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Regional Climate Services

illustrated with experiences from Northern Europe

Hans von Storch, Insa Meinke, Nico Stehr, Beate Ratter, Werner Krauss, Roger A. Pielke jr., Reiner Grundmann, Marcus Reckermann, Ralf Weisse*

Zusammenfassung

Dieser Beitrag erörtert den Charakter von Klimadienstleistungen („Climate Services“) bezogen auf politische und gesellschaftliche Entscheidungskontexte. Klimadienstleistungen dienen dazu, Entscheidungsoptionen zu entwickeln, Entscheidungsfelder zu öffnen und die Dynamik des Klimasystems besser zu verstehen. Neben einer allgemeinen Einordnung und Erörterung werden Beispiele für Klimadienstleistungen auf der regionalen und lokalen Ebene in Norddeutschland, der Metropolregion Hamburg und im Baltischen Meer und deren Wirkung in den politischen Bereich vorgestellt. Kernelemente von Klimadienstleistungen sind regionale Klimabüros, IPCC-vergleichbare regionale Sachstandsberichte und detaillierte, homogene Bestände an regionalen Klimadaten, die die Klimabeobachtungen in den zurückliegenden Dekaden und Projektionen in die Zukunft umfassen.

1. Introduction

In this article, we discuss the advisory capacity of climate science for political and societal decisions. To provide options, open up perspectives and enhance the understanding for the dynamics of climate is a task we name *climate services*. After a general discussion, experiences of providing these services on a regional and local scale – Northern Germany, the metropolitan area of Hamburg and the Baltic Sea Basin – during the last few years is reviewed. Key components of this regional climate service is the establishment of a regional climate office, of regional IPCC-like assessments of knowledge about regional and local climate change, and detailed homogeneous data sets describing changing weather statistics (i. e., climate) in past decades and in perspectives for the next several decades.

Our climate and ecology are changing; societies are changing as well. The speed with which each is being transformed appears to accelerate. Necessary political and economic decisions are about ways of dealing with *uncertain* future events and its

* The members of the author team (HvS, IM, BR, WK and RW), who are part of the CLISAP Center of Excellence in Hamburg, express the satisfaction of being part of the stimulating CLISAP environment. Some of the diagrams were prepared by Beate Gardeike.

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multitude of *contentious* challenges and pathways. Uncertainty resides in nature and society. In society uncertainty is rooted in the unpredictability of social life, that is, in human agency. The collective consciousness of the risks faced from nature and by society has reached an unprecedented level. The representation of the risks we face, our conception of what uncertainty happens to be, is to a large part a matter of social construction.

The different societal challenges, far from being driven only by ecological changes, include transformations in the foundations of the economy, changing values and perceptions, technological advances, and the rearrangement of geopolitical and global economic structures. These transformations take place on different time and spatial scales. The dilemma is that the likely consequences of political and economic actions taken today may be judged unfavorably just a few years later – even if they are based on a broad societal and international consensus. Specific contemporary strategies may be judged to be mistaken at a future time, when they do not comprise flexibility enabling future generations and societies to adapt attitudes and pathways consistent with their own values and perceptions. This might happen even when these strategies are based on what appear to be timeless universal ideals such as international and intergenerational justice and equity as criteria for political decisions.

The climate issue is often communicated as a fundamentally different political problem or, better, it is framed as a non-political issue. The climate problem is presented as an existential threat that is far worse than anything else humankind has ever been confronted with; even more, it is considered as different from other political issues in being associated with a dominant *calculative* and rationalist *conception of uncertainty*. This also accounts for the dominance of economist among social scientists engaged in climate research. In economics a rationalist model of uncertainty has long been dominant. The future uncertainty constitutive for political issues has been removed. In this mindset, only a single pathway is acceptable, for example, the reduction of global greenhouse gas emissions until the year 2100 to a level corresponding to an increase of global mean temperatures of 2 °C. Consequently, this is considered the only way to avoid the serious societal repercussions of global warming. Political assessments and judgments are virtually pre-empted and not required; instead, they are replaced by the findings of a climate science that clearly excludes any alternatives. Politics has been eliminated by science.

Even in times of globalization, people still live in different cultures. This diverse worldwide public is aware of the profound changes underway. In the case of the currently dominant discussion of climate change, people are confronted with a socio-political order that is less conscious of the values, visions and diverse aspirations such as the desire of the poor to gain access to affordable energy, to economic well-being, to education, to human rights and to live in harmony with their environment.

In the past, at high-level scientific and political meetings agreement on the principle of a change limited to no more than 2°C global mean temperature (relative to pre-industrial levels) was easily reached, whereas in practice hardly any substantial progress has been achieved – current atmospheric CO₂ concentrations are increasing unabatedly (Butler, 2009). In 2009, the international conference COP-15 in Copenhagen failed, and the US Senate has once again failed to pass its climate bill on cap and trade. Also COP-16 in Cancun has not caused renewed optimism that a significant reduction of the growth of greenhouse gas emissions would be imminent. Increasingly, different groups of scientists, politicians, social movements and the public are puzzled on how to adopt the international political agenda to the diverse realities we live in (Geden, 2010a,b). Even worse, the insistence on only a single solution is counterproductive in that it discourages societies to examine alternative pathways of dealing with climate change (Prins and Rayner, 2007), such as exploiting the ubiquitous process of modernization (Grossmann, 2001) and regional- or sectoral-specific approaches (Prins et al., 2010).

In the following we first – in Section 1 – discuss the problem of science-society interaction in case of climate science, which may be conceptualized by the framework of post normal science. The idealization of Merton's principles of scientific conduct is no longer applicable; instead concepts like that of the „honest broker“ turn out to be useful approaches, which in practical terms may take the form of regional climate service. In Section 2 experiences gained in the past years on how to build such regional climate service are described. Key elements of such service, namely the availability of regional climate offices, assessments reports of legitimate scientific knowledge and relevant descriptions (data sets) of climatic developments in past decades and scenarios for the coming decades are sketched. The paper is closed with a discussion in Section 3.

2. The role of climate science in planning for the future

As Roger Pielke jr. (2007), Luhmann (1997) and Grundmann and Stehr (2011) have argued, shifting the responsibility for a societal problem to the scientific community is based on a „linear model“ or instrumental model of the science-policy interaction. Such a model banks on a technocratic solution and thereby both depoliticizes policy-making and politicizes science. Depoliticizing policymaking leads to a lack of political debate with a disclosure of economic interests, ideological commitments and cultural values. It can also lead to deepening of opposing views (clad as scientific conflict), and eventually to a lack of broad social acceptance (see also Sarewitz, 2004). In turn, the politicization of science leads to an exaggerated encroachment of political, economic and social utility into the scientific research and the interpretation of scientific findings. Science and civil society commitments converge to some extent, as

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exemplified by the unopposed references to politically motivated grey literature in the WG-II report of the IPCC.

In both instances, societal systems, science and policymaking are suffering. It is recommendable to reconstitute a reasonable division of labor between science and society, which will have advantages for both systems. A new societal contract between society and climate science is needed, based for instance on a renewal and adaptation of traditional concepts (Mooney, 2010). Such an agreement should acknowledge the „post-normal“ state of contemporary science (Funtovicz and Ravetz, 1985; Ravetz, 2006) and reconsider the potential utility of the general norms of science as presented by Merton (1973; see also Stehr, 1978; Grundmann, 2010; von Storch and Stehr, 2010a).

Postnormality describes a situation, in which the uncertainty of scientific knowledge is inherently large, the societal demand for answers is urgent and – at the same time – the implication of any conclusions drawn from such science are costly and societally of great significance. Climate science is clearly in a postnormal phase (Bray and von Storch, 1999). Furthermore, interest-driven forces act upon science, and try to make it a supportive tool for preconceived agendas and political agendas.

In this situation, it is imperative to reconsider Merton's four scientific norms as summarized by Grundmann (2010):

„*Universalism*: Truth claims are to be subjected to pre-established impersonal criteria.

Communism: is the nontechnical and extended sense of common ownership of goods; the products of competition are communized („public domain“); there is an imperative for communication of data and research findings.

Disinterestedness: The virtual absence of fraud in the annals of science has to be attributed to a distinctive pattern of institutional control; it is in the interest of scientists to conform on pain of sanctions.

Organized Skepticism: Research is checked by rigorous, structured scrutiny of peers. This principle pervades into other spheres of society, unfolding its critical powers.“

Such an agreement would imply that science is not *a priori* taking into account the political (or more generally: societal) utility of scientific answers but only the political utility of the questions. Even though there are diverse views on Merton's writings, his ethos of science is a useful contribution to a guideline of social conduct; even if these norms are not strictly met in practice, this does not constitute sufficient reason to give them up. According to Pielke jr. (2007), one role for scientists is acting as 'honest brokers' – primarily through authoritative institutions – in the exchange with society and politics, instead of acting as (stealth) advocates or pure 'ivory tower' scientists. This implies that science recognizes the always-existing possibility of new

future findings that may lead to revisions of the current body of knowledge and an expansion of policy options. Science answers with the current knowledge questions about the dynamics of climate, the effect of certain societal activities on climate (emissions, land use change), and the effect of the present and possible future climate on societal activities (impacts). Science helps to work out response options enabling societies to choose solutions consistent with its values and goals. Instead of imposing an abstract order on society, climate science finally helps to localize and to root climate change and its effects in society in order to enable adequate regional and local responses (Krauss 2009, 2010).

In this sense, science is playing an important but supportive role; the decisive role is still with policymakers and society at large. Thus, science offers a knowledge-based services; science offers knowledge about climate dynamics, change and impact; while recognizing the possibility for revision, it both contributes to the societal contextualization of such knowledge, and accepts feedback into the scientific arena of socio-politically significant issues. We call this bundle of tasks and competencies **Climate Services**.

The societal conceptualization of climate change takes the form of possible response strategies – which could incorporate efforts to avoid climate change (mitigation; abatement), or to adapt to climate risks (adaptation) by reducing vulnerability to extreme weather events such as rain storms, flooding, wind storms, hail, or droughts (Hasselmann, 1990). Abatement can be accomplished by limiting the agent of change, i. e., the emissions, or by geo-engineering. Both approaches need political consensus and will only be effective on the international scale. Adaptation is dominantly a regional or local challenge, since climate risks manifest themselves mostly on a scale corresponding to individual landscapes, extending rarely across more than a few hundred kilometers.

Addressing the former, abatement, its potentials, options and perspectives, is mostly subject of Global Climate Services, whereas the science-society interaction revolving around at local and regional adaptation and mitigation is what we call **Regional Climate Services**. von Storch and Meinke (2008) have listed and discussed key elements of such a regional climate services, which are:

- 1) a „**Regional Climate Office**“, which establishes a dialogue with regional stakeholders.
- 2) an assessment about the **currently available, scientifically legitimate knowledge about regional climate** dynamics, change and impacts – as a kind of mini-IPCC.
- 3) a **data base** describing the regional weather stream in the past decades (typically 60 years), as well as scenarios of possible future climate until, mostly, 2100.

In the following we will describe implementations of such elements in Northern Europe and experiences gained with these elements.

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3. Regional Climate Services

The following presentation of regional climate services activities is based on several years of climate services practice, done at the Institute of Coastal Research of the Helmholtz Zentrum Geesthacht (<http://coast.hzg.de>) together with the Center of Excellence „Integrated Climate System Analysis and Prediction“ (CliSAP; <http://www.klimacampus.de/clisap0.html>).

Here, implemented examples of the three key elements, which were listed above, are:

- 5) the „**North German Climate Office**“ (<http://www.norddeutsches-klimabuero.de/>), which deals with stakeholders in the region of Northern Germany including the metropolitan region of Hamburg (this office has by now been complemented by a series of three other regional climate offices – see <http://www.klimabuero.de/index-en.html> and Schipper et al., 2009)¹.
- 6) an assessment about the **current knowledge about regional climate** dynamics, change and impacts; so far one report has been prepared for the Baltic Sea basin (BACC author team, 2007, or Reckermann et al., 2008) and one for the metropolitan region of Hamburg (von Storch et al., 2010b).
- 7) a **data base** describing the regional weather stream for Northern Europe, including the ocean weather (storm surges, waves mostly in the North Sea) in the past 60 years, as well as scenarios of possible future climate until 2100 (coastDat, see Weisse et al., 2009).

In the following subsections we will discuss these activities in some more detail.

3.1 Regional Dialog through Regional Climate Offices

A key element of any regional climate services is the building of a dialog between science and the public. Such an effort should be based on elements like these listed in Mooney (2010):

- 1) *Heterogeneity*. It is important to remember that both the „public“ and the „scientists/technologists“ are heterogeneous. ·
- 2) *Trust*. The scientific community must build and maintain the public's trust.
- 3) *Education*. Just as the public must be educated on scientific topics, so must the scientific community be educated on public attitudes and opinions.
- 4) *Communication*. There is a need to improve the forums for public communication.

1 For obvious reasons, most of the literature and the references about the regional climate offices are in German.

In this spirit, the Institute of Coastal Research of the Helmholtz Zentrum Geesthacht, as a scientific institution with competence in the field of regional climate research, has set up the North German Climate Office as an interface between science and practice. The intention was to allow for communication and discussion about climate change impacts and risks for Northern Germany. In this region risks are especially related to storms, storm surges and ocean waves (Ratter and Kruse, 2010), but also to flooding, droughts and heat waves as consequence of a changed energy and water cycle. These issues are part of the competence field of the Institute of Coastal Research, so that public need and part of the work done at the institute match well.

Additionally, a group at the institute is monitoring regional perceptions, and is engaged in Integrated Coastal Management research. An example for this work is shown in Figure 1. It shows the result of two surveys conducted among people living at the coast and in Hamburg about their concerns. Both populations share the perception that the major risk of climate and climate change is represented by storm surges (related to increased sea level and intensified storms), but surprisingly people in Hamburg, who are less threatened by storm surges, are more concerned about climate change than those living along the coast.

The communication between science, on the one side, and the public and stakeholders, on the other side, needs to be based on the current scientific knowledge. Besides communicating results of current climate change and perspectives for the future also the limitations and uncertainties associated with this scientific knowledge are to be conveyed. At the same time, science needs insufficient insight in the type of questions and concerns raised in the public and relevant for stakeholders.

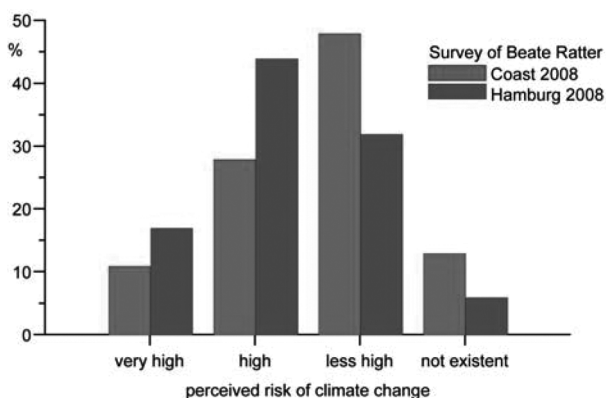


Figure 1: *Perceived risk along the North Sea coast and in the city of Hamburg related to climate change in 2008. (After Ratter et al. (2009), and Ratter and Kruse (2010))*

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Thus, there are two main tasks of the dialogue between science and the public – which is accomplished by the knowledge broker „North German Climate Office“. One is to explore the range of perceptions, views, questions, needs, concerns and knowledge in the public and among stakeholders about climate, climate change and climate risks. The other task is to convey the content of scientific knowledge into the public, to media and to stakeholders. This includes communicating the limitations of such knowledge, the known uncertainties and the unknowable, as well as the limited role of science in complex social decision processes.

Conceptual precision was found to be an important dimension of this dialogue. Concepts, which are particularly important, but often misunderstood, refer to forecasts and scenarios (which is even among scientists often mixed up; cf. Bray and von Storch, 2010), time and space scales, data inhomogeneity, change of statistics, detection and attribution of anthropogenic climate change, role of single extreme events.

An important internet tool, which became operational in 2009, is the regional climate atlas for Northern Germany (see <http://www.norddeutscher-klimaatlas.de>), which allows users an interactive access of regionalized changes of various climate variables at different time windows in the future for the North German region. The change is presented as average across all incorporated scenarios as well as maximum and minimum changes. Averaged across the region, expected summer changes are shown in Figure 2 as an example.

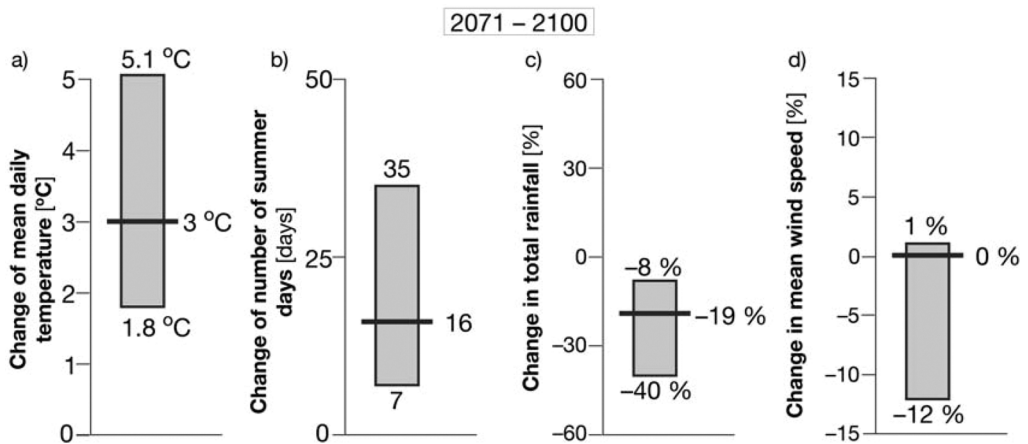


Figure 2: Range of changes in daily mean temperature (left, °C), of the number of summer days (a day with maximum temperature of 25°C or more) according to a series of scenarios, run with different models – for 2071-2100 relative to 1960-1990. (After Meinke and Gerstner, 2009)

3.2 Regional Climate Knowledge Basis – Climate Reports

While the fourth Assessment Report of the Intergovernmental Panel on Climate Change provided much needed knowledge about climate, climate change and impact, the need for such knowledge about regional and local conditions are generally missing. Such knowledge about regional results and scenarios are asked for by local decision-makers and stakeholders (Visbeck, 2008; von Storch and Meinke, 2008). Mimicking the IPCC, an outstanding example of a regional assessment is the BALTEX Assessment of Climate Change for the Baltic Sea Basin (BACC; Reckermann et al., 2008), which was compiled by a consortium of 84 scientists from 13 countries around the Baltic Sea (BACC Author Team, 2008). The assessment covers various disciplines related to climate research and related impacts.

The Baltic Sea Basin represents an old cultural landscape, and the Baltic Sea itself is among the most studied sea areas of the world. Thus, there is a wealth of information, in thousands of publications, concerning past climate conditions in the region. A large part of the information is not in English and also had not been available for western researchers, as the eastern part of the Baltic Sea basin had been behind the iron curtain until the early 1990s. The challenge was to install a writing team that could do „paper mining“ in their home countries and compile the material into a comprehensive, well-written assessment book. Besides looking at past and current climate change, the BACC report presents climate projections until the year 2100 using regional climate models, and an assessment of climate change impacts on terrestrial, freshwater, and marine ecosystems of the Baltic Sea basin.

The results of the BACC assessment process were not biased by political or economic interest groups, and it relied exclusively on published scientific evidence. The BACC report brought together consolidated knowledge which has broad consensus in the scientific community. At times, though, this consensus took the form of „consensus on dissensus“, meaning that for certain points contradicting opinions could not be resolved, as for instance in case of the degree of the past warming of Baltic Sea surface waters.

The BACC report made no recommendations for how to deal with the ongoing and expected future changes. Instead the BACC project liaised with the intergovernmental Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM), which used the BACC report as the basis for the management-oriented „HELCOM Thematic Assessment 2007“ on Climate Change in the Baltic Sea area which was officially adopted by representatives of Baltic Sea riparian states in March 2007. In this Thematic Assessment it reads: *„Adaptation to climate change will need to be regional and local and should aim to reduce the negative effects of climate change. In order to balance management decisions between the precautionary principle and scientific evidence, a robust basis of environmental observations and model projections*

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should be developed to support policy-making and management. ... The HELCOM strategy in relation to climate change should aim to limit or mitigate adverse impacts as well as to enhance the resilience of the Baltic marine environment by improving its capacity to cope with the stress of climate change. ... In order to increase our understanding of climate change and its impacts, it is necessary to continue long-term monitoring and data collection and to develop monitoring programmes further to take into account climate change-related aspects. ... Promotion of cross-sector and interdisciplinary scientific research is invaluable, while co-operation between the scientific and management communities is essential in order to develop cost-efficient and effective measures for adaptation. ... The implementation of the strategic Baltic Sea Action Plan ... to further reduce pollution in the sea and repair the damage done to the marine environment, will provide a basis for enhancing the resiliency and adaptive capacity of the Baltic Sea environment“.

The BACC assessment report has led to the launch of other, similar initiatives, for example, a climate report for the greater Hamburg area, Germany, published in November 2010 (von Storch et al., 2010b), and on the climate of the North Sea (NOSCCA). A 2nd BACC climate report, again compiled under the auspices of BAL-TEX, is due in 2014 (cf http://www.baltex-research.eu/organisation/bwg_bacc2.html). The report for the greater Hamburg area has been used as knowledge basis for writing the „Klimaschutzkonzept“ of the Hamburg Senate (2011)

3.3 Regional Climate Knowledge Basis – Detailed Data Sets

Various stakeholders, ranging from governmental agencies to companies and representatives of economic sectors, as well as regional scientific institutions are regularly asking not only for perspectives of future development but also about recent and current risks and potentials (e.g., concerning off-shore wind energy or other large-scale constructions). As a response to these inquiries, a data set named coastDat with coastal weather analyses and climate change scenarios for the future for Northern Europe has been compiled.

This data set contains no direct measurements but results from numerical models that have been driven either by observed data in order to achieve the best possible representation of observed recent and current conditions (typically 60 years – because it makes use of the NCEP re-analysis, when begins in 1948) or by climate change scenarios for the near future (typically 100 years). The model system used consists of a regional atmospheric model, a model of the hydrodynamics of continental shelf seas (North Sea) and two nested wave models – see for a sketch Figure 3. The key part of the coastDat data set comprises regional wind, wave and storm surge hindcasts and scenarios mainly for the North Sea. A comparison with the limited number of observational data points to the good quality of the model data in terms of long-term statistics such as multi-year return values of wind speed and wave heights.

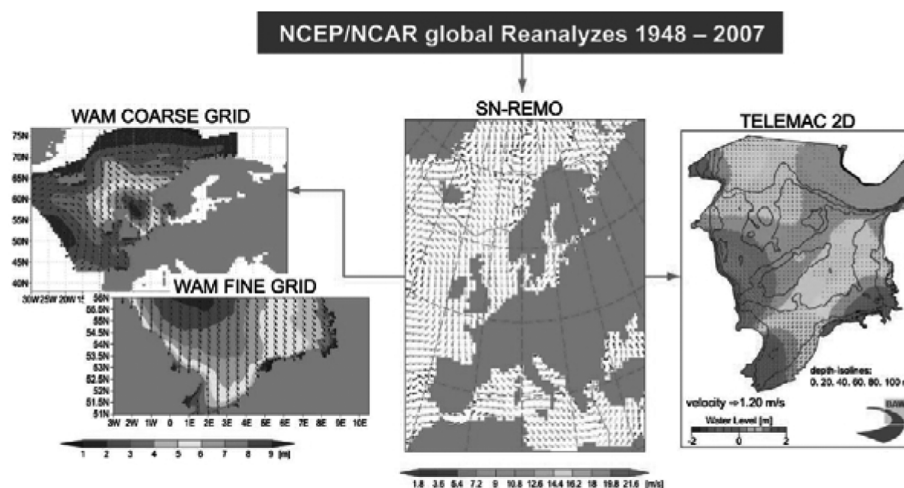


Figure 3. Layout of the consistent metocean hindcast 1948–2007 for the southern North Sea. From the (middle) regional atmosphere hindcast hourly wind fields were used to force a (right) tide surge and a (left) wave model hindcast. The figure shows an example of consistent metocean conditions obtained from the hindcast for 1200 UT C 21 Feb 1993. (middle) Near-surface (10-m height) marine wind fields (m s^{-1}), and corresponding wind direction obtained from the regional atmospheric reconstruction. Left: Corresponding significant wave height fields (m) and mean wave direction from the coarse and the fine grid wave model hindcast. Right: Tide surge levels (m) from the corresponding tide surge hindcast (from Weisse et al., 2009)

These model data provide a unique combination of consistent atmospheric, oceanic, sea state and other parameters at high spatial and temporal detail, even for places and variables for which no measurements have been made. In addition, coastal scenarios for the near-future complement the numerical analyses of past conditions in a consistent way.

A variety of coastal and offshore applications have taken advantage of these data sets. Examples comprise applications in ship design, oil risk modeling and assessment, or the construction and operation of offshore wind farms, marine energy use, coastal protection, water quality studies and navigation safety (Weisse et al., 2010).

4. Epilogue

Establishing climate services on regional and local levels implies that science might play a role as provider of scientific knowledge but also as an honest *broker* of action alternatives and thus a facilitator between politics, stakeholders and society. The climate problem is associated with a conception of uncertainty and has to be regionally

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embedded in different cultures. The different values, visions and diverse aspirations are crucial for the development of regional adaptation and mitigation strategies. In the context of the reconstitution of the reasonable division of labour between science and society, science has a more supportive role. Science can not provide answers in the sense of what to do and how to do it. As Merton puts it, the ethos of science is to be „the guideline of social conduct“ (see Grundmann 2010).

For scientific knowledge about climate change to become part of society's perception of risk and uncertainty, the regional experiences, memories and values have to be understood and analyzed. The information provided by science should be presented in an understandable way and be focused on the specific relevant regional impacts. Science can provide scientific insights on a regional level without pretending that the delivered information are static and fixed truths, but as part of the basis for political and societal action. In dialogue with regional politics and stakeholders, science becomes part of the negotiation process of how to adapt to climate change and to foster mitigation strategies. In doing so, climate change and its effects enter the political arena, with interdisciplinary climate science being a valuable contributor among others in the democratic process. In the realm of regional climate politics, science can provide scenarios and possible outcomes of societal decisions and ambitions. Climate Service is not restricted to greenhouse gas emissions; instead, climate change as a regional challenge entails also the social actors and their cultures.

In conclusion, regional climate services requires the understanding not only of the dynamics of the regional geo-system but also of the socio-cultural dynamics of the respective areas. The linear model, according to which the natural science analysis is sufficient to determine the „right“ way of action vis-à-vis the specter of anthropogenic climate change, does not adequately describe the complexities of the problem. Instead, the application of this model de-politicizes the societal problem „Global Warming“ and inhibits an openly value-based debate and decision process. At the same time, this model leads to a science constrained by its client's interests.

As we have shown in this article, Climate Services have to be based on a trans-disciplinary approach involving both natural and socio-cultural scientists. Our examples of the Climate Services during the past few years provide insights how this challenge can be met.

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