Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

POSTERS

On-site visit RU 1

25.01.2018

Scientific Evaluation
Coastal Research and Climate Services

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Handouts

Research Unit 1

System Analysis and Modelling

Prof. Corinna Schrum

Helmholtz-Zentrum Geesthacht

Centre for Materials and Coastal Research

Postersession & Presentations

Research Unit 1:
System Analysis and Modelling

Long-term changes of coastal systems

Long-term global climate simulations - Climate Globe Visualizations
    Birgit Hünicke, Frauke Feser, Eduardo Zorita, Sebastian Wagner

coastDat – Regional Reconstructions and Scenarios
    Ralf Weisse

coastDat – Deriving Added Value I: Offshore wind energy
    Beate Geyer

coastDat – Deriving Added Value II: Ecosystem modelling
    Ute Daewel

Risk management and Climate Change Adaptation as social process
    Beate Ratter, Birgit Gerkensmeier

Providing information – enabling knowledge.
The Northern German Coastal and Climate Office.
    Insa Meinke

Model Capacity Development with special focus on coastal impacts of natural and anthropogenic stressors

North Sea-Baltic Sea regional coupled models: atmosphere, waves and ocean
    Joanna Staneva, Ha Ho-Hagemann, Burkhardt Rockel

Ocean forecasting for the German Bight – from regional to coastal scales
    Emil Stanev, Johannes Schulz-Stellenfleth, Joanna Staneva

Regional, Coastal and Estuarine Numerical Modelling on Unstructured Grids
    Emil Stanev, Johannes Pein, Benjamin Jacob, Richard Hofmeister

Analysis of offshore windfarm wakes in the German Bight
    Johannes Schulz-Stellenfleth

Loss of primary producers due to benthic bivalves and bivalves on offshore wind farms
    Kai Wirtz, Carsten Lemmen

Organic matter input drives macrobenthic community structure and behaviour
    Anja Singer, Wenyan Zhang, Kai Wirtz, Carsten Lemmen

Socio-cultural values in marine and coastal policy – the case of wind energy
    Andreas Kannen

Long-term global climate simulations

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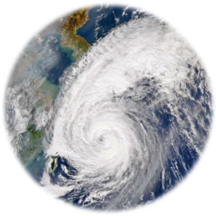
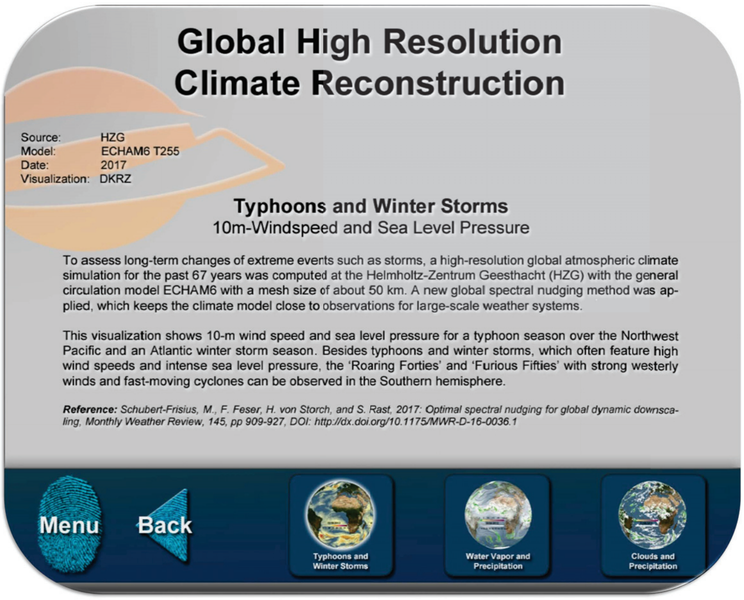
Climate Globe visualizations



We illustrate, on the technical basis of an "Omniglobe", selected results from two unique simulations conducted at HZG that demonstrate the relevance of global climate modelling to address questions which are important for coastal research, such as past and recent changes in the land-ocean system brought about by variations in extreme winds, precipitation and temperature. The visualizations were produced in cooperation with the German Climate Computing Center's (DKRZ) visualization group.



Long and homogeneous meteorological time series of the past decades are needed to deduce long-term changes of extreme events such as storms or extreme precipitation. For this purpose, gridded weather information based on observations is available, but only for the most recent decades with high resolution. Therefore, a new global atmospheric climate simulation for the past decades was performed which stays close to observations for large-scale weather systems such as the North Atlantic Oscillation or the Indian monsoon. Small-scale regional weather phenomena, which cannot be resolved by the gridded weather data, are simulated exclusively by the climate model. An added value in comparison to coarser reanalysis data can be gained for tropical and extra-tropical cyclones or regional storms.

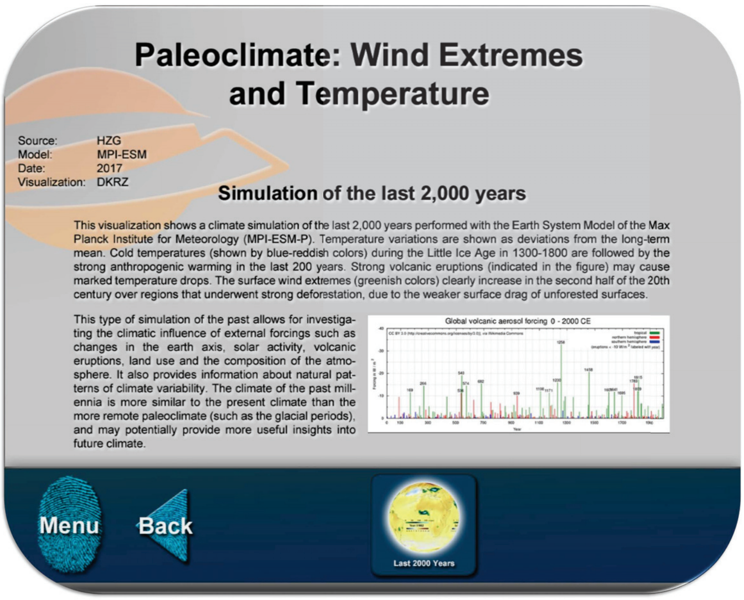
The global ECHAM6 climate simulation is available hourly for more than 200 meteorological variables via the CERA data base of the German Climate Computing Center (DKRZ).

High-resolution climate reconstructions of the last decades

- provide homogeneous global, complete 3-dimensional weather reconstructions
- allow to assess the variability of extremes and small-scale weather phenomena by analysis of the spatio-temporal clustering and their links to global climate

Selected References:

Feser, F., Barcikowska, M., Haeseler, S. Lefebvfre, C., Schubert-Frisius, M, Stendel, M., von Storch, H. and Zahn, M. 2015a: Hurricane Gonzalo and its extratropical transition to a strong European storm, In: Explaining Extremes of 2014 from a Climate Perspective, **Bull. Amer. Meteor. Soc.** 96, 51–55.
Schubert-Frisius, M., F. Feser, H. von Storch, and Rast, S. 2017: Optimal spectral nudging for global dynamic downscaling. **Monthly Weather Review**, 145, 909-927.
von Storch, H., Feser, F., Geyer, B., Klehmet, K., Li, D., Rockel, B., Schubert-Frisius, M., Tim, N. and Zorita, E. 2017: Regional re-analysis without local data - exploiting the downscaling paradigm. **Journal of Geophysical Research – Atmospheres** 122(16), 8631-8649.



Recent anthropogenic climate change is embedded in a background of natural climate and environmental variability. Disentangling the purely anthropogenic trends requires a realistic understanding of past environmental variations and of their mechanisms. The instrumental record is, however, too short to contain the full range of these variations. Together with long-term **Climate Model Simulations** and the analysis of indirect archives, we aim at reconstructing the natural climate and environmental patterns in the past and estimate their impact on land-ocean coastal systems for different aspects, such as morpho-dynamical changes or impacts to the ecosystem. The estimation of past natural climate changes enables us to gain information about expected future variations around the long-term trends in the next few decades.

Paleoclimate simulations

- complement proxy-based reconstructions to understand the mechanism of climate variability
- allow to assess the full variability of longer time periods not covered by the instrumental record

Selected Results:

- Variability of wind extremes is not related to changes in external forcing or global temperature
- Extremes may be stronger influenced by other drivers other than climate, in this case deforestation

Selected References:

Bierstedt, S.E., Hünicke, B., Zorita, E., Wagner, S. and Gomez-Navarro, J.J. 2016: Variability of daily winter wind speed distribution over Northern Europe during the past millennium in regional and global climate simulations. **Climate of the Past** 12, 317-338
Gagen, M. H., Zorita, E., McCarroll, D., Zahn, M., Young, G. H. F. and Robertson, I. 2016: North Atlantic summer storm tracks over Europe dominated by internal variability over the past millennium. **Nature Geoscience** 9, 630–635.
Wang, J., Yang, B., Ljungqvist, F.C., Luterbacher, J., Osborn, T.J., Briffa, K.R. and Zorita, E. 2017: Internal and external forcing of multidecadal Atlantic climate variability over the past 1200 years**. Nature Geoscience** 10, 512-517.
Zhang, W., Harff, J., Schneider, R., Meyer, M., Zorita, E. and Hünicke, B., 2014: Holocene morphogenesis at the southern Baltic Sea: simulation of multiscale processes and their interactions for the Darss-Zingst peninsula. **Journal of Marine Systems** 129, 4-18.

Long-term global climate simulations

Presenter:
Frauke Feser and Eduardo Zorita

Co-Authors:
Birgit Hünicke and Sebastian Wagner

Selected References:

High-resolution climate reconstruction of the last decades

Feser, F., Barcikowska, M., Haeseler, S. Lefebvfre, C., Schubert-Frisius, M, Stendel, M., von Storch, H. and Zahn, M. 2015a: Hurricane Gonzalo and its extratropical transition to a strong European storm, In: Explaining Extremes of 2014 from a Climate Perspective, **Bull. Amer. Meteor. Soc.** 96, 51–55.
In cooperation with: Princeton Environmental Institute, Princeton University, New Jersey; Deutscher Wetterdienst (DWD), Hamburg, Germany; Danish Climate Centre, Danish Meteorological Institute, Copenhagen, Denmark

Schubert-Frisius, M., F. Feser, H. von Storch, and Rast, S. 2017: Optimal spectral nudging for global dynamic downscaling. **Monthly Weather Review**, 145, 909-927.
In cooperation with: Max Planck Institute for Meteorology, Hamburg, Germany

von Storch, H., Feser, F., Geyer, B., Klehmet, K., Li, D., Rockel, B., Schubert-Frisius, M., Tim, N. and Zorita, E. 2017: Regional re-analysis without local data - exploiting the downscaling paradigm. **Journal of Geophysical Research – Atmospheres** 122(16), 8631-8649.
In cooperation with: Institute of Oceanology, Chinese Academy of Sciences, Qingdao, China

Paleoclimate Simulations

Bierstedt, S.E., Hünicke, B., Zorita, E., Wagner, S. and Gomez-Navarro, J.J. 2016: Variability of daily winter wind speed distribution over Northern Europe during the past millennium in regional and global climate simulations. **Climate of the Past** 12, 317-338
In cooperation with: Climate and Environmental Physics, Physics Institute and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Gagen, M. H., Zorita, E., McCarroll, D., Zahn, M., Young, G. H. F. and Robertson, I. 2016: North Atlantic summer storm tracks over Europe dominated by internal variability over the past millennium. **Nature Geoscience** 9, 630–635.
In cooperation with: Department of Geography, Swansea University, UK,

Ljungqvist, F.C., Krusic, P.J., Sundqvist, H.S., Zorita, E.,Brattström, G. and Frank D. 2016: Northern Hemisphere hydroclimate variability over the past twelve centuries. **Nature** 532, 94–98.
In cooperation with: Bolin Centre for Climate Research and Department (Dep.) of History, and Dep. of Physical Geography, and Dep. of Mathematics, Stockholm University, Stockholm, Sweden; Navarino Environmental Observatory, Messinia, Greece; Swiss Federal Research Institute WSL, Birmensdorf, Switzerland

Wang, J., Yang, B., Ljungqvist, F.C., Luterbacher, J., Osborn, T.J., Briffa, K.R. and Zorita, E. 2017: Internal and external forcing of multidecadal Atlantic climate variability over the past 1200 years**. Nature Geoscience** 10, 512-517.
In cooperation with: Key Laboratory of Desert and Desertification, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou, China; Department of History, and Bolin Centre for Climate Research, Stockholm University, Stockholm, Sweden, Department of Geography, Climatology, Climate Dynamics and Climate Change, and Centre for International Development and Environmental Research, Giessen, Germany; Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich, UK

Zhang, W., Harff, J., Schneider, R., Meyer, M., Zorita, E. and Hünicke, B., 2014: Holocene morphogenesis at the southern Baltic Sea: simulation of multiscale processes and their interactions for the Darss-Zingst peninsula. **Journal of Marine Systems** 129, 4-18.
In cooperation with: Institute of Physics, Ernst-Moritz-Arndt-University of Greifswald, Greifswald, Germany; Institute of Marine and Coastal Sciences, University of Szczecin, Szczecin, Poland; Baltic Sea Research Institute Warnemünde, Rostock, Germany

coastDat
Regional Reconstructions and Scenarios

Helmholtz-Zentrum Geesthacht
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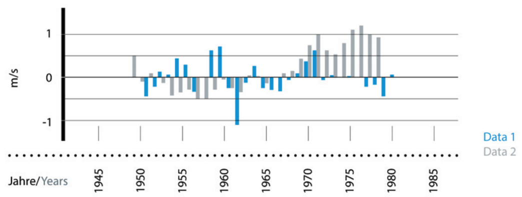
Why coastDat?

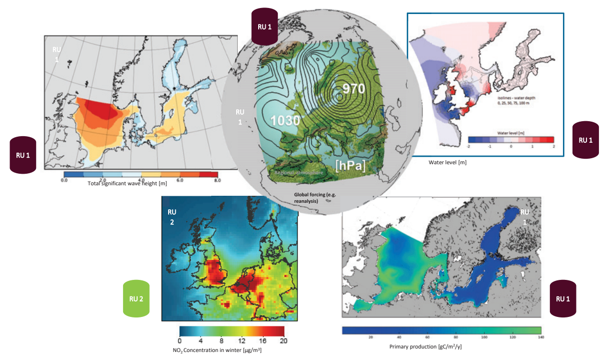
- A large variety of **research questions** in coastal and near-shore marine research such as the estimation of variability and trends **require long records of consistent and homogeneous meteo-marine data**. Often such data are unavailable for various reasons.
- In many cases **observational records are too short** to cover the full range of variability and estimates based on short time series therefore may be biased. In some cases, **sampling in space and time is insufficient** or data for the **parameters of interest are unavailable**.
- Frequently, **longer records are not homogeneous**. For example changes in measurement techniques may exist that may introduce artificial variability or spurious trends in the data.



Changes in mean wind speed in the vicinity of an ocean weather station derived **from two different sources**. While data from one source indicate a strong upward trend, data from the other source do not show such a signal. **Data from at least one source are not homogeneous**.

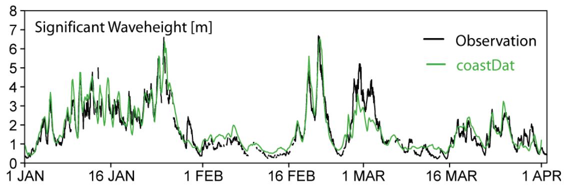
What is coastDat?

- A **model based meteo-marine data base** for the assessment of long-term variability and change.
- **Development of techniques** and methods (e.g. spectral nudging or assessment of added value)
- Contains **regional reconstructions** of past (1948-today) meteo-marine conditions and corresponding **regional climate change projections** until 2100

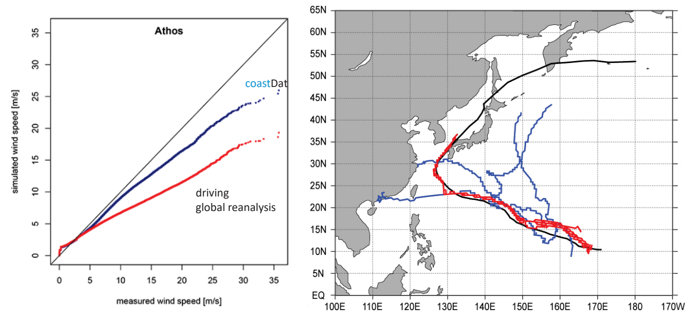


The present coastDat model system: A ***regional atmosphere model*** (middle) is forced by global data (reanalysis, climate change scenarios). High-resolution data are then used to drive ***wind wave*** (upper left), ***tide-surge*** (upper right)**, *air chemistry*** (lower left) and ***ecosystem models*** (lower right). Most of the simulations were done for the **North Sea** and the **Baltic Sea**. Other simulations were performed for **SE Asia** and **Arctic** regions.

How good can we model and Is there an added value?



Comparison between observed and modelled significant wave heights and for a three month period in 1993. In general good agreement is inferred.



Two ***examples of added value***: (Left) Comparison of quantiles between simulated and observed wind speeds at 100 m height for Athos illustrates that compared to the driving data coastDat improved the representation of the observed frequency distribution. (Right) Comparison of the observed track for Typhoon Songda with those obtained from an ensemble of RCM simulations with (red) and without (blue) spectral nudging illustrates the improved model performance using spectral nudging.

What is coastDat used for?

- It is used for addressing a variety of research questions such as "**How has the marine climate changed?"** or "**What changes to expect in the future?".** This way coastDat contributes to the understanding and assessment of past, ongoing and future long-term variability and change.
- It is used for providing **aid in the interpretation of** (short) **monitoring data**.
- It is used by **more than 100 external users** from industry (45%), science (40%) and authorities (15%). Applications range from, for example, uses in **naval architecture** or **risk assessment** to renewable energies including **offshore wind**.
- It provided the basis for international collaboration and internal and external PhD and Master theses.

Key References:

Weisse, R.; Bisling, P.; Gaslikova, L.; Geyer, B.; Groll, N.; Mahboubeh, H.; Matthias, V.; Maneke, M.; Meinke, I.; Meyer, E.; Schwichtenberg, F.; Stempinski, F.; Wiese, F.; Wöckner-Kluwe, K. 2015: Climate services for marine applications in Europe. Earth Perspectives, 2:3, 1-14.

Geyer, B., 2014: High-resolution atmospheric reconstruction for Europe 1948–2012: coastDat2. Earth Syst. Sci. Data, 6, 147-164.

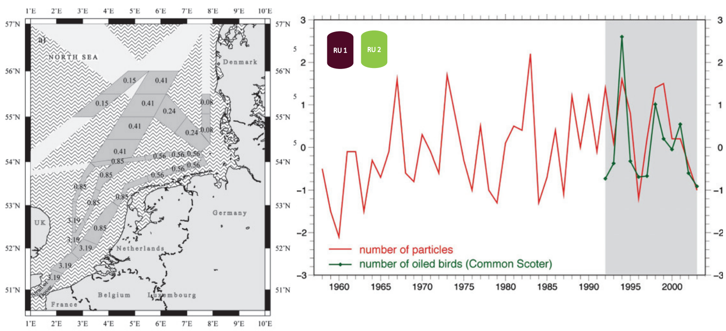
Groll, N.; Weisse, R. 2017: A multi-decadal wind-wave hindcast for the North Sea 1949–2014. coastDat2. Earth Syst. Sci. Data, 9 955–968.

Geyer, B.; Weisse, R.; Bisling, P.; Winterfeldt, J. 2015: Climatology of North Sea wind energy derived from a model hindcast for 1958–2012. J. Wind Eng. Ind. Aerodyn. 147, 18–29.

Feser, F.; Barcikowska, M. 2012: The influence of spectral nudging on typhoon formation in regional climate models. Environ. Res. Lett., 7, 014024.

Weisse, R.; von Storch, H.; Callies, U.; Chrastansky, A.; Feser, F.; Grabemann, I.; Günther, H.; Pluess, A.; Stoye, T.; Tellkamp, J.; Winterfeldt, J. & Woth, K. 2009: Regional Meteorological-Marine Reanalyses and Climate Change Projections: Results for Northern Europe and Potential for Coastal and Offshore Applications Bulletin of the American Meteorological Society, 90, 849-860.

Aid in the Interpretation of Monitoring Data



Beached bird surveys often serve as indicators for **chronic oil pollution (COP)** but **monitoring programs are relatively short**. They **indicate a decline in COP** in recent years (green line, right). Assuming constant releases of oil along major shipping routes (left), **simulations with coastDat** coupled with a Lagrangian transport and an oil chemistry module **reveal that the decline over the past years is mostly related to weather variability**.

Outlook/Conclusion/Summary

- **Techniques, methods and data sets developed useful for assessing long-term changes and variability**
- **More than external 100 users from science, industry and administration**
- **Ensembles need to quantify uncertainties in reconstructions**
- **Extension of system to include additional components and interactions**

coastDat
Regional Reconstructions and Scenarios

Presenter:
Ralf Weisse

Co-Authors:
Peter Bisling, Ulrich Callies, Ute Daewel, Frauke Feser, Lidia Gaslikova, Beate Geyer, Nikolaus Groll, Volker Matthias, Elke Meyer

Selected References:

Weisse, R., Bisling, P., Gaslikova, L., Geyer, B., Groll, N., Mahboubeh, H., Matthias, V., Maneke, M., Meinke, I., Meyer, E., Schwichtenberg, F., Stempinski, F., Wiese, F., Wöckner-Kluwe, K. 2015: Climate services for marine applications in Europe. **Earth Perspectives**, 2:3, 1-14.
In cooperation with: HOCHTIEF Solutions AG, Hamburg, Germany; Universität Flensburg, Flensburg, Germany; Flensburger Schiffbau-Gesellschaft mbH & Co. KG, Flensburg, Germany.

Geyer, B. 2014: High-resolution atmospheric reconstruction for Europe 1948-2012: coastDat2**. Earth Syst. Sci. Data**, 6, 147-164.

Groll, N., Weisse, R. 2017: A multi-decadal wind-wave hindcast for the North Sea 1949–2014. coastDat2. **Earth Syst. Sci. Data**, 9, 955–968.
In cooperation with: Coordinated Ocean Wave Climate Project (COWCLIP).

Mohr, S., Kunz, M., Geyer, B. 2015: Hail potential in Europe based on a regional climate model hindcast. **Geophys. Res. Lett.**, 42, 10,904-10,912.
In cooperation with: Institute of Meteorology and Climate Research (IMK-TRO), Karlsruhe Institute of Technology, Karlsruhe, Germany; Center for Disaster Management and Risk Reduction Technology, Karlsruhe and Potsdam, Germany.

Geyer, B., Weisse, R., Bisling, P., Winterfeldt, J. 2015: Climatology of North Sea wind energy derived from a model hindcast for 1958–2012. **J. Wind Eng. Ind. Aerodyn**., 147, 18–29.
In cooperation with: GE Wind Energy GmbH, Salzbergen, Germany.

Feser, F., Barcikowska, M. 2012: The influence of spectral nudging on typhoon formation in regional climate models. **Environ. Res. Lett**., 7, 014024.
In cooperation with: Princeton Environmental Institute, Princeton University, New Jersey, USA.

A full list of publications and theses contributing to the development or using coastDat is available from:
http://www.coastdat.de/publications/index.php.en

coastDat - Deriving Added Value I

Helmholtz-Zentrum Geesthacht
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Offshore wind energy

Until 2030 the German installed capacity will reach 15 GW. Long term trends and spatial and temporal variability of wind speeds play an important role for evaluating performance of offshore wind farms and supporting construction projects.

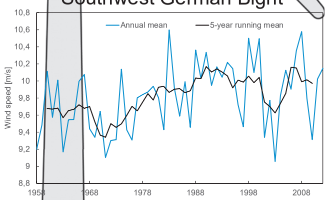
Data from coastDat are optimal for those purposes due to there long time period and high spatial and temporal resolution.

Positions of wind farms using data from coastDat during the design phase.

Multidecadal simulations

How has the marine climate changed?

Southwest German Bight

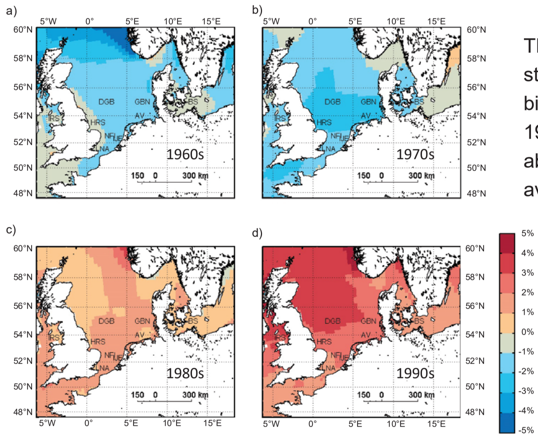


The time series of model-based coastDat wind speeds at 100 m height shows high annual variability.
They were used to assess wind power potential considering both spatial and temporal variability.

- The amplitude of decadal variability is not homogenous for the North Sea but depends on the distance to coasts and the deeper ocean.
- General features like two distinct minima and the pronounced maximum in the 1990s are common for the hole area.

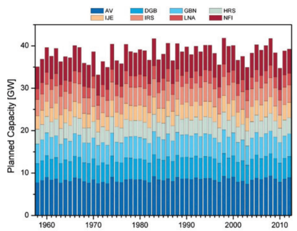
References: Geyer, B., Weisse, R., Bisling, P., Winterfeldt, J., 2015. Climatology of North Sea wind energy derived from a model hindcast for 1958–2012. J. Wind Eng. Ind. Aerodyn. 147, 18–29. ;
Geyer, B., 2014: High-resolution atmospheric reconstruction for Europe 1948–2012: coastDat2, Earth Syst. Sci. Data, 6, 147-164, doi:10.5194/essd-6-147-2014
RLI: Rainer-Lemoine-Institute, Berlin

How is offshore wind energy impacted by changes in the wind field?



The wind speeds show strong decadal variability, the values of the 1990s are considerable above the long-term average.

Deviations of decadal mean wind speeds from long-term mean at a height of 100 m.

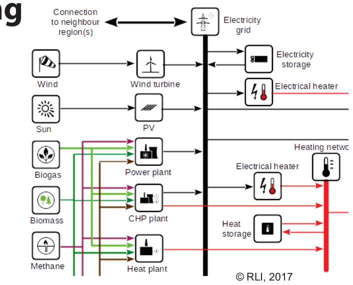


Combining the power output of the largest arrays planned in the North Sea does not compensate the year to year variability of wind speed as all farms are exposed to too similar wind fields.

Annual power output of the planned arrays.

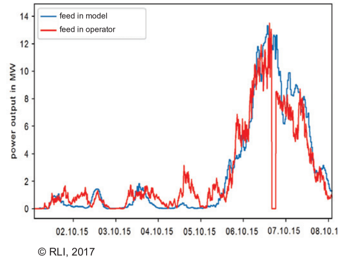
Relevance and further applications

Energy system modeling



The energy system model OEMOF: simulation of the flow within complex power grids is forced with atmospheric data from coastDat.

Wind farm at Nordstrand

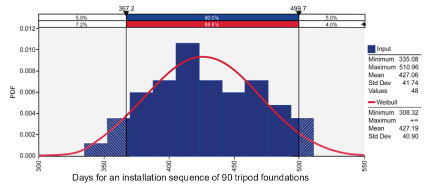


Time series of simulated and actual feedin estimated with the energy system model.

Such feed-in calculated over Germany helps to find optimal locations for power storages.

Development of realistic construction procedures - to minimize expected weather downtimes

Possible project duration in in the North Sea



The procedure is now operational in the Comprehensive Offshore Analysis and Simulation Tool (COAST) developed by Fraunhofer IWES which uses and distributes coastDat as standard met-ocean data base.

Summary
- **coastDat provides high quality information for planning and installation of wind farm constructions**
- **Long term changes in the wind field are economically important**

coastDat
Deriving Added Value I

Presenter:
Beate Geyer

Co-Authors:
Peter Bisling, Ralf Weisse, Burkhardt Rockel, Ronny Petrik

Key References:

Geyer, B., Weisse, R., Bisling, P., Winterfeldt, J., 2015. Climatology of North Sea wind energy derived from a model hindcast for 1958–2012. J. Wind Eng. Ind. Aerodyn. 147, 18–29.

Geyer, B., 2014: High-resolution atmospheric reconstruction for Europe 1948–2012: coastDat2, Earth Syst. Sci. Data, 6, 147-164, doi:10.5194/essd-6-147-201.

coastDat

Deriving Added Value II

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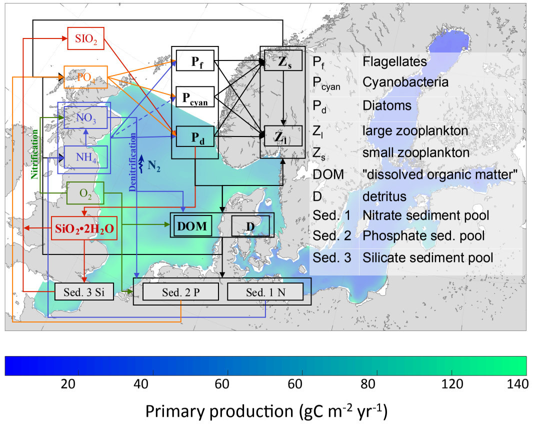
Ecosystem modelling

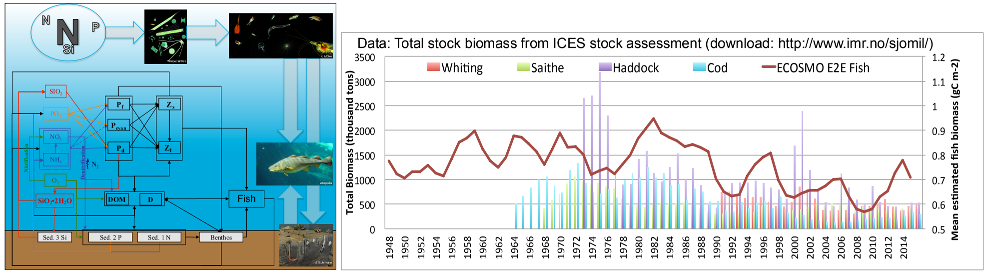
Long-term changes in nutrient cycling and primary production serve as indicators for the environmental status of an ecosystem, and determines e.g. the growth of harmful algae blooms and fish.

The fully coupled ecosystem model ECOSMO (Daewel and Schrum, 2013) estimates changes of lower trophic level productivity in the **North Sea** and **Baltic Sea** for the time period of 1948-2008 using NCEP/NCAR re-analysis atmospheric forcing.



Relevance and future applications

Understanding changes in fish stock biomass and recruitment variability

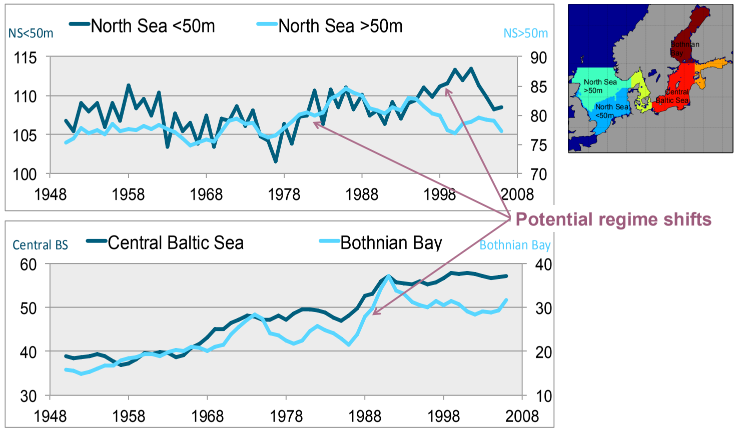


Simulations with the advanced model system ECOSMO E2E including fish and macrobenthos as functional groups. The figure shows annually averaged fish biomass estimates and fish stock biomass from ICES stock assessment for several gadoid species in the North Sea.

Multidecadal simulations

How has the marine climate changed?

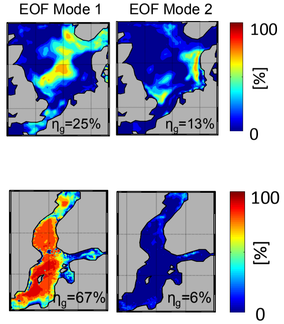
Long term variability of estimated primary production (5 yr running mean)



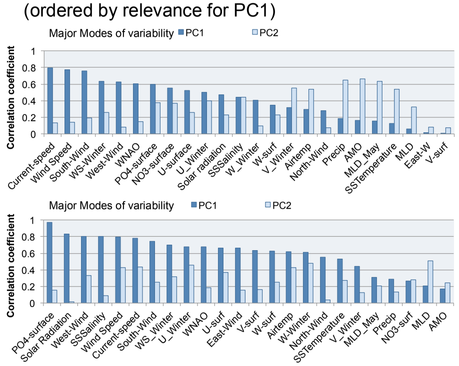
Why has the marine climate changed?

Empirical Orthogonal Functions: Identification of spatio-temporal modes of variability

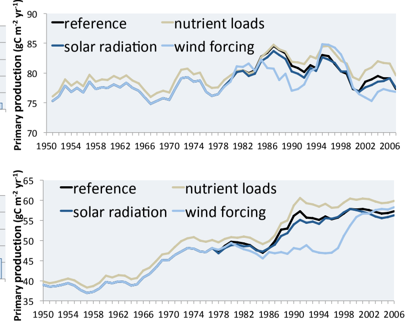
Local explained variance



Correlation analysis: Identification of statistical relationships between the two first major modes of variability (PC: Principle Components) and environmental variables (ordered by relevance for PC1)



Scenario Simulations: through artificial alterations of the temporal variability of forcing variables we identified changes in the wind field to cause major shift in primary production of the North Sea and Baltic Sea.



Conclusion

- Long-term hindcast simulations enables understanding of processes underlying spatio-temporal variations in primary production of regional ecosystems
- Temporal variations in primary production in the North Sea and Baltic Sea are related to reported "regime shifts" in the systems
- Wind field variations determine major changes in ecosystem productivity in the North Sea and Baltic Sea
- In the North Sea, long-term changes of primary production and its causes additionally differ locally in relation to hydrographic features

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Deriving Added Value II

Presenter:
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Key References:

Daewel, U., Schrum, C., 2017. Low-frequency variability in North Sea and Baltic Sea identified through simulations with the 3-D coupled physical-biogeochemical model ECOSMO. Earth Syst. Dyn. 8.

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Risk management and Climate Change Adaptation as social process

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Storms and storm surges in long-term trends

Model-based constructions are used in assessing long-term environmental changes. These assessments show changes in storm activity over the North Atlantic and Northwestern Europe and an increased storm surge activity during the last decades. Periods of low storm activity are particularly critical, due to risk of decreasing risk awareness.

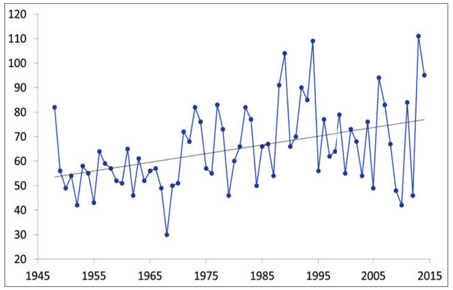


Figure 1: Storms over North Atlantic

The figure shows tracked storms <978 hPa October-March based on CoastDat data 1948 until 2015 (Feser, unpublished)

During the last decades an increase in storm activity can be seen over the North Atlantic. But for longer time scales, no long-term trend is visible, only large decadal variability. At the beginning of the nineteenth century storm activity showed very large values, followed by a decrease until the mid-1960s and then again an increase during the most recent decades.

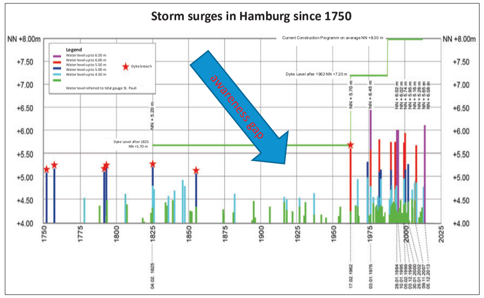


Figure 2: Storm surges in Hamburg St. Pauli since 1750 - including dyke breaches and dyke height development

Between 1828 and 1962 there was no major storm surge affecting the city of Hamburg which led to an *awareness gap* among the population and in consequence a leak in disaster preparedness for the major storm surge of 1962 (Ratter and Kruse 2010)

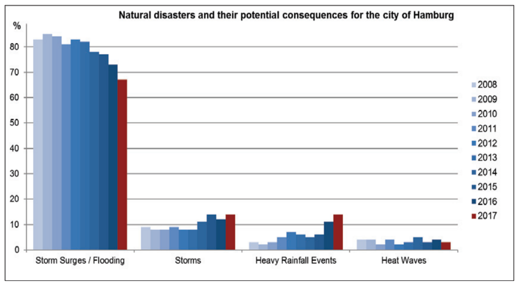
Risk perception in long-term trends

REKLIM Helmholtz-Verbund Regionale Klimaänderungen

Research on people in relation to existing risks such as climate change helps to better understand the different ways by which people deal with their concerns. The long-term, annual survey series among Hamburg citizens (2008-2017) is unique and shows how risk perception depends on experience *and* collective memory.

Figure 3: People's assessment of major hazardous impact on Hamburg due to climate change

Based on collective memory storm surges are assessed as dominant consequence of climate change impacts in Hamburg and only more recently occurring events (wind storms, heavy precipitation) show a change in perception (Ratter 2017; Döring and Ratter 2017)



Stakeholder Involvement

Empirical studies on risks and climate change perception along the German North Sea coast help identifying opportunities to foster preparedness and adaptation – integrating risk reduction within and across sectors. *Participation* beats *information provision*.

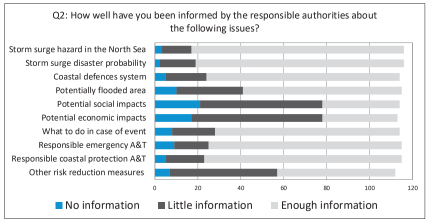


Figure 5: Assessing stakeholders' information on storm surge management at the German North Sea Coast (Gonzalez-Riancho, Gerkensmeier and Ratter 2017)

Assessing measures / strategies

- Managers at the German North Sea coast generally feel well informed on the surge hazard but less about potential and social impacts
- Lower rating for soft protection and spatial planning effectiveness
- High credibility of hard engineering measures & the high trust in hard protection in storm surge management.

IH cantabria

Assessing roles and activity level

- Managers along the North Sea coast tend to shift the responsibility in risk management to the authorities
- But stakeholder also see the need to be involved
- Currently little activities exist beyond public approaches
- Proactive behaviour and preference for participatory risk management options

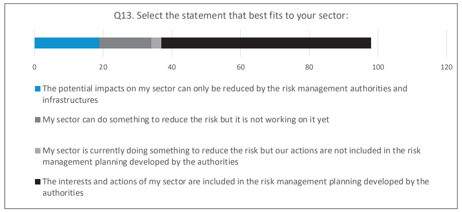


Figure 4: Analysis of stakeholder behavioral patterns (Gonzalez-Riancho, Gerkensmeier and Ratter 2017)

Multi-sector Partnerships (MSP)

WADDEN SEA FORUM

Results from our collaborative work with the Wadden Sea Forum show that the concept of MSP is a practical tool to initiate cooperative processes, to improve and to reframe risk management by involving a mix of partners from public, private and civil society. MSP can foster the discussion on coastal risk management as a transnational, cooperative endeavour.

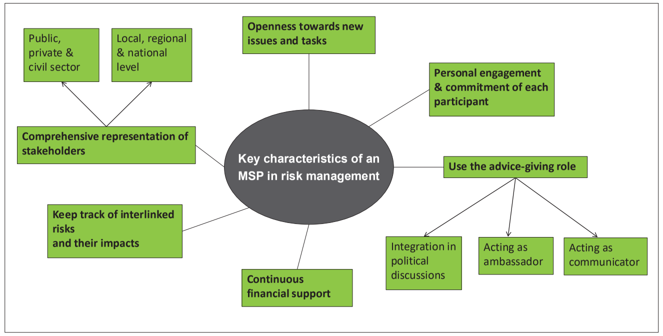


Figure 6: Key characteristics and benefits of a Multi-Sector-Partnership (MSP), based on our experiences with the Wadden Sea Forum (EU-ENHANCE project 2013-2016)(Gerkensmeier and Ratter 2016)

Integrated Risk Management Approach

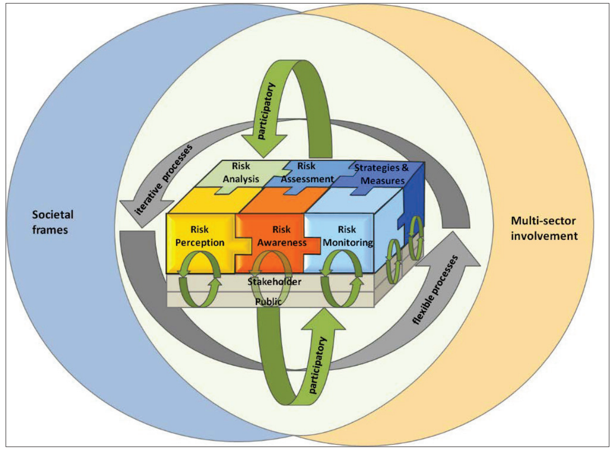


Figure 7: Setting and elements of the Integrative Risk Management Approach (IRMA) – EU Research project ENHANCE (Gerkensmeier and Ratter 2018)

enhance Partnership for Risk Reduction

Integrated Risk Management:

- ➢ is a dynamic and continuous process that stresses consideration of historical framing, risk perceptions and risk awareness of different actors and groups of people;
- ➢ is a crucial task for the sustainable development of coastal regions which needs to coordinate and to balance different interests and to mediate disputes.
- ➢ It considers the traditional elements of risk management (risk analysis, risk assessment, risk evaluation and monitoring) and is embedded in its societal frame, complementing technical and natural science based risk management approaches.
- ➢ Integrated Risk Management requires the support of the society, of different sectors and multiple stakeholders.

Conclusion:

- **Integrated Risk Management is a socially embedded and collaborative process and more than a technical endeavour.**
- **Integration of different (place based) perceptions of risks is fundamental.**
- **Integration of physical assessments as well as sectoral and societal interests fosters successful risk management.**
- **⇨ Risk management is about shaping the future.**

Risk management and Climate Change Adaptation as social process

Presenter:
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Co-Authors:
Martin Döring

References:

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National and International Cooperations:

Providing information – enabling knowledge

-the Northern German Coastal and Climate Office

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Introduction

Although many aspects of coastal research are decision relevant, scientific results cannot directly transferred into practice.

Objective:
Establish a stakeholder dialogue in order to generate decision relevant knowledge

- Since ten years the Northern German Coastal and Climate Office maintains an intensive stakeholder dialogue.
- **More than 2000 stakeholders** from eight user groups have registered for this service, so far (Fig. 1).
- Different communication formats have been developed and established:

Direct inquiries, contribution to stakeholder events (talks and discussions), workshops, expert interviews and surveys.

Stakeholder groups

Norddeutsches **Küsten- und Klimabüro**

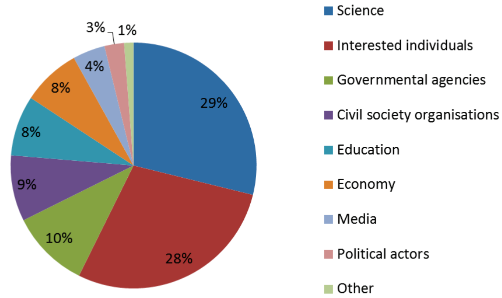


Fig. 1: User groups of the Northern German coastal and climate office (N=2064, January 2018)

Cluster returning information demands

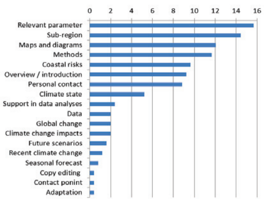
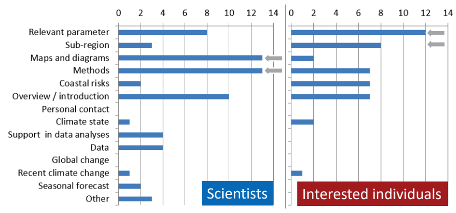


Fig. 2: Focus of individual requests (all groups)

- **Analyses of regional climate data**
  - Relevant parameters
  - Sub-regions of Northern Germany
  - Recent changes, climate state, possible future changes
- **Understandable summaries**
  - Climate change in Northern Germany
  - Coastal risks
  - Methodical aspects



Focus of requests differ among stakeholder groups

Fig. 3: Focus of individual requests from different stakeholder groups

Communication forms addressing stakeholder demands

Regional Assessments of Climate Change

Motivation: Scientific agreement is not documented on regional scales
Basis: Peer-reviewed articles
Method: Lead authors document agreement, disagreement and gaps; Peer-review process

Fig. 4: Regional assessment reports organized by HZG

- **Six** regional assessment reports have been coordinated @ HZG (Fig. 4):
- Metropolitan Region of **Hamburg and Northern Germany** I and II (2010 & 2017, organized by the Northern German coastal and climate office)
- **Baltic Sea Basin** -BACC I and II (2008 and 2016, organized by BALTEX / Baltic Earth secretary)
- **North See Region** -NOSCCA (2016, organized by IFK, research unit 2)
- **Germany** (2016, organized by GERICS)

Adopted for political planning processes by the Hamburg senate and HELCOM.

Understandable summaries in national language

Booklets, brochures & websites on regional climate change:
Research results on climate change in Northern Germany and sub regions are summarized in understandable booklets, brochures and websites in national languages (Fig.5). Source: Regional assessment reports (Fig. 4).

Fig. 5: Brochures and web sites with understandable

Regional climate scenarios in practice - understandable explanations on the methods

Many stakeholders are not used to plan with uncertainties. In these brochures we focus these issues and give some good practice examples of using regional climate scenarios in practice (Fig. 6).

Fig. 6: Fact sheets on reg. climate scenarios

Web-tools on coastal climate

norddeutscher-klimamonitor.de
climate state, recent climate changes and consistency with scenarios. Basis: Observations and regional reanalyses (last 60 years).

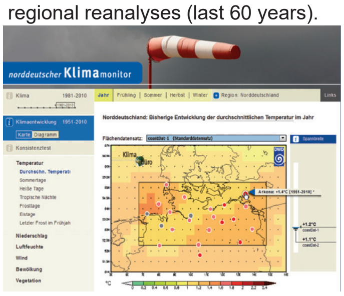


Fig. 7: Web-tool norddeutscher-klimamonitor.de

norddeutscher-klimaatlas.de
possible future climate change in Northern Germany. Basis: More than 120 regional climate projections (SRES and RCP).

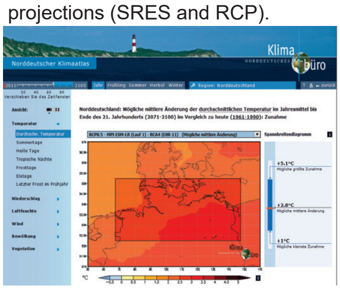
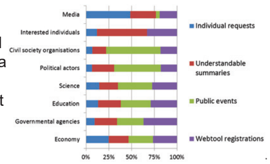


Fig. 8: Web-tool norddeutscher-klimaatlas.de

References:
Meinke, I. (2017): Stakeholder-based evaluation categories for regional climate services – a case study at the German Baltic Sea coast, Adv. Sci. Res., 14, 279-291.
Meinke, I. et al. 2014: Norddeutscher Klimamonitor: Klimazustand und Klimaentwicklung der letzten 60 Jahre (1951-2010). DMG 2014/1,

Fig. 10: Requested communication form by different user groups



Web-tool on coastal climate change impact

Kuestenschutz bedarf.de
is an interactive web tool on recent and possible future coastal protection needs in Northern Germany. Basis are actual water levels and possible future changes.

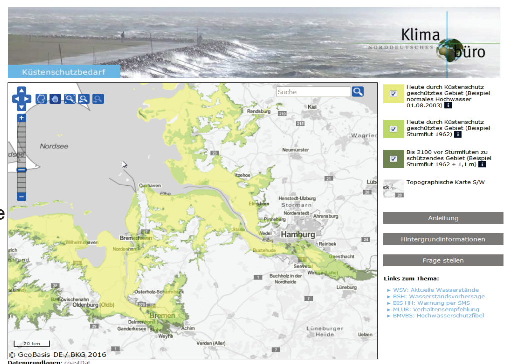


Fig. 9: Web-tool kuestenschutzbedarf.de

Conclusion and Summary

- Besides coastal & climate research a long term dialogue infrastructure is needed to make coastal research usable in practice.
- In a long term dialogue process user demands were localized, different communication forms were developed, tested and established.
- All communication forms are requested & needed.
- Each user group prefers certain communication forms (Fig. 10).

Providing information – enabling knowledge
-the Northern German Coastal and Climate Office

Presenter:
Insa Meinke

Key References:

Meinke, I. (2017): Stakeholder-based evaluation categories for regional climate services – a case study at the German Baltic Sea coast, Adv. Sci. Res., 14, 279-291.

Meinke, I. et al. 2014: Norddeutscher Klimamonitor: Klimazustand und Klimaentwicklung der letzten 60 Jahre (1951-2010). DMG 2014/1

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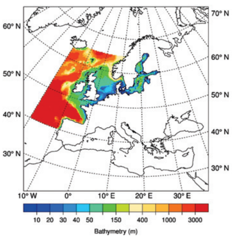
North Sea-Baltic Sea regional coupled models: atmosphere, waves and ocean

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

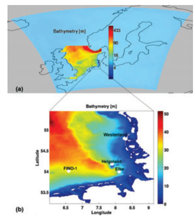
Motivation

The coupling of models is a commonly used approach when addressing the complex interactions between different components of earth system. This study presents the recent developments of a new, high-resolution, coupled atmosphere, ocean and wave model system for the North Sea and the Baltic Sea. The proposed coupling parameterizations account for the feedback between the upper ocean and the atmospheric circulation by accounting for the effects of sea surface temperature and the sea surface roughness. We focus also on the feedback between the wind waves and the circulation, which can no longer be ignored, in particular in the coastal zone where its role seems to be dominant. Sensitivity experiments are performed to estimate the individual and collective effects of different coupling components.

Model Domain

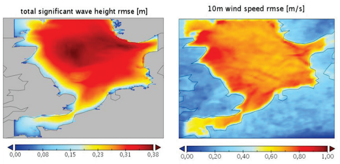


Model domain: COSMO-CLM (white), NEMO and WAM (color).

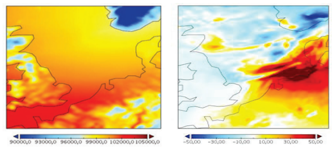


Coastal downscaling: nested-grid high resolution coupled model for the German Bight.

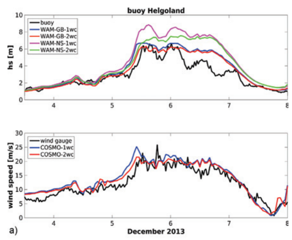
Atmosphere-wave coupling



RMSE of WAM significant wave height (left) and COSMO-CLM wind speed (right) when comparing one-way minus two-way coupled modeling results over the period October-December, 2013.

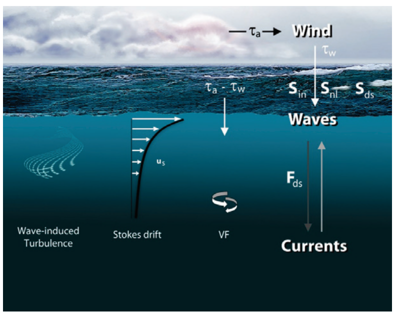


COSMO-CLM (left) pressure (Pa) at mean sea level height during 'Xaver' and (right) mean sea level pressure differences between one-way and two-way coupled models..

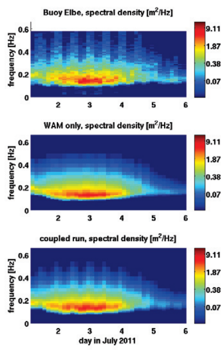


Validation of modeled significant wave height and wind speed: one COSMO-CLM and two nested-grid WAM models - North Sea (NS) and German Bight (GB) simulations against in-situ data.

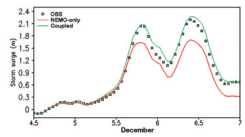
Circulation-wave coupling



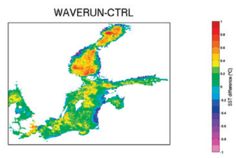
Wave-ocean interaction mechanisms



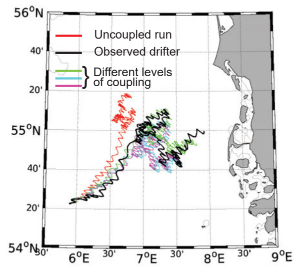
Effects of hydrodynamics on waves: Comparison of measured (top) and computed values of the spectral energy density at the buoy 'Elbe'.



Observed against model storm surges from coupled and NEMO-only model at station Helgoland during storm Xaver.

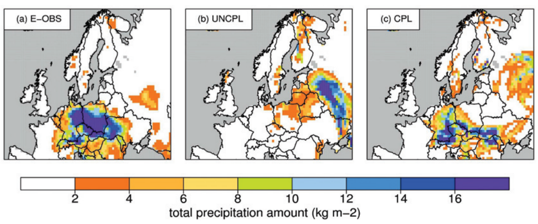


Summer (JJA) sea surface temperature difference between coupled and NEMO-only model

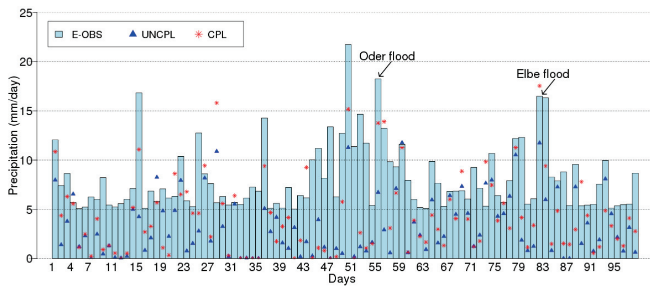


Drifter trajectories: observed (black line) and modelled. The colors of the different experiments are given in the legend.

Atmosphere-ocean coupling



Rainfall (mm/day) of (a) E-OBS data, (b) stand-alone atmospheric model COSMO-CLM and (c) the coupled model COSTRICE averaged for 18-20 July 1997, the phase 2 of the Oder flood event.



Daily rainfall (mm/day) of the E-OBS data (light blue bar), uncoupled COSMO-CLM (blue triangle) and COSTRICE (red asterisk) averaged for Central Europe for very wet days of the Northerly Circulation Type in JJA 1986-2009.

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Conclusions

- **Storm surge and circulation of the coupled model are in better agreement with observations, especially during extremes.**
- **Inclusion of wave coupling decreases strong winds through wave dependent surface roughness; it changes also sea surface temperature, mixing and ocean circulation.**
- **Atmosphere-ocean coupling improves the large-scale moisture convergence from ocean to land and, thus, reduces the rainfall dry bias over Central Europe in summer, especially during extreme rainfall events.**
- **Further developments and implementation of the coupled model systems are essential for both operational and climate research activities.**

North Sea-Baltic Sea regional coupled models: atmosphere, waves and ocean

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Ocean forecasting for the German Bight-from regional to coastal scales

Helmholtz-Zentrum Geesthacht
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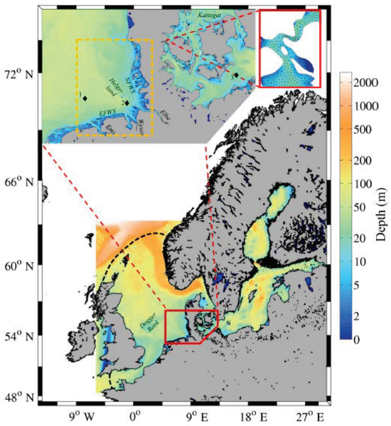
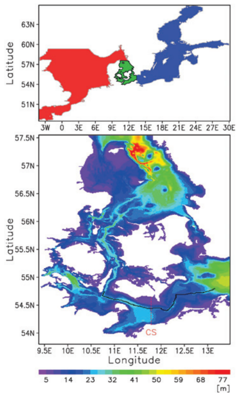
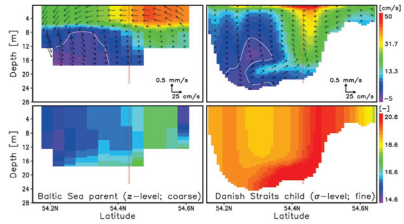
Introduction

Recent developments based on advances in coastal ocean forecasting in the fields of numerical modeling, data assimilation, and observational array design are, exemplified by the Coastal Observing System for the North and Arctic Seas (COSYNA). The region of interest is the North and Baltic seas, and most of the coastal examples are for the German Bight. Several pre-operational applications are presented to demonstrate the outcome of using the best available science in coastal ocean predictions. The applications address the nonlinear behavior of the coastal ocean, which for the studied region is manifested by the tidal distortion and generation of shallow-water tides.



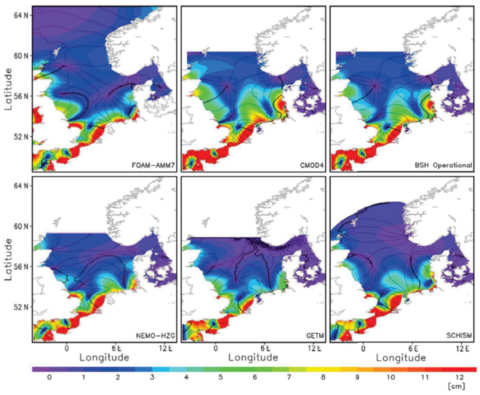
Inter-basin exchange in a system of two parent models (red and blue) and one child model (green)





The Danish Straits act as "choke points", which fundamentally important to the two-layer exchange between the North Sea and the Baltic Sea. This exchange simulated with different resolution exemplifies the role of small-scale processes for the dynamics of regional seas, which fits the major topic of the present study: the transition from regional to coastal scales.

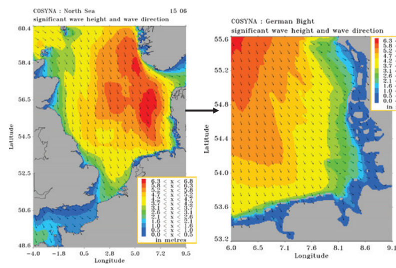
Modelling of tides



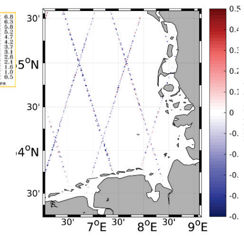
Simulated M4 tidal amplitudes and phases from six different models operating in the North Sea. The simulations using NEMO-HZG, GETM, SCHISM, and BSHcmod are carried out at the HZG, together with FOAM-AMM7 of UKMO and the BSH operational models.

Short-term pre-operational wave model for the North Sea and German Bight

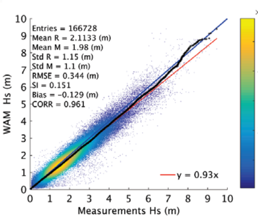
Within the framework of COSYNA a wave model system provides 72 hour wave forecasts twice a day and makes the results available in the web under http://codm.hzg.de/ncWMS/godiva2.html.



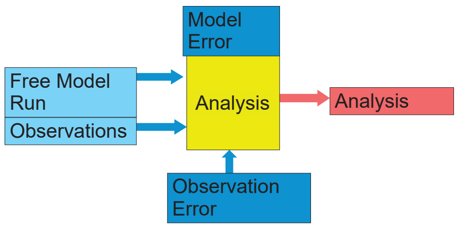
Distribution of the significant wave height in the North Sea and the German Bight



BIAS of significant wave height for Sentinel-3 altimeter data and the German Bight WAM.

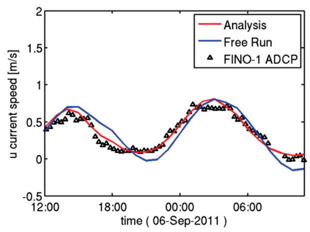


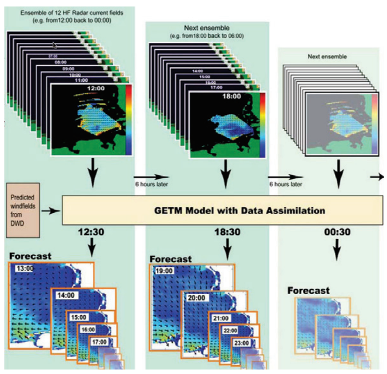
QQ-Scatter plot for measured : Jason-2 (and computed (WAM) significant wave height from June to November 2016



Data Assimilation

As part of the COSYNA system a novel analysis scheme was developed for the assimilation of surface current measurements acquired by three HF radar stations in the German Bight. The method uses an analysis window of at least one tidal cycle and is able to improve short term surface current forecast.





Challenges of data assimilation in the coastal ocean:

- The memory of the system is short at least for the barotropic part
- The dynamics is strongly influenced by open boundary forcing

Our assimilation work concentrated on the following areas:

- Assimilation of HF radar surface currents in the German Bight
- Assimilation of satellite SST and in-situ temperature and salinity data
- Assimilation of altimeter wave height measurements in the North Sea

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Conclusions

- Numerical modelling and data assimilation in coastal areas is challenging and requires dedicated tools
- A new approach was developed to treat North Sea – Baltic exchanges through the Danish Straits
- Analysis schemes were developed to achieve forecast improvements for surface currents, waves and thermohaline circulation.

Ocean forecasting for the German Bight- from regional to coastal scales

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Regional, Coastal and Estuarine Numerical Modelling on Unstructured Grids

Helmholtz-Zentrum Geesthacht
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The North-West European shelf, the Baltic Sea and their coasts are of prime research interest for the HZG. Very diverse bathymetry includes deep ocean, vast shelf areas, Wadden Sea with number of tidal basins and estuaries, as well as an almost enclosed basin. Circulation is substantially tidally-driven (in the North Sea) and dominated by large density contrasts (in the Baltic Sea). The use of the Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM) on case-specific unstructured meshes allows to seamlessly resolve the physical scales from the deep ocean to the coast and into the straits, inlets and estuaries.

Non-linear interactions in the shelf and coastal ocean

The non-linear interaction between tidally and wind driven circulation results in a substantial decrease of the work done by wind in the presence of strong tides[1].

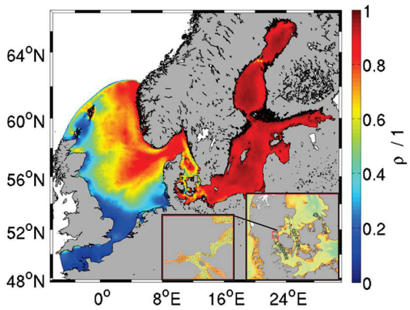


Fig. 1. Kundu correlation coefficient between 10 m wind and surface currents.

Ocean response to morphological changes and channel migration propagate over the entire North Sea revealing the connectivity of dominant processes[2].

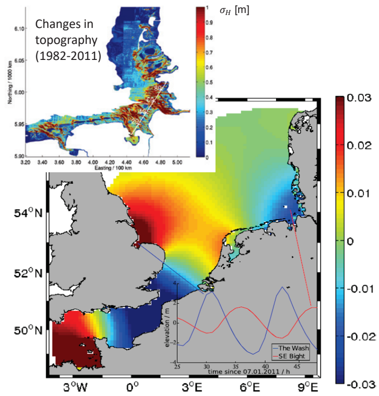


Fig. 2. EOF-pattern showing the dynamical connectivity between different areas in the North Sea.

Baroclinic interaction of waves and currents in the shallow Wadden Sea

Wind wave-circulation coupling during extreme events is associated with a leakage of energy and reduction of estuarine circulation (Fig. 3) [3] . Using the setup as shown in Fig. 2, it has been shown, that wave-current interaction is not only a barotropic feature.

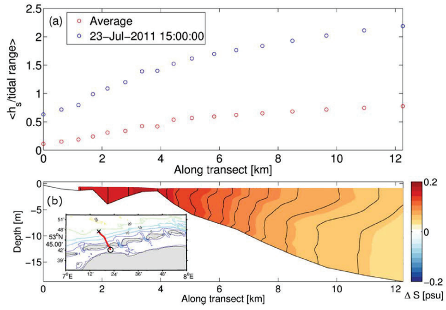
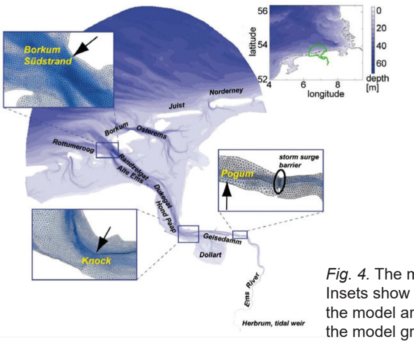


Fig. 3. (a) Mean ratio of significant wave height and tidal range (red). The same ratio for a period of extreme storm (23 Jul 2011), is shown with blue. (b) Difference (coupled minus uncoupled models) in salinity on the transect along the tidal channel averaged over 16 tidal M2 -periods.

Resolve processes from shelf sea into estuary



The model simulations are consistent with observations (Fig. 5) [4] and give credibility to the simulated secondary circulation in the Ems-Dollart estuary. Overtide generation and asymmetries of the tidal signal dominate the circulation in the estuary. The model provides OSE-reconstruction capabilities[5] (see Fig. 6).

Fig. 4. The model area of the Ems-Dollart estuary. Insets show the locations of gauges, the position of the model area within the German Bight, as well as the model grid.

Model vs. observations

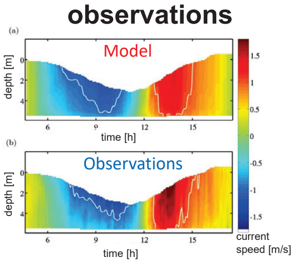


Fig. 5. a) Simulated horizontal along-channel velocities in the Ems river near Pogum and b) observed by ADCP velocities in the same location, time: 12th of June 2012 from 05:00 h to 17:30h.

OSE, a combination of data and models

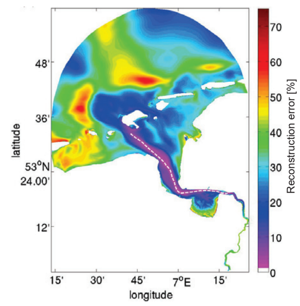
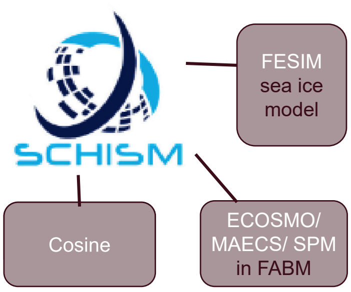


Fig. 6. Average reconstruction error from an OSSE in the Ems estuary (with observations along transect line).

Outlook: SPM, Ecosystem and Sea Ice in cross-scale applications

We extend the flexible coupling to different ecosystem, suspended matter, and sea ice models in the open-source SCHISM model[6,7].



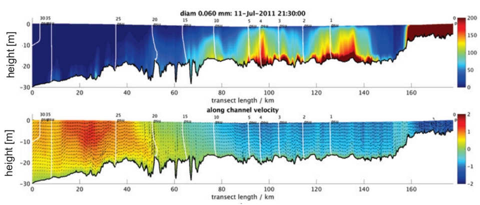


Fig. 7. Vertical transect in the Elbe estuary, showing salinity (contour lines), SPM concentrations, and along-transect current speeds (from open German Bight to the Hamburg harbour).

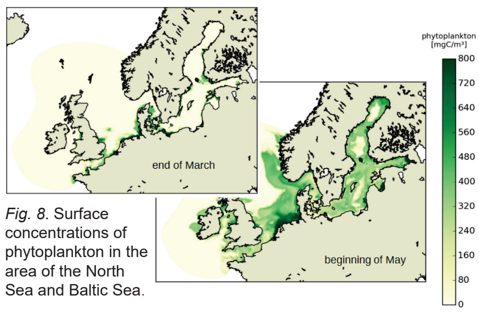


Fig. 8. Surface concentrations of phytoplankton in the area of the North Sea and Baltic Sea.

- The complex non-linear interplay between tidal mixing, wind stirring and wind waves (see references) shapes the physical and BGC gradients and their specific variability patterns in the shelf seas, their coastal zones and estuaries.
- Baroclinic unstructured-grid models used for the first time to resolve cross-scale dynamics in the studied areas, play a fundamental role for the understanding and prediction of SPM variability

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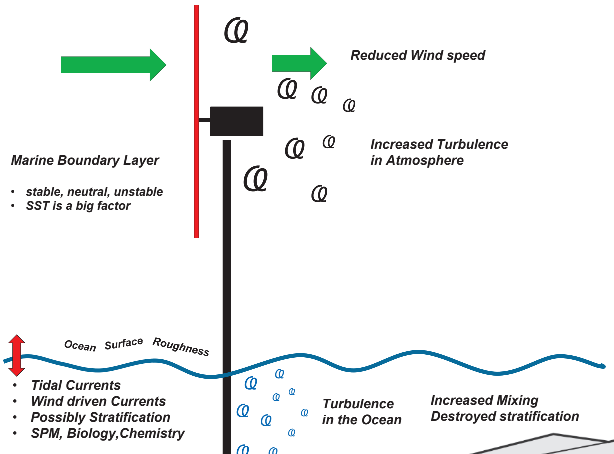
Analysis of offshore windfarm wakes in the German Bight

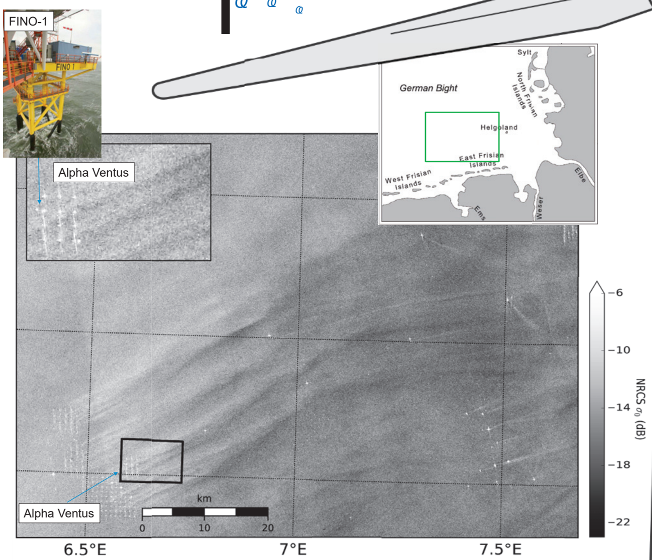
Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Introduction

Wind energy production in Germany is growing rapidly and has reached about 13% of the electricity consumption in 2016. Due to the increasing shortage of suitable locations on land, offshore windfarming has become an important factor as a renewable energy source. Large offshore windfarm installations give rise to a lot of research questions concerning potential impact both in the atmosphere and in the ocean, e.g.:

- In which way are offshore windparks affected by wakes from neighboring wind parks ?
- Which impact do the foundation structures have on processes in the water ?

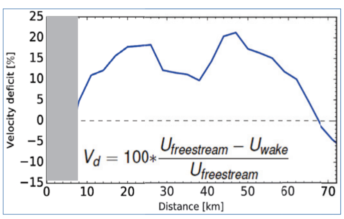




90 x 60 km SENTINEL-1 SAR images acquired on May 22 2015, 17:16 UTC showing the offshore windparks Alpha Ventus with wakes of more than 70 km length.

Used tools and observations

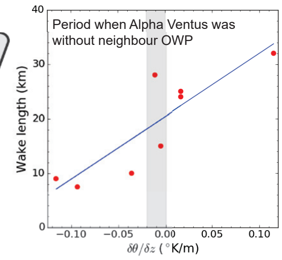
One important source of information for the analysis of atmospheric wakes behind offshore windparks is satellite synthetic aperture radar (SAR). These data are not affected by daylight and cloud conditions and provide information on the small scale roughness of the sea surface, which can be related to near surface wind conditions. SAR scenes as acquired by the European SENTINEL-1 satellite or the German TerraSAR-X satellite provide large coverage (e.g., 200x200 km) and high resolution (e.g., 20x20 m). Wakes behind offshore wind turbines cause very characteristic features on SAR images, which can be used to estimate different parameters like the wake length.



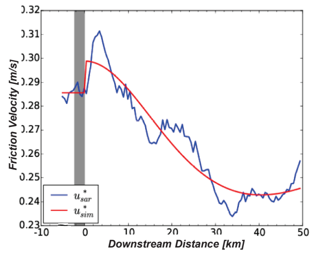
Wind speed velocity deficit estimated from SAR image

Impact of atmospheric stability

Wakes length estimated behind the offshore windpark Alpha Ventus were compared to data from the research platform FINO-1. FINO-1 provides profile information on air temperatures and can thus be used to estimate thermal stability of the atmospheric boundary layer. It was found that there is an increase of wakelength with growing stability. This can be explained by higher vertical momentum fluxes in the case of unstable conditions.
In addition a semi-empirical model was developed to simulate the radar cross section associated with wakes including effects of turbulence created by the turbines.



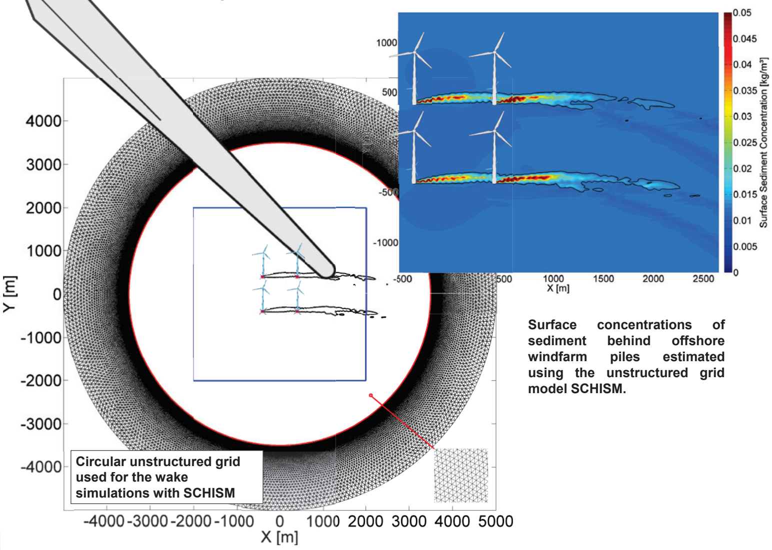
Wake length behind Alpha Ventus derived from SAR as a function of thermal stability



Semi-empirical model to describe friction velocities at the sea surface associoated with an atmospheric wake downstream a wind park

Sediment wakes behind offshore windfarm turbines

In the presence of currents the foundation structures of offshore wind turbines create additional turbulence in the water. This is in particular the case for the tidal currents in the German Bight. The increased turbulence leads to stronger vertical mixing and an increased probability of higher sediment concentrations in the surface layer. This effect was observed on optical satellite data and could be successfully simulated using the unstructured grid model SCHISM.



Surface concentrations of sediment behind offshore windfarm piles estimated using the unstructured grid model SCHISM.

Conclusions

- Using a combination of satellite radar and platform data it could be shown that the wake length behind the windpark Alpha Ventus increases with thermal stability. In cases where wakes from neighboring windparks superimpose, wakes of more than 70 km length were found.
- Vortex features of increased sediment concentration in the water could be successfully simulated based on an unstructured grid model which is able to capture the increased turbulence levels introduced by the pile foundation structures.

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Emeis, S., S. Siedersleben, A. Lampert, A. Platis, J. Bange, **B. Djath, J. Schulz-Stellenfleth**, and T. Neumann: *Exploring the Wakes of Large Offshore Wind Farms. In Journal of Physics: Conference Series/, 753:092014. IOP Publishing, 2016.* doi:10.1088/1742-6596/753/9/092014
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Platis, A., S. Siedersleben, J. Bange, A. Lampert, K. Bärfuss, R. Hankers, B. Canadillas, R. Foreman, **J. Schulz-Stellenfleth, B. Djath**, T. Neumann, and S. Emeis. *First in Situ Evidence of Wakes in the Far Field behind Offshore Wind Farms.* Accepted by Nature Scientific Reports, 2018.

Analysis of offshore windfarm wakes in the German Bight

Presenter
Johannes Schulz-Stellenfleth

Co-Authors
Bughsin Djath, Sebastian Grashorn, Emil Stanev

Key References

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Loss of primary producers due to benthic bivalves and bivalves on offshore wind farms

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Challenge

Benthic filter feeders are key players in near-shore ecosystem dynamics and material flows, but rarely investigated in quantitative, system-wide studies. The build-up of offshore wind farms (OWF) creates new habitats for epistructural filter feeders such as the blue mussel *Mytilus edulis.* Our research asks:

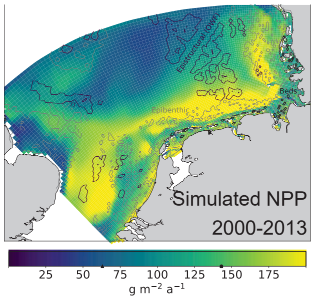
(1) How does natural filtration shape pelagic net primary productivity (NPP) and

(2) how is NPP altered by filtration in new anthropogenic habitats?

Approach

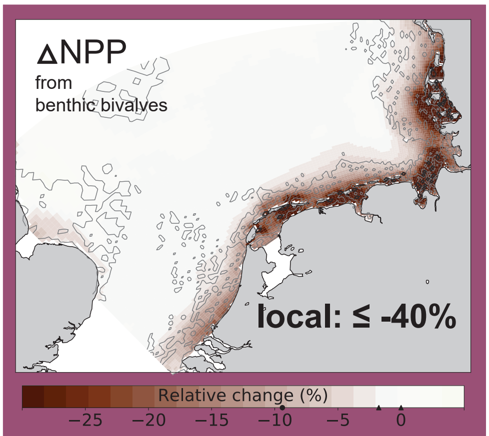
Using a novel **modular** framework we include a **trait-based** ecosystem model into a benthic-pelagic coupled system. After extensive validation, we assess the sensitivity of NPP to:

1. **natural** benthic filter feeding (pre-OWF) and
2. **anthropogenically enhanced** epistructural filter feeding (2030 OWF projection)

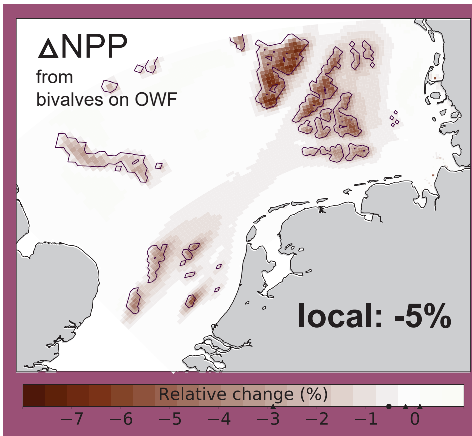


Significance

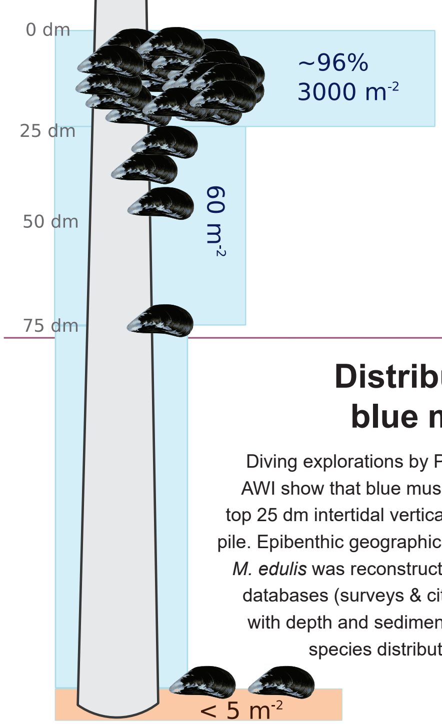
Understanding of filter feeding offers mitigation potential for eutrophication and for meeting EU water quality targets.
This is the first quantitative and system-scale assessment of ecosystem effects after massive OWF build-up.



Natural filtration by benthic *Mytilus edulis* decreases net primary production by up to 40% near the coast. Coastal ecosystem models that so far parameterized filtration by other mortality factors will have to re-consider this spatial effect to successfully represent coastal gradients

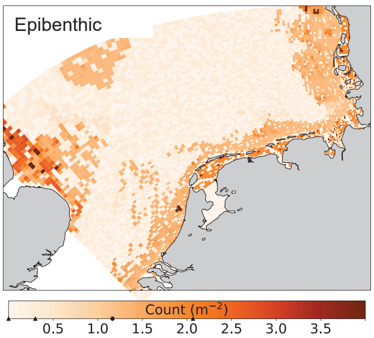


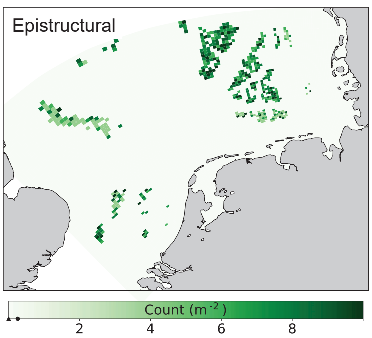
Additional filtration on offshore wind farms decreases net primary production by up to 5% in the OWF. This effect is only one of many other potential changes induced by OWF such as mediated through hydrodynamics or top-predation.



Distribution of blue mussels

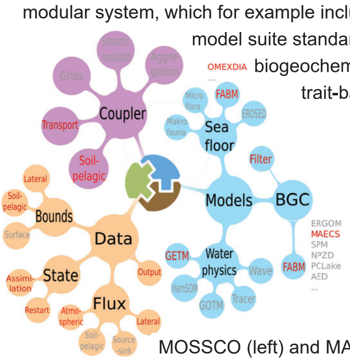
Diving explorations by PACES partner AWI show that blue mussels prefer the top 25 dm intertidal vertical position on a pile. Epibenthic geographic abundance of *M. edulis* was reconstructed from public databases (surveys & citizen science), with depth and sediment grain size as species distribution predictors.

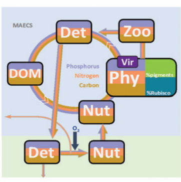




Modular coupling

Based on the novel MOSSCO coupler, we implemented an 18-component modular system, which for example includes GETM hydrodynamics and a model suite standardized by FABM (including benthic biogeochemical model OMEXDIA and pelagic trait-based ecosystem MAECS). Mussel filtration is described using an experimentally derived food-filtration response curve.



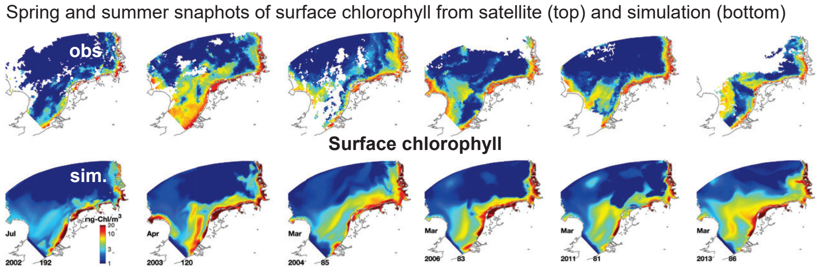


MOSSCO (left) and MAECS (right)

Validation of ecosystem model

The system has high skill in reproducing coast-shelf patterns in relevant biogeochemical and ecological quantities, which were observed using, e.g., Scanfish (*see* COSYNA), remote sensing (ESACCI) and *in situ* monitoring (Helgoland station – AWI – Cooperation in PACES-Topic 2, or Rijkswaterstaat WaterBase stations)

Spring and summer snaphots of surface chlorophyll from satellite (top) and simulation (bottom)



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The basis for this research is the Modelling system MOSSCO, the thesis by Kaela Slavik, and the ecosystem model MAECS
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This research is funded by PACES II of the Helmholtz-Gemeinschaft Deutscher Forschungszentren e.V.. The research received support from the ``Modular System for Shelves and Coasts'' (MOSSCO) grant provided by the Bundesministerium für Bildung und Forschung. And the Erasmus Mundus program (MESPOM) sponsored by the Eureopean Union.

Loss of primary producers due to benthic bivalves and bivalves on offshore wind farms

Presenter:
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Author:
Carsten Lemmen

Co-Authors:
Anja Singer, Onur Kerimoglu, Kaela Slavik, Wenyan Zhang, Kai W. Wirtz

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Organic matter input drives macrobenthic community structure and behaviour

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Challenge

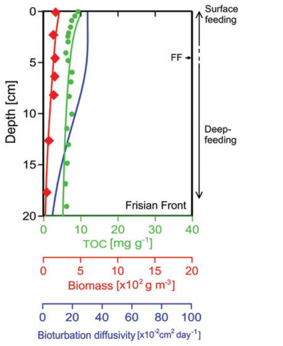
- Shelf-sea ecosystems are affected by macrobenthos (e.g. filtration, bioturbation).
- Macrobenthos faces habitat changes on many spatio-temporal scales (gap in state-of-the-art statistical approaches).

Approach

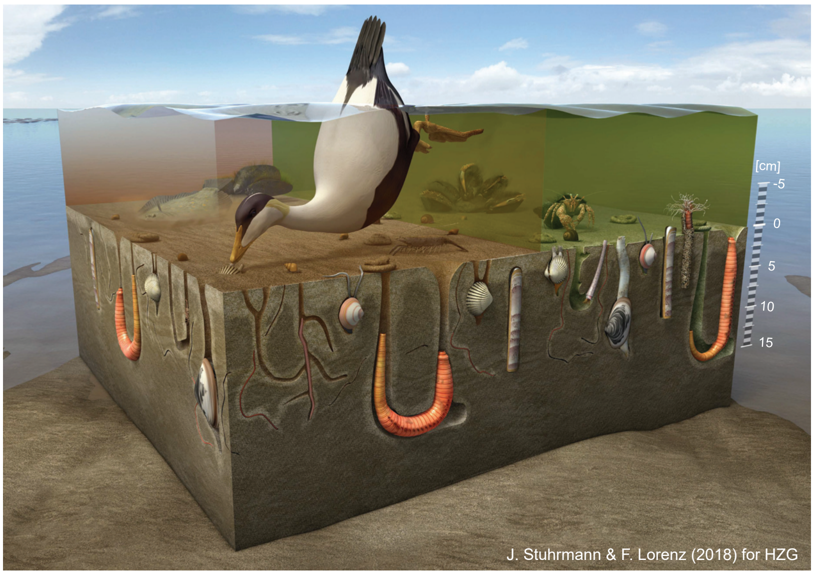
- Develop and apply novel modeling approach that mechanistically predicts changes in macrobenthic communities.
- Identify macrobenthic key trait and its interaction with environment.
- Assess role of key trait at benthic-pelagic interface in North Sea/Baltic Sea ecosystem.

Vertical positioning of macrobenthic communities as trade-off between benefits (food supply) and costs (mortality)

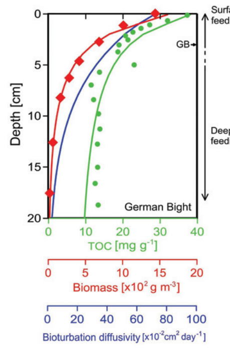
Site with low organic input



Change in TOC, biomass and bioturbation diffusivity with sediment depth (Zhang & Wirtz 2017, data by Dauwe et al. 1998).



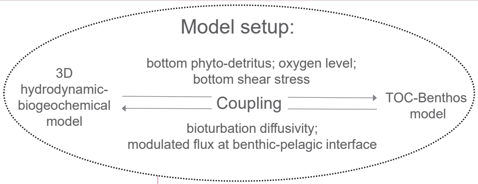
Site with high organic input



Change in TOC, biomass and bioturbation diffusivity with sediment depth (Zhang & Wirtz 2017)

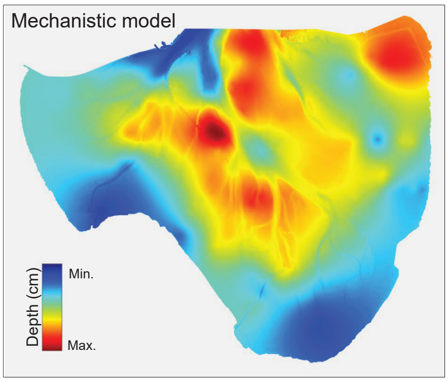
We extracted vertical positioning as key trait for macrobenthic bioengineering with environment

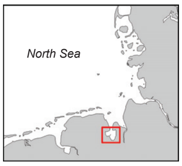
Small-scale variations in the vertical positioning of the macrobenthic community (North Sea, Jade Bay)



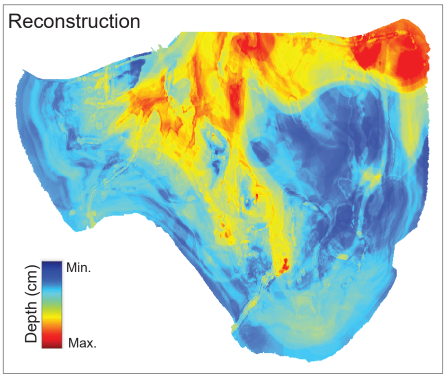
Long-term macrobenthic changes due to increased hypoxia in shallow water (Baltic Sea)

Macrobenthic vertical positioning

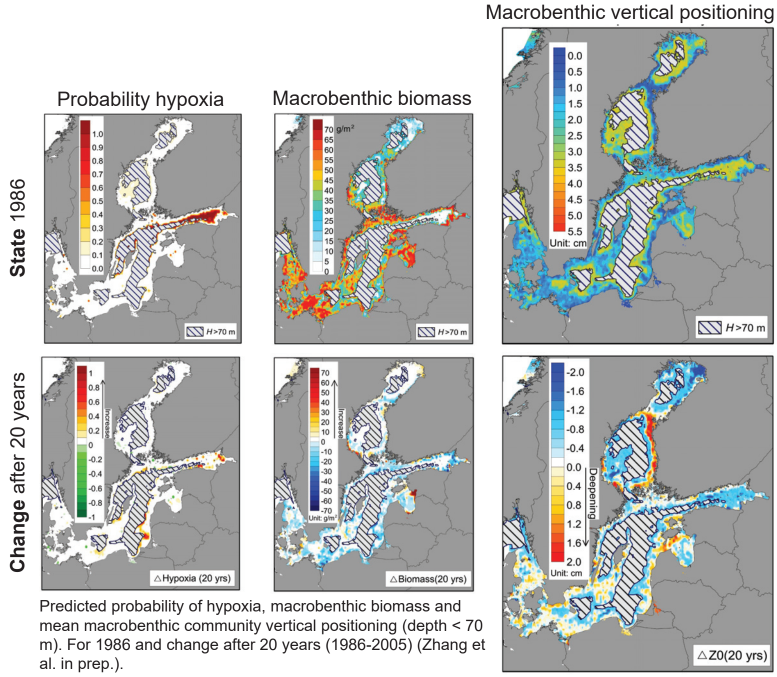




Trait-based, mechanistic model for the Jade Bay macrobenthic community, representing current environmental conditions



Reconstructed vertical positioning of the Jade Bay macrobenthic community, based on present-day empirical data (Singer et al. in prep.).



Predicted probability of hypoxia, macrobenthic biomass and mean macrobenthic community vertical positioning (depth < 70 m). For 1986 and change after 20 years (1986-2005) (Zhang et al. in prep.).

Major results

- **A mechanistic approach to quantify the interaction between sedimentary TOC and macrobenthos was developed.**
- **Jade Bay model captures observed changes in benthic community structure.**
- **Key trait vertical positioning clearly reduces model complexity**
- **Hypoxia have become increasingly important in constraining macrobenthic communities in Baltic Sea shallow waters.**

Organic matter input drives macrobenthic community structure and behaviour

Presenter:
Wenyan Zhang and Anja Singer

Co-Authors:
Carsten Lemmen and Kai W. Wirtz

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Acknowledgements

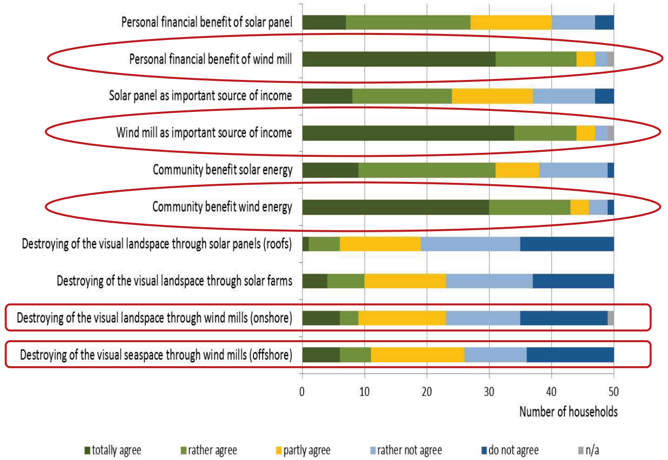
We are grateful to Senckenberg am Meer in Wilhelmshaven, the Institute for Chemistry and Biology of the Marine Environment at the University of Oldenburg and the Coastal Research Station Norderney for the species and environmental data sources for the Jade Bay model. Special thanks to Corinna Schrum and Ute Daewel from HZG for providing the input conditions for the Baltic Sea simulations.

Socio-cultural values in marine and coastal policy – the case of wind energy

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Community wind farms – understanding the social context of climate change innovation

A key aspect for the success of onshore wind farming in North Frisia has been its strong embeddedness in local communities. Perceived personal and community benefits strongly outweigh concerns related to landscape impact.

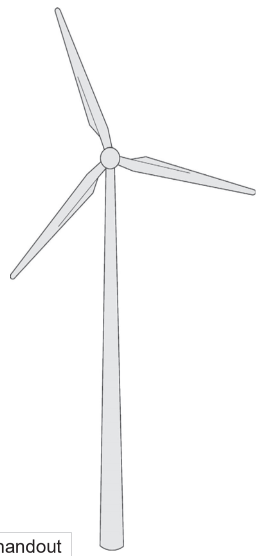


Assessment of community-based renewable energy. Household Survey 2014, N = 51 (Suesser & Kannen 2017)

Locally rooted entrepreneurs have acted as **pioneers** and **investors**. By involving many local shareholders

- **trust,**
- a high level of **acceptance** and
- various **benefits** to local communities

have been created, mainly based on the **place attachment** of the community (Suesser 2016).

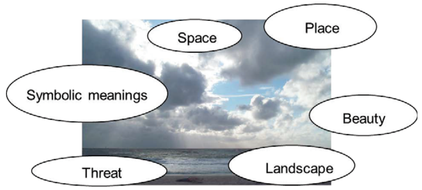


REKLIM Helmholtz-Verbund Regionale Klimaänderungen

Offshore wind farms – socio-cultural views as a challenge for marine planning

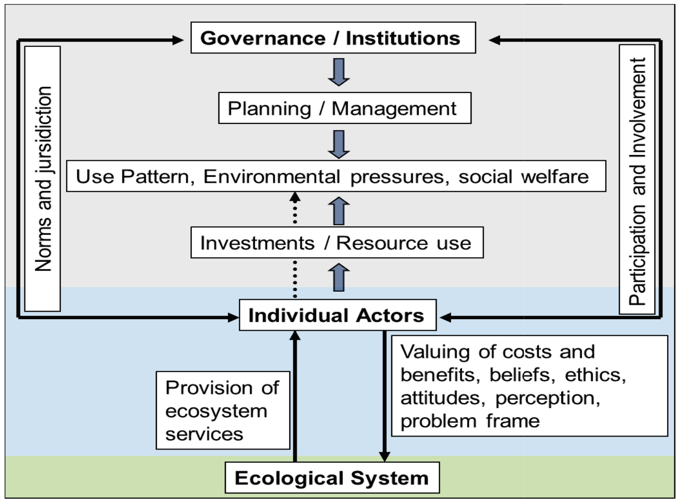
Meanings ascribed to places (or the sea) are driven by personal beliefs and values and expressed as **place attachment**. The sea and the marine environment are understood by many people as an **open and wild natural area** while offshore wind farms imply fixed **large-scale artificial structures**. Moral obligations to protect the wild space clash with moral support of renewable energies (Gee 2013). To recognise such aspects is part of **training courses** on marine planning provided by HZG scientists, e.g. for the **WMU**.

WMU World Maritime University



In policies such as **maritime spatial planning** this implies a need for

- Availability of structured place-specific socio-cultural information;
- Appropriate evaluation mechanisms for such knowledge;
- Decision-making criteria allowing to consider socio-cultural information in trade-off analysis and risk management together with ecological and economic information;

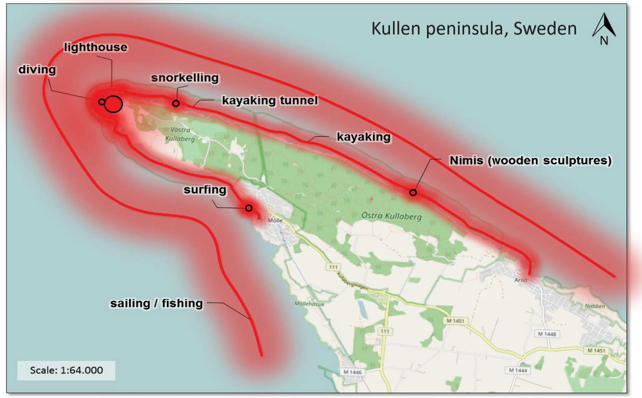


A basic model describing relevant interactions in governance of socio-ecological systems (Kannen 2014)

Culturally Significant Areas (CSA) – transposing socio-cultural ecosystem context into (maritime) spatial planning

CSAs establish **what** is valued by people and **why**, **where** these values are located, **when** in time they are relevant and to **whom**.

CSAs aim to support maritime spatial planning (MSP) by providing **socio-cultural context** to ecological (and economic) information.



Significance can be described by the following **criteria**: Cultural uniqueness, broad cultural/community reliance, importance to system resilience, degree of tradition and, dramatic cultural change. Once established, CSAs can be subject to a **risk management approach.** The still **pre-operational** approach has been developed by HZG scientists together with colleagues from various disciplines in the frame of **ICES** (Gee et al. 2017).

ICES CIEM

Conclusions

- **Community-ownership and locally rooted entrepreneurs support acceptance and increase community resilience.**
- **Marine planning and management need approaches to take greater account of socio-cultural information.**
- **The concept of Culturally Significant Areas may provide a way forward, but requires further testing and development to become operational.**

Key references and authors: See back page on handout

Socio-cultural values in marine and coastal policy – the case of wind energy

Presenter:
Andreas Kannen

Co-Authors:
Kira Gee, Diana Süsser

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