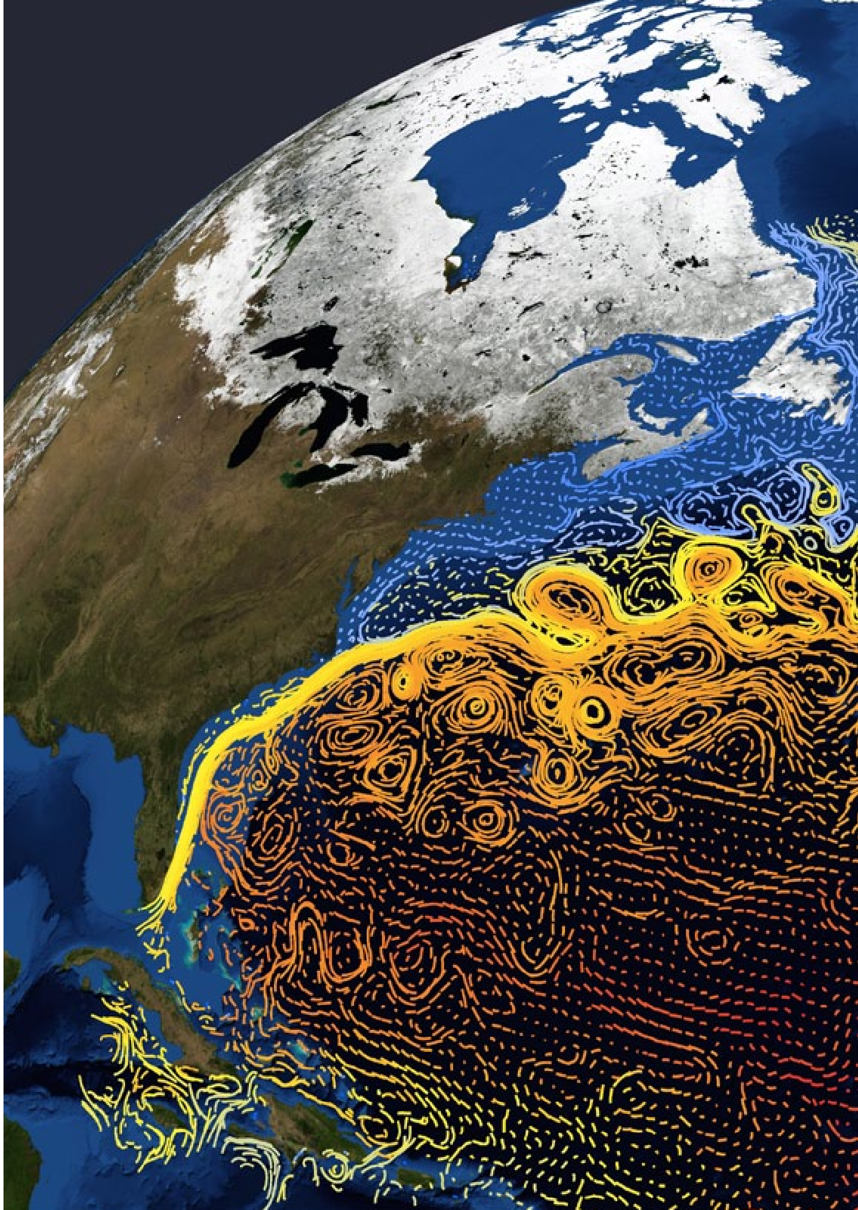
**Dr. Katharina Klehmet** is a geographer at the Helmholtz-Zentrum Geesthacht and completed her doctorate at Universität Hamburg's Cluster of Excellence CliSAP.

# HOW TO PREDICT OCEAN CURRENTS

It performs an invaluable service for our climate: The ocean can absorb and store huge amounts of heat. At the same time, ocean currents act like giant conveyor belts, transporting warm water from the Equator toward the poles; in this way, just like the atmosphere, they ensure that heat is redistributed around the globe.

For example the North Atlantic Current system, which also includes the Gulf Stream, moves warm water from the Gulf of Mexico to Europe's North Sea and into the Arctic—maintaining a mild climate in Northern Europe. As such, the Gulf Stream is part of a giant current referred to as the Atlantic Meridional Overturning Circulation, which is above all driven by temperature and salinity differences in the water, and by the wind: As it flows to the north, surface water becomes increasingly colder and heavier, causing it to sink. When ice forms, the salt is left behind in the water, making it even heavier; then the cold, high-saline water flows back to the south, far below the ocean surface.





At Universität Hamburg's Cluster of Excellence CliSAP, my colleagues and I are analyzing to what extent the variability of this circulation, and of the resultant heat transport, can be predicted: With the help of a numerical model, we can determine when there are fluctuations in the Overturning Circulation, making it stronger or weaker. In this context, we are especially interested in the variations from year to year within ten-year model simulations, which places our study between short-term weather forecasts on the one hand, and long-term climate prognoses for the next 100 years on the other. For long-term predictions, framework conditions like the rising $CO_2$ concentration in the atmosphere are essential, whereas the initial conditions at the starting point of the simulation are crucial for short-term forecasts. Our middle-term simulations have to satisfy both criteria.

In order to estimate how well simulations can predict variations in the circulation, we need a reference value—ideally in the form of observational data. So we're not actually making predictions in the litaral sense (forecasts). Instead, we test our simulations against reference data from the past ("hindcasts") to determine whether or not they can provide accurate estimates. Since taking measurements in the ocean is an expensive and laborious undertaking, in many areas we still have only fragmentary data. Therefore we use an additional numerical modeling, which combines observational data with numerical simulations to realistically represent the ocean, as the reference for our hindcasts. A further advantage: We can assess the accuracy for all latitudes of the North Atlantic, as the analysis is not limited by a lack of observational data. And we don't compare the reference to just one, but all in all to roughly 200 hindcasts, each of which shows one possible development of the ocean. The more closely they correlate with the reference, the more accurate they are.

Our analysis has shown that we can essentially make accurate prognoses for the next two to five years; this varies depending on the latitudes we are researching. We can make the longest-term predictions between the subtropical and subpolar gyres at 40 degrees North—the line of latitude that is home to New York and Madrid.

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**Dr. Bente Tiedje** is an oceanographer at the Climate Service Center Germany (GERICS) of the Helmholtz-Zentrum Geesthacht.

# CLIMATE-RELATED CONFLICTS IN KENYA ARE AVOIDABLE

Developing countries are those hardest hit by climate change. And that includes Kenya, my home country, which is heavily dependent on a climate-sensitive sector: agriculture. But do droughts and water shortages inevitably lead to violent conflicts, as is often claimed?

How is climate change viewed in rural Kenya — and can adaptive strategies already be found there? In order to explore these questions, I investigated the conditions in the small district of Loitoktok. Located at the foot of Mount Kilimanjaro near the border to Tanzania, it is representative of rural, emergent Kenya: agriculture and infrastructure are expanding; wildlife tourism is stable. However, it is also home to several ethnic groups — which means there is always a certain potential for conflicts. Making matters worse, studies have confirmed that climate change has already resulted in less precipitation, higher temperatures and increased animal mortality rates.

In Loitoktok I took a closer look at commercially viable ecological areas like food production, fauna, water and medic-



inal plants. As these factors are important for the district's economic growth, I determined their respective economic values and researched governmental climate adaptation strategies. Above all, however, I analyzed the different networks already in place—e.g. between institutions, farmers, NGOs or government offices.

This approach provided me with a good overview of the local interconnections and allowed me to recognize which areas were well-connected and which weren't. I also collected the responses of 154 people from the respective sectors, based on a questionnaire, group discussions and consultations with experts. Their answers provided valuable insights on the respective actors' views concerning climate change, on whether they attempt to intervene when conflicts arise, and on who potentially resolves these conflicts, and allowed me to identify differences in how the various sectors approach climate change and conflicts.

Interestingly, the findings show that there are a wealth of local networks for agriculture and livestock farming, while there are far fewer in the water sector and effectively none for medicinal plants—most likely due to the fact that the last of the three is still not recognized by the government. My data also showed that conflicts as a result of climate changes don't necessarily have to happen: Above all, the heavily net-



worked areas are already working to prevent them. For example, actors in the agriculture and livestock-farming sector are now shifting to more robust seeds and animals, collecting rainwater, or practicing afforestation to combat the effects of soil erosion. In sectors where the actors are barely connected by networks, the cause is most often a lack of coordination or financial power, a lack of personnel or—in the case of medicinal plants—a lack of appropriate legislation.

In attempting to pave the way for improved climate adaptation in Loitoktok and other regions like it throughout Kenya, my method can be used to identify areas in which the relevant actors are not yet connected, and to demonstrate how these areas can improve their networking, which promotes more effective resources management. After all: the actors in closely networked areas communicate more on climate change and its effects, which helps them to adapt—and helps to make sure conflicts aren't a foregone conclusion.

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**Dr. Grace Wambui Ngaruiya** earned a doctorate from Universität Hamburg's Cluster of Excellence CliSAP with a focus on Kenya's adaptability to climate change.



## WHAT IS THE VALUE OF THE RAIN FOREST?

Environmental and climate protection requires investors as illustrated by the following example: Farmers right outside Munich in southern Germany receive money in exchange for fertilizing less. Thus, groundwater protection keeps production costs for safe drinking-water down. A benefit for all—the municipal utility services which invest in water, the farmers and the environment.

This model may become similarly successful in the tropics and subtropics where rain forests as carbon sinks are crucial to the climate equation. Every destroyed tree increases the global temperature. As a climate researcher at Universität Hamburg's Cluster of Excellence CliSAP, I am currently investigating how to protect forests by assigning them monetary value.

In order to take stock of biomass, I visited Madagascar three times. Assisted by locals, I measured and documented all trees in specific forest sections, assessing trunk diameters, heights, treetop sizes and forms, etc. Aiming to establish the total wood volume we determined the amount of carbon



sequestration in the national woodlands based on satellite data. A comparison with previous data indicated how much carbon had already been released due to deforestation. In years to come, this point of reference will show us whether the island nation will destroy less trees, thereby reducing its emissions.

This science-based method was created in accordance with all participants and is a significant step in realizing the UN's climate protection program REDD+ (Reducing Emissions from Deforestation and Forest Degradation). Its key approach is: Whoever profits from forest climate regulation has to pay for it. Nations like Germany or Norway are backing forest preservation efforts in developing countries through investments. Nonetheless, the latter still find almost all forms of land-use more attractive than the protection of tropical woods. Indonesian or Brazilian farmers, for instance, tend to turn forests into arable land. In the same way, corporations contribute to the destruction by setting up palm oil or animal feed plantations. Therefore, as consumers in industrial nations we have all become indirect motors of deforestation.

The just distribution of REDD+ funds, however, poses quite a challenge. Observing systems never reflect the exact conditions on location. Unpredictability—incident to estimates and extrapolations—cannot be eliminated completely, but I am striving to reduce variables. In particular, because REDD+ participants who protect habitats and manage them sustainably expect funding from the environmental protection program. Unfair distribution would rob them of this income. Reversely, countries supportive of the project would feel deterred if developing nations were to profit from unjustified enrichment. The UN must balance this out to ensure permanent commitment on both sides.

It would be worth the effort! According to UN estimates, the annual global forest loss is thirteen million hectares. Tantamount to all German and Austrian woodlands it causes up to one fifth of all human-induced carbon emissions. Focusing on this factor is the most cost-efficient way to protect our climate.

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**Dr. Daniel Plugge** is a wood scientist. He formerly worked for Universität Hamburg's Institute for World Forestry and the Cluster of Excellence CliSAP.

# THE ELBE RIVER'S OXYGEN HOLE AS A CLIMATE FACTOR

In the past thirty years, the Elbe River water quality has vastly improved. During the eighties, fertilizers, sewage, and pollutants were discharged into the river almost unfiltered. With the collapse of the German Democratic Republic, at the latest, came a radical change of thought. But does cleaner Elbe water have a positive effect on the climate?

Conceivably: the Elbe is an important transport route towards the North Sea, also for carbon—a crucial climate factor. If the carbon cycle is unbalanced, however, the $CO_2$ release starts to increase with repercussions on the climate. In large cities, such as Hamburg in northern Germany, the human influence on the river plays a major role. For that reason, my colleagues from the Universität Hamburg's Center for Earth System Research and Sustainability and I have examined the Elbe estuary, the passage where the river current still interacts with the tide. Our particular focus was on the interdependent carbon and silicon cycles with minute algae as key agents. In clean water, which is flooded with light, algae absorb $CO_2$ into their biomass, while at the same time extracting dissolved silicon as building material. When dying, the algae sink into the depth, taking the carbon with them. This is relevant to the global $CO_2$ balance because the $CO_2$ is thus removed from the cycle. Moreover, converted into shell particles, the silicon also subsides to the riverbed.

My investigation is based on water data collected by Hamburg city authorities over the past thirty years. In addition, I took water samples and analyzed them. Until now, only the saline section of the lower Elbe onwards from Glückstadt, a small town in Schleswig Holstein, had been examined. Hence, our study is the first to include Hamburg's fresh water harbor region. We managed to create a detailed picture of the elements in flux there, in spatial as well as in temporal respect, showing where and when large amounts of $CO_2$ are released. Furthermore, we demonstrated that the fresh water region is highly significant: in the vicinity of the metropolis, the largest $CO_2$ exchange between water and atmosphere–in relation to expanse–takes place.

Surprisingly, although the Elbe water quality has improved over the years, adverse effects have occurred in the estuary. In theory, the cleaner water ought to have generated algal growth and an increase in oxygen. Yet the contrary was the case: Veritable oxygen holes in the harbor area have


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multiplied. Prevalent $CO_2$ highs plus low oxygen levels even cause an increase in fish mortality. How did this come about?

Human interventions, for instance, the deepening of the Elbe, extirpate shallow water areas. Unfortunately, algae cannot survive in deep, dark currents. They die in such environments, consequently being decomposed by bacteria that produce $CO_2$ and use up large amounts of oxygen in the process.

In conjunction with dead algae, the silicon is deposited at the bottom of the Elbe. Subsequently, if not excavated with sediments in the continuous efforts to keep the watercourse navigable, it will disintegrate as well. This may explain why less silicon than expected reaches the North Sea.

Our results prove that the Elbe water quality has bettered with time. Nonetheless, human-induced damage, for example, due to excavations of river channels, is still immense.

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**Dr. Thorben Amann** is a geologist at Universität Hamburg's Center for Earth System Research and Sustainability.

# HOW PEOPLE CHANGE THEIR MINDS TO HELP PROTECT THE CLIMATE

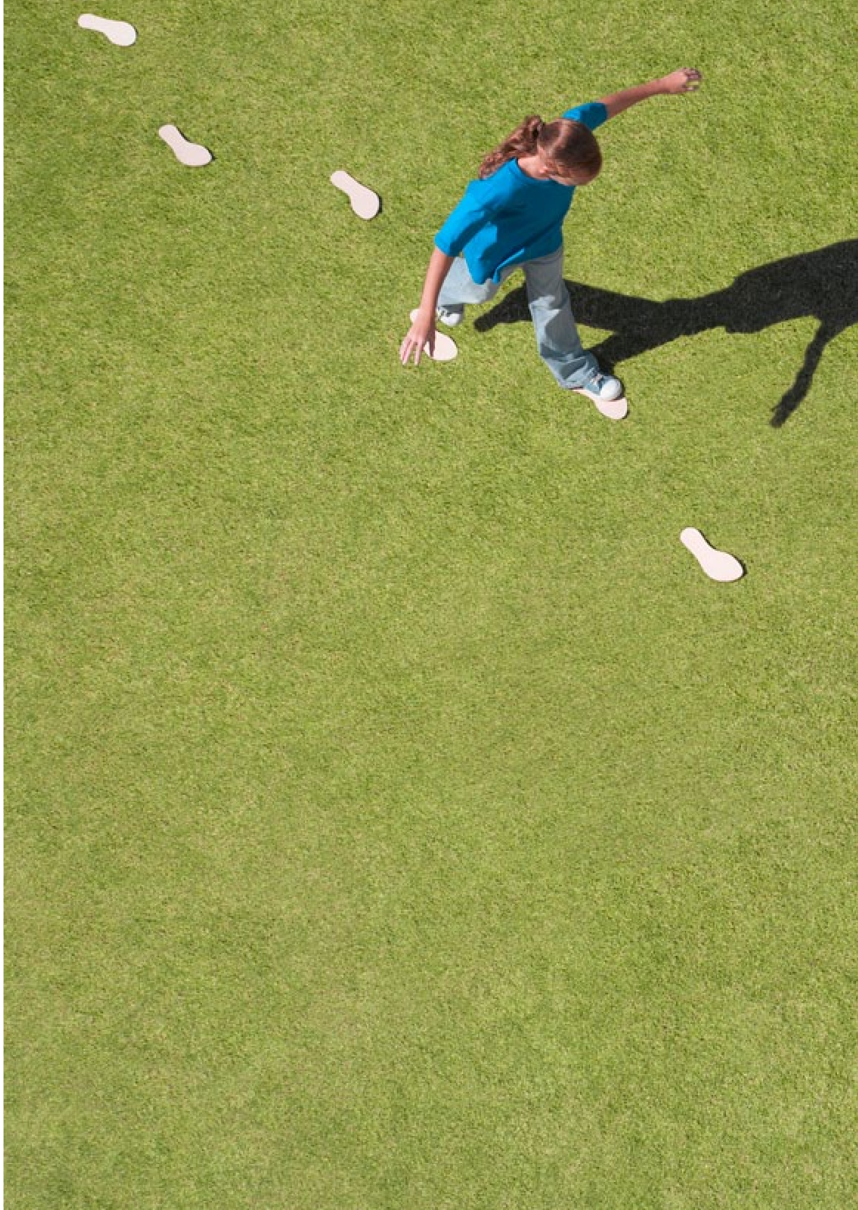
What do typewriters and climate change have in common? The answer: Both are based on so-called path dependency, a term used in sociology to describe how past decisions affect the present.

One example is the arrangement of letters on a keyboard, which was originally developed in the nineteenth century to prevent the type bars on typewriters from jamming. Though modern devices like laptops or smartphones no longer use type bars, the format has stayed the same. The reason: the widespread use and resultant force of habit.

This also explains why we have a hard time changing our behavior to switch to climate-friendlier alternatives. Certain routines—like driving in to the office—are deeply rooted in our society and based on traditional technologies like the internal combustion engine. In these situations, it can be very difficult to leave our familiar paths.

Take electromobility for example: Since there still aren't that many charging stations, electric vehicles aren't yet a practical alternative everywhere. Plus, commonly held preconcep-





tions about speed and horsepower stand in the way of the new technology.

My research at Universität Hamburg's Center for Earth System Research and Sustainability focuses on these types of path dependency. The key question is how people act when their old habits no longer work. In this regard, insights from the field of social psychology provide a helpful basis: People often do not consider the decisions they make and simply imitate the behavior of their "personal experts." Depending on topic and situation, these can be their personal computer expert, their neighbor or the general public. If the expert proves to be reliable, the person in question will continue to mimic their behavior in the future. Over time, this process creates entire networks of dependencies. These can include friends and acquaintances, but also the media—in other words, all sources that a person uses as templates for their own conduct. The stronger the dependency, the less likely change becomes.

Interestingly, at times the same mechanism can also have just the opposite effect. This can happen when people realize that their customary types of conduct are no longer practicable. For example, we know that exhaust from gas and diesel engines harms our climate. In order for the current situation to change, two things are important: The technological framework and the personal experts. If we had more charging stations, people looking to buy a new car would be more likely to consider an electric vehicle. And those who bought one would then become the brand-new experts within their networks. Even a handful of pioneers could have a considerable effect; just like on Facebook or Twitter, more and more of their friends and acquaintances would adopt the new form of conduct. The result: More demand for electric vehicles, which would push production and lower prices. This in turn could reinforce the new path until the new technology was ultimately accepted on a broad scale. So we see that climate-friendly alternatives definitely do have a fighting chance if there are the right technological conditions—and if enough pioneers can be won over.


**Jasmin S. A. Link** combines mathematics and sociology at Universität Hamburg's Center for Earth System Research and Sustainability.

# DYNAMIC COMPUTATIONAL GRIDS IMPROVE STORM SURGE MODELS

Typhoon Haiyan and Hurricane Katrina demonstrated how important it is to warn people of extreme events well in advance, allowing them to get to safety. Today, computer simulations often serve as the basis for risk analysis. My work involves the creation of these scenarios for storm surges at the interface between geosciences and mathematics.

Together with colleagues, I develop processes and computer programs that mathematically describe complex natural phenomena. For example, my model can be used to calculate how high the water level will be where, and how quickly it will move in a particular direction.

To accomplish this, first of all we transform natural laws into mathematical equations so that modern computers can process them. This starts with overlaying the region in question with a computational grid made up of triangles. I can then enter the current values for direction and speed (momentum) and the amount of moving water (mass) at predetermined points on these triangles. These values are subsequently fed into mathematical equations for the conservation of mass and momentum, which are used to simulate the peaks and valleys in momentum and water levels. The smaller the triangles are, the higher the resolution and the more accurate the model.

This last point is a key factor—one of the greatest challenges for flood modeling is to accurately represent processes involving different scales, and even with all of the computing resources at our disposal, we can't calculate all these processes simultaneously.

For realistic simulations we have to take into account various parameters that affect the movement of the water—for example, the profile of the coast and the type of land covered by the body of water, along with the driving effect of the wind. Using our grids we can accurately represent this complex geometry. Our main aim is to also calculate the small-scale phenomena such as the transition from wet to dry as precisely as possible. To better illustrate all of these effects, I have based my model on an adaptive computational grid.

Adaptive computational grids save computer resources by only creating a fine mesh and thus high definition where it is needed. At transitions and margins—such as between wet and dry—the grid provides a high level of resolution. In less relevant areas, coarser mesh is sufficient. This automatic

adaptation offers an intelligent method for accurately and efficiently simulating flooding, reducing the cost and time needed for the calculations without sacrificing precision. At the same time, it was very important for us that our model be practical and easily understood. With this in mind we developed it so that other professionals could quickly learn how to use it.

My method has shown itself to be highly reliable in theory, and the first practical tests have confirmed this. To be absolutely sure that the simulated values are realistic, in the next step (known as validation) I will test them using data from past extreme events. I will start with the example of Hurricane Ike, which swept over Texas in 2008 with winds of over 150 kilometers per hour and flooded the densely populated coast along the Gulf of Mexico. After it has been validated, my method will contribute to better storm-surge modeling and therefore to improved early warning systems.

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**Dr. Nicole Beisiegel** is developing numerical methods in geosciences. She completed her doctoral degree at Universität Hamburg's Cluster of Excellence CliSAP.

# CLIMATE-FRIENDLY HEATING: RESERVATIONS REMAIN, KNOWLEDGE STILL LACKING

In order to slow climate change, we need to cut down on the production of greenhouse gases. What many don't know: Private homes generate at least as many emissions as industry. The majority (three-fourths) of these emissions come from heating.

As a sociologist at Universität Hamburg's Cluster of Excellence CliSAP I'm interested in determining the role of routines in heating, as well as how much people already know about climate-friendly alternatives. To get to the bottom of this, I have analyzed two different cases: heating in so-called Smart Homes and in passive houses.

Smart Homes are a relatively new development in which a computer ensures efficient heating—only the amount of heating energy actually needed is used. Passive houses are a bit different, using optimal heat insulation and controlled ventilation to get by with hardly any need for active heating. As these houses retain nearly all of their internal heat, for most of the year passive heat sources like household



appliances and even the human body are enough.

For my study I conducted extensive interviews with different citizens of Hamburg who live in either a Smart Home or passive house. I also consulted experts from the construction and energy sectors and made empirical observations at energy concerns and informational events, as well as in passive houses and Smart Homes. The most important finding: People still have a number of reservations about these new approaches, often in connection with their cherished routines and certain myths; for example, many are convinced that you can't open the windows in a passive house. And many assume that Smart Homes are complicated and take control away from the people who live in them. Another aspect is that heating in passive houses and Smart Homes isn't like what we're used to: When it's cold outside, we normally turn up the heat. In passive houses and Smart Homes there's no need to, a fact that many find somewhat baffling.

But all that changes once they're a bit more familiar with these new homes. My study shows that, after just a short time in a Smart Home or passive house, many who were at first skeptical become absolute fans. Most choose to try them out not for the sake of the climate, but because of the lower heating costs, or because the houses are well furnished and located near city centers. Many living in passive houses also choose them because they put stock in social interaction—passive houses are often arranged in small communities with attractive community areas. Further, many of these projects offer reduced rents for tenants with lower incomes. As such, with the right incentive programs, the government could effectively kill two birds with one stone: providing more social housing while lowering emissions.

**Johanna Matzat** is a sociologist at Universität Hamburg's Centre for Globalisation and Governance and conducts research at the Cluster of Excellence CliSAP.

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