Recent developments & forthcoming international activities in the study of multiple stressors

Philip Boyd, NIWA/Univ. of Otago, New Zealand

commentary

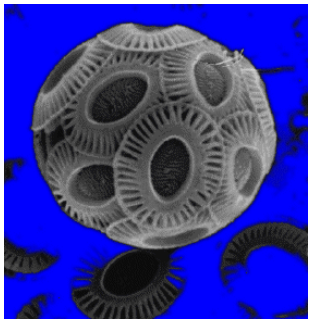
Beyond ocean acidification

Philip W. Boyd

N. Gruber - *Phil Trans R Soc. A* **2011**

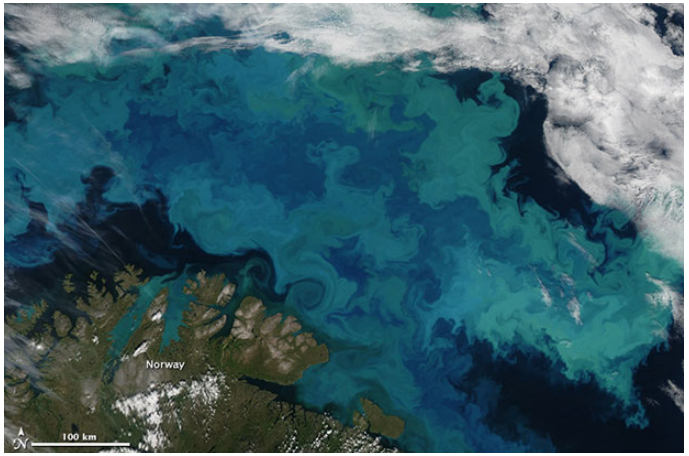
Warming up, turning sour, losing breath: ocean biogeochemistry under global change

Awareness of the role of multiple stressors on oceanic biota is evident for at least a decade



"The impact of such forcing (i.e. increased stratification etc.) on the distributions of coccolithophorids must be reconciled with that of increased pCO_2 on their physiology …

although calcification rates may decrease significantly in response to elevated atmospheric CO_2 levels, these changes may be offset if the incidence of coccolithophore blooms was to increase significantly due to the impact of other oceanic forcing." [Boyd & Doney, 2003]



Single stressor vs. Multiple stressor research

Research facet	Single Stressor	Multiple Stressor
Implementation	Less difficult	Difficult
Communication	Interpretation is less complex	Complex findings
Funding	Long term	Longer term
Outreach	Readily conveyed	Difficult to simplify
Scope	Broad	Broadest
Pertinence	High	Highest

Challenges

Nebulous

Daunting

Building a research community & developing methodologies

Engaging research & government agencies

Modelling

Benefits

‘The real deal’ - the most pertinent and holistic research

Multiple Stressors & Oceanic Biota – examples of prior work

Special session on Global environmental change at ASLO (2009 Nice)

Evolution and Climate Change in the Oceans (ECCO)

The first ECCO workshop, held on May 2010, addressed the issue of adaptation and evolution in marine organisms in response to global change.

Special sessions on Global environmental change:
AGU/ASLO Ocean Sciences (2010 Portland)

AGU/TOS/ASLO Ocean Sciences (2012 Salt Lake City)

Building a research community

Thematic Section of MEPS on Multiple Stressors
(published late 2012)

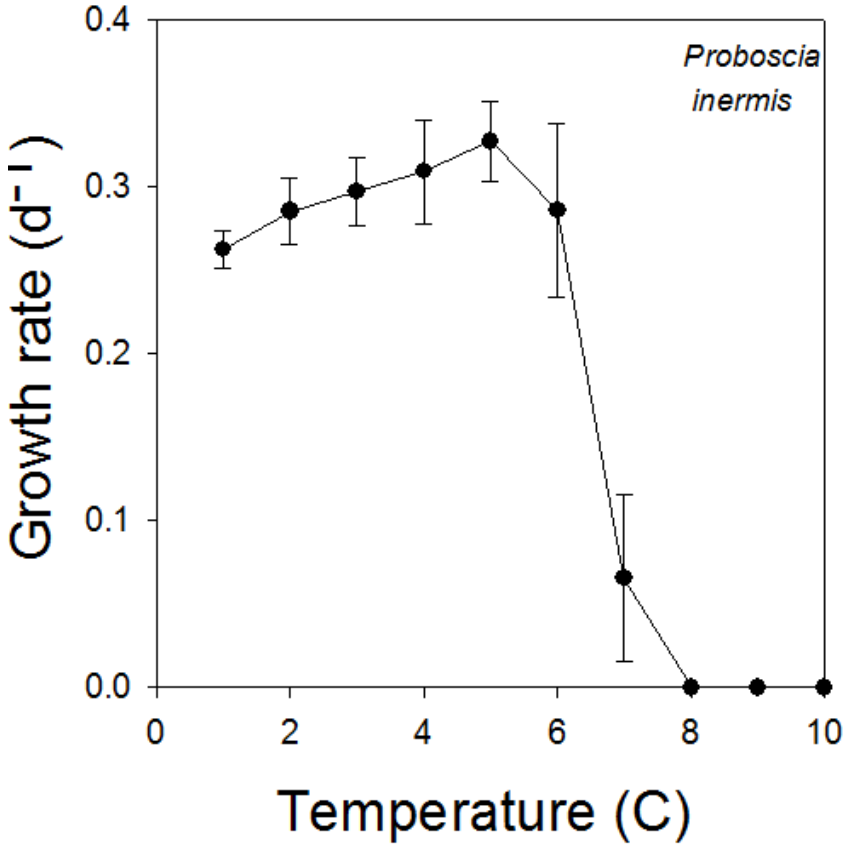
Including:
Synthesis of research from lacustrine, coastal, terrestrial and 'ecotox' research on multiple stressors

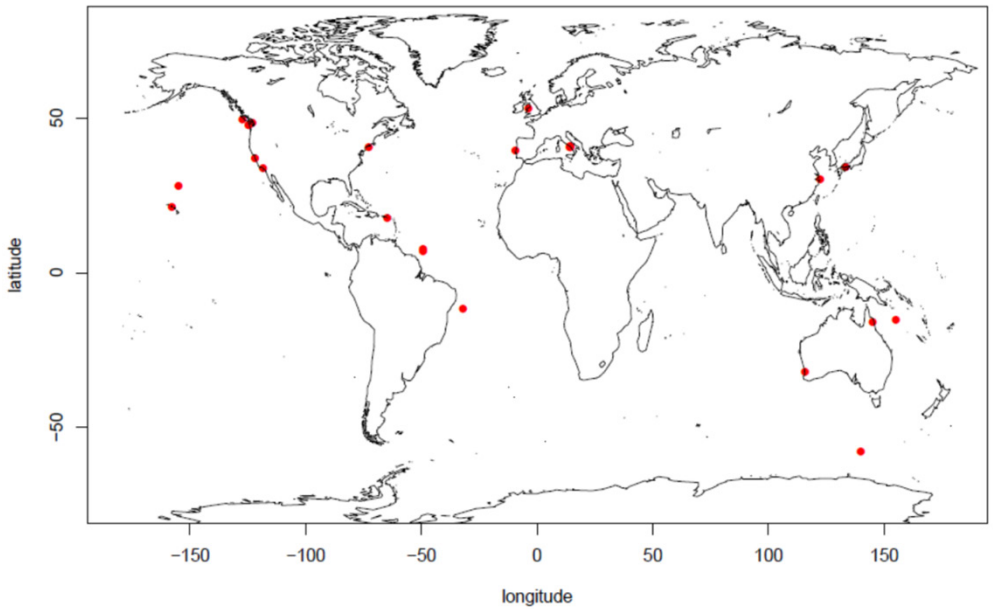
HAB's and stressors
Alteration of the biological pump
Drivers of calcification

Interplay of environmental change and marine harvesting
Synergisms & Antagonisms - Light, CO_2, nutrients
Multiple trophic levels – differential susceptibility
Functional traits and trade-offs

Introducing community-wide initiatives

"Its takes a village to finish science these days" NIH Human Microbiome Project





Species & strains from coastal to offshore
From polar to tropical – 8 labs
Common protocols – goodwill unfunded research as a pilot project

Boyd et al. (submitted)

Bringing disparate research communities together

Oceanographers and experimental evolutionary biologists

New model systems for experimental evolution

Focus on marine model systems (e.g. coccolithophores & dinoflagellates)

Also includes:

- systems from developmental biology
- Artificial systems (PCR-based evolution)
- Wild versions of well-studied systems (yeast)

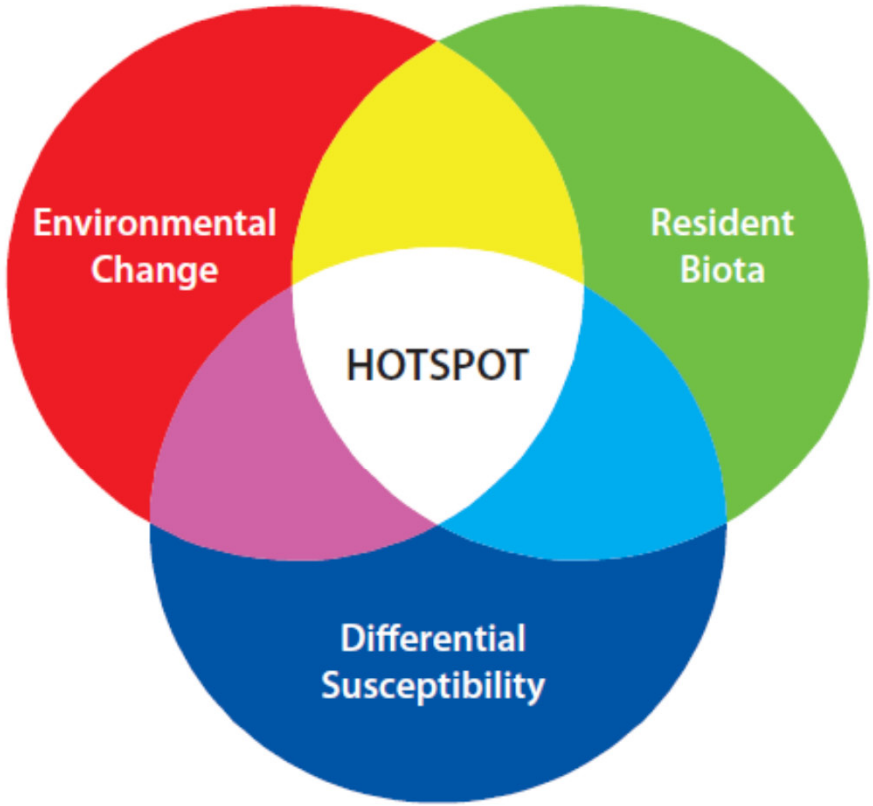
Publication date:

Winter 2012

Special section of Evolution
edited by Sinéad Collins
(University of Edinburgh)

Communicating the implications of multiple stressor research to policy makers

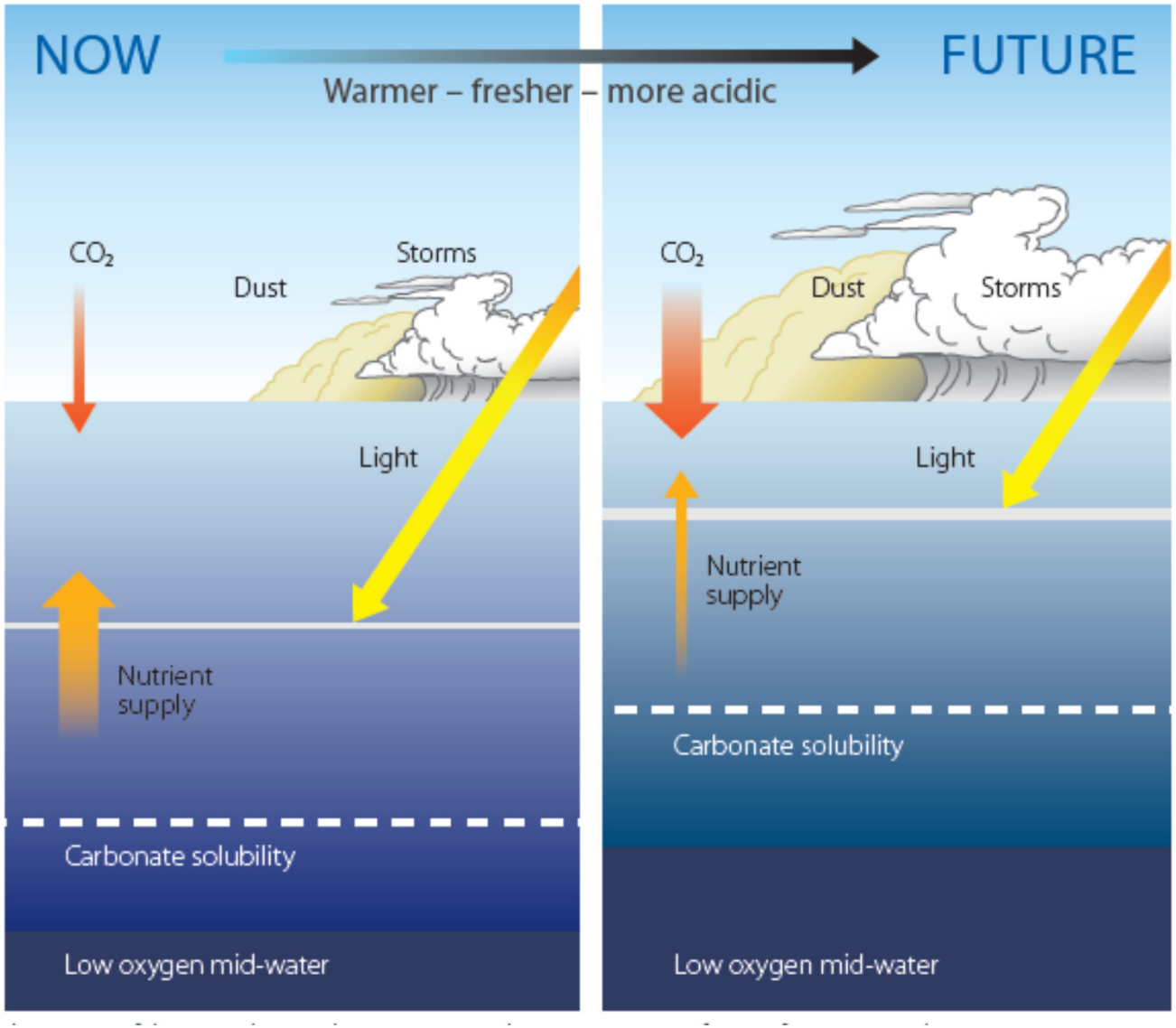
A Climate Change Atlas for the Ocean



Boyd, Law & Doney (2011)

Communication to policy makers

Synthesis of the multiple stressor literature in **IPCC AR5 WG2 chapter 6**



Boyd & Law (2011)

Forthcoming fora for multiple stressor research

Two Gordon Research Conferences

On Multiple Stressors and Oceanic Biota

The GRC was jointly proposed by the OA community and the fledgling multiple stressors community

David Hutchins, Adina Paytan, Shannon Meseck and myself

2014 Chair David Hutchins

2016 Chair Philip Boyd

And with the strong possibility of further GRC's on this topic…….

The Future

commentary

Beyond ocean acidification

Philip W. Boyd

Grasping the nettle

"A decade of research into ocean acidification has provided more than just scientific insights. It has demonstrated clearly the power of building a dedicated research community that can communicate its findings far beyond the traditional scientific audience."

The Challenges

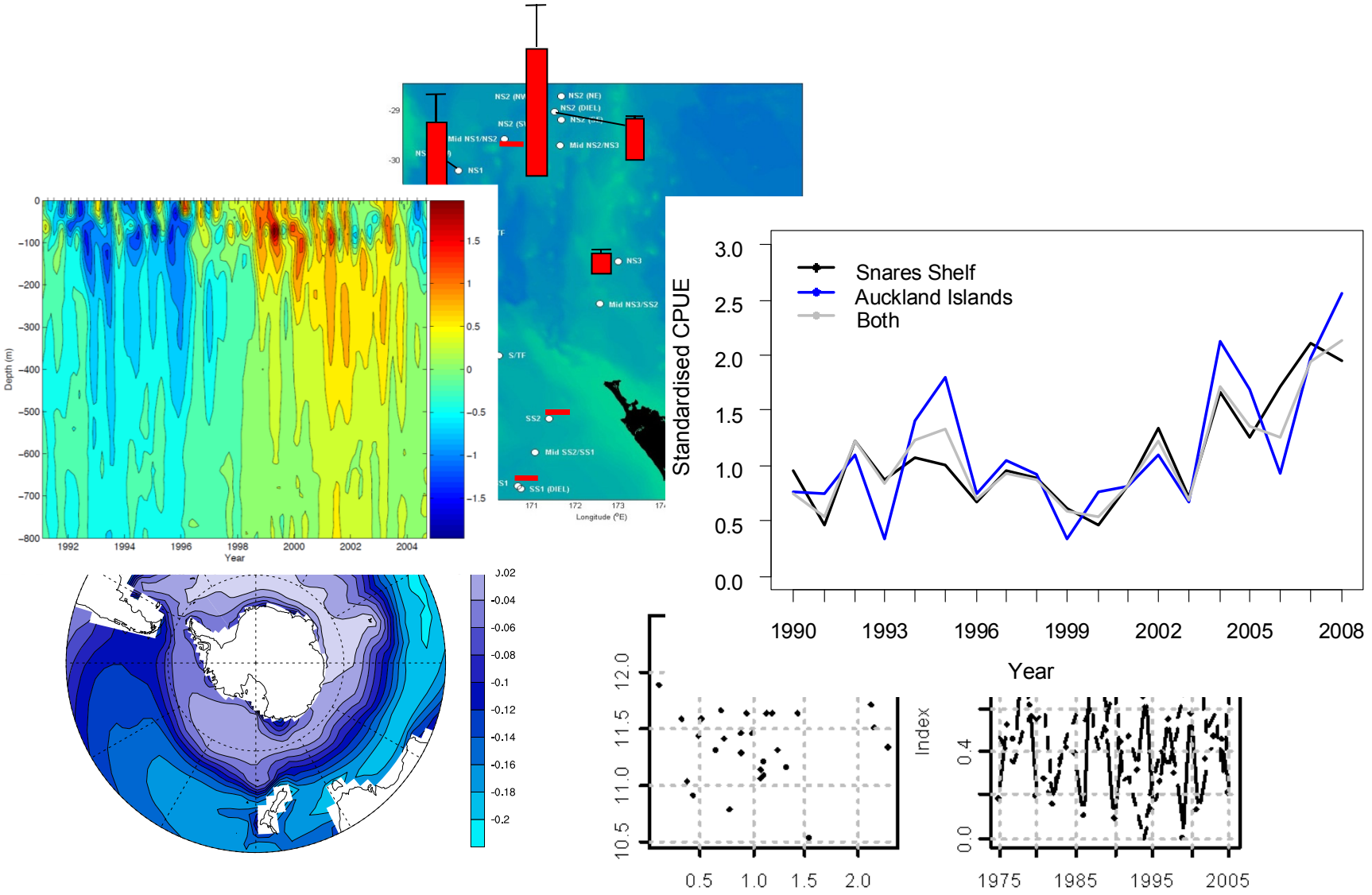
Single stressor research – like OA or iron-enrichments – has been an essential test-bed, but multiple stressor research is a huge step-up.

MS reseach is not so much a broad church as a Cathedral that will test our skills of collegiality and community more so that any time in the past.

We have to learn to do our science in a new way – as other research communities are doing – if we are to advance at a rate as unprecedented as the problem……

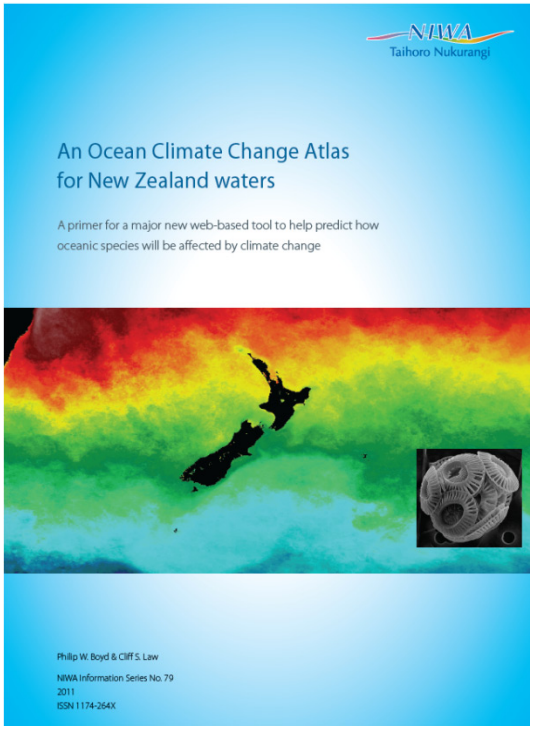
GEC – Integration & Outreach

Global Environmental Change research will generate ever larger amounts of data from a many sources – how can we integrate these datasets?



We propose a Climate Change Atlas as such an integrator

The multi-faceted roles of a www.atlas



- An archive of previously funded research findings
- A repository for future datasets and conceptual advances
- An umbrella for different ocean interest groups
- A record to compare new findings with
- A catalogue to fuel question-driven policy issues
- A tool to reveal important research gaps