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**ENVIRONMENTAL SYSTEMS AND SOCIETIES  
STANDARD LEVEL  
PAPER 2**

Tuesday 7 May 2013 (afternoon)

2 hours

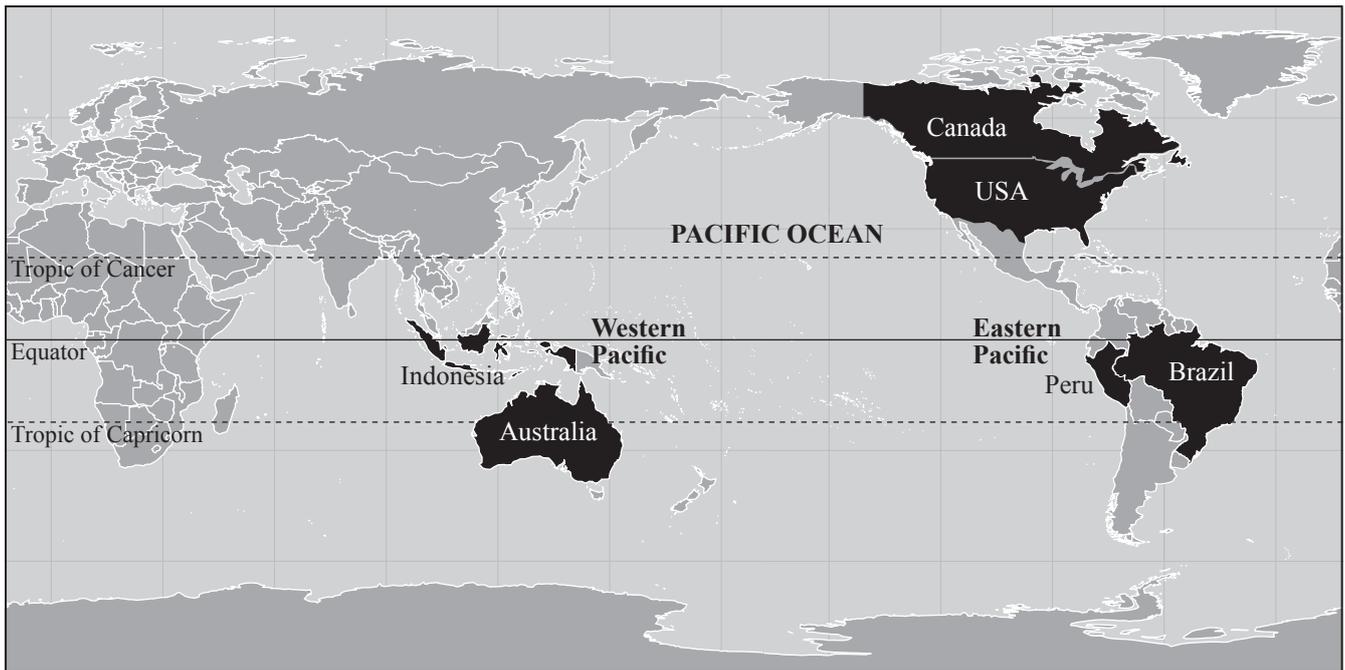
# RESOURCE BOOKLET

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INSTRUCTIONS TO CANDIDATES

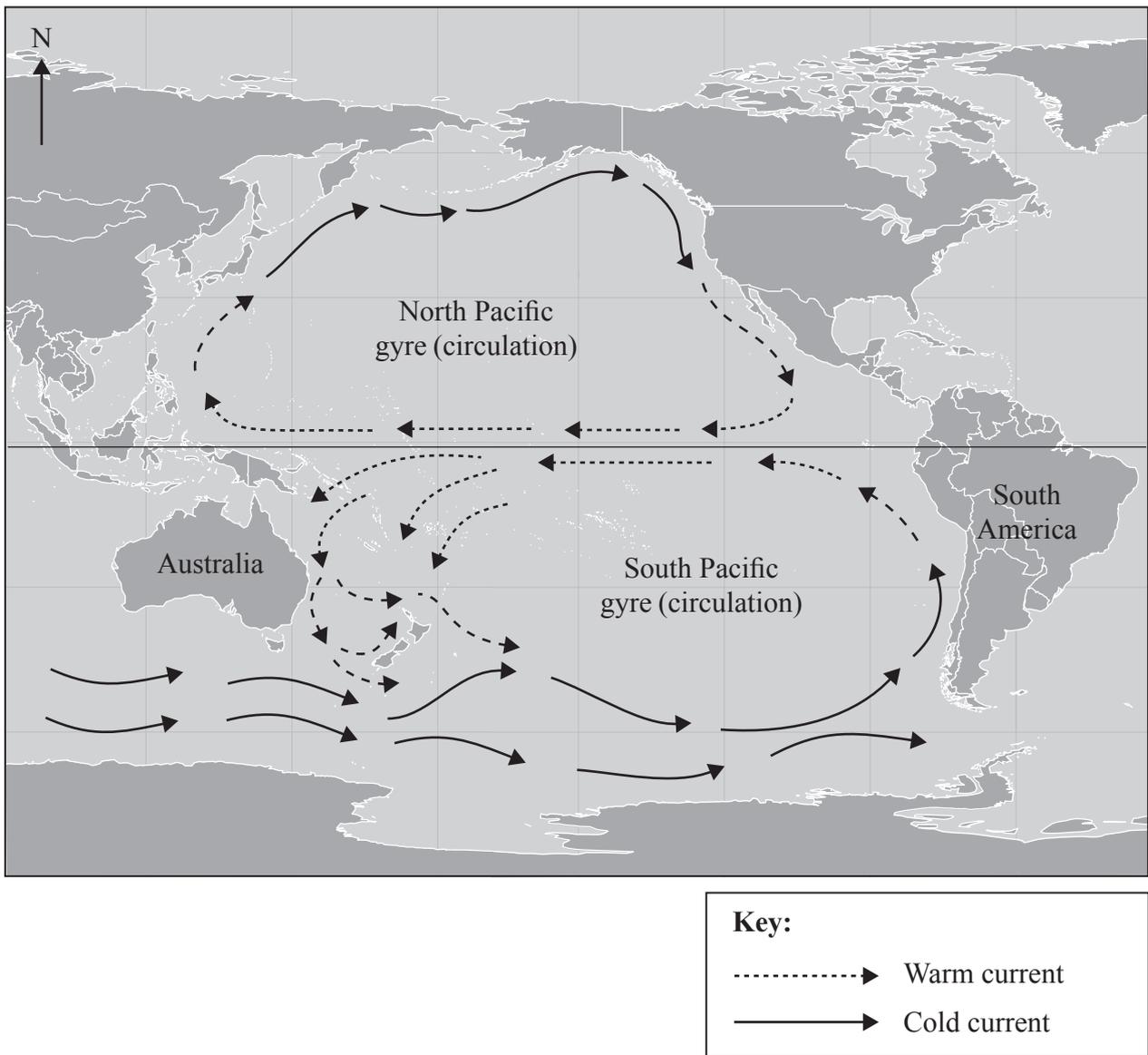
- Do not open this booklet until instructed to do so.
- This booklet contains **all** of the resources required to answer question 1.

**Figure 1 World map showing the location of the Pacific Ocean**



[Source: <http://www.un.org/Depts/Cartographic/map/profile/world.pdf>]

Figure 2 Pacific Ocean gyres (circulation of water)



[Source: <http://www.un.org/Depts/Cartographic/map/profile/world.pdf>]

**Figure 3 Fact file on the Great Pacific Garbage Patch (GPGP)**

- The Great Pacific Garbage Patch (also called the Pacific Trash Vortex) is an area of floating garbage (rubbish, trash) in the North Pacific gyre of the Pacific Ocean. Other ocean gyres also have garbage patches.
- The estimated size of the GPGP varies. Some estimates are that it contains 3.5 million tonnes of plastic.
- Garbage, mostly plastics, from countries bordering the Pacific, floats to the GPGP in ocean currents. The plastics are trapped in the GPGP, circling round and round.
- The garbage consists of pieces of floating plastic of varying sizes which are suspended in the ocean at or just below the surface, as well as denser plastic pieces which sink to the ocean floor.
- Larger pieces of garbage are taken in by fish, sea birds and animals which may then die of starvation.
- Plastic is made from crude oil and is mostly not biodegradable by decomposers. So once plastic is made, it mostly remains on Earth in some form, often breaking into smaller and smaller pieces.
- Some small plastic pieces act as “chemical sponges” and absorb POPs (persistent organic pollutants). Animals eating these also take in toxins.
- One study estimates that around 1 million sea birds (eg albatrosses) and 100 000 animals (eg turtles, whales) are killed by either ingestion of plastic or become entangled with plastic fishing nets.
- Recent research has found photosynthetic bacteria using the plastic as a food source.
- Because the plastic accumulates in the gyres, the rest of the oceans are relatively plastic-free.
- About half of all albatross species are either endangered or critically endangered on the Red List.

**Figure 4 The Albatross**

**(a) A Pacific albatross in flight**



[Source: [http://en.wikipedia.org/wiki/File:Laysan\\_Albatross\\_RWD2.jpg](http://en.wikipedia.org/wiki/File:Laysan_Albatross_RWD2.jpg)]

**(b) Dead albatross chick with plastic garbage in its stomach**

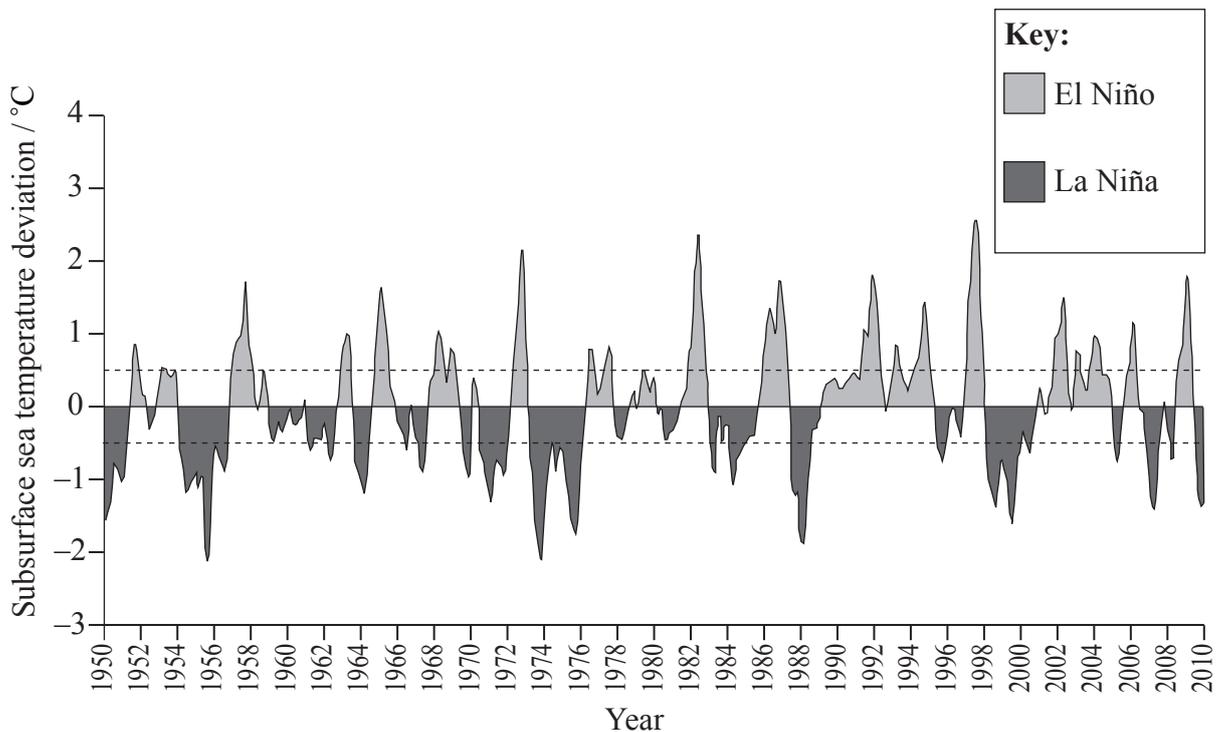


[Source: [http://en.wikipedia.org/wiki/File:Laysan\\_albatross\\_chick\\_remains.jpg](http://en.wikipedia.org/wiki/File:Laysan_albatross_chick_remains.jpg)]

**Figure 5 El Niño and La Niña events**

- El Niño and La Niña events are changes to the normal wind patterns in the southern hemisphere of the Pacific Ocean that affect climate worldwide.
- In **non** El Niño and La Niña years,
  - air pressure in the equatorial Eastern Pacific Ocean near South America is higher than that in the Western Pacific Ocean near Australia and Indonesia.
  - this results in the trade winds that blow air and warm surface water westward for most of the year.
  - the warm water evaporates, rises and causes the monsoon (seasonal rains) in South East Asia.
- In years with El Niño events,
  - the winds do not blow from East to West across the Pacific.
  - so warm water stays near South America and moist warm air is not blown towards Australia.
  - this leads to excess rainfall on the South American coast and droughts in Australia and Indonesia.
- La Niña events follow strong El Niño events
  - the ocean temperature of the Eastern Pacific is unusually cold after being unusually hot in the El Niño events.

**Figure 6 Historical data on equatorial Eastern Pacific Ocean subsurface sea temperatures between 1950 and 2011. A subsurface sea temperature deviation of +0.5 °C or more is defined as an El Niño event and a deviation of - 0.5 °C or more is defined as a La Niña event.**



[Source: Image provided by the NOAA-ESRL Physical Sciences Division, Boulder, Colorado, from their Web site at <http://www.esrl.noaa.gov/psd/>.]

**Figure 7 Effects of 2010–2011 La Niña event**

The UN weather agency stated that the La Niña of 2010–2011 was one of the strongest ever recorded. All of the events below are linked to the 2010–2011 La Niña.

- In **Australia**, Queensland had very heavy rainfall causing widespread flooding, deaths and property destruction.
- In the state capital of Queensland, Brisbane, the Brisbane River broke its banks and many low-lying areas were flooded.
- It was the wettest year on record in Queensland.
- In **Sri Lanka**, floods displaced 325 000 people and several were drowned.
- In **North America**, a winter storm of cold air, heavy snowfall and blizzards covered much of Canada and Eastern and Central America.
- In **Brazil**, more than 400 people were killed and thousands made homeless by mudslides in towns north of Rio de Janeiro.

**Figure 8 The Amazon Tropical Rainforest and information on droughts in 2005 and 2010**

**(a) The Amazon Tropical Rainforest**

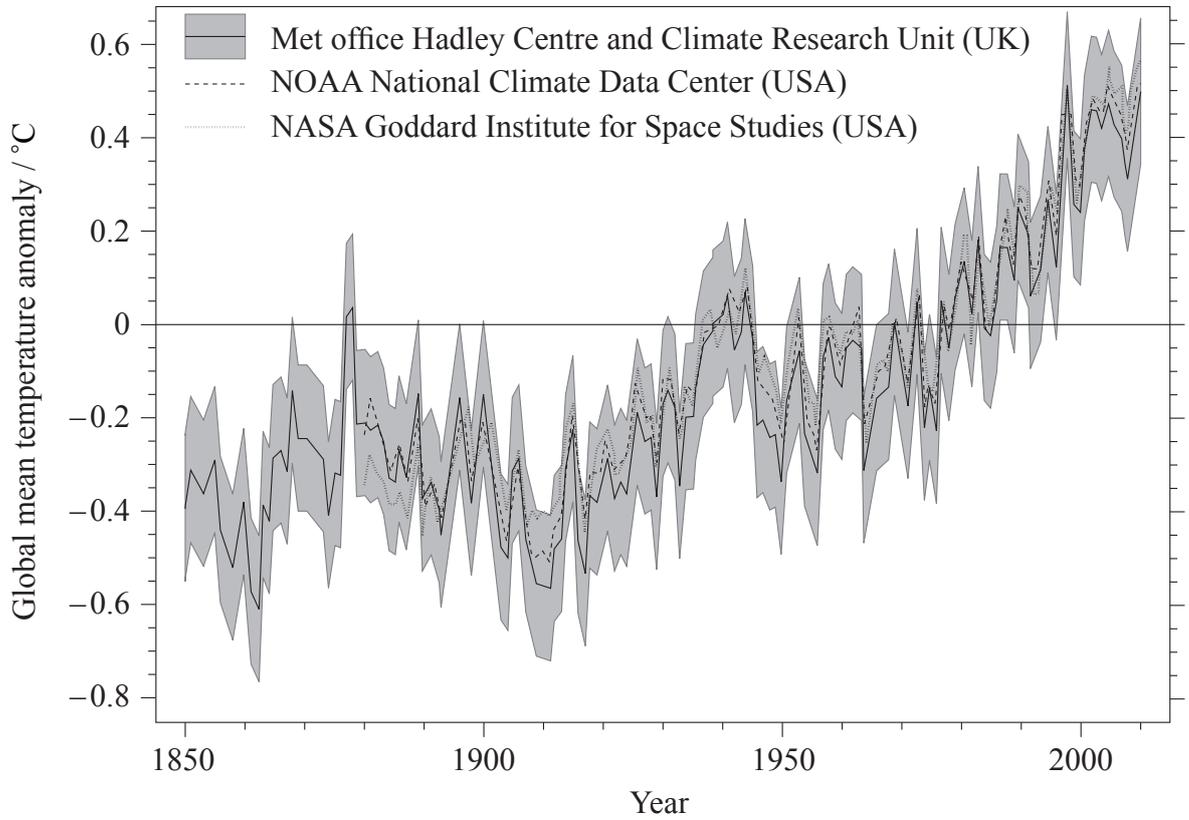


[Source: © Rhett Butler, www.mongabay.com. Reprinted with permission]

**(b) Fact file**

- In 2005 and 2010, there were severe droughts in which many smaller rivers flowing into the Amazon dried up.
- Worldwide, 2010 was the warmest year recorded since records began in 1850.
- In drought years, the Amazon Tropical Rainforest becomes a net emitter of carbon dioxide instead of being a net absorber.
- This is because trees die and decompose giving off carbon dioxide instead of absorbing it.

**Figure 9 Annual global mean temperature compared with 1961–1990 mean temperature published by three organizations**



[Source: Met Office © Crown copyright]