

EDUCATIONAL PACKAGE ON CLIMATE CHANGE

The Inertia Trap is one of two films produced by Kathryn Kelly on climate change, which form a very useful educational package for science teachers. The other film is coverage of a presentation by the Australian Government's climate change advisor, Professor Will Steffen, at the Australian Academy of Science (the Shine Dome) in Canberra in 2010.

The Inertia Trap is 45 minutes long with an extra 88 minutes of full interviews with Australian Climate Scientists. Professor Will Steffen's presentation, with a Q and A session, is 60 minutes.

The Inertia Trap: climate change and the oceans

This documentary fills a significant gap by providing a wealth of scientific information on climate change and the ocean's hydrological systems.

The film focuses on the relationship between climate change and the oceans – it doesn't try to cover other aspects of climate change, apart from in a brief introductory overview. Rather the scientists you'll hear interviewed in the film explain in graphic terms how increasing ocean heat, changes in currents, sea level rise, ocean acidification and feedback effects in the climate system may affect your life in the not too distant future. The scientists are international leaders in their fields of climate research.

It's not easy for us to find out about the science of climate change without politics intervening. Did you know that more than 90% of the heat from greenhouse gas emissions goes into the oceans, not into the atmosphere? Internationally renowned climate scientists give a clear and easy to understand explanation of the changes happening in the world's oceans.

Nine scientists have contributed to this film, so there is variety in the voices you'll hear as well as interesting and informative overlay footage, graphs, stills and newsclips. The scientists contributing to **the Inertia Trap** are Professor James Hansen, Professor David Karoly, Professor Will Steffen, Dr John Church, Dr Susan Wijffels, Dr Steve Rintoul, Dr Bronte Tilbrook, Dr Tessa Vance and Dr Alistair Hobday.

They talk about the ocean warming at the surface and in its depths, changes in salinity and the knock-on effects that those salinity changes may have on the global overturning circulation. North Western Europe, the UK and Eastern Canada could become colder rather than warmer if the overturning circulation were to slow, even while temperatures elsewhere continue to rise.

Changes to ocean acidity affecting corals and marine creatures with shells or skeletons, melting of glaciers, sea ice and the ice sheets are all discussed and the likely impacts of these changes explained. The serious threats from feedback effects are also discussed. The urgent need to reduce greenhouse gas emissions is clear.

The film has an Australian flavour showing familiar places and all of the scientists in the film are Australian, with the exception of Professor James Hansen of NASA. James Hansen is recognized as one of, if not the, foremost climate scientist in the world.

“We’re facing a planetary emergency and its hard for the public to see this, because you can’t blame any one weather event on climate change ...” James Hansen says and David Karoly explains that Greenland ‘is a very very big iceblock’ and ‘it takes a long time to melt iceblocks’. Will Steffen shows that with a one metre sea level rise and storm surge, while you might be able to have a coffee in the second level of the Brisbane airport, your plane won’t be able to come in or take off because the runway will be under water.

There is hope in the film, but also a message that delay in addressing emissions is not inaction, but rather makes the situation more difficult and dangerous.

The narrator, Dr Janette Lindesay, who is also a climate scientist, introduces the different segments of the film.

The audiences for this film will be secondary and tertiary students and teachers and the general public who want to find out more about the facts surrounding climate change and oceans. Teachers and students will find it a useful adjunct to their environmental science studies. Community groups will find it a valuable educational tool.

The film is organized into six segments:

1. Introductory overview;
2. Ocean heat and ocean currents;
3. Glaciers, ice sheets and sea level rise;
4. Ocean acidification;
5. Feedbacks and tipping points
6. Concluding overview.

These could be watched at different times - each segment could separately form the basis for class discussion.

Presentation by Professor Will Steffen

Professor Will Steffen, in this presentation, provides a comprehensive overview of the climate change challenge. He provides data in relation to global average temperature rise, heat waves and fire frequency, sea ice loss, melting of ice sheets and sea level rise, health impacts such as the spread of dengue fever, as well as emission trajectories.

He also addresses the resistance to acceptance of the problem of climate change and answers questions from the audience, for example, on food production, land management and the influence of sunspot cycles on climate.

The audience for Professor Will Steffen's presentation is the general public, teachers and students.

Professor Will Steffen - Biography

Professor Will Steffen is Executive Director of the ANU Climate Change Institute at the Australian National University (ANU), Canberra, and serves on the Australian Government's Multi-Party Climate Change Committee (MPCCC) and as a Climate Commissioner. He is also Co-Director of the Canberra Urban and Regional Futures (CURF) initiative, a joint venture of ANU and the University of Canberra. From 1998 to mid-2004, Professor Steffen served as Executive Director of the International Geosphere-Biosphere Programme, based in Stockholm, Sweden.

His research spans a broad range within the fields of climate change and Earth System science, with an emphasis on the incorporation of human processes in Earth System modelling and analysis; and on sustainability and climate change, with a focus on urban systems.

59 minutes Filmed March 2010

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The Inertia Trap: climate change and the oceans - A film by Kathryn Kelly

DIRECTOR'S BIOGRAPHY

Kathryn grew up on a sheep and wheat farm at Pinnaroo in the Mallee area of South Australia and completed her secondary education at Woodlands Girls Grammar School and Brighton High School in Adelaide.

She trained as a General Registered Nurse at St Vincent's Hospital in Melbourne, passing with Distinction in 1974. She completed Midwifery training at Lyell McEwin Hospital, Elizabeth, SA, in 1976 and worked as a relief nursing sister at the Aboriginal community, Indulkana, in central Australia.

Moving to Brisbane in 1977 she undertook a Bachelor of Science (Australian Environmental Studies) at Griffith University in Brisbane, completing it in 1981. She joined the Department of Aboriginal Affairs in Canberra as a Graduate Trainee in 1984. She completed a Masters in Environmental Management at ANU in 1998.

In her career in the public service, she was Director of the National Pollutant Inventory Program in Environment Australia and Director of the Gender, Education and Social Development Section in AIDAB (now AusAID). She also worked on the establishment of the Australian Solar Institute in the Department of Resources Energy and Tourism. She has also undertaken training in Alternative Dispute Resolution. She was accepted as a part time Ph D Candidate in Politics at the ANU in 2007. Her Ph D studies are currently suspended.

Kathryn has been involved in politics and environmental issues since the days of the anti-Vietnam war and anti-apartheid movements.

She currently lives in Canberra and has two adult sons.

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The Inertia Trap: climate change and the oceans - A film by Kathryn Kelly

DIRECTOR'S STATEMENT



Climate change is the most serious challenge facing humanity. As more information about the science of climate change has emerged, it's clear that it poses a huge danger to people everywhere and other species on the planet. I'm afraid our consumerism and the short term approach of our political leaders will see people battling floods, fires, drought and sea level rise much more often and make the conditions for animal life on earth extremely tenuous.

I have kids and their future is important to me. Making a film about the science of climate change was, I thought, something I could do. The science of climate change isn't accessible to most people and film is one of the best ways of engaging people on a topic. I'd made a film on Palestine after visiting there in 2002 and so had some experience of filming and editing, and enjoyed it. I decided to try making the film and once it was actually happening, I gave up my job to concentrate on it for the next year or so.

The atmosphere, land and oceans systems are inter-related, and while it's not possible to talk just about the oceans in the overall planetary climate system, limiting the main focus to the oceans made the project more manageable. I wanted to do a film which contained rigorous and important scientific information, but in language which students or others could understand. It's a bit hard to do that without a significant budget (the film is self-funded), but I hope I've achieved the objective.

I've changed directions a few times over my adult life, but politics and the environment have been ongoing areas of interest for me since I first became involved during the anti-Vietnam war protests. Even though it doesn't deal with politics per se and it's been a lot of work, making the Inertia Trap has been one of the most fulfilling things I've done.

I'm older than most first filmmakers but I don't really have any inclination to 'retire'. I want to continue being involved on the climate change issue and I'd be bored sitting on the beach or being a grey nomad. I'd much rather keep doing things which are engaged with the society I live in. I've got a couple of ideas for further films, which I've started to research – that should keep me busy for the next decade or so...

BIOGRAPHIES OF PARTICIPANTS

[In order of their appearance in the film]



DR JANETTE LINDESAY – FILM NARRATOR – is Associate Professor of Climatology at the Fenner School of Environment and Society at the Australian National University, and a Deputy Director of the ANU Climate Change Institute. Dr Lindesay obtained her Honours degree in Geography, Postgraduate Teaching Diploma and Doctorate in statistical and dynamical climatology from the University of the Witwatersrand in Johannesburg, and has worked in academic and research organisations in South Africa, the UK and Australia.

Her principal research interests are in climate variability during the period of instrumental record, and climate change science in relation to vulnerability and adaptation. Her current research focuses on integrating multiple influences on low-frequency fluctuations in Australian rainfall, including the potential for deterministic and dynamical seasonal

forecasting; and on the climatological aspects of bushfires and drought in Australia, and temperature and rainfall trends and extremes.

Dr Lindesay has chaired the Atmosphere Reference Group for the ACT Region State of the Environment Report, and is a former President of the Canberra branch of the Australian Meteorological and Oceanographic Society. In addition to convening and teaching programs and courses in climate science and policy at the ANU she teaches by invitation at the United Nations University in Tokyo, is a member of a number of professional meteorological societies, and is on the editorial boards of two international journals.



PROFESSOR JAMES E HANSEN heads the NASA Goddard Institute for Space Studies in New York City, a part of the Goddard Space Flight Center in Greenbelt, Maryland. He has held this position since 1981. He is also an adjunct professor in the Department of Earth and Environmental Sciences at Columbia University.

Hansen is best known for his research in the field of climatology, his testimony on climate change to congressional committees in 1988 that helped raise broad awareness of global warming, and his advocacy of action to limit the impacts of climate change. In 2009 his book, *Storms of My Grandchildren* was published. Prof Hansen obtained a Bachelor of Arts in Physics and Mathematics with highest

distinction in 1963, a Master of Science in Astronomy in 1965 and a Ph D in Physics, in 1967, all three degrees from the University of Iowa. He participated in the NASA graduate traineeship from 1962 to 1966 and, at the same time, between 1965 and 1966, he was a visiting student at the Institute of Astrophysics at the University of Kyoto and in the Department of Astronomy at the University of Tokyo. Hansen then began work at the Goddard Institute for Space in 1967.

Prof Hansen's research interests include the interpretation of remote sensing of the Earth's atmosphere and surface from satellites. Because of the ability of satellites to monitor the entire globe, they may be one of the most effective ways to monitor and study global change. His other interests include the development of global circulation models to help understand the observed climate trends, and diagnosing human impacts on climate.



DR TESSA VANCE - is a glaciologist who analyses ice cores collected by the Australian Antarctic Division (AAD) and other institutions for trace chemical proxies of climate signals such as storminess, marine biological activity, sea ice variability, volcanic emissions and continental dust transport.

Tessa completed a BSc in marine science at James Cook University (QLD) in North Queensland in 2000, and a PhD at Southern Cross University (NSW) in 2008. Her PhD explored the production of dimethylsulfide, a climatically active trace aerosol, by marine phytoplankton communities in the Southern Ocean and Antarctica. She has worked with the Australian Antarctic Division's Ice Core Climate History group since 2006 on ice core chemistry

and has recently commenced a Post doctoral position with the group examining ice core chemistry for proxies of climate modes and atmospheric circulation. She undertakes field work in Antarctica, and was recently (2008/09) part of an ice-coring expedition to Law Dome near Casey Station, where she lived and worked with seven men in a series of tents. She hopes to return with the AAD ice core group in coming years to retrieve an ice core up to a million years old which should answer some complex questions surrounding climate change. Tessa grew up in North Queensland but these days calls Tasmania home.



PROFESSOR DAVID KAROLY is Professor of Meteorology and ARC Federation Fellow in the School of Earth Sciences at the University of Melbourne.

Professor Karoly is an expert in climate change science and was involved, through several different roles, in the preparation of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in 2007. He is active in research on climate variability and climate change, including greenhouse climate change, stratospheric ozone depletion and inter annual climate variations due to El Niño-Southern Oscillation. Recently, he has been studying the impacts of climate change on weather extremes and their impacts on human and natural systems.

He was Chair of the Premier of Victoria's Climate Change Reference Group during 2008-09 and was invited to join the Australian Government's High Level Coordinating Group on Climate Change Science at the end of 2009. He is also a member of the Wentworth Group of Concerned Scientists and the Australian Academy of Sciences' National Committee on Earth System Science.

Professor Karoly joined the School of Earth Sciences at the University of Melbourne in May 2007 after receiving a Federation Fellowship from the Australian Research Council. From 2003 to 2007, he was the Williams Chair Professor of Meteorology in the School of Meteorology at the University of Oklahoma. During 2001-2002, he was Professor of Meteorology and Head of the School of Mathematical Sciences at Monash University in Melbourne. From August 1995, he was Director of the Cooperative Research Centre for Southern Hemisphere Meteorology at Monash University until it closed in June 2000. In 1993, Professor Karoly received the Meisinger Award from the American Meteorological Society. In 1998, he received the Norbert Gerbier-Mumm International Award from the World Meteorological Organization for a joint research paper with ten international collaborators. In 1999, he was elected a Fellow of the American Meteorological Society for outstanding contributions to the atmospheric sciences over a substantial period of years.

In the early 1970s David Karoly enrolled in applied mathematics at Monash University, but later became interested in meteorology. In 1980 he was awarded a doctorate in Meteorology from the University of Reading, UK.



PROFESSOR WILL STEFFEN – Professor Will Steffen is Executive Director of the ANU Climate Change Institute at the Australian National University (ANU), Canberra, and serves on the Multi-Party Climate Change Committee (MPCCC) and as a Climate Commissioner.

He is also Co-Director of the Canberra Urban and Regional Futures (CURF) initiative, a joint venture of ANU and the University of Canberra.

From 1998 to mid-2004, Steffen served as Executive Director of the International Geosphere-Biosphere Programme, based in Stockholm, Sweden.

His research interests span a broad range within the fields of climate change and Earth System science, with an emphasis on incorporation of human processes in Earth System modelling and analysis; and on sustainability and climate change, with a focus on urban systems.



DR STEVE RINTOUL – Dr Steve Rintoul is a physical oceanographer studying the role of the ocean in the Earth’s climate system, with a particular interest in the Southern Ocean, at CSIRO’s Division of Atmospheric and Marine Research and is an expert on ocean currents and salinity.

Dr Rintoul is internationally recognised as a leading authority on the circulation of the Southern Ocean and how it affects global climate systems. His current interests include:

- ocean currents and how they affect Earth's climate
- the Southern Ocean and the Antarctic Circumpolar Current
- how ocean currents influence sea ice, biogeochemical cycles, and the distribution of biological productivity.

Born and educated in the USA, Dr Rintoul joined the CSIRO Division of Oceanography in Hobart in 1990, where he has been based ever since. He has participated in 14 research voyages, 11 as Chief Scientist, on major expeditions to the Southern, Indian and Pacific Oceans. Dr Rintoul's research has laid the foundation for the growing recognition of the importance of the Southern Ocean in the climate system. For example, he has shown that the Southern Ocean plays a critical role in the global overturning circulation that controls climate. He has made pioneering contributions to understanding the dynamics, structure and variability of the world’s largest ocean current, the Antarctic Circumpolar Current.

His scientific interests are broad, including the interactions between physical, biological and biogeochemical processes in the sea.

Dr Rintoul graduated with Honours in Physics from Harvard College, USA, and obtained his Doctorate from the Massachusetts Institute of Technology-Woods Hole Oceanographic Institution Joint Program, USA. He was elected to the Australian Academy of Science in 2006 and was made a CSIRO Fellow, CSIRO's highest recognition for scientific achievement, in 2007.



DR SUSAN WIJFFELS –is a research scientist at CSIRO’s division of Atmospheric and Marine Research and an expert on ocean heat and ocean salinity.

Dr Susan Wijffels is recognised for her international and national leadership in the design, implementation and exploitation of the Global Ocean Observing System. Dr Wijffels leads the CSIRO Wealth from Oceans Flagship's ocean observing system and operational modelling research. In addition, her current projects include:

- investigating variability of the Indonesian Throughflow and its role in climate (the international INSTANT project and follow-on long term monitoring via the Integrated Marine Observing System), and improving its representation in climate models

- leading Australia’s contribution to the global Argo project and co-chairing the International Argo Steering Team
- quantifying global ocean change over the past 50 years, including the anatomy and drivers of ocean warming, how changes in the earth’s hydrological cycle are expressed in large-scale changes to the ocean salinity field and if and how climate models exhibit these behaviours.

Working with colleagues at NASA, Dr Wijffels discovered and corrected small, but systematic biases discovered in 70 per cent of measurements in the global ocean observing system.

On the basis of the corrected data, a team of Australian and American climate researchers, including Dr Wijffels, calculated the world's oceans warmed and rose at a rate 50 per cent faster in the last four decades of the 20th century than documented in the 2007

Intergovernmental Panel on Climate Change Fourth Assessment Report. She contributed to the discovery of broad-scale and rapid warming of the abyssal oceans, with implications for the planetary energy budget and rate of sea-level rise. This informs our understanding of the sea-level budget and rates of global warming, and is driving an international effort to design a more comprehensive deep-ocean observing system.

Dr Wijffels has a Bachelor of Science with First Class Honours from Flinders University, South Australia, 1986 and a Ph D from the Massachusetts Institute of Technology-Woods Hole Oceanographic Institution Joint Program in Oceanography and Oceanographic Engineering, 1993.



DR ALISTAIR HOBDAY - is a research scientist at CSIRO's Division of Atmospheric and Marine Research focussing on marine biology, biological oceanography, and climate impacts on living marine systems.

Dr Hobday is involved in projects studying

- climate impacts on pelagic and tropical ecosystems;
- ecological risk assessment for the effects of fishing;
- migration pathways of juvenile southern bluefin tuna determined by acoustic monitoring;
- spatial global interactions among juvenile southern bluefin tuna;
- habitat prediction for spatial management in the ETBF;
- determining ecological effects of longline fishing in the ETBT.

Dr Hobday's research spans a range of topics, including spatial management and migration of large pelagic species, environmental influences on marine species, and the impacts of climate change on marine resources. He leads the Marine Climate Impacts area within the CSIRO Climate Adaptation National Research Flagship, and has been co-editor of two recent reports on the impacts of climate change on fisheries and aquaculture, and Australian marine life. In addition to his climate research, Alistair has co-lead the development of risk assessment methods for assessing the ecological sustainability of Australia's fisheries. He is a member of the steering committee for the international Climate Impacts on Top Ocean Predators program.

Dr Hobday completed a BSc (Hons) in Biological Science at Stanford University, a PhD in Biological Oceanography at the Scripps Institution of Oceanography, and held a National Research Council Postgraduate Fellowship at the Pacific Fisheries Environmental Laboratory in Monterey, California.



DR JOHN CHURCH – is a Senior Research Scientist, a CSIRO Fellow and leads the Coasts and Sea-level Team in the CSIRO Division of Marine and Atmospheric Research.

Dr John Church's record in sea-level rise research, with CSIRO colleagues, the Antarctic Climate & Ecosystems Cooperative Research Centre and international climate science agencies, has helped generate a new benchmark in understanding the science and issues of sea-level rise. His latest book, released in August 2010, is *Understanding Sea-Level Rise and Variability* (Wiley-Blackwell). Dr Church is the lead editor, with the book identifying the major impacts of sea-level rise, assessments of

past sea-level change and all the factors contributing to sea-level rise, as well as how extreme events might change.

His work contributes to the CSIRO Wealth from Oceans Flagship, building understanding of:

- oceans
- their interactions with climate and land processes
- climate change and its impacts on land and sea.

His immediate team of scientists at CSIRO has a strong publishing record, centred on projects relevant to the international science of ocean warming and sea-level rise, and with implications for Australian communities. Dr Church is the coordinating lead author of the Sea Level Change chapter of the IPCC Fifth Assessment Report, to be published in 2013.

The 420-page book of which he is the lead editor, *Understanding Sea-Level Rise and Variability*, brought together researchers from around the world to generate a new standard in knowledge of sea-level rise, while acknowledging that major uncertainties remain. Many authors were also contributing or lead authors for the *Intergovernmental Panel on Climate Change (IPCC) 4th Assessment*, released in 2007.

The Secretary-General of the World Meteorological Organisation, Michel Jarraud, says in his foreword:

'The findings in this book will help set priorities for research and for observational activities over the next decade that will contribute to future assessments of the IPCC. In turn, improvements in these assessments will better inform governments, industry and society in their efforts to formulate sound mitigation and adaptation responses to rising greenhouse gas concentrations and sea level, and their economic and social consequences.'

Dr Church has a background as a sea-going oceanographer with considerable experience in

Southern Ocean science and as leader of many research voyages. His interest in climate and ocean processes expanded with the formation of CSIRO's Division of Oceanography in 1981. He subsequently led climate and oceanography research programs at CSIRO, the Antarctic Cooperative Research Centre, and the Australian National Antarctic Research Expeditions.

Dr Church graduated in 1972 with a Bachelor of Science (Honours) in Physics, from Queensland University, Australia, and in 1979 was awarded a Doctor of Philosophy.



DR BRONTE TILBROOK is a research scientist at CSIRO's Division of Atmospheric and Marine Research and an expert on ocean acidification.

Dr Tilbrook is an oceanographer involved in research on the ocean carbon cycle. He completed a doctorate in chemical oceanography at the University of Hawaii on the production and consumption of trace gases in the surface mixed layer of the ocean. His research now involves characterizing and understanding the major drivers of ocean CO₂ uptake and storage, and determining how ocean acidification is evolving.

He is based at CSIRO in Hobart and his research emphasis is on the Southern Ocean and Australian regional seas, including the Great Barrier Reef and Coral Sea regions. The work uses a variety of ship and moored platforms to determine the air-sea exchange of CO₂ and carbonate chemistry, and deep-ocean sections to trace the storage and uptake pathways of anthropogenic carbon into the ocean interior. He has participated in more than twenty research cruises in the Indian, Pacific, Atlantic and Southern Oceans, including submersible work on deep ocean vents.

ADDITIONAL PARTICIPANT IN THE FILM – CLIMATE CHANGE AND THE OCEANS: INTERVIEWS WITH AUSTRALIAN CLIMATE SCIENTISTS



DR ANDREW LENTON

Dr Andrew Lenton is a research scientist at CSIRO Marine and Atmospheric Research in Hobart. His research interests span a broad range with the field of climate change including Earth System modeling and observations, with an emphasis on ocean biogeochemical cycles and carbon uptake, and ocean acidification. He is also undertaking work on geoengineering. He has worked in industry as well as in research. Dr Lenton gained a BSc (Physics) from Macquarie University in 1997 and a Bachelor of Antarctic Studies (Hons) from the University of Tasmania in 1998. He was awarded a PhD from the University of Tasmania in 2006.