Climate Change and Its Impacts on Tourism

Report Prepared for WWF-UK

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The opinions expressed in this publication are those of the author and do not necessarily reflect the views of WWF-UK

Executive Summary

This report reviews the impacts of climate change for a wide range of international holiday destinations visited by UK tourists. Tourism as an industry is increasing in both volume and economic importance. Several places, that only a few years ago were inaccessible, are now becoming very popular holiday destinations. However, the ecosystems of many of these resorts are particularly vulnerable to climate change.

Global and regional temperatures are rising. 1998 was the hottest year of the millennium and the 1990s the warmest decade. The four warmest years globally – in decreasing order of magnitude – are 1998, 1997, 1995 and 1990. Climate models suggest a future warming of 0.2 - 0.3°C per decade and sea levels are expected to rise at a rate of 4 to 10cm per decade.

The impacts of climate change on tourism are likely to manifest themselves in a number of different ways according to local conditions. Many of these impacts will develop indirectly through increased stresses placed on environmental systems. The most serious impacts will result from the effects of sea level rise on small island states. The Maldives, which are an increasingly popular tourist destination, are particularly vulnerable to sea level rise.

Climate change is expected to increase the risk of illness in several parts of the world and consequently discourage tourism. More frequent periods of extreme heat will cause discomfort in many resorts of the Eastern Mediterranean, where the number of days above 40°C is estimated to increase. Decreasing cloud cover in Australia will increase exposure to the sun's harmful rays and malaria is likely to re-emerge in Spain, the most popular destination for tourists from the UK.

Winter tourism may also be affected, as the Alps and other skiing destinations experience less snowfall and shorter skiing seasons. These impacts will be especially pronounced in the lower-lying ski resorts, such as Garmish-Partenkirchen, Germany, and those resorts, such as in the Scottish Highlands, where commercial ventures are already marginal.

However, the picture is by no means entirely negative. The attraction of many holiday resorts is the prospect of guaranteed sunshine and heat. A generally warmer climate will benefit those holiday destinations such as the UK where summer weather conditions are at present highly variable. With warmer weather a higher proportion of UK residents may be encouraged to holiday at home. We may witness not only an expansion in the domestic market, but an expansion in the inbound international market as the UK develops a more Mediterranean climate.

1 Introduction

This report examines the extent to which climate change may affect the environmental systems of a range of international tourist destinations wordwide and the potential impacts these changes may have on tourism. International tourism is the largest and most rapidly expanding economic activity in the world today. As reported by the World Tourism Organisation, travel and tourism involved 625 million people internationally and generated $US 445 million in receipts in 1998 (WTO, 1999). Tourism is an important contributor to the economies of most countries and in some can represent up to one fifth of GDP. The global tourism industry is expected to grow significantly in the future as personal incomes and leisure time increase, and transportation networks improve.

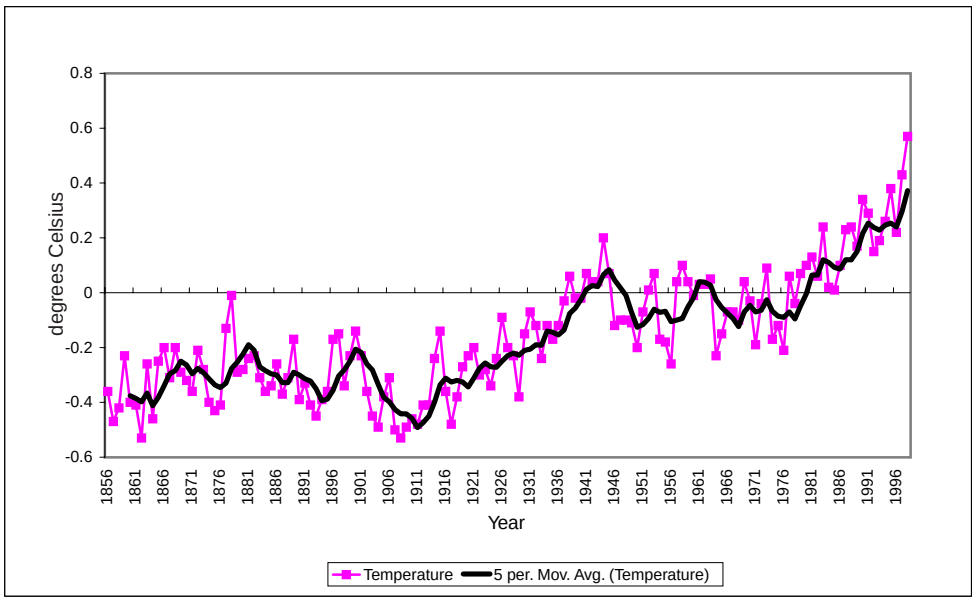

Figure 1. Global mean temperature anomalies, 1860-1998, with respect to 1961-90. (Jones *et al*, 1999).

The climate system is dynamic and varies on all time scales. However, over the last century we have seen an increase of over 0.6°C in the average temperature of the Earth (see Figure 1). The warming this century has been more rapid than any other period for which we have data. The 1990s will be the warmest decade this millennium with 1998 the warmest year and August 1998 the warmest month (Figure 2).

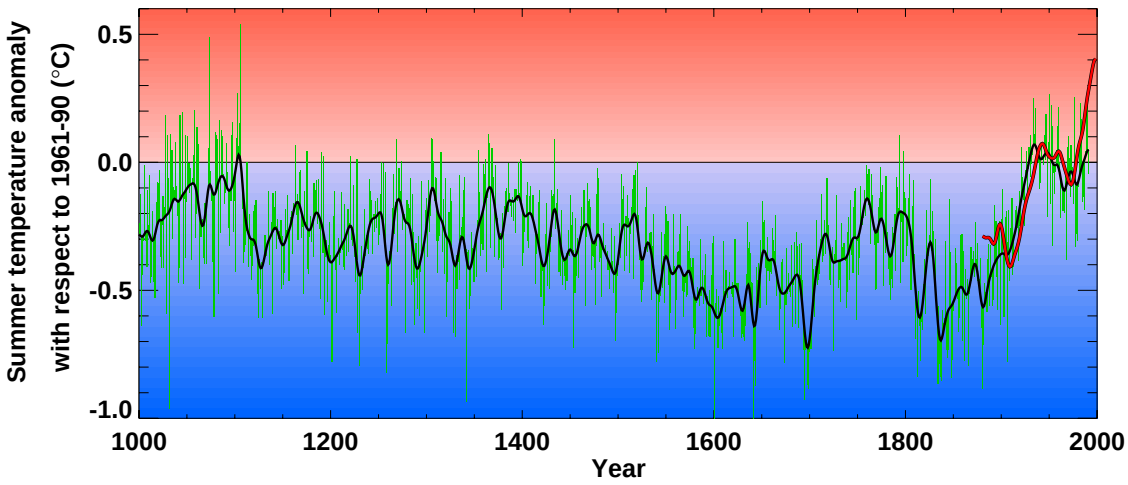

Figure 2. The reconstructed temperature anomaly for the last 1000 years and the observed temperature anomlies (red line). Jones *et al*, 1998)

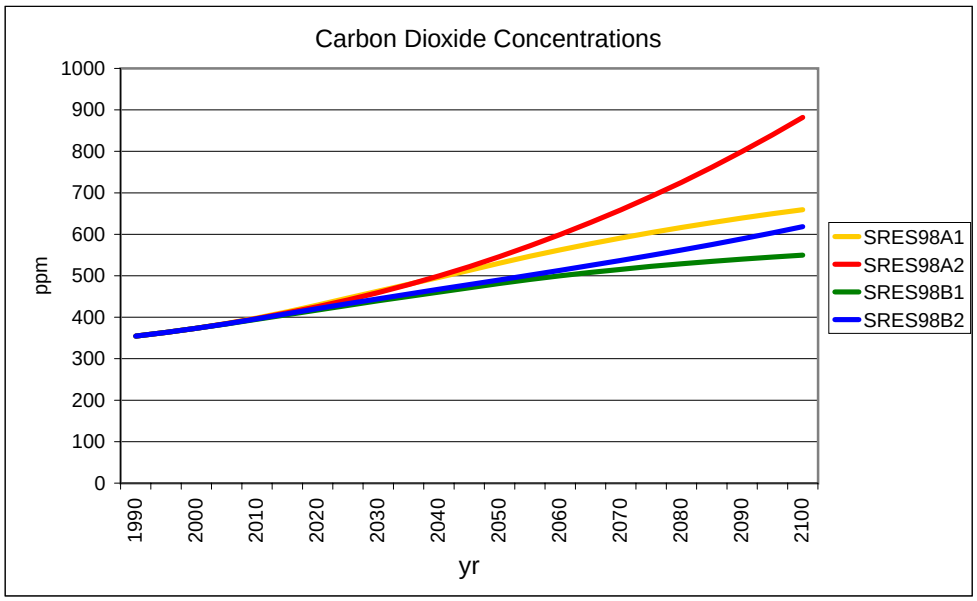

Figure 3. Modelled carbon dioxide concentration estimates for the four Preliminary SRES marker emissions scenarios derived from MAGICC (Wigley *et al*, 1997).

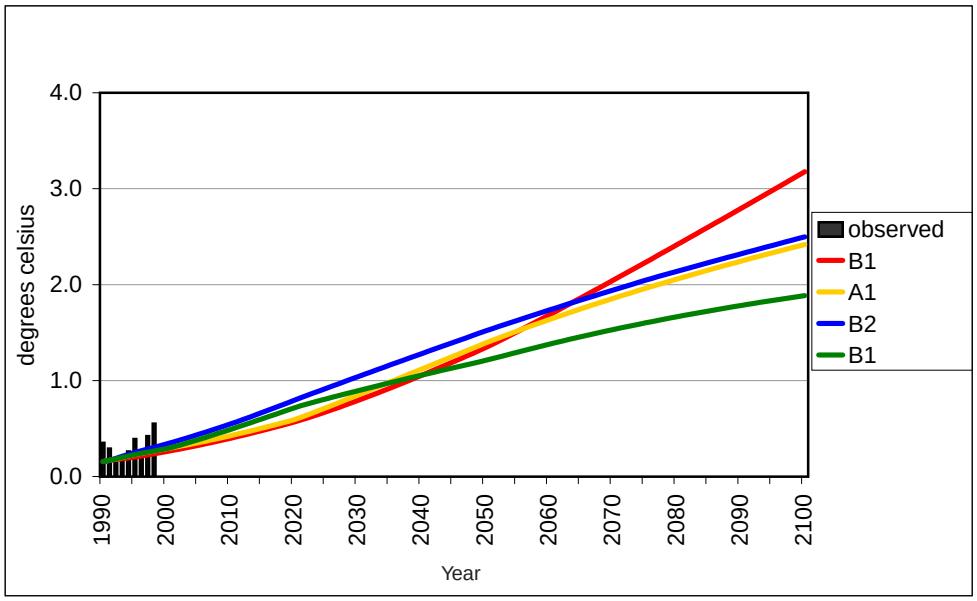

Figure 4. Modelled global mean temperature estimates for the four Preliminary SRES marker emissions scenarios, temperature estimates derived from MAGICC (Wigley *et al*, 1997).

Since the start of the industrial revolution vast quantities of carbon dioxide and other so-called greenhouse gases have been released into the atmosphere by the burning of fossil fuels, most notably coal and oil, and to a lesser extent, gas. This has led to an increase in the atmospheric concentration of carbon dioxide from 280ppm (parts per million) to its present level of 355ppm. Carbon Dioxide is one of the main greenhouse gases, along with water vapour and methane. As a result of the increasing concentration of these gases, more longwave radiation from the Earth is absorbed, thus reducing the energy lost to space and so altering the natural balance between incoming and outgoing radiation. Continued use of

carbon-based fuels will further increase the atmospheric concentrations of carbon dioxide and other greenhouse gases. The most recent estimates of how this will change over the next century have been produced by the IPCC Special Report on Emissions Scenarios (see Figure 3). These estimates of future emissions are used in mathematical climate models (Wigley *et al*, 1997) to explore how this will effect global temperatures (see Figure 4) and regional climates (see Figure 5).

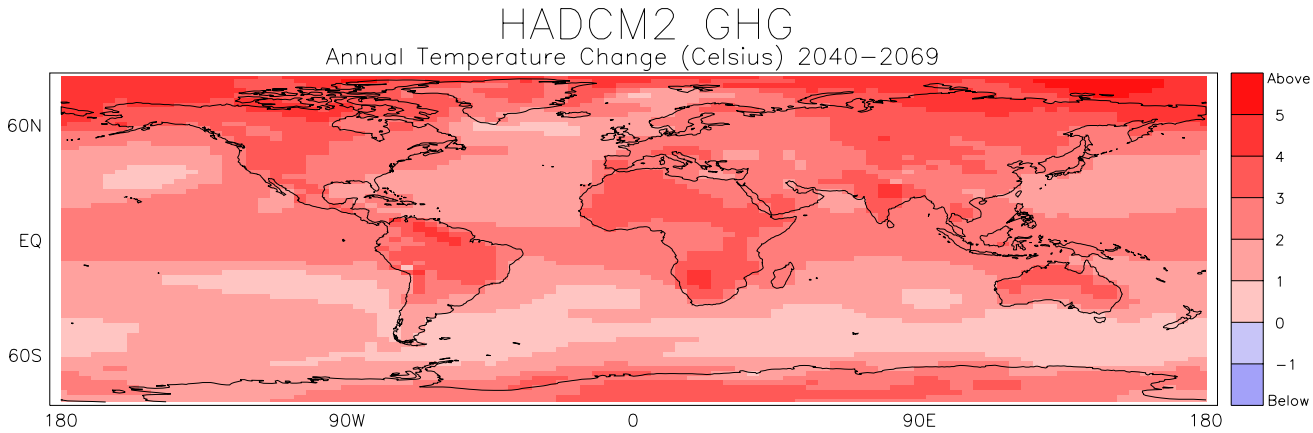

Figure 5. Temperature change for the 2050s (2040-69) with respect to 1961-90 as estimates by the HadCM2 GCM for the IS92a emissions scenario

Detailed analysis of the output from these climate models provides further evidence of the impacts of the enhanced greenhouse effect upon our climate. For example, we can now say with increasing confidence that the average global rainfall will increase. However, this will not be experienced everywhere, and for some regions there will be decreases in rainfall. Extreme climate events (such as droughts and prolonged 'hot' periods) may increase in frequency. For example, in the UK, what is perceived as a hot year or month (eg August, 1997) may become the norm by the middle of the next century, and what we might consider to be an exceptional period in the future will lie outside our present sphere of experience (see Table 1). Changes in the frequency of other extreme weather events such as severe windstorms (tornadoes and hurricanes) are more difficult to determine, but any increase in these would certainly have profound regional impacts.

August 1997	1961-90 +3.15°C	2010-39 +5.41°C	2040-69 +7.14°C
Year 1997	+1.10°C	+2.36°C	+3.08°C

Table 1 Temperature anomalies of warm years and hot months in the UK that have a return period of 1 in 20 years for the present, the 2020s and 2050s. For comparison, in the central England temperature record, August 1997 had an anomaly of 3.4°C and the year 1997 had an anomaly of 1.06°C.

Many aspects of our lives are influenced by the weather and the climate, from the crops we grow to the social activities we engage in. The natural environment and climate conditions are very important in determining the attractiveness of a region as a holiday destination. In the UK, summer weather conditions are classified as 'comfortable' (not too hot, not too humid, not too cold) yet millions of Britons each year fly the relatively short (2-3 hours) distance to Southern Europe in search of better weather. In turn, tourism is having an effect on the environment and climate. For example, the expansion in air travel is itself increasing emissions of greenhouse gases and enhancing the risk of continued global warming (IPCC, 1999).

Holidays have become an essential part of our lives in the latter stages of the twentieth century. They account for one of our most costly items of expenditure with an average package holiday costing £0.70 per household per week for a package holiday in the UK, and £8.10 per household per week for a package holiday overseas (Office of National Statistics). As well as the more frequently visited short-haul destinations, eg Spain, Greece and Turkey, the accessibility of far-flung exotic holiday destinations is now increasing. International tourism is one of the most important and rapidly growing service industries in the world. However, its continued success is closely and symbiotically related to the preservation and enhancement of environmental resources. The environment is one of the most basic resources for tourism; yet unchecked growth in tourism inevitably leads to modification of the environment.

2 Outline and Background

Many experts claim that the tourist industry now involves more people and more money than any other industry on earth. Although these claims may be arguable, tourism is becoming increasingly vital in the economy of many countries. Table 2 shows the top ten international holiday destinations.

2.1 Global tourism

	Country	Arrivals (millions)
1	France	61.5
2	United States	44.8
3	Spain	41.3
4	Italy	32.9
5	Britain	26.0
6	China	22.8
7	Mexico	21.4
8	Hungary	20.7
9	Poland	19.4
10	Canada	17.4

Source: World Tourism Organisation
Table 2 Top world destinations in 1996

The World Tourism Organisation forecasts that international arrivals will increase from 594 million in 1996 to 702 million by the year 2000, 1018 million by 2010, and soar to 1600 million in 2020. International tourism receipts are forecast to grow to US $621 billion by 2000 and US $1.5 trillion by 2010 (Table 3).

2.2 UK Tourism

The tourism industry is a major part of the UK economy and earns the equivalent of £100 million per day from all visitors, sustaining 1.7 million jobs. The importance of British tourism is demonstrated by the high proportion of consumer expenditure (16% of the average household expenditure) spent on tourism, and by the large number of employees in tourist-related activities. During 1996, 127 million domestic tourist trips were taken in the UK, generating a revenue of £13,895 million. Internationally, France and Spain are the most popular destinations for UK tourists (Table 4).

Rank	Country	Arrivals (millions)	Market share %	Growth % (pa) 1996-2020
1	China	137	8.6	8.0
2	USA	102	6.4	3.5
3	France	93	5.8	1.8
4	Spain	71	4.4	2.4
5	Hong Kong	59	3.7	7.3
6	Italy	53	3.3	2.2
7	UK	53	3.3	3.0
8	Mexico	49	3.1	3.6
9	Russian Federation	47	2.9	6.7
10	Czech Republic	44	2.7	4.0

Source: World Tourism Organisation, 1998
Table 3 World's leading tourism destinations - forecast for 2020

Package holidays are popular with UK tourists. Spain accounts for 34% of all package holiday trips abroad from the UK, and the Balearic islands

	Country	Arrivals (thousands)
1	France	11149
2	Spain	8281
3	Republic of Ireland	3613
4	USA	3028
5	Germany	2023
6	Italy	1801
7	The Netherlands	1756
8	Greece	1512
9	Belgium	1419
10	Portugal	1304

Source: UK Office for National Statistics,
Table 4 Top destinations for UK tourists in 1997

The potential impacts of climate change have significant considerations for planning in the tourist industry. With an indication of likely climate-related trends in tourist volumes, decision makers should be better

equipped to manage transport, catering and accommodation requirements more effectively. Moreover, environmental management considerations are wide and varying. From the prevention of coastal flooding and erosion to the conservation of water resources, the control of forest and bush fires, and the conservation of vulnerable flora and fauna.

1	Balearic islands
2	Canary islands
3	Spain
4	Florida
5	Greek Islands
6	Turkey
7	Portugal
8	Italy
9	Malta
10	France

Table 5 Top ten package holiday destinations for the UK (1997)

3 Study Areas

Impacts of climate change are examined for selected tourist resorts and regions across the globe. This sample of destinations is chosen to reflect differences in climate, the environment and socioeconomic conditions. The target resorts service the following holiday markets: mass volume package holidays; exotic 'no news no shoes' holidays; skiing trips; winter sunshine holidays; and ecotourism. The key climate, and tourist characteristics for each of the countries considered are given in Tables 6 to 8.

	Country	Resorts	Mean annual temperature 1961-90
1	The Maldives	Beach resorts and coral reefs	27.2oC
2	The European Alps	Garmisch-Parten Kirchen, Germany Kitzbuhe Austria	2.3oC
3	The Eastern Mediterranean	Greece and Turkey	16.0oC
4	Southern Spain	The Costa's	15.0oC
5	UK	Scottish ski resorts	7.5oC
6	East and South Africa	Lake Manyara National Park, Tanzania Masa Mara, Kenya S. Africa	21.2oC
7	European Lakes	Lake Zurich	10.0oC
8	Australia	Snowy mountains Great Barrier Reef Interior bush Beaches and coast	20.0oC
9	Florida and SE Coastline, UK	Assateague National Seashore, Maryland	10.6oC
10	Brazil	Rainforest	26.o0C

Sources: World Statistics UN 1997.

Table 6: Mean annual temperature for the countries/regions considered

Country/region	Arrivals from all countries (000)	Arrivals from UK	Tourist receipts (US$M)	Tourist spending (US$M)
The Maldives	315		198	37
Germany	14847	1354.4	18902	49845
Austria	17173	512.6	12367	12576
Greece	10130	2418.6	4244	1414
Turkey	7083	915.0	7319	963
Spain	39324	8805.2	34022	5285
UK	24008		22058	28930
Kenya	691	153.1	419	132
Tanzania			915	88
South Africa	4488		2587	1767
Switzerland	11500	1187.0	7864	6554
Hungary			1808	1305
Australia	3726	367.6	8859	5004
USA	43385	3463.0	72751	64886
Brazil	2150	not known	4085	-

Table 7: Annual arrivals in 1996 for the countries considered Sources: Europa 1998 The Europa World Year Book 1998. Europa Publications Ltd; Euromonitor, 1998, The World Economic Fact book 1998/9, 6th Edn, Euromonitor, London.

Notes: Tourist receipts: refers to revenue from foreign nationals, ie payment from visitors within the destination country and to the national carriers, while tourism expenditure refers to the reciprocal expenditure by that country's national in foreign countries, as collected by government agencies such as national statistical bodies and customs and exercise bodies.

AUSTRALIA		
	Sydney New South Wales	Cairns Queensland (Barrier Reef)
	Melbourne Victoria	Adelaide South Australia
	Gold Coast Brisbane, QL	Darwin Northern Territory
	Alice Springs Northern T.	Perth Western Australia
FLORIDA		
	Miami	Orlando
	Tampa	Tallahassee (Capital)
	Fort Lauderdale	Jacksonville
	Keys (West and Largo)	Everglades
S. SPAIN		
	Gibraltar	Malaga
	Torremolinos	Seville
	Marbella	San Pedro
	Puerto Banus	Fuengirola
	Benidorm	Nerja
S.&E. AFRICA	Kilifi	Nairobi
	Mombasa	Zanzibar
	Malindi	Durban
	Cape Town	Johannesburg
	Port Elizabeth	Swaziland
E. MED		
	Crete	Cyprus
	Rhodes	Kos
	Corfu	Turkey

Table 8: Some example of the key resorts and destinations covered by the report (continued on next page)

	Zante	Malta
	Greece	
S. AMERICA		
	Peru: Machu Picchu	Cusco
	Bolivia: La Paz	Sucre
	Quito	Rio de Janiero
	Brasilia	Fortaleza
	Recife	Salvador
EURO LAKES		
	Italy: L. Como, Bellagio	L.Garda, Garda
	L.Maggiore, Pallanza	France: L.Annecy, Talloires
	Slovenia: L.Bled, Bled	Switz: L.Thun, Gunten
	L. Lucerne, Lucerne	L.Geneva, Montreux
	Hungary: L.Balaton	Austria: L.Wolfgang, St Wolfgang
EURO ALPS		
Ski Resorts	Austria: St Anton	Salzburger
	Obertauern	Mayerhofen
	France: Val DIsere	Chamonix
	Switz: Klosters	Davos
	Grindelwald	Zermatt
ASSATEAGUE ISLANDS	Camp sites mostly. Prominent sites State Park and Visitor Centre	

Table 8: continued

4 Maldives, Indian Ocean

4.1 Introduction

The Maldives are located in the Indian Ocean to the South west of the Indian sub-continent. They consist of an archipelago of 1190 coral atolls which are made up of numerous small islands, of which nearly 200 are inhabited. The total population of these islands is 220,000. Many of the islands are less than one metre above sea-level and their total land area is less than 300km^2. The Maldives have become a popular tourist destination since the capital, Male, which is one of the most densely populated islands on the planet, acquired an airport on a neighbouring small island which can handle the wide-bodied tourist jets.

4.2 Climate

The Maldives' climate is tropical, hot and humid. The mean annual temperature is 27°C, with little daily or seasonal variation. Annual rainfall is between 2540 and 3800mm. They experience two monsoons: one in the northeast from November to March, and one in the southwest from June to August. For the Maldives, the impact of climate change on sea level is critical. Whilst any rise in temperature may not have a direct impact upon the islands themselves, except for the bleaching of coral, future sea level rise will. The Maldives form a chain of islands based upon the natural coral reefs that have built up around the rim of a chain of ancient volcanoes. It is these reefs that ensure the islands remain intact. To date the reef growth fluctuates in response to the natural variation in sea level. As the concentrations of greenhouse gases build up in the atmosphere and the temperature of the Earth warms so does that of the ocean. As the oceans heat up they expand, causing sea levels around the world to rise at an estimated rate of between 4 and 10cm per decade. Figure 7 shows the estimated rise in sea level caused by thermal expansion and small-glacier melt based upon the Preliminary SRES emissions scenarios.

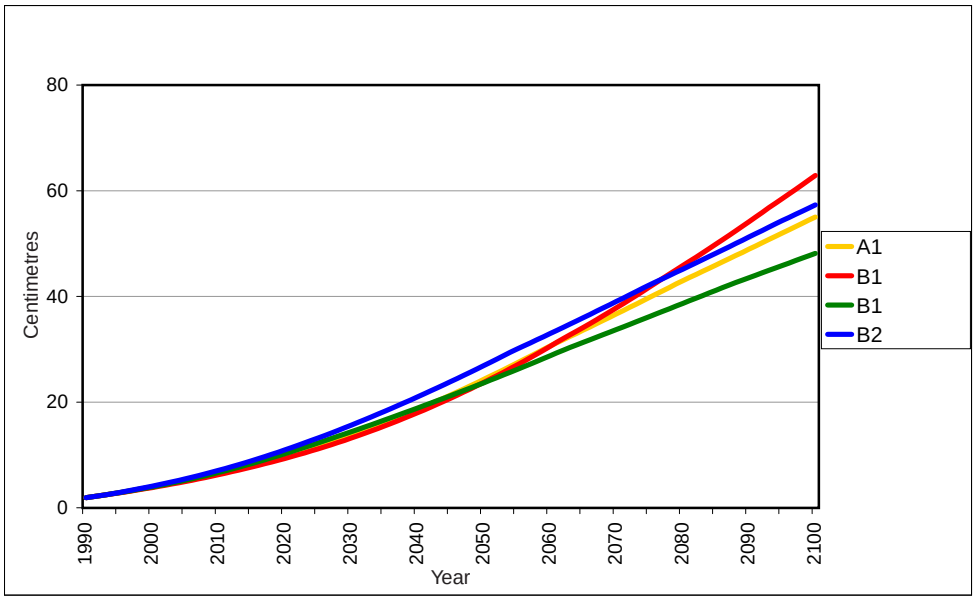

Figure 7 Estimated rise in sea-level caused by thermal expansion and small-glacier melt based upon the Preliminary SRES emissions scenarios using MAGICC (Wigley *et al*, 1997).

4.3 Tourism

During the 1980s, tourism in the Maldives became one of the most important and highest growth sectors of the economy. Tourism is now the backbone of the Maldives' economy, accounting for about 18% of GDP and more than 60% of the Maldives' foreign exchange receipts. Over 90% of government tax revenue comes from import duties and tourism-related taxes. 395,725 tourists visited the islands in 1998, of which 85% were from Western Europe. The UK is the third most important source region after Germany and Italy. The islands' attractions include white sandy beaches and multi-coloured coral formations spread amongst a total of 74 island resorts.

4.4 Potential impacts:

The low elevation of the Maldives archipelago makes them particularly vulnerable to sea level rise. At best a rise in sea level would cause coastal erosion and at worst a sizeable proportion of the landmass could become submerged over the next 30 years. The Republic of the Maldives has not surprisingly become an ardent supporter of international moves to curb global warming. Future projections of sea level are critical. The higher the sea level the more frequently these small islands will be overwashed by storms. The dangers of salt water intrusion of the island aquifers combined with sea level rise, may lead to many of the islands becoming uninhabitable in the future. These unique islands which many tourists view as paradise and the ultimate 'get-away-from-it-all, no news-no shoes' location could soon become, quite literally out of our reach.

The coral reefs provide protection and stability to the islands, represent a great biological diversity of marine ecosystems and have become a very important attraction for tourists (Maldives Tourism Promotion Board). Tourism is the fastest growing economic sector associated with coral reefs and is set to double in the very near future. 40% (158 thousand) of the tourists who visit the Maldives do so for diving experiences (Maldives Tourist Board). The cost of losing 58% of the world's coral reefs has been estimated as $140 billion (Byrant et al, 1998).

However, a temperature increase of only 1 or 2°C could not only cause coral 'bleaching', (death of the coral caused by increased sea-temperatures) but also increase the threat of subsequent flooding. An international team of coral experts reported that the 1997/1998 sea surface temperatures were the warmest in the observed record. The coral bleaching associated with this event had impacted almost all species of corals and many other invertebrates and had a devastating effect on reefs in the Maldives (NOAA, 1998).

Many of the long-haul destinations in the South Pacific are popular venues for the Millennium celebrations since they are near the Date-Line, but are also at risk from sea level rise. These include: Kiribati1, with a population of 75 thousand scattered over 300 islands in two million km^2 of the Pacific (two of these islands have already disappeared), and The Marshall Islands, with a population of 50 thousand covering 1200 islands in 700 thousand km^2 of the Pacific.

5 The European Alps

5.1 Introduction

The European Alps are located in a double border area between the temperate latitudes and the Mediterranean subtropics, and between oceanic and continental Europe. They exhibit a wide range of climatic conditions, with virtually every Alpine valley having a unique local climate.

5.2 Climate

Although the climate is temperate, it becomes very cold in winter because of the high altitude. The higher Alpine winter sports resorts are much sunnier than the valleys where conditions are often cloudy and foggy with low temperatures persisting for several days. Thus, while temperatures are often lower in the mountains it can feel warmer in calm and sunny conditions. Table 9 gives the mean climate values (January to March) for Innsbruck, at an elevation of 582m .

	Max. Temperature	Min. temperature	Rainfall
Jan	1oC	7oC	54mm
Feb	4oC	5oC	49mm
Mar	11oC	0oC	41mm

Table 9 Mean temperature and rainfall values for Innsbruck in winter.

Figure 8 shows future climate scenarios constructed from climate change experiments performed at the Hadley Centre (Mitchell et al, 1995). These provide estimates of future changes in snow amount. It is expected that as temperatures rise there will be a considerable shortening of the snow season and a reduction in the amount of precipitation that falls as snow. In many areas this reduction in snow amount may be as much as 30% by the 2020s and over 50% by the 2050s for the European Alps.

5.3 Tourism

The European Alps is one of the primary winter holiday destination for skiing activities. Tourism is Austria's largest industry, accounting for 6.3% of GDP in 1997. This is the highest share among all the countries in the OECD. However, the industry has been in decline for the past five years. Similarly, in the in the Swiss Alps winter tourism has endured several consecutive years of losses. Garmisch PartenKirchen, is Germany's best known ski resort, and is the site of the famous annual ski jumping and World Cup descents each New Year. The resort (at an elevation of 702m) is located beneath Germany's highest mountain, the Zugspitze and has 150km of ski trails and 38 ski lifts. The skiing season opens in December. Kitzbühel, is another low-elevation ski resort in Austria, lying at 800m. The resort has 28 lifts and 27 pistes, with 61 more pistes in a linked area. The skiing season runs from December to March.

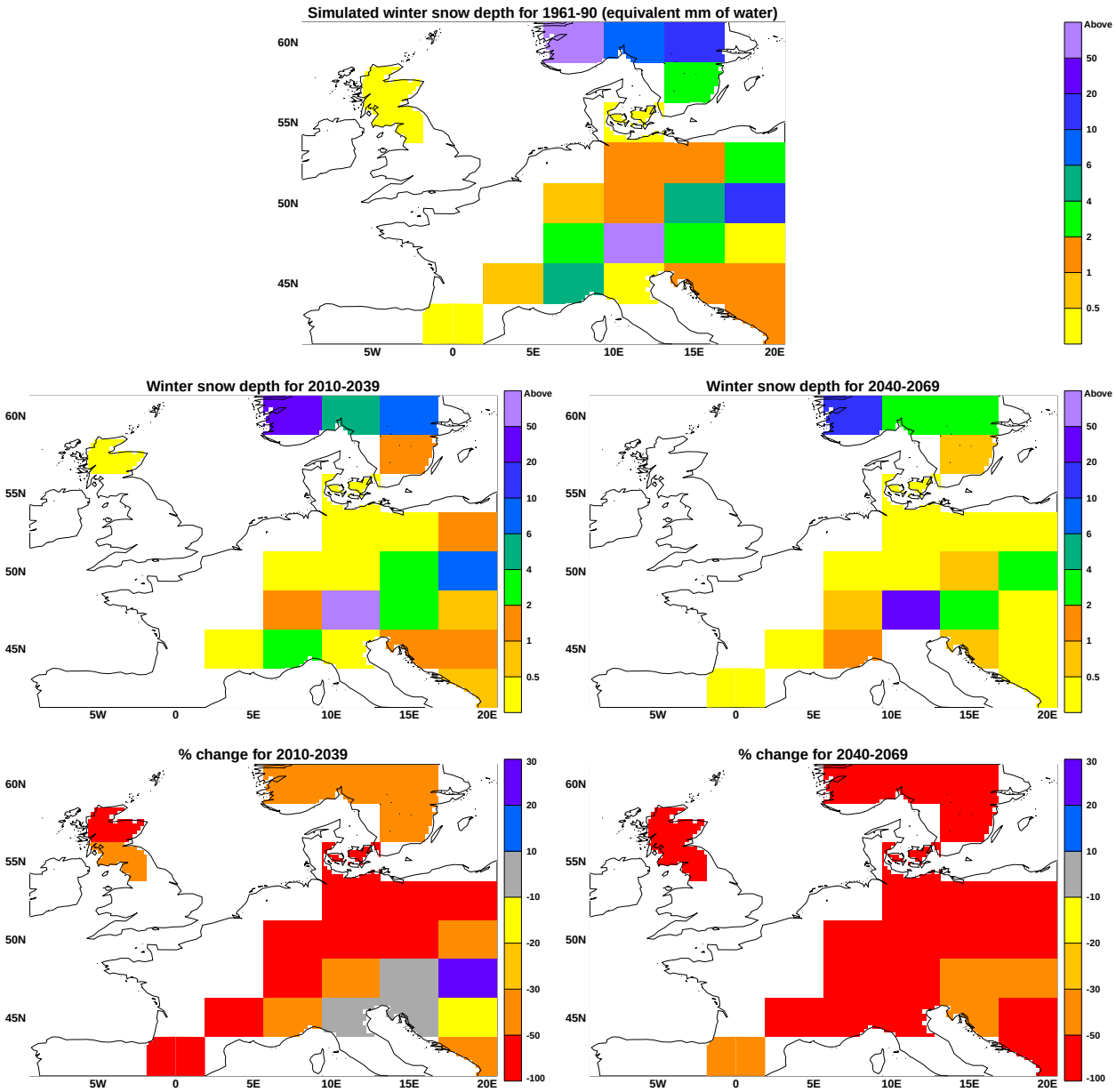

Figure 8. Evolution of snow cover for the European region as estimated by HadCM2 GCM with the IS92a emissions scenario.

5.4 Potential impacts

It is likely that some of the more traditional ski resorts will suffer from a reduction in snow cover duration if the warming trend continues. These resorts are primarily situated at a lower elevation than their modern equivalents. Examples of vulnerable resorts include, Garmisch-PartenKirchen in Germany and Kitzbühel in Austria. Models of snow cover duration for a set of regional climate change scenarios show a decline in the number of days of snow cover, especially for those resorts at low altitude (less than 1400m) sites (Whetton et al 1996; Bultot et al, 1994). The higher altitude ski resorts will experience increasing pressure if their lower-lying counterparts become less commercially viable.

6 The Eastern Mediterranean

6.1 Introduction

We have selected the two countries of Greece and Turkey to represent climate impacts in this region. Greece is a peninsular country, possessing an archipelago of about 2000 islands. The terrain is mountainous, with ranges extending into the sea as peninsulas or chains of islands. The largest island is Crete. Turkey has an extensive coastline bordering the Black Sea, the Aegean Sea and the Mediterranean, and has land borders with Greece, Bulgaria, Syria, Iraq, Georgia and Armenia. The terrain is mostly mountains, with a high central plateau (Anatolia) and a narrow coastal plain.

6.2 Climate

The climate is Mediterranean with mild winters and long, hot summers with maximum temperatures often exceeding 40°C. Climate modelling suggests that mean summer temperature increase will be in excess of 4°C by the middle of the next century (see Figure 9). In the interior of Turkey, the climate is characterised by extremes in temperature, with hot, dry summers and cold snowy winters on the plateau. Temperatures in Ankara vary between 4 and 30°C. On the Mediterranean coast it is more equable, with mild winters and warm summers. As a result of climate change it is estimated that temperatures in the hot summer months may exceed several thresholds of human comfort as the frequency of extreme hot days increases. Figure 10 shows the number of days in August that exceed the temperature thresholds of: 20°C, 25°C, 30°C, 35°C and 40°C.

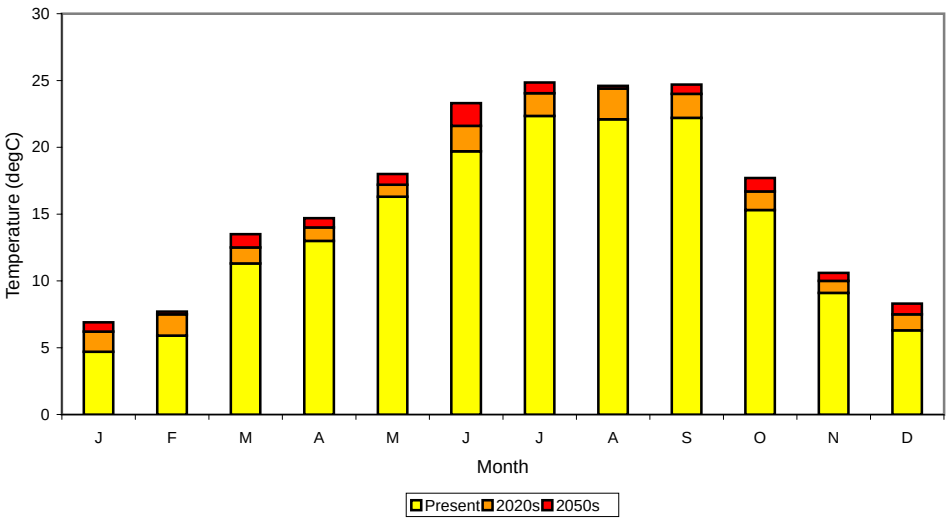

Figure 9. Estimated tempertaures for the Eastern Mediterranean for the present, the 2020s (2010-2039) and the 2050s (2040-2069). Estimates derived from the HadCM2 GCM using the IS92a scenario.

6.3 Tourism

In Greece, tourism is one of the biggest foreign-exchange earners. However, there is growing competition from newer and more exotic sites elsewhere in the world, and as a consequence the number of visitors fell in both 1996 and 1997. To counteract, the government is improving the tourist infrastructure, particularly in the Aegean, where tourism continues

to flourish. In recent years, tourism has expanded rapidly in Turkey, and a 30% increase in the number of visitors is forecast for the year 2000. Just under 1 million British citizens visited Turkey in 1998, almost double that of 1988. Visitors are attracted by the warm spring and hot-dry summer climate, fine beaches and ancient monuments.

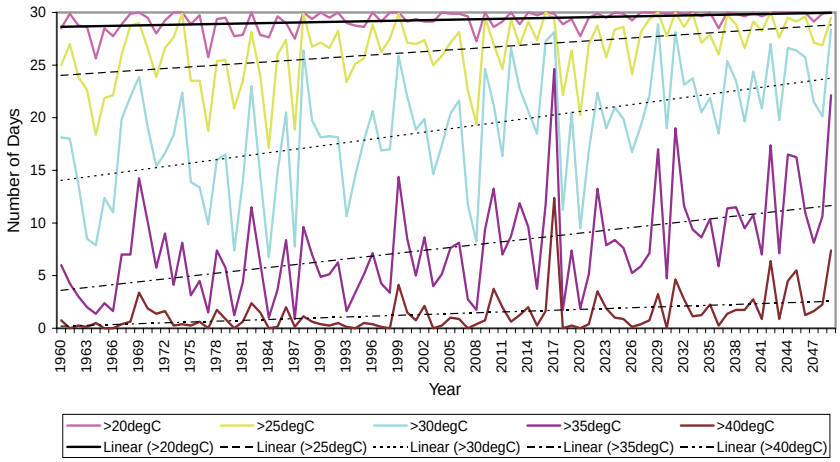

Figure 10. Estimated changes in the frequency of days above certian key temperature thresholds for the Eastern Mediterranean. Estimates derived from the HadCM2 GCM using the IS92a scenario.

6.4 Potential impacts

Increases in summer temperatures to above 40°C will reduce personal comfort and can lead to increased incidence of heat stress and mortality. At present, August (coinciding with UK school summer holidays) is the most popular month for tourist travel to Greece and Turkey. However, it is anticipated that with soaring temperatures and an associated reduction in the comfort index many tourists may be discouraged from visiting at this time of the year. Alternatively, holiday-makers may opt for an earlier or later time of the year (since climate models suggest that June in 2020 will be as warm as July, August and September at present) or they may switch to alternative locations in other countries. Even during the last two decades, Athens has endured uncomfortably high temperatures which have led to an excess number of heat-stress incidents. Other detrimental environmental impacts of climate change are likely to include an increase in water supply restrictions, forest fires and urban smogs. Very high levels of pollution have been recorded during hot spells in resorts of the eastern Mediterranean (Giles and Balafoutis, 1990). An increase in the frequency of these pollution episodes may label the eastern Mediterranean as a less attractive tourist destination.

7 Southern Spain

7.1 Introduction

South-eastern Spain hosts some of the most popular destinations for tourists from the UK and other European countries, for example, the resorts of Benidorm, Malaga and Marbella, which make up the Costa's region. These resorts are popular in the summer months for families, singles, and the under 30s, and are also frequented by longer-stay holiday makers in the winter months. Year-round sun and warmth make the Costa's a tourist destination all through the year.

7.2 Climate

Spain's climate provides the ideal alternative to that currently experienced by the UK: warm summers with large amounts of sunshine and low amounts of rainfall, coupled with mild winters (see Figure 11). With climate change, temperatures are likely to increase. For example, September in 2050 may be as warm as July is today. The indications are that rainfall will not change significantly. As a result, the summer months

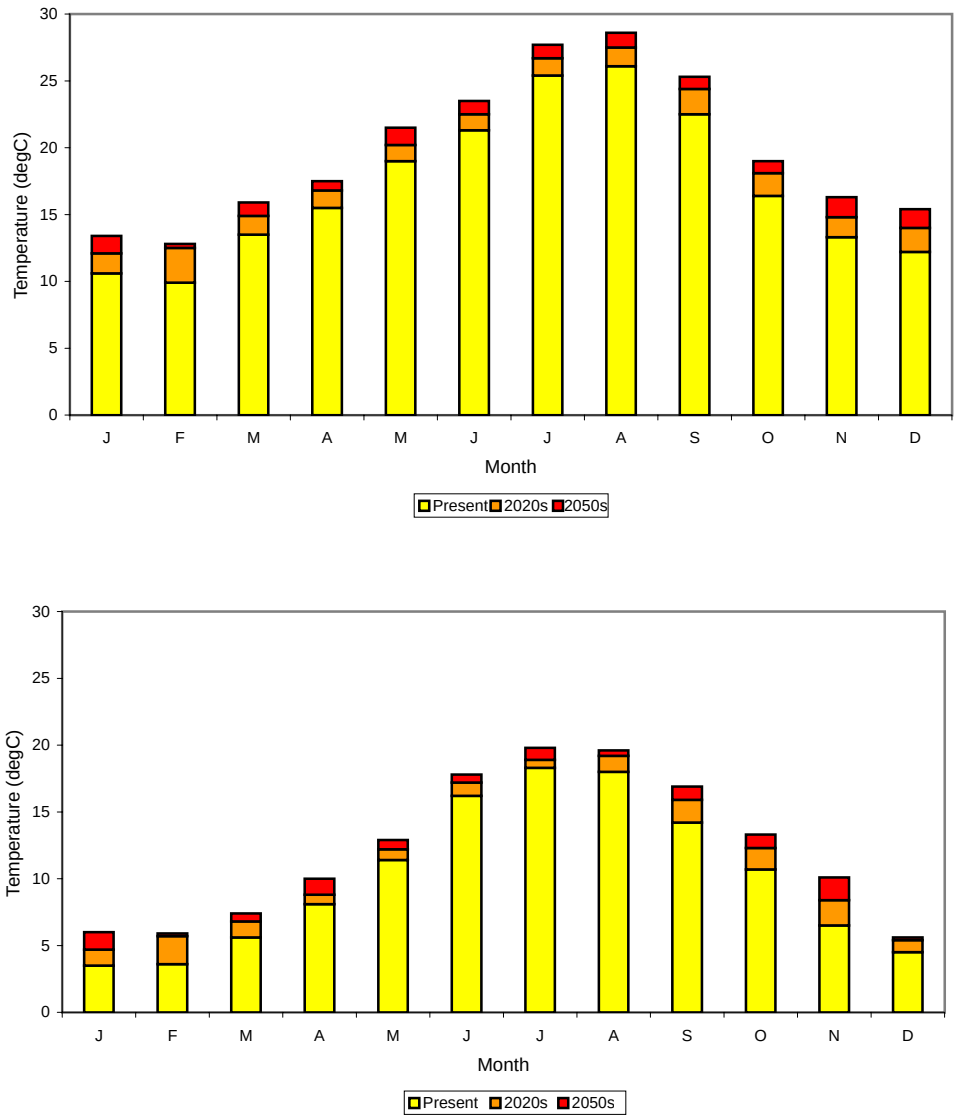

Figure 11. Estimated tempertaures for South-eastern Spain (top) and London (bottom) for the present, the 2020s (2010-2039) and the 2050s (2040-2069). Estimates derived from the HadCM2 GCM using the IS92a scenario.

7.3 Tourism:

Tourism employs 9.5% of the workforce in Spain and is treated by the government as a key economic sector with good prospects. It is one of the major tourist destinations for UK holiday makers, particularly around the Costa Del Sol (eg Marbella and Benidorm). The tourist attractions are its climate, beaches and historic cities.

7.4 Potential impacts:

Spain is seen as a friendly, easily accessible, no risk destination. For example, there is no need for any immunisation against exotic diseases such as malaria and yellow fever. However, more recently Malaria has re-surfaced in Spain, and it is estimated that changes in climate will result in this region becoming a more suitable habitat for certain species of mosquito (eg Anopheles labranchiae). Malaria, which is the worlds largest killer, is spread by a number of species of mosquito which carry either the Plasmodium falciparum or Plasmodium vivax parasite. These are extremely temperature dependent and have sharp thermal gradients. At present the mosquito and parasite are found in North Africa. It is anticipated that by the 2020s suitable habitats for Malaria will have spread northwards into Spain (see Figure 12).

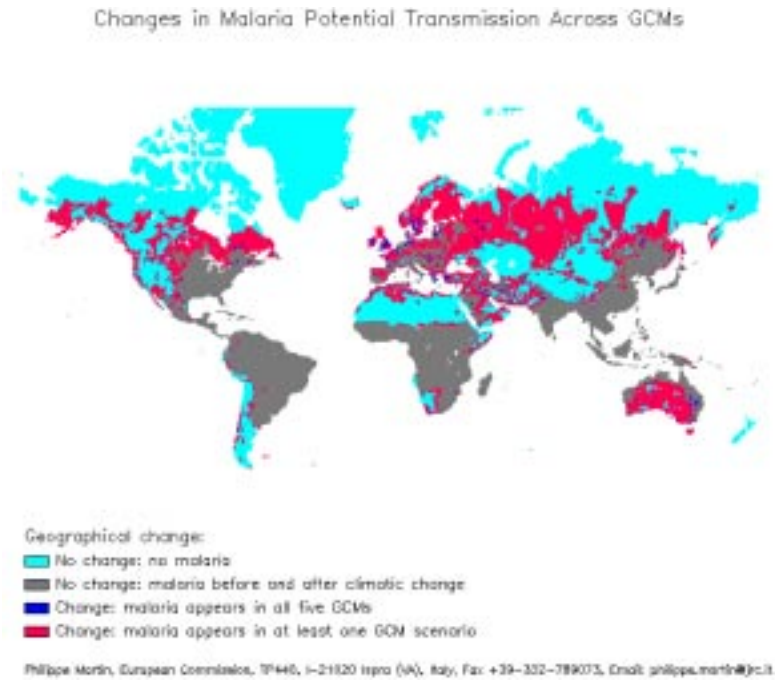

Figure 12 Estimated change in the potential transmission of malaria. Source P. Martin JRC Ispra

Other impacts are likely to include flash floods, heat stress following periods of extreme temperatures, and an increased incidence of forest fires. Forest fires constitute a serious problem within the area of the Mediterranean basin. The environmental consequences of these fires have compelled the governments of the Mediterranean coastal countries to make tremendous efforts towards fire prevention and control. The worst situation is precipitated by hot, dry and windy conditions, when fires become enormous and dangerous. During 1990 there were 175 thousand hectares burnt in Spain (Merillon, 1991). According to data supplied by the Spanish Forestry Service, ICONA, between 1985 and 1994, almost 250 thousand hectares were burnt in the whole of the Spanish territory. In recent years following periods of extreme dryness, there has been a tendency for the annual number of forest fires to increase (LUCC, 1998). As a result, large areas of forest and parkland may be closed off to summer visitors.

8 Scotland

8.1 Introduction

Scotland occupies the northern third of Great Britain. It is bounded by England in the south and on the other three sides by sea: the Atlantic Ocean on the west and north, and the North Sea on the east. The terrain is generally hilly, and traditionally divided into three geographic regions from north to south: the Highlands, the Lowlands, and the Southern Uplands. Scotland is well known for its mountainous and beautiful scenery. Much of the upland of Britain is contained within the borders of Scotland, along with the highest peaks. The Highest peak in Scotland (and Great Britain) is Ben Nevis, in the Grampians. Scotland has 3700km of coastline and about 607 thousand hectares of forest, of which 60% is publicly owned.

8.2 Climate

The Scottish weather is unlikely to be high on the list of factors which attract tourists to Scotland. Indeed, in a Scottish Tourist Board survey the weather was listed as a major source of complaint. Yet temperatures are milder than might be expected given Scotland's northerly latitude, being moderated by the surrounding oceans. There are other positive attributes of the Scottish climate, there is frequently very good visibility and longer daylight hours in summer. However, there is great spatial variability in local weather conditions, even between neighbouring glens!

	Average January temperature	Average July temperature
Eastern coastal region	3.9oC	13.8oC
Western coastal region	3.1oC	15.0oC
Edinburgh	3.5oC	14.5oC

Table 10 January and July mean temperatures in Scotland

Annual precipitation amounts range from 3810mm in the Highlands, to about 635mm in the eastern areas. Ben Nevis has an average maximum snow depth of two metres for 215 days between November and May. The Nevis Range is one of Scotland's five ski areas. Statistically, the Lowlands and the access roads get very little snow and usually stay clear. Snowfall in Scotland is incredibly variable from year to year. In recent years, there has been an increase in the vigour and frequency of westerly airflows which has meant a reduction in the annual frequency of winter frosts and snow days. There has also been a reduction in the mean daily hours of bright sunshine in western regions, in winter.

Future changes in the Scottish climate will result in warmer summers and winters, however, this will be accompanied by a more active hydrological cycle and increased precipitation (Hulme et al, 1998). Temperature trends will determine whether this precipitation falls as snow or rain in the next few decades (Figure 8, refer to section 5).

8.3 Tourism

Tourism is a major industry in Scotland. Scotland attracts tourists from across the globe as well as from the domestic market. Tourism and leisure in Scotland make a significant contribution to the economy, and directly provide over 155 thousand jobs. Numbers of holiday trips and expenditure

for each Scottish region is shown in Table 11. Scotland's rich and colourful history coupled with a diverse range of landscapes and natural habitats attracts tourism throughout the year. The main attractions are: historic monuments and museums, mountain climbing and hill walking, water sports, golf and winter skiing.

	Number of holiday trips (millions)	Expenditure (£million)
Scotland	6.4	32.1
Highlands	1.1	6.4
Aberdeen and Grampian	0.6	2.6
Angus and Dundee	0.2	0.8
Perthshire	0.5	2.1
Argyle, the Isles, Loch Lomond	1.1	4.9
Kingdom of Fife	0.3	1.5
Greater Glasgow and Clyde Valley	0.6	2.4
Ayrshire and Arran	0.6	3.2
Edinburgh and Lothians	0.8	3.0
Dumfries and Galloway	0.4	1.7
Scottish Borders	0.2	0.9

Table 11: Number of holiday trips and expenditure for Scotland, 1996

Two of the tourist activities most sensitive to climate change in Scotland are skiing and golf. Skiing in Scotland is a small and specialised part of UK tourism, but is very important to the local economy. There are three main forms of skiing in Scotland - downhill (which relies on mechanised ski equipment in several mountain areas), cross country, which occurs on upland areas and often on forestry tracks, and ski mountaineering which is wide ranging across all of Scotland's mountain areas. There are five main downhill ski areas in Scotland: Glencoe, Glenshee, The Lecht, Cairngorms, and the Nevis range. During the period 1993-95 around 0.1 million skiing trips were taken annually. Expenditure on these trips is estimated at about £16 million per year, bringing valuable income and jobs to the area.

Golfing is a second tourist activity which is potentially sensitive to climate change. There are 550 golf courses in Scotland (Scottish Tourist Board). Some of the world's most famous golf courses are located in Scotland - the Old Course at St. Andrews and other Open Championship courses at Carnoustie, Muirfield, Royal Troon and Turnberry.

8.4 Potential impacts:

Weather has an important role in influencing tourism in the UK and can affect decision-making in two main ways. First, the choice of main

holiday destination (whether to stay at home or travel abroad). Second, the domestic holiday market is influenced by short-term weather fluctuations, with higher temperatures in July encouraging more Britons to take holiday trips, (Figure 13) especially for outdoor pursuits. In the long-term, a guarantee of fine holiday weather would lead to a growth in both short breaks and main holiday markets (perhaps to the detriment of outward tourism, ie, tourism by UK residents overseas). The UK may also grow in popularity as a holiday destination in the international scene if traditional overseas resorts become unpleasantly hot (Agnew, 1999).

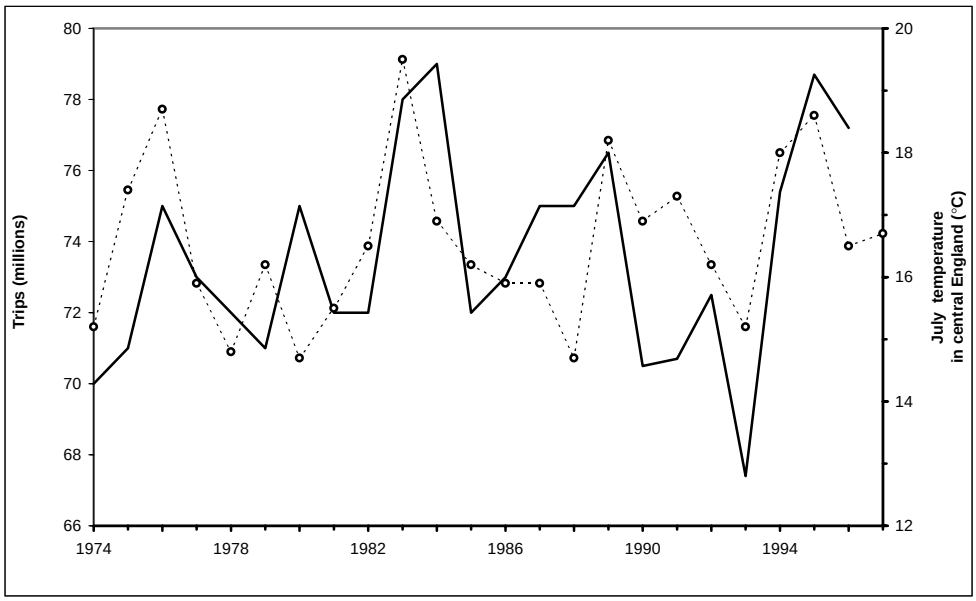

Figure 13. Number of holiday trips taken each year by British residents within Great Britain (solid line) shown in relation to July temperature in central England (dashed line). Source: Agnew, 1999

Snow cover is far from a certainty, even in the current climatic conditions. If a warming trend continues, the Scottish skiing industry may suffer, or even disappear. There are clear relationships between the number of days with snow lying and the number of ski days (Figure 14). Increasing temperatures could reduce the number of days with snow lying, and hence the viability of the skiing industry, although in the early years of global warming might lead to an increase in snow days, provided that the warming in winter is small enough to maintain sub-zero temperatures (Palutikof, 1999).

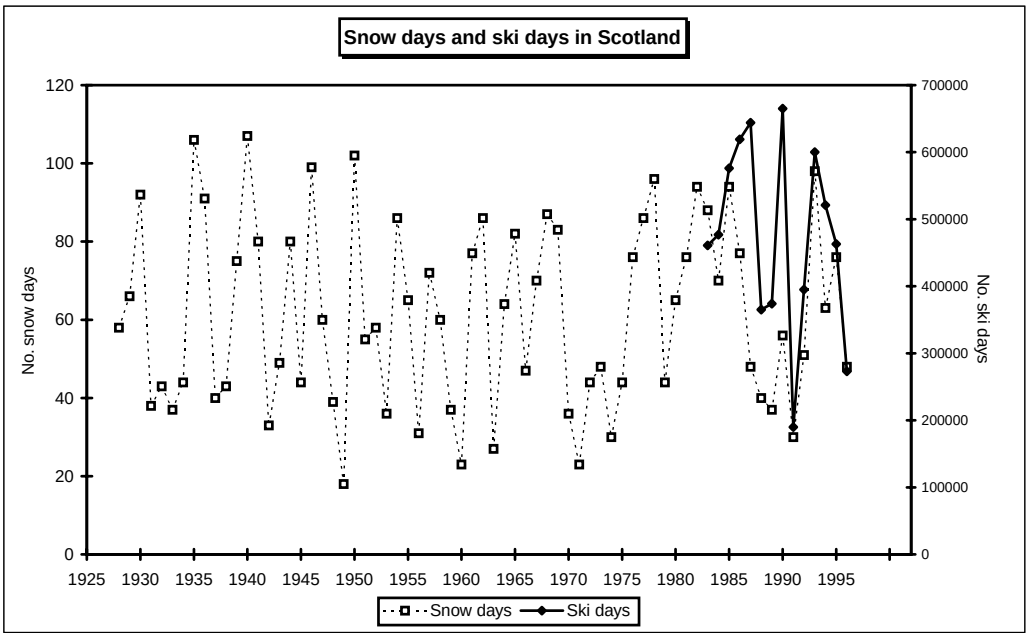

Figure 14. Number of days with lying snow each year at Braemar (dashed line) since 1927, and the more recent record of ski-days at the five main Scottish skiing centres (solid line). Source: Palutikof, 1999.

9 European Lakes

9.1 Introduction

The European Lakes are the playground for water sports enthusiasts. Pleasure cruising, canoeing, wind-surfing, water-skiing and sailing facilities abound. The largest lakes in Switzerland are Lake Geneva (580.6 km^2), Lake Constance, Lake Neuchete, and Lago Maggiore. Lake Zurich is situated 406m above sea level and is situated between two mountains, Zurichberg (676m) and Utliberg (871m). Lake Balaton, in Hungary, covering 598km^2, reaches only 11.5m at its deepest point, south of Tihany. The lake's average depth is only two to three metres, so the water warms up quickly in summer. The over-use of nitrate fertilisers in agriculture has caused groundwater to become contaminated with phosphates and threatens the aquatic environment of the lake.

9.2 Climate

Switzerland has a central European, mild continental climate, with temperatures typically between 20 and 25°C in summer (June to September) and between 2 and 6°C in winter (November to March). The temperature range is largely dependent on altitude. There is perennial snow cover at altitudes above 3000m.

	Average temperature	Annual rainfall	Sunshine
	C	mm	hrs.
Geneva (420m)	10.8	826	2014
Lausanne (461m)	11.3	1046	2031
Zurich (556m)	9.6	1044	1609

Table 13 1998 climate statistics for three Swiss lakes. Source: Swiss Meteorological Institute, 1999

Hungary's climate is continental, with long, dry summers and severe winters, but is also moderated by oceanic and Mediterranean influences. The annual mean temperature is 10°C; in the hottest month, July, it is 21.7°C and in the coldest, January, it is -1.2°C.

The ambient climate controls the physical behaviour of a lake, with temperature, rainfall and wind the key driving parameters. Any changes in these variables will have significant consequences for the lake. Outputs from state-of-the-art General Circulation Models show increases in temperature and decreases in precipitation for the summer. The estimated future changes in mean summer temperatures and precipitation for central Europe are shown in Figures 15 and 16.

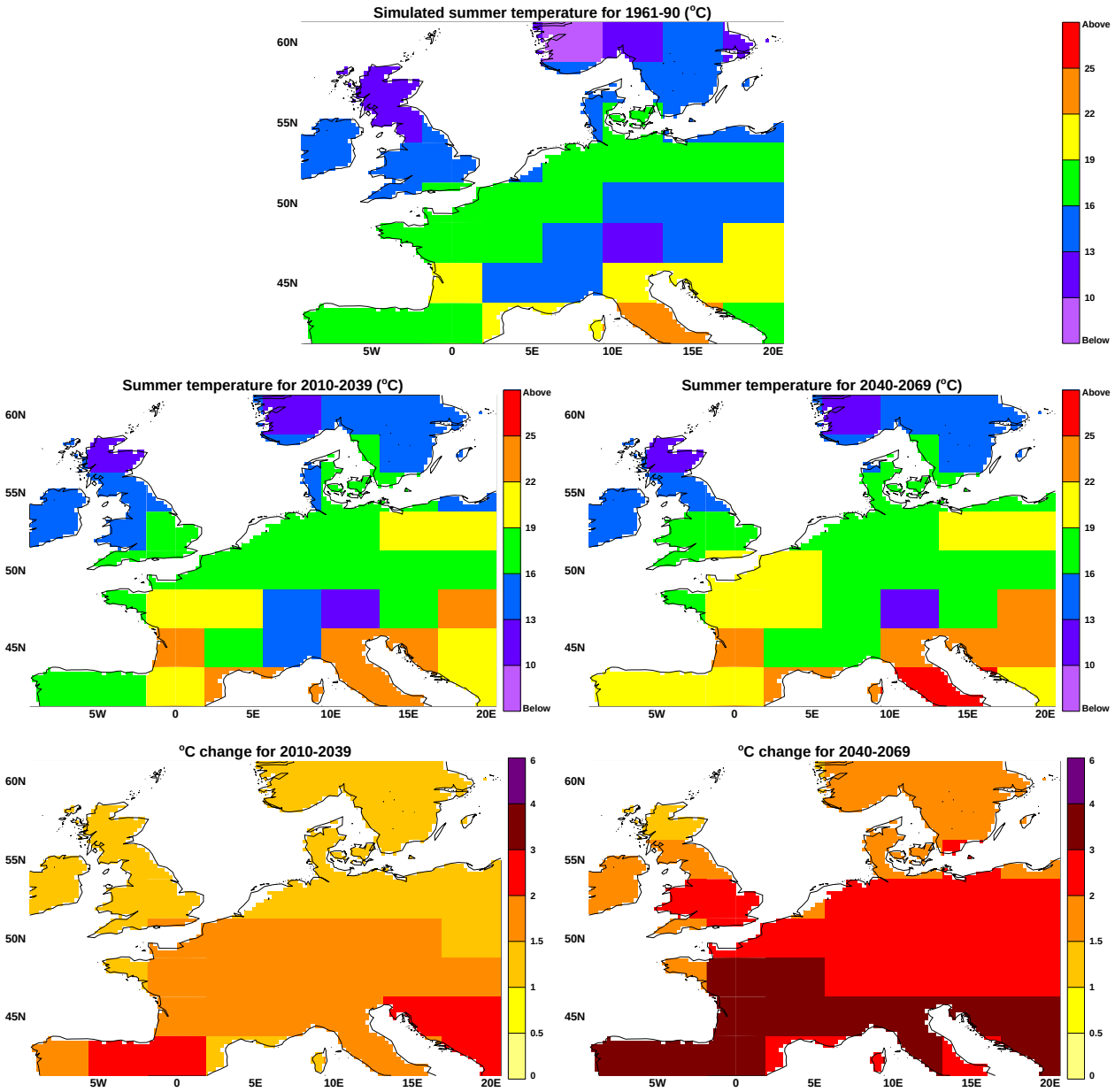

Figure 15. Evolution of summer temperatures (JJA) for the European region has estimated by HadCM2 GCM with the IS92a emissions scenario.

9.3 Tourism

Switzerland's principal tourist attractions are the lakes and the mountains. In 1998, 427 thousand visited Switzerland from the UK and a total of 3.2 million people visited Zurich (1999, Key Statistics. Swiss Federal Statistical Office, Neuchetel). In Hungary, tourism has developed rapidly and is an important source of foreign exchange. Lake Balaton is primarily a recreational lake and is the main holiday centre for boating, bathing and fishing. This lake is the largest freshwater lake in Central and Eastern Europe and is the second most important tourist destination in Hungary, after Budapest. In 1994, nearly 2.5 million tourists visited the lake purchasing goods and services worth approximately $540 thousand USD. (Ratz, 1998).

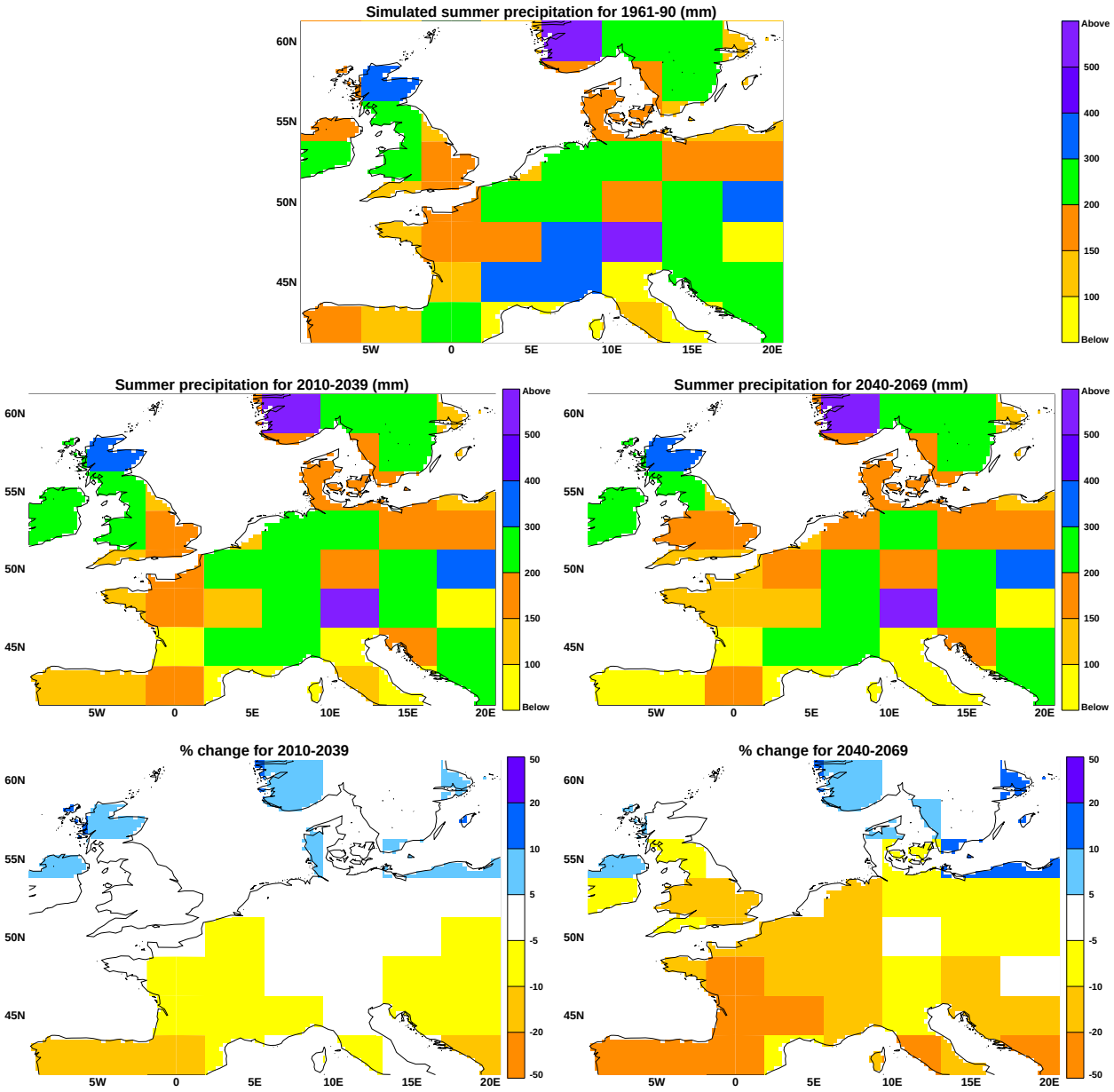

Figure 16. Evolution of summer precipitation (JJA) for the European region as estimated by HadCM2 GCM with the IS92a emissions scenario.

9 Potential impacts

Global warming is threatening the freshwater ecosystems upon which many outdoor recreational and tourist activities depend. Ephemeral streams and small rivers are particularly vulnerable, and any reduction in flow will limit sport fishing. Much tourist outdoor recreation takes place along the shorelines of freshwater lakes. Current research suggests that in a future warmer climate the health of many lakes will be at risk. Increasing temperature and evaporation rates will lower lake levels and may change the tourist potential of such shorelines. Fixed waterfront facilities, such as marinas, will be particularly vulnerable to any change in the level of the lake. Lower water levels, combined with higher

temperatures, may produce higher concentrations of pollution close to the shore.

Lakes of all scales are likely to be affected, from the relatively small alpine lakes to the larger and more extensive lakes such as Lake Zurich. Lake Balaton is another example of a shallow lake subject to eutrophication. It is the largest lake in Central Europe, but has a mean depth of only 3.2m and mean water residence time of 5 years. The outstanding economic importance and ecological value of Lake Balaton has called for large-scale management measures, which are gradually being implemented. Macrophyte growth is largely restricted to a narrow shoreline area. However, this area may expand with global warming. Without appropriate action, these European lakes and their associated tourist activities are threatened.

10 East and South Africa

10.1 Introduction

Kenya lies astride the equator, bordering the Indian Ocean between Somalia and Tanzania. The terrain of Kenya consists of low plains rising to central highlands bisected by the Great Rift Valley and a fertile plateau in the west. Similarly, Tanzania has plains along the coast, a central plateau, and highlands in the north and south. South Africa consists of a vast interior plateau, rimmed by rugged hills and a narrow coastal belt. Each of these countries supports abundant and varied wildlife of immense scientific and economic value. More than 21 thousand km^2 have been set aside as national parks in East and South Africa, harbouring one of the world's last and greatest wildlife populations. Serengeti alone is home to more than one million wild animals. Lake Manyara National Park, lying at the foot of the great Rift Valley, is a popular haven for a variety of animals, and is well known for its extremely rich bird and animal life associated with the lake, as well as its large elephant population and tree-climbing lions. More than 380 bird species have been recorded within the park, and flamingoes and pelicans are particularly plentiful. The Masai Mara Game Reserve has a semi-arid climate and consists of extensive grasslands, as well as bushland and riverine habitats. Large populations of herbivores, such as wildebeest, antelopes, zebras, and carnivores such as lion, form some of the main attractions for tourists.

10.2 Climate

The climate of eastern and southern Africa is very variable, particularly with regard to rainfall. The southern African region has warmed by about 0.05°C per decade this century, consistent with the average temperature for the continent as a whole. Rainfall has been decreasing during the past two decades, and there have been several serious droughts in the 1990s. Climate model results suggest that temperatures will continue to increase, though the effect on rainfall is uncertain. The temperature increase is likely to be strongest in arid zones in southern Africa, and slightly less in the equatorial zone of eastern Africa.

10.3 Tourism

Tourism is among Kenya's top two foreign exchange earners, along with agriculture. However, ethnic unrest and political uncertainties in 1997, along with the devastating effect of the heavy El Niño rains, have contributed to the recent poor performance in tourism. The UK is one of the principal source markets for Kenya's tourism. Visitors are attracted to the equable Indian Ocean beaches, and the 25 national parks and 23 game reserves. The number of visitors to the national parks and game reserves in 1993 was 1.4 million, and half of the earnings from the tourism industry can be attributed, directly and indirectly, to wildlife. Eight out of ten visitors come to Kenya for the wildlife. The most popular game reserves are the Masai Mara, Tsavo East and Tsavo West, Amboseli, Samburu, Lake Nakuru and Nairobi National Park. Tanzania has a huge potential for tourism, with bigger herds of wildlife in dramatic physical surroundings, such as the Ngorongoro Crater and Serengeti. Tanzania has set aside 230 thousand km^2, nearly 26% of the total land area, as protected and conservation areas. Tourism is increasing annually, although Tanzania still earns less in tourist receipts than Kenya. In South Africa, tourism is the sector benefiting most from the end of apartheid.

The number of overseas visitors is growing by more than 50% a year. Here too, the chief attractions for tourists are the pleasant climate, the scenery and the wildlife reserves.

10.4 Potential impacts

Climate change could affect vegetation and ecological zones, and ultimately the distribution of wildlife. The present network of parks and reserves is based on animal distribution and climate conditions, and adjacent areas of land are facing increasing pressure from human uses. Therefore, any redistribution in wildlife could threaten population numbers which would, in turn, reduce the attraction for tourists.

Climate change may increase the frequency of flooding, drought and land degradation, and subsequently reduce the viability of recreation activities and wildlife safaris. The wildlife in both Lake Manyara National Park and the Masai Mara Game Reserve is closely connected to seasonality and climatic conditions. Some of the 380 bird species for which Lake Manyara National Park is renowned are seasonal. It is likely that changes in climate as well as change in the lake level and hydrological conditions may alter both migration patterns and breeding of birds and other wildlife dependent on the lake. Flamingoes, for example, have deserted their lake habitats due to their sensitivity to changed environmental conditions. The annual migration of wildebeest, zebra and antelope from Serengeti is one of the main attractions of Masai Mara Game Reserve. As the growth of grass and vegetation changes with altered rainfall patterns, migration will also shift. More frequent droughts may increase the pressure on the reserve by pastoralists. Changed local climate may also change the human use of land adjacent to the reserve, on which wildlife in the reserve interacts.

Infrastructure crucial for tourism may also be affected by climate change. For example, the lake makes up two thirds of the area of Lake Manyara National Park, and the rich bird and animal populations connected to the lake are among one of its chief attractions. Heavy rainstorms can cause temporary closure of tracks and make the lake shore inaccessible. Roads within both Lake Manyara National Park and Masai Mara Game Reserve as well as roads leading to the park and reserve deteriorate during heavy rains, and some roads and bridges may be temporarily closed as a result of flooding. Road maintenance becomes particularly difficult and expensive during prolonged heavy rains. Incidents of extreme heavy rains, such as the 1997/98 El Niño rains, leave park roads impassable for long periods of time, and result in reduced tourist visits and loss of revenue.

11 Australia

11.1 Introduction

Australia is the only country occupying a whole continent - albeit the smallest one, lying on and extending north and south from the Tropic of Capricorn. With an area covering 7,682,300 km^2 it is the sixth largest country of the world after Russia, Canada, China, the US and Brazil. The coastline is 36,735km long, meeting the Pacific Ocean to the east, the Arafura Sea to the north, the Indian Ocean to the west, and the Southern Ocean to the south. Australia occupies one of the oldest landmasses and the flattest of all continents, the highest point, Mt. Kosciuszko in the Australian Alps, is 2228m. The fertile coastal strip provides a sharp contrast to the dry and inhospitable interior of the 'outback'. In the interior, large expanses of scrubland are interspersed by salt lakes, mountains like the MacDonnell Ranges near Alice Springs, Flinders Ranges in South Australia and the mysterious rock formations of Ayers Rock/Uluru, Mt. Olga/Kata Tjuta, and Mt. Augustus.

11.2 Climate

Due to its size, geographical location and lack of extensive high mountain ranges Australia has a very variable climate ranging from subtropical in the north to the significantly colder regions of the south. Australia's seasons are the opposite of the northern hemisphere. In the summer (November-February) there are tropical monsoons in the northern part of the continents (except for the Queensland coast), but winters (July-August) are dry. In the southern half of the country, winter is the wet season although rainfall decreases rapidly inland. Extremely high temperatures, sometimes exceeding 50°C are experienced during the summer months in the arid interior as well as during the pre-monsoon months in the north.

Major global climate models indicate for Australia an average summer (December to February) temperature increase of over 1.5°C for the 2020s and a summer temperature increase of 3-4°C for the 2050s (Figure 17). Model results also suggest that Australia will experience a marked reduction in cloud cover of on average between 10 and 15% by the 2050s (Figure 18). It is estimated that this in turn would lead to a reduction in seasonal rainfall by between 10-20% (Figure 19).

11.3 Tourism

Tourism is one of Australia's largest and fastest-growing industries. Climatically it is a country conducive to outdoor holidays. The main attractions are the cosmopolitan cities, the Great Barrier Reef, the Blue Mountains, water-based recreation activities and winter sports in the Australian Alps. Over 4 million tourists came to Australia in 1996, generating estimated total foreign-exchange earnings of $11.5 billion. Tourism is also an important source of jobs; it is estimated that tourism employed 694 thousand people in Australia in 1995/96 and accounted directly for about 7.4% of Australia's GDP (Bureau of Tourism Research). In many alpine regions, the winter tourism industry is a major contributor to the local economy and creates about 12 thousand full time jobs for the skiing season (Buckby et al, 1993). Tourism on the Great Barrier Reef generates 1.5 billion dollars each year for Queensland, Australia (Done et al., 1996; Richmond, 1993). The Year 2000 is likely to break all records

as visitors arrive for the Millennium celebrations and the Sydney 2000 Olympic Games.

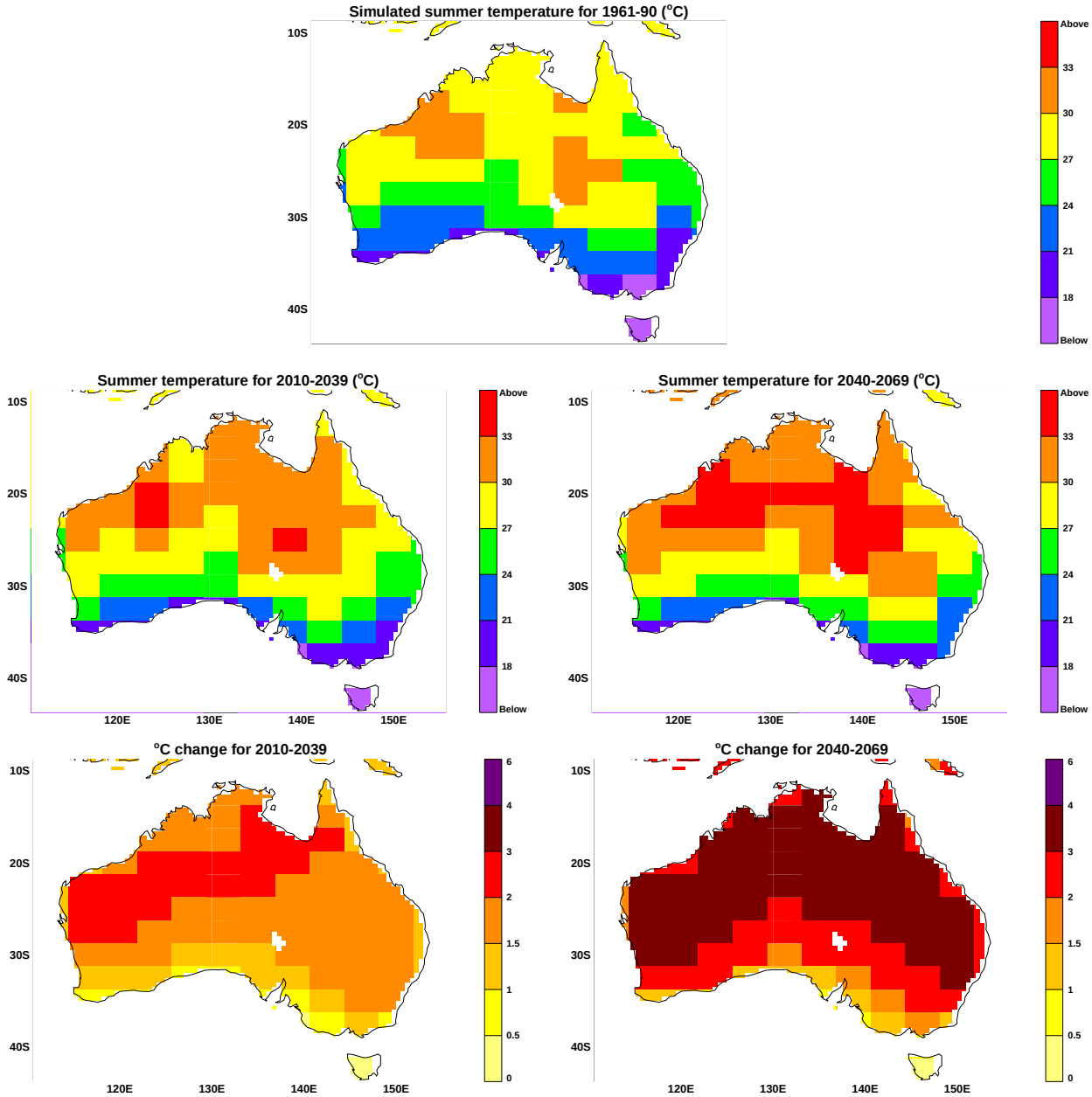

Figure 17. Evolution of summer temperature (DJF) for Australia as estimated by HadCM2 GCM with the IS92a emissions scenario.

11.4 Potential impacts

A continuing warming trend may have several knock-on effects in the Australian tourist industry, through impacts on snow cover, transmission of malaria, bushfires, sea level changes and an increased risk of coral bleaching. Australia's snowfields are small, with a short and variable season. There is a concern that the Snowy Mountains in Australia may not have a sufficiently long season for winter sports if temperatures increase as climate model estimates suggest for the next 20-30 years (Galloway, 1988). The Australian Alps presently enjoy a winter snow

cover lasting from a few weeks at the lower elevation sites to up to four months at the higher elevation ski resorts (Whetton et al, 1996). This snow cover supports major cross country and downhill skiing activities which could be severely threatened as a result of global warming. In the 'worst case scenario', the average snow cover is reduced by 66% by 2030 (Table 13) suggesting that there would be insufficient natural snow for viable commercial ski operations (Whetten, 1998). König (1998) suggested that the Australian ski resorts would lose 44% of their skiers if winters with little natural snow became more common.

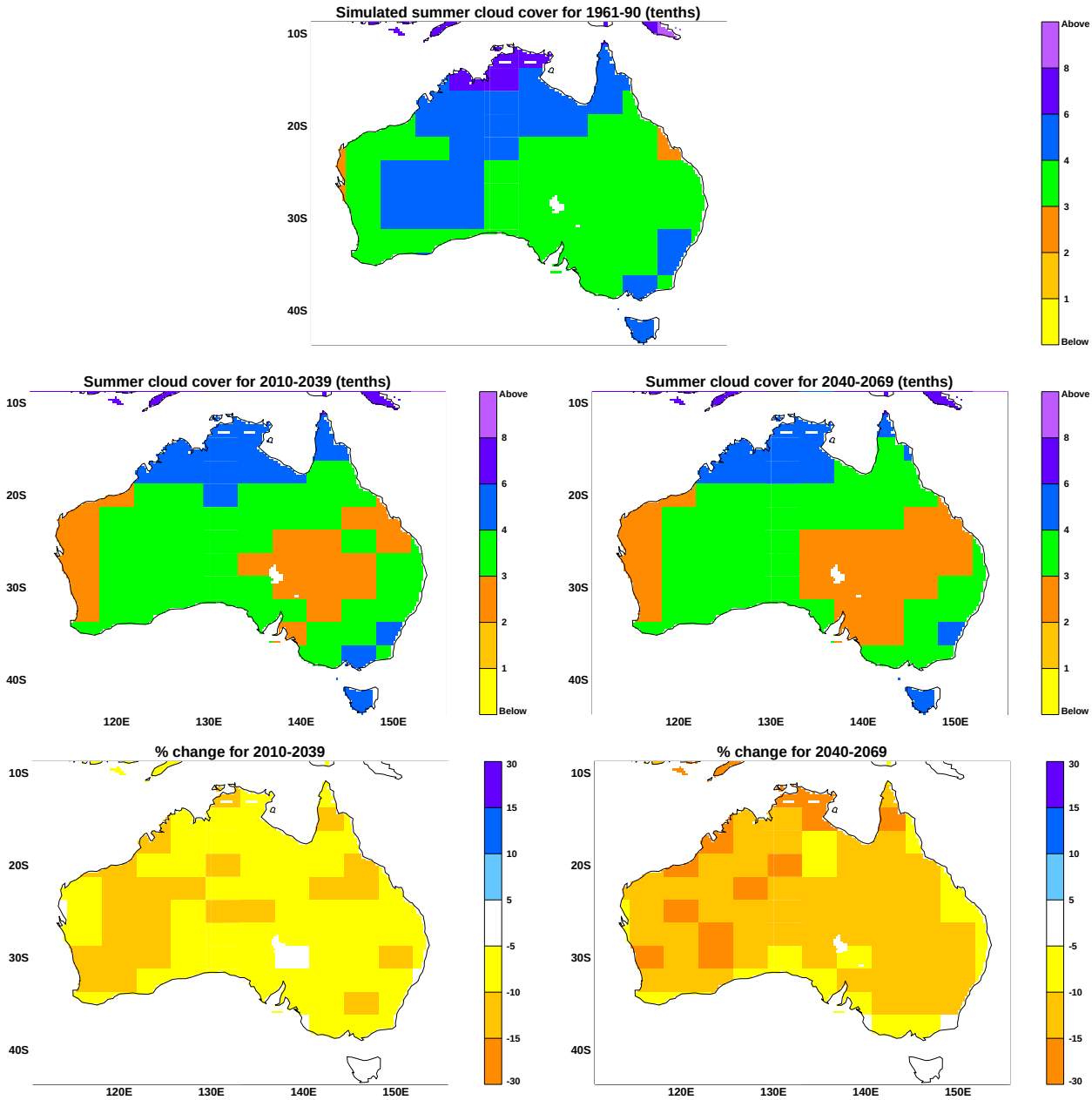

Figure 18. Evolution of summer cloud cover (DJF) for Australia as estimated by HadCM2 GCM with the IS92a emissions scenario.

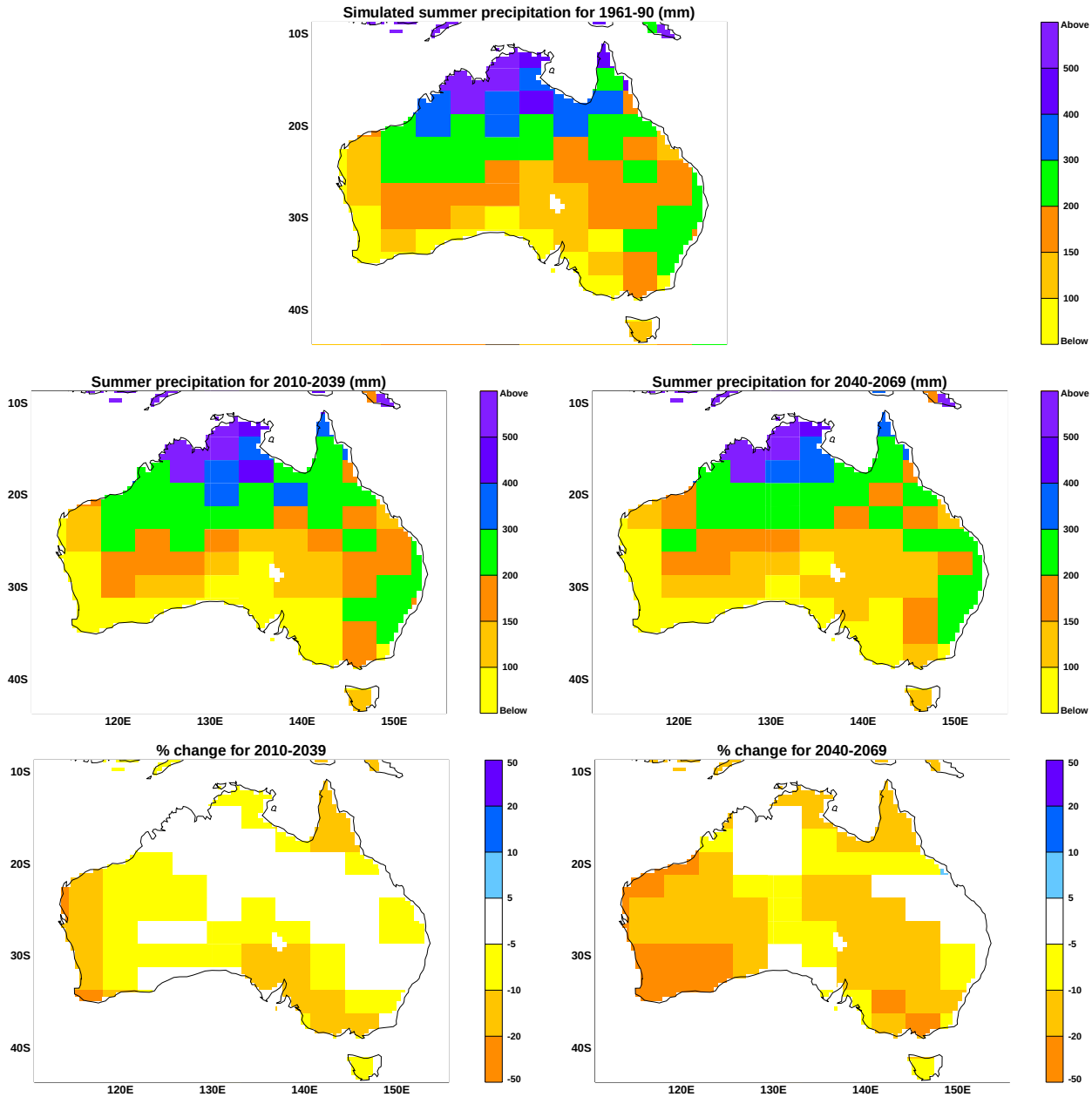

Figure 18. Evolution of summer cloud cover (DJF) for Australia as estimated by HadCM2 GCM with the IS92a emissions scenario.

The wildlife endemic to the Australian snowfields is also vulnerable to a reduction in snowcover. It has been suggested that the existence of the mountain pygmy possum, the only Australian mammal that is restricted to alpine and sub-alpine habitats and an already endangered species, is particularly threatened by climate change (Greenpeace Australia, www.greenpeace.org.au/ClimateChange).

Some health impacts of climate change in Australia will be immediate, for example, death or illness due to heatwaves or bushfires. Other 'indirect' health impacts such as a rise in insect-borne diseases may become more common. An increase in temperature and precipitation can be expected to influence the seasonal and geographical abundance of the major malaria vector species and vertebrate hosts. In turn, this may increase the potential

for transmission of mosquito-borne diseases in both tropical and temperate Australia (Liehne, 1988).

Location	Elevation (m)	Current Snow cover duration (days)	Simulated snow-cover duration (days)	Cl
			2030	2070
Lake Mountain	1400	29	0-17	0-12
Falls Creek	1643	113	64-100	0-92
Mt. Buller	1805	127	80-115	5-107
Mt. Bogong	1986	159	123-150	45-144
Mt. Kosiciusko	2228	187	152-177	92-172

Table 13 Simulated snow cover duration for selected sites and climate change scenarios (Whetton, 1998).

The entire 70 thousand km of Australian open coast, including the 12 thousand islands and extensive estuarine and wetland areas, could be inundated by sea level rise. In addition, storm surges continue to pose a large threat across north Australia. Cairns, in North Queensland, is one of the leading tourism destinations in the Asia Pacific, being situated close to the Great Barrier Reef and the rainforest habitats of the Daintree. However, Cairns is threatened by the ravages of tropical cyclone storm surges. In a warmer climate the risk of storm surges may increase as a result of sea level rise (caused largely by thermal expansion of the oceans), and changes in the intensity and frequency of tropical cyclones (McInnes et al, 1999).

Coral reefs are a crucial source of tourist and other income (Carte, 1996). The Great Barrier Reef alone generates $1.5 billion from tourism (Done et al, 1996). However, according to recent scientific reports (Hoegh-Guldberg, 1999), coral bleaching events associated with global warming will spell catastrophe for these tropical marine ecosystems. At higher than normal temperatures, the reef-building corals become increasingly vulnerable to damage by light. The organisms important to the coral host abandon the reef, and corals die in large numbers. It has been estimated that in the next 20-40 years, the Great Barrier Reef will be severely damaged by an increase in sea temperature, seriously reducing the attractiveness of the area as a tourist destination.

In addition to these impacts, results from state-of-the-art climate models show decreasing cloud cover, which will increase the exposure to harmful ultra-violet rays. It is these rays which cause damage to all living tissue, and in the case of humans, cause skin cancer.

12 Florida and SE Coastline of USA

12.1 Introduction

Florida is the most south-eastern state of the US. It borders Georgia and Alabama in the north, the Atlantic Ocean to the east and the Gulf of Mexico to the west. Florida is uniformly flat and forested, its highest point is only 105m. Florida covers a total area of 150,520km^2, of which 11,368km^2 are water, including over 166 rivers and more than 30 thousand lakes. The tidal shoreline totals 3,648km. The southernmost point in Florida is 2,700km from the equator, closer than any other part of the continental United States.

Assateague Island, Maryland, is an uninhabited barrier island built by sand that has been raised from the ocean floor by the persistent force of waves. Inland, legendary herds of wild horses roam the marshlands. The barrier island of Assateague begins just south of Ocean City, Maryland, and extends southwards to Chincoteague, Virginia. This island is 59km long and 5km across at its widest part. Assateague State Park and the Assateague Island National Seashore are located in the north of the island. The Atlantic Ocean on the Delaware and Maryland coasts attracts tourists for swimming, sunbathing, surf fishing, boating, deep sea fishing, surfing, dolphin watching and walking.

12.2 Climate

The climate of Florida is subtropical, warm and humid. Florida's mild climate derives from the fact that the state is a subtropical peninsula surrounded by the waters of the Gulf of Mexico and the Atlantic Ocean. These bodies of water exercise a moderating effect in both the summer and winter. The average January temperature ranges from approximately 12°C in the north west to 15°C at the southern tip, and 21°C in the Keys. Summer temperatures average between 27 and 29°C. Florida has a moist climate, especially in the summer. The summer rainfall averages from 170mm in the central region to 150mm in the north-west. Maryland has a more seasonal climate than Florida. Winter maximum temperatures are on average 6°C, while summer temperatures range from 28-30°C. Moderate amounts of rain are experienced each month, with the highest monthly totals in summer (on average 100mm).

12.3 Tourism

In 1995, travel and tourism were estimated to have provided US $746 billion to the US GDP, approximately 10%, making tourism the second largest sector in the economy. Tourism is the largest employer in the US providing 14.4 million jobs annually. Much of foreign tourism to the US is coastal-motivated; accordingly 85% of all US tourist revenues are earned by coastal states (Houston, 1996).

Florida became a major tourist destination after World War II. Today, tourism is Florida's biggest industry. The attraction of sun, warmth and beaches brings tourists to Florida's resorts year-round. The Keys are a tourist mecca, while the Everglades and Ten Thousand Islands attract ecotourists. Florida's reefs contribute $1.6 billion annually to the economy from tourism alone (Birkeland, 1997). Florida is a popular destination with UK holiday-makers (Table 14). It is the number one long-haul destination, and in 1997, 1.3 million Britons visited the state.

In Maryland, barrier islands such as Assateague Island, are essentially recreational communities. The market share and number of annual visitors to Maryland and Florida are given in Table 15.

Canada	15.1 Million
Mexico	8.4 Million
Japan	5.3 Million
UK.	3.7 Million
Germany	1.9 Million
France	1.0 Million
Brazil	0.9 Million
South Korea	0.7 Million
Italy	0.6 Million
Argentina	0.5 Million

Table 14 Top inbound travel markets for the US in 1997, Number of Arrivals
Source: US Commerce Dept., International Trade Administration, Office Tourism Industries

State/Territory	1997	1997	1996	1996	Volume
Visitation	Market Share	Visitation (000)	Market Share	Visitation (000)	% Change
Maryland	1.1	266	1.2%	272	-2.1%
Florida	25.1	6,073	25.2%	5,710	6.4%

Table 15 Market share and number of visitors for Maryland and Florida
Source: Tourism Industries, International Trade Administration, 5/98

12.4 Potential impacts

Florida: Sea level rise may be of particular concern for Florida since many recreational and tourist activities are concentrated along the state's coasts, beaches and islands. Characteristically, the state's recreational beaches are low-gradient and particularly vulnerable to erosion (Leatherman, 1989). Some ecologically important wetlands, such as the Everglades, may also be under considerable threat. Human activities have rendered coastal resorts even more vulnerable and coastal wetlands, coral reefs and atolls are particularly at risk. Trends of the past century indicate that coral bleaching events may become more frequent and severe as global warming continues. Coral reefs provide a substantial source of

income from tourism. Visitors from all around the world come to snorkel and fish around the coral reefs and sands. Changes in these ecosystems could have a major adverse impact on tourism and recreational activities (US Department of State, 1999).

Maryland: Further impacts may be felt on the mid-Atlantic and southeastern coastal marshes and barrier islands, including the Assateague National Seashore in Maryland. This area may be threatened by sea level rise, erosion and storm damage on the seaward side and by warming waters on the landward side. Coastal wetlands are already eroding in the state of Maryland, and beach re-nourishment has been prominent in heavily developed areas, such as Ocean City.

13 Brazil

13.1 Introduction

Brazil is the largest country in South America, with a total land area of 8.5 million km^2 and 7.5 thousand km of coastline. Dense tropical forest covers 47% of the landmass. The Amazon rainforest contains 30% of the world's remaining forest, extends over 3.3 million km^2 of Brazilian territory and is the world's largest repository of biological diversity. Draining the basin, the Amazon river is 6516km long, and is the world's largest river by volume of water. Brazil can be divided into six major geographic regions, delimited by vegetation: tropical rainforest in the Amazon Basin and those parts of the Atlantic seaboard which receive high rainfall amounts; the lowlands and plateau of the eastern coast where there is slightly less rainfall and semi-deciduous forest predominates; the caatinga, dry bush of the semi-arid northeast; the cerrado, or woodland savannah of the central portion of Brazil; the needle-leaved pine woods of the southern highlands and the Mato Grosso swamplands which cover the plains of the western central portion of the country.

13.2 Climate

Brazil experiences a wide range of climatic conditions, from the humid equatorial states of the north, to the cooler and drier savannah grasslands of the central and southern uplands. The annual average temperature in the Amazon region is 22-26°C, with only a very small seasonal variation between the warmest and the coldest months. The highest annual temperatures are in the northeast interior. Along the Atlantic coast from Recife to Rio de Janeiro, mean temperatures range from 23 to 27°C. Inland, on higher ground; annual average temperatures are lower, ranging from 18 to 21°C. South of Rio, the seasons are more pronounced and the annual temperature range wider. In the vast upper regions of Amazonia, 2,000mm of rain falls annually. Another important region of heavy rainfall is along the edge of the great escarpment in the state of Sao Paulo. Most of Brazil, however, has moderate rainfall of between 1000-1500mm a year, with most of the rain falling in the summer, between December and April. The winters tend to be dry. The driest part of the country is the northeast, the so called 'polygon of drought', where annual rainfall values are under 500mm.

13.3 Tourism

The tourism sector generated just $12 Billion in 1997, and two thirds of this came from domestic tourism. Altogether, tourism accounts for only 2.5% of GDP (the worldwide average is 10%), and tourism in Brazil is regarded as the economic sector with the most promising prospects for development. About 3.5 million foreign tourists visited Brazil in 1998, a small number in relation to the global figure (over 600 million), but a figure that is growing by 7% per year. Rio de Janeiro, with its famous beaches, is the centre of the tourist trade. Other attractions are the Iguacu Falls, the seventh largest (by volume) in the world, the tropical forest of the Amazon Basin, the wildlife of the Pantanal and the beaches in Salvador, Natal and Fortaleza in the northeast coastal area. Future plans are to promote ecotourism (via the SEBRAE program of Rural Ecological Tourism). Brazil launched a $200 million programme to develop ecological tourism in the Amazon at the opening of an international

ecotourism conference in Rio de Janeiro. Ecotourism, or tourism centred on nature and keeping it intact, is a novelty in Brazil. Only 1% of the country's vast potential is being explored. The Amazon region accounts for around 60% of that potential, followed by the Pantanal wetlands in the centre-west of Brazil (Report from Reuters for Environmental News Network, December 15th, 1997).

13.4 Potential impacts

INPE (National Institute of Space Research, Brazil) present figures on deforestation of the Brazilian Amazonia, which by 1997 were assessed to have reached 530 thousand km^2, an area corresponding to the size of France (Fearnside, 1995). Climate change could add an additional stress to the adverse effects of continued deforestation in the Amazon rainforest. This impact could lead to biodiversity losses, reduced rainfall, and runoff within and beyond the Amazon basin (reduced precipitation recycling through evapotranspiration), and affect the global carbon cycle.

Recent research (Hadley Centre 1998) has shown that under a climate change scenario constructed from one of the most recent General Circulation Model (GCM) experiments, future climate change could have a severe impact upon ecosystems within South America. Model output indicates a considerable reduction in the rainforest region of Amazonia (see Figure 20) caused purely by a combination of increasing temperature and decreasing rainfall. It does not take into account the reduction in this area caused by the direct impacts of human activity. A loss of rainforest of this magnitude, and disturbance to the natural ecosystem, could have profound effects upon the biodiversity of Amazonia and surrounding regions.

Accelerated sea level rise and climate change could have serious impacts on the coastal seaboard of Brazil. It is suggested that socioeconomic impacts will be restricted to the vicinity of ten to fifteen coastal cities, collectively having a coastal frontage of 1300km, or 17% of the shoreline (Muehe and Neves, 1995). At Recife, where there is a population of 2 million people, tide gauge measurements from 1946 to 1988 indicate a sea level rise of 5.6mm per year. With increased beach erosion, shoreline recession may exceed 20m at Boa Viagem Beach, the most valued beach front property in the city. In addition, existing problems of flooding and poor drainage will be greatly exacerbated.

Figure 20. Predicted vegetation types for the present day and the 2050s (2040-2069), Hadley Centre, 1998. Diagram supplied by Dr A White (ITE, Edinburgh).

14 Conclusions

The potential impacts of climate change have been reviewed for a number of key holiday destinations for UK residents. Likely effects are shown to be extremely wide-ranging and may have far-reaching implications for many tourist resorts. Two different types of climate impacts are recognised: direct, and indirect.

Direct impacts:
Climate change may directly influence tourism via the decision-making process. Climate has a direct impact on such decisions as: 'When to go on holiday?' and 'where to go on holiday?' Weather and climate influence decisions both at the destination and at the source region. Some resorts are likely to become less attractive as temperature and humidity increase above comfort levels (such as in the Eastern Mediterranean), other destinations (for example, in the UK) may become more attractive as fine summer weather becomes more of a certainty.

Indirect impacts:
These arise mainly as a result of the impact of climate change on the environment of a given location. For example, without intervention, sea level rise and its effects on coastal erosion will severely threaten recreation and tourist activities associated with coastal locations. Decreasing snow cover and duration may adversely affect low lying ski resorts in the European Alps (eg Garmisch Partenkirchen, Germany) and in the Australian Alps (eg the Snowy Mountains). A reduction in air quality associated with an increase in the incidence of photochemical smogs (caused by a series of chemical interactions between industrial or vehicular pollutants and sunlight) is already noticeable in many large metropolitan areas. With an increase in the frequency of anticylonic (calm) conditions, and if emissions are not curbed, concentrations of pollutants may increase to dangerous levels and further threaten tourist activities in cities such as Athens and Los Angeles. Many regions have become popular tourist destinations as a result of some unique environmental feature, for example, the Barrier Reef in Australia and the Amazon Forest in Brazil. However, recent scientific research suggests that a continued warming trend will have a detrimental impact upon these ecosystems, in the form of coral bleaching and forest die back.

The most vulnerable tourist resorts and regions are a function of the likely magnitude and extent of the climate impact and the importance of tourism to the local economy. For example, for the Assateague Islands and coastline of South Eastern USA, climate change may have a large impact on the environment, but tourism accounts for a relatively small percentage of the national GDP. Tourism in Brazil accounts for a minor component of GDP, but is expected to expand rapidly in the future. However, the effects of climate change upon the Brazilian ecosystems on which much tourism depends, may be widespread. In Spain, the climate impacts are likely to be less extensive, but tourism is very important to the national economy. Some tourist destinations are extremely vulnerable to climate change. The Maldives are a good example. Here, there exists a very fine balance between the environment and human activity. Any further increase in sea level, resulting from a continued warming trend, will threaten not only tourism but the very existence of the islands.

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www.world-tourism.org

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