Challenges of developing a consistent view of future climate projections in the global coastal ocean

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Motivation

Coastal communities and the blue economy require information about emerging and potential climate change to plan and adapt.

Climate impacts can be loosely grouped as relating to:

- Ecosystem services (e.g. food provision and biodiversity)
- Coastal hazards (e.g. flooding, erosion and salt intrusion)

There is a gap in what global climate models can reliably provide due to scale and process representation – they are not designed for this!

Regional downscaling aims to close this gap.

Despite many successful applications the current approach is highly fragmented. Better coordination would:

- Allow global studies to inform process understanding and risk assessment
- Improve understanding of uncertainty
- Build capacity in under-represented areas through partnerships with more established groups
- Better link to global and regional stakeholders to enable co-design
- Better link to other communities, such as observationalists

Models

Model choices are always a tough compromise:

Resolution/Coverage v's Complexity v's Simulation length/Ensemble size

Global Climate Models: Often the only choice

- How well do these perform in the coastal-ocean?

Regional forced: The main-stay of coastal-ocean modelling

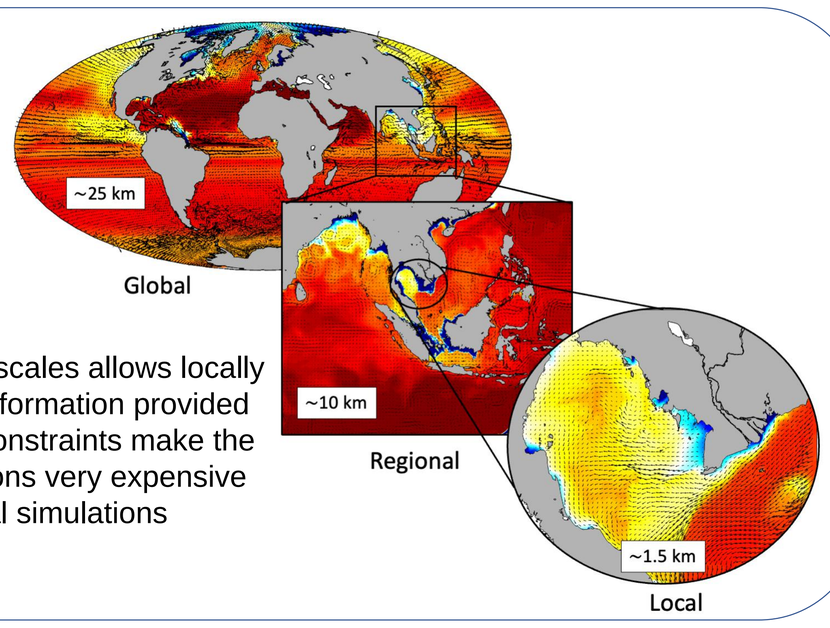
- De-couples the effort and choices of the coastal-ocean from the global - a substantial practical advantage

Global forced: Can alleviate climate model biases and improve resolution and process representation at the expense of ocean-atmosphere dynamical consistency

Regional coupled: An attractive option in many cases, but expensive to configure and run

Near coastal models, often at sub-km scales, can add important extra detail and new process representation

A cascade of scales



Stepping through scales allows locally relevant climate information provided

- But modelling constraints make the highest resolutions very expensive for multi-decadal simulations

Experiment design

Understanding uncertainty is key:

- Emissions Scenario v's Driving Model v's Downscaled Model v's Natural Variability

Shorter time horizons are more policy relevant, e.g. 2050 v's 2100

- Harder to disentangle natural viability.

Climate models often have tough biases

- Bias correction is needed - there are many ways to do this

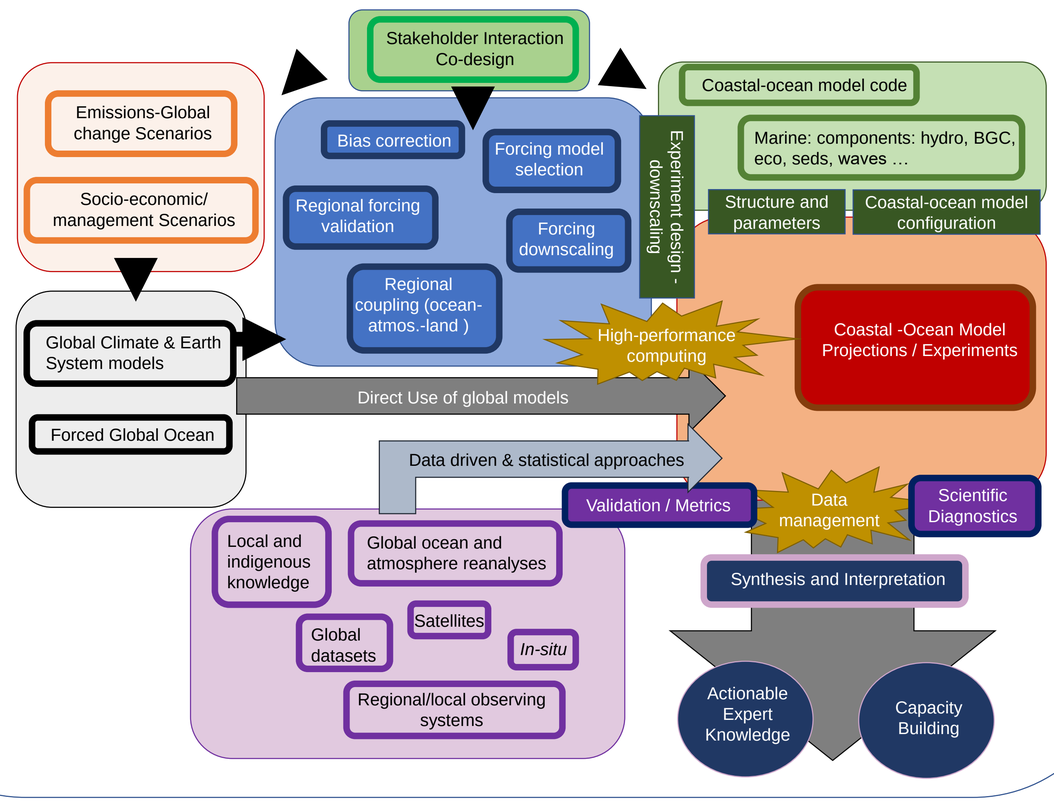
Observations are key to building confidence in future projections

- Within the research community
- Among regional stakeholders

Target applications and stakeholder needs should drive experiments

- Balance specificity v's generality

The FLAME Value Chain



Regions

The regional nature of coastal-ocean modelling is a key challenge to cross-comparison of downscaling studies
Regional classification allows:

- The selection of a set of exemplar regions
- The transfer of knowledge and capability across regions

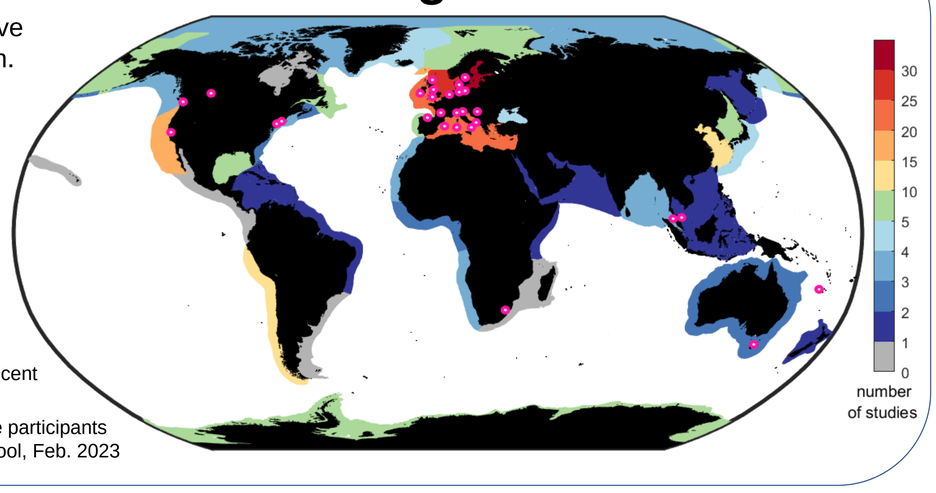
These classifications can be based on:

- Geography and coastal-ocean process (e.g. arctic, tropical, tidal active, upwelling, etc)
- Societal drivers (e.g. vulnerable to flooding, reliant on fisheries, developing blue economy, etc)
- Existing capacity and gaps

Distribution of downscaling studies

Downscaling studies have highly patchy distribution. Building a global picture that draws fully on local knowledge requires:

- International partnerships
- Capacity building
- Knowledge sharing



This map is based on the list of studies given by Drenkard et al 2020 and Holt et al 2023, and recent updates.

Circles show the institutes of the participants in the **FLAME** workshop, Liverpool, Feb. 2023

Options for a Global-Coastal Ocean MIP

Currently there is a diversity of

Models

- This is important (as no models are correct)

Regions

- These can be harmonised, but resources and interest will often determine where groups work

Experiments

- Easiest to coordinate
- Need to make this as inclusive as possible

Ways forward

- An active and engaged coast-ocean climate impacts community of practice in **FLAME**
  - Expanding the community, particularly to encompass under represented areas
  - Exploring ways of working together across the globe
- Common model experiments and protocols, applicable to all coastal-ocean regions
  - Including ways to capture and share model configurations and experiments
- Consider applying for formal WMO recognition as a MIP
  - But without excessive capacity requirement to participate
- Coordinated approaches to stakeholder engagement

References

Drenkard et al 2021 doi:10.1093/icesjms/fsab100

Holt et al 2023 doi:10.1029/2022GL100448

About FLAME: https://projects.noc.ac.uk/flame/

About **CoastPredict:** https://www.coastpredict.org/