PREFACE

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According to the National Research Council, "an essential component of any research program is the periodic synthesis of cumulative knowledge and the evaluation of the implications of that knowledge for scientific research and policy formulation." The U.S. Climate Change Science Program (CCSP) is helping to meet that fundamental need through a series of 21 "synthesis and assessment products" (SAPs). A key component of the *CCSP Strategic Plan* (released July 2003), the S&A products integrate research results focused on important science issues and questions frequently raised by decision makers.

The SAPs support informed discussion and decisions by policymakers, resource managers stakeholders, the media, and the general public. They are also used to help define and set the future direction and priorities of the program. The products help meet the

requirements of the Global Change Research Act of 1990. The law directs agencies to "produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change" and to undertake periodic scientific assessments. This SAP (3.3) provides an in-depth assessment of the state of our knowledge about changes in weather and climate extremes in North America (and U.S. territories), where we live, work, and grow much of our food.

The impact of weather and climate extremes can be severe and wide-ranging although, in some cases, they can also be beneficial. They affect all sectors of the economy and the environment, including human health and well-being. During the period 1980-2006, the U.S. experienced 70 weather-related disasters in which overall damages exceeded $1 billion at the time of the event. Clearly, the direct impact of extreme weather and climate events on the U.S. economy is substantial.

There is scientific evidence that a warming world will be accompanied by changes in the intensity, duration, frequency, and spatial extent of weather and climate extremes. The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report has evaluated extreme weather and climate events on a global basis in the context of observed and projected changes in climate. However, prior to SAP 3.3 there has not been a specific assessment of observed and projected changes in weather and climate extremes across North America (including the U.S. territories in the Caribbean Sea and the Pacific Ocean), where observing systems are among the best in the world and the extremes of weather and climate are some of the most notable occurring across the globe.

Weather extremes as used in SAP 3.3 signify individual weather events that are unusual in their occurrence or have destructive potential, such as torrential rainfall, hurricanes, severe winter

storms, heat waves, and similar kinds of events. The term climate extremes is used to represent the same type of events, but viewed over seasons (e.g., droughts), or longer time periods. In this assessment we are particularly interested in whether or not climate extremes are changing in terms of a variety of characteristics including intensity, duration, frequency, or spatial extent, and how they are likely to evolve in the future. Weather extremes in this assessment are quantified and classified in terms of these characteristics. It is is often very difficult to attribute a specific cause to a particular climate or weather extreme e.g., a single drought episode or a single severe hurricane. It is more feasible to attribute the changing risk of extreme events to specific causes. For this reason, this assessment focuses on the possible changes of past and future statistics of weather and climate extremes.

In doing any assessment, it is helpful to precisely convey the degree of certainty of various findings and projections. For this reason, a lexicon expressing the likelihood of each key finding is

presented below and used throughout this report. There are numerous choices for categories of likelihood and appropriate wording to define these categories. CCSP SAP 5.2, currently under review, but scheduled for public release before SAP 3.3 is finalized, provides useful guidance. Additionally the community of scientists and policy-makers familiar with the IPCC assessments provide yet another consistent way to express likelihood statements. The US National Assessment published in 2000 provides a similar approach to likelihood statements. Figure 1 provides the common terms used in this report to express likelihood of occurrence based on experience with previous likelihood statements. Because of the nature of the topic being consider our likelihood statements do not have discrete boundaries, unlike in IPCC, but characterize likelihood in more general terms (Fig. 1). Statements without such likelihood qualifiers are implied to be certain.

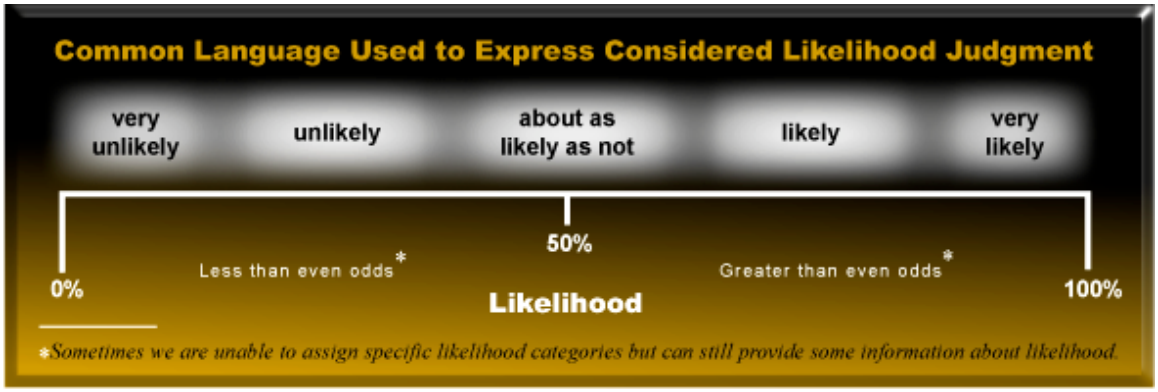

Figure 1 Language in this Synthesis and Assessment Product used to express the team's expert judgment of likelihood.

The material that this SAP considered included peer-reviewed articles that were submitted for review by August 15 2007 and accepted for publication by December 1st 2007. Observations and model output used in SAP 3.3 are all openly available from various federal agencies.

Dedication

This Climate Change and Synthesis Product is dedicated to the memory of our colleague, friend and co-author Dr. Miguel Cortez whose untimely passing during the writing of the report was a loss to us all.