SCOR Annual Meeting 2025

29-31 October 2025

Santa Marta, Colombia

INVEMAR (Hybrid Format), Main Auditorium

Updates from Infrastructural Projects

Sam Dupont – co-chair

On behalf of COBS

Objectives:

"Promote new methods for assessing the effects of multiple environmental factors acting on organisms at the same time"

TOR:

1. Develop **open-access teaching and learning resources** for educators and researchers based on the Best Practice

2. Advocate **coordination and harmonisation of experimental approaches**

3. **Progress the science towards a more holistic approach** to address how multiple drivers will reshuffle marine ecosystems at a decadal scale. To do this, we will develop a strong **conceptual framework** around a subset of key questions. This will allow us to b**ridge disjoints between models, experiments and observations**.
4. Publish a series of **short articles** in both the scientific media and with scientific journalists to disseminate the challenges and opportunities surrounding multiple drivers and ecosystems.

5. **Link to societal questions**, such as food security, by expanding multiple driver research to include higher trophic levels.

Members 2024-2025:

Last Name	First Name	Gender	Location	Scientific expertise
Biswas	Haimanti	F	India	Phytoplankton ecophysiology
Boyd	Philip	M	Australia	Ecosystem modelling, phytoplankton ecophysiology, policy
Collins	Sinéad	F	UK	Experimental evolution, phytoplankton ecophysiology
Cornwall	Christopher	M	New Zealand	Kelp forests. Experimental design, outreach
Dupont	Sam	M	Sweden	Animal ecophysiology, plasticity, policy outreach
Dillingham	Peter	M	New Zealand	Statistics, experimental design
Dutkiewicz	Stephanie	F	USA	Large scale marine ecosystem and biogeochemical models
Hall-Spencer	Jason	M	UK	Natural analogues for future ocean, Asian coastal ecosystems
Hutchins	David	M	USA	Phytoplankton ecophysiology
Leung	Kenneth	M	Hong Kong	Marine pollution, ecotoxicology, environmental risk assessment, ecological restoration
McGraw	Christina	F	New Zealand	Sensors, inorganic chemistry
Renaud	Paul	M	Norway	Benthic ecology, Polar ecosystems
Seifert	Miriam	F	Germany	Biogeochemical modeling
Thomas	Mridul	M	Switzerland	Organism models
Vargas	Cristian	M	Chile	Multiple drivers (various taxa), South America network

Teams:

Team #1 - Identifying priorities for multiple driver / stressor research
[Renaud, Vargas].

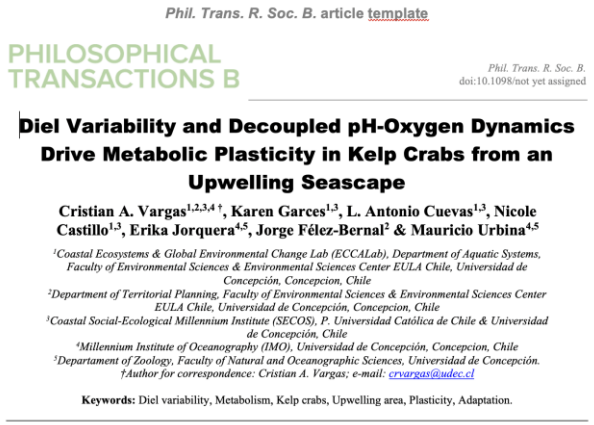
Team #2 - Promoting action on multiple driver / stressor research
[McGraw, Dupont , Collins, Cornwall, Thomas, Dillingham, Biwas, Comeau]

Team #3 & #4 - Model evaluation & From ocean observations to biological thresholds
[Dutkiewicz, Seifert, Gehlen, Thomas, Thomas, Boyd, Collins]

Team #5 – Mechanistic understanding
[Hutchins, Hall Spencer, Leung]

Team #1 - Identifying priorities for multiple driver / stressor research

- ✓ Two manuscripts (1 accepted, 1 in progress)



Phil. Trans. R. Soc. B. article template

PHILOSOPHICAL TRANSACTIONS B

Phil. Trans. R. Soc. B.
doi:10.1098/not yet assigned

Diel Variability and Decoupled pH-Oxygen Dynamics Drive Metabolic Plasticity in Kelp Crabs from an Upwelling Seascape

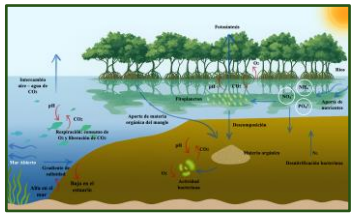
Cristian A. Vargas[1,2,3,4†], Karen Garces[1,3], L. Antonio Cuevas[1,3], Nicole Castillo[1,3], Erika Jorquera[4,5], Jorge Félez-Bernal[2] & Mauricio Urbina[4,5]

[1]*Coastal Ecosystems & Global Environmental Change Lab (ECCALab), Department of Aquatic Systems, Faculty of Environmental Sciences & Environmental Sciences Center EULA Chile, Universidad de Concepción, Concepcion, Chile*
[2]*Department of Territorial Planning, Faculty of Environmental Sciences & Environmental Sciences Center EULA Chile, Universidad de Concepción, Concepcion, Chile*
[3]*Coastal Social-Ecological Millennium Institute (SECOS), P. Universidad Católica de Chile & Universidad de Concepción, Chile*
[4]*Millennium Institute of Oceanography (IMO), Universidad de Concepción, Concepcion, Chile*
[5]*Departament of Zoology, Faculty of Natural and Oceanographic Sciences, Universidad de Concepción.*
†Author for correspondence: Cristian A. Vargas; e-mail: crvargas@udec.cl

Keywords: Diel variability, Metabolism, Kelp crabs, Upwelling area, Plasticity, Adaptation.

Key role of natural variability in multiple stressors research

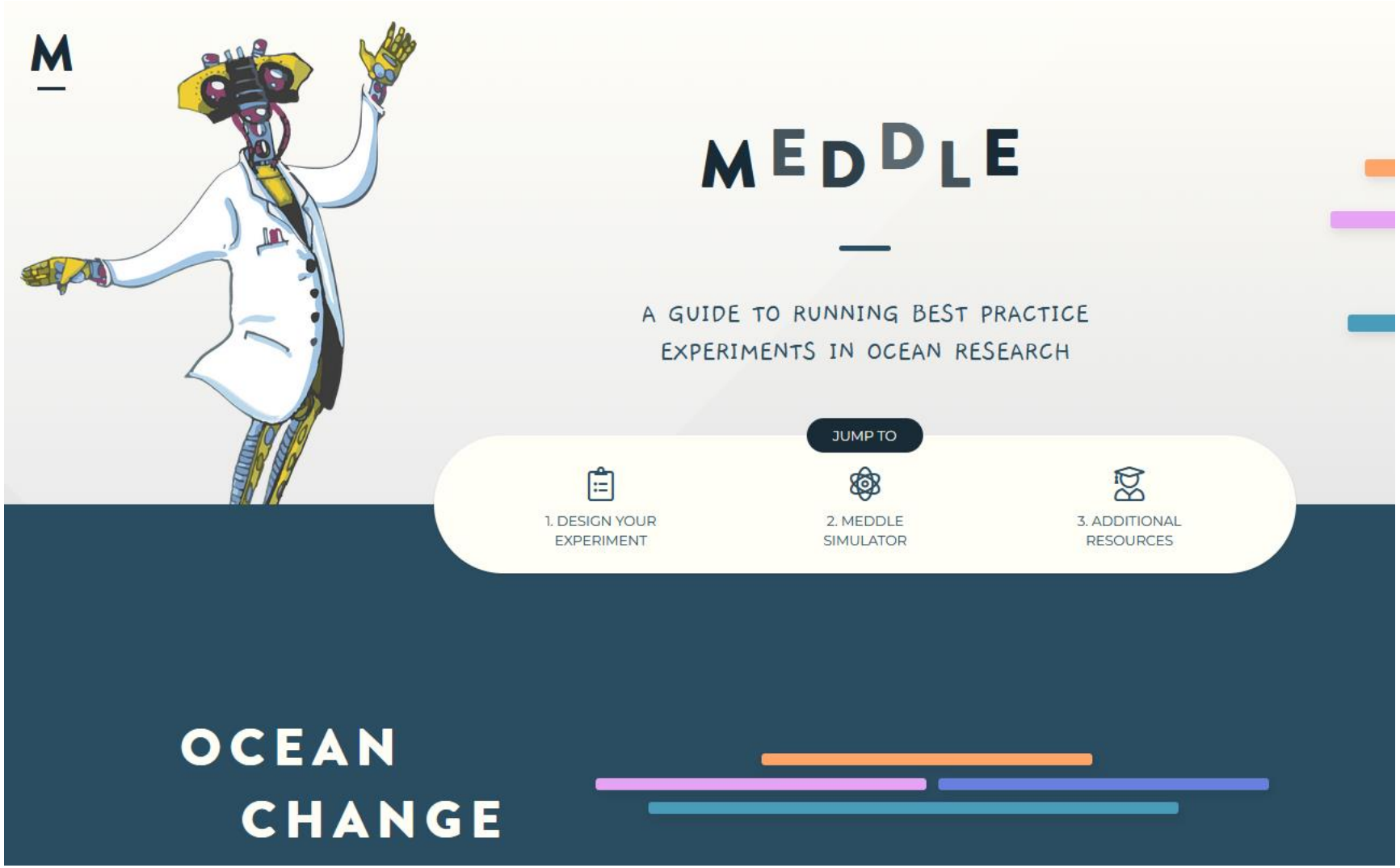
Nature's laboratories: leveraging natural analogues and field experiments to understand multiple stressors impacts on marine life



Tools to study multiple stressors using natural analogs

Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops



Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops

- 7 events in 5 countries + 1 virtual (Africa)
- >130 participants

Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops
- ✓ New resources for MEDDLE - Vignettes

Data Analysis Guides

The MEDDLE data analysis guides illustrate statistical approaches for single and multiple driver experiments. These guides are not meant as an exhaustive list, nor do they replace formal statistical training. However, they provide insight into some of the things we do and the way we think about design, along with helpful R code.

1. Power calculation (some background in statistics is needed)
2. Scenario-based experiment with data file (some background in statistics)
3. Experiments with blocking with data file (intermediate)
4. Time-response variables (advanced)
5. Single-driver response curves with data file 1 and data file 2 (advanced)
6. Response surfaces with data file 1 and data file 2 (stats hero)
7. Model-averaging for experiments with a data file, extended description (pdf), and R files for classical analysis, functions for model averaging, model-averaged analysis, and extended model-averaged analysis (advanced)

These guides are hosted by the New Zealand Ocean Acidification Community (NZOAC), so the links will download the html guide and data files (where needed) from the NZOAC website.

Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops
- ✓ New resources for MEDDLE - Vignettes

Introduction

Question: How do temperature and nutrients jointly affect the growth of our imaginary species *Phytoplanktica draculae*?

What we know

What we want to know statistically

Experimental design

Data

Reading in and visualising the data

Statistical model

Fitting the models

Case 1

Case 2

Temperature

Nutrients

Case 3

What do we learn from each of these analyses? Comparing the three cases.

What can we do with these fitted models?

What else could we do with this data and model fit?

Acknowledgements

Packages used and version info

Fitting a response surface to data from multiple-driver experiments

Mridul K. Thomas, Sinéad Collins

2025-09-29

Introduction

Question: How do temperature and nutrients jointly affect the growth of our imaginary species *Phytoplanktica draculae*?

The ocean is warming. We want to know how warming and changes in nutrient levels will affect this species' range and population growth. And we want to generally understand how phytoplankton communities are likely to respond to environmental changes.

How to analyse data like this depends strongly on mathematical knowledge about how drivers interact. So we will analyse the data assuming different amounts of existing knowledge. We will not comprehensively compare the different situations and address the limitations of each approach.

- **Case 1**: We know *nothing*. We will analyse this non-parametrically using a Generalised Additive Model (GAM).
- **Case 2**: We know mathematically how temperature and nutrients act individually but we do not know how they interact - this type of situation is very common! We have mathematical functions (equations) that can describe the single-driver responses separately and may have a qualitative idea of how the drivers interact, perhaps based on physiological knowledge. But we usually don't have a function that describes the interaction. We will analyse this parametrically by estimating the parameters of the single-driver functions, and seeing how they change with the other driver.
- **Case 3**: We *do* know how temperature and nutrients interact mathematically, but we don't know the parameter values. This is similar to the case of fitting the individual curves above: there is an existing function and we are parameterising it for this specific organism and set of drivers. Having an equation allows us to learn more from the data.

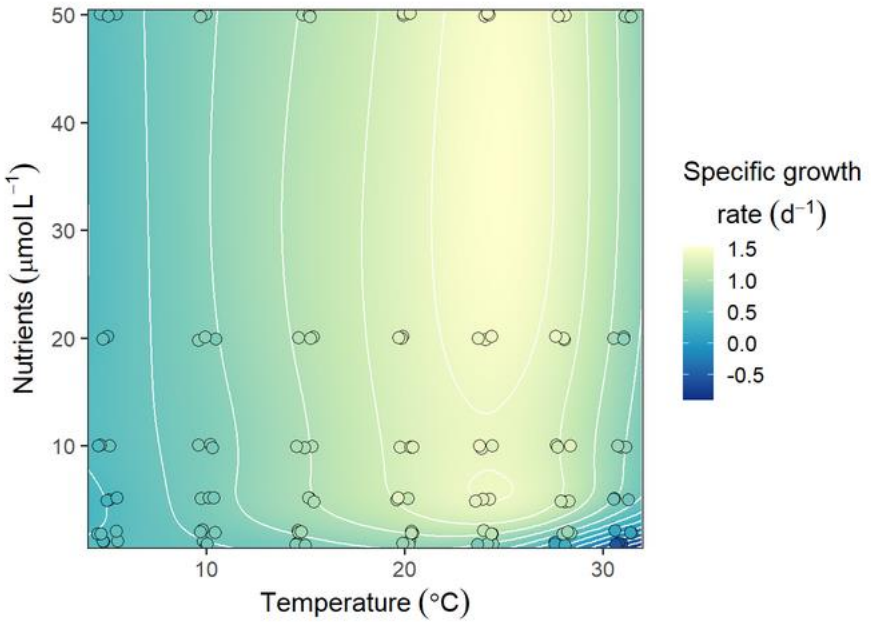
What we know

- We know that this is a subtropical species, so we already have *some* idea about the temperatures where it can grow well or poorly. NOTE: We almost always have some information like this that we use to design experiments!
- We know that temperature and nutrients interact strongly.
- We know that the growth of phytoplankton (and all ectotherms!) follows a standard shape: it increases slowly with temperature till an optimum, and then it decreases rapidly i.e. it is a left-skewed unimodal function. This is described with many equations. This is a convenient one we will use because it is relatively easy to modify it to include nutrients as well (thereby creating an equation describing how temperature & nutrients jointly affect growth).

$$\mu(T) = (b_{\max} + d_0) \cdot \left(\frac{e^{b_2(T - T\text{opt})}}{1 - b_2/d_2} - \frac{e^{d_2(T - T\text{opt})}}{d_2/b_2 - 1} \right) - d_0$$

where

```
# Plot the fitted response surface and overlay with the data points to evaluate fit
ggplot() +
  geom_tile(data = newdat, aes(x = temperature, y = nutrients, fill = growth_rate_predicted)) +
  geom_contour(data = newdat, aes(x = temperature, y = nutrients, z = growth_rate_predicted), colour = "white") +
  geom_jitter(data = dat,aes(x = temperature, y = nutrients, fill = specific_growth_rate),
              pch = 21, size = 3, height = 0.2, width = 0.5) +
  scale_fill_distiller(palette = "YlGnBu") +
  scale_x_continuous(limits = c(min(newdat$temperature),
                                max(newdat$temperature))) +
  scale_y_continuous(limits = c(min(newdat$nutrients),
                                max(newdat$nutrients))) +
  labs(fill = expression(atop("Specific growth", rate~(d^-1)))) +
  coord_cartesian(expand = FALSE)  +
  xlab(expression(Temperature~(degree*C))) +
  ylab(expression(Nutrients~(mu*mol~L^-1)))
```



Here the background colour indicates the growth rate predicted by the fitted GAM. The point colour indicates the measured growth rates; we have 'jittered' the points a bit so that the replicates do not sit exactly on top of each other.

Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops
- ✓ New resources for MEDDLE - Vignettes

Dillingham PW, Collins S, Comeau S, Cornwall CE, Dupont S, McGraw CM, Thomas MK (under revision) The MEDDLE data analysis guides as a living resource for multiple-driver marine research. *Limnology and Oceanography Bulletin*.

Team #2 - Promoting action on multiple driver / stressor research

- ✓ Implementation of MEDDLE trainings and workshops
- ✓ New resources for MEDDLE – Vignettes
- ✓ Best Practices for heat waves studies (led by ECR) – Literature review in progress

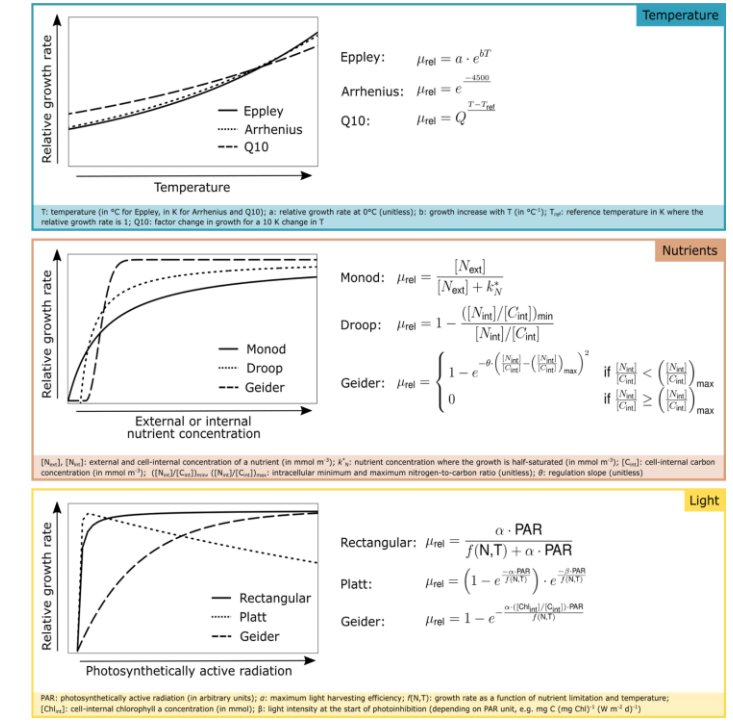
How do we carry out marine heatwave experiments?

François Thoral, Denisa Berbece, Holly Koch, **Ashtyn Isaak,** Laura Bornemann, Imogen Bunting, Peter Dillingham, Katie Fenton, Shinae Montie, Alexandra Northmore, Ohad Peleg, Halyna Romashko, Imke Book, Heidi Burdett, Steeve Comeau, Michael Fox, Maggie Johnson, Lulu Martinez, Nick Kamenos, Erik Krieger, Bayden Russell, Verena Schoepf, **Ben Harvey**

Team #3 & #4 - Model evaluation & From ocean observations to biological thresholds

✓ 6 manuscripts in progress bridging models and observations

- Phytoplankton growth parametrizations in ocean biogeochemistry models: structure, assumptions, and gaps (level of completion: 60%) [Dutkiewicz, Seifert, Thomas]
- How TxL and TxN interactions work in models vs. Data (level of completion: 40%)[Seifert, Thomas]
- How interactions arise from underlying resource allocation (alternative to Geider) (level of completion: 80%) [Thomas]
- Lab temperature curves predict habitat preferences inferred by species distribution models (Level of completion: 80%) [Thomas]
- How salinity affects phytoplankton growth across environments and functional groups (Level of completion: 50%) [Thomas]
- Bayesian optimal experimental design for response curve experiments (Level of completion: 40%) [Thomas]



Team #5 – Mechanistic understanding

✓ New projects

- Using **AI** to gill gaps acoss incomplete libraries of MS experiments and inform future experimental designs (e.g. LLM training) [Boyd]
- Explore the methods used in **ecotoxicology** (see Annex 3) that can be applied to global change stressors & comparison of work culture, etc. Include pollutant in the stressors considered [Leung].
- **Meta-analysis** in progress on the link between questions, methods and terminology [Dupont]

Annual Meeting – Hong Kong 2025:

- ✓ *Back to back with BECoME (all members gave talks)*
- ✓ *MEDDLE and Vignette training (2 days)*
- ✓ *Annual meeting*
  - *Update from the different themes*
  - *Revision of the themes for the next phase of COBS*
  - *Vote for new co-chair and members*
  - *Post-COBS*

Updates of themes:

Team #1 - Bridging methodologies
Stronger connection with ecotoxicology
Methods for the implementation of distributed experiments (e.g. heatwaves)

Team #2 - Methods for ecological impacts of MS
New tools and best practices to work at the ecological level

Team #3 - Training and resources
New vignettes
Simplified methodologies for developing countries

Team #4 – Linking models and experiments
Continuation of the work (6 manuscripts)

Rotations:

- ✓ *4 members rotating off*
- ✓ *Sinead steps down as co-chair*

Last Name	First Name	Gender	Location	Scientific expertise
Biswas	Haimanti	F	India	Phytoplankton ecophysiology
Boyd	Philip	M	Australia	Ecosystem modelling, phytoplankton ecophysiology, policy
Collins	Sinéad	F	UK	Experimental evolution, phytoplankton ecophysiology
Cornwall	Christopher	M	New Zealand	Kelp forests. Experimental design, outreach
Dupont	Sam	M	Sweden	Animal ecophysiology, plasticity, policy outreach
Dillingham	Peter	M	New Zealand	Statistics, experimental design
Dutkiewicz	Stephanie	F	USA	Large scale marine ecosystem and biogeochemical models
Hall-Spencer	Jason	M	UK	Natural analogues for future ocean, ~~Asian coastal ecosystems~~
Hutchins	David	M	USA	Phytoplankton ecophysiology
~~Leung~~	~~Kenneth~~	~~M~~	~~Hong Kong~~	~~Marine pollution, ecotoxicology, environmental risk assessment, ecological restoration~~
McGraw	Christina	F	New Zealand	Sensors, inorganic chemistry
Renaud	Paul	M	Norway	Benthic ecology, Polar ecosystems
~~Seifert~~	~~Miriam~~	~~F~~	~~Germany~~	~~Biogeochemical modeling~~
Thomas	Mridul	M	Switzerland	Organism models
~~Vargas~~	~~Cristian~~	~~M~~	~~Chile~~	~~Multiple drivers (various taxa), South America network~~

New co-chair:

Chris Cornwall – New Zealand

THEME: Solutions from multiple knowledge systems

Subtheme: #5 **Multi-stressors effects on marine organisms**

3 New Members

Damboia Cosa - Mozambique

Noelle Held - USA

Steeve Comeau - France

International Science Council

SCOR

Scientific Committee on Oceanic Research

SCOR Annual Meeting 2025

29-31 October 2025

Santa Marta, Colombia

INVEMAR (Hybrid Format), Main Auditorium

Thanks for your support !!!