



# ICED

Integrating Climate and Ecosystem Dynamics  
in the Southern Ocean



# ANTARCTICA INSYNC

## Antarctica InSync: Improving knowledge and protection of Antarctic life



 **AWI** ALFRED-WEGENER-INSTITUT  
HELMHOLTZ-ZENTRUM FÜR POLAR-  
UND MEERESFORSCHUNG

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**EU Polar Week 2024**

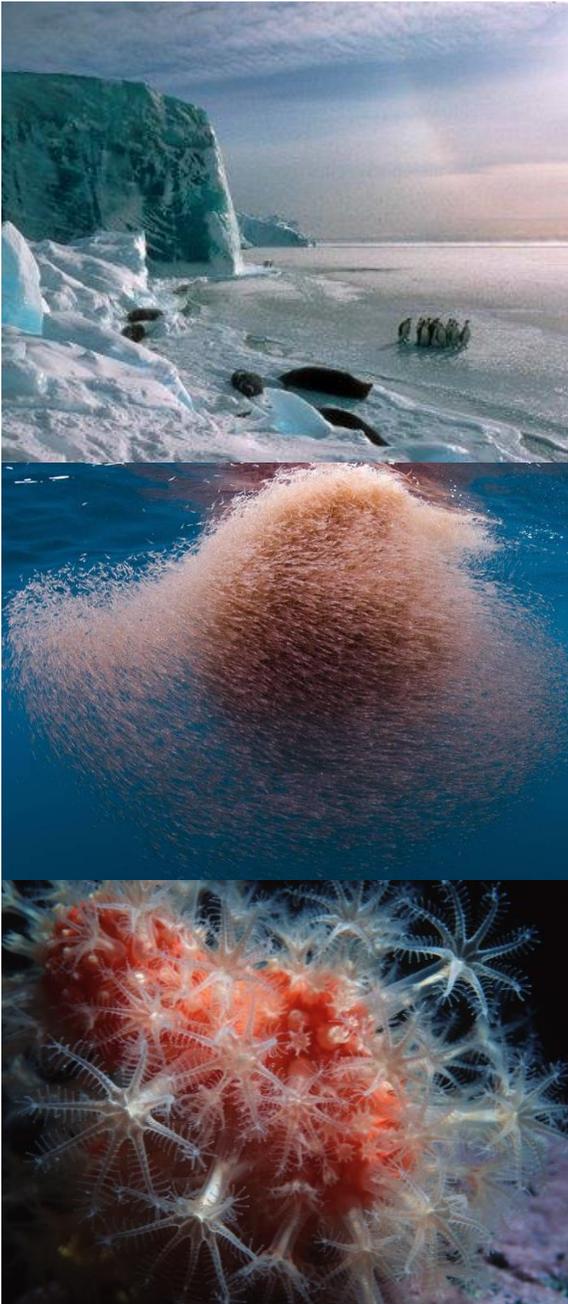
*Emma Cavan, Stuart Corney (ICED), Andrew Constable, Jess Melbourne-Thomas, Monica Muelbert, Anne Hallowed, Sian Henley, Susie Grant, Jilda Caccavo, Huw Griffiths (MEASO), Anton Van de Putte, Eoghan Griffin, Andrea Herbert (DCC-SOR), Southern Ocean Task Force, SOOS*

 **IMBeR** **futureearth**  
research for global sustainability



**British  
Antarctic Survey**  
NATURAL ENVIRONMENT RESEARCH COUNCIL





## Southern Ocean ecosystems

- **Unique** and **highly productive**
- **Resident** and **migrant** species
- **Adapted** to cool thermally stable environment
- **Occupy** a range of habitats from the coast to the deep ocean
- **Under threat** and **need our protection**

Credit: Ali Massey & BAS





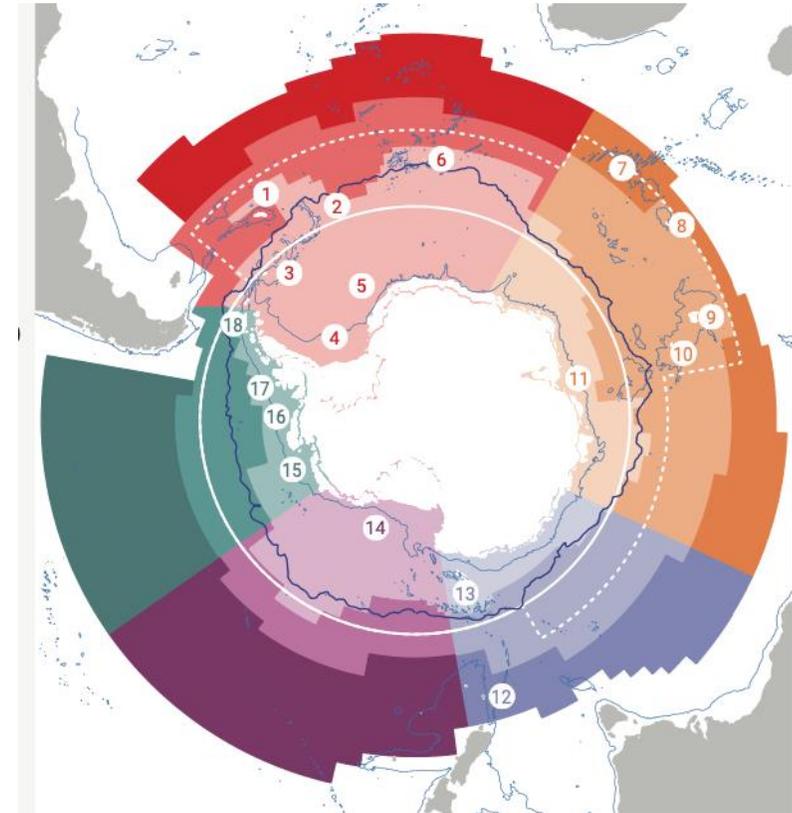
# MEASO | MARINE ECOSYSTEM ASSESSMENT FOR THE SOUTHERN OCEAN



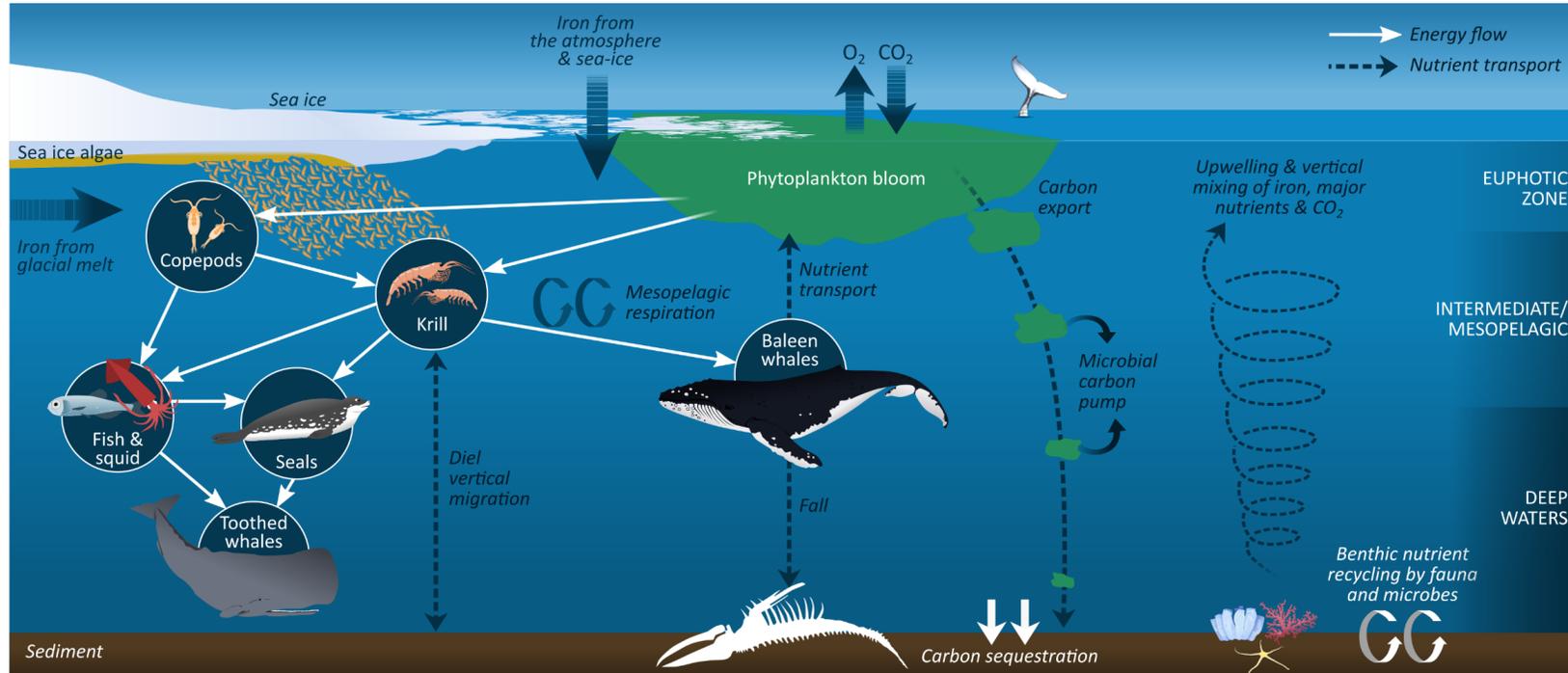
## ICED

Integrating Climate and Ecosystem Dynamics  
in the Southern Ocean

- >200 researchers, >19 countries
- Completed a systematic **assessment of the status and change** of Southern Ocean ecosystems to **inform global and local policy decisions**
- Captured **full spectrum of the ecosystem**
- Assessed a range of **local and global drivers**
- **Published and disseminated** results widely
- **5 key messages**



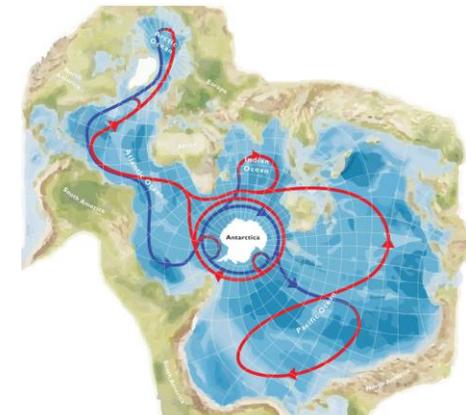
# MEASO Key messages



Henley et al. 2020, Credit: Dr Stacey McCormack @VisualKnow

Southern Ocean ecosystems are:

1. **Globally** connected and provide important ecosystem services (biodiversity, fisheries, tourism, climate regulation, C and nutrient cycling)
2. **Threatened** by a range of global and local drivers
3. **Already changing**
4. **Continued changes** will have **global consequences**



Credit: Meredith et al. BAS



## 5. Action is needed to protect Southern Ocean ecosystems

- Effective local and regional **management and conservation policies** that can account for change and foster ecosystem resilience
- **Systematic long-term measurements of the state of habitats and biota** in the MEASO regions to underpin assessments of change
- Robust future projections of change
- **Global action** to curb climate change and ocean acidification
  
- *Requires international collaboration and coordination*



Scan me!



# Southern Ocean Action Plan

2021 – 2030

In support of the United Nations Decade of Ocean Science for Sustainable Development



2021 United Nations Decade of Ocean Science for Sustainable Development 2030



Scan me!



ANTARCTICA INSYNC



# 7 Working Groups

each identified 4 key questions and research challenges to be addressed



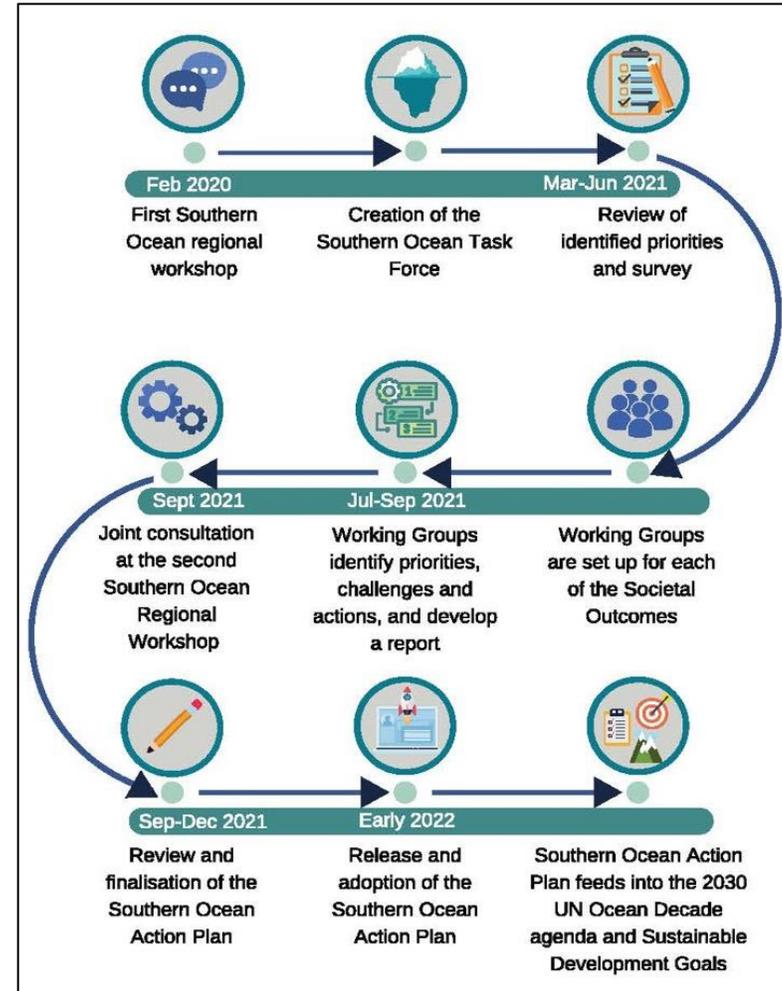
# 5 Bridges



See Southern Ocean action plan for details



2021 United Nations Decade of Ocean Science for Sustainable Development 2030

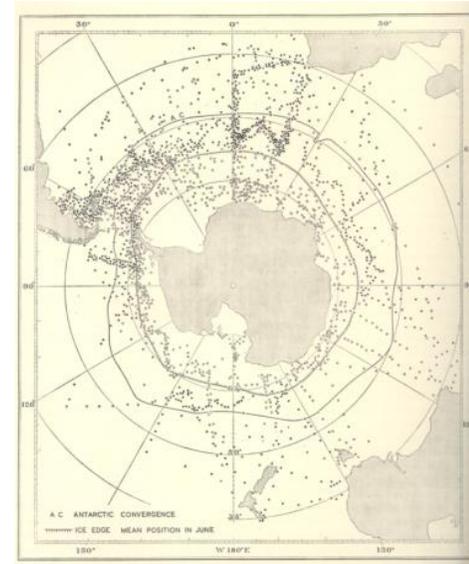


## How can Antarctica InSync contribute?

- ❖ Establish a **network** of systematic long-term measurements of the state of habitats (sea ice, coastal areas, deep ocean) and biota (phytoplankton, zooplankton, benthos) to assess change
- ❖ Identify **mechanisms** involved and **resilience**
- ❖ **Quantify** the role of biology in carbon and nutrient cycles
- ❖ Develop robust quantitative **future projections** of ecosystems and implications for ecosystem services
- ❖ **Standardise protocols** for observations

### *Particularly*

- ❖ In the sea ice environment
- ❖ During seasonal transitions
- ❖ During winter



Discovery Investigations 1925-52





The polar oceans influence **global climate** processes, support unique **biodiversity**, and contribute to **global food security**.

Understanding polar marine ecosystems is key to improving **climate projections**, and in guiding **sustainable management** and **conservation** decisions.

The **British Antarctic Survey Ecosystems Team** undertakes multidisciplinary research into the structure and function of **Arctic and Antarctic** ecosystems, and their responses to change.

Our work informs ecosystem-based management, particularly within the **international governance framework** of the Antarctic Treaty System. This supports the **resilience and adaptation** of polar marine ecosystems to change, ensuring they continue to provide ecosystem services that **benefit global society**.

**We investigate the responses of polar ocean ecosystems to multiple impacts and stressors**

- Changing wind, weather & circulation patterns
- Capacity for carbon uptake & storage
- Loss of sea ice
- Nutrient and freshwater input
- Rising sea temperatures
- Ocean acidification
- Anthropogenic stressors including fishing, pollution, microplastics

Fe H<sub>2</sub>O Mg



**We study the influence of polar ocean ecosystems on global climate processes**

- Uptake and storage of carbon dioxide
- Influences on global ocean circulation
- Biogeochemical cycling and transport



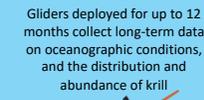
Seabirds and other land-based predators are tracked using satellite tags to identify important foraging areas



RRS Sir David Attenborough is a new state-of-the-art platform for studying polar oceans and ecosystems



Nets are used to sample zooplankton and fish



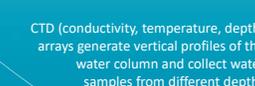
Gliders deployed for up to 12 months collect long-term data on oceanographic conditions, and the distribution and abundance of krill



Echosounders are used to study behaviour and estimate the biomass of pelagic fish and zooplankton



Instruments deployed on moorings collect oceanographic, acoustic and biogeochemical data all year round



CTD (conductivity, temperature, depth) arrays generate vertical profiles of the water column and collect water samples from different depths



Autonomous underwater vehicles (AUVs) can travel long distances on pre-programmed paths, to survey locations that are difficult or dangerous for humans to reach



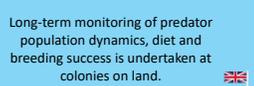
Computer analyses and modelling collates multiple data streams to analyse spatial and temporal patterns, and to project future trends.



Laboratory studies explore the status and health of ecosystem components, as well as interactions between them.



Satellite remote-sensing provides information on sea ice, productivity and sea surface temperature, and allows us to locate and monitor wildlife from space



Long-term monitoring of predator population dynamics, diet and breeding success is undertaken at colonies on land.

**Our multidisciplinary, whole ecosystem approach informs policy and decision-making, supporting adaptation and resilience to change:**

- Monitoring and long-term datasets to understand change
- Modelling and projections of future change
- Sustainable and precautionary fisheries management
- Marine Protected Area design

**Further reading**  
<https://www.bas.ac.uk/team/science-teams/ecosystems/#publications>  
<https://www.ccamlr.org/en/fisheries/fisheries>





## Next steps

- ❖ Southern Ocean ecosystem community strategy
- ❖ Engage physical scientists and other stakeholders
- ❖ Develop standardised protocols
- ❖ Make use of existing data
- ❖ Attract funding
- ❖ *Ensure all processes are inclusive*



# Thank you!



**British Antarctic Survey**  
NATURAL ENVIRONMENT RESEARCH COUNCIL



**PolarRES**  
Exploring future polar climates



**MEASO** | MARINE ECOSYSTEM ASSESSMENT FOR THE SOUTHERN OCEAN



**Additional slides...**





# ICED

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in the Southern Ocean

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**X:** @ICEDantarctic



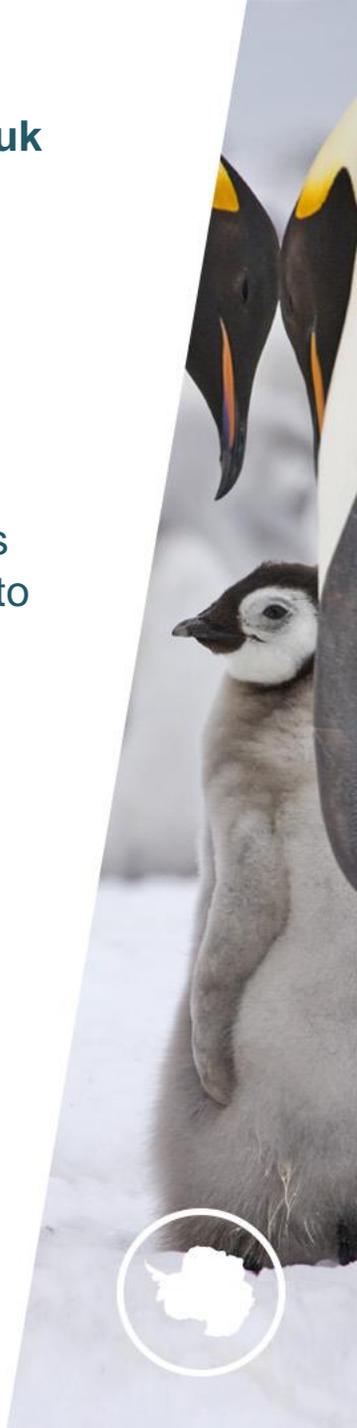
## Vision

- To understand interactions between climate and ecosystem dynamics and generate scenarios and projections of future ecosystem change to support sustainable governance

## Research Challenges

1. Understand and quantify the **state and variability** of Southern Ocean ecosystems
2. Improve **scenarios and projections** of future Southern Ocean ecosystems at multiple scales
3. Inform **conservation and sustainable management**

- *We promote and address these challenges by identifying and undertaking high-priority research, delivering workshops, conference sessions, and stakeholder-engagement activities*

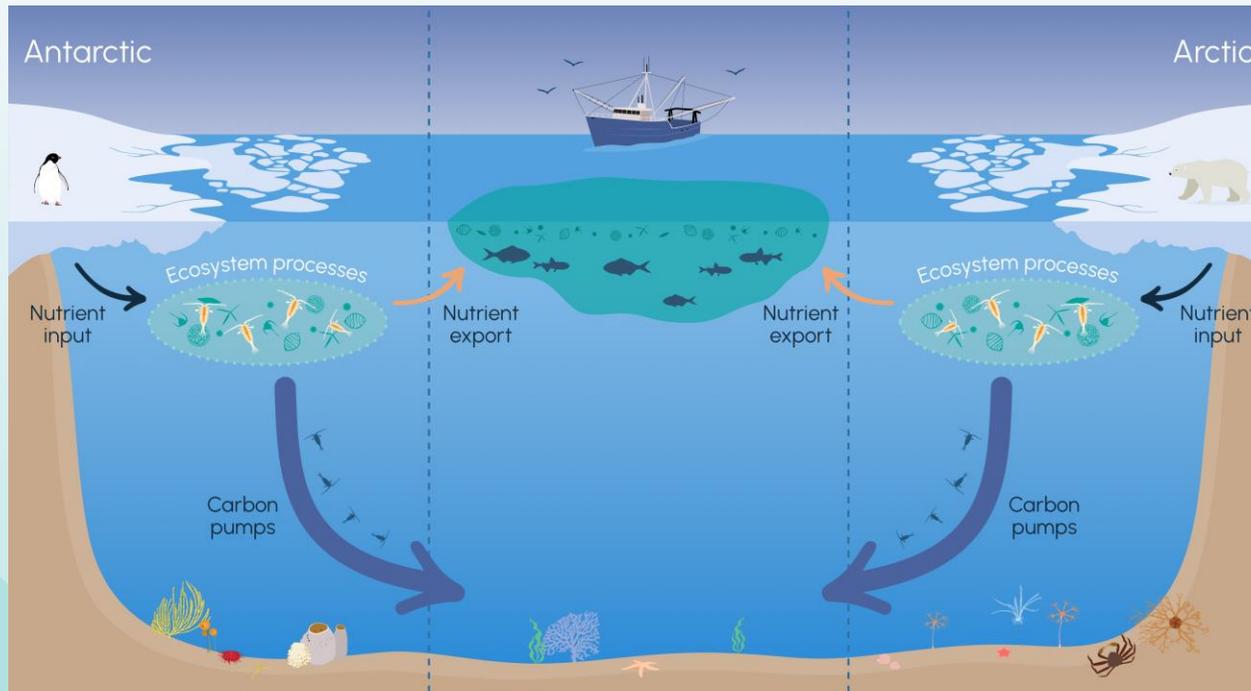




2021  
2030  
United Nations Decade  
of Ocean Science  
for Sustainable Development

## £8.5M NERC Long-term Multi-centre Programme (2022-7)

Goal: To address a fundamental aspect of the Earth System – how nutrients in polar waters drive global primary productivity, fisheries and the carbon cycle



BIOPOLE is answering three key questions

- Q1. What are the key inputs that contribute to nutrient balance in the polar oceans?
- Q2. How do polar marine ecosystems regulate this balance and sequester carbon?
- Q3. What are the global impacts?

