BJERKNES CENTRE
for Climate Research

STRATEGIC PROJECTS 2022 - 2025

Sea Level Prediction and Reconstruction (SeaPR) Unit

NERSC, NORCE, IMR, UiB

UNIVERSITY OF BERGEN
NORCE
NERSC Nansen Center, Bergen
HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15 **SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)

10:15 – 10:30 **Sea-level governing processes in present times and predictability - WP1**
[Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]

10:30 - 10:45 **Reconstruct and attribute sea-level changes during the 20th century - WP2**
[Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]

10:45 – 11:00 **Project sea level with increased confidence - WP3**
[Lead: NORCE; Co-lead: UiB; Partners: NERSC]

11:00 - 11:10 **Communication Strategy**
[Gudrun Sylte, UiB]

11:10 - 11:25 **WCRP - CliC Future Strategy Plan 2022-2031**
[Beatriz Balino, UiB/WCRP]

11:25 - 11:45 **Final Remarks**

BJERKNES CENTRE for Climate Research

Sea Level Prediction and Reconstruction (SeaPR) Unit

Goal

SeaPR aims to establish a Sea Level Prediction and Reconstruction Unit at BCCR to provide and increase confidence in sea-level predictions and projections for more informed decision making.

Objectives

O1-WP1 Understanding of the **processes governing sea level during present times** and assess predictability

O2-WP2 Reconstruct and attribute **20th century** changes

O3-WP3 Project sea level with increased confidence

Sea Level Prediction and Reconstruction (SeaPR) Unit

Motivation

To skillfully project **global, regional and local sea-level rise**, an in-depth **understanding** of the underlying **mechanisms and drivers** as well as their uncertainties is essential

Relevance to Bjerknes Strategy

With its broad and diverse expertise, **BCCR** is one of the few centres worldwide capable of addressing sea-level change across disciplines.

NORCE: in-situ observations, coupled climate/ice-sheet modelling

NERSC: remote sensing observations, ocean/climate models, ocean reanalysis

UiB: sediment supply, climate predictability, human dimension of sea-level change

IMR: hydrographic and altimetry observations; air-sea heat fluxes

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15	**SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)
10:15 – 10:30	**Sea-level governing processes in present times and predictability - WP1** [Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]
10:30 - 10:45	**Reconstruct and attribute sea-level changes during the 20th century - WP2** [Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]
10:45 – 11:00	**Project sea level with increased confidence - WP3** [Lead: NORCE; Co-lead: UiB; Partners: NERSC]
11:00 - 11:10	**Communication Strategy** [Gudrun Sylte, UiB]
11:10 - 11:25	**WCRP - CliC Future Strategy Plan 2022-2031** [Beatriz Balino, UiB/WCRP]
11:25-11:45	**Final Remarks**

WP1
Sea-level governing processes

Project Structure

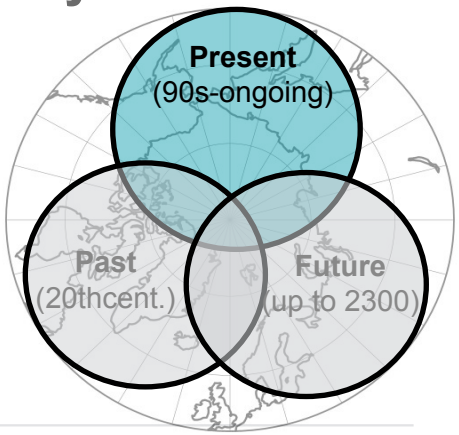
WP1 Sea-level governing processes during present times and predictability
[Lead: NERSC/IMR]

Task 1.1: Multi-platform data-collection

Task 1.2: Sea-level Budget, steric and mass components, SML

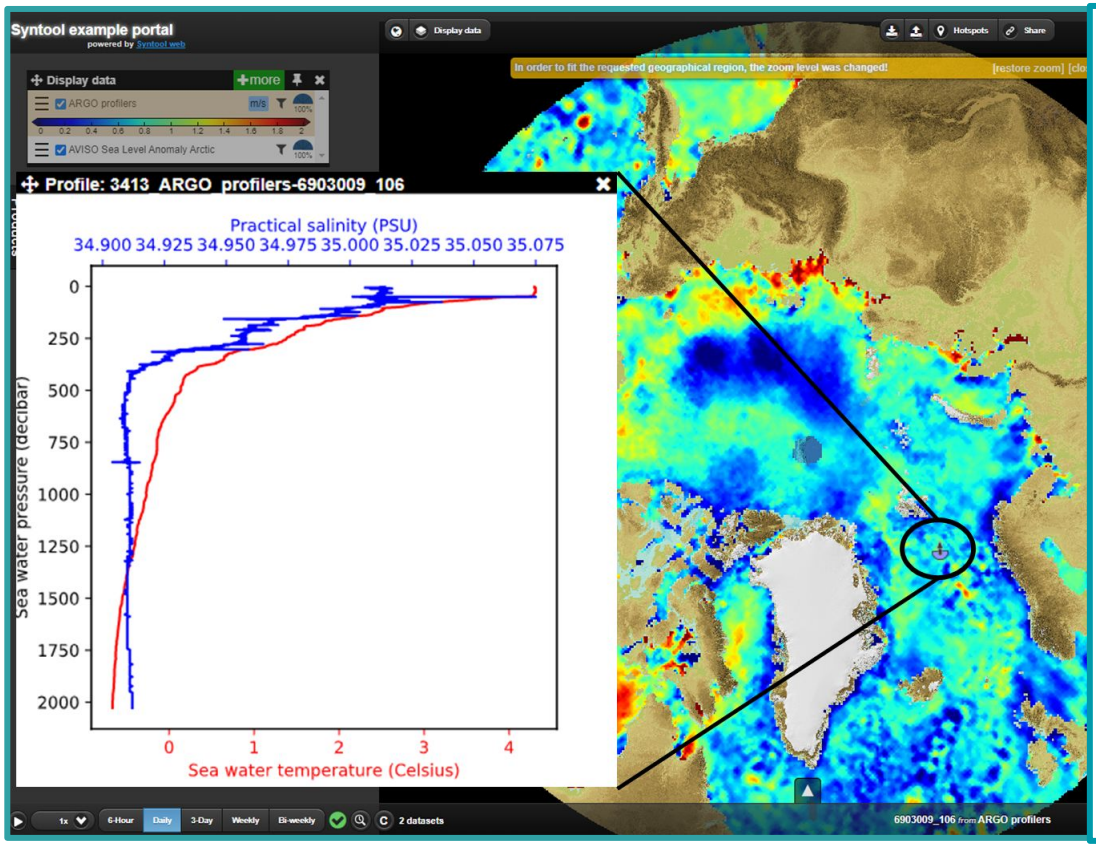
Task 1.3: 3D mesoscale influence on sea-level variability

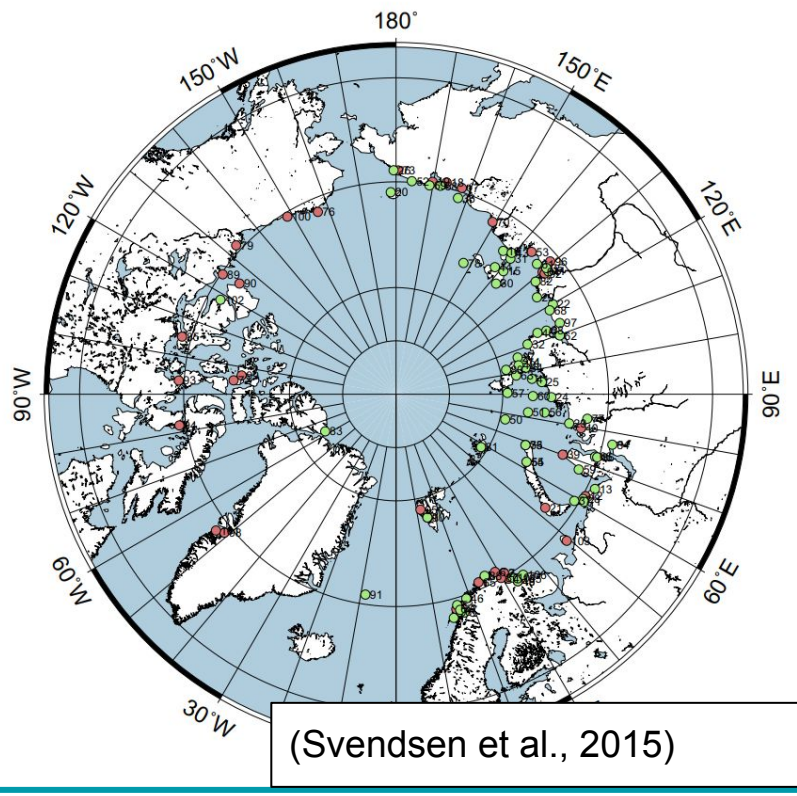
Task 1.4: Sea-level predictability



BJERKNES CENTRE for Climate Research

Input - Multi-platform data collection (T1.1)





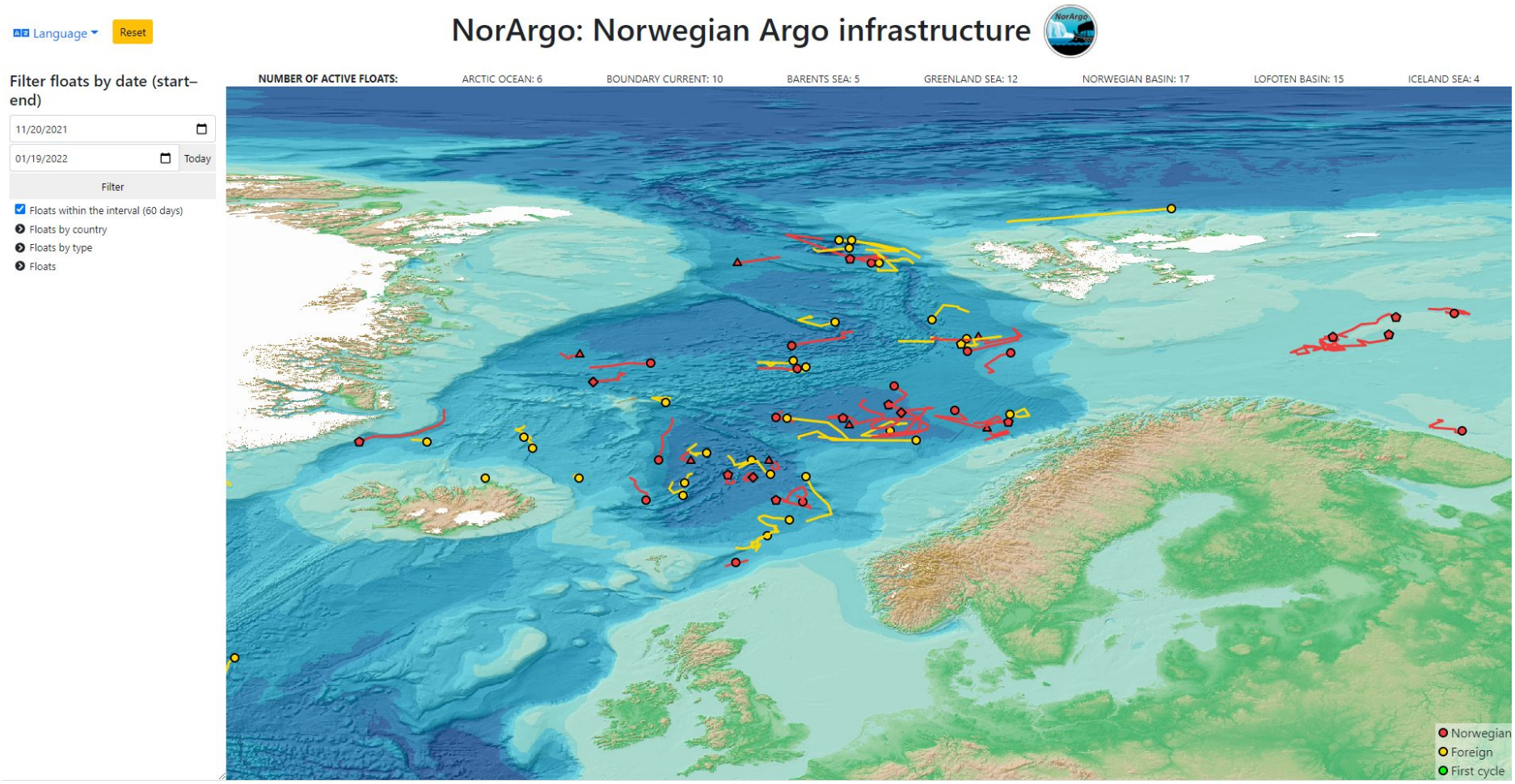
(Svendsen et al., 2015)

- Remote-sensing (satellite altimetry and gravimetry data)
- In-situ
- Global/regional ocean/atmospheric re-analysis and numerical exp.
- Climate models

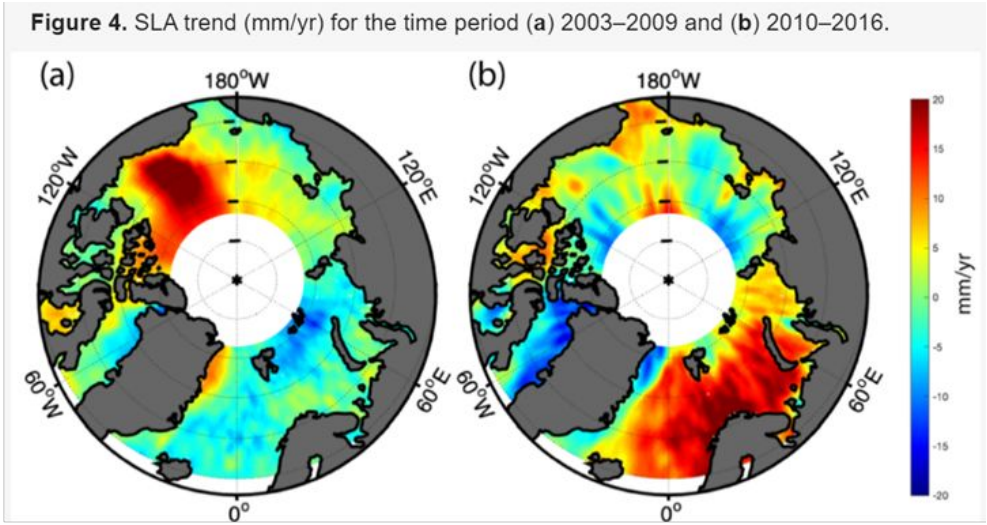
BJERKNES CENTRE for Climate Research

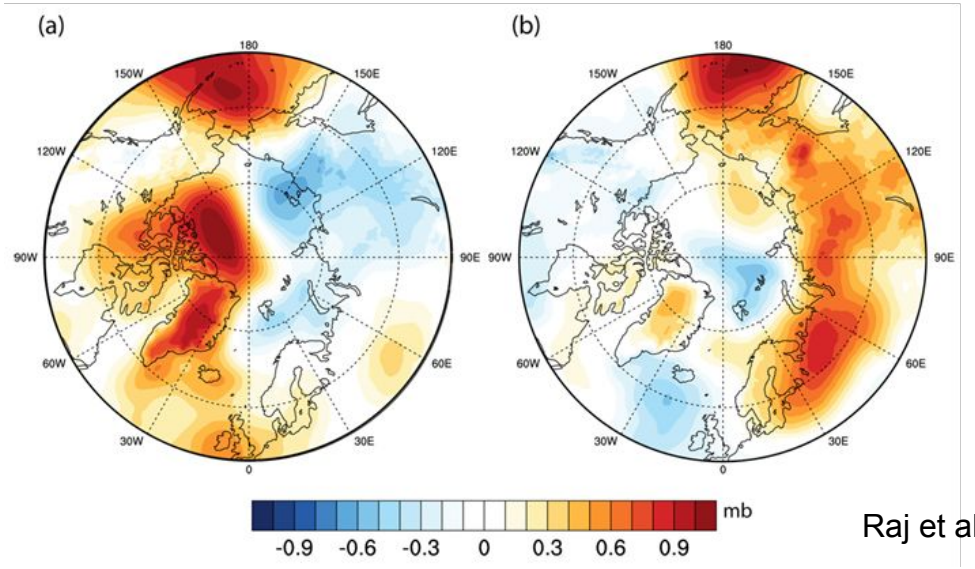
Input - Multi-platform data collection (T1.1)

- **NorArgo** (K. A. Mork, IMR)



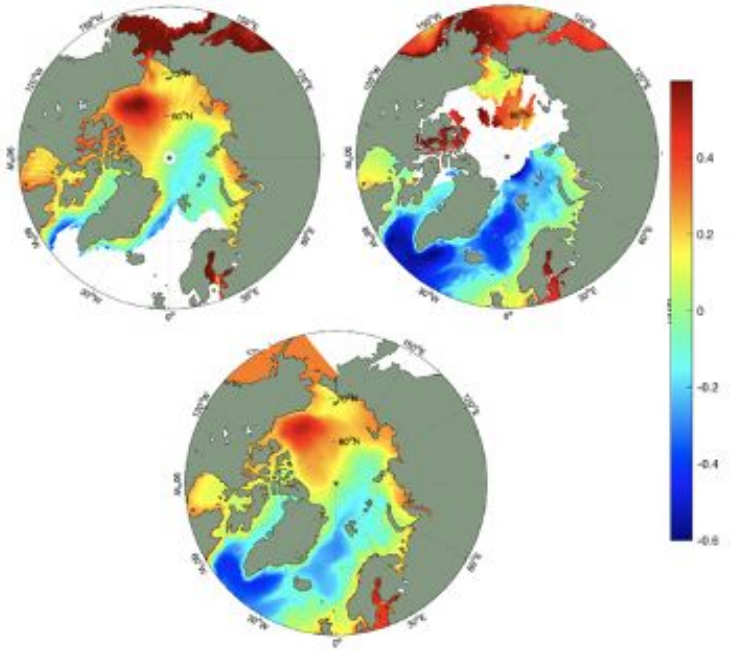
Sea-level Budget (T1.2)





Raj et al., 2020

New Cryo-TEMPO data



Winter (DJF) *Climatology (2010-2021) of absolute dynamic topography (m): (upper left) Cryo-Tempo data; (upper right) CMEMS data; (bottom panel) TOPAZ*

Raj et al., 2022, in review

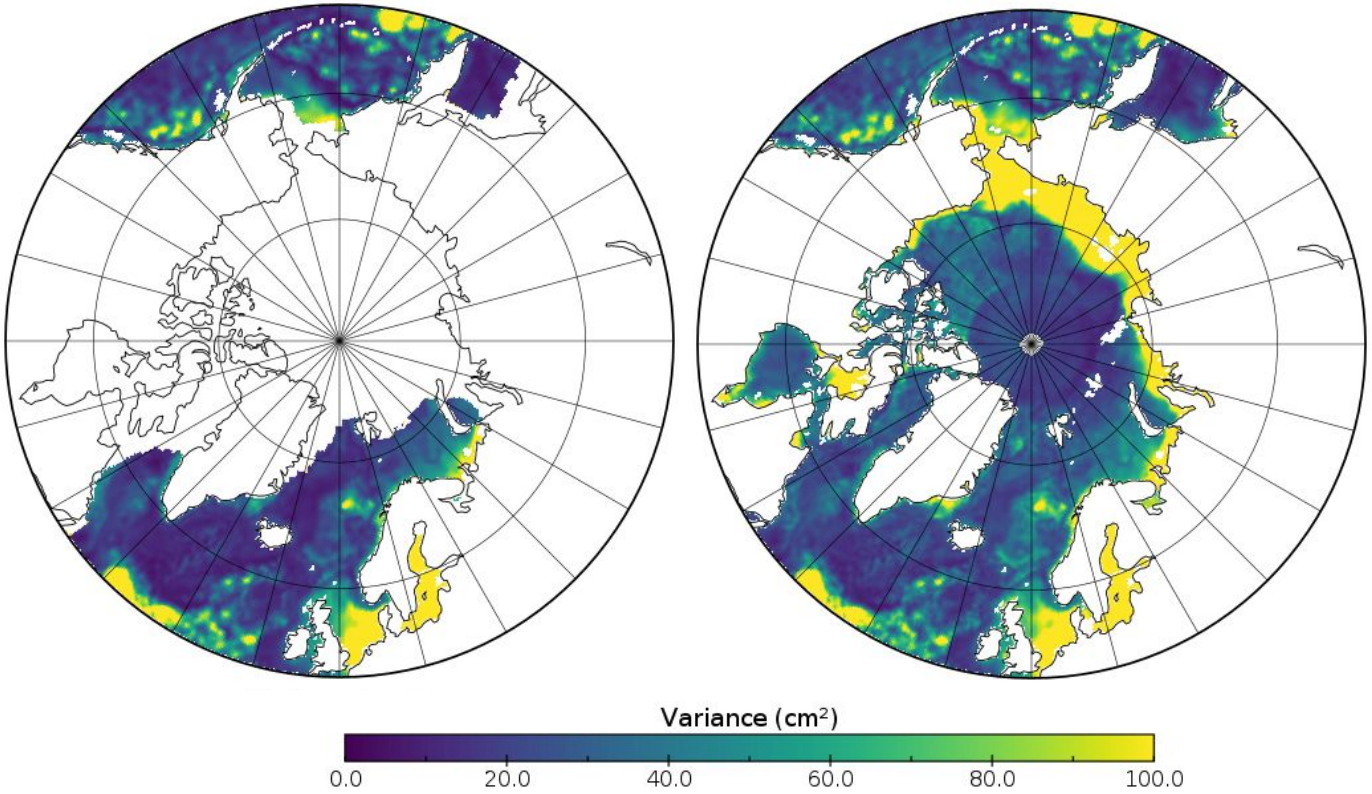
BJERKNES CENTRE for Climate Research

Mesoscale influence on sea-level variability (T1.3)

Standard (1 Hz) Altimetry Data

Experimental (5 Hz) Altimetry Data

(2016 – 2019)



[Reference/Input for Task 3.3]

Bonaduce et al., 2022, in preparation

Sea-level Predictability (T1.4)

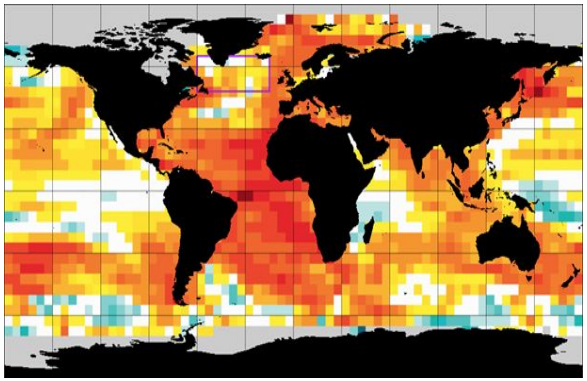
Purpose: attribute/predict sea level change and understand model-data differences

Problem: model-data comparison complicated by that internal variability is not in sync

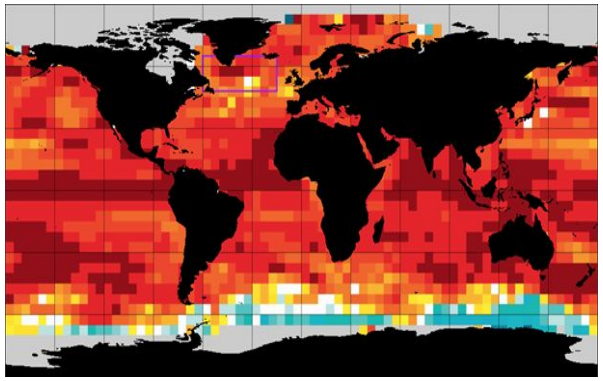
Approach: wind nudging to synchronize internal model variability with obs. (budgets fully preserved)

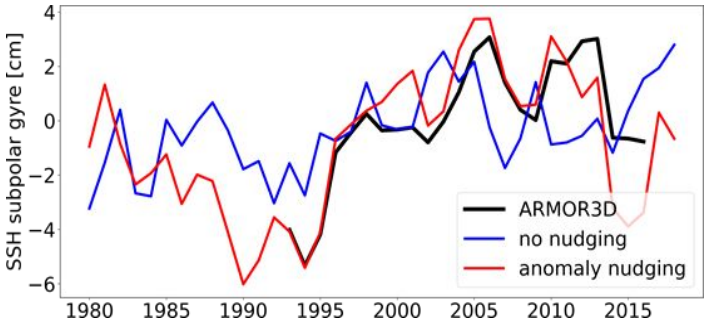
Pilot: Anomaly-nudging of 3d wind fields to ERAI (1970-2018) in NorESM1-ME

hist. simulation, no nudging



hist. pacemaker, wind nudging





SeaPR plans: wind nudging to ERA5 (1950-now) in NorESM2-MM and high-res NorESM2-MH -> reanalysis + predictions

Bethke et al., 2022 (in preparation)

WP1 - Output and Timeline

D1.1 Multi-platform data-lake (e-catalogue) - <u>Input for sea-level reconstructions in WP2</u> (M6); - Milestone

D1.2 Improved **process understanding** and driving mechanisms (M32); [PRP]

D1.3 Improved representation of sea-level **temporal and spatial scales** of variability and drivers (M40); [PRP]

D2.4. Model-based **sea-level predictability** assessment for the northern high-latitudes (M48). [PRP]

Table 1: *Time schedule. Start date: 01/01/22. End date: 31/12/25*

Year	**2022**				**2023**				**2024**				**2025**			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
WP 0	X							X								X
WP 1		X								X		X				X
WP 2						X		X								
WP 3				X			X					X		X		X

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15	**SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)
10:15 – 10:30	**Sea-level governing processes in present times and predictability - WP1** [Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]
10:30 - 10:45	**Reconstruct and attribute sea-level changes during the 20th century - WP2** **[Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]**
10:45 – 11:00	**Project sea level with increased confidence - WP3** [Lead: NORCE; Co-lead: UiB; Partners: NERSC]
11:00 - 11:10	**Communication Strategy** [Gudrun Sylte, UiB]
11:10 - 11:25	**WCRP - CliC Future Strategy Plan 2022-2031** [Beatriz Balino, UiB/WCRP]
11:25-11:45	**Final Remarks**

WP2
Reconstruct and attribute sea-level changes

Sea Level Prediction and Reconstruction (SeaPR) Unit

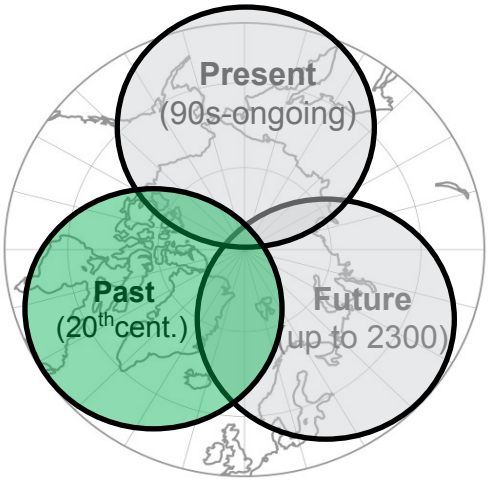
Project Structure

WP2 Reconstruct and attribute sea-level changes during the 20th century
[Lead NORCE/UiB]

Task 2.1 Reconstructing regional sea-level changes

Task 2.2: Attributing regional sea-level changes

Task 2.3: Assessing climate models



Task 2.1: Reconstructing regional sea-level changes

Aim: 20th century sea level **reconstruction** for northern high latitudes (D2.1)

Approaches:

1. probabilistic techniques: fit known spatial patterns of individual sea-level contributors to tide gauge records -> good at low frequencies
2. reduced space optimal interpolation: combine temporal information from tide gauge records with spatial information from altimetry -> good at high frequencies

Hybrid reconstructions combine both approaches at those time scales they have proven skillful! (Dangendorf et al., 2019)

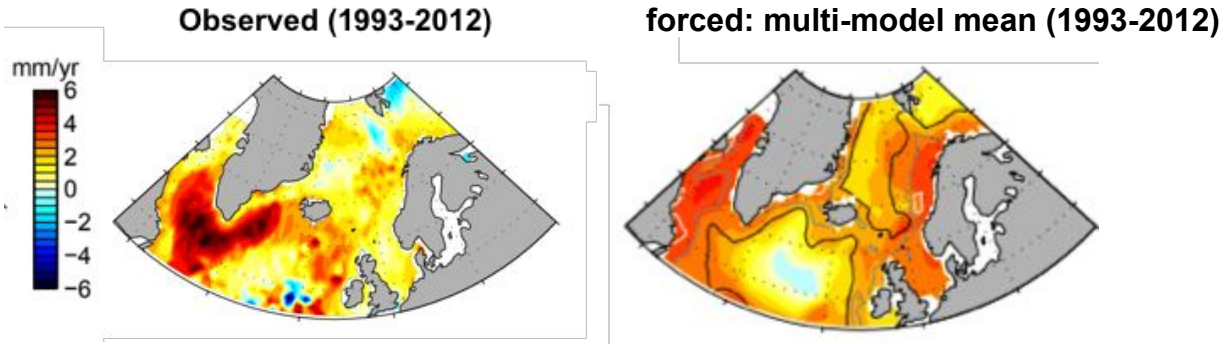
Input:

- Data lake produced in WP1
- NorESM pacemaker simulations with realistic internal variability from WP1
- Land ice fingerprints (WP3)

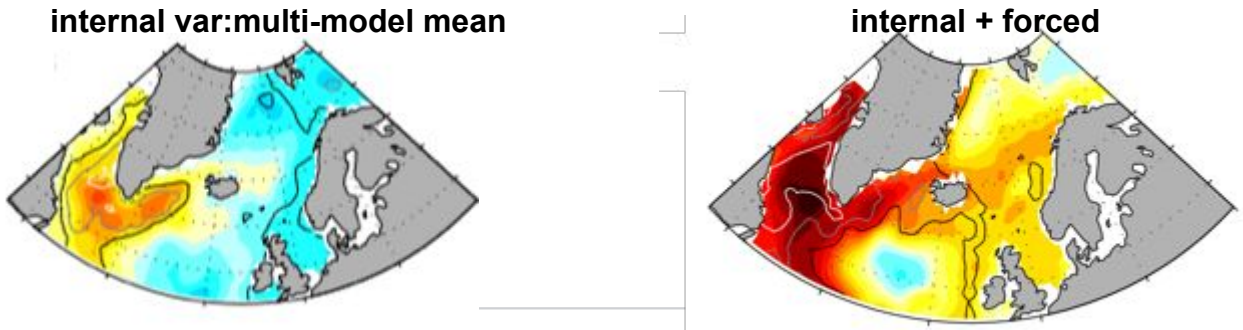
Task 2.2: Attributing regional sea-level changes

CMIP6 archive and Multi Model Large Ensemble Archive (MMLEA)

- robust detection of forced signal and inter-model difference



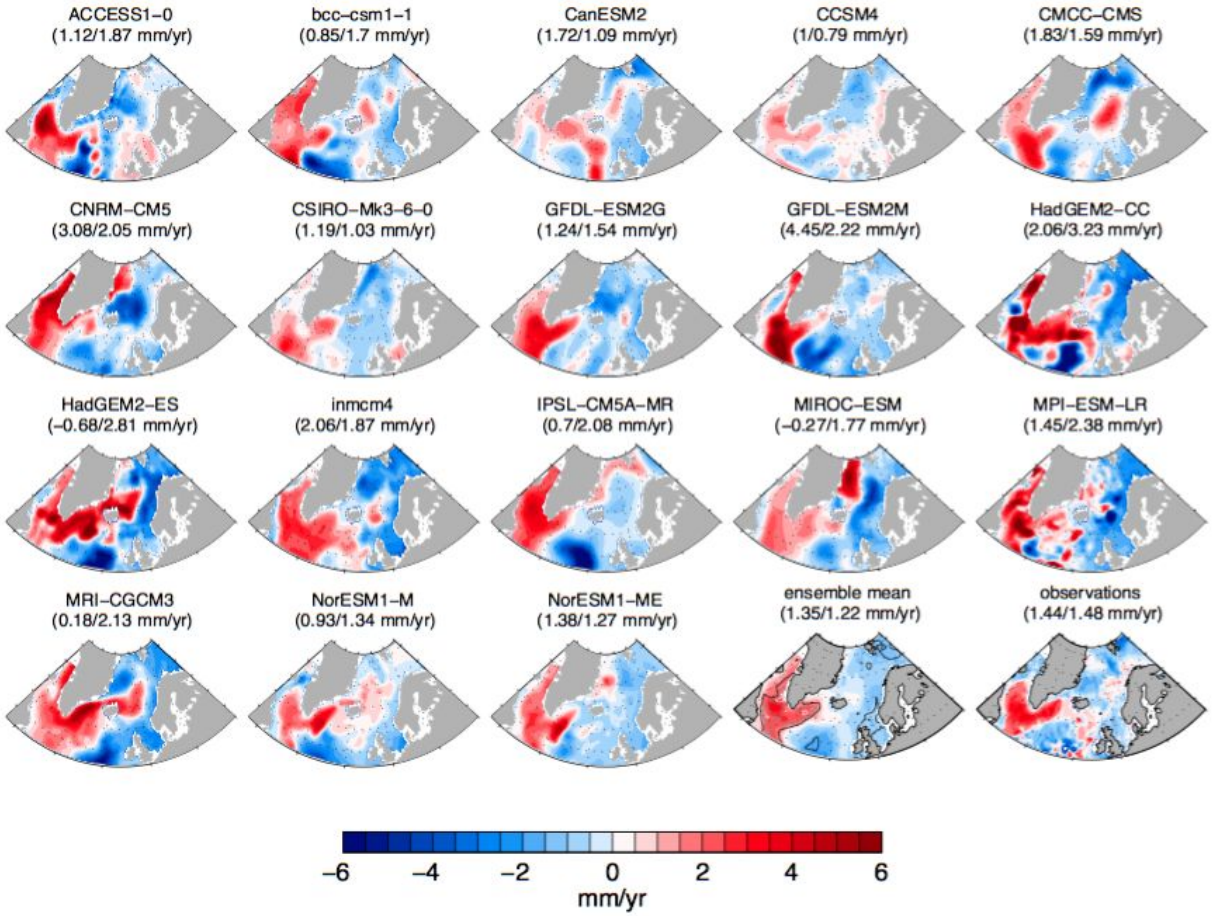
- obtain a better model-data comparison through matching of internal variability with observations (by selecting the period with the “right” internal variability phase



Task 2.3: Assessing climate models

CMIP6 archive and Multi Model Large Ensemble Archive (MMLEA)

- selecting the period with the “right” internal variability phase
- weight models according to their performance



WP2 - Output and Timeline

D2.1 20th century sea level **reconstruction** for northern high latitudes (M18) [e-catalogue]

D2.2 climate models ranking (M24) [e-catalogue] - <u>Input for optimal ensemble in WP3 - Milestone</u>

Table 1: *Time schedule. Start date: 01/01/22. End date: 31/12/25*

Year	**2022**				**2023**				**2024**				**2025**			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
WP 0	X							X								X
WP 1		X								X		X				X
WP 2						X		X								
WP 3				X			X					X		X		X

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15	**SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)
10:15 – 10:30	**Sea-level governing processes in present times and predictability - WP1** [Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]
10:30 - 10:45	**Reconstruct and attribute sea-level changes during the 20th century - WP2** [Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]
10:45 – 11:00	**Project sea level with increased confidence - WP3** [Lead: NORCE; Co-lead: UiB; Partners: NERSC]
11:00 - 11:10	**Communication Strategy** [Gudrun Sylte, UiB]
11:10 - 11:25	**WCRP - CliC Future Strategy Plan 2022-2031** [Beatriz Balino, UiB/WCRP]
11:25-11:45	**Final Remarks**

WP3
Project Sea level with increased confidence

Project Structure

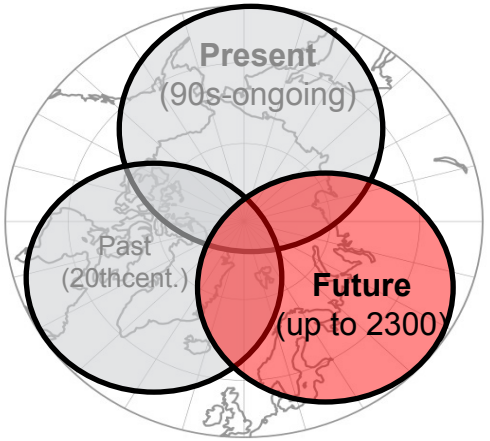
WP3 Project sea level with increased confidence [Lead: NORCE/UiB]

Task 3.1: Process-based sea-level projections for the Greenland ice sheet

Task 3.2: Sea-level fingerprints

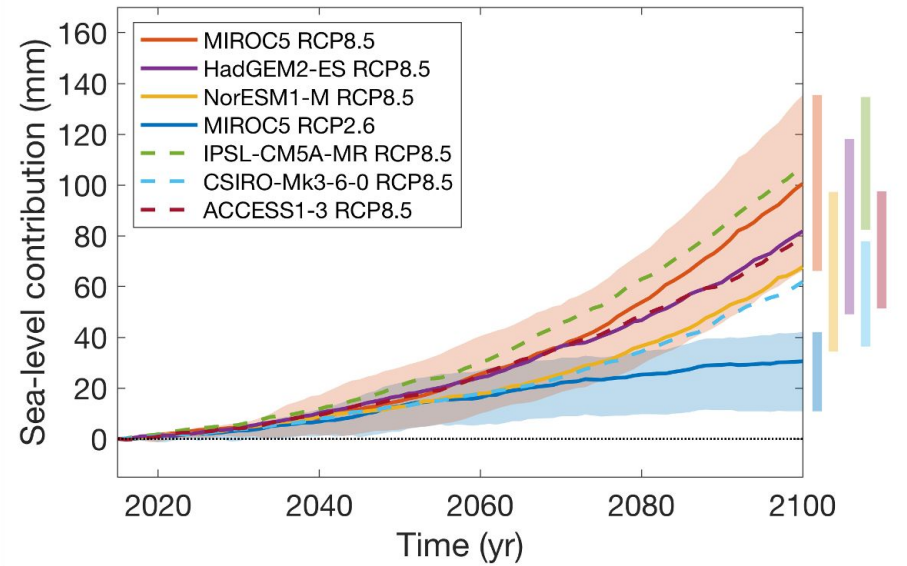
Task 3.3: The impact of resolving mesoscale in the ocean on the reliability of sea-level projections

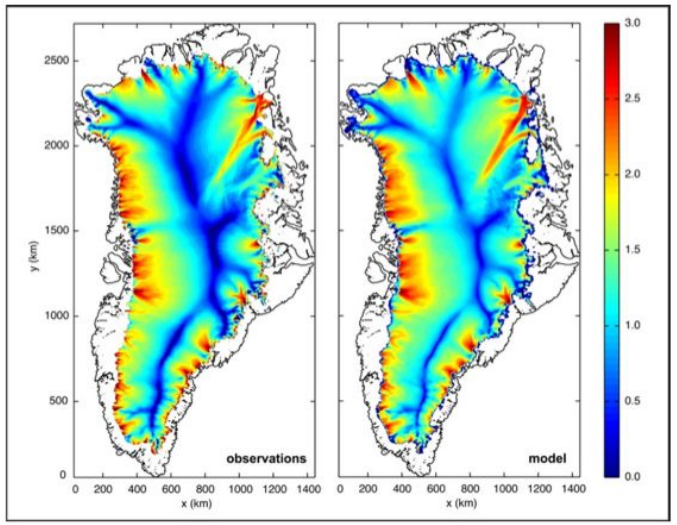
Task 3.4: Information on sediment supply and vulnerability matrix



Task 3.1: Process-based sea-level projections for the Greenland ice sheet

- Complement existing projections with wider range of model forcings now available
- Better represent historical mass changes
- Explore ice sheet-climate coupling with NorESM2





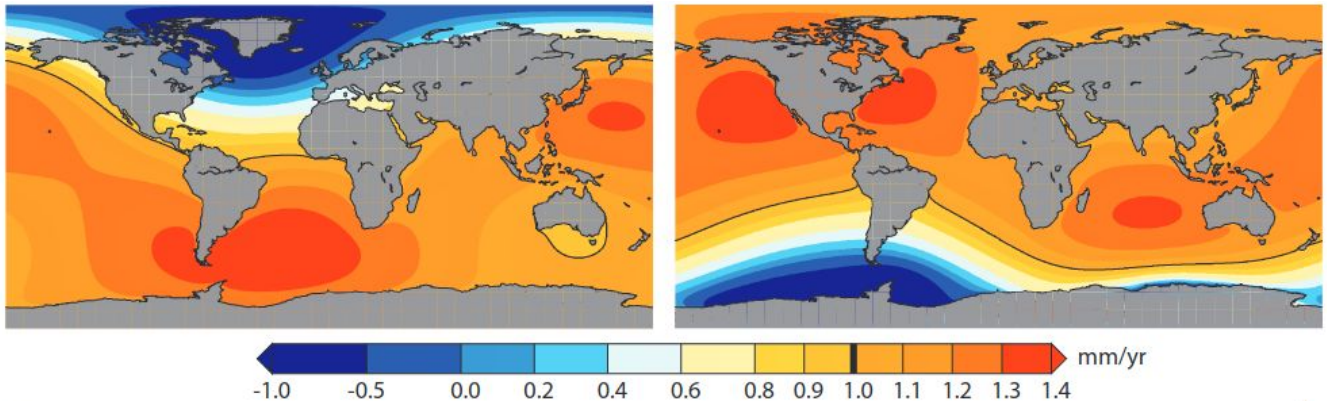
Task 3.2: Sea-level fingerprints

Translating land ice mass loss to regional sea-level changes

Relative sea-level change caused by a mass loss equivalent to 1mm/yr global sea level change from

Greenland

Antarctica

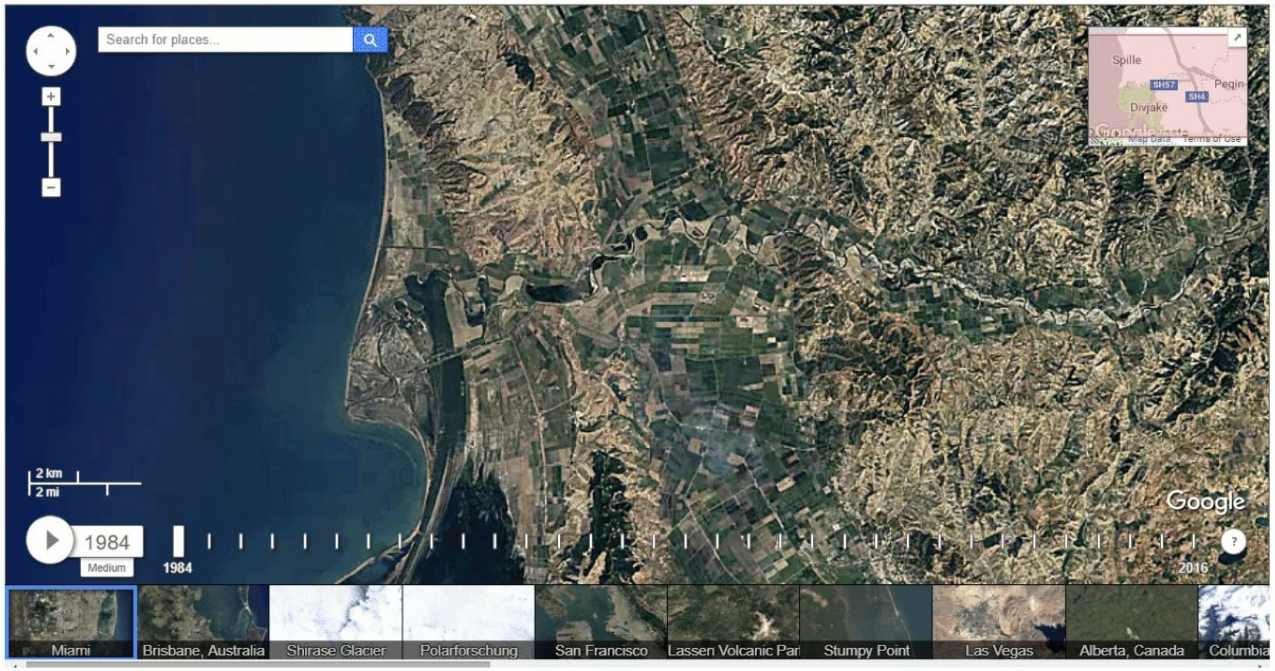


Tamisiea & Mitrovica (2011)

Approach: implement existing open software (SELEN); draw upon expertise of visiting scientist Natalya Gomez (Climate Narratives)

Task 3.4: Information on sediment supply and vulnerability matrix

35 years of satelite imagery as library for maching-learning-based coastline projections

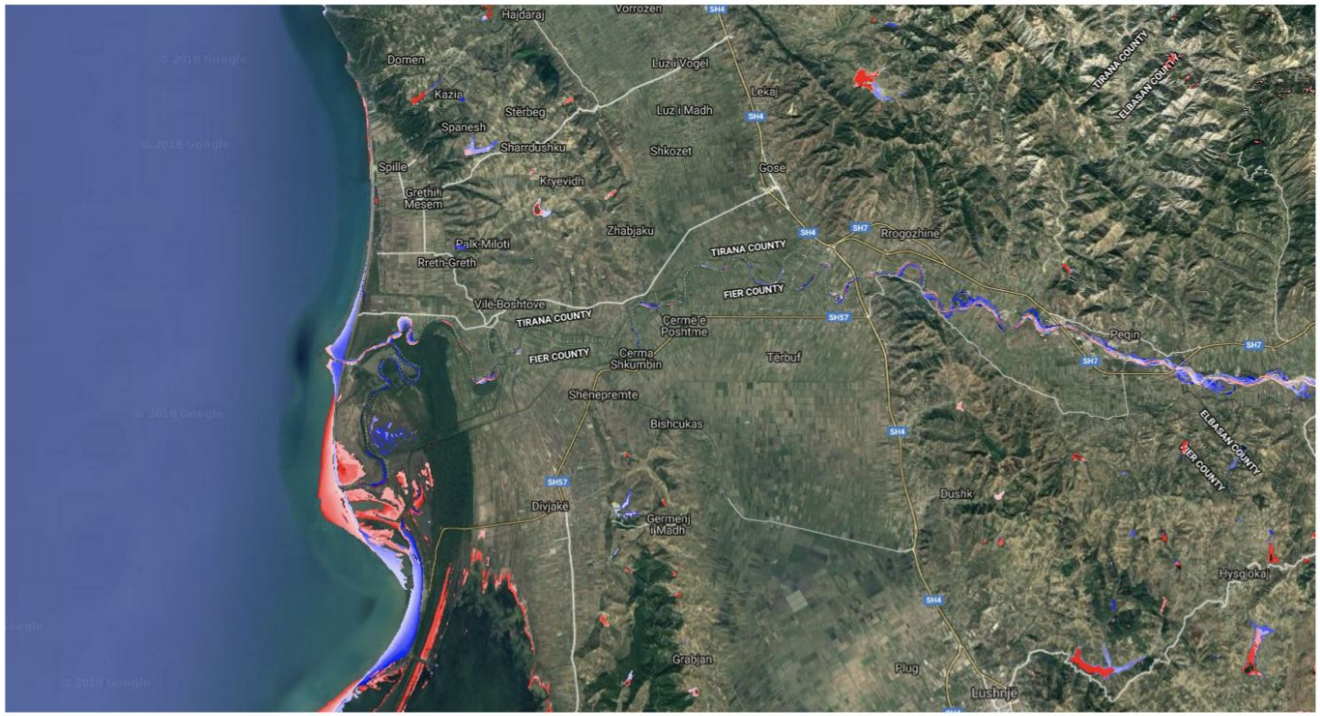


https://earthengine.google.com/timelapse/

uib.no

Task 3.4: Information on sediment supply and vulnerability matrix

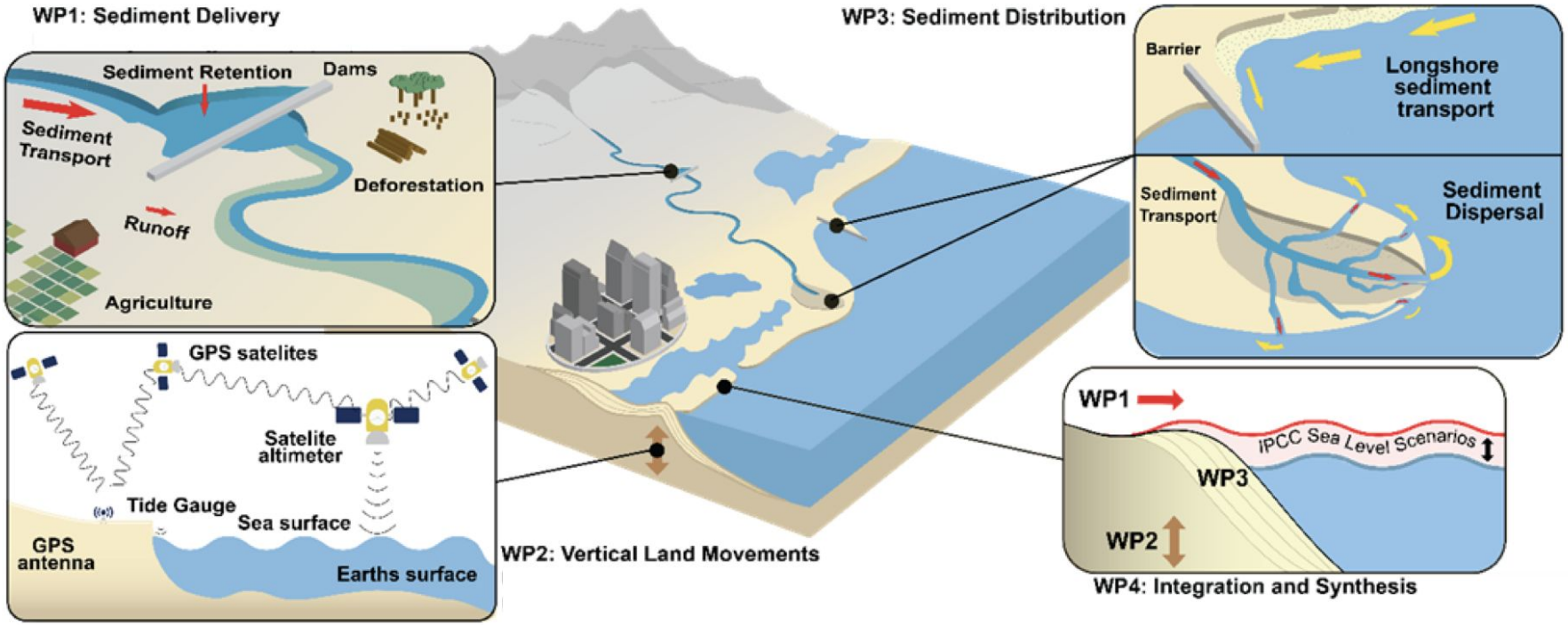
35 years of satelite imagery as library for maching-learning-based coastline projections



https://toreaad.users.earthengine.app/view/coaster

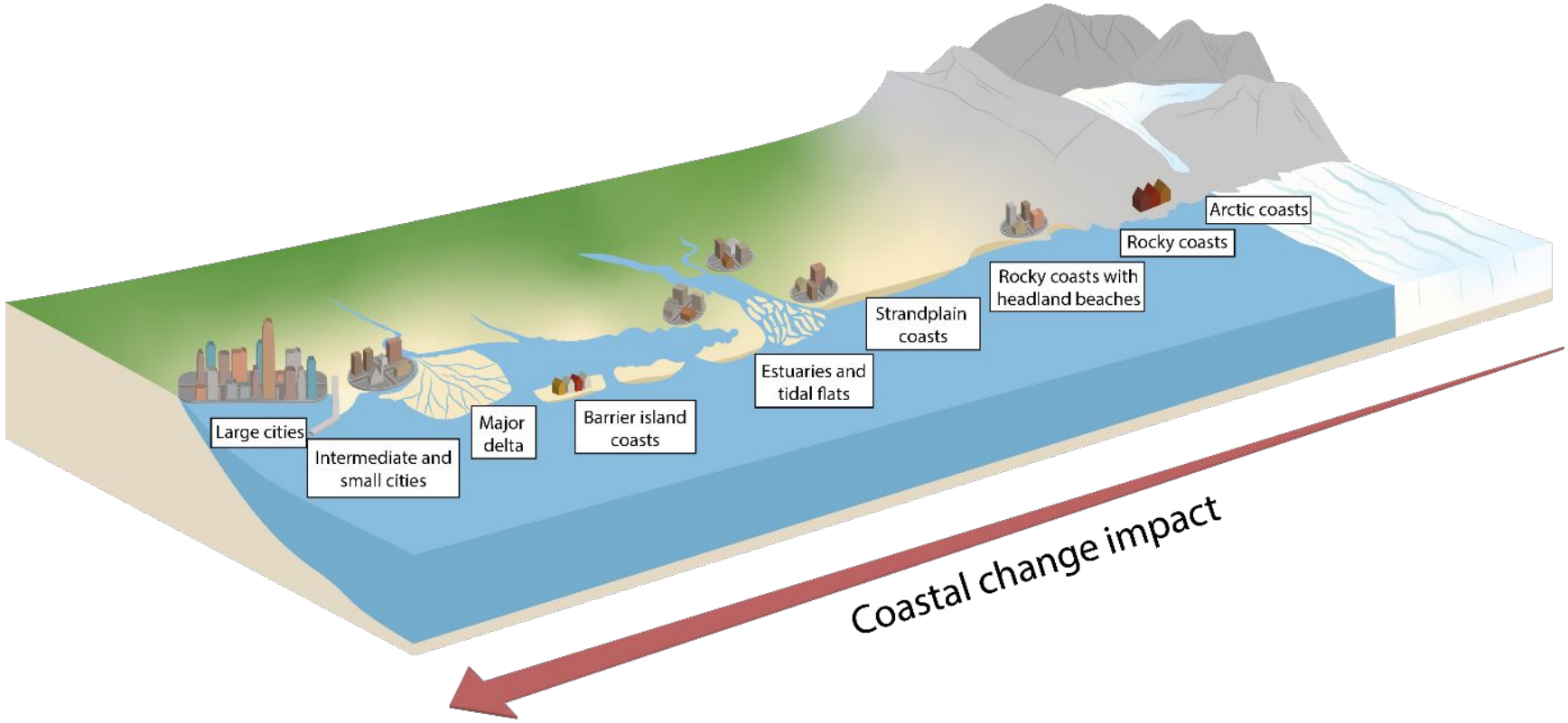
uib.no

Task 3.4: Information on sediment supply and vulnerability matrix



Task 3.4: Information on sediment supply and vulnerability matrix

Impact of SLR on different geomorphologies and communities



The rate of **coastal change** will depend on relative **sea-level rise**, **vertical land movement and sediment supply** controlling the accommodation and supply.

BJERKNES CENTRE for Climate Research

WP3 - Outputs and Timeline

D3.1 Greenland ice sheet sea-level projections with reduced uncertainty (M42) [PRP]

D3.2 Fingerprint model (M12) [GM]

D3.3 Coastal vulnerability matrix accounting for mean and extreme sea-level changes effect on the society (M48) [e-catalogue] - Milestone

D3.4 Role of eddies in sea-level projections (M36) [PRP]

D.3.5 Decadal scale coastal- change maps for a range of SSP and RCP scenarios (M18). [e-catalogue]

Table 1: *Time schedule. Start date: 01/01/22. End date: 31/12/25*

Year	**2022**				**2023**				**2024**				**2025**			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
WP 0	X							X								X
WP 1		X								X		X				X
WP 2						X		X								
WP 3				X			X					X		X		X

UNIVERSITY OF BERGEN NORCE NERSC Nansen Center, Bergen HAVFORSKNINGSINSTITUTTET INSTITUTE OF MARINE RESEARCH

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15	**SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)
10:15 – 10:30	**Sea-level governing processes in present times and predictability - WP1** [Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]
10:30 - 10:45	**Reconstruct and attribute sea-level changes during the 20th century - WP2** [Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]
10:45 – 11:00	**Project sea level with increased confidence - WP3** [Lead: NORCE; Co-lead: UiB; Partners: NERSC]
11:00 - 11:10	**Communication Strategy** [Gudrun Sylte, UiB]
11:10 - 11:25	**WCRP - CliC Future Strategy Plan 2022-2031** [Beatriz Balino, UiB/WCRP]
11:25-11:45	**Final Remarks**

BJERKNES CENTRE for Climate Research

Agenda

10:00 – 10:15	**SeaPR - Goal and Objectives** (A. Bonaduce, NERSC)
10:15 – 10:30	**Sea-level governing processes in present times and predictability - WP1** [Lead: NERSC; Co-lead: IMR; Partners: UiB, NORCE]
10:30 - 10:45	**Reconstruct and attribute sea-level changes during the 20th century - WP2** [Lead: NORCE; Co-lead: UiB; Partners: IMR, NERSC]
10:45 – 11:00	**Project sea level with increased confidence - WP3** [Lead: NORCE; Co-lead: UiB; Partners: NERSC]
11:00 - 11:10	**Communication Strategy** [Gudrun Sylte, UiB]
11:10 - 11:25	**WCRP - CliC Future Strategy Plan 2022-2031** [Beatriz Balino, UiB/WCRP]
11:25 - 11:45	**Final Remarks**

Collaboration

1. Cryo-TEMPO (2020-2023)
2. Dragon5 (2020-2024)
3. ESA CCI SLBC

SeaPR

BJERKNES CENTRE for Climate Research

The Research Council of Norway

1. GREASE (2021-2025)
2. KeyCLIM (2019-2023)
3. INES (2018-2028)
4. NorArgo2 (2018-2023)
5. Ocean States

1. HORIZON2020-PROTECT (2020-2024)
2. Copernicus - ARCMFC (2022-2025)

BJERKNES CENTRE for Climate Research

Young Researchers

PostDoc

NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

Singapore coast

PhDs

NERCI

Indian coast

NANSEN-TUTU CENTRE MARINE ENVIRONMENTAL RESEARCH

South Atlantic Sea level

MSc

UNIVERSITAS BERGENSIS

Norwegian coast

Opportunities

UNIVERSITAS BERGENSIS

2 Master thesis (2022, 2023) ,partly funded: (150KNok)
ESA Dragon5 project

Arctic and Nordic sea level

BJERKNES CENTRE for Climate Research

Outreach

WCRP World Climate Research Programme

Safe Landing climates

Miljø-direktoratet

Sea level report

JPI OCEANS

Sea level rise

ICE SHEET MASS BALANCE AND SEA LEVEL (ISMASS)

ISMIP6 Ice Sheet Model Intercomparison Project for CMIP6

INTERNATIONAL SPACE SCIENCE INSTITUTE

NSRG

USGS science for a changing world

BJERKNES CENTRE for Climate Research

Take Home Messages

- SeaPR (2022-2025) - builds on the outstanding expertise of **BCCR partners**
- **Goal:** establish a Sea Level Prediction and Reconstruction Unit at BCCR
- Boost the **visibility** of the BCCR in Sea Level Research

Next Steps - January 2022

- **Kick-off Meeting** ✓
- **Web-page** - Communication Management at BCCR
- **Postdoc** Position

JPI Sea Level Rise Knowledge Hub

Survey - Open till 21st Feb. 2022
https://ec.europa.eu/eusurvey/runner/KH-SLRsurvey2022

Basin Workshops (March-April 2022)

- **North Sea/Nordic Sea and Arctic Ocean** (21-22 March, Deltares - The Netherlands)
- Eastern Atlantic (28-29 March, Ifremer, France)
- Baltic Sea (28-29 March, IOW, Germany)
- Mediterranean (7-8 April, UPC, Spain)