Confronting Climate Change in the Great Lakes Region

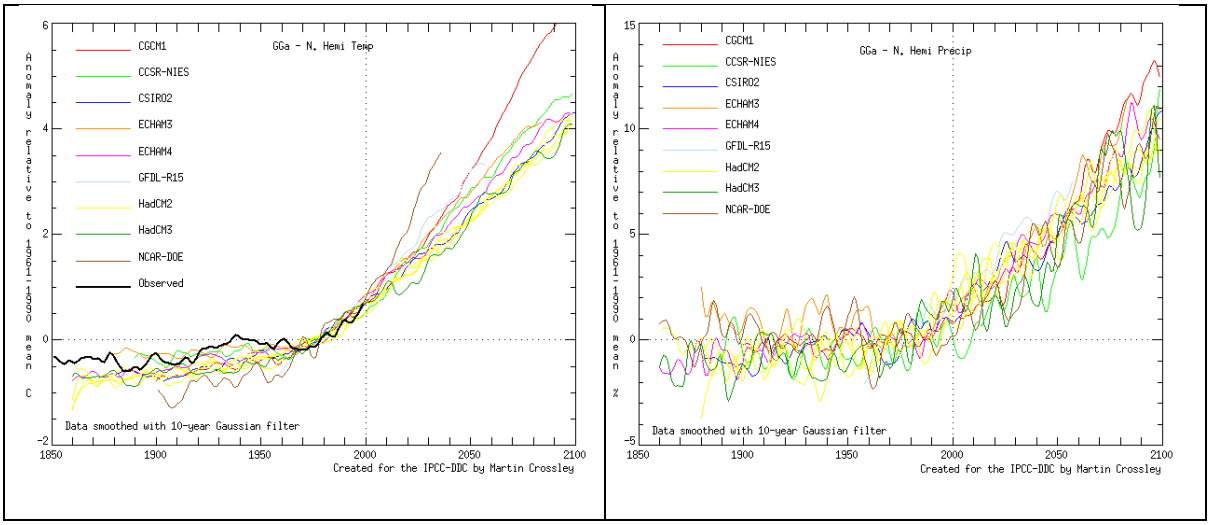
Technical Appendix
Climate Change Projections

CLIMATE MODEL UNCERTAINTIES AND THE RISK OF ABRUPT CHANGE

Detailed projections of changes in regional climate are essential to understanding the potential impacts of climate change, as global patterns can be modified significantly by regional factors. To develop effective climate change policy for adaptation or mitigation, it is necessary to understand regional characteristics and how those may be impacted by climate change.

While regional analyses based on global models are the best tool available at this time, regional interpolations of global data face a number of difficulties. Like the actual climate system, model-simulated climate variability and uncertainty increase as the area under consideration grows smaller. Basically, the finer the model resolution, the larger the number of calculations required to complete a climate projection. For this reason, even the latest models run on the best supercomputers are still limited in their ability to represent the smaller-scale features such as topography and land-water contrasts that drive local climate. The resolution limitations inherent to current models means that greater confidence should be placed in trends of average temperature and precipitation across the Great Lakes region than changes projected to occur for a specific location. Additionally, global model projections of precipitation on a regional level are more uncertain than temperature, with some models showing drying and warming in areas where other models show little or the opposite change. However, model intercomparisons now show an encouraging degree of convergence in terms of temperature and precipitation projections on a global and hemispheric level (Figure 1). In addition, recent model simulations display a few common regional features in which we can place a fair degree of confidence. These include a greater warming over continents than oceans, especially in the Northern Hemisphere high latitudes, and an increase in high-latitude moisture, especially during the winter months.

Figure 1. Intercomparison of model projections for Northern Hemisphere temperature and precipitation. In this comparison, the models were driven by scenarios that only included emissions from the primary greenhouse gases such as carbon dioxide, methane and nitrous oxide (Source: IPCC DDC).



In addition to the gradual long-term trends in climate change that will occur over the next century, we know that very abrupt and strong short-term changes in climate can occur as well, creating by definition an unforeseeable potential for future change. An abrupt change is one that takes place so rapidly and unexpectedly – within decades to years – that human or natural systems have difficulty adapting to it (NRC, 2002). Abrupt changes in past climate are well documented by ice core, sediment and fossil records. Patterns of abrupt change from glacial to interglacial periods are common, with sudden changes in the North Atlantic creating climatic signals that were rapidly transmitted throughout the entire Northern Hemisphere (Alley and Clark, 1999), including the Great Lakes region (Yu, 2000; Yu and Wright, 2001). For example, changes of up to 29°F (16°C) and a factor of 2 in precipitation have occurred in some places in periods as short as decades to years, in response to North Atlantic surface warming following deglaciation (Lang et al., 1999).

In the past, abrupt changes have occurred most often when the climate system was being forced to change most rapidly – as it is now. Humans are currently conducting the largest-scale experiment in the history of mankind by releasing vast amounts of heat-trapping gases into the atmosphere. The rate of temperature change over the next century caused by these emissions will be faster than any since at least the end of the last ice age, ten thousand years ago. A recent report on abrupt climate change (NRC, 2002) concludes that "greenhouse warming and other human alterations of the Earth system may increase the possibility of large, abrupt and unwelcome regional or global climatic events." Abrupt changes in climate could have huge impacts on the Great Lakes

region, with the effects being larger, the faster the climatic changes occur because they leave less time for adaptation or mitigation (USGCRP, 2000).

Many facets of the Great Lakes environment would be affected by an abrupt change in climate. There is a potential for adverse affects on society and the economy, as evidence in geologic records suggests abrupt climate shifts played a role in the disruption or collapse of other civilizations in the past (Weiss et al., 1993; Gill, 2000). While some species in ecosystems may be able to adapt to relatively abrupt changes in climate, long-lived and relatively immobile ecological systems are particularly vulnerable to abrupt climate change. Their vulnerability has only increased by the spread of human activities that alter ecosystems, change land use and block migration. Following the last several glacial-interglacial transitions, pollen and fossil records show dramatic vegetation shifts across eastern North America (Shurman et al., 2002). Transitional vegetation and aquatic plants are particularly responsive to temperature changes in the Great Lakes area (Yu, 2000), with some species migrating over 300 km within 100 years (Shurman et al., 2002). However, longer-lived, non-transitional species may not respond so rapidly; in addition, vegetation patterns following abrupt changes were distinct from those of both earlier and later periods, indicating non-reversing climatic changes changes. Finally, water resources might also be greatly affected by abrupt changes that alter both the available supply and demand for water. Given the importance of water in the Great Lakes region, impacts on this essential resource would significantly affect ecosystems, people, and the regional economy.

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