

Atlantic Pole to Pole: Climate Science 2 Policy

Welcome, Gerard McCarthy (Maynooth University)

Atlantic Ocean Challenges and integrated ecosystem assessment, Andrei Polejack and Mary Wisz (WMU/MISSION ATLANTIC)

The science evidence of the challenge.

- Atlantic-Arctic Ocean Circulation and Impacts, Gerard McCarthy (Maynooth University/Blue-Action)
- Southern Ocean Dynamics and climate, Jean-Baptiste Sallée (CNRS, LOCEAN-IPSL/SO-CHIC)
- Atlantic Climate-Based Marine Ecosystem Prediction for Sustainable Management, Elaine McDonagh (NORCE/NOC /TRIATLAS)

Wrapping up: Vision for the future, John Bell (European Commission, DG RTD)

Panel discussion, moderation by Sheila Heymans (European Marine Board)

with Evelia Rivera-Arriaga (Autonomous University of Campeche), Joern Schmidt (ICES), Isabelle Ansong (University of Cape Town, SEAmester Programme)





Pole to pole ocean science diplomacy in practice

Beyond the All Atlantic Ocean Research Alliance

Mary Wisz & Andrei Polejack
WMU-Sasakawa Global Ocean Institute
World Maritime University



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 862428 (MISSION ATLANTIC). This output reflects only the author's view and the Research Executive Agency (REA) cannot be held responsible for any use that may be made of the information contained therein.



@MISSIONATLANTIC

www.missionatlantic.eu



**Ocean Science
Diplomacy**

What is it?

OCEAN SCIENCE DIPLOMACY

SCIENCE IN DIPLOMACY

**SCIENTIFIC EVIDENCE
INFORMS NEGOTIATIONS AND
SUPPORTS DECISION MAKING**

Examples of international decisions that require ocean science:

- fish stocks management,
- marine ecosystem protection and restoration,
- adaptation and mitigation actions to climate change
- hazards forecast and prediction,
- communities' livelihoods,
- maritime zoning
- others

DIPLOMACY FOR SCIENCE

**OCEAN SCIENCE IS
COOPERATIVE, DIPLOMACY
FOSTERS JOINT GLOBAL OCEAN
RESEARCH PROJECTS AND
CAPACITY BUILDING**

Examples

- Ocean Biodiversity Information System
- Harmful Algal Bloom Monitoring and forecasting programs
- Seabed 2030
- All-Atlantic Ocean Research Alliance
- Global Ocean Observing System
- Tsunami warning system
- The UN Decade of Ocean Science for Sustainable Development (2021-30)

SCIENCE FOR DIPLOMACY

**SHARED CHALLENGES AND
THREATS ENCOURAGE
COORDINATED AND PROBLEM-
DRIVEN SCIENTIFIC
COOPERATION AND DIALOGUE
BETWEEN COUNTRIES TO
INFORM BETTER DECISIONS**

Examples include:

- Displacement of fish stocks due to a changing climate (McIlgorm et al. 2010)
- Sargassum bloom in the Caribbean (Chávez et al. 2020)
- Marine research projects between conflicting nations (e.g. between the US and Cuba (Ramenzoni et al. 2020))



The All-Atlantic Ocean Research Alliance



- 3 Intl agreements + bilaterals between EU and Argentina, Cape Verde and Morocco
- Supports cooperative research for societal benefit
- Bridges communities beyond research
- Is open to other countries and can serve as a model for other basins



Humanities & Social Sciences
Communications



ARTICLE



<https://doi.org/10.1057/s41599-021-00729-6>

OPEN

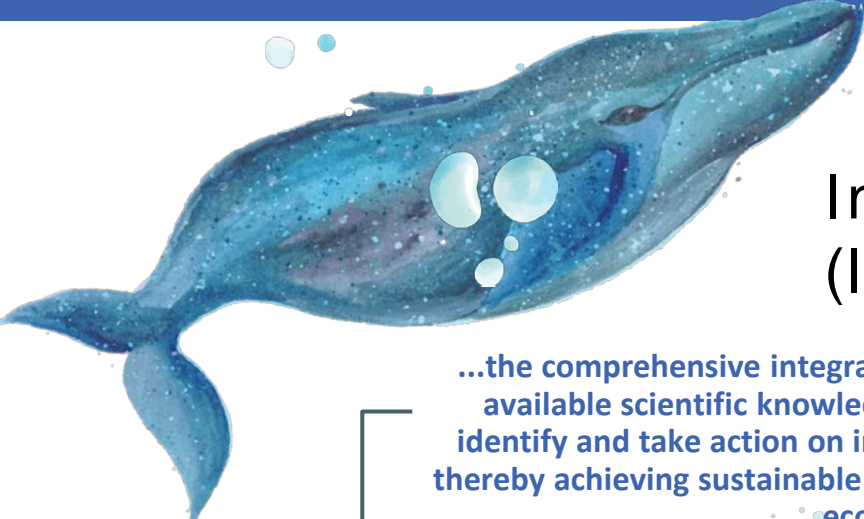
Atlantic Ocean science diplomacy in action: the pole-to-pole All Atlantic Ocean Research Alliance

Andrei Polejack^{1,2}, Sigi Gruber³ & Mary S. Wisz¹




@MISSIONATLANTIC

www.missionatlantic.eu



Integrated Ecosystem Assessment (IEA)

...the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity (UNEP, 2009)



Multiscale!
A tool for
Science
Diplomacy or
vice versa?





The Importance of Ocean Science Diplomacy for Ocean Affairs, Global Sustainability, and the UN Decade of Ocean Science

Andrei Polejack^{1,2*}

¹ Sasakawa Global Ocean Institute, World Maritime University, Malmö, Sweden, ² Ministry of Science, Technology and Innovations, Brasília, Brazil

Mission Atlantic:

- Will analyze the different approaches for science-diplomacy to inform ocean governance on a basin scale for the Atlantic,
- Will collaborate with stakeholders to identify and address societally relevant research questions
- Will evaluate options for the co-creation of IEA decision making tools and indicators



Beyond the All-Atlantic Ocean Alliance



This event will showcase and discuss:

- Pole-to-pole connections through research projects beyond the scope of the Alliance
- The power of ocean science diplomacy for building stronger ocean/polar communities and knowledge for policy and society
- The context of the UN Decade of Ocean Science for Sustainable Development
- Opportunities to bring balance to scientific capacities in the Atlantic
- Integrating and planning research projects going forward





Thank you!

Mary Wisz | Andrei Polejack
msw@wmu.se | andrei.polejack@gmail.com

CONTACT US

Project Coordinator

Patrizio Mariani

Email: pat@aquu.dtu.dk

AORA – Belem Panel Chair

Michael St. John

Email: mstjo@aquu.dtu.dk

Management Team

Elliot J Brown

Maria Kruger-Johnsen

Ivo Grigorov

Email: missionatlantic@aquu.dtu.dk

@MaryWisz



@AndreiPolejack



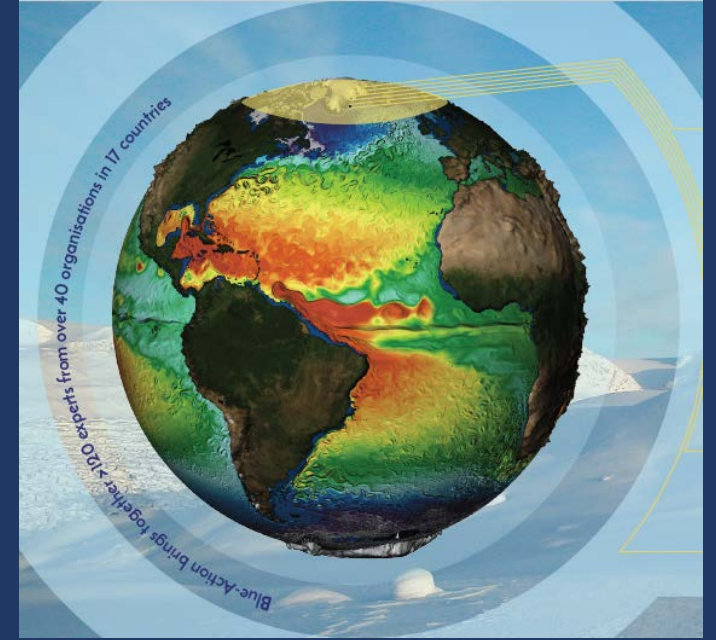
This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 862428 (MISSION ATLANTIC). This output reflects only the author's view and the Research Executive Agency (REA) cannot be held responsible for any use that may be made of the information contained therein.



@MISSIONATLANTIC

www.missionatlantic.eu

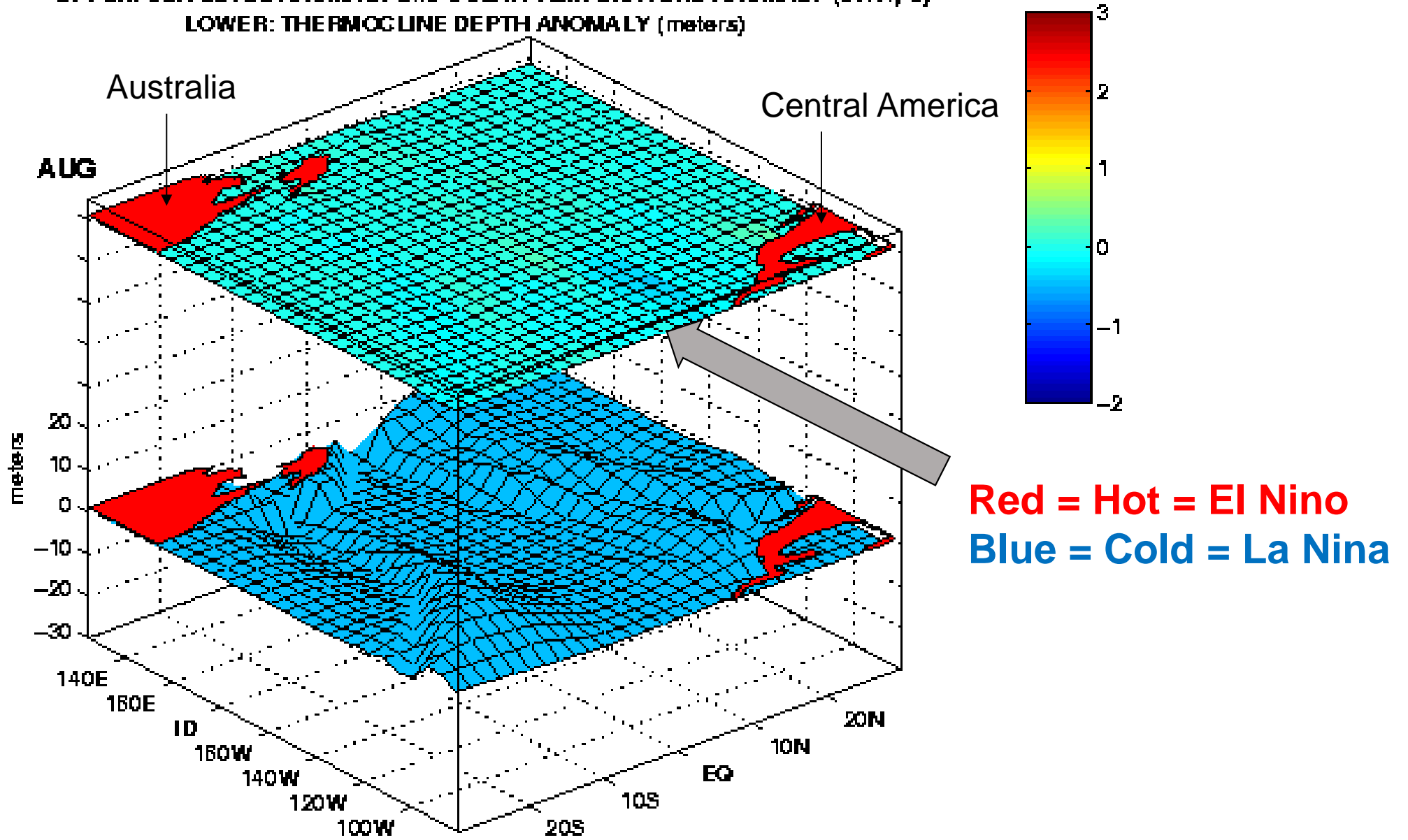
Atlantic-Arctic Ocean Circulation and Impacts



With contributions from Karin Margretha H. Larsen (FAMRI), Gerard McCarthy (NUIM), Didier Swingedouw (EPOC), Helene R. Langehaug (NERSC), Steffen M. Olsen (DMI) and Blue-Action team members

Presented by **Gerard McCarthy (Maynooth University)** www.blue-action.eu
[@BG10Blueaction](https://twitter.com/BG10Blueaction)

UPPER: SEA LEVEL ANOMALY and OCEAN TEMPERATURE ANOMALY (color, C)
LOWER: THERMOCLINE DEPTH ANOMALY (meters)



1997 Joseph Bergquist (GOC), David Battisti (U. of Washington)

El Nino occurs causes widespread flooding that severely impacts farmers

Understanding the coupled ocean-atmosphere dynamics and their effect on climate has led to an index-linked insurance policy, that pays out when sea surface temperatures hit a certain threshold

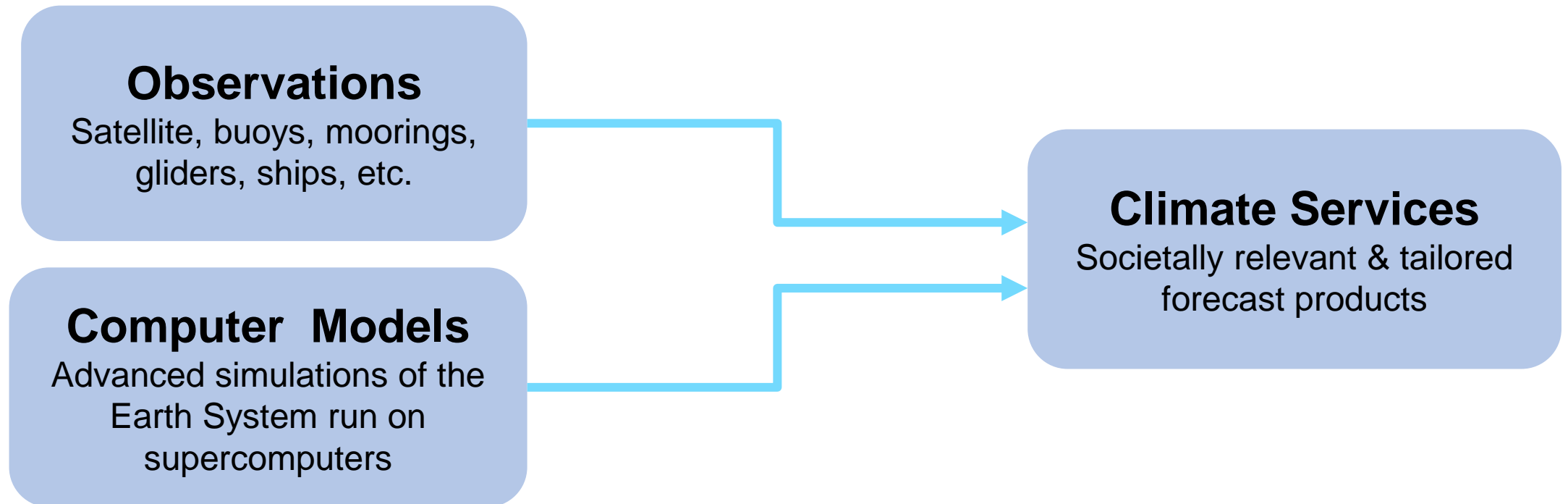


El Nino related flooding in Piura, Peru

(Galeria del Ministerio de Defensa del Perú [CC BY 2.0
(<https://creativecommons.org/licenses/by/2.0/>)])



Building blocks of climate predictions and climate services



Palm Trees in Sligo



Location in Ireland
Coordinates:  54.2667°N 8.4833°W



Palm Trees in Sligo



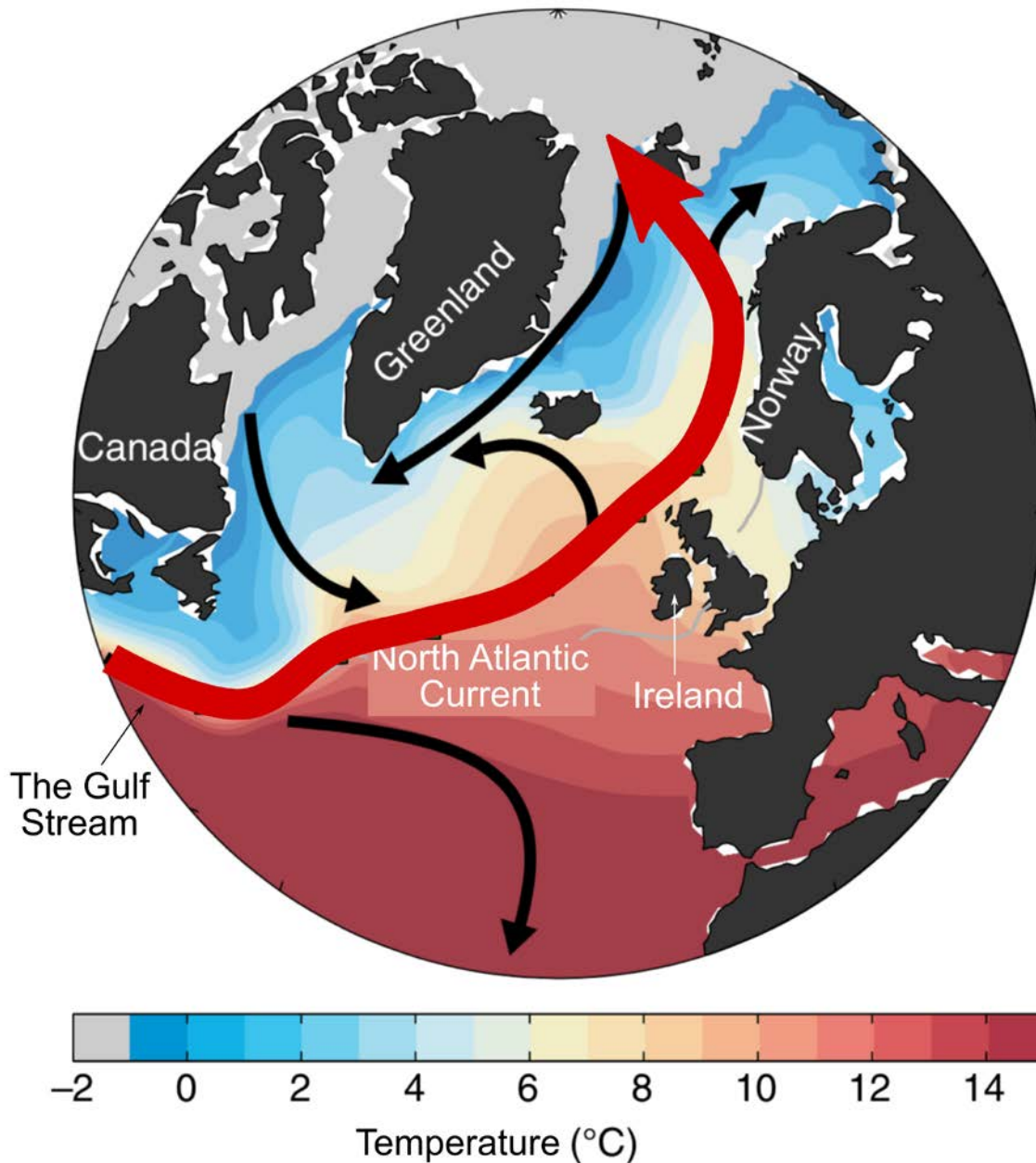
Location in Ireland
Coordinates: 54.2667°N 8.4833°W



Glaciers in Grytviken



South Georgia settlements
Coordinates: 54°16'53.4"S 36°30'28.8"W

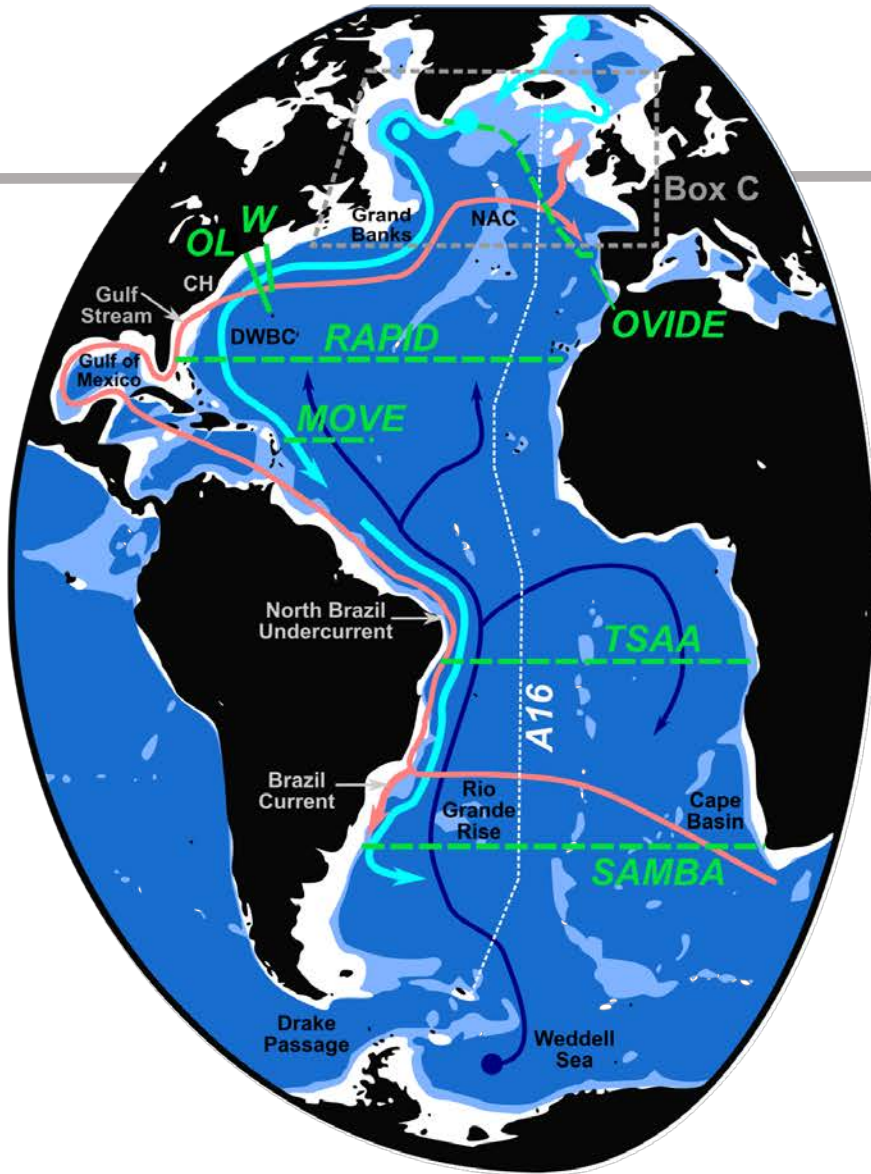


The warm ocean waters carried by the system of currents called the AMOC*, including the Gulf Stream and the North Atlantic Current, contribute to Ireland and northwest Europe's mild climate

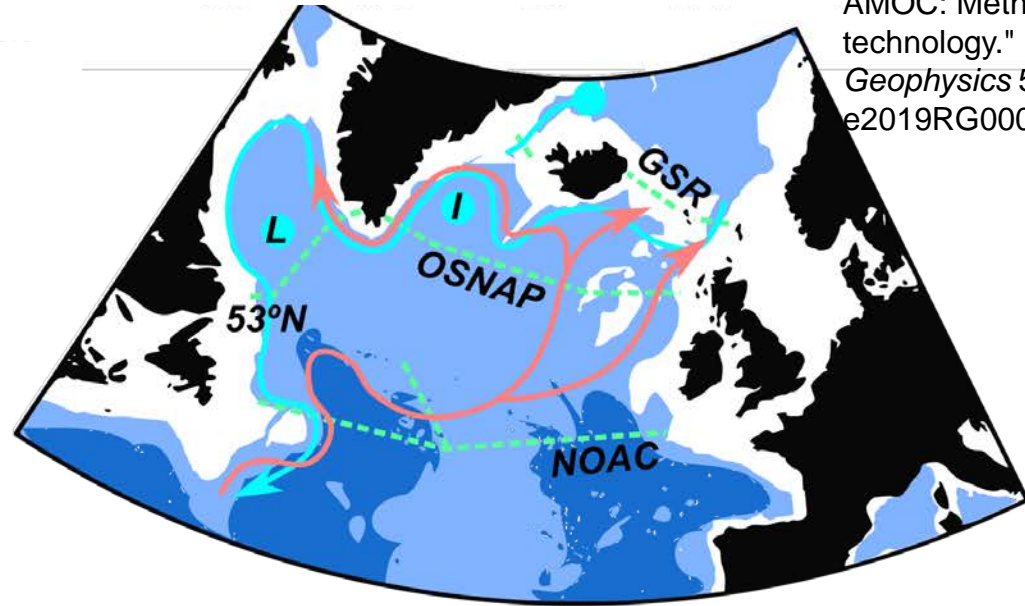
Årthun, M., Eldevik, T., Viste, E., Drange, H., Furevik, T., Johnson, H. L., & Keenlyside, N. S. (2017). Skillful prediction of northern climate provided by the ocean. *Nature communications*, 8, 15875.

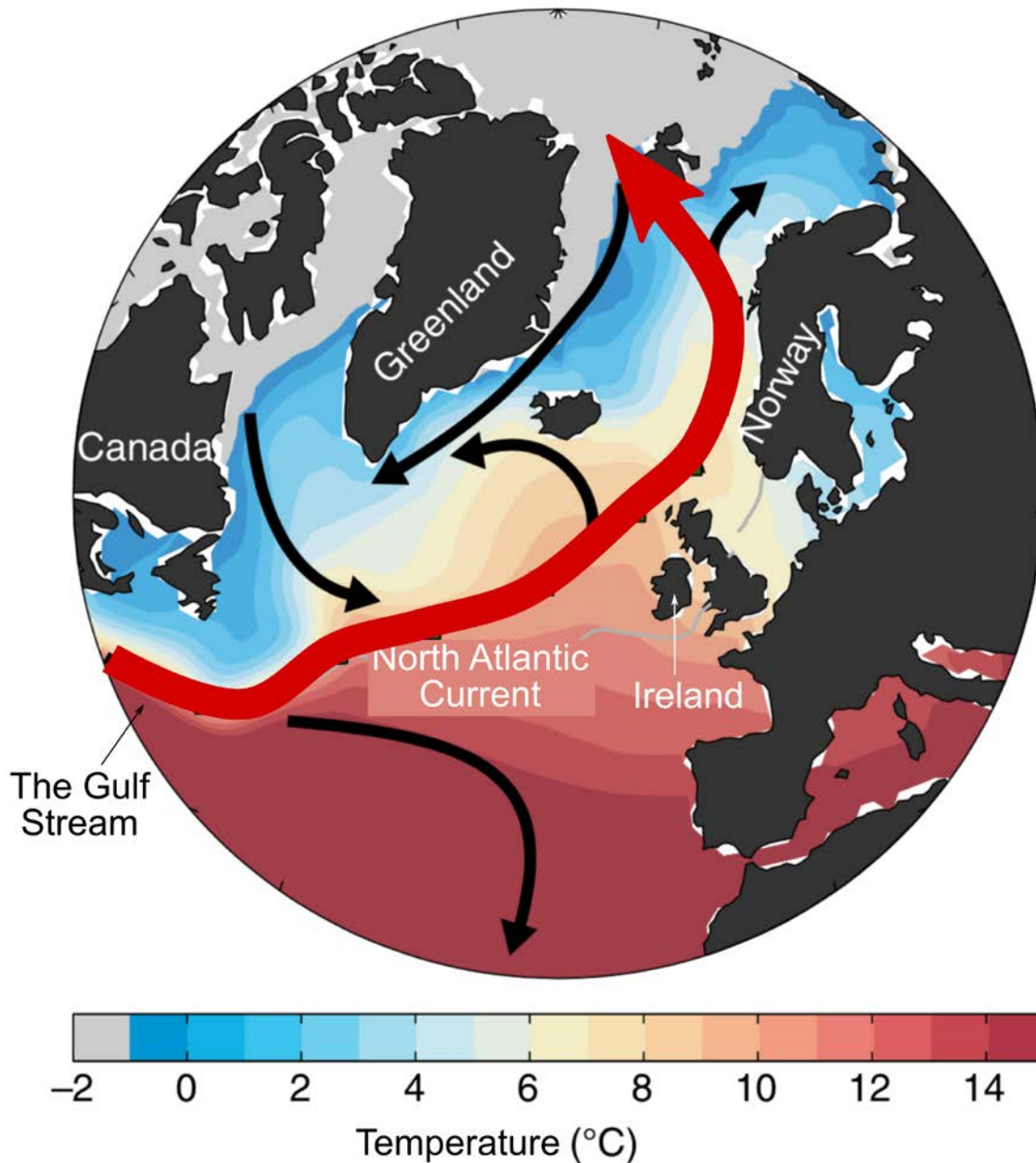
Sustainable AMOC observing

Blue-Action supports sustainable observations of the AMOC



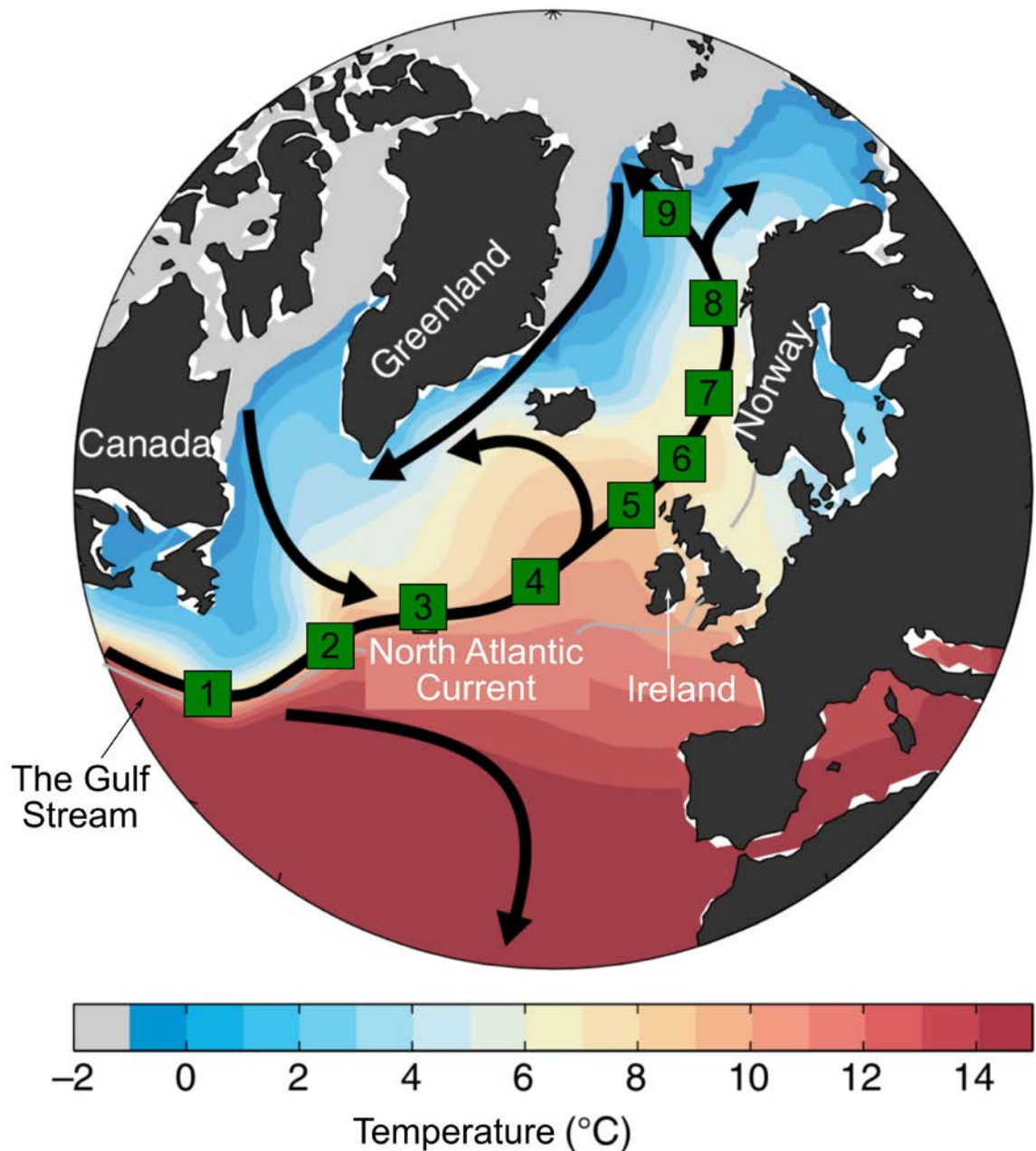
McCarthy, Gerard D., et al. "Sustainable observations of the AMOC: Methodology and technology." *Reviews of Geophysics* 58.1 (2020): e2019RG000654.





The warm ocean waters carried by the system of currents called the AMOC*, including the Gulf Stream and the North Atlantic Current, contribute to Ireland and northwest Europe's mild climate

Årthun, M., Eldevik, T., Viste, E., Drange, H., Furevik, T., Johnson, H. L., & Keenlyside, N. S. (2017). Skillful prediction of northern climate provided by the ocean. *Nature communications*, 8, 15875.

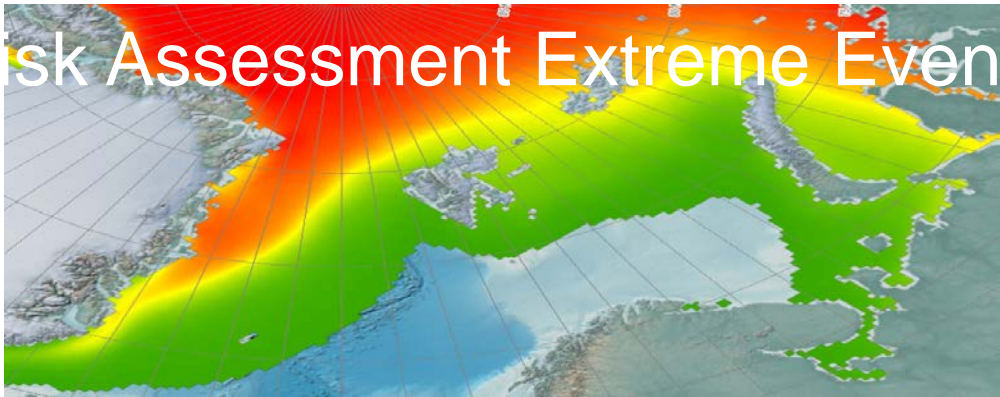


The warm ocean waters carried by the system of currents called the AMOC*, including the Gulf Stream and the North Atlantic Current, contribute to Ireland and northwest Europe's mild climate

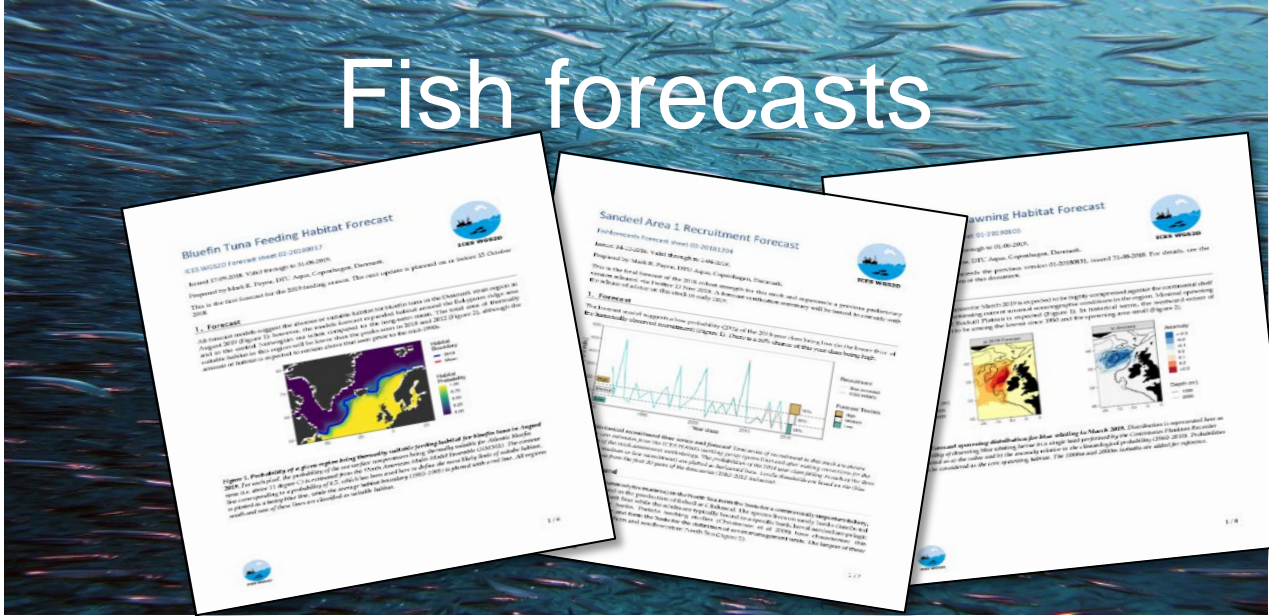
And this ocean highway leads to predictability as warm anomalies track from Canada to north of Norway

Årthun, M., Eldevik, T., Viste, E., Drange, H., Furevik, T., Johnson, H. L., & Keenlyside, N. S. (2017). Skillful prediction of northern climate provided by the ocean. *Nature communications*, 8, 15875.

Climate and Information Service Case Studies

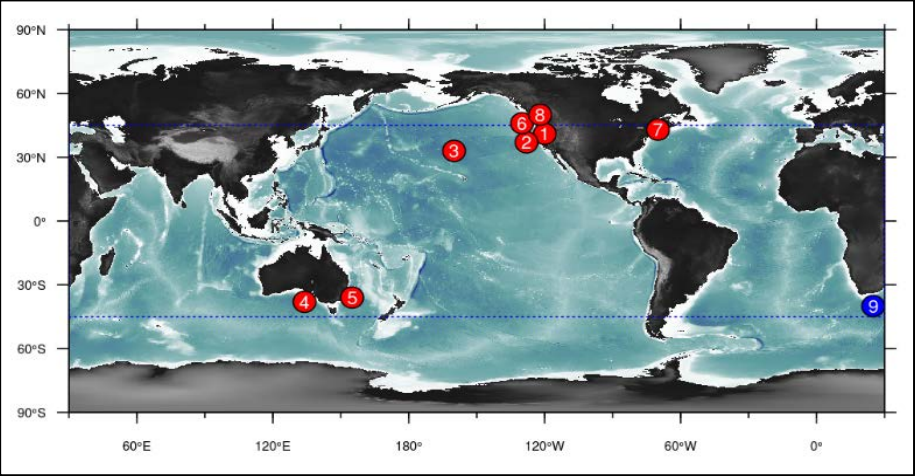


HeatHealth.eu
European Heat Health System



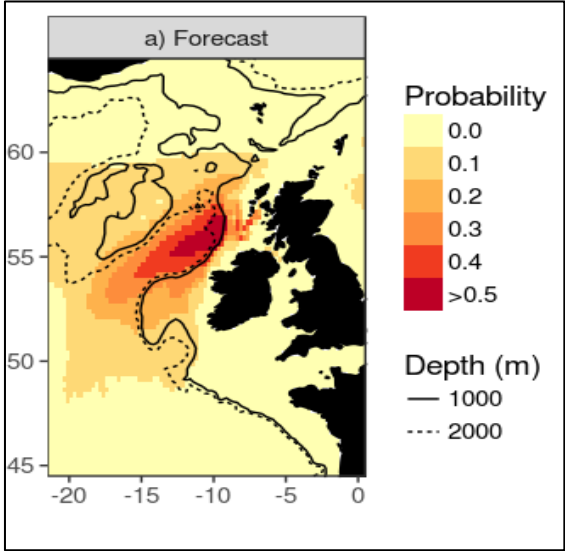
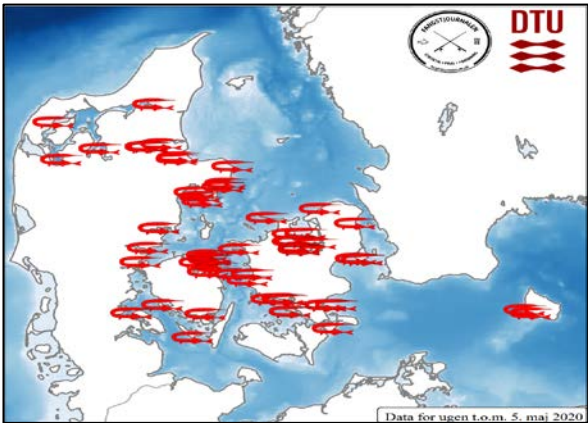
Fishforecasts

Climate Services for Marine Fisheries



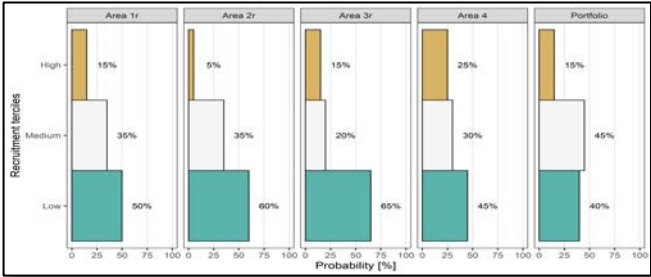
2017

No Forecast Products in Europe



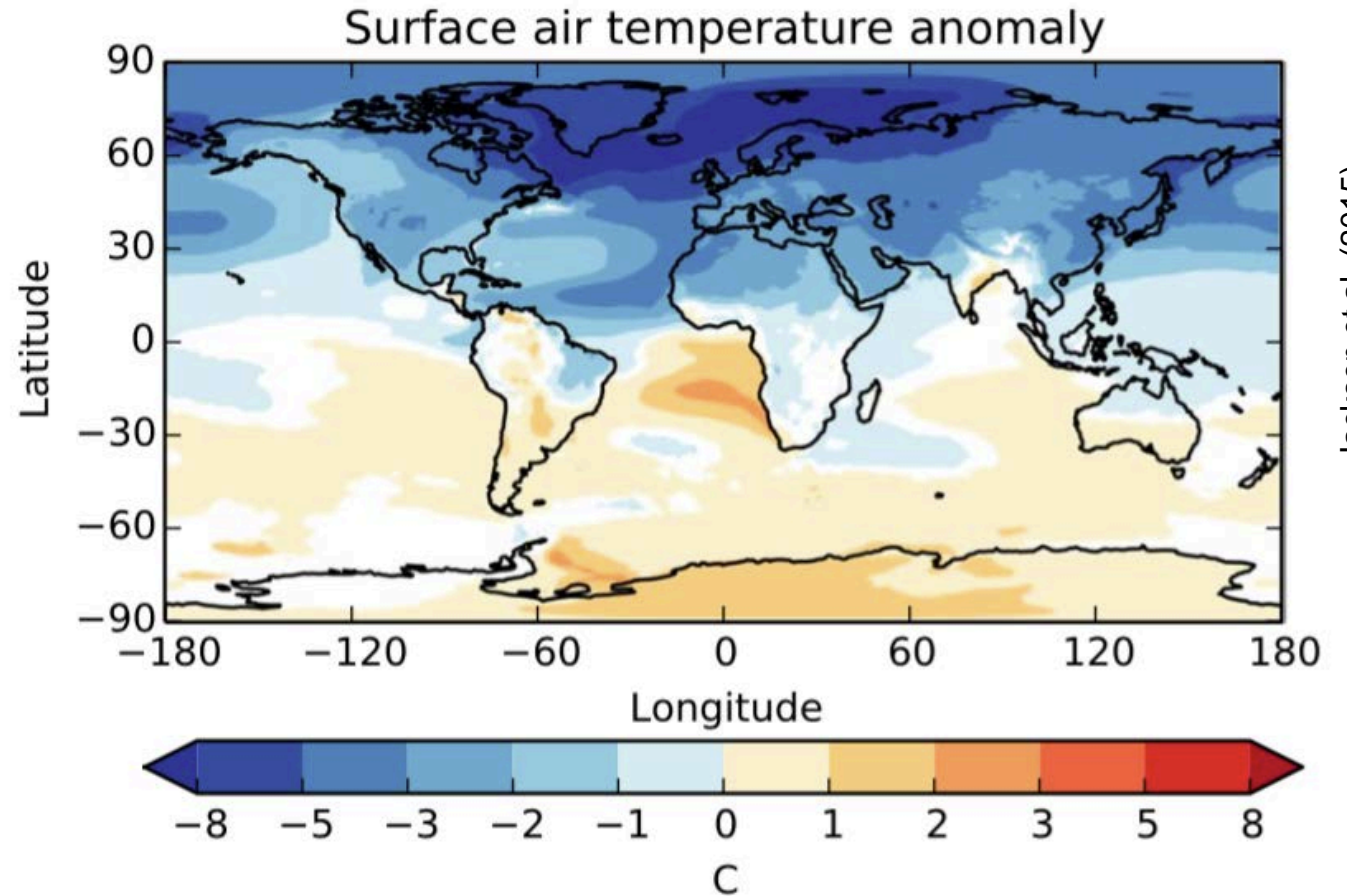
2020

First European Forecasts



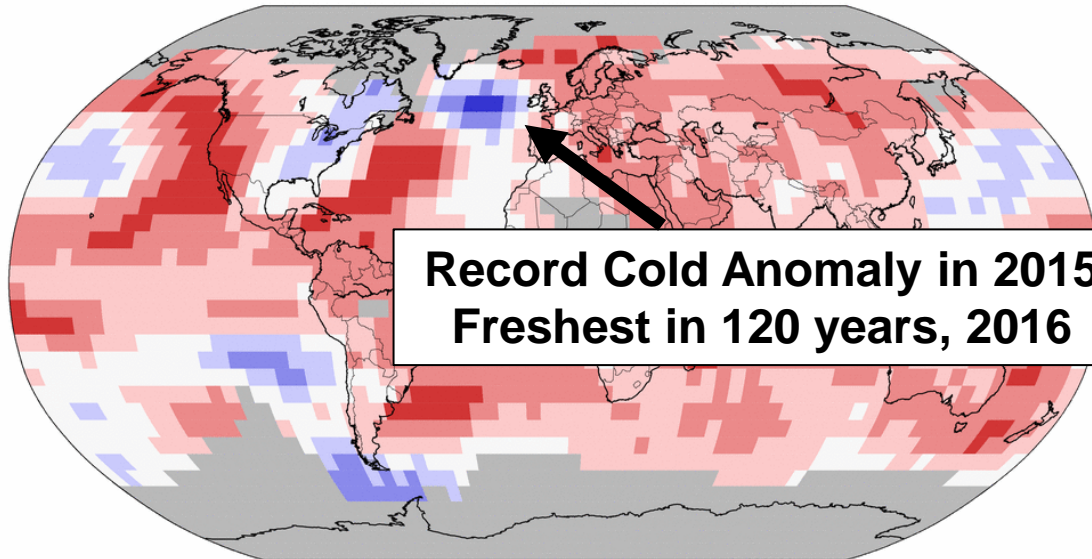
The future AMOC

- The AMOC is 'very likely' to weaken
- An abrupt AMOC collapse would be an environmental disaster for Europe.



Recent changes in the Atlantic

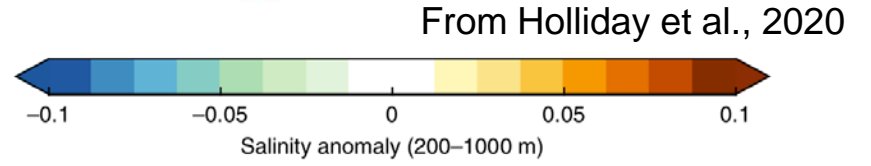
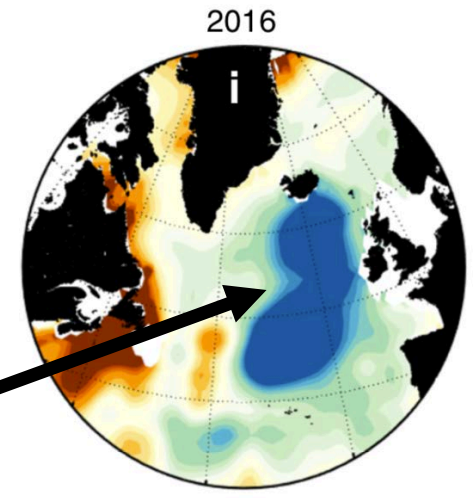
Land & Ocean Temperature Percentiles Dec 2014–Feb 2015
NOAA's National Climatic Data Center
Data Source: GHCN–M version 3.2.2 & ERSST version 3b



**Record Cold Anomaly in 2015
Freshest in 120 years, 2016**



Mon Mar 16 19:53:13 EDT 2015



- Unprecedented changes are ongoing
- We suspect the AMOC has weakened
- How far are we from a tipping point?

The scientific community has tools to meet the challenge of the climate emergency

Long-term sustained observations are critical for understanding and monitoring the Ocean

Climate predictions provide a reliable outlook on conditions in years to come

Climate services translate these into valuable and actionable knowledge for citizens, businesses, NGOs and government

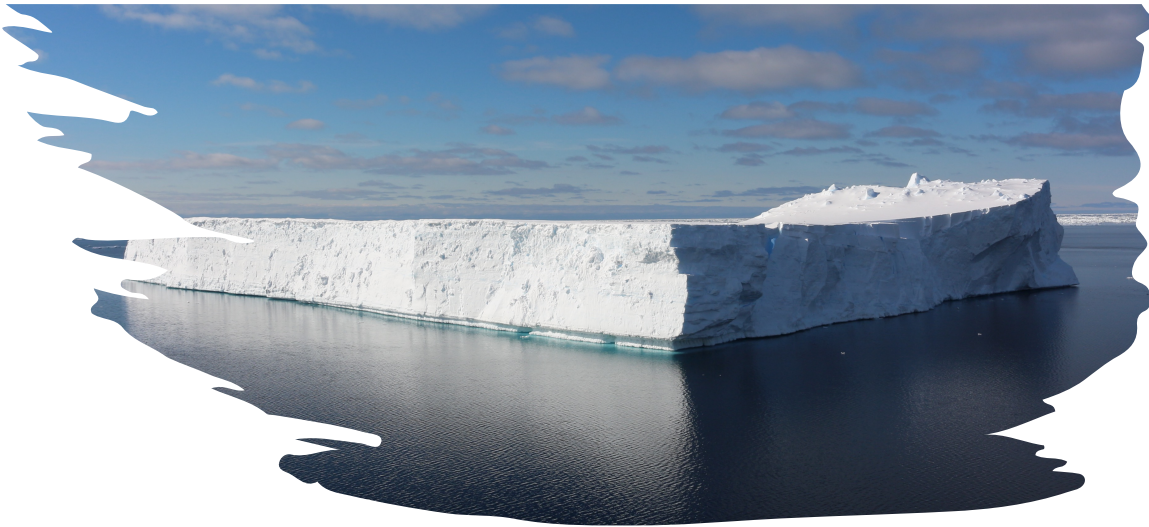




Blue-Action has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727852.

Southern Ocean: a thermostat for our planet

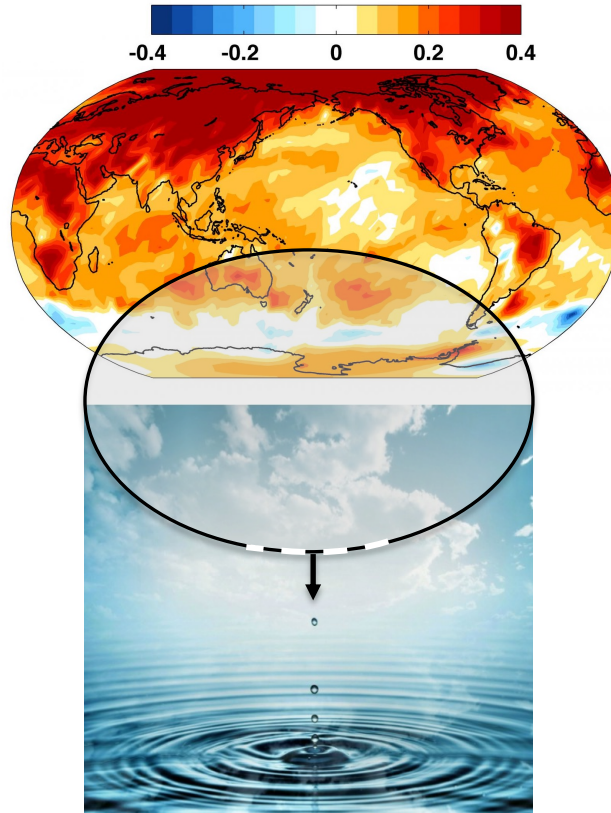
Jean-Baptiste Sallée
SO-CHIC coordinator



Why should we care about the Southern Ocean?



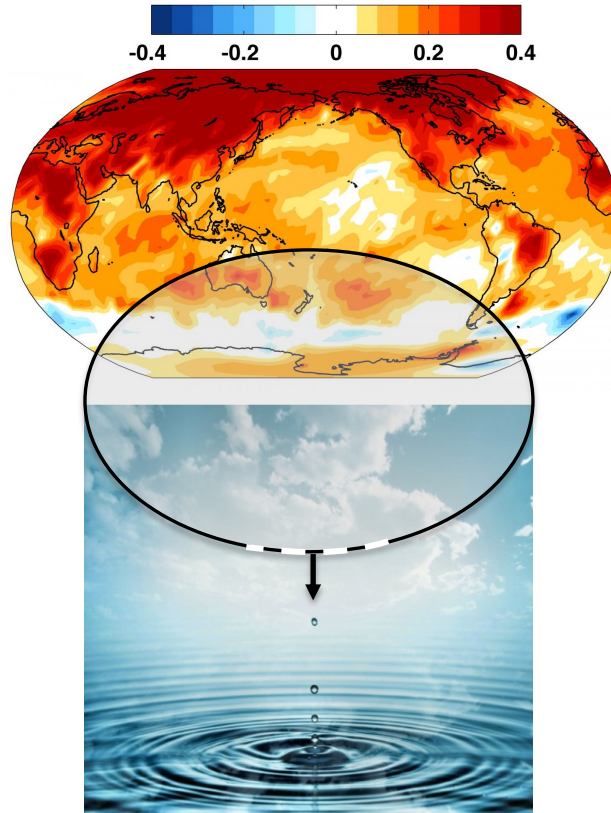
Atmospheric warming 1970-2019 (°C)



Major sink for human-induced carbon and heat

A thermostat for our planet

Atmospheric warming 1970-2019 (°C)



Major sink for human-induced carbon and heat

40% carbon

75% heat

Absorbed by the world oceans since 1970

A thermostat for our planet



Emission

Key for mitigation actions
(Paris agreement)



Atmospheric Warming

Major sink for human-induced carbon and heat

Observation

Targeted innovative experiment
&
Long term monitoring

Numerical Model

Very high resolution process-orientated
&
Earth System Model



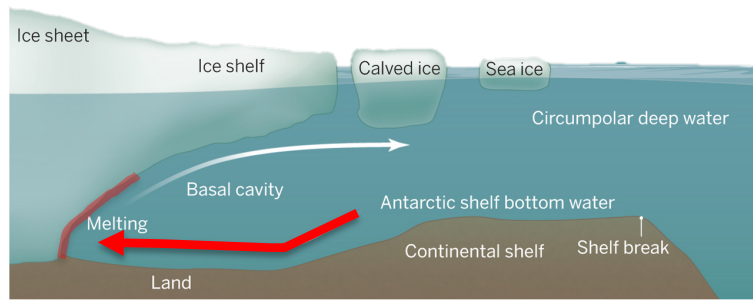
Study key processes & the climate actions

But there is more than heat/carbon budget...

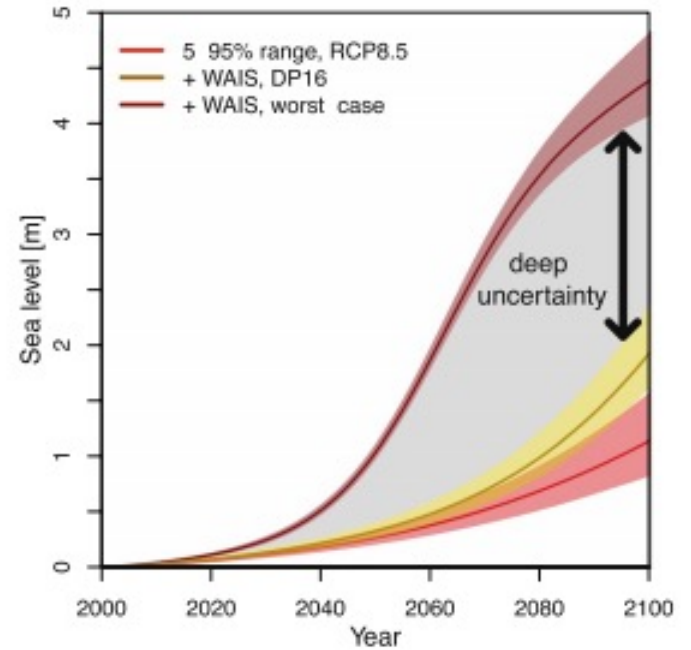
Southern Ocean controls many **irreversible climate change aspects**

Need robust information for today's evidence-based societal choices

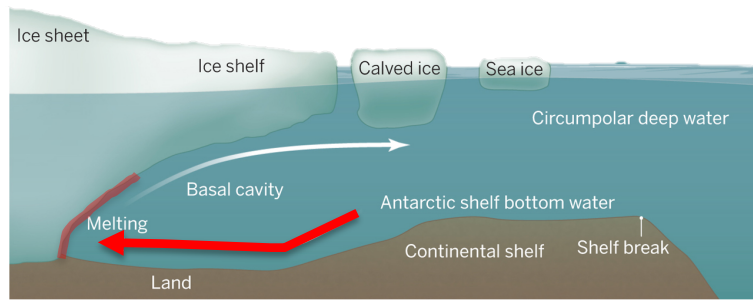
A weak link in our adaptation strategy



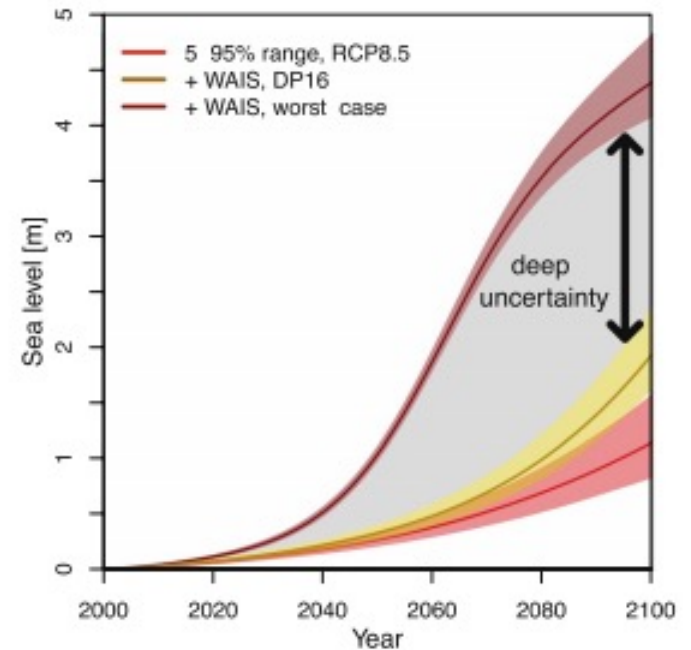
Uncertain futur



(Bakker et al., 2017)



Uncertain futur



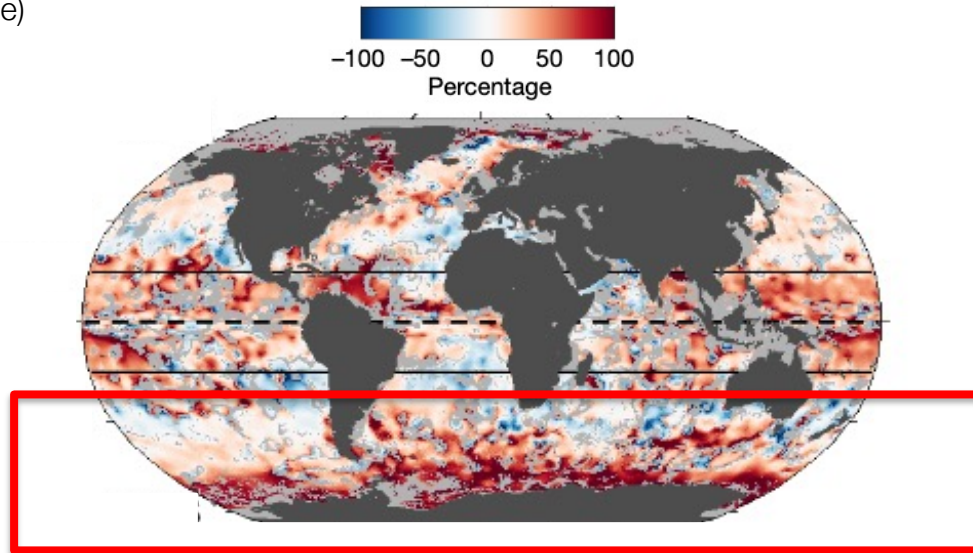
(Bakker et al., 2017)

Icesheet melt also add a freshwater layer at the top of the ocean

The ocean is becoming more stable

(Sallée et al., 2021 - Nature)

(Cheng et al., 2020 - J. Climate)



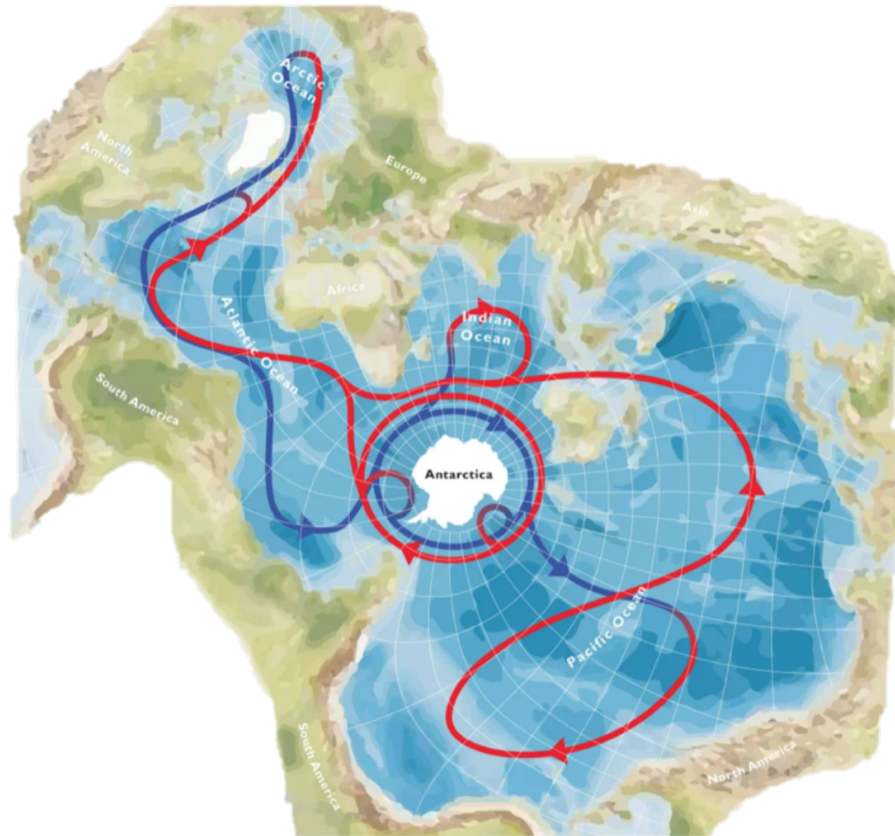
Percentage of ocean stability change due to
added freshwater in the past 50 years

Added stability means:

Slow down of the
deep ocean
circulation

Global ramifications

(Heuzé et al., 2021)

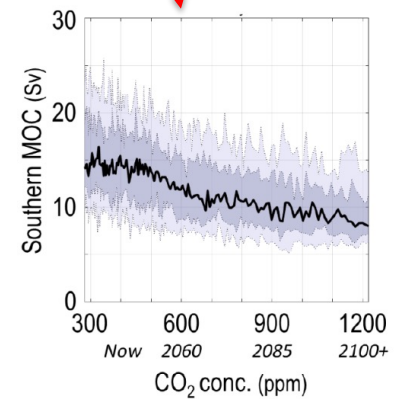
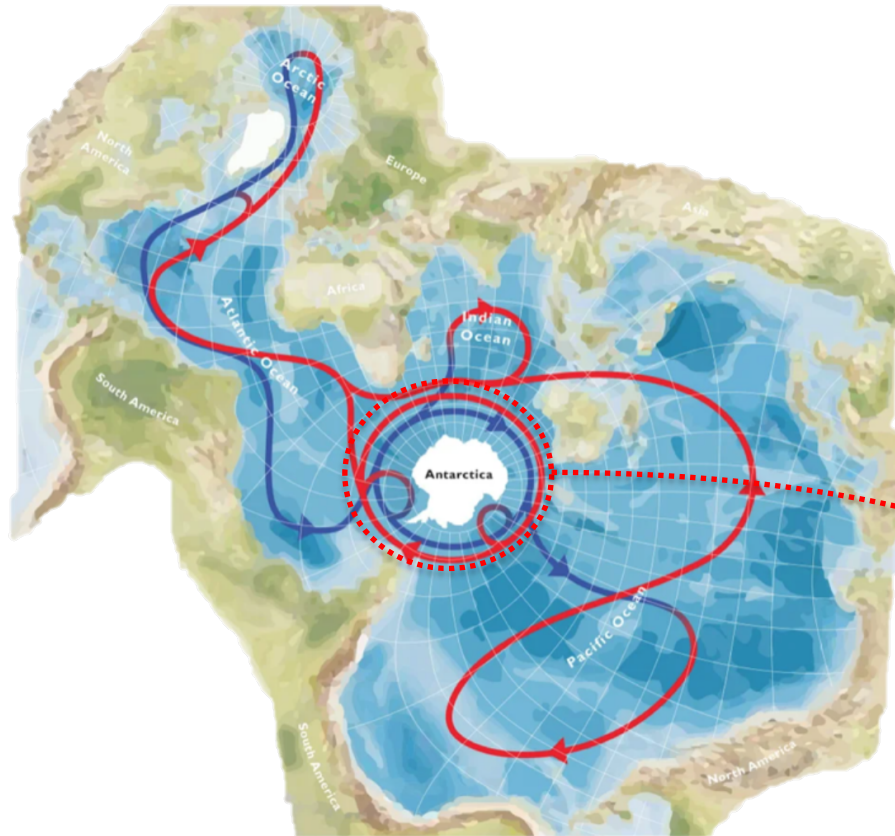


Added stability means:

Slow down of the
deep ocean
circulation

Global ramifications

(Heuzé et al., 2021)

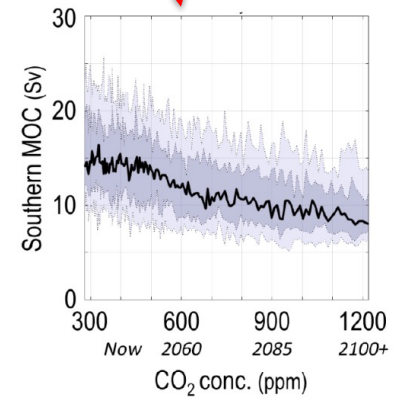
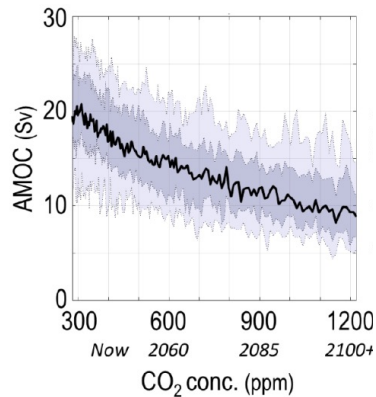
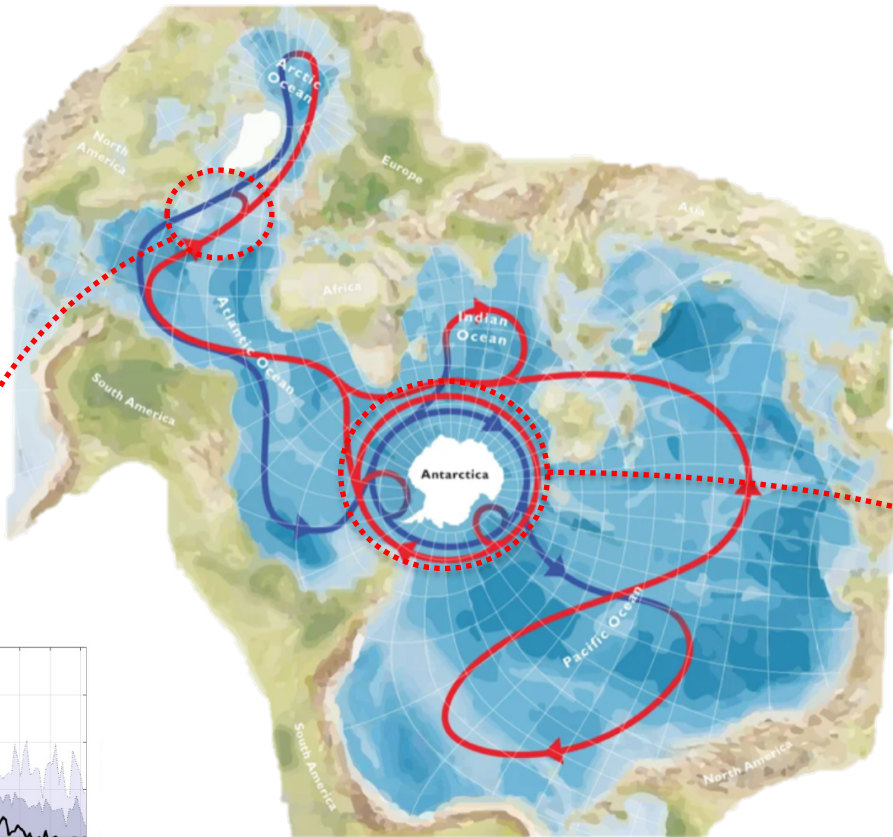


Added stability means:

Slow down of the deep ocean circulation

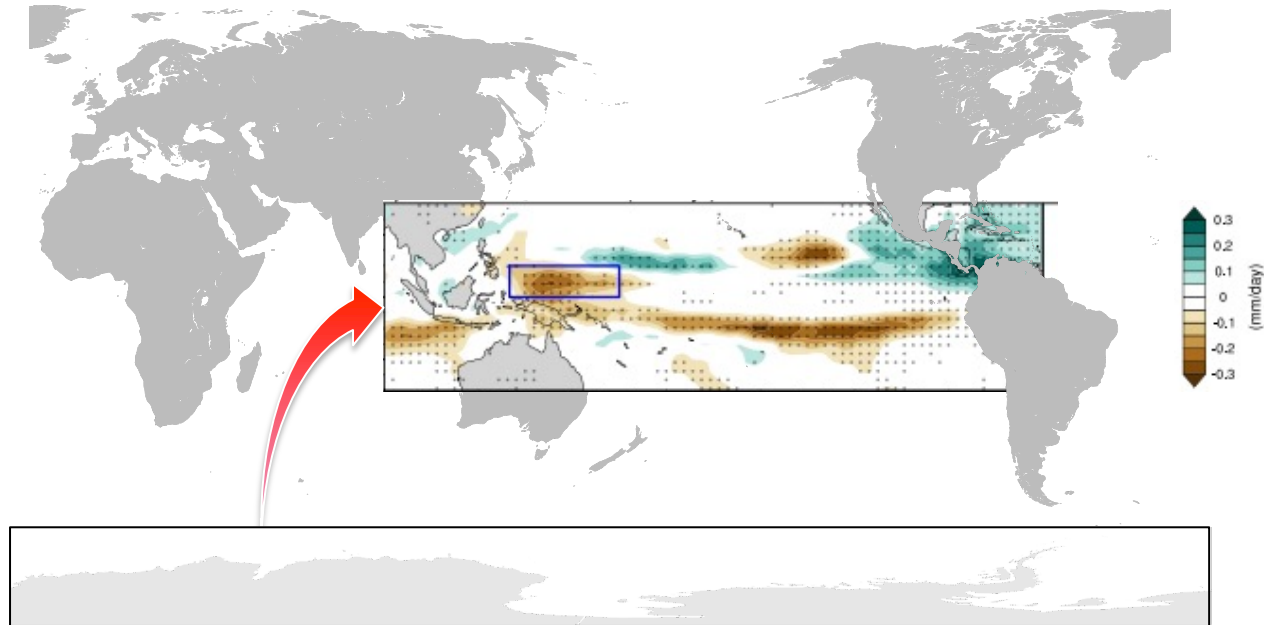
Global ramifications

(Heuzé et al., 2021)



Change in Southern Ocean circulation Large impact on regional climate change

(Oh et al., 2020)





Contribution to IPCC reports:

- 3 AR6 authors as part of the consortium
- Many SOCHIC output feeding the AR6
- Reducing uncertainties in future projections

Science to policy briefs



**UN CLIMATE
CHANGE
CONFERENCE
UK 2021**

IN PARTNERSHIP WITH ITALY

- **Long-term, sustained observations** of the Southern Ocean is required to inform climate predictions and develop a Digital Twin of the Ocean and Earth System.
- Results from global climate models are (*highly*) uncertain for polar regions and **representantion of ice shelf-ocean interaction** need to be improved
- Link between **AMOC and Southern Ocean MOC** must be improved
- Climate change in the remote Southern Ocean must be made **more tangible**, and **awareness must be raised** on its importance for adaptation and mitigation strategy



TRIATLAS

www.triatlas.eu



Elaine McDonagh, NORCE, Norway and NOC, UK



Our Ambition

- To develop the understanding and capacity to predict marine ecosystems and their societal impacts.

All-Atlantic Ocean Research Alliance Flagship Project

2019-2023

33 Partners, 13 Countries, 3 Continents

Focus on Tropical and South Atlantic



BUILDING AN ALL ATLANTIC OCEAN COMMUNITY

Implementing the Belém Statement



TRIATLAS





TRIATLAS

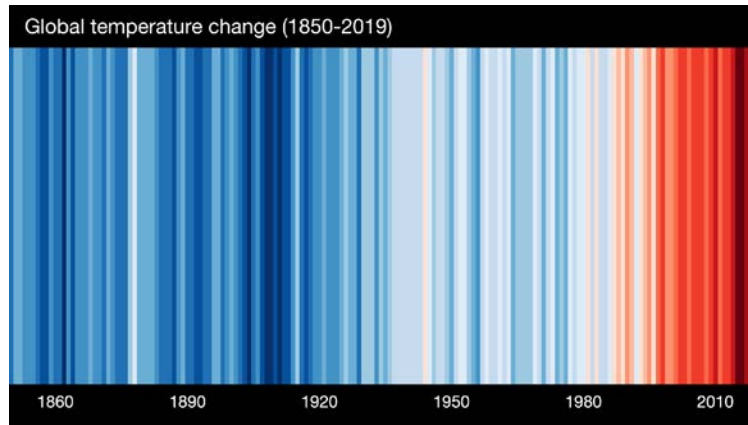
Aim: Climate-based predictions of marine ecosystems and impacts

Tools: observing, modelling, understanding, predicting

Strategy: Consider drivers that will change under climate change

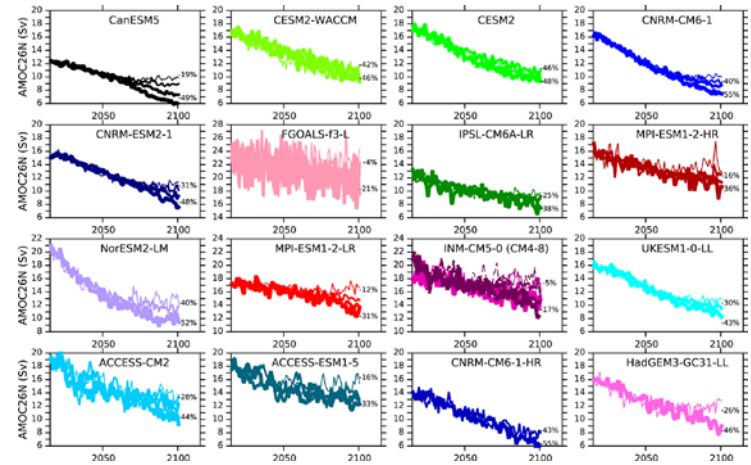
Ocean Warming

www.showyourstripes



Ocean circulation

Predict reduced AMOC

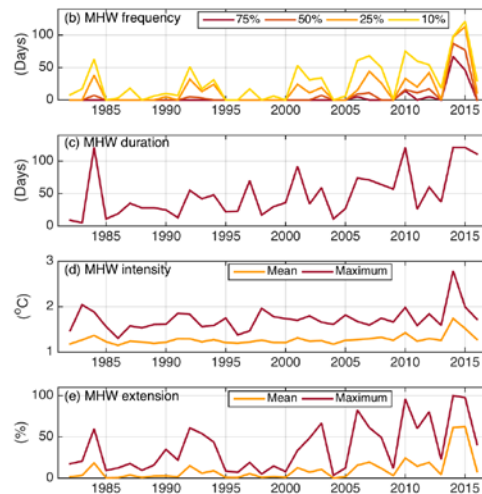


Weijer et al. 2020

Extremes : Marine Heat Waves

increasing in

- frequency,
- duration
- intensity
- extent



Regina R. Rodrigues



Human indicators

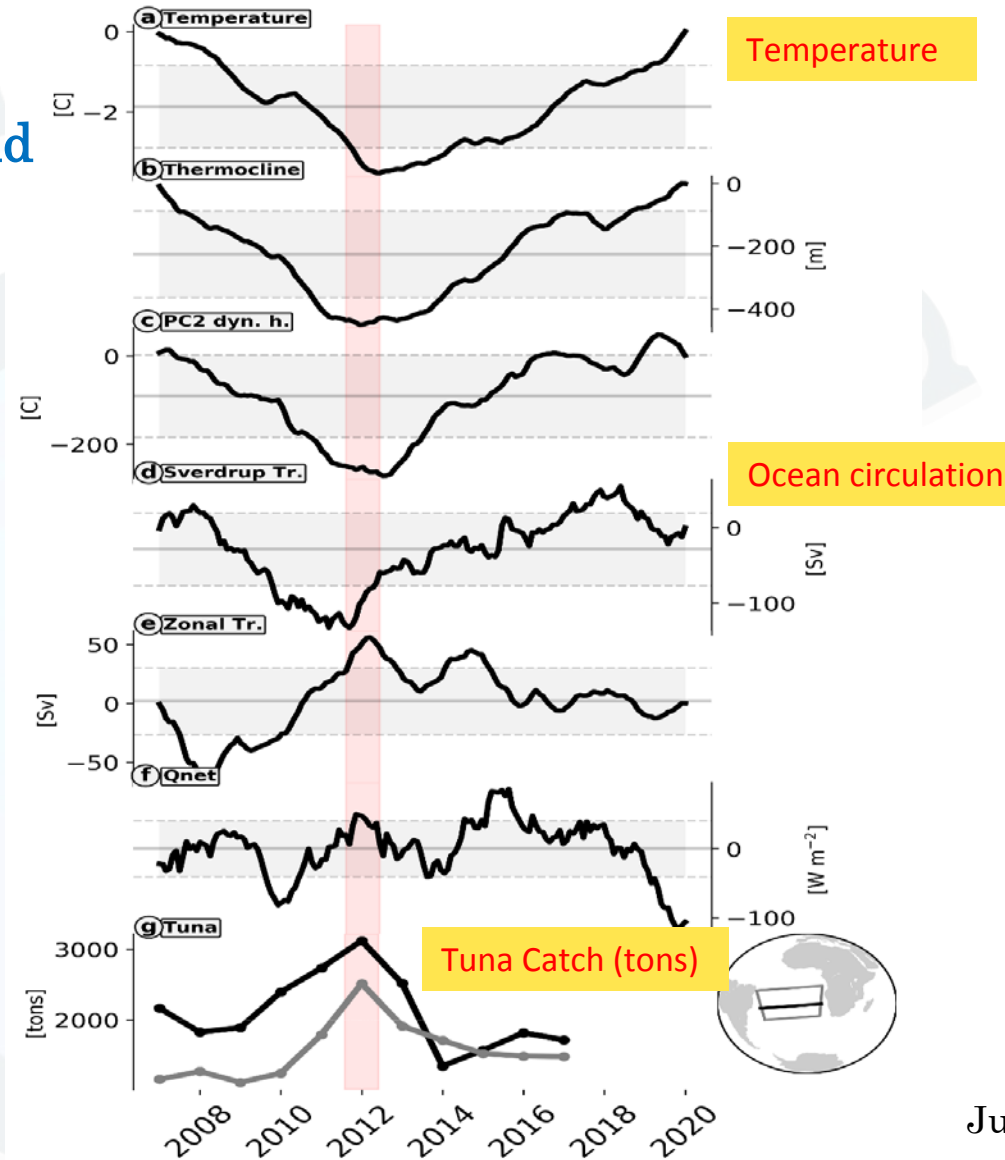
motivation to fish and interact with the ocean

Decadal shifts in Tuna in the South Atlantic

Cool waters are associated with increased catches of both Albacore and Bigeye Tuna

The changes are connected to large-scale ocean circulation variability

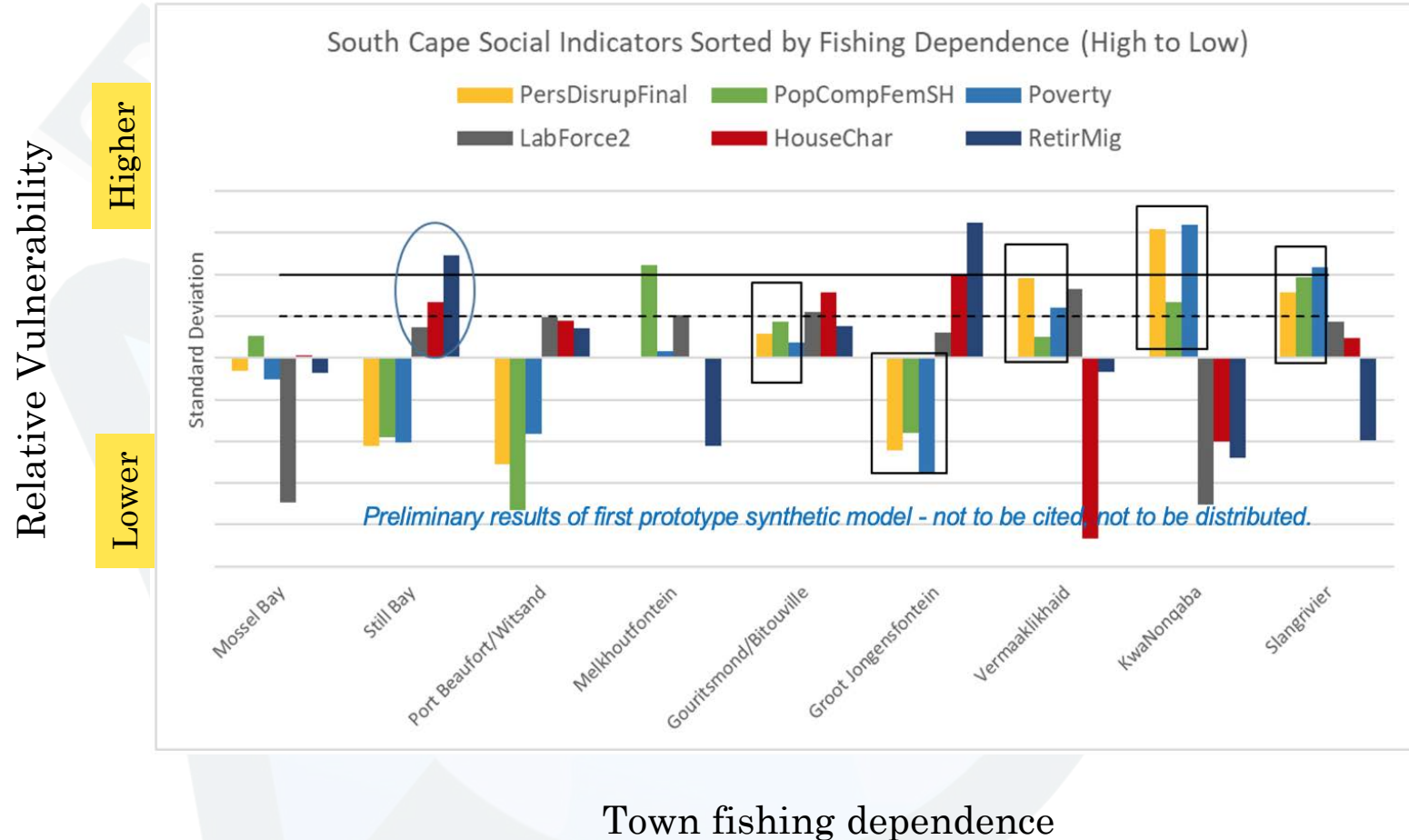
High tuna catch in 2012



Juliano Ramanantsoa



Social indices of South African fishing communities' vulnerability to change – some preliminary results



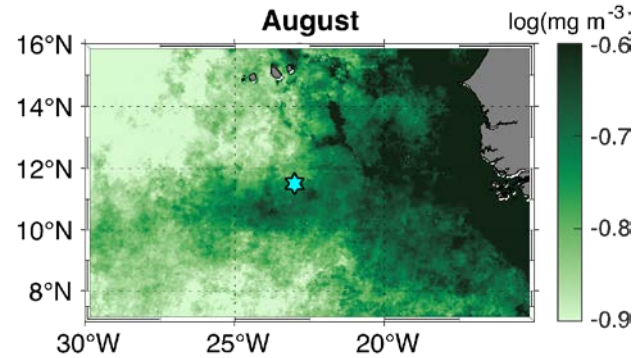
yellow - personal disruption index; grey – labour force (alternative 2), population composition (alternative 1); red – housing characteristics, light blue – poverty, dark blue – retiree migration.



Physics to fish – first step to realising

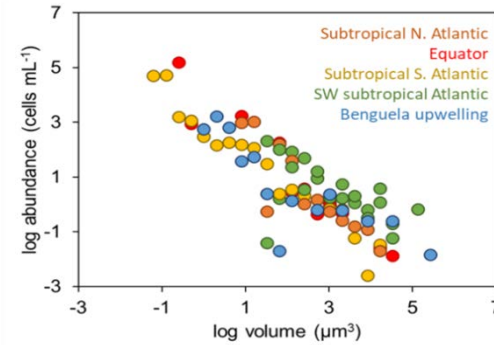
Closing the gap between environmental, ecological, and social systems

Ocean biotic parameters/bio-geochemistry



Seasonal plankton blooms and near-inertial wave mixing (Hummels et al., NCOMMS, 2020)

Lower trophic levels

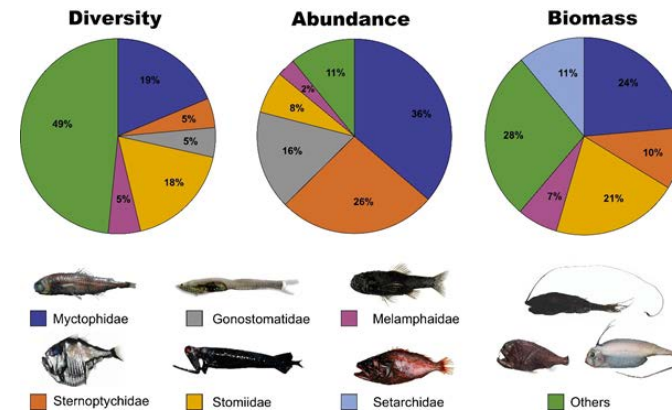


Phytoplankton size spectra, González-García et al. (in prep.).

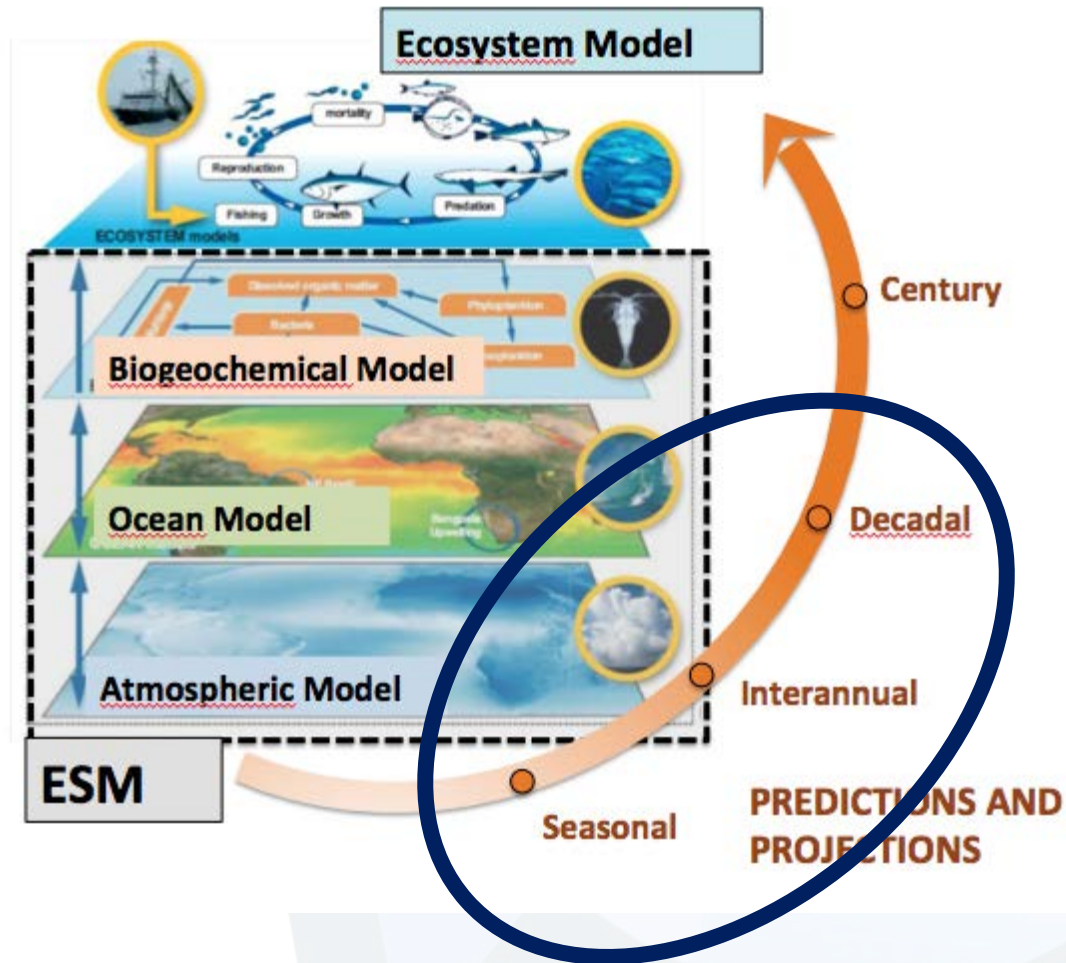
Human activities



Higher trophic levels



Modelling framework



Timescales:

- seasonal-to-decadal predictions
- Climate change projections

Four Earth System Models
CNRM-ESM, EC-Earth, IPSL-CM, NorESM

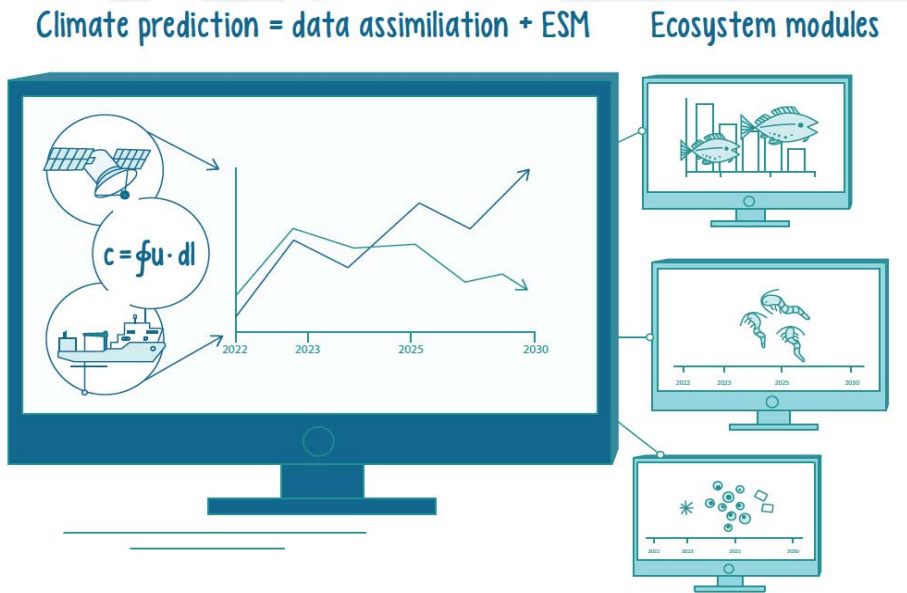
Four marine ecosystem models
APECOSM, EcoOcean, EwE, OSMOSE

TRIATLAS focus on seasonal to decadal timescales is highly novel, very relevant for managers

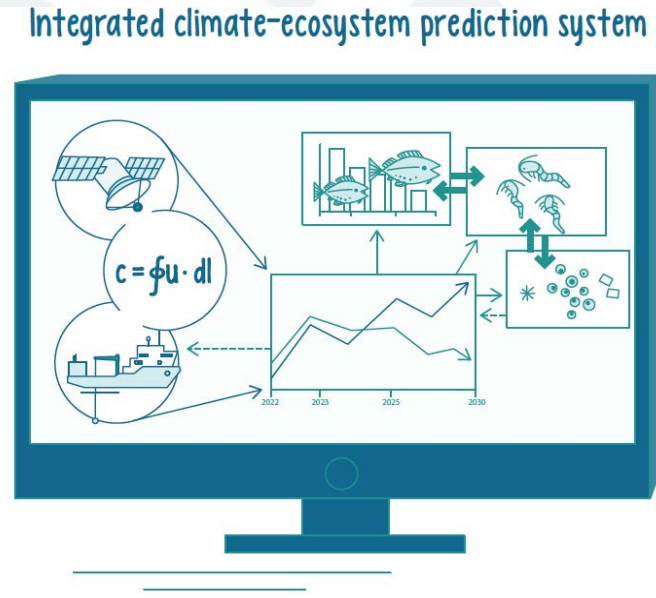


Numerical prediction system for climate-marine ecosystems

Before TRIATLAS



After TRIATLAS



Digital Earth capability to provide a unique tool to build understanding, confidence, and ability to predict future changes in the marine ecosystems, as an aid to managers.



Project implementation and legacy



- Worked across continents and **building a community**
- **Multidisciplinary**
Physics+fish+humans
- **Technology** implementation
- **Training** – CANEMS, Cross-Atlantic
Network of Excellence in Marine Science
- **Multinational** cruises, summer schools
- **Technology development** and
Citizen Science Self-reporting fish
catch app



Empowering - by training a new generation of researchers and providing new tools & technology

Key Words: *Training, Summer School, Science – Policy, Stakeholder, Knowledge, Impact*

Cross-Atlantic Network of Excellence in Marine Science (**CANEMS**)

Training a new generation of interdisciplinary researchers through:

- ✓ Regional master programs (e.g. Benin)
- ✓ Cotutelle degrees
- ✓ Summer school
- ✓ Onboard training
- ✓ Research stays



CANEMS provides strong input to the AANCHOR Joint Action on capacity building (WP3)

