The Greenhouse Effect - what have you learnt?

After reading the article on the greenhouse effect answer the following questions

1. Which decade was the hottest recorded in the last millennia?

2. Without the natural greenhouse effect, what would the estimated temperature of the Earth be?

3. In your own words, briefly describe the enhanced greenhouse effect.

4. Name three common greenhouse gases?

   1)

   2)

   3)

5. Name three types of human activity that contribute to the enhanced greenhouse effect.

   1)

   2)

   3)

6. How do you think land clearing contributes to the enhanced greenhouse effect?

Extracted from *Climate Change* – published by the Western Australia Department of Environment and Conservation.

The Greenhouse Effect continued…

7 What are some of the effects of a rise in Earth's annual mean temperature?

8 Who do you think will be affected the most by these effects, and why?

9 Name five things you can do at school to help reduce your greenhouse gas emissions?

1)

2)

3)

4)

5)

10 Name five things you can do at home to help reduce your greenhouse gas emissions?

1)

2)

3)

4)

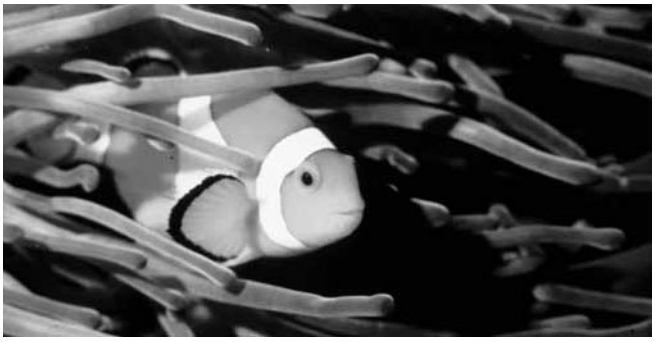
5)

11 Name three things you can do in your community to help reduce the greenhouse effect?

1)

2)

3)



False-clown anemonefish (**Amphiprion ocelloris**). Photo – C. Fleming

Extracted from *Climate Change* – published by the Western Australia Department of Environment and Conservation.

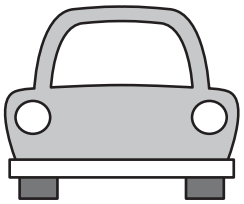
The Carbon Dioxide Game - Action Cards

Humans drive cars

+2

Every litre of petrol puts 2.35kg of CO_2 into the atmosphere.

Add two CO_2 molecules.



Humans ride bikes

-2

Riding a bike is the most energy efficient form of transportation, and it's fun!

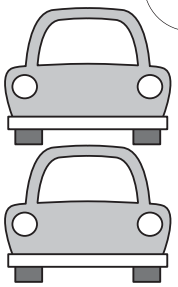
Remove two CO_2 molecules.

Humans drive more cars

+2

In 1908 Ford built the model T car. Between 1908 and 1928, 15 million were sold. Today an estimated 500 million cars are in use worldwide.

Add two more CO_2 molecules



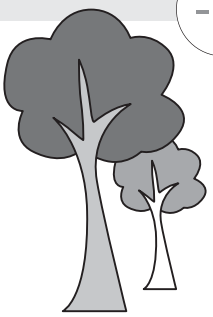
Humans plant trees

-4

Trees remove CO_2 from the atmosphere during the process of photosynthesis.

More trees means less atmospheric CO_2.

Remove four CO_2 molecules.

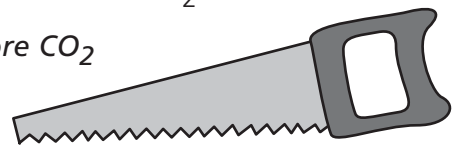


Humans cut down trees

+4

Trees remove CO_2 from the atmosphere during photosynthesis. Fewer trees means more CO_2.

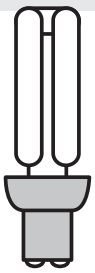
Add four more CO_2 molecules.



Humans create energy efficient technology

Remove four CO_2 molecules.

-4



Humans burn rubbish

+2

Burning waste puts CO_2 into the atmosphere along with other pollutants.

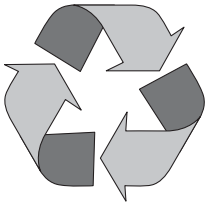
Add two more CO_2 molecules.

Humans recycle

-2

Recycling saves energy, reducing our use of fossil fuels.

Remove two CO_2 molecules.



Adapted with permission from Green Teacher #70, Spring 2003. One year (four issue) online subscriptions cost $29 AUD (approx.)from www.greenteacher.com.

Green Teacher is the world's best-selling environmental education magazine. A Canadian non-profit organization, Green Teacher has also published the following popular books which are available in Australia from the Victorian Association of Environmental Education (www.vaee.vic.edu.au, Ph: (03) 9349 1806): Teaching About Climate Change, Greening School Grounds, Teaching Green - The Elementary Years, Teaching Green - The Middle Years and Teaching Green - The High School Years. Visit www.greenteacher.com for more details about these books or Green Teacher magazine.

Extracted from *Climate Change* – published by the Western Australia Department of Environment and Conservation.

Young Scientists at Work: a group inquiry process

Climate Change and Antarctica

The north-eastern coast of the Antarctic Peninsular houses a series of huge ice shelves. These ice shelves rise up to 200 metres above the ocean surface. Satellite images taken of this section of Antarctica since 1995 reveal that big sections have melted and broken up over the intervening years. Scientists attribute the rate and scale of this break up of ice shelves to global warming.

This lesson will help engage students in a group scientific inquiry to explain some of the observable impacts of Climate Change. It focuses on Antarctica as a continent within an Australian Regional context.

Curriculum links

Society and the Environment
→ Place and Space
→ Investigation, Communication and participation

Science
→ Investigating and Communicating Scientifically

Values
→ Environmental Responsibility

Year levels

Lesson 1: 4 -5
Lesson 2: 6-7

Lesson Plan 1

Years 4 and 5 - Brainstorm and Investigation Lesson

Scientists are actively engaged in learning more about the world around them. They are guided in their explorations through a process of inquiry by posing questions, then testing and seeking answers to those questions. Inquiry is a dynamic process involving asking questions to reveal new facts.

Student Engagement:

1. Introduce the topic of Antarctica using some of the information from the background notes.
2. Either
   a. conduct a whole-of-class brainstorm or class discussion on the topic of Antarctica
   or
   b. break students into groups of three or four to brainstorm and discuss Antarctica.
3. Provide the students with two dated satellite images. Ask them to examine them closely. What do they see? What do they think the small black "dots" are on the ice surface from the January 2002 image? (These are pools of melting water collecting on top of the shelf.)

Use the teacher background notes to help the discussion.

A suggested investigation

Tray of ice cubes
Digital watches/timers

One fun and simple way to get students thinking about the sheer amount of ice melting in Antarctica is to have them work in small investigating teams. Provide each group of three students with one ice cube. Ask them to investigate how long it takes the ice to melt. Some groups may wish to melt the ice by holding it in one of their hands. Others may wish to melt the ice by putting it in direct sunlight or simply by letting it melt at room temperature.

Each group could measure the time taken for the cube to melt completely.

Discussion

How quickly did the ice melt?

If one ice cube takes this long to melt, consider how much heat energy is needed to melt blocks of ice that are many times bigger than Rottnest Island. (That is what is happening on the Antarctica Ice Shelves.)

Conclusion

Ask students to summarise their ideas from the lesson either by:

1. Designing and producing an A3 poster that could be displayed in the school library for other students

or

2. Writing one or two paragraphs that describe what is happening in Antarctica.

Young Scientists at Work: a group inquiry process continued…

Six Rules for a Discrepant Event Inquiry

1. Students make and pose their own questions to achieve a Yes or No answer from the teacher.
2. A student may ask as many questions in a row as desired.
3. When a student poses a theory question – the teacher refrains from answering with a yes or no. Instead, the teacher redirects the question using words similar to "That's a theory: let's explore your idea more."
4. At any time, a student may challenge any proposed theory.
5. Throughout the inquiry, a teacher may provide reference materials.
6. Students may conduct conferences, summarise information and theories without any teacher input.

Lesson Plan 2

Years 6 and 7 - Stages in a discrepant event Lesson

Scientists are actively engaged in learning more about the world around them. They are guided in their explorations through a process of inquiry by posing questions, then testing and seeking answers to those questions. Inquiry is a dynamic process involving asking questions to reveal new facts.

This lesson helps students develop their thinking skills while learning in the science content area in a group inquiry process.

What is a discrepant event Lesson?

A discrepant event lesson begins by presenting them with a puzzling situation or event. Students are engaged in "solving a mystery" – in much the same way as scientists tackle the inquiry process.

What's involved?

Students:

- work as a class group to construct the best answer they have to explain this puzzling situation or event.
- ask questions,
- gather information or data
- pose hypotheses
- analyse information
- listen closely
- synthesise answers
- and finally, construct the best answer.

Teachers:

- present students with the discrepant event with some brief background information
- guide student inquiry through a discrepant event using six rules

Resources:

- Two satellite images of the Larsen Ice Shelf B
- Internet access
- Background information sheets – for teacher
- Three copies of the Rules of a Discrepant Event (Suggestion: enlarge to A3 size)

Running this Discrepant Event Inquiry Lesson

Phase 1: Presenting the discrepant event

Explain the rules and procedures: use the enclosed rules chart. Post them up in the classroom.

Pose the discrepant event: Allow students to closely examine the two satellite images of the Larsen B Ice Shelf taken 35 days apart in 2002. Give them a bit of background information on Antarctica from the teacher's notes.

Engage their interest with enough information to get them interested, but not overwhelmed.

Formulate the problem question: Can you explain the observable differences in the Larsen B Ice Shelf in the two images shown from 2002? We suggest you do not specify the exact date at which each photograph was taken.

Phase 2: Gathering and checking information

Students ask questions about objects and conditions. Ask questions to verify the discrepant event.

Check and use the timeline and Ice Shelf information to provide feedback to students on the conditions and objects in this event. Teachers keep the printed copy of the notes to themselves. Reveal more information in response to student questions.

Simple questions to check facts:

Students may ask a question to verify a matter of time:

e.g. Were these two images taken in different months (or times) in 2002?

Theory questions:

Is it possible that the ice is smaller in one picture because the ice has melted because the temperature of the sea-water is now hotter?

Is it possible the sea temperature is hotter because there are more greenhouse gases (or Carbon dioxide, etc) in the atmosphere?

Phase 3: Presenting the discrepant event

Ask questions about important variables. You may wish to give your class the opportunity to use the internet to research and verify some of the information they are seeking. This could be done in groups of three students.

Ask questions which frame a hypothesis or are informal.

Phase 4: Formulate an explanation

Summarise and reach a likely hypothesis. Ask students to capture and record their ideas.

Phase 5: Analyse the inquiry process

Analyse questioning and strategy. Did students work together? Did they listen carefully to one another and to the teacher responses? How do students rate their own inquiry work? Did they start with several ideas to explain the event?

General background information

Use this for engaging student interest

Antarctica is a continent like no other on Earth. It carries the tag of the driest continent on Earth – receiving an average annual rainfall of just 2.5 centimetres. It also carries the tag of the iciest region on Earth with an average thickness of 2.2km of ice blanketing the land! It is in fact, an icy desert!

Antarctica covers a massive area of over 12 100 000 km^2 and rises on average about 2.3 km above sea level! If Australia is the wide brown land, Antarctica is the vast, icy white land. Antarctica is in fact, nearly twice the size of Australia.

The South Pole lies close to the centre of Antarctica.

The continental land mass of Antarctica is covered by 2 huge ice sheets – one either side of the Trans-Antarctic Mountains.

Basically, West Antarctica is a series of islands buried beneath a thick icy layer or ice sheet. The East Antarctic ice sheet is the largest ice mass on the planet. It covers a solid land mass.

To give you an idea of the volume of water locked in Antarctic ice – about 70 per cent of all fresh water on Earth is frozen in the Antarctic ice sheets!

The history of people in Antarctica is entwined with exploration and scientific study. This continent has been, and continues to be, a living laboratory for scientists from around the world. Scientists from a wide range of fields such as astronomy, oceanography, glaciology and biology, all work and study here.

Dr Barbara Smith is an Australian Antarctic glaciologist who studies the movements and creation of glaciers and ice sheets. Barbara says: "Being a glaciologist is fascinating. On the one hand you could be flying over the vast white emptiness of Antarctica, or you could be in a freezer room cutting up ice for analysis and interpreting the results. But the most exciting thing for me is that you learn how the ice sheet moves, grows and shrinks over time and that you are taking part in ground-breaking research into how our climate is changing and how that can affect our lives."

Antarctica is …

"Antarctica is the highest, driest, windiest, coldest, cleanest, most isolated and most peaceful continent on Earth."
Coral Tulloch (Artist and Author)

"Antarctica is the closest thing to another planet we can experience on this one. It is surreal – completely and unremittingly white in every direction, so vast and so cold – much colder than the Arctic."
Al Gore (Environmental Campaigner)

"The Antarctic continent is such an interesting place that there is far too much to record on paper, so we trust our memories to be etched with the wonderment of it all. Firstly, the weather rules. When there are katabatic winds, things are fine if you're inside a heated building listening to the wind howling. But if you have to go outside, like the weather people do to make an observation, then you soon learn about the power of the wind. You can be blown many metres by the power of the wind."
Steve Pendlebury (Meteorologist)

Young Scientists at Work: a group inquiry process continued…

Background information on the Discrepant Event

Larsen B Ice Shelf collapses in Antarctica

1. Ice shelves are thick plates of ice, fed by glaciers that float on the ocean around much of Antarctica.
2. The Larsen B shelf was about 220 m thick. It has an estimated age of anywhere between 400 and 12,000 years old.
3. From January to March 2002, in terms of volume, the amount of ice released and lost in this short time was 720 billion tons, enough ice for about 12 trillion 10 kg bags!
4. Using MODIS or Moderate Resolution Imaging Spectroradiometer satellite imagery it has been revealed that the northern section of the Larsen B ice shelf, a large floating ice mass on the eastern side of the Antarctic Peninsula, has shattered and separated from the continent.
5. The shattered ice formed a plume of thousands of icebergs adrift in the Weddell Sea.
6. About 3,250 km^2 of shelf area disintegrated in a 35-day period beginning on 31 January 2002.
7. Over the past five years, the shelf has lost a total of 5,700 km^2, and is now about 40 per cent the size of its previous minimum stable extent.

Source: National Snow and Ice Data Research Centre Website
http://nsidc.org/iceshelves/larsenb2002/
University of Colorado Boulder, USA
Posted: 18 March 2002
Updated: 21 March 2002 14:40

Timeline on the Antarctica Larsen B Ice Shelf

- **1978** Scientist John Mercer warns "One of the warning signs that a dangerous warming trend is underway in Antarctica will be the break-up of ice shelves on both coasts of the Antarctic Peninsula, starting with the northernmost and extending gradually southward."
- **1989** Large sections of Antarctic ice shelf begin to break away from the northern tip of the Antarctic Peninsula.
- **Jan 2002** Satellite imagery shows the Larsen B Ice Shelf to be about 240 kms long and about 48 kms wide.
- Within the next 35 days, this entire section of ice shelf had broken up.
- Scientists have attributed the speed at which the ice melted to the melting ice from above and below sea surface.
- If you examine the image from Jan 2002 – you will see black pools on top of the ice surface. Those pools are melting water collecting on top of the shelf.
- Instead of this melt water sinking back into the ice and refreezing, the water kept sinking. It sank straight down and makes the ice mass look like a Swiss cheese.
- The ice shelf consists of a tongue of sea-based ice that stretches out and floats on the sea surface. Behind that is the thick icy layer overlying the land itself.
- **March 2002** With the sea-based ice shelf gone, the land-based ice can begin to shift forward and fall into the sea.

References:

Tulloch C. (2003) *The heart of the world: Antarctica.*
ABC Books

Gore A. (2006) *An Inconvenient Truth The Planetary Emergency of Global Warming and What We Can Do About it.* Bloomsbury Publishing Plc London, Great Britain.

Mindtronics! And Inquiry Alive!
As presented on the website
http://www.hometreemedia.org/subpage 56.html

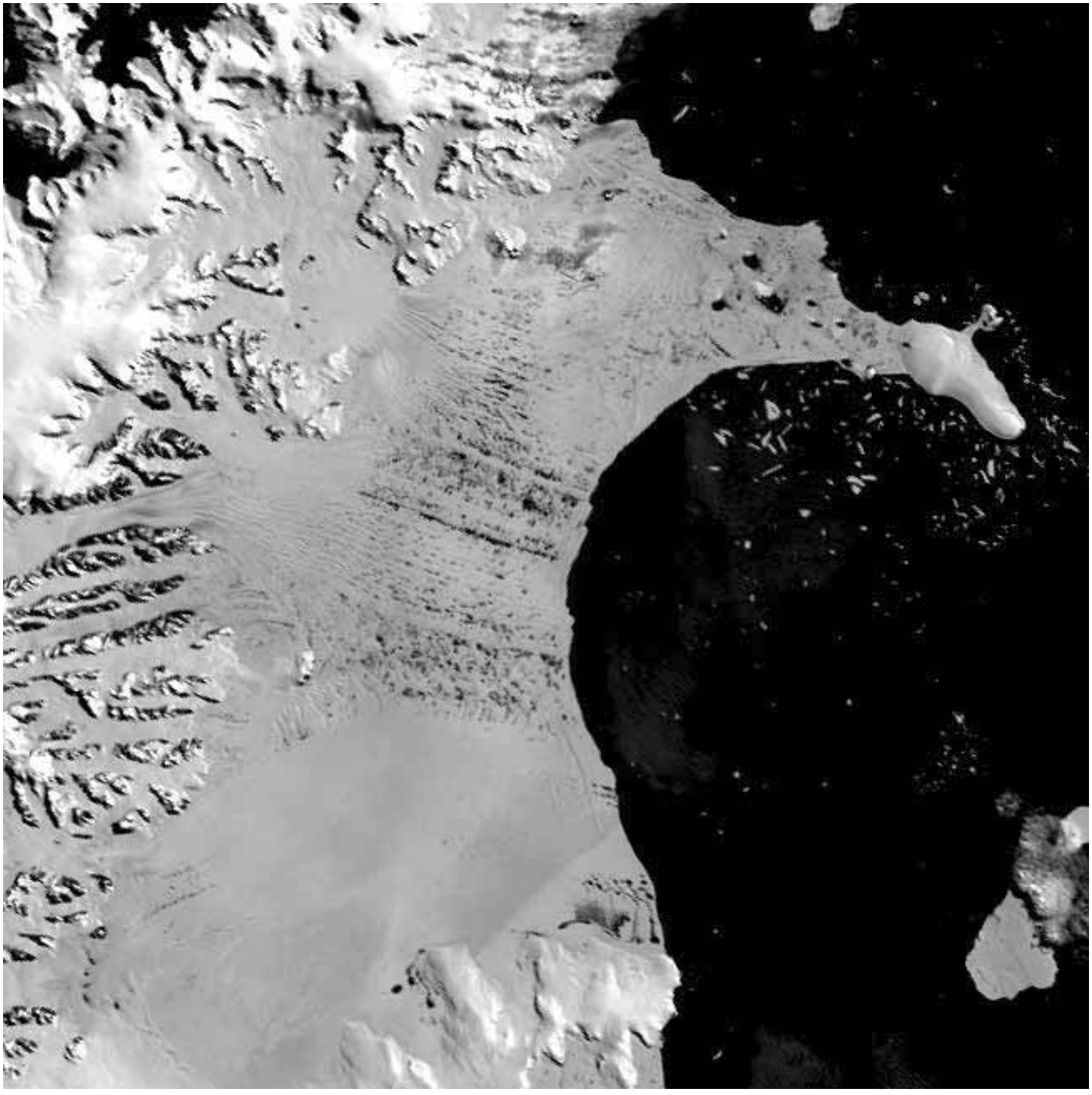
National Snow and Ice Data Research Centre Website
http://nsidc.org/iceshelves/larsenb2002/

World Book Encyclopedia
http://www.worldbook.com

Thanks to:

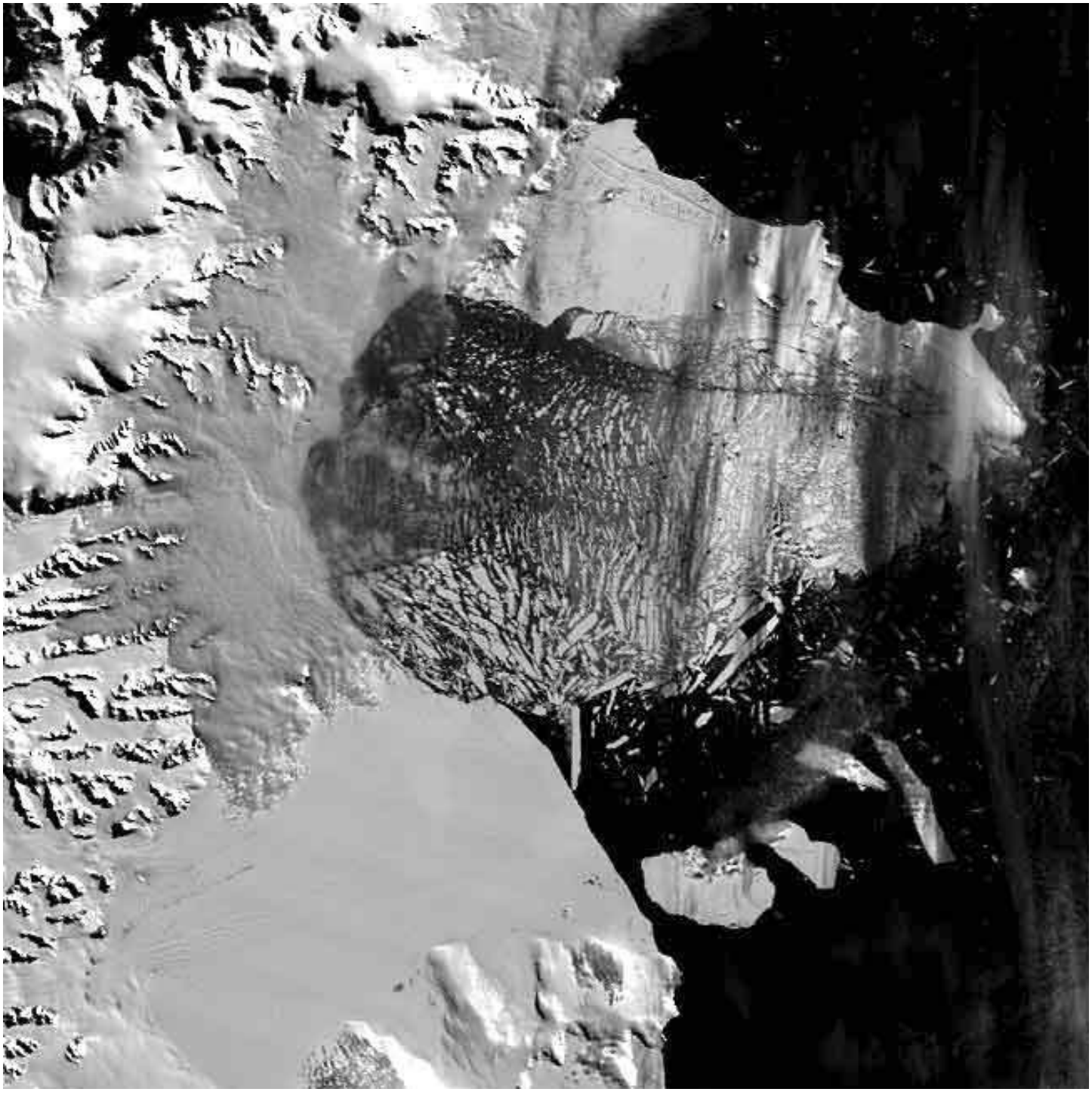
Dr Roland Warner
Antarctic Climate & Ecosystems
Senior Research Scientist
Cooperative Research Centre and
Australian Government Antarctic Division

Antarctic Ice shelves and Icebergs - 31 January 2002



http://nsidc.org/iceshelves/larsenb2002/013102_modis.html

Antarctic Ice shelves and Icebergs - 5 March 2002



http://nsidc.org/iceshelves/larsenb2002/030502_modis.html

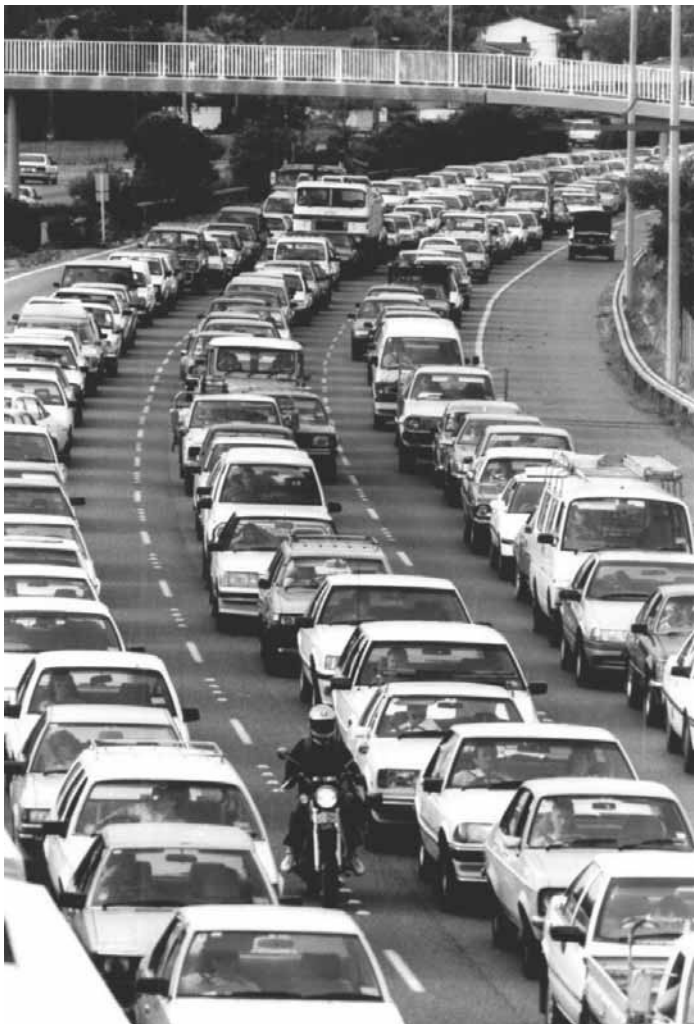
Ten Tips for Fuel Efficient Driving

Driving more efficiently is one easy way you can play your part to reduce global warming, while saving money too!

1. **Plan your trips.** Plan to do a number of errands in one trip rather than several trips. Avoid peak-hour traffic, hard acceleration and heavy braking- they all waste fuel. Driving smoothly and avoiding stop-start traffic will save fuel, and up to 30 per cent of CO_2.
2. **Avoid short trips by walking or cycling.** It's good exercise, and it will save you 200 to 300g of CO_2 every kilometre not driven.
3. **Service your vehicle regularly.** If you keep your vehicle well tuned it will reduce your greenhouse gas emissions by up to 15 per cent.
4. **If your vehicle is manual - change up and go into top gear as soon as possible** without accelerating harder than necessary. Driving in a gear lower than you need wastes fuel. So does letting the engine labour in top gear on hills and corners. Automatic transmissions shift more smoothly if you ease back slightly on the accelerator once the vehicle gains momentum.
5. **Speed kills economy.** High speeds require high fuel consumption. Your vehicle will use up to 25 per cent more fuel at 110km/hr than it does at 90km/hr. On the open road, drive within the posted speed limits.
6. **Stopping and braking.** Resting your foot on the brake wastes fuel, increases brake wear and decreases braking efficiency. If you think you will idle for more than 10 seconds, switch off and restart your engine later.
7. **Filling up.** Filling past the first click of the fuel nozzle may cause fuel to spill through the overflow pipe when you accelerate or go around a corner. A properly fitted fuel cap also saves fuel by minimising evaporation.
8. **Look after your vehicle's tyres.** Inflate your tyres to the highest pressure recommended by the manufacturer, and make sure they are properly aligned. This will reduce fuel consumption, extend tyre life and improve handling.
9. **Use air-conditioning sparingly**- since it will use 10 per cent more fuel. At high speeds, however, air conditioning is more efficient than open windows.
10. **Travel light.** An extra 50kg will increase your emissions by two per cent. Anything fixed to the outside of your vehicle increases wind resistance and emissions.

The Guiness World Record for Vehicle Fuel Efficiency was set by John Gough who averaged 2.43 litres per 100km from Britain's Land's End to John O'Groats in October 2002, driving a Toyota Yaris diesel 1.4-litre D-4D. He averaged 55-65kph, using sensible driving methods to achieve the greatest efficiency. His tips are to accelerate to your desired speed gradually, maintain a constant speed wherever possible and try not to change gear unnecessarily or use excessive braking or acceleration.

Compiled by Guy Dauncey *Author Stormy Weather: 101 Soultions to Global Climate Change* New Society Publishers, 2001.



Counting carbon - How do we measure up?

Greenhouse gases are emitted in many of our daily activities. Understanding just how much of an impact we have is often a difficult task. For example, how much does that extra five minutes in the shower cost the environment? Or that toy inside your cereal box? Well one of the things we can measure fairly accurately is the greenhouse gases from the average family car.

In this exercise we are going to record all the car journeys that the students in your class take for a week and calculate the amount of pollution that is emitted into the air as a result. We will then examine each journey and consider any environmentally friendly travel alternatives that might be available. You will need to research some of these alternatives to find out whether they will be a real possibility for that travel (i.e if there is no train station nearby, you couldn't really use the train as an alternative).

Finally, set yourself a goal. What can you do to reduce your greenhouse gas emissions for the next week? Make sure your goal is one that you can achieve, and don't forget to celebrate once you have achieved it! Good luck!

Now let's begin....

- Conduct a survey for one week (or a nominated period of time) of your family car usage. Include only the trips where you are present. Fill in the table with your results including the number of kilometres travelled, how long the trip took and where you went.
- Next, use the table provided to calculate the total pollutant emissions for your car trips over the week. Then work out the total pollutant emissions for all the cars used by the class.
- Present your class results as a summary.
- In small groups examine the destinations that you travelled to by car this week and consider any alternatives with lower pollutant emissions.

Final Task: Take Action - for the environment!

If we want to encourage people to behave in more environmentally friendly ways, we need to help make it easier for them. One way to do this is to increase the benefits of adopting that behaviour, while removing or reducing any obstacles to that behaviour.

Take a few moments to think about some of the alternatives that you have given to getting around by car. What would you need to seriously consider these alternatives? Which ones are realistic? You may like to discuss this as a group.

Once you have had a good think, it's time to set a goal or two for the environment! Think about your more realistic travel alternatives, and chose the ones you CAN change, at least for the next week. Then write your goal for the week on reducing greenhouse emissions. Here are some examples:

- I will walk to school on Wednesday and Friday morning next week.
- Instead of asking mum to drive me, I will ride my bike to footy training.
- Unless it is dark, I will ride my bike to the shops this week, instead of asking mum to drive me.

Be careful to make sure your goal is:

- Specific - make sure your goal is very clear.
- Positive - reinforce good habits, rather than focussing on bad ones.
- Challenging, yet achievable - Is your goal realistic? Start with small steps.
- Measurable - make sure you will know when you've completed your goal.
- Flexible - ensure that you can make small adjustments to your goal if your circumstances change.
- Celebrate - most importantly, don't forget to celebrate achieving your goal!

How much car pollution is produced?

Vehicle type	Fuel efficiency	CO_2 emissions g/km
Small	16.6km/L	150g/km
Medium	12.5km/L	200g/km
Large	10km/L	250g/km
4WD	8.3km/L	300g/km

This is a conservative estimate but will give you the least amount of pollution produced from the cars being driven.

My Travel Log

Name: _____

Date	Destination and reason for trip	Car type ie. small medium or large	Number of km travelled	Km travelled x CO_2 for car type	CO_2 emissions
Example: 4/1/07	My house in Cottesloe to Aunty Margaret's in Leeming for a family BBQ	Small	23	23 x 150	3.45kg

My greener options

Name: _____

Trip	Alternative	Is it achievable? What will I need to consider this alternative?
Example: *Cottesloe to Leeming*	*Bus route 266*	*Have to walk to bus stop. Bus only comes every hour. Last bus leaves Aunty Margaret's at 6.00pm. Would have to make sure we were ready to leave by 6pm. Might be difficult to achieve.*

The Climate Change Q & A Hand Puzzle

CHANGE

Which is the best way to get to school? Bus, drive or bike?

Bike! It uses people power, not fossil fuels.

True or false? Driving carefully reduces car pollution.

True! Driving carefully uses less fuel.

CLIMATE

Of the 3 Rs, which is the most important?

Reduce! Reducing saves more energy.

Name one type of sustainable energy.

1. Solar
2. Tidal
3. Wind
4. Geothermal

How much energy does recycling an aluminium can save?

Enough to watch TV for 3 hours!

True or false? Cars produce greenhouse gases.

True! They burn fossil fuels.

HELP

What is the colour of most recycling bins?

Yellow and green!

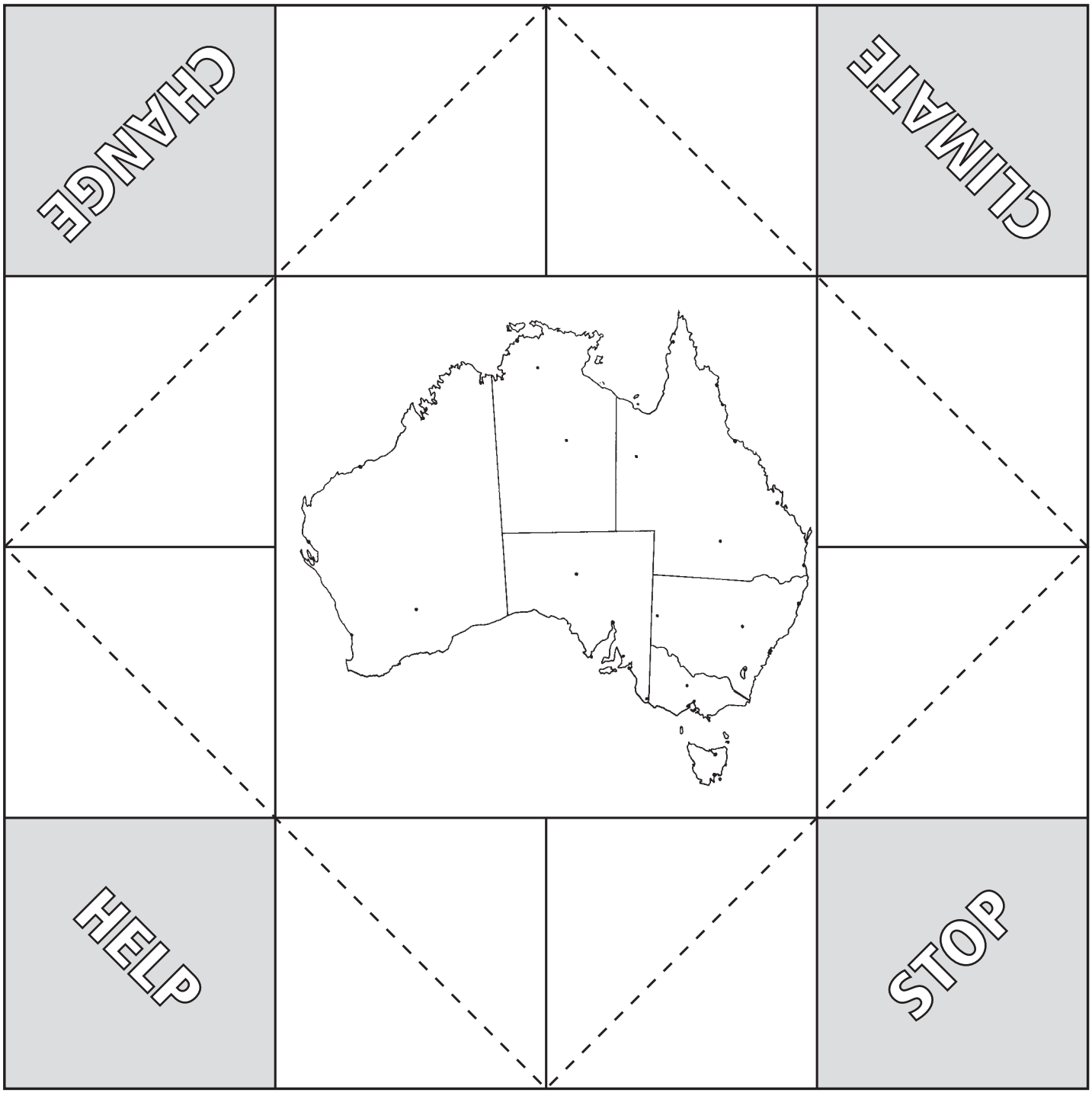
How does recycling paper help fight climate change?

It saves trees. Trees help remove greenhouse gases from the air.

STOP

Adapted from the Climate Change Resource Book, Scouts Canada

Now see if you can make your own...



Adapted from the Climate Change Resource Book, Scouts Canada