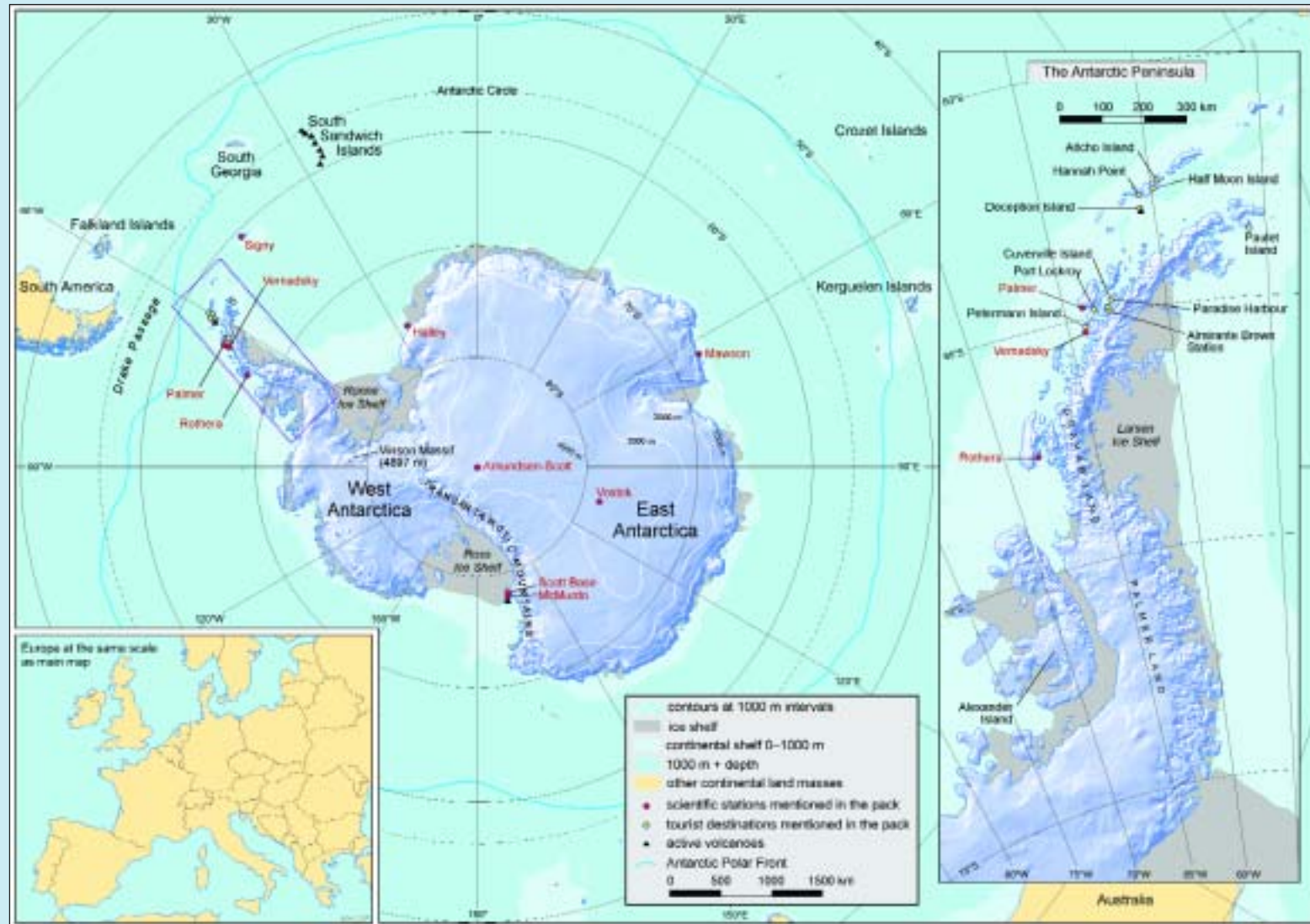




# The continent of Antarctica

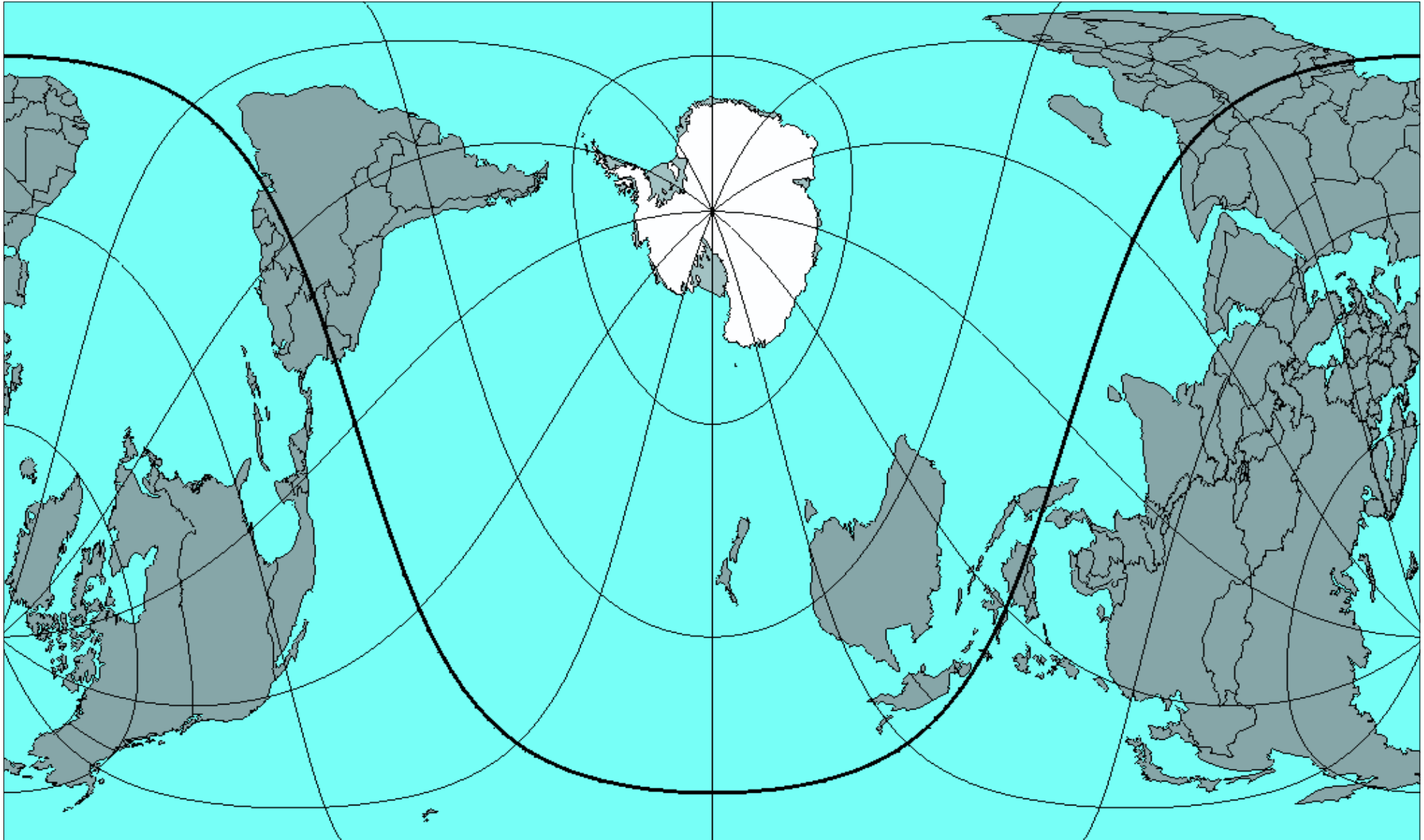
## Resource N1





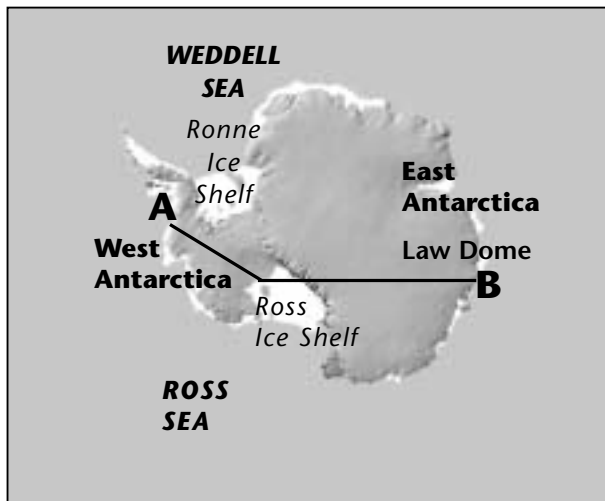
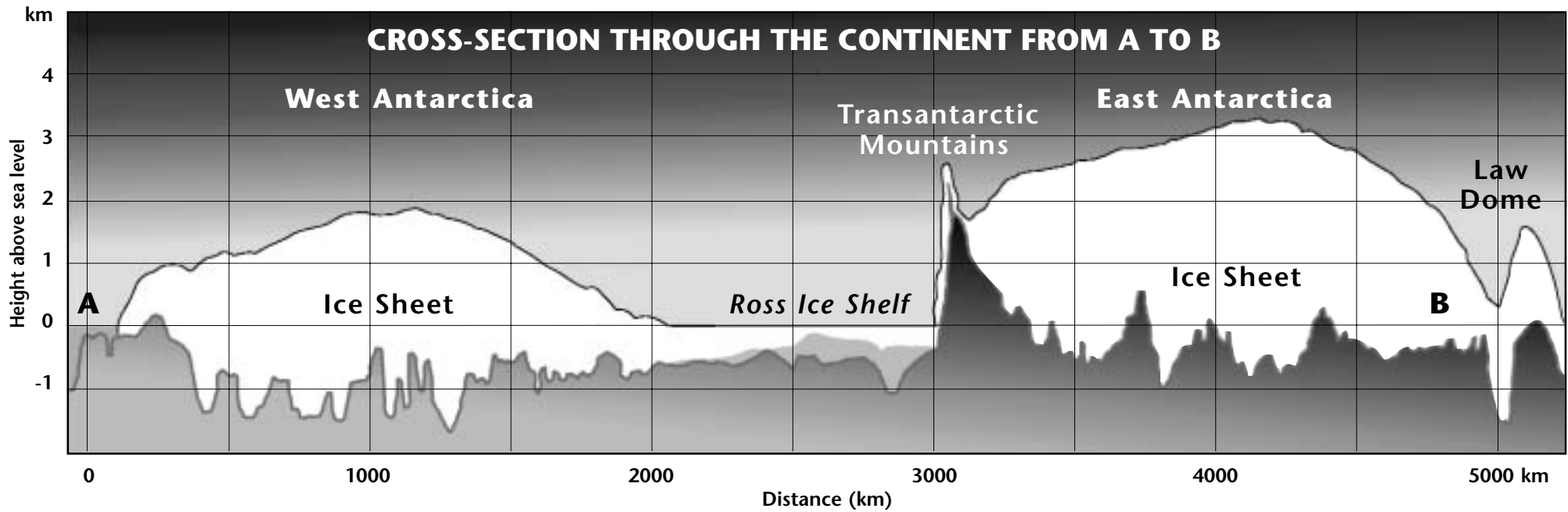
# Equal area projection map of the world

Resource N2





# Cross-section through Antarctica

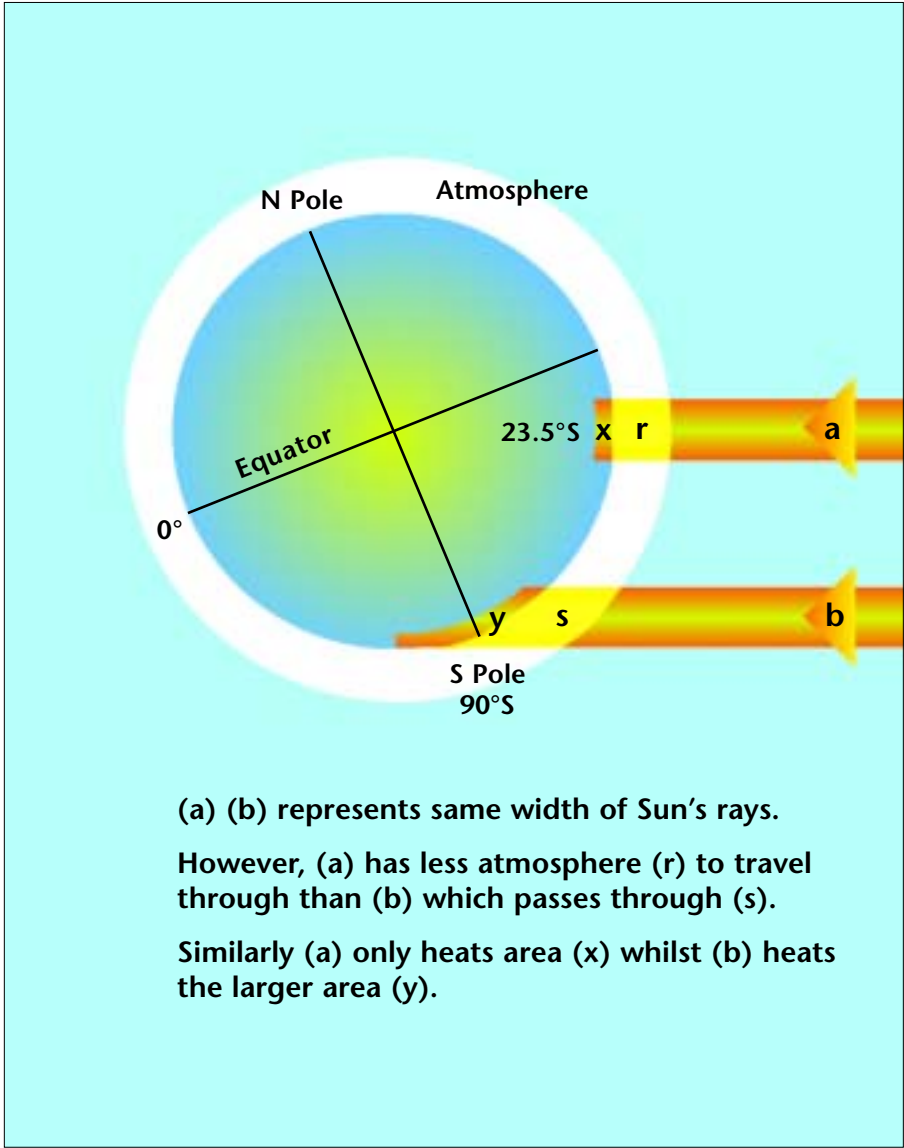
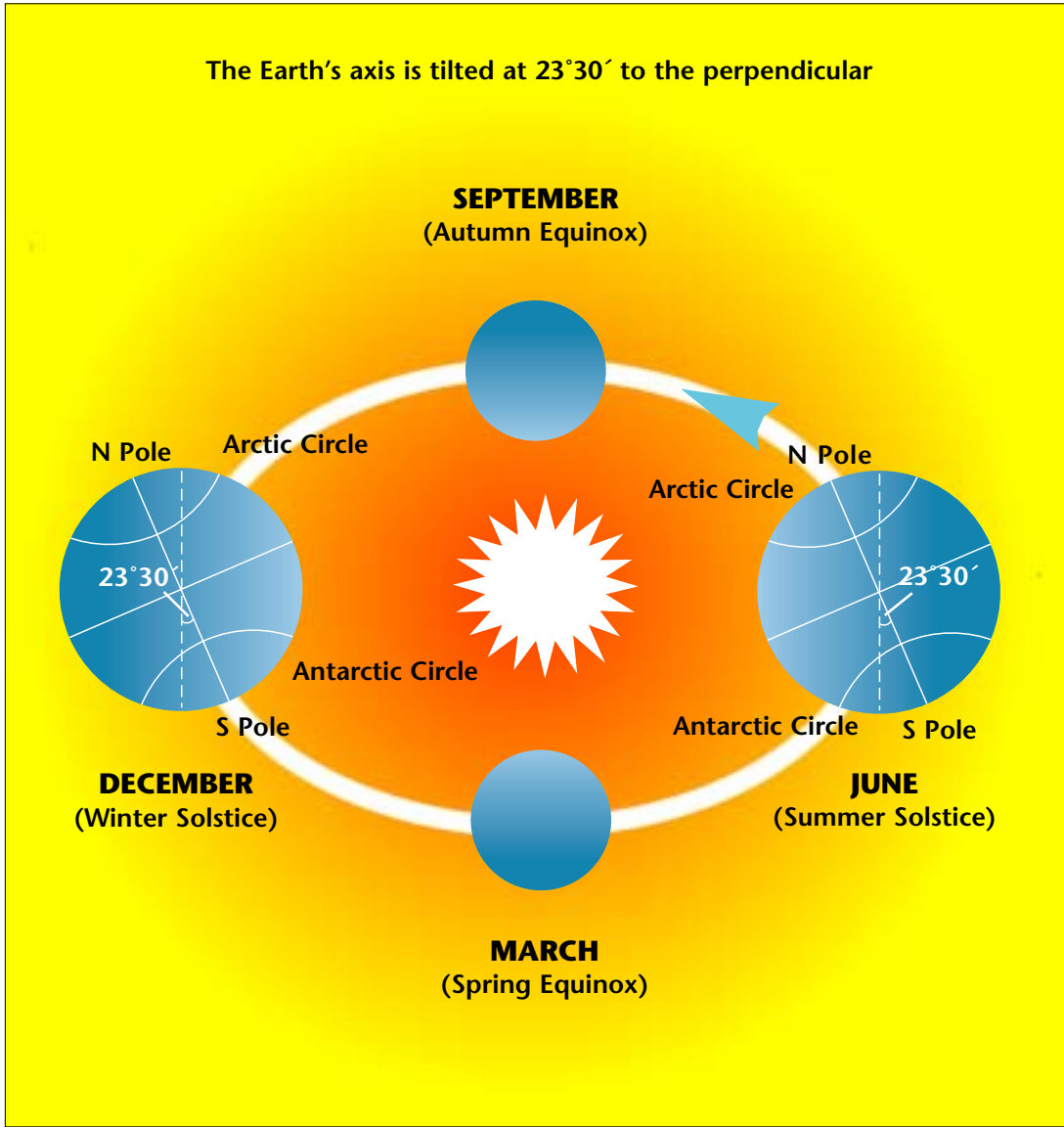


Cross-section through the Antarctic ice sheet from the Ronne Entrance, Bellingshausen Sea, West Antarctica to Colvocoresses Bay, East Antarctica.

Source: Drewy, D.J. (1983) *The surface of the ice sheet*. In: Drewy, D.J. (ed.) (1983) *Antarctica: Glacial and Geophysical Folio*. Scott Polar Research Institute, Cambridge.



# Solar radiation at the South Pole



Seasonal variations in solar radiation at the South Pole.

Solar radiation receipt at latitude  $23.5^{\circ}\text{S}$  and at  $90^{\circ}\text{S}$  during the winter solstice.

BAS

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# Possible effects of sea level rise on the British Isles

Areas in Britain where sea level increases could have a significant impact



\*Note: ODN – Ordnance Datum, Newlyn

The coastline of the Britain if the West Antarctic Ice Sheet were to melt. The likelihood of this happening by the year 2100 is considered by the International Panel on Climate Change to be low.

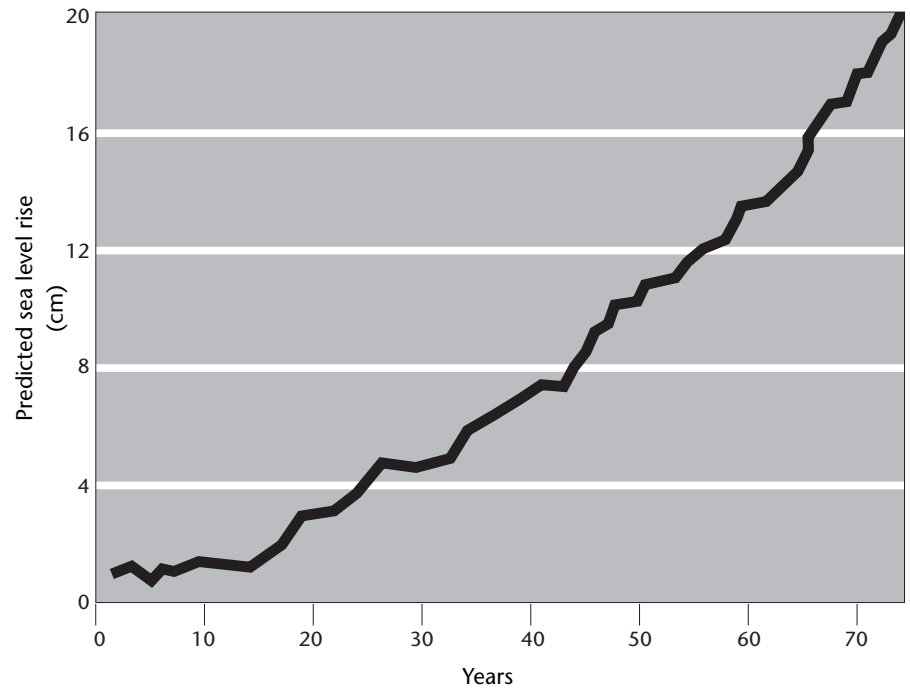
## Predictions of sea level rise

Higher global temperatures caused by greenhouse gas emissions are likely to influence the circulation and heat balance of the world's oceans. This will cause thermal expansion of water, which coupled with increased melting of land ice and glaciers, will result in higher sea levels.

Global sea level has already risen by between 10 to 25 cm over the past 100 years. The International Panel on Climate

Change (IPCC) estimates that sea level will be about 50 cm higher than today by 2100. Sea levels will rise further in the future, even if climate change is halted, because they respond to warming over a very long time-scale.

Sea level rise will put many low-lying coastal regions at risk of flooding, and threaten urban areas, industry, agriculture, and fisheries, as well as saltmarshes, mudflats and other natural habitats.



Predictions made by the UK computer general circulation model (GCM) of sea level rise in the next 70 years



# The nature of Antarctica

## Worksheet 1

Antarctica is the world's last great wilderness. It is a continent almost entirely buried by snow and ice, so hostile and remote that it has no permanent inhabitants. Few people have a realistic concept of Antarctica. This worksheet aims to introduce you to this frozen continent.

**Task 1** Find a globe. Where is Antarctica? If you can, turn the globe upside down. How does this affect your perception of the planet?

**Task 2** Look at Resource N1 which is an A3 map of the Antarctic continent. What shape is Antarctica? How wide is it on average? Assuming Antarctica to be a perfect circle, calculate its area and circumference. Compare your figures with those provided by your teacher.

**Task 3** Resource N2 shows an unusual map centred on Antarctica. In which compass direction do you move from the South Pole to South America, Australia or Africa? Which is the nearest continent to Antarctica? Find the UK.

**Task 4** Look at Resource N1 which shows a map of Europe at the same scale as Antarctica. Choose two cities on either side of Europe, as far apart as the extremes of Antarctica. Find out how long it takes to fly between them on a jet airliner. Look again at the map and estimate what percentage of Antarctica is not covered by ice. What is the continent's highest point? What is the average elevation?

You should by now have an idea of how immense Antarctica is. It covers an area of 14 million km<sup>2</sup>, which is almost as big as Europe. It is the highest continent, with an average height of 2300 m. The highest peak, Vinson



Aerial view of the Transantarctic Mountains

Massif, rises to a height of 4897 m. Over 99% of the continent is covered by ice with an average thickness of 2450 m. Antarctica is remote. It is over 1000 km from the nearest continent – South America. Travel away from the South Pole is always northwards.

### The Antarctic ice sheets

**Task 5** Given an average ice sheet thickness of 2450 m and the area of the continent that you have already calculated, estimate the total volume of ice in Antarctica. Compare this with the figure given to you by your teacher.

- Look at the cross-section through Antarctica shown in Resource N3. What do you think would happen to the land buried under the ice if the ice sheet melted? Why?
- Refer again to Resource N1 and Resource N3. Identify some of the key differences between West Antarctica and East Antarctica. Pay particular attention to the nature of the ice sheets and the amount of land that is above and below sea level. What physical feature separates the two areas?

### The Southern Ocean

The Antarctic continent is entirely surrounded by the Southern Ocean, which accounts for about 10% of the world's seas. The water is extremely cold and surface temperatures can fall to -1.8°C near the continent. The Southern Ocean is driven by prevailing westerly winds, which produce circumpolar currents. Eventually this cold, dense water meets warmer, less dense water from the tropics. This creates a marine zone some 40 km wide, where the sea surface temperature shows an abrupt and significant increase of 2–3°C. The zone is known as the Antarctic Polar Front and marks the northern boundary of the Southern Ocean.

**Task 6** Look at Resource N1 and locate the Polar Front. Estimate the average latitude of this zone. With reference to a map in an atlas showing world ocean currents suggest reasons for the varying extent of the Polar Front. What do you think happens to the Antarctic water when it meets warmer tropical water?

### Sea ice

Sea ice is formed by the freezing of the surface sea water around Antarctica in autumn and winter.

**Task 7** Look at Resource ICE1 (with Worksheet 7 on Antarctic Ice) which shows the extent of sea ice at two different times of year. What is the maximum extent (in kilometres) of the sea ice from the coast? In which month does this occur? Why?

The sea ice reaches its maximum extent in September when it covers 20 million km<sup>2</sup> of the Southern Ocean. It melts back in summer dropping to a minimum of 5 million km<sup>2</sup> in February.

**Task 8** What effect does the annual change in the extent of sea ice have on sea levels? Suggest some of the effects that the annual formation of sea ice might have on marine ecosystems, and on human activity in Antarctica.

### The Antarctic climate

Antarctica is the coldest continent. The world's lowest air temperature of  $-89.2^{\circ}\text{C}$  was recorded at the Russian Vostok station on 21 July 1983. The location of Antarctica at the South Pole, its massive ice sheet and its high altitude ensure that temperatures on the continent are 10 to  $30^{\circ}\text{C}$  colder than at comparable northern latitudes.

**Task 9** Study Resource N4 which shows seasonal variations in solar radiation at the South Pole. What do you notice about sunlight at the South Pole on the June solstice? How does it differ from the December solstice? What is the principal reason for the difference?

Resource N4 also shows the solar radiation receipt at latitude  $23.5^{\circ}\text{S}$  and at  $90^{\circ}\text{S}$  during the December solstice. This is the day when the sun is at its highest in the sky above Antarctica.

**Task 10** Explain in your own words why less solar radiation per square metre reaches the South Pole than the tropics. Consider the ice sheet discussed earlier. How do you think it might affect the absorption of solar energy? Compare it to a tropical rainforest.

Look again in an atlas at Antarctica's position in the southern hemisphere and at the wind belts around it. How does it differ from the Arctic in terms of its location relative to landmasses? How might this affect temperatures?

**Task 11** With reference to the climate data for Antarctic stations shown in Resource C1 (with Worksheet 8, The ►

► Antarctic Climate) summarises the characteristics of the South Pole. Relate your findings to the key factors of latitude, location relative to other landmasses, and global wind circulation.

What climatic regions of the world have similar levels of precipitation to those recorded at the South Pole?

### Climate change

On the Antarctic Peninsula temperatures have risen by around  $2.5^{\circ}\text{C}$  since the 1940s. Scientists do not yet know whether this is due to global warming, or if it is due to natural climate fluctuations. The increase in temperature has caused the disintegration of several small ice shelves along the Antarctic Peninsula. Ice shelves are the floating extension of the ice sheet and fringe much of Antarctica.

Scientists are unsure if the ice sheet might collapse if larger ice shelves, such as the Ronne-Filchner Ice Shelf, were to break up due to warming over the next few centuries. Melting of the West Antarctic Ice Sheet would raise global sea level by 5–7 m.

**Task 12** Look at the map of Britain in Resource N5. This shows the changes in the coastline if sea levels were to rise by 5 m. Which parts of Britain would be most badly affected? Would your home town be flooded? What would be the impacts on society?

### Who owns Antarctica?

Antarctica has no permanent inhabitants and no national government has internationally accepted jurisdiction over any part of it.

**Task 13** Look at Resource ATS1 (with Worksheet 5, The Antarctic Treaty System) which shows the territorial claims of various countries in Antarctica. Suggest reasons for the claims. Which claims overlap? Which countries are have not made claims? Who do you think should own Antarctica? Explain your choice.

Human activities in Antarctica are governed by a unique international agreement: the Antarctic Treaty (1961). The Treaty and subsequent international agreements ensure Antarctica is used for peaceful purposes only and that the environment is protected. The Treaty puts aside the territorial claims.

### Who lives there?

Scientific research is the major activity undertaken in Antarctica, although in summer, fishing and tourism also take place. In winter, the population falls to about 1100. Nearly all these people are scientists and support staff living at 25 research stations dotted around the continent.

**Task 15** What is the overall population density of Antarctica in winter? Compare this to Europe's.



A British Antarctic Survey field party camping on the Antarctic ice sheet



# Correction

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PAGE 5

The 'International Panel on Climate Change' (IPCC) is referenced twice. The correct name of the IPCC is 'Intergovernmental Panel on Climate Change' and the text should read as such.