Exploring Epistemic Shifts in Computer Based Environmental Sciences

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The environmental sciences have experienced a revolutionary shift in the last decades. Computer modelling and computer simulation have become key practises in environmental research. These practices fundamentally changed knowledge production and forms of knowledge and indicate a transformation of science into e-science. The workshop explored these recent and ongoing developments from an interdisciplinary science studies perspective. It had the goal to develop new interdisciplinary and collaborative strategies of research in science and technology studies suited to investigate the computer revolution and its impact on the environmental sciences.

The workshop convened 22 researchers from ten countries and ten different disciplines, with the majority from humanities and social sciences including history of science, philosophy of science, sociology of science and geography and five participants from science and engineering including atmospheric physics, atmospheric chemistry, computer science and environmental engineering, who have an interest in a science studies perspective. Consequently, the workshop had to tackle the challenge of a broad and new research topic as well as of finding a common language and facilitating fruitful exchange across the disciplinary borders. The workshop consisted of plenty of discussion time in three major sessions „Ideas and Infrastructure", „Computability" and "'Good' science" in which pre-circulated papers of the participants were discussed.

Knowledge practices, epistemic politics and geographies of power

A major result of the workshop was the identification of three fields of future research: 1) New knowledge practices and epistemic uncertainty, 2) Institutions, infrastructures and epistemic politics, 3) Geographies of epistemic power and politics of scale. Computer modeling and simulation involved a host of new practices. Historian of science KRISTINE C. HARPER (Florida State University) pointed to the epistemic uncertainty in meteorology, when Rossby, von Neumann, Charney and others developed computer modeling approaches to weather forecasting. Their endeavor involved enormous simplification of the physical theory. Theorists were reluctant at best as were empirical minded synoptic meteorologists to these approaches.

Geographer MATTHIJS KOUW (University of Maastricht) showed for the case of hydrology the problems of constructing models in the course of the 20th century, the epistemic opacity of knowledge codified in models and the lack of closure in this field. For the case of climate simulation, historian of science NILS RANDLEV HUNDEBØL (Aarhus) could show that overcoming problems of complexity involved conceptual inventions like the distinction between chaotic internal processes in the climate system, which cannot be simulated with any certainty, and so-called „external drivers" of climate, which proved accessible to computer simulation approaches. HÉLÉNE GUILLEMOT (Paris) investigated the problem of cloud parameterization in climate models and explained why increasingly physics-based, in the eyes of scientists „better" parameterizations did not necessarily produce better model results.

Computer modeling and simulation is not an autonomous research endeavor, but intensely entangled with politics. Atmospheric chemist PETER BRIMBLECOMBE (Norwich) discussed the politics of air pollution of the Los Angeles type. Its very perception as well as its management heavily depended on simulation models. Political scientist SONJA PALFNER (University of Darmstadt) described computer time as the new capital, on which scientists are dependent. Computer scientist THOMAS LUDWIG, head of the German High Performance Computing Centre for Climate- and Earth System Research in Hamburg, explained the politics of high performance computing, which causes significant energy consumption and CO2 emissions and suffers from an increasing rift between

dramatically increased computational performance and a lack of data management and network performance. Scientists, he contends, can't simply follow their scientific interests, but have to maneuver according to the question: „What is the nature of questions high performance computers allow?"

The cultural authority of computer simulation

A broader cultural impact of computer simulation in the environmental sciences is visible on many levels. Sociologist MIKAELA SUNDBERG (Stockholm) raised the question of epistemic politics and cultures in interdisciplinary physical and economic modeling of climate change. Geographer and climate scientist MIKE HULME (Norwich) described what he calls an „epistemological slippage" caused by climate models. Climate models dramatically reshaped the geography of epistemic power. Global climate models received predominant cultural authority even though they totally neglect any representation of social conditions and local knowledge. According to current malaria models, which rely on climate models, Europe should have lost half its population today. So, what do we lose, Hulme asked, by totally neglecting the realm of the social in climate science as well as politics?

Historian VLADIMIR JANKOVIÇ (Manchester) and geographer MARTIN MAHONY (Norwich) provided strong examples for new geographies of power. Jankoviç showed the importance of local climate, which featured very high in traditional climatology. Today, some six degree heating due to the heat island effects in urban areas raises very little attention. How comes that urban climate change has become invisible and hidden from public attention? And why have cities been largely erased from empirical climatologic investigation? Mahony presented features of the PRECIS regional climate model, which was developed by the UK Met Office Hadley Centre. The PRECIS system comprises the Hadley Centre's regional climate model and a software package enabling the processing and display of data on any personal computer. It is marketed as a tool of regional climate prediction for decision makers particularly in developing countries. The global migration of the PRECIS model represents an instance of the hegemonic epistemology of climate models.

The workshop showed that computer simulation in the environmental sciences raises a host of new questions about scientific practice and uncertainty and its political and cultural implications. Emerging and adopted practices in different fields display a wide range of features and cannot easily be categorized or subsumed under traditional key concepts like theory making or experimentation. For most fields we do know very little about these practices in question, because historical, philosophical and sociological investigations so far are limited and larger collaborative research efforts missing altogether. We know even less about the abundant political and cultural implications computer simulation entails, such as shifts of perceptions and interests, new ways of looking at and making sense of the world, new policies of expertise and geographies of power. A final question remains unanswered so far: How did computer simulation in the environmental sciences gain the cultural authority it currently displays, as visible examples like climate simulation show or less visible examples like simulation based environmental planning and regulation indicate.

Conference Overview:

Introductory Lecture

Kristine C. Harper (Talahassee, USA)
Numerical meteorology and epistemic uncertainty in the mid twentieth century

Session: Ideas and Infrastructures

Sonja Palfner (Darmstadt, Germany)
The becoming of the German high performance computing centre for climate- and earth system research
Commentator: Hans Volkert

Hans Volkert (Oberpfaffenhofen, Germany)
Instruments and simulations at DLR-IPA since 1962: A participant's perspective
Commentator: Sonja Palfner

Martin Mahony (Norwich, UK)
Making models move: The geography of the PRECIS regional climate model
Commentator: Nils Hundebøl

Mathis Hampel (Venice, Italy)
From weather observation to climate change imagination: The role of climate models in circulating reference
Commentator: Matthijs Kouw

Matthijs Kouw (Maastricht, The Netherlands)
The craft of modeling, the modeling of craft
Commentator: Mathis Hampel

Session: Computability

Hélène Guillemot (Paris, France)
How to represent clouds? Parameterization, weak point and /or main activity in climate modeling
Commentator: Vladimir Jankoviç

Vladimir Jankoviç (Manchester, UK)
Urban Climates and Sub-Grid Science
Commentator: Hélène Guillemot

Peter Brimblecombe (Norwich, UK)
The concept of photochemical ozone creation potential (POCP) and the history and politics of smog
Commentator: Thomas Ludwig

Arthur Petersen (Bilthoven, The Netherlands)
Reframing the reliability of models moving from error to quality for use
Commentator: Stig Andur Pedersen

Stig Andur Pedersen (Roskilde, Denmark)
Numerical algorithm, A drifting concept – preliminary notes
Commentator: Arthur Petersen

Thomas Ludwig (Hamburg, Germany)
Computers in science
Commentator: Peter Brimblecombe

Afternoon Lecture:

Helge Kragh (Aarhus, Denmark)
Epistemic shifts and higher speculations in cosmology and fundamental physics

Session: „Good" Science:

Mikaela Sundberg (Stockholm, Sweden)
The economy and climate as objects of interdisciplinary modelling
Commentator: Thomas Potthast

Nils Randlev Hundebøl (Aarhus, Denmark)
Prediction, climate and new global means
Commentator: Martin Mahony

Hans Feichter (Zurich, Switzerland)
Can we trust in climate models?
Commentator: Mike Hulme

Mike Hulme (Norwich, UK)
Epistemological slippage: how climate models promote climate reductionism
Commentator: Hans Feichter

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