Sea level change: mapping municipality needs for climate information

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Setting the frame

A part of Copernicus Climate Change Service (C3S)

Contract “C3S_422 Lot2 Deltares-European Services” to derive

- consistent European dataset for tide, storm surge and wave conditions
- Climate Impact Indicators for the evaluation of climate change impacts on coastal areas in Europe

Includes:

- Data for full European coastline, to be added to C3S data store
- 5-6 use cases, including the presented

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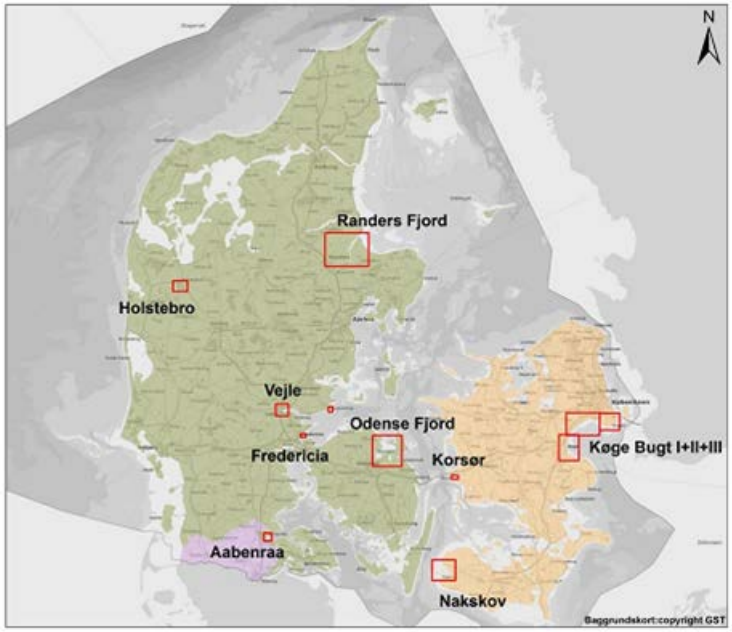
Why this study site

Climate change will affect the coastline of the Baltic Sea.

In Denmark, a large part of the responsibility for climate adaptation lies with the local municipalities.

10 areas have been selected as flood prone according to the EU flood directive.

This study focuses on one of the selected areas, Køge Bay.



Map of the 10 flood prone areas of Denmark selected for the EU flood directive (Danish Coastal Authority, 2015)

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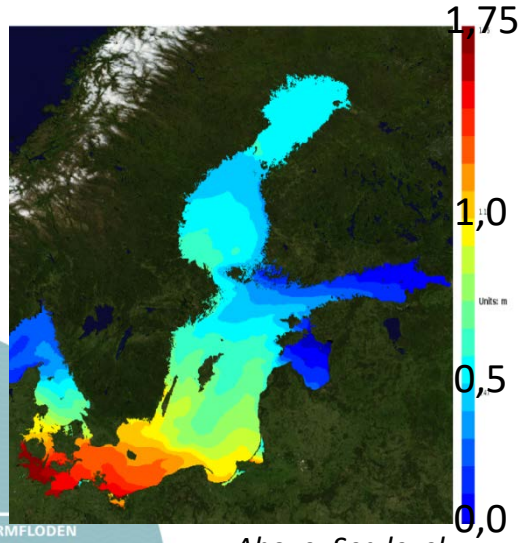
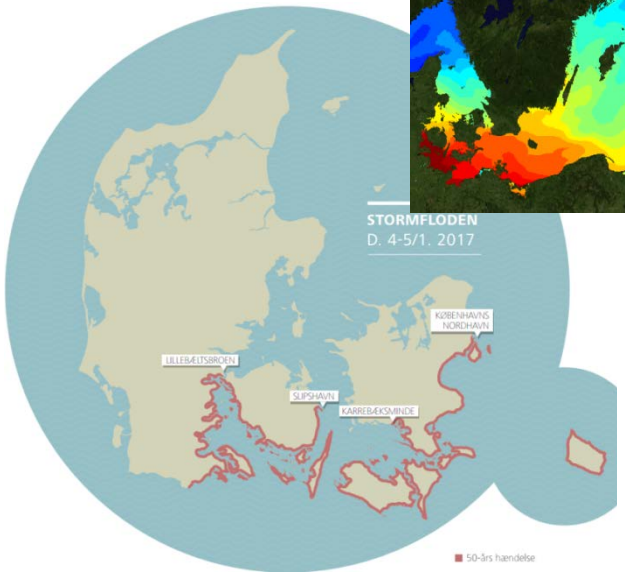
Storm surges of Køge Bay

”Silent” storm surge in January 2017





Above: Sea level from the DMI ocean model [m]. Ref: Copernicus (CMEMS BalMFC).
Left: Map of areas hit by storm surge. Ref: Danish Storm Council.

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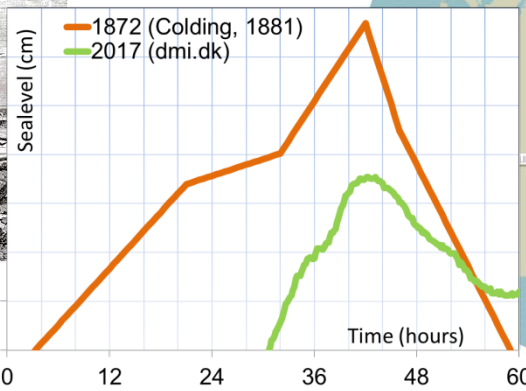
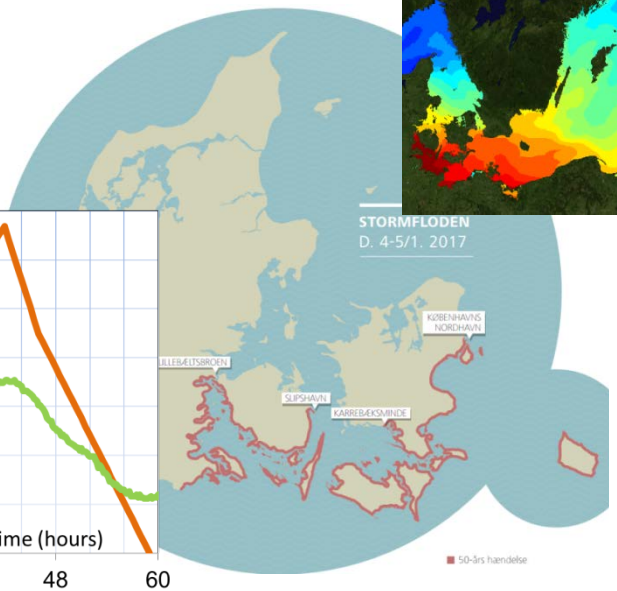
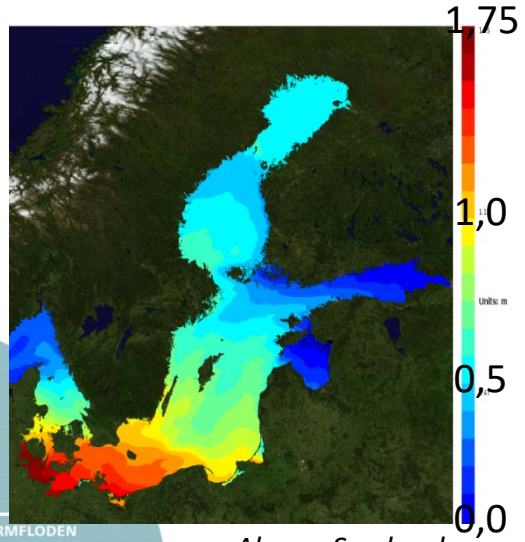
Storm surges of Køge Bay

”Silent” storm surge in January 2017 and the large storm surge in 1872

Above: Sea level (cm) in the Danish town Aabenraa during the storm surges of 1872 and 2017. Background: Damages the storm surge in 1872. Ref: Holger Drachmann, Illustreret Tidende.







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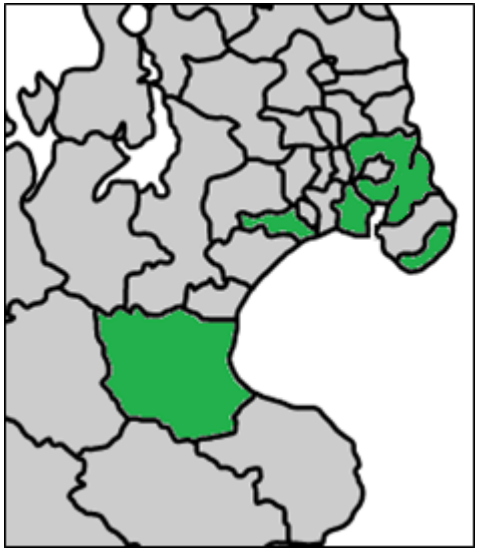
Interviewed partners

We have mapped the user needs for coastal climate change information of five municipalities:

- The central Copenhagen Municipality representing the historical, governmental and cultural capital centre and dense urban population
- Suburban municipalities which also encompass rural areas and areas of natural and recreational interest



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Interview template

Throughout the interview, we will fill in all relevant parts of this form to help define the information service at a technical level. The interview session will last no more than one hour.
(NB to interviewers - please read the guidance protocol that accompanies this form when conducting the interview).

Sector		***Coastal*** C5	
Responsible		***DMI***	
Reference		*C3S-422-Lot2-Deltares-European Services Use case Baltic Sea*	
	Interview table		
NR	**QUESTIONS**	**ANSWERS**	**URDB**
1.	**USER**		T9-T13
1.a.	Name (only if user consents to be named):		
1.b.	Name of organization:		

3.b.	**Climate information (ECV/CIIs)** *Specify the ECV/CIIs that are required. Classification to follow, but will be hierarchical (e.g. variable/indicator/specific characteristics) (e.g. sea level/high water/greater than 110 cm)* Could you please specify the key climate information that you use or require?		C3 C4 CP1 CP2

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Interview template

C1	C2	C3	C4	C5
Keyword(s)	User Requirement (UR) description	UR class	**Raw requirement**	**User sec**
Use terms from the keyword glossary only (leave blank: to be completed at a later date)	Free text. Be specific and quantify statements where possible.	**Choose from:** - **Product** (complete CP) - **Variable** (complete CP) - **General** (complete CG)	Original text. Extract from project source material.	**Choose o** - **Agricul** - **Disaste** - **Health** - **Insuran** - **Transpo**
Copenhagen municipality, Mean Sea Level (MSL) change	**MSL change:** High resolution climate service for local communities: provide **consistent, quality ensured and referenced time series of mean sea level change** in local waters near the coast. Include land rise. The covered timeframe shall include **2050 and 2100**.	Product	**Sea level:** continuous sea level rise curves for various scenarios or with total likelihood. Focus on 2050 and 2100	Coastal, infrastru

3.b.	**Climate information (ECV/CIIs)** *Specify the ECV/CIIs that are required. Classification to follow, but will be hierarchical (e.g. variable/indicator/specific characteristics) (e.g. sea level/high water/greater than 110 cm)* Could you please specify the key climate information that you use or require?		C3 C4 CP1 CP2

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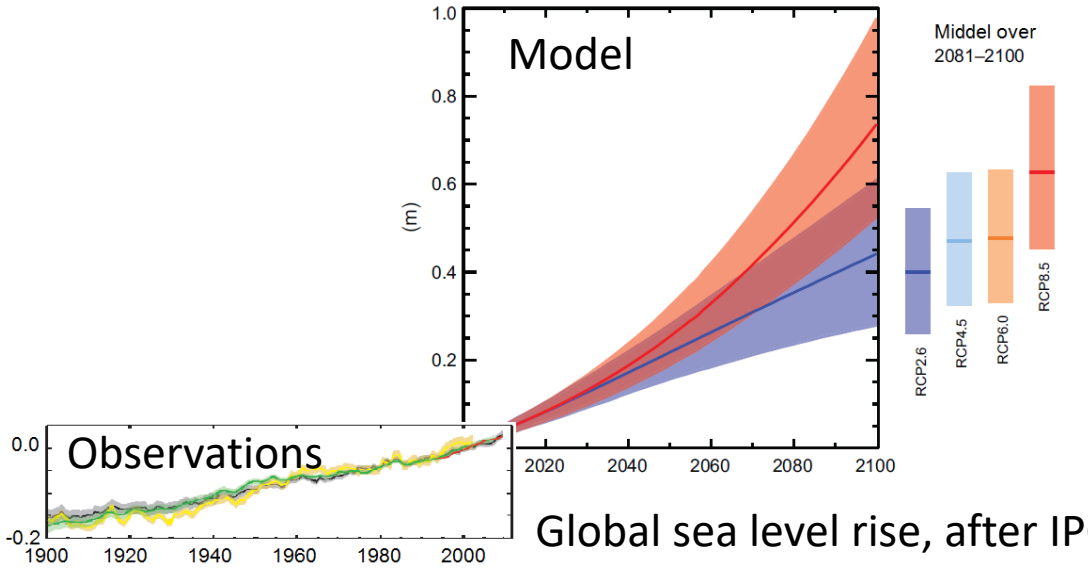
5 planned climate indicators

- Mean Sea level change indicator: mean sea level change of selected reference periods, with and without local land rise.



Global sea level rise, after IPCC 2013

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5 planned climate indicators

- Storm Surge indicator: Storm surge height, duration and frequency changes.

Storm surge wall in town of Lemvig, Denmark

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5 planned climate indicators

- Gate index: Number of flood barrier closures per year and amount of time barriers are closed during an event.

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5 planned climate indicators

- Sea State (Waves) indicator: Changes in wave period, height and duration in a future climate, both for average conditions and high-sea level events, that is, the wave setup during storm surges.

The Storm surge on Sydfalster 13th November 1872. From Illustreret Tidende 1st December 1872

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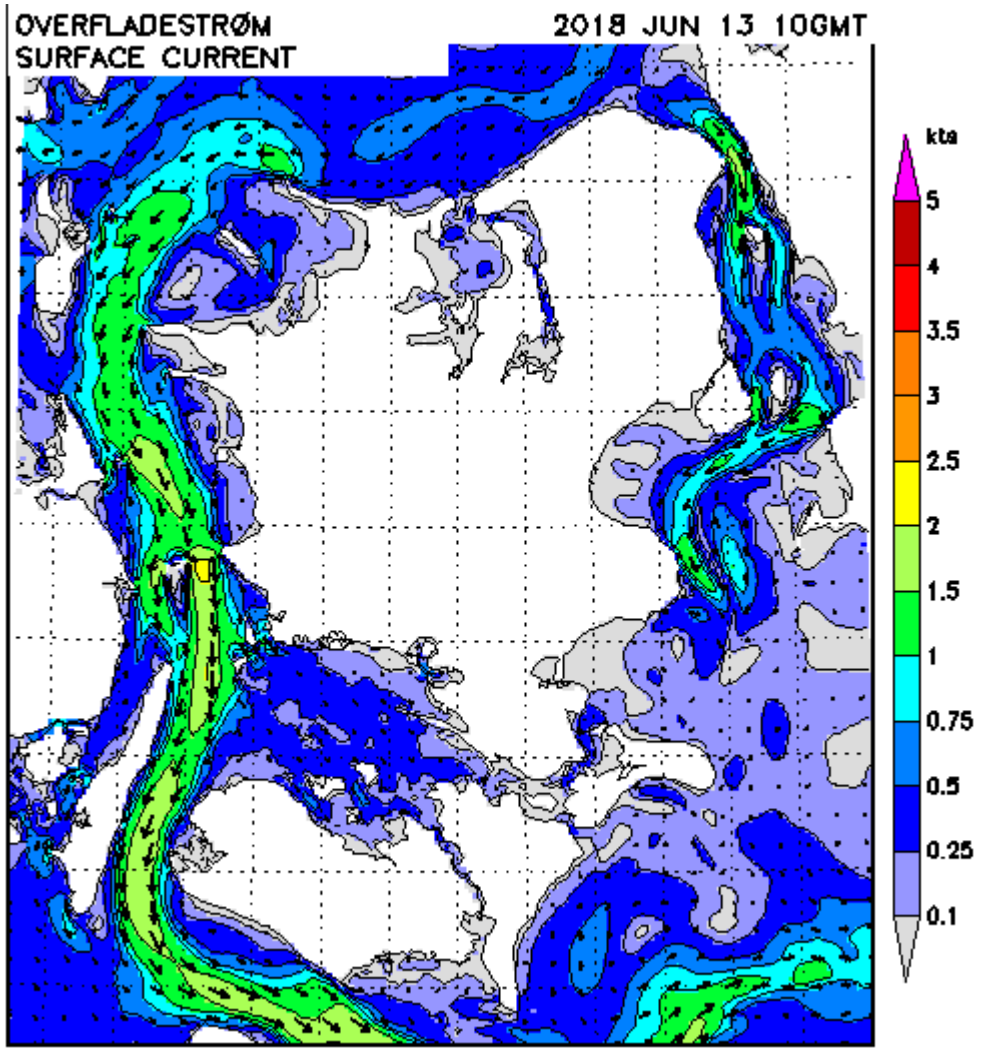
5 planned climate indicators

- Ocean current indicator: Strength and direction of average currents during normal and stormy conditions.



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Metadata & data formats

The municipalities are generally aware of the need for uncertainty information:

- Standard deviations, percentiles or upper- and lower bounds
- The knowledge of ensembles is limited

All municipalities are advanced users of GIS software and would like to integrate the climate information into their present systems, where many other layers of information is available.

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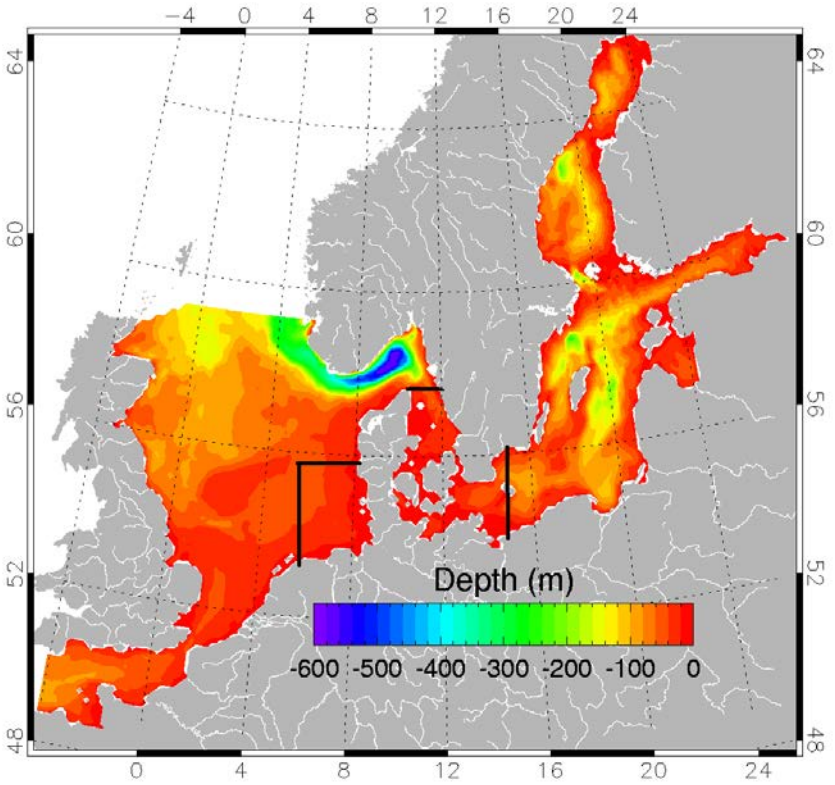
Further work

- Use of our operational storm surge model (HBM 0.5 – 3 nautical mile 3D ocean model) for climate simulations
- Model runs and calculation of indicators will be performed in 2018, before the end of contract in February 2019



HBM DKSS model domain and bathymetry

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Perspective – Contents of the Danish Climate Atlas

Climate information for the Danish Municipalities (and all other interested)

Sea level

- Mean sea level changes
- Storm surges (20- and 50-year events and extreme)

Precipitation

- Mean by season
- Long lasting winter rain and cloud bursts

Temperature

Wind

DMI's driveway 2. July 2011
Photo: Finn Majlergaard

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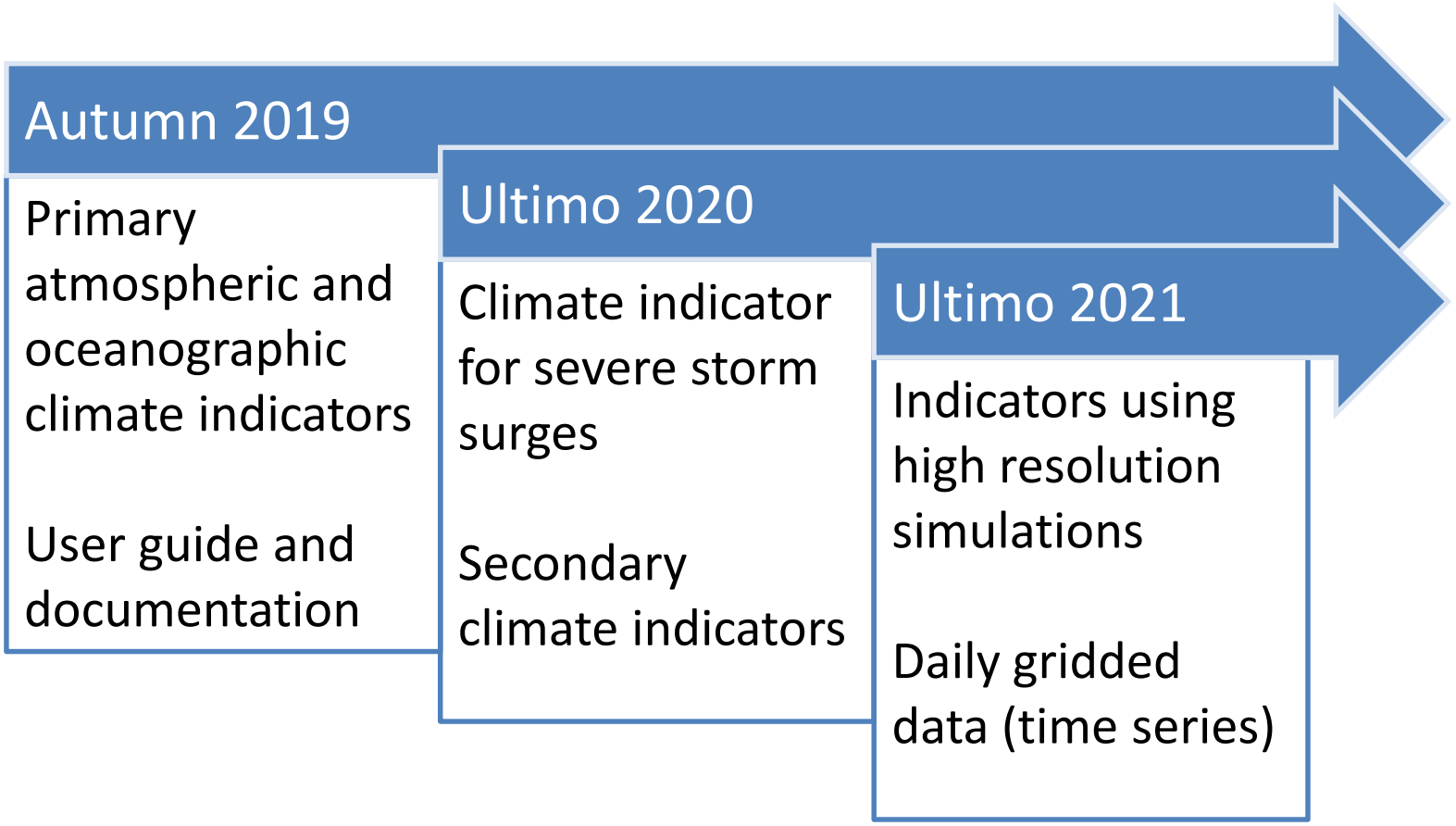
Perspective – Time plan for the Danish Climate Atlas



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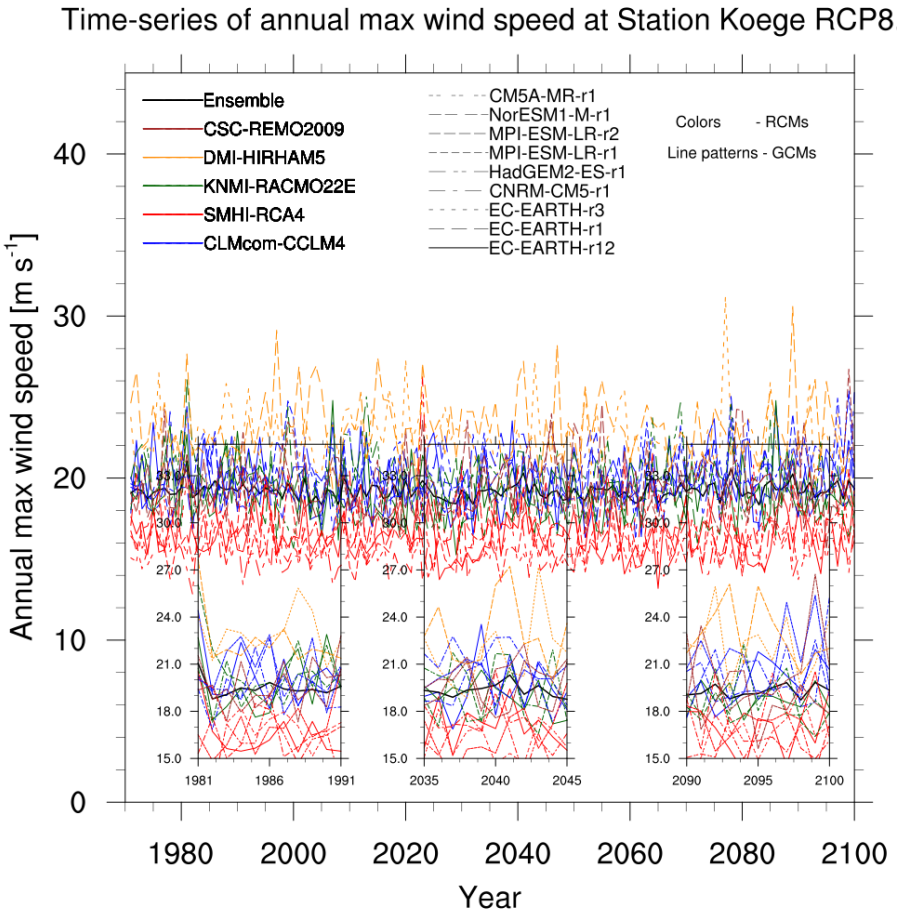
Perspective – Ensemble approach for the Danish Climate Atlas



Use of an ensemble of scenarios – illustration for max wind speed

The spread →

Uncertainty assessment →

Probability of the occurrence of certain events

Summary

- Increasing focus on climate change in the municipalities – and a big wish for guidance
- Interview template worked well to gather user wishes and needs
- 5 planned indicators on sea level, storm surges, waves and currents
- Synergy with the Danish Climate Atlas

Deltares ISMAR JBA consulting UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

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Thank you!

Acknowledgments

The Copernicus Climate Change Service (C3S) is funded by the European Union and aims to:

- Become an authoritative source of climate information for Europe
- Build upon national investments and complement national climate service providers
- Support the market for climate services in Europe
- Provide free public access to climate change information

The Danish Climate Atlas is funded by the Danish government to provide authoritative climate change information to municipalities and the general society