Australian Government
Department of the Environment and Heritage
Australian Antarctic Division

Assessment of climate change impacts on marine ecosystems in East Antarctica:

outcomes of a research collaboration between Australia & Japan

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2nd International Climate Change Symposium, Yoesu, Korea (16May 2012)

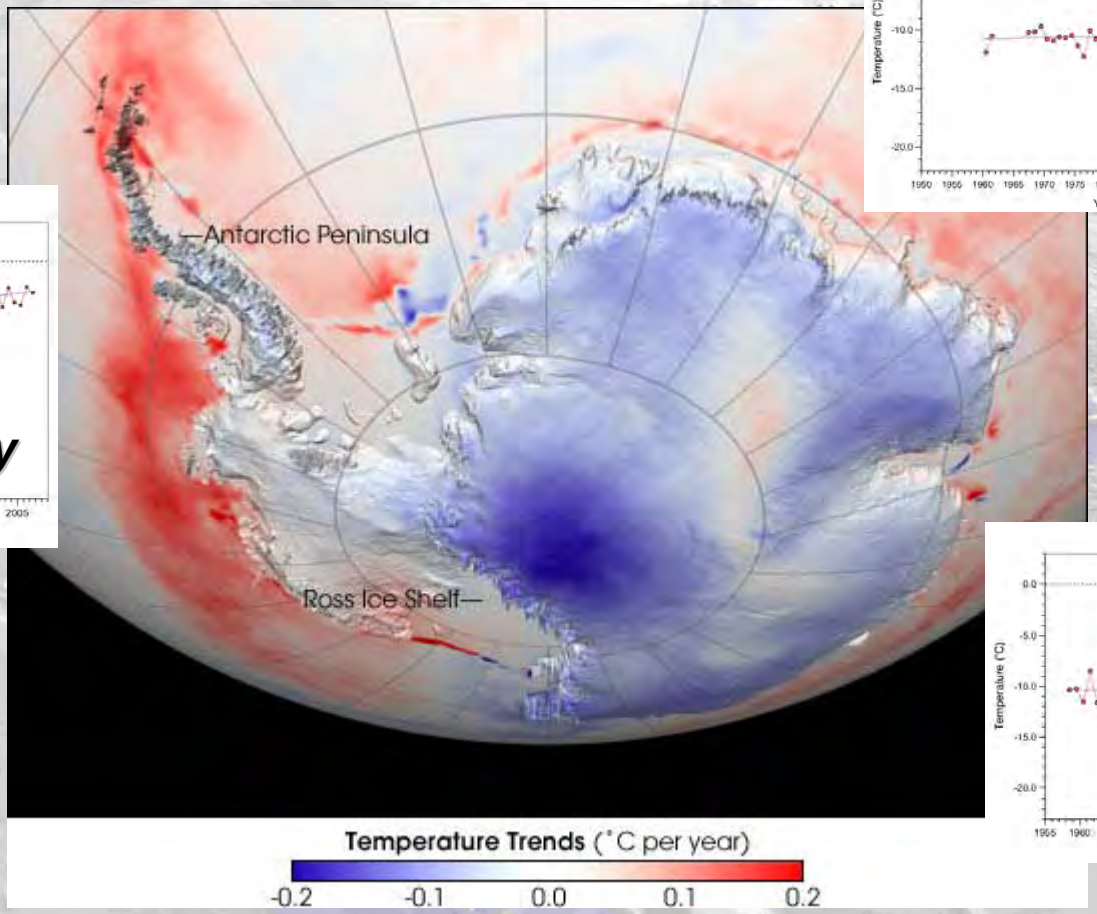
Outline

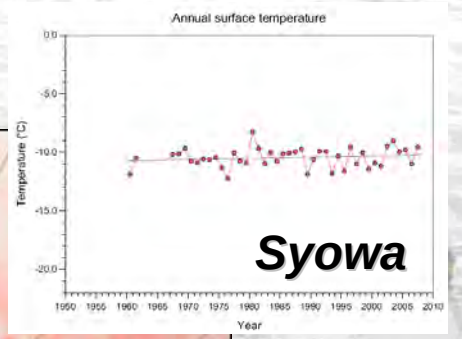
- What's happening in Antarctica?
- Why Australia-Japan Collaboration?
- Project outcomes and the way forward
- Southern Ocean Sentinel

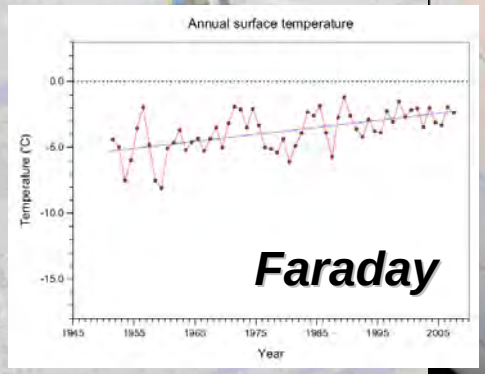
What's happening in Antarctica?

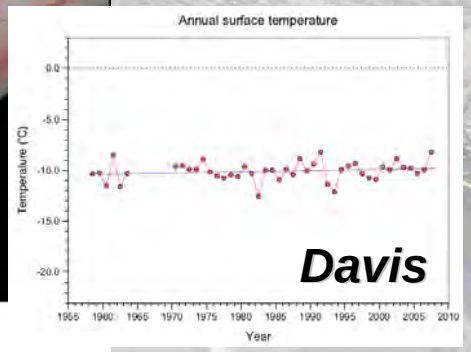
- ***Warming***
  - Parts of Antarctica (e.g. Antarctic Peninsula) are demonstrating one of the most rapid warming paces on the globe.

The rates are different between regions









Source: http://www.antarctica.ac.uk/met/ and http://www.coolantarctica.com

Sea Ice: Future Projections

- *Further decrease in the future*
- *Difference in rates depending on region*

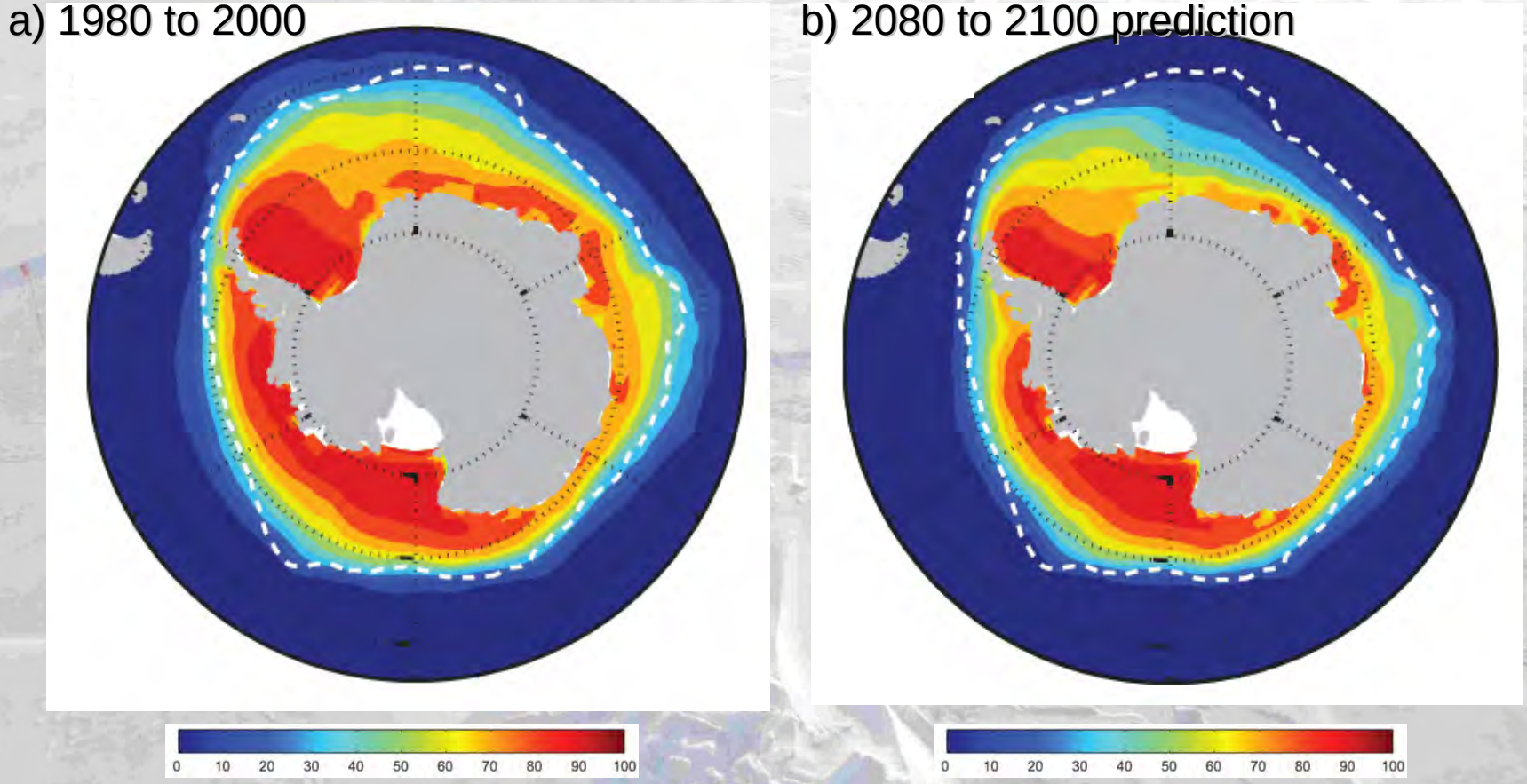


Figure 10.14. Multi-model mean sea ice concentration (%) June to September for the periods 1980 to 2000 and b) 2080 to 2100 for the SRES A1B scenario. The dashed white line indicates the present-day 15% average sea ice concentration limit. Extracted and mondified from IPCC (2007).

- ***Rising CO2 and Ocean Acidification***
  - ***Atmospheric CO2 is increasing globally***
  - ***CO2 is more soluble in cooler waters***
  - ***Southern Ocean is thought to be one of the first ecosystems on the globe to be affected.***

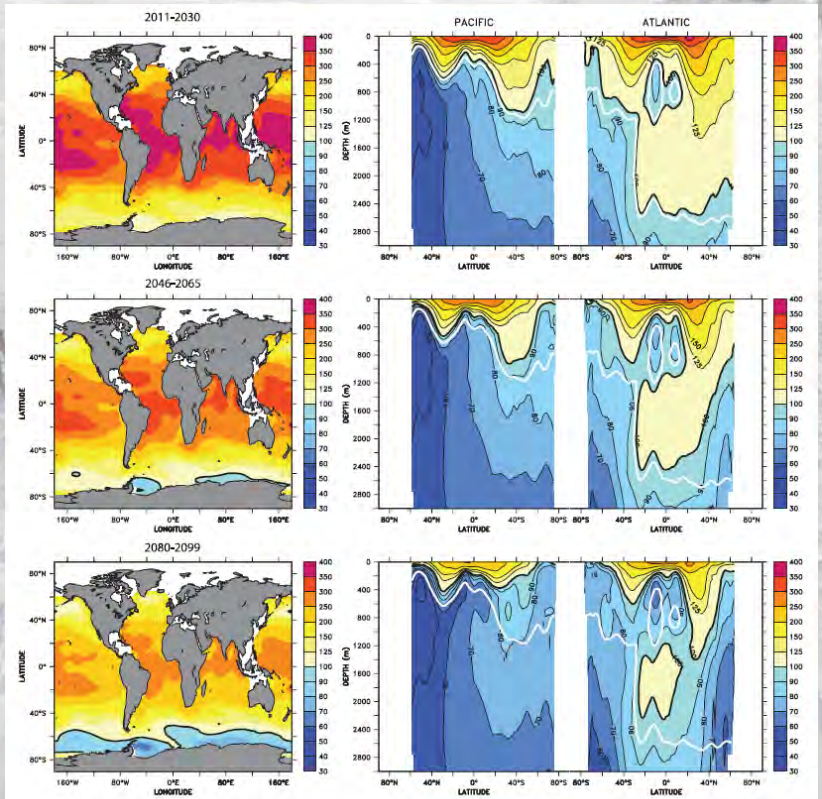
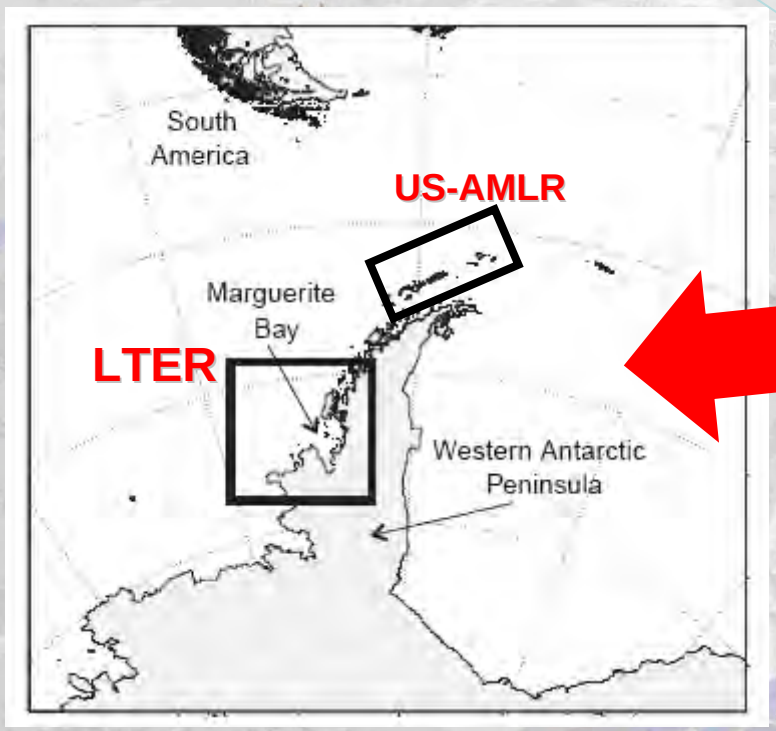
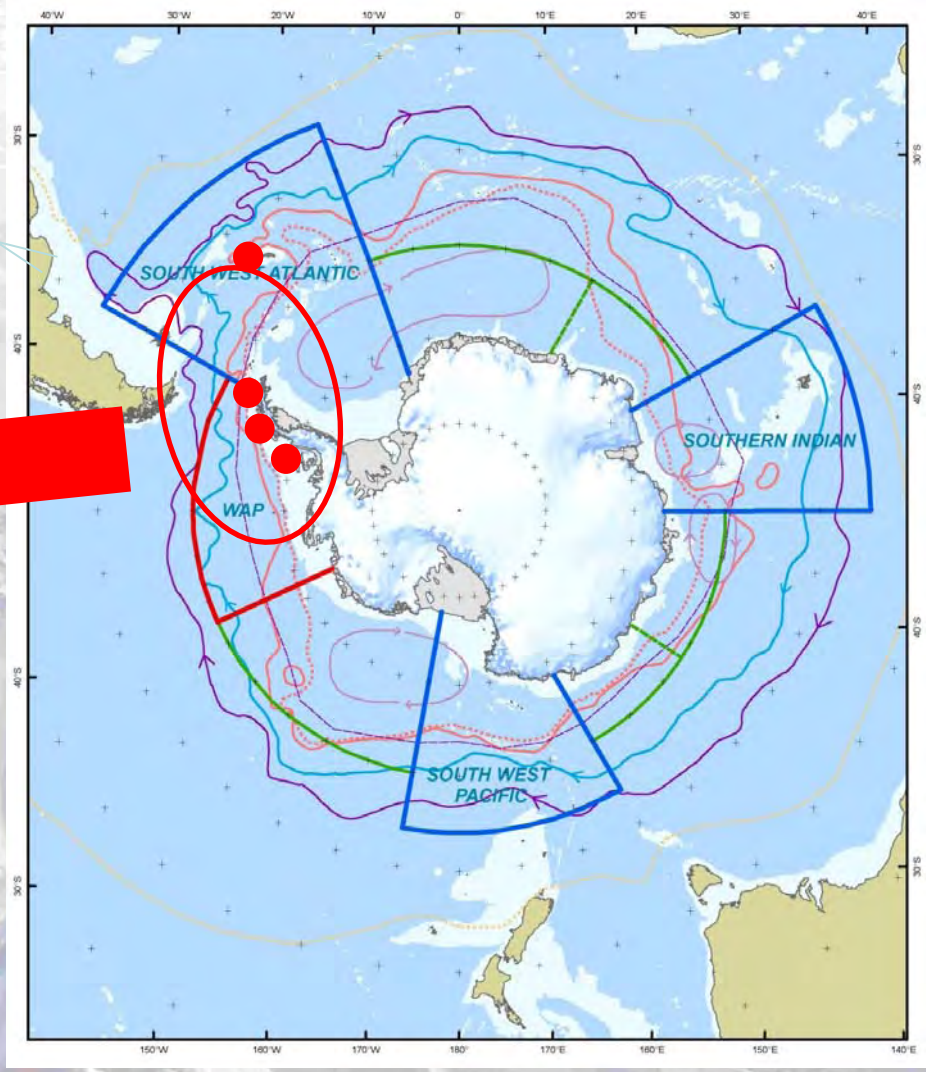


Figure 10.23. *Multi-model median for projected levels of saturation (%) with respect to aragonite, a meta-stable form of calcium carbonate, over the 21st century from the Ocean Carbon-Cycle Model Intercomparison Project (OCMIP-2) models (adapted from Orr et al., 2005). Calcium carbonate dissolves at levels below 100%. Surface maps (left) and combined Pacific/Atlantic zonal mean sections (right) are given for scenario IS92a as averages over three time periods: 2011 to 2030 (top), 2045 to 2065 (middle) and 2080 to 2099 (bottom). Atmospheric CO_2 concentrations for these three periods average 440, 570 and 730 ppm, respectively. Latitude-depth sections start in the North Pacific (at the left border), extend to the Southern Ocean Pacific section and return through the Southern Ocean Atlantic section to the North Atlantic (right border). At 100%, waters are saturated (solid black line - the aragonite saturation horizon); values larger than 100% indicate super-saturation; values lower than 100% indicate undersaturation. The observation-based (Global Ocean Data Analysis Project; GLODAP) 1994 saturation horizon (solid white line) is also shown to illustrate the projected changes in the saturation horizon compared to the present.*

Existing Long-term monitoring sites





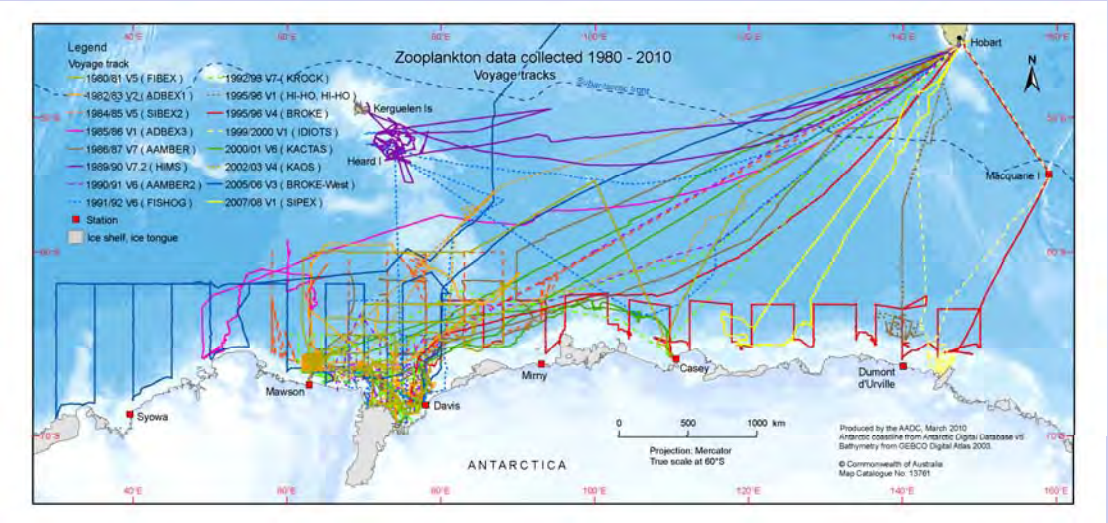
Take home message

- *Trends and rates are not uniform across the Antarctica.*
- *Currently no long-term monitoring site other than Southwest Atlantic sector.*
- *Need to carefully monitor various parts of Antarctica.*

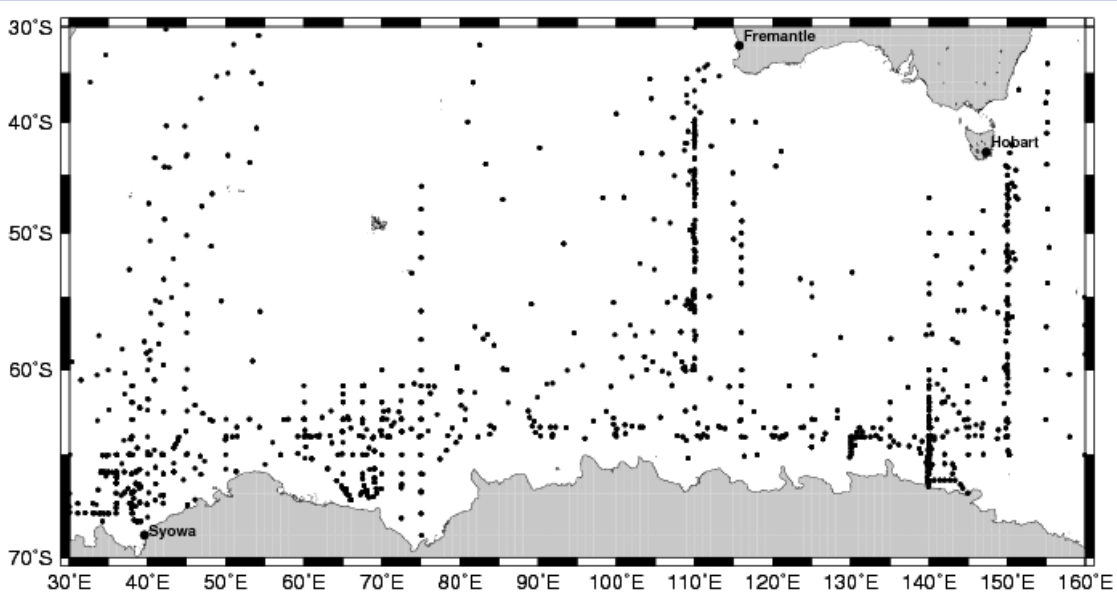
Why Australia-Japan collaboration?

Australia and Japan together make a huge dataset

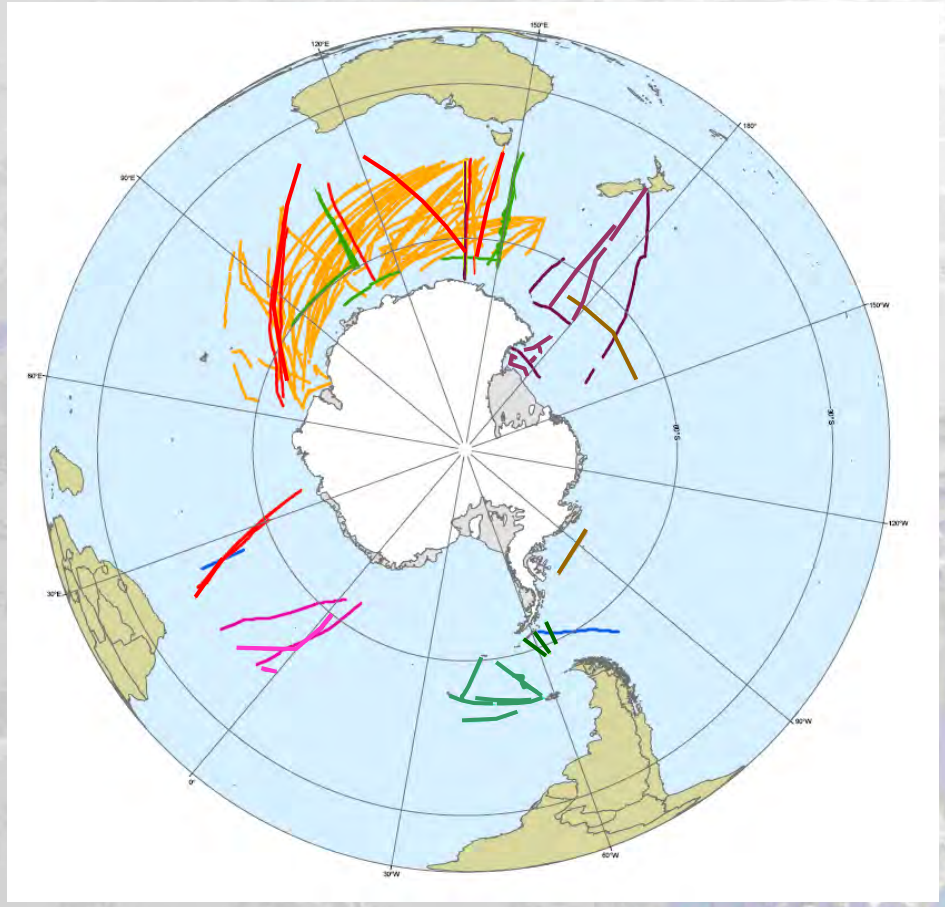
Australian cruises zooplankton were collected



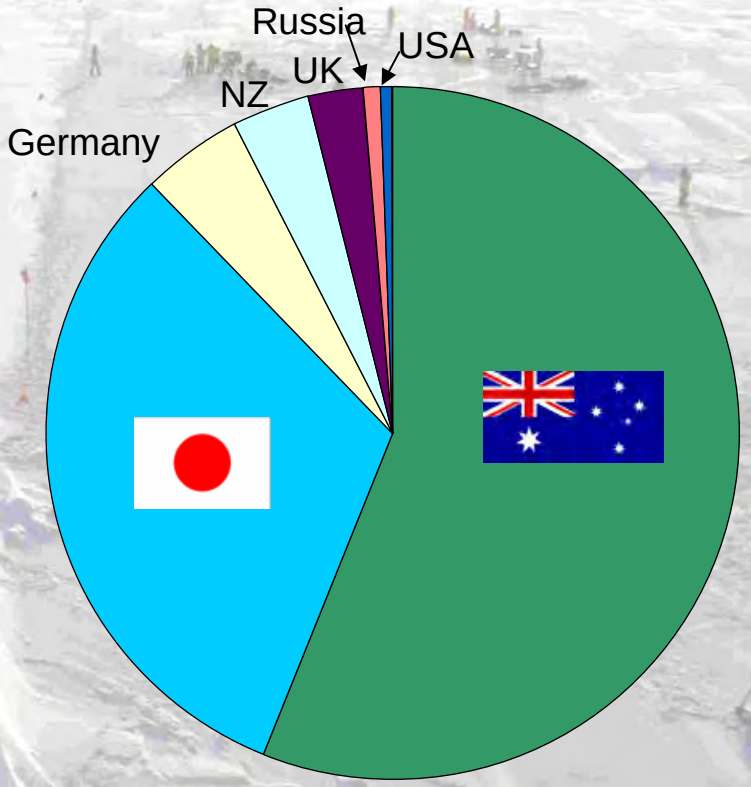
Japanese zooplankton collection stations



CPR Tows 1991-2008



Contribution to SO-CPR Survey



The Collaborative Project

- To construct a comprehensive database on key ecosystem components of the Indian Sector of the Antarctic Ocean.
- Pursued analysis to showcase changes of the zooplankton assemblages and distributions in relation to changes in the ocean frontal structure.

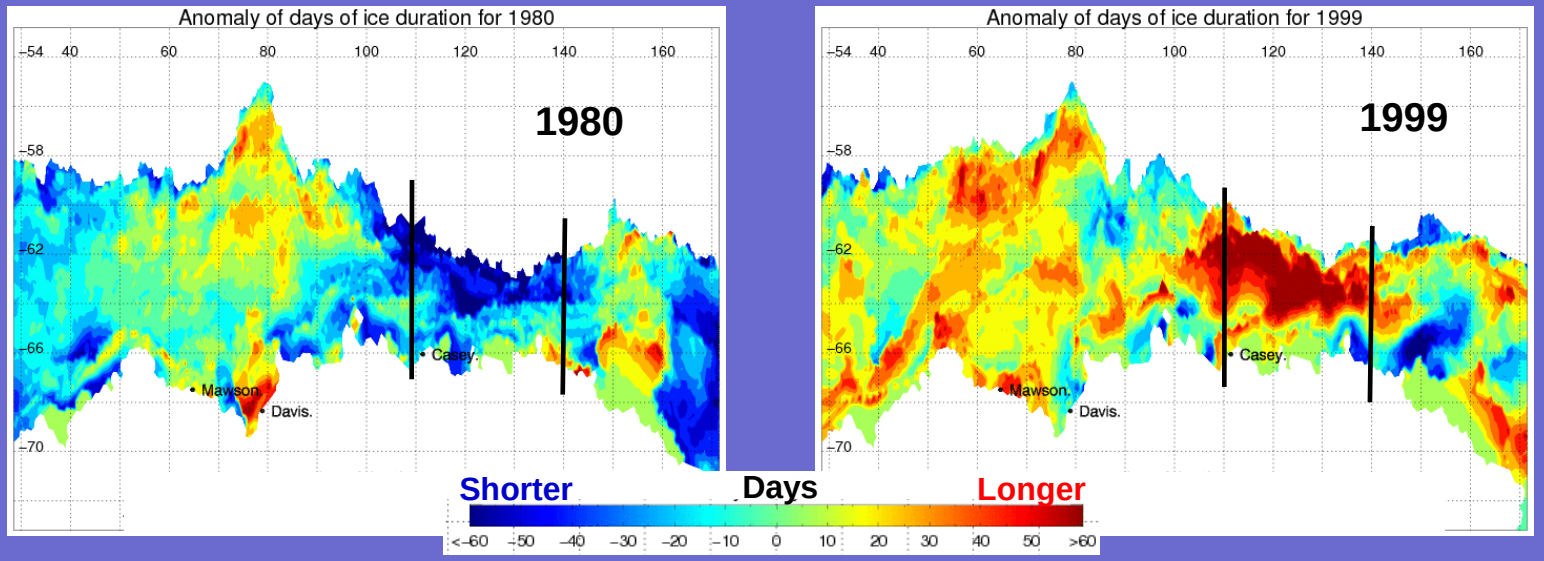
General processing for compiling database (net haul data)

- recover historical data
- standardized as much as possible
  - trawl types (routine, target, etc) by depth profile and gear, split-routine trawls merged
  - taxonomy
  - recalculation of volumes where possible
- error checking
- entered missing data from paper records
- Analysed bottle samples that have not yet been analysed.
- reformatted to standardized templates

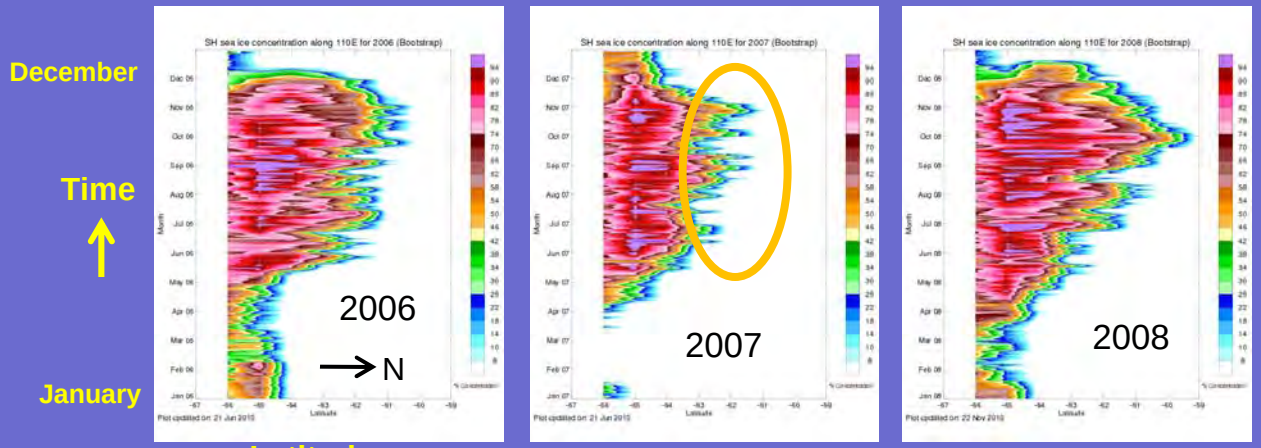
Project outcomes

Some examples of trends and change observed, and the way forward

N.B. Certain years similar in terms of areal coverage ("extent")
BUT very different in terms of seasonality e.g. Duration in 1980 v 1999



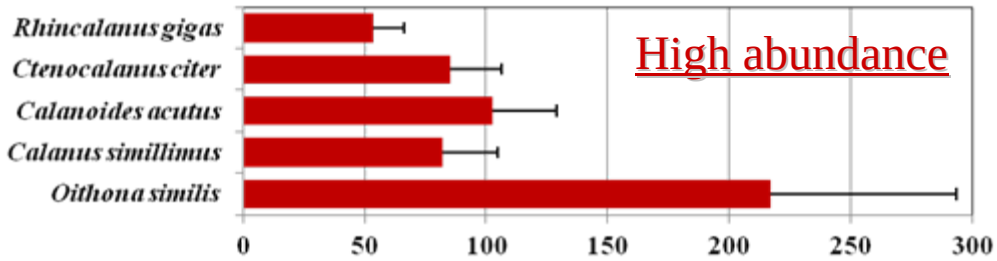
High degree of interannual variability reflected in annual cycles (ice concentration)
e.g. along long-term biological transect 110°E:



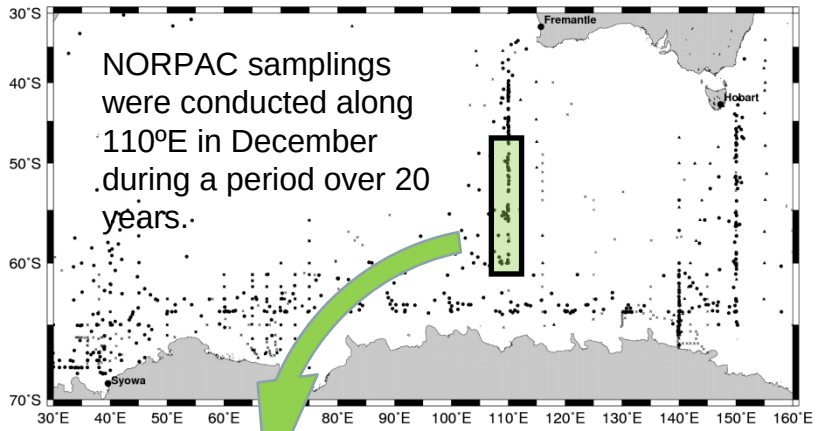
Synoptic variability – passage of storms – rapid change in ice edge zone

Rob Massom (AAD)

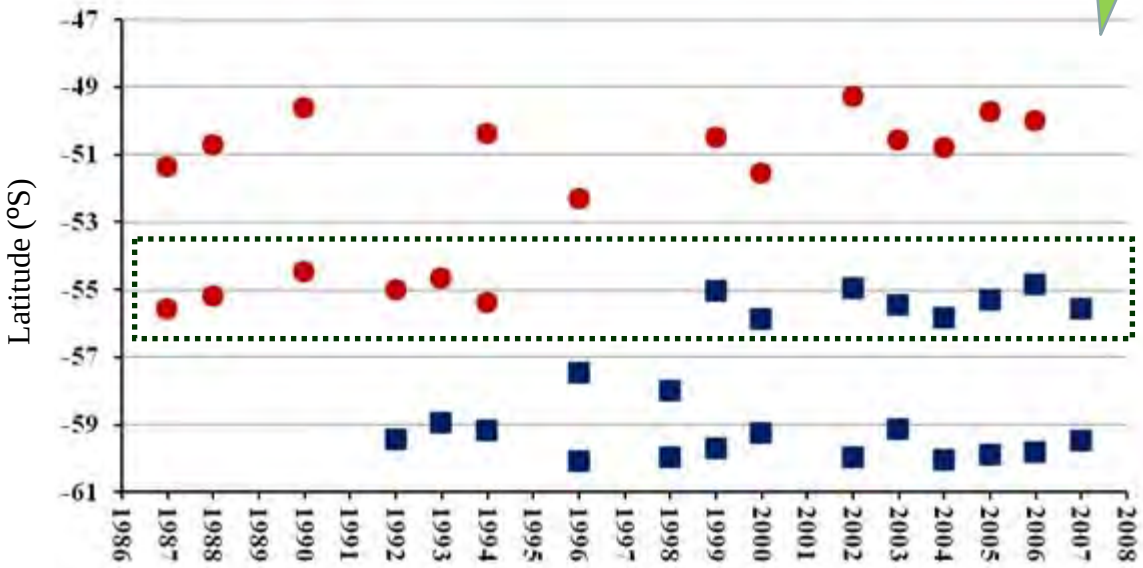
Variability of zooplankton in 110ºE transect



Abundance of dominant **copepods** (ind/m^3)



Group A

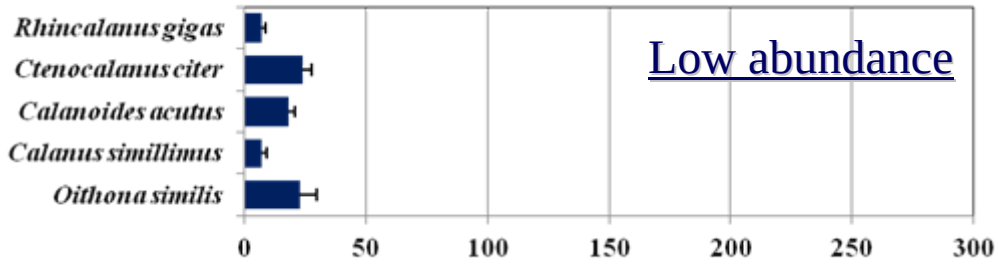


Shift in zooplankton abundance in 55ºS from late 1990s.

Group B

Cluster grouping of zooplankton in 110ºE transect
- 41 samples from 1987 to 2007
- 330μm mesh samples
- 72 categories classified

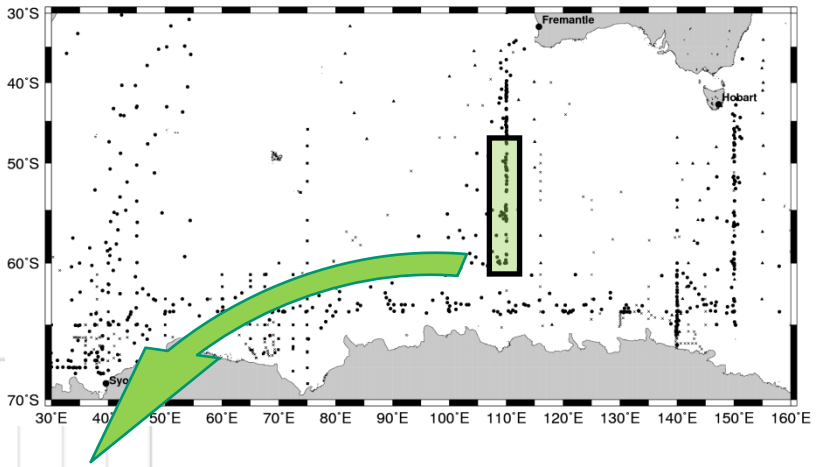
Two major groups (A & B) were divided.



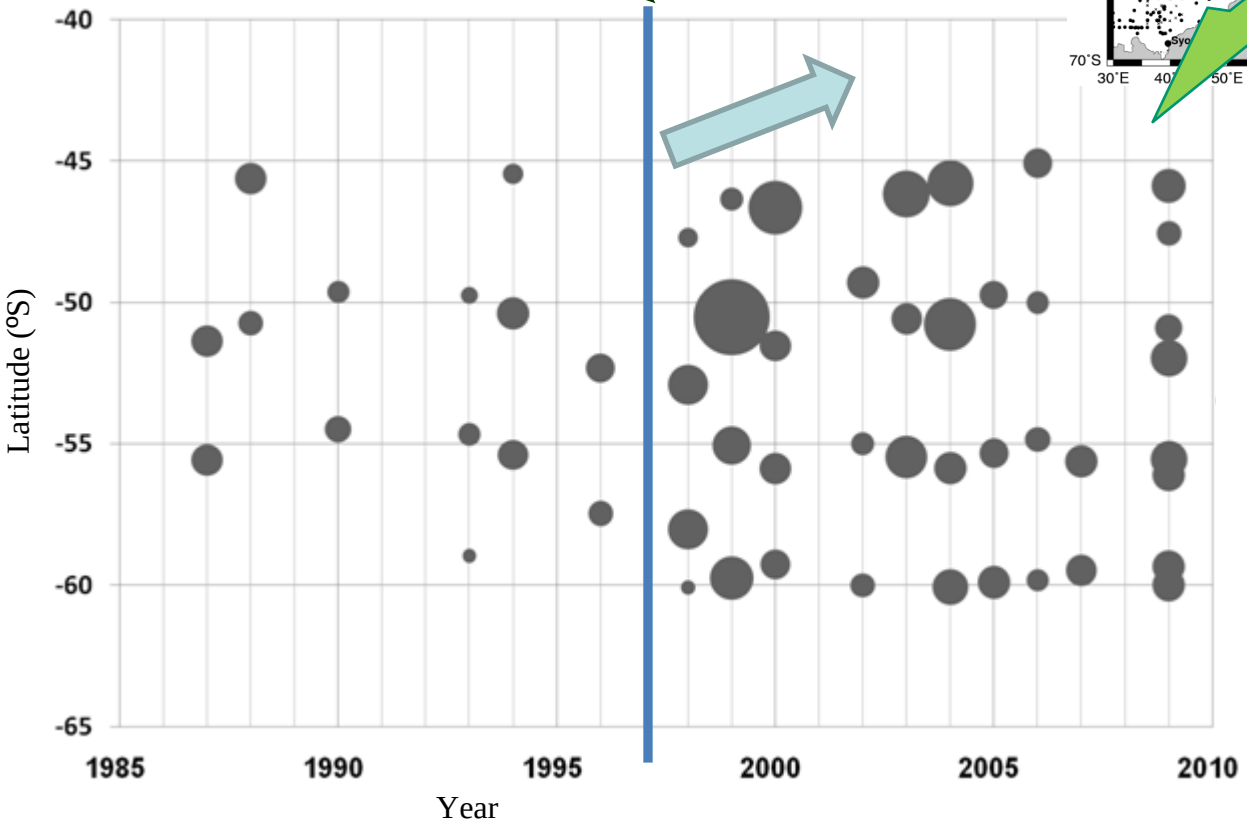
Abundance of dominant **copepods** (ind/m^3)

Kunio Takahashi(NIPR)

Variability of chlorophyll in 110ºE transect



Increasing chl-a from 1998



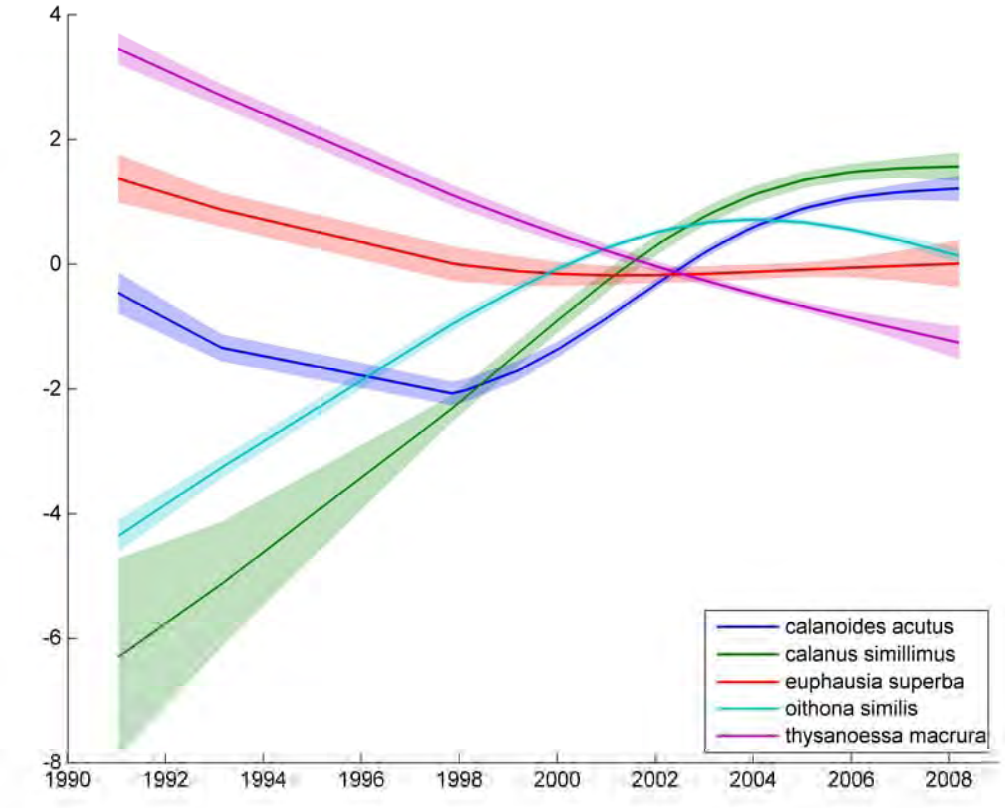
●Vertical integrated (0-100m) Chl-*a* concentration (mgm^{-3})

We do not know
-whether this change is re
-what caused the change.

in situ chrolophyll measurements on board “Shirase”

Takahiro Iida (NIPR)

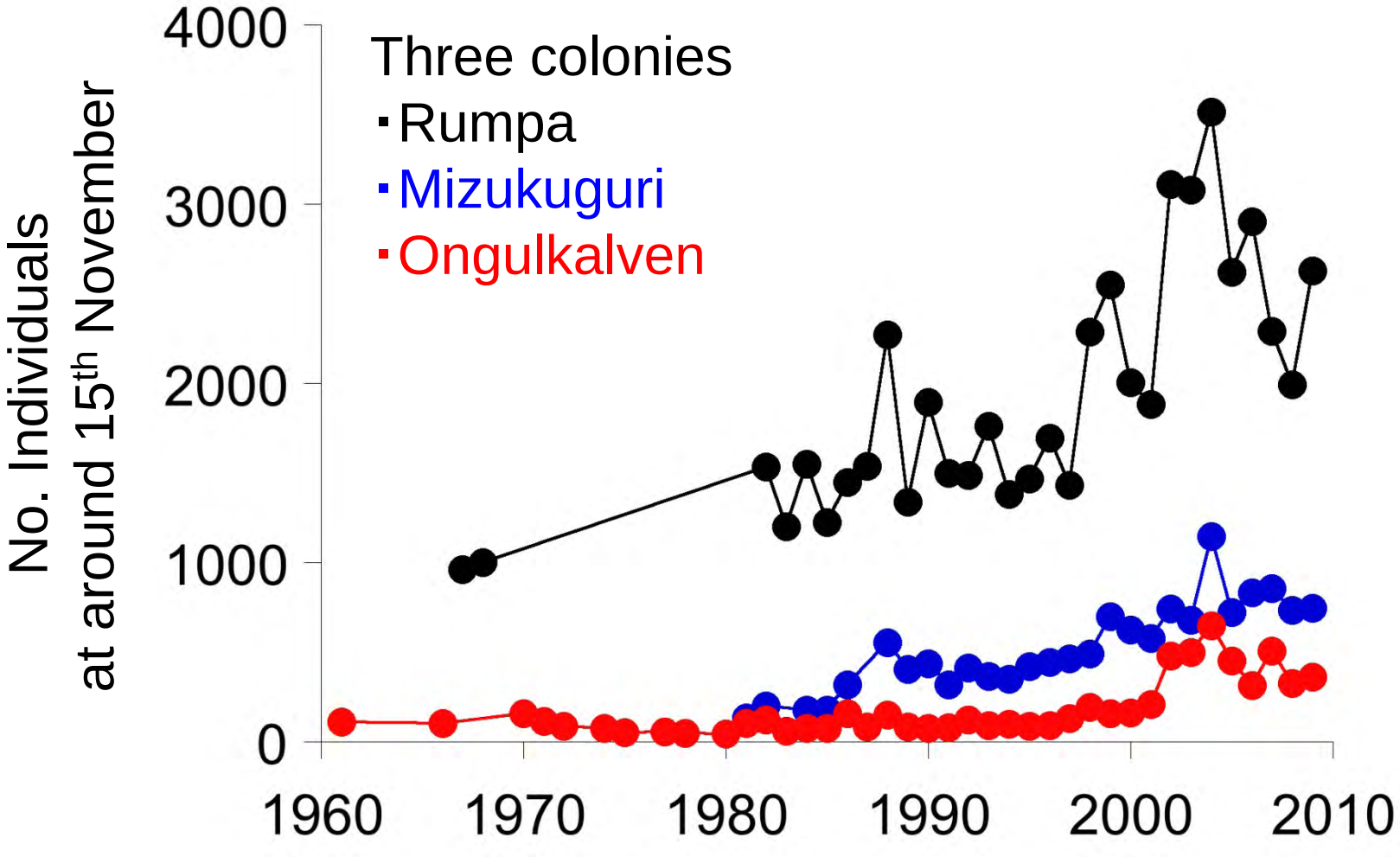
ZOOPLANKTON CHANGES OVER TIME – SEA ICE ZONE (CPR DATA)



Hosie (AAD)

Trends in Adelie populations

(an example near Syowa)



(Data in Kato et al. 2006 Polar Biosci., and NIPR unpublished)

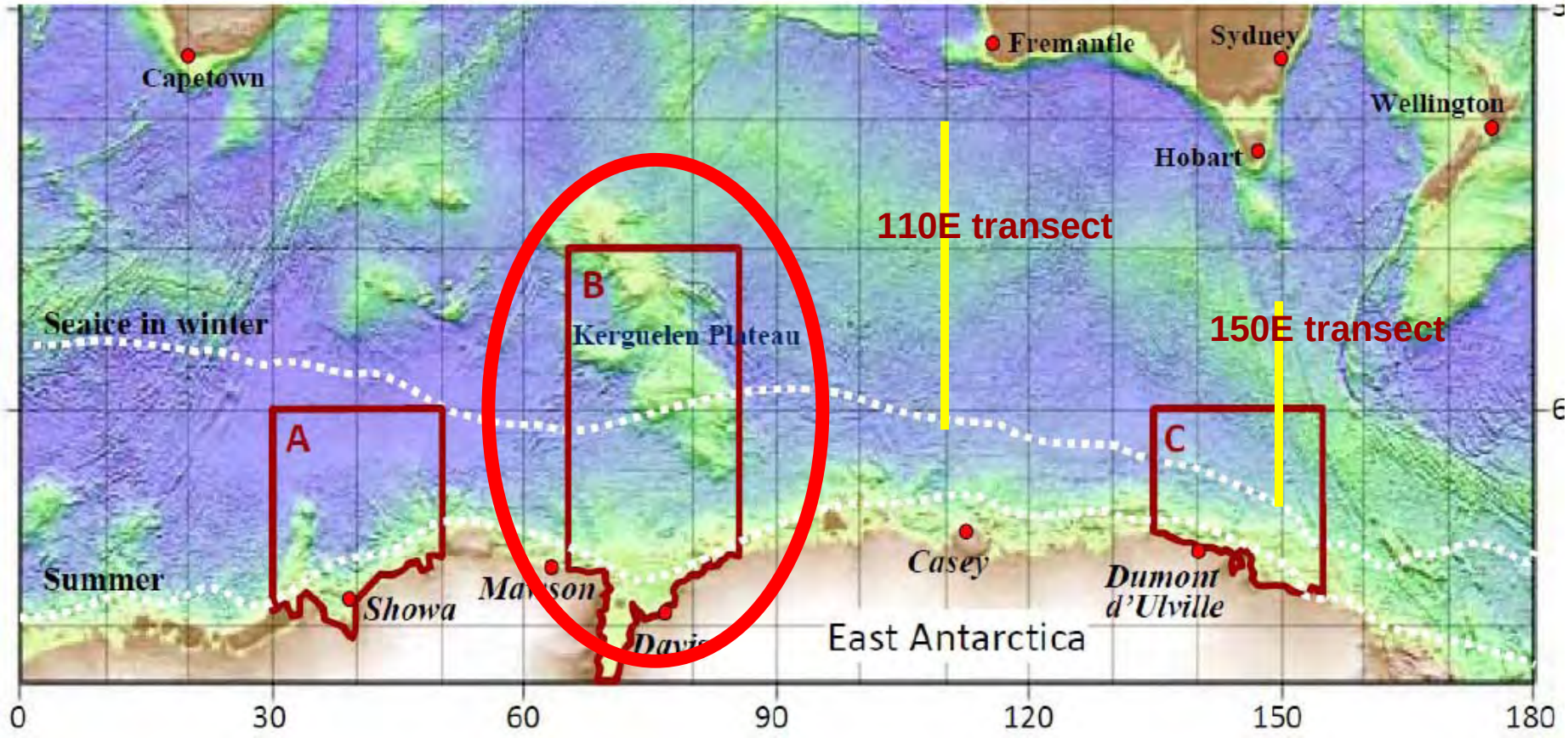
Detected changes

1) Strong decal variability from sea ice and from early satellite data.
2) Further significant and interesting patterns were detected in various components of the ecosystem
3) Processes linking these signals are far from clear
4) Not enough to draw definite trends or change.
5) Need to further pursue synthesis of existing datasets to make connections between these observed signals

Next Step: Strategic monitoring

- *Is it OK to carry on collecting these data in the same manner?*
- *Are the collected data good enough to answer burning scientific questions?*
- *Science Questions*
  - *What are the current state of ecosystem?*
  - *What are the ecosystem response to physical change?*
- *Strategy*
  - *Areas, transects. Where, when, how often?*
  - *Monitoring and intensive process study*
- *Coordination needed at a higher level*

Where to strategically target??



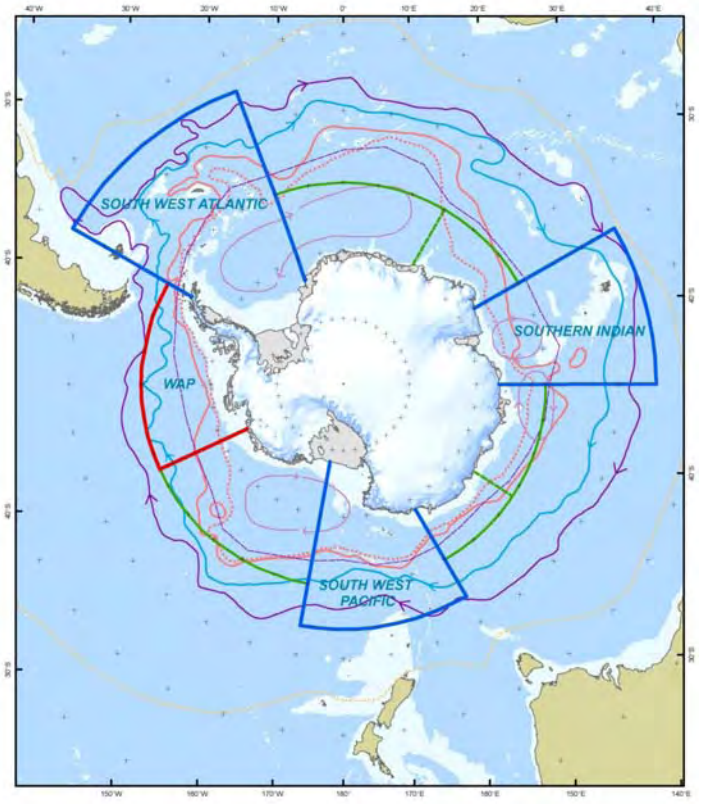
- High productivity associated with Kerguelen plateau
- Frontal system rapidly shifting southwards
- Includes both krill (High latitude) and fish (Subantarctic) based ecosystems within the area
- Area of mutual interest (Australia, Japan, France)

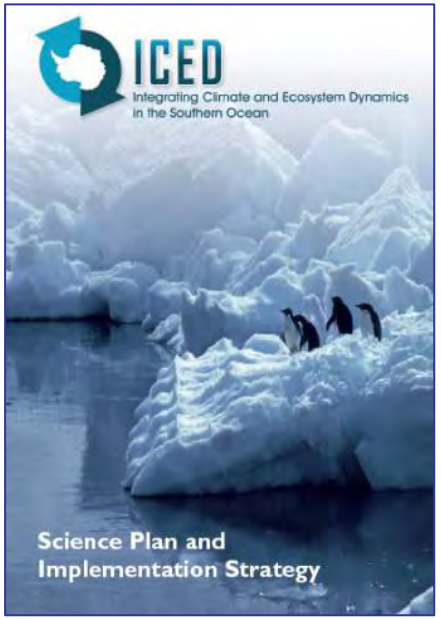

Southern Ocean Sentinel

SOUTHERN OCEAN SENTINEL

GOAL

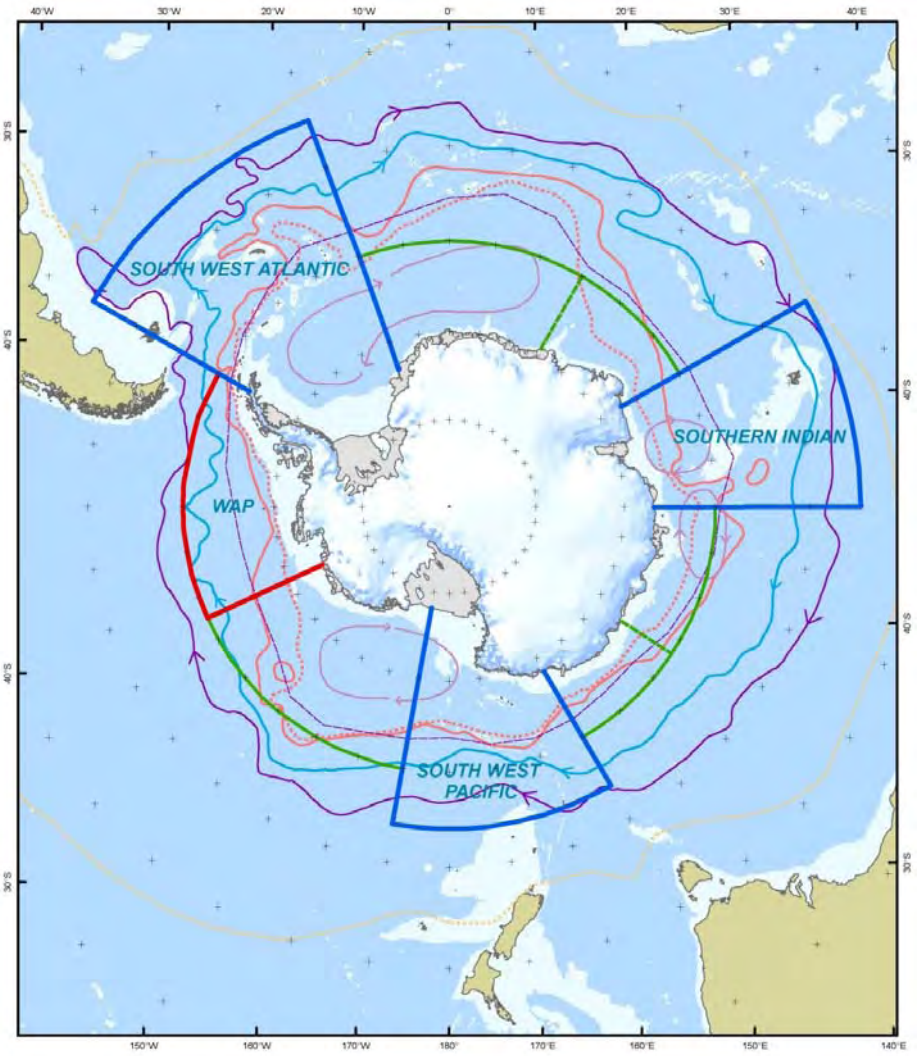
Estimate status of Southern Ocean ecosystems and trajectories of change, accounting for regional, seasonal and inter-annual variation





The Southern Ocean as a natural laboratory

- **Advance warning**
- **Model validation** through regional differences
- Potential to measure ecosystem change in the **absence of direct effects**
- Simplified food web to **test consequences** of climate change
- Management of regional activities requires **measures of regional change**
- Concurrent measures across SO allows **relating local scale studies** (observations/time series)



Southern Ocean Sentinel

Program of work toward benchmarking

Assessment models (2011-2015)

Indicators (2012-2016)

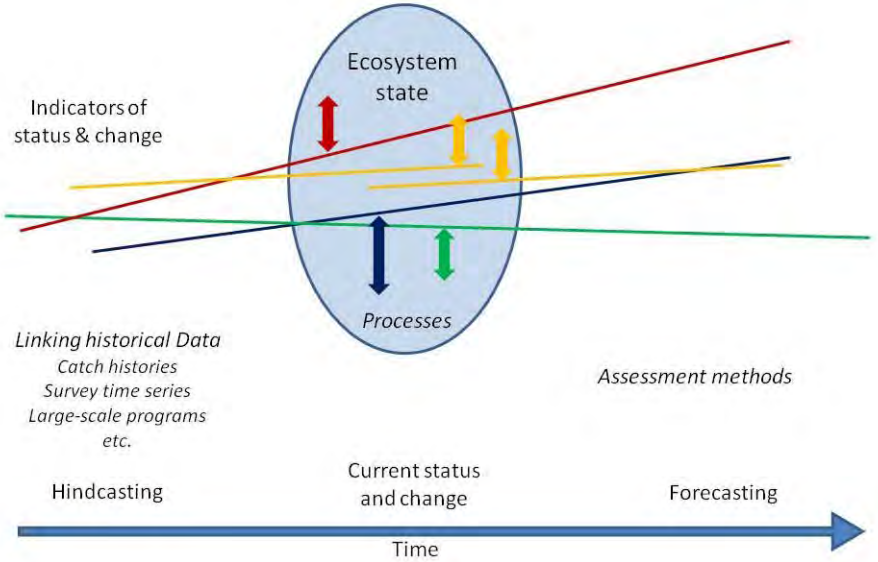
- validation
- methods

Design (2013-2017)

- levels of measurements
- pilot work (transect choice)

Implementation (2014-2018)

Benchmark current status (2020)



For more information contact:
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Concluding Remarks

- Furthter need to link various signals detected from historical data (understand the processes behind)
- Standardisation of methods for future monitoring and observation
- Strategic distribution of the efforts important
- High level coordination essential for effective monitoring within limited resources


Thank you
31.01.2006