Weather and Climate Information for Tourism

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Authors:
Daniel Scott – University of Waterloo, Canada
Christopher Lemieux – University of Waterloo, Canada
1 CONTENTS

1 CONTENTS ........................................................................................................................................... ii
2 PREAMBLE ........................................................................................................................................... iii
3 INTRODUCTION .................................................................................................................................. 1
4 APPLICATIONS OF WEATHER AND CLIMATE INFORMATION IN THE TOURISM SECTOR .......... 11
   4.1 CLIMATE INFORMATION AND SERVICE PROVIDERS ................................................................. 12
       National Meteorological Services and Other Government Agencies ................................................... 12
       Private Sector Climate Service Providers ........................................................................................ 15
       Tourism Operators ........................................................................................................................... 26
       Destinations ................................................................................................................................... 27
   4.2 CLIMATE SERVICE USERS ........................................................................................................ 29
       Tourists ........................................................................................................................................ 29
       Tourism Developers, Operators, and Destinations ............................................................................ 30
       Government Agencies ..................................................................................................................... 34
   4.3 KNOWLEDGE GAPS AND NEEDS ASSESSMENT ...................................................................... 35
   4.4 CLIMATE INFORMATION AVAILABILITY AND RESOLUTION ................................................ 35
   4.5 INFLUENCE OF CLIMATE INFORMATION ON DECISION-MAKING ........................................ 38
   4.6 SOCIO-ECONOMIC BENEFITS OF CLIMATE INFORMATION FOR TOURISM ............................ 41
   4.7 COMMUNICATING CLIMATE INFORMATION TO THE TOURISM SECTOR ................................ 42
5 CONCLUSION ..................................................................................................................................... 43
6 LIST OF EXPERTS CONSULTED AND EXPERT REVIEWERS ............................................................ 47
7 REFERENCES ....................................................................................................................................... 48
2 PREAMBLE

Tourism is one of the largest and fastest growing global economic sectors. It is a significant contributor to national and local economies around the world and is increasingly promoted as having an important role in contributing to the UN Millennium Development Goals, particularly the alleviation of poverty in Least Developed Countries (LDCs). The interface between climate and tourism is multifaceted and highly complex. The tourism industry is characterized by considerable diversity, consequently extensive differences exist in climate sensitivity and the abilities of tourism operators worldwide to incorporate climate services into decision making. Weather and climate have broad significance to tourist decision making and the travel experience, significantly influencing travel patterns and expenditures worldwide. For the tourism industry and tourists alike, climate represents both a vital resource to be exploited and an important risk to be managed. Consequently, it is expected that the effects of climate change will have profound impacts on consumer travel demand and tourism businesses and transform destinations. Demands for accurate and increasingly detailed climate information are therefore anticipated to increase substantially in order to the challenges posed by climate change in the decades ahead.

Despite the growing global economic importance of the tourism sector and the complex interactions between climate and tourism, there has been very limited evaluation of the extent to which climate information is used within the tourism sector or how climate information is being integrated into the specific decision-making processes of tourists or the tourism industry. Knowledge of how different tourism sub-sectors and specific businesses are influenced by weather and climate is still relatively unexplored and has hindered the development of specialized climate products and the use of financial instruments to reduce climate risk (weather derivatives and insurance) within the tourism sector. A systematic assessment of climate services needs within the sector has also not been undertaken. Tourism is also virtually absent from the growing literature on the economic and non-market value of climate information and forecasts. There has been limited evaluation of what sources of climate information tourists and tourism operators utilize, or the effectiveness of different communication pathways and formats.

Meteorological networks do not adequately represent the climatic conditions in many mountain, coastal, and island tourism destinations, particularly in developing nations, encumbering climate change adaptation and the development of climate risk management products. Climate information represents a double-edged sword for the tourism sector, for while accurate climate information can be invaluable to the tourism industry, inaccurate climate information that deters visitation is a lament heard often from the tourism industry. The emergence of new specialized climate products for the tourism from private meteorological companies represents important progress, but thus far lacks the transparency needed to properly evaluate their rigor and validity in the international travel marketplace. Improving the provision and use of climate information in the tourism sector is a challenge that will require close collaboration between the climate and tourism research communities (both physical and social scientists), NMSs, government tourism authorities and the tourism industry at the regional level.
The following recommendations are intended to address the key knowledge gaps and facilitate the collaboration that would provide new capacities to enhance decision-making that would reduce climate risk and enable climate change adaptation in the tourism sector.

**Recommendation:** Investment is required to strengthen climate monitoring networks in areas where the tourism sector is vital to local economies, specifically rural areas and many developing countries (particularly SIDS), in order to improve climate risk management and climate change adaptation in the tourism sector.

**Recommendation:** With the risk of permanent loss of historical climate data in developing countries, which has potentially high value for managing climate risk and informing climate change adaptation, action is urgently needed to establish a coordinated international data rescue initiative.

**Recommendation:** Strengthening of climate monitoring networks is required to support the development and access to innovative financial products (weather derivatives and index insurance) to manage climate risk in the tourism sector.

**Recommendation:** The development of regionally and locally specific climate change scenarios is required to facilitate effective climate change adaptation by the tourism industry and tourism dependent communities. The refinement of near-term climate change predictions (covering the next 25-30 years), that are most relevant to business investment and government policy timeframes are particularly encouraged.

**Recommendation:** Support is required for the fundamental multi-disciplinary research needed to understand the salience of climate (both in source markets [push factor] and destinations [pull factor]) in different travel decision-making contexts, cross-cultural climate preferences for major destination types, the affect of weather on holiday satisfaction and future travel choices, and the climate sensitivity of major tourism activities.

**Recommendation:** Developers of specialized climate products for the tourism sector, whether the private sector, universities or governments, are encouraged to disclose the scientific methodology or market testing results to demonstrate validation in the tourism marketplace.

**Recommendation:** The tourism sector, in collaboration with NMS, private meteorological companies, and university researchers, are encouraged to develop accepted standards for specialized climate products, to ensure consistent and accurate communication of climate information to international travellers and to facilitate objective destination comparisons and marketing claims in a global tourism marketplace.

**Recommendation:** Collaboration between governments, universities, communities, and the private sector (tourism businesses, meteorological service companies, financial services), must be strengthened to drive innovation that connects climate information to the needs of the tourism sector and tourism dependent communities.

**Recommendation:** Greater effort be made to consult with major tourism end-users about their needs for climate information. This consultation must be done regionally in order to adequately represent specific information needs and the capabilities of regional providers.

**Recommendation:** The active collaboration of the tourism industry is required to support the development of climate services to improve outcomes for the sector, and they are strongly
encouraged to provide increased access to sectoral data, consult on specific climate information needs and constraints to its use, provide expert review of specialized products and create effective strategies to communicate weather and climate information to tourists.

**Recommendation:** An interdisciplinary initiative be established to evaluate the economic and non-market societal value of climate information for decision-making by tourists and tourism operators.

**Recommendation:** An interdisciplinary evaluation of best practices for communication of climate information, particularly specialized products and forecast uncertainty, to tourism end-users is encouraged.

**Recommendation:** A series of multi-objective, capacity-building workshops be initiated in major tourism regions around the world, in order to foster the direct interactions and partnerships between climate service providers and tourism user groups needed to make significant progress in the application of climate information in the tourism sector.

**Recommendation:** Training the next generation of tourism professionals to utilize climate information to reduce climate risks and adapt to climatic change in the decades ahead is a priority and it is urged that a ‘Climate Risk Management’ training module be created for use by tourism and hospitality schools around the world.
3 INTRODUCTION

The tourism sector is one of the largest and fastest growing global industries and is a significant contributor to national and local economies around the world. Tourism represents far more than just travel for leisure and holidays. Tourism encompasses travel for education, health, religion, conventions and conferences, general business travel, and visiting friends and relatives. The United Nations World Tourism Organization (UNWTO 1995) defines tourism as including: "... the activities of persons traveling to and staying in places outside their usual environment for not more than one consecutive year for leisure, business and other purposes not related to the exercise of an activity remunerated from within the place visited.” According to the UNWTO (2009), international tourist arrivals have grown from just over 200 million in 1980 to 922 million in 2008. International travel is also forecast to almost double to 1.6 billion arrivals by 2020 (UNWTO, 2001). The economic importance of the sector worldwide is demonstrated by World Travel and Tourism Council (2009) estimates that in 2008 the global travel and tourism industry, contributed 9.6% of global Gross Domestic Product (GDP) and 7.9% of world-wide employment.

While the majority of international tourism currently occurs in developed countries, the sector is a vital contributor to the economy of many developing countries. Between 1995 and 2007, it is estimated that international tourism in emerging and developing markets grew at twice the rate of industrialized countries – by 11% for Least Developed Countries (LDCs) and 9% for other low and lower-middle income economies (UNWTO, 2008). Visitor spending represented more than 10% of national GDP in 36 developing countries in 2006 (United Nations Conference on Trade and Development, 2008). The UNWTO (2007) also estimates that tourism is a primary source of foreign exchange earnings in 46 out of 50 of the world’s LDCs. With the growth of tourism in developing countries, international tourism is increasingly promoted by development organizations and many governments, as having an important role in contributing to the United Nations (UN) Millennium Development Goals, particularly the alleviation of poverty in LDCs, gender equality and environmental sustainability.

While comparable global statistical data on domestic tourism are not available, its volume was estimated at around 8 billion trips worldwide in 2005, of which 4 billion were estimated to be from same-day visitors and 4 billion from overnight tourists (Cabrini 2009 pers. comm.). The shorter term nature of much domestic tourism, particularly day trips or weekend holidays, increases the importance and relevance of nowcast and short-term forecast information for decision-making by tourists. Consequently, domestic tourism is an important consideration of this review.

The tourism sector is characterized by considerable diversity and fragmented structure. While varied conceptualizations of the subsectors that comprise the tourism sector are used in academia and by international organizations, major components include: transportation (air lines, cruise ships, rail lines, ground coaches and taxies for examples), accommodation (hotels, apartments, youth hostels for examples), food and hospitality services (restaurants, bars and pubs for examples), travel agents and tour service operators, visitor attractions (cultural or sporting events, casinos, parks, museums for examples), and tourist focused retail or service providers (insurance, conventions, tourist equipment rentals for examples). Tourism operators differ in terms of ownership (government, non-government organizations, private businesses), size (there is a

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1 The application and needs for climate information in aviation, marine, and ground transport are the focus of the Transport Sector White Paper and will not be discussed in this White Paper.
predominance of small and medium sized enterprises in the sector, but also many international conglomerates), and purpose (for profit or non-profit, as well as conservation, education, community development mandates). Tourism operators have also adapted to provide tourism services in every climatic zone on the planet from deserts and high mountains to the tropics and polar regions. As a consequence of this heterogeneity, there are extensive differences in the nature of climate sensitivities and abilities of tourism operators worldwide to incorporate climate services into decision-making.

Equally as diverse are the motivations and characteristics of domestic and international travelers. Major global tourism market segments include: sun and beach tourism, sports tourism, adventure tourism, nature-based tourism, cultural tourism, urban tourism, health and wellness tourism, cruises, theme parks, visiting friends and relatives, and meetings and conferences. The disparate climate requirements and preferences of tourists within these major market segments, as well as between groups within each major market segment (golf, ski, and windsurfing segments of sports tourism, for examples), create very different demand-side climate sensitivities within the tourism sector.

The interface between climate and tourism is multifaceted and highly complex. Figure 1 outlines the temporal scales (extreme events, seasonality, inter-annual variability, climate change) at which climate influences different subsectors of tourism, either directly (blue lines in Figure 1) or indirectly (black and red lines in Figure 1). Importantly, climate is but one macro-scale influencing factor on the tourism system (see Figure 1) and interacts with other macro-scale factors as well. The selected media headlines in Figure 2 provide illustrative examples of the varied climate sensitivities in tourism supply (tourism destinations and tourism operators) and demand (tourism arrivals and travel patterns) around the world.

Tourism destinations and tourism operators are affected by climate variability and change in a number of ways. All tourism destinations are climate sensitive to a degree, in that they are influenced by natural seasonality in demand, are affected positively or negatively by inter-annual climate variability that brings heat-waves, unseasonable cold, drought or storms and heavy rain, which can affect not only tourist comfort and safety (and thereby satisfaction), but also the products that attract tourists (snow cover, coral reefs, wildlife, for examples). Climate variability also influences various facets of tourism operations (water supply and quality, heating-cooling costs, snowmaking requirements, irrigation needs, pest management, and evacuations and temporary closures, for examples). An international survey with 66 national tourism and meteorological organizations found that a large majority (81%) felt weather and climate were major determinants of tourism in their nation (Wall and Badke, 1994). Indeed some argue that climate is among the most dominant factors affecting global tourist flows (Burton, 1995; Boniface and Cooper, 2004).

There is a general consensus that destination image is a key determinant in destination choice (Pike, 2002) and that climate is dominant attribute of destination image along with scenery and cost (Anderssen and Colberg, 1973). A review of destination image studies found that ‘natural beauty and climate’ were of universal importance in defining destination attractiveness (Hu and Ritchie, 1993). Some tourism destinations can be considered climate-dependent, in that climate is the principal resource on which tourism to the destination is predicated (e.g., many small island developing states [SIDS]).

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2 Among other macro-scale influencing factors, such as: travel distance, time, holiday cost, and travel motivation and those set out in Figure 1.
In the same way that climate affects the destination choice of travellers it highly influences the timing of travel. Seasonal demand is one of the main defining characteristics of global tourism, and is comprised of two elements - ‘natural’ and ‘institutional’ seasonality (Butler, 2001). Seasonal climate fluctuations at tourism destinations and at major outbound markets, particularly at high latitudes, are a key driver of tourism demand at global (Figure 3) and regional scales. When climatic resources are no longer suitable for certain tourism markets, such as ski or beach holidays, tourism operators can be forced to close seasonally (Figure 4).

**Figure 1. Climate influences on the tourism sector**
Figure 2. Recent media headlines of weather/climate impacts on tourism
Climate also has an important influence on environmental conditions that can deter tourists, including infectious disease, wildfires, insect or water-borne pests (for example jellyfish and algae blooms), and extreme events such as tropical cyclones. In Greece, after the devastating fires of summer 2000, more than 50% of all bookings from tourists for 2001 were cancelled (IUCN, 2007). Drought in the State of Colorado (USA) during the spring and summer of 2002 created dangerous wildfire conditions and the media coverage of major fires in some parts of the state had a significant impact on summer tourism. Visitor numbers declined by 40% in some areas of Colorado and reservations in state park campgrounds dropped 30% (Butler, 2002). The drought also affected fishing and river-rafting tourism in the state. Anglers were restricted from fishing in many rivers.
because fish populations were highly stressed by low water levels and high water temperatures. Low water levels also shortened the river-rafting season substantially. Some river rafting outfitter companies lost 40% of their normal business and economic losses in the state’s river rafting industry alone exceeded US$50 million (Associated Press, 2002a, 2002b).

Extreme weather events routinely influence tourism operators and travel decisions in regions such as the Gulf of Mexico. The economic impact of hurricanes on tourism in this region is often substantial. In the Florida Keys, the ten-day closure and clean-up following Hurricane Georges in 1998 resulted in tourism revenue losses of approximately US$32 million (United States Environmental Protection Agency, 1999). The economic impact of the four hurricanes that struck the State of Florida in 2004 was estimated to be several times larger, as the storms caused thousands of cancellations as travelers went elsewhere and a marketing survey found that 25% were also less likely to visit Florida during hurricane season in the future (Pack, 2004; Deravi and Smith, 2005). Importantly, these same extreme events in one destination had a positive impact on other parts of the tourism system, as destinations such as Arizona and California benefited from the transfer of large numbers of visitors and convention business (USA Today, 2005). That same year, the Government of Mexico estimated that as a result of the late season hurricane Wilma and media coverage of damage and stranded tourists it would lose US$800 million in tourism revenue between October and December (Williams, 2005). With 26 tropical storms and 14 hurricanes, the 2005 hurricane season was one of the most active and destructive in history, spawning three of the most intense North Atlantic storms on record, including Hurricane Katrina which caused extensive damage to the tourism infrastructure in New Orleans and Coastal Mississippi, where impacts on convention business and gambling are expected for years, perhaps decades, to come (Bhatnagar, 2005).

The effects of the 2003 summer heat wave on tourism are also illustrative of the complexities of the climate and tourism interface. The 2003 heat wave in Western Europe was exceptional by its temperatures and also its length. Tourism establishments in the Spanish beach destination of Costa Brava reportedly lost an estimated 10% of guest nights during the summer season, with decreased stays at campsite most pronounced, while visitation to inland mountain destinations increased as travellers sought comfortable climatic conditions (WMO, 2005a). Similar shifts in tourist patterns were documented in France, with increased occupancies in destinations in northern and north western shores and central mountains, and decreases in urban centers and southern regions. Activities, accommodations and consumption patterns were also modified, as access to some forests with high fire risk was blocked, fishing restricted, camping and accommodations without adequate space cooling systems became uncomfortable, while demand for accommodations with pools increased and sales of beverages and ice cream increased substantially (UNWTO, 2008).

Tourism operators in certain market segments are also profoundly affected by inter-annual climate variability and extremes. Climate defines the length and quality of multi-billion dollar tourism seasons in different regions. Winter sports tourism, for example, is highly climate sensitive. Figure 5 demonstrates the impact of inter-annual climate variability on the length of ski seasons in the ski regions of the USA. The marginal snow conditions during the record warm winter of 2001-02 (Figure 6) in Northeast, Southeast and Midwest regions had important impacts on skier visits (7 to 11% lower than in the previous climatically average winter) and operating profits (33% lower than during a climatically average winter) (Scott, 2006; Dawson et al., 2009). In the State of Washington (Pacific West Region) skier visits declined 78% in 2004-05 because of warm temperatures and frequent rain. The highly reduced season length caused some resorts to honor 2004-05 season passes again for the 2005-06 season in order to maintain customer loyalty (Goodman, 2005).
Others were forced to forego investment plans, including repairs to a chair lift, indicating they would be in ‘recovery mode’ for several years because of this one poor snow season (Goodman, 2005).

**Figure 5. Annual ski season length (days open) by US ski region**  

**Figure 6. Marginal ski conditions during holiday season**  
(Photo: Jackie Dawson)
The golf industry similarly attributes a considerable share of its annual economic success to climate. According to a number of golf industry reports, the single most important factor impacting season length and rounds played each year (both positively and negatively) is the weather (World Golf Foundation 2001, World Golf Foundation 2004, National Golf Foundation 2004). These same reports also identify climate as a primary determinant of irrigation needs and pest management, which represent major operating costs for most courses.

Weather and climate also play an important role in the planning, financial success and quality of visitor experience at special events that take place in outdoor venues (for example, music concerts; cultural festivals; sporting events – football, golf, auto racing) (Jones et al., 2006). Many outdoor events are held at certain times of the year in order to take advantage of certain climatic conditions or reduce climate risk. For example, the annual Albuquerque International Balloon Fiesta is held in October because of calm winds in the morning and limited severe weather. The Canadian Tulip Festival is held in May, coinciding with the maturate stage of the flowers. Climate conditions have forced organizers to undertake measures such as planting tulips bulbs in shady locations or irrigating flowers beds to delay bulb maturation to adapt the mismatch of tulip phenology and event schedule (Scott et al., 2005). Climatic conditions can affect special events on a short-term basis (e.g., short rain storm) or for the entire event (multi-day rain or high winds, for examples). A study of the reasons for the failure of special events through members of the International Festival and Events Association members, found that weather was ranked first among eight external factors (Getz, 2002). Of the full 30 factors considered in the study, weather was identified as the second most important factor contributing to event failure, only after a lack of corporate sponsorship.

“The golf industry's significant sensitivity to weather will make it one of the first to feel the impacts of increasing weather uncertainty due to climate change. As a result, we anticipate the industry to be impacted in the near-term as the old paradigm of business and financial planning around predictable and cyclical weather patterns may be disrupted by an increasingly volatile climate... certain geographic markets are already facing these challenges...”

WeatherBill Inc. (2007)

Climate is also a salient influence on tourist decision making and the travel experience. Climate is a key factor considered by tourists, consciously or implicitly during travel planning, and represents both a push and pull factor for tourists. Weather and climate are an intrinsic component of the vacation experience and have been found to be a central motivator for travel. General travel surveys conducted in Germany, the UK and Canada, have all found that weather and climate were a primary travel motivation for the majority of travelers (Mintel International Group, 1991; Lohmann and Kain, 1999; Ontario Ministry of Tourism and Recreation, 2002). Other traveler surveys, conducted in a number of countries have also revealed the importance of climate in the selection of a holiday destination and the timing of holiday travel (Lohmann and Kain, 1999; Kozak 2002; Hamilton and Lau, 2005; Gössling et al. 2006; Moreno, 2009). Importantly, travel patterns are often related to the weather and climate conditions at the point of origin and not just the destination. For example, despite the global economic recession in 2008-09 and expectation of reduced travel demand, the very rainy weather throughout much of the early summer in the UK was credited by the Association of British Travel Agents for the increase in foreign holiday bookings over the previous year (Hill 2009).
Climate variability has been found to influence travel patterns (proportion of domestic and international holidays) and tourism expenditures in some nations. Studies of tourism demand in the UK have found that outbound and inbound visitor movements were responsive to weather (temperature and rainfall) during the current year as well as from the previous year (Smith, 1990; Agnew, 1995; Giles and Perry, 1998; Agnew and Palutikof, 2006). Similar correlations between monthly accommodations demand (bed-nights) and summer temperatures (both current year and the previous summer) were found in Italy (Bigano et al., 2005). Demand for summer time inclusive tour charters by Norwegians, most of which (greater than 75%) are to ‘sunshine destinations’, has been found to be influenced by weather conditions in the previous summer (Jorgensen and Solvoll, 1996). The influence of past seasons is understandable, for an individual that has experienced a negative impact on holiday satisfaction or perceived loss of holiday in the past due to weather, is likely to be wary of this potential when contemplating current holiday options. However, there is some evidence from tourist surveys that suggest the decision to return to a destination is largely unaffected by past experiences of poor weather (Lohmann and Kaim, 1999; Moreno 2009). A 1°C warmer than average summer season was found to increase domestic tourism expenditures in Canada by 4% (Wilton and Wirjanto, 1998). A number of sector or destination specific studies have also shown significant relationships between climatic conditions (daily to weekly time scales) and a range of tourism indicators (ski lift tickets, golf rounds, park attendance, special event attendance) (Paul, 1972; Meyer and Dewar, 1999; Hamilton et al., 2003; Jones and Scott, 2006; Scott and Jones, 2007; Moreno et al., 2008; Shih et al., 2009). Importantly, climate information is embedded in a matrix with other information relevant to travel decision making (cost, time, attractions, holiday commitment, motivations, for examples) and these factors bound the use of climate information in travel decisions (Adams, 1973) (see also Figure 1).

There is also evidence that the weather conditions experienced at the destination have important influence on travel and holiday satisfaction (Figure 7). Visitor surveys by the Scottish Tourist Board show that 20% of overseas visitors identify weather as the main cause of dissatisfaction (Smith, 1993). Poor weather has similar impacts at sunshine destinations, where cool and windy conditions, such as those shown at a ‘winter getaway’ resort in the Caribbean, have a highly negative impact on holiday satisfaction and are thought to adversely affect the likelihood repeat visitation to the destination. The importance of snow conditions to skier satisfaction has been documented in several countries (Carmichael, 1996; König and Abegg, 1997; Scott, 2006; Bicknell and McManus, 2006) and influences the satisfaction of visitors to winter resorts to an extent that it must be controlled for in surveying to avoid contamination of holiday satisfaction and destination evaluations (Williams et al., 1997). Poor snow conditions have also been linked to negative impacts on personal safety of tourists. During the poor snow conditions of the 1990/91 ski season in the Swiss and Austrian Alps, accident insurance claims by British skiers were almost double average levels, with approximately half listing accidents caused by exposed rocks and congestion on the slopes (Smith, 1993).

The preceding lines of evidence demonstrate the climate sensitivity of the tourism sector. For the tourism industry and tourists alike, climate represents both a vital resource to be exploited and important limiting factor that poses risks to be managed. Consequently, it is expected that the integrated effects of climate change (both shifts in climatic means and extremes) will have profound impacts on tourism businesses and destinations. Furthermore, because climate, the natural environment, personal safety, and travel cost are primary factors in travel decisions, and each are projected to be significantly impacted by global climate change, far-reaching shifts in
consumer travel demand may also occur. Accumulating evidence indicates that climate change, particularly high emission scenarios, could therefore fundamentally transform aspects of the global tourism sector in the decades ahead (UNWTO, 2003; Gossling and Hall, 2006; Scott, 2006; Becken and Hay, 2007; UNWTO-UNEP-WMO, 2008). The demands for accurate and increasingly detailed climate information are therefore anticipated to increase substantially in order to allow tourism businesses and destinations to minimize associated risks and capitalize upon new opportunities posed by climate change, in an economically, socially and environmentally sustainable manner.

“Climate change will constitute an increasing risk for tourism operators in many destinations. With many tourism activities heavily dependent on the climate and insurance policies increasingly affected by natural hazards, accurate weather information and forecasting of extreme climatic events are becoming ever more important for tourism businesses.”

UNWTO Secretary-General Francesco Frangialli
Beijing, November 2005

Despite the growing global economic importance of the tourism sector and the multiple, complex interactions between climate and tourism, there have been very limited evaluation of the use of climate information or an assessment of the climate services needs within the sector (Scott, 2006; McBoyle, 2007; de Freitas, 2003; Altalo and Hale, 2002). This report provides a synopsis of the scientific and government literature and expert opinion (see list of experts consulted) on the capacities and needs for climate services in the tourism sector and was commissioned by the WMO and UNWTO to provide background information for the parallel working session on Climate Information for Adaptation and Risk Management in the Transportation and Tourism Sector at the 3rd World Climate Conference in Geneva, Switzerland.

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3 The WMO defines ‘climate information’ as including: historical data, analyses and assessments based on these data, forecasts, predictions, outlooks, advisories, warnings, model outputs, model data, climate projections and scenarios, climate monitoring products, etc.
The remainder of the report focuses on current and emerging applications of climate services in the tourism sector and is organized into three sections. The first provides an overview of climate information providers and various delivery pathways of climate information to the end-users within the tourism sector. The varied roles of different providers, types of existing collaborations, and examples of best practice of communication and specialized climate products are identified. The second section summarizes the wide range of current and potential uses of climate information by the diverse tourism sector end-users and key entry points into user decision making. Section three discusses key knowledge gaps, research and capacity building needs, and partnerships that are required to accelerate the application of climate information to manage risks to climate variability and facilitate successful adaptation to climate change.

4 APPLICATIONS OF WEATHER AND CLIMATE INFORMATION IN THE TOURISM SECTOR

There has been a proliferation of climate information providers and communication technologies over the past two decades. The types of information available to tourism end-users from major providers vary considerably. While National Meteorological Services (NMS) are primarily concerned with the production of climate information that benefits society at large in the public interest (for example, minimizing damage and enhancing human well-being), other government agencies and most private sector providers tailor their products specifically for use by special end-users and pay for service customers (WMO, 2002). The relative availability of basic and specialized climate information, the types of providers and the delivery pathways (communication channels) vary substantially from nation to nation and even within nations. Figure 8 provides a conceptual framework of the supply of climate information and services to end-users in the tourism sector.

Sources of primary climate data typically include government agencies (NMSs, for example) and private meteorological companies (for example, The Weather Network®-Canada; The Weather Channel®-US, UK, and Australia; BBC® Weather-UK), but can also include universities, non-governmental organizations (NGOs), and tourism operators that operate their own meteorological data collection station(s) (a ski operator, for example). Climate information is delivered to tourism end-users by many types of providers and communication media, ranging from tourism marketing and guide books, the internet, television (including several all-weather channels in a number of developed countries), radio, newspapers, and hand-held devices (BlackBerry® and iPhone™, for examples). A brief overview of the objectives and capacities of each major type of climate information provider with respect to the tourism sector is provided in section 4.1. Section 4.2 then provides a comprehensive, though not exhaustive, inventory of current and emerging applications of climate information in decision making by major end-users within the tourism sector.

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4 The WMO defines the following: ‘Basic services’ - are those services provided by a NMS in discharging its government’s sovereign responsibilities to protect the life and property of its citizens, to contribute to their general welfare and quality of their environment, and to meet its international obligations under the Convention of the WMO and other relevant international treaties. ‘Specialized services’ are those beyond basic service, which may include the provision of special data and products, their interpretation, distribution and dissemination and consultative advice.
Figure 8. Conceptual framework of climate information in the tourism industry

4.1 CLIMATE INFORMATION AND SERVICE PROVIDERS

National Meteorological Services and Other Government Agencies

Governments play an important role in the provision of climate information and this provision is sometimes dominated by legal requirements and constitutional provisions. Because basic weather and climate information is perceived as an ‘economic public good’, all 187 Member States and Territories of the World Meteorological Organization (WMO) have established some form of National Meteorological Service (NMS) to develop and operate the essential observation and data processing infrastructure needed to support the provision of climate services relevant to minimize the impact of climate-induced natural hazards (i.e., protect life and property of citizens), maintain the quality of environmental systems, enhance the economic performance of climate-sensitive sectors, and meet other obligations are under the Convention of the WMO and other international treaties. NMS services may be organized in many different ways according to national circumstances and the major user communities they are required to serve, and have a high level of awareness within their respective countries (WMO, 2002).

For the tourism sector, NMS climate information can generally be grouped under four main categories: basic weather services (observations/nowcasting and short- to medium-range forecasts, for examples) and warnings to the public, aviation and marine transport weather services5; specialized services for tourism end-users; and more recently climate change projections to facilitate successful adaptation. Like all climate-sensitive economic sectors, the maintenance and enhancement of the global climate monitoring network that provides basic weather services are of vital interest to the tourism sector. Certain key tourism environments are underserviced by the global meteorological observation system (mountains and small islands) and would benefit from

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5 A detailed discussion of the provision of climate information for aviation and marine transport is provided in the Transport Sector White Paper.
system improvements. The improved accuracy of basic weather forecasts is also important for tourism operators, as they benefit operational decisions and because inaccurate forecasts can be detrimental to the tourist experience and tourism demand (see previous section). Improved accuracy (or ‘skill’) of forecasts (short- to medium-term and seasonal) has been identified at workshops in the USA, Spain, Jamaica, Bahamas, Fiji, and Greece, by several of the experts consulted for this report and by Altalo and Hale (2002) and Gamble and Leonard (2005) as a requirement for increased use in operational decision-making in the tourism sector.

Issuing weather watches, warnings, and advisories is a key function of NMSs. These enable appropriate action to be taken to prepare and protect travelers against the dangers of all forms of meteorological hazards (evacuation of people, deploying security personnel, reallocation of resources, or closing down operations, for examples). Table 1 illustrates select countries and legislative responsibilities with respect to the issuance of meteorological warnings and advisories according to a recent World Meteorological Organization survey. While the survey revealed a number of NMSs to be directly responsible for the provision of meteorological information to users (Bahamas, Germany, New Zealand, for examples), others are not legally responsible (Australia, parts of the Caribbean, for examples) or the extent of legislative responsibilities is unknown.

In most nations in the Caribbean, the Ministry of Tourism works very closely with the NMS to monitor hurricane forecasts and is an integral member of national emergency management agencies or task groups that coordinate hurricane preparedness. For example, in the Bahamas the Ministry of Tourism, along with other major government agencies and the Red Cross, is a member of the active hurricane committee that operates within the National Emergency Management Agency. The Ministry of Tourism has its own plan of operation, which includes contacting hotel operators directly by phone or email as soon as a storm threat is forecast and hour by hour updates, and evacuation plans as necessary.

While the quantity and diversity of specialized climate services provided by NMS to the tourism sector is currently limited, however, some of the joint government and WMO demonstration projects of nowcasting systems and applications have focuses on major sporting and tourism events (the Summer Olympic Games in Sydney, Australia and Beijing, China). NMS have a critical role in supplying much of the climate information to the mass media and other tourism specific outlets (tourist guides, marketing brochures, travel planning web sites, for examples) and provide the essential historical, current, and forecast information that allow other providers to develop specialized climate products for the tourism sector. The climate change modeling and scenario communication capacity remain limited in some developing nations. The application of climate change projections for adaptation has also been found to be quite limited thus far within the tourism sector (UNWTO-UNEP-WMO, 2008; Scott et al., 2008).
**Table 1. Select countries and legislated responsibilities for the issuance of meteorological information to the public** (World Meteorological Organization, 2009)

<table>
<thead>
<tr>
<th>Country</th>
<th>Legislated Responsibility for Issuing Meteorological Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahamas</td>
<td>Meteorological Service is the exclusive agent for issuing warnings on hurricanes, tropical storms and other weather conditions that are likely to give rise to floods, surges and wind damage.</td>
</tr>
<tr>
<td>China</td>
<td>The law provides exclusive powers to China Meteorological Association: “The state applies a unified system for the issuance of public meteorological forecasts and severe weather warnings. Meteorological and stations subordinate to the competent meteorological departments at different levels shall, in compliance with their functions and duties, issue to the community, public meteorological forecasts and severe weather warnings … No other organization or individual may issue to the community such forecasts and warning.”</td>
</tr>
<tr>
<td>Germany</td>
<td>Under ‘Duties and Competences’, the Deutscher Wetterdienst is mandated with “issuance of official warnings of weather occurrences that could become a danger for public safety and order, especially concerning the impending danger of floods.” No express provision for exclusive rights to the Met Service to issue forecasts and/or warnings.</td>
</tr>
<tr>
<td>New Zealand</td>
<td>The Minister of Transport who, under Meteorological Services Act 1990, is responsible for ensuring the provision of meteorological warnings and forecasts for New Zealand and the collection of data to support these services. Furthermore, the Minister is required to designate an organization that shall provide the authorized warning service in New Zealand.</td>
</tr>
<tr>
<td>South Africa</td>
<td>In Act No. 8 of 2001, under functions of the Weather Service, “Only the Weather Service may issue severe weather-related warnings over South Africa in order to ensure that there is single authoritative voice in this regard.”</td>
</tr>
<tr>
<td>U.K.</td>
<td>The UK Met Office has no direct legislated responsibility. The Civil Contingencies Act (CCA) 2004 sets out the roles and responsibilities for UK Authorities who are required to respond to incidents (including weather related incidents). A piece of secondary legislation (Statutory Instrument 2042/2005) states that respondents to the CCA should not seek to duplicate information provided by the Met Office.</td>
</tr>
<tr>
<td>U.S.</td>
<td>An Act of Congress provides that NOAA, as an Agency, shall t, except where specifically authorized by statute: establish an exclusive, restricted, or other distribution arrangement that interferes with timely and equitable availability of public information to the public; restrict or regulate the use, resale, or re-dissemination of public information by the public.</td>
</tr>
<tr>
<td>Australia</td>
<td>No express provision for exclusive rights to the Met Service to issue forecasts and/or warnings.</td>
</tr>
<tr>
<td>The Caribbean</td>
<td>No express provision for exclusive rights to the Met Service to issue forecasts and/or warnings.</td>
</tr>
</tbody>
</table>

In addition to NMSs, in some nations, other government departments or agencies maintain basic or specialized climate observation systems that provide climate information relevant to tourism end-users. The Great Barrier Reef Marine Park Authority’s (GBRMPA) *Climate Change Response Programme* is an exemplary example of partnerships to utilize climate data and other monitoring information for both management decision making and communication to tourism stakeholders.
The Great Barrier Reef has experienced several mass coral bleaching events in the past decade (1998, 2002, 2006), with 60% of the reef being bleached during the largest event in 2002 (Great Barrier Reef Marine Park Authority, 2007). The Response Plan has three main components: Early Warning System; Assessment and Monitoring; and, Communication (Great Barrier Reef Marine Park Authority, 2008). The Early Warning System uses climate forecasts, remote sensing data, sea temperature monitoring, BleachWatch reports, and site inspections to monitor conditions and provide early warning of major bleaching events. Based on an emerging understanding of the relationship between weather and sea temperatures for the Great Barrier Reef, current and forecast weather conditions are used to indicate whether conditions conducive to bleaching are likely. The Programme produces tools, such as ReefTemp (a Google™ Earth application), for the monitoring of environmental conditions conducive to coral bleaching or the early signs of bleaching. BleachWatch assists managers to collect data across a wide spatial distribution and is also used to communicate and increase the understanding of broader climate change impacts to the public, tourists and tourism operators.

**Private Sector Climate Service Providers**

Private sector climate service providers have, to a great extent, embraced the rapid technological advancements that have occurred over the past decade with respect to meteorological observation, remote sensing and model development, as well as in communication and delivery systems (advances in cable television, the internet, and more recently wireless hand-held devices such as RIM’s® BlackBerry® and Apple’s® iPhone™), in order to provide more user-friendly access and formats of climate information than provided by NMS and other government agencies, as well as to develop specialized, value-added climate information products for the tourism sector. As a result, private sector climate service providers tend to provide a greater variety of climate information and applications that are of interest to tourism end-users.

Private sector climate service providers have lead in terms of innovation of specialized climate services tailored to specific tourism destinations, individual tourist activities and subsectors. The major private climate service provider in the USA (The Weather Channel®) exemplifies best practice in this area of innovation. The Weather Channel® provides access to specialized weather reports for the following tourism activities, events and destinations: golfing, ski and snowboarding, snowmobiling, special events and major sporting events (Major League Baseball and Professional Golf Association events, for examples®), weather sensitive travel routes (airport weather and highway construction, for examples), coastal beach destinations, international sunshine destinations, and potential wedding and honeymoon locations®. The Weather Channel® has also developed several climate ‘indices’ relevant to the individual tourist and to various tourism sub-sectors. The ‘Spectator Index’ (Figure 9) provides tourists a rating of how comfortable they will feel while watching a sporting event. A variety of weather factors are used to calculate the index, 6

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6 A survey of tourists in Cairns (North Queensland, Australia) asked if they would visit the region if they knew that there had been a recent bleaching event – 29% were uncertain and 35% indicated they would not.

7 It should be noted that other private meteorological companies in the USA (such as Accuweather) and in Europe (such as WeatherNet) also offer a range of forecast products tailored to recreation and tourism sector operations (skiing/snowmaking, golf turf management, marine forecasts, pool management, incident reports, business revenue/visitor analyses, weather risk insurance assessments) and traveler decision-making.

8 The U.S. The Weather Channel® is the ‘official supplier’ of weather information to Major League Baseball and the Professional Golf Association.

9 In some situations, what private meteorological companies identify as activity/destination specific forecasts, are no more than renamed local forecasts for nearby cities and provide little or no added value for tourist decision-making.
including temperature, probability of precipitation, humidity, wind speed, and cloud cover. A Spectator Index value of 1 signifies poor conditions while a 10 signifies ideal conditions for watching an event. The Weather Channel® states that the best index values result from ‘short-sleeve’ temperatures, minimal chances of precipitation, low humidity, light winds, and fair skies. Conversely, cold and stormy conditions will result in the lower values.

Figure 9. The Weather Channel® ‘Spectator Index’
(Source: The Weather Channel®, 2009a)

Other unique multi-variable indices developed by the Weather Channel®, include the ‘Ski Index’ (Figure 10), ‘Golf Index’ (Figure 11), and the ‘Fishing Index’ (Figure 11). While the weather parameters used to calculate the ski index are not entirely known, a number of parameters are acknowledged specifically as being used to calculate the rating: surface snow conditions, average snow depth, new snow accumulation, temperature, precipitation, and wind speed. The Ski Index is based on a 1 to 10 scale (Figure 10), where a 10 signifies ideal ski conditions and 1 signifies dangerous conditions. Unpleasant weather conditions, such as thunderstorms, wind speeds at or greater than 35 mph, and freezing rain will automatically set the Ski Index value to equal 1. A Ski Index will not be calculated for temperatures greater than 60 degrees Fahrenheit. To ensure the up-most accuracy, the Ski Index is only available for the current day and next two days and is updated frequently. The forecast Ski Index is not calculated after 4pm since the lowest temperatures tend to occur at night and would therefore unfavorably skew results. The weather parameters used to calculate the Golf Index are also not known, however parameters known to be included in the rating are: extreme temperatures, high dew points, low visibilities, thunderstorm risk, high winds and precipitation. The Golf Index is based on a 0 to 10 scale (Figure 11, where 0 is an unfavorable golfing day, and 10 is an excellent golfing day. The Fishing Index differs in that it only includes three rating classifications (excellent, good, fair – Figure 11). Variables used to calculate this Index include time of day, solar influence, lunar influence, weather and wildlife charts, and declination and diurnal inequality.
Figure 10. The Weather Channel® ‘Ski Index’
(Source: The Weather Channel®, 2009b)

Figure 11. The Weather Channel® ‘Golf Index’ and ‘Fishing Index’
(Source: The Weather Channel®, 2009c and 2009d)
The Weather Channel® also provides users with current and forecasted weather conditions for most national and state parks in the USA. An unique application developed by the Weather Channel® for its parks reports is the ‘Mosquito Activity Forecast,’ which predicts how active mosquitoes in a particular park will be based on a variety of environmental factors, including temperature, wind, humidity values, and time of day and year. The levels of mosquito activity ranges from none (conditions not favorable for mosquitoes) to very high (light winds and ideal temperatures make it perfect for mosquitoes). The Mosquito Activity Forecast cannot predict how many mosquitoes will be in a particular area (a campground, for example) or bite frequency. Mosquito populations and concentrations of species with different behaviors can vary considerably in short distances and are not taken into account in the forecast.

The development of such indices and user-friendly tools by The Weather Channel®, such as the ability to conduct climate comparisons between two potential tourism destinations, has done much to increase overall brand awareness of private climate service providers in some nations. Moreover, because weather and climate data provided by private MET services can be accessed more readily via a number of different media (internet, TV, desktop applications, mobile phones, RSS feeds, and wireless handheld devices such as SmartPhones, for examples), end-users are constantly reminded of who is providing them with weather and climate-related information and the types of services offered.

Other private sector climate service providers concentrate on specialized climate information to tourists within a single tourism sub-sector. For example, Snow-Forecast.com provides climate information for over 2,200 ski locations around the world (see Table 2 for coverage by nation). It applies ‘topographical corrections‘ to basic NMS data to produce “more accurate” snow forecasts for mountain resort destinations, including snow conditions and forecasts for top-, mid-, and bottom-lifts (Figure 12). Users can access historical weather data, current weather conditions (for up to five weather stations located closest to the resort), and six-day weather forecasts (including morning, mid-day, and night forecasts for each day) free-of-charge. SnowForecast.com also provides access to more detailed two-day and nine-day forecasts for a subscription fee. In addition to static maps, SnowForecast.com provides access to interactive maps that allow users to select from a number of climatic variables (temperature, snowfall and wind, for examples) and animate projected changes for up to a six-day period for a given region. The website also provides other tourism relevant information to end-users, including ski trail maps, resort reviews, and links to ‘current conditions’ webcams that could be used in the destination and activity choice decision-making process. The website also provides visitors with the opportunity to register for ‘Snow Alerts’ that are delivered regularly via e-mail. Such information and functionality is virtually never provided by government agencies and rarely provided by even the largest and most prominent private weather service providers.
Figure 12. SnowForecast.com weather forecast for Turoa ski resort, New Zealand
(Source: SnowForecast.com, 2009)

Table 2. National coverage of mountain/snow forecasts by SnowForecast.com

<table>
<thead>
<tr>
<th>Country</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Argentina</td>
<td>12</td>
</tr>
<tr>
<td>Armenia</td>
<td>2</td>
</tr>
<tr>
<td>Australia</td>
<td>17</td>
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<tr>
<td>Austria</td>
<td>215</td>
</tr>
<tr>
<td>Bolivia</td>
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<td>Bosnia Herzegovina</td>
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<td>Bulgaria</td>
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<td>Poland</td>
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<td>Rep. of Macedonia</td>
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<td>Russia</td>
<td>11</td>
</tr>
<tr>
<td>S. Africa</td>
<td>2</td>
</tr>
<tr>
<td>Serbia/Montenegro</td>
<td>5</td>
</tr>
<tr>
<td>Country</td>
<td>Countries rated</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------</td>
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<td>Finland</td>
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<td>France - Corsica</td>
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</tr>
<tr>
<td>Georgia</td>
<td>1</td>
</tr>
</tbody>
</table>

A similar product has been developed by Surf-Forecast.com for surfers, kite surfers, sea kayakers, and other water sport enthusiasts. NMS weather data are used to develop coastal weather and swell projections for over 8,000 surfing locations around the globe (see Table 3 for coverage by nation). Surf-Forecast.com uses a ‘star’ rating scale to rate the quality of surf conditions at a particular location. The scale is based on swell size and character (the bigger the swell and longer the period, the higher the rating). However if the wind is onshore, the star rating drops in proportion to the wind speed (Figure 13). A rating of 10 is considered to be the best surf with classic conditions and light offshore winds. Flat conditions, blown out waves, onshore winds, or very strong winds in any direction, result in a star rating of 0. Other additional tourism information that is provided by Surf-Forecast.com includes swell and wind maps, surf cams, tide tables, and surf-site-specific user ratings.
Figure 13. Surf-Forecast.com surf forecast for Big Rock, Australia
(Source: Surf-Forecast.com, 2009)
Table 3. National coverage of surf forecasts by Surf-forecast.com

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
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<td>15</td>
<td>Panama</td>
<td>37</td>
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</table>

Avalanches are of high importance to winter sports tourism, as many popular destinations, such as renowned ski resorts, parks, and climbing areas in the European Alps, Rocky Mountains, and Himalayas are in avalanche-prone locations. Approximately 150 avalanche fatalities occur each year within the 17 countries that are members of the International Commission for Alpine Rescue (Canadian Avalanche Association, 2009) and the majority of victims are skiers, snowboarders, and winter climbers (World Tourism Organization, 1998; Canadian Avalanche Association, 2009). The mandate for avalanche prediction and communication varies by nation.

In Canada, a broad coalition of federal, provincial, private and not-for-profit sector stakeholders established the Canadian Avalanche Centre (CAC), as a not-for-profit corporation to provide public
avalanche safety warnings, coordinate public avalanche safety programming, and provide professional "snow science" and avalanche training. The CAC uses a combination of available weather and climate information, technology, and science to develop their avalanche forecasts (Figure 14). Weather and climate information is primarily provided by Environment Canada or directly by local agencies or tourism operators and satellite and remote sensing data is provided by the University of Washington.

**Figure 14. The use of weather and climate information in Canadian avalanche public advisories and the risk management communication chain**

The CAC produces a daily Backcountry Avalanche Advisory, Public Avalanche Forecasts three times a week, and weekly Public Avalanche Information Reports for very specific mountain regions and specific destinations (national parks and major ski resorts, for example). Advisories are posted on the CAC website, The Canadian Meteorological Service website (Environment Canada), agency and operator websites, and are forwarded to the information media and other users of advisories (Figure 15). All areas are rated on the avalanche danger scale, which provides travel and activity recommendations for users. The Canadian Avalanche Association (CAA) (a subsidiary of the CAC) also offers subscription-based mountain weather forecast service for tourism organizations and individuals who are involved in avalanche-related work via its Industry Information Exchange (InfoEx®) program. The over 450 organizations that currently subscribe to InfoEx® are all Professional Members and actively manage avalanche hazards (backcountry and heli-skiing companies, mountain parks, resorts and lodges and road maintenance departments, for examples) (Canadian Avalanche Association, 2009). The ‘fee for service’ options include specialized forecasts for a distinct geographic location and one-on-one consultation services.
In Europe, the WSL Institute for Snow and Avalanche Research SLF (Switzerland) has been publishing public Avalanche Bulletins since the 1940s and the standardized Avalanche Danger Scale shown in Figure 15 has been in use throughout Europe since 1993. National and Regional Avalanche Bulletins are broadcast to the public on several media (television, radio, newspapers, websites) as well as through mobile communications (SMS, MMS).

<table>
<thead>
<tr>
<th>Danger level</th>
<th>Snowpack stability</th>
<th>Avalanche triggering probability</th>
<th>Consequences for transportation routes and settlements / recommendations</th>
<th>Consequences for persons outside secured zones / recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The snowpack is generally well bonded and stable.</td>
<td>Triggering is generally possible only with high additional loads* on very few extreme slopes. Only natural sluffs and small avalanches are possible.</td>
<td>No danger</td>
<td>Generally safe conditions.</td>
</tr>
<tr>
<td>2</td>
<td>The snowpack is only moderately well bonded on some steep slopes*, otherwise it is generally well bonded.</td>
<td>Triggering is possible, particularly through high additional loads**, mainly on steep slopes indicated in the bulletin. Large natural avalanches are not expected.</td>
<td>Low danger of natural avalanches.</td>
<td>Mostly favourable conditions, careful route selection, especially on steep slopes of indicated aspects and altitude zones.</td>
</tr>
<tr>
<td>3</td>
<td>The snowpack is moderately to weakly bonded on many steep slopes*.</td>
<td>Triggering is possible, even through low additional loads***, mainly on steep slopes indicated in the bulletin. In certain conditions, some medium and occasionally large natural avalanches are possible.</td>
<td>Isolated exposed sectors are endangered. Some safety measures recommended in those places.</td>
<td>Partially unfavourable conditions, experience in the assessment of avalanche danger is required. Steep slopes of indicated aspects and altitude zones should be avoided if possible.</td>
</tr>
<tr>
<td>4</td>
<td>The snowpack is weakly bonded on most steep slopes*.</td>
<td>Triggering is possible even through low additional loads****, mainly on steep slopes, in certain conditions, medium and multiple large natural avalanches are expected.</td>
<td>Many exposed sectors are endangered. Safety measures recommended in those places.</td>
<td>Unfavourable conditions, extensive experience in the assessment of avalanche danger is required. Remain in moderately steep terrain / avoid avalanche run out zones.</td>
</tr>
<tr>
<td>5</td>
<td>The snowpack is generally weakly bonded and largely unstable.</td>
<td>Many large natural avalanches are expected, even in moderately steep terrain.</td>
<td>Acute danger. Comprehensive safety measures.</td>
<td>Highly unfavourable conditions, avoid steep terrain.</td>
</tr>
</tbody>
</table>

Figure 15. European avalanche danger rating scale for recreation and travel
(Source: Swiss Federal Institute for Forest, Snow and Landscape Research, 2009)

Private sector climate service providers have been innovators in the use of emerging communications technologies to deliver specialized climate information to tourists and other tourism sector end-users. In the last two years, there has been a tremendous increase in the use mobile phone to search the internet and a proliferation in the development of climate-related applications made available to tourism end-users through wireless hand-held devices. Apple’s® iPod Touch™ and iPhone™ and Research in Motion’s (RIM®) BlackBerry® products offer a diverse range of both ‘free’ and ‘pay for’ weather-related information applications, with Apple’s® App Store™ providing 245 weather-related products to consumers alone. The BlackBerry® App World™ also provides end-users with the opportunity to personalize their BlackBerry® Smartphone with several weather-related applications. With the number of mobile phones expected to exceed 4 billion in 2010, these specialized applications are likely to further revolutionize how travelers receive and utilize weather and climate information over the next decade.

The Weather Channel® 2.0 (USA) for the iPhone™, iPod Touch™, BlackBerry® Bold™ and Storm™, for example, provides users with real-time (current) conditions, hourly and 10-day forecasts, severe weather warnings, and other fully interactive applications, including in-motion radar maps and traffic cameras (for select markets). The original free, ad-based version of The Weather Channel® application for iPhone™ and iPod Touch™ has received more than 3.8 million downloads since its November 2008 launch (as of May 26, 2009 - The Weather Channel®, 2009e) and is the second most downloaded weather-related application available in the Apple® App Store, illustrating the demand for climate information from the general public. For a small fee (US$3.99), consumers can also download a premium version of software. The Weather Channel® Max
provides ‘ad-free’ and more specialized weather information, such as ‘in-motion’ future radar imagery projected on a map. The availability of radar information and warnings on smartphones represent a powerful new information source for tourist activity planning and safety. Where Smartphone communications exist, tourists can be informed of adverse or hazardous weather and revise activities or avoid imminent danger. Other features of the premium application include additional severe weather coverage, an enhanced video center, tropical updates, and a Boat and Beach Forecast that provides marine coastal forecasts, local tide information, and wind and surf conditions for coastal locations around the globe.

Both the Apple® App Store™ and the BlackBerry® App World™ provide a number of more specialized weather applications tailored to specific tourism-related activities. For example, the Apple® App Store™ contains applications developed specifically for alpine skiing (iSki App, The North Face® Snow Report, SkiResort and SnoCountry, for examples), boating (TideApp, for example), sailing, windsurfing and kitesurfing (iWind Italia Light, for example), surfing (Oakely® Surf Report, for example) and fishing (Fishing Calendar, for example) (see Figure 16 for screen captures). The North Face® SnowReport is a free iPhone™ application that provides skiers and snowboarders with up-to-date weather and map information about winter resorts across the globe. The application provides resort-based snow conditions with current and expected snowfall, detailed daily forecasts, and wind direction and speed information. Users can access their favorite resorts and navigate around them once they arrive through Google™ Maps and can also utilize the Trail Maps function to view a detailed lay of the land through high-resolution images. Additional information through links to the National Oceanic and Atmospheric Administration’s (NOAA) Climate Prediction Center, as well as resort specific websites, can be accessed via the application.

Overall, while the number of weather and tourism-related applications available to users is burgeoning, there is still a great opportunity for the wireless hand-held device and Smartphone programming communities to further develop and tailor specific weather and climate-related applications for tourism and recreation end-users.
Tourism Operators

Reviews of tourism marketing materials and web sites have indicated that most tourism operators provide limited climate information to potential travelers, with the most common practice to provide only average monthly temperatures (Smith, 1993; Perry, 1997; McBoyle pers. comm., 2009; Jones pers. comm., 2009). De Freitas (2005) argues that such averages have limited value for tourists and that the tourism community should instead focus on communicating the probability of experiencing certain conditions known to be important to travelers (e.g., temperatures above a certain threshold, sunshine) during specific periods (monthly or bi-weekly). Some tourism operators, especially those in more dynamic tourism environments where weather conditions can pose a health risk to tourists (e.g., mountains, deserts, marine-coastal zones), provide more comprehensive climate information to their potential visitors in order that they can properly prepare for their travels, including when is climatically the best time for travel and what to pack to ensure safe and comfortable travel experience. Resorts and other tourism operators also frequently provide climate information to their guests to assist them with planning holiday activities once they have arrived and as a marketing tool to reinforce the value of the holiday (see Figure 17).

Figure 17. Tourism operator on-site marketing with climate info
(Photo: Daniel Scott)

In most cases, tourism operators obtain primary climate information from NMS or private meteorological companies and relay this information to tourists planning to utilize their travel services or are already travelling. An example of a creative new private sector partnership began in 2009 between Husa Hotels and Cham Palaces and Hotels (Jordan) and Weather Decision Technologies, to provide weather content for each hotel in the two chains (including more than 125 cities) as a value-added service for their customers. Some tourism operators provide multiple sources of climate information to travelers and a limited number also maintain climate monitoring stations and data processing capabilities at the site-level. For example, Whistler-Blackcomb ski resort in Canada provide multiple types of climate information (Figure 18) and have implemented their own climate monitoring network in order to communicate more accurate 'local' conditions to end-users and utilize real-time information in operations decision-making (as input into snow
production management system, for example). More detailed climate information, including conditions at different altitudes (base, mid, and top if chair lifts on each mountain) are provided to more accurately communicate the diverse climatic conditions that can be experienced by visitors and provide greater accuracy of current conditions than NMS and private meteorological service providers. Although such detailed climate information may not be needed by general tourists, it is desired by activity specialists (expert skiers in this case) who have more advanced climate information needs.

![Diagram of climate information sources for Whistler-Blackcomb ski resort]

**Figure 18. Sources of Climate information provided for Whistler-Blackcomb (Canada) ski resort**

**Destinations**

Like tourism operators, organizations that promote tourism to specific destinations typically provide climate information with two purposes: marketing the destination and to assist travelers to prepare for safe and comfortable travel experience. The studies that have examined the way in which climate is used in the advertising of destinations have consistently found that weather and climate is used in a high percentage of brochures (Lanquar and Hollier, 1986; Gómez Martín, 1999, 2000; Gómez Martín and Palomeque, 2001, McBoyle pers comm., 2009; Jones pers. Comm., 2009). According to Besancenot, “the iconographic analysis of tourist brochures and the careful reading of the accompanying text only confirm the obsessive presence of references, direct or indirect, to the climate.” (1991: 208)

The sophistication of climate information within destination marketing communications (brochures, TV, websites, for examples) ranges widely and depends on the prominence of climate within the ‘brand image’ of the destination. At one end of the spectrum are marketing
communications that provide absolutely no climate information on the destination, but display a very obvious 'blue sky' bias in all photography of the destination (Besancenot 1991; Perry, 1993; McBoyle pers. comm., 2009; Jones pers. comm., 2009). Often, even basic climate information (monthly mean temperature and precipitation) and advice on ‘what to wear’ and health-related issues (insect repellent, UV index and sunscreen, for examples) is not provided. More detailed climate information on sunshine hours, water temperatures, elevational differences in temperature and climate related hazards, remains the exception. At the other end of the spectrum are destinations that provide detailed climate information that is tailored to the types of tourists that visit and activities they typically undertake.

In destinations where seasonal weather is not highly conducive to tourism, climate is sometimes downplayed in marketing communications (Iceland’s ‘more solar than polar’ for example) or omitted altogether. Marketing is also used to specifically address unfavorable perceptions about a destination’s climate. For example, a tourism brochure for Brittany, France informs tourists that “Common misconceptions and prejudices have portrayed Brittany as a rainy region when in fact its maritime climate is mild and bracing ... (and its) iodine-rich sea air is unique and just to breathe it in is to enjoy its health-giving properties.” In contrast, other destinations have cultivated a destination image and marketing strategy around certain activities or experiences that are largely based on the local climate. The Cayman Islands promotes its ‘perpetual summer’, while the U.S. State of Florida brands itself as ‘the sunshine state’ (Figure 19). In an effort to differentiate its climate-based destination image, Barbados Tourism Authority began offering it ‘perfect weather guarantee’ in 2009 (see Table 2). Similar, ‘money-back sunshine guarantees’ have begun to be offered for destinations in the south of France by travel agents in France in cooperation with the insurance company Aon France (Allen, 2009).

Figure 19. “The Sunshine State” tourism marketing for northeast Florida
(Source: VisitFlorida.com)
Other destinations use what would typically be considered adverse weather conditions, to develop distinct tourism products. Historically, tourism has not been an important activity to the local economy of Tarifa, Spain as the frequent high winds were not suitable for conventional sun, sand, sea tourism development. However, the high winds of Tarifa are a very valuable resource for water sports, such as windsurfing and kitesurfing, and the community now markets itself as the ‘windsurfing capital of Europe’ or the “Costa de la Luz y el Viento” (“the Coast of Light and Wind”). Vancouver Island (British Columbia, Canada) promotes a Storm Watching product on its Pacific Ocean coast during the fall and winter months and encourages visitors to take advantage of the special conditions created during La Nina phase of Pacific Ocean Southern Oscillation.

“...experience the raw power of the mighty Pacific Ocean as ferocious waves roll in from Japan and pound the shores of the rugged west coast - nature in all its fierce majesty! ... Watch as a smooth sandy beach is transformed when hundreds of pieces of driftwood are pitched up onto its sandy shore. Likewise, the Gulf Islands experience some stunning electrical storms that can only be viewed out over the water... When the storm has passed, you’ll be rewarded with peaceful strolls along cool, deserted beaches – a good time for beachcombing for washed-up treasures. Make the best of these La Nina seasons by creating opportunities to witness some spectacular weather.”

Storm Watching Accommodation and Tours
(Source: BritishColumbia.com)

4.2 CLIMATE SERVICE USERS

The potential use of climate information within tourism is tremendous given the diversity of end-users in the sector (as identified in the beginning of Section 4). The full temporal scale of climate information, from nowcasting (up to 1 hour), to short- and medium range forecasts (1 and 7-10 days), to multi-decadal climate change projections, is utilized within the tourism sector and examples of applications are outlined for each major end-user below. However, to date, there has been no systematic assessment of the extent of climate information use in tourism decision-making in any region or sub-sector or whether the information needs of specific tourism user groups are being met regionally or nationally. User awareness and capacity to use climate products and services also remain largely unknown. All remain important areas future research and capacity building.

Tourists

As indicated, weather and climate have broad significance to tourist decision making and the vacation experience. Climate is of universal importance in defining destination attractiveness and a central motivator in the selection of a holiday destination and the timing of holiday travel. Climate influences travel patterns (proportion of domestic and international holidays), tourism expenditures, and overall holiday satisfaction. Travelers are interested in the climate and weather at their intended destination as well as the weather along the way (travel phase). Business travelers are particularly cognizant of how weather causes delays and diversions and utilize forecasts in routing decisions. Figure 20 conceptualizes the influence of different types of climate information (historic, forecasts, nowcasts) on tourist decision-making.
The limited studies that have examined the use of climate information by travelers reveal widespread use in holiday planning. Tourism and recreation users were shown to generate the largest demand from automated telephone weather services in Scotland and Britain (Smith, 1981). A survey of German outbound tourists found 73% informed themselves about the climate of their destination and the majority of them informed themselves about the climate before booking their travel (42%) (Hamilton and Lau, 2005). A similar survey of Northern European travelers to the Mediterranean region found 86% would obtain information on their destination's climate, with 81% doing so before making any travel reservations (Rutty and Scott, 2009).

Interestingly, consideration of current weather conditions or near-term forecasts (next 1-4 days) has been found to be the most important factor in ‘last minute’ domestic leisure tourism (Szalai and Ratz, 2006). With the trend toward shorter timeframes for travel planning, especially discounted ‘last minute’ bookings made in the week (or day) prior to departure, the value of short- and medium-term forecasts for travel planning is likely to increase. In the same way, the influence of media stories about unfavorable weather for tourism and extreme events may also increase. For example, when a survey of Northern European travelers was asked if media stories about heat waves in the Mediterranean would affect their travel plans to a destination in the region, 51% said they would alter their travel plans in some way and a further 15% would seek additional information before deciding (Rutty and Scott, 2009). This finding was consistent with earlier research that found travelers interpreted weather forecasts differently, depending on the relatively level of commitment to holiday travel (Adams, 1973).

Of course tourist decision-making is a highly complex process, incorporating multiple influencing factors. The place of weather and climate information in the psychological process of travel planning remains an important area for further research.

**Tourism Developers, Operators, and Destinations**

Weather and climate information provide input into a several decision making contexts for tourism developers, operators and destinations. Historic climate information can be used for strategic planning of tourism infrastructure, including: location analysis for new resorts,
architectural and landscape design, to construction scheduling in remote locations. Altalo and Hale (2002) found that weather and climate were not usually cited as reasons for development (or not) of new resorts and accommodations, nor critically influence site selection decisions, relative to other macro-level factors like transportation access, source markets, land ownership, and coastal access. Climate information was utilized more extensively in engineering, construction planning, property design and maintenance, and other post-build decisions (insurance, heating-cooling budgeting, staffing). The limited availability of historic climate information in many developing nations and remote locations (e.g., smaller islands and mountainous areas) at the scale relevant to tourism developers has been a significant barrier in the past (J. Kuehnle pers comm., 2009; N. Trotz pers. comm., 2009) and the limited availability of electronically archived historic climate data from many stations continues to be a barrier in regions such as the Caribbean.

In the same way that historic climate information has been used for strategic planning of future tourism developments, climate change projections are now also being utilized to anticipate and adapt to market risks and opportunities at the business, destination and national level. Since climate change is likely to increase the occurrence of extreme weather events (IPCC, 2007), there is a need for a long-term integrated response. Real estate and tourism developers have begun a billion dollar investment in a giant new ski area near the remote mountain town of Revelstoke (British Columbia, Canada), because they believe the astounding snowfall in the area (an average of 15 meters annually) will become a major market advantage as snow conditions at major ski areas in more southern locations of the US and the European Alps are projected to continue to decline in the decades ahead (Ebner, 2008). At the destination scale, both the internationally renowned mountain tourism community of Aspen (Colorado, USA) (Katzenberger, 2006) and Tourism
Australia are using climate change scenarios in the development of climate change adaptation plans. While the use of climate change information by tourism developers, operators, and destinations remains isolated to date (Scott et al., 2008; UNWTO-UNEP-WMO, 2008), its necessity for successful climate change adaptation is anticipated to increase substantially in the decades ahead (Figure 21).

Historic climate data is also the foundation for the growing application of innovative weather derivatives and index insurance products to reduce weather risk in the tourism sector. Weather derivatives are financial instruments that emerged in the late 1990s to protect against weather-related loss of revenue in the energy and agriculture sectors and differ fundamentally from weather insurance commonly held by tourism operators (Zeng, 2000). Weather index insurance is a financial risk transfer product that operates on similar principles. Insurance policies against infrastructure damage or business interruption from wind, floods or other extreme events, pay out only in the event of an actual economic loss and reimburse only the actual amount of loss via established claim procedures. In contrast, weather derivative contracts and weather index insurance pay a fixed amount based on observed weather conditions regardless of whether actual damages can be demonstrated or the extent of losses experienced. One of the key advantages of weather derivatives and weather index insurance is the scalability of the product can range from individual businesses to national governments (see Table 4), which is particularly suited to SMEs that dominate the tourism sector. The flexibility of designing contracts and insurance based on weather at any climate station is also uniquely suited to the tourism sector, where impacts in revenues can be attributed to weather conditions in source markets that are hundreds or thousands of kilometers from the destination where the impacts occur. Since their inception in the late 1990s, the number of companies that offer weather derivatives and the countries in which they are offered has grown substantially. In 2007-2008, the total market value of weather derivatives was estimated at US$32 billion (Weather Risk Management Association, 2009).

Participation of the tourism sector in the weather derivatives market has remained rather limited. Knowledge of just how dependent different tourism sub-sectors and specific businesses are on the weather is still relatively unexplored and is hampering development within the tourism sector. Nonetheless, as the examples of tourism applications of weather derivatives in Table 4 illustrate, there is tremendous potential to develop innovative partnerships with financial services sector to develop highly customized contract to reduce weather-related revenue loss and create new destination marketing strategies that deliver a competitive advantage regardless of actual weather conditions. For example, the company WeatherBill now provides specialized consultations for ski resorts, sports venues (golf, water and theme parks), events (sports or entertainment), and the travel sector, in order to stabilize income, control costs, improve marketing and public relations and protect special events.

Table 4. Applications of weather derivative contracts in the tourism sector

<table>
<thead>
<tr>
<th>Tourism Operator-Destination</th>
<th>Derivative Contract Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island of Barbados</td>
<td>Weather-related Challenge: low temperatures or heavy rain</td>
</tr>
<tr>
<td>Location/Event</td>
<td>Weather-related Challenge</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>City of Victoria (British Columbia, Canada)</strong></td>
<td>reputation for seasonal rainy conditions</td>
</tr>
<tr>
<td><strong>Bombardier Motor Corp (Montreal, Canada)</strong></td>
<td>limited snowfall</td>
</tr>
<tr>
<td><strong>Corney &amp; Barrow (Wine Bar Chain, London, UK)</strong></td>
<td>low temperatures</td>
</tr>
<tr>
<td><strong>Flagstaff Nordic Center Guaranteed Season Passes (Arizona, USA)</strong></td>
<td>lack of snow or cold temperatures required for snowmaking</td>
</tr>
<tr>
<td><strong>PGA Championship: Greater Hickory Classic at Rock Barn, North Carolina, USA</strong></td>
<td>rain interruption of special event</td>
</tr>
<tr>
<td><strong>Taste of Antwerp (Belgium)</strong></td>
<td>rain interruption of festival with no advance booking of tickets available</td>
</tr>
<tr>
<td><strong>Priceline.com &quot;Sunshine Guaranteed&quot; Vacation</strong></td>
<td>rain during holiday tour</td>
</tr>
<tr>
<td><strong>itravel2000.com “Let it Snow!” Weather Promotion</strong></td>
<td>snow related travel delay</td>
</tr>
</tbody>
</table>
Climate information, particularly real-time observations and short-term forecasts, are used extensively by tourism operators. Recent weather observations are important inputs into a range of decision-support tools, including: automated turf management systems used by golf courses and other sports facilities, snow production systems used by ski areas, cruise ship and aviation routing, fire and avalanche rating and warning systems, and energy management [heating-cooling] systems used by accommodations providers. A study examining the enhancement of swimming pool management decisions with forecast information, found the potential for large annual savings related to staffing. The study also recommended that the pool management company consider using ‘value added’ short-term weather forecasts, produced by private sector meteorologists, in their decisions (Chagnon et al., 2002). However, as Altalo and Hale (2002) point out, despite the acceptance of seasonal and weather influences on tourist flows by the accommodation and hospitality sub-sectors, there are no widely applied business forecast or revenue models allowing for climate or weather data input.

Real-time observations and near-term forecasts are also used by tourism operators for marketing purposes. Tourism operators provide current observations (including web cams) and short-term forecasts to promote their location or event to tourists. Other innovative marketing strategies that utilize forecast information to tailor marketing messages or target certain markets have emerged recently. For example, a major golf course operator in South Carolina monitor forecasts in nearby regional markets and when poor conditions are forecast, target market those locations via pre-arranged internet marketing arrangements with two-day specials for weekend golf and pleasant weather (B. Farren, pers comm., 2008).

The extent to which climate information is used by tourism operators for strategic, operational or marketing purposes has not been evaluated sufficiently to determine its economic value or the degree to which user needs are being met. One exception was a study of the use and need for coastal climatology information in North Carolina (Gamble and Leonard, 2005), which revealed that almost all the interviewees responded that marine and weather information are important in their decision-making processes, but that few managers used climatological information for longer time scales (i.e., month or longer) and that tailored products would serve as an important education resource for teaching coastal managers the utility of the long-term perspective in climatology.

**Government Agencies**

While primarily climate information suppliers, government agencies are also tourism end-users of climate information. Government agencies are often directly responsible for marketing their nation and specific destinations or do so in partnership with the tourism industry. Governments are also operators of tourist attractions (national parks, for example) and other key tourism infrastructure (airports and marinas, for examples). Some governments are also assisting their tourism sectors to assess the risk posed by the impacts of global climate change (Australia’s Tourism Action Plan on Climate Change, for example – see Government of Australia, 2008). In these capacities, governments utilize climate information in the same ways that were previously outlined for private sector operators and destinations.

The regulatory function of government and its central role in emergency preparedness and disaster planning also have important requirements for climate information. A number of regulatory frameworks that are relevant to tourism utilized historic climate information as well as near-term and occasionally seasonal forecasts: coastal management plans and set back requirements, building design standards (for heating and cooling or hurricane force winds, for examples),
emergency management (tourist warning systems, evacuation plans, for examples), environmental impact assessments (influencing property developments as well as operations like snowmaking and desalination plants, for examples), wildlife management (fish and game quotes, for example), water quality standards (swimming bans, for example), and wildfire management (set open fire bans in parks and campgrounds, for example).

4.3 KNOWLEDGE GAPS AND NEEDS ASSESSMENT

Although climate information is increasingly available to tourism users in most countries in a number of forms, there has been little systematic assessment of the extent to which climate information is used within the tourism sector at regional, national or global scale or with any specific tourism sub-sector or tourist market segment. Although decision-makers in the tourism sector are increasingly aware of climate risks, no doubt in large measure due to increased concerns over global climate change, tourism operators and authorities appear generally ill-equipped to make effective use of available climate information. This review has identified major knowledge gaps with respect to: the level of end-user awareness of different types of climate information and services, exactly what climate information (basic or specialized) is being utilized by tourism end-users, how this information is being integrated into the specific decision-making processes of tourists or the tourism industry, and whether there are climate information needs for end-user decision making that are not being met with existing climate information. There also exists a tremendous need to evaluate the value of climate information for decision-making in the tourism sector, both for tourists and business-destination planning, marketing and operations. This review found the following limitations in the provision of weather and climate related services to hinder the effective use of climate information in the tourism sector.

4.4 CLIMATE INFORMATION AVAILABILITY AND RESOLUTION

Effective decision-making requires the right climate information not only in terms of the quality of the data, but in terms of its applicability to tourism operators and specific activities pursued while travelling. As discussed in section 4.1, historical climate information has often been unavailable for tourism planning because meteorological networks are not present (or have lacked electronic archiving) or do not adequately represent the climatic conditions in specific tourism destinations. Climate information in regions with spatially coarse meteorological networks can have reduced applicability to decision making in the tourism sector, because activity patterns and tourism operations are highly localized, often in microclimate conditions (e.g., mountain valleys, high elevations, coasts, or small islands). In this review of the types of climate information provided by destinations or tourism operators, it was observed in a number of cases that the climate station operators or destination promoters used was more than 100 km away from the destination. Weather information being communicated to potential users may therefore differ substantially from the prevailing local conditions.

Altalo and Hale (2002) and Gamble and Leonard (2005) are the only known studies that have explored the climate information needs of specific tourism users and provide the basis for further work in the sector.
Recommendation: Investment is required to strengthen climate monitoring networks in areas where the tourism sector is vital to local economies, specifically rural areas and many developing countries (particularly SIDS), in order to improve climate risk management and climate change adaptation in the tourism sector.

Recommendation: With the risk of permanent loss of historical climate data in developing countries, which has potentially high value for managing climate risk and informing climate change adaptation, action is urgently needed to establish a coordinated international data rescue initiative.

Issues of availability and representativeness of climate data for tourism destinations are likely to encumber climate change adaptation and the further development of weather-linked securities within the tourism sector. It is almost impossible to develop an effective climate change adaptation strategy without knowledge of past climate and how this baseline is projected to change in the future. The pricing of weather derivative contracts and right of a customer to receive payment are based on weather statistics and observations at individual weather stations with a high quality historical record, and are not contingent upon conditions at a specific business location (e.g., ski area, golf course) or event (e.g., music concert). The more coarse the meteorological network, the less representative the conditions at the nearest weather station may be, depending on distance and local geography. The lack of sufficient weather stations and availability of adequate data reduces the potential application for weather-risk reduction through weather derivatives and weather index insurance. These issues are particularly acute in rural areas and some developing nations where tourism is a major part of the economy and that could benefit significantly from weather risk management products.

In situations where multiple sources of climate information were available for a destination (NMSs, private meteorological company, tourism operators), inconsistent information was sometime being provided to tourists. Current conditions more than 10-15°C apart were occasionally reported, as were very different forecasts for temperature, rain and winds. Such varied reporting of climate conditions and forecasts is likely to raise questions about the validity of the source among tourists and will impact tourist decision making for short term visits (day trips and weekend travel especially) and highlights the importance of forecast accuracy for some segments of the tourism sector.

Recommendation: Strengthening of climate monitoring networks is required to support the development and access to innovative financial products (weather derivatives and index insurance) to manage climate risk in the tourism sector.

As indicated in section 3.1, climate information represents a double-edged sword for the tourism sector. While accurate climate information can be invaluable to the tourism industry, inaccurate climate information that deters visitation is a lament heard often by all of the experts consulted in this review and has been the subject of several workshop discussions and media stories. For example, at the Climate, Weather, and Tourism Workshop in North Carolina (Curtis et al., 2009), multiple tourism stakeholders voiced frustration with media reporting of weather and how it unnecessarily affected tourism. Wineries in the region saw visitation decline for an entire season after inaccurate reports that spring frost had ‘wiped out’ that year’s crop (P. McRitchie, pers. Comm., 2008). Similar concerns about forecast skill and media coverage of weather forecasts were expressed by other tourism operators and tourism authorities in the region, especially the typical margin of error in early hurricane track forecasts (7-10 forecasts) that have been observed to be very damaging to the tourism economies of regions at the low probability edges of the forecast track (C. McCormick pers. comm., 2008). The accuracy of early forecasts of extreme events was also
an important topic of discussion at the Secure and Sustainable Living – Social and Economic Benefits of Weather, Climate and Water Services Conference in 2007 (see statement below). Seasonal forecasts have also recently been shown to have adversely affect travel decisions in the UK. In 2009, travel agents and tour operators observed that following the NMS’s long-range forecast summer forecast of ‘unusually warm, dry weather with heat waves up to 30 °C’, demand for foreign holidays declined substantially (Hill 2009). After a very rainy month of July and a revised forecast for ‘wet weather until September’, the Association of British Travel Agents reported an increase in travel bookings of up to 40% and a diminished supply of package holidays to sunshine destinations (Hill 2009).

"...the very early warning of extreme weather events, such as tropical cyclones, can unwittingly put off tourists from destinations unlikely to be affected by the event or if impacted, well outside the time that the tourist would be in the destination. Thus there is a need for the industry and forecasters to work closely together to resolve the issues that arise from lack of specificity in forecasts, while ensuring public safety."

Final Communiqué
Secure and Sustainable Living –
Social and Economic Benefits of Weather, Climate and Water Services

The article ‘Gold Coast Businesses Unhappy with Weather Forecasting’ (Nolan, 2001) describes the concerns of several tourism operators in Queensland, Australia about the accuracy rate of the local forecasts and the financial impact on their businesses. Some tourism operators have indicated that one of the reasons they included additional sources of localized climate information and live webcams on their website, was to overcome perceived limitations in forecasts and bias reporting by mass media, who, in their words, were often 'looking for a story' about a storm or poor travel conditions. As the statement below indicates clearly, tourism businesses affected by weather and forecasts have an economic stake in the quality of the climate information.

"It's a fair assumption to suggest that the weather and the weather forecast – however derived – is a very important part of the (tourist) decision making process. ... I think we both (NMS and tourism industry) want accuracy, but also at the same time, we want it balanced, with a situation where the travelers are not deterred because the off chance of a shower is portrayed as if it was a certainty."

Daniel G-Schwind
Chief Executive, Queensland Tourism Industry Corporation
(in Nolan, 2001)

Unsubstantiated speculation about the impacts of climate change on tourism destinations is likewise problematic and may adversely affect investment and eventually visitation needlessly. A number of media stories have foretold the major threat that increased future summer temperatures poses for tourism in the Mediterranean. Indeed some have gone so far as to state that “The likelihood [is] that Mediterranean summers may be too hot for tourists after 2020” (Guardian, 2006 - based on Amelung and Viner, 2006) and that “by 2030, the traditional British package holiday to a Mediterranean beach resort may be consigned to the ‘scrapheap of history’” (Halifax Travel Insurance, 2006). Such pronouncements have been shown to be unfounded scientifically (see Scott
et al., 2008 and Rutty and Scott, 2009). Similar speculation about the demise of winter sports tourism in the European Alps, North America, and other ski regions is also widespread, with some stories going as far as identifying specific ski areas expected to be lost and ‘where not to buy ski properties’ (real estate investment). Unfortunately, such misinformation continues to be perpetuated by other travel writers even years after the initial stories have been published (see Osborne, 2007; Munns, 2008; The Independent, 2008; Couttswoman 2008; Newsom, 2007) and will continue to negatively impact the reputation of certain destinations. This type of speculation diminishes the credibility of all other climate change assessments designed to help the tourism sector and destination communities adapt to future climate change. In the same way accurate forecasts are in the best interest of the tourism sector, so too are accurate representations of the risks posed by climate change. The tourism sector, particularly destinations, needs to work closely with informed scientist to accurately understand the risks and opportunities posed by climate change and ensure that the misrepresentations of climate change vulnerability in the media does not go unanswered.

**Recommendation:** The development of regionally and locally specific climate change scenarios is required to facilitate effective climate change adaptation by the tourism industry and tourism dependent communities. The refinement of near term climate change predictions (covering the next 25-30 years), that are most relevant to business investment and government policy timeframes are particularly encouraged.

### 4.5 INFLUENCE OF CLIMATE INFORMATION ON DECISION-MAKING

Knowledge about the process of how tourism end-users integrate weather and climate information into specific decisions remains very limited. Key knowledge gaps remain regarding the decisiveness of weather and climate as a factor in decision-making and when end-users require climate information in different decision-making processes. The proportion of tourists travelling primarily for climate-related motivations or to engage in climate-sensitive activities remains unknown and central to understanding the relative climate sensitivity of destinations. Describing the decision-making process requires, at a minimum, describing the key decision-makers, their goals and the context in which they operate (i.e., the decision making environment), the information they use to make decisions, the alternative actions available to them, and the important decision points (Stewart et al., 2004; Keltie 2007). Climate information is typically embedded a ‘matrix’ with other relevant information (Adams, 1973; de Freitas, 2003; Stewart et al., 2004; Scott, 2006) and disentangling the role of climate and its relationship to other situational factors in major decision-making processes in tourism remains an important objective for future research.

Tourists experience and respond to the integrated effects of the weather elements (thermal, physical, aesthetic – de Freitas, 2003) that comprise climate (Mieczkowski, 1985; de Freitas, 2003; de Freitas et al., 2008; Scott et al., 2008), however, there remains very incomplete understanding of the relative importance of different climate parameters to tourists, the range of climate preferences among tourists in terms of the optimal conditions and thresholds of unacceptability for certain variables, how preferences differ for specific tourism environments or destinations, and whether significant cultural, regional or market segment differences exist in climate preferences (Scott et al., 2008, Gómez Martín, 2006, Moreno et al 2009). The complexities of tourist climate preferences are only beginning to be examined. For example, recent survey research in temperate regions of North America, Europe and New Zealand (Lohmann and Kaim, 1999;Scott et al., 2008; Moreno, 2009; Rutty and Scott, 2009) has found that the importance of key climate variables as well as perceptions
of optimal conditions and thresholds for unacceptable conditions differed substantially among tourists and in specific tourism environments (Table 5 and Figures 22 and 23). More research is required to understand whether similar climate preferences exist among tourists from other climatic regions of the world as well as to understand the specific climate sensitivity of specific tourism activities.

Table 5. Importance of weather variables in different tourism environments
(Source: Scott et al., 2008)

<table>
<thead>
<tr>
<th>Importance Rank</th>
<th>Beach</th>
<th>Mean (1-7)</th>
<th>Urban</th>
<th>Mean (1-7)</th>
<th>Mountain</th>
<th>Mean (1-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sun</td>
<td>6.14</td>
<td>Temp</td>
<td>5.98</td>
<td>Rain</td>
<td>6.04</td>
</tr>
<tr>
<td>2</td>
<td>Temp</td>
<td>6.11</td>
<td>Rain</td>
<td>5.77</td>
<td>Temp</td>
<td>5.84</td>
</tr>
<tr>
<td>3</td>
<td>Rain</td>
<td>5.87</td>
<td>Sun</td>
<td>5.14</td>
<td>Sun</td>
<td>5.55</td>
</tr>
<tr>
<td>4</td>
<td>Wind</td>
<td>5.13</td>
<td>Wind</td>
<td>4.75</td>
<td>Wind</td>
<td>5.41</td>
</tr>
</tbody>
</table>

Temp = ‘comfortable temperature’
Rain = ‘absence of rain’
Wind = ‘absence of strong wind’
Sunshine = ‘presence of sunshine’

Figure 22. Tourist rating of temperatures for beach holidays
(Source: Rutty and Scott, 2009)
Recommendation: Support is required for the fundamental multi-disciplinary research needed to understand the salience of climate (both in source markets [push factor] and destinations [pull factor]) in different travel decision-making contexts, cross-cultural climate preferences for major destination types, the affect of weather on holiday satisfaction and future travel choices, and the climate sensitivity of major tourism activities.

Fundamental knowledge of climate conditions that strongly influence destination choice and activity satisfaction is a prerequisite to the development of specialized climate products for the tourism sector. Without it, the validity of existing indices, such as those illustrated in section 3.1 and those utilized in the research literature (the 'Tourism Climate Index' – by Mieczkowski, 1985, for example) remain uncertain. Unfortunately, most of the newly developed specialized products from private meteorological companies lack transparency in the methods and data sources to properly evaluate their application to either domestic or international travellers. Many specialized products will serve to inform destination and activity choices, and their design must be transparent to the consumer to allow objective destination comparisons and marketing claims in a global tourism marketplace. The ‘Heat Wave Vacation’ story in the Wall Street Journal (Barnes, 2002) illustrates how some travellers feel misled by travel operators and destination marketers about the climate of destinations and would benefit from a tool to compare climatic conditions of destinations they are considering. Some specialized products will also affect decisions that have implications for the personal safety of travellers and therefore the design and data inputs should be transparent to tourism professionals that might use them as well as the travellers themselves.
**Recommendation:** Developers of specialized climate products for the tourism sector, whether the private sector, universities or governments, are encouraged to disclose the scientific methodology or market testing results to demonstrate validation in the tourism marketplace.

**Recommendation:** The tourism sector, in collaboration with NMS, private meteorological companies, and university researchers, are encouraged to develop accepted standards for specialized climate products, to ensure consistent and accurate communication of climate information to international travellers and to facilitate objective destination comparisons and marketing claims in a global tourism marketplace.

The availability of climate information has not been the sole barrier to understanding the interface of climate and tourism sufficiently to develop specialized climate services, facilitate greater involvement in the emerging weather derivatives and index insurance market, or determine the weather and climate information for tourism decision making. Access to tourism data has been a frequently noted impediment to research and the development of specialized climate services and climate change assessments (Smith, 1990; Scott et al., 2003, 2004, 2006; Gössling and Hall, 2005; Lise and Tol 2002, Hamilton et al., 2005; Gamble and Leonard, 2005; Shih et al., 2008) and a common frustration of many of the experts consulted for this review. For this partnership to move forward and succeed, the tourism community must be an active contributor. Furthermore, the importance of collecting accurate and consistent domestic and international tourism data to advance scientific understanding of the climate-tourism interface and implication of climate change cannot be over-emphasized. Past recommendations of the UNWTO (1994 and 2008) and the broader tourism research community (Lennon, 2001) for continued efforts to maintain and enhance monitoring of tourism performance indicators are echoed here.

**Recommendation:** Collaboration between governments, universities, communities, and the private sector (tourism businesses, meteorological service companies, financial services), must be strengthened to drive innovation that connects climate information to the needs of the tourism sector and tourism dependent communities.

**Recommendation:** The active collaboration of the tourism industry is required to support the development of climate services to improve outcomes for the sector, and they are strongly encouraged to provide increased access to sectoral data, consult on specific climate information needs and constraints to its use, provide expert review of specialized products and create effective strategies to communicate weather and climate information to tourists.

### 4.6 SOCIO-ECONOMIC BENEFITS OF WEATHER AND CLIMATE INFORMATION FOR TOURISM

Effective use of climate information has the potential for avoiding injury and death, averting property and environmental damage, and a wide range of other societal benefits (Stewart et al., 2004). There is a growing literature on the economic value of climate information and forecasts (Katz and Murphy, 1997) as well as techniques to valuate non-market benefits. The tourism sector is virtually absent from this literature, although Altalo and Hale (2002) contend that the financial benefits of weather and climate information for the sector are likely to be very substantial. One of the few attempts to evaluate the specific financial benefits of improved weather and climate information for the tourism sector was a NOAA study of the multi-sector benefits of new observational equipment (NOAA, 2002 and 2004). Specific to the tourism sector, the study found
that weather information and hurricane forecasts from the new satellite imager and sounder would create US$196 million/year in socio-economic benefits, through improved golf safety, irrigation efficiency, grounds maintenance, tournament and personal golf planning (NOAA, 2004) as well as US$31 million/year in economic benefits, from damage avoidance in recreational boating, amusement, and recreation services (NOAA, 2002; Centrec, 2007). Moreover, no studies of the financial or non-market benefits of specialized products for tourism or the ‘willingness to pay’ for climate information amongst tourists and tourism operators. Consequently, the value of climate information to tourists and the tourism industry remains unknown. Hypothetically, if tourists were willing to pay 1 Euro for weather and climate information needed for trip planning for each of the estimated 900 million international and 8 billion domestic trips, then the global value of climate services would be very significant even without consideration of its value for supply-side operations and marketing. Based on the success of studies that have applied techniques for economic and social valuation of climate services (market prices, normative market models, descriptive behavioural response studies, and contingent valuation studies, for examples) in other economic sectors, it is clear that uncovering the potential value for the tourism sector, and how to fully realize that potential, remains a critical area for future inquiry.

**Recommendation:** An interdisciplinary initiative be established to evaluate the economic and non-market societal value of climate information for decision-making by tourists and tourism operators.

### 4.7 COMMUNICATING WEATHER AND CLIMATE INFORMATION TO THE TOURISM SECTOR

The production of climate information alone is not sufficient for travel or business planning and decision-making. Information must be delivered to end-users in a form that is relevant to them and that they have the capability to interpret. As identified in Section 4.1, there are a range of communication channels for the delivery of climate information to tourists and the tourism sector. How climate information is communicated to tourists and tourism sub-sectors is largely unexplored and communication channels, especially related to warnings of abrupt and dangerous weather events, are not widely documented within the tourism sector. There has been almost no evaluation of what sources of climate information tourist or tourism operators utilize, nor the effectiveness of different communication pathways and formats.

Gamble and Leonard’s (2005) study is the only known attempt to identify web-based tourist preferences for climate information. Examining the communication of coastal climatology information, the authors found that ‘simple sites’ were perceived by tourists to be most effective and included: 1) a limited amount of information presented on the website; 2) efficient and clear web navigation features; 3) limited use of scientific jargon and graphics; and, 4) limited use of colours and ‘flashy’ graphics. Also of note was the identified need for more local data and the annoyance with the need to purchase or download software to further assess climate data. Overall, the authors found that a more organic, bottom-up website design that reflects the needs of users and locals was beneficial. There is a clear need to test these findings for universal applicability across the breadth of tourism-related climate information products available to end-users.

Most weather forecasts today still contain little uncertainty information. Without this information, forecasts can easily be misinterpreted and potentially misused in decision-making. This can have potentially negative social and economic consequences (especially with respect to hazardous
weather events, for example). Although this challenge is recognized by many NMS and private meteorological companies, overall, the meteorological community has limited understanding of how to communicate weather forecast uncertainty effectively to users with diverse technical and intellectual capabilities (National Research Council, 2006). Interdisciplinary research on tourist and tourism sector perceptions of uncertainty within forecasts, preferences for uncertainty communication formats, and a better understanding of the ‘decision stakes’ related to uncertainty across a wide set of weather and climate information end-users is needed.

**Recommendation:** Greater effort needs to be made to consult with major tourism end-users about their needs for climate information. This consultation must be done regionally in order to adequately represent specific information needs and the capabilities of regional providers.

The responsibility for ensuring that the natural hazard information is communicated to the public rests squarely with government agencies. Ensuring adequate community response requires a close partnership and well-established and regularly tested working arrangements and channels of communication. However, understanding how weather forecasters and emergency managers use climate information and how this information is communicated to the tourism sector is currently limited.

Social science research conducted during the last decade has highlighted the difficulty in preparing visitors to effectively respond to warning messages (Drabek, 1994, 1996, 2000; Sorensen, 2000). Tourists can be particularly vulnerable to natural hazards because they often visit highly dynamic environments, can have limited familiarity with the places they are visiting and common meteorological hazards, and remote locations can lack communication channels for public warnings of impending hazards. The tornado that struck the Pine Lake, Alberta (Canada) campground in July 1999, killing nine and injuring over 100, is one such example. Although the Meteorological Service of Canada had issued a tornado warning well in advance of the event, there was a communication breakdown, and virtually all of the tourists at the campground were unaware of the warning of imminent severe weather and there was no on-site emergency warning system available (a siren system used in urban areas, for example). Furthermore, because tourists can be unfamiliar with the local language and are less likely to utilize local media information sources (either purposively or unintentionally), tourists are less apt to receive hazard warnings when they are issued and prompt communication with them of imminent climatic hazards poses a particular challenge (UNWTO, 1998).

**Recommendation:** An evaluation of best practices for communication of climate information, particularly specialized products and forecast uncertainty, to tourism industry and tourist end-users is encouraged.

## 5 CONCLUSION

The past decades has seen tremendous advances in climate science and knowledge of how the global climate is likely to change over the 21st century as a result of anthropogenic greenhouse gas emissions and feedbacks in the global climate system. The revolution in communication technology, particularly the internet and more recently mobile personal data devices (smartphones, for example) has also revolutionized the climate information available to tourists and the tourism industry. Although interest in the climate-tourism interface has also increased markedly during the past decade, as evidenced by a doubling in the number of scientific publications on tourism and
climate between 1996-2000 and 2001-2005 (Scott et al., 2005), the research community has yet to
evaluate how the revolution in climate information and information communication technologies
has translated into improved decision-making in the tourism sector.

This review has documented the many sources of climate information now available to the tourism
sector and the continuing development of specialized climate products for tourists and tourism
operators. It also revealed that there has been no systematic evaluation of the extent and nature of
climate information use in any tourism sub-sector or specific destination region. There is very little
insight into the role of climate information in specific decision-process within the tourism sector
(either demand or supply-side), the economic and non-market value of climate information and
related service to end-users and society, or the most effective ways to communicate climate
information to diverse tourism end-users. Addressing these key knowledge gaps and others
identified throughout this review would provide significant opportunities to enhance decision-
making and reduce climate risk in the sector.

Critically, accumulating evidence indicates that climate change, particularly high emission
scenarios, will be a pivotal issue affecting the medium and long-term future of tourism development
and management (Gössling and Hall, 2006; Scott, 2006; Becken and Hay, 2007; UNWTO-UNEP-
WMO, 2008). Consequently, it is recognized that the need for climate services will increase
throughout the 21st century as the magnitude of climate change increases and ability to rely on
previous experience diminishes. As the statements from the Secretary-Generals of the WMO and
UNWTO indicate, both organizations recognize that improving the use of climate information is an
important strategy to facilitate sustainable development of tourism that contributes to the United
Nations Millennium Development Goals.

“Given that climate change is expected to pose an increasing threat to tourism operations in
many destinations [...] WMO urges governments and the private sector to increasingly use
climate information [...] and to take additional steps towards incorporating climate
considerations in tourism policies, development and management plans.”

WMO Secretary-General M. Michel Jarraud (2007)

“Climate change will constitute an increasing risk for tourism operators in many destinations.
With many tourism activities heavily dependent on the climate and insurance policies
increasingly affected by natural hazards, accurate weather information and forecasting of
extreme climatic events are becoming ever more important for tourism businesses.”

UNWTO Secretary-General Francesco Frangialli (2005)

Improving the use of climate information in the tourism sector is a challenge that will require closer
collaboration between the climate and tourism research communities (both physical and social
scientists), NMSs, government tourism authorities and the tourism industry. Over a decade ago
Smith (1993: 389) argued that the limited research on the complex interactions of climate and
tourism was in large measure because, “... meteorologists and leisure specialists rarely
communicate with each other.” With substantial opportunities to more effectively deliver climate services that are of immediate and recognizable value to tourists and the tourism industry and the imperative of adapting to climate change in the decades ahead, the time has come for the conversation between climate service providers and tourism end-users to begin in earnest. Positively, a number of key new partnerships have emerged in recent years that provide a solid foundation for necessary future collaboration. The collaboration between the WMO and UNWTO to establish an Expert Team on Climate and Tourism in 2005 is a critical initiative at an international level. New partnerships have also developed between meteorological institutions and tourism stakeholders (WMO, 2005b). This cooperation has taken multiple forms, from new forecasts for tourism destinations, improved media training and cooperation to deliver forecasts related to tourism, to specific contracts between meteorological services and destinations, tour-operators and other stakeholders.

What is now most needed is a strategic initiative that will encourage direct interaction and catalyze regional and local partnerships among climate service providers, governments, universities and the diverse user groups within the tourism sector. It is recommended that a series of multi-objective, capacity-building workshops be undertaken over the next five years in major tourism regions with diverse climate sensitivities. The regional workshops would build capacity in both climate services and tourism sectors. The workshops would stimulate interest in the impacts of climate variability and change, increase awareness of existing basic and specialized climate services among tourism professionals, determine specific needs for climate forecasts and information by tourism sub-sectors, and provide educational sessions the use of probability-based products, decision support tools, and weather risk markets and weather derivative/index insurance products. Despite visibly increased attention to the challenge of climate change by the UNWTO over the last five years, a number of studies a review of climate change awareness and adaptation practice for the UNWTO, UNEP and WMO (Scott et al., 2008) and a recent multi-sectoral comparison by KPMG (2008) consistently found low awareness of climate change risk and little evidence of strategic planning within the tourism industry. Developing awareness of the regional, tourism specific implications of climate change, with the aim of improving adaptation, would therefore be a second major objective of the capacity-building workshops. Climate services professionals would be provided with feedback on the diverse information needs of specific tourism stakeholders in their region, the potential development of specialized products, and how to improve communications to enhance the utility of climate information. The lessons learned from Regional Climate Outlook Forum workshops undertaken by the WMO, the APELL (Awareness and Preparedness for Emergencies at the Local Level) workshops for tourism destinations coordinated by UNEP, and other recent climate and tourism specific workshops (Caribsave in the Bahamas and Jamaica, GEF and UNWTO in Fiji, NOAA and East Carolina University in the USA), would inform the themes and structure of the workshops. In addition to establishing key regional partnerships, these workshops would build a pool of professionals qualified to transfer advances in climate science and climate prediction to climate-related decision frameworks and develop decision support tools for the tourism sector. By adopting a regional approach, the capacity-building workshops would also overcome some of the major regional knowledge gaps on the sensitivity of tourism to climate variability and change in developing nations, notably Africa, Southeast Asia, Latin America (Scott et al. 2008; Hall, 2008).

**Recommendation:** A series of multi-objective, capacity-building workshops be initiated in major tourism regions around the world, in order to foster the direct interactions and partnerships between climate service providers and tourism user groups needed to make significant progress in the application of climate information in the tourism sector.
Recommendation: Training the next generation of tourism professionals to utilize climate information to reduce climate risks and adapt to climatic change in the decades ahead is a priority and it is urged that a ‘Climate Risk Management’ training module be created for use by tourism and hospitality schools around the world.

As an important contributor to national and local economies around the world, tourism is also highly inter-linked with other major sectors for which White Papers are being produced, such as health (tropical disease outbreaks and dispersion by traveler, for example), urban (heat warnings, for example), and biodiversity (involvement in coral reef monitoring programs, for example). Consequently, common interests and recommendations are probable, providing a basis for multi-sectoral collaboration on the improvement of global climate services that foster sustainable development.
6 LIST OF EXPERTS CONSULTED AND EXPERT REVIEWERS

Dr. Bruno Abegg, University of Zurich, Switzerland
Dr. Susanne Becken, Lincoln University, New Zealand
Luigi Cabrini, United Nations World Tourism Organization
Dr. Jean Paul Ceron, Université de Limoges, France
Dr. Christopher de Frietas, University of Auckland, New Zealand
Dr. Stefan Gössling, Lund University, Sweden; Western Norway Research Institute, Norway
Dr. Michael Hall, University of Canterbury, New Zealand
Dr. Brenda Jones, Parks Canada
Jacqueline Kuehnel, JK Consulting and Enterprises
Dr. Patrick Long, East Carolina University, USA
Leslie Malone, World Meteorological Organization
Dr. Geoff McBoyle, University of Waterloo, Canada
Alvaro Moreno, Maastricht University, Netherlands
Dr. Neville Trotz, Caribbean Climate Change Centre
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51


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