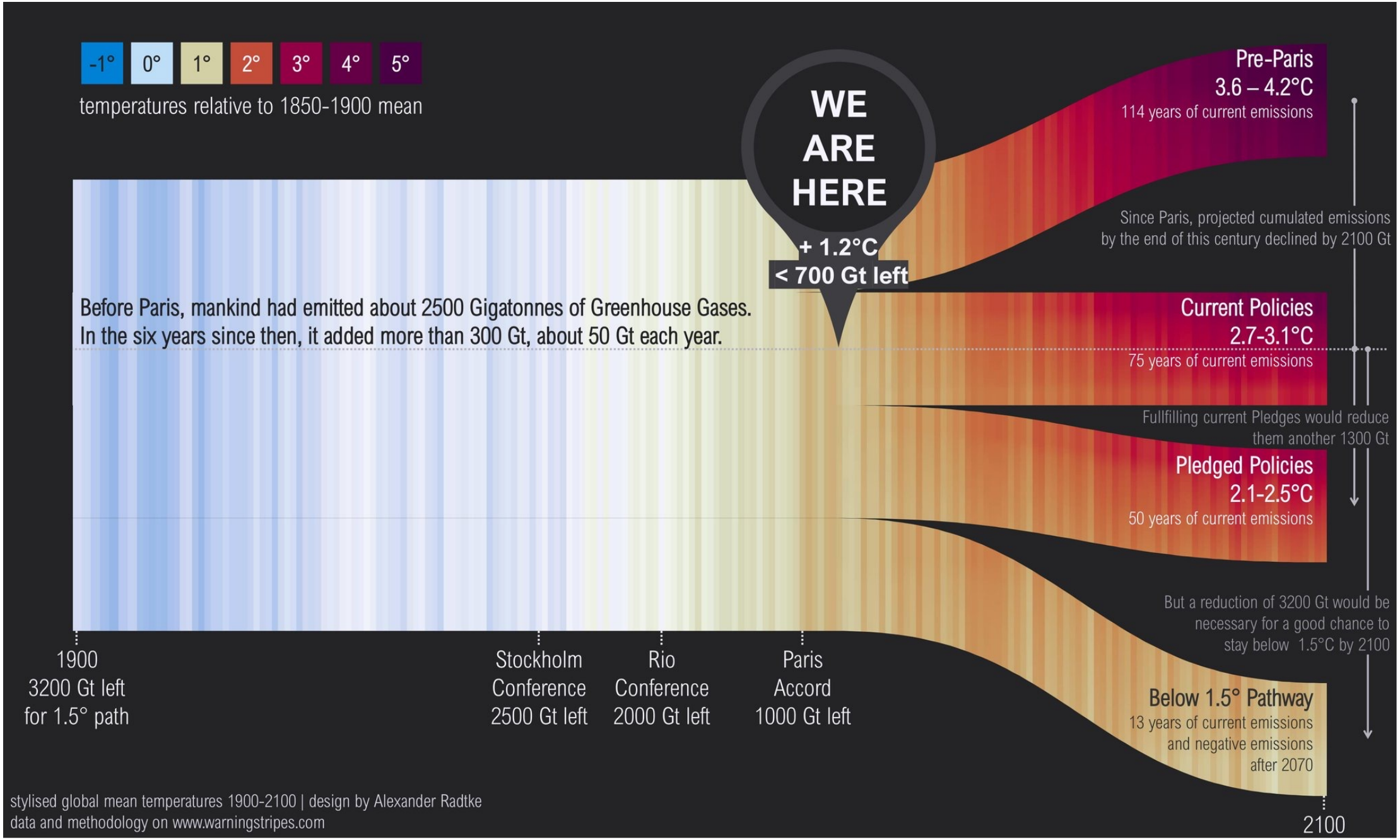
FOO 2021
Climate, Marine Heatwaves, and Temperature

Marine industries, climate extremes and adaptation, and ocean data and modelling needs across time scales

Alistair Hobday

Research Director, Coasts and Ocean Program

CSIRO Oceans and Atmosphere


-1°
0°
1°
2°
3°
4°
5°
temperatures relative to 1850-1900 mean
WE ARE HERE
+ 1.2°C
< 700 Gt left
Before Paris, mankind had emitted about 2500 Gigatonnes of Greenhouse Gases.
In the six years since then, it added more than 300 Gt, about 50 Gt each year.
Pre-Paris
3.6 – 4.2°C
114 years of current emissions
Since Paris, projected cumulated emissions by the end of this century declined by 2100 Gt
Current Policies
2.7-3.1°C
75 years of current emissions
Fullfilling current Pledges would reduce them another 1300 Gt
Pledged Policies
2.1-2.5°C
50 years of current emissions
But a reduction of 3200 Gt would be necessary for a good chance to stay below 1.5°C by 2100
Below 1.5° Pathway
13 years of current emissions and negative emissions after 2070
1900
3200 Gt left for 1.5° path
Stockholm Conference
2500 Gt left
Rio Conference
2000 Gt left
Paris Accord
1000 Gt left
2100
stylised global mean temperatures 1900-2100 | design by Alexander Radtke
data and methodology on www.warningstripes.com

@alxrdk

Five priority areas for the critical decade

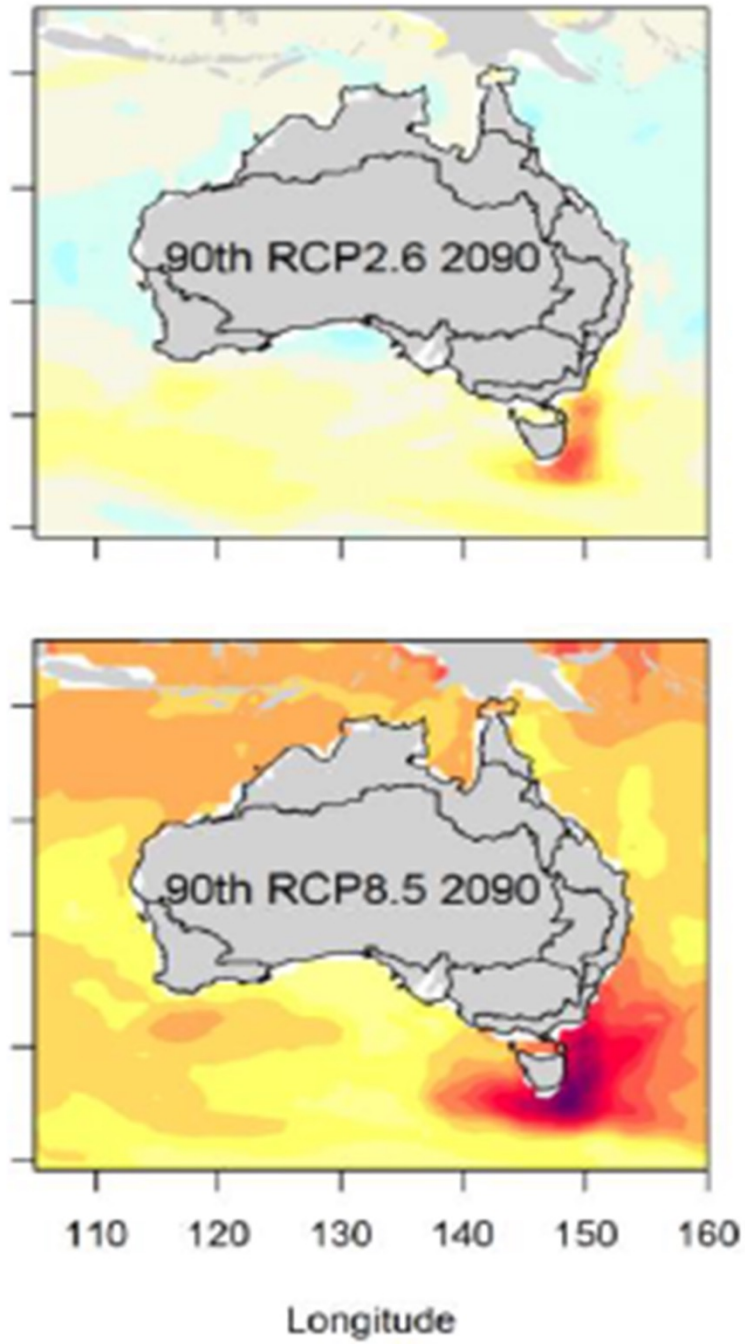
- Past experience less useful
  - Novel combinations of physics, chemistry, and biology
- Need to make decisions that are generally ok even if the details change, based on the best information available at the time
- Learn as fast as we can!

1. Incorporate climate change into assessment and management
2. Help industry and management manage environmental risk (short-term & long-term) – adaptation options and **forecasts**
3. Test adaptation options - models
4. Use new technologies to improve data collection efficiency (and reduce costs, esp. for data limited fisheries)
5. Provide information faster!

Seafood futures

- Environmental challenges
  - Climate change (e.g. warming)
  - Extreme events (e.g. marine heatwaves)
  - Range changes (e.g. new species)
  - Disease (e.g. new pathogens)

- Socio-economic challenges
  - Recreational and commercial
  - Markets – domestic and international
  - Community - Values and Certification
  - Competition from other industries
    - Renewables, oil and gas



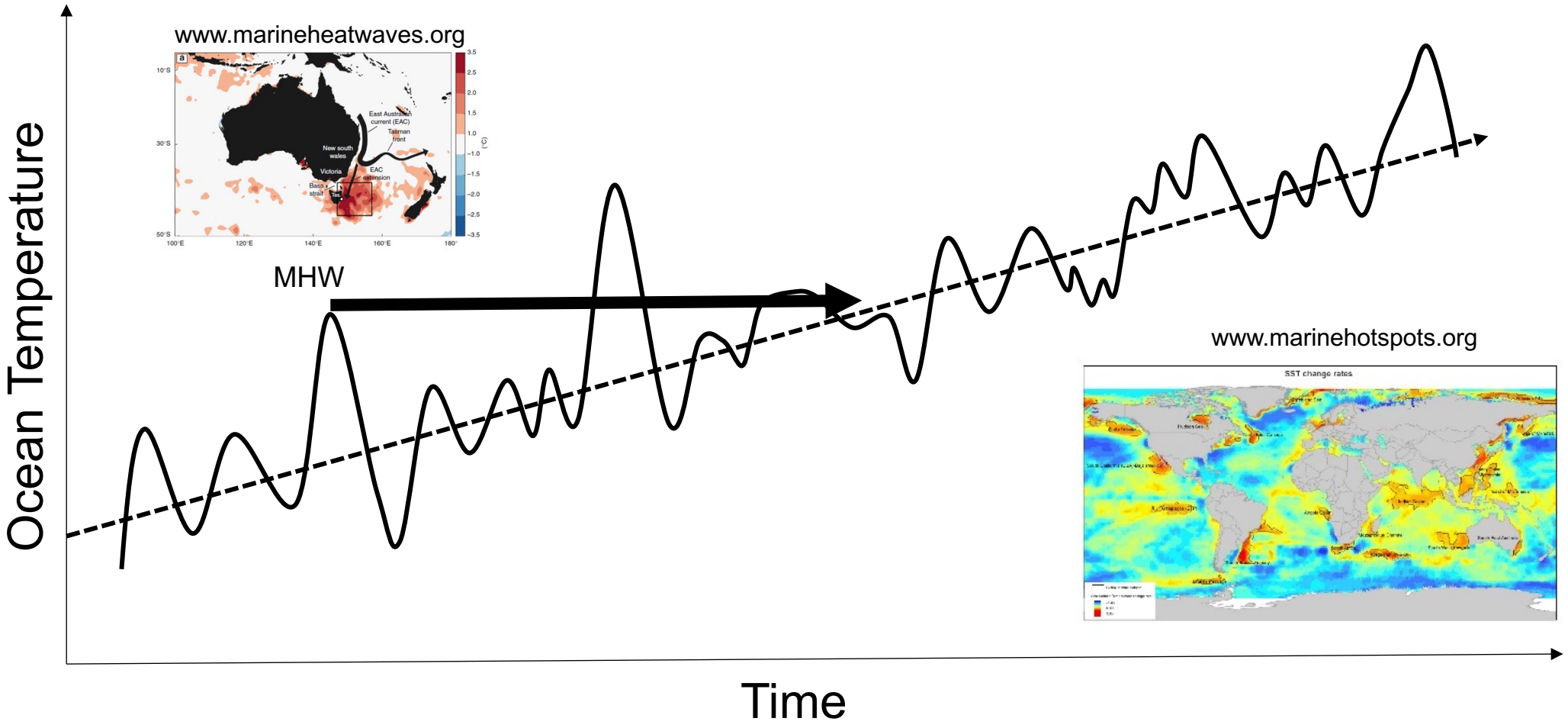
What do fisheries* need to know about the future?

*fishers and managers and policy makers

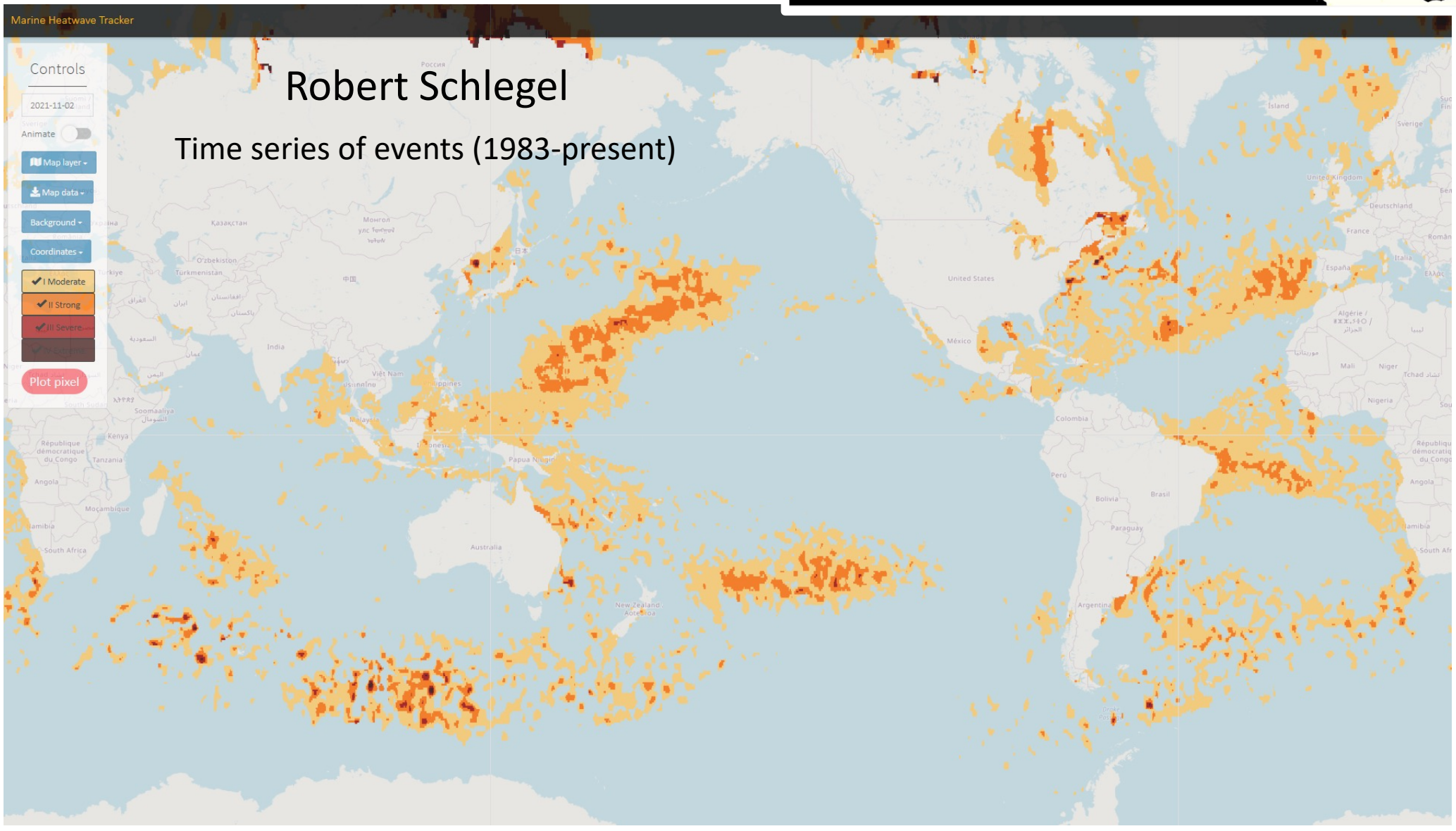
1. How many fish?
2. Where are the fish?
3. When will they migrate?
4. What are the prey/predators doing?
5. Plus other stuff

Physical change: Trend and variability (extremes)

Extreme events – a window to the future



MHW tracker (www.marineheatwaves.org/tracker)

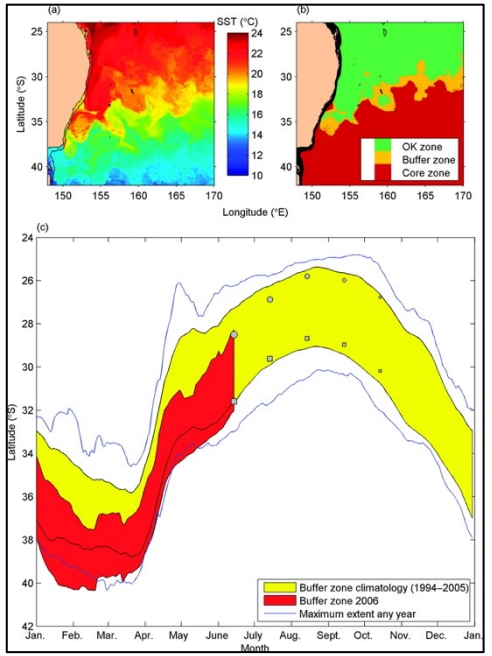


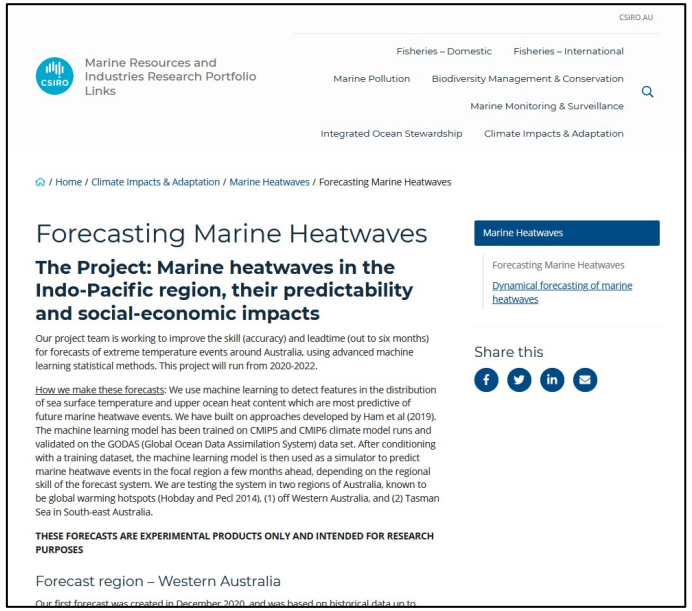
Forecasting the future

- Nowcasts
- Short-term (up to 1 year)
- Decadal (next 1-20 years)
- Long-term (to 2100)

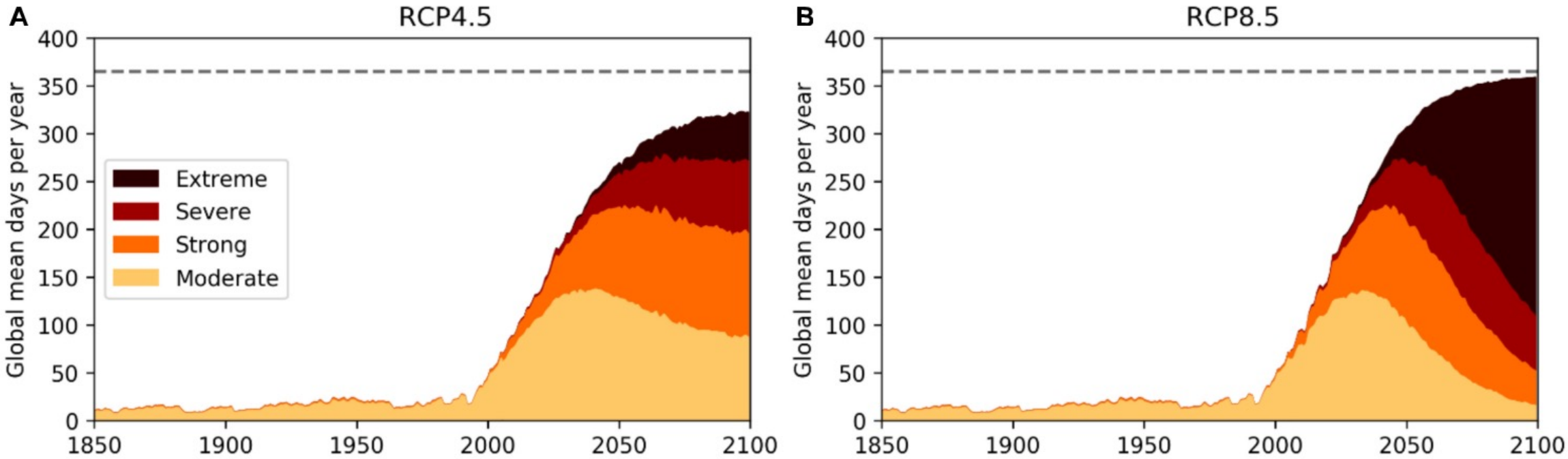
- Dynamical models (ACCESS)
- Statistical models (Machine)

- Physics
- Biology (distribution, abundance)



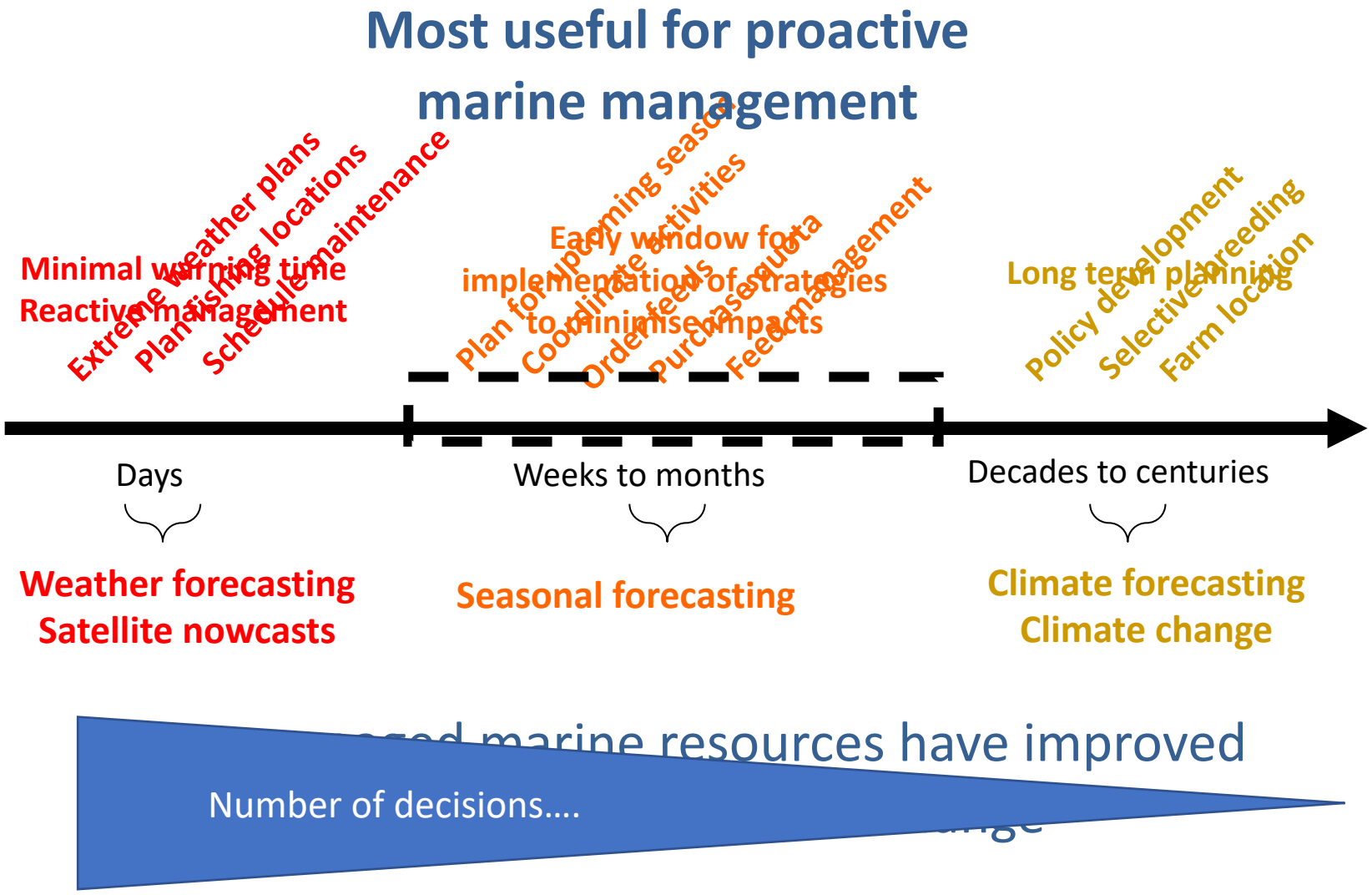


Long-term Projections – MHWs to 2100



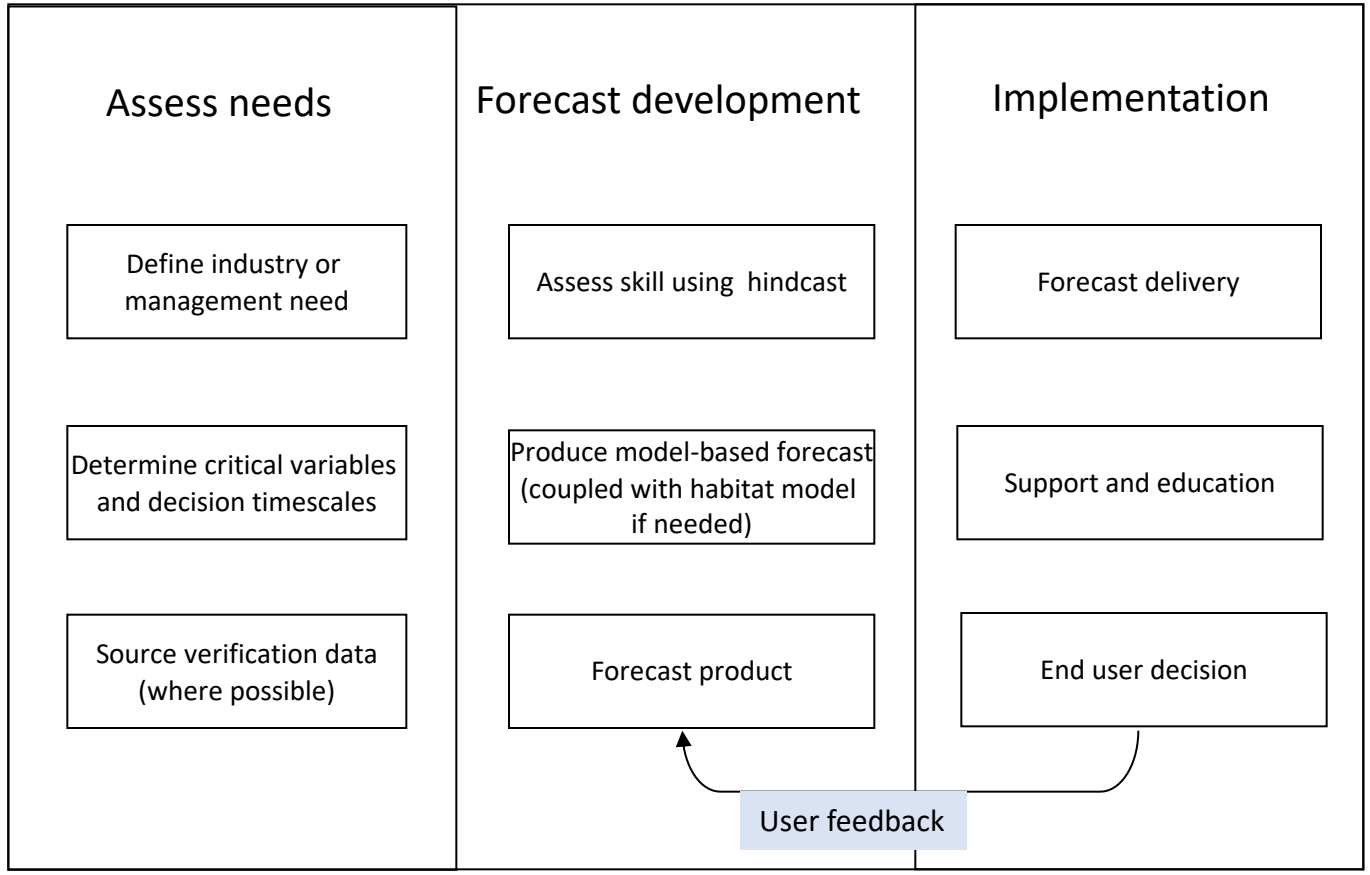
Oliver et al . 2019

Forecasts and decision timescales for fisheries & aquaculture



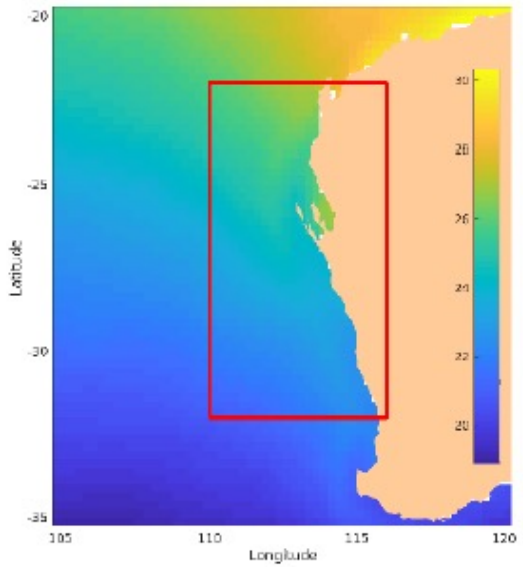
Hobday et al, 2016

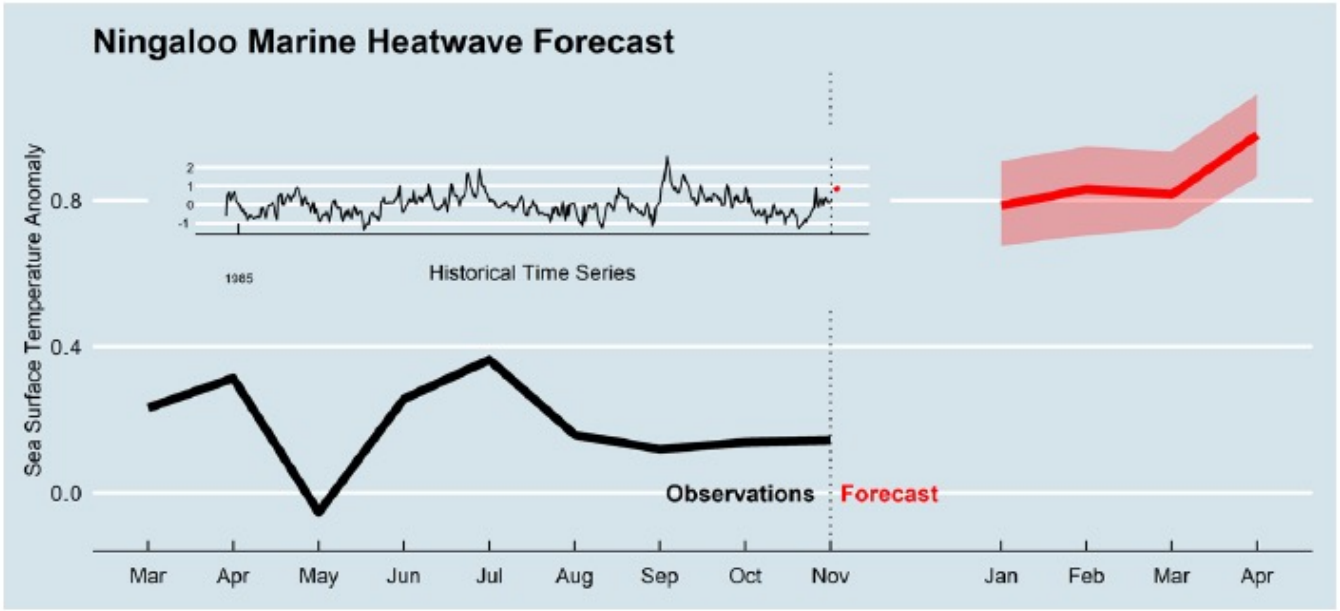
Developing a forecast – partnerships needed

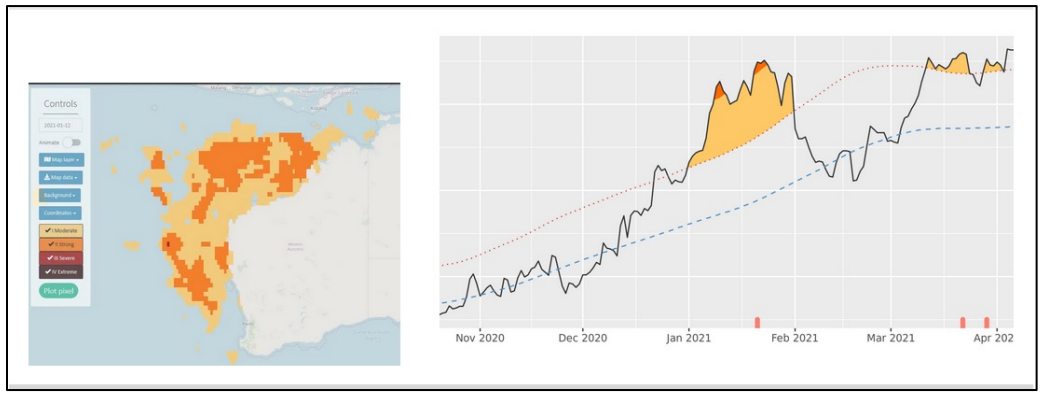


Hobday et al 2016

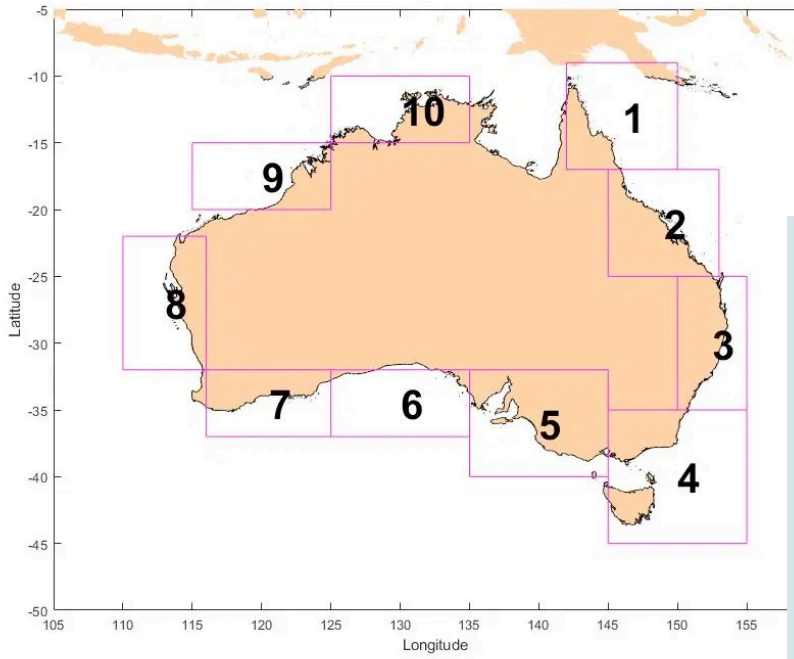
Seasonal Forecasts - Predicting WA 2021 MHW

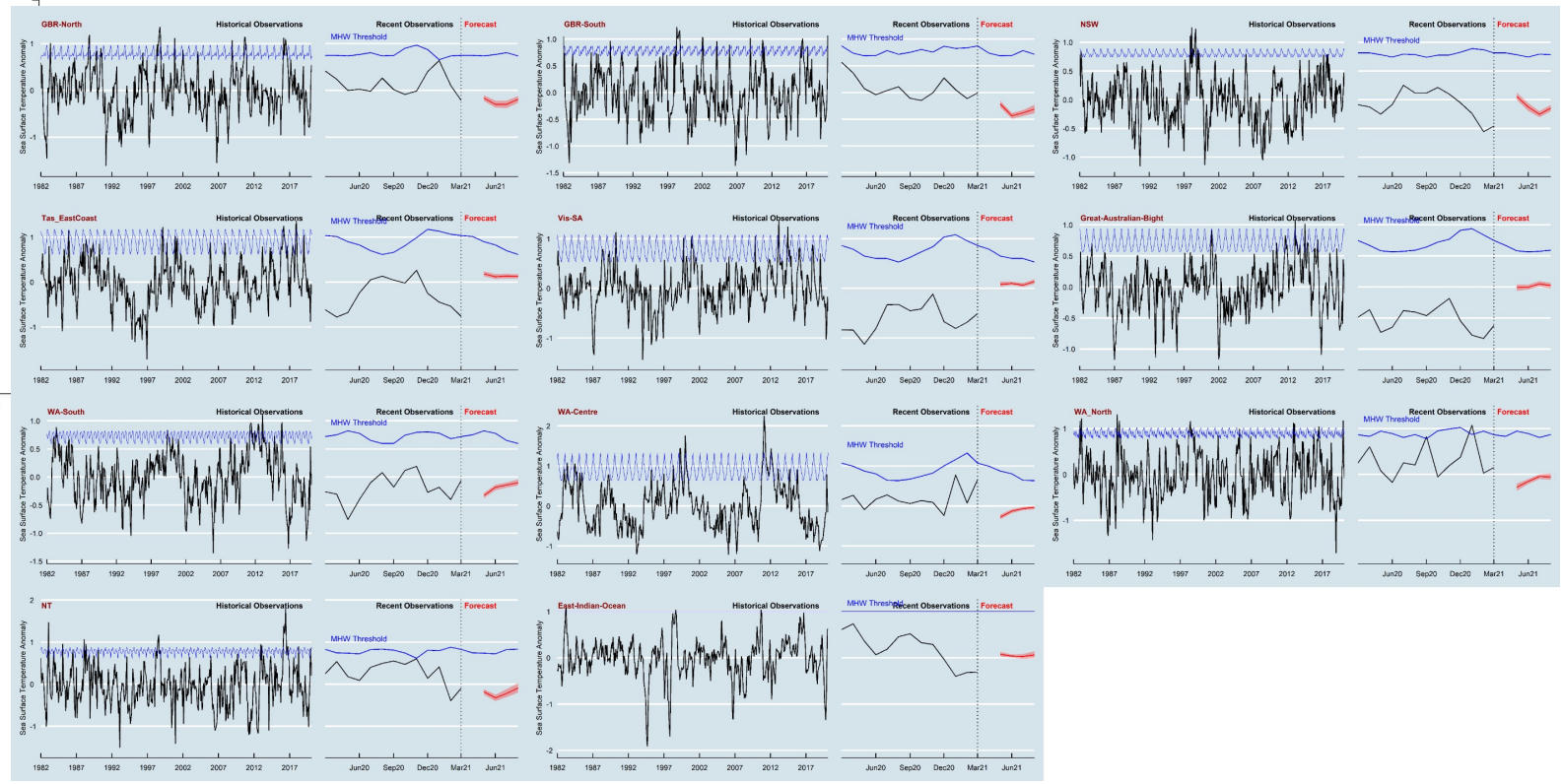






Australian Regions – MHW seasonal forecasts

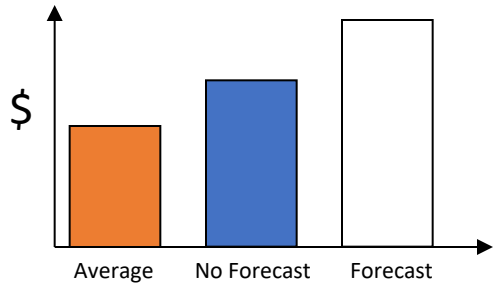




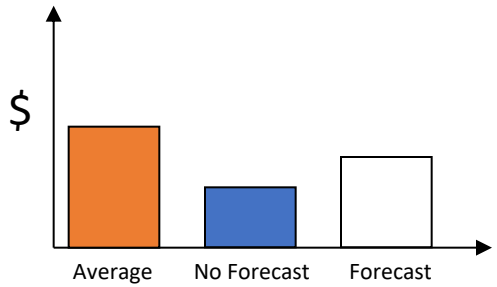
https://research.csiro.au/cor/home/climate-impacts-adaptation/marine-heatwaves/

Benefit of forecast – make money

- With forecast information - in a “good” year do better



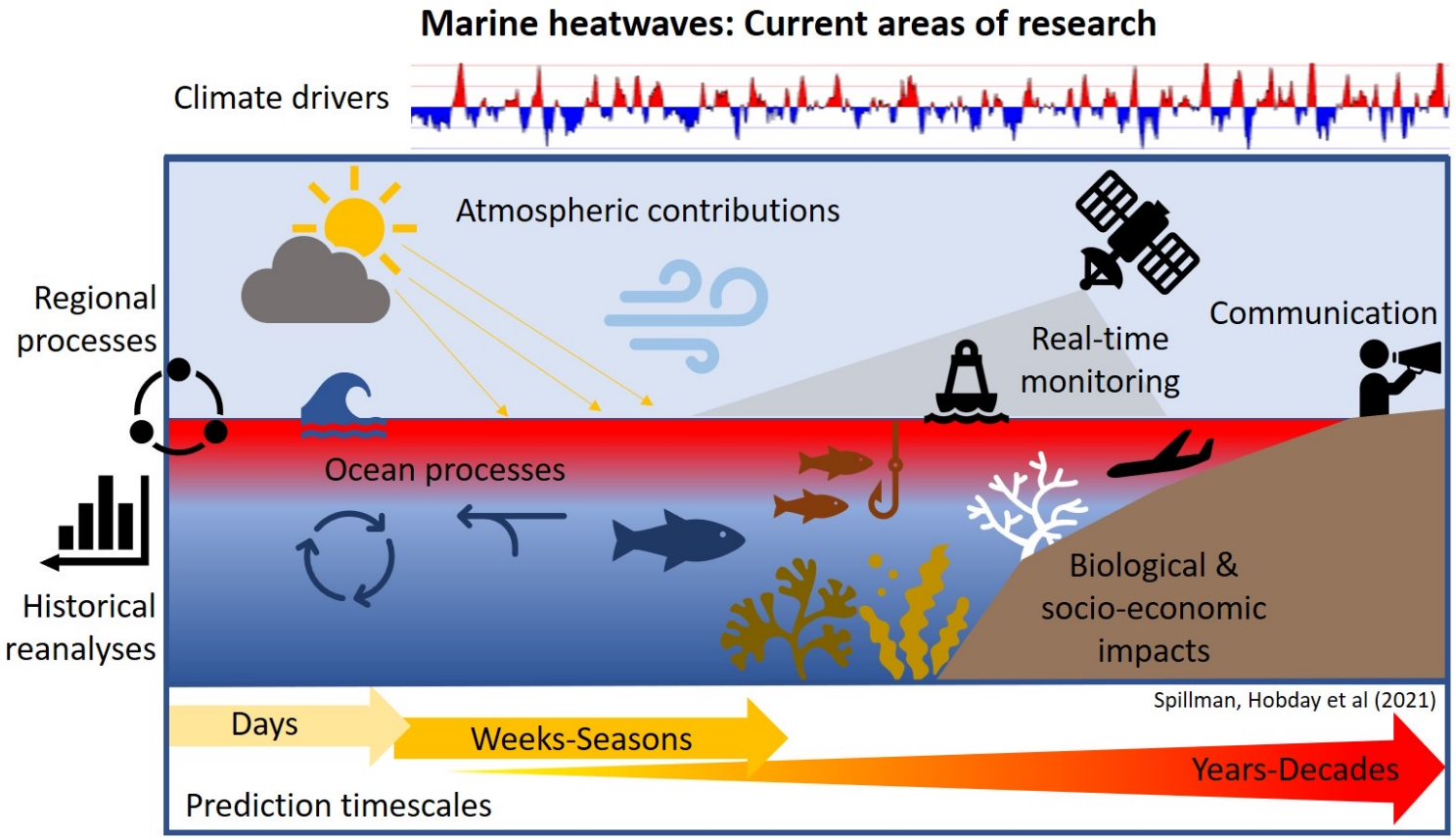
- With forecast information - in a “bad” year lose less



The future – forecasting extreme events…

- What would you do with a marine heatwave forecast?

- Inform?
  - Who and why?
- Monitor?
  - What and where?
- Intervene?
  - How and when?



MHW definition (commonly used)

Anomalously warm: a MHW must lie above a high percentile, calculated from a baseline climatology

- 90th percentile; vary with climatology throughout year
- Common baseline among studies/data if possible (e.g. 1990-2010)

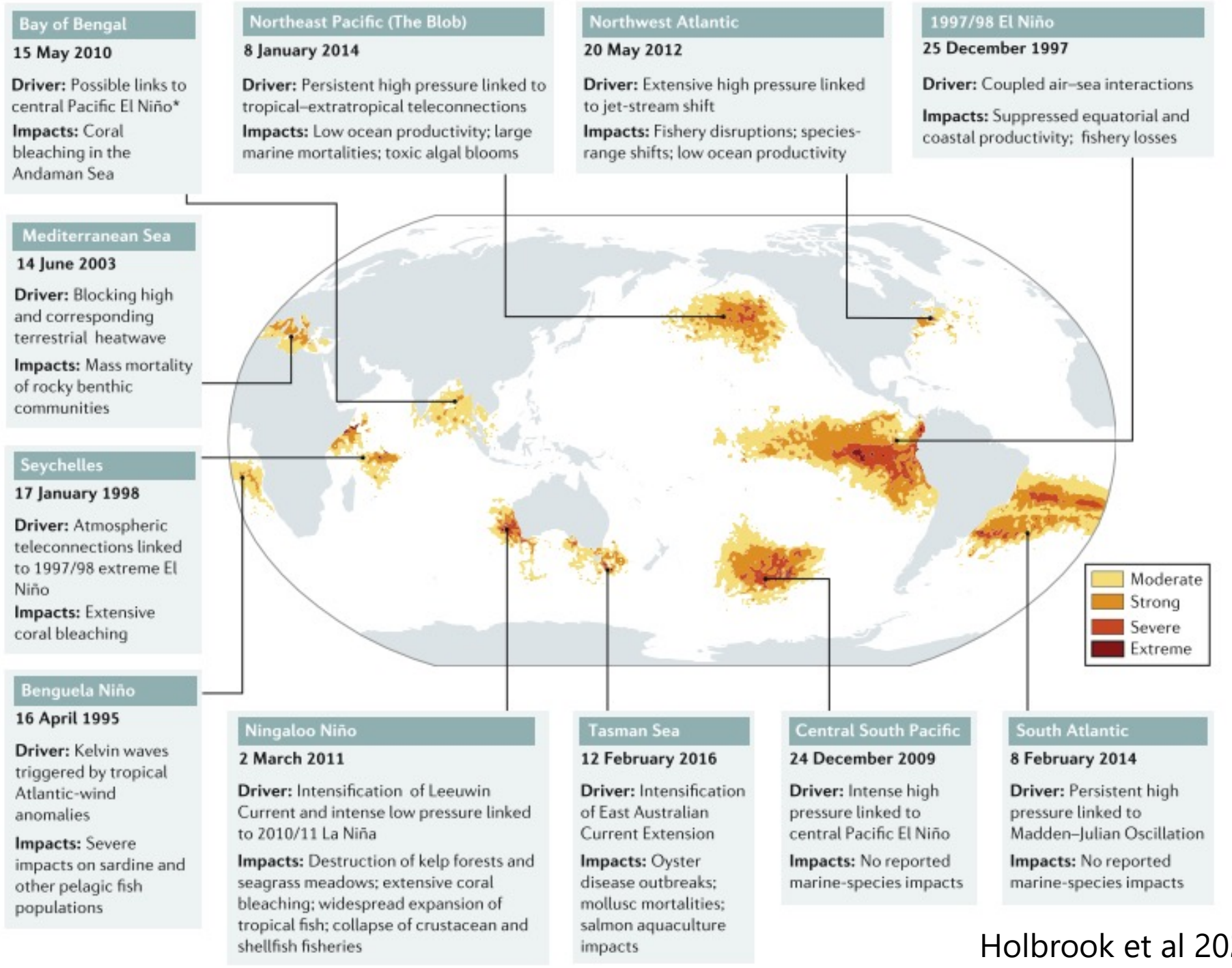
Prolonged: MHW persists under above conditions for at least 5 days (thoroughly tested)

Discrete: clear start and end dates.

- Events punctuated by 2 or less days considered 1 event

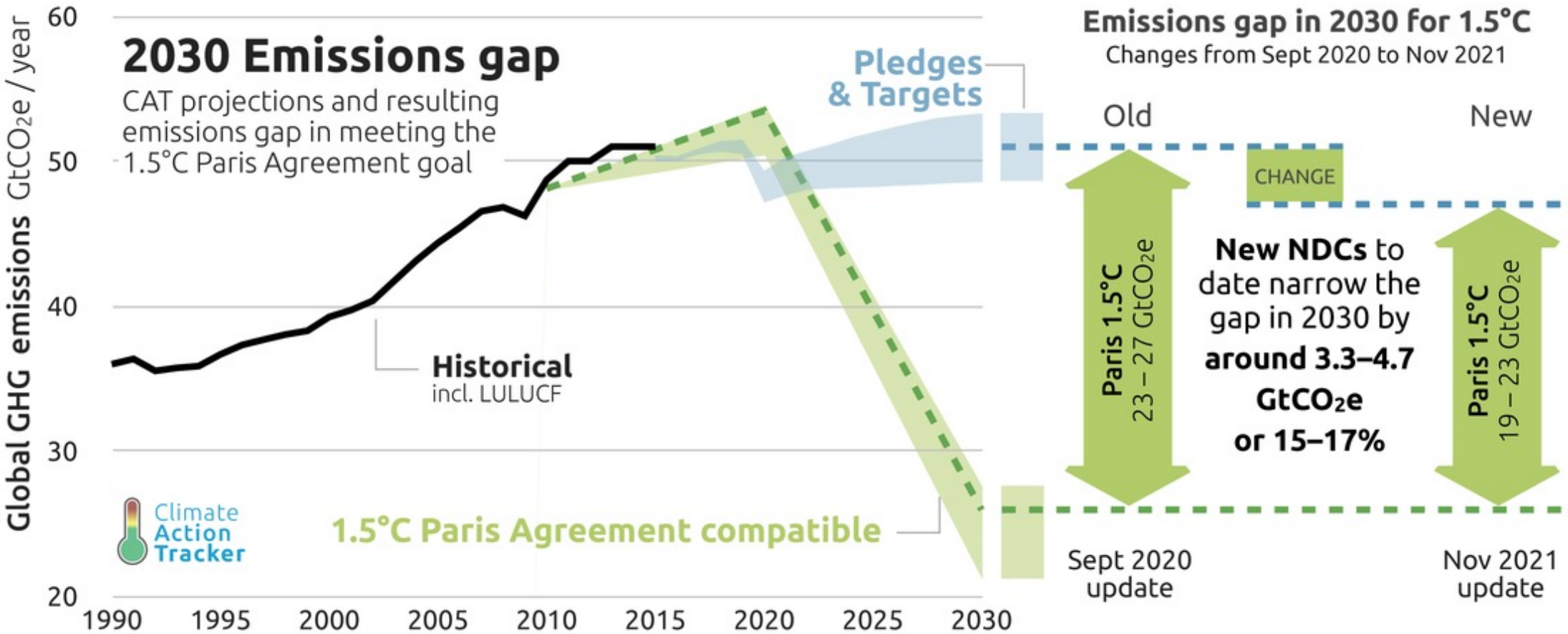
Hobday et al 2016

MHWs – dramatic effects



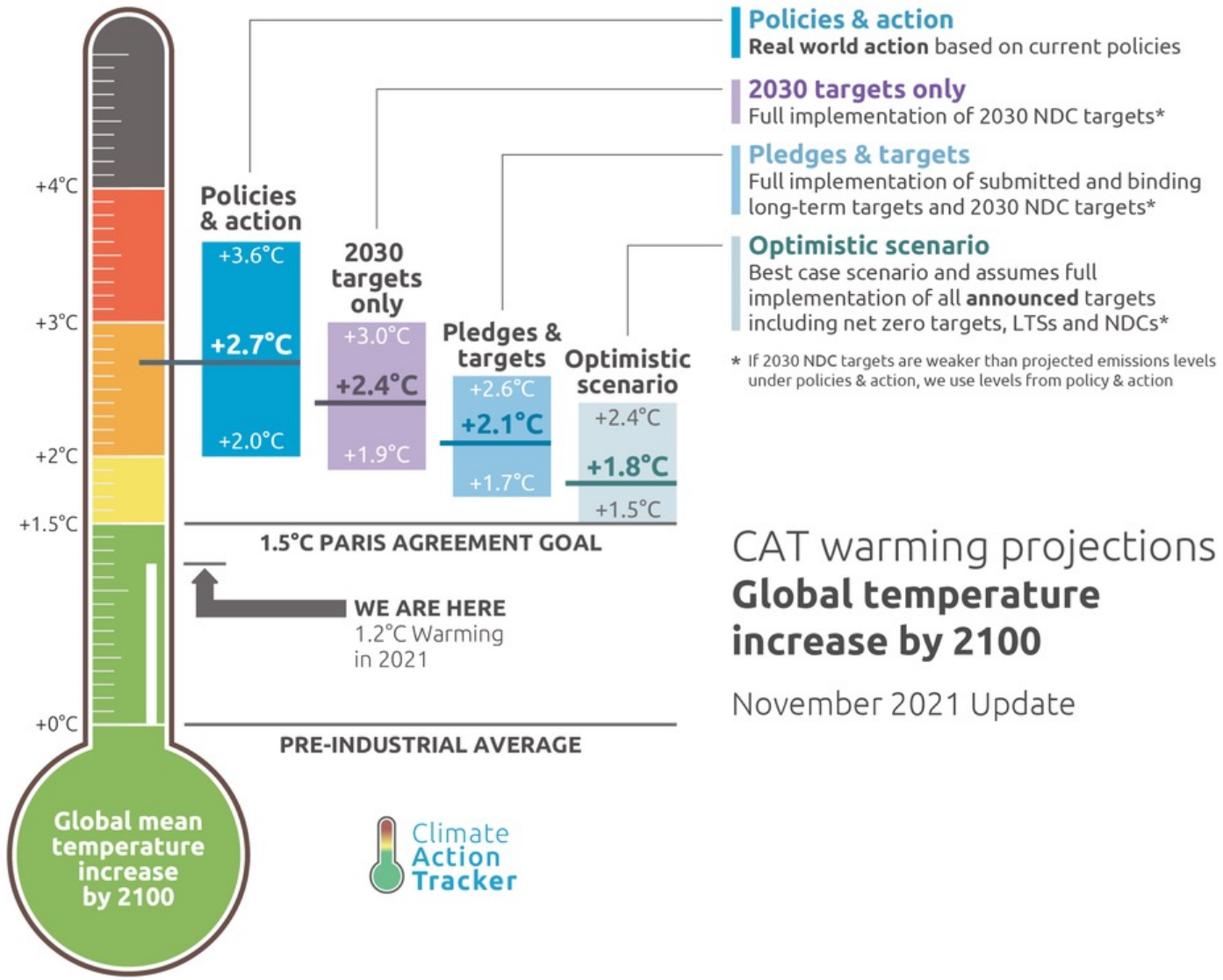
Holbrook et al 2020

After COP26 in Glasgow



https://climateactiontracker.org/global/cat-emissions-gaps/

After COP26



https://climateactiontracker.org/global/cat-thermometer/

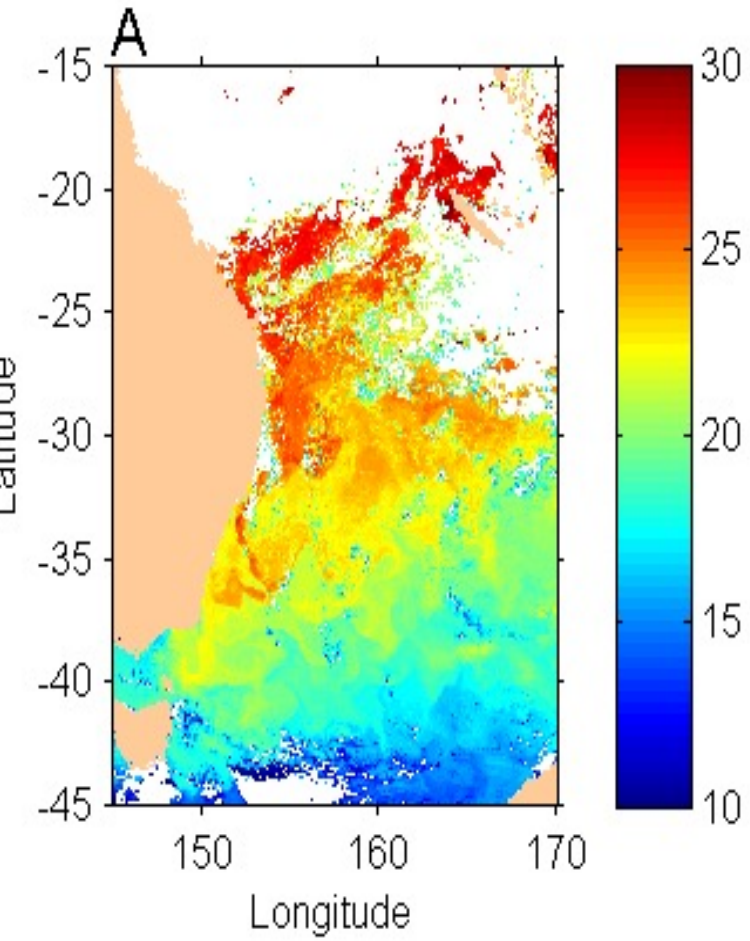
Variables used to describe fish distribution (habitat)

	Variables	Climatology	Observed	Modelled/derived
Surface	Temperature		x	
	Ocean color (chl)		x	X
	Salinity	X		X
	Fronts		x	
	EKE		x	
Water column	T@D (e.g. 200m)		X	X
	Mixed layer depth	X		X
	Bottom temp	X	x	X
	Nutrients		BGC-ARGO	X
	Oxygen	X	BGC-ARGO	X
	Chlorophyll	X	BGC-ARGO	X
Climate drivers	ENSO, IOD, SAM etc		X	X

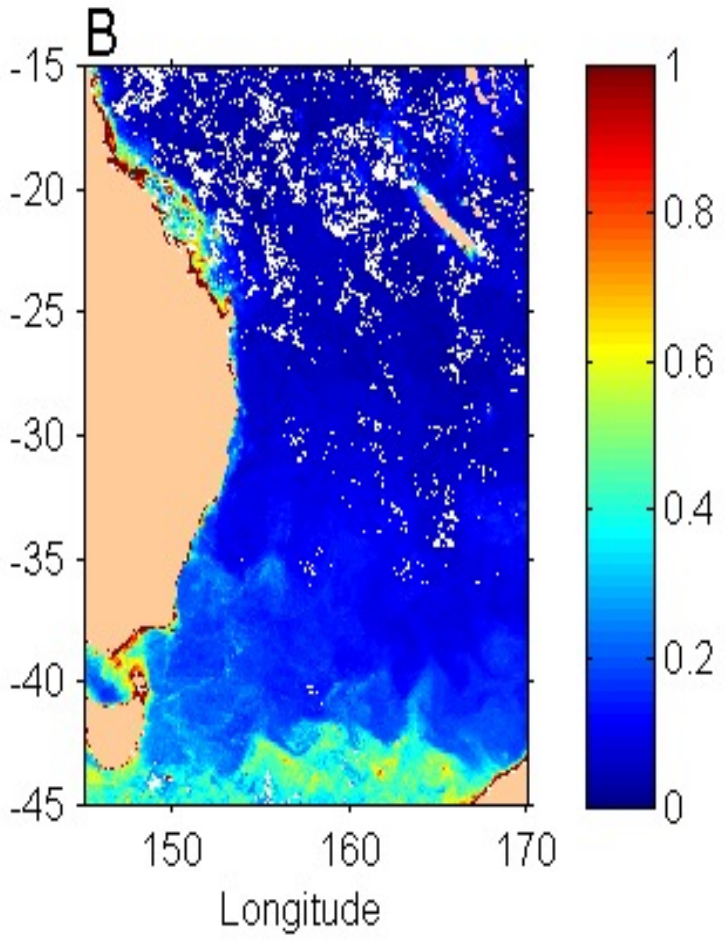
IMPORTANT: Gridded fields used most often for habitat modelling

Variables used to create distribution maps

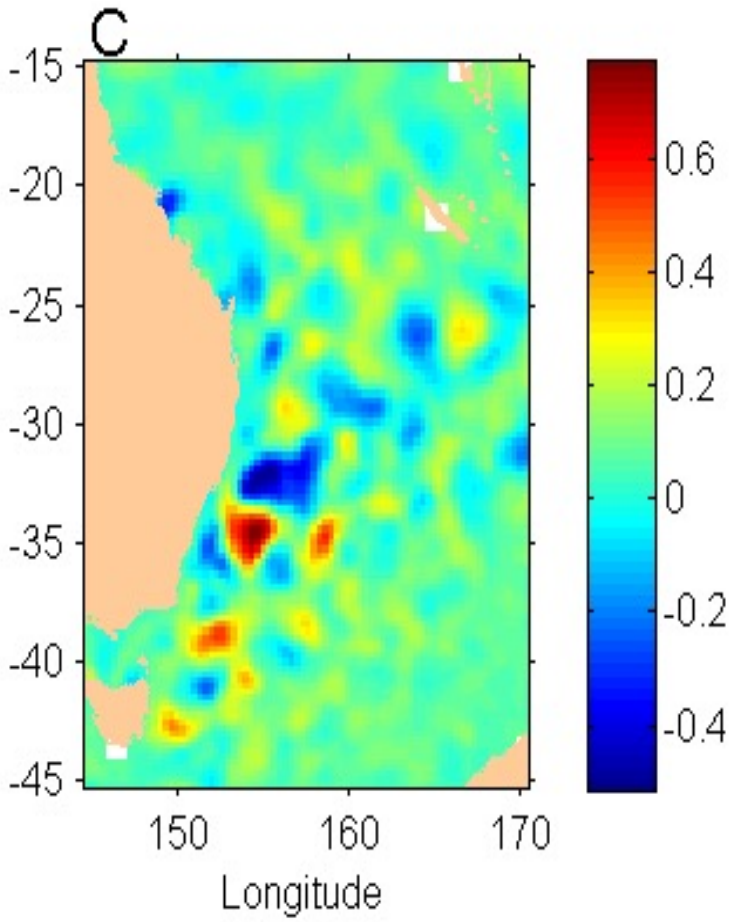
Primary - Temperature



Secondary - Chlorophyll-a



Derived – Eddies (SSH-a)



Hobday and Hartog (2014)