

Ocean predictions and observations in response to the climate emergency

Dr Hannah Grist, Scottish Association for Marine Science

22nd October 2020

www.triatlas.w.uib.no

www.blue-action.eu

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There is a global climate
emergency.

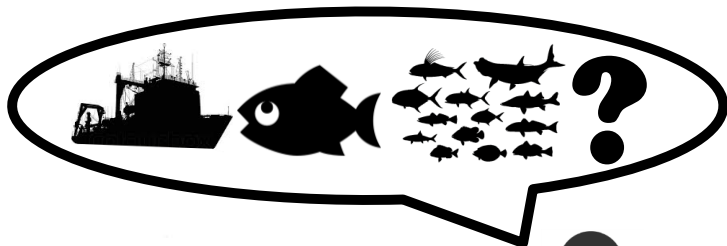
Climate change will change life in our ocean



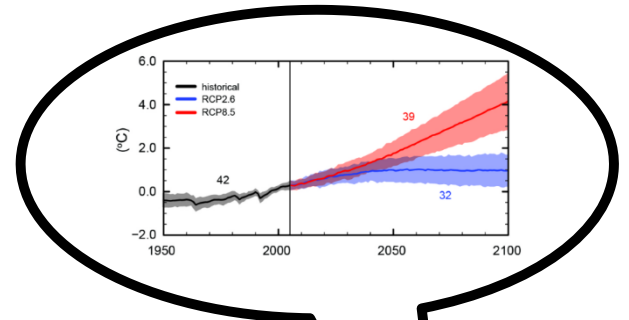
Climate change will change our relationship with the ocean



Predictions



Projections



Days Weeks Months Seasons Years Decades Centuries

BLUE ACTION

2016 – 2020: Understanding the impact of a changing climate on Northern hemisphere weather and climate

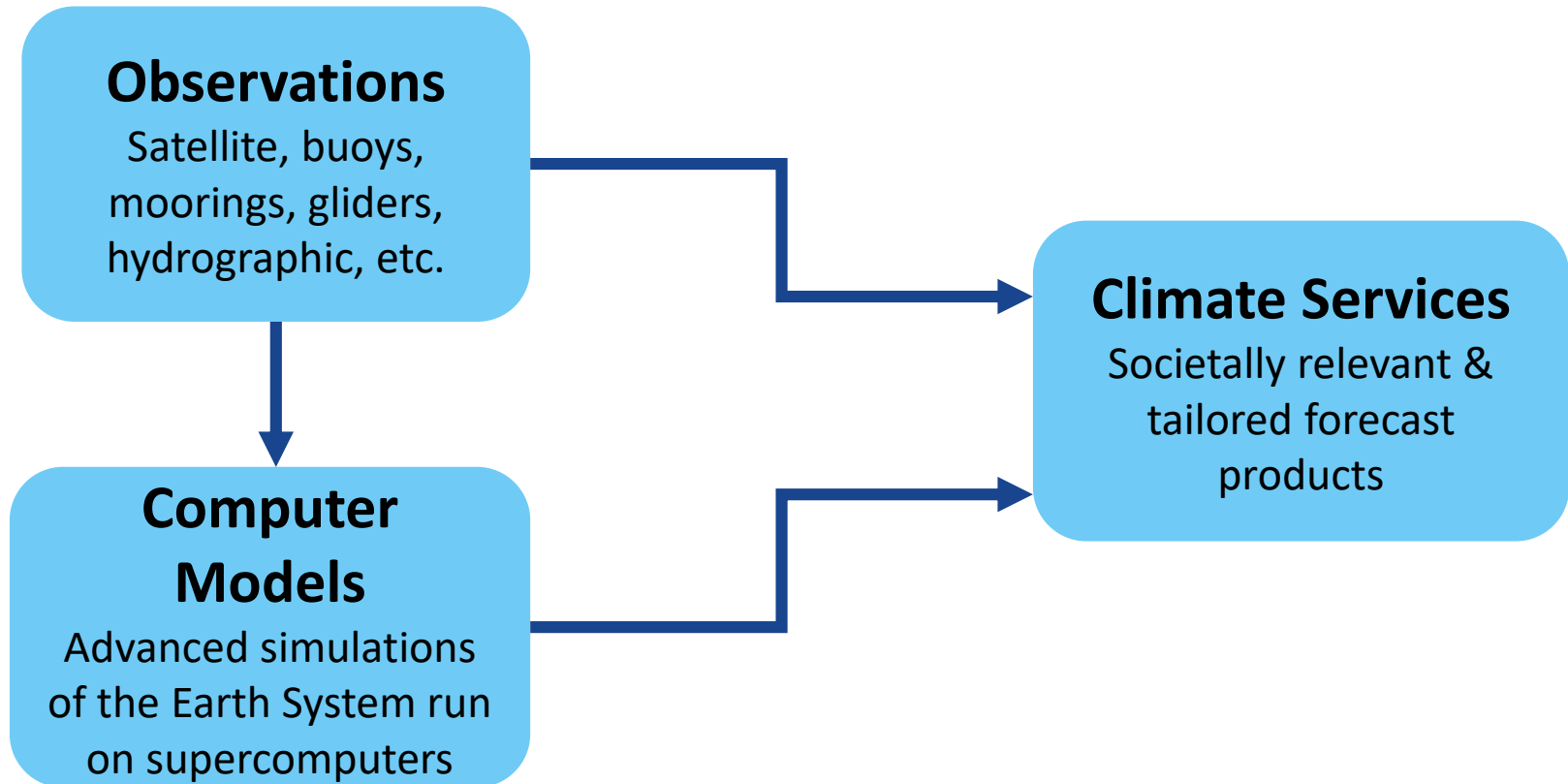
TRIATLAS

2019 – 2023: To develop the understanding and the capacity to best predict changes in the tropical Atlantic marine ecosystem and its societal impacts

MISSION ATLANTIC

2020 – 2025: Mapping and assessing present and future status of Atlantic marine ecosystems under multiple stressors

Building blocks of climate predictions and climate services



Agenda



Bee Berx (Marine Scotland Science)

Ocean Observations - the start of a journey

Observations



Noel Keenlyside (Bjerknes Centre for Climate Research and University of Bergen)

Climate models - telling the Atlantic Ocean's story of the years to come

Computer models



Mark R. Payne (Technical University of Denmark)

Climate services and fish forecasts in the Atlantic

Climate services

Ocean Observations - the start of a journey

Dr Bee Berx, Marine Scotland Science

22nd October 2020

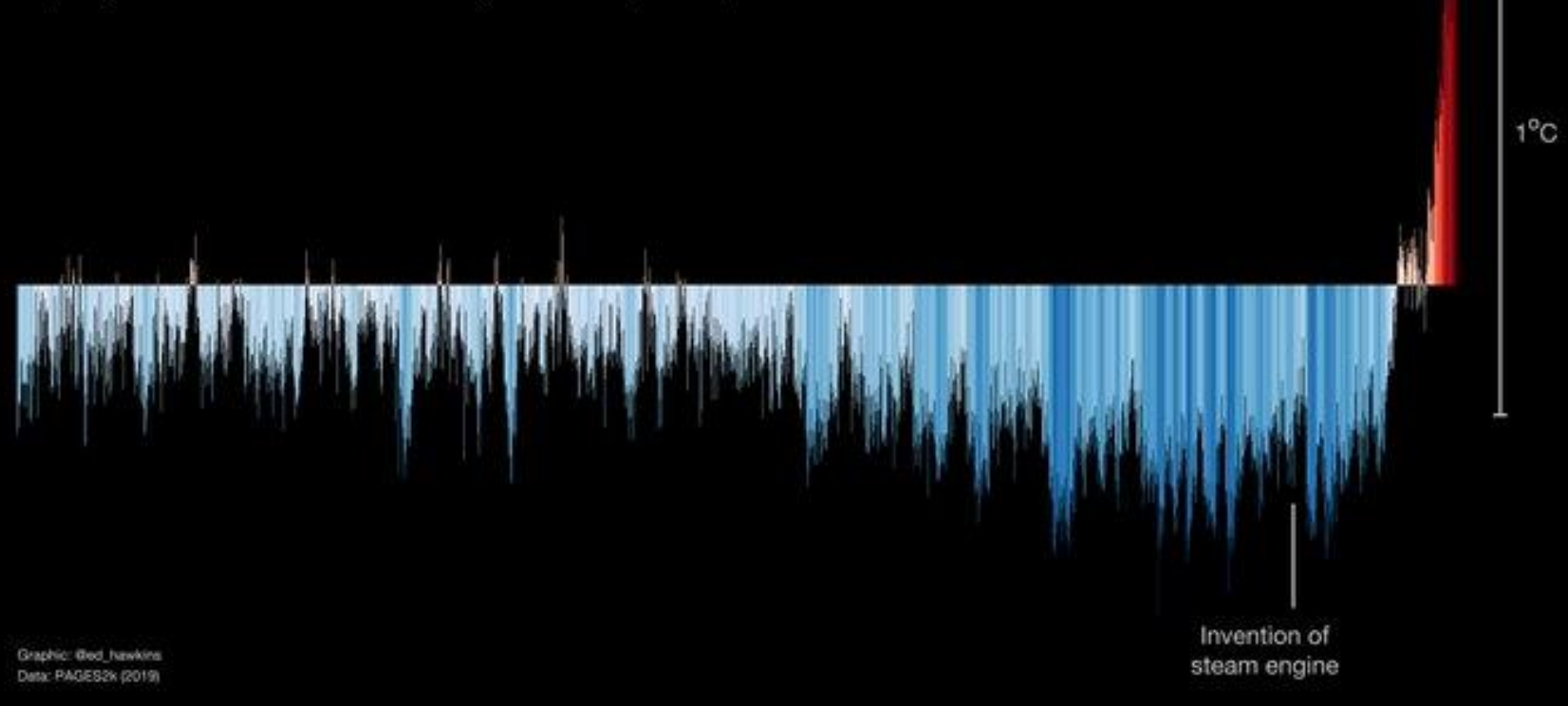
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Global temperature variations over last 2000 years



(using information derived from tree rings and other 'proxies')





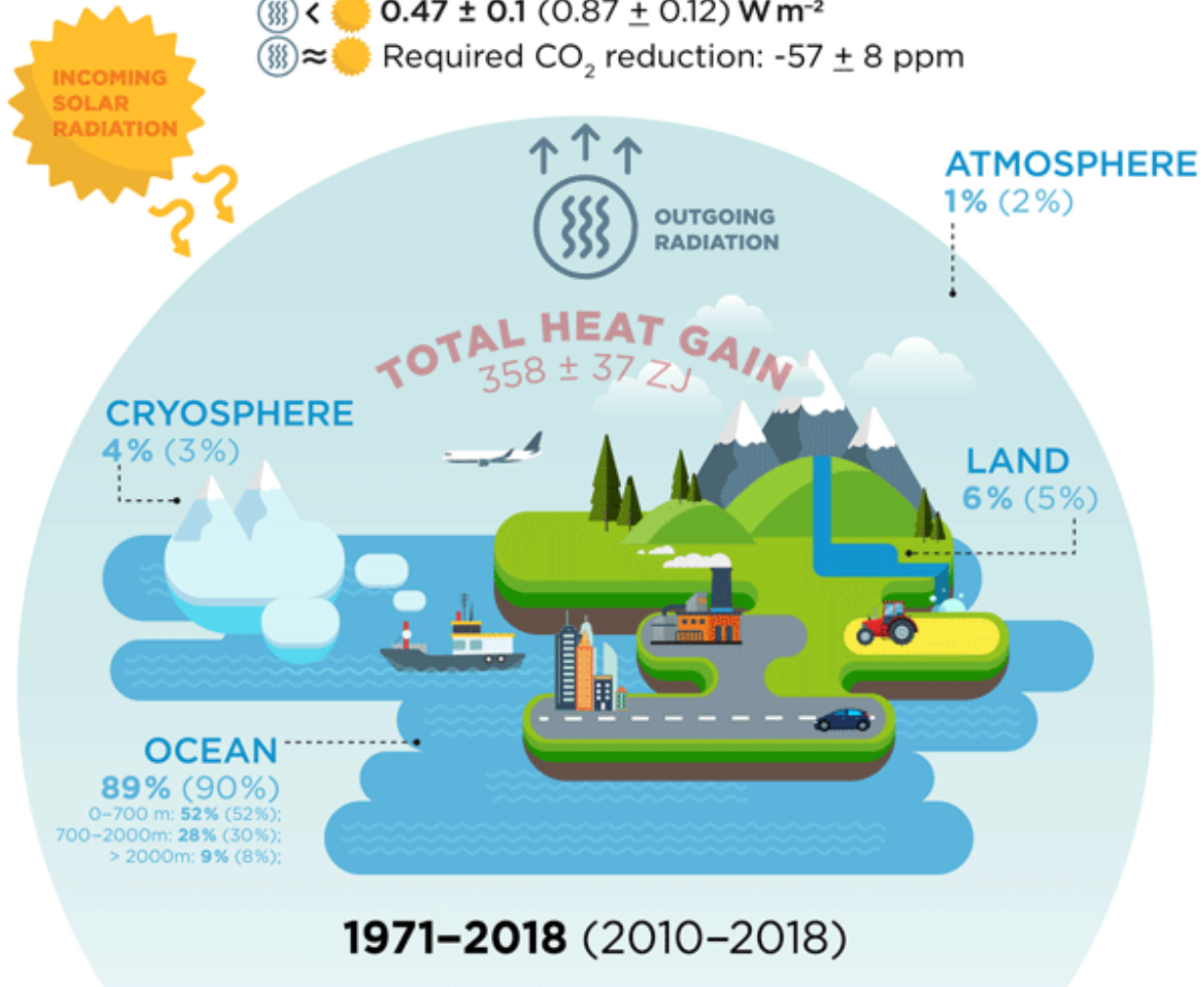
Graphic: @red_hawkins
Data: PAGES2k (2019)



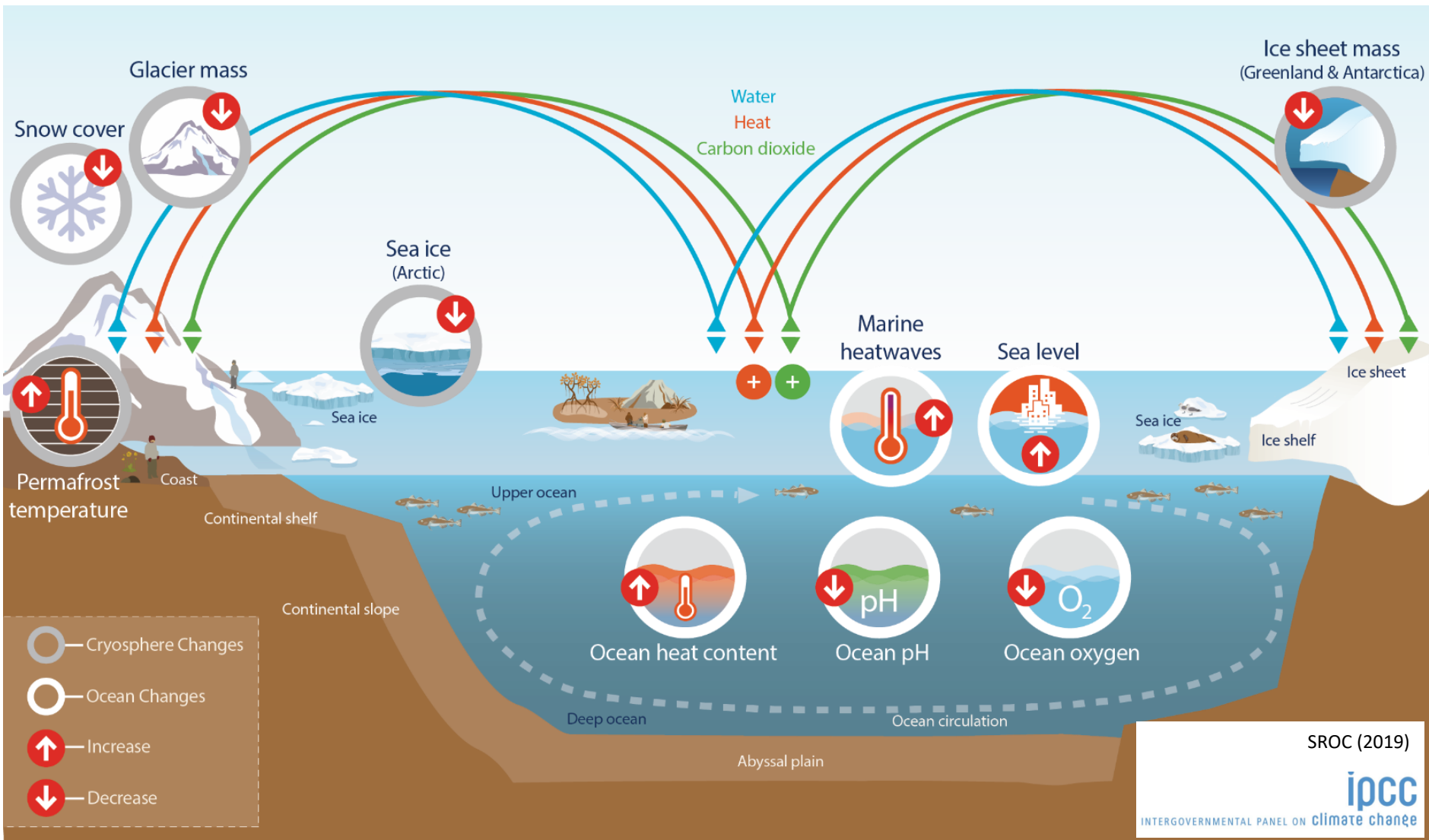
EARTH ENERGY IMBALANCE :

 <  0.47 ± 0.1 (0.87 ± 0.12) W m^{-2}

 \approx  Required CO₂ reduction: -57 ± 8 ppm



von Schuckman et al. (2020)

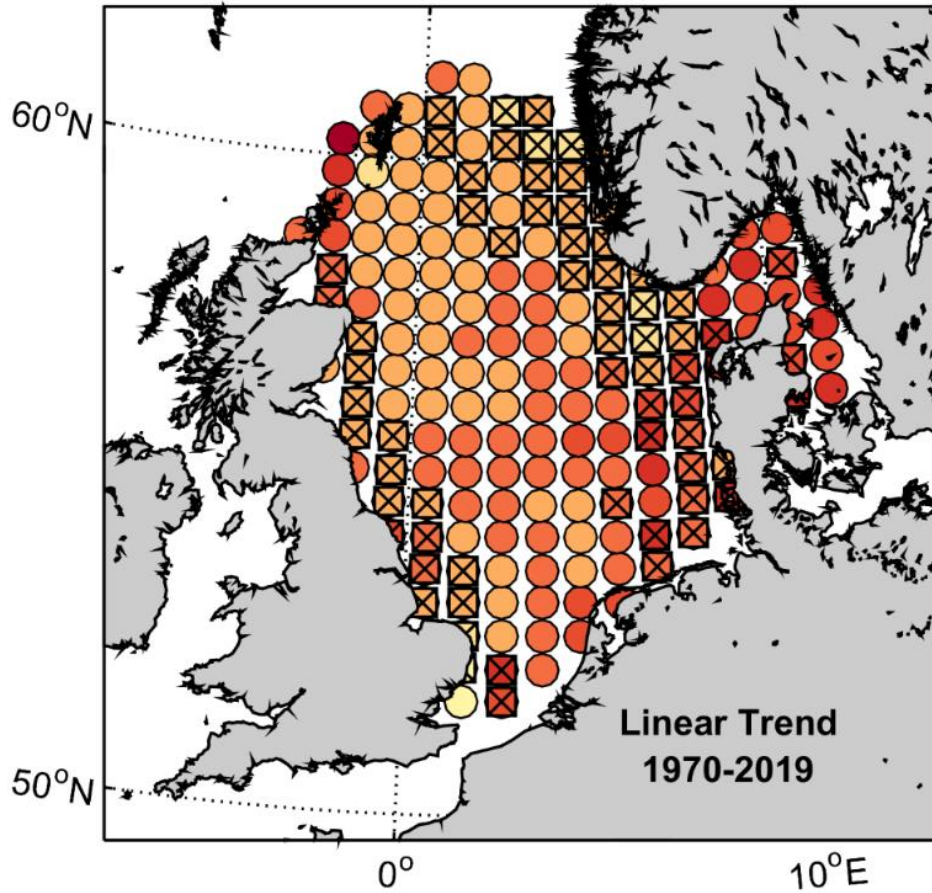


Global Climate Observing System Implementation Plan

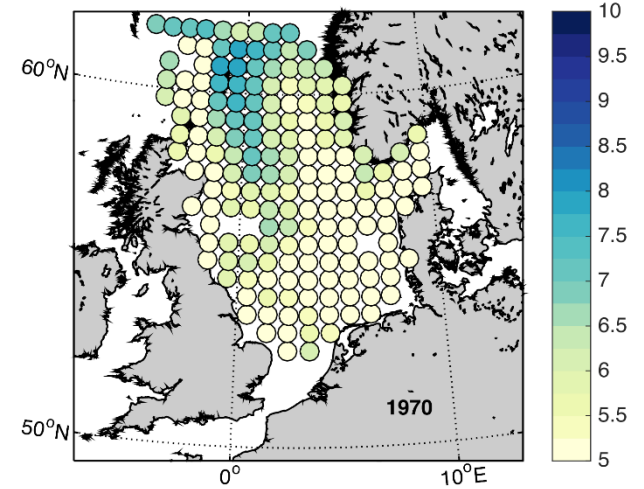
A multi-platform approach is needed to deliver to Essential Climate Variable at the required range of scales and accuracy.



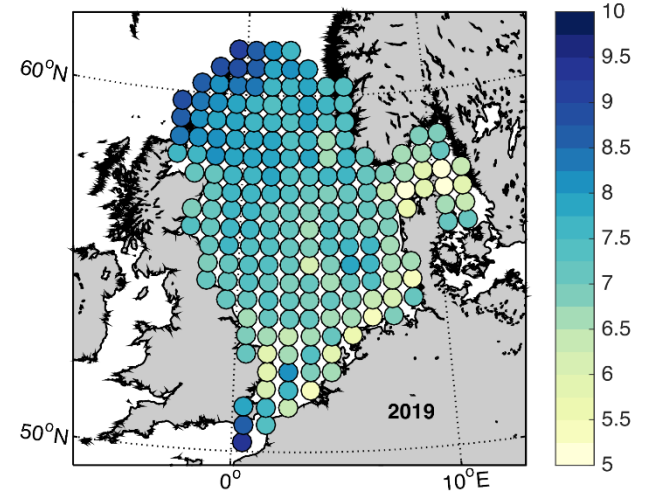
Linear Trend Winter Bottom Temperature (°C decade⁻¹)

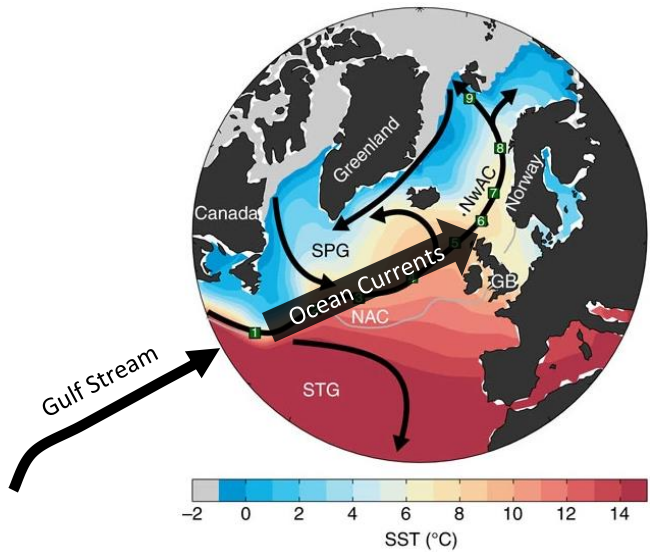


North Sea Winter Bottom Temperature (°C) in Year 1970

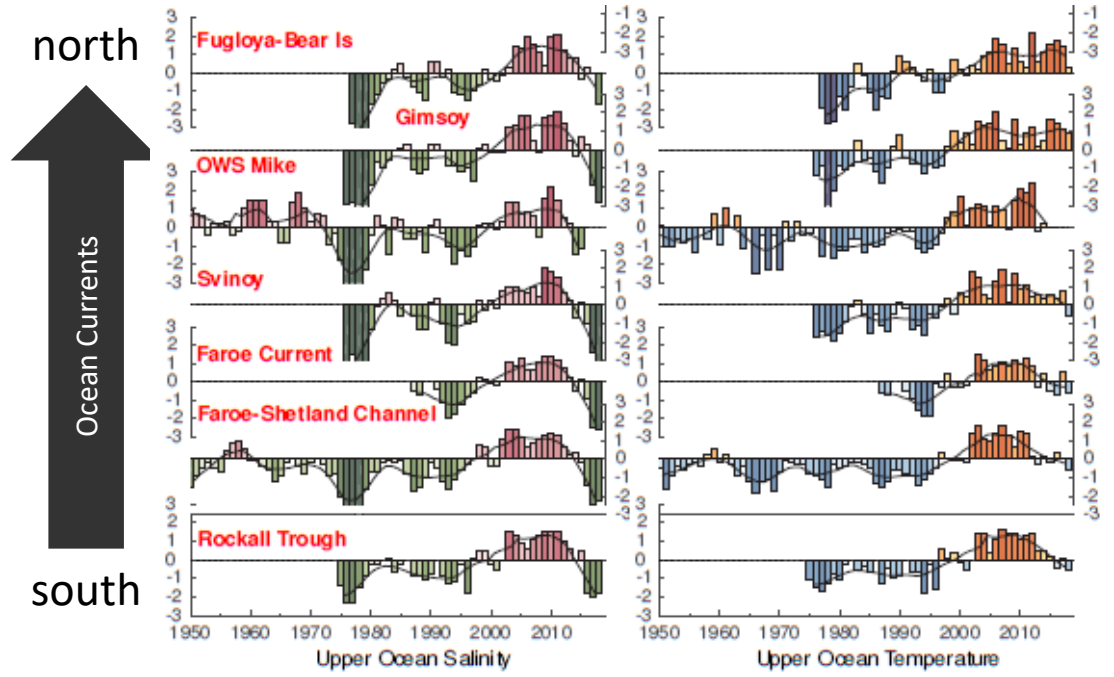


North Sea Winter Bottom Temperature (°C) in Year 2019

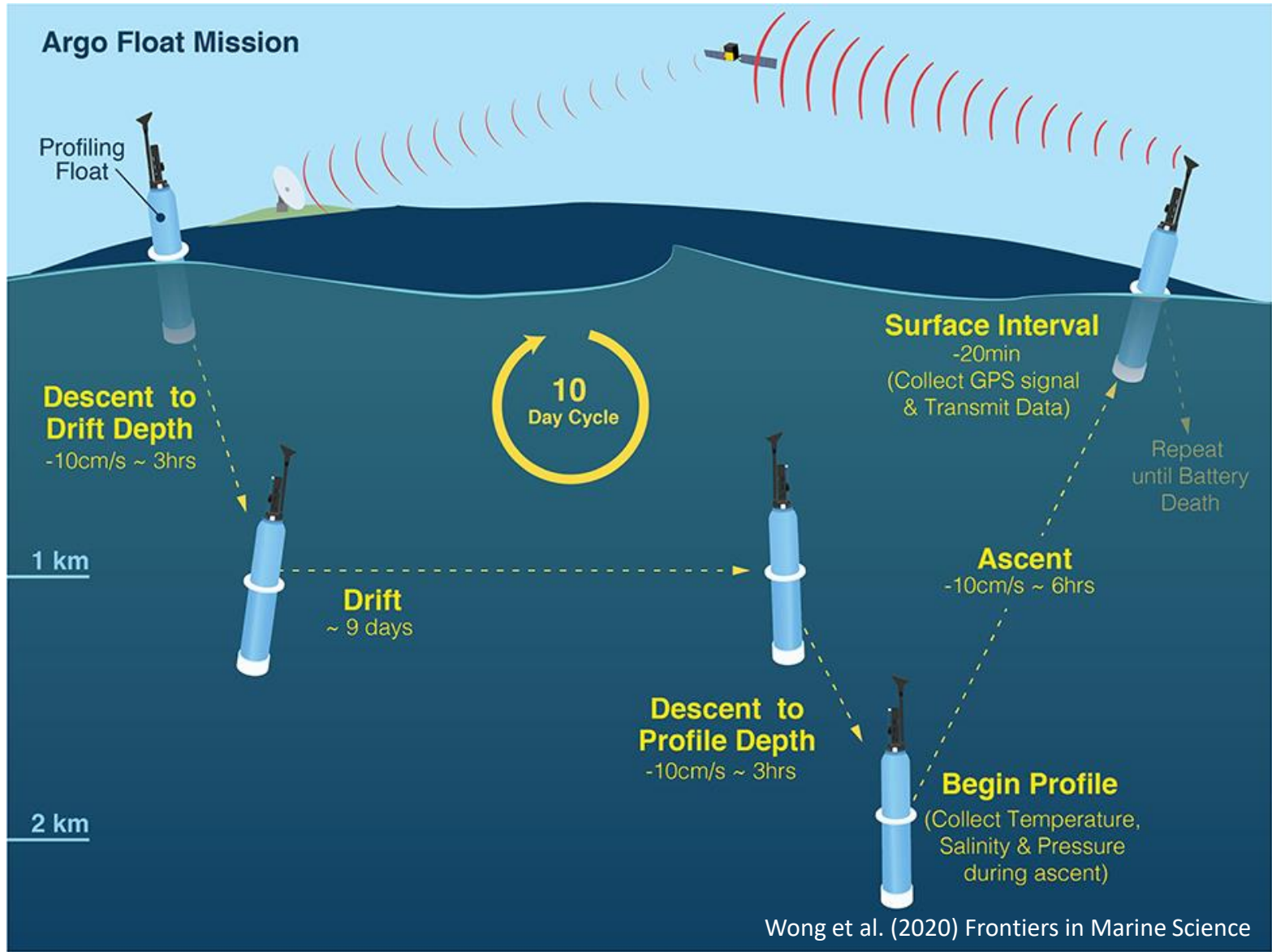


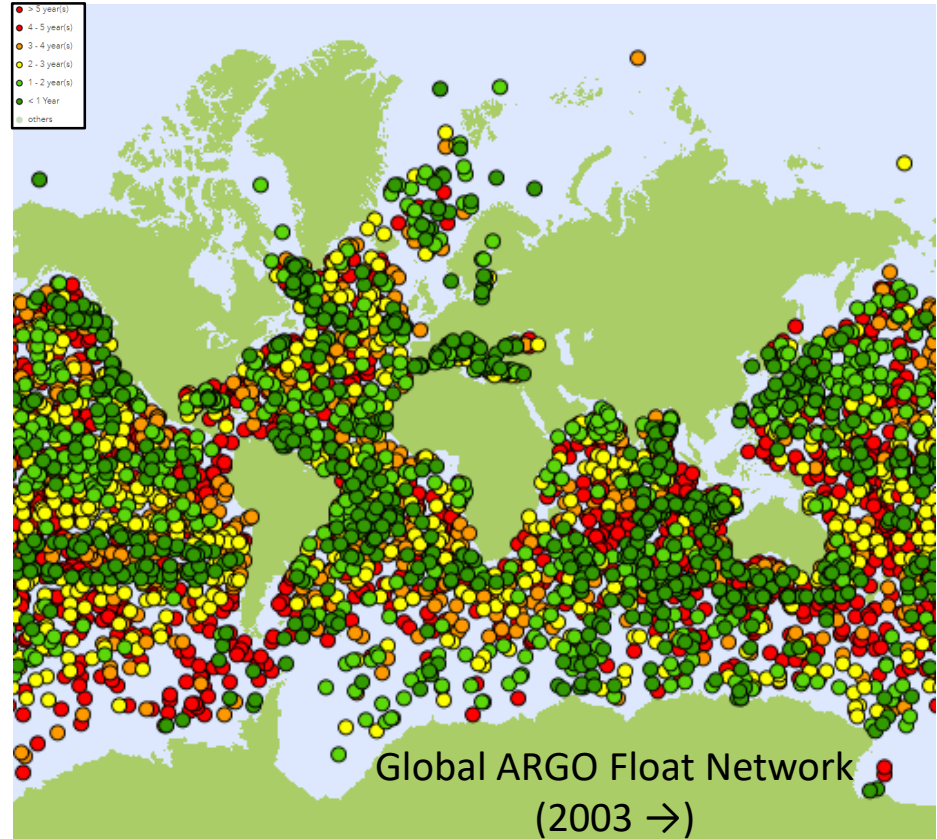


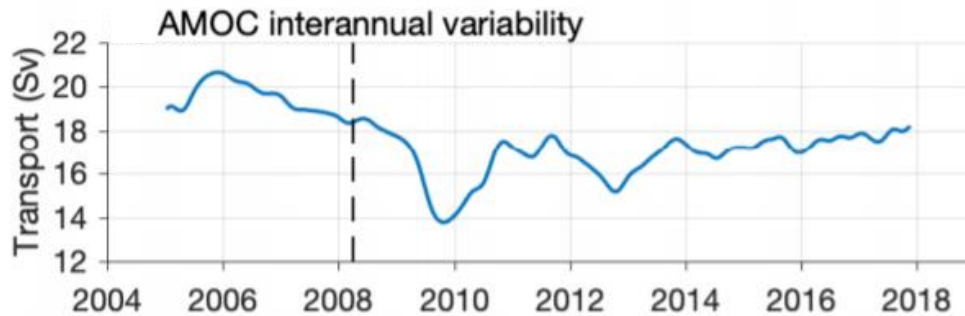
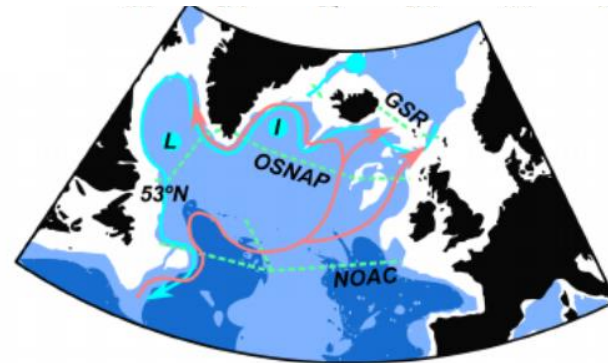
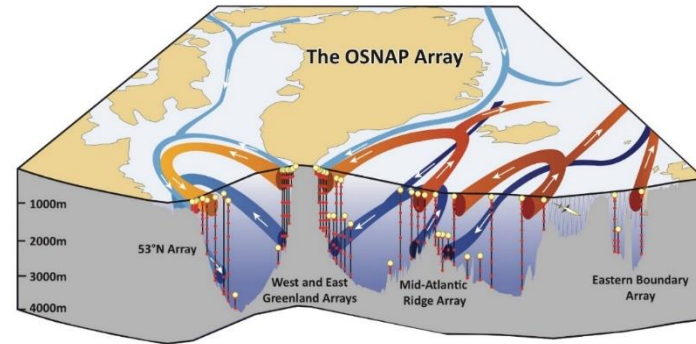
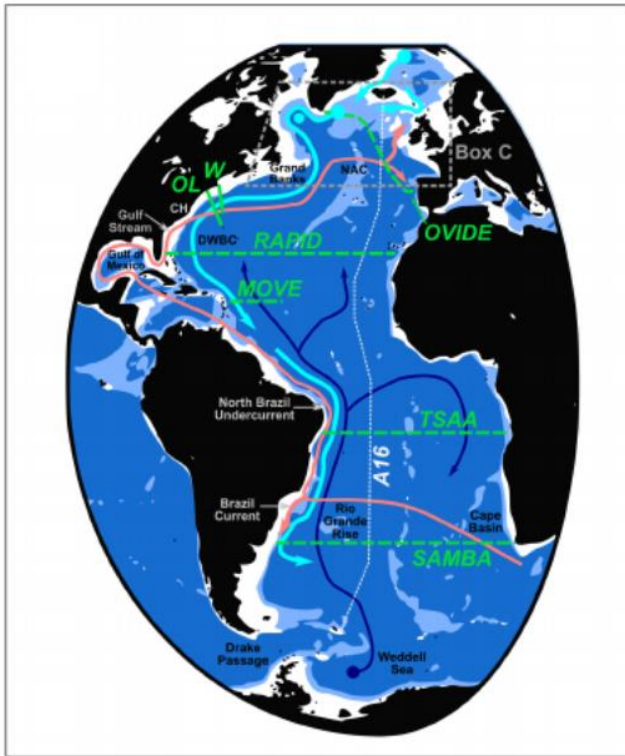
Årthun et al. (2017) *Nature Communications*



Updated from Holliday et al. (2011) *GRL*







Moat et al. (2020) *Ocean Science*

Climate models - telling the Atlantic Ocean's story of the years to come

Prof. Noel Keenlyside

University of Bergen, Bjerknes Centre for Climate Research

22nd October 2020

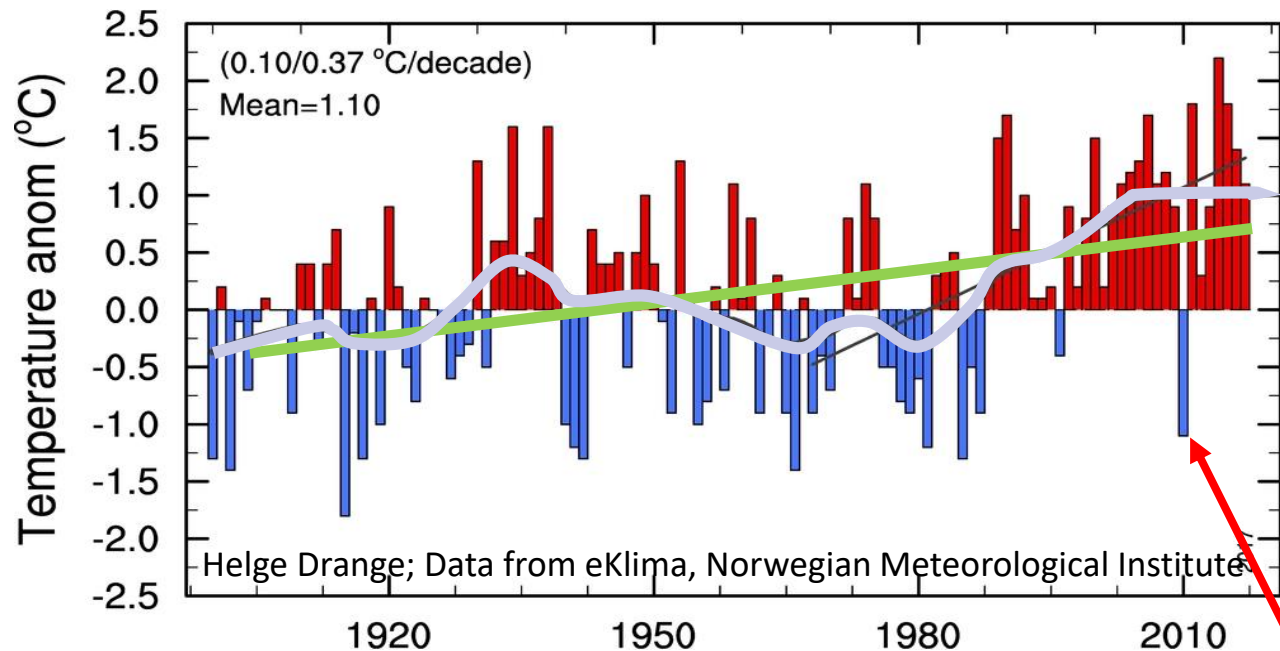
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The different types of climate prediction

Annual mean temperature for Norway as deviations to the long-term mean



Long-term trend
caused mainly by
global warming

IPCC

Decade to decade changes
caused by both natural and
anthropogenic factors

Decadal prediction

Year to year fluctuations
caused by natural processes in
the climate system

Seasonal prediction

Elements of a numerical climate prediction

Comprehensive numerical models

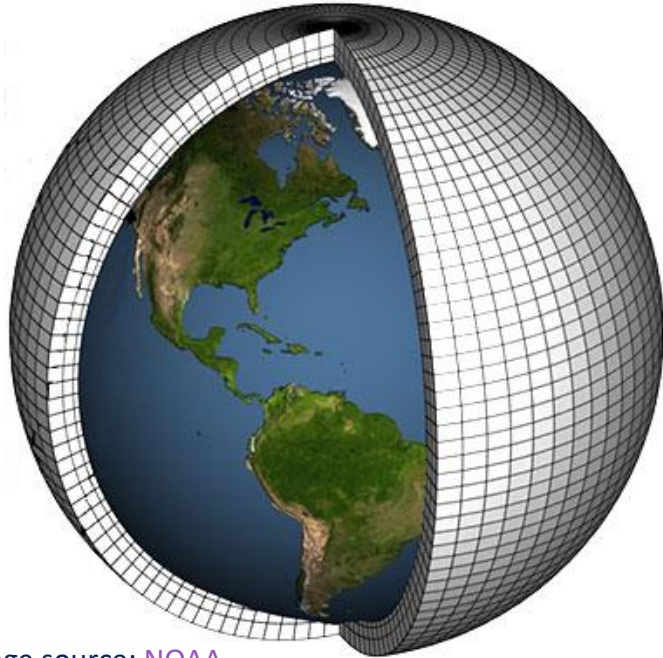
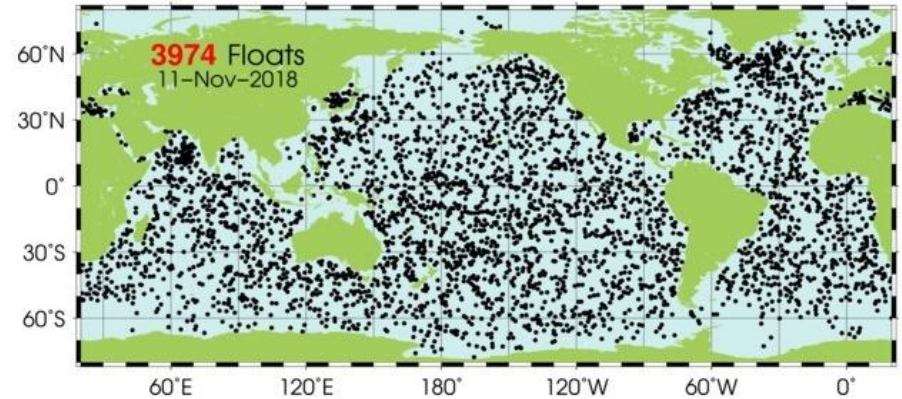


Image source: [NOAA](http://www.noaa.gov).

Detailed climate observations

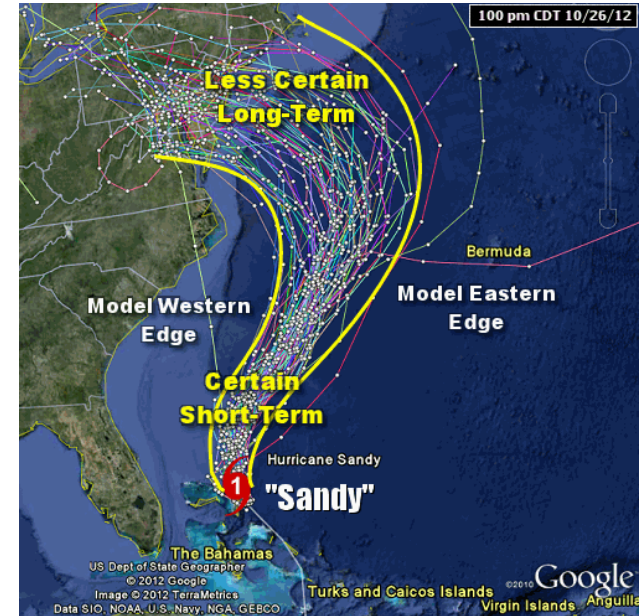


<http://www.argo.ucsd.edu>

Powerful super computers



Data assimilation - synchronizing model with observations



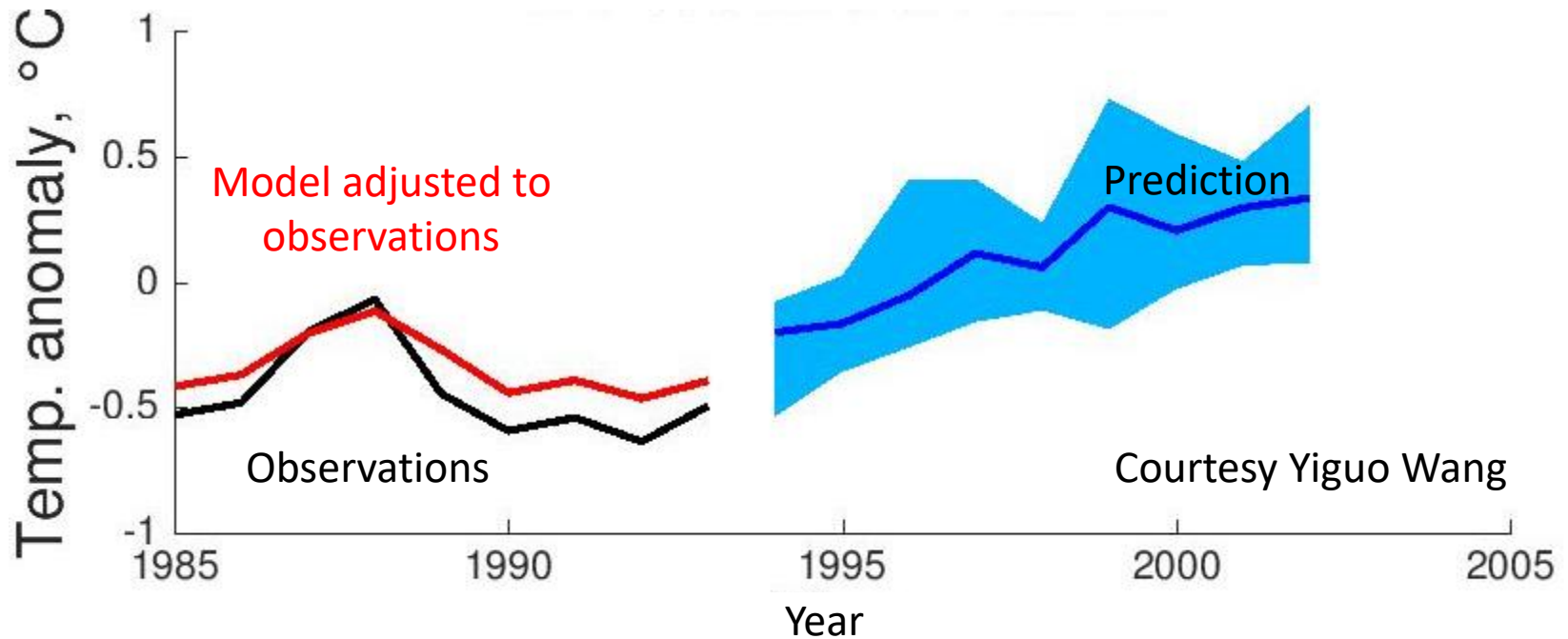
Data assimilation **corrects the initial condition (position, shape, strength ...)** in order to provide more accurate predictions

We can predict the North Atlantic

with advanced models and data assimilation techniques

Results from the Norwegian Climate Prediction Model

Prediction of North Atlantic Sea Surface Temperature, starting in October 1993

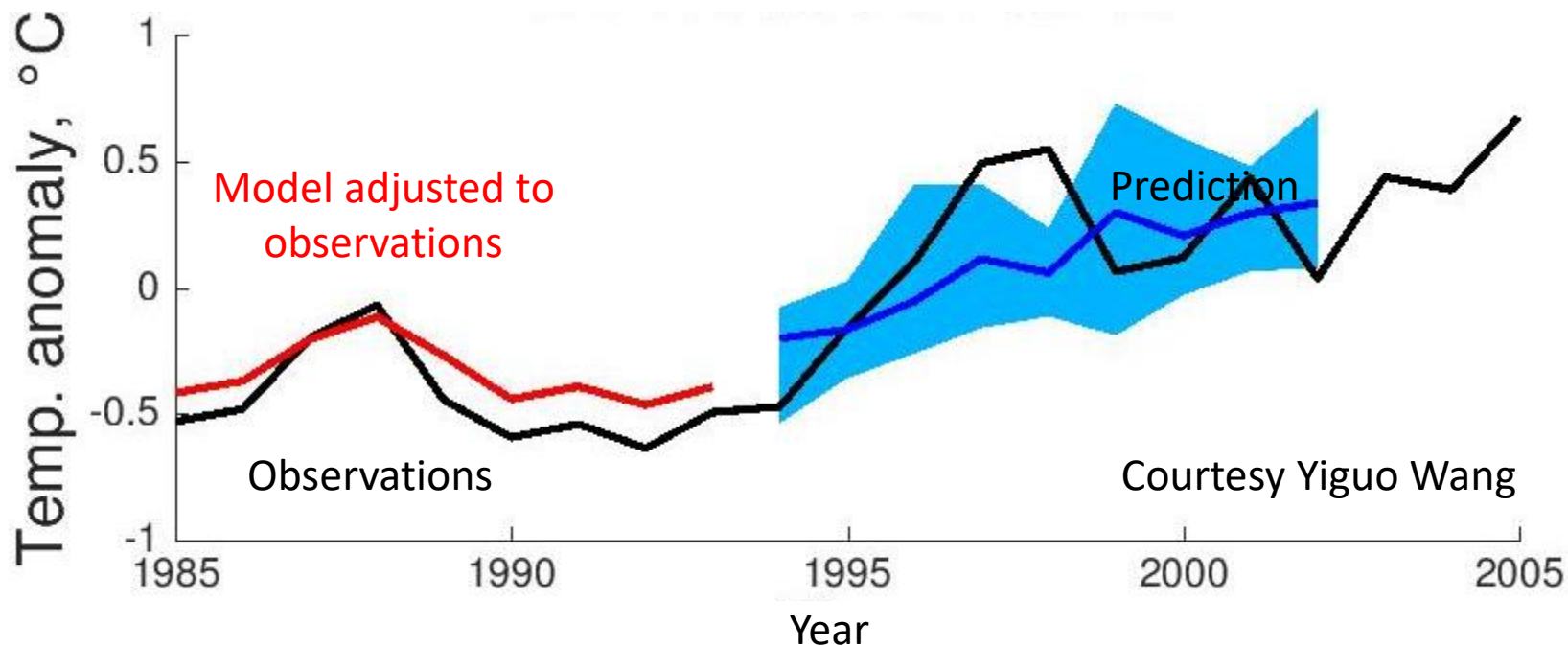


We can predict the North Atlantic

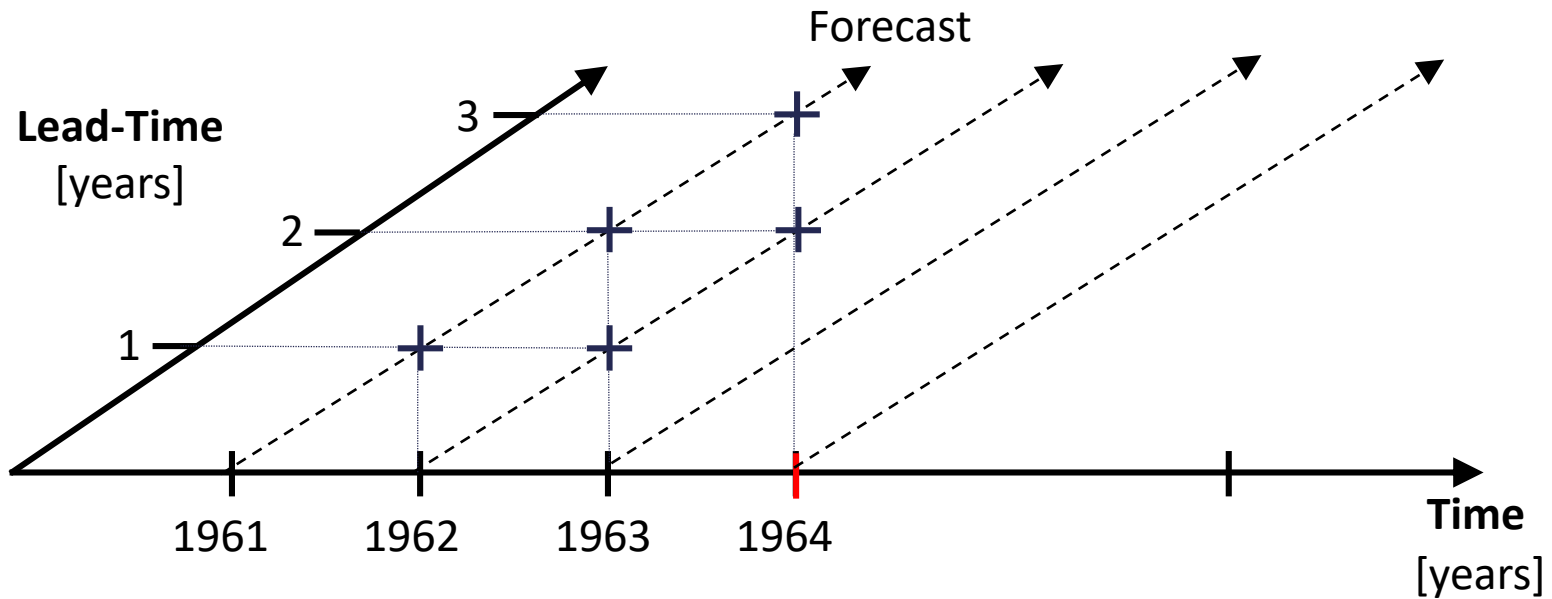
with advanced models and data assimilation techniques

Results from the Norwegian Climate Prediction Model

Prediction of North Atlantic Sea Surface Temperature, starting in October 1993



Measuring skill using retrospective forecasting (hindcasting)



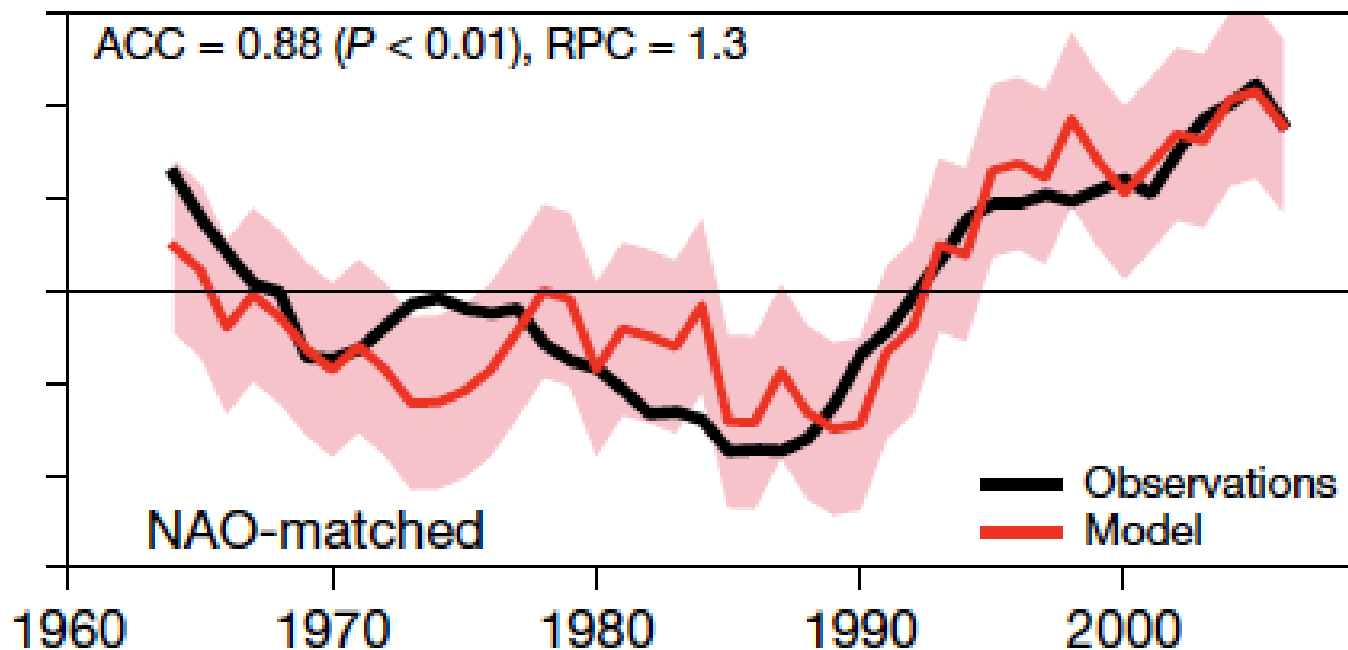
Skill is correlation between
forecast and observed

Atlantic Multi-decadal variability (AMV) highly predictable

Multi-model retrospective forecasting for AMV for years 1 to 9

Atlantic averaged sea surface temperature with long-term trend removed

Forecasts have been recalibrated to enhance signal to noise ratio



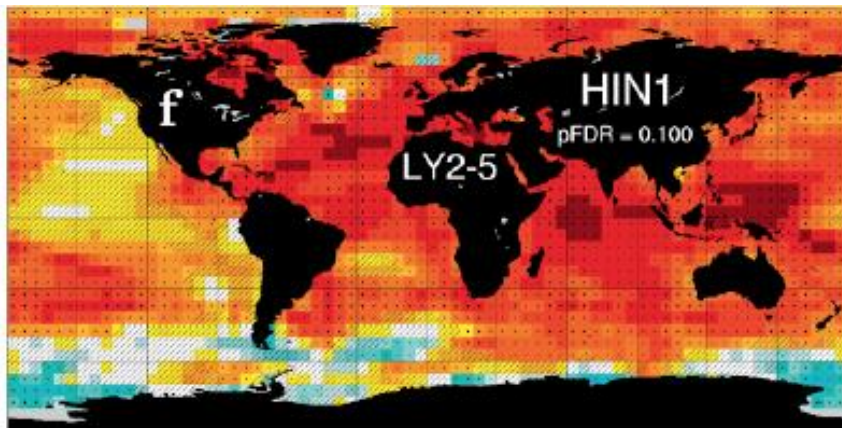
Smith et al. 2020

Skillful multi-year predictions is global, but the North Atlantic ocean is special

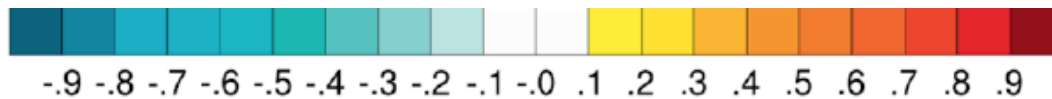
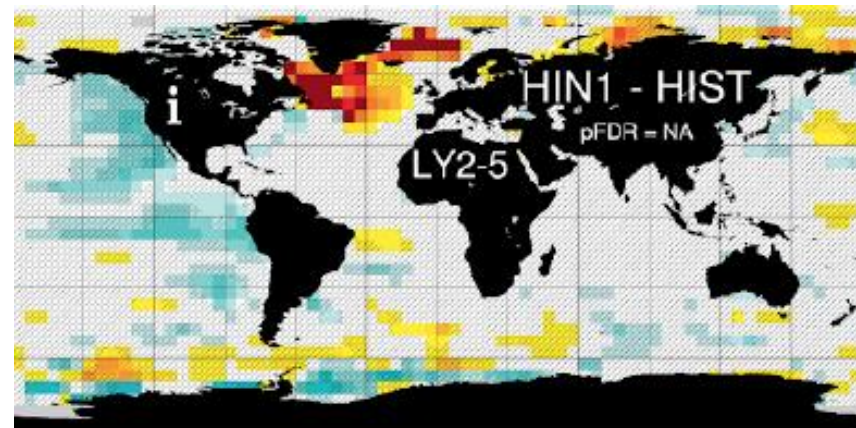
Correlation skill in predicting Sea Surface Temperature 2-5 years ahead

NorCPM, yearly hindcasts 1960-2010, 10 members

Total skill (greenhouse gas + ocean)



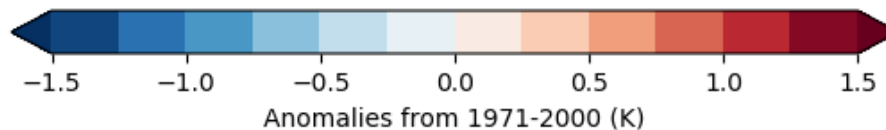
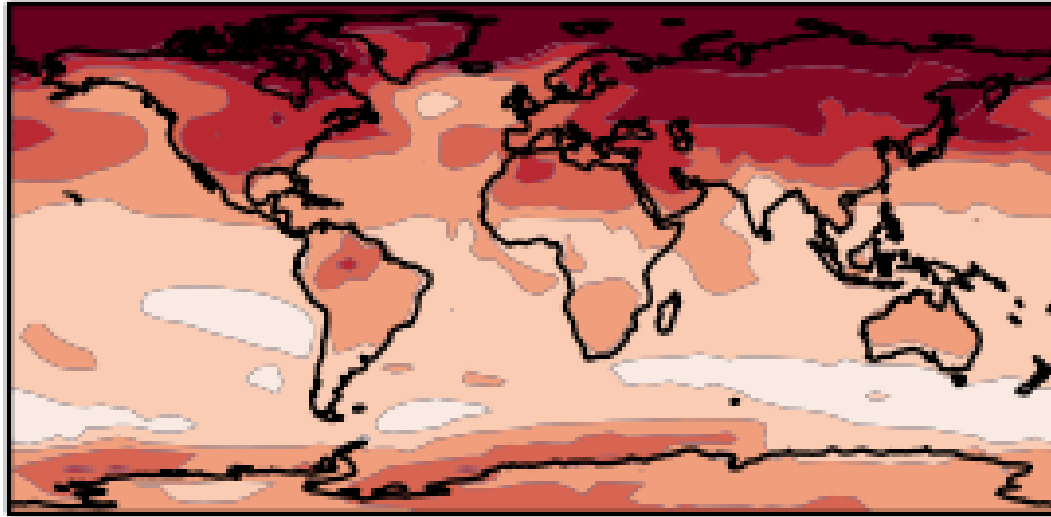
Skill added by ocean data



Bethke to be submitted

Experimental climate predictions are available

Multi-model Prediction of surface temperature for the 2020-2024



See report: WMO Global Annual to Decadal Climate Update for 2020–2024

<https://hadleyserver.metoffice.gov.uk/wmolc/>

Climate Services and Fish Forecasts in the Atlantic

Dr Mark R. Payne, Technical University of Denmark

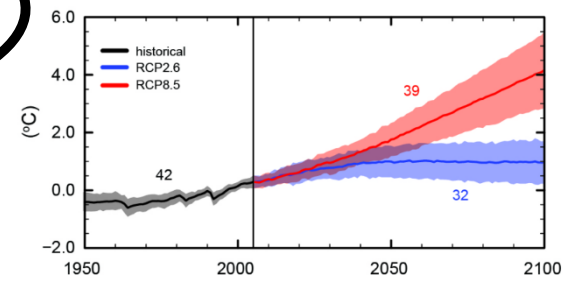
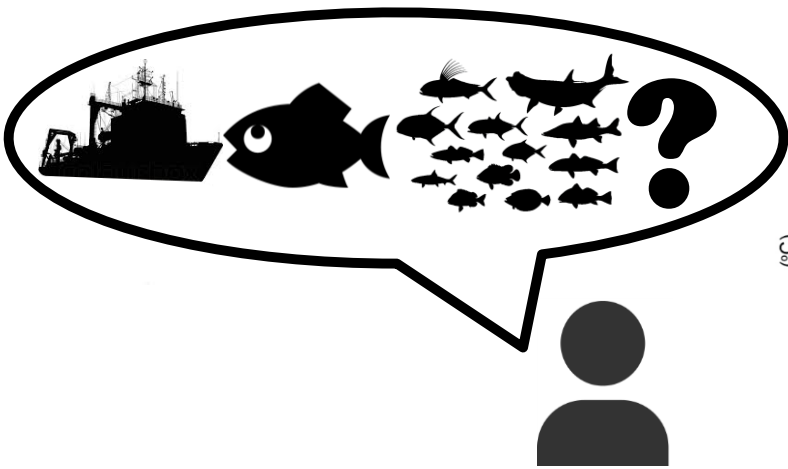
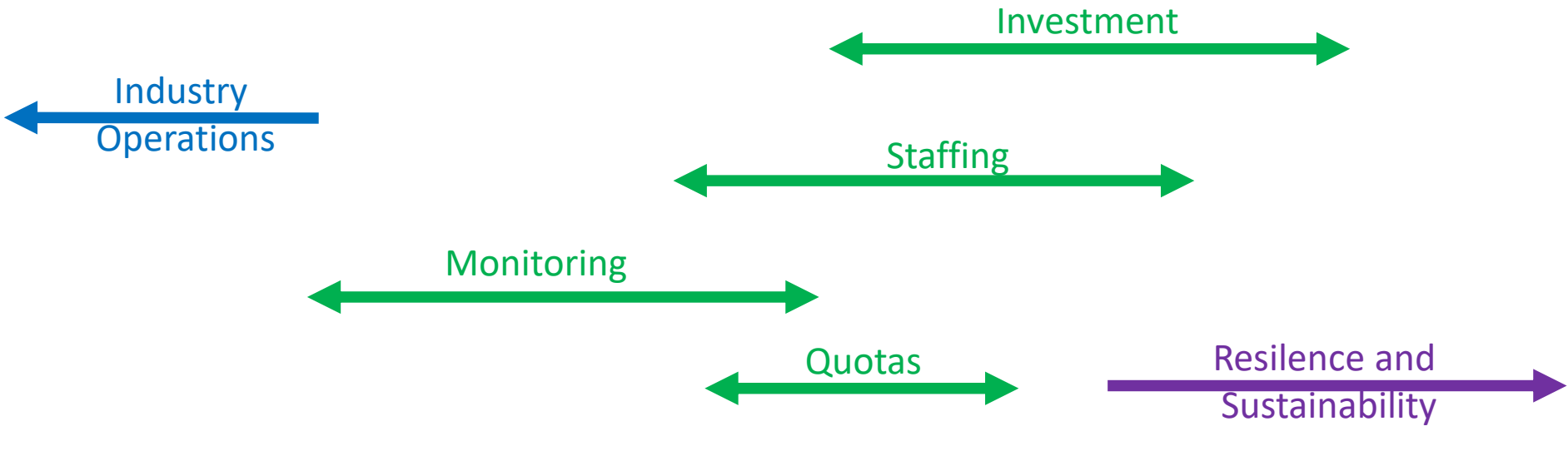


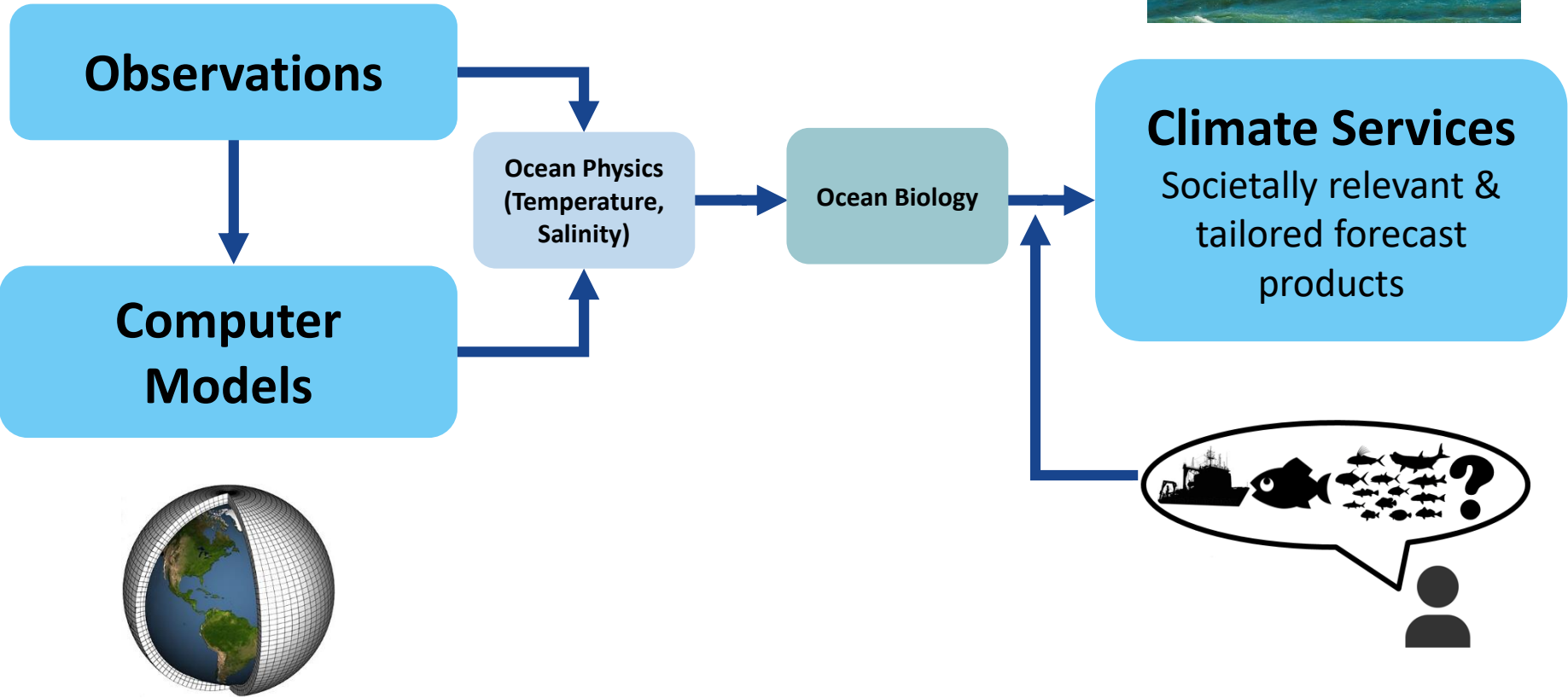
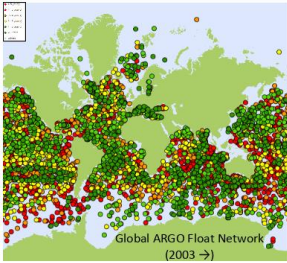
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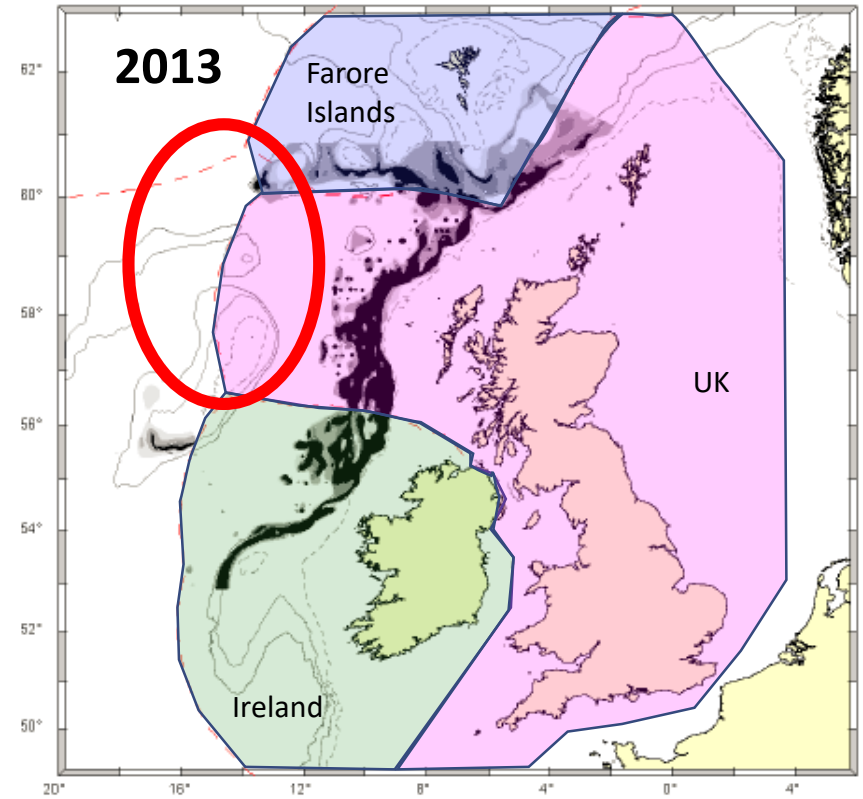
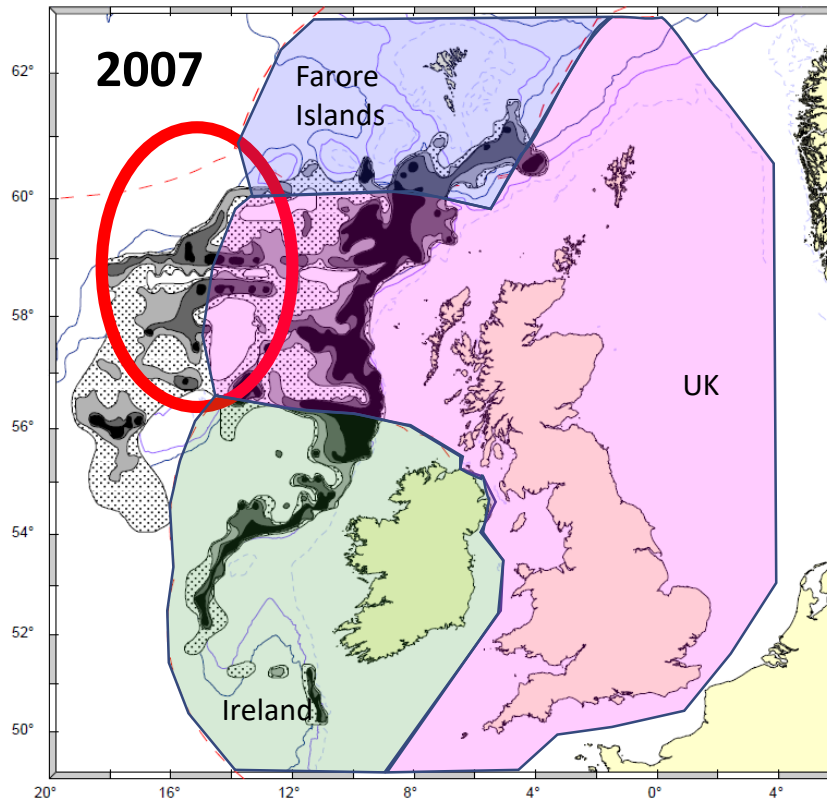
Blue whiting case study



Observed distribution of blue whiting

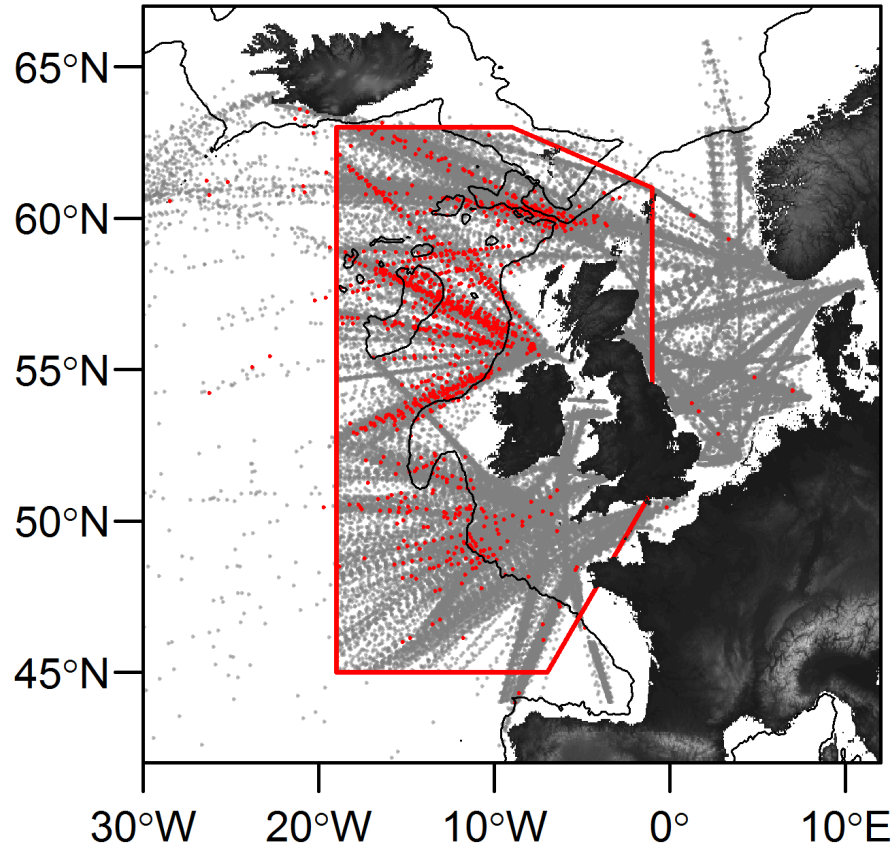
Expanded distribution

Compacted distribution



(Data from scientific monitoring surveys)

Blue whiting biological model

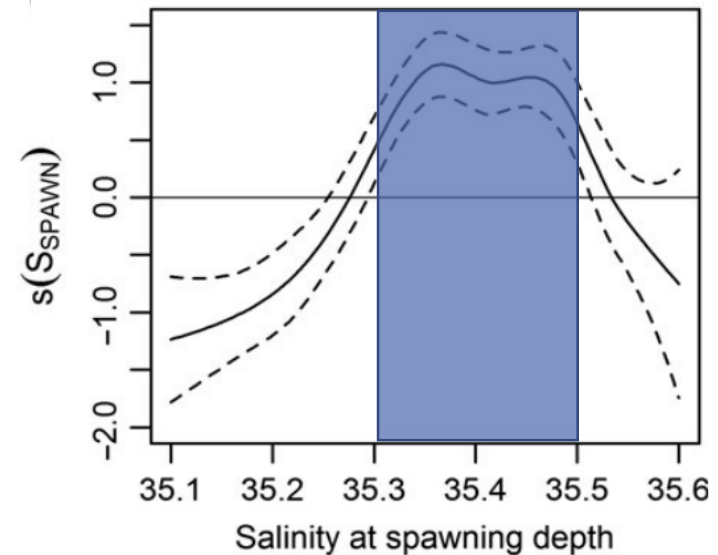


Blue whiting larval data

- 1951-2005
- 34 422 observations (1100 presences)

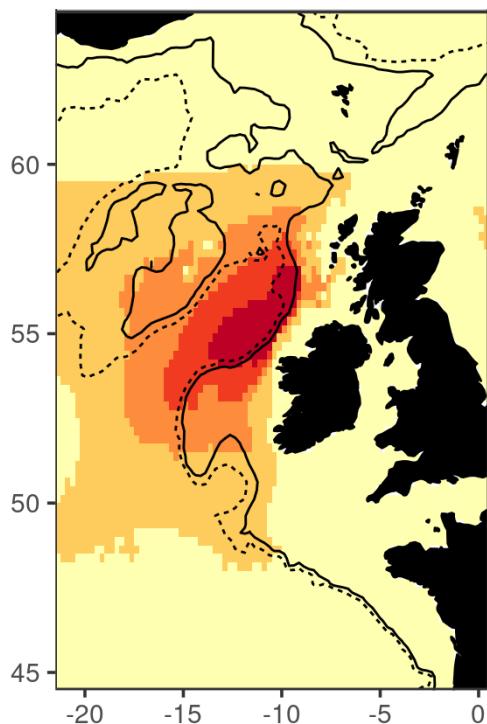
Ecological niche model

- Characterise preferred conditions (habitat)



(Miesner & Payne 2018 Fish. Ocean.)

Blue whiting climate service



2019 Forecast Distribution

Forecast Habitat, 2019

Habitat compacted against shelf edge

Little / no spawning on Rockall plateau

Probability

- 0.0
- 0.1
- 0.2
- 0.3
- 0.4

Depth (m)

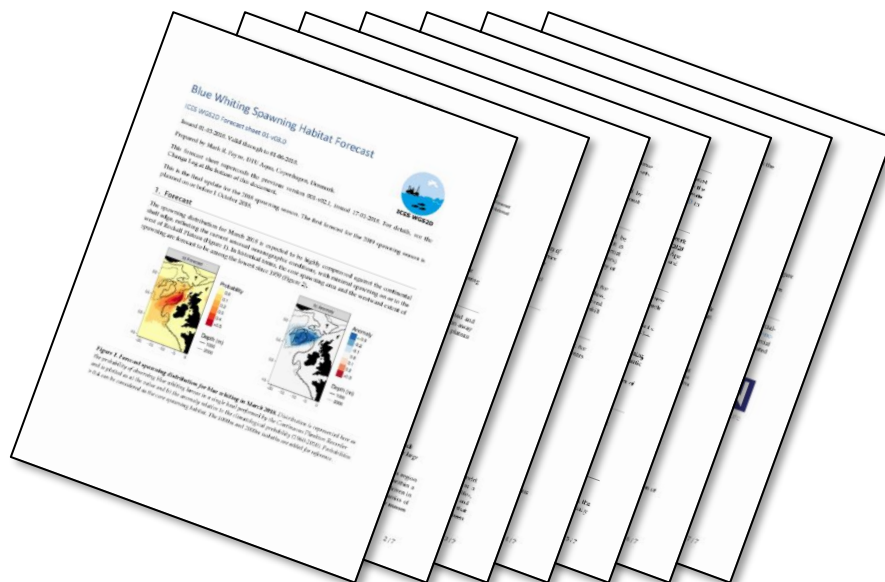
- 1000
- 2000

a) 2019 Forecast

Blue Whiting Forecast, 2019

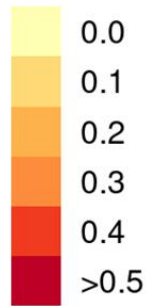
Mark R Payne (@MarkPayneATWork)

<http://fishforecasts.dtu.dk>

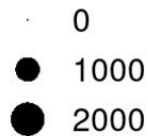


Does it work? 2018 Forecast Verification

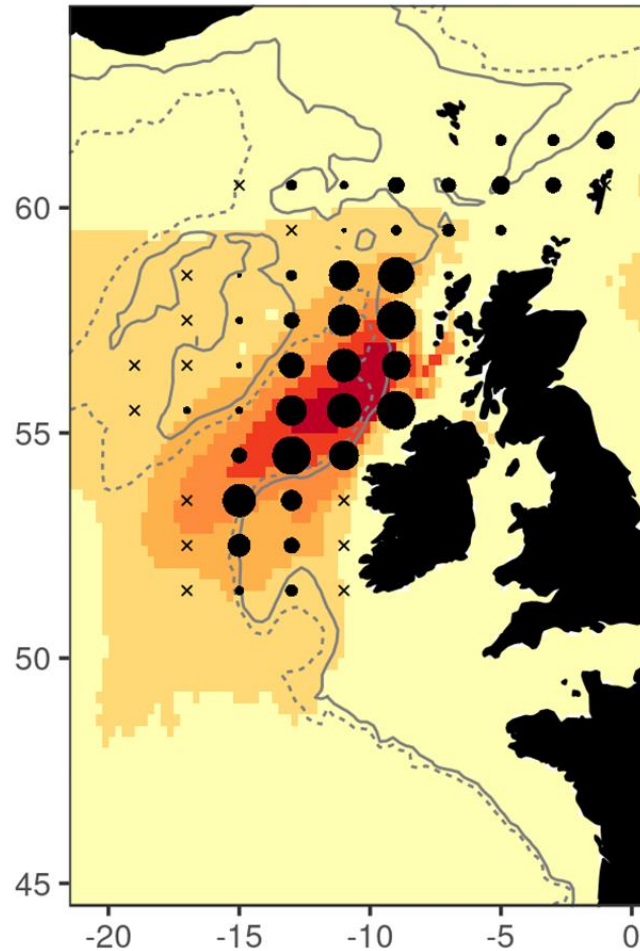
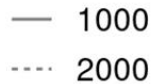
Jan'18 Forecast



Mar'18 Survey



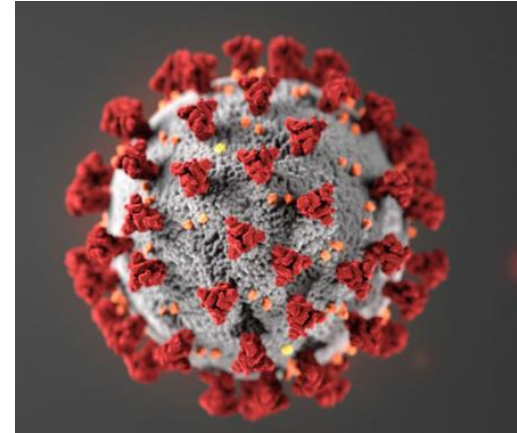
Depth (m)



Does it have value?



1. Active use in monitoring of this fish stock



2. Use of forecast model for an emergency redesign of the monitoring system

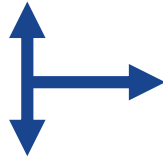


3. Need to wait for more forecast cycles before we can truly show value

How far out can we forecast?



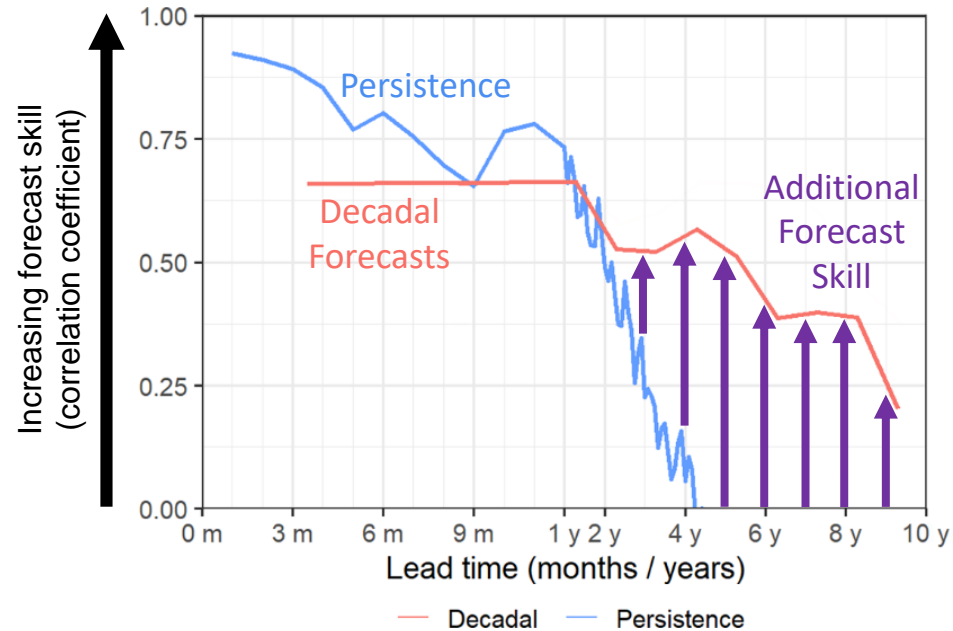
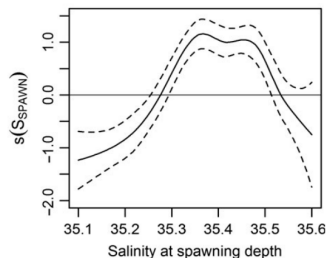
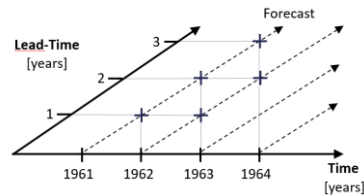
Ocean Physics
Forecasts



Biological
Model

Biological
Forecasts

Skill assessment



Decadal-scale forecasts and climate services are possible

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 and government



Thank you for joining us



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