BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Prototype products for climate change adaptation in German coastal regions

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Overview

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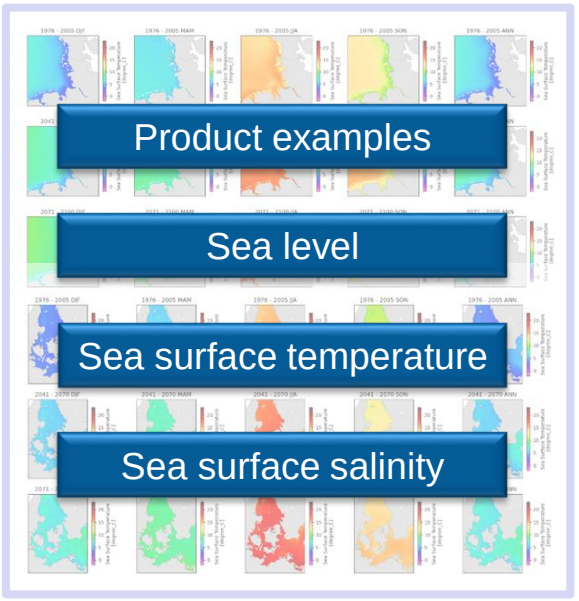

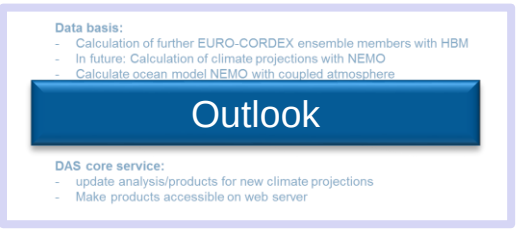

Abstract

The “German Strategy for Adaptation to Climate Change” (DAS) is the political framework to climate change adaptation in Germany. The newly established DAS core service “Climate and Water” will provide monitoring and projection data to meet requirements for climate change adaptation. Various products covering the German water bodies (coastal and inland) and its response to climate change will be generated and frequently updated by a cooperation of four German federal agencies. The products will be tailored to stakeholders needs.

Within this framework, the Federal Maritime and Hydrographic Agency (BSH) will provide products based on an ensemble of climate projections for the German coast which will be created in cooperation with different research institutes and authorities, e.g. the Danish Meteorological Institute (DMI).

Data from a DMI climate projection run based on the HIROMB-BOOS model (HBM) with meteorological forcing from DMI-HIRHAM5 (one of the RCMs in EURO-CORDEX ensemble) and for the RCP 8.5 scenarios has been analysed in view of different oceanographic parameters such as sea level, sea surface temperature, salinity, currents and ice. This data set includes the historical periods 1976-2005 and the RCP 8.5 periods 2041-2070 and 2071-2100. Therefore, it provides an expedient basis to develop prototype products regarding climate change adaptation at the German coasts for customers of the DAS core service “Climate and Water”. The initial prototype products are presented and discussed with regard to the sufficiency to evaluate requirements for climate change adaptation.

DAS core service “climate and Water”

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German Strategy for adaptation to Climate Change (DAS):

- DAS is a political framework to climate change adaptation in Germany.
- One of the general aims of DAS is a reliable, verified and nationwide consistent data basis for medium- and long-term requirements.
- BSH takes part in the DAS core service „climate and water“ together with three further German Federal Agencies.
- DAS core service „climate and water“ deals with several modules.
- The main goal is the establishment of a forecasting and projection service for climate, extreme weather and coastal and inland waterbodies in Germany.

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Deutscher Wetterdienst
Wetter und Klima aus einer Hand

BAW Bundesanstalt für Wasserbau

bfg Bundesanstalt für Gewässerkunde

DAS Core Service at BSH

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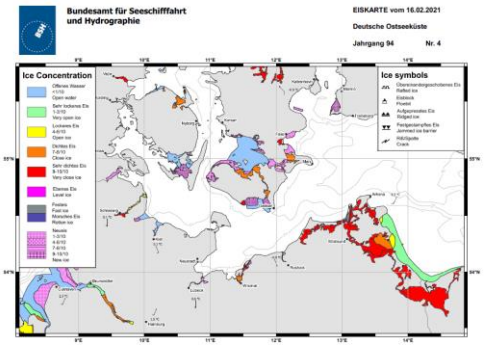
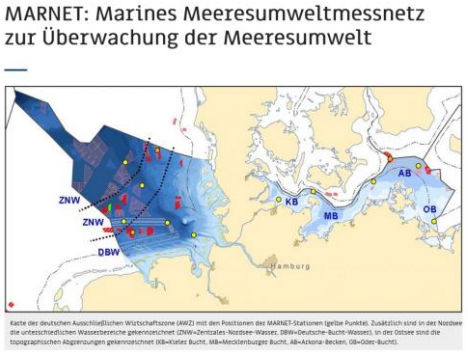
General

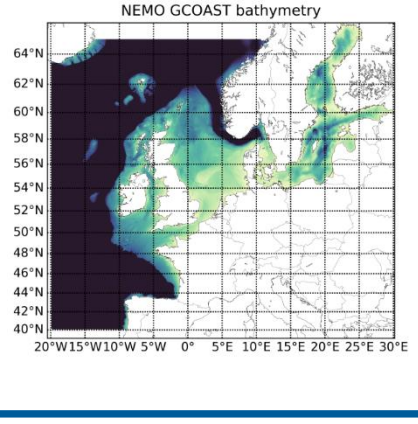
- Task: preparation of tailored products for a variety of stakeholder needs
- Information: climate information about past, present and future
- Target area: North Sea and Baltic Sea with focus on the German coastal region and its estuaries.

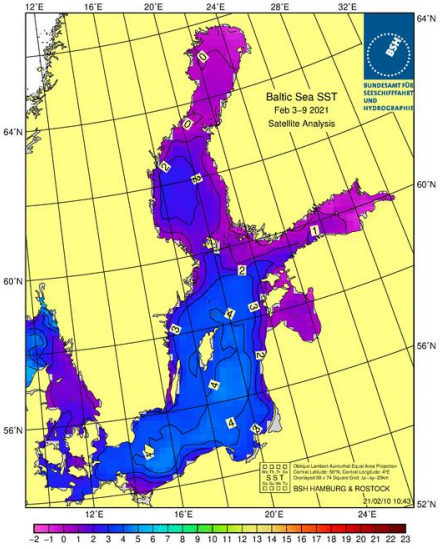
Data basis:

- Monitoring: continuous measurements at offshore stations (e.g. MARNET), ship cruises
- Analysis: e.g. (satellite) SST, sea ice
- Modelling: preparation of an regional ocean model i.a. as ocean component for a coupled model and processing of climate scenario runs









Data basis (cooperation with DMI)

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Reference: Danish Climate Atlas (https://www.dmi.dk/klimaatlas/)

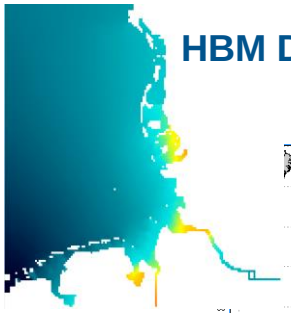
Model: HIROMB-BOOS model, DMI model set-up with two-way nested high resolution models „Transition Area“ und „Wadden Sea“

Scenarios and periods:

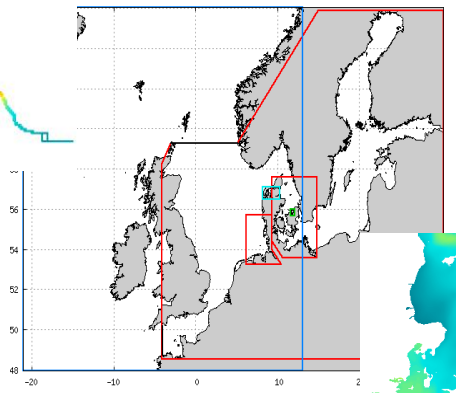
- historical period, 1976-2005
- RCP 4.5 period, 2041-2070
- RCP 4.5 period, 2071-2100
- RCP 8.5 period, 2041-2070
- RCP 8.5 period, 2071-2100

Meteorological forcing (EURO-CORDEX) for the Climate Atlas (release 2019):

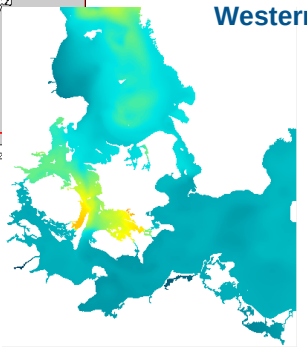
- DMI-HIRHAM5
- SMHI-RCA4



HBM DMI (Wadden Sea)
German Bight



HBM DMI (Transition Area)
Western Baltic Sea



Model set-up

The HBM model set-up consists of 6 model domains:

- **NOAMOD** - 2-dimensional mesocale model, that calculates sea level as a function of wind speed and air pressure. Generates boundary data (external surge) for the regional 3-dimensionan model
- **North Sea - Baltic Sea** - 3-dimensional regional model with subdomains
- **Transition Area** - high resolution model of the waters south of Skagen and west of Bornholm
- **Wadden Sea** - high resolution model of the German Bight
- **Limfjord** - high resolution fjord model (appended)
- **Roskilde/Isefjord** - high resolution fjord model (nested)

Study overview

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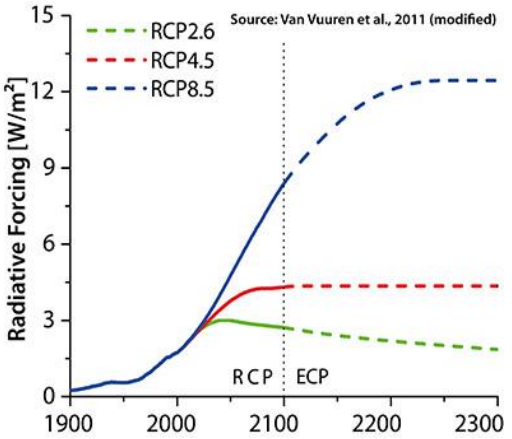
Data for prototype product development

Selected ensemble member for prototype:
- Historical run 1976 – 2005 (DMI-HIRHAMv1 downscaled from EC-EARTH)
- RCP 8.5 (DMI-HIRHAM5) 2041-2070
- RCP 8.5 (DMI-HIRHAM5) 2071-2100

Areas:
- German Bight
- Western Baltic Sea

Example parameters:
- Sea level
- Sea surface temperature
- Sea surface salinity



DAS product example: Sea level

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Required Information:

- sea level rise at German coasts
- frequency, duration of height extrem events (storm surge, low tides)

adaptation to sea level changes is e.g. needed for:

- coastal protection
- planning for mid- and long-term construction projects e.g. dikes
- drainange of Kiel Canal
- navigability estuaries and ports

Product example:

- change of height of severe storm surges for the German Bight
- please note: the model result does not include global sea level rise

Product example

DAS product example: Sea level

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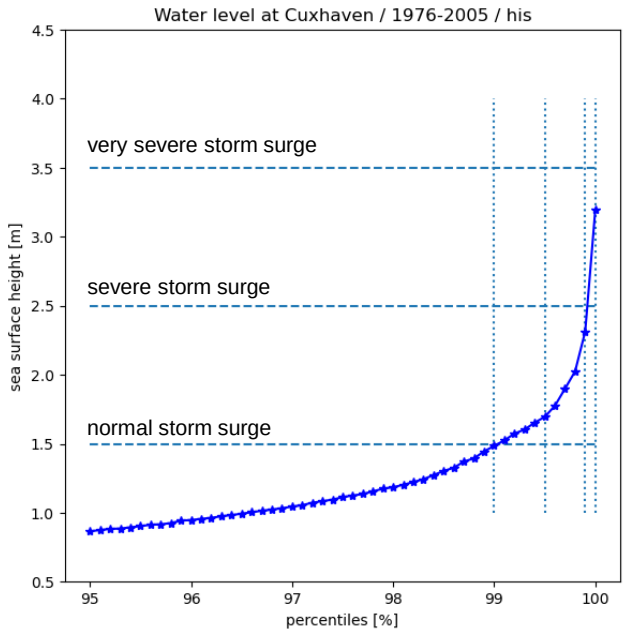
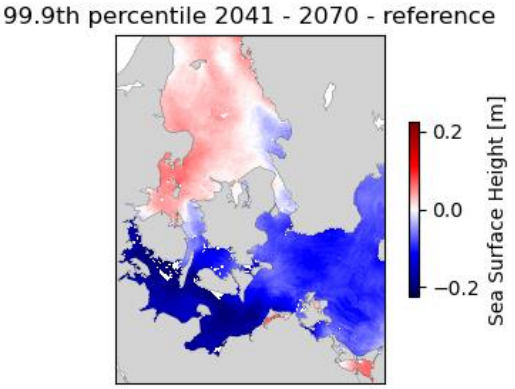
Station Cuxhaven high water levels:

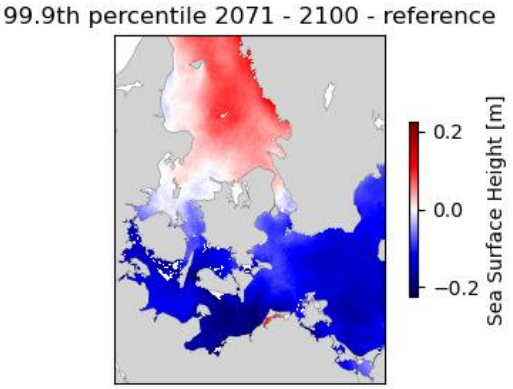
- 21173 high tide events from 1976-2005
- maximum sea surface height above MHW: 3.2m
- evaluate percentile for severe storm surge → 99.9th percentile: 2.31m



Western Baltic Sea
99.9th percentile of hourly data:

- 99.9th percentile from 2041-2070 minus 99.9th percentile of reference period 1976-2005 (left) and from 2071-2100 minus reference period 1976-2005 (right)
- slight decrease of 99.9th percentile south of transition zone but increase in the Kattegat
- 99.9th percentile in Kattegat is increased from period 2041-2070 to period 2071-2100





DAS product example:
Sea surface temperature (SST)

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Required Information:

- sea surface temperature at German coasts

adaptation to sea surface temperature changes is e.g. needed for:

- Biogeochemistry questions
- sea ice occurence
- tourism
- fishery

Product examples:

- SST for modelled period for the German Bight and the western Baltic Sea
- SST annual cycle for the German Bight and the western Baltic Sea (timeseries)
- SST seasonal maps for the German Bight and the western Baltic Sea
- Number of days at which SST > 19°C for the German Bight and the western Baltic Sea

Product examples

DAS product example:
Sea surface temperature (SST)

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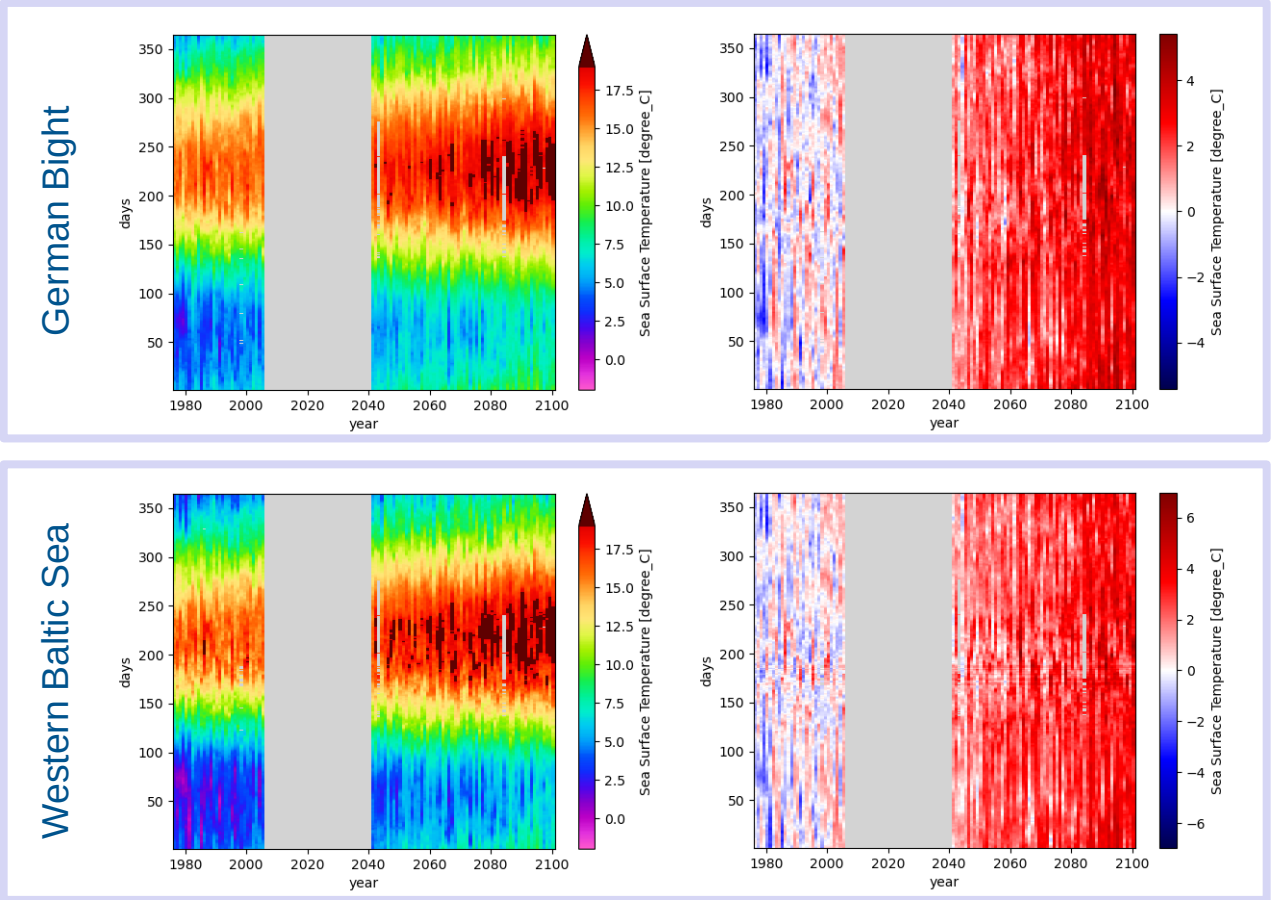

- SST (left) and SST minus mean SST reference period 1976-2005 (right) for German Bight (top) and Western Baltic Sea (bottom)
- dark red: days with SST > 19°C
- increase of SST with time

Link to timeseries

- no obvious difference in SST increase with seasons

Link to season maps

- increased number of days with SST > 19°C

Link to maps SST > 19°C

DAS product example: Sea surface temperature (SST)

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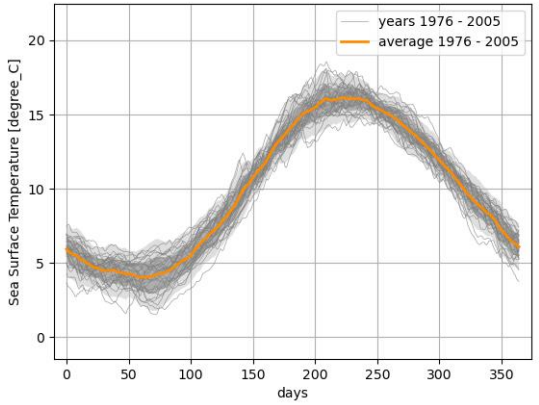
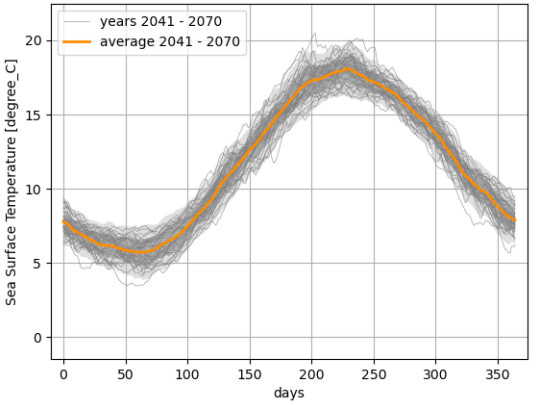
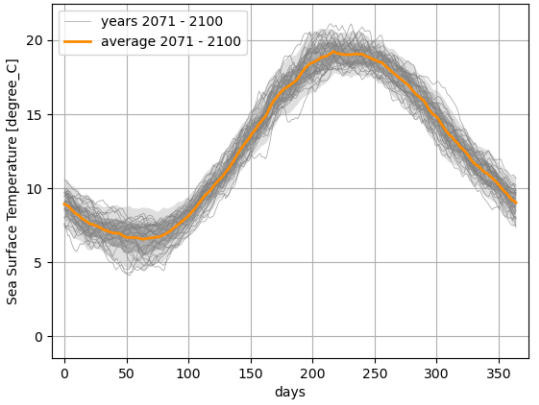
Annual cycle of area mean SST

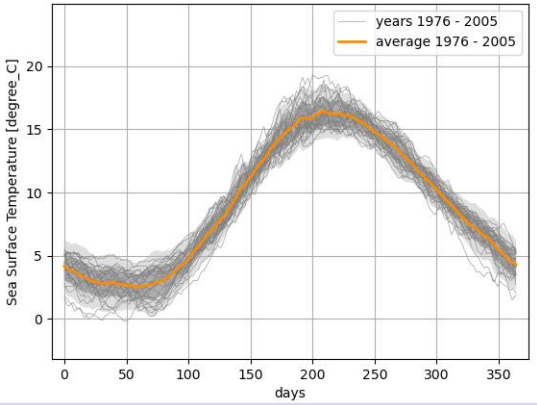
German Bight

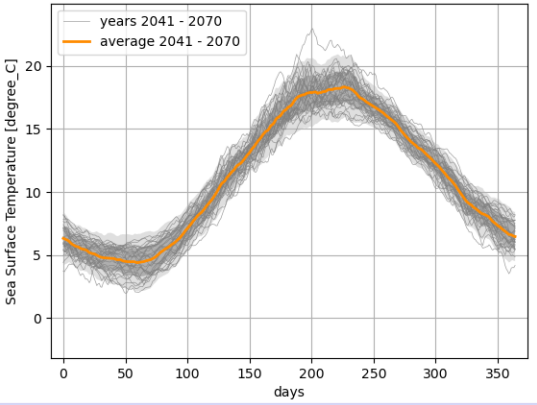


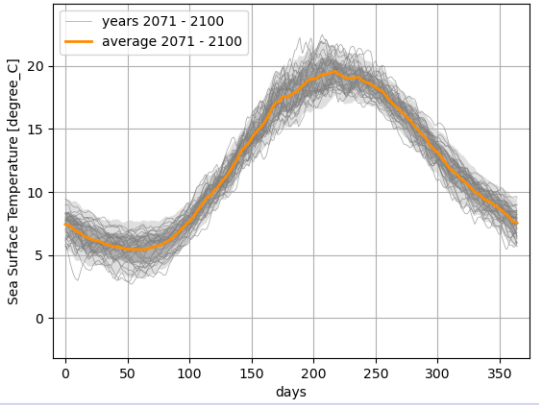




Western Baltic Sea







1x standard deviation 2x standard deviation

DAS product example: Sea surface temperature (SST)

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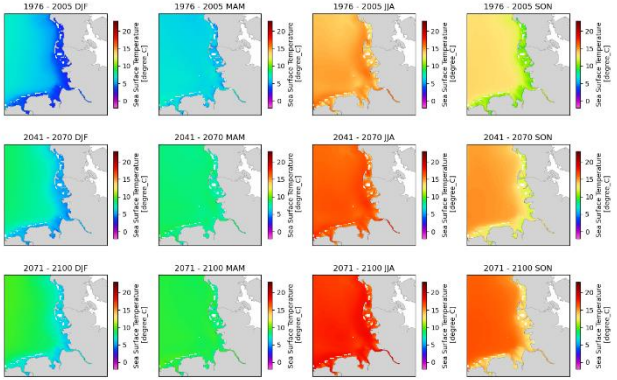
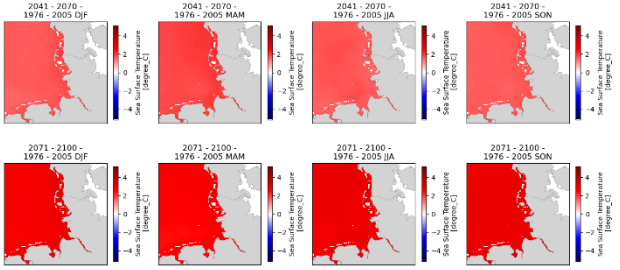
Seasonal maps SST

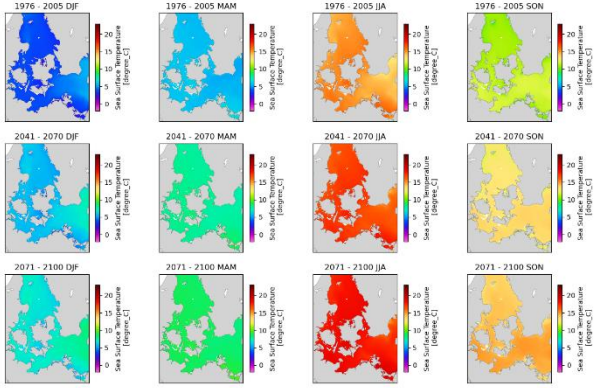
- Season maps DJF, MAM, JJA and SON
- Periods 2041-2070 and 2071-2100 minus reference period 1976-2005

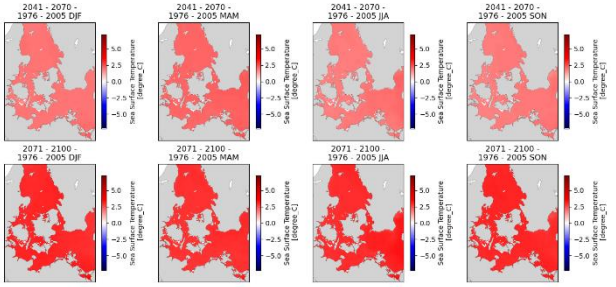
German Bight





Western Baltic Sea





DAS product example:
Sea surface temperature (SST)

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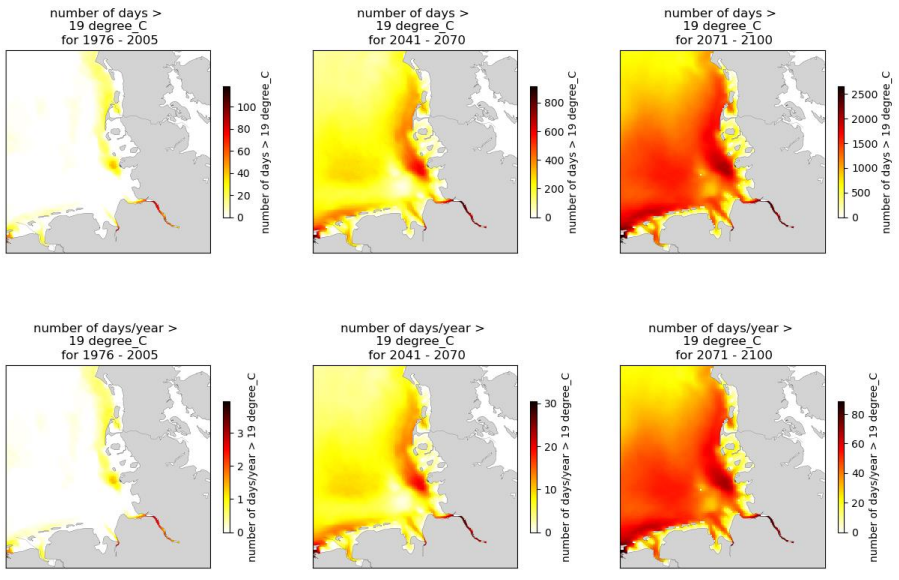
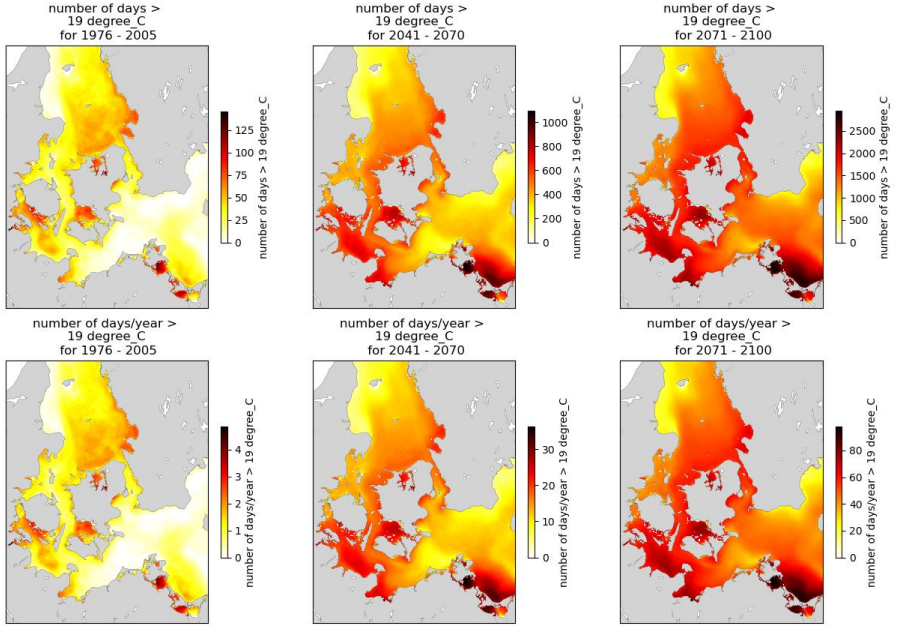
German Bight



Western Baltic Sea



- Number of days with SST > 19°C (top) and number of days per year with SST > 19°C (bottom)
- high increase of days with SST > 19°C especially along the coasts

→ changes in ecology especially in coastal areas during summer season

DAS product example: Sea surface salinity (SSS)

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Required Information:

- sea surface salinity at German coasts

adaptation to sea surface salinity changes because of:

- changes in river runoff
- changes in ocean currents
- changes in ecology

Product examples:

- Seasonal changes in SSS for modelled periods for the German Bight and the western Baltic Sea

Product example

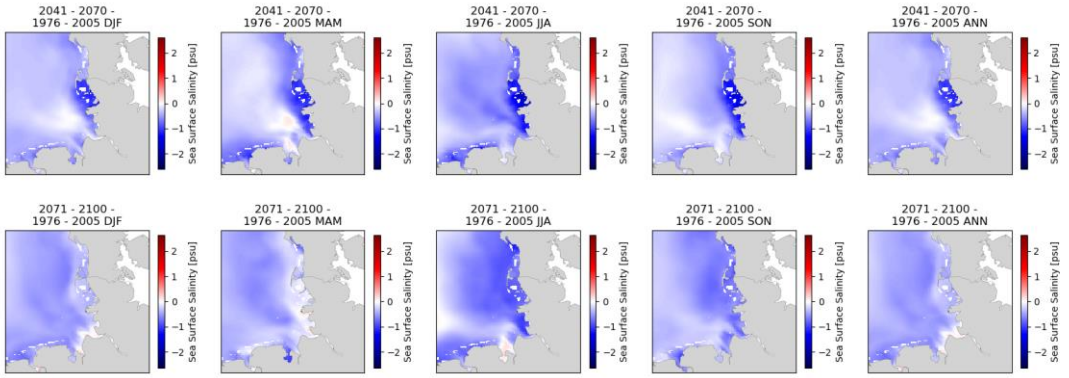
DAS product example: Sea surface salinity (SSS)

BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Seasonal maps SSS

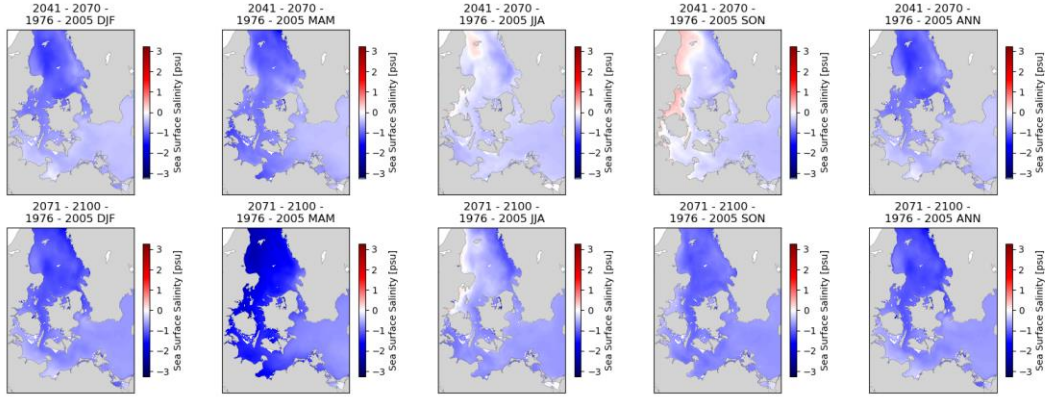
- Season maps DJF, MAM, JJA, SON and annual map
- Periods 2041-2070 and 2071-2100 minus reference period 1976-2005

German Bight



- decreased salinity in the German Bight
- highest decrease especially during summer season along the German northern coast of the German Bight

Western Baltic Sea



- decreased salinity in the Western Baltic Sea
- strongest decrease in salinity during spring season in the Kattegat

Outlook

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Data basis:
- Calculation of further EURO-CORDEX ensemble members with HBM
- Future planning: Calculation of climate projections with NEMO
- Calculate ocean model NEMO with coupled atmosphere

Analysis:
- Analyse ensemble data for various scenarios

Products:
- Evaluate stakeholder requirements in view of climate projections
- Develop further tailored products for a variety of stakeholder needs

DAS core service:
- Update analysis/products for new climate projections
- Make more products accessible on web server

Thank you!

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