Internet Appendix A18: Climate Change
Figure A18.1 Topic: Illustrative Pitch on Sea temperatures

Pitcher's name	Marita Smith
(A) Working Title	Molecular biomarker records of Australian sea-surface temperatures over the past five centuries
(B) Basic Research Question	What is the change in temperature of Australia's oceans using biomarker records?
(C) Key paper(s)	• Brassell, S. C., Eglinton, G., Marlowe, I. T., Pflaumann, U. & Sarnthein, M. (1986). Molecular stratigraphy: a new tool for climatic assessment. *Nature*, 320, 129 – 133. • Hendy, E. J., Gagan, M. K., Alibert, C. A., McCulloch, M. T., Lough, J. M. & Isdale, P. J. (2002). Abrupt Decrease in Tropical Pacific Sea Surface Salinity at End of Little Ice Age. *Science*, 295, 1511 – 1514. • Schouten, S., Hopmans, E. C., Schefuß, E. & Sinninghe Damsté, J. S. Distributional variations in marine crenarchaeotal membrane lipids: a new tool for reconstructing ancient sea water temperatures? *Earth and Planetary Science Letters,* 204, 265-274
(D) Motivation/Puzzle	The few climate records available show major differences in the timing of climate changes between the northern and southern hemispheres over the last millennium. Instrumental records in the southern hemisphere are only available for the last century, and reconstructed records are based on ancient core samples taken near Antarctica or the equator. None of these provide relevant climate information for the last several centuries. There is a distinct need to analyse new climate data for the Australian region to assess global climate changes.
THREE	Three core aspects of any empirical research project i.e. the "iDioTs" guide
(E) Idea?	The 'hockey-stick' temperature increase of the 20th century has instigated concern for a global warming trend. In order to investigate this temperature increase, it is necessary to derive high-resolution temperature records that span the last several centuries. Currently, data from this period is sourced almost exclusively from the Northern Hemisphere, predominantly from terrestrial records. There is a considerable lack of temperature records for the Southern Hemisphere, making analysis of hemispheric and global trends in temperature changes difficult. The lipids of specific haptophyte marine algae (alkenones) and marine Thaumarchaeota (glycerol dialkyl glycerol tetraethers) in the sedimentary record are biomarkers that may be converted to sea-surface temperature (SST) via the UK'37 and TEX86 proxies, respectively. Recently, the lipids of some eustigmatophyte algae (long chain diols) have been proposed as an additional measure of SST via the LDI proxy. These proxies have never been used together to provide new records of temperature. These records would provide an important means of palaeoenvironmental inference for hemispheric and global climatic trends during this period.
(F) Data?	- Data will be sourced from the continental sea-shelf around Australia using the CSIRO *RV Southern Surveyor* and a specially constructed multiple corer. A month-long voyage from Fremantle to Brisbane circumnavigating the southern part of Australia will be undertaken to sample the sea floor at key positions. - Samples will be analysed for specific organic composition and dated using radionuclides

	- Ultimately, a biomarker record of sea-surface temperature would be generated for south-east Australia using three independent biomarker records.
(G) Tools?	Physical apparatus will be necessary, including sampling equipment on-board ship (in particular, the multiple corer device) and analysis equipment (Gas Chromatogaph-Mass Spectrometer and Liquid Chromatograph-Mass Spectrometer). Records of specific organic compounds will be generated using laboratory work and chromatograph software used to provide raw data for generating biomarker records as per literature formulas.
TWO	Two key questions
(H) What's New?	There are no existing climate records for the Australian region over the last few centuries. This project will generate three independent measures of sea-surface temperature to provide important data for analysis of climate change to rectify this gap. This is the first project to combine these biomarker proxies. Thus, it provides an important means of palaeoenvironmental inference for period. The DATA will be completely new, and provide avenues for further research that can be compared to the results of this project.
(I) So What?	Currently, data for climate change models is a hot commodity. New data, particularly in Australia, will provide completely novel records of temperature change to rectify a gap in the scientific literature. This data will inform future management of Australia's oceans and potentially affect policy on carbon emissions and trading.
ONE	One bottom line
(J) Contribution	Primary source of the contribution: Raw and processed data in the form of biomarker temperature records is the primary contribution. Changes in temperature over the past several centuries will be assessed from a climatic standpoint in relation to world-wide fluctuations.
(K) Other considerations	Is Collaboration needed/desirable? -Idea: no; -Data; yes – multi-disciplinary and multi-institutional -Tools; yes – CSIRO, representatives and funding from various institutions Target journals – *Nature, Nature Climate Change* "Risk" assessment: -"no result" risk: Extremely low. With three independent sources of biomarker records, it is extremely unlikely that no results would be obtained. Even if all three records indicated minimal temperature change, this would be an important result to indicate that northern hemisphere rates of warming are non-comparable to southern hemisphere -"competitor risk"(i.e. being beaten by a competitor): Low. Only the ANU has the facilities for this kind of research in Australia, and there is a distinct lack of Australian core samples. Thus, no available study material means no competition. -risk of "obsolescence": Low. Climate change is a hot topic, with demand for new, modern records of temperature change world-wide.

Figure A18.2 Topic: Illustrative Pitch on sustainable systems/consumer behaviour

Pitcher's Name	Saphira Rekker
(A) Working Title	"Converting planetary boundaries into action: A new approach to meeting global greenhouse gas targets"
(B) Basic Research Question	How can we use scientific planetary boundaries on greenhouse gas emissions as a tool to create guidelines for individuals to take action?
(C) Key paper(s)	Rockstrom, J., Steffen, W., Noone, K., Persson, A., Chapin, F. l., Lambin, E., et al. (2009). Planteary boundaries: exploring the safe operating space for humanity. Ecology and society , 14 (2).
(D) Motivation/Puzzle	Targets for global greenhouse gas emissions have been set by scientists, engineers and economists, to avoid the most severe consequences of climate change. However achieving these targets is a "wicked problem", i.e. a unique and complex problem, constantly changing, involving multiple stakeholders with conflicting interests and certitudes. Currently there is an essential link missing in the literature that translates theory into practice. While multiple schemes exist to engage industry and government, little recognition has been given to the role of individuals in reducing greenhouse gas emissions. Hence, there is a need for practical tools that help individuals to reduce emissions to a 'fair-share' level. Herewith, this project addresses the global challenge of greenhouse gas (GHG) emissions reduction from a completely new angle. It uses a bottom up approach, using economic theory and scientific data.
THREE	**Three** core aspects of any empirical research project i.e. the "**ID**io**T**s" guide
(E) Idea?	This project addresses the global challenge of greenhouse gas (GHG) emissions reduction from a completely new angle. It uses a bottom up approach, using economic theory and scientific data. Ultimately the project develops a new tool to drive individuals to reduce GHG emissions associated with their consumption. Existing scientific knowledge is used to calculate individual quotas and lays the foundation of this research, currently missing in the literature. When this information is translated for individuals to use, it develops a practical solution to a complex problem, and thus filling a missing but essential piece to address this intractable global problem. By creating awareness about a range of actions that an individual could take-up, presenting the decision about what action to take as a game or app and linked to social networks/media, this research will develop an effective decision-support tool that could be commercialised. Also, the underlying model can be used to develop range of tools to fit different age groups and lifestyles.
(F) Data?	- Use available data on GHG emissions of production and consumption, and calculate individual GHG emission quotas (based on global emission targets) using GHG emission accounting techniques. The global Trade Analysts Project Database provides per capita CO_2 emissions of 8 different consumption categories for all countries. Prices of this database are $1080, should be able to get funding. Research by Rockstrom et al. (2009) provide calculations of global emission boundaries for our planet. - Ultimately the emissions per consumption category per capita would be calculated in a universal way, though as of yet this data varies per country, so as a starting point we would use Australian CO_2 emissions per consumption category.
(G) Tools?	An optimization model will be developed and applied to determine how the constraint of this individual quota can be met to reduce GHG emissions globally, given constraints and meaningful options for individuals. Economic modelling (including input---output techniques) and systems dynamics will be used to identify an (a most) optimal solution based on emission constraints. Development of software that utilizes the optimization model that can be 'played' by the individual according to his/her preferences, motivated by incentives and meeting the emission constraints. This final stage is constructed using economic theory (e.g. game theory) and psychology on consumer behaviour. The underlying model of the software, can be used to develop several applications to create a change in consumption behaviour.
TWO	**Two** key questions
(H) What's New?	The research will be distinctive in that carbon footprints of individuals are compared to scientifically determined limits to CO_2 emissions. These limits outline

	how much we can emit if we want to keep living in a 'safe human operating space' – and live life as we know it. These scientific limits are only known recently and there is <u>no research as of yet that translates these planetary limits into individual's consumption</u> patterns and thus into how to take practical and effective action into meeting these targets (individuals being one of the multiple parties playing a role in meeting these targets). Economic theory and psychology on consumer behaviour provide insight on how to best design a practical tool to assist individual consumer's decision-making. This will be a software game or an 'app', possibly linked to social networks/media, that takes into account the individuals' planetary GHG constraints but honours the individuals' freedom of choice to meet this constraint. The tool will aid people to monitor and reduce their emissions, motivated by meeting constraints. It ultimately draws upon natural human behaviour, such as competitive or financial incentives, to make it attractive to a wide range of individuals including those unaware or sceptical of climate change.
(I) So What?	Urgent action should be taken if humans want to avoid the most severe consequences of climate change and individual's play a key role in meeting the CO_2 limits set by scientists.
ONE	**One** bottom line
(J) Contribution?	Using an interdisciplinary approach to calculate individuals' GHG emission quotas and use economic theory and psychology on consumer behaviour to translate this into practical and effective action by individuals.
(K) Other Considerations	As it is very interdisciplinary, collaboration with experts in different fields is necessary. Knowledge needed of ecological processes (natural scientists), software development, programming, economic theory, and psychology. I have little knowledge of relevant journals. As it is interdisciplinary a wider range of journals might be interested. Probably journals in the natural sciences would be most interested.