

ESF Exploratory Workshop on

# Exploring Epistemic Shifts in Computer Based Environmental Sciences

Aarhus (Denmark), 10-12 June 2010

Convened by:  
**Matthias Heymann<sup>①</sup> and Gabriele Gramelsberger<sup>②</sup>**

---

① Department of Science Studies, Aarhus University  
② Department of Philosophy and Humanities, Freie Universität Berlin

---

*Co-sponsored by*



Aarhus University

---

## SCIENTIFIC REPORT

---

## **1. Executive Summary**

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 indicates 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 nine 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. This succeeded very well. All participants shared experiences and vocabularies from the same domains of research (computer simulation in environmental sciences) with detailed knowledge about technicalities involved and showed considerable sensitivity for sharing concepts and knowledge with colleagues from other fields. Interdisciplinary participation contributed considerably to the mutual learning.

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. These pre-circulated papers of 3-15 pages length had been made available in form of a compendium of about 150 pages. Discussions were pursued on every single paper initiated by a commentary of one of the participants. The workshop closed with a final discussion serving for a summary of the results, suggestions for future research directions and an evaluation of the discussion. 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. The evaluation showed a very high degree of enthusiasm and satisfaction of the participants.

## **2. Scientific Content of the Event**

Computer simulation has become a constitutive practice in many fields or whole disciplines in the environmental sciences. Disciplines like meteorology or climate science today are computational sciences, because both observation and theory building are intricately linked to computerized data-processing and simulation. A systems-based approach forms the basis for our current understanding of climate, weather, oceans, pollution transport and other environmental phenomena. Computer based models and simulations underpin a good deal of knowledge in the environmental sciences. These relatively new methods allow for the creation and exploration of complex system behaviour through the study of process-related interdependencies and feedback mechanisms. These methods also offer the potential to forecast future developments and

scenarios, which is important for integrated assessment, policy writing, and long-term decision making.

Computer simulation in the environmental sciences raises a host of questions in the history, sociology and philosophy of science. The exploratory workshop was designed to make this research field accessible by focusing on a limited number of crucial questions. Senior researchers as well as young scholars were invited from a broad range of fields including the history of science, philosophy of science, sociology of science and atmospheric sciences to take advantage of different methodologies and experiences. Referring to the transformations described above the proposed workshop addressed the following three main questions:

1. How does scientific knowledge become accessible for computational applications? And what happens to areas of knowledge, which are not computable?
2. Do established standards of science still work in computational sciences, where simulation results cannot be tested easily? How are new standards established in these fields?
3. Which research strategies are required to explore – from a science studies perspective - these shifts in computer based environmental sciences?

These questions guided as leading questions all discussions at the workshop and received particular attention in the three sessions “Ideas and Infrastructure” and “Computability” (question 1) and “Good” science” (question 2) as well as in the final discussion (particularly question 3). As a result of the papers and discussions a great number of research questions and issues were mentioned and discussed and fields of future research identified.

### **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 20<sup>th</sup> 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. H  l  ne 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 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 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 CO<sub>2</sub> 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 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 asks, by totally neglecting the realm of the social in climate science as well as politics?

Historian Vladimir Jankovič, Manchester, and geographer Martin Mahony, Norwich, provided strong examples for new geographies of power. Jankovič 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 needs to remain 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.

### **3. Assessment of the results**

Systematic historical, sociological and philosophical research on computer simulation in the environmental sciences is still in its infancy even though quickly growing. Most research to date has been pursued by individual researchers. Focused collaborative research efforts remained the exception and mostly very limited in scale and scope. A number of special issues, edited books and numerous articles appeared in recent years. Typically for an emerging research field, most of these collections comprise rather arbitrary assemblages of contributions from different fields, on different domains, with different questions and based on different methodologies. Furthermore, a younger generation of researchers appears to outnumber established senior scholars.

The workshop was a very productive event and the results accomplished were considered highly satisfactory in the final discussion and appropriate for the development of international collaborative research in this research domain. The identified 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, help to structure the field, make it accessible for further research approaches and can form the basis of future collaborative research proposals in the history, sociology and philosophy of science. It was decided to proceed with work in these directions by convening further meetings and elaborating concrete research plans. Further applications on a national basis to facilitate the envisaged meetings and collaborative work are underway in Germany, France and the UK.

## 4. Final Programme

### Thursday, 10 June 2010

- 12.30-13.00 *Welcome Sandwiches and Coffee*
- 13.00-13.30 **Welcome by Convenors and presentation of participants**  
**Matthias Heymann** (Aarhus)  
**Gabriele Gramelsberger** (Berlin)
- 13.30-14.00 **Presentation of the European Science Foundation (ESF)**  
**Aslihan Kerç** (Standing Committee for Life, Earth and Environmental Sciences (LESC))
- 14.00-15.00** **Introductory Lecture**  
**Numerical meteorology and epistemic uncertainty in the mid twentieth century**  
**Kristine C. Harper** (Tallahassee, USA)
- 15.00-16.00** **Afternoon Session: Ideas and Infrastructures**
- 15.00-16.00 **Discussion of papers by**  
**Sonja Palfner** (Darmstadt, Germany)  
**Hans Volkert/Dania Achermann** (Oberpfaffenhofen, Germany)
- 16.00-16.30 *Coffee / Tea Break*
- 16.30-18.30 **Discussion of papers by**  
**Martin Mahony** (Norwich, UK)  
**Nils Hundebøl** (Aarhus, Denmark)  
**Mathis Hampel** (Venice, Italy)  
**Matthijs Kouw** (Maastricht, The Netherlands)
- 20.00 *Dinner*

### Friday, 11 June 2010

- 9.00-10.30** **Morning Session: Computability**
- 9.00-10.30 **Discussion of papers by**  
**Hélène Guillemot** (Paris, France)  
**Vladimir Janković** (Manchester, UK)  
**Peter Brimblecombe** (Norwich, UK)
- 10.30-11.00 *Coffee / Tea Break*
- 11.00-12.30 **Discussion of papers by**  
**Arthur Petersen** (Bilthoven, The Netherlands)  
**Stig Andur Pedersen** (Roskilde, Denmark)  
**Thomas Ludwig** (Hamburg, Germany)
- 12.30-14.00 *Lunch*

<b>14.00-15.00</b>	<b>Afternoon Lecture</b> <b>Epistemic shifts in science</b> <b>Helge Kragh</b> (Aarhus, Denmark)
<b>15.30-17.30</b>	<b>Afternoon Session: "Good" Science</b>
15.00-16.00	<b>Discussion of papers by</b> <b>Thomas Potthast</b> (Heidelberg, Germany) <b>Mikaela Sundberg</b> (Stockholm, Sweden)
16.00-16.30	<i>Coffee / Tea Break</i>
16.30-18.00	<b>Discussion of papers by</b> <b>Henrik Kragh Sørensen</b> (Aarhus, Denmark) <b>Hans Feichter</b> (Zurich, Switzerland) <b>Mike Hulme</b> (Norwich, UK)
20.00	<i>Dinner</i>

## **Saturday, 12 June 2010**

<b>9.00-11.00</b>	<b>Final Session: How to deal with epistemic shift?</b>
9.00-9.30	<b>Commentary</b> <b>Kristine Harper</b> (Tallahassee, Florida, USA)
9.30-11.00	<b>Discussion on follow-up activities/networking/collaboration</b>
11.00	<i>End of Workshop and departure</i>

## 5. Final List of Participants

### Convenor:

1. **Matthias HEYMANN**  
Department of Science Studies  
Aarhus University  
Bygning 1110  
C.F. Møllers Alle 8  
8000 Århus C  
Denmark  
E-mail: [matthias.heyman@ivs.au.dk](mailto:matthias.heyman@ivs.au.dk)

### Co-Convenor:

2. **Gabriele GRAMELSBERGER**  
Institute of Philosophy  
Dept. of Philosophy and Humanities  
Freie Universität Berlin  
Habelschwerdter Allee 30  
14195 Berlin  
Germany  
E-mail: [gab@zedat.fu-berlin.de](mailto:gab@zedat.fu-berlin.de)

### ESF Representative:

3. **Aslihan KERÇ**  
Marmara University  
Faculty of Engineering  
Department of Environmental Engineering  
Marmara Universitesi Muhendislik Fak.  
Cevre Muh. Bolumu  
34722 Istanbul  
Turkey  
E-Mail: [aslihan.kerc@marmara.edu.tr](mailto:aslihan.kerc@marmara.edu.tr)

### Participants:

4. **Dania ACHERMANN**  
Mühlebachstr. 172  
8008 Zürich  
Switzerland  
E-mail: [dania.achermann@access.uzh.ch](mailto:dania.achermann@access.uzh.ch)
5. **Peter BRIMBLECOMBE**  
School of Environmental Sciences  
University of East Anglia  
Norwich NR4 7TJ  
United Kingdom  
E-mail: [p.brimblecombe@uea.ac.uk](mailto:p.brimblecombe@uea.ac.uk)
6. **Johann FEICHTNER**  
Liechtensteinerstr. 116  
6800 Feldkirch  
Austria  
Email: [johann.feichter@zmaw.de](mailto:johann.feichter@zmaw.de)

7. **Hélène GUILLEMOT**  
CNRS- Centre A.Koyré  
27, Rue Damesme  
75013 Paris  
E-mail: [guillemot@damesme.cnrs.fr](mailto:guillemot@damesme.cnrs.fr)
8. **Mathis Lauren HAMPEL**  
Prof. Franz Spath. Ring 11/8  
8042 Graz  
Austria  
E-Mail: [mathis.hampel@gmail.com](mailto:mathis.hampel@gmail.com)
9. **Kristine HARPER**  
Department of History  
Florida State University  
PO Box 3062200  
Tallahassee FL 32306-2200  
USA  
Email: [kcharper@fsu.edu](mailto:kcharper@fsu.edu)
10. **Mike HULME**  
School of Environmental Sciences  
University of East Anglia  
Norwich NR4 7TJ  
United Kingdom  
E-mail: [m.hulme@uea.ac.uk](mailto:m.hulme@uea.ac.uk)
11. **Nils Randlev HUNDEBØL**  
Department of Science Studies  
Aarhus University  
C.F. Møllers Alle 8  
8000 Århus C  
Denmark  
E-mail: [nils.randlev.hundeboel@ivs.au.dk](mailto:nils.randlev.hundeboel@ivs.au.dk)
12. **Vladimir JANKOVIĆ**  
History of Science, Technology and Medicine  
University of Manchester  
Simon Building, Oxford Road  
Manchester, M13 9PL  
United Kingdom  
E-mail: [Vladimir.Jankovic@manchester.ac.uk](mailto:Vladimir.Jankovic@manchester.ac.uk)
13. **Matthijs Vincent KOUW**  
Sillebergweg 2a  
6219 NL Maastricht  
The Netherlands  
E-mail: [m.kouw@maastrichtuniversity.nl](mailto:m.kouw@maastrichtuniversity.nl)
14. **Helge KRAGH**  
Department of Science Studies  
Aarhus University  
C.F. Møllers Alle 8  
8000 Århus C  
Denmark  
E-mail: [helge.kragh@ivs.au.dk](mailto:helge.kragh@ivs.au.dk)



15. **Thomas LUDWIG**  
Deutsches Klimarechenzentrum  
Bundesstraße 45a  
20146 Hamburg  
Germany  
E-mail: [ludwig@dkrz.de](mailto:ludwig@dkrz.de)

16. **Martin MAHONY**  
Flat 4  
3 College Road  
Norwich NR2 3JW  
UK  
E-mail: [M.Mahony@uea.ac.uk](mailto:M.Mahony@uea.ac.uk)

17. **Sonja PALFNER**  
Graduiertenkolleg Topologie der Technik  
Technische Universität Darmstadt  
Karolinenplatz 5 (Fach 1404)  
64289 Darmstadt  
Germany  
Email: [palfner@ifs.tu-darmstadt.de](mailto:palfner@ifs.tu-darmstadt.de)

18. **Stig Andur PEDERSEN**  
Department of Philosophy and Science  
Studies  
Roskilde University, PA6  
4000 Roskilde  
Denmark  
Email: [sap@ruc.dk](mailto:sap@ruc.dk)

19. **Arthur PETERSEN**  
Netherlands Environmental Assessment  
Agency  
P.O. Box 303  
3720 AH Bilthoven  
The Netherlands  
E-mail: [arthur.petersen@pbl.nl](mailto:arthur.petersen@pbl.nl)

20. **Henrik Kragh SØRENSEN**  
Department of Science Studies  
Aarhus University  
Bygning 1110  
C.F. Møllers Alle 8  
8000 Århus C  
Denmark  
E-mail: [hks@ivs.au.dk](mailto:hks@ivs.au.dk)

21. **Mikaela SUNDBERG**  
Sociologiska institutionen  
Stockholms universitet  
106 91 Stockholm  
Sweden  
E-mail: [mikaela.sundberg@sociology.su.se](mailto:mikaela.sundberg@sociology.su.se)

22. **Hans VOLKERT**  
Deutsches Zentrum für Luft- und Raumfahrt  
(DLR)  
Institut für Physik der Atmosphäre (IPA)  
82234 Oberpfaffenhofen  
Germany  
Email: [Hans.Volkert@dlr.de](mailto:Hans.Volkert@dlr.de)

## 6. Statistical information

### By nationality:

Austria:	2
Denmark:	5
France:	1
Germany:	4
Netherlands:	2
Sweden:	1
Switzerland:	1
UK:	4
USA:	1

**Total: 21**

### By gender:

Male:	19
Female:	7