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# Predicting the distribution of framework-forming cold-water corals

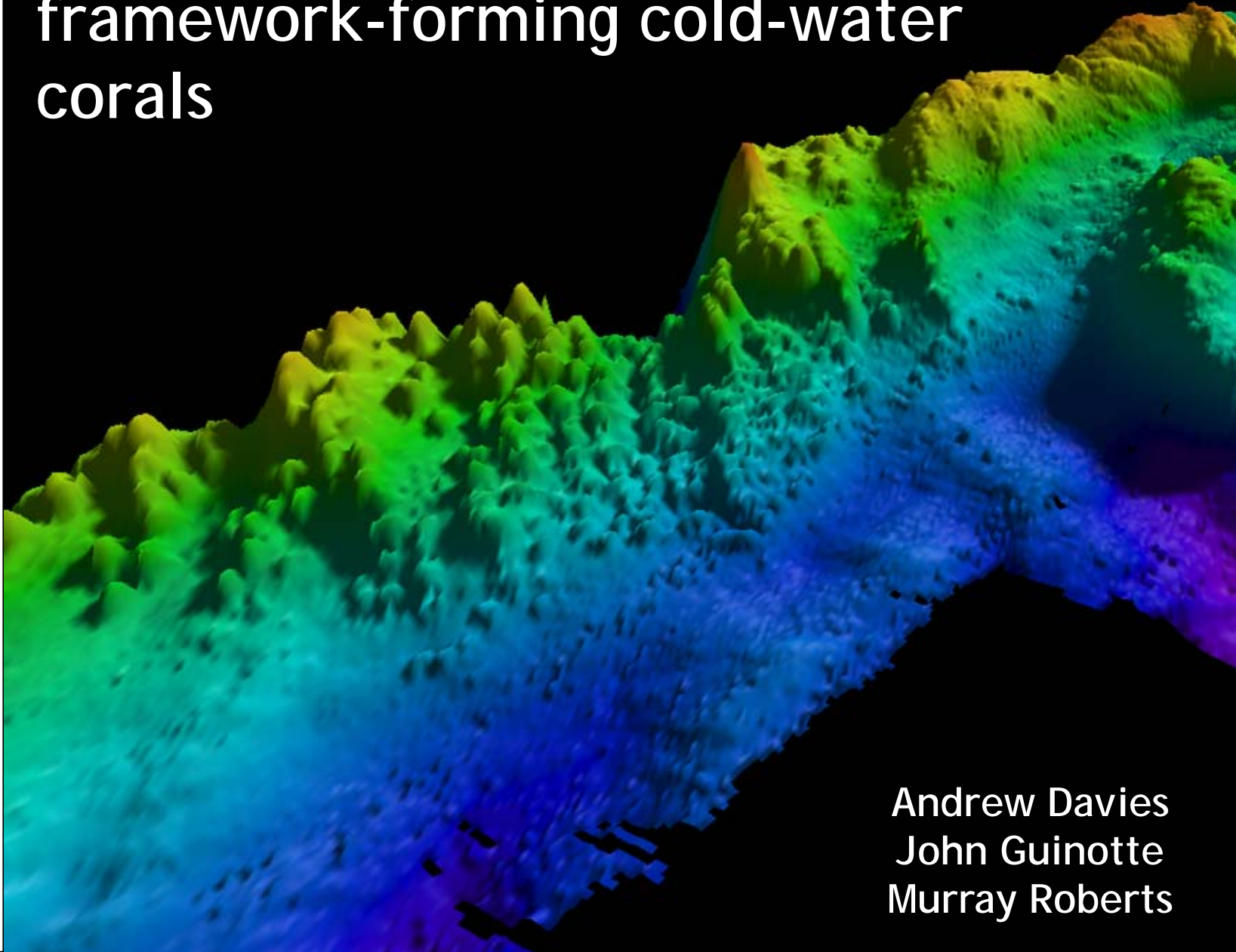


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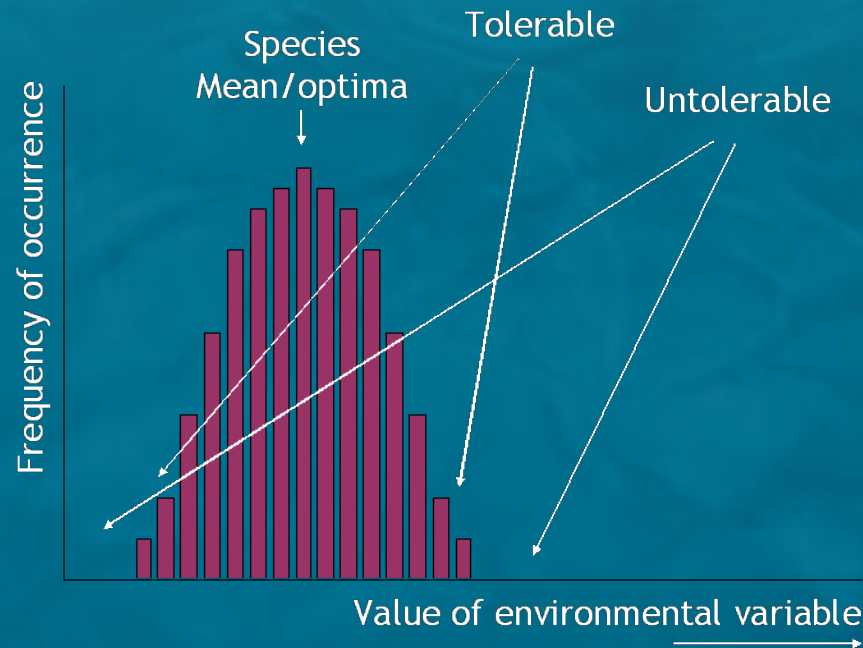


Andrew Davies  
John Guinotte  
Murray Roberts



# How can we find where a species is?

- Niche
  - The range of environmental conditions (biological and physical) under which an organism can exist.
- Tolerance
  - The ability of organisms to exist at the fringes of its niche.





Data

Presences

Environmental data

95%

Processing

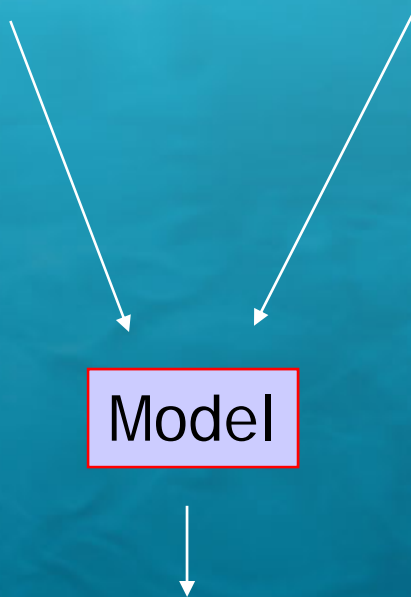
Model

2%

Output

Idealised niche  
=  
Possible distribution

3%





The reef forming  
coral *Lophelia  
pertusa*

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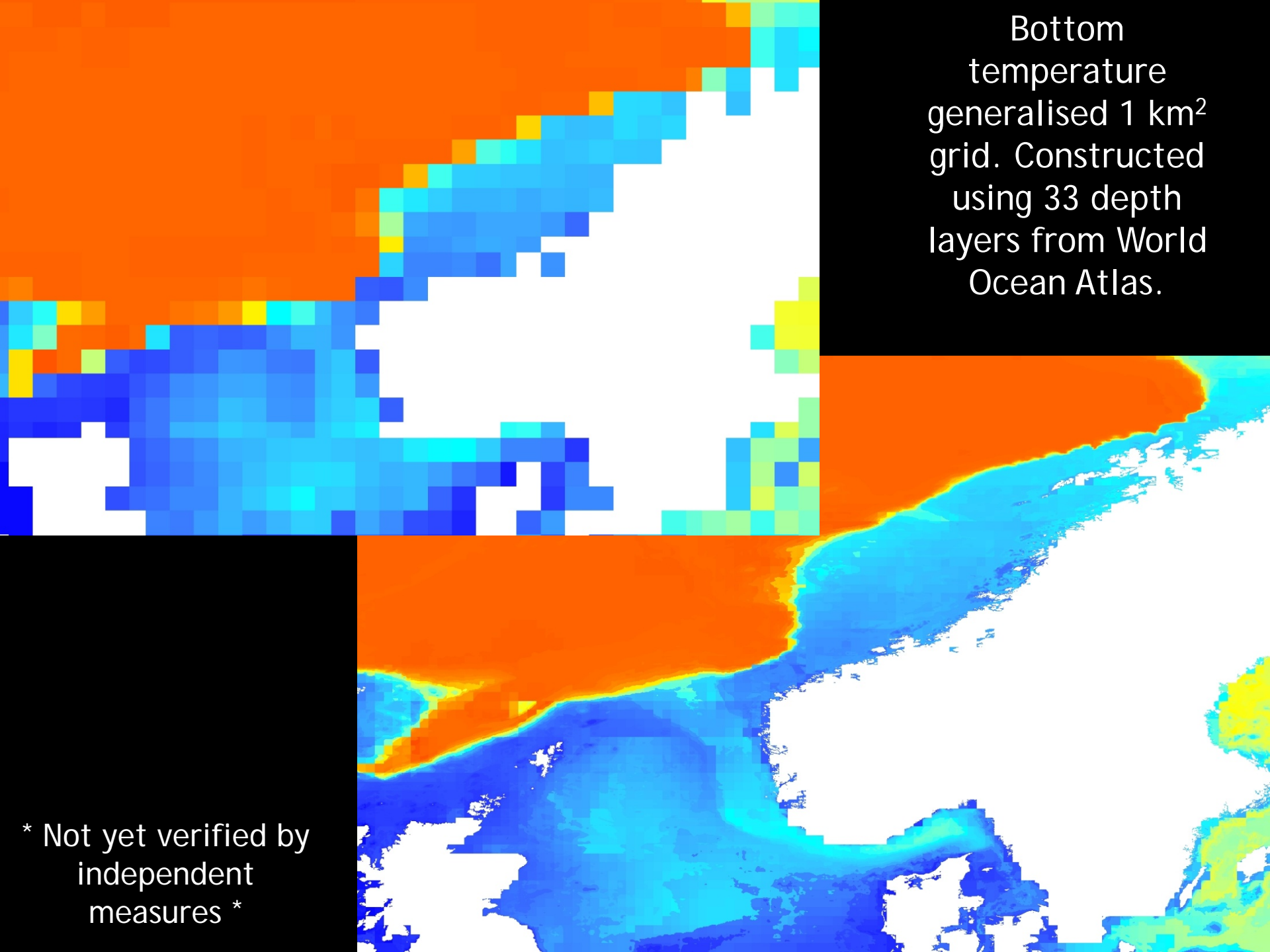


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# 2008, on our First attempt, We encountered limitations...

- Low resolution of environmental data.
- Incomplete geographical distribution of environmental data.
- Paucity of presences.
- Lack of absences reduces the available modelling techniques.
- How can we address these?

Bottom  
temperature  
generalised 1 km<sup>2</sup>  
grid. Constructed  
using 33 depth  
layers from World  
Ocean Atlas.



\* Not yet verified by  
independent  
measures \*



# New models

- Uses Maxent model (Phillips et al. 2006).
- 26 global variables created at 1km cell size.
  - Geophysical: slope, BTM, rugosity etc.
  - Chemical: carbonate chemistry, nutrients, salinity etc.
  - Biotic: food supply.
  - Physical: currents, temperature etc.

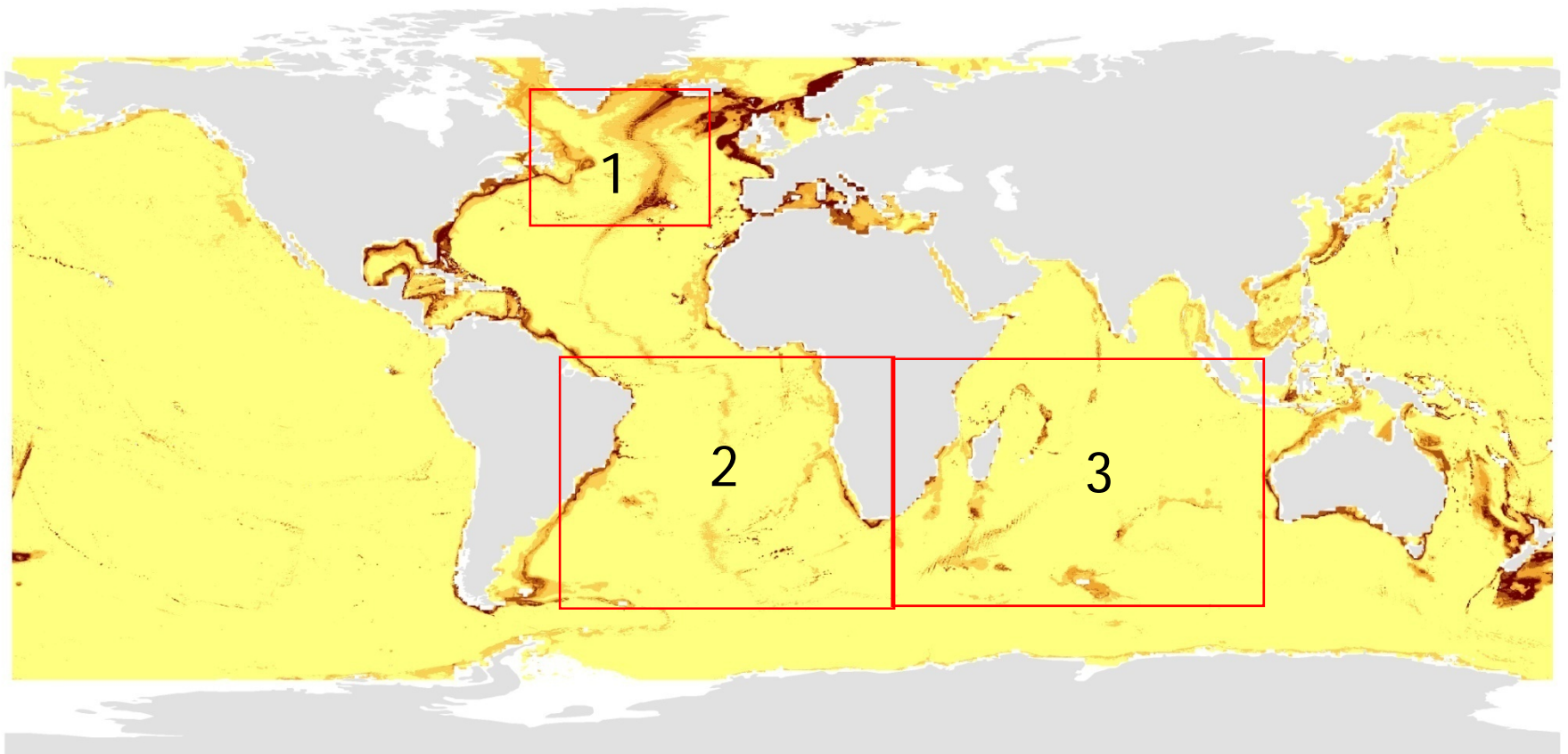
	Variable	Unit	Name	Cell size (x,y)	Depth Range (levels)	Reference
	Geophysical variables	-				
1	Depth	m	DEPTH	0.0083°	Ocean depth (1 level)	Becker et al. (in press)
2	Slope	m m <sup>-1</sup>	SLOPE	0.25°, 0.2°	Ocean depth (1 level)	Becker & Sandwell (2008)
3	Rugosity	-	RUGOS	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>1</sup>
4	Aspect eastings	-	ASPE	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>2</sup>
5	Aspect northings	-	ASPN	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>2</sup>
6	Bathymetric position index	-	BTM1	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>1</sup> 1 – 5 <sup>1</sup>
7	Bathymetric position index	-	BTM2	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>1</sup> 2 - 10 <sup>1</sup>
8	Slope 2	°	SLOPE2	0.0083°	Ocean depth (1 level)	Derived from Becker et al. (in press) <sup>1</sup>
	Hydrographic variables					
9	Regional current flow	cm s <sup>-1</sup>	REGFL	0.5°	5-5374m (40 levels)	Carton et al. (2005) <sup>3</sup>
10	Vertical flow	m/s	VERTFL	0.5°	5-5374m (40 levels)	Carton et al. (2005) <sup>3</sup>
	Chemical variables					
11	Alkalinity	µmol cm <sup>-3</sup>	ALK	3.6°, 0.8-1.8°	6-4775 m (25 levels)	Steinacher et al. (2008) <sup>4</sup>
12	Apparent oxygen utilisation	ml l <sup>-1</sup>	AOXU	1°	0-5500 m (33 levels)	Garcia et al. (2006a)
13	Aragonite	Ω <sub>arag</sub>	ARAG	3.6°, 0.8-1.8°	6-4775 m (25 levels)	Steinacher et al. (2008) <sup>4</sup>
14	Calcite	Ω <sub>calc</sub>	CALC	3.6°, 0.8-1.8°	6-4775 m (25 levels)	Steinacher et al. (2008) <sup>4</sup>
	Carbonate ion			3.6° 0.8-		



# New models

- These models presented here focus on Scleractinia, and includes mostly *L. pertusa*, *M. oculata*, *D. dianthus*, *S. variabilis*, *G. dumosa* and includes approximately 270 other species of Scleractinia (most we only have few records).
- In total, we modelled the niche using 4140 records split into 75% training and 25% test data sets.
- Have data for Octocorals, Antipatharians etc, but am not showing it here, please ask me if you are interested.

# Scleractinia (global)



Habitat suitability

0 - 20 %

20 - 40 %

40 - 60 %

60 - 80 %

80 - 100 %



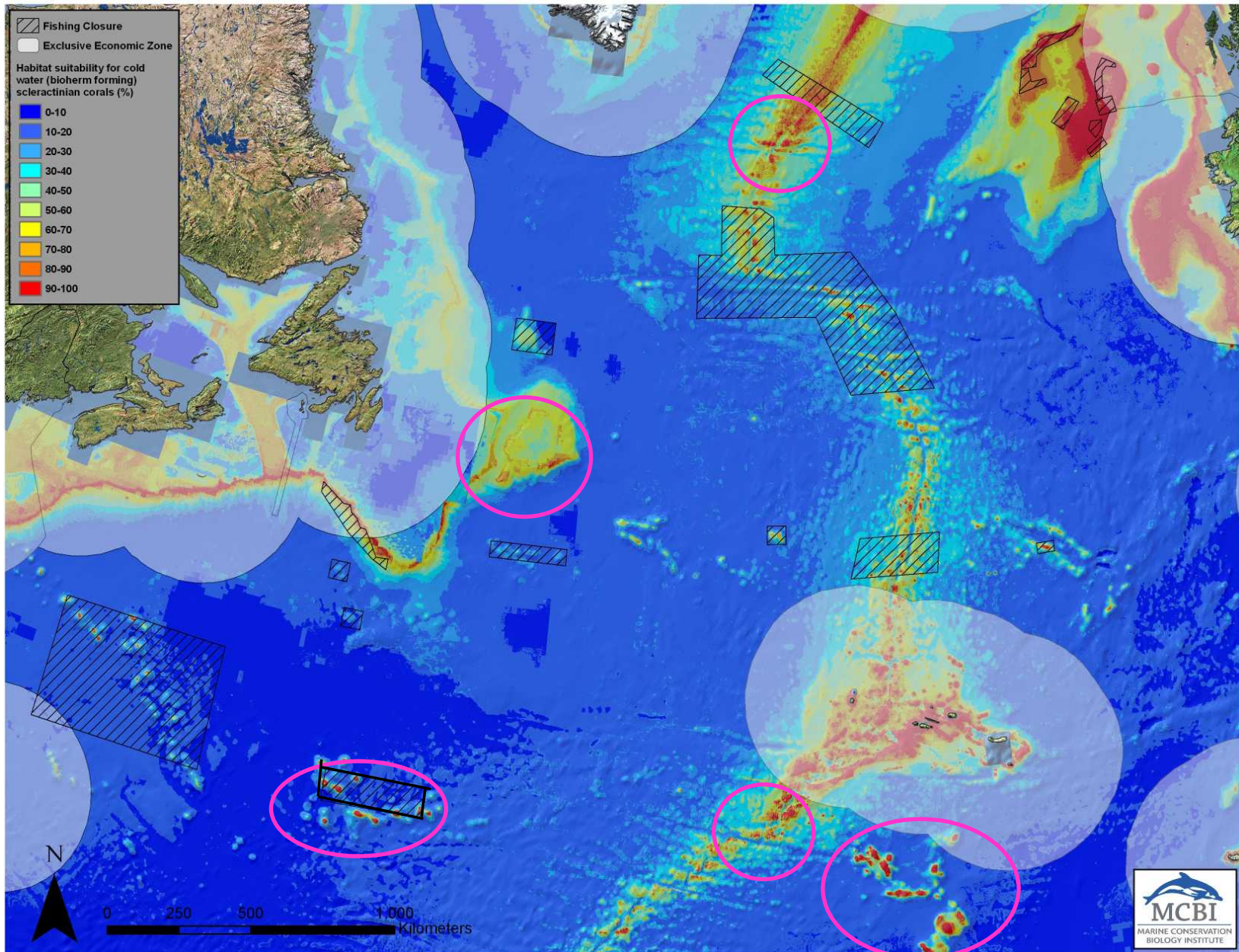
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# N Atlantic Closures





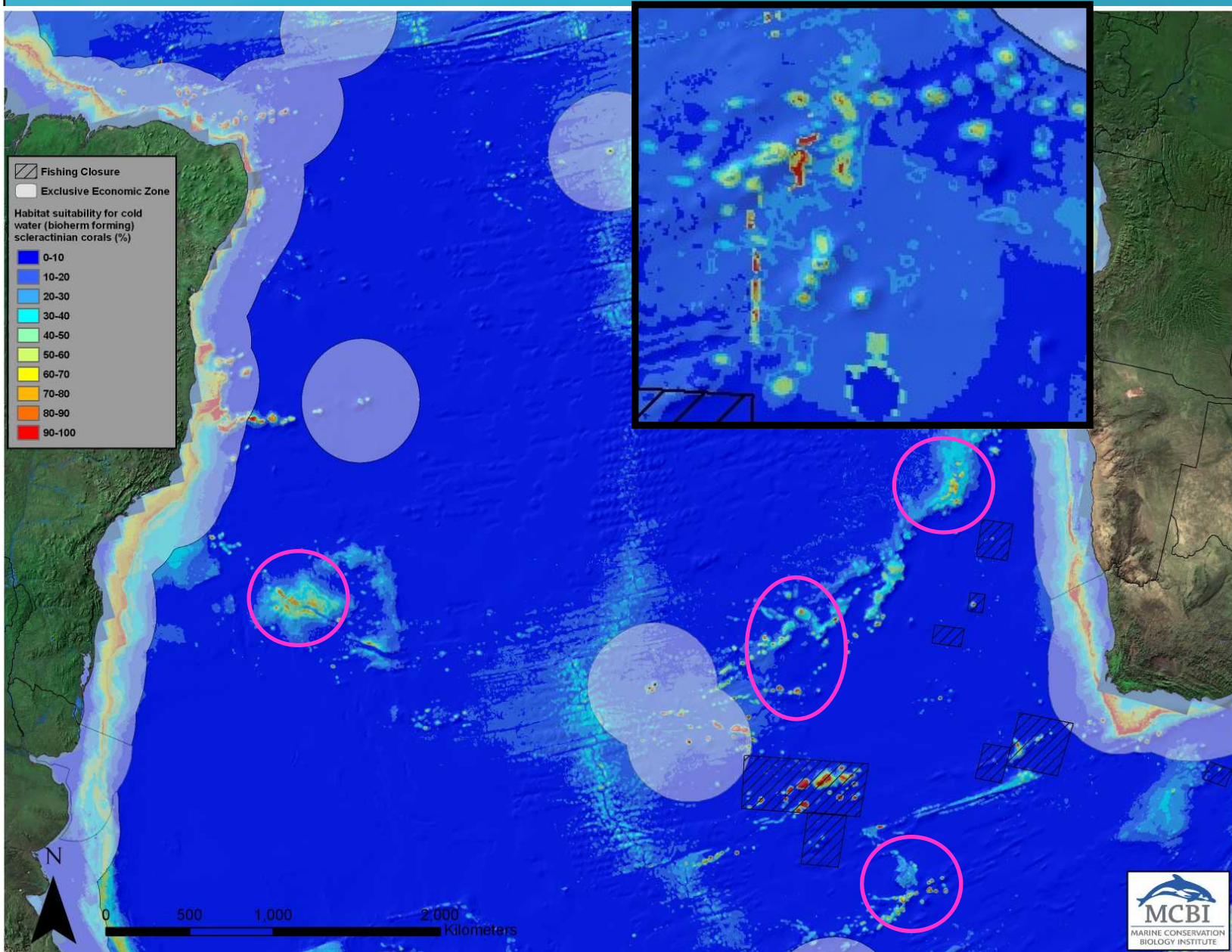
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# S Atlantic Closures





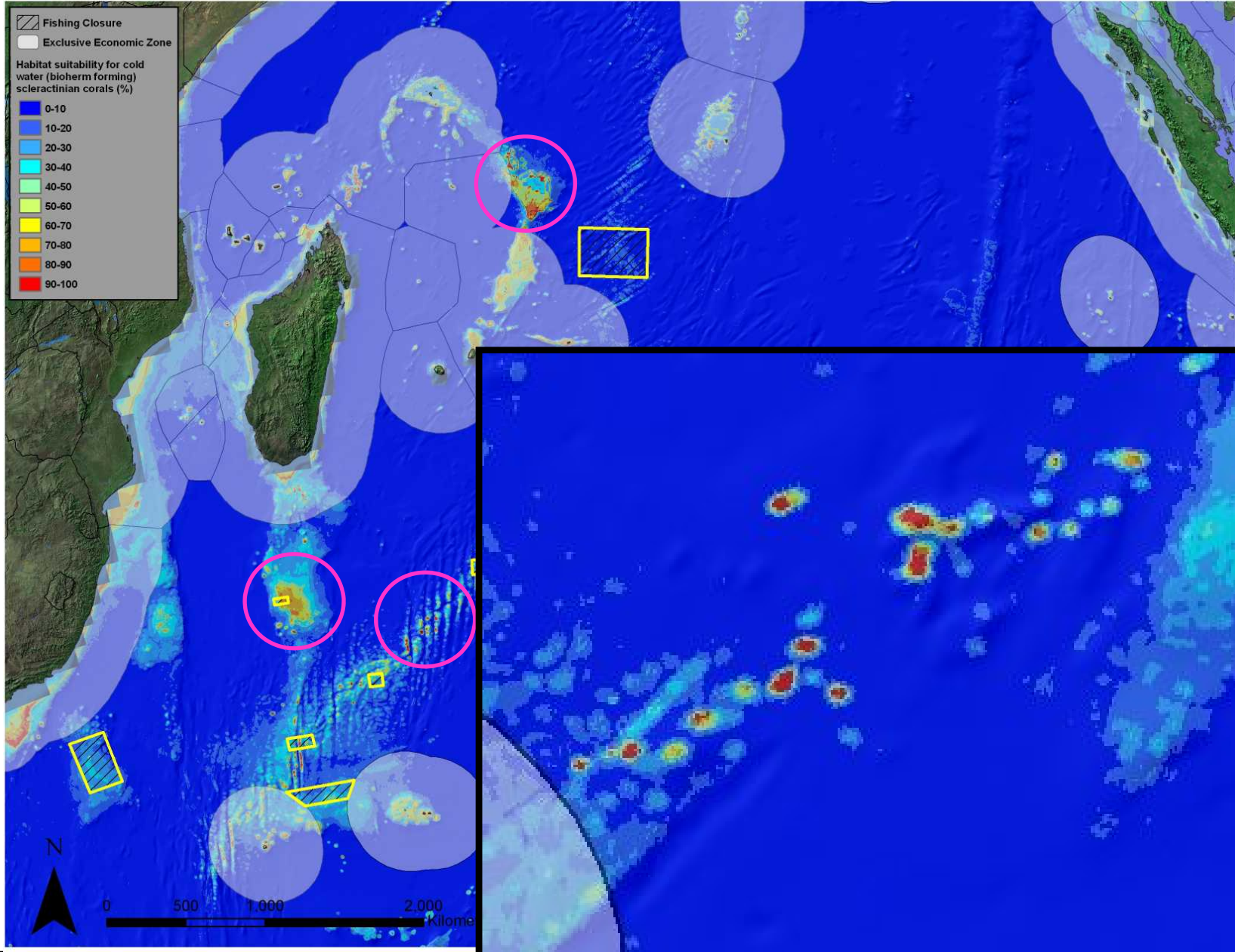
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# S Indian Ocean Vol. Closures





# What are the major drivers?

- Combination:
  - Carbonate chemistry.
  - Temperature.
  - Salinity.
  - Nutrients.
  - Dissolved O<sub>2</sub>.
  - Topography.
  - Food supply.
- Must not forget that modelling can only provide an indicator of niche, our data does not resolve temporal variability, competitive exclusion/competition. We still need experiments and observations.

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# Future outlook

- Local and regional scale modelling.
- Improvements to earlier *L. pertusa* models.
- Use our dataset for other coral species.
- Further modelling for other deep-sea species.
- Necessary to form new collaborations to gain access to more species presences and new environmental data.
- We're happy to collaborate with anyone who is interested in using this data for any means.



# Thanks for your attention

- Any further questions please contact me via email: [andrew.j.davies@bangor.ac.uk](mailto:andrew.j.davies@bangor.ac.uk)
- Key papers:
  - Bryan TL, Metaxas A (2007) Predicting suitable habitat for deep-water coral in the families Paragorgiidae and Primnoidae on the Atlantic and Pacific continental margins of North America. Marine Ecology - Progress Series.
  - Davies et al (2008) Predicting suitable habitat for *Lophelia pertusa*. Deep-sea Research Vol 1.
  - Leverette TL, Metaxas A (2005) Predicting habitat for two species of deep-water coral on the Canadian Atlantic continental shelf and slope. In: Cold-water Corals and Ecosystems.
  - Phillips et al (2006) Maximum entropy modeling of species geographic distributions. Ecological Modelling.
  - Tittensor et al (2009) Predicting global habitat suitability for stony corals on seamounts. Journal of Biogeography.



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