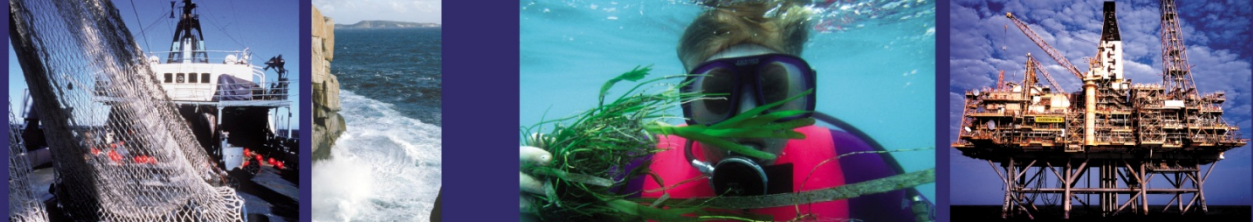


IZPS 2007



Modeling Climate Change Impacts on Zooplankton in the Tasman Sea, Southwest Pacific

Thomas Kunz, Alistair Hobday & Anthony Richardson

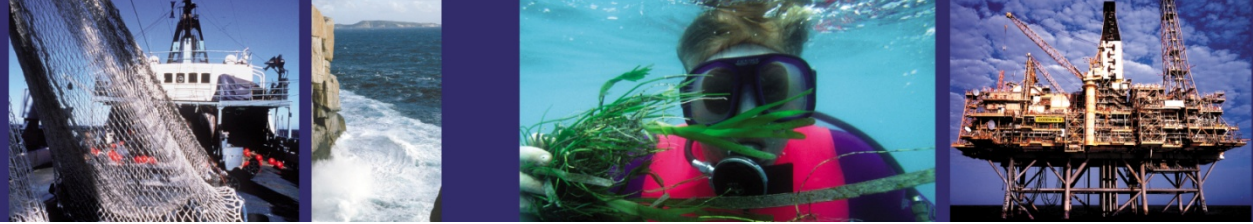
Climate Impacts, Wealth from Oceans Flagship
CSIRO Marine and Atmospheric Research
Australia

Overview



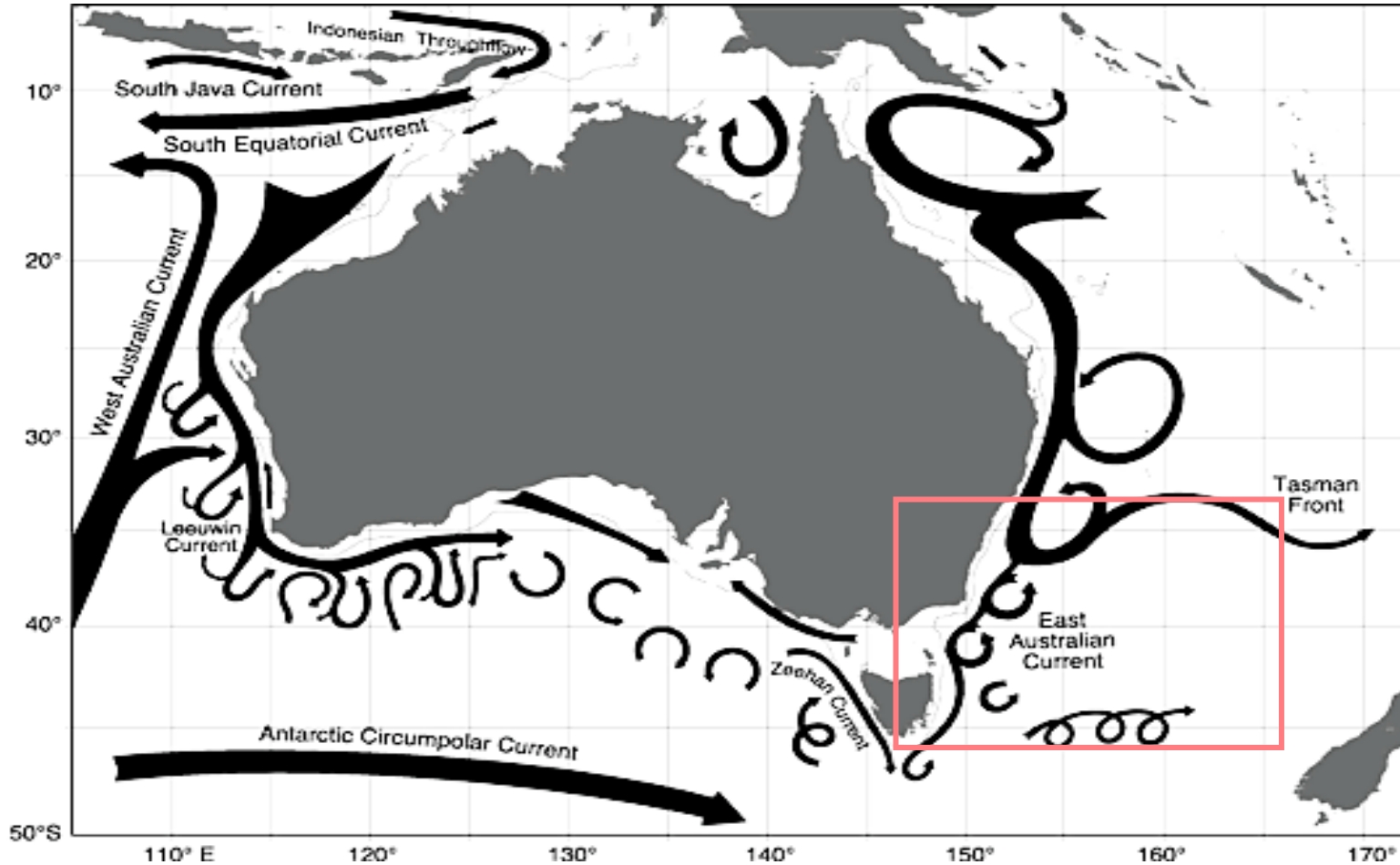
1. Aims of modeling climate impacts on zooplankton
2. Oceanographic features of the region
3. Projections of physical oceanographic variables
4. Observed changes in the plankton
5. Biological impacts – how to predict ?
6. Preliminary results

Modeling: Aims



- Assess impacts of changes in the climate system on production of key plankton in waters around Australia, starting with SW Tasman Sea
- Predict prey fields of key zooplankton seasonally & in the long-term
- Help identify potential trophic mismatch and future risks for fish populations
- Increase accuracy of spatial management tools for fisheries

Focal region: *Tasman Sea*

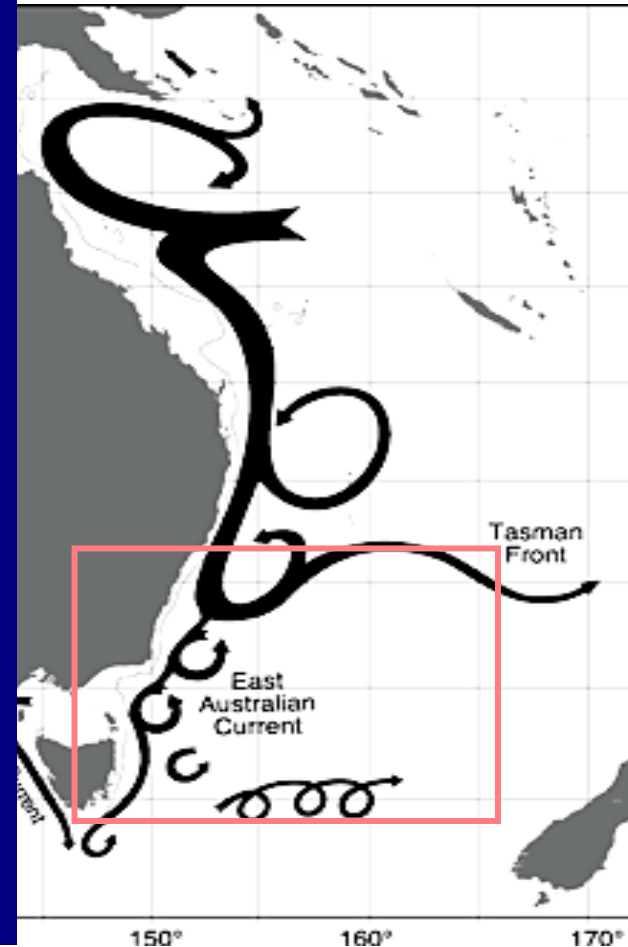


Focal region: *Tasman Sea*



Characteristics:

- Region shows considerable mesoscale physical activity
- Advection of warm, nutrient-poor waters (*East Australian Current*) into cool, relatively nutrient-rich waters
- Ocean climate and circulation are highly variable both seasonally and inter-annually

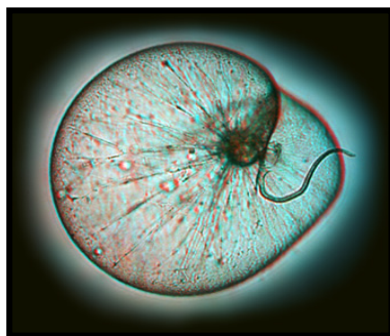


Observed impacts in SE Australia



Total nitrogen and dissolved NO_3 , PO_4 and DOC decreased with increasing SST during second half of 1980s (Harris et al. 1991)

Earlier timing of spring bloom in Tasmanian shelf waters - long-term trend (Harris et al. 1993)



Changing phytoplankton composition off eastern Tasmania – increased warm-water strains, e.g. *Noctiluca scintillans* (S. Blackburn, G. Hallegraeff)



Rock lobster catch and distribution correlated with regional SST changes around Tasman Sea (Harris et al 1988)

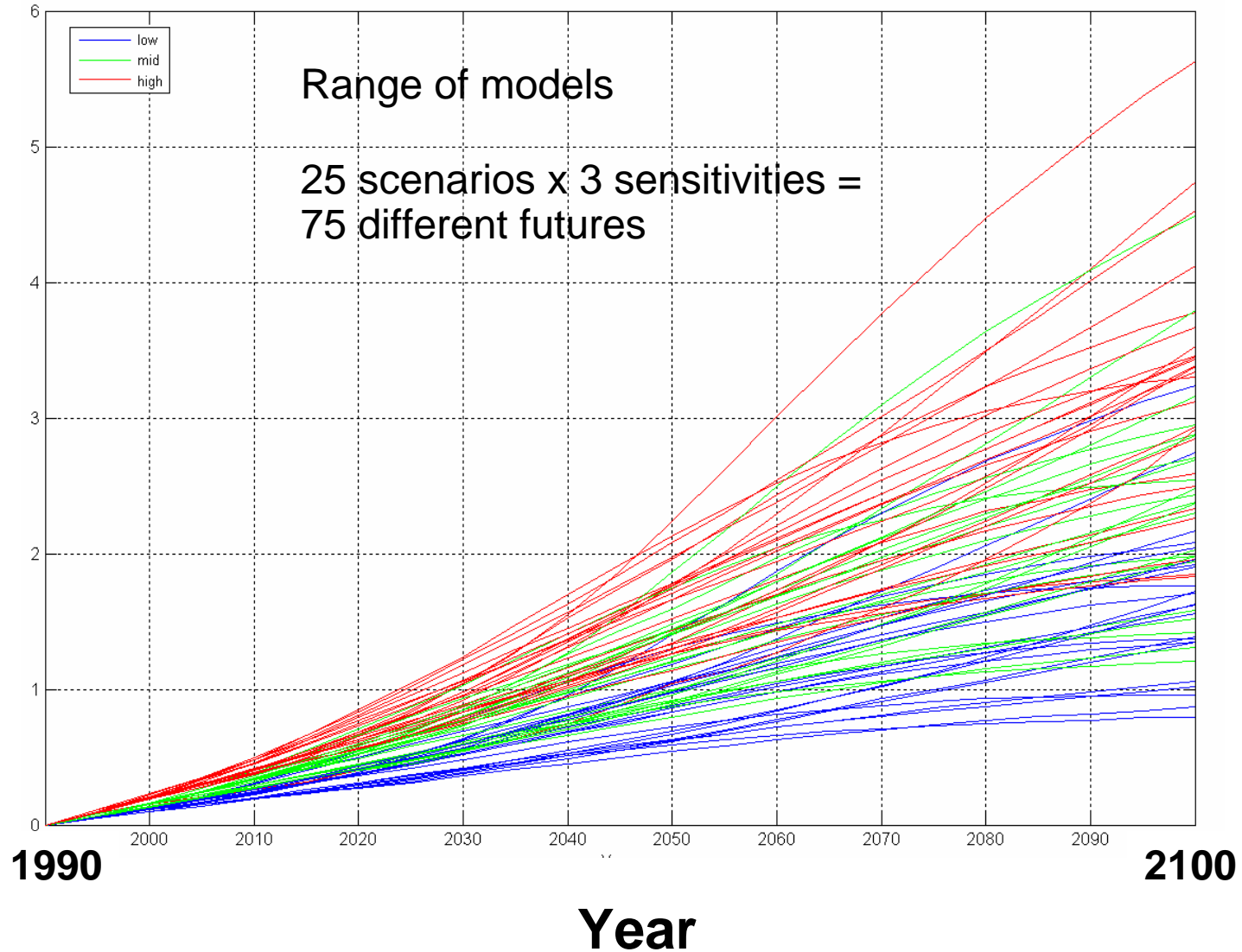


In last decade 34 fish species became either newly established south of Bass strait, or show significant range extensions (P. Last)

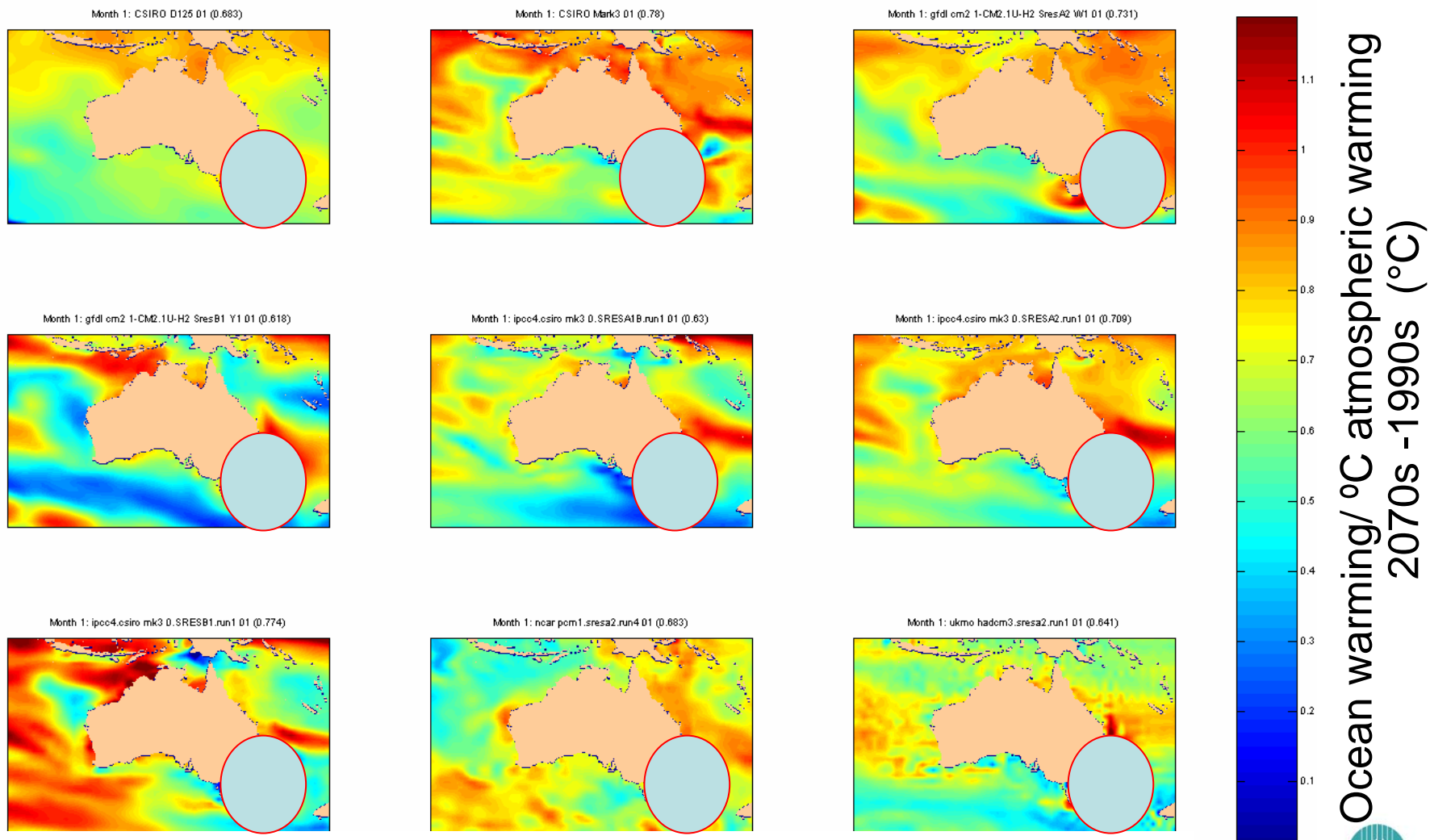
Future scenarios (OceanClim)



Atmospheric warming
(°C)

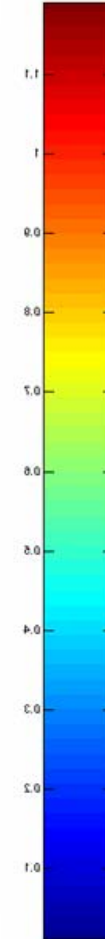
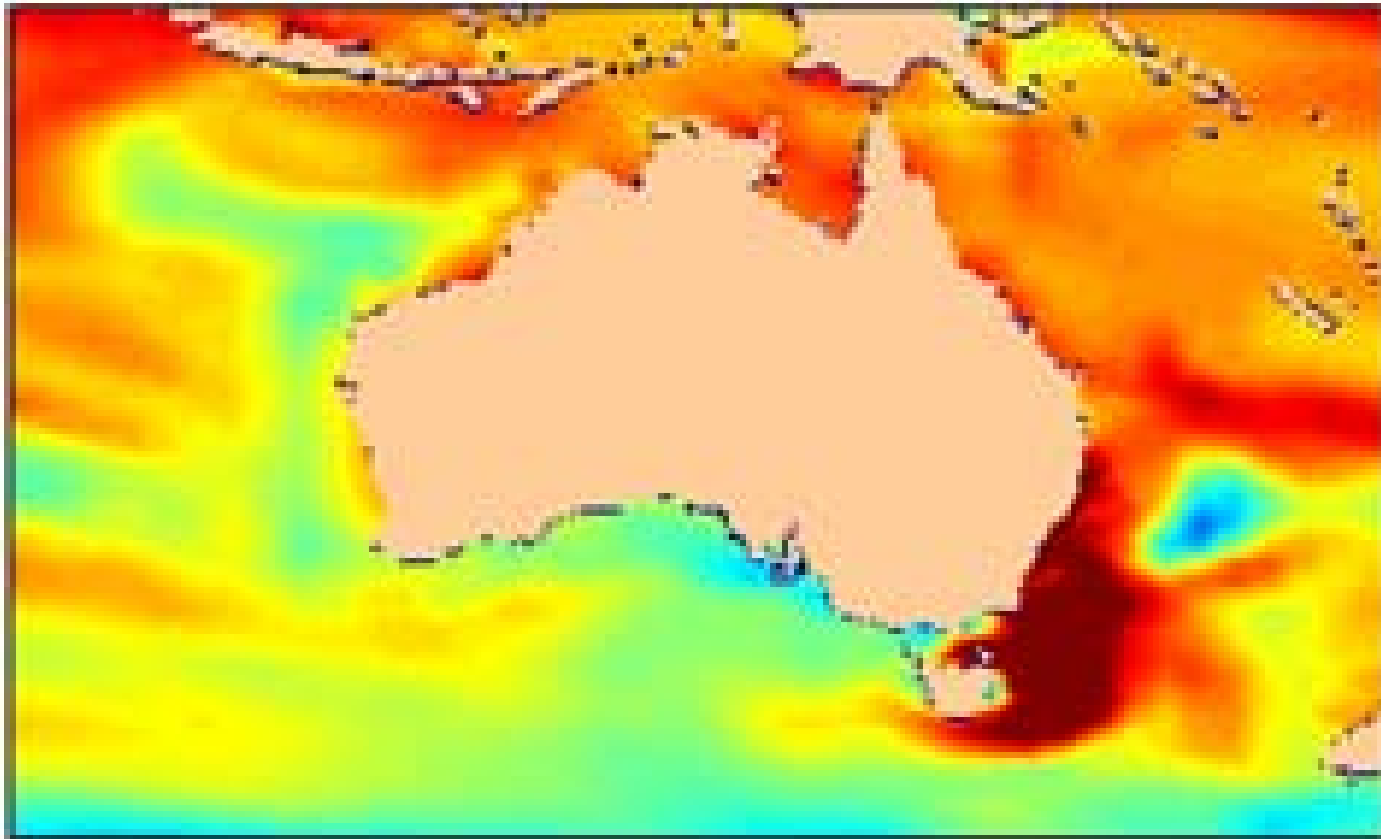
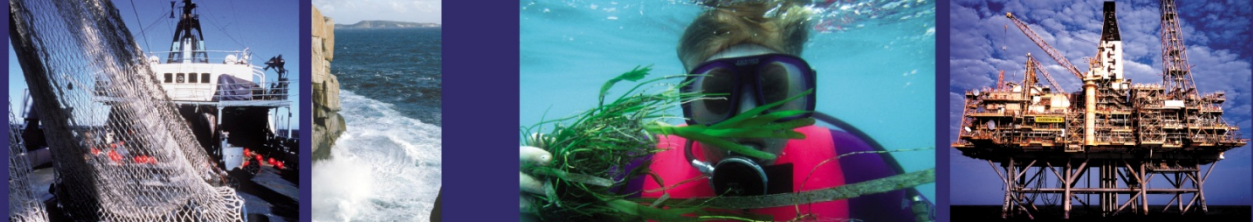


Ensemble analyses (e.g., SST)



Predicted change by month, e.g. January

Predicted change in SST



Δ SST / °C atmospheric warming

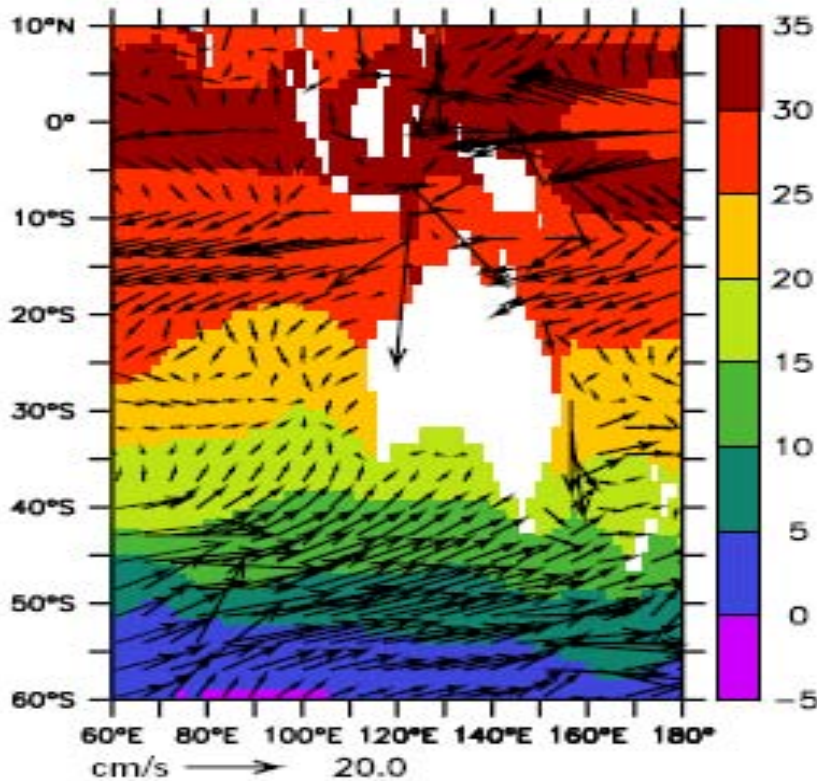
CSIRO Mk3 Climate Model

Predicted change in currents

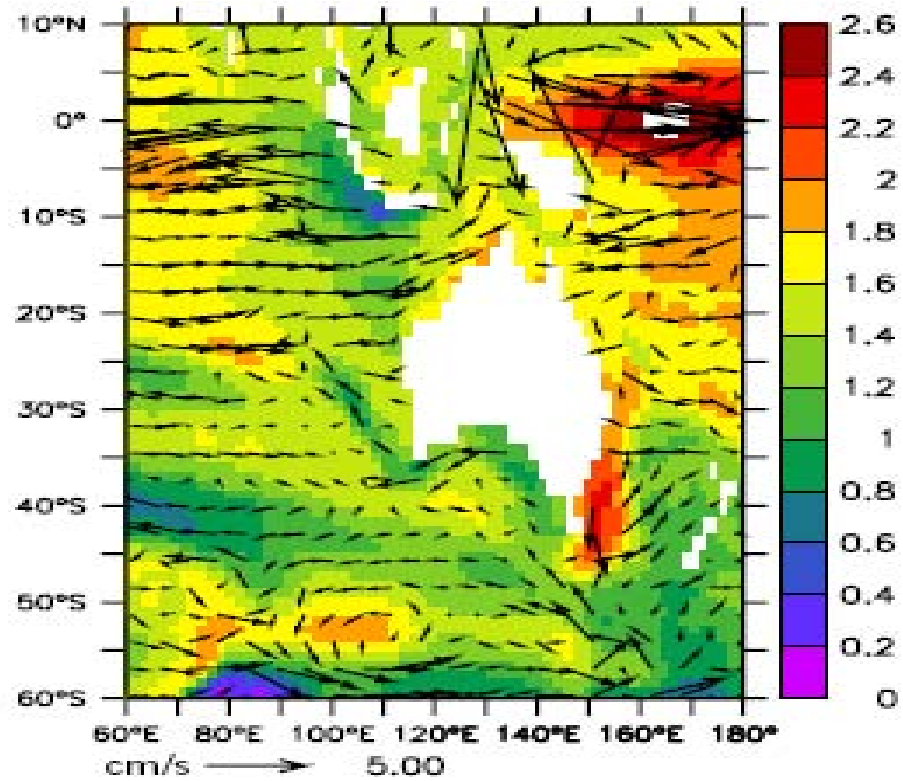


1990s

2070s - 1990s



Surface currents (cm/s) T (°C)



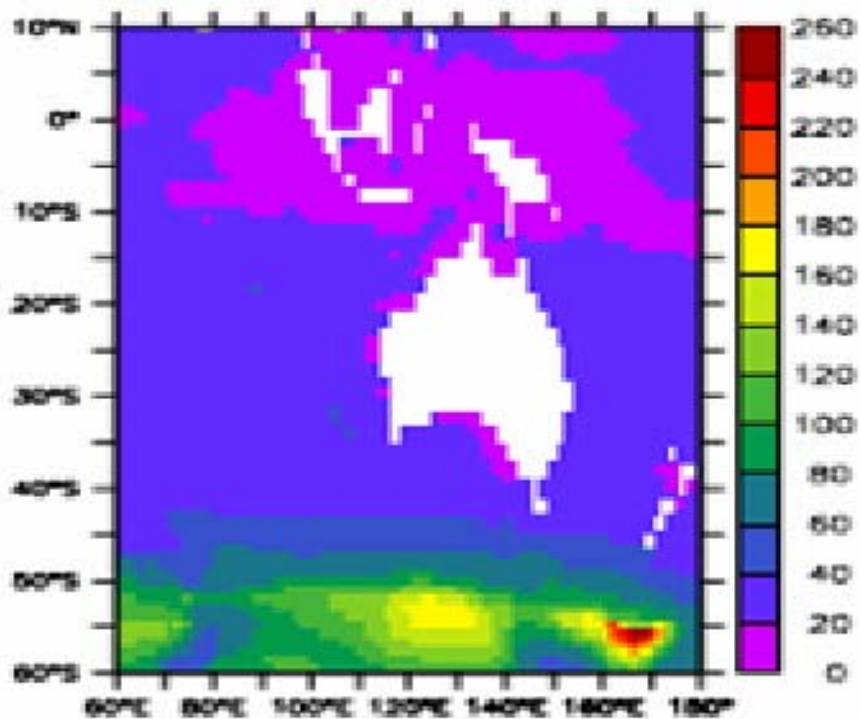
Δ Surface currents (cm/s) Δ T (°C)

Poloczanska et al. 2007 (*in press*)

Predicted Change in Stratification

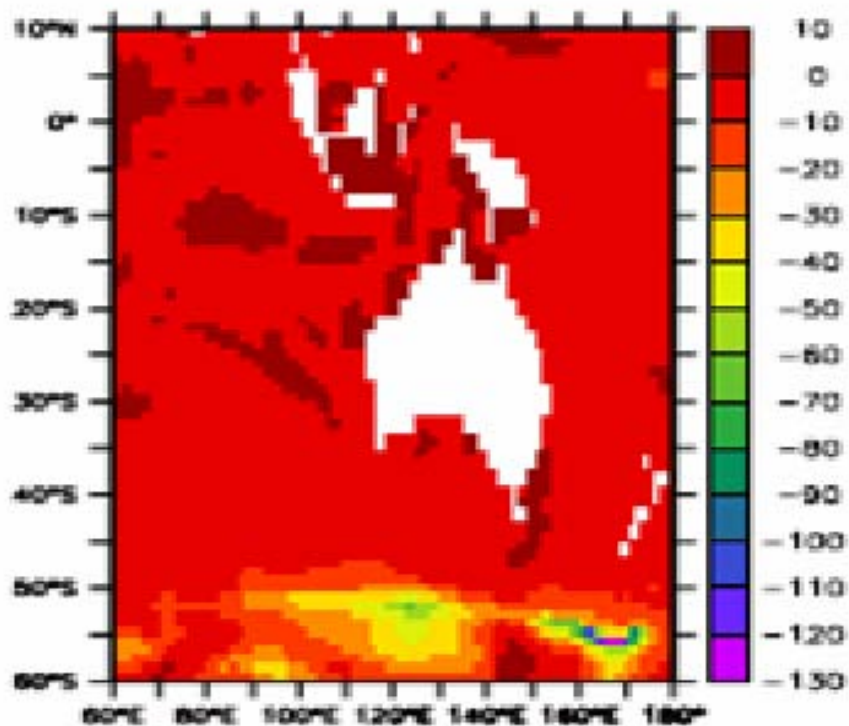


1990s



**Mixing
depth (m)**

2070s - 1990s -



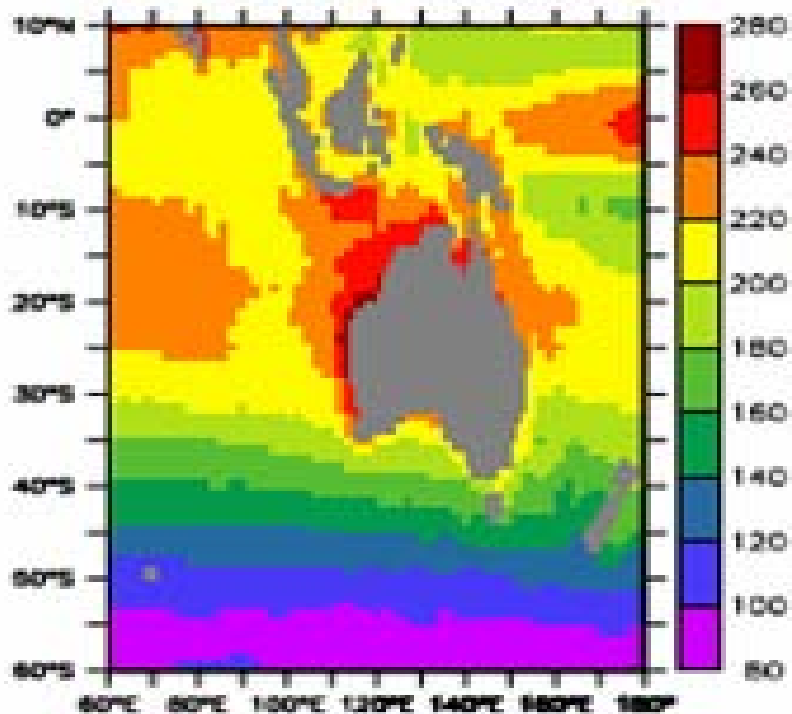
**Δ Mixing
depth (m)**

Poloczanska et al. 2007 (*in press*)

Predicted change in mean solar radiation

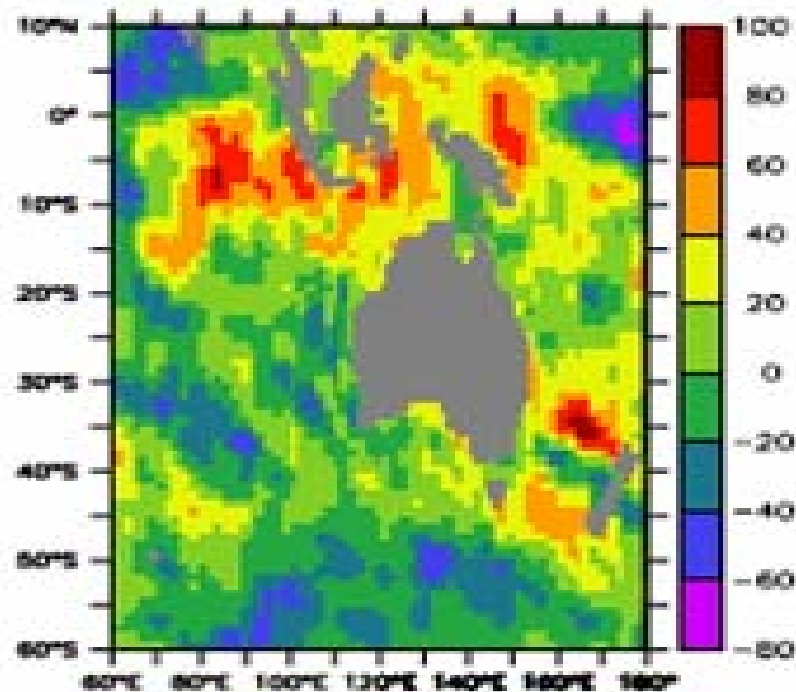


1990s



I (W/m²)

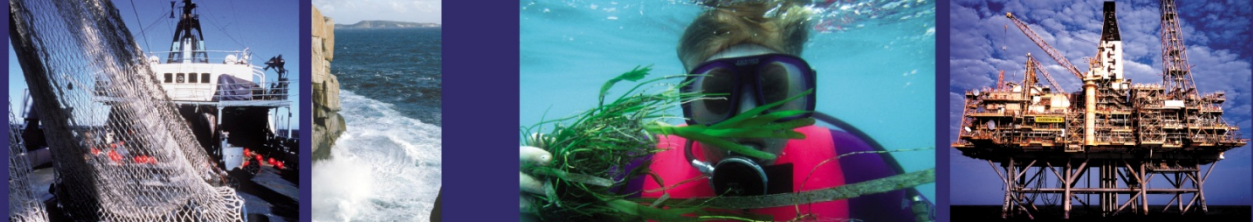
2070s – 1990s



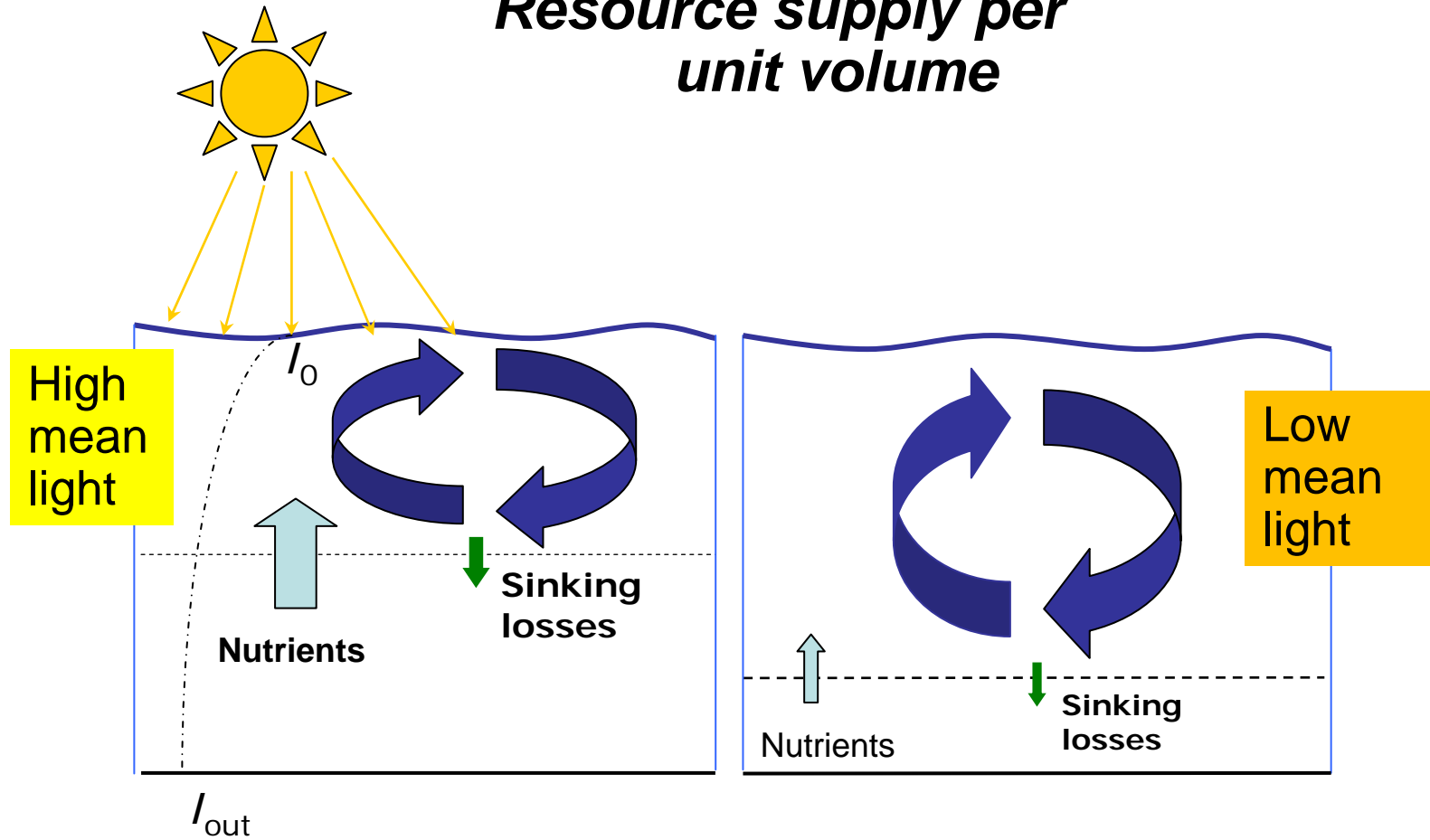
ΔI (W/m²)

Poloczanska et al. 2007 (*in press*)

Some theory...



Resource supply per unit volume



After Diehl (2002)



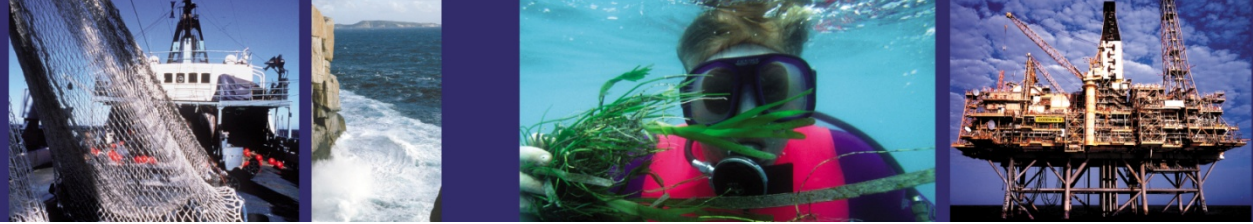
Expectations for standing stocks of resources

Functional group	+SST¹	+ MLD	+ EAC¹
Nutrient	(-)	+	(-)
Dinoflagellates	+	X ³	+
Diatoms	(-)	+ / - ²	-
Copepods	?	(+ / -)	+
Krill (<i>Nyctiphanes australis</i>)	?	(+ / -)	-

¹ after G. Harris et al. 1992

² Kunz et al., in preparation

Modeling approaches

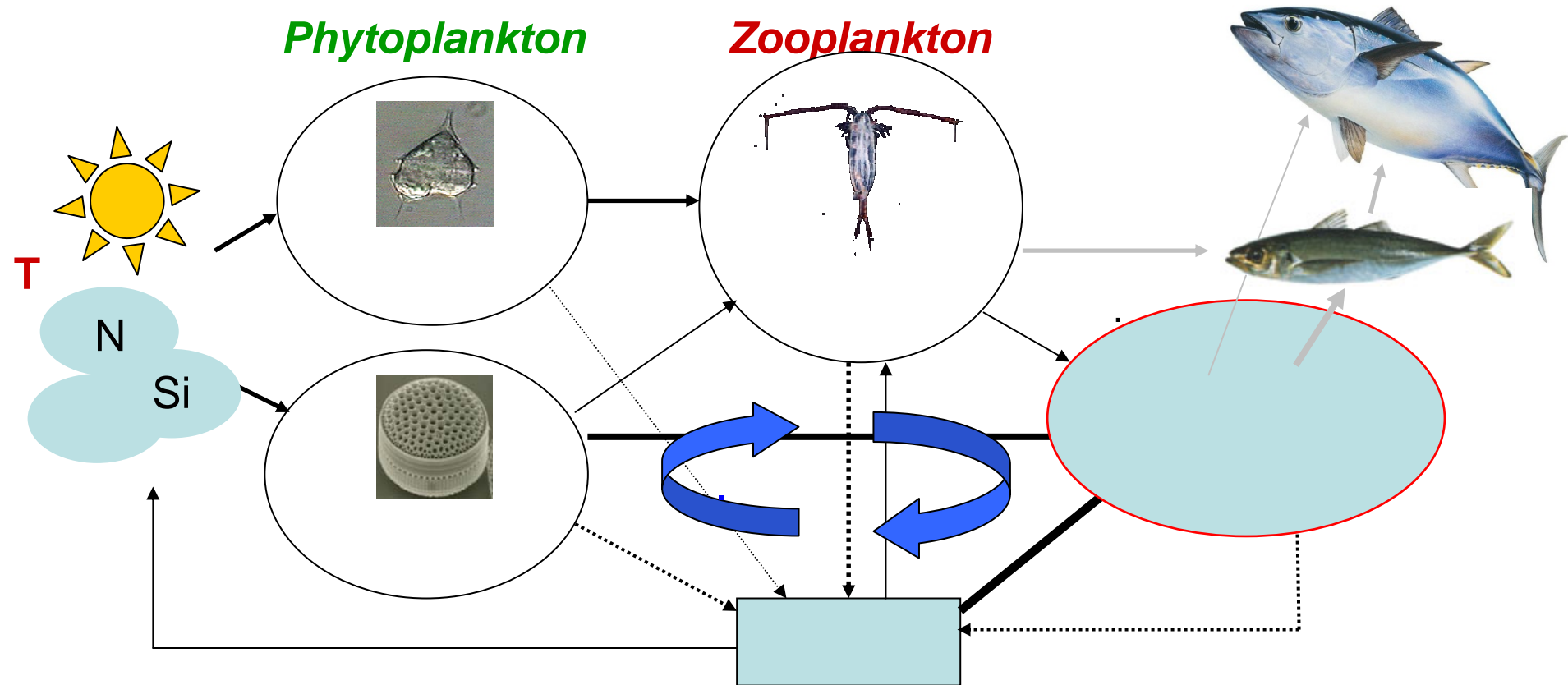


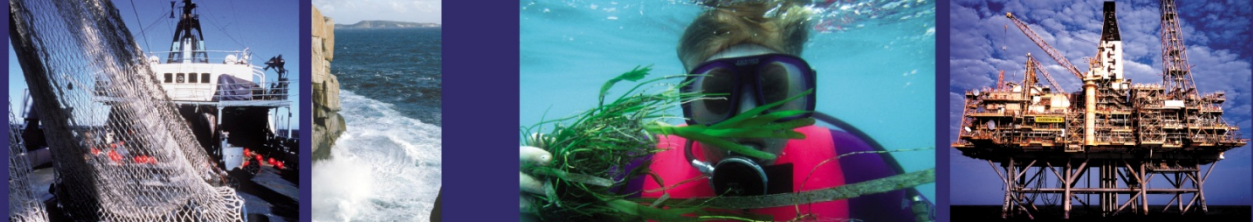
- Trophic approaches
 - Minimal NPZ
 - Minimal realistic $N_3P_2Z_3D$
 - Full complexity $N_3P_{10}Z_{16}D_2$ (e.g. ERSEM)
- Non-trophic approach
 - Size-based (e.g. SEPODYM)

Model structure



E.g., Tasmanian shelf waters

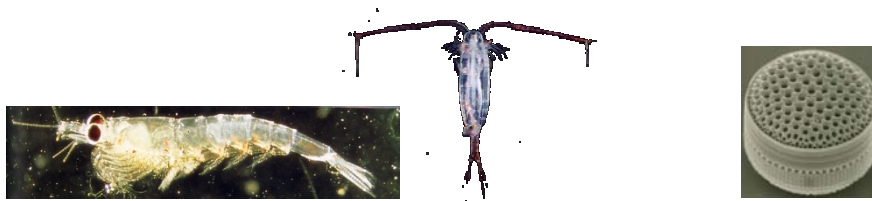




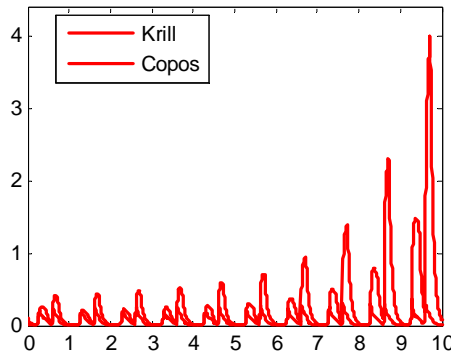
Model stages - now

1-D model:

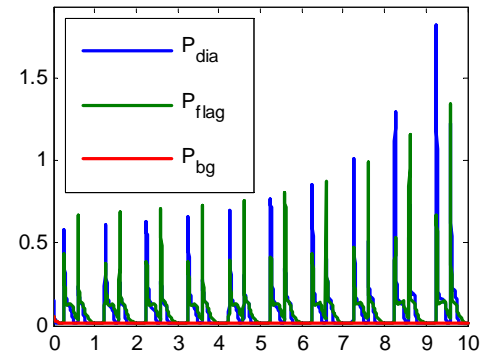
Warming-only scenario: 3 °C / 100 yr

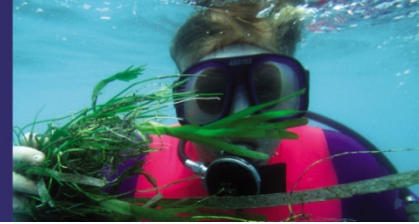


Krill and copepods - Mixed layer



Phytoplankton - Mixed layer





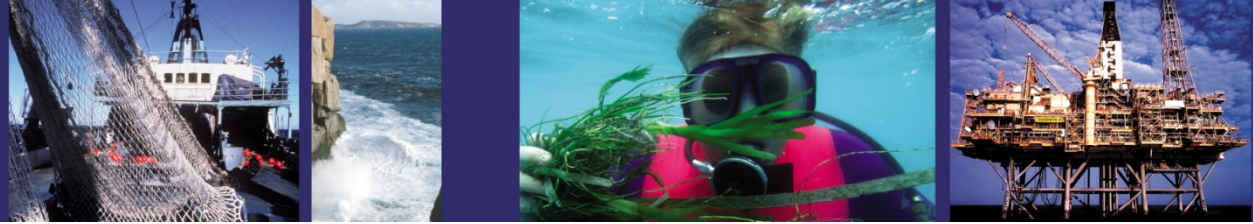
Future

1-D model:

- + Altered stratification
- + Microzooplankton (dinoflagellates)

2-D model:

- Enhanced flow of East Australian Current



Thank You!

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